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PART 7
CONSTRUCTIONAL PRACTICES AND SAFETY

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CONSTRUCTION PRACTICES AND SAFETY
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7.1 CONSTRUCTIONAL PRACTICE

7.1.1 GENERAL

This approved code of practice should be followed unless there is an alternative course of action, which achieves the same or better standard of health and safety in the workplace.

7.1.2 PLANNING, MANAGEMENT AND PRACTICES

7.1.2.1 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, and 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.

7.1.2.1.1 Preconstruction Phase

- a) Besides the design aspects, preconstruction phase should also address all the issues related to the implementation of the design at the site through suitable construction strategy. During the design stage, the site conditions should be fully understood with anticipated difficulties and avoid the risk of subsequent delays and changes after the construction has started.
- b) The selection of construction methods, building systems and materials, components, manpower and 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.
- c) Construction in busy localities of cities needs special considerations and meticulous planning due to restricted space, adjoining structures, underground utilities, traffic restrictions, noise and other environmental pollution and other specific site constraints.
- d) The constructability aspects of the proposed construction methods needs to be carefully evaluated at the planning stage to ensure ease of construction besides optimizing the construction schedule and achieving quality, reliability and maintainability of the constructed facilities.
- e) 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.
- f) Durability of constructions in corrosive atmospheric conditions like coastal regions and aggressive ground situations with high chlorides and sulphates should also be taken care of with appropriate constructional practices.

- g) Constructional practices in disaster prone areas need specific planning. The type of construction, use of materials, construction techniques require special considerations in such areas.
- h) Adverse weather conditions have strong bearing on construction phase. Situations wherein constructions are to be carried out in adverse weather conditions, such as heavy and continuous rain fall, extreme hot or cold weather, dust storms, etc, the practice 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:
 - 1) Site layout which enables accessibility in adverse weather.
 - 2) Adequate protected storage for weather sensitive materials/equipments.
 - 3) Protections to personnel from extreme hot/control conditions.
 - 4) Scheduling to allow maximization of outdoor activities during fair weather conditions.
 - 5) Special design and construction provisions for activities in extreme temperature condition like hot or cold weather concreting, staple of false work in extreme wind conditions (gusts).
 - 6) Adequate lighting for shorter days in winter/night work.
 - 7) Design for early enclosure.

7.1.2.1.2 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 appropriations in the event of favorable deviation. Organizational capability, commitment to the project requirements and other constraints such as time and cost, need to be considered as inputs while planning resources.

Techniques of management and planning, such as, Programme Evaluation and Review Technique (PERT) and Critical Path Method (CPM) (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.

7.1.2.1.3 Construction Phase

7.1.2.1.3.1 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.

7.1.2.1.3.2 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 combustible materials as far as possible including emergency medical aids.
- (h) Roads for vehicular movement with effective drainage plan.
- (i) Construction safety with emergency access and evacuations and security measures.
- (j) Fabrication yards for reinforcement assembly, concrete precasting and shattering materials.
- (k) Fencing, barricades and signage.

7.1.2.1.3.3 Access for Fire fighting equipment vehicles

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

- a) Free access from the street to fire hydrants/static water tanks, where available, shall be provided and maintained at all times.
- b) No materials for construction shall be placed within 3.0 m of hydrants/static water tanks.
- c) During building operations, free access to permanent, temporary or portable first-aid firefighting equipment shall be maintained at all times.

7.1.2.1.3.4 Access to the upper floors during construction

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

7.1.2.1.3.5 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.

7.1.2.1.4 Scope Management

Construction management efforts should ensure that the project features and functions that characterize 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.

7.1.2.2 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 fulfill 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.

7.1.2.2.1 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.

7.1.2.2.2 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, subcontracting, materials, processes and controls during process, auditing, training of personnel, final inspection and acceptance. All activities shall be planned and controlled. Quality systems approach may be referred for planning, suitable to a particular project for implementation.

7.1.2.2.3 Health, Safety and Environment

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.

7.1.2.2.4 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.

7.1.2.3 Construction Control and Practices

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

7.1.2.3.2 Construction of All Elements

Construction of all elements of a building shall be in accordance with Accepted Good Practice [7(1)]. It shall also be ensured that the elements of structure satisfy the appropriate fire resistance requirements as specified in 'Fire and Life Safety', and quality of building materials/components used shall be in accordance with 'Building Materials'.

7.1.2.3.2.1 Construction for Foundation

a) Excavations near footings or foundations

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

b) Placement of backfill.

The excavation outside the foundation shall be backfilled with soil that is free of organic material, construction debris, cobbles and boulders or a controlled low-strength material (CLSM). The backfill shall be placed in lifts and compacted, in a manner that does not damage the foundation or the waterproofing or damp proofing material.

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

c) Site grading

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

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

d) Grading and fill in flood hazard areas

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

- 1) Unless such fill is placed, compacted and sloped to minimize shifting, slumping and erosion during the rise and fall of flood water and, as applicable, wave action.
- 2) In floodways, unless it has been demonstrated through hydrologic and hydraulic analyses performed by a registered design professional in accordance with standard engineering practice that the proposed grading or fill, or both, will not result in any increase in flood levels during the occurrence of the design flood.

- 3) In flood hazard areas subject to high-velocity wave action, unless such fill is conducted and/or placed to avoid diversion of water and waves toward any building or structure.
- 4) Where design flood elevations are specified but floodways have not been designated, unless it has been demonstrated that the cumulative effect of the proposed flood hazard area encroachment, when combined with all other existing and anticipated flood hazard area encroachment, will not increase the design flood elevation more than 1 foot (305 mm) at any point.

e) Compacted fill materials

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

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

Exception: Compacted fill material less than 12 inches (305 mm) in depth need not comply with an approved report.

The compaction shall be verified by a qualified inspector approved by the building official.

f) Controlled low-strength materials (CLSM)

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

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

7.1.2.3.2.1.1 Footing and Foundation**Depth of footings**

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

Frost protection

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

- 1) Extending below the frost line of the locality
- 2) Erecting on solid rock.

Exception: Free-standing buildings meeting all of the following conditions shall not be required to be protected

Footings shall not bear on frozen soil unless such frozen condition is of a permanent character.

Isolated footings

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

Shifting or moving soils

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

7.1.2.3.2.1.2 Footings on or adjacent to slopes

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

a) Building clearance from ascending slopes

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

b) Footing setback from descending slope surface

Footings on or adjacent to slope surfaces shall be founded in firm material with an embedment and set back from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. Where the slope is steeper than 1 unit vertical in 1

unit horizontal (100-percent slope), the required setback shall be measured from an imaginary plane 45 degree (0.79 rad) to the horizontal, projected upward from the toe of the slope.

c) Pools

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

7.1.2.3.2.2 Construction Using Masonry

7.1.2.3.2.2.1 Soaking of Brick

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

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

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

7.1.2.3.2.2.2 Laying of Brick

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

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

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

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

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

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

a) Walls

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

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

b) Plasters

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

c) Arches

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

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

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

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

d) Fixing of Frame

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

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

e) Reinforced Brickwork

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

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

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

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

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

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

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

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

f) Protection against Damage

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

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

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

g) Provision for Service Instillations

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

h) Cavity Walls

As the main object of providing a continuous cavity in an external wall is to prevent rain penetrating to the inner face, care shall be exercised during construction that the cavity is continuous and free from obstruction. As far as

possible, mortar droppings shall be prevented from falling down the cavity by the use of laths or by hay bands which shall be drawn up the cavity as the work proceeds. Any mortar which may unavoidably fall on the wall-ties be removed daily and temporary openings shall be provided to permit the daily removal of mortar droppings from the bottom of the cavity.

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

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

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

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

i) **Ventilation**

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

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

Parapets - If the top of a hollow party wall ends with a parapet, the cavity shall be carried up to the full height of the wall or stopped at the roof-fleshing level.

Eaves - If a roof projects over the top of the wall, the cavity shall be closed at the top.

Party Walls - In a hollow party wall, the top of a cavity shall be closed *just* above the uppermost ceiling level and the courses over shall be continued in solid brickwork.

A sound-insulating material shall be interposed between the hollow wall and the solid brickwork.

At the points where the two leaves of the hollow wall come into contact (for example, at windows and doors), they shall be separated by a water-tight membrane.

Above the lintels of doors and windows, damp-proof membrane shall be inserted slopping downwards and outwards.

At solid jambs a vertical damp-proof course shall be inserted between the outer and inner parts of the wall.

7.1.2.3.2.2.3 Concrete-Block Masonry Work in Foundation and Basement Construction of Masonry

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

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

7.1.2.3.2.2.4 Laying Concrete Block Masonry in Superstructure

a) Use of Mortar in Masonry

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

b) Horizontal (Bedding) Joints

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

c) Vertical (Cross) Joints

For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or to the next unit to be laid alongside of it. But it will be more convenient to apply mortar on the edges of the succeeding unit when it is standing vertically and then placing it horizontally well-pressed against the previously laid unit. However, whatever the method used for applying mortar, care must be taken to produce well compacted vertical joints. ‘_In the case of two cell blocks, there is a slight depression on their vertical sides, which may also be filled up with mortar where it is considered necessary to secure greater lateral rigidity.

Mortar shall not be spread so much ahead of the actual laying of the units that it tends’ to stiffen and lose its plasticity, thereby resulting in poor

bond. For most of the work, the joints, both horizontal and vertical, shall be one centimeter thick. Except in the case of extruded-joint construction described later in (d), the mortar shall be raked out from the joint with a trowel to a depth of about one centimeter as each course is laid so as to ensure good bond for the plaster.

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

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

d) Operation for Laying Block Masonry

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

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

When filling in the wall between the corners, a mason's line shall be stretched from corner to corner for each course and the top outside edge

of each block shall be laid to this line. The manner of handling or gripping the block shall be such as to position the block properly with minimum adjustment. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block or it will stiffen and lose its plasticity. As each block is laid, excess mortar extruding from the joints shall be cut off with the trowel and thrown back on the mortar board to be reworked into the fresh mortar. If the work is progressing rapidly, the extruded mortar cut from the joints may be applied to the vertical face shells of the block just laid. Should there be any delay long enough for the mortar to stiffen on the block, the mortar shall be removed to the mortar board and reworked. Dead mortar that has been picked up from the scaffold or from the floor shall not be used.

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

e) Provisions for Door and Window Frames

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

For jambs of very large doors and windows either solid concrete blocks shall be provided or, if hollow units are used, the hollows shall be filled in with concrete of mix 1:3: 6.

Mild steel bar holdfasts should be so fastened to the door or window frames that these occur at block course level and their ends are embedded in a hollow which shall be filled up with 1:3:6 cement concrete.

f) Provisions for Lintels

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

g) Provision for Roof

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

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

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

h) Intersecting Walls

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

- 1) **Bearing Walls** - When two bearing walls meet intersect and the courses are to be laid up at the same time, a true masonry bond between at least 50 percent of the units at the intersection is necessary. When such intersecting bearing walls are laid up separately, pockets with 20 cm maximum vertical spacing shall be left in the first wall laid. The corresponding course of the second wall shall be built into these pockets.
- 2) **Non-bearing Walls** - Meeting or intersecting non-bearing walls shall be bonded in a manner approved by a specialist experienced on such construction. Either of the two methods recommended for bearing walls may be used.

i) Pilasters and Piers

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

7.1.2.3.2.2.5 Rendering and Other Finishes**a) External Renderings**

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

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

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

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

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

b) Internal Renderings

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

c) Waterproofing Basement Walls below Ground Level

The portion of walls below ground level shall be waterproofed by application of 12 mm thick cement plaster 1:3 mix put on in two coats. The plaster shall be started on the outside of the wall just below the ground line and continued down the wall and across the edge formed by the projection of the footing. In case the subsoil is wet, the plaster shall be coated with asphalt.

7.1.2.3.2.2.6 Laying the Blocks

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

a) Coursing and Bonding

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

b) Mortar Joints

The joints shall be as thin as possible. Where the partition is to be plastered, the joint shall be left roughly flush or they may be slightly raked out. If the partition is not to be plastered, the joints shall be neatly

finished flush with the face as the work proceeds and care shall be taken to keep the faces clean and free from mortar splashing and stains.

c) Frames for Doors and Other Openings

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

d) Lintels

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

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

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

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

e) Treatment at Heads Partitions

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

f) Dwarf Partitions

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

7.1.2.3.2.7 Finishing

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

7.1.2.3.2.8 Repairing Brickwork

Defects and cracking in brickwork may be due to one or several causes

Where proper materials and workmanship are used, brickwork will need little maintenance.

If, however, defects occur, they may be due to the following causes:

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

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

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

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

a) Treatment of Structural Damage

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

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

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

b) Treatment of Cracks across Wall

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

- 1) If the cracks are of such nature that they are likely to encourage the penetration of rain if they are not repaired, it is necessary to cut out and replace the cracked bricks.
- 2) If the cracks are wide, the two portions can be stitched by inserting bond stone or precast reinforced concrete blocks at suitable intervals. The cracks shall then be grouted. Sufficient care has to be taken in preparing the precast concrete blocks so that the patched surface will match with the surrounding surface. In repairing cracks with mortar it is important to secure satisfactory adhesion between the masonry of the existing work and the new bricks and also not to use too strong a mortar mix. Otherwise shrinkage of the new rich mortar may cause a fresh crack to develop. To promote adhesion, the brickwork shall be wetted before the mortar is filled in.

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

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

c) Surface cracks

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

7.1.2.3.2.3 Construction Using Bamboo

- a) Bamboo being a versatile resource characterized by high strength, low mass and ease of working with simple tools, it is desirable to increasingly make appropriate use of this material.
- b) Bamboo can be cut and split easily with very simple hand tools. Immature bamboos are soft, pliable and can be molded to desired shape. It takes polish and paint well.
- c) While it is possible to work with bamboo simply using, a few basic tools, such as, a machete, hack saw, axe, hatchet, sharpening tools, adze, chisel (20 mm), chill, wood rasps, steel rod, and pliers, will greatly increase the effectiveness of the construction process.
- d) For providing safety to the structure against fire, bamboo may be given fire retardant treatment using following chemicals: a few drops of concentrated HCL shall be added to the solution to dissolve the precipitated salts:

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

- e) Bamboo indirect contact with ground, bamboo on rock or preformed concrete footing, bamboo incorporated into concrete or bamboo piles may form the foundation structure.
- f) The floor of bamboo may be at ground level with covering of bamboo matting, etc. In elevated floors, bamboo members become an integral part of structural framework of building. The floor will comprise structural bamboo elements and bamboo decking.

7.1.2.3.2.4 Site Preparation

While preparing the site for construction, bush and other wood, debris, etc, shall be removed and promptly disposed for 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 construction from noncombustible material as for as possible.

7.1.2.3.5 Construction Using Concrete

7.1.2.3.5.1 Mixing and Placing of Pneumatic Mortar

- a) **Mixing**-The aggregate and cement should be mixed in an approved mechanical mixer and delivered from an approved mechanical digester. The minimum amount of water should be injected into the mixture as this will ensure maximum density of the mortar.
- b) **Placing**-The pneumatic mortar should be applied with an approved nozzle by a skilled operator. The velocity of the material leaving the nozzle should be

maintained uniform and should be such as to produce minimum rebound of sand.

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

7.1.2.3.5.2 Construction of Floors

a) Floors Founded on the Ground

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

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

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

b) Suspended Floors

Floors which are not directly supported on the ground should be cast in panels, the sides of which should not exceed 7.5 m. At joints in suspended floors, the surface of the panels for a width not less than the thickness of the panel on each side of the joint should be primed and painted with at least two coats of bituminous or other approved paint.

c) Junction of Floor and Walls

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

7.1.2.3.5.3 Construction of Walls

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

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

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

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

7.1.2.3.5.4 Surface Finish to Prestressed Concrete Cylindrical Tanks

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

7.1.2.3.5.5 Formwork

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

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

7.1.2.3.5.6 Placement, Protection and Curing

Placement and Finishing-

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

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

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

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

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

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

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

7.1.2.3.6 Construction Using Steel

7.1.2.3.6.1 Connections

- a) **General** - As much of the work of fabrication as is reasonably practicable shall be completed in the shops where the steel work is fabricated.
- b) **Rivet & Close Tolerance Bolts, High Strength Friction Grip Fasteners, Black Bolts and Welding**

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

- c) **Composite Connections**

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

- d) **Members Meeting at a Joint**

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

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

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

- e) **Bearing Brackets**

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

- f) **Gussets**

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

- g) **Packing**

- 1) **Rivets or Bolts through Packing**

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

2) Packing in Welded Construction

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

3) Packing Subjected to Direct Compression only

Where properly fitted packing are subjected to direct compression only.

h) Separators and Diaphragms

Where two or more rolled steel joists or channels are used side by side to form a girder, they shall be connected together at intervals of not more than 1 500 mm except in the case of grillage beams encased in concrete, where suitable provision shall be made to maintain correct spacing. Bolts and separators may be used provided that in beams having a depth of 300 mm or more, not fewer than 2 bolts are used with each separator. When loads are required to be carried from one beam to the other or are required to be distributed between the beams, diaphragms shall be used, designed with sufficient stiffness to distribute the load.

i) Lug Angles

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

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

In the case of channel members and the like, the lug angles and their connection to the gusset or other supporting member shall be capable of developing strength of not less than 10 percent in excess of the force not accounted for by the direct connection of the member, and the attachment of the lug angles to the member shall be capable of developing 20 percent in excess of that force.

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

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

7.1.2.3.6.2 Shop Erection

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

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

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

7.1.2.3.6.3 Inspection and Testing

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

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

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

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

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

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

7.1.2.3.6.4 Site Erection

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

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

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

7.1.2.3.6.5 Security During Erection

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

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

7.1.2.3.6.6 Field Connections

- a) **Field riveting** - Rivets driven at the site shall be heated and driven with the same care as those driven in the shop.
- b) **Field bolting** - Field bolting shall be carried out with the same care as required for shop bolting.
- c) **Field welding** - All field assembly and welding shall be executed in accordance with the requirements for shop fabrication excepting such as manifestly apply to shop conditions only. Where the steel has been delivered painted, the paint shall be removed before field welding, for a distance of at least 50 mm on either side of the joint.

7.1.2.3.6.7 Painting after Erection

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

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

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

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

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

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

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

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

7.1.2.3.6.9 Construction of Steel Chimney

a) Erection Tolerance

The variation in the eccentricity of the axis of chimney from the vertical at any level shall not exceed 1/1 000 of the height, at that particular section.

b) Clearance

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

c) Sealing

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

d) Gas Tightness

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

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

e) Erection Tension

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

7.2 STORAGE, STACKING AND HANDLING OF MATERIALS

7.2.1 GENERAL

7.2.1.1 Planning and Storage Layout

- a) For any site, there should be proper planning of the layout for stacking and storage of different materials, components and equipments with proper access and proper maneuverability 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.
- b) Materials shall be segregated as to kind, size and length and placed in neat, orderly piles that are safe against falling. If piles are high they shall be stepped back at suitable intervals in height. Piles of materials shall be arranged so as to allow a passageway of not less than 1 m width in between the piles or stacks for inspection or removal. All passageways shall be kept clear of dry vegetation.
- c) Materials shall be stored, stacked and handled in such a manner as to prevent deterioration or intrusion of foreign matter and to ensure the preservation of their quality and fitness for the work.
- d) Materials shall be stacked on well drained, firm and unyielding surface. Materials shall not be stacked so as to impose any undue stresses on walls or other structures.
- e) Materials shall be stacked in such a manner as not to constitute a hazard to passerby. At such places the stacks shall have suitable warning signs in daytime and red lights on and around them at night.
- f) Stairways, passageways and gangways shall not become obstructed by storage of building materials, tools or accumulated rubbish.

7.2.1.2 Protection Against Atmospheric Agencies

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

7.2.1.3 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.

7.2.1.4 Protection Against Fire and Other Hazards

- a) Materials, like timber, bamboo, coal, paints, etc, shall be stored in such a way that there may not be any possibility of fire hazards. Inflammable materials like kerosene and petrol, shall be stored in accordance with the relevant rules and regulations so as to ensure the desired safety during storage. Stacks shall not be piled so high as to make them unstable under fire fighting conditions and in general they shall not be more than 4.5m in height. **The provisions given in good practice [7(2)].**

- b) Materials which are likely to be affected by subsidence of soil like precast beams, slabs and timber of sizes shall be stored by adopting suitable measures to ensure unyielding supports.
- c) Materials liable to be affected by floods, tides, etc shall be suitably stored to prevent their being washed away or damaged due to floods, tides, etc.

7.2.2 STORAGE, STACKING AND HANDLING OF MATERIALS

7.2.2.1 General

The storage stacking and handling of materials generally used in construction shall be as given in 7.2.2.2 to 7.2.2.3.1, which have been summarized in the form of a check list in Annex B. Exposure to asbestos fibers/dust is known to be harmful to health of human beings.

7.2.2.2 Cement

- (a) Storage and Stacking — Cement shall be stored at the work site in a building or a shed which is dry, leak proof and as moisture-proof as possible. The building or shed for storage should have minimum number of windows and close fitting doors and these should be kept closed as far as possible. Cement received in bags shall be kept in such a way that the bags are kept free from the possibility of any dampness or moisture coming in contact with them. Cement bags shall be stacked off the floor on wooden planks in such a way as to keep them about 150 mm to 200 mm clear above the floor. The floor may comprise lean cement concrete or two layers of dry bricks laid on a well consolidated earth. A space of 600 mm minimum shall be left around between the exterior walls and the stacks. 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 3.0 m. In stacks more than 8 bags high, the cement bags shall be arranged alternately length-wise and cross-wise so as to tie the stacks together and minimize the danger of toppling over. Cement bags shall be stacked in a manner to facilitate their removal and use in the order in which they are received; a table showing date of receipt of cement shall be put on each stack to know the age of cement.

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

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

Different types of cements shall be stacked and stored separately.

- (b) Handling — Hooks shall not be used for handling cement bags unless specifically permitted by the engineer-in-charge. For information regarding bulk handling of cement, see 7.2.2.4.

7.2.2.3 Lime

7.2.2.3.1 Quicklime Before Stacking

- (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 around the heaps to avoid bulging of walls. Unslaked lime shall be stored in a place inaccessible to water and because of fire hazards, shall be segregated from the combustible materials.
- (b) Handling — See 7.2.2.4

7.2.2.3.2 Hydrated Lime

- (a) Storage and stacking — Hydrated lime is generally supplied in containers, such as jute bags lined with polyethylene or craft paper bags. It should be stored in a building to protect the lime from dampness and to minimize warehouse deterioration. The building should be with a concrete floor and having least ventilation to eliminate draughts through the walls and roof. In general, the recommendations given in 7.2.2 for storing of cement shall be applicable for hydrated lime. When air movement is reduced to a practical minimum, hydrated lime can be stored for up to three months without appreciable change.
- b) Handling — See 7.2.2.4.

7.2.2.3.3 Dry Slaked Lime

- (a) Storage and stacking — The lime shall be stored in a dry and closed go down.
- (b) Handling — See 7.2.2.4.

7.2.2.4 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 shutdown and locked out electrically as well as mechanically. When necessary for a workman to enter such storage area, he shall wear a life-line, with another workman outside the silo or hopper attending the rope.

7.2.2.5 Masonry Unit

- (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 1.0 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 ease in counting, the stacks shall be 50 bricks long, 10 bricks high and not more than 4 bricks in width, the bricks being placed on edge, two at a time along the width of the stack. Clear distance between adjacent stacks shall not be less than 0.8 m. Bricks of each truckload 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, autoclave 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 be permitted

7.2.2.6 Floors, Wall and Roof Tiles

- (a) Storage and Stacking — Floor, wall and clay roof tiles of different types, such as, cement concrete tiles (plain, coloured and terrazzo) and ceramic tiles (glazed and unglazed) shall be stacked on regular platform as far as possible under cover in proper layers and in tiers and they shall not be dumped in heaps. In the stack, the tiles shall be so placed that the mould surface of one faces that of another. Height of the stack shall not more than 1.0 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.

7.2.2.7 Aggregate

- (a) Storage and Stacking — Aggregates shall be stored at site on a hard dry and level patch of ground. If such a surface is not available, a platform of planks or old corrugated iron sheets, or a floor of bricks, or a thin layer of lean concrete shall be made so as to prevent the mixing with clay, dust, vegetable and other foreign matter. Stacks of fine and coarse aggregate shall be kept in separate stock piles sufficiently removed from each other to prevent the material at the edges of the piles from getting intermixed. On a large job it is desirable to construct dividing walls to give each type of aggregates its own compartment. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum.
- (b) Handling — When withdrawals are made from stock piles, no 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.

7.2.2.8 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 7.2.2.4.

7.2.2.9 Timber

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

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

7.2.2.10 Bamboo

- a) The site shall be properly inspected and termite colonies or mounds if detected shall be destroyed. All refuse and useless cellulosic materials shall be removed from the site. The ground may then be disinfected by suitable insecticides. The area should have good drainage.
- b) Bamboo may preferably be stacked on high skids or raised platform atleast 300 mm above ground. Storage under cover reduces the liability to fungal attack. Good ventilation and frequent inspection are important.
- c) Bamboo dries by air-seasoning under cover in the storage yards from 6 to 12 weeks time.

7.2.2.11 Partially Prefabricated Wall and Roof

- a) **Storage and Stacking** — The wall components comprise blocks, sills, lintels, etc. The blocks shall be stacked in accordance with 7.2.2.5(c). These shall be stacked on plane level ground having a floor of bricks or a thin layer of lean concrete. The roof components such as precast RC joists, prefabricated brick panels, RC planks, channel units, cored units, waffle units, L-panel, single tee and double tee sections, ferrocement panels, etc shall be unloaded as individual components. These shall be stacked on plane level ground having a floor of bricks or a thin layer of lean concrete. RC planks, prefabricated brick panels and ferrocement panels shall be stacked against a brick masonry wall in slightly inclined position on both sides of the wall. Channel units, cored units and L-panels shall be stacked one over the other up to five tiers. The waffle units shall be stacked upside down as individual units. The RC joists, single tee and double tee sections shall be stacked as individual units one adjacent to the other. The distance between any two adjacent stacks shall not be less than 450 mm.
- b) **Handling** — The components shall be handled by holding the individual component by holding a specified points so that the stresses due to handling are minimized.

7.2.2.12 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.

7.2.2.13 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 sided over each other, to protect the anodizing layer.

7.2.2.14 Doors, Windows and Ventilators

- a) **Storage and Stacking** — Metal and plastic doors, windows and ventilators shall be stacked upright (on their sills) on level ground preferably on wooden battens and shall not come in contact with dirt or ashes. If received in crates they shall be stacked according to manufacturer's instructions and removed from the crates as and when required for the work. Metal and plastic frames of doors, windows and ventilators shall be stacked upside down with the kick plates at the top. These shall not be allowed to stand for long in this manner before being fixed so as to avoid the door frames getting out of shape and hinges being strained and shutters drooping. During the period of storage of aluminium doors, windows and ventilators, these shall be protected from loose cement and mortar by suitable covering, such as tarpaulin. The tarpaulin shall be hung loosely on temporary framing to permit circulation of air to prevent moisture condensation. All timber and other lignocellulosic material based frames and shutters shall be stored in a dry and clean covered space away from any infestation and dampness. The storage shall preferably be in well-ventilated dry rooms. The 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 stack 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 lignocelluloses material based frame or shutter becomes wet during transit, it shall be kept separate from the undamaged material. The wet material may be dried by stacking in shade with battens in between adjacent boards with free access of dry air. Separate stacks shall be built up for each size, each grade and each type of material. When materials of different sizes, grades and types are to be stacked in one stack due to shortage of space, the bigger size shall be stacked in the lower portion of the stacks. Suitable pallets or separating battens shall be kept in between the two types of material. Precast concrete door and window frames shall be stored in upright position adopting suitable measures against risk of subsidence of soil/support.
- b) **Handling** — While unloading, shifting, handling and stacking timber or other lignocellulosic material based, metal and plastic door and window frames and shutters, care shall be taken that the pieces are not dragged one over the other as it may cause damage to their surface particularly in case of the decorative shutters. The pieces should be lifted and carried preferably flat avoiding damage to corners or sides.

7.2.2.15 Roofing Materials

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

7.2.2.15.2 Asbestos Cement Sheet

- a) **Storage and stacking** — Asbestos cement sheets shall be stacked to a height of not more than 1.0 m 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.

7.2.2.15.3 CGI Sheets

- a) **Storage and stacking** — CGI sheets shall be stacked in not more than 100 sheets per stack built solidly. 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.

7.2.2.16 Boards

7.2.2.16.1 Gypsum Boards

- a) **Storage and stacking** — Gypsum boards shall be stored flat in a covered clean and dry place.
- b) **Handling** — See 7.2.2.15.2 (b)

7.2.2.16.2 Plywood, Fiber Board etc

- a) **Storage and Stacking** — Plywood, fibre board, etc, shall not be stored in the open and exposed to direct sun and rain. The boards shall be stacked on a flat dun age, on the top of which a wooden frame shall be constructed with battens of 50 mm x 25 mm (Min) in such a way that it supports all four edges and corners of the boards with intermediate battens placed at suitable intervals to avoid warping. If required, the stack shall be adequately raised above ground level to ensure that it will not be affected by accumulation of water under it. The board shall be stacked in a solid block in a clear vertical alignment. The top sheet of each stack shall be suitably weighed down to prevent warping, wherever necessary.
- b) **Handling** — The board shall be unloaded and stacked with utmost care avoiding damage to the corners and surface. In case of decorative plywood and decorative boards, the surface of which are likely to get damaged by dragging one sheet over another, it is advisable that these are lifted as far as possible in pairs facing each other.

7.2.2.17 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. 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.

7.2.2.18 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 fiber 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.

7.2.2.19 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.

7.2.2.20 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.

7.2.2.21 Unplasticized PVC Pipes

- a) **Storage and Stacking** — Pipes should be stored on a reasonably flat surface free from stones and sharp projections so that the pipe is supported throughout its length. The pipe should be given adequate support at all times. In storage, pipe racks should be avoided. Pipe should not be stacked in large piles especially under warm temperature conditions as the bottom pipes may distort thus giving rise to difficulty in jointing. Socket and spigot pipes should be stacked in layers with sockets placed at alternate ends of the stacks to avoid lopsided stacks. It is recommended not to store a pipe inside another pipe. On no account should pipes be stored in a stressed or bend condition or near a source of heat. Pipes should not be stacked more than 1.5 m high. Pipes of different sizes and classes should be stacked separately. In tropical conditions, pipes should be stored in shade. In very cold weather, the impact strength of PVC is reduced making it brittle. The ends of pipe should be protected from abrasion particularly those specially prepared for jointing either spigot or socket solvent welded joints or soldered for use with couplings. If due to unsatisfactory storage or handling a pipe 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.

7.2.2.22 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.

7.2.2.23 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 shall be followed.

7.2.2.24 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 in confined spaces where flammable or explosive vapours may develop, any necessary heat shall be provided through duct work remote from the source of flame. Sources of ignition, such as open flame and exposed heating elements, shall not be permitted in area or rooms where spray painting is done nor shall smoking be allowed there.

Care should be taken not to use any naked flame inside the paint store. Buckets containing sand shall be kept ready for use in case of fire. Fire extinguishers when required shall be of foam type conforming to **accepted good standards [7(4)]**.

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

7.2.2.25 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 pyramidal stacks neatly in rows.
- b) **Handling** — See 7.3.14.3.1.2 and 7.3.14.3.4

7.2.2.26 Bituminous Roofing Felts

- a) **Storage and Stacking** — Bituminous roofing felts shall be stored away from other combustible materials and shall be kept under shade.
- b) **Handling** — Bituminous roofing felts should be handled in a manner to prevent cracking and other damages.

7.2.2.27 Flammable Materials

- a) **Storage and Stacking** — In addition to the requirements as laid down in 7.2.1.4 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.

7.2.2.28 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.

7.2.2.29 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 are attached.

7.2.2.30 Other Materials

Polymeric materials such as coatings, sheeting, reflective surfacing/sheeting, etc shall be stored as per the manufacturers' instructions. Special precautions shall be taken in case of storage, handling and usage of toxic materials. Small articles like screws, bolts, nuts, door and window fittings, polishing stones, protective clothing, spare parts of machinery, linings, packings, water supply and sanitary fittings, and electrical fittings, insulation board, etc, shall be kept in suitable and properly protected containers or store rooms. Valuable small materials shall be kept under lock and key.

7.2.2.31 Special Considerations

- a) Materials constantly in use shall be relatively nearer the place of use.
- b) Heavy units like precast concrete members shall be stacked near the hoist or the ramp.
- c) Materials which normally deteriorate during storage shall be kept constantly moving, by replacing old materials with fresh stocks. Freshly arrived materials shall never be placed over materials which had arrived earlier.
- d) Appropriate types of fire extinguishers shall be provided at open sites where combustible materials are stored and for each storage shed/room where flammable/combustible materials are stored. **For guidance regarding selection of the appropriate types of fire extinguishers reference may be made to good practice [7(4)].** It is desirable that a minimum of two extinguishers are provided at each such location.
- e) Workers handling excavated earth from foundation, particularly if the site happens to be reclaimed area or marshy area or any other infected area, shall be protected against infection affecting their exposed body portions.
- f) Stairways, walkways, scaffolds, and access ways shall be kept free of materials, debris and obstructions. The engineer-in-charge/the foreman shall initiate and carry out a programme requiring routine removal of scrap and debris from scaffolds and walkways.
- g) Where stacking of the materials is to be done on road side berms in the street and other public place, the owner shall seek permission from the Authority for such stacking and also for removing the remnants of the same after the construction is over, so as to avoid any hazard to the public.

7.2.3 UNLOADING RAIL/ROAD WAGONS AND MOTOR VEHICLES

7.2.3.1 Loading and Unloading Rail/Road Wagons

- a) Appropriate warning signals shall be displayed to indicate that the wagons shall not be coupled or moved.
- b) The wheels of wagons shall always be sprigged or chained while the wagons are being unloaded. The brakes alone shall not be depended upon.
- c) Special level bars shall preferably be used for moving rail wagons rather than ordinary crow bars.

- d) Where gangplanks are used between wagons and platforms of piles (heaps), cleats at lower end of gangplank, or pin through end of gangplanks, shall be used to prevent sliding. If gangplank is on a gradient, cleats or abrasive surface shall be provided for the entire length.
- e) When rail/road wagons are being loaded or unloaded near passageways or walkways, adequate warning signals shall be placed on each end of the wagon to warn pedestrians.

7.2.3.2 Loading and Unloading From Motor Vehicles

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

7.2.3.3 Handling Heavy/Long Items

- a) Loading and unloading of heavy items, shall, as far as possible, be done with cranes or gantries. The workman shall stand clear of the material being moved by mechanical equipment. The slings and the ropes used shall be of adequate load carrying capacity, so as not to give way and result in accidents.
- b) While heavy and long components are being manually loaded into motor vehicle, wagons, trailer, etc, either wooden sleepers or steel rails of sufficient length and properly secured in position shall be put in a gentle slope against the body of the wagon/vehicle at 3 or 4 places for loading. These long items shall be dragged, one by one, gently and uniformly along these supports by means of ropes, being pulled by men with feet properly anchored against firm surface. As soon as the items come on the floor of the vehicle, the same may be shifted by crowbars and other suitable leverage mechanism, but not by hands to avoid causing accident to the workmen.
- c) Similar procedure see 7.2.3.3(b) shall be followed for manual unloading of long or heavy items.

7.3 SAFETY IN CONSTRUCTION OF ELEMENTS OF A BUILDING

7.3.1 General

- a) The provisions of this Section shall apply to the erection/alteration of the various parts of a building or similar structure. The construction of the different elements shall conform to 7.1.2.3.2.
- b) Nothing herein stated shall be construed to nullify any rules, regulations, safety standards or statutes of the local state governments. The specific Rules, Regulations and Acts pertaining to the protection of the public or 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.
- c) Safety Management
 - 1) The safety of personnel engaged in building construction should be ensured through a well planned and well organized mechanism. For this, depending on the size and complexity of building construction project, safety committee shall be constituted to efficiently manage all safety related affairs. The site in-charge or his nominee of a senior rank shall head the committee and a safety officer shall act as member-secretary. The meetings of the safety committee shall be organized regularly say fortnightly or monthly depending on the nature of the project, however, emergency meetings shall be called as and when required. The safety committees shall deal with all the safety related issues through well structured agenda, in the meetings and all safety related measures installed at the site and implementation thereof shall be periodically reviewed.
 - 2) Notwithstanding the guidelines given in 7.3.1, all provisions given in relevant Act/Rules/Regulations as amended from time to time shall be followed.

7.3.2 Terminology

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

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

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

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

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

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

7.3.2.6 Materials Handling Hoists — A platform, bucket or similar enclosure exclusively

meant for the lifting or lowering of construction material the hoists being operated from a point outside the conveyance.

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

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

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

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

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

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

7.3.3 Temporary Construction, Use Of Side Walls And Temporary Encroachments

7.3.3.1 Temporary Construction

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

Temporary structure shall apply to the following types of structures:

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

7.3.3.2 For detailed information regarding fire safety aspects in respect of construction, location, maintenance and use of temporary structures, reference may be made to **Accepted Good Practices [7(5)]**.

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

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

7.3.4 TESTING

7.3.4.1 Tests

No structure, temporary support, scaffolding or any construction equipment during the construction or demolition of any building or structure shall be loaded beyond the allowable loads and working stresses as provided for in Structural Design **see also good practice [7(6)]**.

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

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

7.3.5 Inspection and Rectification of Hazardous Defects

- a) 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.
- b) The owner shall proceed to rectify the defect, hazardous condition or violation within 24 h of the receipt of the notice from the Authority. The Authority shall have full powers to rectify the unsafe condition and all expenses incurred in this connection is payable by the owner of the property. Illegal encroachments and non-payment of money due, in respect of the rectification of unsafe conditions may vest a lien on the property with the Authority.
- c) When the strength and adequacy of any scaffold or other construction equipment is in doubt or when any complaint is made, the Authority shall get the same inspected before use.

7.3.6 Foundations

7.3.6.1 General

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

7.3.6.2 Adjoining Properties

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

adjoining property owner. 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 behavior and timely precautions taken against any undesirable effect.

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

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

7.3.7 General Requirements And Common Hazardous During Excavation

7.3.7.1 Location of Machinery and Tools

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

7.3.7.2 Excavated Materials

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

7.3.7.2.1 Other Surcharges

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

7.3.7.3 Types of Strata

Adequate precautions, depending upon the type of strata met with during excavation (like quick sand, loose fills and loose boulder) shall be taken to protect the workmen during excavation. Effect of climatic variations and moisture content variations on the materials

under excavation shall be constantly watched and precautions taken, where necessary, immediately to prevent accidents at work site.

7.3.7.4 Overhang and Slopes

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

7.3.7.5 Blasting

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

7.3.7.5.1 Burrowing

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

7.3.7.6 Health Hazards

Where gases or fumes are likely to be present in trenches, 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.

7.3.7.7 Safety of Materials

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

7.3.7.8 Fencing and Warning Signals

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

7.3.7.9 Effect of Freezing and Thawing

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

7.3.7.10 Vibrations from Nearby Sources

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

7.3.7.11 Precautions While Using Petroleum Powered Equipment

At the site of excavation, where petroleum powered equipment is used, petroleum vapours are likely to accumulate at lower levels and may cause fire explosion under favorable circumstances. Care should, therefore, be taken to avoid all sources of ignition in such places.

7.3.8 Piling and Other Deep Foundations

7.3.8.1 General

7.3.8.1.1 Safety Programme

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

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

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.

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)].**

7.3.8.2 Piling Rig

- a) Pile drivers shall not be erected in dangerous proximity to electric conductors. If two pile drivers are erected at one place these shall be separated by a distance at least equal to the longest leg in either rig.
- b) The frame of any rig shall be structurally safe for all anticipated dead, live or wind loads. Whenever there is any doubt about the structural strength, suitable test shall be carried out by the foreman and the results of the test recorded. No pile driving equipment shall be taken into use until it has been inspected and found to be safe.
- c) Pile drivers shall be firmly supported on heavy timber sills, concrete beds or other secure foundation. If necessary, to prevent danger, pile drivers shall be adequately guyed. When the rig is not in use, extra precautionary measures for stability, such as securing them with minimum four guys, shall be adopted to prevent any accidents due to wind, storm, gales and earthquake.
- d) Access to working platforms and the top pulley shall be provided by ladders. Working platforms shall be protected against the weather.
- e) In tall driven piling rigs or rigs of similar nature where a ladder is necessary for regular use, the ladder shall be securely fastened and extended for the full height of the rig.
- f) Exposed gears, fly wheels, etc, shall be fully enclosed.

- g) Pile driving equipment in use shall be inspected by a competent engineer at regular intervals not exceeding three months. A register shall be maintained at the site of work for recording the results of such inspected pile lines and pulley blocks shall be inspected by the foreman before the beginning of each shift, for any excess wear or any other defect.
- h) Defective parts of pile drivers, such as sheaves, mechanism slings and hose shall be repaired by only competent person and duly inspected by foreman-in-charge of the rig and the results recorded in the register. No steam or air equipment shall be repaired while it is in operation or under pressure. Hoisting ropes on pile drivers shall be made of galvanized steel.
- i) Steam and air lines shall be controlled by easily accessible shut-off valves. These lines shall consist of armoured hose or its equivalent. The hose of steam and air hammers shall be securely lashed to the hammer so as to prevent it from whipping if a connection breaks. Couplings of sections of hose shall be additionally secured by ropes or chains.
- j) When not in use the hammer shall be in dropped position and shall be held in place by a cleat, timber or any other suitable means.
- k) For every hoisting machine and for every chain rig hook, shackle, swivel and pulley block used in hoisting or as means of suspension, the safe working loads shall be ascertained. In case of doubt, actual testing shall be carried out and the working load shall be taken as half of the tested load. Every hoisting machine and all gears referred to above shall be plainly marked with the safe working load. In case of a hoisting machine having a variable safe working load, each safe working load together with the conditions under which it is applicable shall be clearly indicated. No part of any machine or any gear shall be loaded beyond the safe working load except for the purpose of testing.
- l) 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.

When loads have to be inclined:

- a) They shall be adequately counter-balanced, and
- b) The tilting device shall be secured against slipping.
- m) Adequate precautions shall be taken to prevent a pile driver from overturning if a wheel breaks.
- n) 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.
- o) Adequate precautions shall be taken to prevent the hammer from missing the pile.

- p) If necessary, to prevent danger, long piles and heavy sheet piling should be secured against falling.
- q) Wherever steam boilers are used, the safety regulations of boilers shall be strictly followed and safety valves shall be adjusted to 7N/cm² in excess of working pressure accurately.
- r) Where electricity is used as power for piling rig, only armoured cable conforming to the relevant EI standard shall be used.
- s) All checks as given in any manuals issued by the manufacturers shall be carried out.

7.3.8.3 Operation of Equipment

- a) Workers employed in the vicinity of pile drivers shall wear helmets conforming to the **accepted good standards [7(9)]**.
- b) Piles shall be prepared at a distance at least equal to twice the length of the longest pile from the pile driver.
- c) Piles being hoisted in the rig should be so slung that they do not have to be swung round, and may not inadvertently, swing or whip round. A hand rope shall be fastened to a pile that is being hoisted to control its movement. While a pile is being guided into position in the leads, workers shall not put their hands or arms between the pile and the inside guide or on top of the pile, but shall use a rope for guiding.
- d) 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.
- e) When piles are driven at an inclination to the vertical, if necessary, to prevent danger, these should rest in a guide.
- f) No steam or air shall be blown down until all workers are at a safe distance.

7.3.9 Walls

7.3.9.1 General

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

7.3.9.2 Scaffold

Properly designed and constructed scaffolding built by competent workmen shall be provided during the construction of the walls to ensure the safety of workers. The scaffolding may be of timber, metal or bamboo sections and the materials in scaffolding shall be inspected for soundness, strength, etc, at site by the engineer-in-charge prior to erection of scaffolds. Steel scaffolds intended for use in normal building construction work shall conform to **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 noncombustible 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)].**

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

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

7.3.9.3 Ladders

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

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

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

Wooden ladders shall be inspected at least once in a month for damage and deterioration. Close visual inspection is recommended in preference to load testing. This condition is particularly applicable to rope and bamboo ladders wherein fraying of ropes and damage to bamboo is likely to occur due to materials falling on them. When a ladder has been accidentally dropped it shall be inspected by the engineer-in-charge prior to 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 **accepted good practice [7(12)]**.

7.3.9.4 Opening in Walls

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

7.3.9.4.1 Guarding of Wall Openings and Holes

Wall opening barriers and screens shall be of such construction and mounting that they are capable of withstanding the intended loads safely. **For detailed information may be made to good practice [7(13)]**. Every wall opening from which there is a drop of more than 1.2 m shall be guarded by one of the following:

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

7.3.9.4.2 Every chute wall opening from which there is a drop of more than 1.2 m shall be guarded by one or more of the barriers specified in 9.4.1 or as required by the conditions.

7.3.9.5 Projection from Walls

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

7.3.10 Common Hazards During Walling

7.3.10.1 Lifting of Materials for Construction

Implements used for carrying materials to the top of scaffoldings shall be of adequate strength and shall not be overloaded during the work. Where 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.

7.3.10.2 Haulage of Materials

- a) In case of precast columns, steel beams, etc, proper precautions shall be taken to correctly handle, use and position them with temporary arrangement of guys till grouting of the base.
- b) Manila or sisal rope shall not be used in rainy season for hoisting of heavy materials as they lose their strength with alternate wetting and drying.

7.3.10.3 Electrical Hazards

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

7.3.10.4 Fire Hazards

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

7.3.10.4.1 Where extensive use of blow torch or other flame is anticipated scaffoldings, gangways, etc, shall be constructed with fire resistant materials. A portable dry powder extinguisher of 3.0 kg capacity shall be kept handy.

7.3.10.5 Mechanical Hazards

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

7.3.10.6 Fragile Materials

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

7.3.11 Roofing

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

7.3.11.2 While roofing work is being done with corrugated galvanized iron or asbestos cement sheets, it shall be ensured that joints are kept secured in position and do not slip, thus causing injury to 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.

7.3.11.3 If any glass work is to be carried out in the roof, it shall be ensured that injury to passerby due to breaking of glass is prevented. During wet conditions, the 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.

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

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

7.3.11.6 Guarding of Floor Openings and Floor Holes

- a) Every temporary floor opening shall have railings, or shall be constantly attended by someone. Every floor hole into which persons can, accidentally fall shall be guarded by either
 - 1) A railing with toe board on all exposed sides, or
 - 2) A floor hole cover the adequate strength and it should be hinged in place. When the cover is not in place, the floor hole shall be constantly attended by someone or shall be protected by a removable railing.
- b) Every stairway floor opening shall be guarded by a railing on all exposed sides, except at entrance to stairway. Every ladder way floor opening or platform shall be guarded by a guard railing with toe board on all exposed sides (except at entrance to opening), with the passage through the railing either provided with a swinging gate or so offset that a person can not walk directly into the opening.
- c) Every open-sided floor or platform 1200 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
 - 1) Persons may pass;
 - 2) There is moving machinery; or
 - 3) There is equipment with which falling materials could create a hazard.

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

7.3.12 Additional Safety Requirements For Erection Of Concrete Framed Structures (High-Rise Buildings)

7.3.12.1 Handling of Plant

7.3.12.1.1 Mixers

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

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

7.3.12.1.2 Cranes

- a) Crane rails where used shall be installed on firm ground and shall be properly secured. In case of tower cranes, it shall be ensured that the level difference between the two rails remains within the limits prescribed by the manufacturer to safeguard against toppling of the crane.
- b) Electrical wiring which can possibly touch the crane or any member being lifted shall be removed, or made dead by removing the controlling fuses and in their absence controlling switches.
- c) All practical steps shall be taken to prevent the cranes being operated in dangerous proximity to a live overhead power line. In particular, no member of the crane shall be permitted to approach within the minimum safety distances as laid down in 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.
- d) Cranes shall not be used at a speed which causes the boom to swing.
- e) A crane shall be thoroughly examined at least once in a period of 6 months by a competent person who shall record a certificate of the check.
- f) The operator of the crane shall follow the safe reach of the crane as shown by the manufacturer.
- g) No person shall be lifted or transported by the crane on its hook or boom.
- h) Toe boards and limit stops should be provided for wheel barrows on the loading/unloading platforms. Material should be loaded securely with no projections.
- i) Concrete buckets handled by crane or overhead cableway shall be suspended from deep throated hooks, preferably equipped with swivel and safety latch. In the concrete buckets, both bottom drop type and side drop type, closing and locking of the exit door of the bucket shall always be checked by the man-in-charge of loading concrete in the bucket to avoid accidental opening of the exit door and consequent falling of concrete.
- j) Interlocking or other safety devices should be installed at all stopping points of the hoists. The hoists shaft way should be fenced properly.
- k) When the buck or other members being lifted are out of sight of the crane operator, a signaller shall be posted in clear view of the receiving area and the crane operator.

- l) A standard code of hand signals shall be adopted in controlling the movements of the crane, and both the driver and the signaler shall be thoroughly familiar with the signals. The driver of the crane shall respond to signals only from the appointed signaler but shall obey stop signal at any time no matter who gives it
- m) If a traveling gantry crane is operating over casting beds, a warning signal which sounds automatically during travel should be provided to avoid accidents to workmen crossing or standing in the path of the moving loads.

7.3.12.1.3 Trucks

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

7.3.12.2 Formwork

- a) Formwork shall be designed after taking into consideration spans, setting temperature of concrete, dead load and working load to be supported and safety factor for the materials used for formwork.
- b) All timber formwork shall be carefully inspected before use and members having cracks and excessive knots shall be discarded.
- c) As timber centering usually takes an initial set when vertical load is applied, the design of this centering shall make allowance for this factor.
- d) The vertical supports shall be adequately braced or otherwise secured in position that these do not fall when the load gets released or the supports are accidentally hit.
- e) Tubular steel centering shall be used in accordance with the manufacturer's instructions. When tubular steel and timber centering is to be used in combination necessary precautions shall be taken to avoid any unequal settlement under load.
- f) A thorough inspection of tubular steel centering is necessary before its erection and members showing evidence of excessive resting, kinks, dents or damaged welds shall be discarded. Buckled or broken members shall be replaced. Care shall also be taken that locking devices are in good working order and that coupling pins are effectively aligned to frames.
- g) After assembling the basic unit, adjustment screws shall be set to their approximate final adjustment and the unit shall be level and plumb so that when additional frames are installed the tower shall be in level and plumb. The centering frames shall be tied together with sufficient braces to make a rigid and solid unit. It shall be ensured that struts and diagonals braces are in proper position and are secured so that frames develop full load carrying capacity. As erection progresses, all connecting devices shall be in place and shall be fastened for full stability of joints and units.
- h) In case of timber posts, vertical joints shall be properly designed. The connections shall normally be with bolts and nuts. Use of rusted or spoiled threaded bolts and nuts shall be avoided.

- i) Unless the timber centering is supported by a manufacturer's certificate about the loads it can stand, centering shall be designed by a competent engineer.
- j) Centering layout shall be made by a qualified engineer and shall be strictly followed. The bearing capacity of the soil shall be kept in view for every centering job. The effect of weather conditions as dry clay may become very plastic after a rainfall and show marked decrease in its bearing capacity.
- k) Sills under the supports shall be set on 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.
- l) All centering shall be finally, inspected to ensure that:
 - 1) Footings or sills under every post of the centering are sound
 - 2) All lower adjustment screws or wedges are snug against the legs of the panels
 - 3) All upper adjustment screws or heads of jacks are in full contact with the formwork.
 - 4) Panels are plumb in both directions.
 - 5) All cross braces are in place and locking devices are in closed and secure position.
 - 6) In case of balconies, the props shall be adequate to transfer the load to the supporting point.
- m) During pouring of the concrete, the centering shall be constantly inspected and strengthened, if required, wedges below the vertical supports tightened and adjustment screws properly adjusted as necessary. Adequate protection of centering shall be secured from moving vehicles or swinging loads.
- n) Forms shall not be removed earlier than as laid down in the specifications and until it is certain that the concrete has developed sufficient strength to support itself and all loads that will be imposed on it. Only workmen actually engaged in removing the formwork shall be allowed in the area during these operations. Those engaged in removing the formwork shall wear helmets, gloves and heavy soled shoes and approved safety belts if adequate footing is not provided above 2 m level. While cutting any tying wires in tension, care shall be taken to prevent backlash which might hit a workman.

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

7.3.12.3 Ramps and Gangways

- a) Ramps and gangways shall be of adequate strength and evenly supported. They shall either have a sufficiently flat slope or shall have cleats fixed to the surface to prevent slipping of workmen. Ramps and gangways shall be kept free from grease, mud, snow or other slipping hazards or other obstructions leading to tripping and accidental fall of a workman.
- b) Ramps and gangways meant for transporting materials shall have even surface and be of sufficient width and provided with skirt boards on open sides.

7.3.12.4 Materials Hoists

- a) The hoist should be erected on a firm base, adequately supported and secured. All materials supporting the hoist shall be appropriately designed and strong enough for the work intended and free from defects.
- b) The size of the drum shall match the size of the rope. Not less than two full turns of rope shall remain on the drum at all times. Ropes shall be securely attached to the drum.
- c) All ropes, chains and other lifting gear shall be properly made of sound materials, free from defects and strong enough for the work intended. They shall be examined by a competent person who shall clearly certify the safe working load on each item and the system.
- d) Hoist ways shall be protected by a substantial enclosure at ground level, at all access points and wherever persons may be struck by any moving part.
- e) Gates at access points should be at least 2 m high wherever possible. Gates shall be kept closed at all times except when required open for immediate movement of materials at that landing place.
- f) All gates shall be fitted with electronic or mechanical interlocks to prevent movement of the hoist in the event of a gate being opened.
- g) Winches used for hoists shall be so constructed that a brake is applied when the control lever or switch is not held in the operating position (dead-man's handle).
- h) The hoist tower shall be tied to a building or structure at every floor level or at least every 3 m. The height of the tower shall not exceed 6 m after the last tie or a lesser height as recommended by the manufacturer. All ties on a hoist tower shall be secured using right angled couples.
- i) The hoist shall be capable of being operated only from one position at a time. It shall not be operated from the cage. The operator shall have a clear view of all levels or, if he has not, a clear and distinct system of signaling shall employed.
- j) All hoist platform shall be fitted with guards and gates to a height of at least 1 m, to prevent materials rolling/falling from the platform.
- k) Where materials extend over the height of the platform guards, a frame shall be fitted and the materials secured to it during hoisting/lowering. (Care should be taken to ensure that neither the frame nor materials interfere or touch any part of the hoisting mechanism.)
- l) The platform of a goods hoist shall carry a notice stating:
 - 1) the safe working load; and
 - 2) that passengers shall not ride on the hoist.
- m) All hoist operators shall be adequately trained and competent, and shall be responsible for ensuring that the hoist is not overloaded or otherwise misused.
- n) All hoists shall be tested and thoroughly examined by a competent person before use on a site, after substantial alteration, modification or repair of hoists, and at least every 6 months.

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

7.3.12.5 Prestressed Concrete

- a) In pre-stressing operations, operating, maintenance and replacement instructions of the supplier of the equipment shall be strictly adhered to.
- b) Extreme caution shall be exercised in all operations involving the use of stressing equipment as wires/strands under high tensile stresses become a lethal weapon.
- c) During the jacking operation of any tensioning element(s) the anchor shall be kept turned up close to anchor plate, wherever possible, to avoid serious damage if a hydraulic line fails.
- d) Pulling-headers, bolts and hydraulic jacks/rams shall be inspected for signs of deformation and failure. Threads on bolts and nuts should be frequently inspected for diminishing cross section. Choked units shall be carefully cleaned.
- e) Care shall be taken that no one stands in line with the tensioning elements and jacking equipment during the tensioning operations and that no one is directly over the jacking equipment when deflection is being done. Signs and barriers shall be provided to prevent workmen from working behind the jacks when the stressing operation is in progress.
- f) Necessary shields should be put up immediately behind the prestressing jacks during stressing operations.
- g) Wedges and other temporary anchoring devices shall be inspected before use.
- h) The prestressing jacks shall be periodically examined for wear and tear.

7.3.12.6 Erection of Prefabricated Members

- a) A spreader beam shall be used wherever possible so that the cable can be as perpendicular to the members being lifted as practical. The angle between the cable and the members to be lifted shall not be less than 60°.
- b) The lifting wires shall be tested for double the load to be handled at least once in six months. The guy line shall be of adequate strength to perform its function of controlling the movement of members being lifted.
- c) Temporary scaffolding of adequate strength shall be used to support precast members at predetermined supporting points while lifting and placing them in position and connecting them to other members.
- d) After erection of the member, it shall be guyed and braced to prevent it from being tipped or dislodged by accidental impact when setting the next member.
- e) Precast concrete units shall be handled at specific picking points and with specific devices. Girders and beams shall be braced during transportation and handled. In such a way as to keep the members upright.
- f) Methods of assembly and erection specified by the designer, shall be strictly adhered to at site. Immediately on erecting any unit in position, temporary connections or supports as specified shall be provided before releasing the lifting equipment. The permanent structural connections shall be established at the earliest opportunity.

7.3.12.7 Structural Connections

- a) When reliance is placed on bond between precast and in-situ concrete the contact surface of the precast units shall be suitably prepared in accordance with the specifications.
- b) The packing of joints shall be carried out in accordance with the assembly instructions.
- c) Leveling devices, such as wedges and nuts which have no load bearing function in the completed structure shall be released or removed as necessary prior to integrating the joints.
- d) If it becomes necessary to use electric power for in-situ work, the same should be stepped down to a safe level as far as possible.

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

7.3.13 Additional Safety Requirements for Erection of Structural Steel Work

7.3.13.1 Safety Organization

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

7.3.13.2 Safety of Work persons

- a) While engaging persons for the job the supervisor should check up and make sure that they are skilled in the particular job they have to perform.
 - 1) The personnel protective equipment (helmets, goggles etc.,) shall be worn properly and at all times during the work and shall conform to the **accepted standards [7(9)]**
 - 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.
 - 3) The welders and gas cutters shall be equipped with proper protective equipment like gloves, safety boots, aprons and hand shields. The filter glass of the hand shield shall conform to **accepted standards [7(15)]** and should be suitable to the eyes of the particular worker.
 - 4) When the work is in progress, the area shall be cordoned off by barricades to prevent persons from hitting against structural components, or falling into excavated trenches or getting injured by falling objects.
 - 5) Warning signs shall be displayed where necessary to indicate hazards, for example (a) '**440 VOLTS**', (b) '**DO NOT SMOKE**', (C) '**MEN WORKING AHEAD**', etc. Hand lamps shall be of low voltage preferably 24 V to prevent electrical hazards.
 - 6) All electrically operated hand tools shall be provided with double earthing.
- b) Anchors for guys or ties shall be checked for proper placement. The weight of concrete in which the anchors are embedded shall be checked for uplift and sliding.
 - 1) Split-end eye anchors shall only be used in good, solid rock.

- 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.
- c) When a number of trusses or deep girders is loaded in one car or on one truck, all but one being lifted shall be tied back unless they have been tied or braced to prevent their falling over and endangering men unloading.
- d) The erection gang shall have adequate supply of bolts, washers, rivets, pins, etc, of the correct size. Enough number of bolts shall be used in connecting each piece using a minimum of two bolts in a pattern to ensure that the joint will not fail due to dead load and erection loads. All splice connections in columns, crane girders, etc, shall be completely bolted or riveted or welded as specified in the drawing before erection.
- e) Girders and other heavy complicated structural members may require special erection devices like cleats and hooks, which can be shop assembled and bolted or riveted or welded to the piece and may be left permanently in the place after the work.
- f) If a piece is laterally unstable when picked at its centre, use of a balance beam is advisable, unless a pair of bridles slings can be placed far enough apart for them to 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.
- g) On deep girders, and even on some trusses, a safety 'bar' running their full length will aid the riggers, fitters and others employed on the bottom flange or bottom chord to work with greater safety. This can be a single 16 mm diameter wire rope through vertical stiffeners of such members about 1 m above the bottom flange and clamped at the ends with wire rope clamps. If the holes cannot be provided, short eye bolts can be welded to the webs of the girder at intervals to be removed and the surface chipped or ground to leave it smooth after all work on the piece has been completed.
- h) Safety belts shall always be available at work spot to be used whenever necessary. The rope shall be chemically treated to resist dew and rotting. These shall not be tied on sharp edges of steel structures. They shall be tied generally not more than 2 m to 3 m away from the belt.
- i) On a guy derrick or climbing crane job, the tool boxes used by the erection staff shall be moved to the new working floor each time the rig is changed. On a mobile crane job, the boxes shall be moved as soon as the crane starts operating in a new area too far away for the men to reach the boxes conveniently. While working a tall and heavy guy derrick, it is advisable to control tension in guys by hand winches to avoid jerks, which may cause an accident.
- j) The proper size, number and spacing of wire rope clamps shall be used, depending on the diameter of the wire rope. They shall be properly fixed in accordance with **accepted 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 be tight enough.
- k) When the men can work safely from the steel structure itself, this preferable to hanging platforms or scaffolds, as it eliminates additional operations, which in turn, reduces the hazard of an accident.

- l) To aid men working on floats or scaffolds, as well as men in erection gangs, or other gangs using small material, such as bolts and drift pins, adequate bolt baskets or similar containers with handles of sufficient strength and attachment to carry the loaded containers, shall be provided.
- m) The men should be trained to use such containers, and to keep small tools gathered up and put away in tool boxes when not in use. Material shall not be dumped overboard when a scaffold is to be moved. Rivet heaters shall have safe containers or buckets for hot rivets left over at the end of the day.
- n) 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 fiber ropes which are UV stabilized and conforming to the accepted good standard.
- o) Safety against Fire

A fire protection procedure is to be set up if there is to be any flame cutting, burning, heating, riveting or any operation that could start a fire. For precautions to be observed during welding and cutting operations, reference may be made to accepted good practice.

- 1) The workers should be instructed not to throw objects like hot rivets, cigarette stubs, etc, around.
- 2) Sufficient fire extinguishers shall be placed at strategic points. Extinguishers shall always be placed in cranes, hoists, compressors and similar places. Where electrical equipments are involved, CO₂ or dry powder extinguishers shall be provided **accepted good practice [7(4)]**.
- p) Riding on a load, tackle or runner shall be prohibited.
- q) The load shall never be allowed to rest on wire ropes. Ropes in operation should not be touched. Wire rope with broken strand shall not be used for erection work. Wire ropes/manila ropes conforming to acceptable good standards shall be used for guying.
- r) Lifting Appliances

Precautions as laid down shall be followed.

- s) Slings
 - 1) Chains shall not be joined by bolting or wiring links together. They shall not be shortened by tying knots. A chain in which the links are locked, stretched or do not move freely shall not be used. The chain shall be free of kinks and twists. Proper eye splices shall be used to attach the chain hooks.
 - 2) Pulley blocks of the proper size shall be used to allow the rope free play in the sheave grooves and to protect the wire rope from sharp bends under load. Idle sling should not be carried on the crane hook along with a loaded sling. When idle slings are carried they shall be hooked.
 - 3) While using multi legged slings, each sling or leg shall be loaded evenly and the slings shall be of sufficient length to avoid a wide angle between the legs.
- t) Riveting Operations
 - 1) 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.

2) Riveting dollies

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

3) Riveting Hammers

Snap 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 worn.

4) Fire Protection

The rivet heating equipment should be as near as possible to the place of work. A pail of water shall always be kept ready for quenching the fire during riveting operations and to prevent fires when working near inflammable materials.

u) Welding and Gas Cutting

- 1) For safety and health requirements in electric gas welding and cutting operations, reference may be made to accepted good practice.
- 2) All gas cylinders shall be used and stored in the upright position only and shall be conveyed in trolleys. While handling by cranes they shall be carried in cages. The cylinders shall be marked 'full' or 'empty' as the case may be. Gas cylinders shall be stored away from open flames and other sources of heat. Oxygen cylinders shall not be stored near combustible gas, oil, grease and similar combustible materials. When the cylinders are in use, cylinder valve key or wrench shall be placed in position. Before a cylinder is moved, cylinder valve shall be closed. All cylinder valves shall be closed when the torches are being replaced or welding is stopped for some reason. The cylinder valve and connections shall not be lubricated.
- 3) Gas cutting and welding torches shall be lighted by means of special lighters and not with matches. The cables from welding equipment should be placed in such a way that they are not run over by traffic. Double earthing shall be provided. Before undertaking welding operations near combustible materials, suitable blanketing shall be provided and fire extinguishers kept nearby. Welding shall not be undertaken in areas where inflammable liquids and gases are stored.
- 4) Gas lines and compressed air lines shall be identified by suitable colour codes for easy identification, to avoid confusion and to prevent fire and explosion hazards.

7.3.13.3 Safety of Structures

- a) The structure itself should be safeguarded during its erection. The first truss of the roof system shall be guyed on each side before the hoisting rope is detached from it. After the subsequent trusses and roof purlins are erected, protective guides shall be firmly established and the required wind bracings shall be erected to prevent the whole structure being blown over by a sudden gale at night. Bracing and guying precautions shall be taken on every structure until it is complete. Guying shall be specifically done for trusses and structural components which after their erection

form an erection device, on structures used for temporary material storage overloading shall be avoided.

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

7.3.14 Miscellaneous Items

7.3.14.1 Staircase Construction

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

7.3.14.2 Lift

Till the installation of the lift is completed, lift wells shall be protected with check boards or railings together with notice boards, danger lights, etc, to prevent persons accidentally falling into the wells. The handrails provided shall be capable of withstanding pressure exerted due to normal bumping of an individual against the same.

7.3.14.3 Construction Involving the Use of Hot Bituminous Tar Materials

7.3.14.3.1 Safety Programme

7.3.14.3.1.1 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.

7.3.14.3.1.2 Protective covering

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

7.3.14.3.1.3 Fire fighting arrangements

When heating and handling of hot bituminous materials is to be done in the open, sufficient stocks of clean dry sand or loose earth shall be made available at the work site to cope with any resultant fires. When 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 foam extinguisher conforming to accepted good standards shall be kept in readiness on the work site.

7.3.14.3.2 Sprayer, Spreader/Paver**7.3.14.3.2.1 Sprayer**

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

7.3.14.3.2.2 Spreader/Paver

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

7.3.14.3.3 Equipment for Heating of Bitumen and Tars

- a) Tanks, vats, kettles, pots, drums and other vessels for heating tar, bitumen and other bituminous materials shall be:
 - 1) Adequately resistant to damage by heat, transportation, etc;
 - 2) Capable of holding a full load without danger of collapse, bursting or distortion;
 - 3) Provided with a close fitting cover suitable for smothering a fire in the vessel or protection from rain; and
 - 4) Leak proof, and provided with suitable outlets which can be controlled for taking out the hot material.
- b) Suitable indicator gauges shall be used to ascertain level and temperature of the material in the boiler. 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.
- c) 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.
- d) Buckets for hot bitumen, bituminous materials of tar shall have:
 - 1) The bail or handle firmly secured, and
 - 2) A second handle near the bottom for tipping.
- e) Bitumen or tar boilers mounted on wheels for easy transport or towing shall preferably be provided with hand pumps for spraying purposes.
- f) 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.

- g) 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 antifoaming 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 cutoff and the heating tube shall be thoroughly blown out by the fan so as to prevent a back fire.
- h) 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.
- i) Piping shall not be warmed with burning rags and instead blow-lamps or similar devices shall be used.
- j) Spilled bitumen or tar shall be promptly cleaned up around boilers.
- k) Inspection openings shall not be opened while there is any pressure in the boiler.
- l) When tanks are cleaned by steam, adequate precautions shall be taken to prevent any built up of pressure.

7.3.14.3.4 Handling Bitumen/Tar

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

7.3.14.4 Timber Structure

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

7.3.15 Finishes

7.3.15.1 Painting, Polishing and Other Finishes

Only the quantity of paint, thinner and polish required for the day's work should be kept at the work spot.

- a) All containers of paint, thinner and polish which are not in actual use should be closed with tight fitting lids and kept at a safe place away from the actual work site.
- b) **A 5 kg dry powder fire extinguisher conforming to acceptable good standards [7(23)] shall be kept handy.**

- c) Metal receptacles with pedal operated metal lids shall be kept handy at the work site for depositing used cotton rags/waste. The contents of such receptacles shall be disposed off before the end of each day's work at a safe place, preferably by burning under proper supervision.
- d) All containers of paint shall be removed from the work site and deposited in the paint store before the close of day's work. Used paintbrushes shall be cleaned and deposited in the store along with the containers.
- e) Some paints/polishing and finishing materials are injurious to the health of workmen. Adequate protective clothing, respiratory equipment, etc, shall be provided for the use of workmen during such operations where necessary.

7.3.16 Fragile Fixtures

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

7.3.17 Electrical Installations And Lifts

7.3.17.1 Temporary Electrical Wiring

- a) Frayed and/or bare wires shall not be used for temporary electrical connections during construction. All temporary wiring shall be installed and supervised by a competent electrician. Adequate protection shall be provided for all electrical wiring laid on floor which may have to be crossed over by construction machinery or by the 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.
- b) All electrical circuits, other than those required for illumination of the site at night, shall be switched off at the close of day's work. The main switch board from which connections are taken for lighting, power operated machinery, etc, shall be located in an easily accessible and prominent place. No articles of clothing nor stores shall be kept at the back of or over the board or anywhere near it. One 3 kg/4.5 kg CO₂ extinguisher or one 5 kg dry powder extinguisher shall be provided near the switch board.

7.3.17.2 Permanent Electrical Installations

Besides the fire safety measures for electrical installations covered under 7.3.17.1 safety in electric installations in buildings and installations of lifts shall be in accordance with 'Building Services'.

7.3.18 General Requirements

7.3.18.1 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.

7.3.18.2 Fire Protection

- a) In addition to the provision of fire extinguishers, as specified in this Part of the Code, other fire extinguishing equipment shall also be provided and conveniently located within the building under construction or on the building site, as required by the Authority.
 - 1) All fire extinguishers shall be maintained in a serviceable condition at all times in accordance with **accepted good practice [7(4)]** and all necessary guidelines regarding fire protection at workplaces followed in accordance with **accepted good practice [7(2)]**.
 - 2) It shall be ensured that all workmen and supervisory staff are fully conversant with the correct operation and use of fire extinguishers provided at the construction site.
 - 3) Telephone number of local fire brigade should be prominently displayed near each telephone provided at construction site.
 - 4) Watch and ward services should be provided at construction sites during holidays and nights.
- b) Access shall be provided and maintained at all times to all fire fighting equipment, including fire hose, extinguishers, sprinkler valves and hydrants.
 - 1) Approach roads for fire fighting should be planned, properly maintained and kept free from blockage. Width of approach road should be not less than 5 m to facilitate fire fighting operations.
 - 2) Emergency plan and fire order specifying the individual responsibility in the event of fire should be formulated and mock drills should be practiced periodically in case of large and important construction sites to ensure upkeep and efficiency of fire fighting appliances.
 - 3) Periodical inspection should be carried out to identify any hazard and proper records maintained and follow up action taken.
 - 4) Evaluation facilities and fire exits should be provided at all locations susceptible to fire hazards.

- c) Where the building plans require the installation of fixed fire fighting equipment, such as hydrants, stand pipes, sprinklers and underground water mains or other suitable arrangements for provision of water shall be installed, completed and made available for permanent use as soon as possible, but in any case not later than the stage at which the hydrants, etc, are required for use as specified.
 - 1) 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.
 - 2) The standpipe (landing valve/internal fire hydrant) and its installation shall conform to the accepted good standards.
 - 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.
 - 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.
- d) Close liaison shall be maintained with the local fire brigade, during construction of all buildings above 15 m in height and special occupancies, like educational; assembly, institutional, industrial, storage, hazardous and mixed occupancies with any of the aforesaid occupancies having area more than 500 m² on each floor.
- e) It is desirable that telephone system or other means of inter-communication system be provided during the construction of all buildings over 15 m in height or buildings having a plinth area in excess of 1000 m².
- f) All work waste, such as scrap timber, wood shavings, sawdust, paper, packing materials and oily waste shall be collected and disposed of safely at the end of each day's work. Particular care shall be taken to remove all waste accumulation in or near vertical shaft openings like stairways, lift-shaft, etc.
- g) An independent water storage facility shall be provided before the commencement of construction operations for fire-fighting purposes. It shall be maintained and be available for use at all times.
- h) Fire walls and exit stairways required for a building should be given construction priority. Where fire doors, with or without automatic closing devices, are stipulated in the building plans they should be hung as soon as practicable and before any significant quantity of combustible material is introduced in the building.
- i) As the work progresses, the provision of permanent stairways, stairway enclosures, fire walls and other features of the completed structure which will prevent the horizontal and vertical spread of fire should be ensured.

7.3.18.3 Clothing

- a) 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 loose garments shall be prohibited.

- b) Workmen engaged in processes which splash liquid or other materials which will injure the skin shall have enough protective clothing to cover the body.
- c) Individuals engaged in work involving use of naked flames (such as welding) shall not wear synthetic fiber or similar clothing which increases the risk of fire hazards.

7.3.18.4 Safety Measure Against Fall Prevention

Persons working at heights may use safety belts and harnesses. Provision of cat-walks, wire mesh, railings reduces chances of fall-ladder and scaffoldings, stagings etc, should be anchored on firm footing and should be secured and railing should be provided as far as possible. All accesses should be barricaded to prevent accidental fall **in accordance with good practice 7(27).**

7.3.18.5 Falling Materials Hazard Prevention

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

7.3.18.6 Disposal of Debris

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

7.3.19 Construction Machinery

- a) Specification and requirements of construction machinery used in construction or demolition work shall conform to **accepted good standards 7(30).**
- b) For safety requirements for working with construction machinery, reference may be made to accepted good practice.
- c) Petroleum powered air compressors, hoists, derricks, pumps, etc, shall be so located that the exhausts are well away from combustible materials. Where the exhausts are pipes to outside the building under construction, a clearance of at least 150 mm shall be maintained between such piping and combustible material.

7.4 Maintenance Management, Repairs, Retrofitting and Strengthening of Buildings

7.4.1 Maintenance Management

7.4.1.1 Maintenance management of building is the art of preserving over a long period what has been constructed. Whereas construction stage lasts for a 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.

7.4.1.2 Terminology

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

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

7.4.1.2.2 Maintenance Management — The organization of maintenance within an agreed policy. Maintenance can be seen as a form of ‘steady state’ activity.

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

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

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

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

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

7.4.1.3 Building Maintenance

7.4.1.3.1 General

Any building (including its services) when built has certain objectives and during its total economic life, it has to be maintained. Maintenance is a continuous process requiring a close watch and taking immediate remedial action. It is interwoven with good quality of house keeping. It is largely governed by the quality of original construction. The owners, engineers, constructors, occupants and the maintenance agency are all deeply involved in this process and share a responsibility. Situation in which all these agencies merge into one is ideal and most satisfactory. There are two processes envisaged, that is, the work

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

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

- a) **Cleaning and servicing** — This is largely of preventive type, such as checking the efficacy of rain water gutters and servicing the mechanical and electrical installations. This covers the house keeping also.
- b) **Rectification and repairs** — This is also called periodical maintenance work undertaken by, say, annual contracts and including external replastering, internal finishing etc.
- c) **Replacements** — This covers major repair or restoration such as reproofing or re-building defective building parts.

7.4.1.3.2 Factors Affecting Maintenance

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

- a) **Technical factors** — These include age of building, nature of design, material specifications, past standard of maintenance and cost of postponing maintenance.
- b) **Policy** — A maintenance policy ensures that value for money expended is obtained in addition to protecting both the asset value and the resource value of the buildings concerned and owners.
- c) Financial and economic factors see (7.4.1.9)
- 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.

7.4.1.3.2.2 Influence of design

The physical characteristics, the life span and the aesthetic qualities of any building depend on the considerations given at the design stage. All buildings, however well designed and conscientiously built, will require repair and renewal as they get older. However, for better performance of the building envelop, the following are the ways to minimize troubles at the later stage.

- a) Minimize defects during construction and design,
- (b) Detail and choose materials during construction so that the job of maintenance is less onerous.

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

7.4.1.3.2.2.2 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.

7.4.1.3.3 Maintenance Policy

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

- a) the present use of the building anticipating any likely upgradings and their effect on the life cycles of existing components or engineering services; and
- b) a change of use for the building and the effect of any conversion work on the life cycles of existing components or engineering services.

7.4.1.3.4 Maintenance Work Programmes

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

- a) maintenance work should be carried out at such times as are likely to minimize any adverse effect on output or function.
- b) programme should be planned to obviate as far as possible any abortive work. This may arise if upgrading or conversion work is carried out after maintenance work has been completed or if work such as rewiring is carried out after redecoration.
- c) any delay in rectifying a defect should be kept to a minimum only if such delay is likely to affect output or function. The cost of maintenance increases with shortening response times.
- d) maintenance work, completed or being carried out should comply with all statutory and other legal requirements.

7.4.1.3.5 Maintenance Guides

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

- a) type of construction and residual life of the building, and
- b) environment and intensity of use see (7.4.1.3.2)

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

7.4.1.3.6 Planning of Maintenance Work

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

7.4.1.3.7 Feedback

7.4.1.3.7.1 Feedback is normally regarded as an important procedure of providing information about the behavior of materials and detailing for the benefit of the architect/engineer designing new buildings, which will result in lessening maintenance costs. It is an equally valuable source of information for the persons responsible for maintenance. Every maintenance organization should develop a sample way of communicating 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.

7.4.1.3.7.2 Feedback should aim at the following:

- a) User satisfaction,
- b) Continuous improvement, and
- c) Participation by all.

7.4.1.3.7.3 Source of information

The information on feedback can be obtained from the following:

- a) Occupants,
- b) Inspections,
- c) Records, and
- d) Discussions.

7.4.1.3.8 Means of Effecting Maintenance

7.4.1.3.8.1 Responsibility

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

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

- a) Directly employed labour,
- b) Contractors, and
- c) Specialist contractors under service agreement or otherwise.

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

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

7.4.1.4 Access

7.4.1.4.1 General

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

7.4.1.4.2 Access Facilities

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

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

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

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

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

7.4.1.4.3 Access to Confined Spaces

7.4.1.4.3.1 Ventilation

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

7.4.1.4.3.2 Lighting

Good lighting is necessary in order that maintenance work can be carried out satisfactorily. This is particularly important in confined spaces. When the normal

lighting is inadequate it should be supplemented by temporary installations. These should provide general and spot illumination as appropriate.

7.4.1.5 Records

7.4.1.5.1 General

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

7.4.1.5.2 Use of Building Records

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

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

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

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

7.4.1.5.3 Maintenance Records

Following should be typical contents of the maintenance records:

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

- 1) Location and service arrangements of all fire alarm and call points;
 - 2) Location and service arrangements of all extinguishers, hose reels and other fire fighting installations;
 - 3) Location of all fire compartment walls, doors, floors and screens;
 - 4) Location of all areas of exceptional fire hazard;
 - 5) Fire escape routes;
 - 6) Details of application of any fire protection treatment; and
 - 7) Location details and description of any installation for smoke control or protection of escape routes.
- (l) There should be a wall chart showing at a glance the various operations which have to be undertaken. Line drawings of buildings are always useful.
- (m) Records of security measures should be known to authorized personnel only.
- (n) Where no records exist, information should be slowly built up as it becomes available during the course of maintenance work.
- (o) Use of computers for storing information may be preferred.

7.4.1.5.4 Mechanical Records

7.4.1.5.4.1 Documentation

Documentation should record the following as installed:

- a) The location, including level if buried, of all public service connections (for example, fuel gas and coldwater supplies) together with the points of origin and termination, size and materials of pipes, line pressure and other relevant information;
- b) the layout, location and extent of all piped services showing pipe sizes, together with all valves for regulation, isolation and other purposes as well as the results of all balancing, testing and commissioning data;
- c) the location, identity, size and details of all apparatus and all control equipment served by, or associated with, each of the various services together with copies of any test certificates for such apparatus where appropriate. The information with respect to size and details may be presented in schedule form;
- d) the layout, location and extent of all air ducts showing dampers and other equipment, acoustic silencers, grilles, diffusers or other terminal components. Each duct and each terminal component should be marked with its size, the air quantity flowing and other relevant balancing data, and
- e) The location and identity of each room or space housing plant, machinery or apparatus.

7.4.1.5.4.2 Drawings

Drawings should record the following as installed:

- a) detailed general arrangements of boiler houses, machinery spaces, air handling plants, tank rooms and other plant or apparatus, including the

location, identity, size and rating of each apparatus, The information with respect to the size and rating can be presented in schedule form;

- (b) Isometric or diagrammatic views of boiler houses, plant rooms, tank rooms and similar machinery, including valve identification charts. It is useful to frame and mount a copy of such drawings on the wall of the appropriate room, and
- (c) comprehensive diagrams that show power wiring and control wiring and/or pneumatic or other control piping including size, type or conductor or piping used and identifying the terminal points of each.

7.4.1.5.5 Electrical Records

Documentation should record the following including locations, as installed:

- a) main and submain cables, showing origin, route, termination, size and type of each cable; cables providing supplies to specialist equipment, for example, computers, should be identified separately; and
- b) lighting conduits and final sub circuit cables, showing origin, route, termination and size of each, together with the number and size of cables within each conduit. The drawings should indicate for each conduit or cable, whether it is run on the surface or concealed, for example, in a wall chase, in a floor screed, cast in-situ, above a false ceiling etc.

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

- a) location and purpose of each emergency lighting fitting including an indication of the circuit to which it is connected;
- b) single and three phase power conduits and final sub-circuit cables showing; locations of power distribution boards, motors, isolators, starters, remote control units, socket outlets and other associated equipment.
- c) other miscellaneous equipment, conduits and cables;
- d) lightening conductor, air terminals, conductors, earth electrodes and test clamps;
- e) location of earth tapes, earth electrodes and test points other than those in (f); and
- f) cables providing earth circuits for specialist equipment, for example computers, should be identified separately,

Documentation should also include, when applicable.

- a) distribution diagrams or schedules to show size, type and length (to within 1m) of each main and sub main cable, together with the measured earth continuity resistance of each;
- b) schedule of lighting fittings installed stating location, manufacturer and type or catalogue number together with the type or manufacturer's reference, voltage and wattage of the lamp installed;
- c) schedule of escape and emergency lighting fittings installed 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;
- (f) main switchgear details; for purpose made equipment this should include a set of manufacturers' drawings and the site layout;
- (g) transformer, capacitor and power plant details; the leading details should be given, for example, for transformers the V.A rating, voltages and type of cooling; and
- (h) Completion certificate

7.4.1.6 Inspections

7.4.1.6.1 General

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

7.4.1.6.2 Frequency of Inspection

Inspection should be carried out at the following frequencies:

- (a) **Routine** — Continuous regular observations should be undertaken by the building user as part of the occupancy of building. Feedback resulting from this type of observation should be encouraged.
- (b) **General** — Visual inspections of main elements should be made annually under the supervision of suitably qualified personnel at appropriate times.
- (c) **Detailed** — The frequency of full inspection of the building fabric by suitably qualified personnel should not normally exceed a 5 year period.

7.4.1.6.2.1 Inspection schedule

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

7.4.1.6.3 Inspection of Engineering Services

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

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

- a) to check if maintenance work is required,
- b) to check if maintenance work is being adequately carried out, and
- c) for safety reasons to comply with statutory requirements and if required, with recommendations of other relevant organizations.

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

7.4.1.6.3.3 Method of inspection

The limited life of building services means it is important to record their residual life so that their replacement can be budgeted for, and inspection methods should be arranged accordingly. A checklist of items of plant to be inspected should be considered. Detailed specifications of how inspections should be carried out are necessary because a simple visual inspection is unlikely to show whether plant is operating correctly and efficiently.

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

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

7.4.1.6.4 Records of all inspections should be kept.

7.4.1.6.5 Inspection Report

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

7.4.1.7 Maintenance of Electrical Appliances

7.4.1.7.1 Planning of Maintenance Work

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

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

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

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

7.4.1.7.2 Following two types of maintenance are envisaged

7.4.1.7.2.1 Routine maintenance

Routine maintenance of the electrical equipments goes along with the regular inspections of the equipments. Inspections shall reveal the undue damage and excessive wear to the various components. Examination of the equipment shall reveal

any need for conditioning of the contact system, lubrication and adjustment of the mechanisms.

7.4.1.7.2.2 Post fault maintenance

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

7.4.1.7.3 Guidelines for the Maintenance of Electrical Appliances

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

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

7.4.1.8 Operating and Maintenance Manuals

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

7.4.1.9 For details on labour management concerning building maintenance, reference shall be made to accepted good practice.

7.4.1.10 For details on financial management concerning building maintenance, reference shall be made to accepted good practice.

7.4.2 Prevention of Cracks

7.4.2.1 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.

7.4.2.2 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.

7.4.3 Repairs and Seismic Strengthening of Buildings

7.4.3.1 General Principles and Concepts

7.4.3.1.1 Non-structural/Architectural Repairs

7.4.3.1.1.1 The buildings affected by earthquake may suffer both non-structural and structural damages. Nonstructural 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.

7.4.3.1.1.2 "Non-structural and architectural components get easily affected/dislocated during the earthquake. These repairs involve one or more of the following:

- a) Patching up of defects such as cracks and fall of plaster;
- b) Repairing doors, windows, replacement of glass panes;
- c) Checking and repairing electric conduits / wiring;
- d) Checking and repairing gas pipes, water pipes and plumbing services;
- e) 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
- i) Redecoration — white washing, painting, etc.

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/nonstructural 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.

7.4.3.1.2 Structural Repairs

7.4.3.1.2.1 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 amenable for repair; whether continued occupation is permitted; to decide the structure as a whole or a part require demolition, if considered dangerous;
- b) If the structure is considered amenable for repair then detailed damage assessment of the individual structural components (mapping of the crack pattern, distress location; crushed concrete, reinforcement bending yielding,

etc). Non-destructive testing techniques could be employed to determine the residual strength of the members; and

- c) To work out the details of temporary supporting arrangement of the distressed member so that they do not undergo further distress due to gravity loads.

7.4.3.1.2.2 After the assessment of the damage of individual structural elements, appropriate repair methods are to be carried out component wise depending 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 the 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, jacking, etc.

7.4.3.1.3 Seismic Strengthening

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

- a) Increasing the lateral strength in one or both directions by increasing column and wall areas or the number of walls and columns.
- b) Giving unity to the structure, by providing a proper connection between its resisting elements, in such a way that inertia forces generated by the vibration of the building can be transmitted to the members that have the ability to resist them. Typical important aspects are the connections between roofs or floors and walls, between intersecting walls and between walls and foundations.
- c) Eliminating features that are sources of weakness or that produce concentration of stresses in some members. Asymmetrical plan distribution of resisting members, abrupt changes of stiffness from one floor to the other, concentration of large masses and large openings in walls without a proper peripheral reinforcement are examples of defects of this kind.
- d) Avoiding the possibility of brittle modes of failure by proper reinforcement and connection of resisting members.

7.4.3.1.4 Seismic Retrofitting

Many existing buildings do not meet the seismic strength requirements of present earthquake codes due to original structural inadequacies and material degradation due to time or alterations carried out during use over the years. Their earthquake resistance can be upgraded to the level of the present day codes by appropriate seismic retrofitting techniques, such as mentioned in 7.4.3.1.3

7.4.3.1.5 Strengthening or Retrofitting Versus Reconstruction

7.4.3.1.5.1 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.

7.4.3.1.5.2 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 codes.

7.5 SAFETY IN DEMOLITION OF BUILDINGS

7.5.1 General

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

7.5.1.2 Planning

Before beginning the actual work of demolition a careful study shall be made of the structure which is to be pulled down and also of all its surroundings. This shall, in particular, include study of the manner in which the various parts of the building to be demolished are supported and how far the stage by stage demolition will affect the safety of the adjoining structure. A definite plan of procedure for the demolition work, depending upon the manner in which the loads of the various structural parts are supported, shall be prepared and approved by the engineer-in-charge and this shall be followed as closely as possible, in actual execution of the demolition work. Before the commencement of each stage of demolition, the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.

It should be ensured that the demolition operations do not act any stage, and endanger the safety of the adjoining buildings. 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.

7.5.2 Precautions Prior to Demolition

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

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

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

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

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

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

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

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

7.5.2.9 Protection of the Public

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

7.5.2.9.2 If the structure to be demolished is more than two storied or 7.5 m high, measured from the side walk or street which cannot be closed or safely diverted, and the horizontal distance from the inside of the sidewalk to the structure is 4.5 m or less, a substantial sidewalk shed shall be constructed over the entire length of the sidewalk adjacent to the structure, of sufficient width with a view to accommodating the pedestrian traffic without causing congestion. The side walk shed shall be lighted sufficiently to ensure safety at all times. For detailed information reference maybe made to accepted 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 sheathing/planking to prevent falling material from penetrating into the shed.

The roof of sidewalk sheds shall be capable of sustaining a load of 73 N/mm². Only in exceptional cases, say due to lack of other space, the storing of material on a sidewalk shed may be permitted in which case the shed shall be designed for a load of 146 N/mm². Roof of Sidewalk shed shall be designed taking into account the impact of the falling debris. By frequent removal of loads it shall be ensured that the maximum load, at any time, on the roof of work shed is not more than 6000 N/mm². The height of sidewalk shed shall be such as to give a minimum clearance of 2.4 m.

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

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

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

7.5.3 Precautions During Demolition

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

7.5.3.2 All openings shall be boarded up.

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

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

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

7.5.4 SEQUENCE OF DEMOLITION OPERATIONS

7.5.4.1 The demolition work shall be proceeded within such a way that:

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

7.5.4.2 All existing fixtures required during demolition operations shall be well protected with substantial covering to the entire satisfaction of the rules and regulations of the undertakings or they shall be temporarily relocated.

7.5.4.3 Before demolition work is started, glazed sash, glazed doors and windows, etc, shall be removed. All fragile and loose fixtures shall be removed. The lath and all loose plaster shall be stripped off throughout the entire building. This is advantageous because it reduces glass breakage and also eliminates a large amount of dust producing material before more substantial parts of the buildings are removed.

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

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

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

7.5.5 WALLS

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

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

7.5.5.3 Adequate lateral bracing shall be provided for walls which are unsound. For detailed information reference may be made to accepted good practice.

7.5.6 Flooring

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

7.5.6.2 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.

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

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

7.5.7 Demolition of Steel Structures

7.5.7.1 When a derrick is used, care shall be taken to see that the floor on which it is supported is amply strong for the loading so imposed. If necessary, heavy planking shall be used to distribute the load to floor beam and girders.

7.5.7.2 Overloading of equipment shall not be allowed.

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

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

7.5.7.5 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.

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

7.5.8 Catch Platform

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

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

7.5.8.3 Catch platform shall be capable of sustaining a live load of not less than 6100 N/m²

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

7.5.9 Stairs, Passageways And Ladders

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

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

7.5.10 Mechanical Demolition

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

- a) The area shall be barricaded for a minimum distance of 1.5% times the height of the wall,
- b) While the mechanical device is in operation, no workmen shall be allowed to enter the building being demolished,
- c) The device shall be so located as to avoid falling debris, and
- d) The mechanical device when being used shall not cause any damage to adjacent structure, power line, etc.

7.5.11 Demolition of Certain Special Types And Elements of Structures

7.5.11.1 Roof Trusses

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

7.5.11.1.1 Temporary backing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.

7.5.11.1.2 The bottom tie of roof trusses should be cut until the principal rafters are prevented from making out ward movement.

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

7.5.11.2 Heavy Floor Beams

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

7.5.11.3 Jack Arches

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

7.5.11.4 Brick Arches

Expert advice should be obtained and, at all stages of the demolition, the closest supervision should be given by persons fully experienced and conversant in the type of work to ensure that the structure is stable at all times. However, the following points may be kept in view.

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

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

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

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

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

7.5.11.5 Cantilever (Not Part of a framed structure)

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

7.5.11.6 In-situ Reinforced Concrete

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

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

7.5.11.6.1 Reinforced Concrete Beams

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

7.5.11.6.2 Reinforced Concrete Columns

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

7.5.11.6.3 Reinforced Concrete Walls

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

7.5.11.6.4 Suspended Floors and Roofs

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

7.5.11.7 Precast Reinforced Concrete

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

7.5.11.8 Prestressed Reinforced Concrete

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

7.5.12 Lowering, Removal and Disposal of Materials

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

7.5.12.2 Through Chutes

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

7.5.12.2.2 Chutes, if provided at an angle of more than 45° from the horizontal, shall be entirely enclosed on all the four sides, except for opening at or about the floor level for receiving the materials.

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

7.5.12.2.4 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.

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

7.5.12.3 Through Holes in the Floors

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

7.5.12.3.2 All intermediate floor openings for passage of materials shall be completely enclosed with barricades or guard rails not less than 1.0 m high and at a distance of not less than 1.0 m from the edge of general opening. No barricades or guard rails shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.

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

7.5.12.4 Removal of Materials

7.5.12.4.1 As demolition work proceeds, the released serviceable materials of different types shall be separated from the unserviceable lot at suitable time intervals and properly stocked clear of the spots where demolition work is being done.

7.5.12.4.2 The unserviceable lot obtained during demolition shall be collected in well-formed heaps at properly selected places, keeping in view safe conditions for workmen in the area. The height of each unserviceable lot shall be limited to ensure its toppling over or otherwise endangering the safety of workmen or passersby.

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

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

7.5.12.5

- 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, i.e. 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.

7.5.13 Miscellaneous

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

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

7.5.13.3 Safety devices like industrial safety helmets conforming to the accepted good standards 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.

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

7.5.13.5 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.

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

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

7.5.13.8 Grading of Plot

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

7.5.14 First-Aid

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

7.5.14.2 Depending on the scope and nature of the work, a person, qualified in first-aid shall be available at work site to render and direct first-aid to casualties. He shall maintain a list of individuals qualified to serve in first aid work. Enough first-aid kit, including a stretcher and 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 there on shall be forwarded to the competent authorities.

ANNEX A

(Section 1, Clause 7.1.2.1.2)

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 Advanced 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 synchronies.

A-1 PREPARATION OF CPM CAHART (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 approved 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) Construction safety aspects specially in case of pile foundations.
- h) Blasting if required (for deep foundations).
- j) Fire protection measures.
- f) Excavation in foundations, including demolition, if needed.
- g) Construction safety aspects specially in case of pile foundations.
- h) Blasting if required (for deep foundations).

j) 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 could 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 of 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

(Section 2, Clause 7. 2.2.1)

CHECK LIST FOR STACKING AND STORAGE OF MATERIALS

Sr no	Material/Component	Base			Stack				Type of Cover		
		Firm Level Ground	Hard Floor	Off-Floor	Heaps	Tiers	Flat	Vertical	Open	Open but covered	Under shed
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Cement			♦		♦					♦
2	Lime										
	a) Quick lime		♦		♦					♦	
	b) Hydrated lime			♦		♦					♦
3	Stones and Aggregates										
	a) Stones, aggregates, fly ash and cinder	♦			♦				♦		
	b) Veneering stones	♦				♦		♦	♦		
4	Bricks and Blocks	♦				♦			♦		
5	Tiles										
	a) Clay and concrete floor, wall and roof tiles	♦				♦	♦		♦		
	b) Ceramic tiles		♦			♦	♦				♦
6	Partially Pre-fabricated Wall and Roof Components										
	a) RC planks, prefabricated brick panels and ferrocement panels	♦						♦	♦		
	b) Channel units, corced units and L-panels	♦				♦			♦		
	c) Waffle units, RC joists single tee and double tee	♦					♦		♦		
7	Timber			♦		♦					♦
8	Steel	♦					♦		♦		
9	Aluminium Sections		♦				♦				♦
10	Doors, Windows and ventilators		♦					♦			♦
11	Roofing Sheets										
	a) AC	♦				♦	♦		♦		
	b) GI and Aluminium sheets	♦				♦	♦			♦	
	c) Plastic sheets			♦		♦	♦				♦
12	Boards like Plywood, Fibre Boards and Gypsum Boards			♦		♦	♦				♦

13	Plastic and Rubber Flooring										
	a) Sheets in rolls	◆						◆			◆
	b) Tiles	◆				◆	◆				◆
14	Glass Sheets		◆					◆			◆
15	Glass Bricks/Bolcks		◆			◆					◆
16	CI, GI and AC Pipes and Fittings										
	a) Pipes	◆				◆	◆		◆		
	b) CI and GI Fittings		◆				◆				◆
	c) AC Fittings		◆				◆		◆		
17	Polyethylene Pipes			◆		◆	◆				◆
18	Unplasticized PVC Pipes	◆				◆	◆		◆		
19	Bitumen, Road Tar, Asphalt, etc in Drums	◆				◆			◆		
20	Oil Paints		◆			◆					◆
21	Sanitary Appliances			◆			◆				◆

ANNEX C

(Section 4, Clause 7.4.1.3.2.2.2)

COMMON CAUSES FOR MAINTENANCE PROBLEMS

C-0 MAJOR CAUSES FOR MAINTENANCE PROBLEMS

C-1 FLOORS

- a) Poor quality construction which includes quality of construction material and workmanship
- b) Improper slopes, mainly in kitchen, bathrooms/toilets etc
- c) Lack of rounding at junctions of walls with floors
- d) Lack of damp proof course treatment in walls and particularly in sunken floors
- e) Poor design of buildings

C-2 ROOFS

- a) Inadequate roof slopes
- b) Inferior quality of construction
- c) Cracks on roof surfaces
- d) Inadequate provision of rain water spouts
- e) Blockages in grating/rain water pipes
- f) Worn out felts
- g) Bubbling up of tarfelt and separation of joints
- h) Leakage from the openings provided on the roof

C-3 PLUMBING

- a) Inadequate slopes in soil/waste pipes
- b) Improper lead joints
- c) Joints in walls
- d) Improper junctions of stacks
- e) Inadequate cleaning eyes at junction
- f) Inadequate slopes in sewage pipes
- g) Throwing of solid wastes in WC s
- h) Lack of periodical checking and cleaning
- i) Lack of motivation/education to users for proper use
- j) Overflow from service tanks
- k) Inferior quality of fittings and fixtures
- l) Inadequate design

C-4 DRAINAGE

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

C-5 ELECTRICAL

- a) Loose connections
- b) Improper earthing and earth connections

- c) Damages to wires, cables and other installations
- d) Under rated cables/wires and other installations

ANNEX D
(Section 4, Clause 7. 4.1.6.5)
FORMAT FOR INSPECTION REPORT

Date :
Building/Block :
.....

		Condition		
		Sound	Suspect	Defective
FLOORS & STAIRCASES				
Ground Floor				
Finish				
Skirting				
Structure				
Damp-proofing				
Ceiling				
Under floors, spaces, (Suspended floors)				
Termites/insects				
Upper Floors				
Finish				
Structure				
Ceiling				
Suspended ceiling				
Staircase				
Structure				
Treads				
Finishes				
Balustrade				
Soffits				
Finishes				
ROOFING				
Flat/Pitched				
Finish				
Insulation				
Structure				
Roof lights/glazing				
Parapets				
Cutters				
Rain Water Pipes				
Roof interiors (Pitched)				
Growth of Vegetation				
SANITARY INSTALLATION				
Plumbing				
Fittings/Pipings, WC's				
Taps				
Sinks				
Basins				
Urinals				
Cisterns				
Geysers				
Sewage Disposal				
Soil Pipes				
Manholes				
Sewerlines				
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

(Section 4, Clause 7.4.1.7.3.2)

GUIDELINES FOR MAINTENANCE OF ELECTRICAL EQUIPMENTS

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

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

- a) Manufacture's name
- b) Nameplate of the requirement and its salient features such as capacity, rating etc.
- c) Manufacturer's recommendations regarding availability/usage of spare parts.
- d) Manufacturer's recommendations for periodical maintenance and post fault maintenance.
- e) Details of the maintenance operations performed in the past.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

The following list records those standards which are acceptable as 'accepted good practice' and 'accepted good standards' in the fulfillment of the requirements of the Code. The latest version of a standard shall be adopted at the time of enforcement of the Code. The standards listed may be used by the Authority as a guide in conformance with the requirement of the referred clause in the Code.

Suffixes

1. Components of Elements

1.1 Foundations

- 1.1.1 [IS 1080: 1985](#) Code of practice for design and construction of shallow foundations on soils (other than raft, ring and shell) (Second Revision)
- 1.1.2 [IS 1904: 1986](#) Code of practice for design and construction of foundations in soils: General requirements (third revision)
- 1.1.3 IS 2911 Code of practice for design and construction of pile foundations
 - [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 4:1985](#) Load test on piles (first revision)
- 1.1.4 IS 2974 Code of practice for design and construction of machine foundations
 - [Part 2:1980](#) Foundations for impact type machines (hammer foundations) (first revision)
- 1.1.5 IS 9456: 1980 Code of practice for design and construction of conical and hyperbolic paraboloidal types of shell foundations
- 1.1.6 IS 9556: 1980 Code of practice for design and construction of diaphragm walls

1.2 Masonry

- 1.2.1 [IS 2212:1991](#) Code of practice for brickwork (first revision)
- 1.2.2 [IS 2572:1963](#) Code of practice for construction of hollow concrete block masonry
- 1.2.3 [IS 3630:1992](#) Code of practice for construction of non-load bearing gypsum block partitions (first revision)

1.3 Concrete

- 1.3.1 IS 456:2000 Code of practice for plain and reinforced concrete (fourth revision)
- 1.3.2 IS 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
1.3.3	IS 7861	Code of practice for extreme weather concreting
	Part 1:1975	Recommended practice for hot weather concreting
	Part 2:1981	Recommended practice for cold weather concreting
1.3.4	IS 10262:1982	Recommended guidelines for concrete mix design
1.4	Steel	
1.4.1	IS 800:1984 (second revision)	Code of practice for general steel construction
1.4.2	IS 805:1968 tanks	Code of practice for use of steel in gravity water tanks
1.4.3	IS 806:1968	Code of practice for use of steel tubes in general building construction (first revision)
1.4.4	IS 4000:1992	Code of practice for high strength bolts in Steel structures (first revision)
1.5.5	IS 6533 chimneys	Code of practice for design and construction of steel chimneys
	Part 1:1989	Mechanical aspects (first revisions)
	Part 2:1989	Structural aspects (first revision)
1.5	Flooring and Roofing	
1.5.1	IS 1196:1978 (second revision)	Code of practice for laying bitumen mastic flooring
1.5.2	IS 2571:1970	Code of practice for laying in-situ cement Concrete flooring (first revision)
1.5.3	IS 6061 and roof with joists and filler blocks	Code of practice for construction of floor and roof 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 filler blocks	Precast hollow clay blocks joists and hollow clay filler blocks
1.6	Finishes	

- | | | |
|-------|--------------------------------------|--|
| 1.6.1 | <u>IS 1346:1991</u> | Code of practice for waterproofing of roofs with bitumen felts (third revision) |
| 1.6.2 | IS 6278:1971 | Code of practice for white washing and color washing |
| 1.7 | Measurements | |
| 1.7.1 | IS 1200 | Method of measurement of building and civil engineering work (fourth revision) |
| | Part 1:1992 | Earthwork (fourth revision) |
| | Part 2:1974 | Concrete work (third revision) |
| | Part 3:1976 | Brick work (third revision) |
| 2. | <u>IS 2750:1964</u> | Specification for steel scaffoldings |
| 3. | <u>IS 3559:1966</u> | Specifications for pneumatic Concrete breakers |
| 4. | <u>IS 13935:1993</u> | Guidelines for repair and seismic strengthening of buildings |
| 5. | <u>IS 13828:1993</u> | Improving earthquake resistance of low strength masonry buildings _ Guidelines |
| 6. | <u>IS 13827:1993</u> | Improving earthquake resistance of Earthquake resistance of earthen buildings _ Guidelines |
| 7. | <u>IS 4130:1991</u> | Safety code of demolition of buildings (second revision) |