

EBCS 13:2014

Ethiopian Building Code Standard

Fire Precautions during Building Construction Design, Works and Use

ONLY FOR REVIEW PURPOSE

**Ethiopian Building Code Standard Revision Committee on
“Fire Precautions during Building Construction Design, Works
and Use”**

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NATIONAL FOREWORD

The Proclamation to define the powers and duties of The Executive organs of The Federal Democratic Republic of Ethiopia Proclamation No 691/ 2010 and Ethiopian Building Proclamation No 624/2009 empowers the Ministry of Urban Development, Housing and Construction to prepare the Country's Building Code, issue Standards for design and construction works, and follow up and supervise the implementation of same.

This Ethiopian Standard is the official English language version of "FIRE PRECAUTIONS DURING BUILDING CONSTRUCTION DESIGN, WORKS AND USE - **EBCS 13:2014**". With an eye on the latest technological advancements and trends worldwide and with the aim of bringing the Ethiopian Construction Standard at par with the present state-of-the-art, this code is newly included. The major benefits to be gained in applying this standard is the harmonization of professional practice and the ensuring of appropriate level of workmanship, level of safety and quality of construction work.

EBCS 13:2014 is prepared by a Technical Committee "FIRE PRECAUTIONS DURING BUILDING CONSTRUCTION DESIGN, WORKS AND USE" the secretariat of which is held by Addis Ababa University. The document is intended to be used in conjunction with EBCS 0:2014 to EBCS 14:2014 for the design of services of buildings and civil engineering works. As this standard is technical document which, by their very nature, require periodic updating, revised edition will be issued by the Ministry from time to time as appropriate.

The Ministry of Urban Development, Housing and Construction, Ethiopian Standard Agency, Ethiopian Airport Enterprise, Fire and Emergency Prevention and Rescue Agency contributed in the drafting of this EBCS 13 through Provision of Documents and Existing Standards, Active participation and Assistance to the Technical Committee, Provision of Information and Panel Discussions.

This document does not purport to include all the necessary provisions of a contract. Users are responsible for their correct application.

Compliance with this Ethiopian Building Code Standard does not of itself confer immunity from legal obligations.

The Ministry of Urban Development Housing and Construction as mandated acknowledges this document as a national resource tool and reference document which comprises a front cover, an inside front cover, a title page, National foreword, Table of Contents, pages 1 to 125 and a back cover. This Ethiopian Construction Standard, having been prepared under the direction of the Ethiopian Building Proclamation No 624/2009, was published under the authority of the Ministry of Urban Development, Housing and Construction on 01 December 2014.

Ministry of Urban development, Housing and Construction

FDRE

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INTRODUCTION

This Part of EBCS 13, is the first Ethiopian Building Code Standard with respect to “Fire Precautions during Building Construction Design services, Works and Uses.

This Code covers:

- Fire precautions bases during building design services, works and uses;
- Fire safety and means of escape and egress;
- Fire safety and construction details;
- Fire related ancillary engineering services;
- Fire, Smoke and Heat transmission, detection, alarm and control system;
- Firefighting system; and
- Fire safety and firefighting management.

This Code also formally recognizes:

- The Vision of the FDRE to reach to the middle income groups level by 2025;
- The contexts and wide variations of the status of the cities / towns this code will be applicable;
- The Building Laws, Regulations and Directives;
- The Framework agreement requirements of the MoUDC;
- The enforcement and practicability of the fire precautions set by this code;
- The Preventive focus and mixed approach to the prescriptive and performance based approach in preparing this code; and
- The Mandatory nature of this code as compared to the Voluntary nature of the Ethiopian Standards.

It has been assumed in the drafting of this Code that only minimum requirements are set and the executions and enforcement of its provisions will be interested to appropriately qualified and experienced experts or professionals certified by the Construction Coordination Office of the Ministry of Urban Development and Construction or its delegates.

Abbreviations

AAIT	Addis Ababa Institute of Technology
BMA	Classification for fire A based on building materials or elements
BS	British Standard
EBCS	Ethiopian Building Code Standards
CFA	Classification for fire A based on Combustibility and Flammability of materials
ES	Ethiopian Standards
ESA	Ethiopian Standardization Authority
ISO	International Standard Organization
MoUDC	Ministry of Urban Development, Housing and Construction
OFA	Classification for fire A based on Occupancy and / or Functions of buildings

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SECTION 1 General

1.1 Title and Purpose

1.1.1 Title

The Title of this Code is “EBCS 13: Fire precautions during Building Construction Design Services, Works and Uses” as part of the other Ethiopian Building Codes of Standards.

1.1.2 Purpose

The purpose of this code is to provide minimum requirements developers, designers, contractors and professionals to respect during building construction design services, works and uses.

1.2 Scope and General References

1.2.1 Scope

The scope of this Code is to:

- Describes the bases in which fire precautions were made for buildings during their design, works and uses;
- Provides fire safety, means of escape and / or egress, and construction detail requirements;
- Sets minimum requirements regarding fire, smoke and heat detection, alarm, control and or fighting systems, installations and / or equipment; and
- Provides guidelines with respect to the overall fire safety and firefighting management.

1.2.2 General References

The following general references are made applicable to this code:

- FDRE Statutory Provisions related to Building and Fire.
- Ethiopian Standards related to Building and Fire.

1.3 Definitions and Interpretations

1.3.1 Definitions

The definitions and vocabularies provided in the following statutory provisions of the FDRE and Ethiopian Standards are valid for this code:

- Definitions provided in the Ethiopian Building Proclamation (Proclamation No. 624/2009), Regulations (Regulations No. 691/2010) and Directives (MoUDC, 2012) of the FDRE.
- Definitions provided in ES ISO 8421-1:2002, ES 1425:2005, ES ISO 13943:2005, ES 1492:2005, ES1494:2005, ES 3081:2006, ES 3083:2006 and ES 3084:2006.

1.3.2 Interpretations

General

Interpretation when necessary shall only be made by qualified personnel certified by the relevant public body and the interpretation given by the MoUDC or his delegate will be final and binding.

Words

Words in singular form can be interpreted as in the plural form and vice versa.

Words in the heading and sub headings shall not be taken into consideration in the interpretation of this Code.

Gender

Words expressed in a single gender may serve for both genders.

Values

Values or figures or numbers indicated except outline numbers are considered as minimum requirements for their intended provisions and shall not deter use of more in values.

Diagrams

The diagrams / figures in this code are intended to clarify concepts and form an integral part of the written recommendations. However, they should not be taken as indicating the only acceptable forms of planning of buildings. Features such as Windows and Doors not relevant to the concepts or principles being illustrated are not included. Diagrams may not be drawn to scale hence no measurement shall be taken and used as reference for any purpose of this Code.

1.4 Fire Safety Signs and Graphical Symbols

Fire protection Safety Signs and Graphical Symbols for fire protection plans shall be as provided in ES ISO 6309:2002 "Fire protection – Safety signs" and ES ISO 6790:2002 "Equipment for fire protection and firefighting – Graphical symbols for fire protection plans – Specification".

SECTION 2 Basis for Fire Precautions

2.1 Introduction

2.1.1 Scope

The scope of this section is to describe and define the basis for fire precautions during building design services, works and uses including:

- The four basic elements of fires, its development and extinguishing methods;
- The purpose of safety measures and planning requirements in relation to fires;
- The classifications, resistance, grading and rating of fires;
- The information to be provided regarding fire precautions to key stakeholders;
- The relationship of this code with related FDRE Statutory provisions and Ethiopian standards; and
- The uses of principles and application of recommendations of this code.

2.2 Fire Safety or Protection and Firefighting

2.2.1 Fire Elements

Fire is constituted by four basic elements called “Tetrahedron of Fire” (Figure 1.1); namely:

- (1) **Fuel or Combustible substance** such as ordinary combustible materials, liquids and gases,
- (2) **Oxygen or other supporters** such as hydrogen to sustain combustion,
- (3) **Sufficient heat** for the attainment and maintenance of a certain minimum level of energy to raise the material to its ignition temperature, and
- (4) **Unbroken or Uninhibited exothermic chemical chain reaction.**

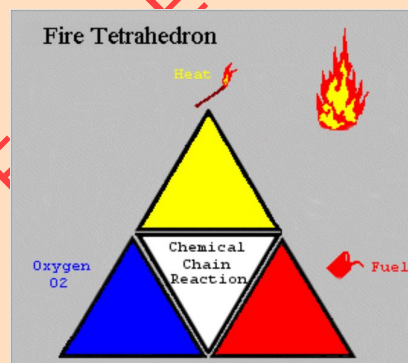


Figure 2.1. Fire Elements

The existence of the above four elements are necessary for combustion; that is, to start ignition of a fire.

2.2.2 Fire Development

During the early stages of fire, smoke is the first detectable evidence either by occupants or by an alarm when fire breaks out. It is increased spread of smoke within a room that causes severe effect on human life including intoxication, incapacity, unconsciousness and possibly death. As the fire grows in area, flames spread to combustible furnishings, electrical fittings, inflammable materials and ceilings which accelerate fire development and enable heat to

spread through radiation. If the space has insufficient openings to provide a continuing air supply, the burning rate of the fire will diminish because of lack of sufficient oxygen but the gases generated can be extremely toxic.

Fire may also spread and penetrate to adjacent rooms and / or buildings if the enclosing walls do not form a fire tight joint with the floor or ceiling above and its spread is rapid if they penetrate into a vertical shaft such as stairways, lift wells or ducts acting as chimneys. Hence, Fire development can either be from within the building or outside of the building. It is within the building that the most direct and serious risks to life arise.

Fire development within the building: In such situations, the following three origins of fire locations shall be given due considerations and be identified in order to choose appropriate fire safety and firefighting precautions:

- a) **A fire may start in an occupied room by the actions of an occupant** (deep fat frying, smoking in bed or children playing with matches) requiring the occupant to exit from the room immediately and give alarm to other occupants followed by closing the room in order to confine the fire to that room and save appreciable time before spreading into the other rooms. Fire will quickly develop to all accesses including corridors, stairways and other rooms if the occupant cannot escape from the room and provide alarm. Furthermore, if the room is left open threatening the life of other occupants becomes evident.
- b) **A fire may start in an occupied room because of discarded smoking materials, electric faults, furniture left too close to heating appliances, etc. without any occupants in the room.** Fire will be a risk to all occupants especially if the door is open and trap them from the exits by the presence of products of combustions. Occupants asleep may be in greater risk in such a situation.
- c) **A fire may start in the entrance hall or circulation spaces of the buildings which will present the most immediate and sever danger possible to all the occupants, particularly to those in upper floors.** In such situations Fire, Heat and Smoke will rapidly develop. For this reason, it is essential to ensure that the potential for a fire starting in such places shall be minimized during design and users advised not to store combustible materials in such places. Besides, external accesses for escape route shall be provided for upper floors.

The risks in all cases will be more serious in storey buildings as heat and smoke transfer rapidly upwards rather than sideways.

Fire development outside of the building: The risks to occupants of other buildings from a fire in another buildings are parallel to, but much less direct than, the risks to the occupants of the buildings of the fire origin. In such situations, the following four conditions shall be given due considerations and be identified in order to choose appropriate fire safety and firefighting precautions:

- a) **A fire may spread through the separating walls or across the face of the building** from one window to another or by radiated heat from a fire in adjacent premises in the case of semi-detached or terraced buildings and hence risks to occupants of an adjoining building will arise.
- b) **A fire may be discovered at its initial stagey the occupants of the adjacent building who make their way out and give alarm or call the fire service.** If extinction is delayed and doors and windows of the adjacent building left open; fire, heat and smoke spread quickly filling exits making difficult for escape and cause direct risk to persons using common access and occupants in the adjacent dwellings.

- c) **A fire may not be discovered by occupants of the adjacent until fire is fully developed within the origin building** and penetrated to the adjacent one with consequences similar to b above. If the adjacent building entrance gives on to an open balcony than an internal corridor, smoke effects will be of little consequence to provide certain time for occupants to escape.
- d) **A fire spread within a mixed use building** requires consideration of effects of one upon another as a fire in one occupancy having serious consequences on another.

2.2.3 Fire Extinction Methods

For fire extinguishing or extinction; it is essential to limit or eliminate one or more of the four fire elements (section 2.2.1) using either or a combination of two or more of the following four methods (Figure 1.2); namely:

1. **Starvation** (limitation or elimination of fuel or any other combustible substance),
2. **Smothering / Blanketing** (limitation of oxygen or other supporter of combustion),
3. **Cooling** (limitation of the attainment and maintenance of a certain minimum level of Energy or Temperature), and
4. **Inhibition / Breaking** (Control of flames or interrupting or delaying the chain reaction by removal or suppression of free radicals)

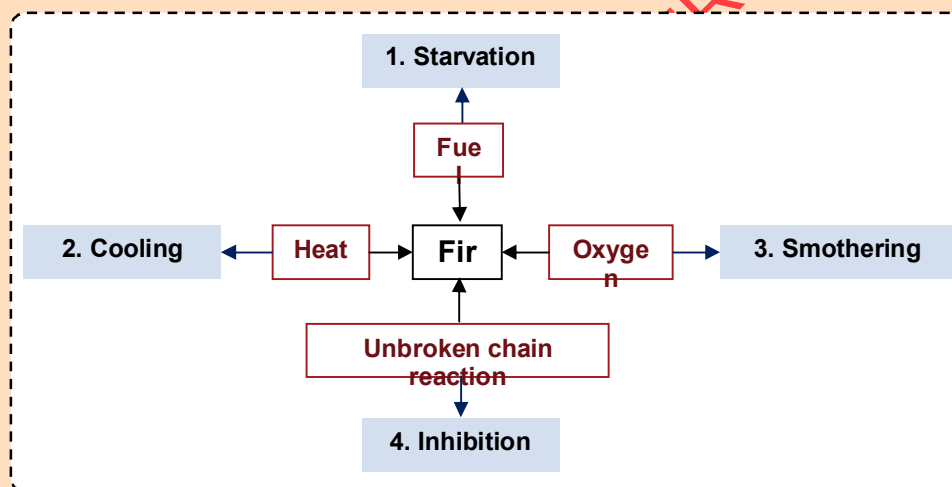


Figure 2.2. Fire extinguishing / extinction methods

Starvation can be made by either or any of the following three approaches:

1. Removing combustible material from the neighborhood of the fire, or
2. Removing the fire from the neighborhood of combustible material, or
3. Sub - dividing the burning material.

Fire blankets and Bucket containing Water or Sand are some of the fire extinction methods used in Starvation.

Smothering can be made by using various types of extinguishers of different types in order to prevent or impede the access of fresh air to the seat of the fire, and allow the combustion to reduce the oxygen content in the confined atmosphere until it extinguishes itself.

These extinguishers can use foam, clouds of finely divided particles of dry powder, etc partly creating inert gases in the immediate vicinity of the fire to disrupt combustion and

partly creating interference within the chain reaction of flame propagation through chemical reaction with the fire and / or oxygen; hence reducing the oxygen content.

Foam, gas and chemical based portable and mobile fire extinguishers are some of the fire extinguishing systems or installations used in Smothering. Besides, provision of fire tight joints and confining fire in a closed room can have a certain smothering effect.

Cooling helps to reduce the rate of heating generated by combustion using the application of water (which is the most useful fire extinguishing agent) and other liquids on fires (using jets or sprays) to increase its rate of dissipation such that the possibility of combustion to persist is nullified. Besides, it reduces the spread and strengths of heat and smokes created as a result of the fire.

Fire Hydrant, Sprinkler system, Hose reel system, etc are some of the fire extinction methods used in Cooling.

Inhibition is extinguishing of fire by flame breaking the chain of reaction when the available free radicals such as OH, H and O or chain carriers are illuminated or suppressed using several types of dry chemical powders.

Dry chemical based portable and mobile fire extinguishers are some of the fire extinguishing systems or installations used in Inhibition.

2.2.4 Safety Measures

The following fire safety measures are available for use and are recommended in this code during building design services, works and uses:

1. Planning and protection of alternative exits and escape routes from rooms and buildings at all times.
2. Defining restrictive or maximum travel distances.
3. Selective positioning of rooms within buildings and segregation of high fire risk or hazard areas.
4. Provisions of automatic (where appropriate) fire, smoke, flame and heat warning or detection, alarm and control systems or installations or equipment to maintain the effectiveness of exits and escape routes.
5. Provisions of self-closing fire doors where appropriate.
6. Provisions of structural fire barriers within and between buildings and as separation to circulation spaces when serving as escape routes.
7. Provisions of automatic (where appropriate) firefighting or extinguishing systems to limit growth of fires and to assist firefighters.
8. Construction with appropriate fire resistant components of buildings and building materials.
9. Provision of appropriate and sufficient access for firefighters to buildings when fire arises.
10. Timely notifying or informing or alarming occupants and fire brigades when ignition or potential cause for fire is observed.

2.2.5 Planning in relations to Fires

Careful attention to details during building design services, works and uses shall be given taking into consideration risks that can be predicted to exist from the outbreak and development of a fire together with routes smoke and hot gases might go through in a building and their effect for evacuation.

Escape routes shall be designed and protected in order to ensure safety to occupants through:

- Attempting to locate the positions of all possible sources of outbreak of fire,
- Predicting the courses that fire follows as it develops, and
- Predicting the risks to occupants that smoke and hot gases are likely to produce.

All parties shall recognize that:

- Fires do not normally start in two different places unless arson is involved, unlikely to originate in the structure itself and unlikely to involve a large area but may spread through or along circulation routes.
- Smoke will be the effect and hence the first detectable product of combustion which cause difficulty in breathing and impair visibility, in the early stages of fires.
- Hot smoke laden gases rise upwards when a fire occurs in an enclosed space and form a layer deepening to fill the whole space downwards and may ignite combustible ceiling, furnishings, etc.

Building Official or the building controlling authority shall be consulted when restrictions imposed by urban planning requirements may cause fire hazards in order to ensure (a) the safety of escape routes outside of the building, (b) access to buildings during firefighting by fire brigade services, and (c) the effects of car parking adjoining buildings.

Water supply sources for firefighting purposes shall be identified and designated as such for sufficiency and location.

Modern furniture used in buildings and certain polymeric materials commonly used in the manufacture of furniture increased risks to fires and producing greater volumes of smoke and other combustion products. Therefore, rooms and / or buildings containing such combustible materials shall be given due considerations than other rooms and / or buildings.

For mixed use occupancy, the following factors need to be considered in addition:

- Fire hazard posed by one occupancy on another,
- Provision for giving warning in case of fire such as automatic fire, smoke, flame and heat detection equipment, and
- Provision of recommended firefighting systems for each and every occupancy.

Occupants observing fires and potential ignitions thereof shall take the following actions:

- Leave the room where fire or probable fire is observed.
- Close the door to contain or confine the fire within the room.
- Initiate alarm to let other occupants to leave.
- Do not use lifts to leave.
- Use only recommended escape routes, do not use balconies which are non-escape route.
- Call fire brigade and inform the full address where fire or probable fire is observed.

To facilitate escape, it is necessary to (a) ensure escape routes are safeguarded from the ingress of smoke, (b) provide a means of smoke ventilation to assist during firefighting, and (c) regulate the travel distance to a story or final exit.

This code provides sufficient but minimum standards and planning requirements in relation to fires to be used during building design services, works and uses in order to ensure the safety of life and property.

2.3 Fire Classifications

2.3.1 General

This section lays down the Classifications, Resistance, Grading and Rating of fires.

2.3.2 Fire Classifications

Fire classifications are made based on:

- (1) Combustibility and flammability of building materials designated as CSA to CSE and CSK classes,
- (2) Building Occupancies and functions designated as OFA to OFH and OFJ,
- (3) Building Hazard levels designated as Light (low) to High (extra) hazard levels,
- (4) Components or types of building materials / elements designated as BMA and BMB classes, and
- (5) Construction Types designated as Types I to IV classifications.

(1) FIRE CLASSES BASED ON COMBUSTIBLE AND FLAMMABLE MATERIALS

Internationally six types of fire classes are acknowledged based on combustible and flammable materials (Table 2.1). This classification replaces fire classifications provided in ES ISO 3941:2002 and are used to describe recommendations for minimum requirements of firefighting provisions.

(2) FIRE CLASSIFICATIONS BASED ON BUILDINGS OCCUPANCIES AND FUNCTIONS

This Classification is specifically based on buildings occupancy and function and its application is limited to this Code. Such classification is preferred as it is more suitable for fire prevention, protection and fighting purposes. For other general design, permit and construction requirements, the classifications provided in the Ethiopian Building Proclamation, Ethiopian Building Regulation and Directives shall be used.

The occupancy of any building shall be in conformity with the appropriate occupancy class given in Table 2.2. Classification shall reflect the primary function of any building divided into two or more areas not having the same primary function. This classification is mainly to define minimum requirements for fire safety precautions.

Notwithstanding the requirements of Table 2.2 above, Space in any building occupancies which is used for other purposes ancillary to fire classification made based on building occupancies subject to adequate facilities and safety measures being provided for it; shall not be classified as a separate occupancy.

The above provision remains valid if and only if a space is not more than;

- a) 100 m² of an occupancy for any occupancy classifications, or
- b) 300 m² of an occupancy classified as J2 or J3 within an occupancy so classified.

Table 2.1. Classes of Fire Based on Combustible and Flammable Materials

Fire Classes	Description
Class CFA: Ordinary Combustible	Fires involving ordinary combustible materials (Organic Solids – compounds of carbon) such as wood, cloth, paper, rubber and most plastics. This is the type of fire that would occur in most building conditions.
Class CFB: Flammable and Combustible Liquids	Fires involving flammable and combustible liquids: petroleum-based materials such as oils, greases and tars; paints, solvents, alcohols and flammable gases. This type of fire would likely to occur where such materials are used, dispensed, or stored.
Class CFC: Energized Electrical Equipment	Fires involving energized electrical equipment. In addition to building electrical service equipment, this type of fire could occur with electric equipment such as computers, copiers, etc. It is important that the extinguishing agent / media shall be nonconductive.
Class CFD: Combustible Metals	Fires involving combustible metals such as magnesium, titanium, zirconium, sodium, lithium, and potassium or metal alloys (commonly found in chemical labs). The extinguisher must match the metal. It will be labeled with a list of metals that match the extinguishing agent.
Class CFE: Flammable Gases	Fires involving flammable gases such as Propane, Butane, Acetylene and Natural Gas
Class CFK: Cooking Oils and Fats	Fires in cooking appliances involving combustible cooking materials, such as vegetable or animal oils and fats. This is for commercial kitchens.

(3) FIRE CLASSIFICATIONS BASED ON FIRE HAZARD LEVELS

In addition to fire classifications provided above; building spaces containing large amounts of flammable and combustible materials and the different building occupancies are also classified based on their perceived fire hazard levels.

The three fire hazard level classifications are determined using two approaches; namely:

- (1) The anticipated quantity of Class CFA and Class CFB Materials (Table 2.3), and
- (2) Broad classifications of Building Occupancies (Table 2.4).

Table 2.2. Fire Classification Based on Building Occupancies or Functions

Classes	Occupancies
OFA. Institutional	A1 Entrainment and Public Assembly Occupancy where persons gather to eat, drink, dance or participate in other recreation
	A2 Theatrical and Indoor Sport Occupancy where persons gather for the viewing of theatrical, operatic orchestral, choral, cinematography or sport performances
	A3 Place of Instruction Occupancy where school children, students or other persons assemble for the purpose of training or learning
	A4 Worship Occupancy where persons assemble for the purpose of worshipping
	A5 Outdoor Sport Occupancy where persons view outdoor sport events
OFB. Mercantile / Commercial	B1 High Risk Commercial Service Occupancy where a non-industrial process is carried out and where either the material handled or the process carried out is liable in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions
	B2 Moderate Risk Commercial Service Occupancy where a non-industrial process is carried out and where either the material handled or the process carried out is liable in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions
	B3 Low Risk Commercial Service Occupancy where a non-industrial process is carried out and where neither the material handled nor the process carried out falls into the high or moderate risk category
OFC. Public	C1 Exhibition Hall Occupancy where goods are displayed primarily for viewing by the public
	C2 Museum Occupancy comprising a museum, art gallery or library
OFD. Industrial	D1 High Risk Industrial Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions
	D2 Moderate Risk Industrial Occupancy where an industrial process is carried out and where either the material handled or the process carried out is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes, or cause explosions

OFF. Rehabilitation / Institutional	D3	Low Risk Industrial Occupancy where an industrial process is carried out and where neither the material handled nor the process carried out does not fall into the high or moderate category
	D4	Plant Room Occupancy comprising usually unattended mechanical or electrical services necessary for the running of a building
	E1	Place of Detention Occupancy where people are detained for punitive or corrective reasons or because of their mental condition.
	E2	Hospital Occupancy where people are cared for or treated because of physical or mental disabilities and where they are generally bed-ridden.
OFF. Business	E3	Other Institutional (residential) buildings Occupancy where groups of people who either are not fully fit, or who are restricted in their movements or their ability to make decisions, reside and are cared for.
	F1	Large Shop Occupancy where merchandise is displayed and offered for sale to the public and the floor area exceeds 250 m ²
	F2	Small Shop Occupancy where merchandise is displayed and offered for sale to the public and the floor area does not exceed 250 m ²
	F3	Wholesalers' Store Occupancy where goods are displayed and stored and where only a limited selected group of persons is present at any one time.
G1 OFFG. Office		Offices Occupancy comprising offices, banks, consulting rooms and other similar usage
OFFH. Residential & Hotel	H1	Hotel Occupancy where persons rent finished rooms, not being dwelling units
	H2	Dormitory Occupancy where groups of people are accommodated in one room
	H3	Domestic Residence Occupancy consisting of two or more dwelling units on a single site
	H4	Dwelling House Occupancy consisting of dwelling unit on its own site, including a garage and other domestic buildings, if any

OFJ: Storage & Garage	H5 Apartments
	J1 High Risk Storage Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with extreme rapidity or give rise to poisonous fumes, or cause explosions
	J2 Moderate Risk Storage Occupancy where material is stored and where the stored material is liable, in the event of fire, to cause combustion with moderate rapidity but is not likely to give rise to poisonous fumes or cause explosions.
	J3 Low Risk Storage Occupancy where the material stored does not fall into the high or moderate risk category
	J4 Parking Garage Occupancy used for storing or parking of more than 10 motor vehicles
OFK: Basements	Basements

Table 2.3. Fire Classifications based on Hazard Levels for stored quantities of Fire Classes

Hazard Classification	Class CFA Materials	Class CFB Materials
Light (Low) Hazard	Normally expected quantities of furnishings	Expected quantities to be less than 1 gal.
Ordinary (Moderate) Hazard	Occasionally contains materials beyond normal anticipated	Expected quantities to be from 1 to 5 gal.
Extra (High) Hazard	Involve the storage, packaging, handling, or manufacture of materials	Expected quantities to be more than 5 gal.
NB: All other Classes (Classes C, D, E & K) of fires are considered as Ordinary (Moderate) or Extra (High) hazard fires based on their occupancies placed in Table 2.4 below.		

Table 2.4. Fire Classifications Based on Hazard Levels among Broad Classification of Occupancies

Hazard Classification	Classification of Occupancies
Light (Low) Hazard	Residential buildings, Dwellings, Lodges and Dormitories; Office premises; Educational and research institutions; Warehouses; Places of worships; Clubs; Assembled Buildings, Coffee curing, roasting and grinding plants; Poultry farms; Fruits and Vegetables dehydrating, drying and producing factories; Sugar Candy manufacturing and Abrasive Manufacturing Premises; Condensed milk manufacturing, pasteurizing and dairies plants; Sugar factories; Aerated Water factories; QC Laboratories; Battery manufacturers and charging and service stations; Breweries; Clay based

	plants; Canning factories; Cement factories & cement based plants; Ceramic factories; Clock and Watch manufacturing; Electric lamps and TV tube manufacturing; Engineering Workshops; Glass and Glass fiber manufacturing; Tanneries; Mica, gum, gelatin and glue manufacturing; and Gold thread / gilding factories and Zinc / Copper factories.
Ordinary (Moderate) Hazard	Residential Apartments, Hotels, Cafes and Restaurants; Airport and other transportation terminal buildings; Aluminum factories; Assembly buildings; Bakeries and Biscuit factories, Book binders, envelopes, Carbon paper, type writer ribbon and paper bag manufacturing; Candle factories; Carpentry, wood, filler, wax paper, carpet, garment and furniture makers; Cigar factories; Cold Storage premises; Chemical manufacturers; Computer installations; Dry cleaning and dyeing laundries; Cable Manufacturing; Flour mills; Hospitals; Mercantile Occupancies; Rubber based manufacturing; Soaps and glycerin factories; Textile mills and Starch factories.
Extra (High) Hazard	Aircraft hangers; Aluminum / Magnesium powder plants; Bulk storage of flammable liquid and combustible goods warehouses; Chemical Manufacturing; Cigarette filter manufacturing; Cinema films and TV production studios; Steel Plants; Distilleries; Duplicating / stencil paper making; Fire Works Manufacturing; Match factories; Oil mills; Paints / varnish factories; Explosive factories; Petroleum refineries and Underground shopping complexes.
NB: Airports, Industrial buildings, Petrol Stations, Other Building occupancies and functions requiring fulfillment of international standards, which are not subjects of this Code but classified here under hazard levels can be used as indicative to fire safety and fighting provisions when specific and international industry standards and practices are referred and adopted.	

(4) FIRE CLASSIFICATIONS BASED ON COMPONENTS OR TYPES OF BUILDING MATERIALS / ELEMENTS

The characteristics of a typical fire resisting material shall be such that it shall not disintegrate under greater heat, its expansion should not be excessive so as to damage the structure; and its contraction on account of sudden cooling from a hot state should not be so rapid as to break into pieces. Their relevant general properties of concern are hardness, thermal characteristics of insulation and expansion, weight, uniformity, appearance and workability. The choice of material for a particular building element shall be determined by its suitability for the intended purpose, cost, availability and compatibility with other materials.

The building material classes specified in this section (Table 2.5) shall apply only to the specified building material or composite building materials. Composite materials that are not specified, for example composite of combustible building materials with other combustible or non-combustible building materials; may have a different fire behavior and hence can be assigned to another building material class. For building materials or composite materials not classified, one may need to refer to a specialist literature and proof shall be established as to the class to which they are assigned.

Table 2.5. Fire Classifications based on Building Materials / Elements

Class BMA Non Combustible Material	
	<p>(1) Sand, gravel, loam, clay and all other soils or rocks occurring in nature used for civil engineering purposes; (2) Minerals, earths, scoria and pumice; (3) Building materials obtained from rocks and minerals by combustion processes and/or expansion processes such as cement, lime gypsum, anhydrite, blast furnace, slag, expanded clay, expanded shale, expanded glass, perlite and exfoliated vermiculite; (4) Mortar, concrete, reinforced concrete, pre-stressed concrete, bricks and building boards made of mineral materials, including those having the usual proportions of mortar or concrete aggregates; (5) Mineral fibers case without organic additives; (6) Stone ware and ceramic tiles; and (7) Metals and alloys not in finely divided form, with the exception of alkali metals and alkaline earth metals and their alloys.</p>
Class BMB Limited Combustible Material	<p>BMB1</p> <p>(1) Wood wool slabs; (2) Gypsum plastered board with plain or cellular surface; (3) Un-plasticized PVC pipes and fittings with a wall thickness not greater than 3.2mm; (4) Floor coverings; (5) PVC floor adhesively bonded to a solid mineral backing; and (6) Oak parquet floors consisting of parquet strips, parquet mosaic fingers, parquet battens, in each case, with sealant finishes.</p>
	<p>BMB2</p> <p>(1) Timber and standardized timber derivatives, unless specified below, with bulk density of not less than 400 kg/m³ and thickness greater than 2mm or with a bulk density of not less than 230 kg/m³ and thickness greater than 2mm or with a bulk density of not less than 230 kg/m³ and thickness greater than 5mm; (2) Standardized timber derivatives, unless specified below, with a thickness greater than 2mm, coated over the whole surface with wood veneers or with decorative laminated pressed board, bonded by a non-thermoplastics bond; (3) General purpose decorative plastics sheet veneered wood flat pressed board with a thickness of not less than 4mm; (4) Decorative plastics sheet veneered wood fiber board with a thickness of not less than 3mm; (5) Decorative laminated pressed board; (6) Gypsum composite plaster board (7) Laminated light weight building slabs made of foamed plastics and wood wool; (8) Un-plasticized PVC panels; (9) Pipes & fittings made of un-plasticized PVC, Polypropylene, Un-plasticized polypropylene, acrylonitrile-butadiene-styrene and acrylester-styrene-acrylonitrile; (10) Cast polymethyl methacrylate panels, with a thickness of not less than 2mm; (11) Un-foamed polystyrene (PS) molding compounds, in the form of panels with a thickness of not less than 1.6 mm; (12) Un-saturated polyester resin (also with glass fiber reinforcement or with mineral additives) with a thickness of not less than 1.3mm; (13) Un-foamed polyethylene, with a bulk density not exceeding 940 kg/m³ and a thickness of not less than 1.4mm; (14) Un-foamed PP-B-M polypropylene molding compounds, with a thickness of not less than 1.4 mm; (15) Un-foamed polyurethane-based joint sealing compound, without tar or bitumen additives, and also polysulfide, silicon and acrylate in all cases installed between building materials of at least class B2; (16) Floor coverings i.e. PVC coverings; adhesively bonded, linoleum coverings or textile floor coverings; (17) Asphalt; and (18) Roofing felts and roof sheeting.</p>

This Classification is mainly used to determine appropriate building material for the building components or elements when designed or executed for fire safety precautions.

(5) FIRE CLASSIFICATIONS BASED ON CONSTRUCTION TYPES

For the purpose of fire protection requirements, based on types of construction all buildings shall be classified into four categories according to fire resistance as listed below.

- A. Type I (Fire Resistive):** Construction in which the main structural members are made using non-combustible materials and are fire protected: include such a manner that at least a four hour rating is available for bearing walls, party walls, isolated piers and columns; at least a three hour rating is available for beams, girders, joists, floors and floor ceilings assemblies; a two hour rating for roofs roof assemblies and partitions.
- B. Type II (Non-combustible):** Construction type in which the main structural members are made using non-combustible or limited combustible include and shall be protected to have

some degree of fire resistance; include all buildings having similar requirements with Type I construction, except that bearing walls, isolated piers, columns and main girders which support walls shall have at least a three hour fire resistance; the floor & floor assemblies, roofs and roof ceiling assemblies shall have a two hour fire rating.

- C. Type III (Exterior Protected Combustible):** Construction type in which main structural members are made using limited combustible materials: includes all building with bearing walls, piers & columns (may be masonry, concrete or heavy timber) which shall have at least a two hour fire rating; beams girders, floors and floor assemblies, roofs & roof ceiling assemblies shall have at least a one hour fire rating.
- D. Type IV (Unprotected)** Construction type in which the exterior walls shall be made using limited combustible and/or combustible materials: include all buildings where the exterior walls are of masonry or reinforced concrete with at least two hour rating, interior structural members may be partially or wholly of wood of smaller section; or of iron or steel which is not specially treated against fire.

2.4 Fire Resistance Grading or Rating

Fire resistance grading or Rating is the shortest period for which a building element or building component complies with the requirements for stability, integrity and insulation when tested in accordance with a standard fire rating test. It is used to choose the right materials for different parts of a building based on the time set for occupants to escape or fire to be contained within a building. This part covers:

- A. The different Division areas within a building,
- B. The separating elements for different occupancies,
- C. The different Types of Constructions, and
- D. The designations in portable fire extinguishers that affects or determines the fire resistance grading or rating levels of the building as a whole or a building component or a building material.

(A) DIVISION AREAS

Division area is area of portion of a building separated from the remainder of such building by one or more separating elements

Any building shall be divided into divisions with a floor area of not more than that given in columns 2, 3, or 4 of Table 2.6 below, and such divisions of the respective floor areas shall be separated effectively from each other by division separating elements provided that:

- a) Where an occupancy classified OFJ1, used for storage of flammable liquids, forms part of any building, such part shall be a separate division and the area of such division shall be not more than 100 m²;
- b) Where storage of goods is expected to be to a height of more than 3m in any occupancy classified OFJ1 or OFJ2, an approved fixed installation of automatic fire extinguishing system or other recommended firefighting provision shall be provided.

There is a need to limit the maximum division area in order to effectively provide fire safety and firefighting precautions during building design, works and uses. Table 2.6 provided the maximum division areas recommended.

Maximum division areas are spaces of each occupancy classes that are allowed to extend without separation based on the provisions of fixed firefighting system or installation or not; that is with or without fixed fire extinguishing system or installation.

Table 2.6. Maximum Division Areas for classes based on building occupancies and functions

1	2	3	6
Occupancy	Maximum Division Area (m ²)		
	No fixed automatic Fire extinguishment installation	With fixed automatic fire extinguishment installation	
		One storey	Two storey and over
OFE1a, OFE2a, OFE3a	1 250	1 250	1 250
OFE4	250	1 250	1 250
OFA2, OFB2, OFB3, OFC1, OFC2, OFG1	5 000	No limit	10 000
OFA4, OFD3, OFA5, OFJ3, OFJ4	No limit	No limit	No limit
All other occupancies	2 500	No limit	5000
NB: The maximum division area on any storey, and all such divisions, shall be interconnected.			

(B) SEPARATING ELEMENTS

Separating elements can be Occupancy, or Division, or Tenancy, or Partition or Partition walls.

(1) OCCUPANCY SEPARATING ELEMENTS

Occupancy is a particular use or the type of use to which a building or portion thereof is normally put or intended to be put and Occupancy Separating Elements are partition elements that separate one occupancy from the other.

Any portion of a building having an occupancy in any one of the groups of occupancies (OFA) to (OFG) defined in Table 2.2 shall be subject to the requirements contained in Table 2.5 above, and be separated by means of an occupancy separating element from any portion of such building used for an occupancy in any other of such groups of occupancies.

Where any occupancy separating element is required, such occupancy separating element shall have a fire resistance not less than that given in Table 2.7 below.

Table 2.7. Fire Resistance of Occupancy Separating Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
OF Classes	Fire Resistance (min)																
	B1	B2	J1	A1-3	F3	D4	E1-4	A3	J2	F2	G1	J3	J4	H1-5	A5	C1	B3
	D1	D2		F1												C2	D3
B1, D1	·	12 0	12 0	120	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
B2, D2	120	·	12 0	120	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
J1	120	12 0	·	120	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
A1 - A3, F1	120	12 0	12 0	·	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
F3	120	12 0	12 0	120	·	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
D4	120	12 0	12 0	120	12 0	·	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0	12 0
E1 - E4	120	12 0	12 0	120	12 0	12 0	·	90	90	90	90	90	90	90	90	90	90
A3	120	12 0	12 0	120	12 0	12 0	90	·	90	90	90	90	90	90	90	90	90
J2	120	12 0	12 0	120	12 0	12 0	90	90	·	90	60	60	60	60	60	60	60
F2	120	12 0	12 0	120	12 0	12 0	90	90	90	·	60	60	60	60	60	60	60
G1	120	12 0	12 0	120	12 0	12 0	90	60	60	60	·	60	60	60	60	60	60
J3	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	·	60	60	60	60	60
J4	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	60	·	60	60	60	60
H1 - H5	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	60	60	·	60	60	60
A5	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	60	60	60	·	60	60

C1, C2	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	60	60	60	60	60	60	60
B3, D3	120	12 0	12 0	120	12 0	12 0	90	60	60	60	60	60	60	60	60	60	60	60

(2) DIVISION SEPARATING ELEMENTS

Division is portion of a building separated from the remainder of such building by one or more separating elements and Division Separating Elements are internal walls that separate one division from another division.

Where a division separating element is required, such division separating element shall have a fire resistance of not less than the relevant figure given in Table 2.8 below for the respective building classifications.

Any construction or expansion joint provided to cater for any movement effects of a building component in a division separating or occupancy separating element shall have the same fire resistance rating as that required for the separating element. No combustible roof components shall penetrate the occupancy separating elements or division separating elements between occupancies and divisions.

Table 2.8. Fire Resistance of Division Separating Elements for different Occupancies

1	2
Occupancy	Fire resistance (minutes)
All occupancies other than those referred to below	60
OFB1, OFC1, OFD1, OFE1-E3, OFF1, OFF3, OFJ1	120

(3) TENANCY SEPARATING ELEMENTS

Tenancy separating elements are separating element between tenants within the same occupancy classification group. Any tenancy separating element between tenancies shall have a fire resistance of not less than 30 min, except for OFE1-E3, and OFH1-H3 occupancies; which shall not be less than 60 min.

(4) PARTITION WALLS AND PARTITIONS

Partition is interior construction less than one storey in height, and which is generally of a light construction and demountable component. Partition Wall is non-structural internal wall that extends to the ceiling and is constructed for the purpose of subdividing a space.

Any partition or partition wall in any occupancy;

- Shall have a nominal fire resistance of not less than 30 min and be non-combustible, or
- Where combustible materials are present, shall not contribute a fire load of more than 5 kg/m² of floor area.

In any building classified as OFH3 or OFH4;

- a) Any separating element (wall and floor) between any garage that is not large enough to be classified as OFJ4 and any habitable room shall have a fire resistance of not less than 30 min and the wall shall extend to the underside of the roof; and
- b) Any door between such garage and any such room shall have a fire resistance of not less than 30 min.

Any solid timber door constructed with double rebated joints, that have a thickness of not less than 40 mm, shall be deemed to comply with the requirement of section 3 and 4 of this code for a rating of at least 30 min.

(C) Fire Resistance rating based on Type of Constructions

The fire resistance ratings for various types of construction for structural and non-structural members shall be as given in Table 2.9.

Table 2.9. Fire resistance ratings of building elements in Hours

Sr. No	Building Elements and functioning	Types of Construction			
		I	II	III	IV
1	Exterior Walls				
	• Fire separating and load bearing walls	4	3	2	2
	• Fire separating and non-load bearing walls	2	1.5	1	1
2	Interior bearing walls, bearing partitions, columns, piers, girders, trusses (other than roof trusses) and framing				
	• supporting more than one floor	4	3	2	2
	• supporting a roof or one floor only	1	1	1	1
3	Fire Walls for dwelling unit, tenant spaces and non-load bearing partitions	4	2	2	2
4	Fire enclosures of exit ways, stairways; shafts other than in exit ways, elevator, hoist ways	2	2	2	2
5	Exit way access to corridors; vertical separation for dwelling unit, tenant spaces and non-load bearing partitions	1	1	1	1
6	Structural members supporting walls; floor construction and their assemblies	3	1.5	1	1
7	Roof construction:				
	• 5m or less in height	2	1.5	1	1
	• more than 5 m height	1	1	1	1

For buildings above 15 m in height non-combustible materials with minimum fire rating of 2 hours shall be used for construction of load bearing framework. The internal walls of staircases shall be brick work or reinforced concrete, or any other material of construction with minimum of two hour fire rating. All floors be compartmented with area not exceeding 750 m² by a separation wall with 2 hours fire rating.

For floors having provisions of sprinklers, the area may be increased up to 50%. In long buildings, the fire separation walls shall be at distance not exceeding 40m. For departmental stores, shopping centers and similar occupancies, the area shall be reduced to 500 m². Where this is not possible, provision of sprinklers or appropriate firefighting precaution shall be made with appropriate spacing.

Walls for chimney shall be considered as Type I construction.

The fire resistance of an element of a structure or combination of elements is determined from one of the following:

- Information as established by research data or by internationally accepted standards
- Direct application of the results of fire resistance test on an element of structure
- On the basis of calculating the fire resistance of a structural element.

(D) Fire Resistance Rating and designations for portable fire extinguishers

All extinguishers capable of extinguishing Class CFA, CFB or CFK fires carry a Fire Rating which is indicated by a number and letter such as 13A, 55B, etc. The number indicates the size of fire it can extinguish under normal test conditions, that is; the larger the number, the larger the fire it can extinguish. The letter indicates the fire classification based on combustibility and flammability provided in Table 2.1 above. Class CFC, CFD and CFE fires do not carry a rating designations.

The minimum effective discharge time of extinguishers with a 2A rating shall not be less than 13 seconds. Similarly, the minimum effective discharge time of extinguishers with Class B fire ratings shall be not less than 8 to 15 seconds.

2.5 POPULATION /OCCUPANCY LOAD/

Population or Occupancy load is the design number of users accommodated in a building. It is a vital tool that alongside the building type, governs the fire exit placement and evacuation strategy for a building. For determining the exits required, the number of person's within any floor area or the occupant load shall be based on the actual number of occupants, but in no case less than that specified.

The occupant load of a mezzanine floor discharging to a floor below shall be added to that floor occupancy and the capacity of the exits shall be designed for the total occupancy load thus established.

The number of occupants for an existing building with a reasonably fixed population may be ascertained by questioning the responsible person(s) who owns or occupies the building. For buildings such as theatres or cinemas, the number of seats provided should be assessed. In situations where the number of occupants is unknown, the following calculation [Eq. 2.1] using the density factor and the relevant floor space, will give values for the occupant load.

Below is further information on the density factor and an equation for calculating the occupant load.

The occupant load is equal to the floor space, subtracting the permanent features, divided by the density factor; that is:

$$\text{Occupant Load} = \{\text{Floor Space} - \text{permanent features}\} / \text{Density Factor} \quad [\text{Eq. 2.1}]$$

To calculate the maximum numbers of people permissible in any given occupancy – the occupant load – one must refer to **density factors**. The density factor may be defined as “the available floor space per person”.

Design codes for buildings lay down specific density factors, which will vary, dependent upon the intended use of the space. To ascertain the maximum number of people, one calculates the floor space and deletes the area of permanent features such as stairs, toilets, lifts, escalators, corridors and other circulation spaces.

What is left is the usable floor space and this is divided by the density factor giving you the number of people who may occupy that area. With the ascertained occupant load numbers, one can design the buildings fire exits accordingly.

As a result; the population of any room or story or portion thereof shall be taken as the actual population of such room, story or portion thereof where such population is known or determined using the above expression, where such population is not known; the population shall be calculated from the criteria given in Table 2.10.

Table 2.10. Design Occupancy Load /Population/

1	2
Class of Occupancy of Room or Story or Portion thereof	Occupancy Load / Population /
OFA1, OFA2, OFA4, OFA5	Number of fixed seats or 1 person per m ² if there are no fixed seats
OFA3, OFH2	1 person per 5 m ²
OFB1-B3, OFD1-D3	1 person per 15 m ²
OFC1, OFE2, OFF1, OFF2	1 person per 10 m ²
OFC2, OFF3	1 person Per 20 m ²
OFE1, OFE3, OFH1, OFH3, OFH4	2 persons per bedroom
OFG1	1 person per 15 m ²
OFJ1-J4	1 person per 50 m ²

In the case of any occupancy classified as OFF1, where the total floor area is more than 500m², that portion of the floor area that is in excess of 500 m² shall, for the purposes of calculation of population, be reduced by an amount of 20 % .

2.6 Relationships with Statutory Provisions / Legislations and Ethiopian Standards

2.6.1 General

The relevant statutory provisions and Ethiopian Standards indicated in Annex A have to be complied within the event of a conflict with this Code. However, this Code is of a wider scope and includes matters relevant to the protection of buildings from fire as well as the safety of the occupants and properties; hence enjoys priority over the statutory provisions in case they provide requirements of a specific nature and explicitly described hereof.

It is to be noted that this code is obligatory in nature and has precedence over voluntary standards made available by the other fire related Ethiopian Standards (Annex B).

2.7 Duties and Roles of Key Stakeholders

2.7.1 General

Information shall be sufficiently communicated to all parties specifically to Regulatory Bodies, Developers or Clients, Designers, Supervisors, Contractors and Users or Occupiers and their agents, as the effectiveness of fire safety and firefighting provisions included in this code are highly dependent upon their cooperation and actions.

2.7.2 Regulatory Bodies

Regulatory bodies or their agents are advised to use the following guidance in fulfillment of their fire safety and firefighting precautions requirements:

- It is necessary that waiver of fire precautions requirement be made strictly based on justifiable reasons in towns where such hazards are minimal and / or their provisions are non-economical by a committee established for such a specific purpose approved by the Ministry of Urban Development and Works or its successors and / or delegates hereinafter called the Ministry.
- It is necessary that the Ministry or its delegate keep records of qualifications and experiences to certify fire related professionals or occupations to authorize their ability and involvement in fire precautions design or installation or inspection or supervisory or management and maintenance services.
- It is necessary that the Ministry to cause review of recommendations in this code and any waivers approved thereof periodically based on the development of the imminent increase of fire hazards in any town or city.
- It is necessary that fire related designs need to be approved prior to installation in buildings.
- It is necessary that fire precautions installed in buildings are checked for conformance to this code and periodically inspected and maintained for their operations.

2.7.3 Developers / Clients

Developers or their agents are advised to use the following guidance in fulfillment of their fire safety and firefighting precautions requirements:

- It is necessary that fire precautions need to be provided in accordance with the requirements of this code and subsequent approved fire design services.
- It is necessary that all escape routes are finished, safe, unobstructed and made operational before occupation.
- It is necessary that fire doors are always closed, are not wedged open and self-closing mechanisms are well maintained where provided.
- It is necessary that fire, smoke and heat warning or detection, alarm and control or fighting systems shall always be made operational; that is, need to be inspected, tested and maintained periodically and enable early detection to let occupiers escape early and minimize their spread.
- It is necessary that any alterations, additions, inspections, repairs, or modifications to fire services facilities and equipment shall be carried out only by competent persons (Occupational or Professional).

- It is necessary to consult the relevant public body and competent persons when alterations to buildings are being considered for any effects with respect to fire safety and firefighting precautions.

2.7.4 Designers and Supervisors

Designers and Supervisors shall inform their Clients of the nature, functions and if necessary limitations of fire precautions taken into considerations in the building construction design services including provision of emphases to those whose nature may be less evident in order to enable Clients to possess a better understanding of the responsibility for ensuring that a high standard of safety from fire to be maintained.

Designers shall ensure the fulfillment of minimum standards (but not limited to) set in this Code during building design services and recognize negligence and / or intentional failure to respect for will call upon failure of professional liability legally.

Designers also require referring and using recommendations of Ethiopian Standards listed in Appendix A-2, specialist literatures, relevant international practices and specific industry requirements for those which are not specifically covered in this code and will be liable for their fire safety and fighting provisions.

Supervisors shall ensure the conformance of fire design requirements only to the extent the design shall respect the recommendations set in this code or any approved waiver thereof or use of international standards for specific industries not covered in this code.

Supervisors shall strictly approve fire precaution installation systems based on the approved design and specifications included in the specific contract and follow the installation of fire precautions by the Contractor for conformance.

2.7.5 Contractors

Contractors shall ensure the fulfillment of minimum standards (but not limited to) set in this Code during construction works and recognize negligence and / or intentional failure will call upon legal liabilities.

2.7.6 Users / Occupiers

Users / Occupiers or their agents are advised to use the following guidance in fulfillment of their fire safety precautions requirements:

- It is necessary that smoke alarms are inspected periodically for operability.
- It is necessary that all escape routes do not store anything, especially easily combustible and flammable materials.
- It is necessary not to store combustible and flammable materials where gas and electricity lines and / or meters are fitted.
- It is necessary not to block access roads to the building for firefighting services.
- It is necessary to leave straight away from a room where fire breaks out and close the door behind, do not stay behind to put out the fire.
- It is necessary to let others to leave from the surrounding rooms using either alarm or all other available means and close the front door of the building behind.
- It is usually safe to stay where you are if you identify fire in a nearby building unless smoke and / or heat is transmitted into your building.

- It is necessary not to use lifts, balconies unless they are part of the escape routes and call the fire brigade, tell the address where the fire breaks out and your telephone number but do not shut your telephone before the fire brigade representative repeats all the information.

2.7.7 Use of the Principles and Application of recommendations in this Code

Recommendations provided in this code shall be taken as minimum requirements only. Buildings providing beyond minimum requirements stated in this code that enhance safety of people and property are not prohibited if economy is not questionable.

Intelligible and contextual appreciation of principles and application of recommendations in this code is essential as it is not possible to make comprehensive fire precautions covering all possible fire risks. As a result, designers shall take into account the particular type of buildings, their contents and kinds of occupants they serve in relation to potential fire risks or hazards.

Recommendations provided in all sections of this code shall be considered integratively; that is, isolated or individual recommendations may give little or no benefit relating to fire safety as well as firefighting precautions.

Before using or purchasing this code; it is recommended to ensure its status towards the latest version as it may be subject to reviews.

Use of recommendations in this code shall apply for the building design and works of new buildings and alterations of existing buildings.

ONLY FOR REVIEW PURPOSE

SECTION 3 Fire Safety and Means of Escape and / or Egress

3.1 Introduction

3.1.1 Scope

This section covers the fire safety and means of escape / egress requirements for planning within the building and the building site and site planning.

3.2 Escape from Fire

Escape from fire safely through sufficient escape routes (means of escape) and exits (means of egress) is central to allowing occupants to reach an area of relative safety without undue delay during fire emergency. Such provisions shall be given appropriate consideration including staged evacuation possibilities during building program definition and design services.

Not only fire but products of fire such as smoke, heat and flames need also be considered in determining the appropriate escape routes and exits as well as their containment for some time using compartmentalization, firefighting precautions, etc.

Each floor plan should show the location of all main corridors and exits as a means of escape, the location of fire-protection equipment—including evacuation devices—and a list of all at-risk building occupants, including their usual location within the building. Evacuation procedures should also incorporate the individual evacuation plans of the building's at-risk occupants and establish an area outside of the building including refuge areas where occupants can meet to ensure that everyone has evacuated the building safely.

Practical experiences have shown that provision of appropriate escape routes and exits is not a sufficient requirement to enable occupants evacuate to safety places. It is also necessary to build occupants motivation to escape by providing package of fire precaution measures and complementary training on how to evacuate including practices of Fire drill.

People with disabilities shall also be given appropriate assistance as well as means of escape and egress for evacuation during fire emergency. Refuge areas other than spaces occupied by escape flow, ramps with appropriate slope, firm and slip resistant surface finishes and lifts designated for firefighting services can be utilized for evacuating disable persons. Designers may refer ES 3083:2006 and relevant standards and literatures to determine minimum requirements with respect to means of escape for disable people. It is advisable and practicable that disable people be placed in ground floors having a direct horizontal means of escape wherever possible.

When designing a building and the resulting fire escape measures, one must be aware of six main points; namely: (1) Fire Classification based on building occupancy and function (Table 2.2); (2) Evacuation Time; (3) Travel distance; (4) Occupancy load (Table 2.5); (5) Widths of Escape routes and Exits; and (6) Number of exits or means of egress.

The minimum recommended requirements of means of escape and / or egress of this code is provided based on the fire classification of building occupancy and function defined in section 2 above.

Evacuation time is mainly dependent upon the fire resistance rating of building materials and separation and division elements as provided in section 2 of this code.

While limitation of travel distance determine the position of exits; the occupancy load; that is, the number of persons to be evacuated determine the size or widths and numbers of escape routes and exits. However, one shall also consider the height and size of the building in order to determine additional escape routes or stairs for firefighting purposes.

Designers full appreciation of the probable behavior of fire section by section in an occupancy is an important requirement to design the means of escape and / or egress taking into consideration the above six points and development rate of fire and its primary products such as smoke, heat and flame.

The basic criteria for determining the design for means of escape and / or egress are (To be checked for repetition in the final draft):

1. Provision of alternative means of escape.
2. Every part of the building within restricted travel distance to either an exit to safe place or protected areas such as staircases or refuge areas.
3. Lifts other than firefighting lifts, passenger conveyors and escalators, portable and throw out ladders and self-rescue apparatus are not acceptable as a means of escape.

3.3 Planning Building Site and Site Planning

Planning building site and site planning for firefighting includes provisions for:

1. Emergency vehicular access;
2. Open spaces within the sight; and
3. Accessibility for firefighting including access staircase for firemen, firemen lifts and firefighting and rescue staircases which are called protected areas.

3.3.1 Emergency Vehicular Access (EVA)

Every building shall be provided with adequate access to allow firemen safe and unobstructed access around and to all floors of the building in the event of a fire. Every building shall also be provided with an EVA to allow the safe and unobstructed access for the Fire Services Brigade around the building and to the site of the building for the safe operation of such a vehicle.

EVA for all the building categories should be designed and constructed complying with the following requirements, unless otherwise specified and given a special exception:

- (a) The width of an EVA in the form of a carriageway should not be less than 7.5m. An EVA that is not in the form of a carriageway should be hard-paved, not less than 6m wide and well demarcated on site and should be free from surface parking;
- (b) If there is any overhead structure over any part of the EVA, clear headroom, of not less than 4.5m should be maintained;
- (c) The EVA should allow safe and unobstructed access and safe operation of a vehicle of the Fire Services Department having the specifications of the standard of Ethiopia fire brigade vehicle. Turning space for vehicles of the Fire Services Department should be provided at all dead-ends;
- (d) The EVA must serve at least one major facade of the building. A major facade of a building is defined as having more than one-fourth of the total length of all the perimeter walls of the

building. In case the major facade is less than one-fourth of the total length of all the perimeter walls of the building, the EVA should serve this major facade and, in addition, other facades of the building such that the aggregate length of the facades served is not less than one-fourth of the total length of all the perimeter walls of the building. A part of the building facade is deemed to be served by the EVA if the horizontal distance between the EVA and such part of the facade does not exceed 10m. The part of the EVA serving a building facade should not be covered.

- (e) Alongside any EVA reliable and adequate water supply should better be provided to enable the fire brigade to effectively fight the fire and carry out rescue operations.

3.3.2 Open spaces within the site

The open spaces around or inside a building shall conform to the general building requirements set by the zoning law.

For high rise buildings, the following additional provisions of means of access to the building shall be ensured:

- (a) The width of the main street on which the building abuts shall not be less than 12 m and one end of this street shall join another street not less than 12m in width; the road shall not terminate in a dead end except in the case of residential building, no higher than 30m.
- (b) The compulsory open spaces around the building shall not be used for parking; and, adequate passageway and clearances required for fire fighting vehicles to enter the premises shall be provided at the main entrance; the width of such entrance shall not be less than 4.5m. If an arch or covered gate is constructed, it shall have a clear head-room of not less than 5m.
- (c) The approach to the building and the open spaces of the building, on all its sides up to 6m in width or greater, is to be built of a hard surface capable of taking the mass of fire engine weighing from 20 to 40 tons.
- (d) The main entrance to the plot shall be of adequate width to allow easy access to the fire engine and in no case shall it measure less than 6m in width. If the main entrance at the boundary wall is built over, the minimum clearance shall be 4.5m. A turning radius of 9m shall be provided for firefighting and fire brigade movement.
- (e) The road shall not terminate in ahead end except in the case of residential building up to a height of 30m.
- (f) Ramp for basement or storied parking:- For parking spaces in a basement and upper floors, at least two ramps of adequate width and slope shall be provided preferably at the opposite side and such ramps may be permitted in the side and rear marginal open spaces after leaving sufficient space for movement of firefighting equipment.

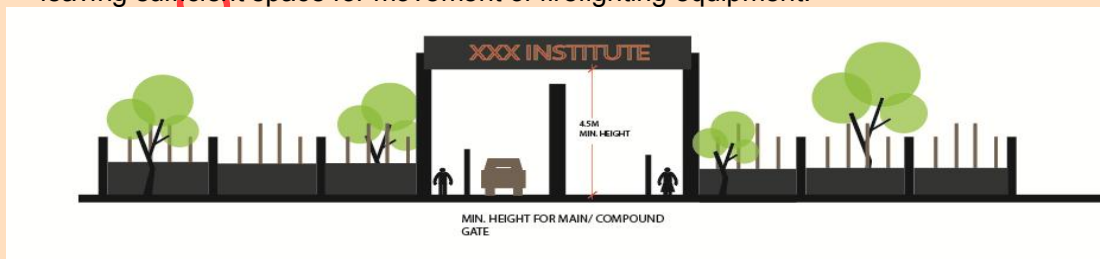


Figure 3.1. Gates Headroom Height

3.3.3 Accessibility for firefighting

Accessibility for firefighting such as the minimum numbers of access staircase required for firefighting, firemen's lift and additional firefighting and rescue stairways are provided for defined fire classifications based on occupancy and functions and additional building height considerations (Table 3.1).

Table 3.1. Minimum Requirements of Numbers of Accesses for Fire Fighting

Fire Classification based on Occupancy and Function	Additional Requirements	Numbers of Access for firefighting services		
		Staircases	Fireman's Lifts	Fire fighting and Rescue Stairways
Residential (OFE3, OFH3, OFH4)	Not exceeding three storeys	None		
Residential (H5), Business(F1)	(a) Exceeding 1 but not exceeding 6 storeys and uppermost floor not exceeding 13m above ground and usable floor area not exceeding 250m ² per floor	One	None	
	(b) Exceeding 1 but not exceeding 6 storeys and uppermost floor exceeding 13m but not exceeding 17m above ground and usable floor area not exceeding 150m ² per floor	One		
Residential (H5), Business (F1)	(a) Exceeding 1 but not exceeding 30m above mean level of lowest street, irrespective of cubical extent	Two or more		
	(b) Exceeding 2 storeys and exceeding 30m above the mean level of lowest street, irrespective of cubical extent	Two or more	One within 60m of any part of floor	None
All Non-Residential Buildings other than OFD, OFH1, OFJ, or buildings listed above	(a) Exceeding 1 storey but not exceeding 15m above mean level of lowest street, irrespective of cubical extent	Two or more	None	
	(b) Exceeding 1 storey and exceeding 15m but not exceeding 30m above the mean level of the lowest street and not exceeding 7000m ³ in cubical extent including basements	Two or more		
	(c) Exceeding 2 storeys and exceeding 15m but not exceeding 30m above mean level of the lowest street and exceeding 7000m ³ in cubical extent including basements	Two or more	One within 60m of any part of floor	None

	(d) Exceeding 2 storeys and exceeding 30m above mean level of lowest street, irrespective of cubical extent	Two or more	One within 60m of any part of floor
Hotels (OFH1), Institutional (OFE1 – E3) and Assembly(OFA1-A2)	(a) Exceeding 1 but not exceeding 2 storeys	Two or more	
	(b) Exceeding 2 storeys, irrespective of height above mean level of lowest street and cubical extent	Two or more	One within 60m of any part of floor
Industrial (OFD) and Storage (OFJ1 – J3)	(a) Exceeding 2 storeys but not exceeding 30m above the mean level of the lowest street and not exceeding 7000m ³ in cubical extent including basements	Two or more	One within 60m of any part of floor
All Basements		Two or more	One within 60m of any part of floor
NB: Additional provisions <ol style="list-style-type: none"> 1. Every building having a height of more than 25mts shall be provided with diesel generators which can be utilized in case of failure of the electricity. 2. Water Supply: Underground tank of the capacity of 100000 liters and 200000 liters for the buildings situated within the municipal limit and outside of the municipal limit respectively be invariably provided in all the high rise buildings. 3. The detailed plan showing the arrangement of pipe lines. Booster pumps and water-tanks at various levels shall be submitted for approval of the concerned authority along with the plans and sections of the buildings. 4. All the requirements under the above regulations shall be clearly indicated on plans duly signed by the owner and the person who has prepared the plans. The Competent Authority may direct the owner to submit such further drawings as may be necessary to clarify the implementation of the provisions of the above regulations. 5. Mixed Occupancy when any building is used for more than one type of occupancy. Then is so far as fire safety is concerned it shall conform to the requirements for the occupancies of higher hazard. Unless the high hazard area is separated by separating walls of 4 h rating. The occupancies shall not be treated individually. 			

3.4 Planning within Buildings

3.4.1 Exit or Means of Escape / Egress Facilities and Arrangements

Exit Facilities and Arrangements deals with: (A) Evacuation Routes, (B) General Exit requirements, (C) Capacity of Exits, (D) Exit arrangements and Travel distance, and (E) Exit Facilities.

A. Evacuation / Escape Routes

There are three main strategies for evacuations routes. Every building should have a Fire Emergency Evacuation Plan (FEEP) posted in the lobby and kept with the building administrator. Below are the three evacuation strategies that present themselves:

- (a) **Simultaneous Evacuation:** In most premises, the evacuation in the case of fire will simply be by means of everyone reacting to the warning signal and making their way, by the means of escape, to a place of safety away from the premises. This is known as a simultaneous

evacuation and will normally be initiated by the sounding of the general alarm over the fire warning system.

- (b) **Vertical Phased Evacuation:** In some larger buildings with complex premises, it is appropriate to start the evacuation by initially evacuating only the area closest to the fire and warning other people to stand by. This is normally done by immediately evacuating the floor where the fire is located and the floor above and below. The other floors are then evacuated one by one to avoid congestion on the escape routes.

A variation on the Vertical Phase Evacuation is a Horizontal Phased Evacuation, which may be appropriately used for Institutions, Group C buildings such as hospitals. A Horizontal Phase Evacuation divides the floor into a number of fire resisting compartments and the occupants are moved from the compartment involved in the fire to an adjacent compartment, and if necessary, moved again.

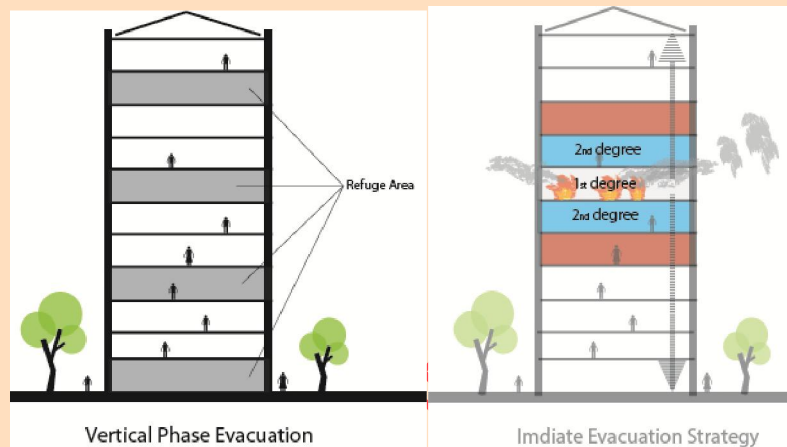


Figure 3.2. Vertical and Immediate Evacuation Types

Because of the extra time a Horizontal Phased Evacuation takes other fire precautions may be required. These include the use of:

- (i) Fire control points.
- (ii) Compartmentation of the premises using fire-resisting construction.
- (iii) Sprinklers in buildings where the top floor is 30 meters or more above ground.

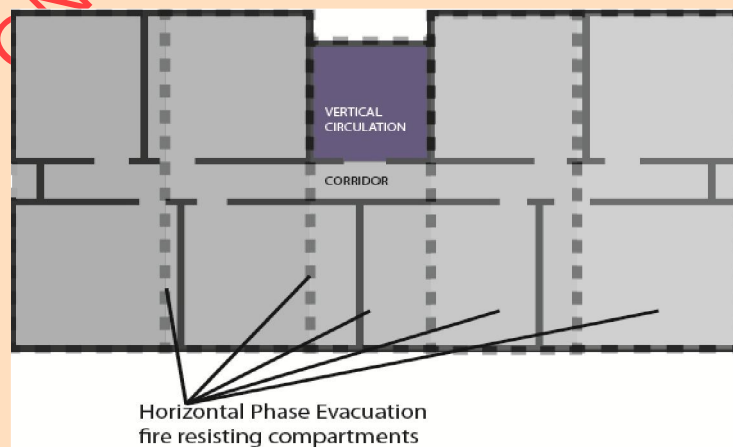


Figure 3.3. Horizontal evacuation type

- (c) **Staff Alarm Evacuation:** In some cases it may not be appropriate for a general alarm to start immediate evacuation for a building, for example in a cinema or assembly hall. The staff alarm scenario is because of the need for the staff to enact pre-arranged plans for the safe evacuation of the premises.

B. General Exit Requirements

An exit may be a doorway; corridor passageway(s) to an internal staircase or external staircase or to a verandah or terrace (s) which have access to the street or to the roof of a building or a refuge area. An exit may also include a horizontal exit leading to an adjoining building at the same level.

The following general requirements shall be adhered for a safe exit:

- Lifts and escalators shall not be considered as exits.
- Every exit access or exit discharge shall be continually maintained free of all obstructions or impediments to full use in the case of fire or other emergency.
- Every Building meant for human occupancy shall be provided with exits sufficient to permit safe escape of occupants in case of fire or other emergency.
- In every building or structure exits shall comply with the minimum requirements of this part, except those not accessible for general public use.
- No building shall be so altered as to reduce the number width or protection of exits to less than that required.
- Exits shall be clearly visible and the route to reach the exits shall be clearly marked and signs posted to guide the occupants of the floor concerned. Signs shall be illuminated and wired to an independent electrical circuit on an alternative source of supply. The size and colors of the exit signs shall be in accordance with good practice. The colour of the exit signs shall be green.

Note: - this provision shall not apply to H-3 and H-5 (To be checked in the final draft) occupancy less than 15 m in height.

- The floors of areas covered for the means of exit shall be illuminated to values not less than 30 cm candle (10 lux) at floor level in auditoriums theaters connects halls and such other pieces of assembly. The illumination of floor exit/ access may be reduced during period of performances to values not less than 6cm candle (2 lux).

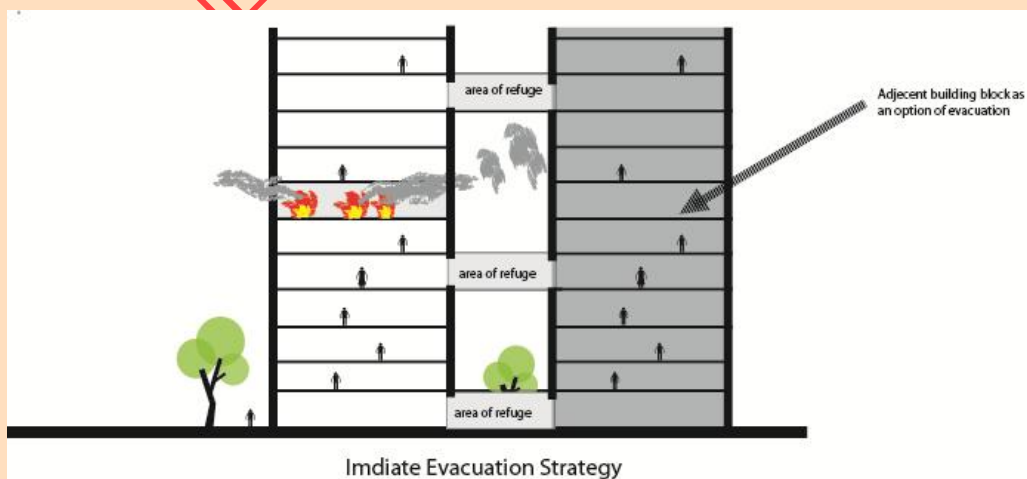


Figure 3.4. Adjacent building as a means of escape

- Fire doors with 2hrs fire resistance shall be provided at appropriate places along the escape route and particularly at the entrance to lift in by and stair well where a funnel or flue effect may be created, inducing an upward spread of fire to prevent spread of fire and smoke.

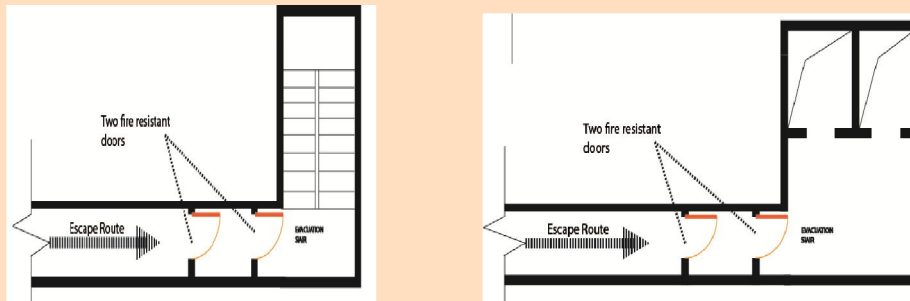


Figure 3.5. Fire Doors

- All exits shall provide continuous means of egress to the exterior of a building or to an exterior open space leading to a street.
- Exits shall be so arranged that they may be reached without passing through another occupied unit.

C. Capacity of Exits

The role of fire exits and their corresponding capacity of evacuation are to safely facilitate the means of escape in case of a fire from any point in a building to a place of safety, clear of the building, without outside assistance.

The average exit flow rate used internationally is 60 people per minute for a single unit escape route, which leads to a single unit door. The value is used herein for calculations relating to exit flow speeds and capacities. Single unit escape route should have a minimum width of 1050mm and a single unit door should have a minimum width of 750mm.

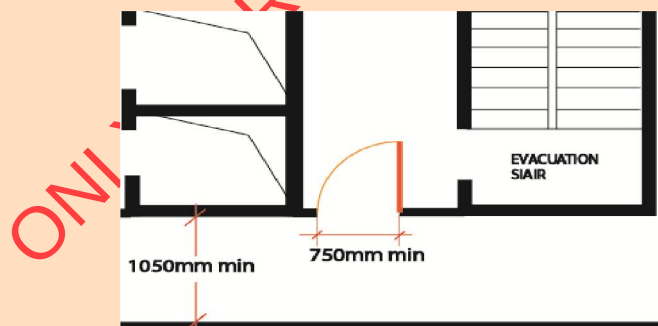


Figure 3.6. Minimum Widths for Fire Doors and Escape Routes

The capacity and number of exits and escape routes should follow the designated values given in Table 3.2 below:

Table 3.2. Minimum Number and Width of Exit Doors and Exit Routes

Occupancy Load / Population (No. of persons)	Minimum No. of exit doors / exit routes	Minimum total width (in mm)		Minimum Width (in mm) of each	
		Exit Doors	Exit Routes	Exit Doors	Exit Routes
4-30	1	750	1050	750	1050
31-200	2	1750	2100	850	1050
201-300	2	2500	2500	1050	1050
301-500	2	3000	3000	1050	1050
501-750	3	4500	4500	1200	1200
751-1000	4	6000	6000	1200	1200
1001-1250	5	7500	7500	1350	1350
1251-1500	6	9000	9000	1350	1350
1501-1750	7	10500	10500	1500	1500
1751-2000	8	12000	12000	1500	1500
2001-2500	10	15000	15000	1500	1500
2501-3000	12	18000	18000	1500	1500

For buildings with occupancy rates greater than 3,000 people per floor, it is required for the fire engineering services, of the fire brigade, to design the exit capacities. Minimum total width is the aggregate total of all the exit doors or exit routes added together.

The unit of exit width, used to measure the capacity of any exit, shall be 500 mm; a clear width of 250 mm shall be counted as an additional half unit. Clear widths less than 250 mm shall not be counted for exit width.

When horizontal exit is provided in buildings of mercantile, Storage, industrial, business and assembly occupancies, and the capacity per storey per unit width of exit of stairways in Table may be increased by 50 percent and in buildings of institutional occupancy it may be increased by 100 percent.

Calculations for exit flow speeds are given below in Table 3.3 for different building densities, heights and capacities.

Table 3.3. Discharge Values of Required Staircases in Buildings

No. of Storeys served	Width of required staircase (mm)					
	1050 - 1200	1200 - 1350	1350 - 1500	1500 - 1600	1600 - 1700	1700 - 1800
1	210	240	270	300	320	340
2	242	278	315	351	377	402
3	274	316	360	402	434	464
4	306	354	405	453	491	526
5	338	392	450	504	548	588
6	370	430	495	555	605	650
7	402	468	540	606	662	712
8	434	506	585	657	719	774
9	466	544	630	708	776	836
10	498	582	675	759	833	898
Add for each additional storey	32	38	45	51	57	62
<p>*Discharge values for exits moving upwards, for example to access a roof or an escape staircase leading from a basement, should be multiplied by a reduction factor of 0.8.</p> <p>*Discharge values for a scissor staircase without a landing area between floors should be multiplied by reduction factor of 0.7 for every floor without landing.</p>						

A. Arrangement of Exits and Travel Distance

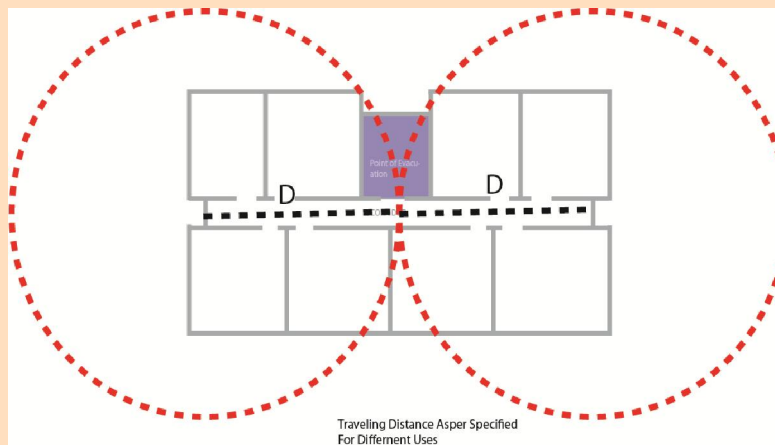
It is recommended that in buildings with more than one exit, exits to be arranged at opposite sides of a room or floor to minimize the risk of both exits being impassable due to smoke or fire. In the case of larger buildings, with greater than two exits per floor, it is required that exits be well spaced and placed at a minimum of a 45 m from each other. Therefore;

- Exits must be arranged so that they lead to an ultimate place of safety
- Directional and exit signs should be provided to indicate the location of protected exits and assist occupants with their path of travel along the exit route. Such signs should comply with the standard requirements set in section five of the code labeled "Fire Detection and Alarm Systems".
- Every building, except those buildings small enough and permitted to have only one required escape staircase (refer to Table B1) should be so constructed that from each storey, not less than two exit routes or such greater number, are available. The width of each exit route and the total width of all the exit routes should be not less than the width shown in Table 3.2 according to the occupant capacity and the number of exit routes provided that.
- It has to be ensured that the exits and stairways of any buildings are always kept clear of all obstructions or hazardous materials.
- Every door across an exit or into an exit route from a room or storey with the occupant capacity exceeding 30, should:

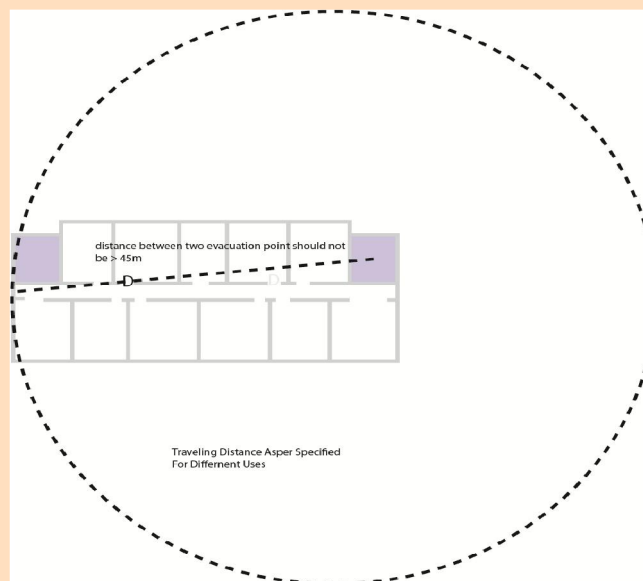
- open in the direction of exit, or
 - If constructed to open both ways, have transparent upper view panel.
- (f) If it is necessary to secure an exit door against entry from outside, the locking device should be of the type that is capable of being readily opened from the inside without the use of a key. When a Push plate, push bar or a single action lever handle is installed, it should not be encased. A locking device which is electrically operated should be capable of automatic release upon activation of an automatic heat or smoke detection system from the operation of an alarm system; or, allow for a central manual override designed and installed to the satisfaction of the fire brigade. Upon power failure, the electrical locking device should be released automatically. In the case of a door to a required staircase or to a protected lobby of the required staircase, the security mechanism should not affect compliance regardless of the situation.
- (g) Every door opening on to a landing between flights of a required staircase, should not at any point of its swing, reduce the effective radius of the landing to less than the minimum width of the required staircase.
- (h) The travel distance to an exit from the dead end of a corridor shall not exceed half the distance specified in Table 3.4 except in assembly and institutional occupancies in which case it shall not exceed 6m.
- (i) Whenever more than one exit is required for any room space or floor of a building. Exits shall be placed as remote from each other as possible and shall be arranged to provide direct access in separate directions from any point in the area served.

Table 3.4. Travel Distance for Occupancy and Type of Construction

No	Group of Occupancy	Maximum Travel Distance (D)	
		Types 1&2	Types 3&4
i)	Residential	30.00	22.50
ii)	Educational	30.00	22.50
iii)	Institutional	30.00	22.50
iv)	Assembly	30.00	30.00
v)	Business	30.00	30.00
vi)	Mercantile	30.00	30.00
vii)	Industrial	45.00	30.00
viii)	Storage	30.00	30.00
ix)	Hazardous	22.50	30.00



(a)



(b)

Figure 3.7. Minimum Travel Distance**Notes**

1. For fully sprinkled building, the travel distance may be increased by 50 percent of the values specified in Table 3.4 above.
2. Ramps shall be protected with automatic sprinkler system or any appropriate equivalent and shall be counted as one of the means of escape.

B. Exit Facilities

Building shall be so designed and constructed so that there are adequate means of escape from the building to a place of safety outside the building that can be safely and effectively used.

The requirement of proper exit facilities maybe met:

- (a) If there are routes of sufficient number and size, which are suitably located, to enable persons to escape to a place of safety in the event of fire. Details on the specifications and number of these routes have been specified in Tables 3.1, 3.2 and 3.3.
- (b) If the routes are sufficiently protected from the effects of fire in terms of enclosures, where necessary, and through the deliberate use of fire retardant materials on these routes.
- (c) If sufficient lighting, means of smoke control and an alarm system to warn the occupants of the existence of fire are provided to enable them to use the routes safely.

Each qualification is dependent on the use of the buildings, its size and height. The basic principles of the means of escape are such that:

- There should be alternative means of escape whenever possible.
- Where direct escape to place of safety is not possible, the means of escape should consist of a refuge area that leads to a protected escape route that should ultimately lead to a place of safety. The final place of safety is the open air, which is clear of the effects of the fire; however, in modern large and complex buildings, reasonable safety may be reached within the building itself. For such case the FEEP must designate the place of safety clearly.

Egressibility means that, in case of an emergency, the occupants have the ability to leave a building or to reach an area of safety. There are various options to ensure egressibility of a building; namely:

- One of the suggested options is the use of refuge areas in a building. This option implies that occupants with disabilities do not have to evacuate during a fire; rather they move to an area of refuge where they can be rescued later.
- Another option being considered is the provision of "safe elevators" in high rise building.
- A third option is to develop specific evacuation procedures for people with disabilities. The "buddy" system, for example, identifies one or a few persons who have the responsibility of looking after or reporting the presence of a person with limitations in case of an emergency.
- In the case of mezzanines or balconies open to the floor below, or other unprotected vertical openings between floors, the population of the mezzanine or other subsidiary floor for level shall be added to that of the main floor for the purpose of determining the required exits, provided, however, that in no case shall the total number of exit units be less than that required if all vertical openings were enclosed.
- At least two separate exits shall be accessible from every part of every floor, including basements; such exits shall be as remote from each other as practicable and so arranged as to be reached by different paths of travel in different directions. Except that a common path of travel may be permitted for the first 15m from any point.
- Not less than two exits shall be provided for every floor. Including basements occupied for office purposes or uses incidental thereto.
- In addition to the general requirements specified for type of construction and occupancy and the exit requirements given and the requirements given for mixed occupancy
- No dwelling unit shall have its sole means of exit through any mercantile occupancy in the same building except in the case of a single family unit where the family operates the storey.

Generally exit facilities include (1) Doorways and Openings, (2) Corridors and Passageways; (3) Stairways, Lifts, Lobbies and Corridors; (4) Roof Exits; (5) Ramps; and (6) Areas of Refuge.

1. Doorways and Openings

Doorways: Doorways have two main functions for fire codes either as exit facilities or as fire doors. The two uses of doorways are further explained below.

Exit Doors:

The main function of exit doors is to facilitate the safe and expedient exit from a place emergency to a place of safety. It is important that a fire exit door opens easily; that they are sufficiently wide; that it is well marked, and that the fire door is readily accessible in the case of fire.

- (a) Fire exits of all kinds should be quick and easy to open without the need for a key. It is important to highlight that the most problematic, and also most important of these exits, is usually the final exit door of building.
- (b) The most commonly used type of exit door used is a “push bar”, which can only be opened from within. There are a number of other options available; however, most are prohibitively expensive and/or not as reliable as a push bar door. A push bar door should be widely adapted as the standard. Considerations for not using a push bar door are situations in which the exit door must also double as a normal passage way to get in and out of the building.

Fire Doors:

Fire doors have two important functions in a fire; when closed they form a barrier to stop the spread of fire and when opened they provide a means of escape. Fire doors come in different degrees of resistance but the majority range from half hour resisting doors to one hour resisting doors. There uses are for large buildings and industrial facilities where a high hazard rate of fire is to be expected.

A well designed fire door will delay the spread of fire and smoke without causing too much hindrance to the movement of people and goods. Every fire door is therefore required to act as a barrier to the passage of smoke and/or fire to varying degrees depending upon its location in a building and the fire hazards associated with that building.

A fire door required to provide resistance to the passage of a well-developed fire must be fitted with proper seals. These seals remain dormant under normal conditions but expand greatly in the heat of a fire to close the gap between the door and its frame.

As smoke spreads it is an even greater threat to life and property than flames, particularly in the early stages of a fire. Fire doors should also be fitted with a „cold smoke” seal to prevent the ingress of smoke around the door edges.

Openings in separating Walls and Floors: At the time of designing openings in separating walls and floors. Particular attention shall be paid to all such factors that will limit fire spread through these openings and maintain fire rating of the structural member.

For Types 1 to 3 Constructions

A doorway or opening in a separating wall on any floor shall be limited to 5.6 m in area with a maximum height/ width of 2.75 m. every wall opening shall be protected with fire – resisting doors having the free rating of not less than 2h in accordance with accepted standard. All openings in the floors shall be protected by vertical enclosures extending above and below such openings, the wall of such enclosures having a fire resistance of not less than 2 h and all openings there in being protected with a fire-resisting assembly as specified further.

For type 4 Constructions

Openings in the separating walls or floors shall be fitted with 2 hrs fire-resting assemblies.

Openings in walls or floors which are necessary to be provided to allow passages of all building services like cables, Electrical wirings, Telephone cables, plumbing's pipes etc. be protected by enclosure in the form of ducts/ Shaft having a fire resistance not less than 2h. The inspection door for electrical shafts/ ducts shall be not less than 2 h and for other services shafts/ ducts shall be not less than 2h and for other services shafts/ ducts.

Note: – in the case of building where it is necessary to lower of in heavy machinery or good from one floor to the other. It may be necessary to provide large openings in the floor such openings shall be provided with removable covers which shall have the same strength and fire resistance as the floor.

Vertical Opening: Every vertical opening between the floors of a building shall be suiting enclosed or protected as necessary to provide Reasonable safety to the occupants while using the means of ingress by preventing spread of fire. Smoke or fume through vertical openings from floor to floor to allow occupants to completes the use of the means of egress. Further it shall be ensured that sill of such opening abutting on any open space shall not be less than 90cms above the level of the floor from which such opening is accessible. Provided that if such opening is to be constructed flush with floor level its lower portion for a height of 90cms shall be protected by bars or grill or similar other devices to the satisfaction of the Competent Authority.

2. Corridors and Passageways

A corridor or passageway should be wide enough to allow people to pass each other especially in commercial buildings and high occupancy apartments. For larger buildings a corridor is generally one of the main escape routes. Corridor width must be adequate, meeting the standards of Codes, and focus must be directed to prevent the unintentional impediment of corridor width.

Restrictions on corridors in low-density residential buildings are not needed because the numbers of occupants is low enough to ensure the safe exit, regardless of the corridor widths. Below are further guidelines:

- (a) The unobstructed clear width should be at least 1.5m. Elements such as columns and fire hoses should not project into this corridor width.
- (b) Passing places, with an unobstructed total width of corridor 2m wide over by 2m in length should be provided at reasonable intervals and junctions. This will expedite the flow of traffic in case of disabled people.
- (c) The floor should be predominantly level with a gradient no steeper than 1:50.
- (d) Any door opening towards a corridor that is a major access route or an escape route should be recessed so that when fully open, it does not project into the corridors space except where the doors are minor utility spaces such as small storerooms and locked cupboards.
- (e) Floor surface finishes should be slip resistant, especially in buildings with overhead sprinkler systems installed.

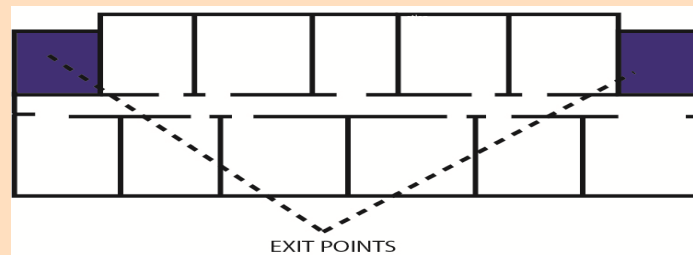


Figure 3.8. Fire Exits

3. Stairways, Lifts, Lobbies and Corridors

a) Stairway

Stairways shall conform to the following provisions in addition to given in (i) to (vii) below, provided that stairs comply with these requirements:

- The stair-case & lifts (elevators) shall be so located that it shall be within accessible distance of not more than 25 Mts. from any entrance of tenement or an office provided on each floor.
- The design of the lift & stair along with the tread and riser shall comply with the provisions of the National Building Code for that class of building.
- In all cases the leading edges of all treads should be readily visible during both descent and ascent; means of egress via stairs must permit unobstructed travel at all times.

The following requirements are necessary with respect to stairways for firefighting purposes; namely: (i) Stairways width, (ii) Flight, (iii) Risers; (iv) Threads; (v) Head Room; (vi) Floor Indicator; and (vii) Hand Rails.

(i) Width: The minimum width of a staircase other than a fire escape is given in Table 3.5 below.

Table 3.5. Minimum width of a stairway

Sr. No	Type of occupancy	Minimum width of Stairway/Corridor (Mts)
(1)	(2)	(3)
1	Residential buildings	
	(a) Low rise	1.2
	(b) Hotels and High rise	1.5
2	Educational building	
	(a) Up to 24 m. high	1.5
	(b) Over 24 m. high	2.0
3	Institutional buildings(i.e. hospital)	
	(a) Up to 10 beds	1.5
	(b) Over 10 beds	2.0

4	Assembly building	2.0
5	Mercantile, Business, Industrial, Storage, hazardous buildings	1.5
	(a) Low Rise	2.0
	(b) High Rise	

In addition; the following requirements shall be adhered too:

- Landings should be provided at the top and bottom of each flight not less in width and length than the width of required staircase, and no exit door should be at any part of its swing reduce the effective width or effective radius of such landing as the case maybe.
- No required staircase should exceed 1800mm in width. If a wider staircase is required, it should be divided by central handrail into separate sections such that each section should be not less than 1050mm but not more than 1800mm in width.
- Whereas in case of residential dwelling unit occupied by single family and constructed up to three floors width of the stairs shall not be less than 1.2 mtr.
- In case of all non-residential and high-rise residential buildings, The clear width of stair and landing exclusive of parapet shall not be less than 1.5 Mts. This includes the stairways that handle 50 persons cumulative for all stories (building higher not more than 125') and each stairway serves < 30 occupants per floor
- Minimum stair width for more than 6 tenements on each floor shall be 1.2 Mts.

(ii) Flight: Required staircases should be arranged in straight flights without winders and no flight shall contain more than 14 risers and not less than 2 risers except the residential buildings in narrow plots and in high density Housing a single flight staircase may be permitted.

(iii) Risers: The maximum height of a riser shall be 19 cm. in a residential building and 16.71 cm in any other occupancy.

(iv) Treads: The minimum width of the tread without nosing shall be 25 cm. for staircase of a residential building. Other than fire escapes, in other occupancies the minimum width of the tread shall be 30cm. It shall have a non-slippery finish and shall be maintained in that fashion.

(v) Head Room: The minimum head room in a passage under the landing of a staircase under the staircase shall be 2.1 m.

(vi) Floor Indicator: The number of each floor shall be conspicuously painted in figures at least 15 cm. large on the wall facing the flight of a stairway or at such suitable place as is distinctly visible from the flights.

(vii) Hand-rails: It is worth noting that handrails are one of the most important components of a staircase, and therefore, its design should be such as to enable a comfortable grip and also to facilitate the hand to be slid along the rail without encountering obstructions while negotiating the stairs. A handrail should be provided on each side of the required staircase. Every such handrail should:

- Be at a height not less than 850mm or more than 1100mm from the center of the tread shall be provided.

- Not project so as to reduce the clear width of the required staircase by more than 90mm, for each handrail.

b) Elevators (Lifts)

A lift shall be provided in all buildings as prescribed hereunder:

- In case of Building having height more than 13.0 Mts. lift shall be provided.
- Lift shall be provided at the rate of one lift for 20 tenements of all the floors or part thereof for residential buildings and at the rate of one lift per 1000sqmts or part thereof of built-up area for non-residential buildings. The tenement and built-up area on ground floor and two upper floors shall be excluded in computing the above requirement.
- Notwithstanding anything contained in the Control Regulations in case of building with 21 meters or more in height at least two lifts shall be provided.

c) Lobbies and Corridors

The recommended minimum widths of lobbies or corridors in building shall be as provided in Table 3.5 below.

Table 3.6. Minimum Widths of Lobbies and Corridors

Length of Corridor (Mts)	Width of Corridor (Mts)	
	Residential	Non-residential
Up to 6	1.0	1.2
Up to 9	1.2	1.5
Up to 15	1.2	2.0
Above 15	1.5	2.5
NB: (1) For every additional 3.00mts length or part thereof the width of corridor shall be increased by 0.15mts up to a maximum of 3.00mts. (2) In case of Star hotels the width of the corridor shall be as per the authorized standards of the Star hotels.		

4. Roof Exits

The main roof of a building may be regarded as a refuge floor for the purpose of creating a safe escape, when routes to a final place of safety are unavailable provided that:

- The roof should be of flat surface with easy access.
- The net area for refuge should be not less than 50% of the gross floor area of a typical floor below the main roof.
- Any required staircase serving the floors immediately below the main roof should be continued to give access to the main roof without any obstruction at all times.
- The minimum dimension of the area for refuge should be at least 50% greater than the width of the widest required staircase serving the roof.
- Every part of the area for refuge should be provided with at all time with lighting of a horizontal luminance at floor level meeting the standard set herein of not less than 30 lux. The lighting can be a combination of natural and artificial light and should be backed up by

- an emergency lighting system that complies with the code.
- (f) Terraces shall be free from partitions of any kind and accessible by a common staircase

5. Ramps

Ramps are ways that facilitate the means of egress. The provisions applicable to stairway shall generally apply to ramps.

The gradient of every ramp forming part of an exit route should not at any part be steeper than 1:12. Ramps are used much like corridors or passageways; however, their restrictions are limited to that of their gradient slope. The slope requirement is different from that of passageways.

For parking spaces in a basement and upper at least two ramps of adequate width and slope shall be provided preferably at the opposite and such ramps may be permitted in the side and rear marginal open spaces after leaving sufficient space for movement of firefighting equipment.

6. Areas of Refuge

Areas of refuge, also known as safe areas, staging areas, areas of rescue assistance or areas of evacuation assistance, consist of an accessible space, separated from the rest of the building by fire-resisting materials and fire doors that limit the passage of fire and smoke.

The area of refuge should offer the same protection and fire-rating as an exit staircase. Some buildings use staircase landings as their areas of refuge. In these cases, the landing area must be large enough so that the staircase is not obstructed by disabled occupants waiting there, including wheelchair users and area of refuge should be directly connected to an escape route, such as a staircase or elevator.

In situations where firefighters plan to use elevators to evacuate occupants, the elevator lobby should be designed to serve as an area of refuge, protecting occupants while they wait to use the elevators if leaving the floor is necessary. If an area does not open directly onto a stairway or elevator, it should at least be situated close to one.

Other locations for areas of refuge include same-level connections between two buildings, where two separate buildings are linked by a passageway, through which occupants can move to the next building and use its elevators to egress. Another option is the horizontal separation of floors, where floors are divided into two or more sections, with fire and smoke resistant doors between each compartment. In the event of a fire in one of the zones, occupants move to the other zone and wait there until the fire is extinguished or until they are rescued.

In apartment buildings, balconies are often defined as areas of refuge. From an owner's point of view, areas of refuge should not represent non-leasable space.

The safety of areas of refuge depends on the details of the design, the type of fire exposure, the outside wind, the temperature conditions and the capability and reliability of the smoke control system.

A crucial aspect of the success of the area of refuge concept is the occupants' willingness to accept and use these areas during a fire that is dependent on design details: telephone, window, chairs, distance to exit, etc. Two-way communication should be provided in each area of refuge to allow occupants to signal their presence to rescue officers and to obtain information on the situation.

Windows looking either to the outside or inside of the building could prove to be a source of reassurance for occupants having to stay in refuge areas for a prolonged period of time. Areas of refuge must be clearly indicated as such, and suitable signs should be installed.

Depending on their size and location, the areas of refuge can be used either only for disabled occupants, or for all occupants. For example a staircase landing cannot hold more than a few occupants, while a horizontal separation may allow all occupants to remain in the building to wait for further instructions.

ONLY FOR REVIEW PURPOSE

SECTION 4 Fire Safety and Construction Details

4.1 Introduction

4.1.1 Scope

The building components shall be structurally stable for a reasonable amount of time so that the occupant can leave within a reasonable time. During planning the building, care shall be taken that they can leave the building safely and quickly. This chapter therefore, lay down the essential requirements of fire safety of buildings with respect to details of construction.

Information of building materials and building components that have been classified with respect to their fire behavior is on the basis of internationally accepted standards which are assumed to have a reasonable safety factor against the stated fire exposure.

The information given generally relate only to building material and building components whose properties can be assessed on the basis of local standards that are/ or to be established for improvement or amendment. For building materials and building components not covered in this standard, the fire behavior shall be verified by testing in accordance with the requirements of internationally accepted standards.

The information in the following clauses shall apply only for the purpose of fire protection. Other specifications, such as minimum dimensions, concrete cover of reinforcement for reasons of corrosion, and design requirements shall be adhered to as given in the particular Codes & standards. The minimum requirement for fire safety shall always be met irrespective to the requirements by the other codes and Standards.

4.2 Walls

4.2.1 Wall types and function

From the point of view of fire protection, distinction is made between non-load bearing and load bearing walls and between enclosing walls and non-enclosing walls, and bracing walls.

- a) Non-load bearing walls are flat membrane like building components that are loaded predominantly only by self-weight and do not provide bracing for load bearing walls. However, they may transfer wind loads acting on their surface to load bearing building components such as walls or floors.
- b) Load bearing walls are flat, membrane, like building like building components, predominantly subject to compressive stress for supporting gravity and/or lateral loads.
- c) Enclosing walls are walls exposed to fire on only one side such as in walls along escape ways, walls of stair, partitions of living rooms and fire walls.
- d) Non-enclosing walls are exposed to fire on two or more sides.
- e) Bracing walls are flat, membrane, like building components, for bracing load bearing walls against buckling. For the purposes of fire protection they shall be designed as load bearing walls.
- f) Whenever the case refers to load bearing walls, the data do not apply to walls with width less than 60mm. Such walls shall be designed in accordance with the specifications for column.

4.2.2 Wall thickness

Unless otherwise indicated, the minimum thickness shall be the thickness of the uncovered wall or uncovered wall leaf.

4.2.3 Fixtures

Apart from the exceptions given below, the fire resistance classes of the walls classified below shall apply in all cases to walls without fixtures.

Socket boxes, switch boxes, splitter boxes, etc shall not be installed at precisely opposite in enclosed walls^{1*}. For walls of prefabricated or panel construction, any insulating layers necessary for protection purposes may be compressed to a thickness of 30 mm in the region of such boxes. Individual electric cables may be passed through the walls if the remaining cross-section of the hole is completely sealed with mortar or concrete.

When glazing or fire barriers of a particular fire resistance class have to be installed in enclosure walls of a particular fire resistance class, the suitability of such fittings in conjunction with the wall shall be verified.

4.2.4 Concrete and Reinforced Concrete walls

The specifications listed here under shall apply to concrete and reinforced walls made of normal weight concrete.

Plain concrete and reinforced concrete made of normal weight concrete, shall comply with the conditions specified in Table 4.2.

Table 4.2. Plain Concrete and Reinforced Concrete walls (Required to Resist Fire from one side at a time)

Structural Features (see Figure 4.1)	Minimum requirement for fire resistance in hours									
	Load bearing					Non load bearing				
	1	1.5	2	3	4	1	1.5	2	3	4
I. Uncovered walls										
1. Slenderness ratio = storey height/wall thickness	25					—				
2. Minimum wall thickness t, in mm	120 250	140	160	190		120 150	120	120	120	
3. Minimum Center line depth t ₁ in mm of the longitudinal bars	20 60	20	30	40		----				
II. Walls with plaster covering on both sides										
1. Slenderness ratio	25					-				
2. Minimum wall thickness t in mm	80					60				
3. Minimum centerline depth t ₁ * in mm of the longitudinal bars	15	15	20	30	50	-				

^{1*} This limitation shall not apply to walls made of concrete or masonry with a total thickness = minimum thickness + thickness of covering not less than 140mm

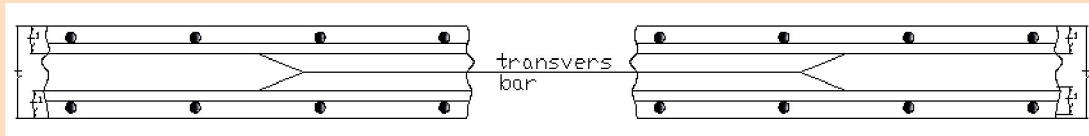


Figure 4.1. Structural feature of RC walls

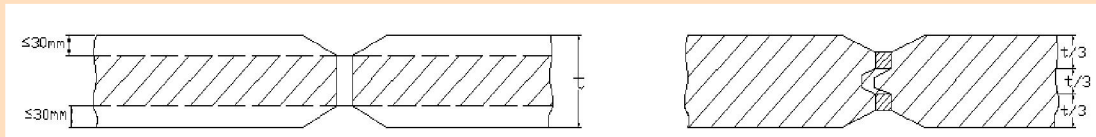


Figure 4.2. Wall joints (Schematic)

Joints between precast components shall be filled with mortar as shown in Figure 4.1 & 4.2, so that the mortar depth or concrete depth complies with the minimum thickness given in Table 4.2.

Beveled edges may be ignored if the bevel is not greater than 30 mm. For bevels greater than 30 mm, the minimum thickness shall relate to the point where the bevel ends. In case of tongue and groove type joints as shown in Figure 4.2, mortar filling of the joints in outer third of the wall shall be considered sufficient.

4.2.5 Light weight concrete walls

Non-load bearing enclosing walls made of light weight concrete with closed structure shall be produced with a minimum thickness of 150mm for all fire resisting types.

In the case of plaster covering using cement mortar or concrete on both sides, the minimum thickness may be reduced by considering half of plaster thickness to substitute for the wall thickness. However, the minimum wall thickness shall not be less than 60mm.

The production of joints between precast components shall be as described in sub-clause 4.2.4.

4.2.6 Masonry walls and piers

The following specifications shall apply to masonry walls and piers built in bricks, normal and light weight concrete, no-fine concrete which may be solid or hollow or perforated. No-fine concrete is porous concrete made without the use of fine aggregate.

For the purpose of fire protection, masonry walls and piers shall have the minimum dimensions specified in Table 4.3.

Insulating layers in connecting joints include for sound insulation, or any cavity formed for other reasons shall be tightly sealed.

Heads, sills and lintels used as bracing shall at the minimum have the same fire resistance class as the walls, on which they are mounted.

The width of lintels made of reinforced concrete shall have the same minimum thickness as the wall.

Mortar plaster may be used as covering for improving fire resistances. The condition for its effectiveness for fire protection is the provision of adequate bonding to plaster base.

Table 4.3. Minimum thickness and width of Masonry Wall and Piers to resist fire from one side.
[The values in brackets shall apply to walls plastered on both sides]

Structural feature (See Figure 4)	Minimum provision for fire resistance in hours									
	Load bearing					Non-load bearing				
	1	1.5	2	3	4	1	1.5	2	3	4
A Minimum thickness t in mm of:										
Bricks of clay or sand lime, and slag sand blocks	115 (115)	115 (115)	115 (115)	140 (115)	175 (140)	115 (71)	115 (71)	115 (115)	140 (115)	175 (140)
Bricks with horizontal perforation	115 (115)	165 (115)	165 (165)	190 (165)	240 (190)	115 (71)	115 (71)	140 (115)	170 (140)	190 (175)
Normal weight concrete blocks:										
Solid	115 (90)	115 (90)	115 (90)	--- (100)	--- (100)	115 (75)	115 (75)	115 (75)	165 (90)	165 (100)
Hollow	--- (190)	--- (200)	--- (200)	--- ---	--- ---	125 (125)	125 (125)	140 (140)	140 (140)	150 (140)
Blocks of light weight concrete										
Solid	115 (90)	115 (90)	115 (90)	140 (100)	150 (100)	75 (75)	75 (75)	75 (75)	125 (75)	140 (75)
Hollow	115 ---	115 ---	115 ---	--- ---	--- ---	115 (75)	115 (75)	115 (115)	140 (140)	150 (140)
Blocks of no fine concrete						150 (150)	150 (150)	150 (150)	150 (150)	150 (150)
Minimum dimensions for pier of masonry with										
$\sigma \leq 1.4 \text{ MPa, } b \text{ (mm)}$	240	240	240	300	365					
$\sigma \leq 3.0 \text{ MPa, } b \text{ (mm)}$	240	300	365	365	365					
	240	300	365	365	365					
	240	365	365	365	365					

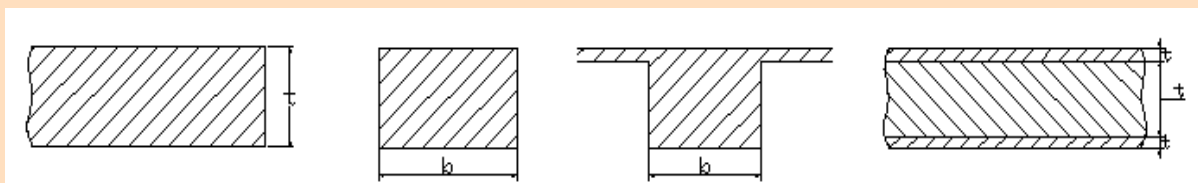


Figure 4.3. Structural features of Masonry walls and Piers

4.2.7 Fire walls

Fire walls shall be constructed using non-combustible materials with fire ratings as specified in Table 4.1 such as normal weight concrete, no fines concrete, solid masonry units-to subdivide buildings to restrict the spread of fire.

Construction of fire walls start at foundation and extends continuously throughout all storey and above the roof.

Bracing for fire walls including in floors, heads or sills, supports or frames, lintels above openings at the minimum have same fire resistance rating as the fire wall.

Fire walls shall comply with the specifications listed in Table 4.4 with regard to slenderness ratio, minimum wall thickness and centerline depth t_1 to longitudinal reinforcement, wherever applies.

Table 4.4. Minimum dimensions of Fire Walls to resist fire from one side [the values in bracket stands for min. thickness of double leaf walls only]

	Nature of Construction & materials	Minimum desired provision for fire protection in	
		Load bearing	N Non load bearing
1	Walls of normal weight concrete:		
	Without reinforcement		
	Slenderness ratio h_s/t	----	----
	Minimum thickness t in mm	----	200 (2x180)
	With reinforcement (Figure 4.1)		
	Slenderness ratio h_s/t	25	----
	Min thickness in mm	140(2x140)	120(2x100)
	Centre line depth t	25	----
2	Walls of no fines light weight concrete:		
	Slenderness ratio h_s/t	----	25
	Min thickness in mm	----	300(2x200)
3	Walls of prefabricated brickwork:		
	Slenderness ratio h_s/t	25	25
	Perforated filled with mortar, Min thickness in mm	165(2x165)	165(2x165)

Composite panels with one layer of blocks, t in mm	190(2x165)	190(2x165)
Composite panels with two layers of block, Min. thickness t in mm	240(2x165)	240(2x165)
4 Walls made of masonry of concrete blocks		
Bulk density>1.2, Min thickness	240(2x175)	240(2x175)
Bulk density> between 0.8 to 1.2, t in mm	290(2x190)	290(2x190)
Bulk density<0.8, Min thickness in mm.	290 (2x240)	290(2x240)

No allowance shall be considered for covering (plaster) to reduce the minimum wall thickness specified in Table 4.4.

Junction of in situ concrete walls and masonry walls with adjacent building components shall be made with the complete joint filled with mortar.

4.2.8 Plastered Double-leaf walls of wood wool slabs

The specification shall apply to non-load bearing, double leaf partition walls, the leaves of which consist of wood wool slabs, woven wire protection and plaster with an insulating layer arranged between the leaves of the walls.

The individual layers of double leaf walls shall have at least the minimum thickness specified in Table 4.5.

Plastering shall be applied to the wood wool slabs without joints and the plaster shall make a tight joint with the adjacent solid components.

A protection consisting of woven wire or similar materials shall be placed on the outside of the wood wool slabs to ensure the stability of the walls; this protection shall be fixed to the adjacent solid components at intervals not exceeding 250 mm.

The insulating layer between the leaves wall shall consist of mineral fibers of building material class A, with a bulk density of not less than 30 kg/m³ and melting point of not less than 1000°C. The insulating layer shall make a tight joint with adjacent solid components.

Table 4.5. Minimum thickness of non-load bearing double-leaf walls made of wood wool slabs

Structural Feature	Minimum thickness for fire resistance	
	1 to 3 hrs	4 hrs
[See Figure 4.4]		
1. Min. thickness d1 in mm, of wood wool slabs	50	50
2. Min. thickness d2 in mm of plaster, measured from top edge of the wood wool slab	15 40	20 40
3. Min thickness D, in mm of the insulating layer		

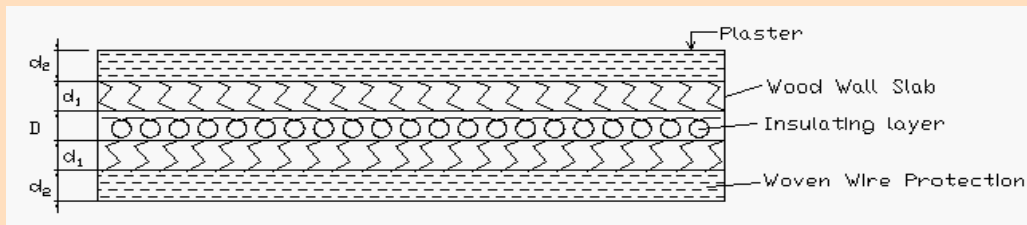


Figure 4.4. Walls of wood wool slabs (Table 4.5)

4.2.9 Gypsum plasterboard walls

This specification shall apply to non-load bearing single-leaf and double-leaf partition walls, the covering of which consist of gypsum plasterboards, having a close-graded surfacing with the zone around the joints in the covering filled with plaster and an insulating layer arranged between the coverings.

Specification for load bearing and non-load bearing framed walls with paneling in which the coverings consist partly or completely of gypsum plasterboards are provided in sub article 4.2.10 and 4.2.11.

The gypsum plasterboard shall be butted tight against posts frames; shall be fixed onto steel sections with bolts and onto timber or layer of gypsum plasterboard planks with screws, nails or flat head nails. The heads of screws, nails or flat head nails shall be spotted.

The minimum thickness of covering, minimum thickness and minimum bulk density of the insulating layer shall be as specified in Table 4.6.

Table 4.6. Minimum thickness of single or double leaf non-load bearing walls made of gypsum plasterboard and minimum thickness and bulk density of insulating layer

Nature of Construction and Materials (See Figure 4.5 & 4.6)	Minimum thickness for fire resistance hours				
	1	1.5	2	3	4
1. Minimum thickness of covering d in mm with posts or frames made from:					
• 30445 Steel section or gypsum plasterboard plank	18	2x12.5	15+12.4	2x18	3x12.5
• 30445 timber section	18	2x12.5	12x12.5	---	---
2. Minimum thickness of insulating layer D in mm/minimum bulk density ρ in Kg/m^3 , with posts or frames made from:					
• 30445 steel section or gypsum plastered plank D/d	40/40	40/40	40/40 or	40/40 or	80/50 or
			80/30	80/50	60/100
			or 60/50 or 40/100	or 60/100	
• 30445 timber section D/d	40/40	40/40	80/100	-----	-----

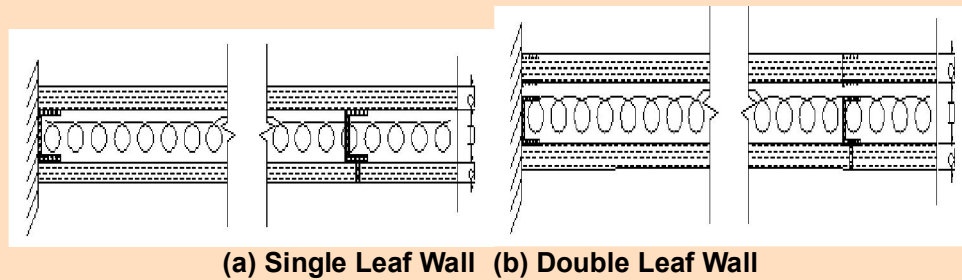


Figure 4.5. Gypsum plaster board with posts made from steel section

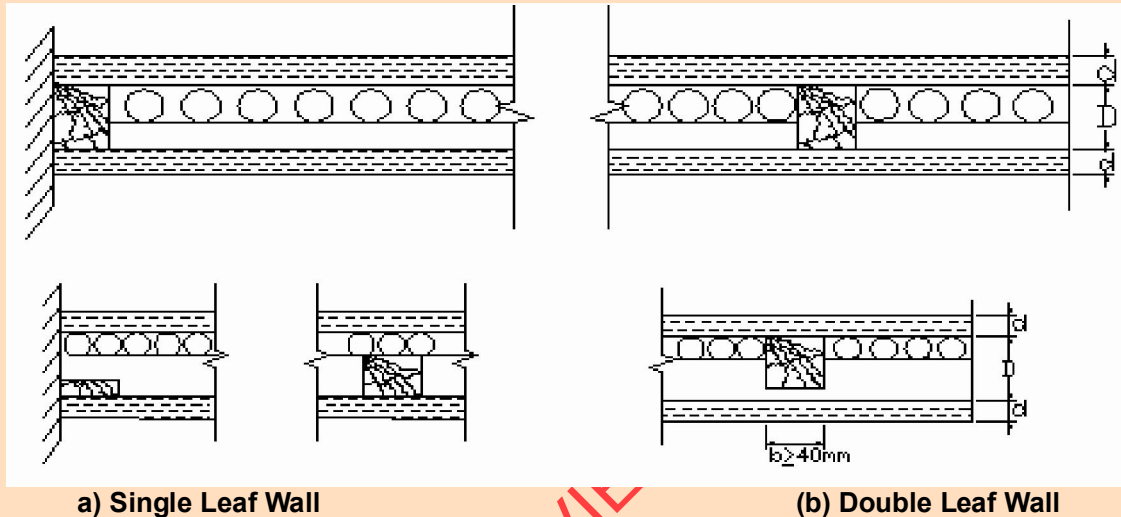


Figure 4.6. Gypsum plaster board with posts made from wooden section.

4.2.10 Filled in framed walls

The following specifications shall apply to load bearing and non-load bearing walls consisting of posts joined by heads, sills and struts, etc made of timber with the framework filled in and with a covering on at least one side.

The specification shall apply only to wall requiring fire rating not more than one hour.

The posts, frames, struts and other timbers shall have cross-sectional dimensions not less than 10 mm x 100 mm or equivalent.

The spaces of the framework shall be completely filled with clay puddle, wood wool slabs or masonry.

At least one side of the wall shall be provided with a close graded covering either with.

- Gypsum plaster board of not less than 18 mm thick, or
- Plaster of not less than 15 mm thick, or
- Wood wool slabs of not less than 25 mm thick and covered with plaster, or
- Boards made of timber derivatives of not less than 16 mm thick, with bulk density of not less than 600 kg/m³

4.2.11 Framed walls in paneling

The following specifications shall apply to single and double leaf, load bearing and non-load bearing framed walls with paneling.

The timber studs shall consists of cut and sawn building timber in the case of load bearing, chipboard in case of non-load bearing, where the minimum cross-sectional dimensions required for the purpose of fire resistance with compressive stress not exceeding σ_D specified in Table 4.7.

The boards and coverings of the studs consists of boards of timber derivate, times boards, gypsum plasterboard, plywood, wood fiber board, beveled edge soft wood boards, soft wood weather boarding, match boards with apparent groove, soft wood tongued and grooved boards, wood wool slabs.

All slabs panel and boards shall be butted tight against timber studs as shown in Figure 4.7.

The minimum thickness of the boarding and coverings shall be as provided in Table 4.7.

For enclosing walls, for the purpose of improving its fire resistance, insulating layers shall be placed between the boards or covering. They shall consist of mineral fibres of building material class A with a melting point of not less than 1000°C, or of wood wool slabs fixed at all edges abutting the studs by wood strips of not less than 25mmx25mm. The minimum thickness and bulk density of insulating layers are as specified in Table 4.8.

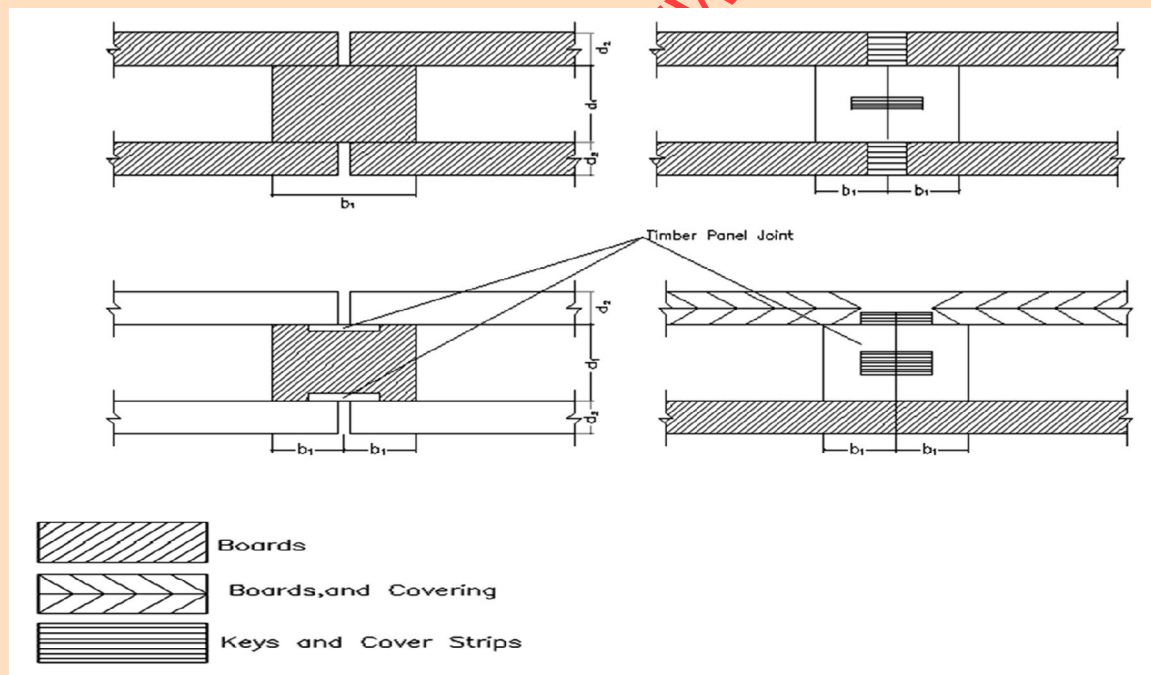
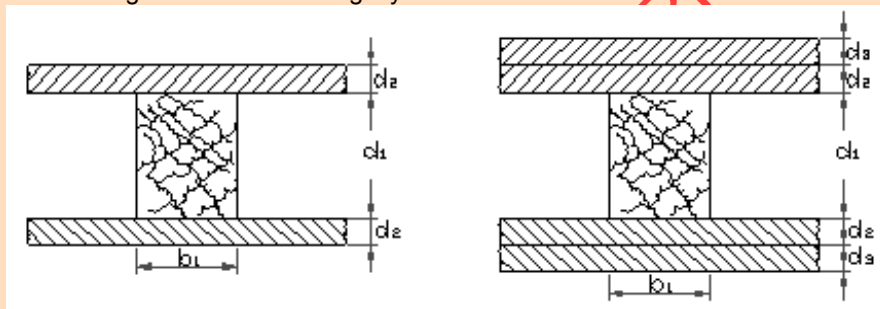


Figure 4.7. Butted boards and covering (schematic)

Table 4.7. Minimum dimensions of load bearing, non-enclosing framed walls with paneling for the purpose of fire resistance

Structural Features	Timber Studs		Boarding and covering minimum thickness of		Fire Resistance (hrs)	
	Min dimensions item 2 of Clause 4.2.9 $b_1 \times d_1$ (mm x mm)	Permissible stress σ_D (N/mm ²)	Board of timber derivatives with $p \geq 600 \text{ Kg/m}^3$ d_2 (mm)	Gypsum plaster board		
				d_2 (mm)		d_3 (mm)
[See Figure 4.8]	50x80	2.5	25 or 2x16			
	100x100	1.25	16			
	40x80	2.5		18		
	50x80	2.5		15		
	100x100	2.5		12.5		
	40x80	2.5	8		12.5	
	40x80	2.5	13	12.5	9.5	
	40x80	2.5			9.5	
	40x80	2.5	22		15	
	50x80			15	12.5	
	2.5					

Note: No insulating layer is necessary for fire protection purpose. Thus, there are no conditions with regard to the type, thickness or fixing etc of the insulating layer

**Figure 4.8.** Walls of timber studs, boarding and covering (Table 4.7)**Table 4.8.** Minimum Dimensions of enclosing framed walls with paneling

Structural Features	Timber Studs		Boarding and Covering Minimum thickness		Insulator layer Minimum			Fire resistance hrs.
	Min Dimensions b1xd1 (mm x mm)	Permissible stress σD (N/mm2)	Boards of timber derivatives P≥600 (Kg/m3) d2 (mm)	Gypsum plaster board or Mats D mm	Thickness of Mineral fibre board or mats D (mm)	Bulk density kg/m3	Thickness of wood wool D mm	
[See Figure 4.9]		2.5	13		80	30		1
		2.5	13		40	50		
		1.25	8		60	100		
		25	13				25	
		1.25	8				50	
	40x80	2.5	2x16		80	30		1.5
		2.5	2x16		60	50		
		1.25	19		80	100		
		1.25	19				50	
		0.5	2x19		100	100		2

0.5	2x19	75
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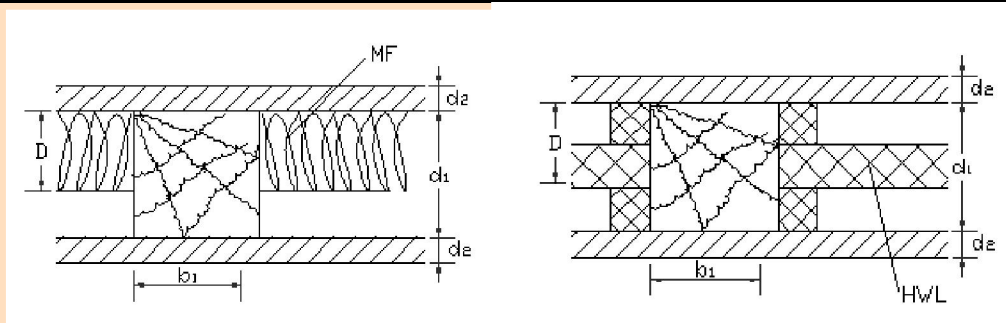


Figure 4.9. Minimum Dimensions of enclosing framed walls with paneling

4.3 Beams, columns & Brackets and Floors

4.3.1 Concrete Beams and Columns

The following specifications shall apply to RC beams, columns and brackets made of normal weight concrete

The fire resistance of reinforced concrete and pre-stressed concrete beams, columns and brackets acting as structural element should be not less than that required for an element which it supports and in no case less than 60 minutes

The concrete cover of the reinforcement is the distance between the surfaces of the reinforcing bar nearest to the surface of the building component. (See Figure 4.10).

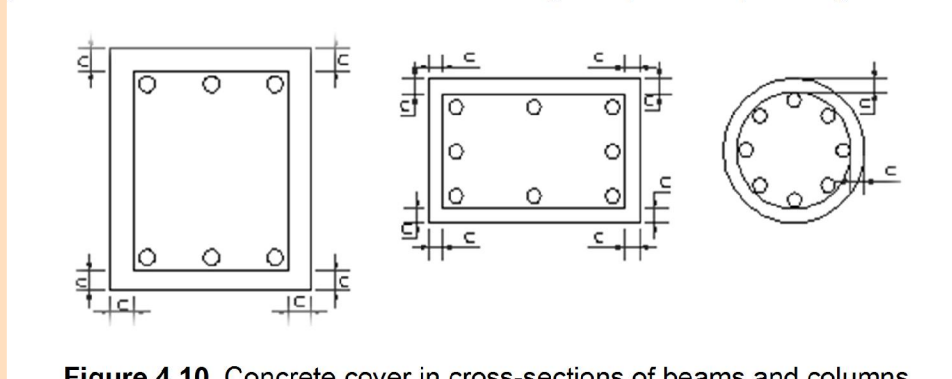


Figure 4.10. Concrete cover in cross-sections of beams and columns

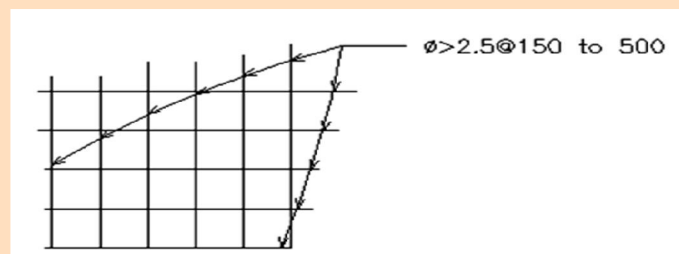


Figure 4.11. Wire mesh reinforcement for concrete cover greater than 40 mm

When the concrete cover c of the reinforcing bar closest to the surface of the building component is greater than 40mm, the concrete cover shall be reinforced with bars arranged

cross-wise and solidly connected at the joints. The protective reinforcement shall consist of bar diameter not less than 2.5 mm with mesh width range between (150x150)mm to (500x500) mm and concrete cover of 15mm (See Figure 4.11).

When the concrete cover in reinforced concrete or pre-stressed concrete components is limited for design reasons but the minimum requirements for fire rating of one hour are complied with, or when building components have to be subsequently reinforced for fire protection purpose, the necessary cover for higher fire resistance classes shall be met by a plaster cover in accordance with the specification given in Table 4.9.

Table 4.9. Plaster thickness used as substitute for providing adequate cover

Type of Plaster	Required plaster thickness in mm, as a substitute of 10 mm of		Maximum allowable plaster thickness in mm
	Normal weight concrete	Light weight concrete	
Cement mortar plasters applied without lathings	10	12	25
Cement mortar plasters applied with wire fabric lathing, clay lathing or any other non-combustible lathings	8	10	25
Fire resistant insulating plasters of vermiculite cement or perlite cement or vermiculite gypsum or perlite gypsum, applied in two layers.	5	6	30

4.3.2 Reinforced and Pre-stressed Concrete Beams

Fire exposure-distinction is made between exposures to fire on three sides at the most and on four sides at the most. Exposure to fire on three sides exists when the top of the beams has a covering of similar elements with at least same fire resistance class.

Exposure to fire on four sides when the top of the beams has some other type of covering such as steel, wood or plastic or has no covering.

RC and PC beams made of normal weight concrete shall have the minimum width b , thickness and reinforcement cover c , as specified in Table 4.10 when exposed to fire on three sides at the most.

RC and PC beams likely to be exposed to fire on four sides, shall have the same minimum dimensions as beams exposed to fire on three sides as specified in Table 4.10 provided:

- The minimum height (depth) of the beams shall be not less than the minimum width b ,
- The beams cross-sectional areas shall be not less than twice b^2

The minimum dimension b for rectangular section is the width of the beam and in the case of beveled side; it shall be measured at the level of the centroid of the reinforcement. For I beams, b is the bottom flange width and t is the web thickness.

Table 4.10. Minimum dimensions, and reinforcement cover of RC & PC beams of normal weight concrete, exposed to fire on three sides at the most

Structure features and nature of Construction		Minimum dimensions (mm) excluding any finish for fire rating in hour					
[See Figure 4.12]		½	1	½	2	3	4
1. Min dimensions in mm of statistically determinate uncovered beams in the tension zone due to bending or in the pre-compressed tension zone in:							
RC beams	Width b	80	120	150	200	240	280
	Cove C* ¹	15	20	25	30	40	50
PC beams	Widths b	100	120	150	200	240	280
	Thickness t	80	80	90	100	120	140
	Cover C* ¹	20	25	45	50	60	70
2. Min dimensions in mm of statistically indeterminate uncovered beams in the tension zone due to bending or in the pre-compressed tension zone in:							
RC beams	Width b	80	120	150	200	240	280
	Cove C* ¹	15	15	20	25	35	40
PC beams	Widths b	80	100	120	150	200	240
	Thickness t	80	80	80	90	100	120
	Cover C* ¹	20	25	35	45	50	60
3. Min dimensions in mm of statically determinate uncovered beams in the tension zone due to bending or in the pre compressed tension zone around support in							
RC beams	width b _____	80	90	120	140	160	240
	Cover c _____	12	35	45	55	60	70
PC beams	width b _____	80	90	120	140	160	240
	Cover c _____	12	35	45	55	60	70
4. Min. dimensions in mm of statically indeterminate uncovered beams in the tensions zone due to bending or in the pre compressed tension zone around support in							
RC & PC beams,	Width b _____	90	100	150	220	240	400
	Cover c _____	12	20	35	45	60	70

*1 For a concrete cover C greater than 40 mm, protective reinforcement in accordance with sub-clause 4.5.1, item 4 is necessary

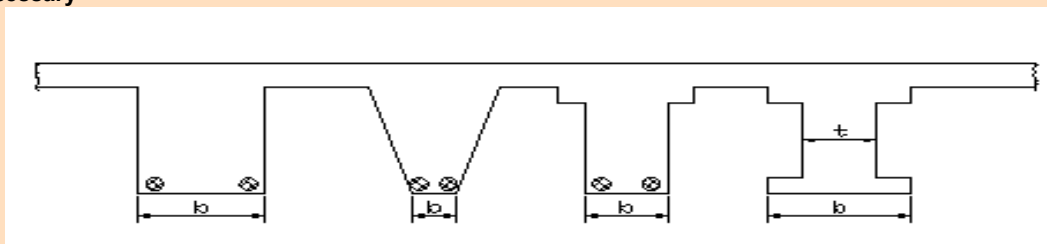


Figure 4.12. Structural features of RC and PC beams (Table 4.10)

4.3.3 Reinforced and Pre-stressed Concrete Columns and Brackets

The following specifications shall apply to PC columns and brackets made of normal weight concrete. A Distinction is made between fire exposure on one side and more than one side.

Fire exposure - A state of exposure to fire on more than one side exists if the columns are exposed to fire on more than one face. A state exposure to fire on one side exists if the columns over their entire height are built into enclosing walls made of concrete or masonry so that the room-side surface of the columns is flush with the room-side surface of the wall.

If the columns are not flush with the wall or if their distance from opening in the wall is less than the amount specified in Table 4.11 of item 2, that part of the column embedded in the wall shall be able to withstand the fire exposure alone or the column shall be designed as for exposure to fire on more than one side.

Reinforced and pre-stressed concrete made of normal weight concrete, to satisfy the fire ratings indicated, shall comply with the minimum thickness and minimum reinforcement cover specified in Table 4.11.

The minimum thickness b in cases of columns of rectangular cross-sections, the dimension of the smaller side and in the case of columns with circular cross-section is the diameter.

Table 4.11. Minimum thickness b and minimum reinforcement cover in reinforced and pre-stressed concrete columns made of normal weight concrete

Structure features and nature of exposure	Minimum dimensions (mm) for fire rating hrs					
	½	1	1.5	2	3	4
[See Figure 4.13]						
1. Minimum cross -sectional dimensions of uncovered RC columns exposed to fire on more than one side:-						
thickness b (mm)_____	150	200	250	300	400	450
Reinforcement cover c (mm)_____	20	25	30	35	35	35
2. Minimum cross-sectional dimensions of uncovered RC columns exposed to fire on						

one side;						
thickness b (mm)_____	100	120	140	160	200	240
Reinforcement cover (mm)_____	20	25	25	25	25	25
3. Minimum cross-sectional dimensions of uncovered PC columns (tension members) exposed to fire to more than one side:-						
thickness b (mm)_____	120	160	190	240	280	320
Reinforcement cover (mm)_____	20	25	25	30	35	40

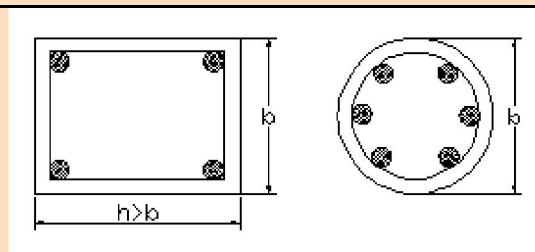


Figure 4.13. Structural Features of RC and PC Columns (Table 4.11)

When columns are placed at expansion joints, the minimum thickness “b” shall be related to two adjacent columns in accordance with Figure 4.14.

The minimum dimensions specified in Table 4.11 may be reduced if reinforced with plaster covering is applied in accordance with the specifications given in sub-clause 4.3.1.

Steel connections in PC tension members with no concrete cover shall be protectively covered on all sides.

Reinforced concrete brackets on columns shall have the minimum cross-sectional dimensions and reinforcement cover specified in Table 4.12

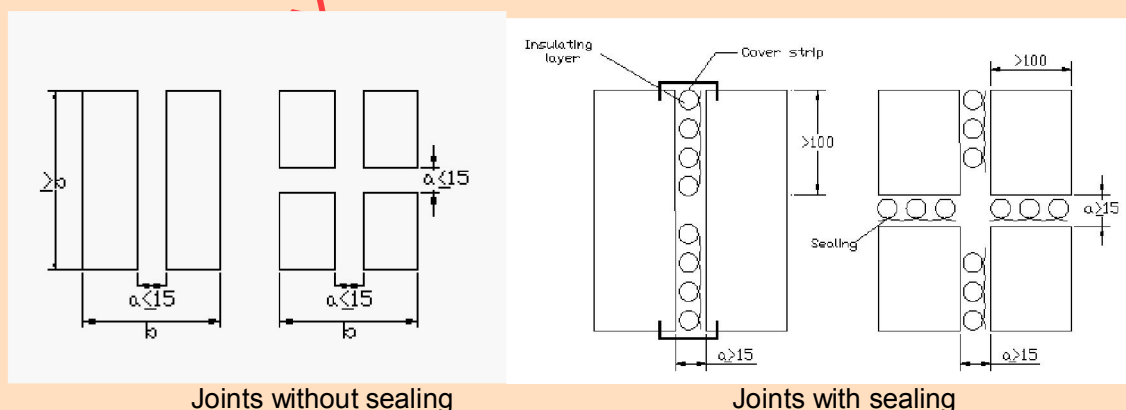
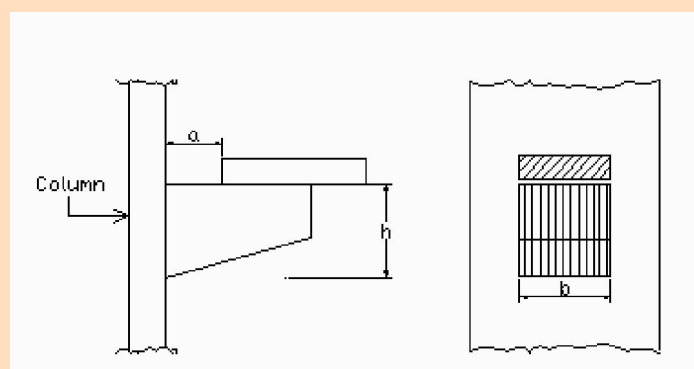


Figure 4.14. Expansion joint for adjacent columns

Table 4.12. Minimum cross-sectional dimensions of RC brackets

Structure features [See Figure 4.15]		Minimum dimensions in mm for fire rating in hour					
Side view	Front view	½	1	1.5	2	3	4
Minimum width b, in mm		110	120	170	240	320	400
Minimum height h, in mm at place of intersection		220	240	340	480	640	800
Minimum Cover C mm		20	25	30	35	35	35

**Figure 4.15.** Structural Features of RC Brackets (Table 4.12)

4.3.4 Reinforced Concrete Floors

The following specifications shall apply to reinforced and pre-stressed concrete floors made of normal weight concrete exposed to fire either from below or above.

Minimum thickness of slabs h_f and reinforcement cover C: uncovered reinforced and pre-stressed concrete slabs made up of normal weight concrete without and with cavities (containing non-combustible constituents) irrespective of the screed laid shall have at least the minimum thickness h_f , and minimum reinforcement cover c specified in Table 4.13.

Floors made of precast concrete slabs shall comply with the specification given in item 2 of sub-clause 4.5.4 with regard to minimum thickness and reinforcement cover. Joints between precast slabs shall be sealed with mortar or building material class A. Beveled edges may be ignored if the bevel is not greater than 40 mm, otherwise, the minimum thickness h_f shall refer to the end point of the bevel.

Uncovered reinforced and pre-stressed concrete ribbed floors made up of normal weight concrete shall have the minimum dimensions assigned to the required fire resistance given in Table 4.14.

Table 4.13. Minimum dimensions of reinforced and pre-stressed concrete floors exposed to fire either from below or above.

Structural feature	Minimum dimensions in (mm) for fire resistance rating in hours					
	½	1	1 ½	2	3	4
1. Uncovered solid slabs without screed statically determinate and:						
▪ Without cavities						
Thickness h_f mm	75	95	110	125	150	170
Reinforcement concrete mm	15	20	25	35	45	55
[See Figure 4.16a]						
▪ With cavities						
Thickness h_c mm	60	60	60	60	60	60
Cover c mm	15	20	20	25	25	25
[See Figure 4.16b]						
2. Uncovered solid slabs without screed statically indeterminate and:						
▪ Without cavities						
Thickness h_f mm	75	95	110	125	150	170
Cover C mm	15	20	20	25	35	45
▪ With cavities						
Thickness h_c mm	80	80	80	80	80	80
Cover C mm	15	20	20	25	25	25
3. Uncovered flat slabs without screed supported by columns						
▪ With splayed heads						
Thickness h_f (mm)	150					
	15	150	150	150	150	150
Cover c (mm)		20	25	35	45	55
[See Figure 4.16c]						
Without splayed heads						
Thickness h_f (mm)	150	200	200	200	200	200
Cover c (mm)	15	20	20	25	35	45
[See Figure 4.16d]						

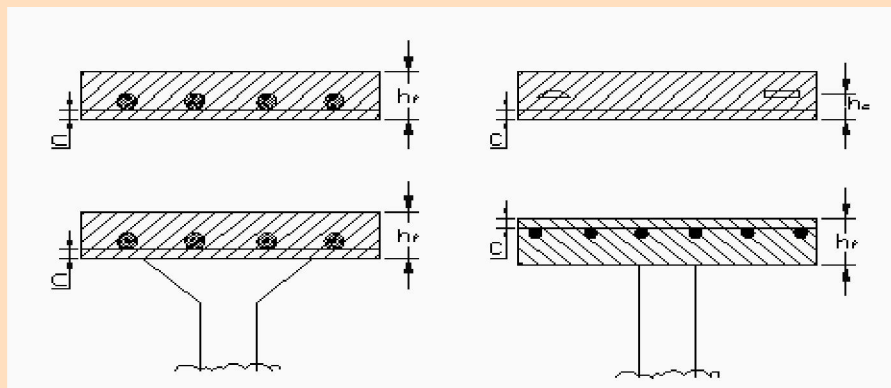


Figure 4.16. Structural feature of RC floors (a), (b), (c) and (d) (Table 4-13), respectively

Table 4.14. Minimum dimensions of reinforced and pre-stressed ribbed floors exposed to fire either from below or above.

Structural Feature	Min. dimensions (mm) for fire resistance of in hours					
	1/2	1	1.5	2	3	4
[See figure 4.17]						
1. Min dimensions of uncovered RC ribs statically determinate with open soffit	70	90	105	115	135	150
Thickness h_f (mm)	75	90	110	125	150	175
Width b (mm)						
2. Min. dimension of uncovered RC ribs statically indeterminate with open soffit.	70	90	105	115	135	150
thickness h_f (mm)	75	80	90	110	125	150
width b (mm)	15	20	20	35	45	55
Reinforcement cover C (mm)						
3. Min dimensions of uncovered PC ribbed floor with open soffit	80	80	100	120	150	150
Thickness h_f (mm)	120	120	160	190	260	300
Width b (mm)	20	30	40	50	60	70
Reinforcement cover C (mm)						

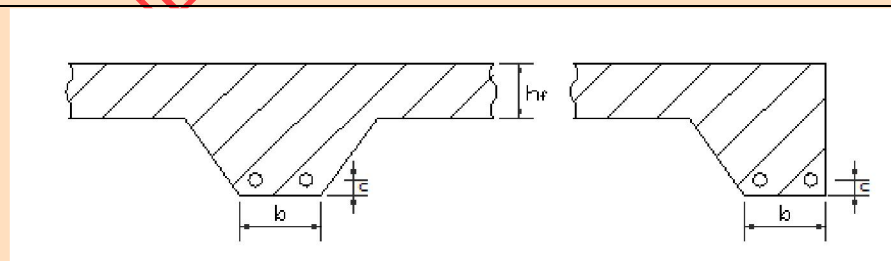


Figure 4.17. Structural Feature (Table 4.14)

4.3.5 Reinforced Concrete Floors with Steel Beams Embedded in Concrete

The following specifications shall apply to RC floors with steel beams embedded in concrete and exposed to fire from above or below

RC floors with steel beams embedded in concrete without infill components shall have at least the minimum dimensions specified in Table 4.15.

Table 4.15. Minimum dimensions of RC floors with steel beams embedded in concrete and exposed to fire either from above or below

Structural features and nature of construction	Min. dimensions in (mm) for fire resistance rating in hours					
	½	1	1.5	2	3	4
1. Min dimensions of RC slabs: [See Figure 4.18]						
Thickness h_f (mm)	100	100	100	120	150	170
Concrete cover C (mm)	15	25	35	45	60	70
Non-combustible screed or an asphalt screed						
Thickness D (mm)	10	15	25	30	50	60
Plaster thickness d_1 (mm)	15	15	25	25	25	25
2. Min. dimension floors with beams projecting from slabs [See figure 4.18b]						
Width b in (mm)	120	150	180	200	240	300
Concrete side cover C_s	35	50	65	75	90	90
other min. dimensions h_f , d_1 , D	See 1 above					

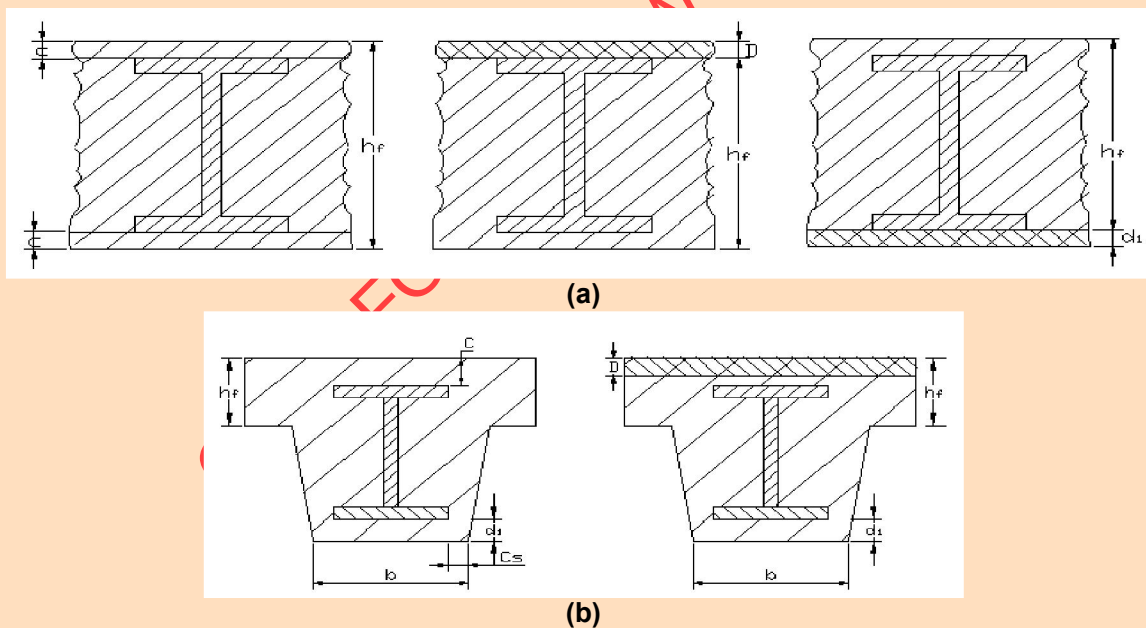


Figure 4.18. Structural features of RC floors with steel beams (Table 4.15)

4.3.6 Reinforced Concrete Roof Slabs

The specifications given in sub-clause 4.5.4 and 4.5.5 shall apply to the design of reinforced concrete roof slabs made of normal weight concrete provided:

- a) A gravel fill not less than 50 mm thick or a layer of concrete slabs not less than 50mm thick tightly abutted is laid on the roof sealing and if,
- b) Mineral fibre insulating materials of building material class B2 are used as insulating layer and then;

The minimum floor thickness h_f specified in 4.5.4 to 4.5.5, may be reduced in each case by 20 mm, but not less than the thickness h_f specified for half hours fire rating in each case.

4.3.7 Timber Beams

The Specification here under shall apply to statistically determinate or statically indeterminate timber beams of rectangular in cross-section without holes, exposed to fire on three sides at the most and on four sides at the most subjected to bending stress specified.

Covered beams, irrespective of the bending stress and the type of the timber shall have the minimum cross-sectional dimensions and covering thickness specified in Table 4.16.

Uncovered beams when made from solid or laminated timber shall have at least the minimum cross-sectional dimensions specified in Table 4-17.

Beams joined with dowels may be used provided the total cross-section meets the above requirements, and the timber cover of the dowel bars is not less than 50 and 100 mm for $\frac{1}{2}$ and 1 hour fire resistance class, respectively.

Table 4.16. Minimum dimension of rectangular uncovered beams made of solid or laminated timber

Timber Type	Bending stress N/mm2	Min dimension b/h in mm/mm for fire resistance of			
		$\frac{1}{2}$ hr		1 hr	
		and exposed to fire on			
		3 sides	4 sides	3 sides	4 sides
Solid timber	≥ 13	150/260	160/300	300/520	320/600
	10	120/200	130/240	240/400	260/480
	7	100/160	110/200	200/320	220/400
	< 3	80/160	90/180	180/240	200/400
Laminated timber	≥ 13	140/280	150/300	280/560	300/600
	10	110/220	120/240	220/440	240/480
	7	90/180	90/180	170/30	180/360
	< 3	80/160	80/160	140/280	160/320

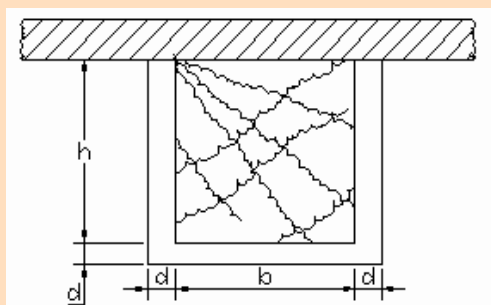


Figure 4.19. Structural feature of covered timber beam (Table 4.17)

Table 4.17. Covered beams made from solid or laminated Timber

Structural feature [See figure 4.19]	Fire resistance class of	
	½ hour	1 hour
Minimum cross-sectional dimension b/h mm/mm	80/110	160/220
Min. thickness d in mm of gypsum plaster board covering (may be single layer or two layer cover.)	15	2x12.5

4.3.8 Timber Columns

The specification here under shall apply to columns made from laminated timber, uncovered or covered solid timber without holes, grooves but joints, which may be exposed to fire on not more than four sides.

Uncovered rectangular columns length not exceeding 5m made of laminated timber shall have the minimum thickness d specified in Table 4.18 to resist the prescribed fire ratings for the corresponding buckling stress.

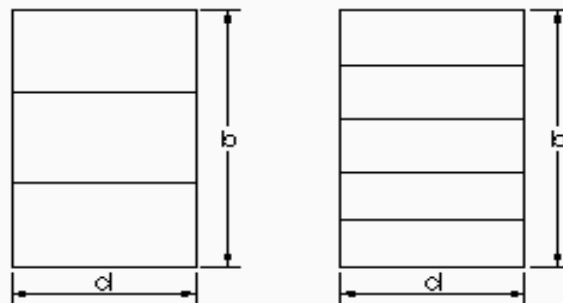
Uncovered column of laminated timber with an + or I cross-section and length not exceeding 3m shall have the minimum dimension specified in Table 4.18.

Uncovered columns of solid timber of rectangular cross-section with length not exceeding 3m shall have the minimum dimension specified in Table 4.18.

Covered timber columns, irrespective of the buckling stress and length shall have the minimum cross-sectional dimension and cover thickness specified in Table 4.21. The covering may be made by using gypsum plaster board, concrete or masonry or wall slabs in accordance with the data given in the schematic drawings.

Table 4.18. Minimum thickness of uncovered columns made from laminated timber, length not exceeding 5m

Cross sectional feature	Buckling stress N/mm ²	Min. thickness d in mm for idealized pin support column for fire resistance of ½ hours			
		½ hours		1 hours	
		Pin ended	Fixed end	Pin ended	Fixed ended
[See figure 4.20a] b = d	≥11	184	162	300	260
	=8.5	163	149	263	234
	≤5	132	126	210	198
[See figure 4.20b] b ≥ 2d	≥11	164	152	274	240
	=8.5	148	139	242	216
	≤5	126	118	194	182

**Figure 4.20.** Structural feature of laminated timber column-rectangular section (Table 4.18)**Table 4.19.** Minimum dimension of uncovered column made of laminated timber with + or I sections length not exceeding 3m.

Cross-sectional feature	Building Stress N/mm ²	Min. dimension d in mm for fire resistance of							
		½ hours				1 hours			
		d ₁	d ₂	d ₃	d ₄	d ₁	d ₂	d ₃	d ₄
[See Figure 4.21a]	≥11	120				180			
	=8.5	100				160			
	≤5	70				140			
[See Figure 4.21b]	≥11		100	120	120	140	200	200	
	=8.5		90	110	110	130	180	180	
	≤5		80	100	100	120	150	150	

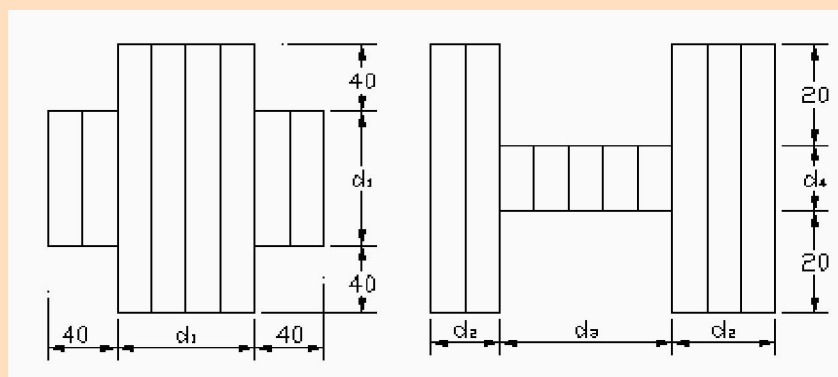


Figure 4.21. Structural feature of laminated timber column –I section (Table 4.19)

Table 4.20. Minimum thickness of uncovered columns made of solid timber for fire resistance of ½ hours

Cross-Sectional feature	Buckling stress N/mm^2	Min. thickness d in mm for column length not exceeding		
		2m	3m	4m
[see figure 4.22]	≥ 11	240	260	280
	$= 8.5$	200	220	240
	$= 5.0$	160	180	200
	≤ 2	120	140	160

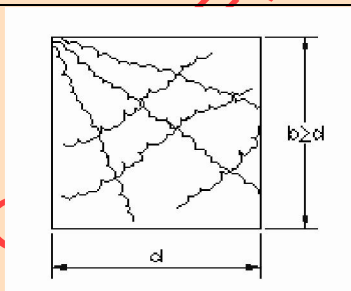


Figure 4.22. Cross-section of solid timber column

Table 4.21. Min dimension of covered columns of solid or laminated timber

Cross-sectional feature $b \geq d$	Min. dimension in mm		Fire resistance class in Hours
	Column size D	Covering d_1	
[See figure 4.23a]	80	15	½
[See figure 4.23b]	160	2x12.5	1
[See figure 4.23a]	80	50	1

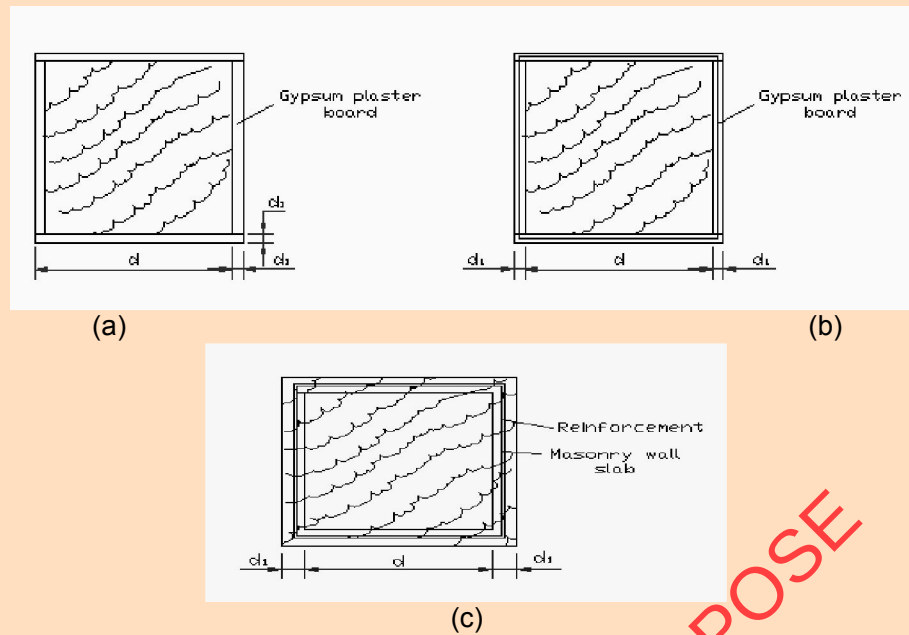


Figure 4.23. Cross-section of solid or laminated covered timber column (Table 4.21)

4.3.9 Timber Floor

Floors of timber panels

- The following specifications shall apply to floors of timber panels exposed to fire from above or below and to roofs regarded as structurally equivalent.
- These floors shall consist of cut and sawn building timber studs, whose width shall not be less than 40 mm, soffit board and covering which can be of chipboard, gypsum plasterboard, gypsum baseboard, wood wool slabs, gypsum floor slabs, wire lathing and plaster floors; upper boarding may be plywood boards, chipboard, soft wood tongued and grooved boards. The panels and boards shall have a close –graded surfacing, butted tight against the timber studs. Gypsum plasterboards shall be fixed with screws, nails or flat head nails.
- The various minimum dimensions of lower and upper boarding or covering s, floating screeds, permissible span of boarding and size of the of the studs for fire rating of $\frac{1}{2}$ and 1 hours are specified in Table 4.22.
- For better fire protection, the lower boarding can have insulating layer which consists of mineral fibers (density $\rho=30\text{KG/m}^3$) or made of any other building material of class A (melting point not less than 1000°C).
- Mineral fibre insulating layers in the form of boards shall be forced tightly between the studs and adhesively bonded to the ribs to prevent them falling out. Mineral fibre insulating layer in the form of mats may be used if they are stitched to woven wire, which in turn shall be fixed to the timber studs by mailing.
- Joints of butted insulating layers shall be tight. Insulating layers without joints or which are in two layers shall be staggered for fire protection purpose. Insulating layers in the form of mats shall overlay at the joint but not less than 100mm.
- The minimum thickness of floating screed specified in Table 4-22 may be omitted if the upper boarding consists of chipboard not less than 19mm, or soft wood tongued and grooved boards not less than 21 mm in thickness and the floor does not bear a live load exceeding 1KN/m^2 .

Floors supported by timber beams

- a) The following specification shall apply to timber beam floors exposed to fire from above and below and for roofs regarded as structurally equivalent.
- b) Timber beam floors with floating screed or floating floors shall consist of
 - Timber beam exposed to fire on three sides,
 - A boarding consisting of chipboard, soft wood tongued and grooved boards, sound boarding with an apparent groove and/or soft wood beveled boards.

The various minimum dimensions of timber floors with floating screed where the beams are completely exposed to fire are given in Table 4.23. The bending stresses specified refer to the timber beams.

- c) It is permitted to use additional coverings, except for steel plate covering on the soffit and to apply floor coverings or roofing on the top surface of the floor or roof without any additional verification.
- d) The various minimum dimensions of timber beam floors with partly exposed beams to fire on three sides in the lower region only are given in Table 4-24.
- e) All boards shall have a close-graded surfacing and form a tight joint to the beams. The insulating layer for the purpose of fire protection shall consist of mineral fibers of building material class A (bulk density 30Kg/m³, melting point not less than 1000°C) and be in the form of a board installed by driving tightly in (compression of up to about 1 cm) and fixed with timber lath not less than 40mmx60mm in size. In case where this insulating layer is absent, the thickness d1 (chipboard) and d2 (board of timber) specified in Table 4.24 each need to be multiplied by 1.25.

Roofs made of Timber or timber derivatives

- a) The following specifications shall apply to roofs of timber or timber derivatives exposed to fire from below and having continuous roofing on their upper side
- b) Roofs with timber beams or timber studs of dimensions specified in item (2) above may be used replacing the floating screed with a roofing material with or without insulating layer
- c) When the upper side of the roof is covered with
 - Gravel fill not less than 50 mm thick
 - Layer of concrete slab tightly butted not less than 50 mm thick or
 - Floating screed as specified in 2 above;

The roofs can be considered as having fire resistance class if exposed to fire from above.

- d) Roofs with roof joists, trusses etc of any dimensions which have a roofing or a boarding of any thickness with a roofing on the upper side shall have a covering and where applicable any insulating layer necessary for fire protection purpose.
- e) The covering can be chipboard in combination with gypsum plasterboard; gypsum plasterboard, plastered gypsum base board, plastered wood wool slabs or wire lathing and plaster ceilings. All coverings shall have a closed graded surfacing and shall be butted tight together. The coverings shall be fixed to the roof joints, trusses etc with or without the use of base lathing or fine lathing. The various minimum dimensions of roofing for fire resistance of 30 minutes when ever exposed to fire are specified in Table 4.25.

Table 4.22. Minimum dimension of floors of timber panel exposed to fires from above and below

[See Figure 4.24]

Lower boarding or covering					Insulating layer thickness d (mm)	Upper boarding board of timber derivates d ₃ (mm)	Floating Screed				Fire Resistance class in hours	
Timber Studs Minimum Width b (mm)	Gypsum Plasterboard		Chipboard				Maximum Span (mm)	Insulating layer d ₄ (mm)	Mortar gypsum or asphalt d ₅ (mm)	Boards of timber derivates or parquet d ₅ (mm)		Gypsum plaster board d ₅ (mm)
	d ₁ (mm)	d ₂ (mm)	With insulating layer d ₁ (mm)	Without insulating d ₁ (mm)								
40	---	---	16	19	625	60	16	15	20	---	---	½
	---	---	16	19	625	60	16	15	---	16	---	
	---	---	16	19	625	60	16	15	---	---	9.5	
40	12.5	12.5	---	---	400(500)*	60	19	15	20	---	---	1
	12.5	12.5	---	---	400(500)*	60	19	30	---	25	---	
	12.5	12.5	---	---	400(500)*	60	19	15	---	---	18	

*The value in the parenthesis are used when insulator layer is provided to lower boarding or covering

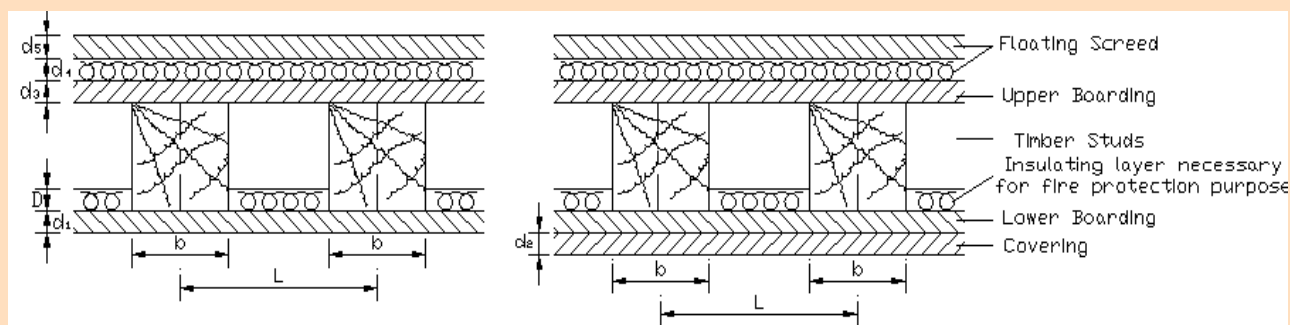


Figure 4.24. Floors of timber panels (Table 4.22)

Table 4.23. Minimum dimensions of Timber beam floors exposed to fire from above and below

[See figure 4.25]							
Min. dimensions of beams for a specified bending stress			Minimum thickness of boarding when using		Minimum thickness of Floating Screed		Fire resistance class in hours
Bending stress σ N/mm ²	Solid timber b/h mm/mm	Laminated timber b/h mm/mm	Chipboard d1 mm	Boards or plank d1 mm	Insulating layer d2 mm	Chipboard d3 mm	
≥ 14	----	140/260					
≥ 13	----	130/240					
$= 11$	130/220	110/200					
$= 10$	120/200	100/190					
$= 7$	100/160	80/150	25	28	15	16	$\frac{1}{2}$
≤ 3	80/160	80/120					
≥ 14	----	280/520	45	50	30	25	1
≥ 13	----	260/480					
$= 11$	260/430	220/400					
	240/400	200/375					

=10	200/320	160/300
=7	180/240	140/220
≤3		



Figure 4.25. Timber beam floors exposed to fires from above and below (Table 4.23)

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Table 4.24. minimum dimensions of timber beam floors with partly exposed beams

[See figure 4.26]			Bending stress s N/mm ²	Min. dimension of timber beams b/h (mm/mm) as a function of Bending stress and different fire class (FR)					
				Solid timber			Laminated timber		
				b/h	b/h	b/h	b/h		
				FR = ½ hrs	FR = 1hrs	FR = ½ hrs	FR = 1 hr		
			≥ 14	---	—	140/150	280/260		
			≥ 13	---	—	130/150	260/240		
			= 11	130/150	260/215	110/150	220/200		
			= 10	120/150	240/200	100/150	200/190		
			= 7	90/150	200/160	80/150	160/150		
			≤ 3	80/150	180/150	80/120	140/150		
Covering			Mineral Fiber insulating layer thickness D (mm)	Boarding Boards of timber derivates d ₂ (mm)	Floating screed or Floating floor			Gypsum Plaster Board d ₄ (mm)	Fire resistanc e Class (hrs)
Chipboard d ₁ , mm	Gypsum Plaster board d ₁ mm	Max. span l (mm)			Insulatin g Layer D ₃ (mm)	Mortar or gypsum or asphalt d ₄ (mm)	Boards of timber Derivates or parquet d ₄ (mm)		
16	--	625	30	13	15	20	16	9.5	½
-	2×12.5	500	30	13	15	20	25	18	1

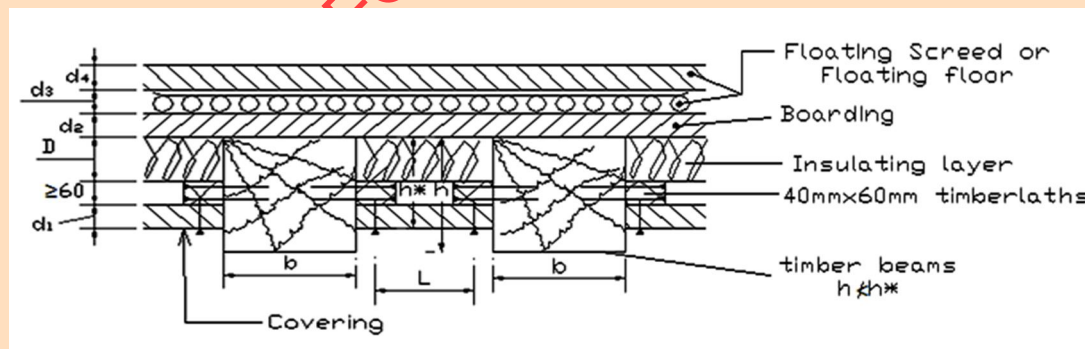


Figure 4.26. Minimum dimensions of Timber beam floors with partly exposed beams (Table 4.24)

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Table 4.25. Minimum dimensions of roof coverings with board covering on the underside for fire resistance of 30 minutes

Structural Features	Minimum dimensions of covering					Insulating layer mineral fibre	
	Chip board d_1 (mm)	Gypsum plasterboard d_2 (mm)	Gypsum base-board d_1 (mm)	PIV plaster d_1 (mm)	Max span 1mm	Thickness d (mm)	Bulk-density ρ kg/m ³
[See figure 4.27]	16	12.5	9.5	15	6.25	No requirement	
	13	15			6.25		
	0	2x12.5			500		
	-				400		
	0	15			400	40	100
	0	15			400	60	50
	0	15			400	80	30
	13	12.5			625	40	100
	13	12.5			625	60	50
	13	12.5			625	80	30

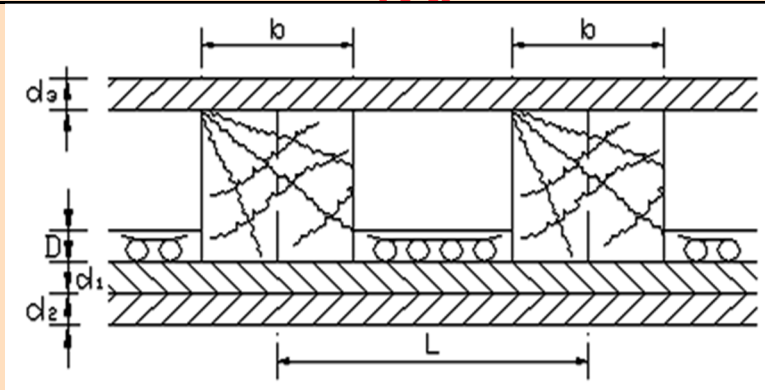


Figure 4.27. Roof covering with board covering on underside (Table 4.25)

4.3.10 Covered Steel Beams

1. General

a) Critical steel temperature

The critical temperature Crit T of steel is the temperature at which the yield point of the steel falls to the level of the stress present in the steel of the building component. For steel building components classified as ST37, STS2, stressed up to the permissible value in accordance with this standard Crit T is 500°C.

b) In order to ensure that steel building components when exposed to fire heat up only to a temperature of less than 500°C, it is generally necessary to place a protective covering. This

depends on the ratio U/A (m^{-1}), the ratio of the peripheral area exposed to fire to the cross sectional area exposed to fire, i.e., the cross-sectional area to be heated.

c) **Calculation of U/A ratio**

- I. When there is exposure to fire on four sides and the protective covering follows the section profile,

$$\frac{U}{A} = \frac{l_p}{A}$$

Where, A is the cross-sectional area of the section and

l_p is developed length

- II. Where there is exposure to fire on four sides and the protective covering in the form of box.

$$\frac{U}{A} = \frac{2h + 2b}{A}$$

- III. Where there is exposure on three sides and the protective covering follows the section profile.

$$\frac{U}{A} = \frac{l_p - b}{A}$$

As failure of the complete section generally results from heating up of a part facing the fire, a modified U/A ratio for the part of the section heating quickest can be calculated as:

$$\left(\frac{U}{A} \right)_{\text{mod}} = 200 / t$$

Where, t is the thickness of the part of the section concerned in cm. In this case the larger of the two values U/A obtained shall be used for determining the minimum thickness of the protective covering

- IV. When there is exposure to fire on three sides and the protective coverings in the form of a box

$$\frac{U}{A} = \frac{2h + b}{A}$$

- V. When there is exposure to fire only on one side such as in I beams bricked in or concreted in and only the outer surfaces of the flange are heated,

$$U/A = 100/t$$

- d) Limiting the ratio U/A : For all classified steel building components the U/A ratio shall be not greater than $300m^{-1}$. For steel building components with U/A ratio exceeding $300m^{-1}$, it will be necessary to carry out standard tests.

- e) When steel building components are to be fixed that are not required to be assigned to any fire resistance class to load bearing or bracing steel building components assigned to a particular fire resistance class the joints and the adjacent steel components shall be given a protective covering over a length 300mm for fire resistance class of $\frac{1}{2}$ to 1.5 hours; and 600 mm for fire resistance class of 2 to 3 hours.

2. Fire protection of Steel Beams

- a) The following specifications shall apply to statistically determinate or indeterminate steel beams with protective covering subject to bending stress and exposed to fire on three sides at the most or with exposure to fire on four sides when the beams have a protective covering on four sides
- b) Protective plaster coverings of beams without beam filling of the areas between the flanges shall have at least the minimum plaster thickness specified in Table 4.26.
- c) For protective plaster covering of beams with beam filling of the areas between the flanges, the minimum plaster thickness given in Table 4.27 shall apply in the region of the lower flange. However, the minimum thickness of the brickwork for the fire class of $\frac{1}{2}$ to 1.5 hours shall not be less than 50mm and for fire class of 2 and 3 hours this shall not be less than 70mm and 120mm, respectively.
- d) Gypsum plaster board protective coverings shall comply with the requirements specified in Table 4.27 with regard to the arrangement of the boards and minimum thickness. The span of the boards or the spacing of the supporting steel section shall not be greater than 400mm.

Table 4.26. Minimum plaster thickness of covered steel beams without beam filling

U/A	[See figure 4.28]									
m ⁻¹	Minimum Plaster thickness d, in mm overlathing when using plaster of									
	Mortar and Fire class					Vermiculite or perlite for fire class				
	$\frac{1}{2}$ hrs	1 hrs	1.5hrs	2 hrs	3 hrs.	$\frac{1}{2}$ hrs	1 hrs	1.5hrs	2 hrs	3 hrs
<90	5	5	15	15	25	5	5	15	15	25
90to 119	5	5	15	25	-	5	5	15	25	-
120 to 179	5	15	15	25	-	5	5	15	25	-
180 to 300	5	15	25	-	-	5	5	25	25	-

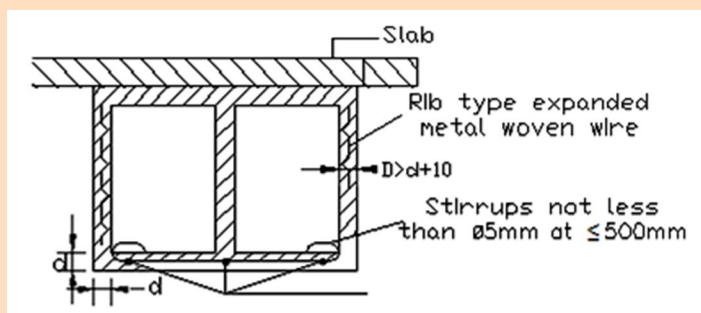


Figure 4.28. Plaster thicknesses of covered steel beams without beam filling (Table 4.26)

Table 4.27. Minimum thickness of gypsum plasterboard protective covering d in mm of steel beams with $U/A \leq 300\text{mm}$

[See figure 4.29]	Minimum covering thickness d in mm for fire resistance class of ____ hours			
	$\frac{1}{2}$	1	1.5	2
	12.5	12.5+9.5	2x15	2x15+9.5

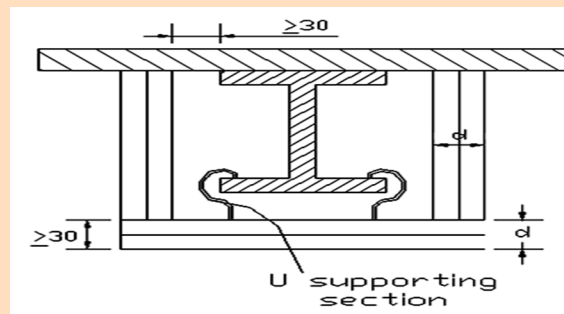


Figure 4.29. Structural feature of steel beams covered with gypsum plasterboard (Table 4.27)

4.3.11 Covered Steel Columns and Bracket

The following specifications shall apply to covered steel columns and steel columns with brackets (brackets shall be provided with protection covering of type described as function of U/A) exposed to fire on not more than four sides.

Protective coverings shall be placed over the whole height of the columns from the top edge of lower floor to lower edge of the uncovered upper floor.

Steel columns with closed cross-section with concrete mortar infilling shall have at least two holes of size 6 cm^2 per pair of holes placed opposite each other at the top and bottom of the columns and if necessary at another level so that the distance between is not more than 5m.

Steel columns with open cross-section in which the areas between the flanges are completely filled with mortar, concrete or masonry may have any desired covering in addition to covering necessary for fire protection purposes.

Covering of concrete, masonry or slabs: The minimum thickness of protective covering d in mm of steel columns with $U/A \leq 300\text{m}^{-1}$ with a protective covering of concrete, masonry or slabs shall be as specified in Table 4.28.

The protective coverings shall be reinforced by steel stirrups of $\phi 6$ placed at intervals of not less than 250mm in the centre of the covering. This reinforcement may not be necessary where columns are built into the walls over their entire height and the parts on the wall running

by columns are bonded to the adjacent parts of the wall and have at least the minimum thickness specified in Table 4.28.

Table 4.28. Minimum thickness d in mm of protective covering, concrete masonry or slabs to steel columns

Covering description	Minimum d (mm) for fire resistance class hours				
	½	1	1.5	2	3
1 Reinforced concrete or reinforced gas concrete	50 (30)	50 (30)	50 (40)	60 (50)	75 (60)
2 Masonry or wall slabs, gas concrete blocks or gas concrete building slabs, hollow blocks, solid blocks or wall slabs made of light weight concrete	50 (50)	50 (50)	50 (50)	50 (50)	75 (50)
3 Wall bricks but not including bricks with longitudinal perforation, sand lime bricks or slab sand blocks	52 (52)	52 (52)	71 (52)	71 (71)	115 (71)
4 Gypsum wall slabs	60 (60)	60 (60)	80 (60)	100 (80)	120 (100)

[The values in brackets shall apply to hollow steel columns filled with concrete and columns with open sections but the areas between the flanges filled with concrete, mortar or masonry]

Protective plaster covering of columns shall have at least the minimum plaster thickness specified in Table 4.29.

The arrangement and fixing of the non-combustible lathing, the edge protection rails and the woven wire placed near the surface of the protective covering shall comply with the specifications given in the schematic drawing. The lathings and woven wire shall be carefully fixed by tying back with soft tying wire; they shall be tied together at the longitudinal and transverse joints and the joints shall be staggered.

Table 4.29. Minimum thickness of plaster covered steel columns

U/A	Min. plaster thickness d in mm, over the lathing (rib type expanded metal, expanded metal or woven wire) in accordance with schematic drawing below and when using plaster of [See figure 4.30]									
m ⁻¹	Cement mortar for fire resistance class of ____ hours					Vermiculite or perlite mortar for fire resistance class of ____ hours				
	½	1	1.5	2	3	½	1	1.5	2	3
<90	15	25	45	45	65	10	10	35	35	45
90 to 119	15	25	45	55	65	10	20	35	45	55
120 to 179	15	25	45	55	65	10	20	35	45	55
180 to 300	15	25	55	55	65	10	20	45	45	55

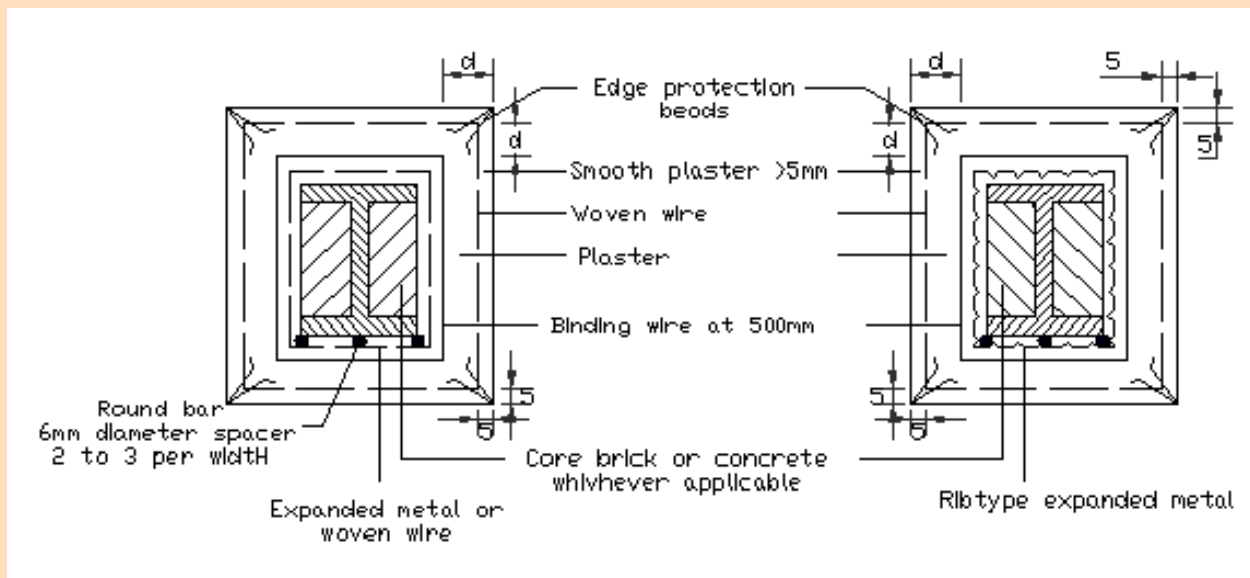


Figure 4.30. Structural feature of covered steel columns (Table 4.29)

4.4 Stair Cases and Lifts

4.4.1 Stair case

All buildings with more than 15m height and having area more than 500 m² on each floor should have a minimum of two stair cases. They should be enclosed type and at least one of them should be on external walls of the building and should open to a place of safety.

Every area used for storage of hazardous commodities should have an exit within 22.5m of any point in the area where persons may be present or 30m where automatic sprinkler protection is provided.

Stairs should be constructed using non-combustible building materials with fire ratings not less than 2 hours.

Other details provisions & stair are given in Section 3 of this code.

4.4.2 Lifts

The general requirements for provision of lifts with regard to fire safety or protection shall be as listed below:

- 1) The walls of lifts and enclosures should have a fire rating of 2 hours; lift shaft should have a vent at the top of area not less than 0.2 m².
- 2) Lift motor room should be located preferably on top of the shaft and separated from the shaft by the floor of the room.
- 3) Landing doors in lifts and enclosures should have a fire resistance of not less than 1 hour.
- 4) Lift care door should have a fire resistance rating of not less than 1 hour.
- 5) Collapsible gates should not be used for lifts and should have doors with fire resistance of at least 1 hour.

- 6) In opening other than the lift lobby, door in the lobby enclosure wall should also have the minimum fire resistance of one hour.
- 7) Suitable arrangements, such as providing slope in the floor of lift lobby should be made to prevent water used during firefighting, etc, on any landing from entering the lift shaft.
- 8) The safety signs should be posted and maintained at every floor at or near the lift indicating that in case of fire, occupants should use the stairs unless instructed otherwise. The safety signs should also contain a plan for each floor showing the location of staircase.

4.5 Chimneys

For the purpose of fire safety or protection, chimneys shall have the following provisions.

- 1) A clearance of at least 40mm between the outer surface of the chimney and any adjacent combustible material forming part of a wall lining enclosing the chimney.
- 2) The fire resistance of any structure surrounding flew or flew pipe should be not less than the one for external walls. In the case of flew pipe there should be an air space between it and the surrounding structure of sufficient width to permit access to the pipe for inspection and repair.
- 3) When flew pipe passes through any other room or an enclosed roof space it should be protected by structure having a fire resistance equal to the external walls.
- 4) The Chimney excluding the pot should be carried to a minimum height of 1m above the highest point of its junction with the roof.
- 5) The outlet of a flew from domestic appliance having a roof covering should be at least 2.5m in a horizontal plan from the roof of any structure built upon the roof or at least 0.6m higher than any ridge within 2.5m.
- 6) If the roof covering is not fire resistant, no flew outlet should be lower than the ridge for the highest point of the roof or less than 1m above any ridge within 2.5m.
- 7) Where a metal chimney passes through a roof covering which is not fire resistance, it shall be guarded by a suitable iron or metal thimble extending not less than 225 mm above and below roof construction and of a size to provide not less than 150mm clearance on all sides of chimneys.

4.6 Basements

For the purpose of fire protection, buildings with single or multi-level basements should conform to the following requirements:

- 1) Each basement should be separated by ventilated and vents with cross-sectional area not less than 2.5% of the floor area spread evenly round the perimeter of the basement should be provided in the form of grills or breakable stall boards lights or pavement lights or by way of shafts. Alternatively, a system of air inlets should be provided at basement floor level and smoke outlets at basement ceiling level.
- 2) The staircase of basements should be enclosed type having fire resistance of not less than 2 hours and should be situated at the periphery of the basement to be entered at ground level only from the open air and in such positions that smoke from any fire in the basement should not obstruct and exit serving the ground and upper storey of the building and should communicate with basement through a lobby provided with fire resisting self-closing doors of 1 hour fire resistance.
- 3) In multi-level basements, intake ducts may serve all basement levels, but each basement and basement compartment should have separate smoke outlet duct or ducts.

- 4) Ventilating ducts should be integrated with the structure, and made out of brick masonry or RC as far as possible and when this duct crosses the transformer area or electrical switch board, fire dampers should be provided. Basement/sub-basement should not be used for storage, cooking purposes, garage and shops unless provision is made for sprinkler system.

ONLY FOR REVIEW PURPOSE

SECTION 5 Ancillary Engineering Services

5.1 Scope

Ancillary engineering services comprise of Gas and Electrical services; Lighting; Heating, Air Conditioning and Ventilation services; Incinerators and Lifts, Escalators and Conveyor systems.

5.2 Gas and Electrical Services

Siting of gas service pipes in a protected stairway or lobby is prohibited where this provide the only means of escape in case of fire only.

Siting of electrical installation including distribution boards and meters within any protected stairway shall be separated by a building element with 30 minutes fire resistance.

Emergency controlling valves or breakers shall be provided at appropriate places preferably external to the buildings and at floor levels in order to discontinue their supplies.

Gas and Electrical services shall be installed, inspected periodically, tested and maintained by suitably qualified professionals and / or Occupational.

Gas and Electric services as they are potential sources of fire shall be installed and maintained as per relevant EBCS and by suitably qualified professionals and / or Occupational; where inapplicable relevant voluntary Ethiopian Standards, other international standards, specific industry practices and relevant literatures shall be consulted.

Besides and for the purpose of fire safety, electrical services should conform to the following requirements:

- The electric distribution cables/wiring should be laid in a separate duct. The duct should be sealed at ever alternative floor with non-combustible materials having the same fire resistance as that of the duct. Low and medium voltage wiring running in shaft and above false ceiling should run in separate conduits.
- Water mains, telephones lines, inter-com lines, gas pipes or any other services line should not be laid in the duct for electric cables.
- The inspection panel doors and any other opening in the shaft should be provided with fire doors having fire resistance of not less than 1 hour.
- Medium and low voltage wiring running in shafts and within false ceiling should run in metal conduit. Any 220V wiring for lighting or other services above false ceiling should have about 660V grade insulations. The false ceiling including all fixtures used for its suspension should be of non-combustible material.
- An independent and well ventilated service room should be provided on the ground floor with direct access from outside or from the corridor for the purpose of termination of electric supply from the licensee's service and alternative supply cables. The doors provided for the service room should have fire resistance of not less than 2 hours.

5.3 Lighting

Artificial light sufficient enough for visibility shall be provided to all escape routes.

Visible lighting needs to be provided and maintained in all escape routes in order to clearly delineate internal circulatory exit routes and identify fire related any directional or warning signs including location of fire alarm call points and firefighting equipment locations in case of fire.

Escape lighting in addition to artificial lighting is designed to provide illumination when part or all of the normal lighting system has failed and shall be provided in all escape routes within the following:

- Underground or windowless accommodations;
- All stairs serving storeys 18 m or more above ground level, internal corridors, external escape routes, those parts of rooms, premises regularly used outside normal daylight hours without direct natural or indirect light;
- All escape routes in public car parks; and
- All services installation rooms as defined in section 5.6 below

Types of luminaire used for escape lighting shall be in accordance with the relevant EBCS, relevant voluntary Ethiopian standards, other international standards, specific industry practices and relevant literatures.

5.4 Heating, Air Conditioning and Ventilation Systems

Heating systems rarely cause fires by themselves but their potential increases if sited near local heating units or when local heating units are placed adjacent to them.

Provisions of automatic fire detectors, smoke control system using pressure differentials compatible to the air conditioning and ventilation systems and fire dumpers are necessary to limit spread of flames and smoke when break into ventilation systems such as ducts to minimize rapid fire development.

Heating, Air conditioning and Ventilations systems shall be installed, inspected periodically, tested and maintained by suitably qualified professionals and / or Occupational.

Heating, Air conditioning and Ventilations systems, as they are potential sources for rapid spread of fire; shall be installed and maintained as per the relevant EBCS; where inapplicable relevant voluntary Ethiopian Standards such as ES 2888:2006, other international standards, specific industry practices and relevant literatures shall be consulted.

Fire resistance of ventilation system

To prevent propagation of fire and smoke into other storey or fire compartments, the following specifications shall apply to ventilation shafts and ducts which can be classified in fire resistance class of ½ to 2 hours ratings.

Escape routes like stair cases, common corridors, lifts, lobbies etc should not be used as return air passage. As far as possible metallic ducts should be used even for the return air instead of space above the false ceiling.

The ducting may be constructed from concrete when it bears on earth or solid material otherwise should be metal.

Area more than 750 m² on individual floor should be segregated by a fire wall and automatic fire dampers for isolation should be provided.

Air-conditioning systems circulating air to more than one floor area should be provided with dampers designed to close automatically in case of fire and thereby prevent spread of fire or smoke. Such a system should also be provided with automatic controls to stop fans in case of fire, unless arranged to remove smoke from a fire, in which case these should be designed to remain in operation.

Air-conditioning system serving large places of assembly (over 1000 persons), large departmental stores or hotels with over 100 rooms in a single block should be provided with effective means for preventing circulation of smoke through the system in the case of a fire in air filters or from other sources drawn into the system even though there is insufficient heat to actuate heat sensitive devices controlling fans or dampers.

Ventilation shafts made of light weight concrete precast components need to meet a minimum requirement of fire resistance class of 1½ hours rating with regard to aggregates, binders and concrete structures. Solid side walls or projections shall be at least 50mm thick and side walls and projections with cells shall be at least 80mm thick.

Floors interrupted by the shafts shall consist of class A building materials including their insulating layers in the region of the penetrations.

Barriers across openings in shaft walls shall be assigned at least to the same fire resistance class as the shaft walls. Any ventilation duct inserted in shaft be fully grouted in with mortar at the entry points.

Ventilation Ducts

Ventilation ducts made of light weight concrete precast components shall meet the requirements of fire resistance of 1½ hours rating if the precast components bear on the earth or on solid building components and sub-clause 4.6.2 of item 2 to 4 shall apply as appropriate.

When the duct system does not bear on earth or on solid building components, sheet steel ventilation ducts with an outer insulating layer shall be deemed to meet the requirements for fire resistance class of ½ to 1½ hours ratings. They consist of black or galvanized sheet of not exceeding 1.5mm thickness and have no openings, the thickness of galvanizing not exceeding 25 µm.

The materials used for insulating the duct system shall consist of mineral fibres or building materials of class BMA.

Horizontal pipes or ducts may only be fixed to reinforced concrete beams or floors or roofs, whereas vertical pipes may only be fixed to solid walls.

A wall penetration, the cavity between the pipe insulating layer and wall shall be completely sealed with insulating material. In case of penetration through floors, the space between the ducts or pipes and the floor shall be completely sealed with mortar or concrete or building material of class BMA to a thickness not less than 100mm measured in the direction of the axis of the duct or pipe.

Shafts ducts and Cables for Services

Shafts and ducts for building services shall be designed as ventilation ducts in accordance with the specification given in sub-clause 4.6.3 subject to the following provisions.

Pipe and cables penetrating the walls of a shaft or duct shall be fully grouted in with mortar in the region of the walls.

Shafts and ducts for building services in which combustible materials are used shall be sealed off by a mortar grout not less than 200mm thickness at each floor or building material of class BMA.

Fuel lines in shafts and ducts for building services shall consist of non-combustible building materials. Pipes or cables of combustible materials or pipes carrying materials with temperature of more than 1000C shall not be laid inside shafts or ducts for building services containing fuel lines.

5.5 Incinerators

Incinerators other than sanitary incinerators require special considerations and preferably be isolated in a separate building.

5.6 Engineering services installation rooms

Engineering services installation rooms include:

1. Electric control rooms including Transformer rooms
2. Boiler rooms
3. Fuel storage spaces
4. Mechanical ventilation and air conditioning plant rooms
5. Lift machine rooms
6. Rooms containing fixed internal combustion engine
7. Rooms containing highly flammable or toxic materials
8. Battery charging rooms

The following recommendations are applicable to such rooms:

- Sitting of such rooms shall not prejudice escape from other exits in case of fire.
- Imperforate sills to doorways and necessary drainages with interceptors shall be provided if such rooms contain highly flammable liquids and gases.

- Such rooms shall be ventilated, either directly or indirectly; to the outside air without impairing any fire resistance requirements in order to avoid undue built up of heat that may cause fire.
- Appropriate voluntary Ethiopian Standards, specialist literatures, industry practices and other international standards shall be consulted for fire related specific requirements.

ONLY FOR REVIEW PURPOSE

SECTION 6 Fire Detection, Alarm and Control Systems

6.1 Introduction:

This part covers the requirements for fire detection, alarm and control systems.

6.2 Fire Detection Systems

6.2.1 General

One of the prime objectives of fire safety and protection is to enable occupants to have sufficient time to escape during fire. The detection time, the alerting time, the reaction time, the evacuation time and the fire extinguishing time are necessary to protect life safety and property. Among these time requirements; the first two can be fulfilled using Fire detection and alarm system.

Fire detections help to identify one or more characteristics of fires known as “fire signatures”; namely: heat, smoke and flames. No one type of detector can be considered to all conditions of fires but dependent upon the fire classifications described in section 2.3 and 2.4 of this Code. As a result, proper selection and siting of fire detectors are essential for achieving the fire safety, protection and fighting objectives.

Fire detection systems include Heat and/or Smokes and/or Flames detectors and are described below.

6.2.2 Heat, Smoke and Flame Detection system

Heat Detectors: There are two types of heat detectors; namely (1) Fixed temperature and (2) Rate of rise detectors.

Fixed temperature detectors are designed to detect heat exhibiting and reaching a pre-determined temperature either for a small area called point detectors or having a linear sensing device protecting larger area called line detectors.

Rate of rise detectors are designed to detect heat exhibiting a rise of 1°C per minute above a pre-determined temperature level.

In both cases the detector operates using a fusible metal or heat sensitive covering or expansion effect on metals or gases to make or break a circuit when either the pre-determined temperature rate or a designated rate of rise in temperature exists.

Smoke Detectors: There are two types of smoke detectors; namely (1) Ionization and (2) Optical detectors.

Ionization detectors are designed to detect the invisible products of smoke when flow of ions created is slowed towards electrodes across which a potential difference is maintained which reduces the flow of current in the chamber that actuate the alarm system.

Optical detectors are designed to detect the visible products of smoke when the amount of light falling on the photo electric cell reaches a pre-determined value to actuate the alarm.

Flame Detectors: There are three types of flame detectors; namely (1) Infra-red radiation, (2) Ultra-violet radiation, and (2) Combined IR/UV radiation detectors.

Both infra-red and Ultra-violet radiations are results energy forms produced from a fire reaching a flame stage. While Infra-red radiation detectors operate based on a pre-set period of normally 2 – 15 seconds to activate the alarm; Ultra-violet radiation detector operates similar to the ionization smoke detector for activating the alarm.

There are also **Multi-sensor or Combination fire detectors** which are point type resettable detectors that can detect both heat and smoke.

6.2.3 Choice or Selection of fire detectors

Each type of detector responds at a different rate to different kinds of fire. The following characteristics of the different types of fire detectors will assist designers to recommend the appropriate choices of detectors:

- Smoke detectors provide faster response than heat and flame detectors, but may provide false alarms.
- Ionization detectors are not suitable to fires caused by smoldering or PVC or Polyurethane foam or clearly burning fires like hydrogen, certain grades of petroleum and the like.
- Optical smoke detectors are more sensitive to larger particles of smoke hence slow in detecting fire.
- Smoke detectors cannot detect products from clean burning liquids such as alcohol because no smoke is produced; hence optical smoke or heat detectors are preferable.
- Heat detectors are not suitable for detection in life safety and in slow burning or air-conditioned premises.
- Heat detectors are suitable in compartments where heat producing equipment such as kitchen, pantry, etc. are used.
- Heat detectors with rate of rise elements are more suitable where ambient temperature is low or vary very slowly while fixed temperature detectors are more suitable where the variation is rapid over a short period of time.
- Flame detectors are particularly suited for outside and general surveillance of wider open areas such as warehouses and for critical areas where flaming fires rapidly spread such as in areas pumps, valves or pipes containing flammable liquids.
- An approved automatic smoke detection system shall be installed in areas containing stationary storage battery systems having a liquid capacity of more than 190 liters. The detection system shall be supervised by an approved central, proprietary or remote station service or a local alarm that will sound an audible signal at a constantly attended location.
- A minimum of one smoke detector shall be installed in the following areas:
 - Mechanical equipment, electrical, transformer, telephone equipment, elevator machine or similar Rooms;
 - Elevator lobbies;
 - The main return and exhaust air plenum of each air-conditioning system serving more than one story and located in a serviceable area downstream of the last duct inlet;

- Each connection to a vertical duct or riser serving two or more floors from return air ducts or plenums of heating, ventilating and air-conditioning systems, except that in Group R occupancies, a listed smoke detector is allowed to be used in each return air riser carrying not more than 2.4 cubic meter per second and serving not more than 10 air inlet openings.

6.3 Smoke and Heat Control Systems

6.3.1 Smoke Control System

Smoke which is a primary cause for loss of life during fire spreads faster than fires themselves. Though the logical response to fire is to evacuate from the vicinity; this cannot be always possible from tall and wide buildings, and its efficiency is markedly affected by existence and rapid spread of smoke. This is more challenging in the case for physically challenged occupants and patients in hospitals during fires. As a result, Smoke Control systems need to be designed and installed to provide an added prevention of loss of life and enable them to evacuate safely.

The initial aim of smoke control is to raise smoke above head height by venting smoke and hot gases by direct means to the external atmosphere. The recommendations made related to restrictive travel distance and protected escape route where applicable are based on containment. In instances where such provisions are difficult or such provisions alone could not cater for rapid and efficient evacuation; smoke control system as part of a fire safety engineering solution integrative to the other fire safety and fighting systems are recommended.

The purposes of smoke control systems include:

- Inhibiting migration of smoke out of the source compartment;
- Inhibiting smoke from entering means of egress or escape (maintaining tenable environment for evacuees);
- Maintaining a tenable environment outside of the source compartment for emergency personnel;
- Protecting life; and
- Reducing damage to property.

Smoke controlling systems can either be physical features that concerns about smoke resisting construction elements; or equipment such as fans, smoke detectors and operable windows; or methods such as design schemes such as compartmentation, smoke venting, stairwell pressurization or a combination thereof.

Smoke Resistive Construction is a means to enable occupants be protected from smoke.

Compartmentation uses physical features designed to control smoke movement by passively containing it within the smoke source area.

Smoke Venting uses non-ducted, stand-alone equipment (i.e., smoke vents in building envelopes) designed to control smoke movement by releasing it under its own pressure to the outside.

Stairwell Pressurization is a means to establish a pressure difference across a barrier to protect a designated escape route such as stairway, lobby, or a room from smoke penetration.

Smoke Control uses equipment (e.g., fans, ductwork, dampers, smoke detectors) designed to control smoke movement by actively and mechanically creating pressure differentials.

6.3.2 Heat Transmission and Control Systems

Heat is transferred from regions of higher temperature to lower temperature through three methods; namely: (1) Conduction, or (2) Convection, or (3) Radiation from ignition to extinguishment of fires.

Conduction: In fires, thermal conductivity which is the ability to transfer heat through conduction determines the danger of fire spread, hence due attention shall be given to Heat Conducting materials used in buildings as they are potential sources to spread fire quickly.

Generally good conductors of electricity such as Copper, Silver and most metals are good conductors of heat; therefore, Steel / Metal elements in buildings provided across rooms or through walls can be good causes for fire spread rapidly from one room to another.

Relevant provisions to protect buildings from fires created due to conduction of heat are mandatory during design, construction, operations and maintenance stages sections 3 and 4 of this code shall be adhered to.

Convection: In fires, the enormous amount of chemical energy released by the movement and circulation of hot gases can be circulated in liquids and gases to spread them quickly. Domestic heating systems; open stair wells, lift shafts and other open wells are potential building elements spreading fires through convection.

Relevant provisions to protect buildings from fires created due to convention of heat are mandatory during design, construction, operations and maintenance stages and sections 3 and 4 of this code shall be adhered to.

Radiation: In fires, 10 to 50 % of heat is released through radiation which is a form of energy capable of causing fires if specially there is nearby combustible or flammable materials such as clothes.

Relevant provisions to protect buildings from fires created due to radiation of heat are mandatory during design, construction, operations and maintenance stages and sections 3 and 4 of this code shall be adhered to.

6.4 Fire Alarm System

6.4.1 General requirements for fire detection and alarm systems

A fire alarm system is used primarily to evacuate the premises in the event of occurrence of a fire condition and then secondarily to report the fire to the proper authorities.

The following general requirements shall be adhered where fire detection and alarm systems are recommended:

1. If the numbers of fire detection and alarm system exceeds 20; individual zones and / or centers shall be determined, provided and plan showing such zoning and / or centers in addition to other planning requirements shall be made and put in a place legibly seen in a building.
2. A control center shall be provided for buildings having high hazard level for fire and preferably placed on the Ground floor with an area not less than 16m² and emergency lighting system.
3. Fire detection and alarm system sounder shall be electronic hooter or horn or electric bells having a minimum frequency of 500Hz, a minimum sound level of either the greater of 65dB or 5dB above expected noise level in any occupancy, and likely to persist for more than 30 seconds.
4. Fire detection and alarm places shall be sited in a place where the alarm is heard at all designated locations in the building both on days and in evenings or nights.
5. In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms shall emit a signal when the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for over-current protection.
6. Where more than one smoke alarm is required to be installed in a building, the smoke alarms shall be interconnected in such a manner that the activation of one alarm will activate all of the alarms in the individual unit. The alarm shall be clearly audible in all bedrooms over background noise levels with all intervening doors closed.
7. Activation of any single smoke detector, the automatic sprinkler system or any other automatic fire detection device shall immediately sound an alarm at the building at a constantly attended location from which emergency action can be initiated.
8. A fire alarm system shall be installed in occupancies with an atrium that connects more than two stories.
9. Where the lowest level of a structure is more than 18 meters below the lowest level of exit discharge, the structure shall be equipped throughout with a manual fire alarm system, including an emergency voice/alarm communication system.
10. Manual fire alarm boxes shall be located not more than 1.5 meters from the entrance to each exit. Additional manual fire alarm boxes shall be located so that travel distance to the nearest box does not exceed 60 meters.
11. The height of the manual fire alarm boxes shall be a minimum of 1 meter and a maximum of 1.2 meters measured vertically, from the floor level to the activating handle or lever of the box.
12. Manual fire alarm boxes shall be red in color.
13. Upon completion of the installation of the fire alarm system, alarm notification appliances and circuits, alarm-initiating devices and circuits, supervisory-signal initiating devices and circuits, signaling line circuits, and primary and secondary power supplies shall be tested.
14. Fire alarm systems shall be monitored by an approved supervising station except for Single- and multiple-station smoke alarms and Smoke detectors in Class OFG-3 occupancies.

6.4.2 Fire alarm requirements for different Occupancies

The fire alarm requirements for different occupancies are provided in the following tables.

Fire Class OFA: Institutional	
Recommended Fire Alarm System	Exceptions
Occupancy Load less than 300	
A manual fire alarm system shall be installed in Class OFA occupancies having an occupant load of 300 or more.	Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system and the alarm notification appliances will activate upon sprinkler water flow.
Occupancy Load more than and equal to 1000	
Activation of the fire alarm in Group A occupancies with an occupant load of 1,000 or more shall initiate a signal using an emergency voice/alarm communications system.	Where approved, the prerecorded announcement is allowed to be manually deactivated for a period of time, not to exceed 3 minutes, for the sole purpose of allowing a live voice announcement from an approved, constantly attended location.
Night Clubs	
An automatic fire detection system shall be installed throughout all nightclubs with an occupant load of 100 or more. If the alarm is activated by smoke detectors, it shall be activated by either two cross-zoned smoke detectors within a single protected area or a single smoke detector monitored by an alarm verification zone or an approved equivalent method, and the smoke detectors shall be of a type designed to reduce the possibility of false notifications based on the conditions present in the area protected. The automatic fire detection system shall be tied to the performance sound system and to the house lights in such a way that activation of the fire detection system mutes the performance sound system and restores the intensity of illumination.	Automatic fire detection systems are not required in buildings provided with an automatic sprinkler system throughout
Fire Class OFD: Industrial	

Recommended Fire Alarm System	Exceptions
Occupancy Load 500 or more	
A manual fire alarm system shall be installed in Class OFD occupancies that are two or more stories in height and have an occupant load of 500 or more above or below the lowest level of exit discharge.	Manual fire alarm boxes are not required when the building is equipped throughout with an automatic sprinkler system and the notification appliances will activate upon sprinkler water flow.
Fire Class OFE: Rehabilitation	
Recommended Fire Alarm System	Exceptions
Occupancy Load 500 or more	
A manual fire alarm system shall be installed in Class OFE occupancies. An electrically supervised, automatic smoke detection system shall be provided. Alarms activated by smoke detectors required by this section shall be activated by a single smoke detector monitored by an alarm verification zone or an approved equivalent method.	<p>Manual fire alarm boxes in resident or patient sleeping areas of Class OFE-1 and OFE-2 occupancies shall not be required at exits if located at all nurses' control stations or other constantly attended staff locations, provided such stations are visible and continuously accessible and travel distances are not exceeded.</p> <ol style="list-style-type: none"> 1. Smoke detection in habitable spaces is not required where the facility is equipped throughout with an automatic sprinkler system. 2. Smoke detection is not required for exterior balconies.
Class OFE-2: Hospital	
Corridors in nursing homes (both intermediate care and skilled nursing facilities), detoxification facilities and spaces permitted to be open to the corridors shall be equipped with an automatic fire detection system. Hospitals shall be equipped with smoke detection.	<ol style="list-style-type: none"> 1. Corridor smoke detection is not required in smoke compartments that contain patient sleeping units where patient sleeping units are provided with smoke detectors. Such detectors shall provide a visual display on the corridor side of each patient sleeping unit and an audible and visual alarm at the nursing station attending each unit. 2. Corridor smoke detection is not required in smoke compartments that contain patient sleeping units where patient sleeping unit doors are equipped with automatic door-closing devices with integral smoke detectors on the unit sides installed in accordance with their listing, provided that the integral detectors perform the required alerting function.
Class OFE-3: Other Institutions	
Class OFE-3 occupancies shall be equipped with a manual and automatic fire alarm system installed for alerting staff.	

System initiation

Actuation of an automatic fire-extinguishing system, a manual fire alarm box or a fire detector shall initiate an approved fire alarm signal which automatically notifies staff. Pre-signal systems shall not be used.

Manual fire alarm boxes

Manual fire alarm boxes are not required to be located where the fire alarm boxes are provided at staff-attended locations having direct supervision over areas where manual fire alarm boxes have been omitted. Manual fire alarm boxes shall be permitted to be locked in areas occupied by detainees, provided that staff members are present within the subject area and have keys readily available to operate the manual fire alarm boxes.

Fire Class OFF: Business	
Recommended Fire Alarm System	Exceptions
Occupancy Load 500 or more	
A manual fire alarm system shall be installed in Class OFF occupancies having an occupant load of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge.	
Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system and the alarm notification appliances will activate upon sprinkler water flow.	
Place of Instruction (Education)	
A manual fire alarm system shall be installed in such occupancies. When automatic sprinkler systems or smoke detectors are installed, such systems or detectors shall be connected to the building fire alarm system.	
<ol style="list-style-type: none">1. Occupancies with an occupant load of less than 50.2. Manual fire alarm boxes are not required in such occupancies where all the following apply:<ol style="list-style-type: none">2.1. Interior corridors are protected by smoke detectors with alarm verification.2.2. Auditoriums, cafeterias, gymnasiums and the like are protected by heat detectors or other approved detection devices.2.3. Shops and laboratories involving dusts or vapors are protected by heat detectors or other approved detection devices.2.4. Off-premises monitoring is provided.2.5. The capability to activate the evacuation signal from a central point is provided.2.6. In buildings where normally occupied spaces are provided with a two-way communication system between such spaces and a constantly attended receiving station from where a general evacuation alarm can be sounded, except in locations specifically designated by the fire code official.3. Manual fire alarm boxes shall not be required	

in Group E occupancies where the building is equipped throughout with an approved automatic sprinkler system, the notification appliances will activate on sprinkler water flow and manual activation is provided from a normally occupied location.	
Fire Class OFH: Residential and Hotel	
Recommended Fire Alarm System	Exceptions
Occupancy Load 500 or more	
<p>A manual fire alarm system shall be installed in Class OFH occupancies having an occupant load of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge. The initiation of a signal from a manual fire alarm box shall initiate alarm notification appliances.</p> <p>Occupant notification</p> <p>During times that the building is occupied, the initiation of a signal from a manual fire alarm box or from a water flow switch shall not be required to activate the alarm notification appliances when an alarm signal is activated at a constantly attended location from which evacuation instructions shall be initiated over an emergency voice/alarm communication system.</p> <p>The emergency voice/alarm communication system shall be allowed to be used for other announcements provided the manual fire alarm use takes precedence over any other use.</p>	
<ol style="list-style-type: none"> 1. Covered mall buildings 2. Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system and the alarm notification appliances will automatically activate upon sprinkler water flow. 	
Class OFH-1: Hotel	
<p>A manual fire alarm system shall be installed in Group H-1 occupancies.</p> <p>Alarms activated by smoke detectors shall be activated by a single smoke detector monitored by an alarm verification zone or an approved equivalent method.</p> <p>An automatic fire alarm system shall be installed throughout all interior corridors serving sleeping units.</p> <p>In buildings that are not equipped throughout with an automatic sprinkler system, the smoke alarms in sleeping units shall be connected to an emergency electrical system and shall be annunciated by sleeping unit at a constantly attended location from which the fire alarm system is capable of being manually activated.</p> <p>Single- or multiple-station smoke alarms shall be installed in all of the following locations in Group H-1:</p> <ol style="list-style-type: none"> 1. In sleeping areas. 2. In every room in the path of the means of egress 	
<ol style="list-style-type: none"> 1. A manual fire alarm system is not required in buildings not more than two stories in height where all individual sleeping units and contiguous attic and crawl spaces are separated from each other and public or common areas by at least 1-hour fire partitions and each individual sleeping unit has an exit directly to a public way, exit court or yard. 2. Manual fire alarm boxes are not required throughout the building when the following conditions are met: <ol style="list-style-type: none"> 2.1. The building is equipped throughout with an automatic sprinkler system; 2.2. The notification appliances will activate upon sprinkler water flow; and 2.3. At least one manual fire alarm box is installed at an approved location. <p>An automatic fire detection system is not required in buildings that do not have interior corridors serving sleeping units having a means of egress door</p>	

from the sleeping area to the door leading from the sleeping unit.

3. In each story within the sleeping unit, including basements. For sleeping units with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

opening directly to an exterior exit access that leads directly to an exit.

Single- or multiple-station smoke alarms shall not be required where the building is equipped throughout with an automatic fire detection system.

Smoke alarms are not required to be equipped with battery backup in ClassOFH-1 where they are connected to an emergency electrical system.

Class OFH-2: Dormitory

A manual fire alarm system shall be installed in Class OFH-2 occupancies where:

1. Any dwelling unit or sleeping unit is located three or more stories above the lowest level of exit discharge;
2. Any dwelling unit or sleeping unit is located more than one story below the highest level of exit discharge of exits serving the dwelling unit or sleeping unit; or
3. The building contains more than 16 dwelling units or sleeping units.

Single- or multiple-station smoke alarms shall be installed and maintained in ClassesOFH-2 - 4 regardless of occupant load at all of the following locations:

1. On the ceiling or wall outside of each separate sleeping area in the immediate vicinity of bedrooms.
2. In each room used for sleeping purposes.
3. In each story within a dwelling unit, including basements but not including crawl spaces and inhabitable attics. In dwellings or dwelling units with split levels and without an intervening door between the adjacent levels, a smoke alarm installed on the upper level shall suffice for the adjacent lower level provided that the lower level is less than one full story below the upper level.

In ClassOFH-2 occupancies required to have a fire alarm system, all dwelling units and sleeping units shall be provided with the capability to support visible alarm notification appliances.

4. A fire alarm system is not required in buildings not more than two stories in height where all dwelling units or sleeping units and contiguous attic and crawl spaces are separated from each other and public or common areas by at least 1-hour fire partitions and each dwelling unit or sleeping unit has an exit directly to a public way, exit court or yard.

5. Manual fire alarm boxes are not required throughout the building when the following conditions are met:

5.1. The building is equipped throughout with an automatic sprinkler system.

5.2. The notification appliances will activate upon sprinkler flow.

3. A fire alarm system is not required in buildings that do not have interior corridors serving dwelling units and are protected by an approved automatic sprinkler system, provided that dwelling units either have a means of egress door opening directly to an exterior exit access that leads directly to the exits or are served by open-ended corridors.

SECTION 7 Firefighting Systems

7.1 Introduction

7.1.1 Scope

This chapter lays down the requirements of firefighting systems including first aid, fixed and mobile firefighting installation equipment; namely:

- Fire extinguishing types based on medias or agents and systems; and
- Firefighting systems or installations or equipment.

7.1.2 Specific References

The following specific references shall be read and construed to this section:

- ESISO 5923:2002: Fire extinguishing media: CO₂
- ES ISO 7202:2002: Fire extinguishing media: Powder
- ES ISO 7165:2002: Firefighting Portable fire extinguishers: Performance and Construction
- ES ISO 6182:2002: Fire protection Automatic Sprinkler: Part 1 to 5

7.2 Firefighting Systems

7.2.1 Fire extinguishing types

(1) Firefighting types based on fire extinguishing medias or agents

Based on fire extinguishing agents or medias; firefighting system is classified into the following four types of fire extinction systems or installations (Table 7.1):

Table 7.1. The different types of Fire Extinguishing Agents or Medias

No.	Types	Descriptions
1	Water and Steam based	Fire Extinguishers, Hydrant, Sprinkler, Water Spray and Deluge & Drencher installations
2	Foam based	Low, medium and high expansion foam based fire extinguishers Protein, Chemical, Synthetic and Alcohol resistance concentrations
3	Gaseous based CO ₂ or Other Inert gases Clean gases	Low and High Pressure CO ₂ or other inert gasses Fire Extinguishers Halogenated and Halon Alternative Fire Extinguishers (Not Recommended)
4	Chemical based	

Dry Powder	BC, ABC and Special powder (D Powder) based fire extinguishers
Wet Chemical	Alkaline solution of Potassium acetate fire extinguishers

Water and Steam based fire extinguishing agent

Water and Steam based fire extinguishing agents remain the most efficient, cheapest and readily available medium for extinguishing fires of a general nature. While Water is used as a cooling method of fire extinction; steam directly or developed from water is used as smothering effect for fire extinguishing.

Therefore, Water and steam extinguish fires by a combination of cooling combustible substances and flames, and generating steam that prevents or reduces oxygen access acting as fog or clouds in order to block the radiative effect of heat and create smothering effects.

Water has the following special properties to be used as a fire extinguishing media or agent:

- kj/kg/per °c heat capacity,
- 4 times higher latent heat of evaporation per unit of mass (2260 kj/kg) than any other non-flammable liquid,
- 1760 times expansion when water changes from liquid to vapor state (steam),
- Outstandingly non – toxic, and
- Lower boiling point (100 °c) than most solid combustibles (250 – 450 °c).

To increase the effectiveness of water based fire extinguishing agents, detergent based surfactants (additives) can be added to improve the penetration of the water into the burning material. This allows greater firefighting capacity and a 3 liter of water additive extinguisher can extinguish the same area of fire as a 9 liter plain water extinguisher.

Water is not safe for use on other classes of fire; it will spread a Class CFB and CFK fires, conduct electricity from energized electrical equipment (Class CFC fires), release explosive hydrogen from Class CFD fires and will boil over on class F fires. Therefore, its application is restricted for Class CFA fires only unless additives are added in which case it can be safe for Class CFC fires for a limited capacity say < 35 KVA.

Steam is a smothering agent rarely used nowadays but useful in certain ship holds, refineries, benzol plants, oil tanks and industries but only for local applications using pipes from boilers whose control valves need to be opened slowly.

Foam and Foam Making Compounds based Fire extinguishing media

Foam is usually generated by the mechanical agitation of a diluted foam compound solution in the presence of air in order to resist radiant heat fuel vapors and loss of water content.

Foam as a fire fighting agent is the most efficient because of its minimum rate of application; that is 50 liters per m² of surface area per minute. Foam concentrates can be classified either by Expansion or its Constituents (Table 7.2).

Mixing different types or brands or batches of foam concentrates is strictly forbidden in the same equipment. When using foam based fire extinguishers, respecting following Manufacturer's instruction and recommendations is mandatory.

The following foam concentrate requirements may be used for dealing with the various areas of Class CFB and CFE flammable liquid and gas fires (Table 7.3).

Detergent or protein based compounds added to water will produce a film or froth that can float over the surface of Class CFB fires forming a vapor proof seal that smothers a fire. Effective on Class CFA fires as well as Class CFB fires; Foam allows partial extinction of a liquid fire and can prevent re-ignition.

Table 7.2. Classification of Foam based Fire Extinguishers based on expansion and associated Concentration

Classification by Expansion			
Low Expansion	Up to 50:1	Protein Foam	Low expansion stiff foam (8:1) with good resistance to burn back @ 4 % concentration effective on most hydrocarbon fuels
		Fluro-protein Foam	Low expansion fluid foam (9:1) giving quicker control & extinction of fire with good resistance to burn back and fuel contamination @ 4 % concentration most suitable for sub surface injection for oil tanks
		Fluro-chemical Foam	Low expansion fluid foam (10:1) giving rapid control and extinction of fire @ 3 - 6 % concentration effective on hydrocarbon fuels and some water miscible liquids
		Alcohol Resistant	Low expansion protein foams (8:1) with additives @ 4 - 6 % concentration effective on water miscible liquids and the only practical choice for fires in many polar solvents like acetone
		Synthetic Foam	Low (11:1) expansion foam between 1.5 to 3 % concentrations effective on low boiling point hydrocarbon fuels
Medium Expansion	50:1 – 500:1	Synthetic Foam	Medium (75 to 150:1) and High (750 to 1000:1) expansion foam between 1.5 to 3 % concentrations effective on low boiling point hydrocarbon fuels
High Expansion	500:1 – 5000:1		

Table 7.3. Foam concentration requirements

Fire Area (m ²)	Rate of Application (liters per minutes)	Duration of Application (minutes)	Foam Concentration requirements (liters)
100	80	20	1600
1000	800	20	16000
10000	8000	20	160000
NB: In Industrial and Storage occupancies where large quantities of flammable liquids and gases are processed and stored and where fire hazards are high; large quantities / concentrations are required; hence refer international standards.			

Foams are normally unsafe on energized electrical equipment due to their water content which precludes them from use on Class CFD fires. On Class CFK fires the tremendous heat of the burning fat destroys the foam blanket rendering it ineffective. Care shall be taken as certain flammable liquids (polar solvents) may destroy normal foam solutions reducing them ineffective.

Carbon di oxide (CO₂) and Other inert gases

CO₂ as a fire extinguishing media is non-combustible, does not react with most substances, can easily penetrate and spread to all parts of fire areas, does not conduct electricity, do not leave residue, can easily be liquefied and bottled, can extract heat from the fire surroundings and can serve as smothering by reducing oxygen content of the air. A reduction of Oxygen percentage by from 21 to 10 % by volume will extinguish fire and explosions impossible, except for a few special gasses such as H, C₂H₂ and CS₂ which require greater dilution.

Care should be taken not to reach 9 % concentration of CO₂ in the air because this is the maximum amount most human beings withstand without losing consciousness within a few minutes while using as a fire extinguishing media. The extinguishing concentration of CO₂ required for various types of fuels vary approximately from 30 to 62 % (Table 7.4).

Table 7.4. CO₂ concentrations required to extinguish various types of flammable materials

Flammable Materials	Minimum CO ₂ concentration to extinguish fire	Flammable Materials	Minimum CO ₂ concentration to extinguish fire
Acetylene	55	Ethylene Dichloride	21
Acetone	26	Ethylene Oxide	44
Benzene	31	Gasoline	28

Butadiene	34	Hexane	29
Butane	28	Hydrogen	62
CS₂	55	Isobutene	30*
CO	53	Kerosene	28
Coal / Natural Gas	31*	Methane	25
Cyclpropane	31	Methyl Alcohol	26
Dowtherm	38*	Pentane	29
Ethane	33	Propane	30
Ethyl Ether	38*	Propylene	30
Ethyl Alcohol	36	Quench, Lubricating Oils	26
Ethylene	41		

Carbon dioxide is a non-conductive gaseous agent that displaces oxygen to smother a fire. CO₂ is especially suited for Class CFC fires (energized electrical equipment) as it penetrates & floods enclosures and leaves no residue. It is also effective on small indoor Class CFB fires. It is ineffective against Class CFA, CFD or CEFK fires and has the same flashback risks on Class CFB fires like Powders.

Other Inert Gases: There are at least four types of inert gases or gas mixtures for fire; namely, Nitrogen, Argon and each blended with Carbon-di-oxide (approx. 8%). They are used in concentrations of 35 – 50 % by volume which will reduce oxygen concentration to between 14 – 10 % by volume during fire extinguishing. As they are required to be stored as high pressure gasses in order to be effective in firefighting; they require high pressure storage cylinders.

Halogenated Agents and Halon Alternatives

Halogenated agents and Halon alternatives are strictly forbidden for use because of their effect in depleting the Ozone layer of the Environment and their consequential damages. Subsequently, ES ISO 14520: 2000 Part 1 to 15 are not any more applicable.

Dry Chemical Powders

Finely divided chemical compounds that extinguishes by separating the four elements of the fire tetrahedron. It prevents the chemical reaction between heat, fuel and oxygen by inhibition. There are commonly three types of extinguishing dry chemical powders in the market; namely,

- **BC Powder (Ordinary):** A Sodium or Potassium Bicarbonate compound designed for Class CFB & CFC fires which do not conduct electricity with high performance blends (Monnex, Purple K) and are used in the petrochemical industry.
- **ABC Powder (Multi-Purpose):** Mono-ammonium Phosphate compound that melts and flows to seal and smother Class A fires in addition to its chemical inhibition properties used on Class CFB & CFC fires. It does not conduct electricity.
- **D Powder (Special):** Sodium Chloride, Graphite or Copper compounds that are designed to melt and form a crust around burning metals, smothering the fire and allowing the metal to cool.
- The following dry chemical agents are commonly used for fire extinguishing (Table 7.5).

Table 7.5. Dry Chemical Powders in use as Fire Extinguishers

No.	Description	Formula	Remark
1	Sodium bicarbonate (Backing Soda)	NaHCO_3	Base Chemical
2	Sodium Chloride (Common Salt)	NaCl	
3	Potassium bicarbonate (Purple K)	KHCO_3	Effective twice than Baking Soda
4	Potassium Chloride (Super K)	KCl	
5	Potassium Sulfide	K_2SO_4	
6	Mono ammonium phosphate (ABC or Multipurpose powder)	$(\text{NH}_4)\text{H}_2\text{PO}_4$	Corrodes more readily than others and can damage delicate electrical / electronic equipment
7	Urea + Potassium bicarbonate (Pot. Carbamate or Monnex)	NH_2CONH_2	Effective thrice than Baking Soda

Powders are almost multipurpose and knock down most fires in seconds but have some drawbacks – they do not cool, reducing their effectiveness on Class CFA fires, the discharge is messy and obscures vision and on Class B fires the flames will flashback if the whole fire is not extinguished in one go or if an ignition source remains (unlike foam which is not affected either way).

Enclosed electrical equipment is difficult to tackle and the powder (especially if ABC) will damage electronic components. ABC Powder is ineffective on Class K fires as the heat of the oil causes flashback once the extinguisher is empty, although BC Powder can have a limited effect.

Wet Chemical: It is an alkaline solution of potassium acetate that reacts with the burning fat of a Class K fire to saponify it and turn the surface into a soapy crust, sealing it from the air and allowing it to cool.

It is the definitive extinguishing agent for all Class CFK fires in fryers over 3 liter capacity/300 mm diameters (the limits for using a fire blanket) and due to its water content it is also effective on Class CFA fires. It is a conductor of electricity, hence not recommended for Class CFC fires.

(2) Firefighting types based on fire extinguishing systems

Firefighting types based on extinguishing systems are of three types; namely:

1. **First aid Firefighting systems** such as Portable Fire Extinguishers and Fire Hose Reel system;
2. **Fixed Fire extinguishing systems / installations** such as Fire Hydrant, Fire Sprinkler and Other Automatic systems / installations; and
3. **Mobile Fire extinguishing systems / installations.**

Generally, the following six types of firefighting systems are often used to extinguish fires in both cases (Table 7.6).

Table 7.6. The different types of firefighting systems

No.	Types	Descriptions
1	Fire Extinguishers	Portable and Mobile Fire Extinguishers
2	Fire Hose Reel Systems	Automatic and Non Automatic Hose reel systems
3	Fire Hydrant Systems	External and Internal Hydrant Systems
4	Fire Sprinkler Systems	Wet, Dry, Alternate and Pre-action Sprinkler System Conventional, Spray, Ceiling flush, Side wall and Dry upright systems
4	Fire Water Spray Systems	Automatic system based on fire and smoke detection
6	Fire Deluge & Drencher Systems	Automatic systems for higher concentrations of highly flammable liquids

7.3 First Aid Fire extinguishing Systems / Equipment

7.3.1 Portable Fire Extinguishers

All fires start small, and if immediately tackled with proper type and amount of extinguishing medium, can be easily extinguished. Portable Fire extinguishers are specially designed for the purposes of tackling fires in their incipient stage and are considered as the first line of defence or first aid firefighting systems.

Portable fire extinguishers can be carried manually to any desired fire scene and can be operated by a single person as their maximum weights are limited to 23 kg for manufacturers.

The two most important considerations while selecting portable fire extinguishers are:

1. The nature of the area to be protected, and
2. The nature of the hazard involved.

Besides, the human element involved and their behavior and reaction to a fire situation including the operators whose familiarity, training and experience in operating fire extinguishing equipment is vitally important in using portable fire extinguishers.

There are five types of portable fire extinguishers which are allowed for use as first line of defense in firefighting operations (Table 7.7).

Table 7.7. Types of Portable Fire Extinguishers

No	Type	Identification	Rating	Recommendation
1	Water type portable extinguishers	Fully Red in color	Typically 13A or 21A rated	Suitable only for Class A Fires NA for fires on live electrical equipment because of electrocution.
2	Foam type portable extinguishers	Red with light cream strips	Typically 8A, 13A or 21A rated	Suitable only for Class A, B & E Fires Safe for accidental fires on live electrical equipment
3	CO ₂ type portable extinguishers	Red with Full black strips	Typically 34B or 55B rated	Suitable only for Class B Fires Safe for direct use for fires on live electrical equipment
4	Dry Powder type portable extinguishers	Red with French blue strips	Typically 5A, 8A, 13A or 21A & B rated	Suitable only for Class A, B, C & E Fires Safe direct use for fires on live electrical equipment whose V < 1000
5	Wet Chemical type portable extinguishers	Red with bold canary yellow strips	Typically 75F or 13A rated	Suitable only for Class A & F Fires Safe for indirect use for fires on live electrical equipment
NB: Halon or Halon alternatives type extinguishers are banned for use because of their effect in depleting the Ozone layer of the Environment and their consequential damages, hence are not considered here. NA = Not Applicable				

An extinguisher shall be selected and provided for protection against a specific class or classes of fire in accordance with table 7.8 below.

Table 7.8. Appropriate Fire Extinguishers for the different fire classes

Fire Class	OFA	OFB	OFC	OFD	OFE	OFK
Description Extinguishant	Fires involving flammable solid materials, e.g. wood, paper, textiles and Other carbonaceous materials	Fires involving Flammable liquids, e.g. petrol, diesel, paraffin, paint and spirits. Not alcohol or hot cooking oils	Fires involving live electrical apparatus e.g. computers, printers, heaters, etc	Fires involving flammable metals, e.g. magnesium, titanium, sodium and lithium	Fires involving flammable gasses, e.g. Propane, Butane, Acetylene and natural gas	Fires involving hot cooking oil and fat, e.g. sunflower oil, maize oil, rapeseed oil and lard
Water	R	NR	NB	NR	NR	NR
Foam	R	R	NB	NR	R	NR
CO ₂	NR	R	R	NR	NR	NR
Powder						
ABC Powder	R	R	R	NR	R	NR
BC Powder	NR	R	R	NR	R	NR
Special Powder	NR	NR	NR	R	NR	NR
Wet Chemical	R	NB	NB	NR	NR	R
R = Recommended; NR = Not Recommended; NB: SOME of the latest water, water with additive, foam and wet chemical extinguishers often indicate on the front label that they have passed an electrical dielectric test of 35KVA or state they are safe for “inadvertent use” on live electrical equipment. This means that the extinguisher SHOULD be safe if used ACCIDENTALLY on live electrical equipment so they are ideal in offices where it is easy to overspray a PC or Printer but this does not mean it will replace a dedicated electrically rated extinguisher i.e. CO₂.						

It is recommended to employ a professional Fire Engineer in order to select, site, install / commission and follow up portable fire extinguishers in order to ensure their performances as insurance claims and further criminal liability largely depends upon the use of the right fire extinguishing equipment and their proper maintenance and operation.

An extinguisher shall be classified by suitability for a class of fire as defined in Table 7.7 and 7.8 above and rated for extinguishing capability. An extinguisher shall bear an approved label indicating its class and rating.

The number and classes of extinguishers needed shall be based on the area of the building or occupancy, the severity of the hazard and the anticipated classes of fire. A specific rule may be set forth in other general industry safety standards where, due to process hazards, additional portable fire extinguishers may be required.

The minimum rating of Class “OFA” fire extinguishers required which can be a base to determine the numbers thereof shall be in accordance with Table 7.9 below.

Travel distance to the nearest extinguisher shall not be more than 20 m. A combustible building having an occupancy hazard subject to class “CFB” or “CFC” fires shall have the required class “A” extinguishers in addition to class “CFB” or “CFC” extinguishers except where ABC or multipurpose fire extinguishers are provided.

Table 7.9. Class OFA fire Extinguishers requirements (To be reconsidered in the final draft)

			Light / Low Hazard Occupancy	Ordinary / Moderate Hazard Occupancy	Extra / High Hazard Occupancy
Minimum extinguisher	rated	single	2-CFA	2-CFA	4-CFA
Maximum floor Area per unit of recommended minimum single extinguisher		rated	275 m ²	140 m ²	90 m ²
Maximum floor Area for Extinguishers				1045 m ²	
Maximum travel distance for Extinguishers				20 m	

A floor area of a building less than that specified in Table 7.9 above shall have at least One Class “OFA” extinguisher of the minimum size. The requirements of Table 7.9 may be fulfilled by numbers of extinguishers of lower ratings whose total ratings are equal to or exceed the minimum rating for the area specified, except that an extinguisher with a rating of less than “2CFA” shall not be acceptable.

A Class “CFB” extinguisher shall be provided according to the severity of the fire hazard levels of the occupancies or stored amount of flammable liquids are listed in table 7.10 below.

Table 7.10. Class B fire Extinguishers requirements

Fire Hazard Level	Basic Minimum Extinguisher Rating
Light / Low Hazard Occupancy	5OFB
Ordinary / Moderate Hazard Occupancy	10OFB
Extra / High Hazard Occupancy	20OFB

Travel distance to the nearest Class “CFB” extinguisher in a building shall be not more than 15 m. widely separated hazards, such as but not limited to kitchens, boiler rooms and paint storage rooms shall be protected with an extinguisher for the type of hazard present, if the travel distance exceeds 7.5 m. A Class “CFB” extinguisher shall be located on the same floor as the hazard and shall be located so as not to expose an employee to undue danger in order to reach the extinguisher.

A Class “CFC”, “CFD”, “CFE” and “CFK” extinguishers shall be provided in accordance with specialist literature, international standards and specific industry requirements approved by relevant public authority.

An employer in control of a property where extinguishers are required and placed shall be responsible for compliance with this part.

A portable extinguisher shall be maintained in a fully charged and operable condition and kept at its designated place ready for use.

An extinguisher or extinguishing device containing an active agent or propellant whose thermal decomposition produce or products having a level of vapor toxicity equal to or greater than any of the materials listed in Table 7.11 below shall not be used, installed for use, or allowed to remain for use.

Table 7.11. Prohibited Fire Extinguisher containing active agents or propellant

No	Description	Formula	No	Description	Formula
1.	Carbon tetrachloride,	CCl_4	7.	Methyl bromide	CH_3Br
2.	Chlorobromo methane,	CH_2BrCl	8.	Ethylene di bromide	$\text{CH}_2\text{BrCH}_2\text{Br}$
3.	Azeotropic chloromethane,	CM_7	9.	Hydrogen bromide	HBr
4.	Di bromo di fluoro methane	CBr_2F_2	10.	Methylene	CH_2Br_2

				bromide	
5.	1, 2-di bromo-2-chloro-1, 1, 2-trifluorothane,	Cbr-F ₂ CBrClf	11.	Bromo di fluoro methane	CHBrF ₂
6.	1, 2-dibromo-2, 2-difluorothane,	CH ₂ BrCBrF ₂			

Portable fire extinguishers can also be grouped into two categories based on their method of operation, namely; (1) **Gas Cartridge**, or (2) **Stored Pressure** type of extinguishers (Figure 7.3).

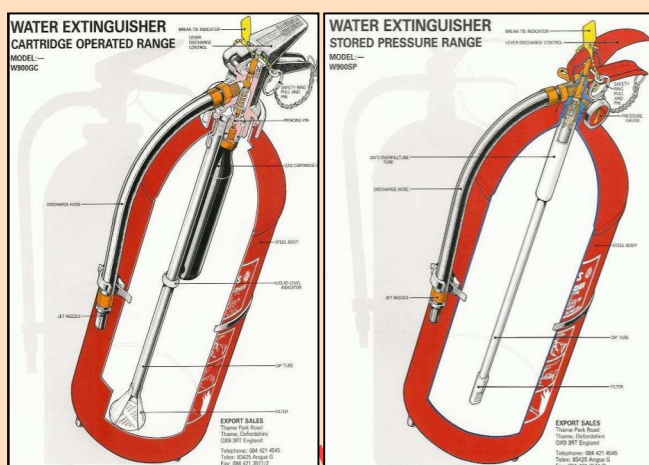


Figure 7.1. Gas Cartridge and Stored Pressure type of portable fire extinguishers

While Gas Cartridge type are operated by using a cartridge containing inert gases (normally CO₂) under pressure; Stored Pressure type portable fire extinguishers are permanently pressurized such that they are operated by the use of air or gas pressure in the upper part of the container which forces the extinguishing medium out through the nozzle.

In the case for Gas Cartridge type; the cartridge need to be pierced in order to let the gas pressure released from the cartridge which drives out the extinguishing medium.

Markings

The following information should be labeled on all portable fire extinguishers:

- The word 'extinguisher'
- Extinguishing medium and nominal charge
- Types of fires
- Instructions for use (pictograms and text)
- Restrictions or dangers of use
- Unsuitability for use on electrical equipment, where applicable
- Manufacturer/suppliers name and address

Operating instructions include pictograms to enable any person to quickly and easily identify the method of operation. This does not detract from the need for staff at any premises to be trained in the correct use of the fire equipment provided.

The following information may be found on a separate sheet or label:

- Instructions to refill after use
- Instructions to check periodically
- Instructions to use conforming spare parts
- Identification of extinguishing medium
- Propelling gas
- Identification of percentages of additives for water-based extinguishers
- Manufacturer's model number
- Temperature limits
- Warning against freezing (if applicable)

Operating position

Extinguishers shall operate without being inverted. The operating devices shall be located on the upper part of the extinguisher or partly on the upper part and partly on the lower part and partly at the end of the hose or nozzle.

Hose assembly

Extinguishers with a mass of extinguishing medium or volume greater than 3kg or 3 litres shall be provided with a discharge hose. The flexible section of the hose shall be 400mm or greater.

Inspections and Maintenance

An inspection is a quick check that visually determines whether the Fire Extinguisher is properly placed and will operate. However, maintenance is a complete and thorough examination of each extinguishers involving opening the extinguishers, examining all its parts, cleaning, replacing defective parts, reassembling, recharging and re-pressurizing the extinguishers.

Extinguishers should be routinely inspected by the user at not less than quarterly and preferably at monthly intervals to make sure that appliances are in their proper position and have not been discharged or lost pressure. The user should replace extinguishers not available for use, by serviceable extinguishers. Annual inspection, service and test discharging should be carried out by a competent person.

It is recommended to use a competent person and extinguishers should be serviced to manufacturer's standard and recommended procedure. To ensure a person is competent it is recommended that they should be able to prove he/she has a registered certificate from relevant public body and has attended a refresher course within the last three years. This will ensure he/she has been trained on the maintenance to be followed for portable fire extinguishers installed in industrial and commercial premises.

The servicing procedures include three levels of maintenance:

- **Basic:** Annual inspection and servicing by competent person.
- **Extended:** Every 5 years a basic service plus test by discharge and internal examination of stored pressure extinguishers.
- **Overhaul:** Every 10 years for carbon dioxide extinguishers only that include detailed inspection and hydraulic pressure test.

During Inspection and/or Maintenance; the following are undertaken:

Pressure Test

The test pressure shall not be less than 1.3 times the working pressure or at least 20 bars. The body shall not leak or show any visible signs of permanent deformation.

Burst Test

The burst pressure shall not be less than 2.7 times the working pressure or at least 55 bars. The burst test shall not cause the body to fragment.

Plastic Components

Plastic components on extinguishers subject to pressure undergo artificial ageing conditions and ultra violet light tests. These components are subjected to burst pressure tests at different temperature ranges. The burst pressure shall be at least equal to 3.4 times the working pressure or at least 55 bars. Plastic components are fitted to charged extinguishers and impact tested.

Safety Devices

The operating mechanism shall be provided with a safety device to prevent accidental operation. It shall be possible to determine whether the extinguisher has been operated by means of a safety element (used indicator) e.g. used/empty indicator, gauge reading zero, nonreturnable pin.

Sitting of Extinguishers

Extinguishers should be located in conspicuous positions, available at all times for immediate use and fitted on brackets or stands where they will be readily seen by persons following an escape route. Fire extinguishers should be securely hung on wall brackets. Where this is impractical extinguishers should be located on suitable stands (not on the floor).

If wall mounted; the carrying handle of larger and heavier extinguishers should be 1 m from the floor but smaller extinguishers should be mounted so that the carrying handle is 1.5 m from the floor.

Extinguishers should be sited in such a way that it is not necessary to travel more than 30 meters from the site of a fire to reach an extinguisher. To avoid confusion, all extinguishers installed in any one building or single occupancy should have the same method of operation and if intended for the same function, they should be similar in shape, appearance and color.

Wherever possible, portable extinguishers should be grouped to form a fire point.

Extinguishers should normally be sited

- In prominent positions on brackets or stands.
- On escape routes and in similar locations on all floors.
- Near room exits, corridors, stairways, landings and lobbies.

The following factors should be considered when sitting fire extinguishers:

- Extinguishers should be on an escape route.
- Elevated to a height so that the carrying handle is 1m from the floor for heavier units and 1.5m for smaller units.
- Adjacent to the risk but not too close to prevent use in the event of fire occurring.
- Near a door, inside or outside according to occupancy.
- In multi-storey buildings at the same position on each storey.
- In groups forming 'fire points'.
- In shallow recesses where possible.
- Away from extremes of temperature within extinguisher temperature ranges.
- Maximum 30m travelling distance from a fire to an extinguisher.

7.3.2 Hose Reel Systems

Hose reel system is one of the first aid firefighting equipment which can readily and rapidly brought into action to extinguish fire in its early stage of its development. It delivers small quantities of water as compared to automatic sprinkler, fire hydrants, water spray systems and fire deluge and drencher systems; but larger quantities than water based portable fire extinguishers.

Hose reel system can be capable of operation using untrained person who discovered a fire unlike other firefighting equipment. It is more effective than portable fire extinguishers due to its continuous and easily controlled provision of water jet to extinguish the fire.

Hose reel system shall be provided to cover 500 m² of floor space or part thereof and shall be sited in prominent and accessible positions at each floor level adjacent to exits or in corridors on exit routes such that it shall be within 6m of each room taking into consideration any obstruction thereof in such a way that the nozzle can be taken into every room of the building.

Hose reels for the purposes of firefighting shall be installed in any building of two or more story in height or in any single-story building of more than 250 m² in floor area at a rate of 1 hose reel for every 500 m² or part thereof of floor area of any story. Where a satisfactory water supply and pressure are not available, two portable fire extinguishers with rating of 2A shall be provided in place of each required hose reel.

Hose reels shall preferably be installed in recesses and whose doors shall open 180° and not fitted with locks in order to avoid obstruction allowing to serve in both directions. Hose reels which do not automatically operate shall be warned to turn on the inlet valve before running out the hose. They shall be drained prior to returning the hose into the drum and shall not be left under pressure.

Legible notices shall be posted to indicate the fire hose reel and including whether there is a need to open the inlet valve or not prior to running the hose reel.

Hose reel system shall be installed on all building floors above 15 m in height. When installation is in open areas, the position shall be above head height and the nozzle retainer and the inlet valve shall be at about 90cm above floor level.

The length of hose reels shall be such that no part of the floor so protected is more than 6 m away from the nozzle when the hose reel is fully extended. Hose reels brackets should be firmly fixed to the wall.

The static pressure in any line of the hose connected to a landing valve shall not exceed 7 kg/cm² using appropriate and automatic arrangements in order to reduce the risk of hose bursting when the water is shut off at the nozzle.

Water Supplies and Pumping Arrangements:

The flows and pressures in the supply pipelines and in the hose reels shall at all times be adequate to serve the designed numbers of jets likely to be used (reference shall be made to relevant EBCS on Plumbing).

The hose reel system shall install two automatic pumps with interlocking arrangement designed as per relevant EBCS on Plumbing and one of which shall serve as standby. The standby pump shall operate automatically in case of failure of the duty pump.

The supply pipeline shall be provided with:

- Draining arrangements to enable any necessary repairs to be carried out, and
- Air release valves above the highest outlet to allow any air trapped to escape when water is pressurized in the hose reel system.

The landing valves shall be provided with suitable arrangements (such as orifice flange or other measures) to reduce excess pressure (in excess of 4 kg/cm²) at ground or lower floors.

Tests, Inspection and Maintenance:

The pipe work feeding the hose reels shall be thoroughly flushed out to remove any debris not to destroy the reels prior to connecting the hose reel system.

The hose reel system shall be tested for:

- Operability by running the hose reel system;

- 10 kg/cm² or two times the maximum working pressure of the hose reel, whichever is greater for its pipe work for the period of at least 30 minutes,
- Leakages of water in both the pipelines or the hose and accessories,
- Pressure drops not more than 0.5 kg / cm²
- Operability of all accessories such as booster pumps including the standby pump, various valves, nozzle, etc.

A flow test shall finally and during yearly inspections be carried out to ensure discharge of at least 0.5 l / sec is achieved.

The standby pump shall automatically operate when failure of the operating pump occurs.

Once a year, the hose reel system shall be inspected and be completely run out and subject to appropriate pressure of water to ensure the hose reel and all other accessories are in good conditions and be operational. Defective pipes, hose reels and accessories shall be replaced.

7.4 Fixed Fire extinguishing Systems / Installations

Automatic Fixed extinguishing systems have proved to be the most effective means of controlling fires in buildings. These include:

- a) Water based systems such as Fire Hydrant, Automatic Sprinkler, Automatic Water Spray and Automatic Deluge and Drencher installations;
- b) Foam based systems such as Installed, Fixed and Semi-fixed low, medium and high expansion automatic installations; and
- c) CO₂ Extinguishing systems such as High and Low pressure automatic installations.

This code covered the requirements for Water Based fixed fire extinguishing systems only. For Foam and gaseous based fixed fire extinguishing systems specific literatures, international and industry standards shall be used.

7.4.1 Fire Hydrant Systems

Water, being the main fire extinguishing media; is usually obtained either from external (installed external to buildings) or internal (installed within buildings) hydrants.

Fire Hydrants can be used either to:

- Suppress an initial outbreak of fire, or
- Quench a dying fire by an automatic protection system such as automatic sprinkler system, or
- Provide the sole firefighting facility after first aid fire extinguisher systems such as portable fire extinguishers or hose reels have been unsuccessful.

There are four basic requirements for firefighting purpose using any hydrant systems, namely:

1. Source of water supply,
2. Pumps to make water available at required pressures,
3. Pipelines (water mains) for conveying water under pressure to the required places, and
4. Hydrants (outlets) installed on pipelines for drawing water using delivery hoses during fire.

Besides, the following ancillary equipment / components can be installed with fire hydrants, namely; fire hose, valves, pipeline supports and cabinets.

Source of water supply

The **sources of water supply** can either be the Town's Main Supply or Storage tanks. Storage tanks or interconnected tanks shall be provided in cases where the town's main supply may not provide sufficient pressure and flow at all times.

Water Tanks supplying for domestic use shall not be used as tanks for fire hydrants unless arrangements have been made for domestic supplies to be drawn in such a manner that the required service for firefighting is always preserved.

When water tanks are used as tanks supplying fire hydrants, deterioration of the quality of water for domestic supply due to stagnation shall be considered and appropriate inspection and cleaning shall be performed.

Pumps

Two automatic **pumps** (one as standby) each recommended to be supplied from a different source of power (electrical or diesel) operating automatically and manually shall be installed to feed fire hydrants.

Pipelines

Internal **pipelines** shall be supported from masonry, concrete or any load bearing walls and arrangements shall be incorporated to enable any necessary repairs to be carried out. When a pipe supporting system is provided, the following considerations shall be made to correctly position such pipe supports:

- a. Stresses and loads which may be imposed on the support system from external causes,
- b. Transmission of vibrations from the buildings due to lateral forces to the pipelines,
- c. Effects of corrosive environments which may have the pipeline materials, and
- d. Fire resistance capacity of the pipeline material.

External pipelines shall be located underground as far as practicable; where this is not possible; it shall be made to protect pipelines and any supports thereof from mechanical damages and fire.

In both cases, Isolating valves shall be installed in the system so that sections of pipelines can be isolated for repairs and maintenance works.

Hydrants

(1) Internal Fire Hydrants: These systems are generally installed for firefighting of buildings or special structures and comprise of the following installation elements:

1. Water tank designed to store water for firefighting,

2. Firefighting pumps with all accessories when necessary,
3. Pipelines (Rising and Down mains) feeding the water tank from the source of water supply and providing pressurized water to the hydrants, and
4. Hydrants, hose reels, hoses and branch pipes in cabinets.

Internal fire hydrants shall be installed in all occupancy buildings with four or more floors. Besides, they may also be provided in all residential except dwellings, all assembly, business such as banks and city halls, industrial, institutional, mercantile and storage occupancies.

The minimum number of internal fire hydrants shall be installed for floor areas specified in table 7.12 below.

Table 7.12. Minimum numbers of Internal Fire Hydrants

No.	Building Floor Area [m ²]	Minimum numbers of Internal Fire Hydrants
1	< or = 1000	One
2	> 1000 to < or = 5000	Two
3	> 5000 to < or = 10000	Three
4	> 10000	One additional hydrant for each additional 5000 m ²

Internal fire hydrants shall be installed in accessible positions such as within a lobby approaching stairways where this is provided or in a stairway enclosure or in such other accessible position as may be agreed with relevant public authority, but shall be within reach of a 6m hose stream issuing from the nozzle at the end of a hose connected to the hydrant outlet.

When a number of fire hydrants are required in a building; the pipelines shall be installed in the form of ring to form a complete circuit.

(2) External Fire Hydrants: External fire hydrants shall be provided for industrial, storage and buildings with high or extra hazard occupancies. They shall be located so that they are accessible but not less than 6 m from an external wall of the building except allowed by relevant public authority where site conditions dictates and not apart more than 150 m when they are more than one in a compound, and shall be protected from mechanical damage such as parking, loading and unloading from vehicles, etc.

External fire hydrants provide the means of drawing water from the water mains for firefighting purposes. There are two types of external fire hydrants; namely (1) stand-post or (2) underground / sluice valve types.

Tests, Inspections and Maintenances of Hydrants

Upon completion of the fire hydrant system; all trapped air within the system including the pipelines shall be expelled and the system shall be fully operational.

Hydrostatic Pressure Test: All pipelines of a hydrant system shall be tested for a hydrostatic pressure of not less than 10 kg/cm^2 , or two times the highest working pressure for firefighting purposes (whichever is greater) for a period of at least 1 hr with no leakages of water. Where pipelines are underground or inaccessible; the hydrostatic pressure test shall be made prior to covering or concealment of the pipelines.

Flow Test: All pipelines of a hydrant system shall be tested for a flow test by recording flow gauge readings subsequent to a hydrostatic pressure test in order to investigate inability of the pipeline to sustain effective firefighting obtained from the top most outlet or any undue loss of pressure in the fire main when water passes through the system under pressure.

Pumps in a hydrant system shall be investigated with particular attention to automatic operation of a standby pump when a failure of the duty pump occurs.

The above tests shall be repeated after the failure of one or more of the above treats are remedied.

For internal hydrants; valves, accessories and hydrant cabinets shall be inspected every six months in order to ensure for immediate use of the hydrant during fire. Besides, checks shall be made to the cleanliness of storage tanks (especially when used for both domestic and firefighting purposes) and booster pumps together with associated mechanical and electrical equipment.

For external hydrants;

- a. continuous and / or periodic inspection shall be made to ensure that:
 - Around the vicinity of the hydrants there are no obstructions impeding accessibility and mechanical damages,
 - All isolation valves are kept in an open position in the hydrant system,
 - Supplies have not been deteriorated or their flow and pressure reduced
 - Cleanliness of storage tanks, and
 - Functionality of the booster pumps and all associated mechanical and electrical equipments.
- b. Maintenance shall be carried out by competent person at least once a year.

7.4.2 Automatic Sprinkler Systems

Automatic sprinklers are used to prevent spread of fire and extinguishing it completely by automatically discharging water upon the fire. Automatic sprinklers are effective for life safety

because of giving early warning about the initiation of fire and simultaneously start discharging water onto the fire. The downward force of the water also helps to minimize the smoke accumulation and providing cooling environment in a building or room of fire. Longer travel distances to exits and tackling higher fire load density can be possible by using automatic sprinklers.

Partial coverage of automatic sprinkler system in a building is not advisable both from firefighting and cost effectiveness requirements as an already developed fire from unprotected areas will overpower and make sprinklers non-operable.

Automatic sprinklers are categorized into either wet, dry, alternate and Pre – action; or Conventional, Spray, Ceiling flush, Side wall and Dry upright pattern based on the supply pipeline and the sprinkler head types (Table 7.13).

Table 7.13. Sprinklers pipeline and head types

Sprinkler Pipeline types	Descriptions	Sprinkler Head types	Descriptions
Dry	Pipes are charged with air under pressure	Conventional	Spherical discharge upward
Wet	Pipes are charged with water under pressure	Spray	Hemispherical discharge downwards
Alternate	Can be either to be wet or dry depending on the ambient temperature	Ceiling flush	Installed flushing the Ceiling with heat sensitive instrument facing downwards
Pre-action		Side wall	Installed along the walls close to the ceiling and produces a horizontal pattern of spray

Automatic sprinkler systems require a suitable and acceptable water supply, pipelines, pumps and other accessories. The Sprinkler heads can either be fusible solder or glass bulb type and have various temperature ratings and are color coded for easy identifications (Table 7.14).

Table 7.14. Color coding for sprinklers temperature ratings

Sprinkler Temperature ratings	Fusible Link Type	Bulb Type
57 °C	Orange	---
68 °C	Red	Uncoloured
79 °C	Yellow	---
93 °C	Green	White

141 °C	Blue	Blue
182 °C	Violet / Light Purple	Yellow
204 - 260 °C	Black	Red (227 °C)

The automatic sprinkler design density of discharge and the maximum area of operations are dependent on the three classes of fire load systems; namely Low, Moderate and High Hazard systems (Table 7.15).

Table 7.15. Design discharge and Maximum area of operation for different fire load systems

Fire Load Systems	Design density of Discharge	Maximum area of Operation
Low Hazard	2.25 lpm / m ²	84 m ²
Moderate Hazard	5.0 lpm / m ²	360 m ²
High Hazard		
Process risks	7.5 - 12.5 lpm / m ²	260 m ²
Piled storage risks	7.5 - 30 lpm / m ²	260 - 300 m ²

The maximum area covered by a sprinkler in different hazard classes of occupancies is shown in table 7.16 below.

Table 7.16. Maximum area covered by a sprinkler for different classes of occupancies

Hazard Class	General	Special risk areas (Storage racks)
Low Hazard	21 m ²	9 m ²
Moderate Hazard	12 m ²	9 m ²
High Hazard	9 m ²	7.5 – 10 m ²

Automatic sprinklers shall be installed in:

1. Basements used as car parks or storage occupancies if the area exceeds 200 m²;
2. Multi-level basements, covered upper floors used as car parks and for housing essential services ancillary to a particular occupancy or for storage occupancy, excluding any area to be used for substation;
3. Any room or other compartments of a building exceeding 1125 m²;
4. Department stores or shops if the aggregate covered area exceeds 750 m²;
5. All non-domestic floors of mixed occupancy which constitute a hazard and are not provided with staircases independent of the remainder of the building;
6. On all floors of the buildings other than residential buildings, if the height of the building exceeds 30 m and 45 m in case for group housing and apartments;
7. Dressing room, scenery docks, stages and stage basements of theatres;

8. Hotels, hospitals, industries having low and moderate hazard, mercantile buildings of height 15 m or above;
9. Hotels below 15 m but covered area at each floors exceeds 1000 m²; and
10. Warehouses and worshipping places as advised by relevant public authority.

The design, installations, operations, testing inspections and maintenance services of sprinkler system shall adhere to voluntary Ethiopian Standards such as ES ISO 6182: 2002, Part 1 to 5; specialist literature of good engineering practice; relevant international standards and specific industry requirements.

7.4.3 Automatic Water Spray Systems

Automatic water spray system is a special fixed pipe system connected to a reliable source of pressurized water supply equipped with water spray nozzles. The system works with an automatic smoke or fire detection and alarm system.

Water spray systems are generally used for firefighting of Class B fires such as flammable liquids; Class C fires such as fires from electrical equipment including transformers, oil switches, rotating electrical machineries; and Class E fires such as gas storage tanks. Besides they are useful to control spread of fires through protection of openings in fire walls and floors.

The design, installations, operations, testing inspections and maintenance services of automatic water spray system shall adhere to specialist literature of good engineering practice, relevant international standards and specific industry requirements.

7.4.4 Automatic Deluge and Drencher Systems

Automatic deluge system is water based fixed firefighting installation fitted with open spray nozzles controlled by a single deluge valve and actuated by automatic fire detector or sprinkler heads to spray water over the whole area of the building under protection.

Automatic deluge system are recommended where there is a concentration of highly flammable liquids such as aircraft hangars, fuel stations, tank farms filling gantries, etc and for cooling purposes.

Automatic drencher system is water based fixed firefighting installation placed on roofs, walls, windows and external openings to control spread of fire from adjacent premises.

The design, installations, operations, testing inspections and maintenance services of automatic deluge and drencher systems shall adhere to specialist literature of good engineering practice, relevant international standards and specific industry requirements.

7.4.5 Foam Based and CO₂ Extinguishing Systems

Fixed foam based and CO₂ extinguishing system is beyond the scope of this code of practice and it is recommended that specialist literatures, relevant international practices and specific industrial practices shall be fulfilled during designing, installations, operations, testing inspections and maintenance services.

7.5 Mobile Fire extinguishing System

Mobile fire extinguishing systems are larger sizes Portable type fire extinguishers which are difficult to carry by a fire fighter but wheeled or towed and in some instances can be connected to water supply sources. The provisions of such fire extinguishing systems are recommended for extra or high hazard occupancies and class of fires indicated in Table 2.1 above; however the provision of such fire extinguishing system shall be compatible to specialist literatures, relevant international practices and specific industrial practices.

7.6 Other provisions

7.6.1 Building and Site Requirements for firefighting systems

The building and site requirements for firefighting system are as laid down in chapter / section 3 of this Code of Practice.

7.6.2 Fire, Heat and Smoke Detection and Alarm systems to initiate firefighting

The fire detection and alarm system requirements for the different building occupancies are as laid down in chapter / section 6 of this Code of Practice. As soon as these fire detecting and alarming systems indicates to possibility of fire break outs; the potential cause shall be determined and appropriate firefighting interventions shall be identified to initiate firefighting.

SECTION 8 Fire Safety and Firefighting Management

8.1 Introduction

8.1.1 Scope

This part covers the general requirements for Fire safety and firefighting management.

8.2 Fire Safety Management

It is impractical to prevent fires 100 % as there are unpredictable factors including vagaries of nature and acts of human omission and commission which are bound to occur. These should not deter all those concerned and responsible for enhancement of building fire safety standards untiring effort to mitigate loses of lives and properties.

This is because, effective fire safety management can reduce potential fire danger, assist occupants to reach the ultimate place of safety in case of fire and regular maintenance will ensure all fire safety provisions in the building can be kept in good workable conditions. As a result, the following good and integrated fire safety management systems are recommended:

1. **Good fire safety includes good life safety** such as (1) keeping harmful effects of fire (flammable or combustible materials) away from occupants; (2) keeping occupants segregated from harmful effects of fire by adopting methods based on time, distance or shielding; (3) Fire

prevention, and (4) creating awareness regarding fire effects in order to ensure readiness of occupants in their the physical and mental characteristics individually and in groups.

2. **Accessible staircases / means of egress** such as (a) readily visible leading edges of all treads during descent and ascent; (b) unobstructed travel at all times; (c) comfortable hand rails to grip and slid hands without obstructions; and (d) avoidance of steps near doorways to minimize accidents and blockages thereof.
3. **Ensuring appropriate Means of Escape** and barrier free environment to enable all occupants including physically challenged people (at least to the nearest refuge areas within the building) from any part of the buildings to safely evacuate the building without external assistance during fire.
4. **Minimizing smoke hazards** by compartmentalization, dilution, air flow control, pressurization and buoyancy of smoke as good Smoke Control / Management system in order to assist easier evacuation, firefighting and preventing loss of life and reducing property damages during building fires.
5. **Special consideration for design of Atrium Buildings** with respect to fire protection using compartmentation, ventilation, automatic suppression and smoke control.
6. **Special Structures and High Rise Buildings** call for special considerations compatible to recent world standards including provisions of concealed combustible spaces, various exits to decrease remoteness, containment of hazardous areas, smoke and fire proof enclosures for designated periods (at least 2 hrs.), etc.
7. **Appropriate provisions of Fire detection and Firefighting systems**
8. **Appropriate Registration / Certification / Accreditation / Calibration Schemes** for Fire related designers, installers and equipment (detecting and fighting).
9. **Regularly scheduled Inspections and Maintenance** of fire detecting and firefighting equipment for their proper functionality and their non-obstructed accessibility.

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8.3 Firefighting Management

However and despite provisions of and adherence to all of good fire safety requirements; experience proved that no fire prevention strategy can be totally effective. As a result, it is recommended to prepare emergency plan, train occupants, practice fire drill and accustomed to evacuation procedures in order to prevent loss of life and minimize loss of property.

8.3.1 Emergency Plan

Emergency Plan

The employer is responsible for preparing and implementing plans covering the actions that employers and employees must take to ensure employee safety in the event of fire. The elements of this plan include:

- Emergency-escape procedures and emergency escape-route assignments;
- Procedures for employees who remain to operate critical equipment before they evacuate;
- Procedures to account for all employees after an emergency evacuation;
- Rescue and medical duties for employees who perform them;
- The preferred means of reporting fires;
- Names and job titles of persons who can be contacted for further information or explanation of duties under this plan.

8.3.2 Fire Drill, Evacuation Procedures and Rescue Tools

Fire Drill

Practice what to do in an emergency before one happens. Fire drills should be scheduled to help people prepare for an evacuation. These include:

- Know where the nearest fire extinguisher is located and how to use it.
- Know where the nearest fire alarm pull station is located.
- Know the proper evacuation methods for disabled persons.
- Know primary and secondary evacuation routes, as well as the location of a safe gathering place.

The schedule for Fire Drill is recommended as:

- At least twice a year for Extra or High hazard Occupancies and Classes of Fires.
- At least once a year for Moderate or Ordinary hazard Occupancies and Classes of Fires.

Evacuation Procedures

Fire and evacuation alarms are intended to alert building occupants that a fire or other life - threatening situation exists. Upon hearing the alarm, everyone should leave the building immediately. In the event of a fire, the following steps should be taken to ensure the safety of all building occupants:

1. **Activate the fire alarm:** In the event of a fire breakout requiring evacuation, activate the nearest fire alarm or verbally notify occupants if the building is not equipped with a fire alarm system.
2. **Call Fire & Emergency Prevention and Rescue Agency:** Telephone immediately to inform about fire breakout and give all necessary information including your name, location, nature of the emergency (including need for medical and telephone number).
3. **Assist injured personnel:** If properly trained, assist with first aid or evacuation.
4. **Assist physically impaired individuals.** Physically impaired individuals should be given assistance to a secure area, such as a large stairwell or an office separated from a corridor by a fire door. Emergency personnel must be notified of their locations. Each supervisor should be aware of any physically impaired persons in their work areas and any special assistance needed to safely evacuate them.
5. **Extinguish small fires:** If the fire is small and you know how to use a fire extinguisher, attempt to extinguish the fire yourself. Do not attempt to extinguish any fire if there is a threat to your safety.
 - a. **Report hazardous conditions:** If you are working in a research area and have sufficient time, ensure that the lab and experiments are in safe condition before leaving the area. Report any hazardous conditions to responding emergency personnel.
 - b. **Stay low:** If confronted with smoke, keep near the floor. Smoke, heat and toxic gases will normally rise to the ceiling. All closed doors should be checked for heat prior to opening. If a door knob is hot, the door should not be opened.
 - c. **Exit the building:** At the sound of a fire alarm, all building occupants should proceed to the nearest exit and leave the building immediately. During pre-emergency planning, all occupants should learn two evacuation routes from each building area.
 - d. **Ensure all personnel are out of the building:** Ensure all personnel are out of the immediate area. If there is time and no present danger, close all doors and windows while evacuating. Do not use the elevators. Elevators may lose power during a fire. If elevators are working during a fire emergency, their use is reserved for emergency response personnel only.
 - e. **Stay away from the building until it is safe to return:** Do not re-enter the building until advised to do so by the authorities.

Rescue Tools

All buildings shall be made accessible for rescue tools used by the Fire brigade.