

BUILDING CONSTRUCTION



Unit - 7 Basic Civil Engineering

7.1 LINTELS AND ARCHES



7.2 DOORS AND WINDOWS



“ Intelligence plus character -
that is the goal of true education”

Martin Luther King Jr.



TABLE OF CONTENTS

7.1 Lintels and Arches

- 7.1.1 Introduction
- 7.1.2 Types of Lintels used in Building Construction
- 7.1.3 Arches – Introduction
- 7.1.4 Technical Terms used in Arches
- 7.1.5 Classification of Arches
- 7.1.6 Difference Between Arches and Lintels

7.2 Doors and Windows

- 7.2.1 Introduction
- 7.2.2 Terms Used in Doors and Windows
- 7.2.3 Size and Location of Doors and Windows
- 7.2.4 Types of Doors
- 7.2.5 Types of Windows
- 7.2.6 Fixture for Doors and Windows

7.1

LINTELS AND ARCHES



Learning Objectives

At the end of this lesson you shall be able to

- Understand the types of lintels and arches.
- Differentiate lintels and arches.

7.1.1 Lintel - Introduction

A lintel is a horizontal member which is placed across the openings like doors, windows, etc., in buildings. Lintels take the load from the structure above it and provide support to it. Lintel is also a type of beam. The width of lintel is equal to the width of wall and the ends are built into the wall. These are very easy to construct when compared to arches.

Bearing of Lintel

The bearing of lintels should be provided as follows.

1. 10 cm to 20cm
2. Height of lintel beam
3. $1/10^{\text{th}}$ to $1/12^{\text{th}}$ of span of the lintel

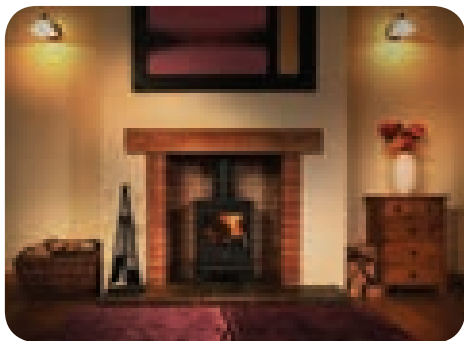
7.1.2 Types of Lintels used in Building Construction

Lintels are classified based on the material used for the construction as:

1. Timber Lintel
2. Stone Lintel
3. Brick Lintel
4. Steel Lintel
5. Reinforced Concrete Lintel
6. Reinforced Brick Lintel

7.1.2.1 Timber Lintel

In olden days of construction, timber lintels were mostly used. But, now-a-days they are replaced by concrete lintels based on modern techniques. However in hilly areas still timber lintels are in use. The main disadvantage of timber lintels are (i) more expensive (ii) less durable (iii) non-fire resistant.



7.1.2.2 Stone Lintel

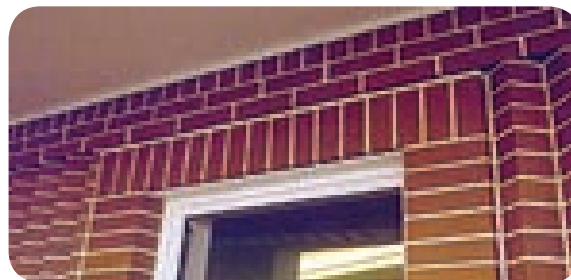
These are the most common type of lintel especially where stone is available in large quantities. The thickness of lintels are most important factor of its design. These are also provided over the openings in brick walls. Stone lintels are provided either single piece or multiple pieces.



7.1.2.3 Brick Lintel

When the opening is less than 1m and for lesser loads, brick lintels are used. The depth of brick lintel varies from 10cm to 20 cm depending upon the span. Bricks with frogs are most suitable than

normal bricks because, frogs when filled with mortar gives more sheer resistance of end joints. Such lintel is known as joggled brick lintel.



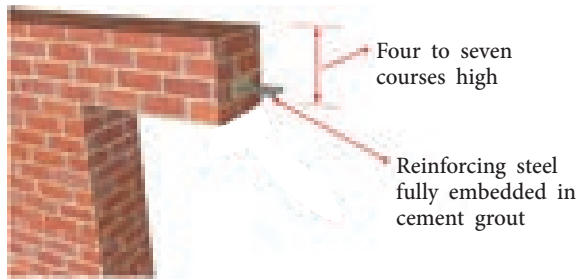
7.1.2.4 Steel Lintel

If the super imposed loads are heavy and openings are large, we can go for steel lintels. These lintels consist of channel sections or rolled steel joists. Single steel section or combinations of two or more are used depending upon the requirement.



7.1.2.5 Reinforced Brick Lintel

If loads are heavy and span is greater than 1m, then reinforced brick lintels are useful. The depth of reinforced brick lintel should be equal to 10cm to 15 cm or multiple of 10 cm. The bricks are so arranged that 2 to 3 cm wide space is left in lengthwise between adjacent bricks for the insertion of mild steel bars for reinforcement. Then cement mortar(1:3) is used to fill up the gaps.



7.1.2.6 Reinforced Cement Concrete Lintels

At present, the lintels of RCC are widely used for the openings of doors, windows, etc., in the buildings because of its strength, rigidity, fire resistance, economy and ease in construction. RCC lintels are suitable for all the loads and to any span. The width of lintel is equal to width of wall. Depth of lintel is depend upon the length of span and magnitude of loading.

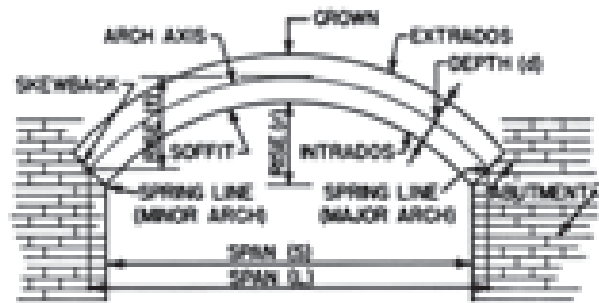


7.1.3 Arches - Introduction

An arch is a structure that is curved at the top and is supported on either side by a pillar, post or wall. It is constructed of wedge shaped block of stones or bricks joined together with mortar and provided across the opening to carry the weight of the structure above the opening.



7.1.4. Technical Terms



The various technical terms used in arches are as follows:

- a) **Abutment:** This is the end support of an arch.
- b) **Pier:** These are the intermediate supports of an arcade.
- c) **Intrados:** This is the inner curved surface of an arch.
- d) **Extrados:** This is the outer curved surface of an arch.
- e) **Voussoirs:** The voussoirs or arch stones are the wedge shaped units forming the arch.
- f) **Springing stone:** The springing stone or springer is the first voussoir at springing level on either side of the arch.
- g) **Springing line:** This is an imaginary line joining the two springing points.
- h) **Crown:** This is the highest point of extrados or it is the highest part of an arch.
- i) **Key stone:** This is the highest central wedge shaped block of an arch.
- j) **Skew back:** This is the inclined surface of the abutment on which the arch rests.

- k) **Span:** This is the clear horizontal distance between the two supports.
- l) **Rise:** This is the vertical distance between the highest point of intrados and springing line.
- m) **Depth of arch:** This is the perpendicular distance between the extrados and intrados.
- n) **Haunch of an arch:** Haunch is the lower part of the arch between crown and skewback.

7.1.5 Classification of Arches

A) Classification according to shape.

According to this classification, arches may be of the following types.

- 1) Flat arch
- 2) Segmental arch
- 3) Semi-circular arch
- 4) Horse shoe arch
- 5) Pointed arch or gothic arch
- 6) Relieving arch
- 7) Circular arch
- 8) Inverted arch

B) Classification based on materials of construction.

- 1) Stone arches
- 2) Brick arches
- 3) Concrete arches

Flat Arch

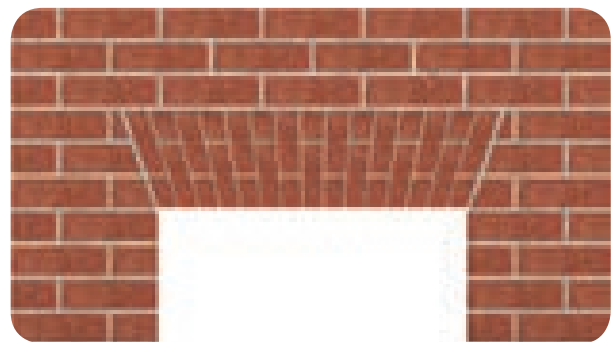
A flat arch usually the angle formed by skew backs is 60° with horizontal, thus forming an equilateral triangle with intrados at the base. The intrados is apparently flat, but it is given a slight rise of camber of about 10mm to 15mm per meter width of opening to allow for small settlements.



India gate, New Delhi, India is one of the most popular arch in the world. This monuments dedicated to Indian soldiers who died in World War 1 and the Afghan wars.



However, the extrados is kept horizontal and flat. Flat arches are used only for light loads and for spans up to 1.5m.



Segmental Arch

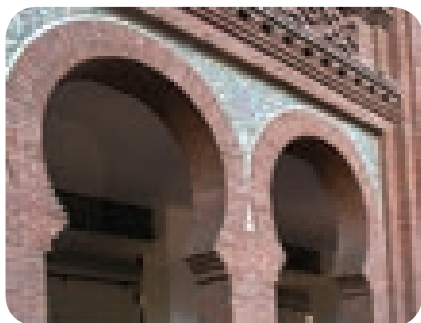
This is common type of arch used for buildings. The centre point of these arches lies below the springing line. It is one of the strongest arch because, it is able to resist thrust. Segmental arches are most commonly used for residential

constructions over doorways, windows and fire places.



Semi Circular Arch

It is also known as Roman arch. This is the modification of segmental arch in which the centre point lies on the springing line. The shape of these arches are semi-circle. The thrust transferred to the abutments is perfectly in vertical direction since the skewback is horizontal.



Horse Shoe Arch



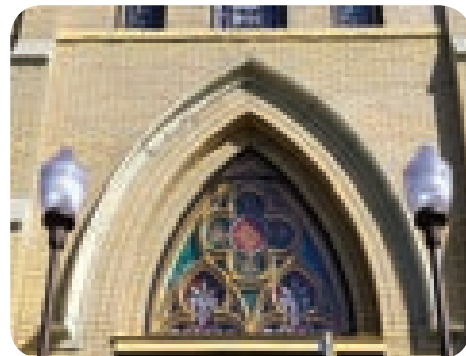
Gateway arch, St. Louis, United States is the tallest arch monument in U.S (height

630 feet)



ACTIVITY 1

Collect the pictures of a popular arches around the world and make an album.



Pointed Arch



Relieving Arch



Circular Arch



Inverted Arch

7.1.6 Difference Between Arches and Lintels

| S.No | Arches | Lintels |
|------|---|---|
| 1 | Generally curved in shape. | Horizontal in shape. |
| 2 | Gives excess rises over door and window openings. | There is no excess rises in lintels. |
| 3 | Good for uniformly distributed loads and weak in point loads. | Strong in uniformly distributed loads as well as point loads. |
| 4 | Joints should be in radial shape. | Joints should be vertical. |
| 5 | Supported at the abutments and piers. | There is no supports like piers and abutments. |
| 6 | Arches gives beautiful appearance to the buildings. | Gives ordinary appearance to the buildings. |

Model Questions

PART I (1 Mark)

Choose the correct answer

- takes the load from structure above the doors and windows opening.
 - Sunshades
 - Pillars
 - Lintels
 - Columns
- Brick lintels are used when the opening is less than
 - 1m
 - 2m
 - 3m
 - 0.5m
- The end support of an arch is
 - Pier
 - Abutment
 - Springer
 - Crown
- is the highest central wedge shaped block of an arch.
 - Sill stone
 - Springing stone
 - Key stone
 - Bond stone



PART II (3 Marks)

Answer in one or two sentences

- Write short notes on lintel.
- List the type of lintels.
- What is springing line?
- State the types of arches based on materials of construction.

PART III (5 Marks)

Answer shortly

- List the types of arches.
- Explain stone lintel with sketch.
- What are the difference between arches and lintels?

PART IV (10 Marks)

Answer in detail

- Explain the terms involved in the arches with a neat sketch.
- What are the types of lintels? Explain any two with neat sketch.

1. (c) 2. (a) 3. (b) 4. (c)

Part – I Answers

7.2

DOORS AND WINDOWS



Learning Objectives

At the end of this lesson you shall be able to

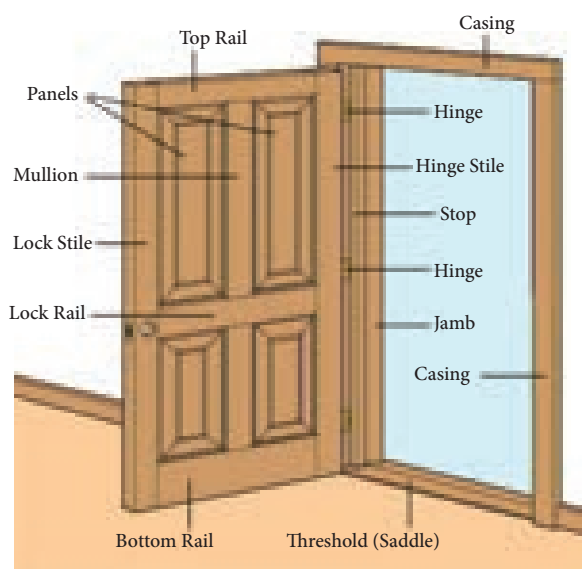
- Understand the terms used in doors and windows.
- Classify the doors and windows.
- Explain the fixtures for doors and windows.



7.2.1 Introduction

A door may be designed as a frame work secured in an opening left in a wall for the purpose of providing access to the uses of the structure. A window may be defined as an opening made in a wall for the purpose of providing day light, vision and ventilation.

7.2.2 Terms used in Doors and Windows



1. **Frame:** It is a group of members which form a support for a door or window.

2. **Shutter:** These are openable parts of a door or window. It is an assembly of styles, panels and rails.
3. **Style:** The vertical outside member of the shutter of a door or window is termed as style.
4. **Top rail:** The topmost horizontal member of the shutter is termed as top rail.
5. **Bottom rail:** The lowermost horizontal member of the shutter is termed as bottom rail.
6. **Lock rail:** The middle horizontal member of a door shutter, to which locking arrangements are fixed is termed as lock rail.
7. **Panel:** The area of shutter enclosed between adjacent rails is termed as panel.
8. **Sash:** The frame made for glass like panels is termed as sash.
9. **Mullion:** The vertical member of a frame which separates the shutter in the middle is mullion.
10. **Transom:** The horizontal member of a frame which divides the shutter into two parts is termed as transom.

11. Louver: The small strips of wood fixed inclined in the shutter is termed as louver.

12. Putty: The mixture of lime and linseed oil used for fixing the glass with shutters is termed as putty.

7.2.3 Size and Location of Doors And Windows

The following guidelines should be kept in view while deciding the location of doors and windows in a building.

1. As far as possible door should be located near the corner of a room, but 20 cm away from the corner.
2. The number of doors in a room should be kept minimum to achieve optimum utilisation of space.
3. The window sill should be placed at 75 to 100 cm above the floor level.
4. Windows should be located opposite to each other wherever possible.
5. The size and number of windows should be sufficient to provide adequate light, ventilation and privacy in the room.
6. The shutters of windows in external walls should be opened at outside.

The Size Of Doors:

For Residential buildings

Internal doors -

0.90×2.10 m (or) 0.90×1.95 m

External doors -

1.20×2.10 m (or) 1.00×1.95 m

Bathroom doors -

0.75×2.10 m (or) 0.75×1.95 m

For Public buildings

Schools and Hospitals - 1.20×2.25 m

Car Shed - 2.25×2.75 m

The minimum height of the doors should be 1.80 m.

In general,

Width of the door = 0.40 to $0.60 \times$ height.

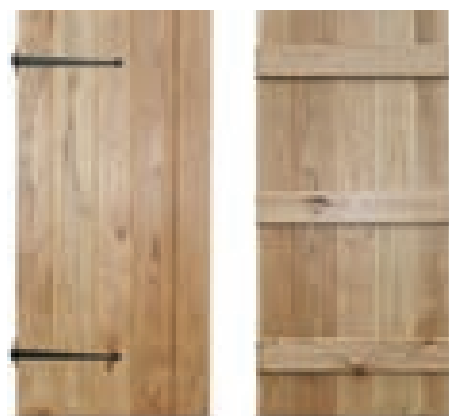
Height of the door = Width of the door + 1.20 m

7.2.4 Types of Doors

1. Ledged doors.
2. Ledged and braced doors.
3. Ledged and framed doors.
4. Ledged, braced and framed doors.
5. Framed and panelled doors.
6. Glazed doors.
7. Flush doors.
8. Louvered doors.
9. Collapsible doors.
10. Revolving doors.
11. Rolling shutters.
12. Sliding doors.

7.2.4.1 Ledged Doors

This door consists of a series of vertical battens fixed together with horizontal members known as ledges. There are three ledges named top ledge, bottom ledge and middle ledge. The door is hung on the frame by means of T - Hinge. These types of doors are mostly used for rooms where economy rather than the appearance is the main consideration.



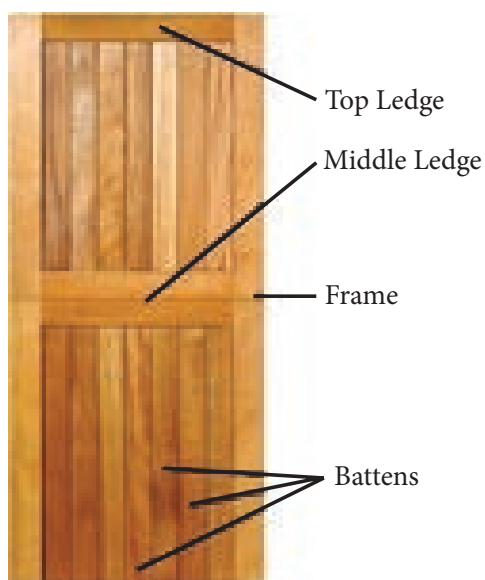
7.2.4.2 Lugged and Braced Doors

It is also like ledge doors. But, there are two additional members called braces, fixed in an inclined manner towards the side on which the door is hung. As the braces gives more strength to these doors, it is used in the places where the width of the door way is more. It is hung on the frame by means of T-hinges.



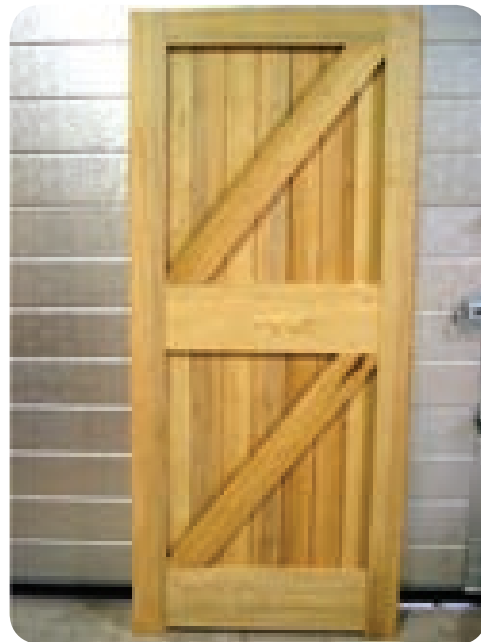
7.2.4.3 Lugged and Framed Doors

These doors are formed by fixing two styles at either end of lugged door setup. These are stronger and beautiful in appearance than lugged doors.



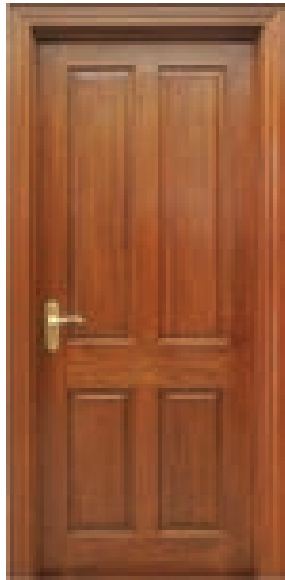
7.2.4.4 Lugged, Braced and Framed Doors

This door consists of battens, ledges, braces and frames. It has more strength, durability and good in appearance. The braces are housed and inclined towards the side on which the door is hung.



7.2.4.5 Framed and Panelled Doors

This type of door is commonly provided in all types of buildings. This door consists of frame work of styles and rails which are grooved inside to receive one or more panels. The number of panels and type should be selected according to the places used. The thickness of shutter should be 30mm to 40mm and thickness of panels should be 20mm. The door may be single, double, three, four or six panelled and so on. This door is good in appearance.



7.2.4.6 Glazed Door

This type of door is used in residential as well as public buildings like hospitals, schools or colleges, etc., to get extra natural lighting in addition to the lighting provided by windows. They may be partially or fully glazed. The glass should be fitted in frames by using putty.



Fully Glazed Door

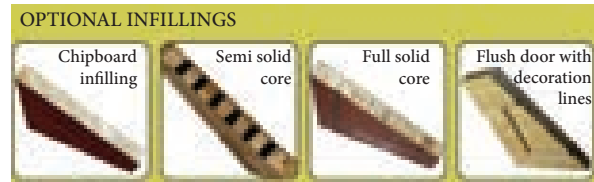


Partly Glazed Door

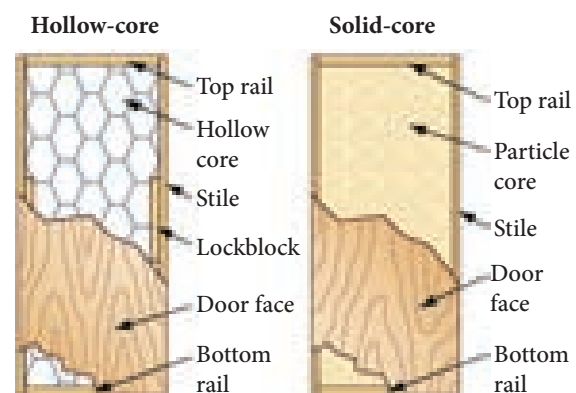
7.2.4.7 Flush Doors

Flush doors have pleasing appearance, simple construction, high strength, durability and economic. Flush doors can be classified in following types.

- i. Solid core type flush door
- ii. Hollow core type flush door



- i) **Solid core type flush door:** This type of door is made out of selected pieces of timber placed in series and pasted together in between the frame work. As it is sandwiched between plywoods, it acts as a solid material. The thickness of the shutter should be 30mm.
- ii) **Hollow core type flush door:** In this type, the frame consists of styles, top rail, bottom rail and minimum intermediate rails. The space between styles and the rails is divided by fixing wooden battens not less than 25mm in width. Thus the voids are equally distributed. The voids should be filled with light weight material like cork. Plywood sheets and face veneers are then glued under pressure on both faces of the core.



7.2.4.8 Louvered Doors

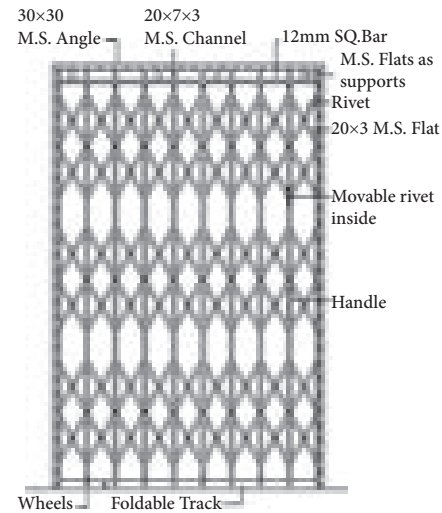
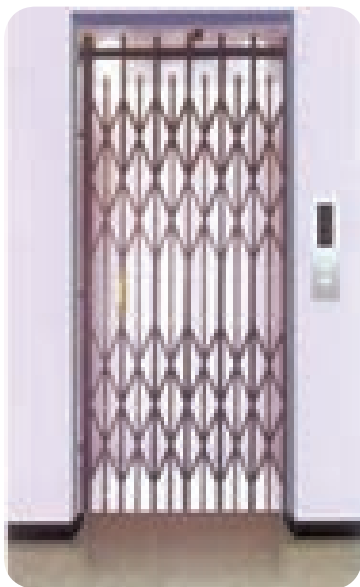
In this type, the styles of shutter are grooved to receive a series of louvers which may be of glass or wood. The Louvers are set within the grooves in inclined position, so

that they sloped downward to the outside in order to run off the rain water and obstruct the horizontal vision. It may be fixed or pivoted. These are commonly used in residential buildings.



7.2.4.9 Collapsible Doors

These doors are used for shops, garages, public buildings, godowns, etc., and in situations where width of opening is large. The door essentially consists of vertical double channels each 20 x 10 x 2mm in size and spaced at 10 to 12 cm apart. These are braced with flat iron diagonals 20mm wide and 5 mm thick. The door shutter slides over rollers mounted in position by the rails. This door is also used for residences to increase safety and protection.



7.2.4.10 Revolving Door

This door essentially consists of four leaves radially attached to a centrally placed mullion in a circular opening. The leaves may be glazed, panelled or partly glazed. Such doors are commonly provided in hotels, banks, offices, ATM Centres and other such important public buildings.





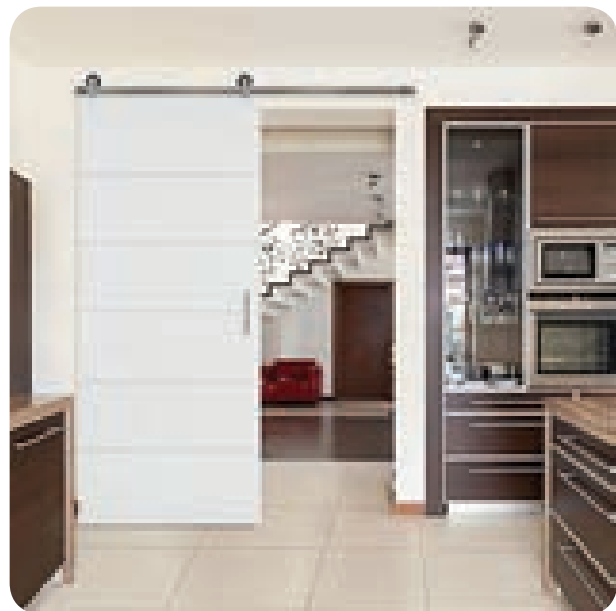
7.2.4.11 Rolling Shutters

The door consists of thin steel slabs interlocked to each other and wind upon in a specially designed pipe shaft mounted at the top of the opening. The door shutter travels into two vertical steel guide channels installed at either end of the opening. The shutter is counter balanced by means of helical spring enclosed in the drum. These are used for shops, factories, garages, etc.



7.2.4.12 Sliding Doors

This door is provided with top and bottom guide rails or runners within which the shutters slide. The guide rails run past the opening for a distance equal to the width of shutter. So that, when the door is required to be opened, the door shutter occupies a new position parallel to the wall face and clear off the opening. This type of door is suitable for shops, sheds, godowns, offices and garages.



ACTIVITY 2

1. Collect photos of world's 5 tallest doors and make an album.
2. List out the doors available in your school campus.

7.2.5 Types of Windows

1. Dormer window.
2. Louvered window.
3. Bay window.



Largest door in the world:

It is located in NASA. There are four entries to the bays located inside the VAB buildings which are four of the largest doors in the world. Each door is 456 feet high, has 7 vertical panels and 4 horizontal panels, and takes 45 minutes to completely open or close.



4. Lantern window.
5. Skylight window.
6. Gable window.
7. Corner window.
8. Sliding window.
9. Glazed or sash window.

7.2.5.1 Dormer Window

It is a vertical window built in the sloping side of a pitched roof. This window is provided to achieve proper ventilation and lighting to the room constructed below the roof.



7.2.5.2 Louvered Window

In this type, the styles of shutter are grooved to receive a series of louvers. The louvers are set within the grooves in inclined position. So that, they slope downward to outside in order to obstruct the horizontal vision. Louvers should be fixed or pivoted. Mostly it is used in the residential buildings.



7.2.5.3 Bay Window

A window projecting outward from the walls of a room is termed as a bay window. Bay window may be square, rectangular or polygonal in plan. It is introduced with a view to provide an

increased area of opening to admit light and ventilation.



7.2.5.4 Lantern Window

If the light from the windows in the walls is not enough, windows are provided on the roof also. These are called as lantern window. It should be square or rectangular in shape.



7.2.5.5 Skylight Window



In this type, a fixed window provided on the sloping surface of the pitched roof. The frame work of skylight window supports the glass panels. This type of windows are provided to get more light.

7.2.5.6 Gable Window

The triangular wall constructed to provide sloped roof in a building is known as gable wall. The window provided in the gable wall of a building is termed as gable window.



7.2.5.7 Corner Window

This type of window is essentially located in the corner of a room. It serves an architectural features for improving the elevation of the building.



7.2.5.8 Sliding Window

In this type of window, the shutters move on the rollers and can be slid either horizontally or vertically depending upon the provision made.



7.2.5.9 Glazed Window

The shutter of this window should be glass. The glass panels are secured in either by putty or by small fillets known as glazing beads. These windows provide light even if it is closed.



7.2.6 Fixtures For Doors and Windows

(i) HINGES

1. **Back flap hinge:** It should be used when the thickness of door shutter is less.
2. **Butt hinge:** It is commonly used type of hinge.
3. **Counter flap hinge:** While closing the door the two parts of the door should join together.
4. **Garnet hinge:** It is used in ledged and braced doors.



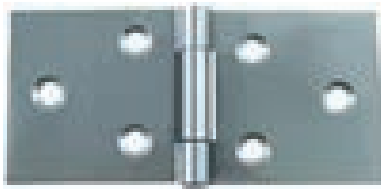
Do you know about UPVC doors and windows? What is UPVC?

UPVC is the general abbreviation for **Unplasticized Polyvinyl Chloride**. The recent material mostly used in all commercial and other buildings for making doors and windows is UPVC.

UPVC is extensively used because it is not easily affected by climatic changes unlike other substances like wood. The best part about it is it lasts longer without any such prior repairs.

Search link: <https://aparanavenstar.com>

5. **Rising butt hinge:** It increases height by 10mm while opening.
6. **Strip hinge:** It is used for heavy doors.



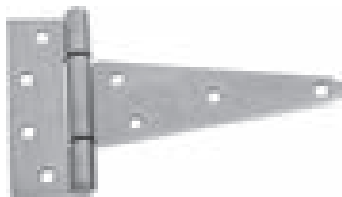
Back flap hinge



Butt hinge



Counter flap hinge



Cornet hinge



Rising butt hinge



Strip hinge



ACTIVITY 3

Prepare a report on various fixtures and fittings used in doors and windows with pictures.

(ii) BOLTS

1. **Aldrop bolts:** These are used in external doors of the building.
2. **Barrel bolt:** These are fixed in the backside of doors.
3. **Latch:** These are used for all types of doors and windows.
4. **Hasp and staple bolt:** These are used for external doors.
5. **Tower bolt:** It is nearly the same as barrel bolt. But three or two rings used instead of the barrel.



Aldrop



Barrel bolt



Latch



Hasp and staple bolt



Mortise lock



Tower bolt



Pad lock

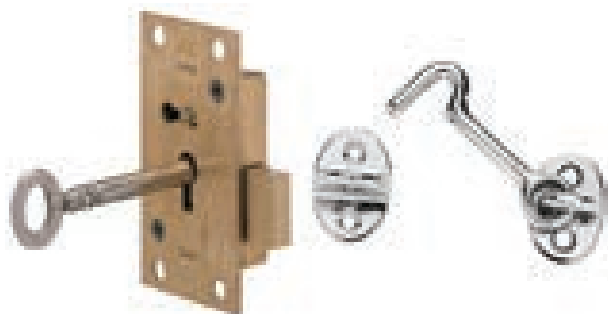
(iii) LOCKS

1. **Cupboard lock:** This is used for small doors.
2. **Hook and eye:** To keep the windows in open condition and also in the door of almirahs where there is no need of safety, these bolts are used.
3. **Mortise lock:** This type of lock is used to lock the flush doors from outside of the rooms.
4. **Pad lock:** These are used together with aldrop bolt.



ACTIVITY 4

1. Prepare a report about UPVC doors and windows with photos.
2. Prepare report about fixtures and fittings with photos.



Cupboard lock



Hook and eye

Model Questions

PART I (1 Mark)

Choose the correct answers

1. The vertical members in both the sides of shutter is
 - a. Rail
 - b. Sash
 - c. Style
 - d. Panel
2. are the horizontal members used in ledged doors.
 - a. Style
 - b. Transom
 - c. Head
 - d. Ledges
3. Dormer window is a window built in the sloping side of a pitched roof.
 - a. Vertical
 - b. Inclined
 - c. Horizontal
 - d. Sloped
4. A window projecting outward from the walls of a room is
 - a. Corner window
 - b. Pivoted window
 - c. Bay window
 - d. Lantern window



PART II (3 Marks)

Answer in one or two sentences

5. Define window.
6. What are the parts of a door shutter?
7. Write short notes on 'putty'.
8. List the hinges used in doors.

PART III (5 Marks)

Answer shortly

9. What are the types of doors?
10. List the types of windows.
11. List the types of bolts and locks used in doors and windows.

PART IV (10 Marks)

Answer in detail

12. Explain flush doors with sketch.
13. Explain framed and panelled doors with a neat sketch.

1. (c) 2. (d) 3. (a) 4. (c)

Part – I Answers