

# Lecture 13

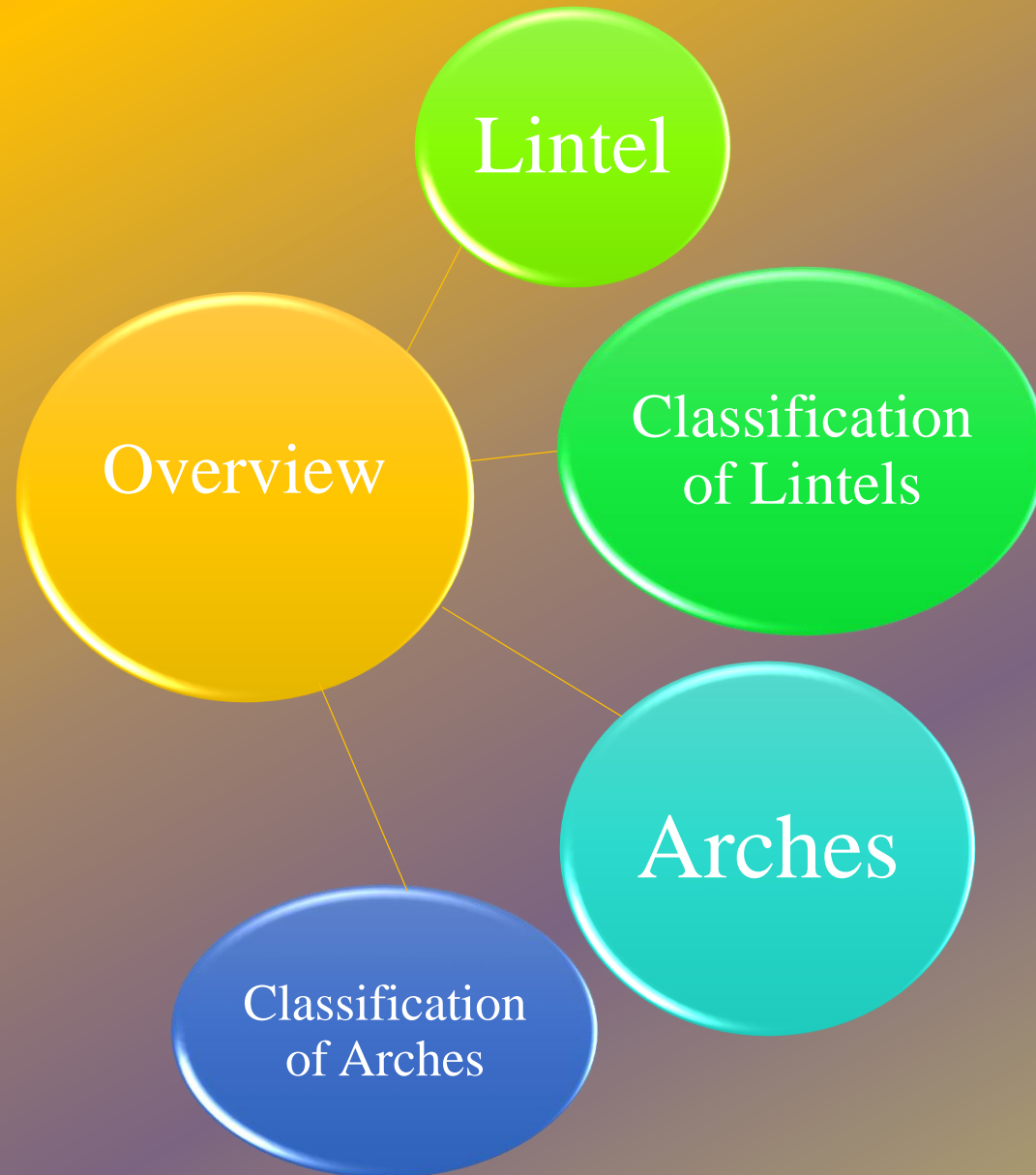
## Lintels and Arches

By  
Dr. Himanshu Chawla



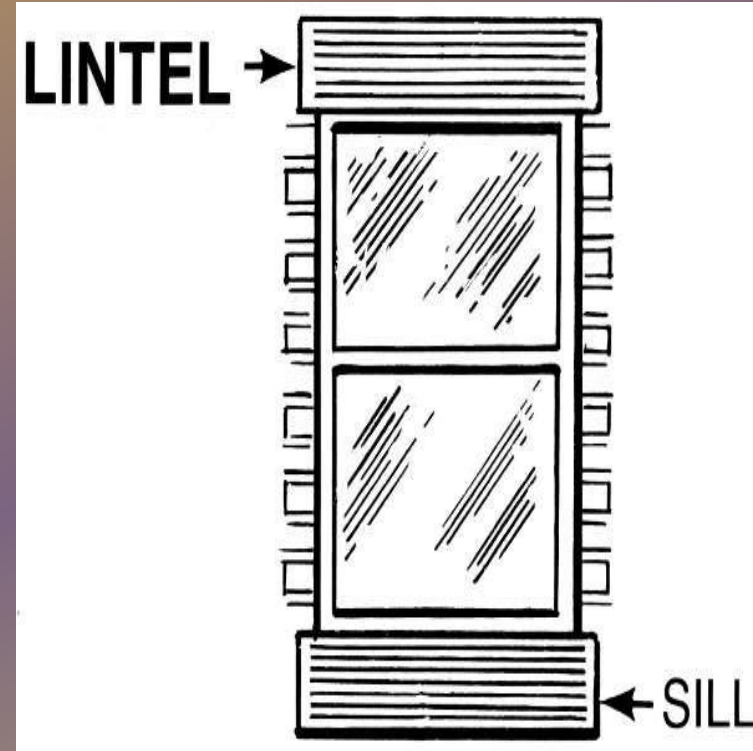
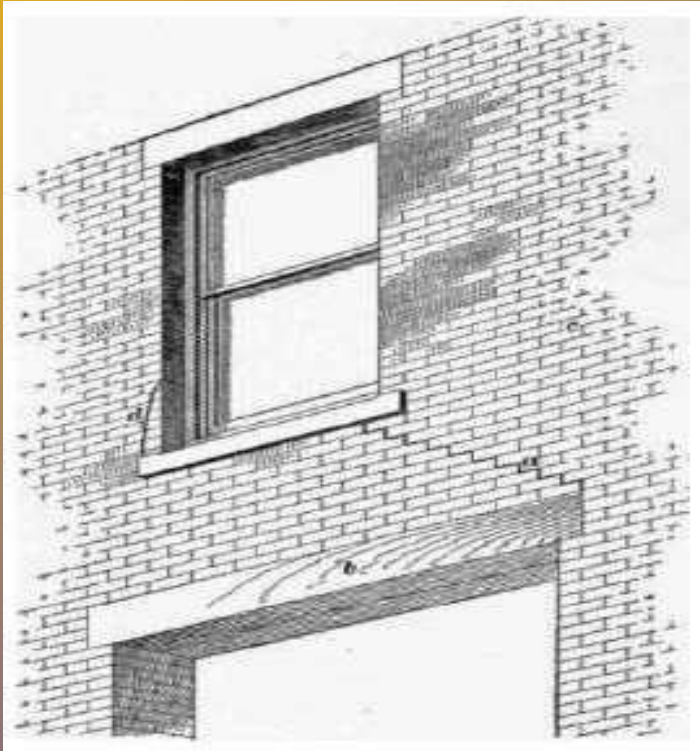
THAPAR INSTITUTE  
OF ENGINEERING & TECHNOLOGY  
(Deemed to be University)





# Introduction

A lintel is defined as a horizontal structural member which is placed across the opening (window or door), it is provided to carry the load of the wall above it and transfer it to the side of the opening

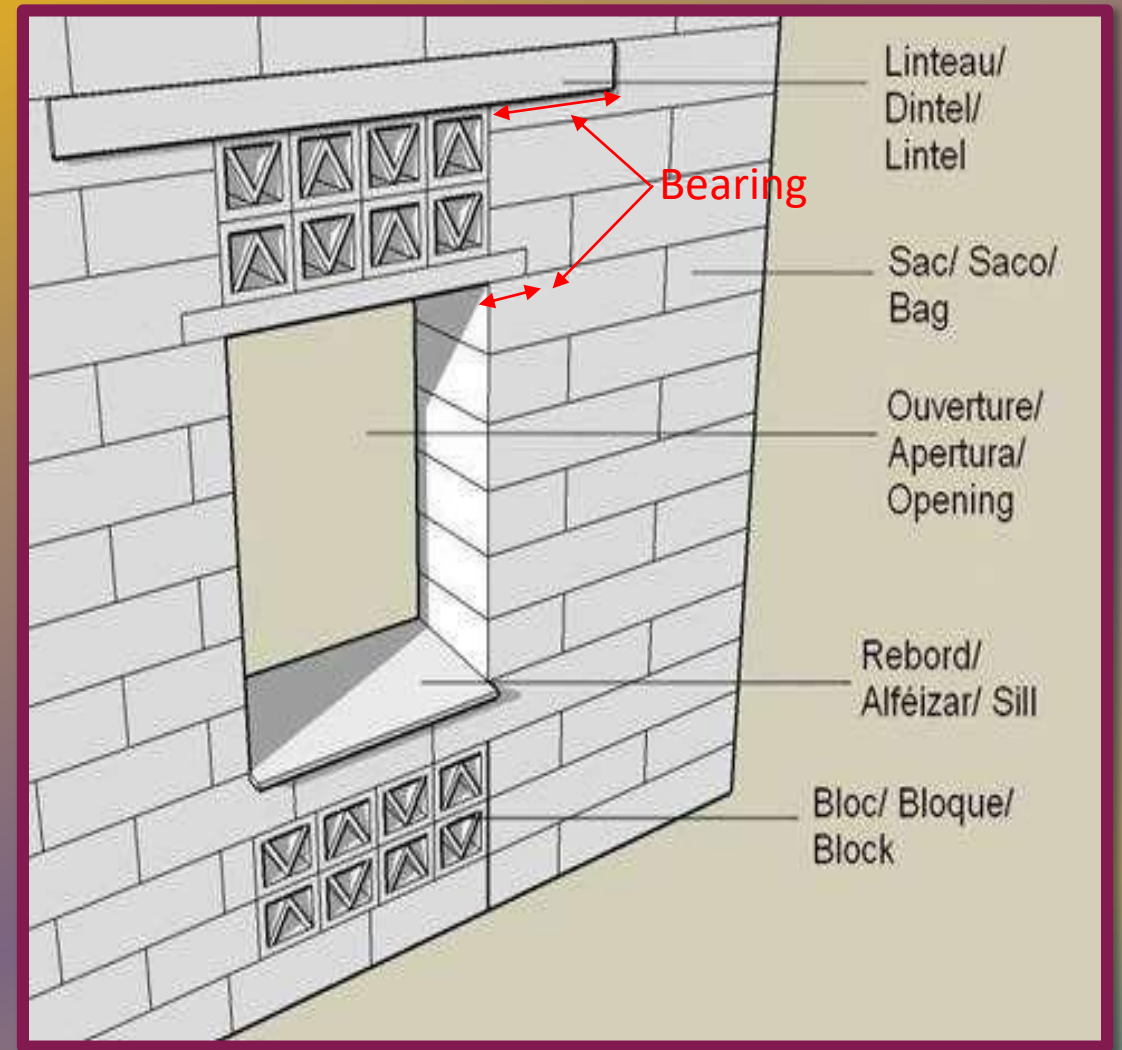


# Structure of lintel

Width of lintel is equals to thickness of the wall and its ends should be built into the wall.

The bearing of lintel should be minimum of the following:

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



# Classification of lintel

**Lintels are classified into the following types, according to the materials of their construction:**

- [1] Timber lintels**
- [2] Stone lintels**
- [3] Brick lintels**
- [4] Reinforced Brick lintels**
- [5] Steel lintels**
- [6] Reinforced cement concrete lintels**



# Timber lintels

- ❖ Easily available in hilly area.
- ❖ Relatively costly, structurally weak and vulnerable to fire.
- ❖ Easily decay, if not properly taken care.
- ❖ The minimum depth of the lintel should be 7.6 cm.



# Stone lintels





# Stone lintels

- ❖ Used, where stones are easily available.
- ❖ Consists of a simple stone slab of greater thickness.
- ❖ Due to high cost and its inability to withstand the transverse stress load.
- ❖ The thickness is taken as 4 cm per 30 cm length of span





# Brick Lintels

- They are considered suitable for small openings with light loading conditions.
- The brick are hard, well burnt, **first class bricks**.
- Suitable for small span.
- The bricks having frogs are more suitable.

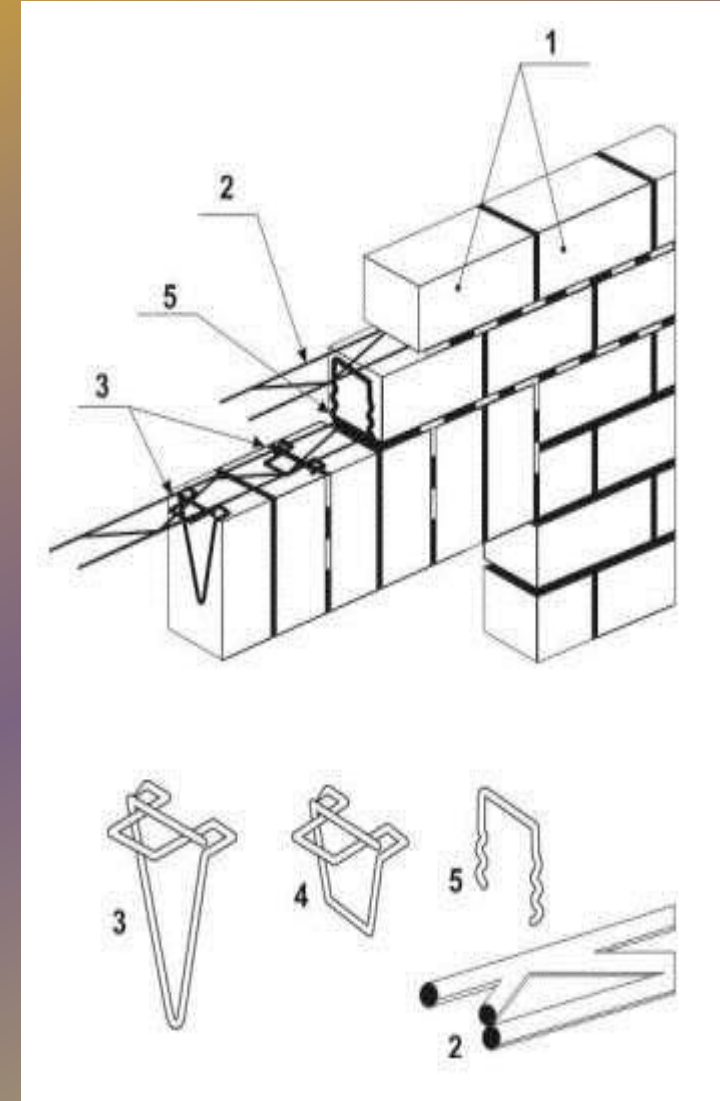


Brick lintel



# Reinforced Brick lintels

- ❖ For large spans and heavy loads.
- ❖ They are reinforced with mild steel bars.
- ❖ Very common due to durability, strength and fire resisting properties.
- ❖ Joints are filled with cement concrete.





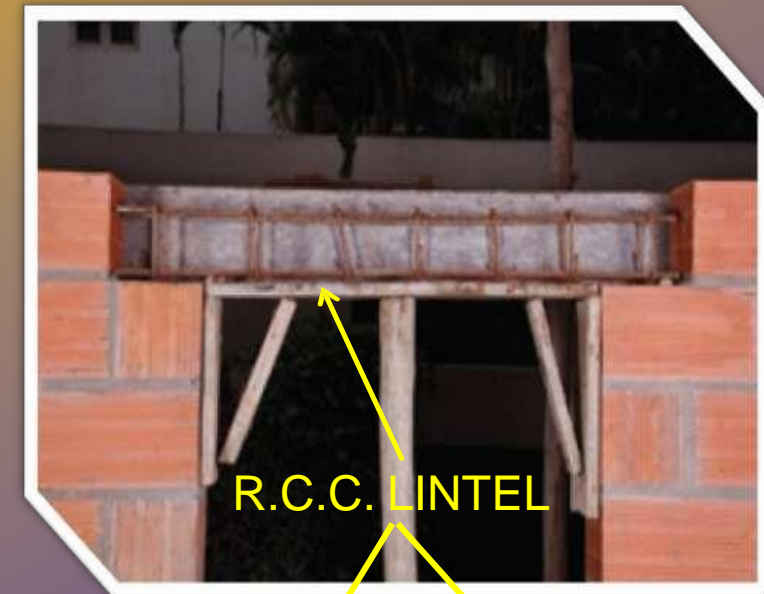
# Steel lintels

- Provided at large opening and where the super-imposed loads are heavy.
- It consists of rolled steel joists.
- Either used singly or in combination of two or three units.
- Joint with bolts.



# REINFORCED CEMENT CONCRETE LINTEL

- Common in used.
- It may be pre-cast.
- For smaller span, the pre-cast concrete lintels are used.
- It is used for durability, strength and fire resisting property.
- It is used for bigger span and heavy loading.
- It is constructed with 1:2:4 cement concrete reinforced with steel bar.





# ARCHES

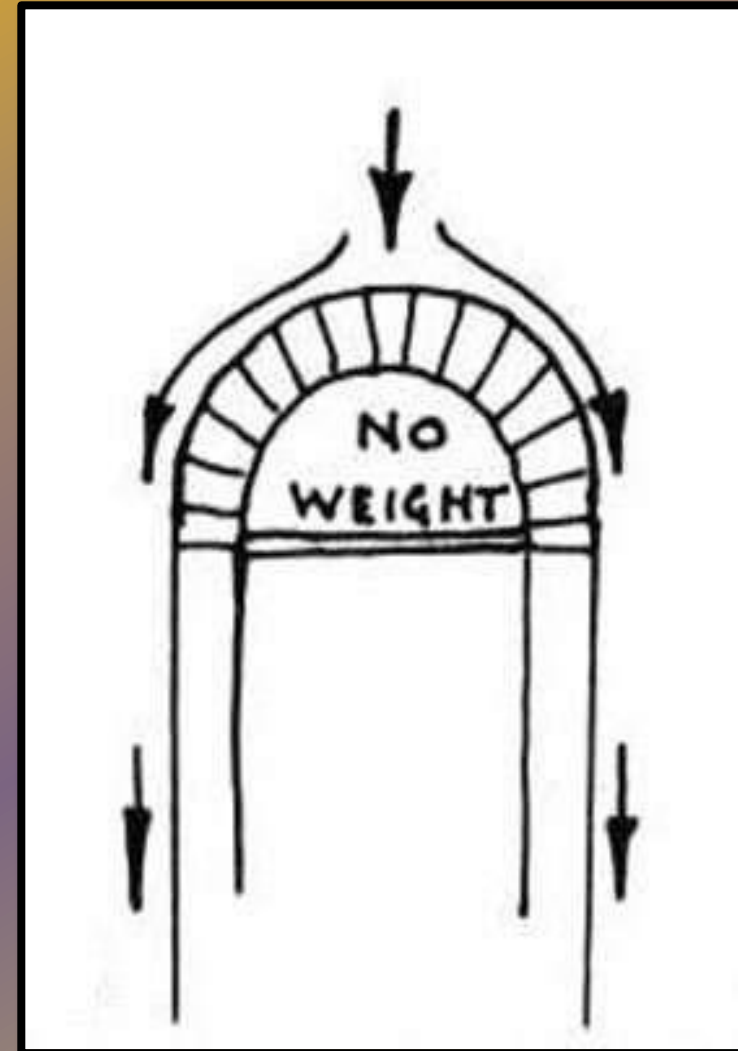
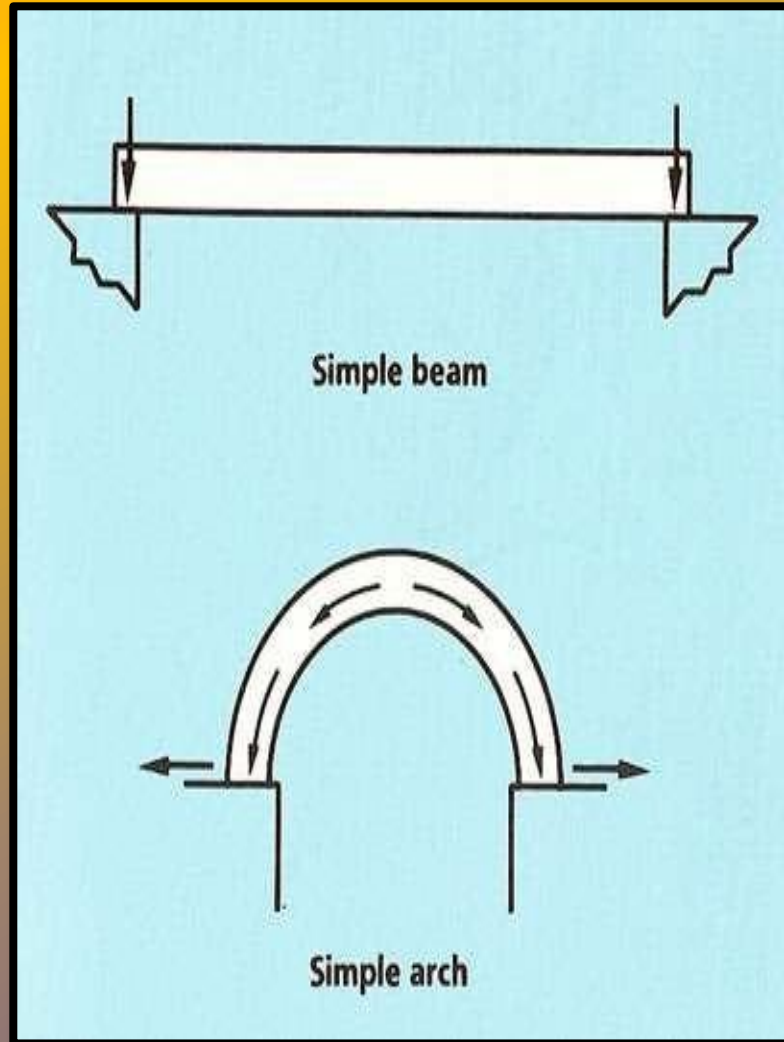


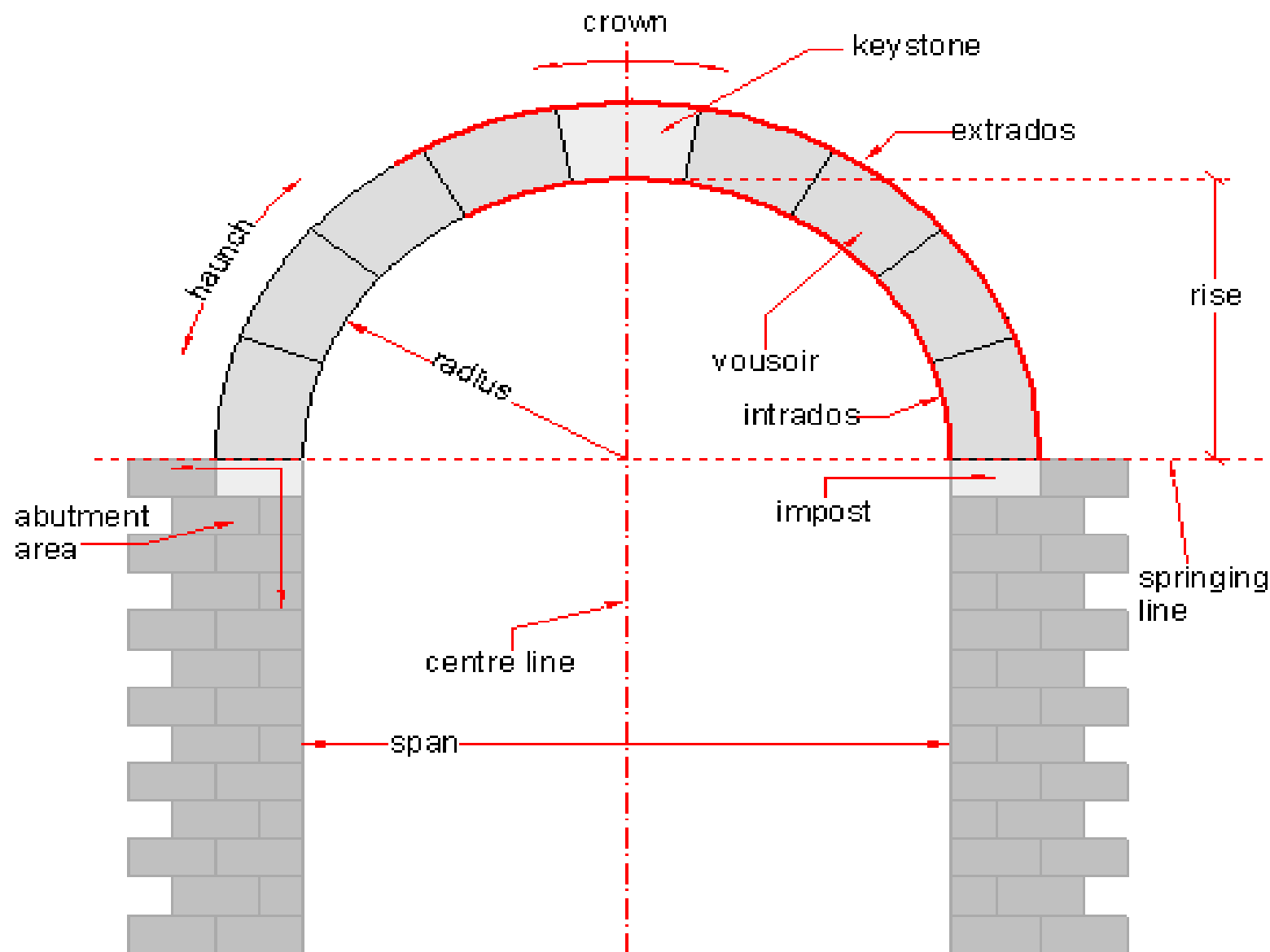
# ARCHES

The structure constructed of wedge shaped block of stones or bricks, jointed together with mortar and provided across the opening to carry the weight of the structure above the opening.









## ELEMENTS OF ARCHES



# TECHNICAL TERMS

The various technical terms used in arches are as follows:-

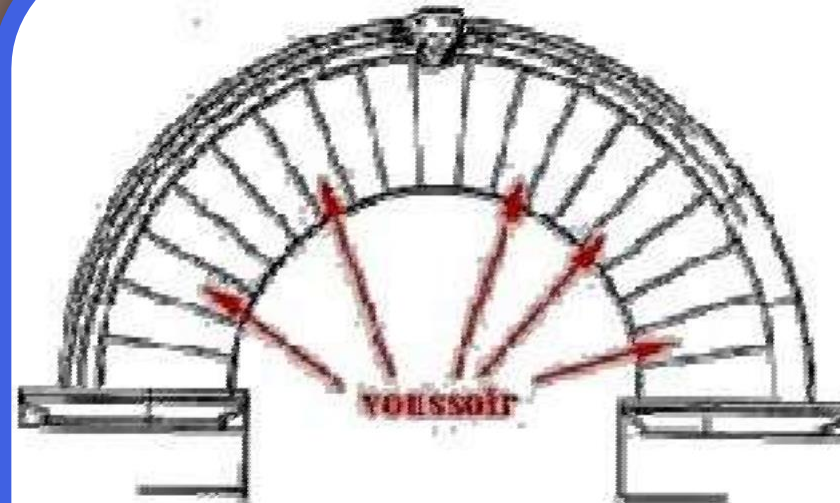
- 1) **Abutment**:- This is the end support of an arches.
- 2) **Pier**:- This is support an intermediate of an arch.



3)**Intrados** :-This is the inner curve or surface of an arch.

4)**Extrados** :-This is the outer curve or surface of the arches.

5)**Voussoirs** :-The voussoirs or arch stones are the wedge shaped units forming the arch.

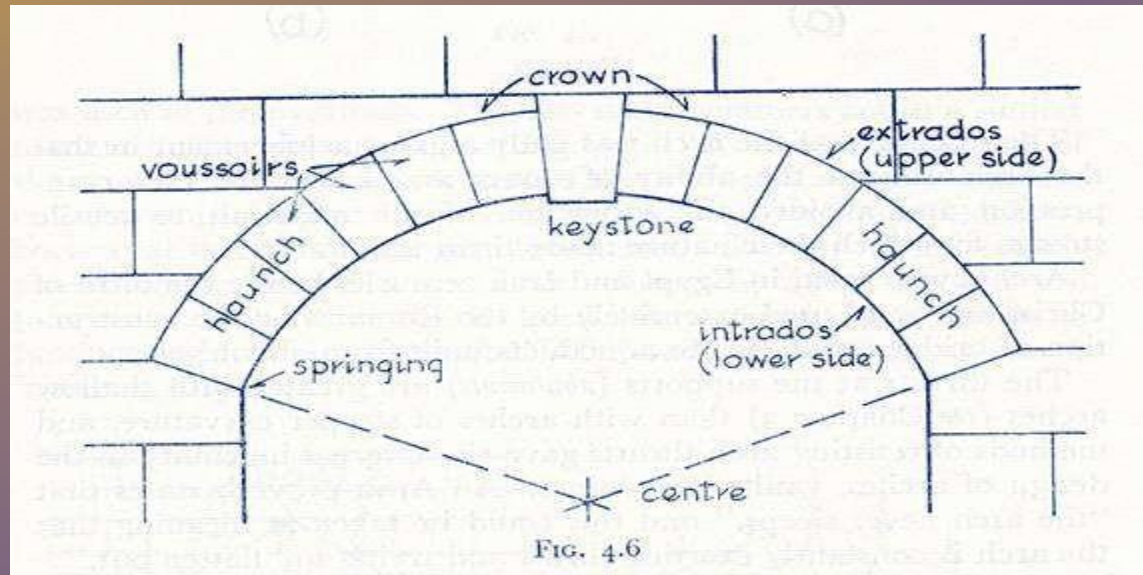




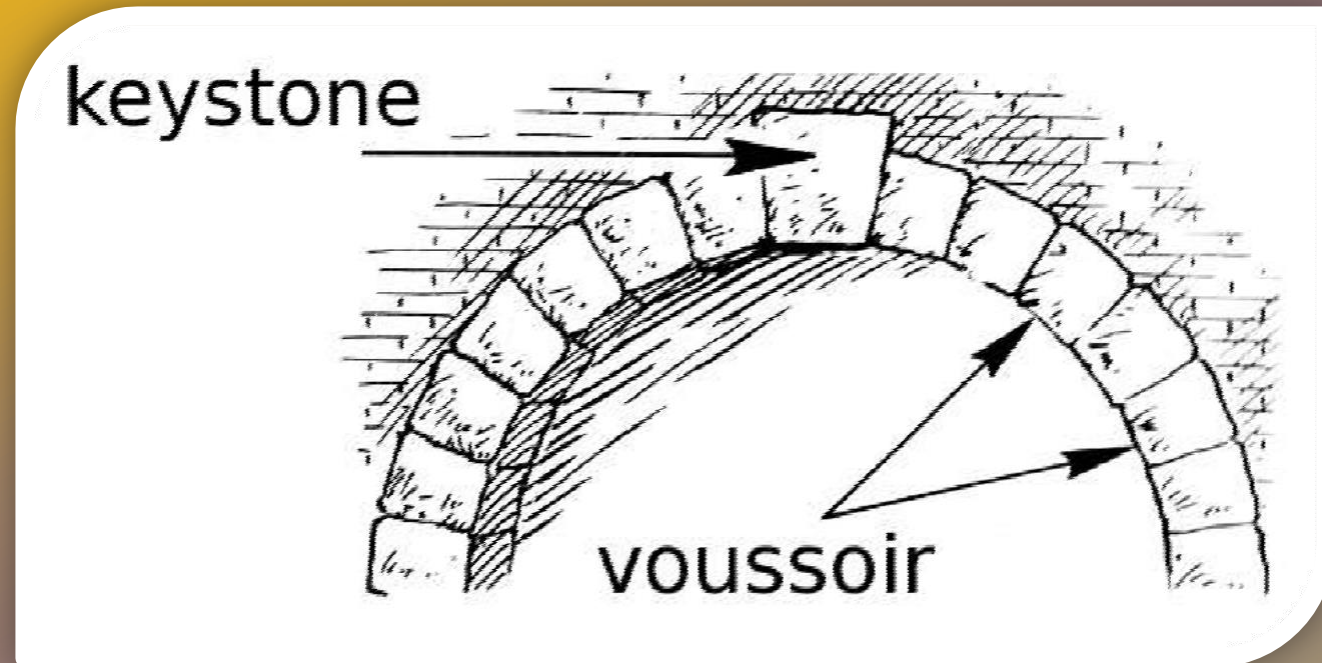
6)**Springing stone**:-The springing stone or springer is the first voussoir at springing level on either side of the arches.

7)**Springing line**:-This is an imaginary line joining the two springing points.

8)**Crown**:-This is the highest point of extrados or it is the highest part of an arches.



9) **Keystone**:-This is the highest central wedge shaped block of an arch.



10) **Skew back**:-This the surface of the abutment on which the arch rests.



11)**Span**:-This is the clear horizontal distance between the two supports.

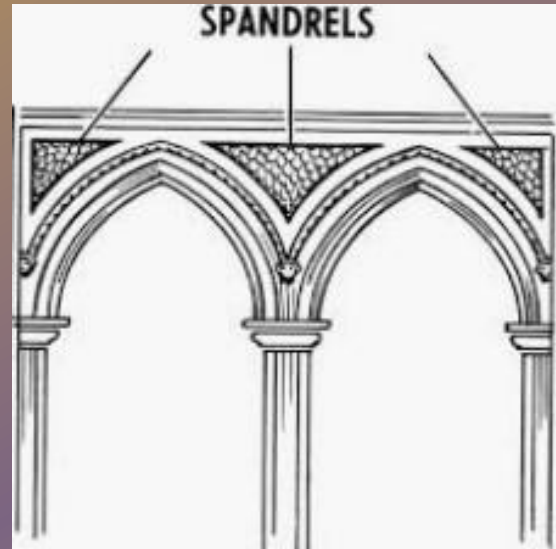
12)**Rise**:- The clear vertical distance between the highest point on the intrados and the springing line.



13)**Depth of arch**:-This is the perpendicular distance between the intrados and extrados.

14) **Haunch of an arch**:-This is the portion of arch situated centrally between the key and skew backs.

15) **Spandril**:-This is the triangular walling enclosed by the extrados of the arch, a horizontal line from the crown of the arch and perpendicular line from the springing of the outer curves.





# Construction of Brick Arch



# FAILURE OF AN ARCH

- ❖ **EVERY ELEMENT OF ARCH REMAINS IN COMPRESSION**
- ❖ **An arches fail due to:-**
  - 1)Crushing of the masonry
  - 2)Sliding of voussoirs
  - 3)Rotation of some joints about an edge
  - 4)Uneven settlement of an abutment or pier.

# CRUSHING OF THE MASONARY

- If the compressive stress exceeds the safe crushing strength of the masonry unit and mortar, the arch will fail in crushing.
- The material should be of adequate strength and size of voussoirs and should be properly designed to bear the thrust transmitted through them.



# SLIDING OF VOUSSOIRS

To safeguard against sliding of voussoirs past each other due to transverse shear, the voussoirs of **greater height** should be provided.

## Rotation of Some Joint about an Edge

Due to compression, some times mortar comes out from the voussors, which leads to the rotation of some joints about an edge. Therefore, strength of the mortar should be sufficient to bear the compressive stresses.

# UNEVEN SETTLEMENT OF AN ABUTMENT OR PIER

- Uneven settlement of abutment, which causes secondary stresses in an arch.
- Hence, the abutment which has ultimately to bear all the load transferred to the arch, should be strong enough.
- Also, the arch should be symmetrical, so that unequal settlements of the two abutment is minimised.

# CLASSIFICATION OF ARCHES



# Classification of arches

An arch may be classified according to their:

- Material of construction and workmanship
- Shape of curve formed by their soffit or intrados
- Number of centers

# Classification Based on Material and Workmanship

## ➤ **BRICK ARCHES**

- \*Rough brick arches
- \*Axed brick arches
- \*Gauged brick arches

## ➤ **STONE ARCHES**

- \*Rubble arches
- \*Ashlar arches

## ➤ **GAUGED ARCHES**

- \*Precast concrete block arches
- \*Monolithic concrete arches

# ROUGH BRICK ARCHES

These arches are built with ordinary bricks, which are not in wedge shape.

Made up of rectangular brick that are not cut into wedge shape.  
**Curvature are obtained by mortar.**





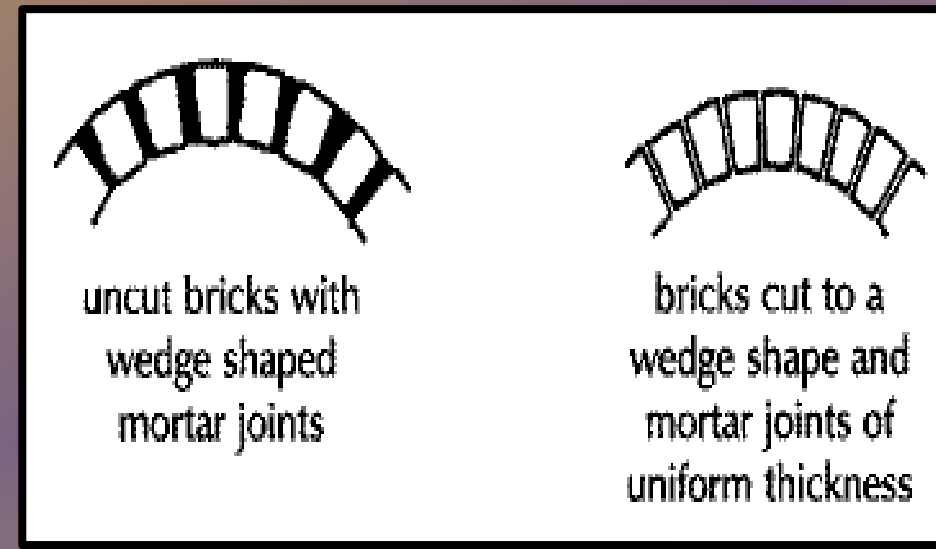
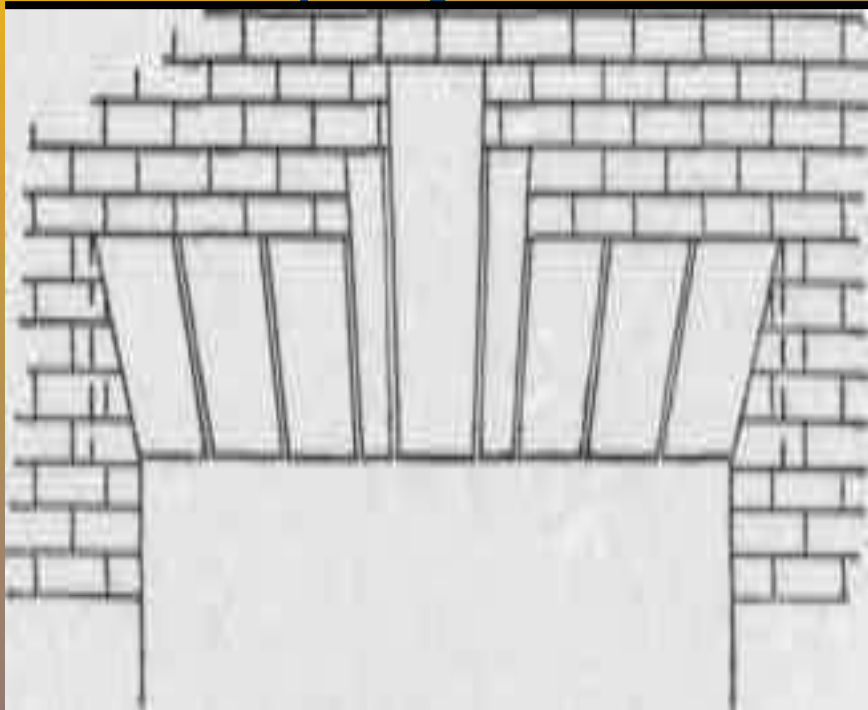
# AXED BRICK ARCHES

- Bricks are cut to wedge-shape.
- Joints of arches are of uniform thickness.
- Not dress appearance. finely so it does not give much attractive



# GAUGED BRICK ARCHES

- Accurately prepared to wedge shape.
- Specially shaped bricks known as “RUBBER BRICKS” are used .
- The lime putty is used for binding the blocks



# RUBBLE ARCHES

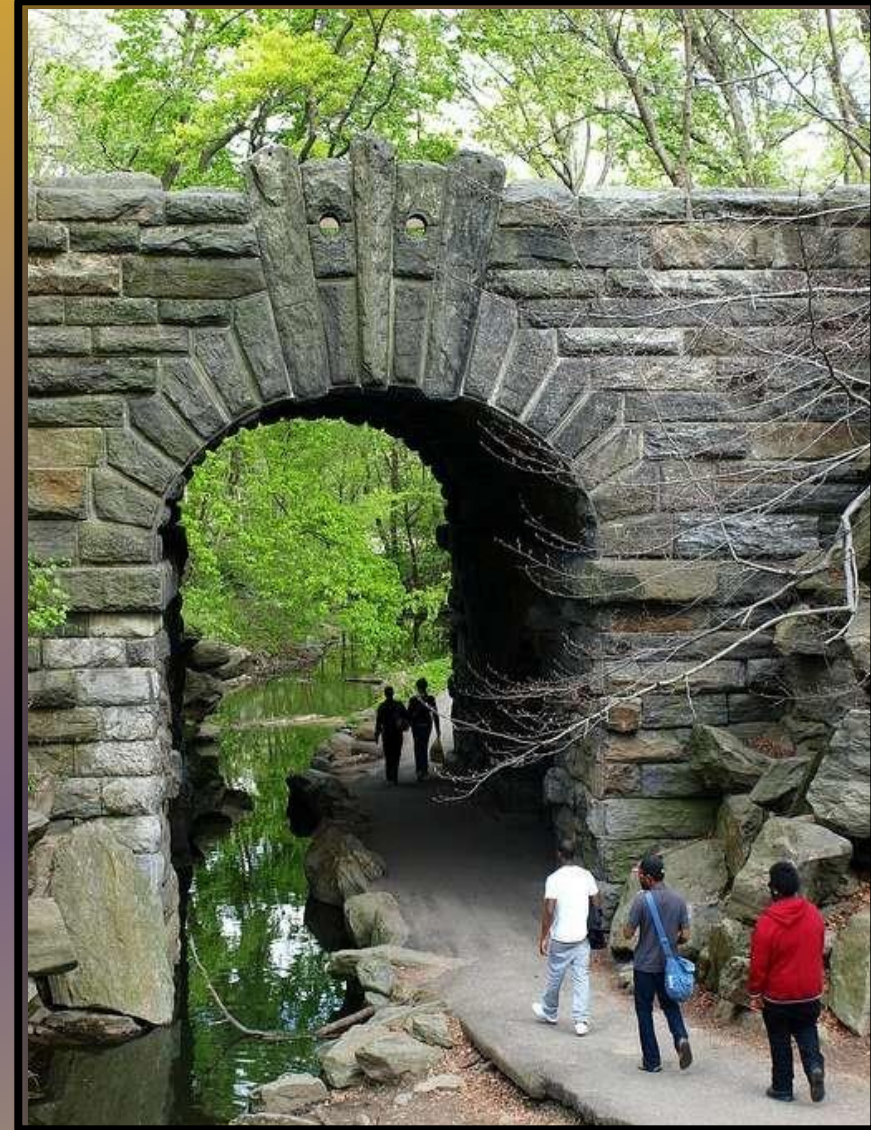
- Made of rubble stones, which are hammer dressed, roughly to the shape and size of voussoirs of the arch and fixed in cement mortar.
- These arches are used for small span upto 1 m.





# ASHLAR ARCHES

- Stones are cut to proper shape of voussoirs and are fully dressed, properly joint with cement or lime.
- The voussoirs made of full thickness of the arch.



# PRECAST CONCRETE BLOCK ARCHES

- Precast concrete arch elements provide a cost-effective design solution for small bridging and tunnel-like applications.
- Precast arches are predominantly produced as a single arch unit or as two-piece arch units connected at the crown with either a pin or moment type connection.





# MONOLITHIC CONCRETE ARCHES

- Constructed from cast-in-situ concrete, either plain or reinforced, depending upon the span and magnitude of loading.
- Quite suitable for larger span (3.0 m).
- The curing is done 2 to 4 weeks.





## **Classification according to shape**

- Flat arch
- Segmental arch
- Semi-circular arch
- Relieving arch
- Dutch or French arch

# FLAT ARCH

- Acts like a lintel, when it is provided over the opening.
- Joints radiate to center.
- Used only for light loads only.
- Span up to 1.50 m.



# SEGMENTAL ARCH

- Segmental in shape and provided over the openings.
- Joints radiate from a center of arch, which lies below the springing line.
- Provided over lintel.
- Thrust transferred to the arch in an inclined direction





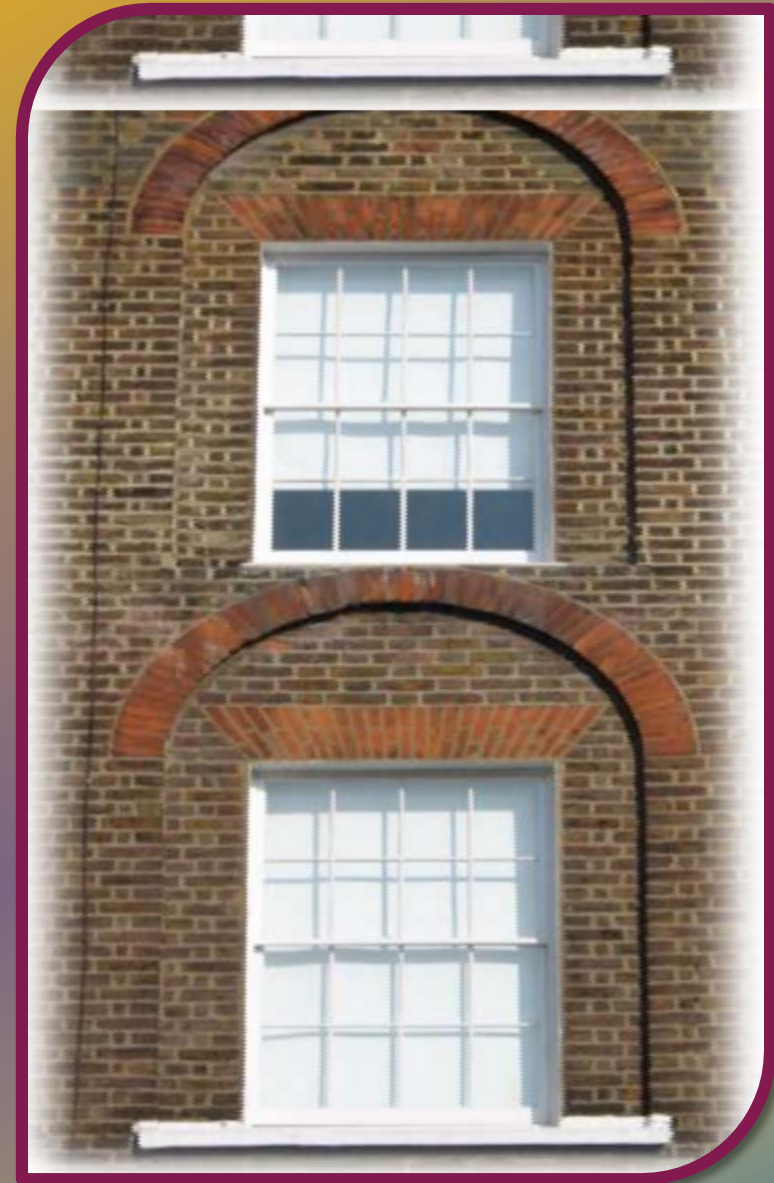
# SEMI-CIRCULAR ARCH

- The shape of the curve given to the arch soffit is semi-circular.
- The center of the arch lies on the springing line.



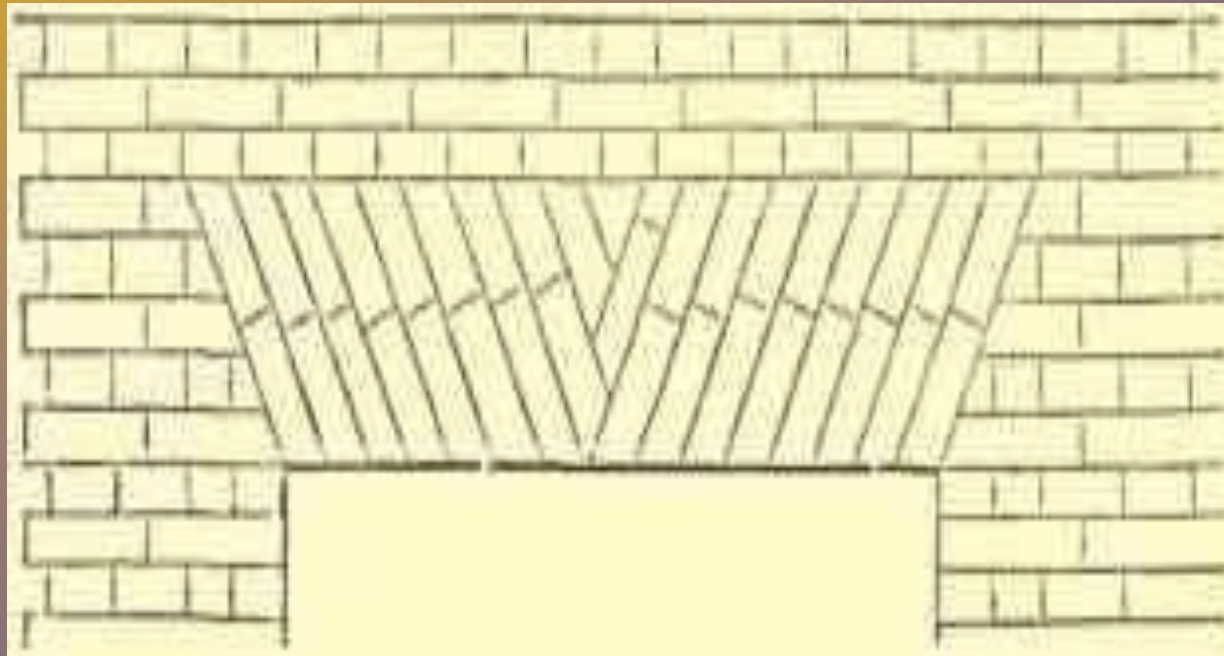
# RELIEVING ARCH

- When wooden lintel is provided over the wider opening, a brick relieving arch is constructed above the lintel.
- Relieving the load of masonry over lintel.



# DUTCH OR FRENCH ARCH

- Similar to the flat arch in design, but differs in shape and method of construction.
- Suitable for small opening.



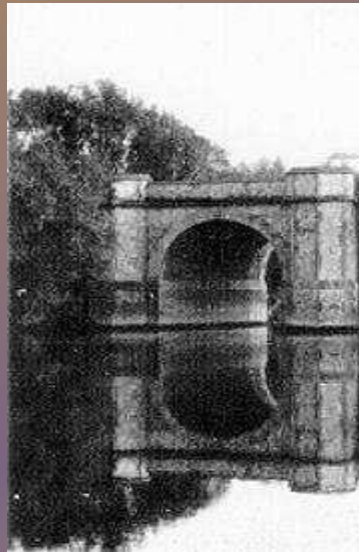


# Classification Based on Number of Centres

- One centred arch.
- Two centred arch.
- Three centred arch.
- Four centred arch.
- Five centred arch.

# ONE CENTRED ARCH

- Segmental, semi circular, flat arches come under this category.
- Sometime, a perfectly circular arch known as bull's eye arch, provided for circular window.



# TWO CENTRED ARCH

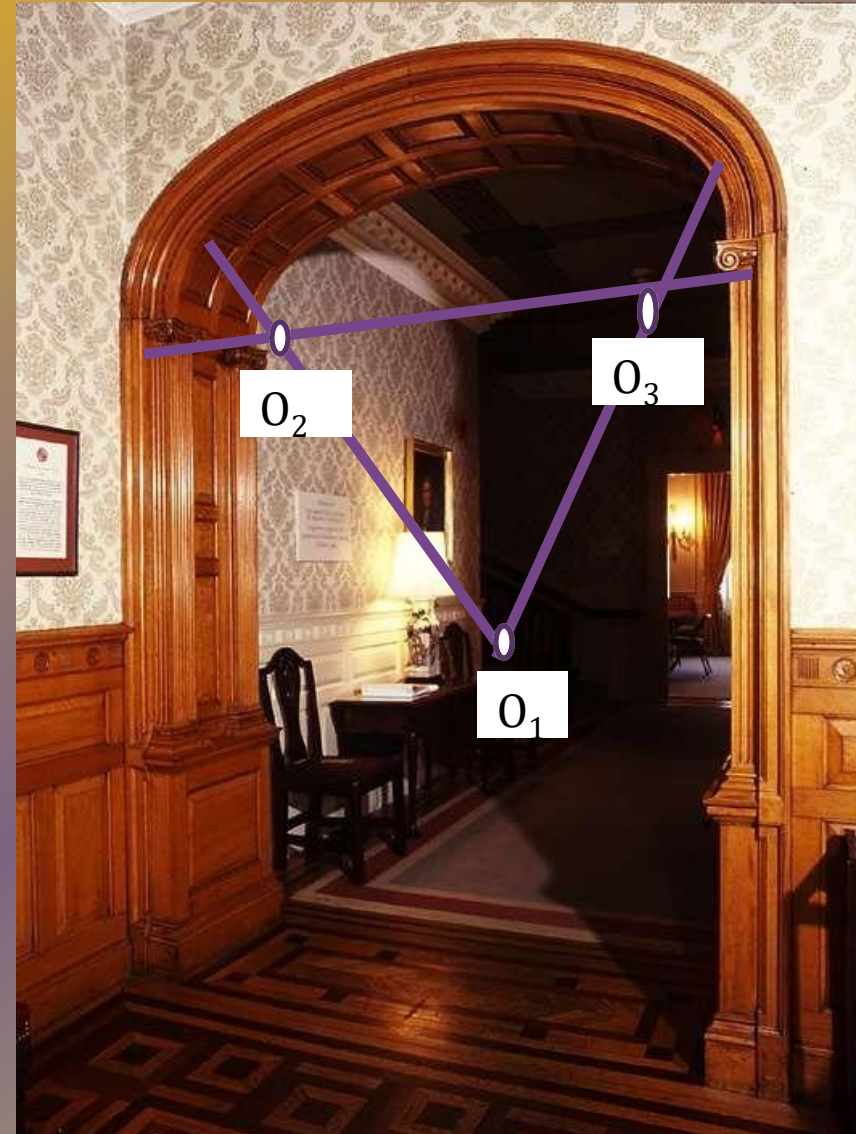
- Pointed, semi-elliptical arches come under this category.





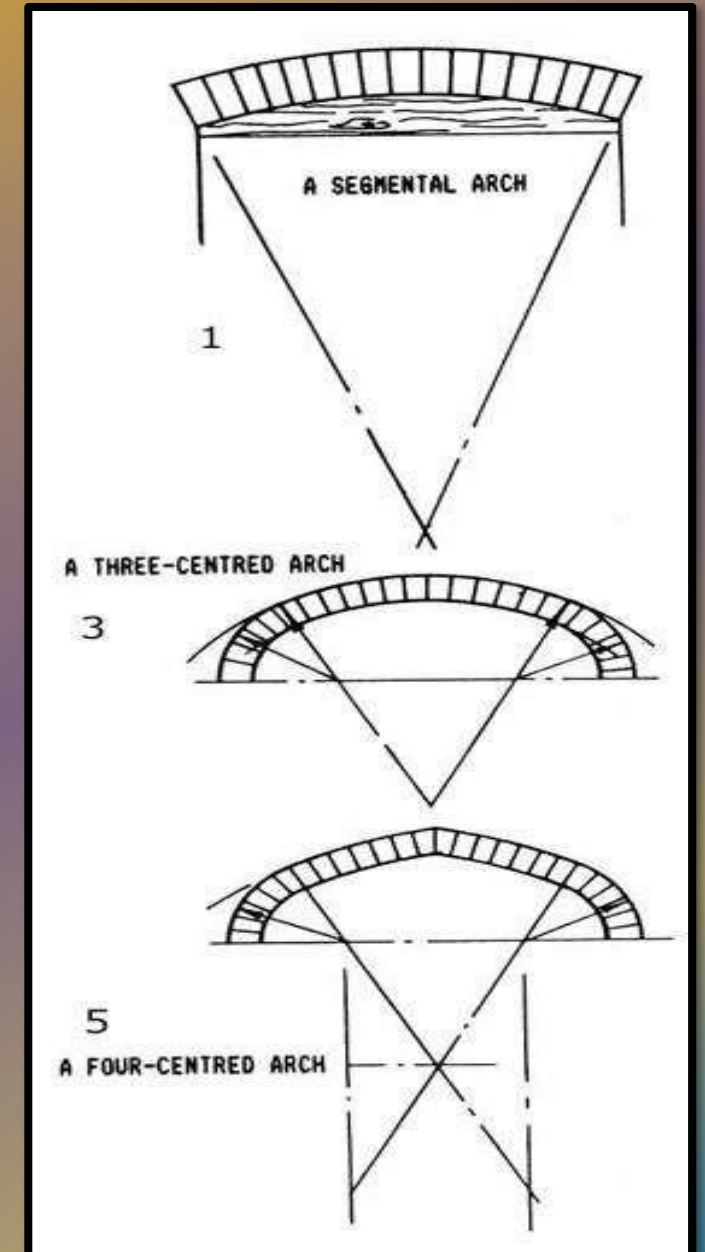
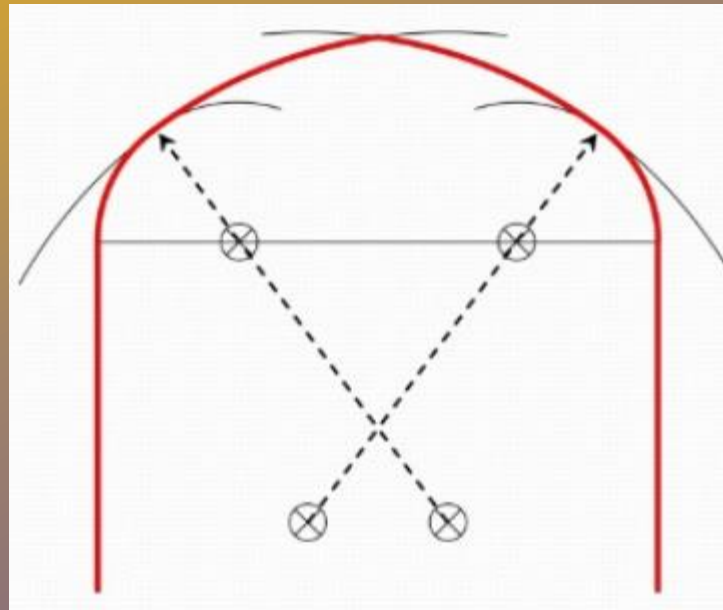
# THREE CENTRED ARCH

- Elliptical arches come under this category.
- $O_1, O_2$  and  $O_3$  are the center.



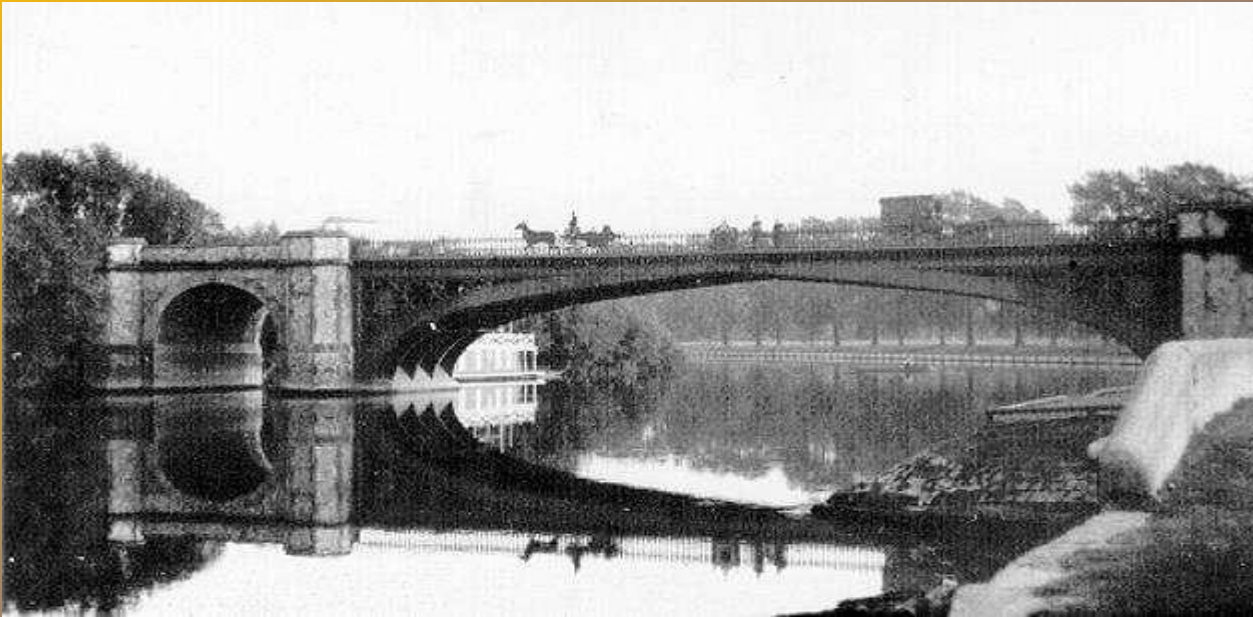
# FOUR CENTRED ARCH

- It has four center.
- Venetian arch is typical example of this type.



# FIVE CENTRED ARCH

This type of arch, having five centre's, gives good semi-elliptical shape.



Four centred Arch



Five centred Arch



*Thankyou*



**THAPAR INSTITUTE**  
OF ENGINEERING & TECHNOLOGY  
(Deemed to be University)

