JECRC Foundation

JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

# JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE
## DEPARTMENT OF CIVIL ENGINEERING

Class – III Semester /II Year
Subject –Building Materials And Construction
Chapter – 9(Lintel & Arch)
Presented by – Teekam Singh (Assistant Professor )

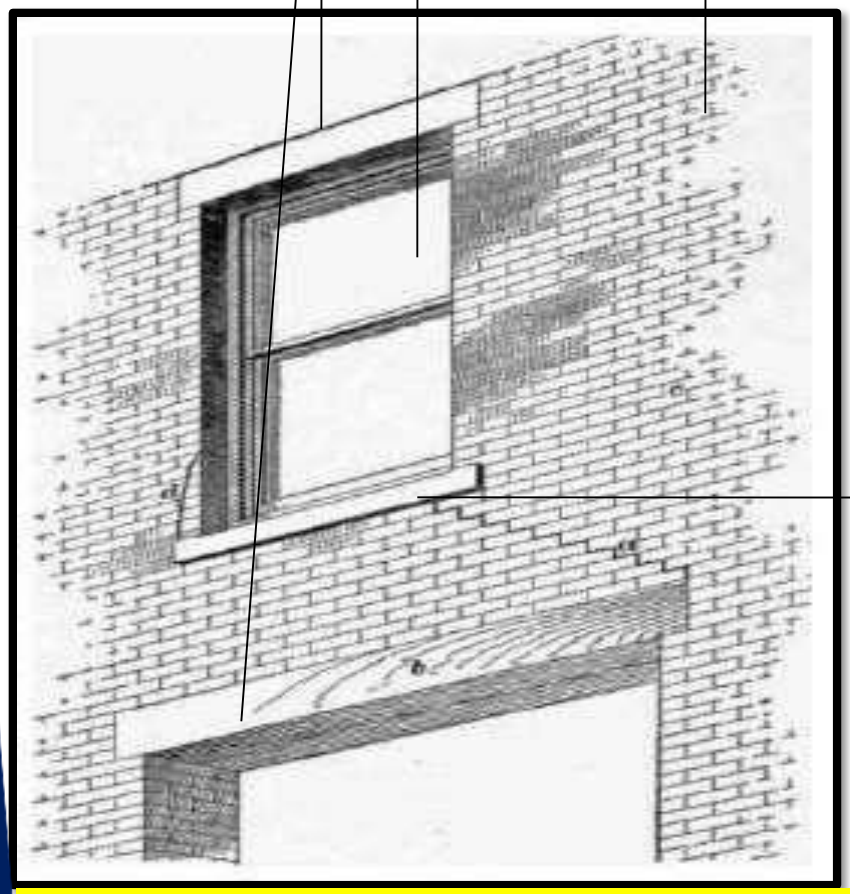
# Introduction

## Lintel

- A lintel is defined as a horizontal structural member which is placed across the opening.
- Hence, the structure remains in the position by the resistance from the support.

## Arch

- An Arch may be defined as mechanical arrangement of wedge-shaped blocks of stones or bricks mutually supporting each other and supported at the end by piers or abutments.
- An arch is a structure that spans a space and supports structure and weight below it.
- Arches appeared as early as the 2nd millennium BC in Mesopotamian brick architecture and their systematic use started with the Ancient Romans who were the first to apply the technique to a wide range of structures.


OPENIN
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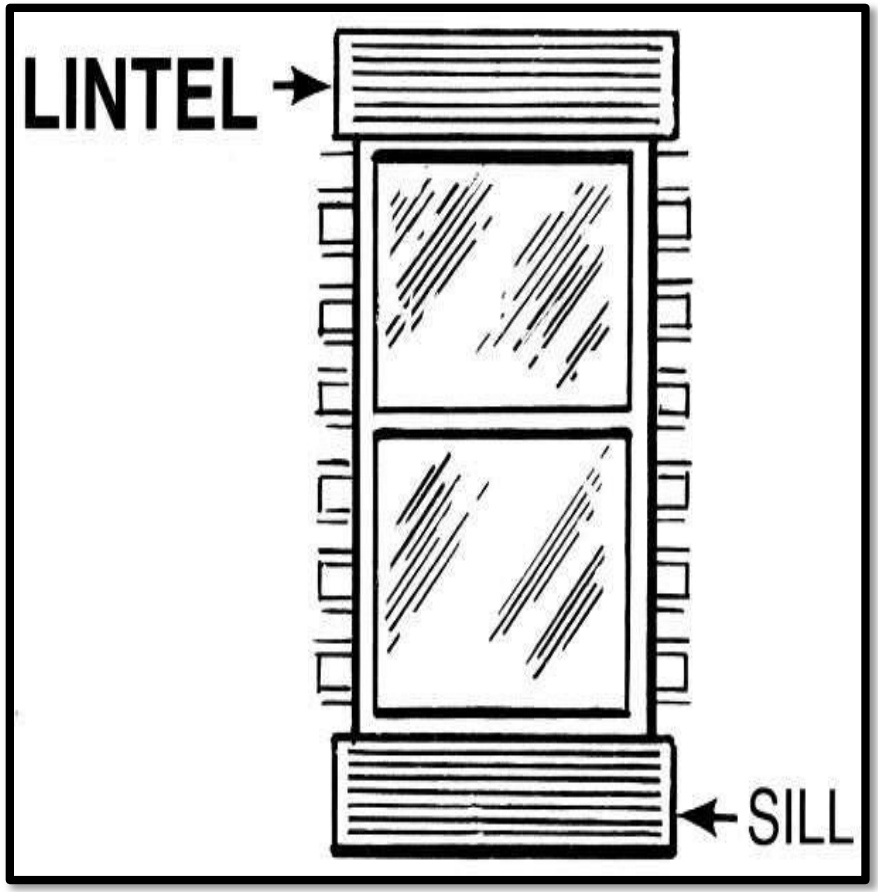

LINTEL
SILL

# Classification of lintel

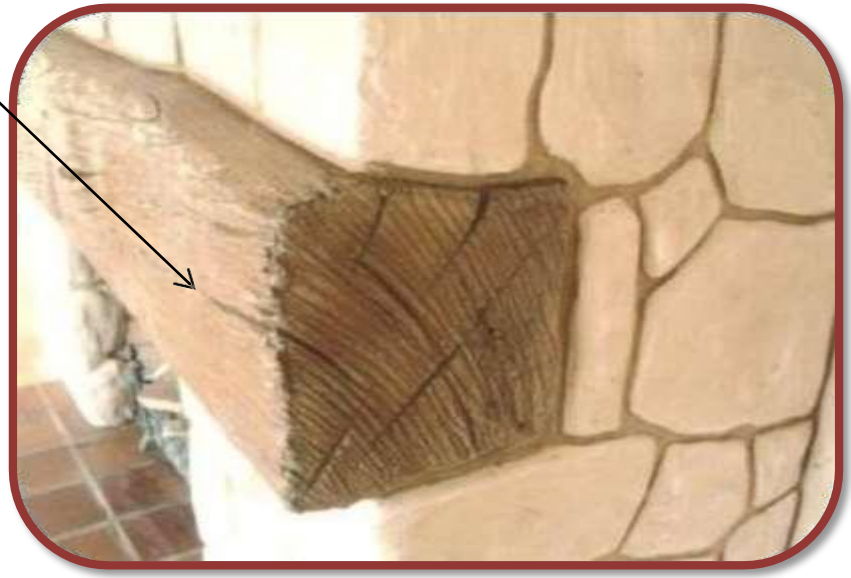
**Lintels are classified into the following types, according to the materials of their construction:**

- Timber lintels
- Stone lintels
- Brick lintels
- Reinforced Brick lintels
- Steel lintels
- Reinforced cement concrete lintels

# Timber lintels

- Easily available in hilly area.
- Relatively costly, structurally weak and valnerable to fire.
- Easily decay, if not properly taken care.

*TIMBER LINTEL*



# Stone lintels

- Used , where stones are easily available.
- Consists of a simple stone slab

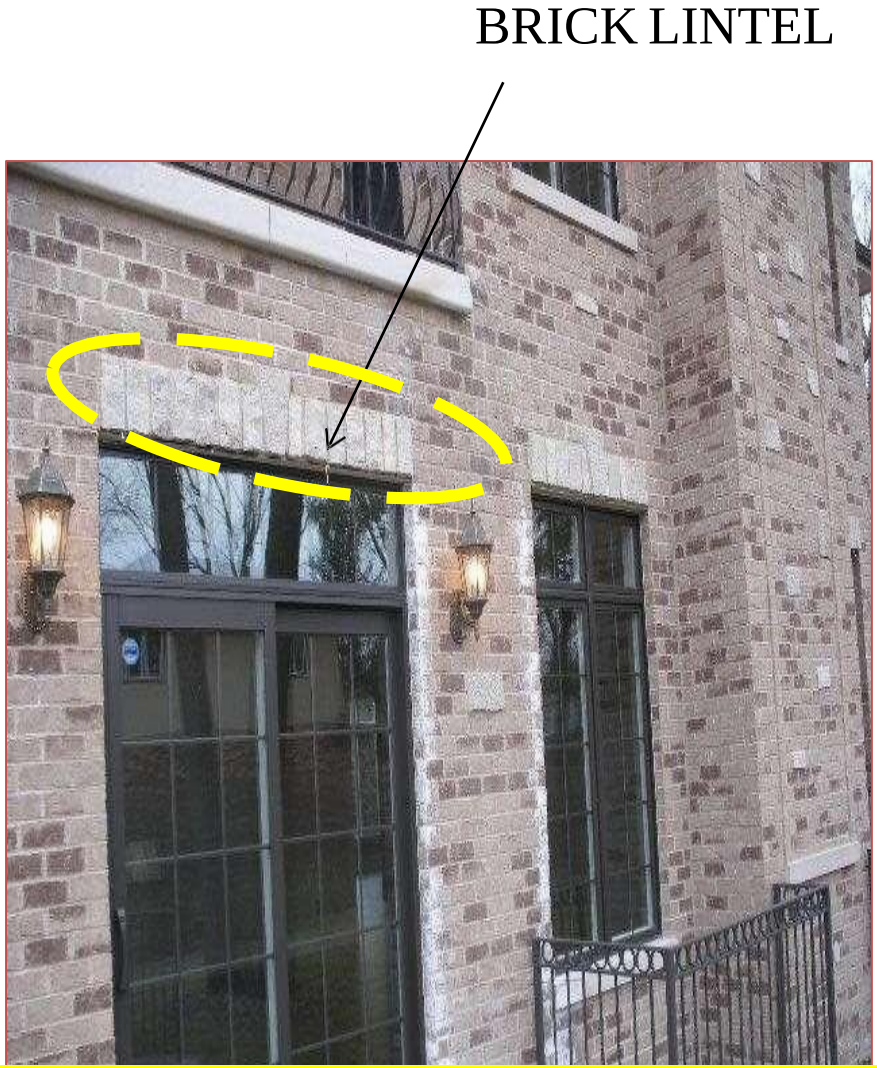
  of greater thickness.
- Due to high cost and its

  inability to with stand the transverse stress load it

STONE LINTEL

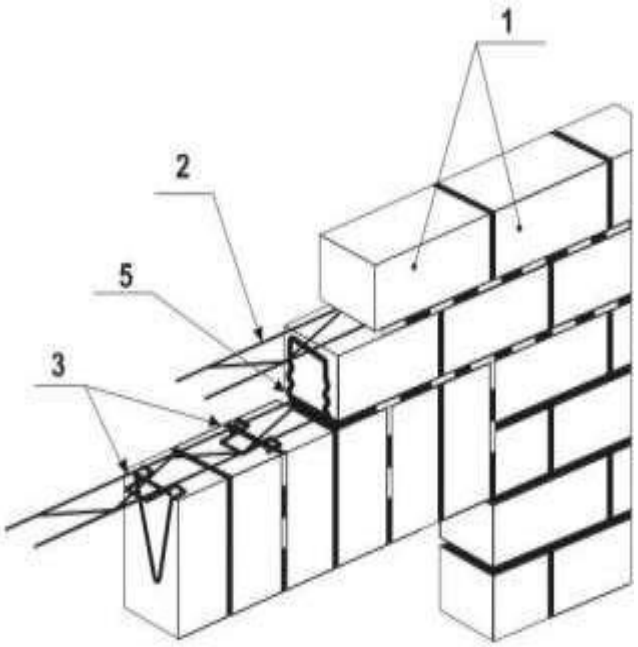
# Brick lintels

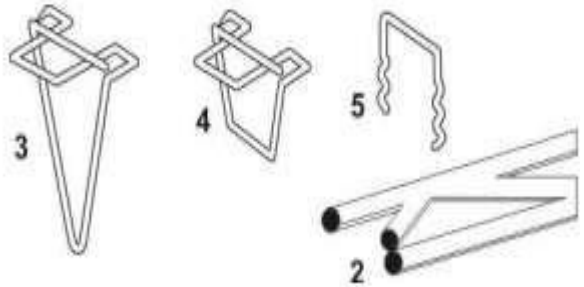
- The brick are hard, well burnt , first class bricks .
- Suitable for small span.
- The bricks having frogs are more suitable.



# 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

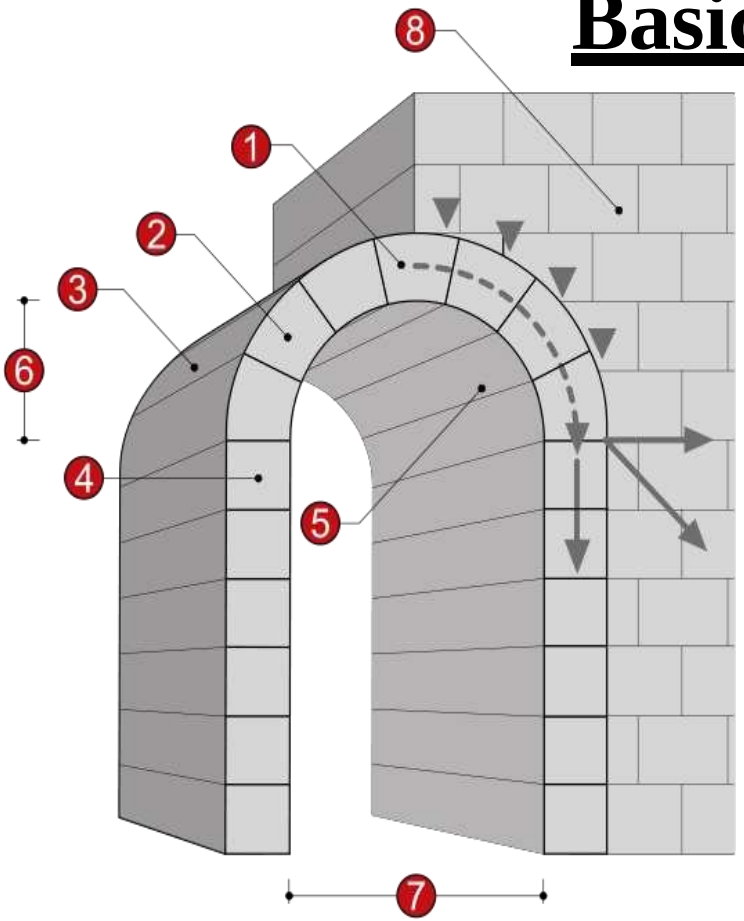
- Provided at large opening and where the super-imposed loads are heavy.
- It consists of rolled steel joists .
- Either used singly or in combination of two or three units.
- Joint with bolts.

ROLLED STEEL JOIST

# REINFORCED CEMENT CONCRETE LINTEL

- Common in used.
- They may be pre-cast .
- For smaller span, the pre-cast concrete lintels are used.
- Depth of lintel depend on span.

# Basic concept

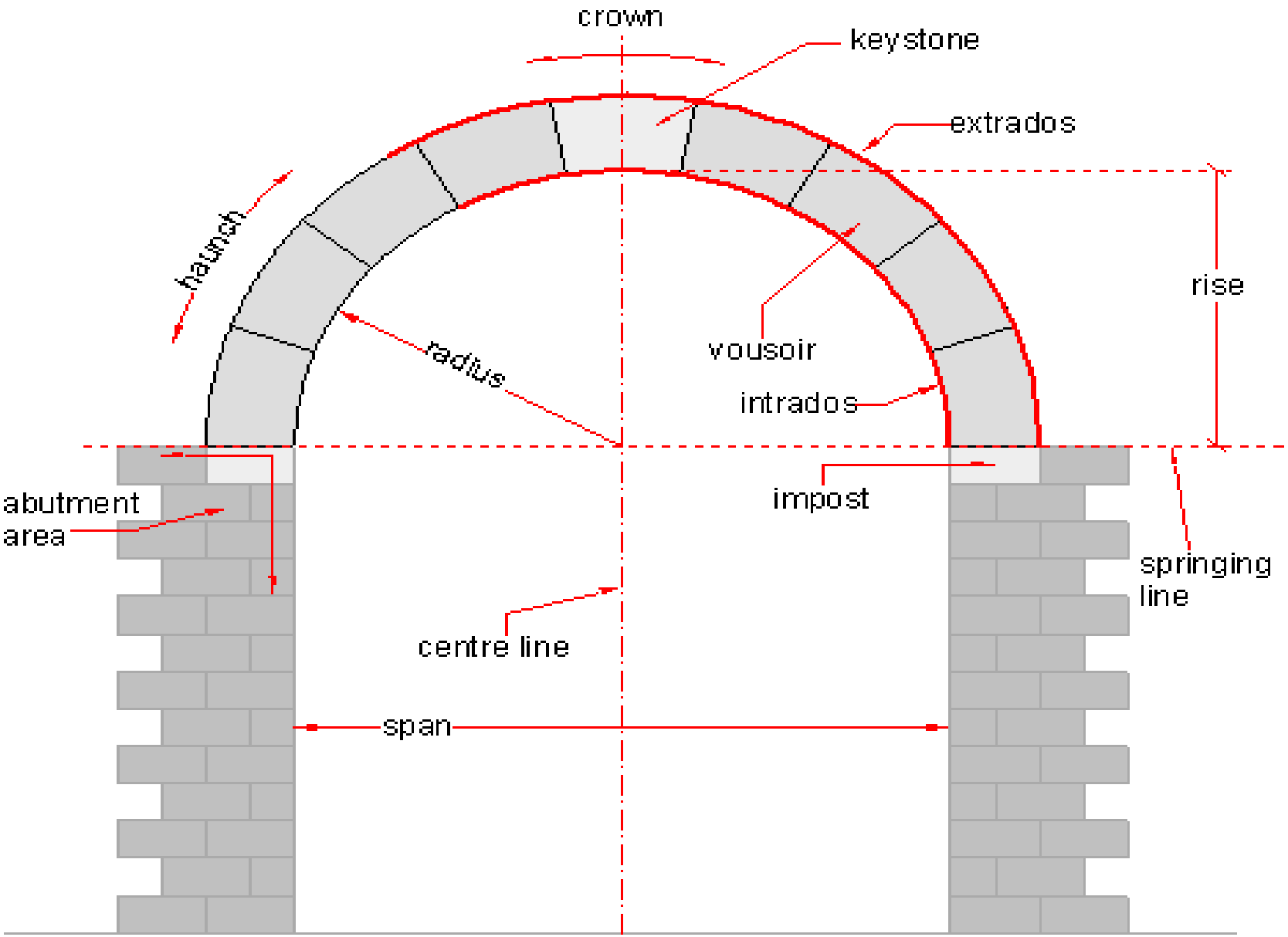



1. Keystone 2. Voussoir 3. Extrados

4. Impost 5. Intrados 6 . Rise

7. Clear span 8. Abutment

An arch is a pure compression form. It can span a large area by resolving forces into compressive stresses and, in turn eliminating tensile stresses. This is sometimes referred to as arch action. As the forces in the arch are carried to the ground, the arch will push outward at the base, called thrust. As the rise, or height of the arch decreases, the outward thrust increases. In order to maintain arch action and prevent the arch from collapsing, the thrust needs to be restrained, either with internal ties, or external bracing, such as abutments.


crown
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abutment
area
impost
springing
line
centre line
span

# TYPES of ARCHS

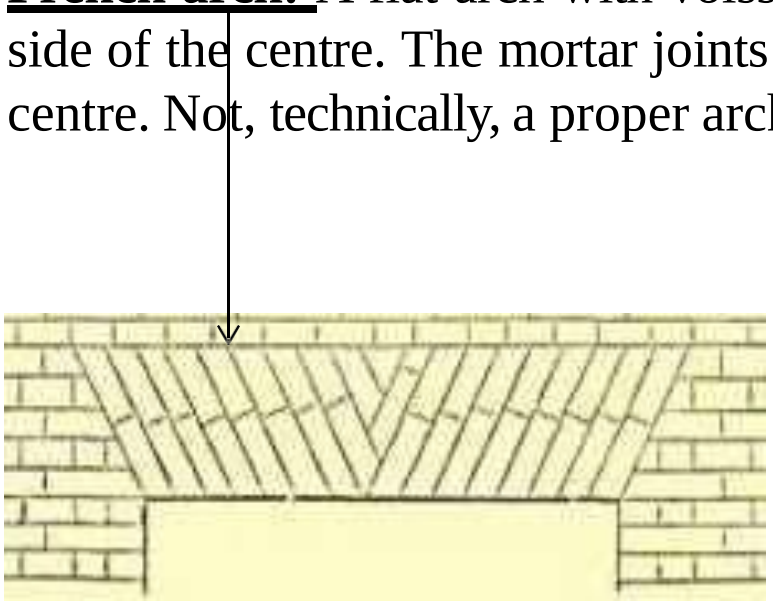
**GEOMETRY BASED ARCHES**

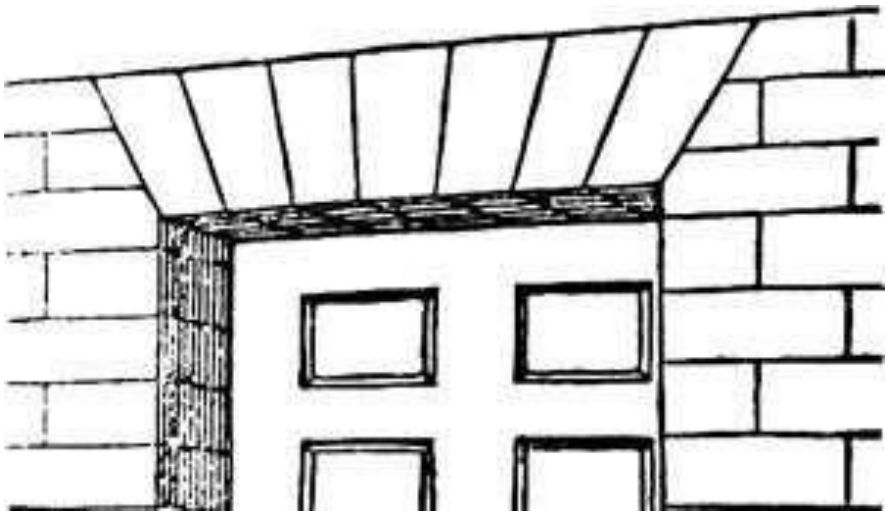
1. **Flat Arch.**
2. **Semi-circular Arch.**
3. **Segmental Arch.**
4. **Reliving Arch**
5. **Parabolic Arch.**
6. **Trefoil Arch.**
7. **Ogee Arch.**
8. **Multifoil Arch.**
9. **Basket handle Arch.**

# FLAT or JACK ARCH

An arch having a horizontal intrados with voissoirs radiating from a centre below, often built with a slight camber to allow settling is called a flat or jack arch.

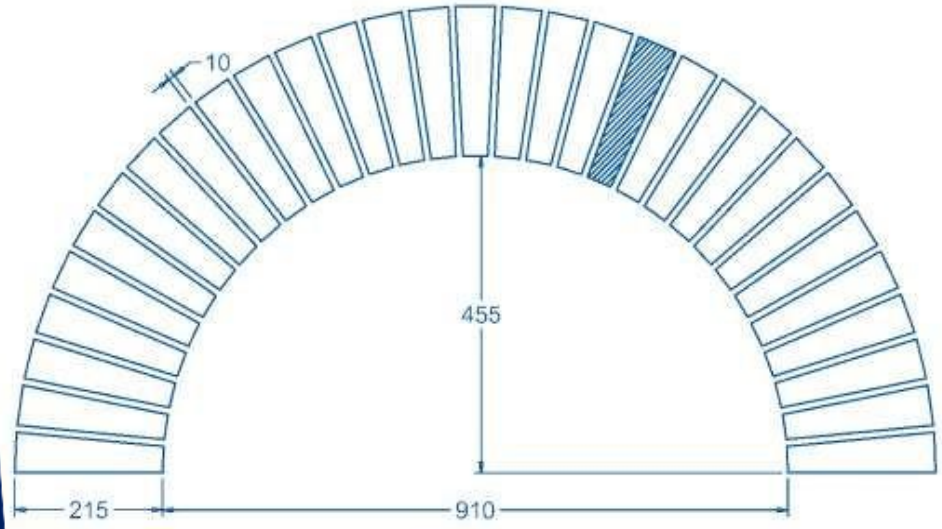
**French arch:** A flat arch with voissoirs inclined to the same angle at each side of the centre. The mortar joints do not, therefore, radiate to a common centre. Not, technically, a proper arch, and of weak form.

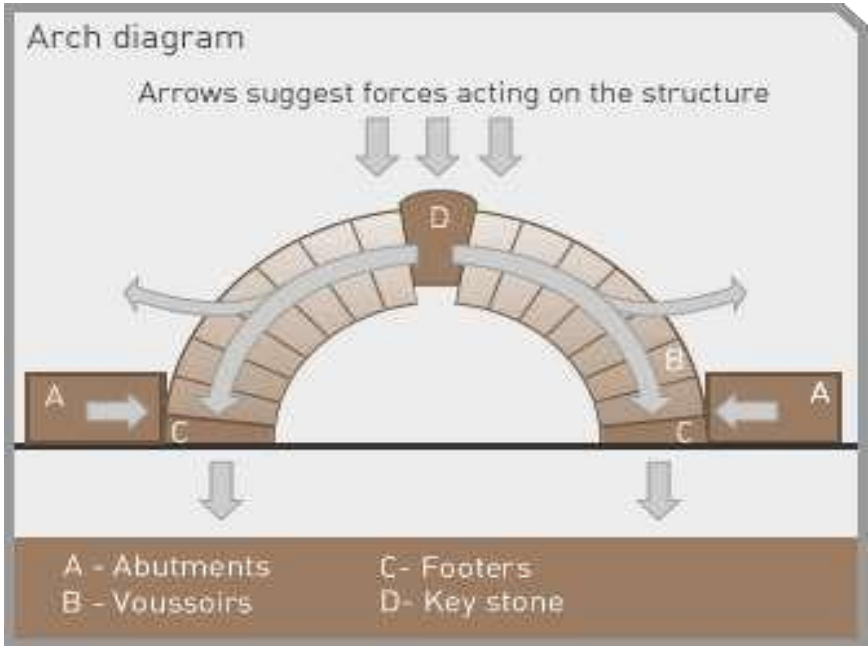




# SEMI CIRCULER OR ROMAN ARCH

- **Semi-circular arch** is very simple to construct or design as there is no complex geometry or cutting of bricks. Its semicircular shape with all the bricks facing towards the centre of the arch creates a wonderful view. Two or three rows of bricks are layered to add decorative touch to the beauty of the building.



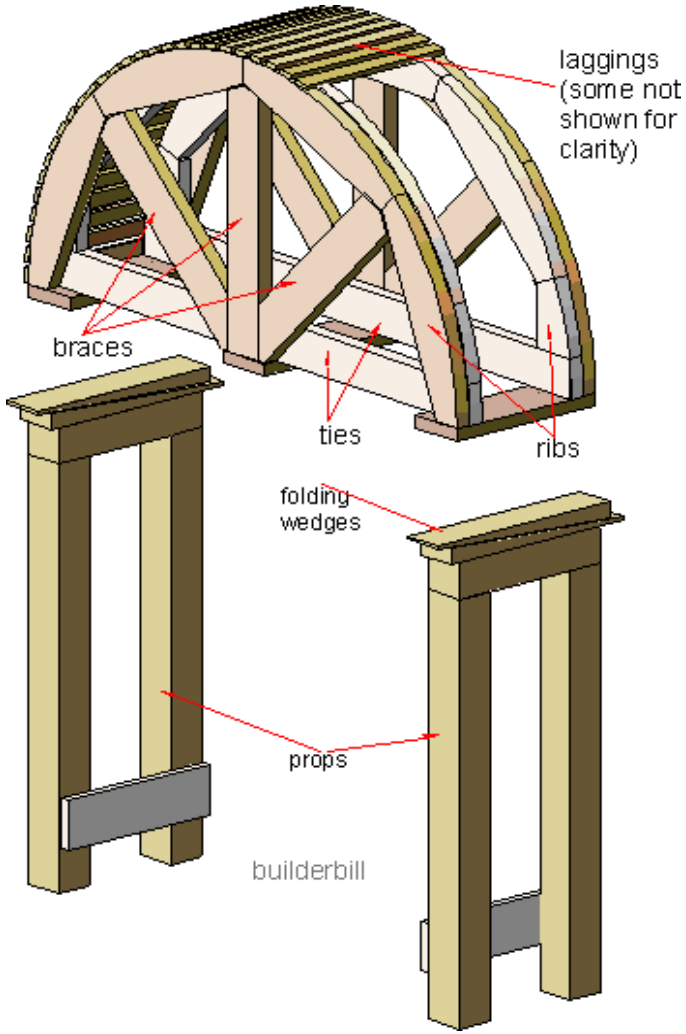



# SEMI CIRCULER OR ROMAN ARCH

- The main parts of an arch centre and they define the curves are the ribs. They are made up of the doubled up curved section. The ties and the braces. These can of course be made out of plywood or rolled steel sections, but timber is still commonly used.

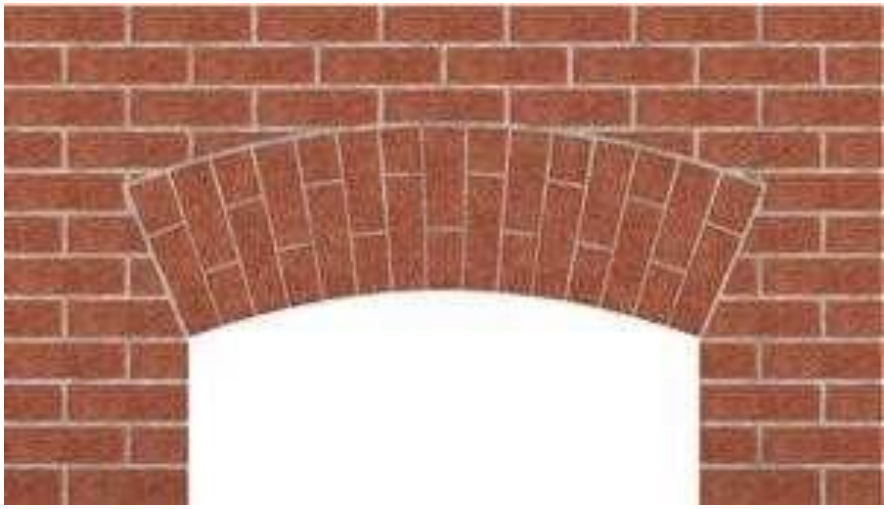
- The ribs are joined together by the lagging and the plates.

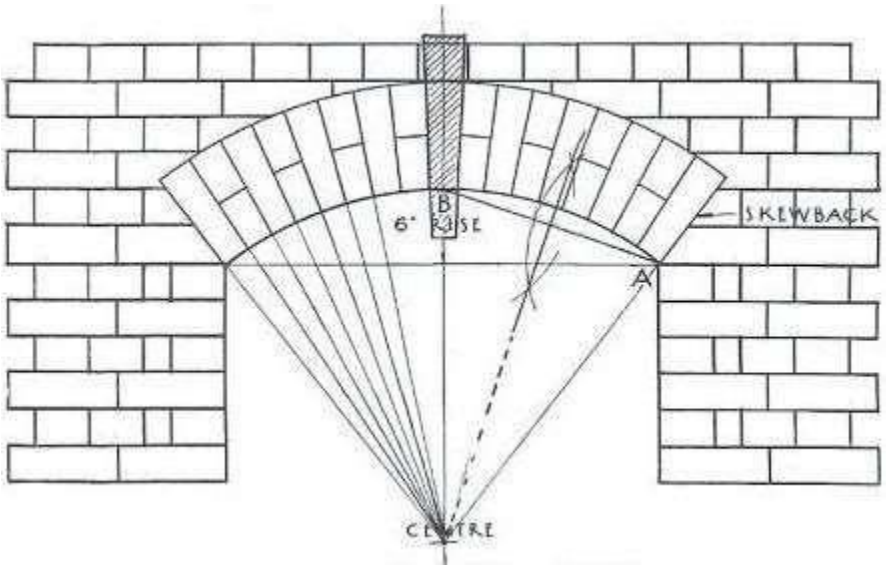
- The number of ribs used in the sketch is only two, and so it is suitable for an arch in a wall. However if more ribs are added, along with more supports then it is easy to see that a barrel vault could be centered.

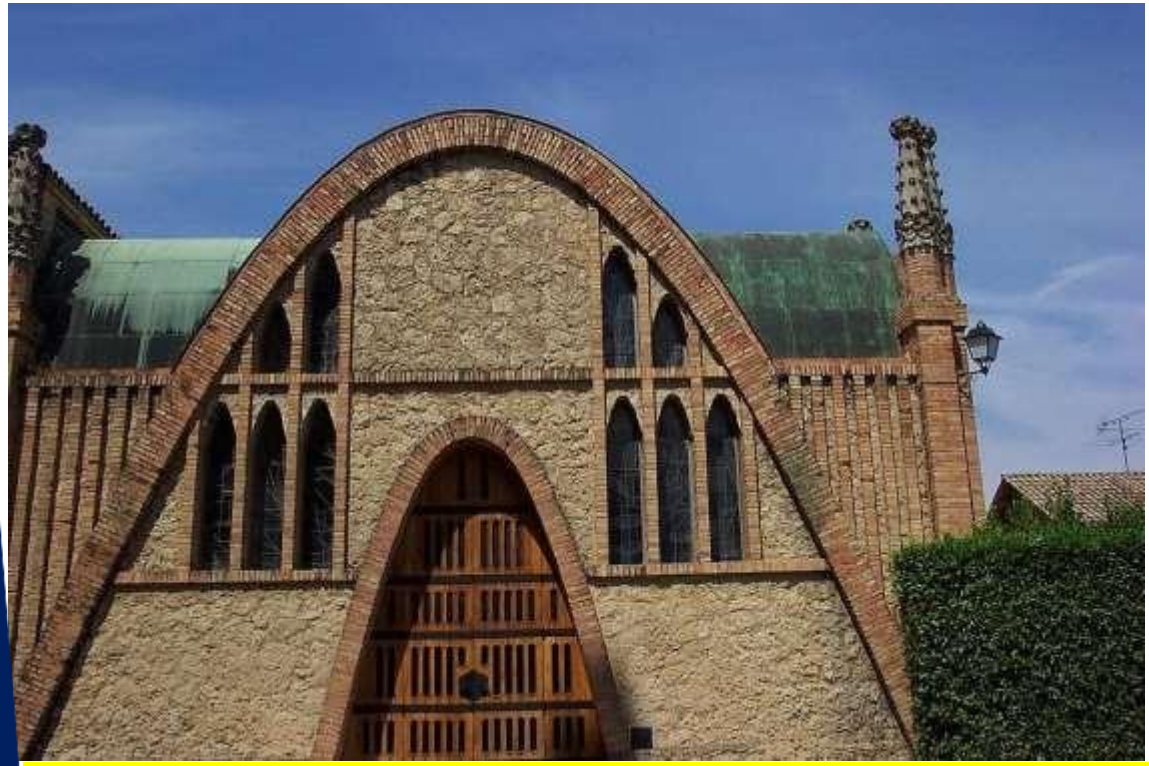


# SEGMENTAL ARCH

The procedure is similar to that of the semicircular arch, but as the curve is less than a semicircle, the centre will lie below the springing line





PARABOLIC arch

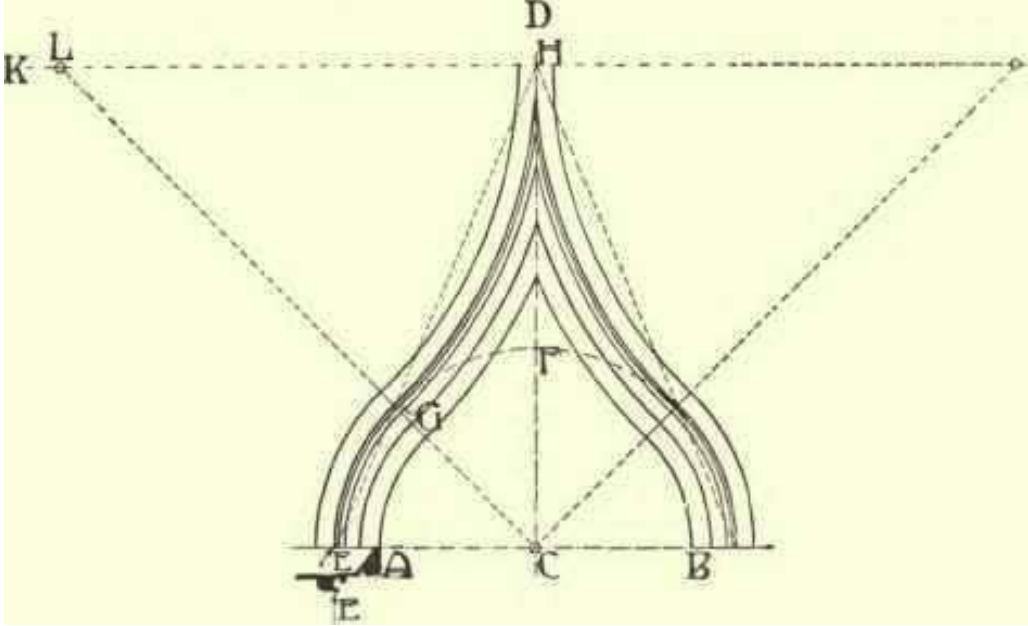
# RELIVING ARCH

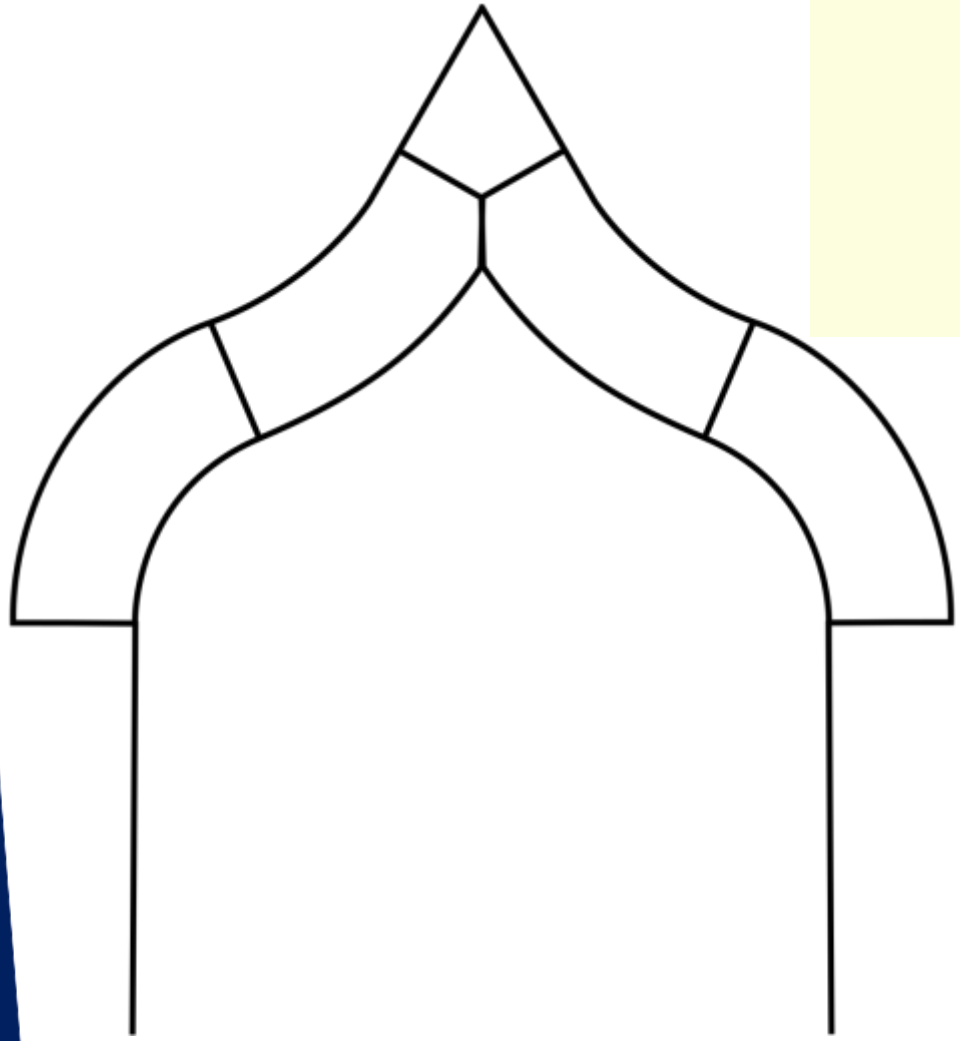
An arch built over a lintel to relieve or distribute the weight of the wall above —called also *discharging arch*

# TREFOIL ARCH

# MULTIFOIL ARCH

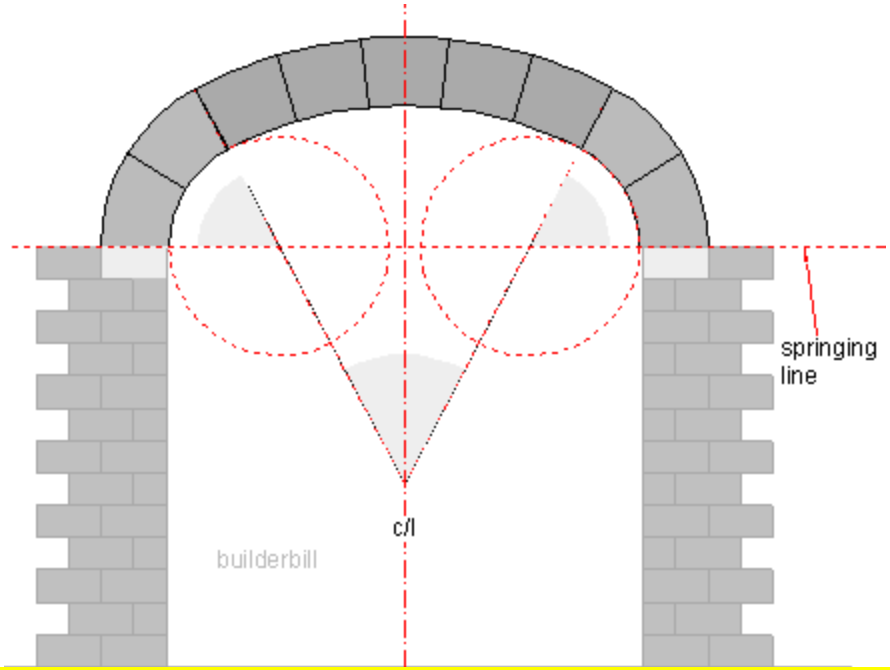
# OGEE ARCH



# BASKET HANDLE ARCH

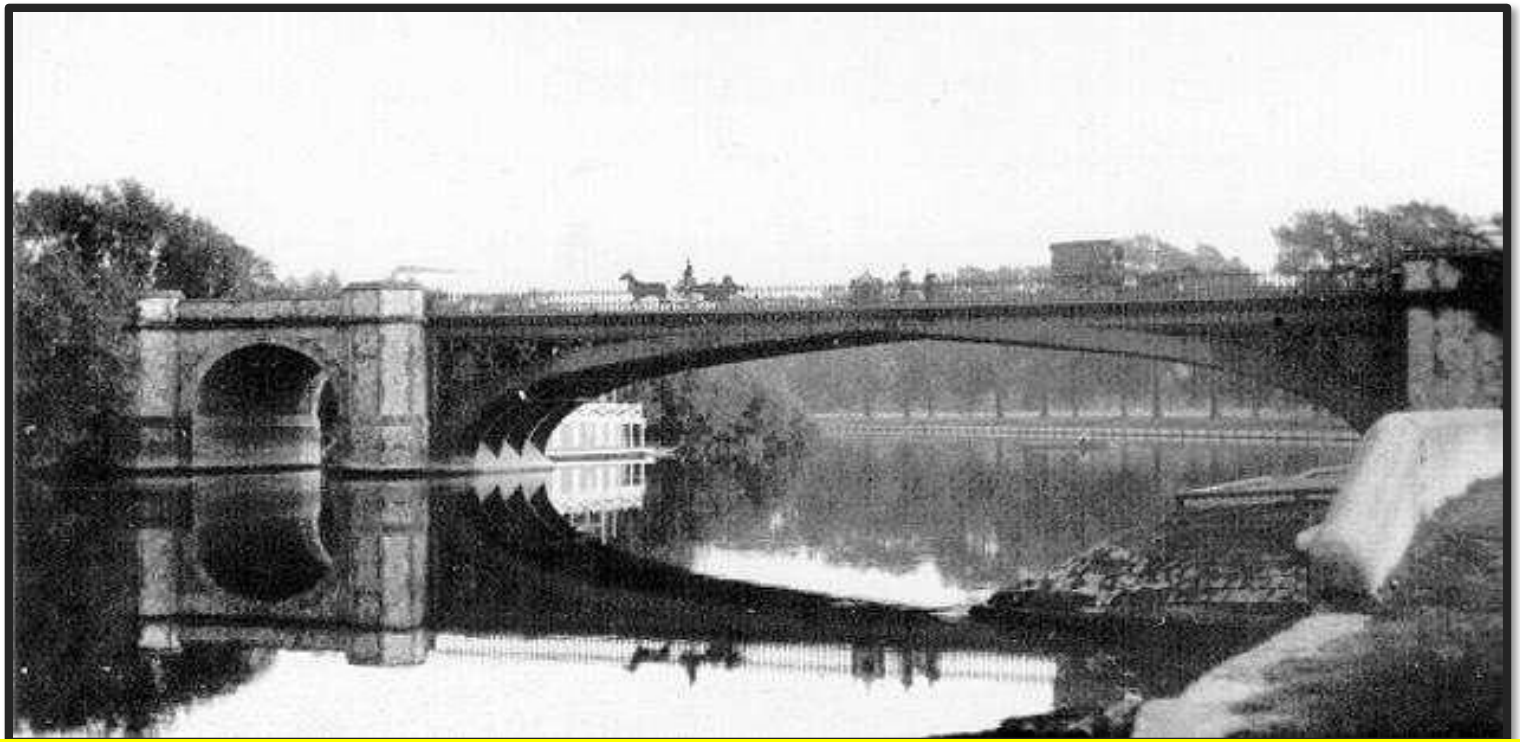
A three-centered arch that is somewhat flattened giving the effect of a false ellipse.

# CENTERED ARCH

***One Center Arch***

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



# CENTERED ARCH

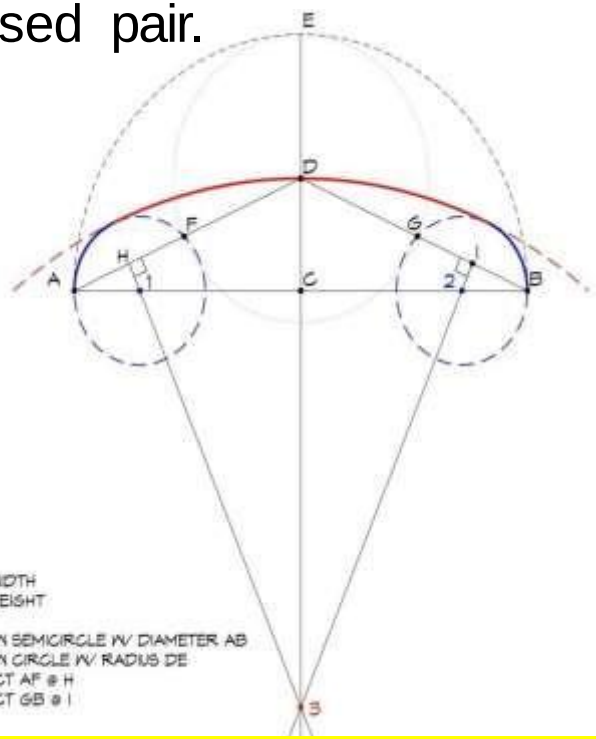
***Two Center Arch***

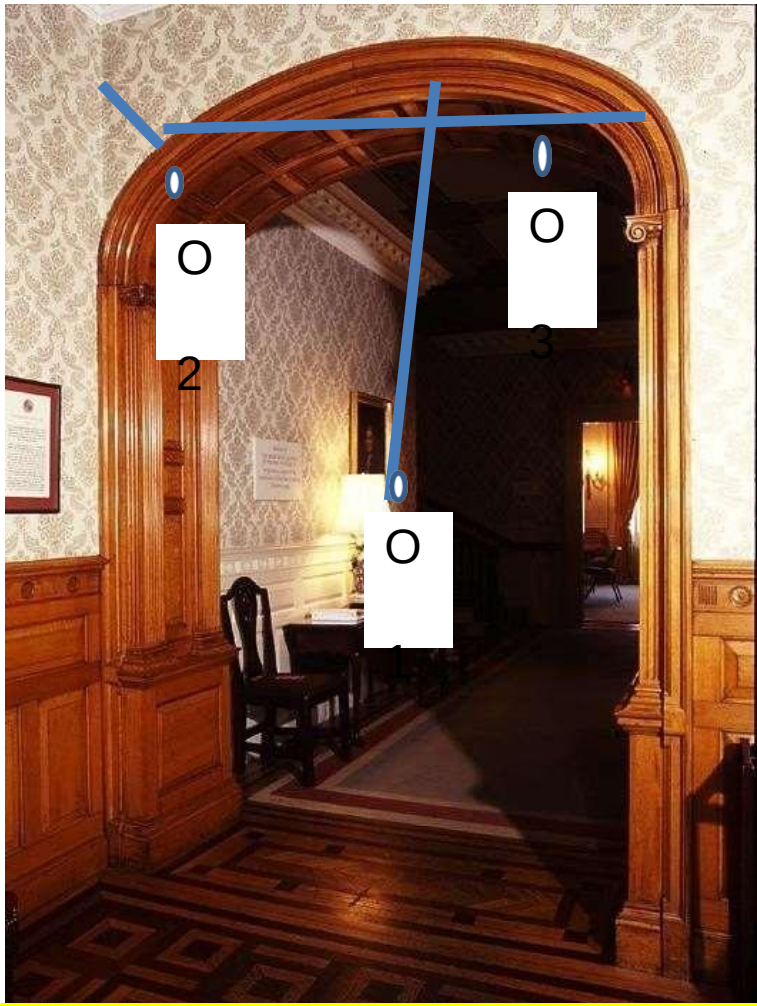
- Pointed, semi-elliptical arches come under this category.

# CENTERED ARCH

***Three CenterArch***

- Elliptical arches come under this category.
- An arch in which the intrados is a Combination of three arcs with one centered between a symmetrically disposed pair.



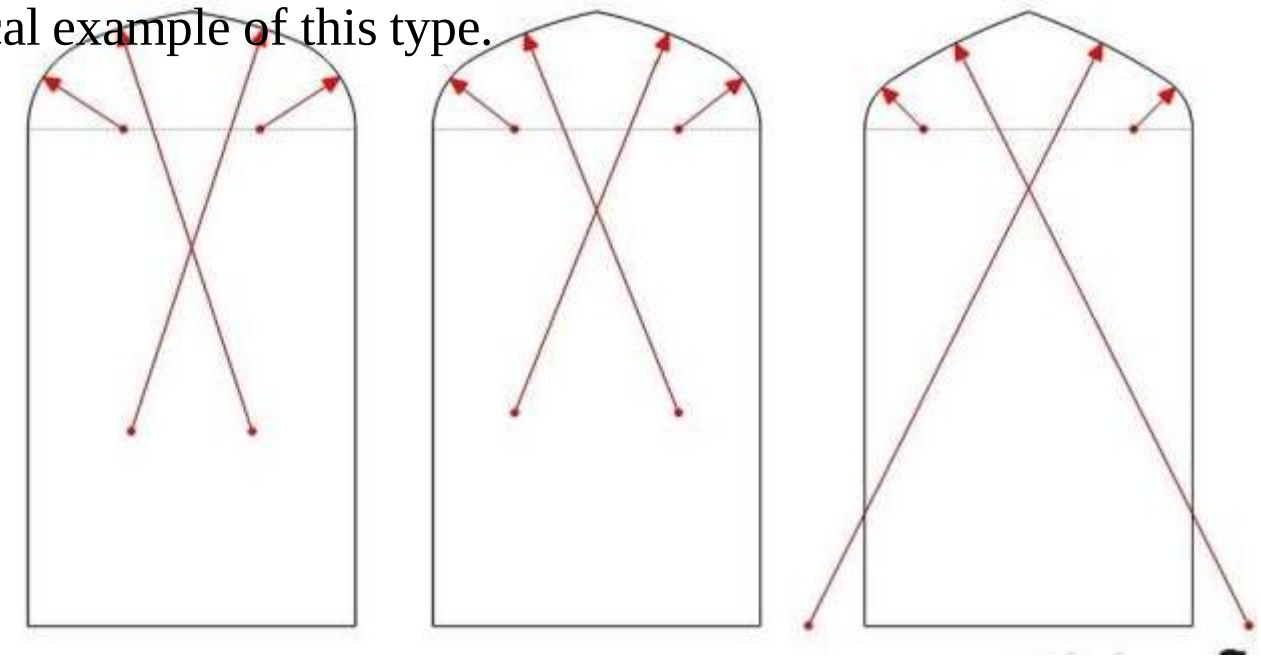
# CENTERED ARCH

***Four Center Arch***

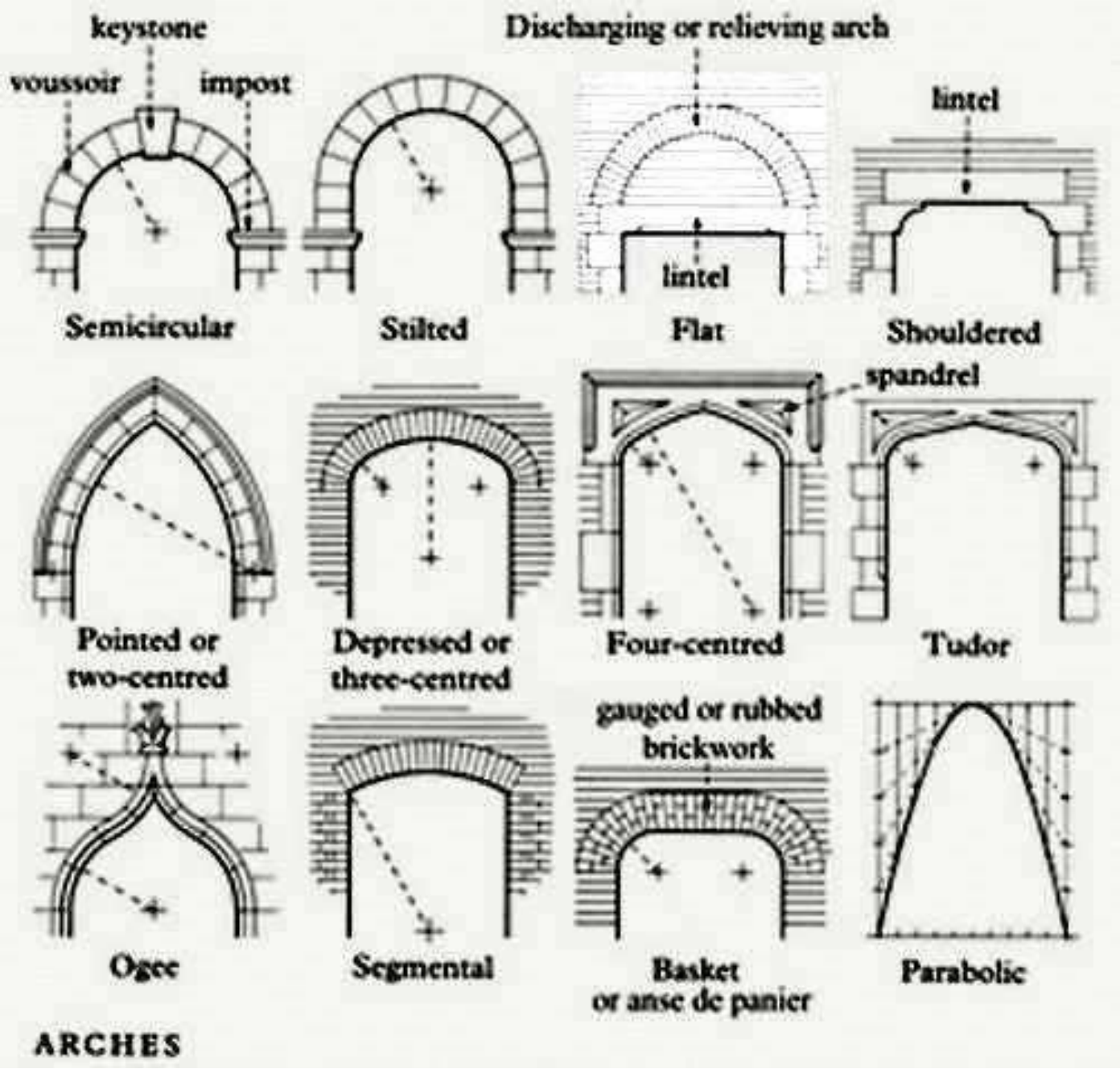
- A **four-centred arch**, also known as a **depressed arch** or **Tudor arch**, is a low, wide type of arch with a pointed apex.
- It is much wider than its height and gives the visual effect of having been

flattened under pressure.

- Venetian arch is typical example of this type.



# Types of Arches on Geometry



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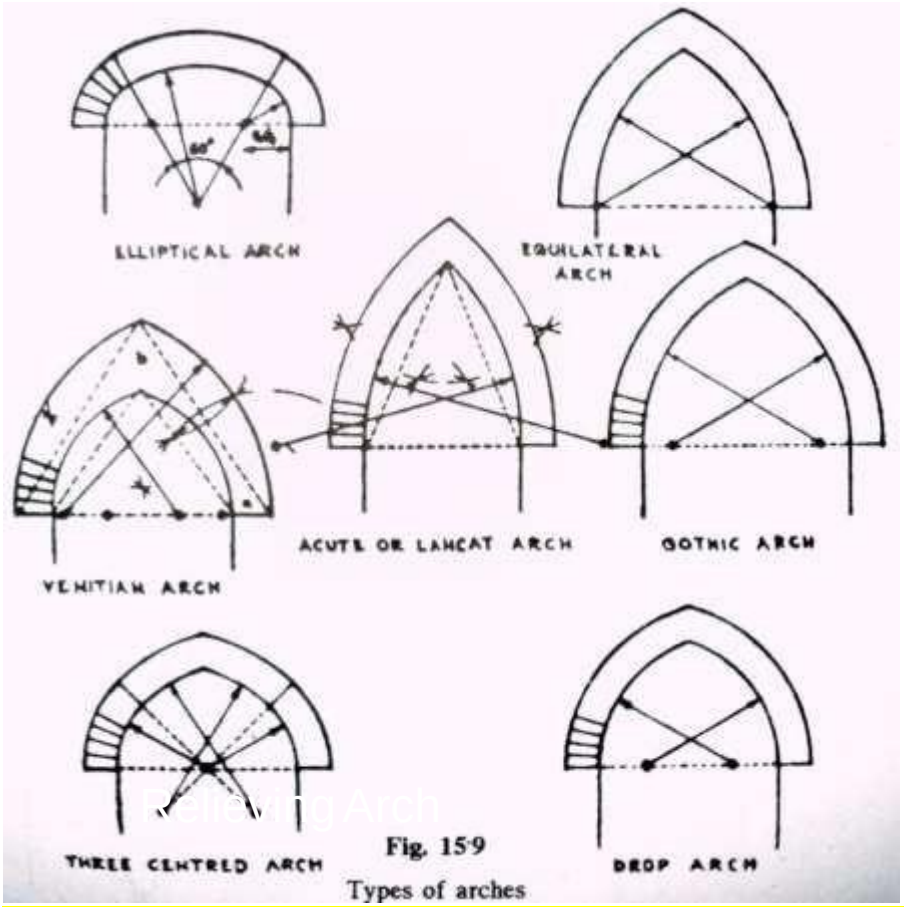
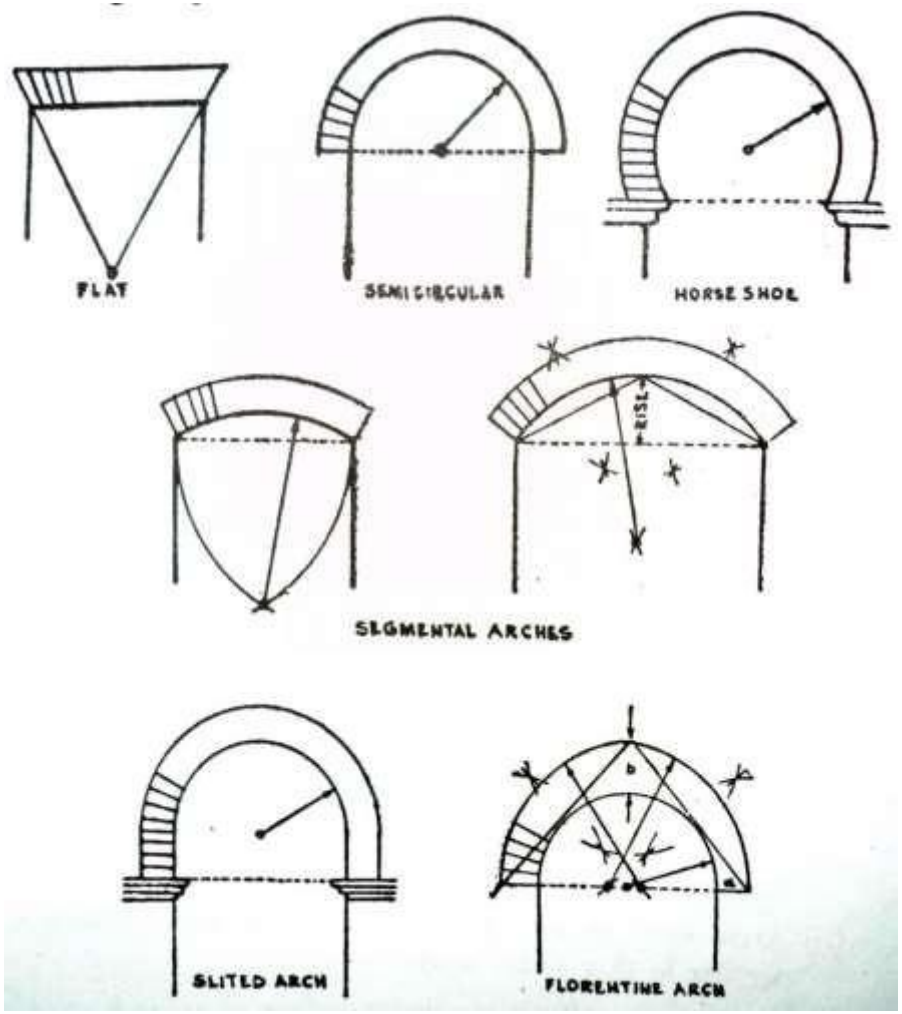



Fig. 159
Types of arches



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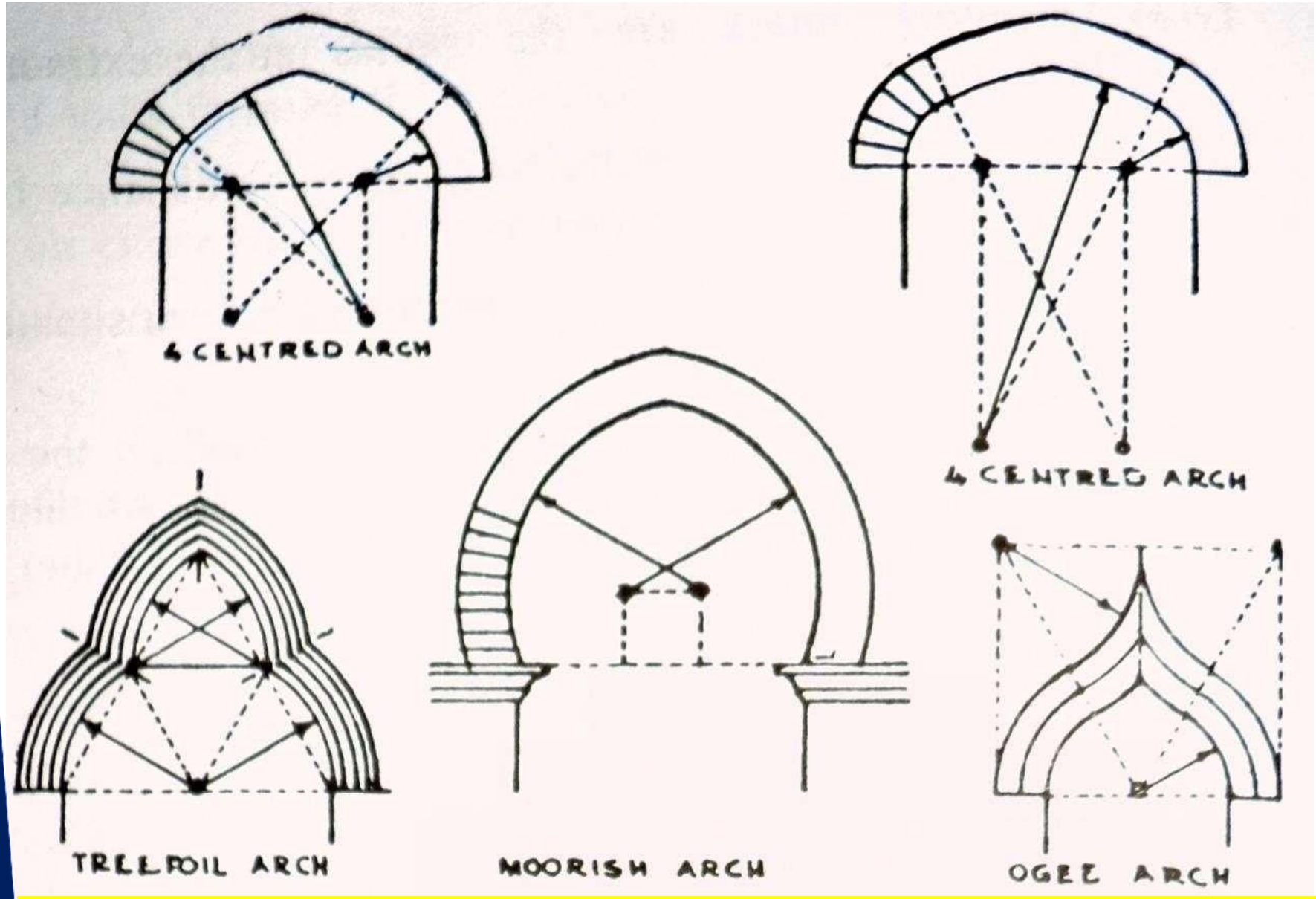
4 CENTRED ARCH
4 CENTRED ARCH
TREEFOIL ARCH
MOORISH ARCH
OGEE ARCH

# Cont.

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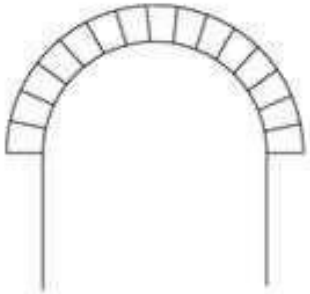
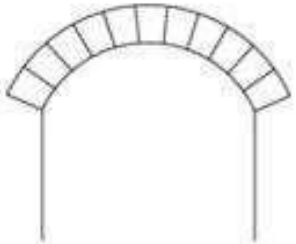
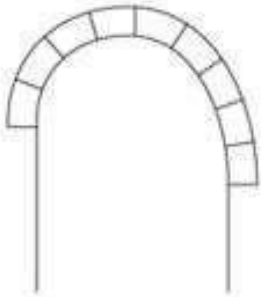
Triangular arch



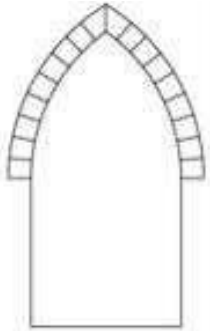
Round arch or Semi-circular arch



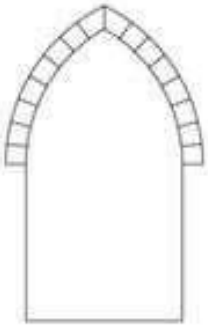
Segmental arch or arch that is less than a semicircle



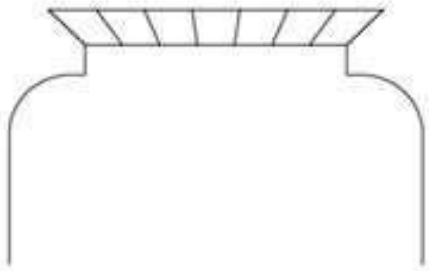
Unequal round arch or Rampant round arch



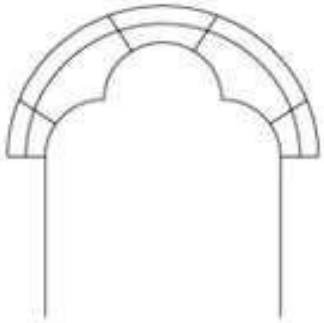
Lancet arch



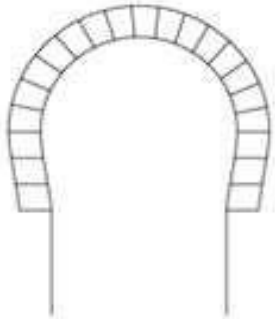
Equilateral pointed arch



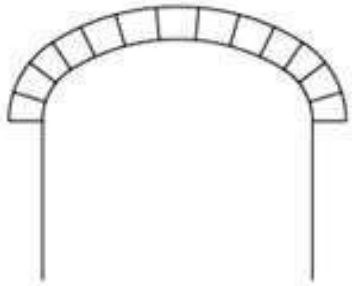
Shouldered flat arch -see also jack arch



Trefoil arch, or Three-foiled cusped arch



Horseshoe arch



Three-centered arch

# Cont.

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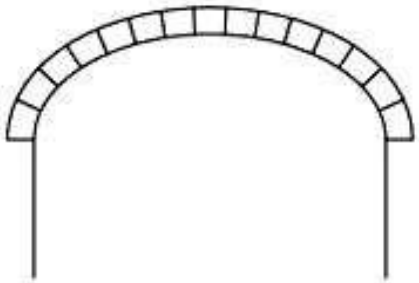
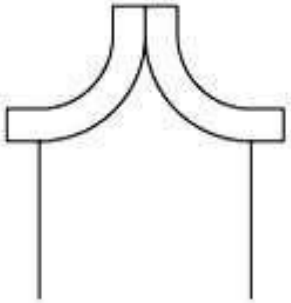
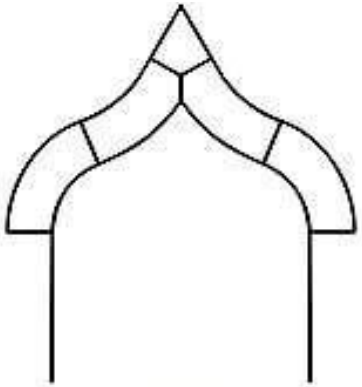


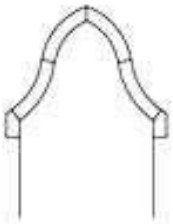
Elliptical arch



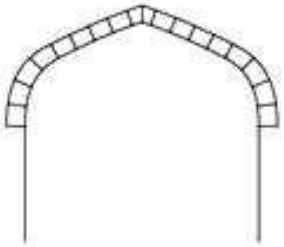
Inflexed arch



Ogee arch



Reverse ogee arch



Tudor arch

Parabolic arch

# Types of Arches on Material of Construction

- **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

# Types of Arches on Material of Construction

Rubble Arch


AshlarArch

Monolithic Concrete Arch

R.C.C Arch

Metal Arch

Wooden Arch

# Rough Brick Arches

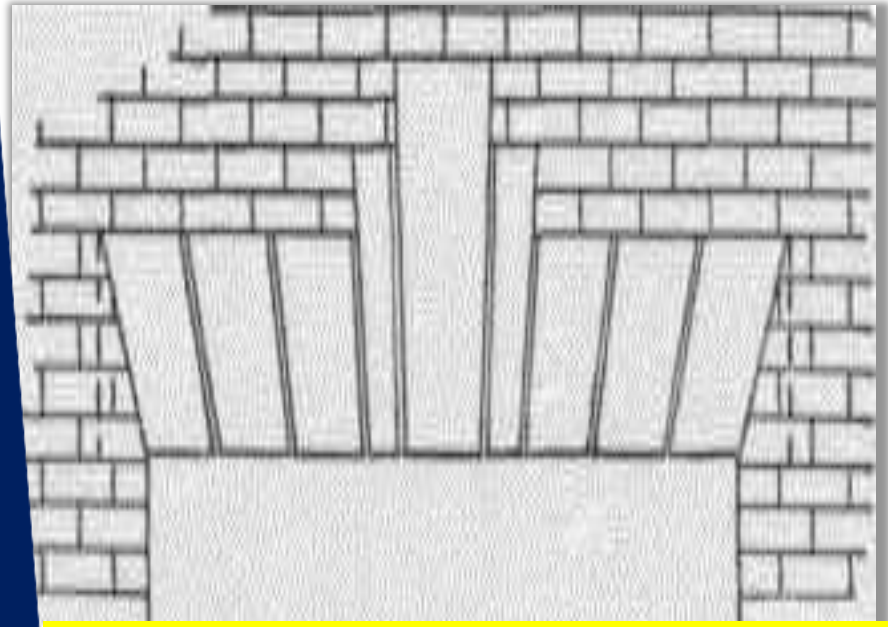
- These arches are built with ordinary bricks, which are not in wedge shape .
- Also known as “RELIEVING ARCHES”.
- Made up of rectangular brick that are not cut into wedge shape. Curvature are obtained by mortar.

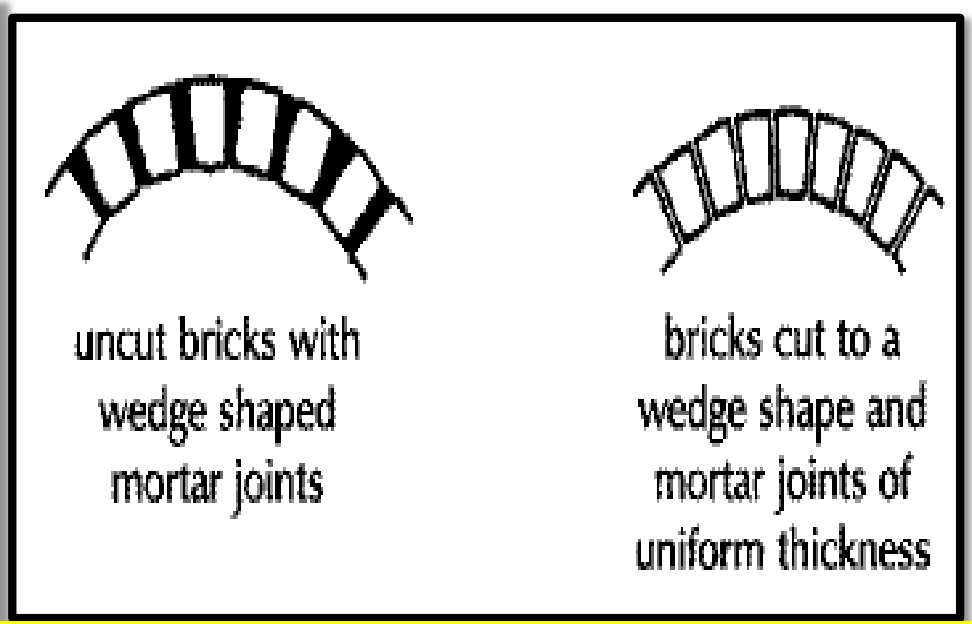
# Axed Brick Arches

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

# 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.





# Stone Arches

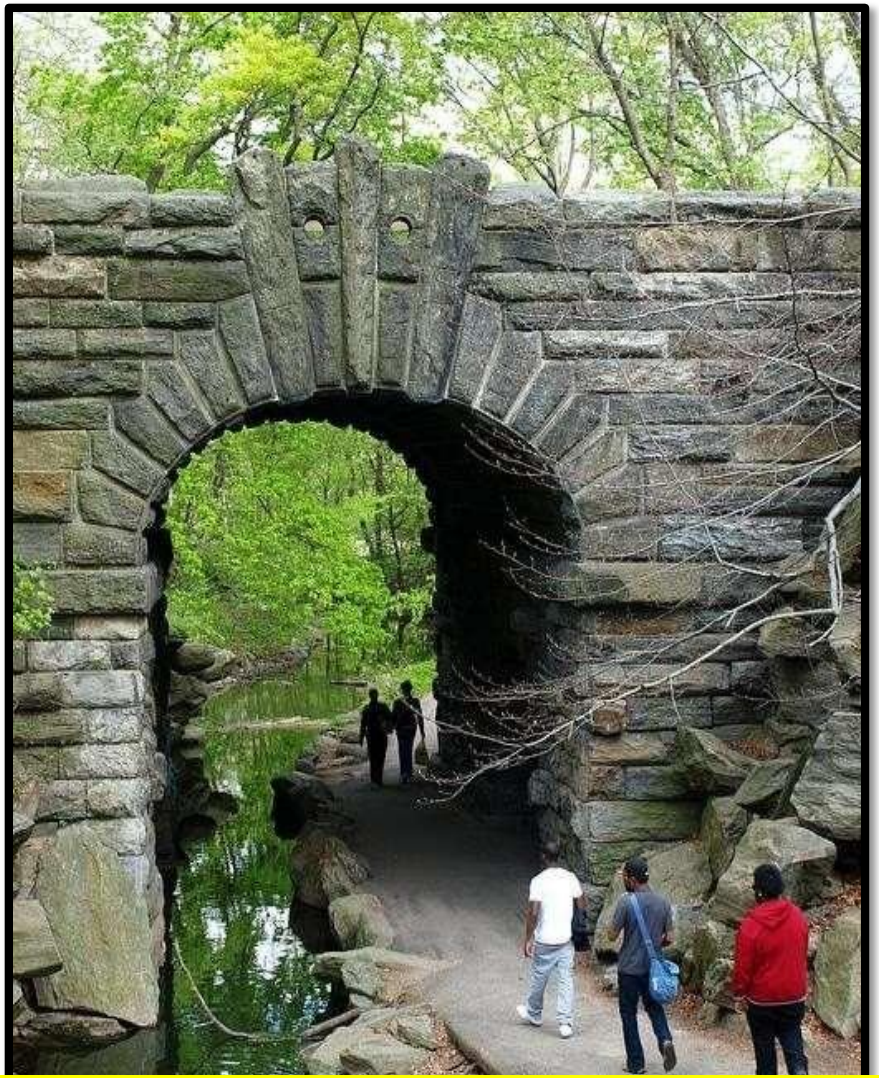
## 1.Rubble Arches

- 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.

# Stone Arches

## 2. 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.



## GAUGED ARCHES

Precast Concrete Block Arches

- Used for small openings in building.
- The voussoirs, in the form of cement concrete blocks are prepared in special moulds .
- Generally , the concrete blocks are used without reinforcement.

# GAUGED ARCHES

## Monolithic Concrete Arches

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

# 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 Masonry

- 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

- Rotation can be prevented ,if the line of resistance is kept within intrados and extrados.

- Also, the line of thrust should be made to cross the joint away from the edge to prevent the crushing of that edge.

# Uneven Settlement of An Abutment or Pier

- Uneven settlement of abutment ,which causes secondary stresses in 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.

# Construction of Arches

**Critical Factors**

1. Curing
2. Quality of Bricks
3. Providing arch - shaped door/window frames
4. Quality of sand for mortar
5. Availability of skilled masons

**Tools Used**

1. Trowels
2. Plumb bob
3. Thread
4. Shovel
5. Baskets

# Construction of Arches

**DO'S DON'T'S**

1. Curing shall be done for seven days
2. The mix should be of ratio 1:4
3. Mortar joints should V - shaped with minimum thickness at bottom
4. Mortar should be used within 30 minutes of adding water to the mix
5. Masonry should be always laid from both sides upwards

1. Fine sand should not be used for masonry
2. Arch should not be disturbed while removing the mould

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*Thank you!*

STAY HOME, STAY SAFE