UNIT-1

ARCHES

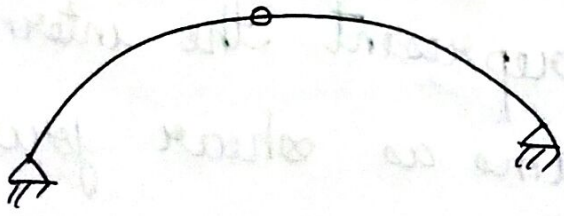
INTRODUCTION

An arch may be looked upon as a curved girder which is either a solid rib or braced supported at its ends and carrying transverse loads which are frequently vertical.

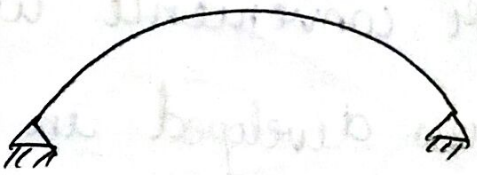
Since the loading at any section normal to the axis of girder is at an angle to the normal face, an arch is subjected to three restraining forces. They are thrust, shear force and bending moment

Depending upon the number of hinges, arches may be divided into four classes

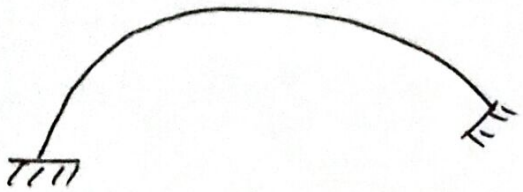
1. Three hinged arch
2. Two hinged arch
3. Single hinged arch
4. Fixed arch.



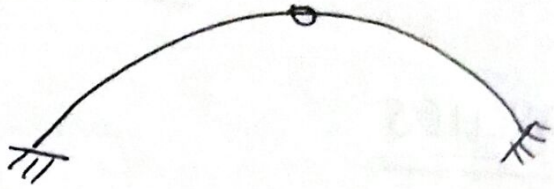
Three hinged arch



Two hinged arch



Fixed arch



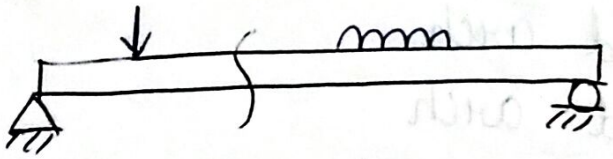
Single hinged arch

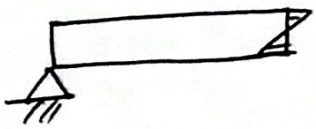
A three hinged arch is a statically determinate structure while the rest three arches are statically indeterminate.

In bridge construction, especially in rail road bridges, the more frequently used arches are the two hinged arches and the fixed ones.

Explanation: for why do we need to curve a beam

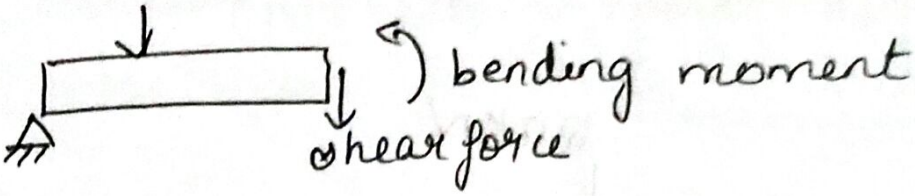
When a beam is subjected to loads internal stresses develop.





internal stress develops

For convenience we represent the internal stress developed in beams as shear force and bending moment.



In the context of structural design there is a direct relation between these forces and the size of the structure

The greater these forces the deeper the section goes to resist these forces.

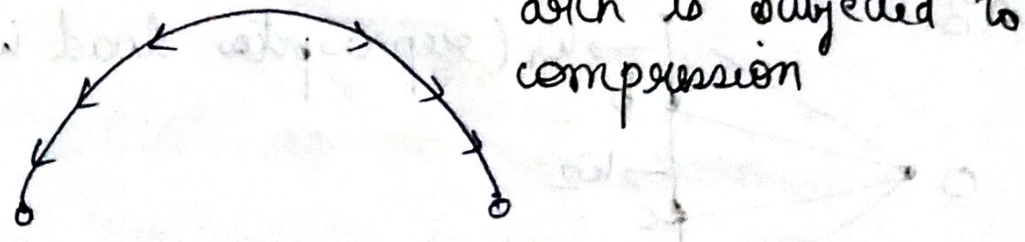
Deeper sections are not economical.

For beams with relatively long span bending moment could become excessively large, even requiring deeper sections

In such a situation it may be desirable curving the beam to form an arch

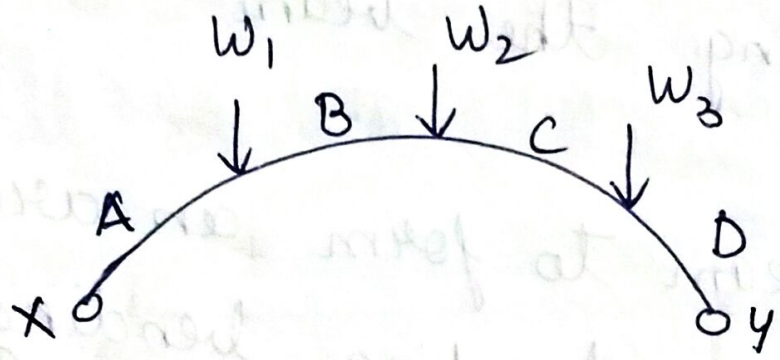
Curving the beam to form an arch results in smaller bending but at an expense of putting the beam in compression.

(arch)



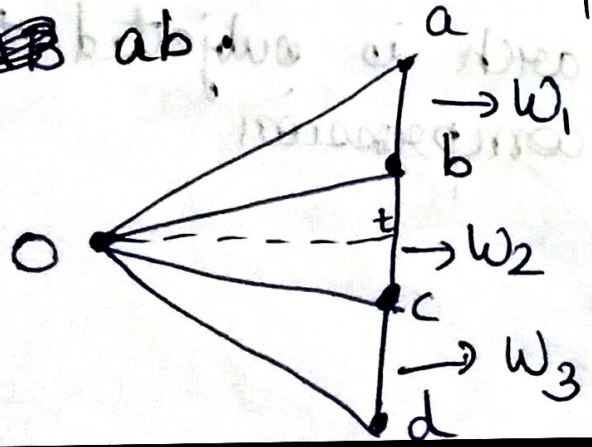
LINEAR ARCH OR THEORETICAL ARCH

Let us consider an arch being subjected to point loads W_1, W_2, W_3



Now we need to draw a diagram showing the loads and spaces between them. This diagram is known as vector diagram.

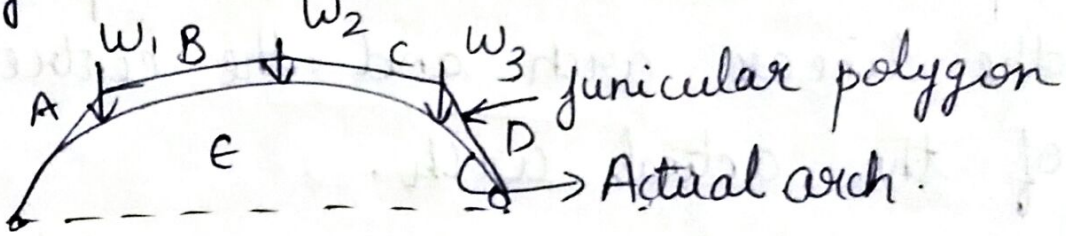
The load W_1 is represented by space ab, load W_2 by space bc and load W_3 by cd



→ W_1 (represents load W_1)

Let us consider a pole O (polar distance) The diagram is draw to a certain scale.

The oa is shown in the diagram connecting the load and hinge



Similarly others are joined

OA in the space A, OB in the space B and so on

The connected lines represent the bending moment diagram of a simply supported beam subjected to loads W_1, W_2 and W_3.

The bending moment diagram is called a funicular polygon or theorical arch or linear arch

If we provide the arch like funicular polygon there will be no bending moment.

But we will not provide the arch of the polygon shape but we will provide an arch of uniform shape which is called as Actual arch.