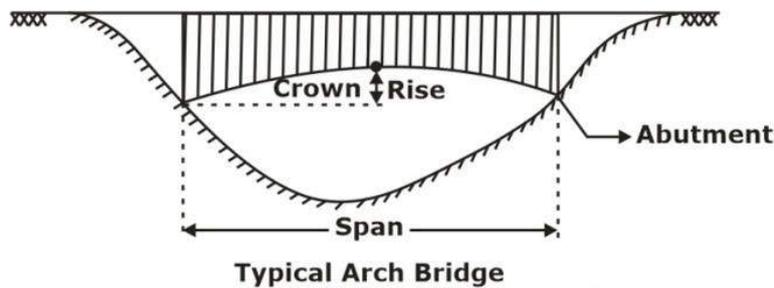


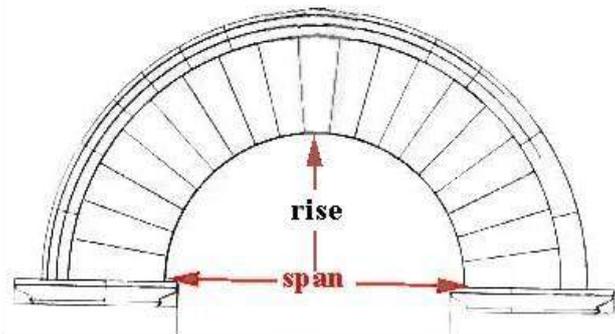
# Arches

Arches are the curved structure that supports the weight of something above it, such as a bridge or the upper part of a building. Beams generally transfer the applied load to end supports by bending and shearing, but arches transfer load to abutments at spring points. The topmost point is called the crown, which sometimes has a hinge. Arches are an important part of the [GATE CE syllabus](#) and help candidates build strong conceptual knowledge for the upcoming exam. The height of the crown above the support level is known as the rise. An arch is generally economical for a larger span than a simply supported beam.



## Arch Meaning

Arches' meaning is generally understood as a circular arc. But an arch can be of any shape. Generally, a parabolic arch is preferred mostly for the design because of its advantages. The meaning of Arch is also an important aspect of the [GATE exam](#). An arch also means making a curved shape that can resist the load above it.



## Arch Design

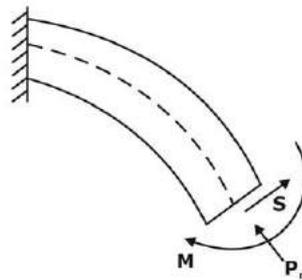
The design of an arch is done based on forces acting over it. Based on the requirement of the arch, it can be designed in many shapes. But the parabolic arch is

mostly preferred for the design because the bending moment reduces in this shape of the arch. Arch design can be used to formulate the MCQ-based questions in the [GATE question paper](#). In the case of arch design following forces are considered.

## Design Forces in Arches

An arch will be subjected to three forces.

- Bending Moment
- Normal Thrust
- Radial shear force



## Application of Arches

Arches have a variety of applications in the civil engineering design of structures. It is used to encounter the effect of external load acting over them. An arch structure can be constructed at two different levels, and it induces horizontal thrust and a negative moment due to an external load. Application of the arches has been used as questions in the [GATE previous year's question paper](#). The hinge support at its end mostly supports arches, and that becomes an indeterminate structure that provides extra stability to the structure. Sometimes a hinge is also provided on its crown to become the determinate structure.

Arches are generally preferred structures due to their simplicity in transferring the load. An arch structure can be used in buildings, roof trusses, industrial buildings, etc. An arch structure can resist large weight over it. Arches can also be used in the case of doors and window frames. In the case of truss bridges, an arch structure is preferred because it provides better support than the beams.

## Advantages and Disadvantages of Arches

Arches are the structures mostly used to resist the higher flexural load. Arches can be used in truss bridges, industrial roof structures, etc. Advantages of arches The joints of an arch bridge are rigidly connected, and they can transfer more weight through their span. Here some advantages and disadvantages of an arch bridge structure are given below.

## Advantages

- The arch structure has higher strength in comparison to other similar structures.
- Arch structures like bridges get strengthened as time passes, unlike other structures, because of the arches' design.
- Arches can be made up of any material. It can be made of stones to withstand a high amount of pressure.
- Arches structures look aesthetically pleasant over the other structures.

## Disadvantages

- Construction of arches is difficult due to their design.
- Arches structures require stronger supports in comparison to other structures.
- Arches structures do not have enough spans; It has only limited spans.
- Arches can be built only when it is suitable.
- Arches structures require maintenance regularly.
- The design of arch structures can be expensive.

## Transfer of Loads in Arches

Arches are mainly used to transfer transverse loads, But an arch structure can transfer the bending moment, normal thrust and radial shear force. These loads are finally transferred to the structure's foundations through its spans. The thrust in the arch structures can be transferred by weight or supporting walls.

In arch bridge structures, the bridge's weight and external load are transferred partially through the action of horizontal thrust and partially through the abutments. Overall transfer of these forces through arches will depend upon the design of structures. And it will also govern by the shape of the arch structure.

## Difference Between an Arch structure and a Beam structure

An arch structure is a structure which consists of some arches designed in the structure, and beams are structures that are used to transfer the transverse load of the superstructure. Both beams and arches are important to comprehend the [GATE syllabus](#) thoroughly. Beams and arches are the oldest designed structures. But the construction of a bridge is easier than the construction of arches. And both are designed to resist mainly flexural loads. Here a few differences between arch and bridge types of structures are given.

- An arch structure can carry a higher load than a beam structure.
- Arch and beam structures are different in the perspective of their shape and design.
- Construction of a beam is easier than arches.
- A negative bending moment is induced in arch-type structures due to the horizontal thrust, while, in the beam, a negative bending moment will not induce.

## Example of Arches

As we discussed, Arches are an important part of a superstructure. It will mainly be used to resist the external flexural load, and it can bear higher loads than the beam. The design of arches is more effective than designing similar types of structures, like beams, in terms of their strength. Hence, it is important to understand arches in detail. Here an example of the types of arches is given.

