Load Distribution of Arch

Assignment No.: 05.04

Assignment

How does an arch transfer loads differently compared to a beam or a slab?

Answer

An arch is a curved member that is used to span an opening and to support loads from above. Any downward pressure on an arch member result in stresses that tend to squeeze the blocks together instead of separating.



Figure 1: Arch structure beside MIST Field



Figure 2: Arch structure at Atia Mosque, Tangail

Load transfer in an arch

In load-bearing arch structures, elements are held together by compression. As vertical load appears on the structure, it resolves into horizontal and vertical reactions at the ends. The vertical load produces a positive bending moment in the arch while the inward-directed horizontal reaction provides a counterbalancing negative moment.

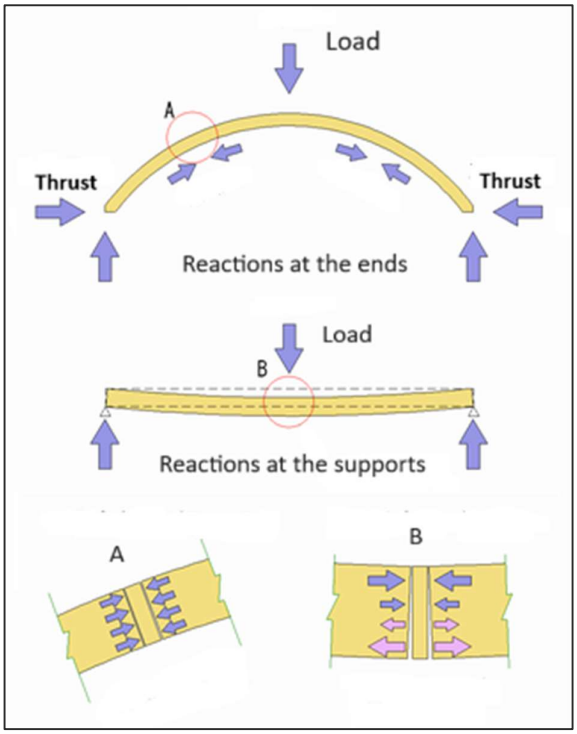


Figure 3: Arch (A) action diagram in comparison with a beam (B). Source: wikipedia.org/wiki/Arch.

Load transfer in a beam and slab

Both beam and slab resist load through bending moments. The top fiber experiences compression while the bottom fiber experiences tension (see Figure 3 (B)). As a result, the bottom fiber tends to tear apart while the top fiber gets squeezed.

Comparison

Since there are counter-balancing moments in the case of an arch while beam or slab doesn't provide any such moments, the bending moment in any segment of the arch is much smaller than in a beam with the equivalent load and span. As a result, with the same amount of materials arches can have a larger span, carry more weight, and can be made from smaller and thus more manageable pieces