3.1 ARCHES

Introduction

Mainly three types of arches are used in practice: three-hinged, two-hinged and hinge less arches. In the early part of the nineteenth century, three-hinged arches were commonly used for the long span structures as the analysis of such arches could be done with confidence. However, with the development in structural analysis, for long span structures starting from late nineteenth century engineers adopted two-hinged and hinge less arches. Two-hinged arch is the statically indeterminate structure to degree one. Usually, the horizontal reaction is treated as the redundant and is evaluated by the method of least work. In this lesson, the analysis of two-hinged arches is discussed and few problems are solved to illustrate the procedure for calculating the internal forces.

Arches

An arch is defined as a curved girder, having convexity upwards and supported at its ends. The supports must effectively arrest displacements in the vertical and horizontal directions. Only then there will be arch action.

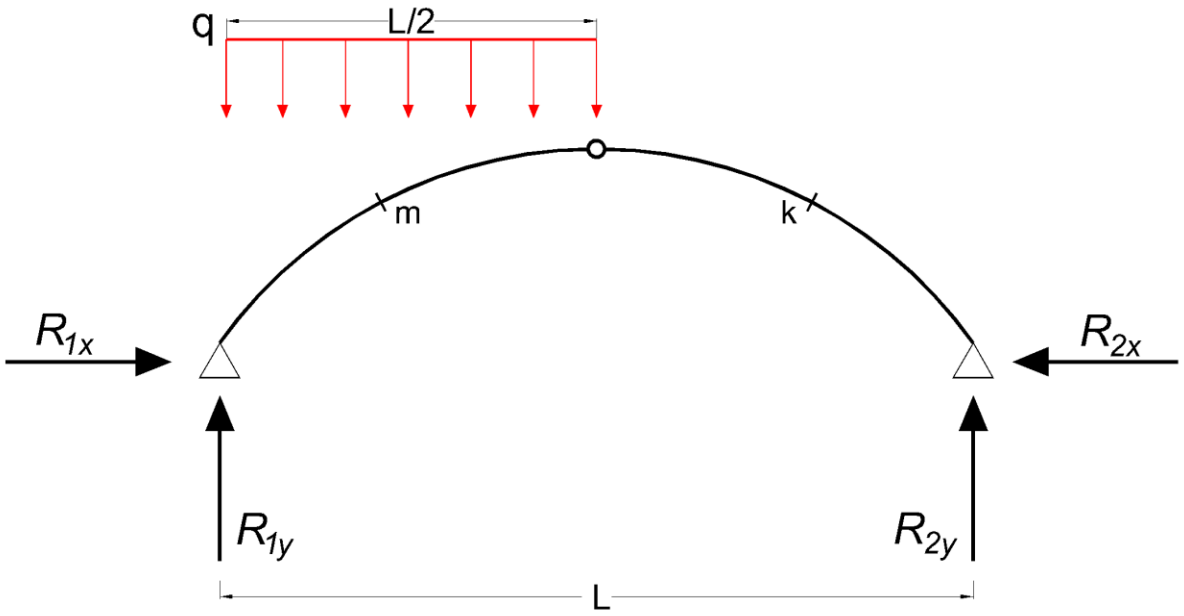

Fig. 3.1.1 Arches

Linear arch

If an arch is to take loads, say W1, W2, and W3 (fig) and a Vector diagram and funicular polygon are plotted as shown, the funicular polygon is known as the linear

arch or theoretical arch.

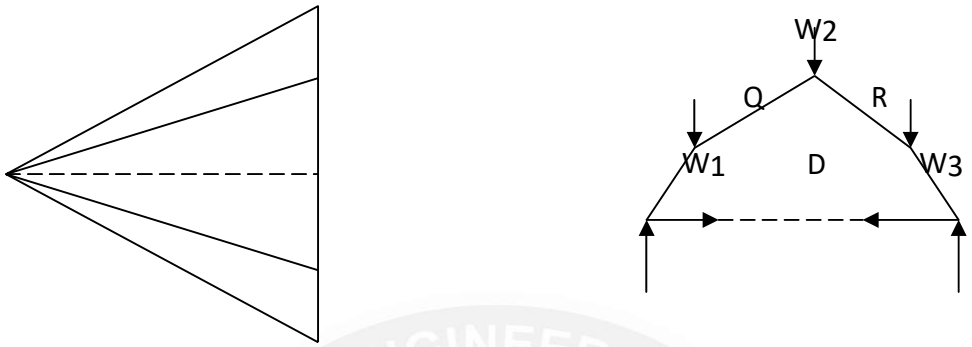

Fig. 3.1.2 Linear Arches

The polar distance ‘ot’ represents the horizontal thrust. The links AC, CD, DE, and EB will be under compression and there will be no bending moment. If an arch of this shape ACDEB is provided, there will be no bending moment.

For a given set of vertical loads W1, W2…..etc., we can have any number of linear arches depending on where we choose ‘O’ or how much horizontal thrust (ot) we choose to introduce.

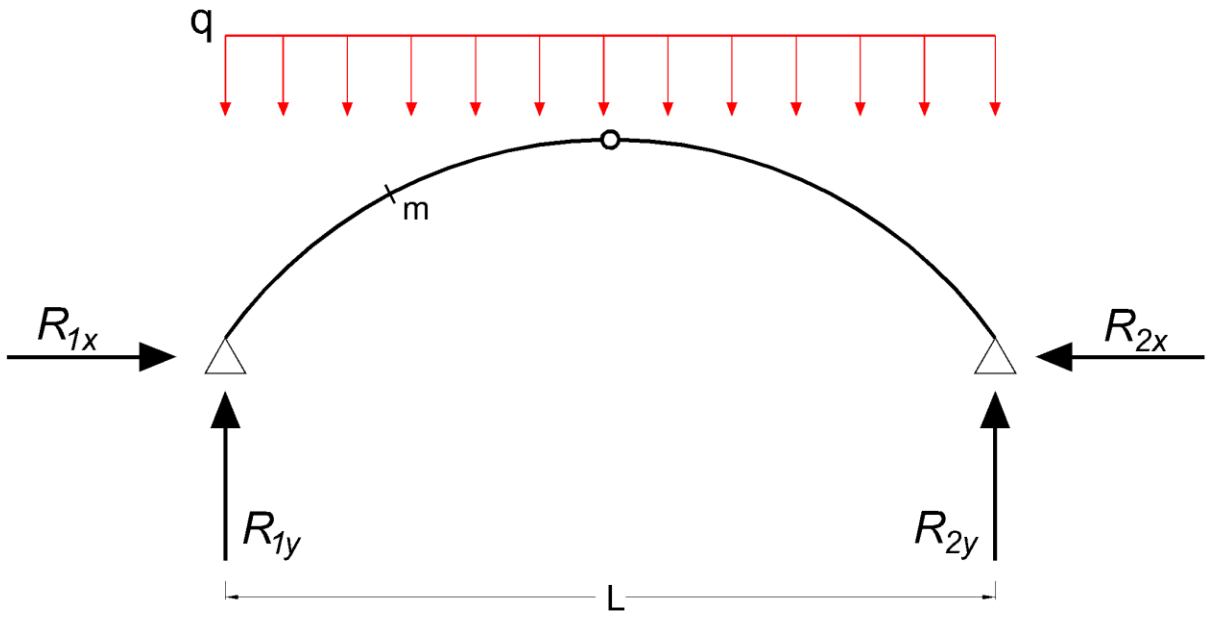

Fig. 3.1.3 Linear Arches

State Eddy's theorem.

Eddy's theorem states that " The bending moment at any section of an arch is proportional to the vertical intercept between the linear arch (or theoretical arch) and the centre line of the actual arch."