Skew Placement of Arches with respect to the Bridge Deck

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Abstract

Designers try to find new ways to make landmark bridges slenderer and distinctive. A new trend for arch bridges is placing the arch not co - linear with the bridge axis, but slightly skew. While visually attractive, this concept introduces a number of design problems which are not normal for arch bridges: the arch becomes subjected to significant out of plane bending moments, a permanent torsional effect develops, hangers are not possible in certain areas because of conflict with traffic and the tied arch concept becomes quite difficult to realize. The aim of this research is to study the skew arch concept using finite element modelling. A parametric study is undertaken to investigate the main design problems and to find an allowable application area in terms of bridge span, bridge deck width and skewness of the arch. Hereby, two different skew arch hanger configurations are considered including also a minimization of the number of hangers.

Keywords: skew placement, arch bridge, buckling, finite element modelling.

1 Introduction

For centuries, bridges have played an important role in the traffic system to allow passage across a body of water, a valley or a road.

The construction material for bridges evolved from timber in the early ages, to stone masonry during the Roman period and the Middle Ages. In those periods, compressive strength of the materials could be relied upon whilst tensile strength could not. Hence, an arch bridge structure was often the logical choice as it transfers the loads towards a horizontal thrust at the abutment by means of compression forces in the arch shape. With the invention of iron during the industrial revolution, larger span bridges became possible containing elements with a significant tension strength. Nowadays several designs of bridges exist. They vary depending on the nature of the terrain where the bridge is located, the function of the bridge, the required span length, the materials used to build it and the available funds for the bridge construction. As a consequence, a distinction can be made between beam bridges, truss bridges, arch bridges, suspension bridges, cable stayed bridges and movable bridges. Concrete and steel are the most frequently used materials for bridges. Steel is preferred for longer span bridges due to a larger strength to weight ratio compared to concrete.

Over the years, several configurations for arch bridges have been developed. Old arch bridges are associated with fairly massive brickwork structures. In this way, the possibility of tension forces could be minimized. The last century, the use of steel and reinforced concrete allowed more slender and elegant arches. Depending on the position of the deck with respect to the arch and the load transfer from the deck to the arch, different arch type bridges can be distinguished. The deck can run below, through or above the arch. A tied arch can

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