DESIGNING AND MODELLING OF A SINGLE SPAN ARCH BRIDGE TO THE EXISTING NINE ARCH BRIDGE IN DEMODARA

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ABSTRACT

The main objective of this study is to design and develop a scaled physical model of a single span concrete arch bridge as a replacement for the existing Nine Arch Bridge located in Demodara. The bridge is located across a valley with the maximum depth from the existing road level being about 29.85 m approximately. The linear length of the bridge is about 116 m. It is a stone arch bridge having nine arches and is more than 90 years old.
The proposed single span arch bridge is designed for a live load of 50 kN uniformly distributed load, which is generally taken as the weight of a train. The bridge is a single span fixed concrete arch bridge. The fixed supports make the arch statically indeterminate to the 3rd degree. The method chosen to analyse the arch for the specified load is the "Strain Energy Method" using the Castigliano's theorem. The internal forces that could develop in the arch are the axial forces, mainly compression forces. The load of the train is transferred to the arch and as compressive forces they are transferred to the abutments and therefore to the foundation of the bridge.

Initially, four different types of arches were selected and analysed for the maximum bending moment, maximum shear force and axial force. The first case selected had a span length of 71.98 m and a height of 11.8 m. This shape was a parabola with the equation 0.009x (71.98-x) and with a span length to height ratio of 6.1. The second case selected was also a parabola with a span length of about 84.35 m and height 10.41 m and with a span length to height ratio of 8.1. The third case selected was also a parabola with a span length of 84.39 m and height 7.93 m and with a span length to height ratio of 10.6. The fourth selected case had the span length of 56.48 m and height 15 m.

After analysing for all four cases, the 4th case was selected as the appropriate shape. When analysing for all four cases, this shape gave the maximum bending moment value of -176.52 kNm, maximum shear force of 1414.8 kN and maximum axial force of about -1322.5 kN in the arch. Comparatively this shape gave the minimum values for maximum bending moment, maximum shear force and the maximum value for the maximum axial force generated in the arch. Therefore, it was concluded that this is the appropriate shape that has to be considered for modelling and designing. The span length to height ratio of this particular arch is about 3.8, which is ideal to develop mainly the axial forces in the arch. This will considerably reduce the generation of very high bending moments and shear forces in the arch.

The cross-section selected for the arch is a square shape, which would not generate vast amount of bending and shearing stresses in the arch. Finally a computer model was generated using the SAP2000 Finite element modelling program, and the physical model has been constructed according to the scale. The arch will be verified for any kind of bending stresses and shear stress generation and it is tested for the stability of the arch.

Keywords: Concrete Fixed Arch, Compressive forces, Finite element model, Scale model