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Vertical Acceleration in Network Tied Arch Bridge due to Moving Vehicle

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Abstract

This paper deals with the influence of speed on vertical acceleration on Network Tied Arch Bridge. The parameter considered in this study are speed of vehicle, span of bridge, hanger spacing. For a given span (100m, 150m, 200m) three different hanger spacing of 2.5m, 5m and 7.5m are considered. So by varying the hanger spacing, behavior of vertical acceleration is also varying. Main goal of this paper is parametric analysis of bridge with different span. For analysis we took three different span of bridge then, and changed hanger spacing. The graph of vertical acceleration vs speed are developed in the model using CSI bridge software which can be used in geometric design of Network Tied Arch Bridge.

Keywords

Network Tied Arch Bridge – Vertical acceleration – CSI Bridge – Finite element model

1. Introduction

The network arch can be seen as a simply supported beam with a tensile and a compressive flange. The hangers are the web. Most of the shear force is carried to the supports by the vertical component of the force in the arch. Much of the variation in the shear force is taken by variation in the hanger forces. The hangers distribute the load between the chords in such a way that the chords have little bending. [1] The axial forces in the tensile and the compressive flanges are inversely proportional to the distance between them. In tied arches, aesthetic reasons limit the distance between the arch and the tie. When the rise of the arch has been decided, saving of materials depends mainly on whether or not a design gives light chords and a light web. The arch could be part of a circle. This gives evenly distributed bending moments in the chords. A reduced radius of curvature near the ends of the arch can give less bending in the wind portal and a constant axial force in a longer portion of the arch.[2] Network arch bridges are tied-arch bridges with inclined hangers that cross each other at least twice.

2. Bridge Description

The Bridge considered in this model is of three different span of 100m, 150m and 200m. The isometric view of the bridge is shown in figure below. The carriage way of the bridge is taken as 7.5m and 1m footpath has been considered in both sides making a total of 9.5m width.

3. Bridge Modelling

A three-dimensional finite element model of the study bridge was created using CSI Bridge v16. The arch was modeled as beam element, slab as shell element, hanger as cable element by providing initial pretension and suitable strain so that axial forces in all cable are uniform after the application of dead load and all cables are in tension even after relaxation .

4. Analysis and Result

Modal Analysis: Modal Analysis or mode-superposition method, is a linear dynamic-response procedure which evaluates and superimposes free-vibration mode shape to

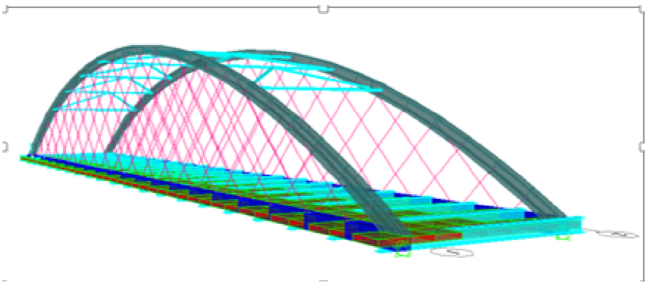

Figure 1: Bridge Modeling

characterize displacement patterns. Mode shapes describes the configurations into which structure will naturally displace.

Linear Static Method Static linear analysis was performed.However non-linear analysis considering p-delta effect on hanger is analyzed.Under linear static method, design seismic force in X and Y direction has been considered. Three different span of the bridge 100m, 150m and 200m was modelled. In each span, three different hanger spacing is considered. The speed of vehicle (IRC Class A) was varied from 20 Kmph to 140 Kmph. The section used in each model was analyzed and minimum section required for the bridge was used.

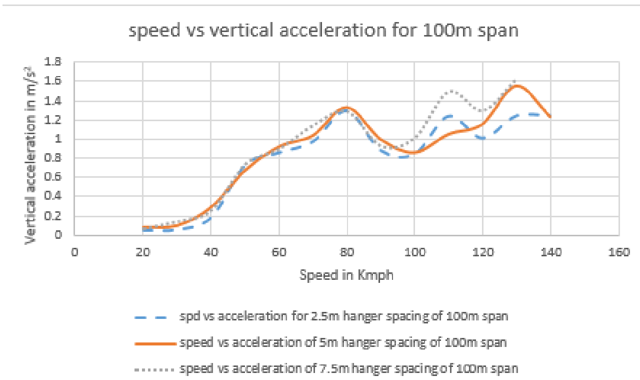

Figure 2: speed vs vertical acceleration for 100m span for different hanger spacing

5. Conclusions

In the present work, the vertical acceleration were first found out for minimum section used in each model and it was concluded that the design speed of the bridge

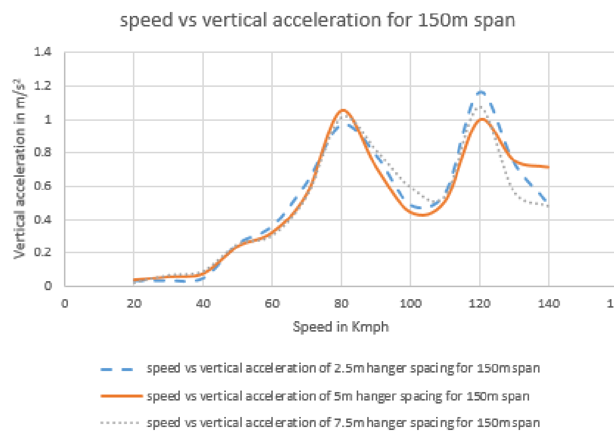

Figure 3: speed vs vertical acceleration for 150m span for different hanger spacing

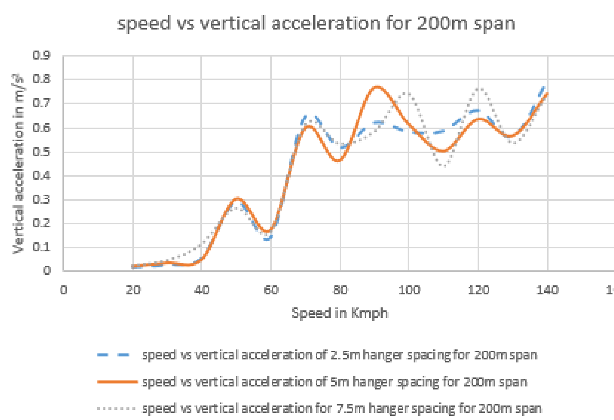

Figure 4: speed vs vertical acceleration for 200m span for different hanger spacing

should incorporate the vertical acceleration produced by moving vehicle. By analyzing the structure using CSI bridge software, the following conclusion have been obtained:

1. In all three scenarios of bridge span, it was found that to limit vertical acceleration within permissible limit, the design speed should be under 55 Kmph, 70 Kmph, 70 Kmph
2. In order to limit maximum vertical acceleration within permissible limit which was found to be developed at the same point where deflection is maximum, we need to increase the size of section.

References

[1] Bernardo Morais da Costa. Design and analysis of a network arch bridge, 2013.

[2] D. Bruno, P. Lonetti, and A. Pascuzzo. An optimization model for the design of network arch bridges. 2016.

[3] Per Tveit. *Systematic Thesis on Network Arches*. PhD thesis, 2013.

[4] *The Network Arch Findings on network arches during 54 years*. PhD thesis, 2011.

[5] N Sapkota. Seismic analysis of optimal hanger arrangement of network arch. Master's thesis, Pulchowk Campus,Tribhuvan University, 2016.