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Static Analysis on Tied Arch Bridge

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Abstract: The bound bridge is in the position of the bridge where the external horizontal force of the upper singing unit is carried as the lowest volume of the bridge. This removal of horizontal forces in connected areas allows for bound bridges to be created with slightly stronger foundations. Therefore, bounded bridges may be located at higher elevations or created in areas with unstable soil conditions. That the structure does not depend on the horizontal compression force for its integrity in the associated arch bridge. Combined bridges may be out of place, and may later be covered locally. The flexible reaction of a hard-pressed concrete bridge under an earthquake load is investigated using a limited portion of the model in the ANSYS software package. A bridge identified as the New Kozhencherry Bridge in Kerala, India has been selected for research. The bridge is a proposed project of the Department of Public Works, Kerala. My paper mainly focus on investigate the performance of frequency influence of vehicle load in bridge.

Keywords: Reinforced concrete bridges, viscous dampers, finite element analysis, seismic retrofit, modal analysis, dynamic analysis, seismic analysis, transient analysis

I. INTRODUCTION

A bounded bridge is a type of arch bridge in which the horizontal force is directed outside the upper chord, which is treated as a low pitch. This removal of horizontal force in abutments allows for bound-up bends bridges to be built with slightly stronger foundations. Therefore, closed arches bridges can be over steel or built in areas with unstable soils. Since the structure is not dependent on horizontal compression forces for its integrity, the bounded bridges can be made out of place, and later attached to the area. Of the many methods used for efficient building operations during earthquake incidents, the use of dampers has proven to provide promising results. The structures try to withstand the dramatic conditions with small modifications, energy absorption by plastic hooks etc. But these methods cannot provide the required level of mitigation to resist strong seismic vibrations. We must therefore use additional lubrication methods: the provision of dampers. Although the effect of dampers is well studied and recorded in the case of buildings, studies in the field of bridges are rare. Buildings and bridges thrive in a very different way from earthquake incidents. Research is available on existing bridges and dampers, but this study focuses on the proposed government work. The proposed Kozhenchery Bridge is located across the river Pamba River across the Thiruvalla and Pathanamthitta under the Pathanamthitta Division. The new bridge is proposed to have six 32.08 + m panels and two pairs of 23.40 m (Arch beams on both sides). The MFL is +93.050 direct clearance of the bridge over the MFL proposed to be 5m when the Beaked Boat is played. The width of the bridge is complete 8.5 m and wagon road is 7.5 m wide and the superstructure consists of two longitudinal girders, fourteen cross girders, two bows and two bracing

II. FINITE ELEMENT ANALYSIS

Finite element analysis was performed by using the ANSYS program. ANSYS is finite element modeling package which helps in solving even complex problems. In Finite Element Analysis, the complex analysis gets simplified in order to make the analysis easier.

A. Modelling in ANSYS

Model of tied arch bridge for the analysis is created in ANSYS Workbench 21. After the modelling, meshing has been done to get accurate result of analysis. It breaks up a whole body into pieces, where each piece represents an element. The mesh was set up such that square or rectangular elements were created. Mesh sizing is also a factor which determines the accuracy of the results obtained.

B. Non Linear Analysis

Total load applied to a finite element model is divided into a series of load increments called load steps. Two loading plates and two support plates were provided. Total load is divided into two loading plates and two point loading is applied. Chart is plotted with the

Force Reaction on Y axis and corresponding deformation on X axis. Ultimate load value corresponding to each curved deep beam is noted.

After applying load steps by changing analysis settings, non-linear analysis has been carried out. From solutions, force reaction and total deformation were inserted. The geometry of model, meshed model and deformed shape of deep beams obtained after the analysis are given below.

III. MODELLING OF THE STRUCTURE

The bridge was modelled using Design Modeller of ANSYS Workbench platform according to the data as show table 1.

Table-1: Section Properties

Member	Dimensions
Deck slab thickness	225 mm
Tie member dimension	600 X 600 mm
End Cross girder dimension	600 X 950 mm
Intermediate Cross girder dimension	300 X 850 mm
Bow dimension	600 X 1000 mm
Bracing dimension	300 X 600 mm
Hanger diameter	72 mm
Pier Diameter	1500 mm

Diameter of rebar's used are 32 mm, 25 mm, 20 mm, 12 mm, 10 mm and 8 mm. 12 T 13 strands were used for pre stressed members. The deck slab consists of 12 mm diameter bars @ 200 mm c/c+16 mm diameter bars @ 200 mm c/c as top and bottom steel and 10 mm diameter bars as distributors

The Bow consists of 36 no's of 25 mm diameter bars with 10 mm diameter bars at 150 mm c/c as shear reinforcements. The bracings are 8 no's of 25 mm diameter bars. The cross beams with 8 no's of 25 mm diameter bars at top and 4 no's of 25 mm diameter barsat bottom and shear reinforcement of 10 mm diameter bars.

The pier consists of 34 no's of 32 mm diameter bars with a shear reinforcement of 8 mm diameter bars at 200 mm c/c. The damper was modelled to have a length of 0.7 m as a longitudinal damper connecting the pier to the deck. The model is shown in Fig-1

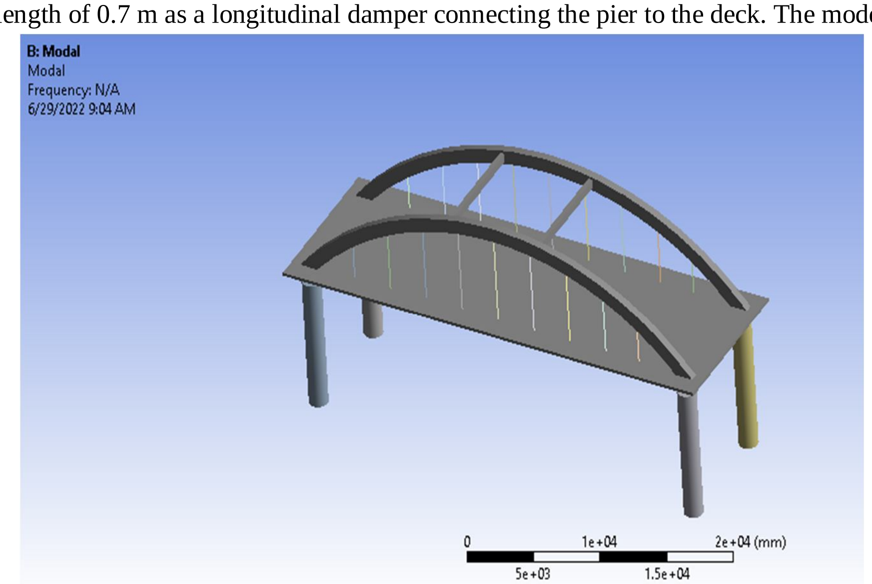


Figure 1: Model of the bridge in ANSYS 21

IV. MATERIAL DATA

M40 grade concrete is designed to be used for construction of the bridge along with Fe500 grade steel bars. The concrete Is modeled using solid element and the rebar's hangers and pre stressing cables are modeled as beam elements. The hangers used are Macalloy tension rods M76 of 72 mm nominal diameter. A brief material description is given in Table-2.

Table-2: Material description

Concrete	
Compressive strength	40 MPa
Density	24 kN/m^3
Poisson's Ratio	0.17
Structural Steel	
Tensile Strength	500 N/mm^2

The hangers have a minimum yield load of 1756 kN and a minimum breaking load of 2329 kN.

V. ANALYSIS

Coupled Static and modal analysis of the models are completed. The analyses of the structure are done with and without the provision of dampers and the deformation values and resultant acceleration are compared ANYS workbench 2022 R1 offers a wide selection of solvers. The Sparse MAPDL solver was used for the FE analyses.

A final mesh of 228387 nodes and 128216 elements were generated during the user controlled meshing process. Further fine meshing proved unnecessary since required convergence criteria were met after the initial trials.

VI. RESULTS AND DISCUSSIONS

The results and inferences of the analysis are as described below.

A. Static Analysis Results

The static analysis is used to find the deformation under the dead load of the structure. The only load applied in this case is the Earth's gravity. Fig-2 shows the static analysis results.

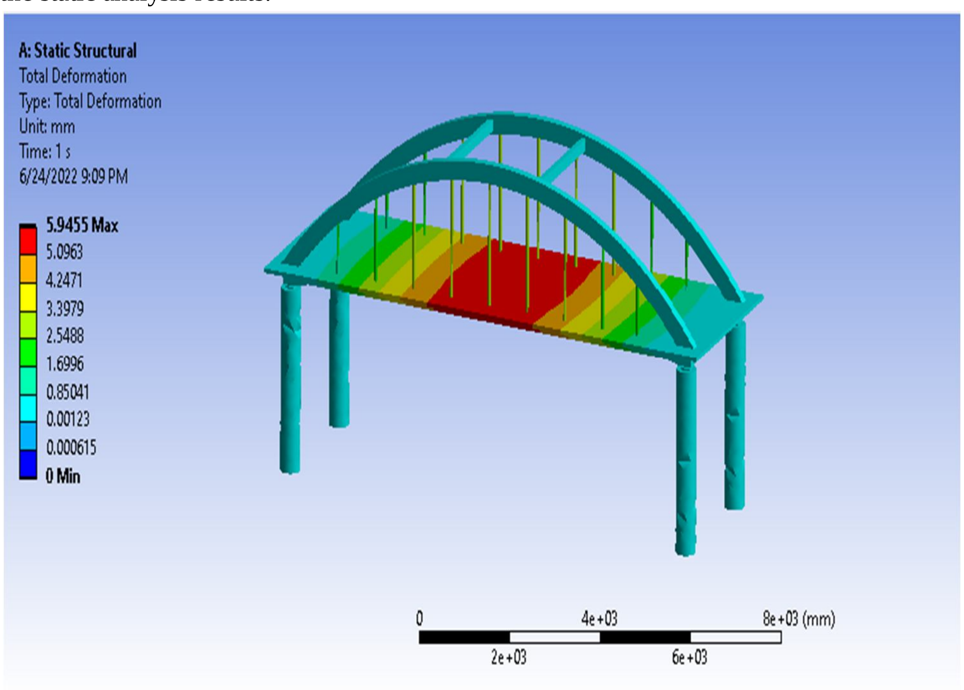
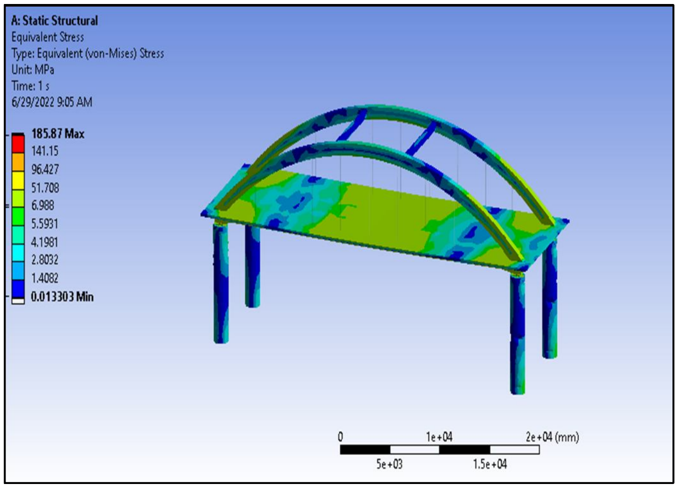


Figure 2: Deformation of the bridge



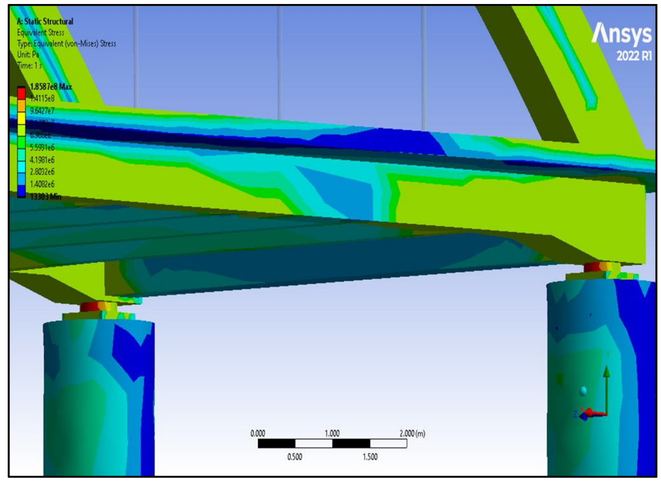


Figure 3: Equivalent stress generated on bridge

The maximum deformation is found out to be 5.945mm at the middle portion of the deck slab and Maximum equivalent stress is 185.87Mpa. Maximum stress is generated at bearing.

B. Modal analysis

A total of 6 modes were identified prior to the transient analysis through a modal analysis. The mode numbers and respective frequencies and maximum deformation is provided in table 3

Table-3: Modal analysis results

Mode Number	Frequency (hz)	Total deformation (mm)
1	1.5362	0.13525
2	1.9016	0.087343
3	2.1911	0.05889
4	2.7938	0.052195
5	3.3133	0.14257
6	3.5361	0.08311

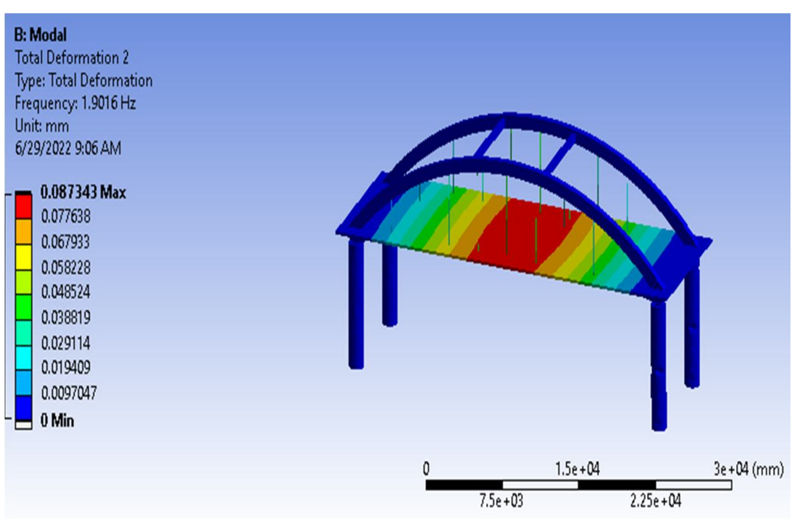


Figure 3: Second mode shape for frequency 1.9016 Hz

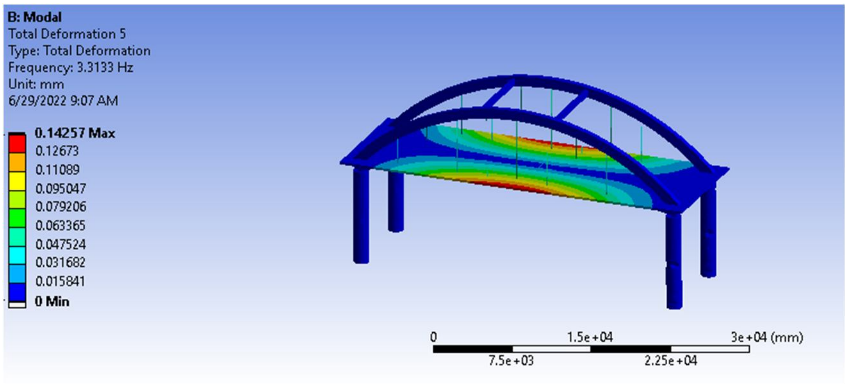


Figure 5: Fifth mode shape for frequency 3.3133 Hz

VII. CONCLUSIONS

A. Maximum deformation occurs at center area of deck slab.
B. Deformation cam re reduced by providing dampers to bridge..
C. Total of 6 mode shapes where identified through modal analysis.The mode numbers and respective frequencies and maximum deformations are given in Table-3. A mode shape is shown in Fig-4 and fFg. 5. .
D. Maximum equivalent stress is 185.87Mpa.
E. Maximum stress is generated at bearing.

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