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Design and Analysis of Arch-Type Pedestrian Bridge Structure at different Element Sections using Ansys

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Abstract: The objective of the research study is to model Arch bridge with two different design i.e. simple arch bridge and arch bridge with truss structure, using ANSYS software and to perform a modal analysis of bridge problem. For every one of the four materials eight node solid component is chosen and cross section is done exclusively for every modal. The material property of each material is selected as per literature database in ANSYS software. The modal analysis and design of bridge in ANSYS is analyse to find the natural frequency, deformations, stresses and mode shapes of bridge to avoid the resonance of the bridge. optimize cable and bridge deformations with comparison of simple arch bridge and arch bridge with truss structure.

Keywords: arch bridge, Truss structure, deformation, Finite element modelling, Ansys.

I. INTRODUCTION

In this study, the instructions and actions used to describe these models were remarkably like, even for various bridges. A truss component is a two-strength element that is subjected to axial loads either tensile or compression. The only 1D for a truss (bar) component is axial movement at each node. The cross-sectional area and material behaviours of each part are typically assumed constant with its length. The element can interrelate in a two-dimensional (2-D) or three dimensional (3-D) configurations. Truss elements are usually utilized in investigation of truss structures. A bridge is a structure that crosses over a gorge, street, river, railway, or other obstructions, permitting smooth and secure passage of cars, trains and pedestrians. A pedestrian railway bridge is a connection planned for pedestrians and in a few instances' cyclists, animal site visitors and horse riders, instead of vehicular passage. Pedestrian bridges set off the scenery and may be used decoratively to visually hyperlink wonderful areas or to indication a transaction. In many evolved nations, pedestrian bridges are each functional and can be stunning works of art and sculpture. Nowadays, the analysis of truss is concerned of many designers and consultants. The truss structures are required to be designed in such a way that they have enough strength and rigidity to satisfy the strength and serviceability limitation. In order to archive the minimum requirement, it is necessary to carry out an accurate analysis to investigate the reaction and stress that acting inside the member of the truss. When the load acting on a truss, the structure may deform and change to different shape or size. The bridges are the structures, which provide means of communication over a gap and they provide passage for the highway and railway traffic over these gaps. There are several classifications of bridges based on different considerations. Some of the major classifications are based on: material used, makeup of main load carrying elements, the structural layout of the principal load carrying members, floor location, type of connections, the level of crossing of highway and railway track and the nature of connections, the level of crossing of highway and railway track and the nature of movement of the bridge. The present analytical study is limited to only steel truss bridges, in particular truss portion.

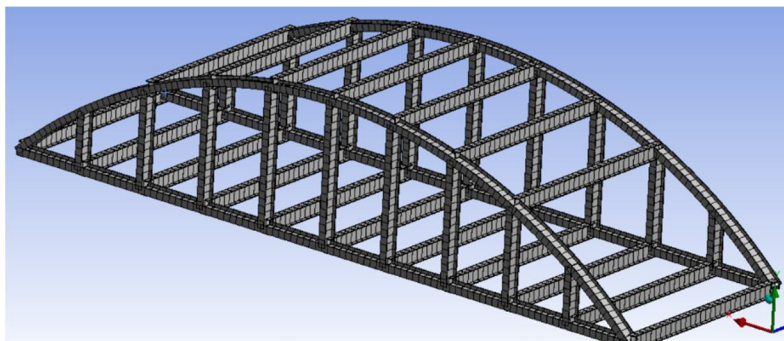


Figure 1: Arch Bridge Truss structure

II. FINITE ELEMENT ANALYSIS

Experimental Truss bridge structure was analyzed by with ANSYS that is associate with engineering simulation commercially used software package providing a complete group that extends the complete variety of physics, offering right to use to almost several field of engineering replications that a design method needs. The software package use it's tools to place a virtual product through a rigorous testing procedure like testing a beam below totally different loading circumstances before it turns into a considerable object. ANSYS will perform advanced engineering analyses quickly, safely and much by kind of contact algorithms, time based mostly loading options and nonlinear material models. During this study it familiar with carry out distinct modeling of Truss bridge structure investigates it below static loading conditions.

III. MODELLING OF BRIDGE STRUCTURE

A. Geometry of Sections

Two types of bridge structure design here, 'I' section and 'L' section used to designed bridge. Firstly, bridge designed by using 'I' section beam and then second bridge designed by using 'L' section of beam. Geometry of 'I' section and 'L' section are described below. Structural steel used as material for designing of bridge structure.

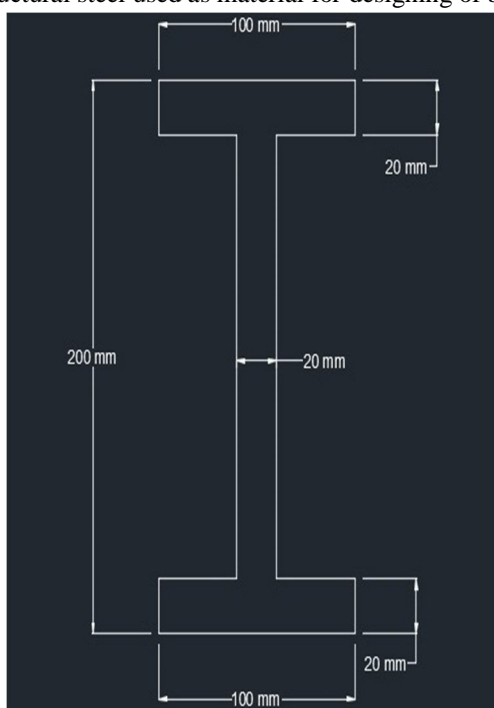


Figure 2: Dimensions of 'I' Section

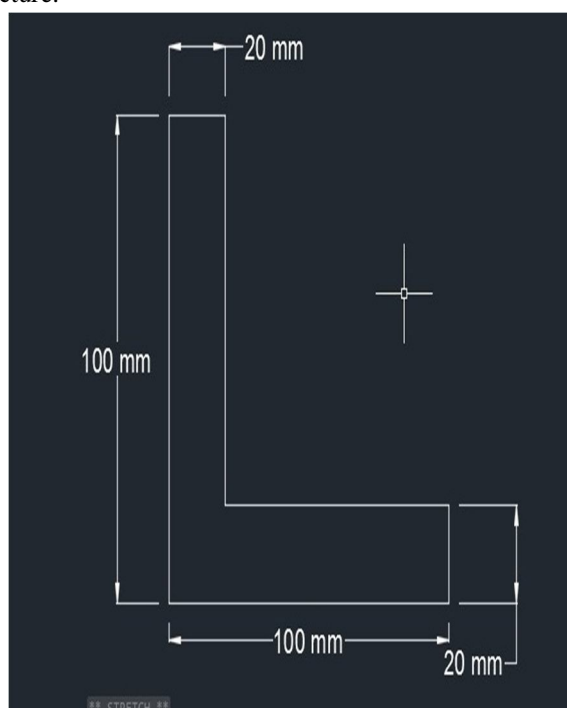


Figure 3: Dimensions of 'L' section

'I' section beam designed in two different designs, Truss Type 'A' and Truss Type 'B'. 'L' Section Bridge designed in two different designs, Truss 'A' and Truss 'B'.

B. Dimensions of Bridge Truss

Dimensions of bridge structure are described below.

Table 1: dimensions of bridge truss structure

Bridge Type	Length (mm)	Height (mm)	Bridge (mm)
Type 'A'	20000	2000	3000
Type 'B'	20000	2000	3000

C. 'I' Section Bridge

Bridge truss designed using 'I' section of two types, Truss Type 'A' and Truss Type 'B'. Figure shows the design of 'I' Section Bridge.

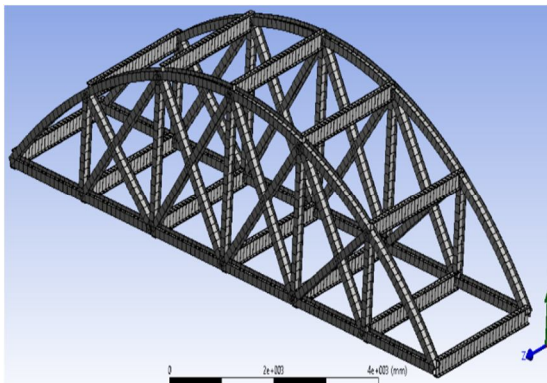


Figure 4: 'I' Section Bridge of Type 'A'

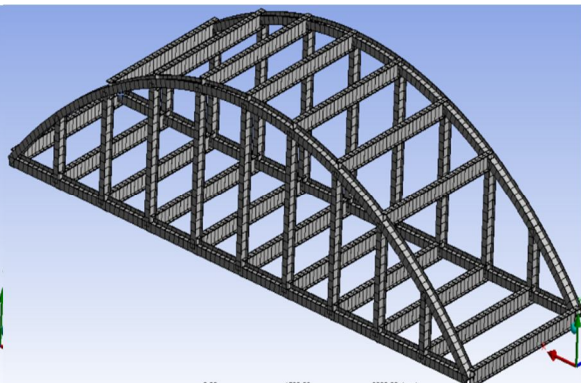


Figure 5: 'I' Section Bridge of Type 'B'

D. 'L' Section Bridge

Bridge truss designed using 'L' section of two types, Truss Type 'A' and Truss Type 'B'. Figure shows the design of 'I' Section Bridge.

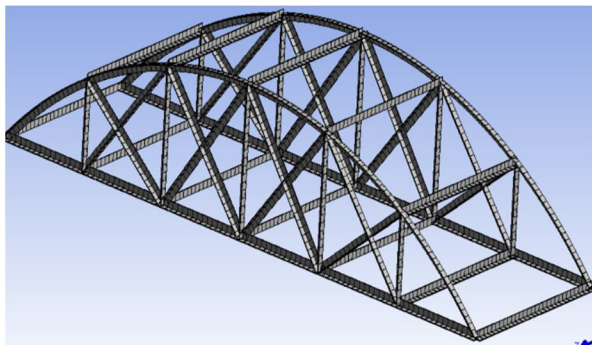


Figure 6: 'L' Section Bridge of Type 'A'

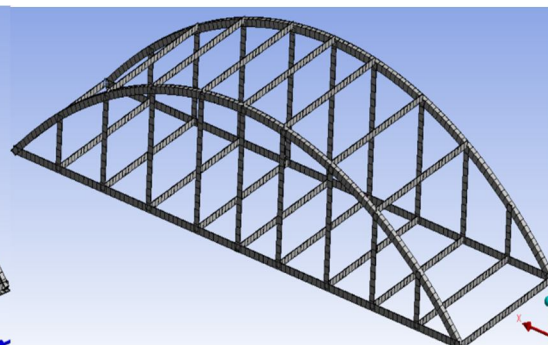


Figure 7: 'L' Section Bridge of Type 'B'

E. Applying Boundary Conditions

Applying boundary conditions on bridge, one end of bridge kept fixed support and, on another end, applying 30000 N load. In Type 'A' and Type 'B' bridge structure.

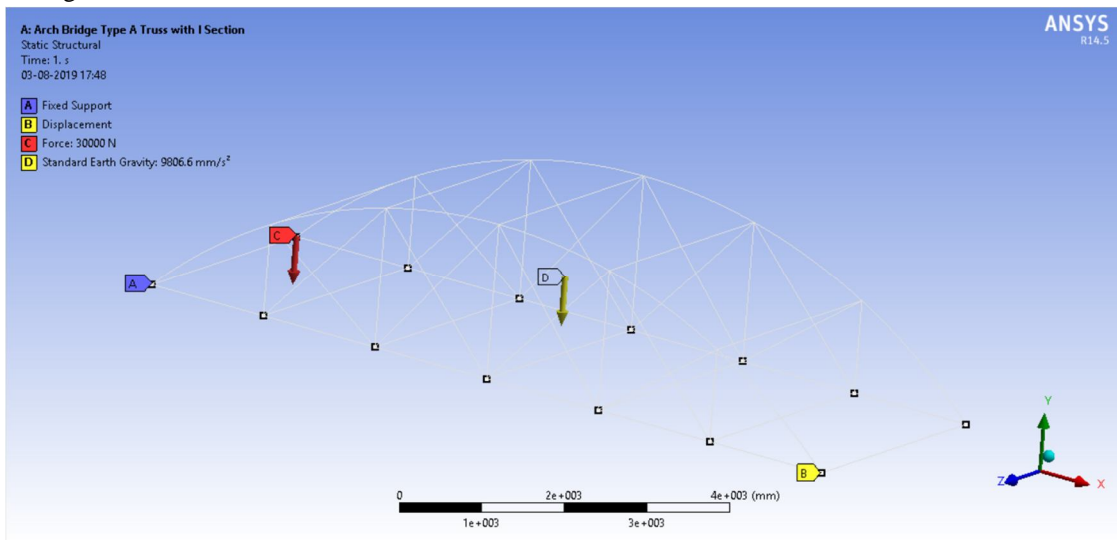


Figure 8: Applying Boundary conditions on Type 'A' Bridge Structure.

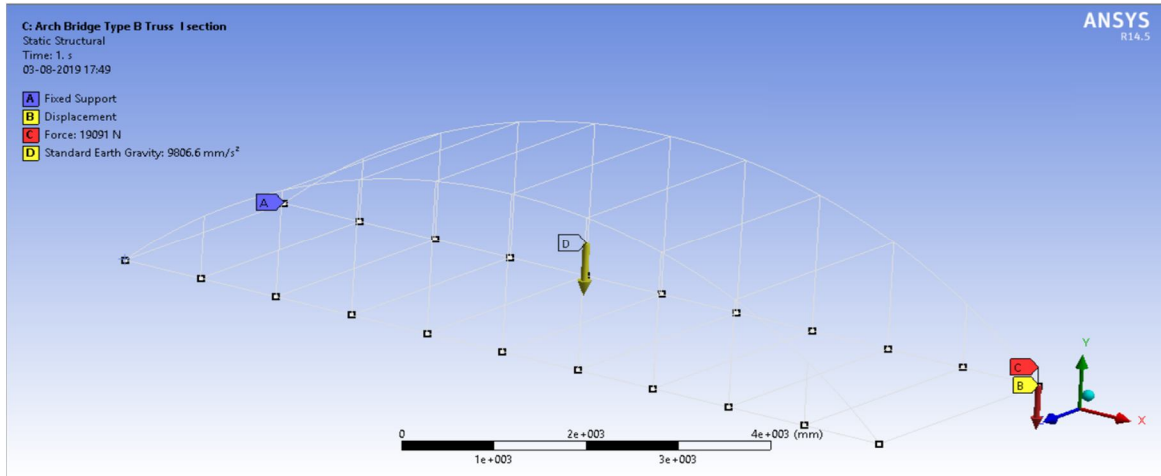


Figure 9: Applying Boundary conditions on Type 'B' Bridge Structure.

IV. TEST RESULTS AND DISCUSSION

The deflection occurred in bridge structure model is optimized and compared. Two types of section used in bridge element designing i.e. 'I' section and 'L' section. In 'I' section two type of bridge structure used for study i.e. Type 'A' which is bridge truss design used and Type 'B' simple design of arch bridge also in 'L' section two section two type of bridge structure used for investigation i.e. type 'A' and Type 'B'. Figure shows the deflection.

A. Deflections Of Bridge Structure Due To Load

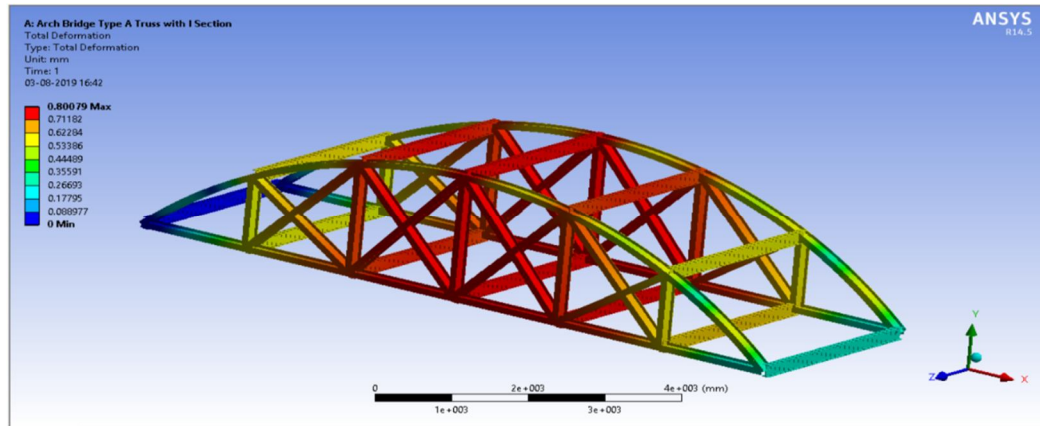


Figure 10: 'I' Section Bridge Truss Type 'A' deformation

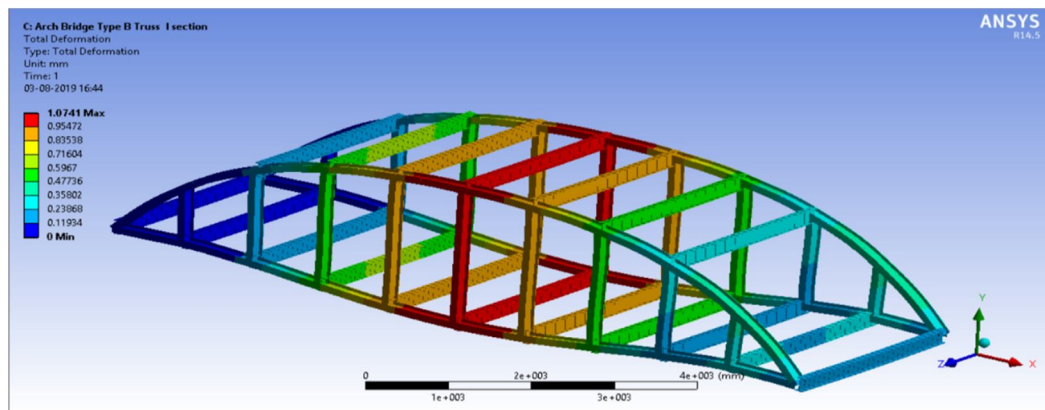


Figure 11: 'I' Section Bridge Truss Type 'B' Deformation

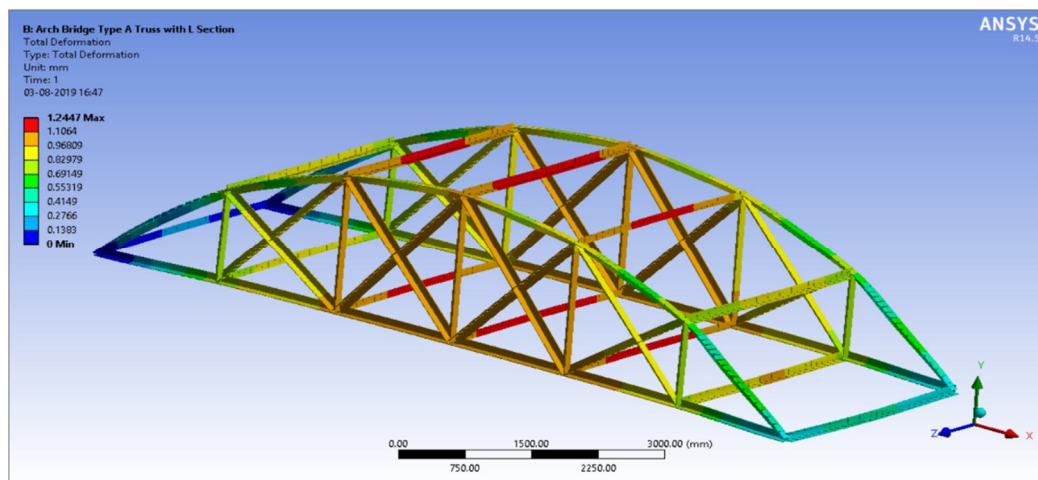


Figure 12: 'L' Section Bridge Truss Type 'A' Deformation

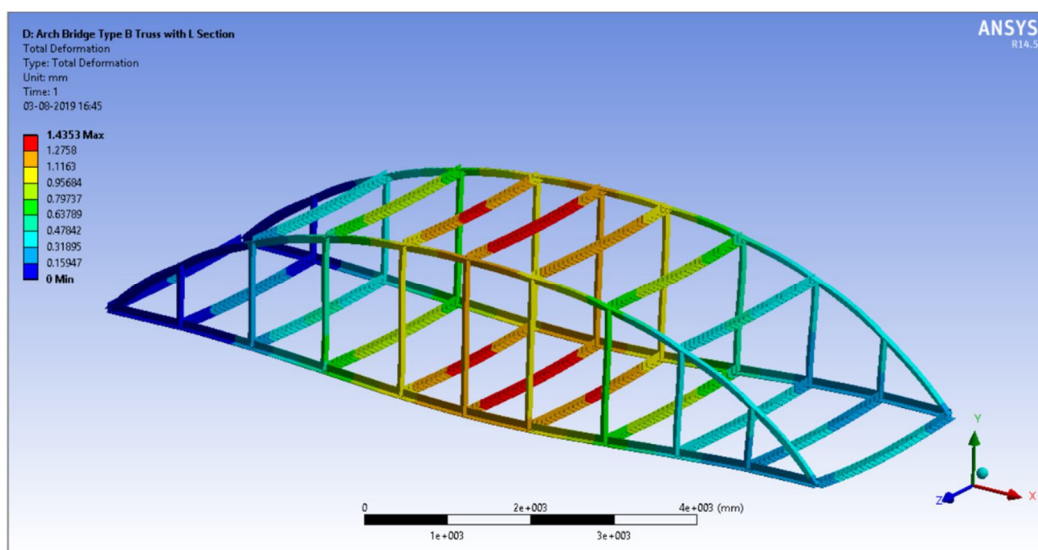


Figure 13: 'L' Section Bridge Truss Type 'B' Deformation

Table shows the values of deformation developed in bridge truss structure due to load, and direct stresses generate in bridge structure.

Table 2: Arc Bridge Structure Type 'A' Analysis Results

Parameters	Bridge Type A		Bridge Type B	
	I Section	L section	I Section	L section
Total deflections (mm)	0.8	1.244	1.074	1.435
Direct Stress (MPa)	5.637	7.698	4.603	6.154
Maximum Combined Stress (MPa)	21.422	21.027	15.2	15.14

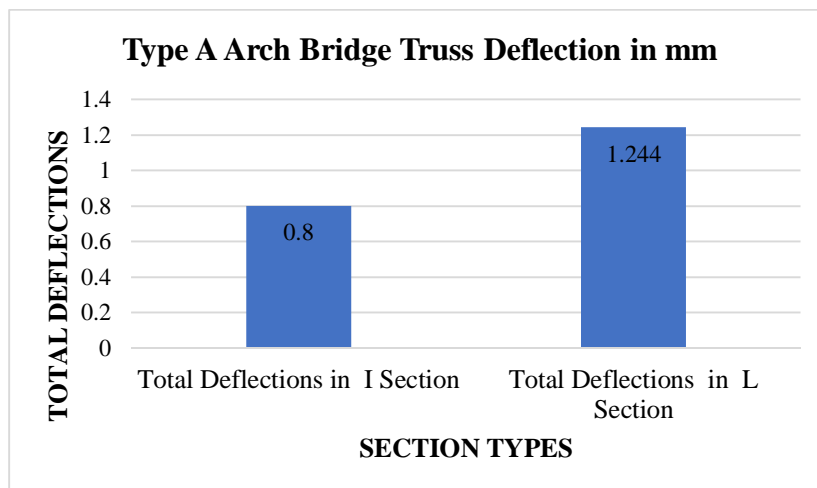


Figure: Deflections in Arch Bridge Structure Type A

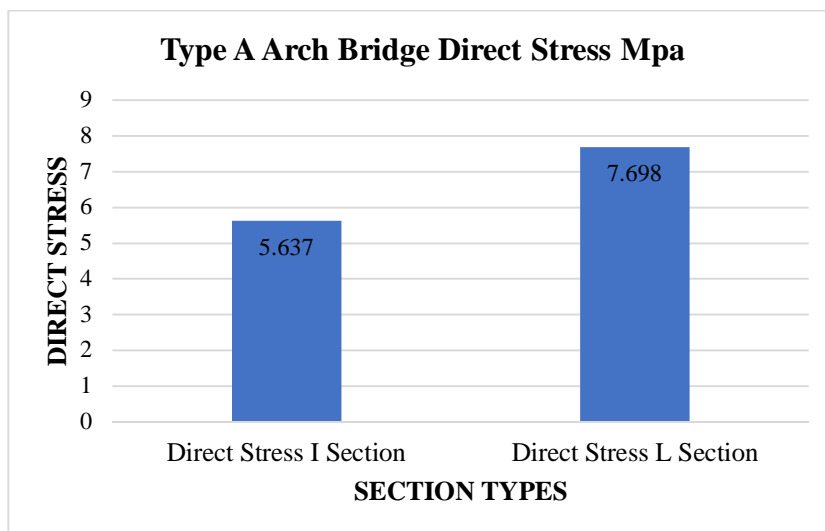


Figure: Direct Stresses in Arch Bridge Structure Type A

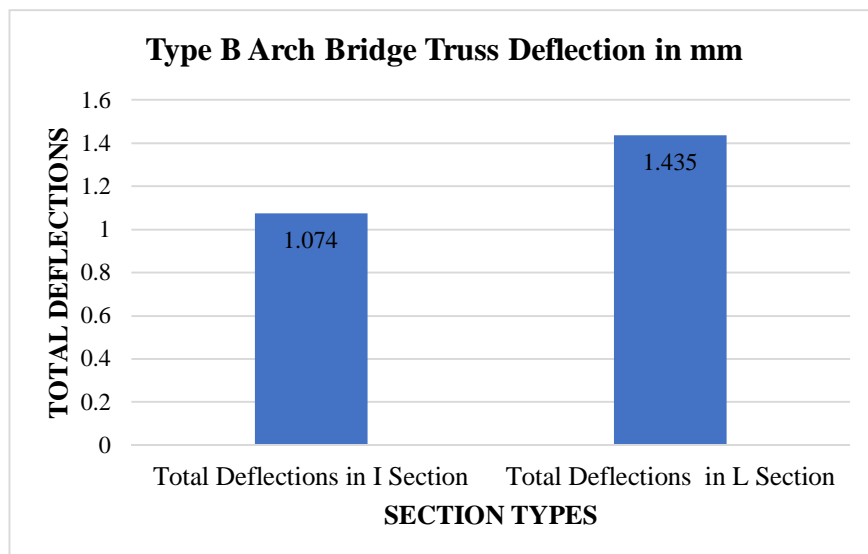


Figure: Figure: Deflections in Arch Bridge Structure Type B

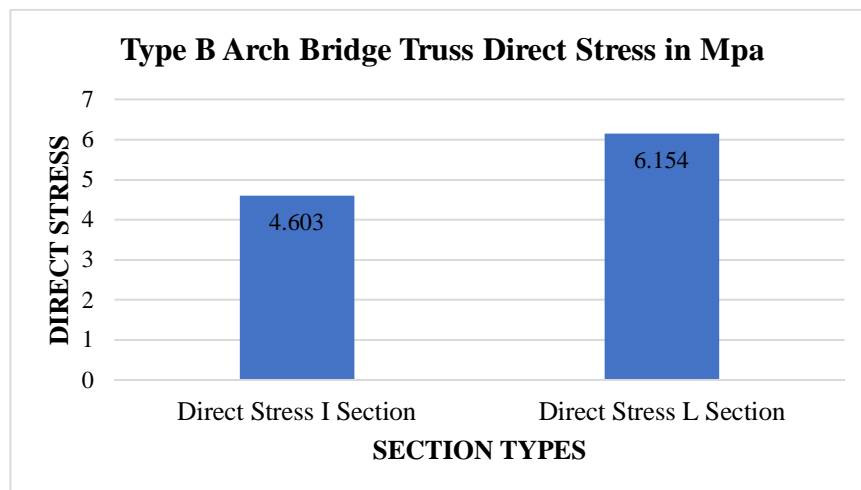


Figure: Direct Stresses in Arch Bridge Structure Type B

Table 3: Arch Bridge Type 'A' Deflections Due to Frequency

Modes	Arch Bridge Type 'A' with I Section		Arch Bridge Type 'A' with L Section	
	Frequency in Hz Type A	Deflections Type A	Frequency in Hz Type A	Deflections Type A
1	5.226	0.71	2.0622	1.042
2	15.686	0.757	6.7152	1.357
3	22.73	0.749	12.829	1.592
4	23.241	0.635	15.093	1.279
5	31.028	0.849	20.171	1.869
6	38.191	0.266	22.869	1.314

Table 4: Arch Bridge Type 'B' Deflections Due to Frequency

Modes	Arch Bridge Type 'B' with I Section		Arch Bridge Type 'B' with L Section	
	Frequency in Hz Type B	Deflections Type B	Frequency in Hz Type B	Deflections Type B
1	5.8176	0.748	5.8176	0.748
2	10.934	0.81	10.934	0.81
3	13.068	1.019	13.068	1.019
4	15.08	0.991	15.08	0.991
5	17.378	0.88	17.378	0.88
6	18.12	1.109	18.12	1.109

V. CONCLUSION

The ANSYS analysis for this steel truss is done based on the standard loading system, and the results are within the limited preconditions sated by the standard value.

From this study we can conclude the ANSYS analysis for this truss is very perceptive. The study has shown the possibility of analysis and design of Arch Truss bridges structure with locally available steel profiles. Even though the cost of local production is closer to importing it is still a good option since it helps in the capacity building of local design, fabrication and construction firms, creates job opportunities for many people and is a saving in foreign currency. For many short span temporary bridges in road construction projects.

- A. As per above study, it is concluded that 'L' section Arc bridge structure having more deflection in comparison of 'I' section therefore 'I' section suitable and acceptable for designing of Bridge truss structure.
- B. In Comparison of Truss Type A and B, we found in analysis that arch bridge structure with Type 'A' having minimum deflection in both 'I' and 'L' section as comparison to Type 'B' Truss structure.
- C. It shows as per above study that Arch bridge structure with type 'A' using I section gives better stability than section 'L'.

VI. SCOPE OF FUTURE WORK

- A. Design different Bridge truss structure using 'C' Section and compare that with 'I' and 'L' Bridge structure.
- B. Using various types of truss structure.

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