# 3D Steel Truss Bridge with GFRC Deck

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***Abstract*— In this paper, a 3D bridge truss is to be analyzed in (ANSYS Workbench) The floor material of the Bridge was changed to Glass fiber reinforced concrete. Compared to a normal concrete structure, GFRC Erection is simple due to the relative lightness of members. GFRP offers the designer a new combination of properties not available from other materials and effective rehabilitation systems. The high amount of glass fibers leads to high tensile strength while the high polymer content makes the concrete flexible and resistant to cracking. Because of the high early strength of GFRC, in part provided by the fibers, it can be demolded quickly. Most GFRC works can be demolded in 24 hours. Site details including span are taken from Vengara- Pazhayangadi ( Major District Road) in which the bridgework (Box girder bridge) is going on.**

***Keywords*—GFRC; GFRP**

## I. INTRODUCTION

Truss structures that are comparatively simple to assemble and are more economical are used for many purposes such as crossing areas, railroads, and other transportation bridges. Steel truss bridges have more flexibility than concrete bridges. In this paper, a 3D truss bridge is to be provided with GFRP deck portions and is to be analyzed and designed in ANSYS WORKBENCH software. The truss component makes up reinforcement for the bridge. The truss dissipates the load through the structure as a result, the middle of the beam experiences less compression and tension. A truss is typically made up of a large number of triangles. The triangle is the strongest shape, when subjected to force it evenly distributes the weight without changing its proportions and maintains its shape in position. Deck portions are provided with the GFRP deck. GFRP possesses low weight compared to concrete It requires a short erection time through pre-assembly, and easy handling on site GFRP possesses more corrosion resistance When rectangular sections are subjected to forces, they will easily deform but if it is provided with diagonal or triangle members are provided, the stability of the structure will get enhanced. Squares are made up of four-sided but we can change the angle to any quadrilateral shape with the same sides. But triangles are different having 3 sides with valid lengths and we can't change the angles to get a new triangle with the same sides as there is exactly one triangle that we can make from those sides. This is how triangles hold their shape. And by interconnecting carry relatively heavy loads in truss bridges.

## II. OBJECTIVES

- To conduct a literature review about 3D bridge Truss
- To familiarize with ANSYS workbench software
- To plan and model a 3D truss bridge with h GFRP deck by considering the requirements in Vergara
- To analyze 3D bridge truss.

## III. SCOPE OF THE WORK

- The scope of the study has been limited to the analysis of a 3D bridge truss in Vergarara by the method of finite element software.
- The scope of GFRP is to be analyzed
- To achieve sound knowledge related to 3D bridge truss, ANSYS workbench software
- The aesthetic and structural advantages of composite bridge truss were a highlight
- The main components of the steel truss were analyzed using ANSYS workbench software.
- Models are prepared considering the relevant site conditions.

## IV. SITE DETAILS

The total span of the bridge is 321.6 m, which consists of 5 number 25 m Span 3 number of 15.5 m Span 3 number of 9.5 m Span 1 number of 22 m 1 number of 21 m 1 number of 20.4 m 1 number of 27 m and Railway over bridge portion - 31.2 m Box girder bridge is the proposed one. Deferent crocross-sections are provided for support sections and mid-span sections. Box girders are connected with a pier with an elastomeric bearing.

The cross-sections in the support and midspan portions are shown below:

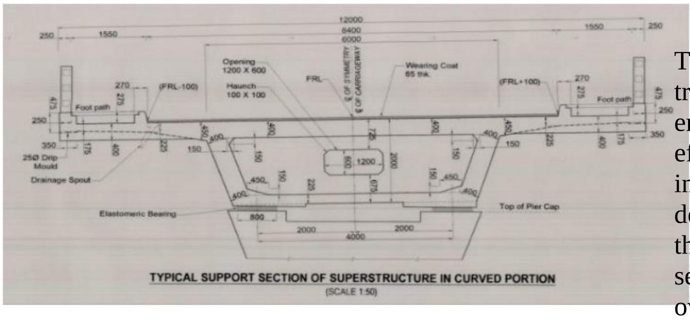


Fig 1: Typical support section of the superstructure in the curved portion

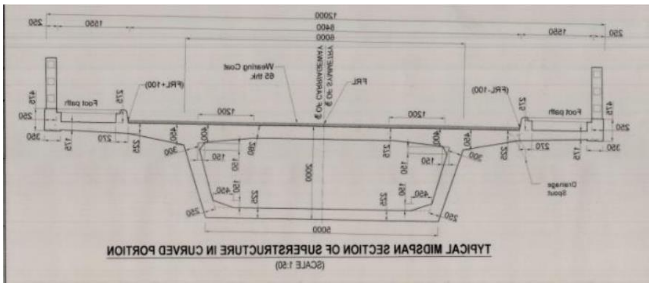

Fig 2: Typical Midspan section of the superstructure in the curved portion

Code of references are :

- IRC:5-2015 - coP for road bridges: General features of design • IRC:6-2014 – coP for road bridges: loads and stresses
- IRC:78-2014 – coP for road bridges: foundations and substructure
- IRC:112-2019 – coP for road bridges:
- IS:2911 ( Part1/Sec2) – coP for bored cast in situ concrete pile

The bridge elements are designed with 1 lane for IRC Class 70R loading,2 lanes for IRC Class A loading, and 1 lane for IRC Class A loading ever governs in addition to a footpath live load corresponding to 5 kN/m² of footpath area as per clause 206.3 of IRC 6

However, the precast footpath slab has also been designed for a wheel load of 40 kN (distributed over a contact area of 300 mm dia) as per clause 206.4 of IRC 6

## V. SUMMARY OF LITERATURE REVIEW

From the literature review the following conclusions were observed:

Truss bridges made with different deck materials were studied. Pratt truss configuration type was selected. This design produces a more efficient ridge truss structure. Shear connection in the steel-concrete composite truss reduces its deflection by approximately 50 % in comparison to the steel truss. The significant influence of the top chord section on the shear forces in the shear connectors was observed. GFRP as a deck material suitability is studied by considering the experimental results. The material is found to be safe for use as a deck material.

## VI. MODELLING

The figure shows a 3d bridge truss. in this paper, the pratt truss configuration type was selected. this structure has been employed within bridges for the past two centuries as an effective truss technique. in which the diagonal members are in tension while the vertical ones are in compression. This design produces a more efficient structure since the steel in the diagonal members can be reduced. This decreases the self-weight and eases the structure. it would also reduce the overall cost of the construction. This type of structure is most suitable for horizontal spans, where the force is in the vertical direction. finite element analysis (fem) of bridge truss was used for observing the structure behavior by the structural static analysis

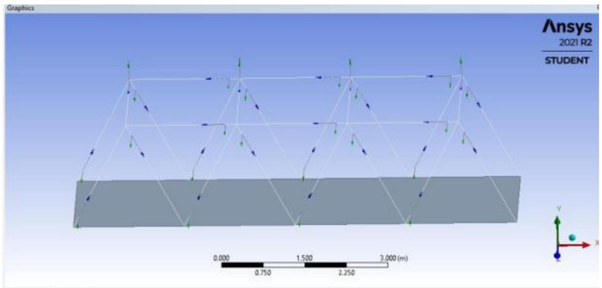


Fig 3: Model

### A. *Material Properties*

Two types of materials (steel and concrete) are selected and used to build the structure of the bridge. The table demonstrates the materials' properties. Then the bridge truss is analyzed to find out which one will give high strength to weight ratio.

TABLE 1 MATERIAL PROPERTIES

| | Steel | Concrete |
|---|---|---|
| Young's modulus (Mpa) | 2x $10^{11}$ | 3x $10^{11}$ |
| Poisson Ratio | 0.3 | 0.13 |
| Density (kg/m³ ) | 7850 | 2300 |

## VII. PARAMETRIC STUDY

Various spans of bridges are modeled in ANSYS WORKBENCH and then analyzed. A comparative study between the steel-concrete model and steel- GFRC models is also done.

The total span of the bridge portion is 321.6 m including 31.2 the of the ROB portion. Varispansspan having 40m, 20m, etc are separately modeled and analyzed in ANSYS WORKBENCH

*A. 8m span model*

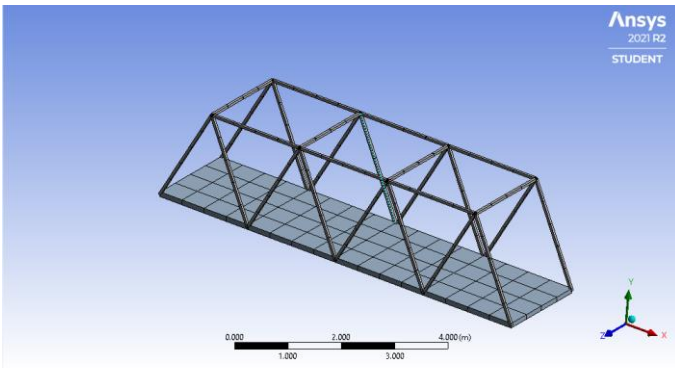


Fig 4: 8m Span model

The 8m span model is created and analyzed. Material properties of steel- concrete, and steel- GFRC are assigned. The results thus obtained are used for comparative study.

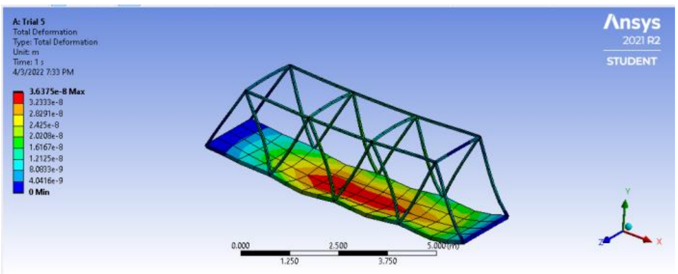


Fig 5: Total deformation of 8 m span model

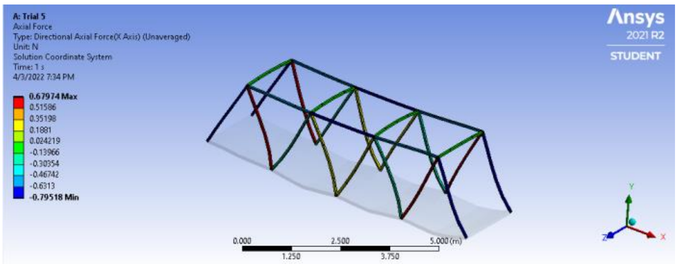


Fig 6:Axial force of 8 m span model

TABLE 2. RESULTS

| | STEEL + CONCRETE | | STEEL + GFRC | |
|---|---|---|---|---|
| | Maximum | Minimum | Maximum | Minimum |
| Total deformation (m) | 3.261x $10^{-8}$ m | 3.624x $10^{-9}$ m | 3.233x $10^{-9}$ m | 0 |
| Axial force (N) | 0.68238 N | -0.7967 N | 0.67974 N | -0.79518 N |

By comparing the results it is clear that the Steel+ GFRC model shows a smaller value of deflections and axial force as compared to the Steel+ concrete model. It shows the suitability of GFRC as a deck portion in a bridge structure. Also, GFRC has a high light-reflecting character compared to concrete, this property makes it more suitable for bridge construction.

321.6 m of bridge span is analyzed by giving Steel+ GFRC combination in ANSYS WORKBENCH, and it is found to be more advantageous than the existing one. 40m span model of 7.5 m road width and 9 m truss height is given below

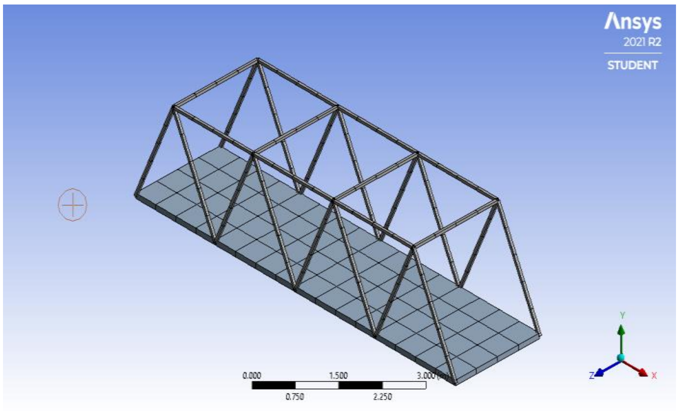


Fig 7: 40 m span model

The results obtained are:

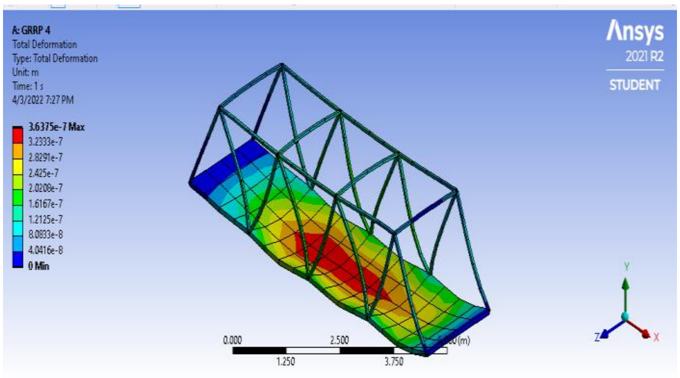


Fig 8: Total deformation of 40 m span model

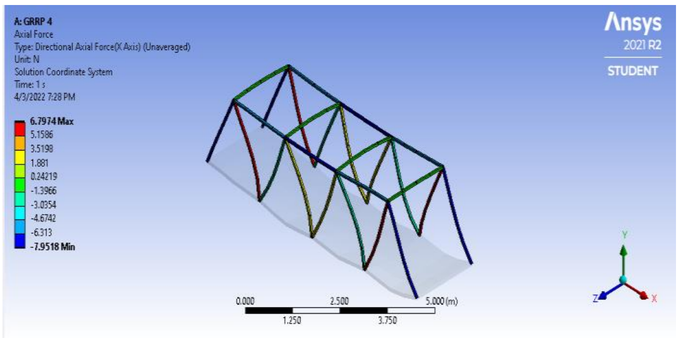


Fig 9:Axial force of 40 m span model

## VIII. RESULTS AND DISCUSSION

Truss structures are simple to assemble and more economical. They are used for many purposes such as crossing areas, railroads, and other transportation bridges. Here a combination of steel truss and Glass fiber reinforced concrete is used in bridge construction and which is analyzed in ANSYS WORKBENCH software. Through parametric study, it is clear that the Steel+ GFRC model is more advantageous than the conventional Steel+ concrete model. At the beginning of the model study, the 8 m model is modeled and compared with the conventional stee+ concrete model. Then various spans of the bridge are modeled and analyzed

## IX. CONCLUSIONS

Steel truss bridges are composed of members that are connected to form a rigid frame of steel and arranged in a triangular manner resulting in the loads carried becoming either tension or compression. The flexibility of a steel truss bridge is more than other bridges, and the scrap and salvage value will be more. GFRC has high early strength, it can be demolded quickly. Most GFRC projects can be demolded in one day. There’s less likelihood of cracking. Because of GFRC’s toughness and strength, it can take a lot more abuse before it cracks. GFRC can even bend. In general, traditional precast projects should stay in the molds for at least a couple of days. A faster turnaround means you can do more projects and bring in more revenue. All the above study shows the overall suitability of the Steel+ GFRC model compared to Steel + concrete model.

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