ANALYSIS AND DESIGN OF SUPER STRUCTURE OF ROAD CUM RAILWAY BRIDGE ACROSS KRISHNA RIVER

T. Pramod Kumar*1, G. Phani Ram2

1Post Graduate Student (Structural Engineering), VRSEC, Vijaywada (A.P), India.
2Asst. Prof, Department of Civil Engineering, VRSEC, Vijaywada (A.P), India.

ABSTRACT

To perform analysis and design of super structure of road cum railway bridge across Krishna river proposed on downstream side of existing bridge between Mahanadu road of Sithanagram and P.N.Bus station, Vijayawada. The bridge is made of through type steel truss which carries two railway tracks at lower level and a roadway of three lane carriage way in the upper level. The span length matches with that of existing nearby railway bridge. Analyses of top floor members, truss members and bottom floor members are done using STAAD.Pro. The design of structural members of the truss, top floor and bottom floor members is done as per Indian railway standard code and Indian roads congress code.

Keywords: Top chord, bottom chord, stringers, cross beams or floor beams, truss members.

1. INTRODUCTION

A bridge is a structure, by which a road, railway or other service is carried over an obstacle such as a river, valley, other road or railway line.

The superstructure of a bridge is the part directly responsible for carrying the road or other service. Its layout is determined largely by the disposition of the service to be carried. Supports at convenient locations.

A typical configuration of a truss bridge is a ‘through truss’ configuration. There is a pair of truss girders connected at bottom chord level by a deck that also carries the traffic, spanning between the two trusses.

At top chord level the girders are braced together, again with a triangulated framework of members, creating an ‘open box’ through which the traffic runs. Where clearance below the truss is not a problem, the deck structure is often supported on top of the truss; a slab is made to act compositely with the top chords, in a similar way to an ordinary beam and slab bridge.

The bridge is made of through type steel Truss (K truss) which carries a two lane railway track at lower level and road lane of 3 lane carriage way at upper level. The span length matches with that of existing nearby Railway Bridge. (i.e Span of 89.066m Krishna Bridge)

Analysis of top floor members, truss members and bottom floor members are done using STAAD Pro.

Analysis of top level slab (i.e., road level slab) is done using effective width from IRC 21 code

Design of truss members, stringers and floor beams are done using IRS Steel Bridge Code.

Functions of various parts of truss

The stringer beams carry railway loads at bottom level of the truss and highway loads at top level of truss cross girders (i.e. floor beams) having depth more than the stringer beams take load from stringer beams and finally distributed to the truss chords.

Bracings are provided at top floor and bottom floor to carry the lateral loads.

The load transfer mechanism is load from the deck is transferred to the stringers from stringers to cross beam and from cross beams to truss chords then to bearings and piers properties have been approximately given based on the existing structures across Godavari and Krishna.

*Corresponding Author
www.ijesr.org
The vertical and diagonal members of the truss are built up sections created by two channel sections front to front connected by lacings and battening. Elastic modulus, Poisson’s ratio and density are provided and the material steel is used in the STAAD.Pro analysis.

Nomenclature for various parts of truss

Sectional view of road cum rail bridge showing traffic facility

3D Model of rail cum road bridge span
Length of span is 89.066m
Number of panels = 14
Length of each panel in span = 6.4 m
Number of members in each span are
Number of Cross beams or floor beams = 180
Number of truss members = 170
Number of Stringer beams = 126
Number of bracings = 341
Number of R.C.C beams = 28
Total number of members for each span of bridge = 845
Applying of loads

There are different types of loads like dead load, superimposed dead load, live load, wind load etc. The dead load is applied by using self-weight command in STAAD. And slab weight is applied separately in STAAD.

The live loads at road level are given based on IRC:6-2014 code book, different loads like CLASS-A loading, 70R (both wheeled and tracked) loading and their combinations at different positions are applied on top level stringer beams.

The live loads on bottom level stringers which carry railway loads are given based on the IRS bridge rules code book “DFC loading (32.5 axle load), BROAD GAUGE -1676 mm Equivalent Uniformly Distributed Loads (EUDL) of railway loading in kilo Newtons (tonnes) on each track, and Coefficient of Dynamic Augmentation (CDA) are taken from bridge rules. Here EUDL is taken from the table providing total load for Bending Moment and Shear force for a given length of the span.

From Appendix IX-XXVI EUDL on each track from page 91 of IRS bridge rules is taken.

Load on each stringer beam due to EUDL at rail level is 59.803 KN/m

![IRC Class A-3 Lane Loading](image)

Superimposed dead loads (SIDL) is also applied at both road level and rail level stringer beams.

**The SIDL are**

At top level (road level) SIDL - foot path, wearing coat, hand rails, kerb, hand rails

**Load of slab on stringers at top level**

Stringer 1 and 5 = 9.1 kN/m each, Stringer 2 and 4 = 9.125 kN/m each, Stringer 3 = 9.15 kN/m.

And other superimposed dead loads at top level

Total weight of wearing coat = 14.6 kN/m

Weight of footpath (kerb + sand cushion + railing beam + hand rail) = (1.62 + 3.9375 + 2.88 + 5.5) = 13.9375 kN/m on each side.

At bottom level (rail level) SIDL – weight of rails, sleepers, hand rails

Weight of the sleepers = 0.418 kN/m, Weight of rails = 0.5886 kN/m, Weight of handrails = 3 kN/m
Assigning roadway vehicle loading in STAAD

EUDL representing Railway load when the span is fully loaded
Cross sectional view of railway loading in model

When both railway and road traffic loads are applied in STAAD.Pro model

Analysis methods

Analyses of top floor members, truss members and bottom floor members are done using STAAD.Pro.

Forces due to combination of loads are analysed.

The combinations of loads used are DEAD LOAD + SIDL + LIVE LOADS. Various members of superstructure of the bridge are analysed and the max forces and moments of the live loads are multiplied with impact factors (CDA).

Truss members are axial members that carry axial compressive force and axial tensile force and the stringers and cross beams carry bending moment. The load system is so placed that the resultant of all the loads is maximum.

Maximum forces and moments in longitudinal stringers and cross beams at bottom floor level are calculated based on EUDL for railway loading given in bridge rules for design purpose

Maximum force in all the members due to CLASS –70R 1 LANE and CLASS-A 1LANE are individually analysed and then added. Maximum axial force in all the members due to CLASS A 3 lane is determined. The maximum forces and moments on the truss members due to highway live loads with different combinations of Class A, Class 70R have been determined using STAAD model. Of these combinations, 3 lane of class-A loading has given max forces and moments.

Analysis results from STAAD. Pro

Results are obtained from postprocessing mode of staad pro after running analysis for worst combination of loads on bridge here in this case for CLASS-A 3 LANE and railway loading (32.5 axle load ).
Maximum forces in all the members due to self weight, super imposed dead loads and live loads are tabulated in excel sheet.

Maximum design forces for each type member i.e., top chord, bottom chord, vertical, inclined members of truss, stringers and floor beams or cross beams and bracings of truss obtained and tabulated in spread sheets as shown below:

![Table 1: Design Forces in Top Chord and Vertical Members of Truss](image1)

![Table 2: Design Forces in Inclined Members of Truss and Stringsers in Road Level Cross Beams](image2)

Design of slab at road level is done using effective width method (as per clause 305.16.3 of IRC 21)

Area of steel per meter in cantilever portion = $2428.72 \text{ mm}^2$;

Area of steel in simply supported continuous portion = $217.59 \text{ mm}^2$;

**Reinforcement at top zone**

main reinforcement 20 mm dia at 130mm center to center

distribution reinforcement 8mm dia at 200 mm center to center

**Reinforcement in bottom zone**

Main reinforcement 10 mm dia at 200mm center to center
Distribution reinforcement 8mm dia at 200 mm center to center

Sections selected for design

Truss – Channel Section connected Face to Face by battening and lacing ISMC 350

<table>
<thead>
<tr>
<th>StaadName</th>
<th>Area cm^2</th>
<th>D mm</th>
<th>Bf mm</th>
<th>Tf mm</th>
<th>Tw mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISMC350</td>
<td>54.4</td>
<td>350</td>
<td>100</td>
<td>13.5</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Stringer beams – I Sections

<table>
<thead>
<tr>
<th>StaadName</th>
<th>Area cm^2</th>
<th>D mm</th>
<th>Bf mm</th>
<th>Tf mm</th>
<th>Tw mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>I100012B55012</td>
<td>423</td>
<td>1024</td>
<td>550</td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

Cross beams – I Sections

<table>
<thead>
<tr>
<th>StaadName</th>
<th>Area cm^2</th>
<th>D mm</th>
<th>Bf mm</th>
<th>Tf mm</th>
<th>Tw mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>I125012B55016</td>
<td>497</td>
<td>1282</td>
<td>550</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>
6. CONCLUSION

1. Road cum railway bridge reduces the construction cost by providing a single bridge for both railway traffic and road traffic instead of providing two separate bridges.

2. It meets the increased railway and road traffic needs across the river Krishna.

3. It reduces the land acquisition problem by providing a single bridge.

Acknowledgments: The authors thank the Head of the department and Principal of VR Siddhartha College of Engineering, kanuru, Vijayawada for continued support and cooperation to do this study.

REFERENCES


[3] Xueyi L, Pingrui Z. Feng DM. Advances in design theories of high-speed railway ballastless tracks. Key Laboratory of High-Speed Railway Engineering, Southwest Jiaotong University, Chengdu, China.

[4] Li Z, Zhiyun S. Progress in high-speed train technology around the world. Transport Bureau, The Ministry of Railways of China, Beijing, China. Traction Power State Key Laboratory, Southwest Jiaotong University, Chengdu 610031, China


[7] Indian railway standards-Steel Bridge Code indian railway standard code of practice for the design of steel or wrought iron bridges carrying rail, road or pedestrian traffic.


Bracings – Angle sections

<table>
<thead>
<tr>
<th>Area cm^2</th>
<th>D mm</th>
<th>B mm</th>
<th>T mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISA75x75x6</td>
<td>8.66</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>