



INVESTIGATING IN ANALYSIS AND DESIGN OF 24M LONG SPAN STEEL GIRDER CONSIDERING THE LOAD OF SPECIAL VEHICLE

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ABSTRACT

This paper deals with the design of 24 m long span steel girder considering the loading specified in amendment-1 IRC: 6-2014. The vehicle is 30 m long having gross vehicular load of 385 tones. The live load specified in amendment 1 of IRC: 6-2014 i.e. IRC class Special Vehicle will only be considered as live load for analysis and design. The design considering Special Vehicle live load will be compared with the standard design from R.D.S.O. and the feasibility of R.D.S.O. section will be checked for new IRC loading i.e. special vehicle. R.D.S.O. provides the design 36.0m span, so in this project for the same span length (i.e. 36.0m) comparison will be made. The design parameters will be same as per the RDSO however No wind, seismic, braking force and dynamic impact on live load is considered as IRC 6 -2014 has clearly neglected it.

The final conclusion will be drawn whether the RDSO span can carry the load of GVW 385 tones safely or not.

Keywords: IRC: 6-2014, RDSO, Special Vehicle, Steel Girder, Vehicular Load

I INTRODUCTION

BRIDGE:- A structure provided for passage over an obstacle without closing the way beneath is technically termed as bridge. The passage over the obstacle may be required for a roadway, a railway, pedestrian way, a canal or a pipeline i.e. for water way. The obstacle to be crossed for which the bridge is provided may be a river, a road, railway or a valley.

Composite Steel-Concrete Structures are used widely in modern bridge and building construction. A composite member is formed when a steel component, such as an I-beam, is attached to a concrete component, such as a floor slab or bridge deck. In such a composite T-beam the comparatively high strength of the concrete in compression complements the high strength of the steel in tension. The fact that each material is used to the fullest advantage makes composite Steel-Concrete construction very efficient and economical. However, the real attraction of such construction is based on having an efficient connection of the Steel to the Concrete, and it is this connection that allows a transfer of forces and gives composite members their unique behavior.



Steel-concrete composite systems have become quite popular in recent times because of their advantages against conventional construction. Composite construction combines the better properties of the both i.e. concrete and steel and results in speedy construction. The present work includes Analysis and Design of 36.0m Steel-Concrete composite superstructure for Road Over Bridge subjected to IRC loading by Limit State Design Method. The design available on this topic was considering Class AA Load, Class A Loading, Class 70R Loading, etc. those specified in IRC:6-2000 or IRC:6-2014 but in this project Special Vehicle recommended by IRC:6-2014 will also be consider for the analysis purpose in addition to above mentioned loading.

The use of Steel in construction industry is very low in India compared to many developing countries. Experiences of other countries indicate that this is not due to the lack of economy of Steel as a construction material. There is a great potential for increasing the volume of Steel in construction, especially the current development needs in India. Exploring Steel as an alternative construction material and not using it where it is economical is a heavy loss for the country. Also, it is evident that now-a-days, the composite sections using Steel encased with Concrete are economic, cost and time effective solution in major civil structures such as bridges and high rise buildings.

The most important and most frequently encountered combination of construction materials is that of steel and concrete, with applications in multi-storey commercial buildings and factories, as well as in bridges. These essentially different materials are completely compatible and complementary to each other; they have almost the same thermal expansion; they have an ideal combination of strengths with the concrete efficient in compression and the steel in tension. Concrete also gives corrosion protection and thermal insulation to the steel and additionally can restrain slender steel sections from local or lateral-torsional buckling. Unfortunately these two important building materials, steel and concrete, are promoted by two different industries. Since these industries are in direct competition with each other, it is sometimes difficult to promote the best use of the two materials.

II OBJECTIVES

The primary objectives of this study can be summarized as follows:

- 1) The study of Road over Bridge (ROB) and composite action of Steel-Concrete.
- 2) The study of different IRC codes required for analysis and Design of Steel-Concrete Composite Super-structures.
- 3) Analysis of Composite Superstructure with different IRC Loadings.
- 4) Design of Composite Superstructure as per Limit State Design Method specified in IRC: 24-2010 and IRC: 22-2015.

III RESEARCH METHODOLOGY/PLANNING OF WORK

The proposed work is done in the following manner

- Study of IRC code IRC: 5-1998, IRC: 6-2014, IRC: 22-2015, IRC: 24-2010.
- Study of Limit State Design Method.
- Analysis and Design of Composite Superstructure

In this project the model of Composite Superstructure of Road Over Bridge will be prepared in STAAD-Pro considering 7.5m clear carriageway, 0.45m crash barrier, 1.5m footpath and 0.2m parapet walls on both sides which leads to 11.8m wide superstructure. 5 longitudinal girders are provided at center to center spacing of 2.5m. Loading as per IRC: 6-2014 will be considered and design will be based on Limit State Method specified in IRC: 24-2010 for Steel Section and IRC: 22-2015 for composite section. The live load specified in amendment 1 of IRC: 6-2014 i.e. IRC class Special Vehicle will only be considered as live load for analysis and design. The design considering Special Vehicle live load will be compared with the standard design from R.D.S.O. and the feasibility of R.D.S.O. section will be checked for new IRC loading i.e. special vehicle. R.D.S.O. provides the design for 24.0m. These span of 24m is used whenever the road over bridge is to be constructed over the railway crossing for single track intersecting the road or the highway. The bridge is not proposed on the curve hence, neglect the centrifugal force. The bridge is to be designed for the special vehicle load according to the journal of IRC 6:2014 amendment 2014 which specifies that wind, seismic, dynamic impact and braking force are not to be considered. This special vehicle is having a gross vehicular load of 385 tones, having 18T per axle of 20 numbers of the trailer unit and the two axles of 9.5T and one axle of 6T of the prime mover. The total length of the vehicle is 38.459m having 28.50m length of the railer unit, 4.57m length of the prime mover and 5.389m length of the tow bar.

V RESULTS OBTAINED FROM THE ANALYSIS ON STAAD PRO

5.1 Analysis of Shear Force

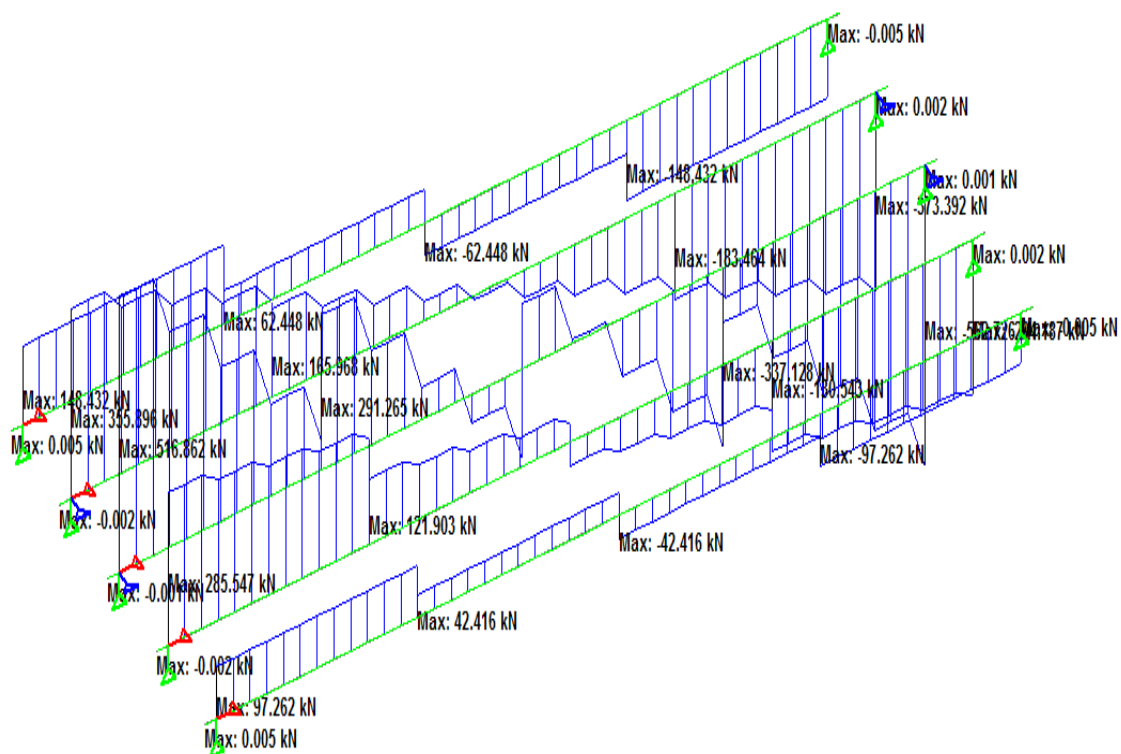


FIG 1 SHEAR FORCE RESULTS OBTAINED FROM STAAD PRO

The above figure shows the shear force diagram obtained by the staad input results which is the critical case of load combination giving the maximum value of the shear force for the 24m span of composite superstructure made up of the RDSO section.

Shear Force due to Dead Load + super imposed dead load + Shrinkage + Thermal + Special Vehicle
= 1006.92 KN

Permissible average shear stresses = 91.20 Mpa

Average shear stress in web (τ) = $\frac{1006.9 \times 1000}{1500 \times 18} = 37.29$ Mpa

Here, the permissible stress is more than the average shear stress developed in the section of the web hence the section is safe in shear.

5.2 Analysis of Bending Moment

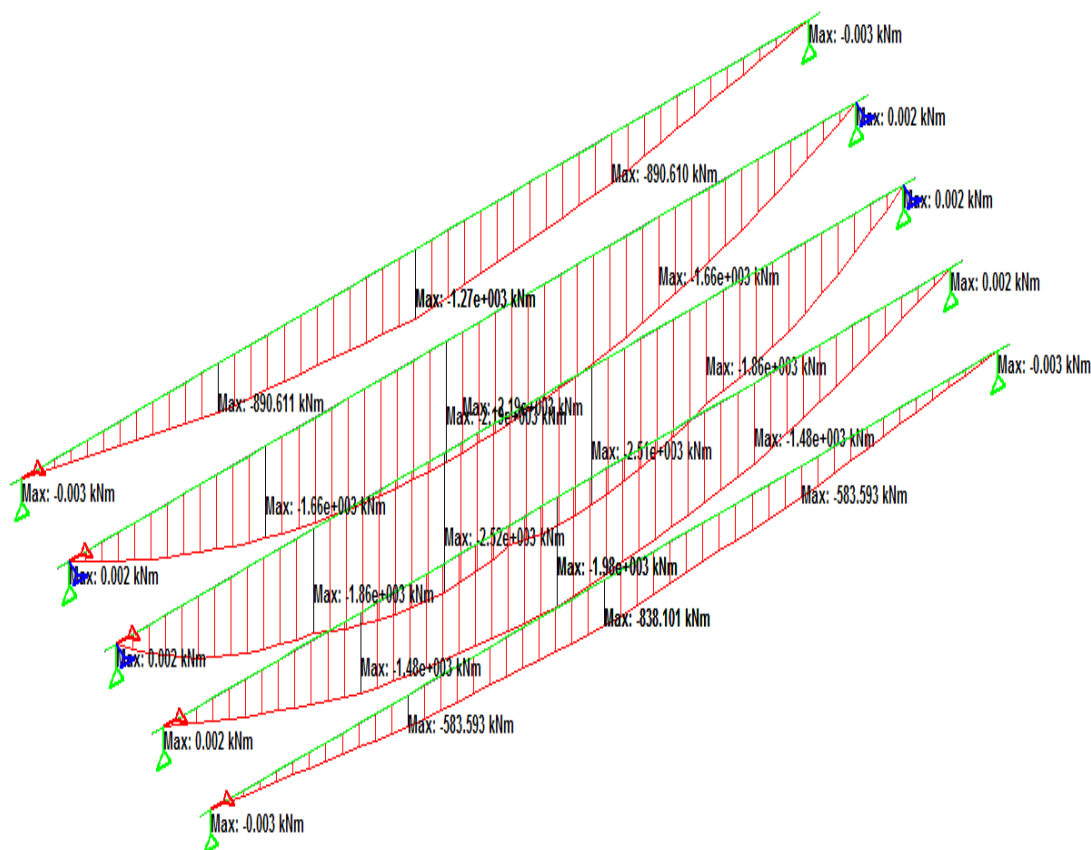


FIG 2 BENDING MOMENT RESULTS OBTAINED FROM STAAD PRO

The above figure shows the bending moment diagram obtained by the staad input results which is the critical case of load combination giving the maximum value of the bending moment for the 24m span of composite superstructure made up of the RDSO section.



Bending Moment due to Dead Load + super imposed dead load + Shrinkage + Thermal + Special Vehicle
= 6258.30 KN-m

Moment carrying capacity of the section = 5685.00 KN-m

Here, the moment carrying capacity of the section is less than the actual moment developed on the section of the main girder. Hence the girder of the bridge whose sections are as per the RDSO fails to carry the load of the special vehicle for 24m span.

5.3 Analysis of Deflection

Permissible deflection in girder under Dead load, live load = 40.00 mm

Permissible deflection in girder under live load = 30.00 mm

Deflection of girder under = 13.80 mm

Deflection of girder under Dead load, Live load = 13.51 mm

Here the deflection in the section is less than the permissible deflection in the girder hence the section is safe under the deflection with respect to the live load and dead load.

Since the structure is fails in the bending criteria, the section of the RDSO for 24m span is not safe. Hence this section is to be redesigned.

VI CONCLUSION

The moment Resistance capacity of the section as per RDSO drawings for 24.0m span is compared with the bending moment calculated for Special Vehicle loading and from result it is seen that the moment resistance capacity of section is less than that of the design bending moment. From that it can be concluded that, the section cannot withstand for special vehicle loading and hence the section properties need to be modified for design bending moment, whereas the section is safe in shear and deflection check.

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