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MODELING, ANALYSIS AND STRUCTURAL PERFORMANCE EVALUATION OF T-BEAM AND TURN-OVER PLATE GIRDER BRIDGE USING STAAD.PRO

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Abstract

Roads are the lifelines of contemporary transport and bridges are the foremost vital elements of transportation systems. They are prone to failure if their structural deficiencies are unidentified an oversized range of bridges made round the world were styled throughout the amount once bridge codes had no unstable design provisions, or once these provisions were lean per this standard. In present research work is to investigate the difference in design results when using 3D analysis based on Finite element analysis. Analysis and comparison of results were performed for four types of bridge structures, a T- Frame concrete plate girder bridge, T- Frame steel plate girder bridge, Turn Over (TO) concrete I-type girder plate bridge and Turn Over (TO) steel I-type girder plate bridge. Structural modelling, loads and load combinations were carried out according to the relevant parts of Indian code with nationally determined parameters according to (IRC Chapter -3. Further, a dynamic analysis over different class (Class AA, Class 70R, Class A and Class B) was performed in order to evaluate the most suitable structure.

Keywords: *Concrete Bridge; Steel Bridge; T-Beam Girder; TO Girder; Finite Element Analysis.*

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1. Background

For short spans, a solid reinforced concrete slab, generally cast in-situ rather than precast, is the simplest design. It is also cost-effective, since the flat, level soffit means that falsework and formwork are also simple. Reinforcement, too, is uncomplicated. With larger spans, the reinforced slab must be thicker to carry the extra stresses under load. This extra weight of the slab itself then becomes a problem, which can be solved in one of two ways. The first is to use pre-stressing techniques and the second is to reduce the deadweight of the slab by including 'voids', often expanded polystyrene cylinders. Up to about 25m span, such voided slabs are more economical than pre-stressed slabs.

Figure 1. Concrete bridge structure

With introduction of the new generation of design codes, Eurocodes, the Swedish transport administration demands a new approach for analysis of bridge structures where the overall structural behavior shall be accounted for. Furthermore, for bridges with slab superstructures, the Swedish transport administration recommends an analysis based on plate or shell theory. The equivalent frame analysis according to the Swedish transport administration, not anymore, an acceptable method for analysis of slab bridges. However, the new demands require more comprehensive analysis and it can be questioned if these are motivated for simpler cases. Furthermore, the more comprehensive analyses in combination with design for maximum load effects in all sections may lead to less economical design solutions

2. Methodology

Generally, the bridge superstructure can be divided into two categories. One type is a closed system and the other is an open system, such as a box-type girder or plate-type girder system, respectively. The box-type girder system is advantageous in torsion and durability, but it is disadvantageous in terms of construction costs.

2.1 Design & Analysis

Cross section of Deck

- Thickness of deck slab = 200mm.
- Wearing coat = 80mm.
- Width of main girders = 300mm.
- Breadth of cross girder = 300mm.
- Depth of main girder = 160cm at the rate of 10cm per meter of span.

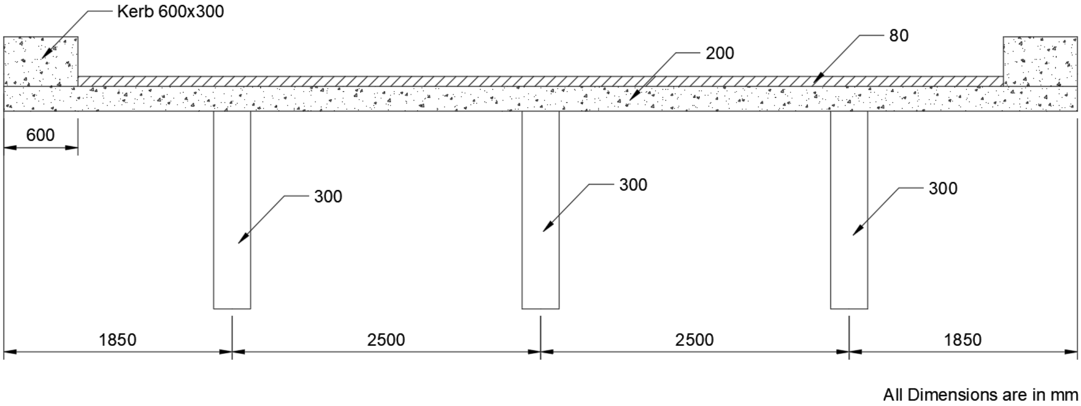

Figure 2. Cross section of Deck

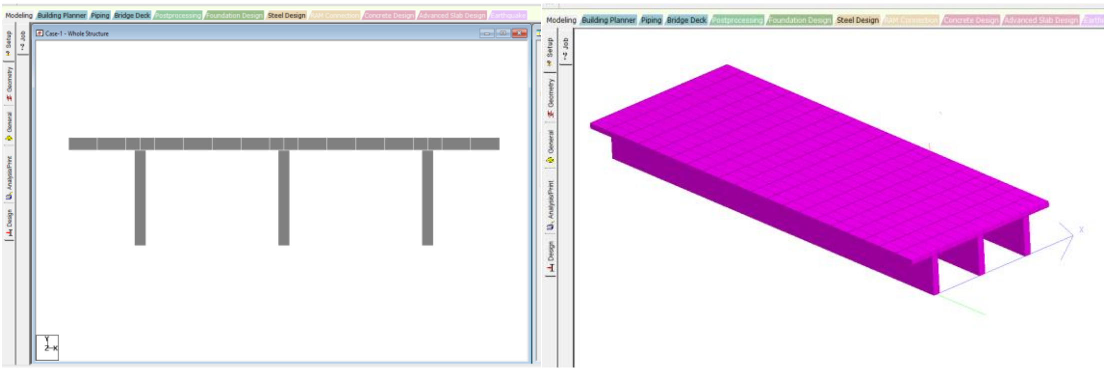

Figure 3. Structure model of T–Frame three-girder concrete bridge

3. Results and Discussions

The multi-span highway bridge under investigation has three continuous spans in the longitudinal direction with a span length of 20 m.

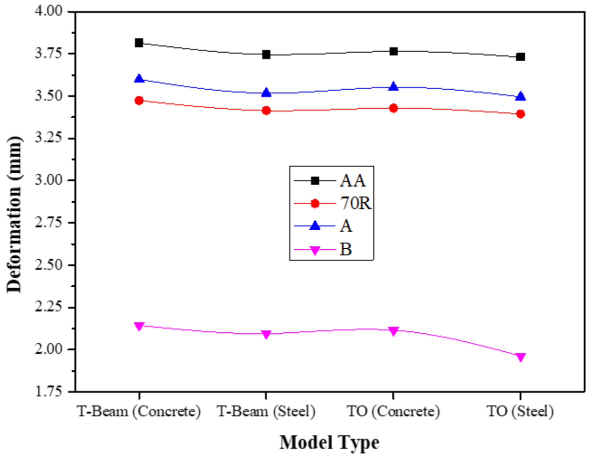

Figure 4. Variation of deformation with different IRC classes and design model

The bridge girders are equally distributed in the cross or transverse direction with a girder spacing of 4 m. In order to determine the optimal design action between the concrete/steel and plate sections, the location of the confining concrete section in the cross section is varied, as shown and discussed in previous chapter. The effective height of the bridge cross section is maintained at 1.6 m for all four cases.

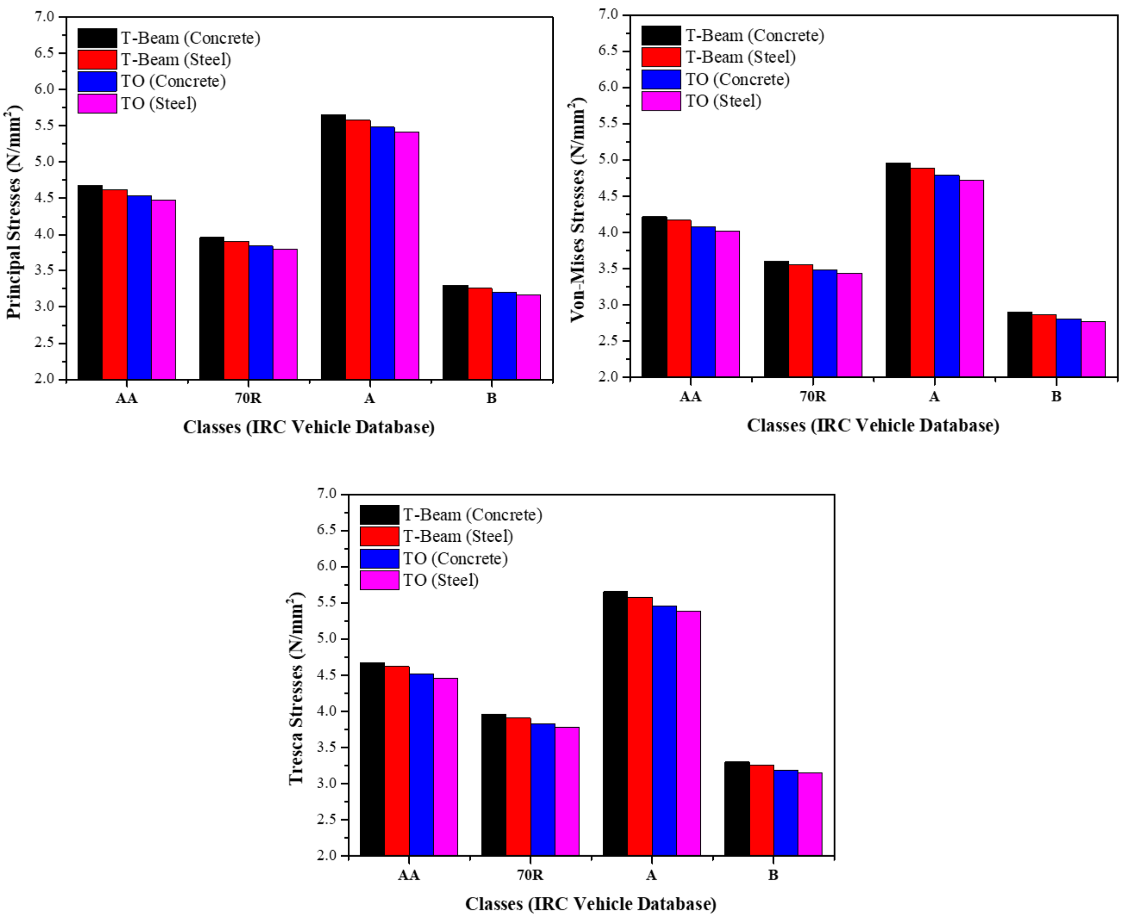

Figure 5. Variation of Principal, Von-Mises and Tresca stress in top side of the bridge deck

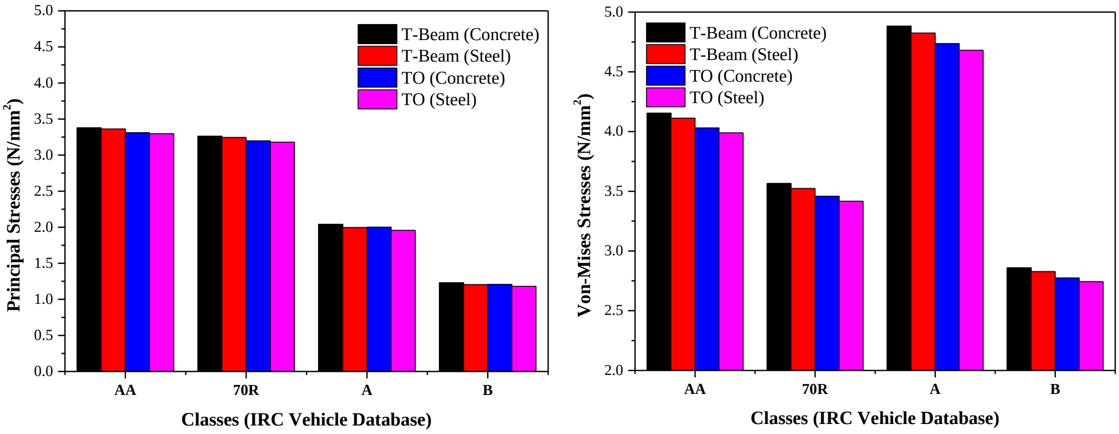

Figure 6. Variation of Principal, Von-Mises and Tresca stress in bottom side of the bridge deck

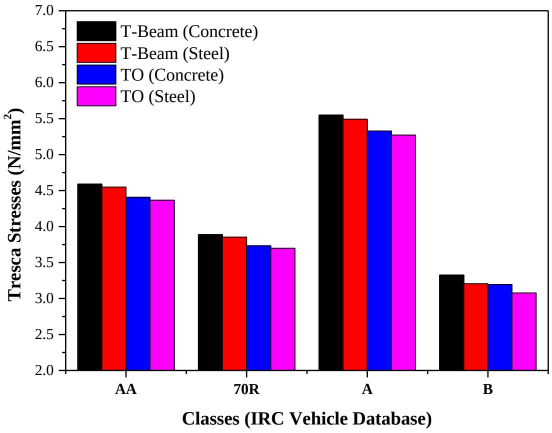

Figure 6. Continue

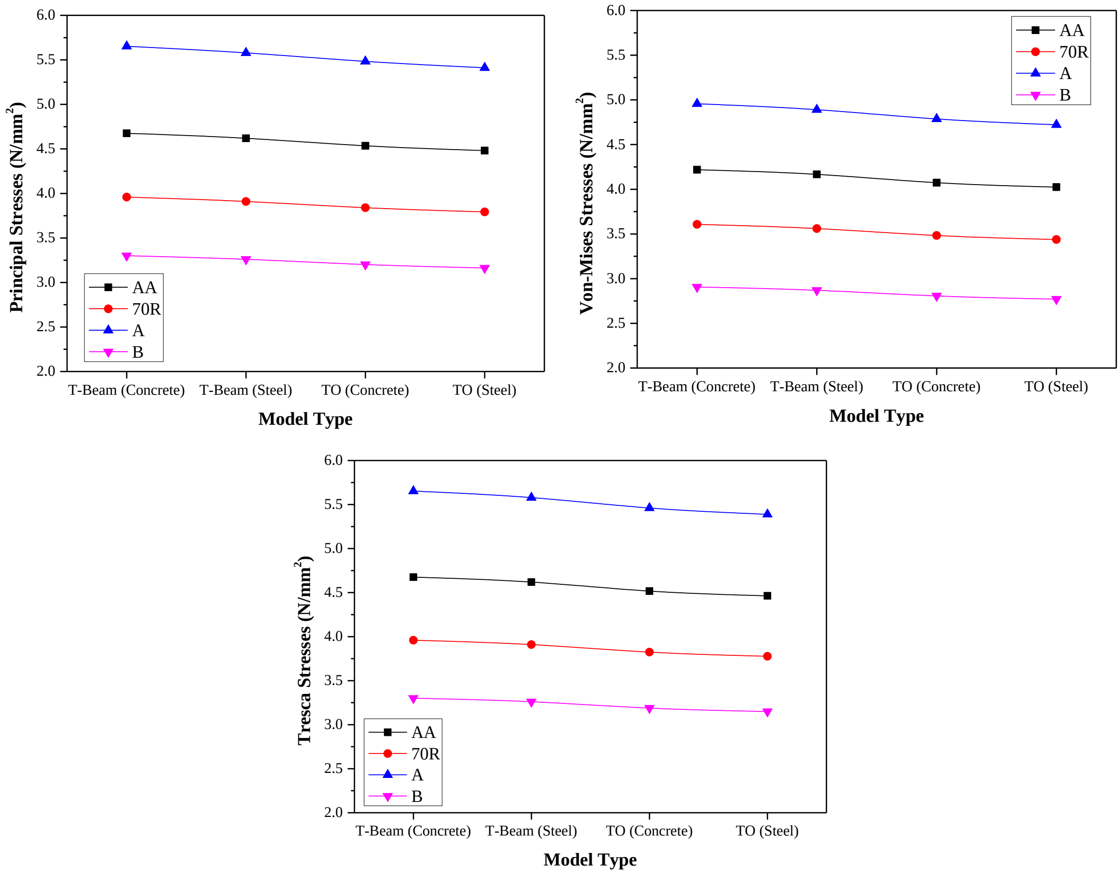

Figure 7. Variation of Principal, Von-Mises and Tresca stress with effect of classes and model type in bridge deck

4. Conclusion

From analysis the major conclusion has been drawn:

- In this work, a T-Frame bridge with replaced plate (concrete and steel); and modified precast construction method called Turn Over (TO) is proposed for construction efficiency improvement for turning over an I-section concrete and steel girder. A full-scale 20 m three girder specimen were used to investigate the optimum design to evaluate the structural performance.

- A plate girder bridge is a bridge constructed by placing a concrete plate on steel or concrete I-type girders. Therefore, a plate girder bridge is usually a precast-type that can save construction time, and works by transporting and placing the pre-casted girders on top of the pre-constructed bridge piers on-site.
- A full-scale 20 m T- Frame concrete plate girder bridge, T- Frame steel plate girder bridge, Turn Over (TO) concrete I-type girder plate bridge and Turn Over (TO) steel I-type girder plate bridge has been performed in order to evaluate the most suitable structure.
- In order to evaluate with variation of load, the IRC Chapter 3 Indian code has been applied (Class AA, Class 70R, Class A and Class B) in the bridge deck.
- Analysis of the results showed that the proposed TO with steel plate can be applied to practical designs as an improved the design

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