

PREFACE

In the past, several steel open web girder bridges have failed during various stages of construction or in-service conditions. Sudden failure or collapse of the bridge is always a catastrophic disaster, as such a type of collapse does not give any precautionary warning. The possibility of a sudden collapse of truss bridges has always been due to the buckling of non-redundant critical compression members. Unlike compression members, tension members do not usually fail suddenly since they experience noticeable elongation and can take stress up to ultimate stress beyond the yield stress. One way to avoid buckling is to provide a composite RCC deck with the compression members. The use of composite RCC decks in steel bridges is now increasing. A detailed experimental study was conducted to ascertain improvements due to composite RCC deck over non-composite bridge model. Deck-type steel bridge models, with and without composite decks were tested in the laboratory up to failure. The failure in the non-composite model was observed due to buckling of the top chord member at a stress of 234.6 N/mm^2 , whereas for the model with the composite deck it changed to rupture of the bottom chord in tension at a stress of 614.8 N/mm^2 . The failure load and stiffness of the structure also increased significantly due to the composite action. Shear connectors designed as per IRC 22:2015 transferred the shear effectively and the deck slab participated in load sharing. Further, load sharing in the top chord compression member comprising the steel top chord, the concrete in the deck slab, and the reinforcing steel in it, was also explored. It is found that 72.0% of the composite top chord compressive force is taken by the RCC deck, and in the RCC deck, 30.7% force is taken by the reinforcement. Strain variation in deck slab was also recorded using strain gauges. Strain in deck slab over top chord members was observed to be 54% more than the strain in the middle of the deck slab.

In the literature, detailed provisions for the analysis and design of steel and RCC deck composite open web steel girder bridges do not exist. The model on which the experiment is

performed is modelled on STAAD Pro. v8i software. The experimental test results are used to validate the STAAD analysis results. Bottom chord strain and mid-span deflection of the composite bridge model as found from the STAAD analysis and the laboratory experiment closely tally with each other. This validates the standard STAAD analysis results. However, in the top chord member, due to shrinkage cracks in the deck slab concrete and deformation in shear connectors, the experimentally recorded strain is higher by about 100% than the STAAD analysis result. Shear force in studs is considerably large near supports and joints as compared to the midsection. Therefore, the design of shear studs may be carried out based on the shear forces in the studs found from the STAAD analysis. Thus it is recommended that STAAD or any other standard finite element analysis software can be used for the analysis and design of the composite bridges.

Moreover, the impact of a composite deck is also studied for through type and deck type truss bridges. In trusses, deck type and through type truss systems are generally provided with various member arrangements. To study the effectiveness of composite deck with through type and deck Type Bridge, analysis of 60.0 m deck type and through type, non-composite and composite bridges are done. The bridges are modelled using STAAD. Pro v8i software with truss members as beam element and deck slab modelled as four noded plate element. The loading on the bridge is done as per the provisions of IRC 6:2017 and IRC 24:2010. The composite deck decreases vertical stiffness and increases the stiffness of the bridge. The composite deck effectively reduces the horizontal deflections due to lateral seismic and wind loads in both the truss systems. Stresses in the members made composite with the deck slab were also reduced and hence may result in material saving and decreased steel offtake. In the case of composite deck-type bridges due to load sharing by the deck slab, the stresses in the top chord are reduced significantly hence eliminating the chances of buckling. Advantages of

the composite deck are better utilized in deck type bridge system compared to through type bridge system.