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Comparative Study Of RCC Skew T-Beam Bridge Using Grillage Analogy Method

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Abstract-*T-beam Bridge is a common choice among the designers for small and medium span bridges. In order to cater to greater speed and more safety to present day traffic, the modern highways are to be straight as far as possible. But the presence of skew in a bridge some time cannot be avoided due to constraints in fixing straight alignment. For the T- beam bridges with small skew angle, it is frequently considered safe to ignore the angle of skew and analyse the bridge as right bridge with a span equal to the skew span. However, T-beam Bridge with large angle of skew can have considerable effect on the behavior of the bridge especially in the short to medium range of spans. Hence an attempt is made to study the behavior of T-beam skew bridges with respect to bending moment, shear force, torsion and deflections under standard IRC loadings. The skew angle chosen for study are 0˚, 15˚, 30˚, 45˚ and 60˚. The analysis carried out by grillage analogy method.*

***Keywords*: TEE beam bridge deck, IRC 6, Grillage analogy method, Skew angle**

1. INTRODUCTION

When stream crosses the road at an angle other than 90˚, such bridges are called skew bridges. Construction of skew bridges results in saving of time and traffic requirements. The stresses in skew slab are significantly influenced by the skew angle. Various methods are available for bridge analysis like grillage and FEM. Grillage technique of analysis is more often used and is a simple method. Grillage method results have greater accuracy and is design oriented compared to experimental results. In the present study, a simply supported T-beam bridge deck of span length 16m is selected for analysis and the cross section is shown in figure 1. The longitudinal beam should run parallel to free edges and transverse beams can either run right angle to the longitudinal beam or parallel to support. T-beam bridge deck is most commonly adopted type of bridge for span of 10m to 25m. The stress parameters such as bending moment, shear force, torsion in the longitudinal girders are studied by grillage analogy method. Also the straight bridge results are compared with different skew angle bridges under IRC class AA tracked vehicle and IRC class A wheeled vehicle. The different skew angles selected for the study are 0˚, 15˚, 30˚, 45˚ and 60˚. The analysis was carried out in STAAD Pro.

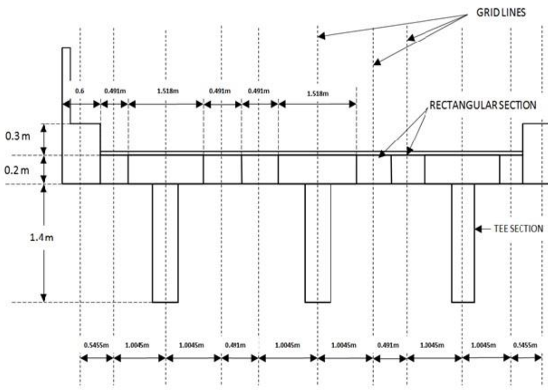

Figure 1. Cross section of TEE beam bridge deck

2. Aim of the study

The present study aims to compare the stress parameters such as bending moments and shear forces by grillage analogy method with varying skew angle, hence to find more economical values for a particular skew bridge design. A simply supported 2-lane T-beam bridge deck is studied under IRC class AA tracked vehicle and IRC class A wheeled vehicle including impact factor as per IRC 6.

3. Objective of the study

- Comparison of bending moment, shear force, Torsion and deflection values of longitudinal skew bridge girders by grillage analogy method for skew angles 0˚, 15˚, 30˚, 45˚ and 60˚.

4. Methodology

Models are done using STAAD Pro for investigations of stress parameters for skew angles of 0˚, 15˚, 30˚, 45˚and 60˚. The models are subjected to dead load and live load. The self weight due of railings and self weight of kerbs above the slab level are neglected. The live load is applied according to IRC 6:2014, Live load considered for analysis are IRC class AA tracked vehicle and IRC class A wheeled vehicle along with impact factor as per IRC 6. The parameters investigated are bending moment, shear force, torsion and deflection.

DATA

Total width of roadway = 8.7 m
Width of carriageway = 7.5m
Effective span length = 16m

Thickness of wearing coat = 80mm
Live load = I.R.C Class AA tracked vehicle and I.R.C Class A wheeled vehicle
f_{ck} = M- 25
f_y = Fe- 415HYSD bars
Number of main girders = 3
Spacing of longitudinal girder = 2.5 m
Thickness of deck slab = 200 mm
Cross section of longitudinal girder = 300mm x 1600mm
Cross section of cross girder = 300mm x 1600mm
Spacing of cross girders = 4m
Size of Kerb = 600mm x 300mm

The plans of bridges for different skew angles are shown below;

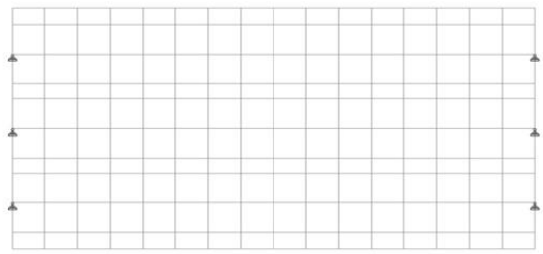

Figure 2. Skew angle =0˚

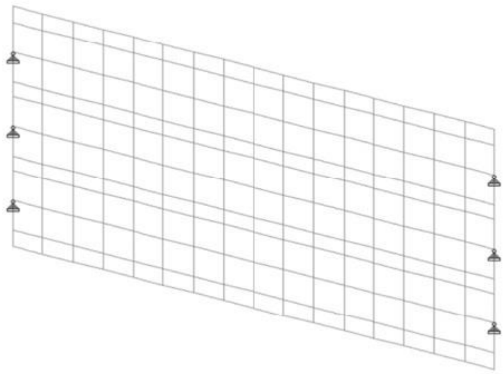

Figure 3. Skew angle =15˚

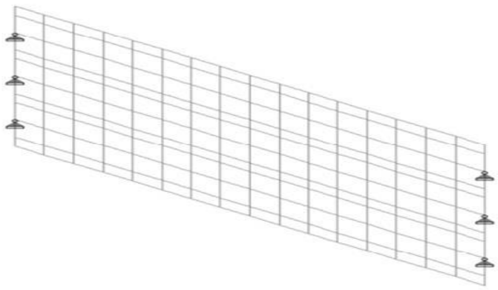

Figure 4. Skew angle =30˚

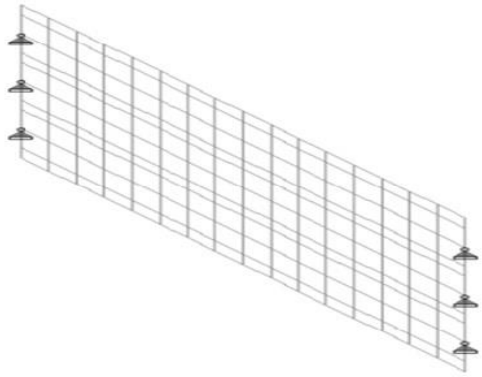

Figure 5. Skew angle =45˚

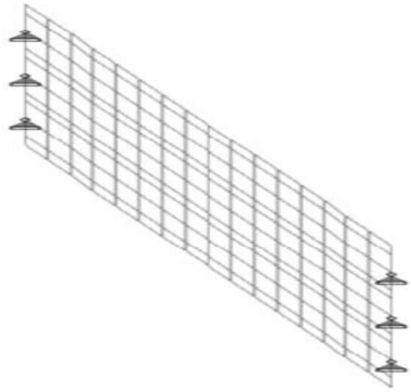

Figure 6. Skew angle =60˚

Following are the various methods used for analysis of longitudinal girder.

1. Courbon's method
2. GuyonMassonet method
3. Hendry Jaegar methods

From the above three methods, courbn's method is more flexible and simplest method. In longitudinal girder, dead load includes self weight of deck, kerb and wearing coat. Live load is calculated by moving load including impact factor.

5. Discussions of the Results obtained from the present study

A simply supported T-beam bridge deck is analysed for dead load and moving load along with impact factor. Bending moment, shear force, torsion and deflection obtained from grillage method for different skew angles were compared.

IRC class AA tracked loading:

The following figures explains the variation in bending moment, shear force, torsion and deflection when subjected to dead load, live load IRC class AA tracked vehicle including impact factor for different skew angles

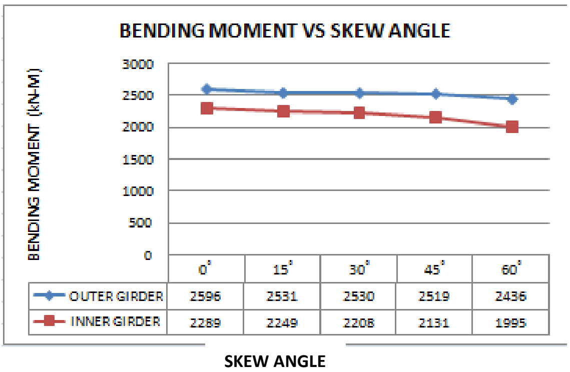

Figure 7. Maximum bending moment in T-beam

The above figure shows that the bending moment in outer and inner girder decreases with increase in skew angle. Also it shows that load shared by outer girder is more than the inner girder.

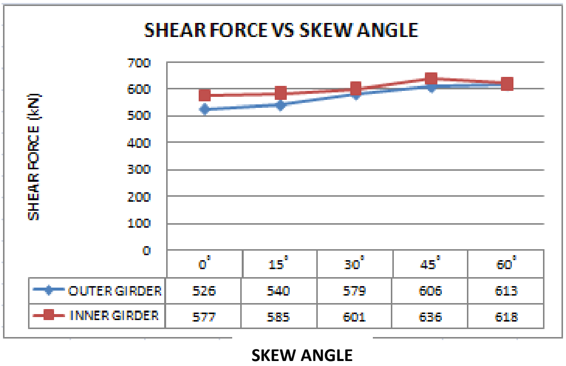

Figure 8. Maximum shear force in T-beam

Shear force variation in outer girder between angle 0° and 15° is almost same but after 15° increase in shear force is observed. Whereas in inner girder, shear force increases with skew angle up to 45° and then decreases.

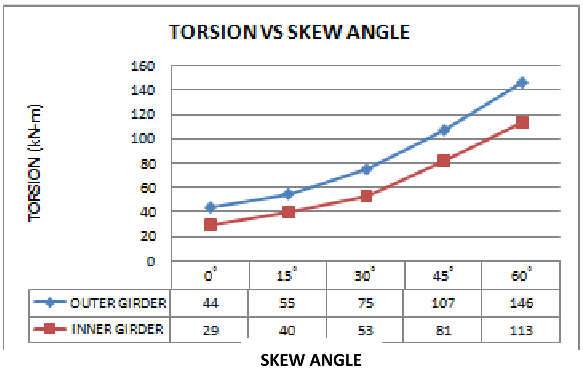

Figure 9. Maximum torsion in T-beam

From the above figure, constant increase in the torsion can be observed in inner girder with increase in skew angle and it follows a smooth curve both in outer and inner girder. The torsion in outer girder is higher than the inner girder.

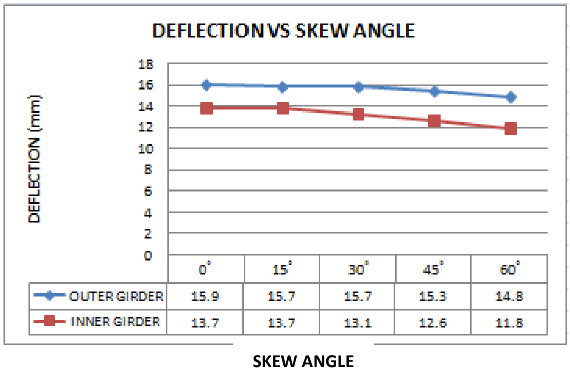

Figure 10. Maximum deflection in T-beam

The deflection in outer girder is higher than the inner girder depending on corresponding bending moment and change in deflection with change in skew angle can be observed.

Class A loading:

The behavior under the IRC class A wheeled loading is same as behavior observed under IRC class AA tracked loading with lesser magnitude of bending moment, torsion and deflection. But shear force variation is not much between skew angle 0° and 30°.

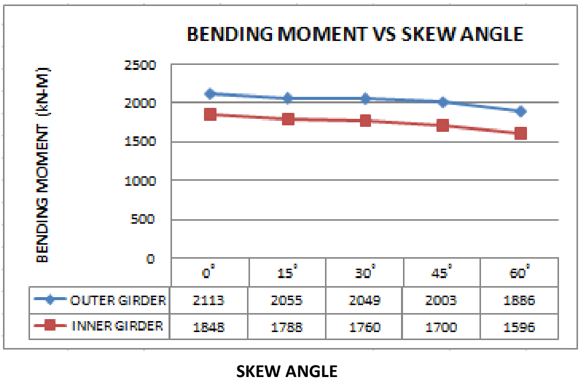

Figure 11. Maximum bending moment in T-beam

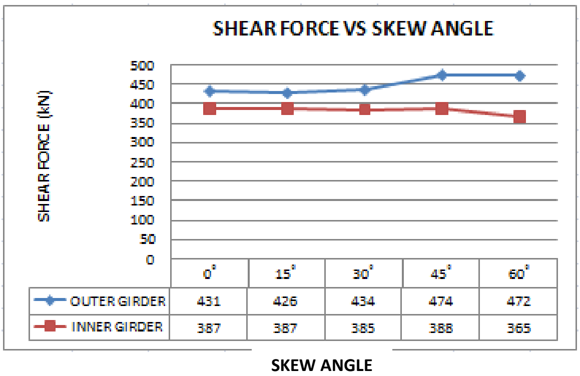

Figure 12. Maximum shear force in T-beam

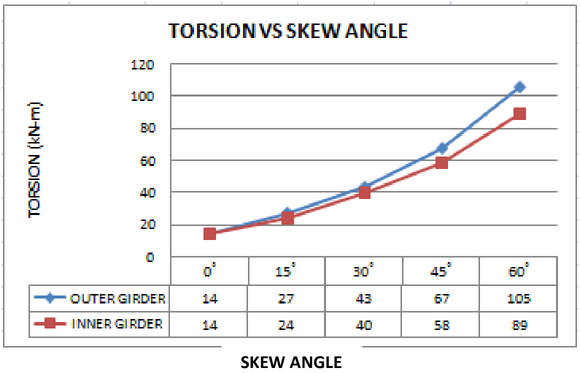

Figure 13. Maximum torsion in T-beam

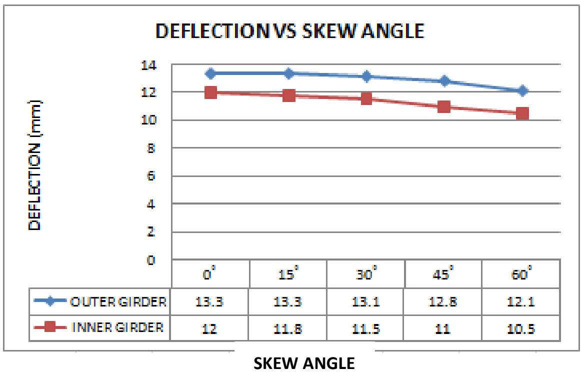

Figure 14. Maximum deflection in T-beam

Conclusion

From the obtained results for the defined objectives, the following conclusion is drawn and discussed.

- Torsion in outer and inner girder increases with increase in skew angle. Hence it is an important factor to be considered in the design of skew bridges.
- Bending moment and deflection decreases with increase in skew angle.

Recommendation

In this study, it is recommended to adopt bridge having skew angle less than 15˚. While designing skew bridges, designer needs to concern more about torsion.

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