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To study the various parameter and the behavior of a Curved Box Girder Bridges.

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Introduction : Parametric study of box girder bridges using finite element method is described in this paper . The parameters of box girder bridges considered in this study are radius of curvature, span length, span length to the radius of curvature ratio and number of boxes. The various responses parameters considered are the longitudinal stress at the top and bottom, shear, torsion, moment, deflection and fundamental frequency. Numerical analysis carried out by Gupta et al. (2010) is used for validation of the finite element model. The parametric study is carried out, using 60 bridge models, to investigate the behaviour of box girder bridges. Also, the results obtained from par ametric study are discussed briefly in this paper .

Validation Of The Finite Element Model : To validate the finite element model of box girder bridges in SAP 2000, a numerical example from the literature (Gupta et al., 2010) is considered. Figure 4.1 shows the cross section of simply supported Box Girder Bridge considered for validation of finite element model. Box girder considered is subjected to two concentrated loads (P = 2 X 800 N) at the two webs of mid span. Span Length assumed in this study is 800 mm and the material property considered are Modulus of elasticity (E) =2. 842GPa and Modulus of rigidity (G) =1. 015GPa. It can be concluded that the present model gives the accurate result.

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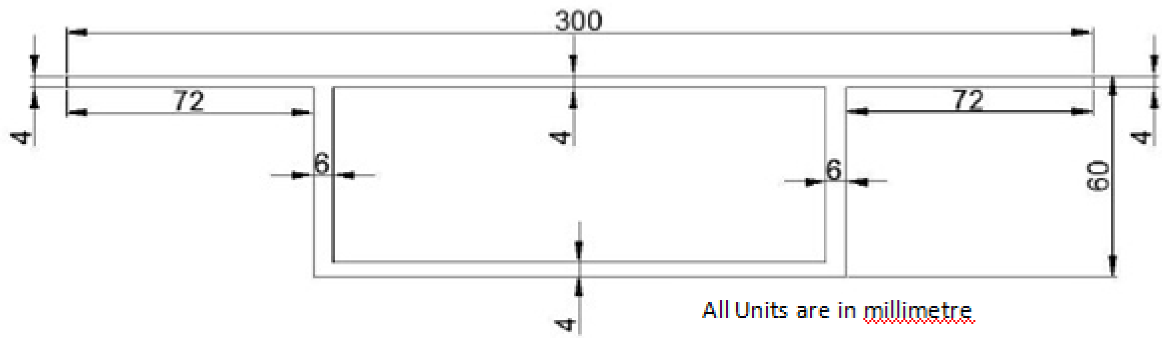

Figure 1: Cross Section of Simply Supported Box Girder Bridge

Case Study Of Box Girder Bridges

The geometry of Box Girder Bridge considered in the present study is based on the design basis report of the Bangalore Metro Rail Corporation (BMRC) Limited. In this study, 60 numbers of simply supported box girder bridge model is considered for analysis to study the behaviour of box girder bridges. The details of the cross section considered for this study is given in Figure 2

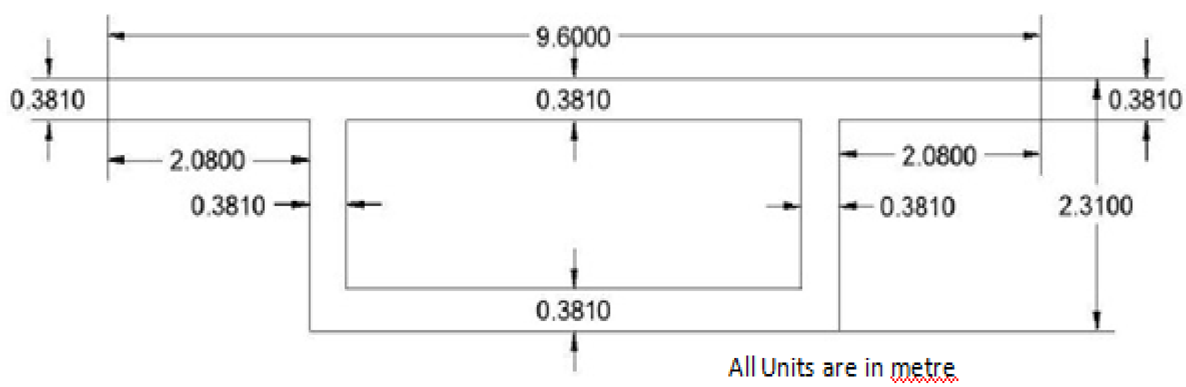

Figure 2 : Cross Section of Simply Supported Box Girder Bridge considered for study

Parametric Study : The parametric study is carried out to investigate the behaviour (i.e., the longitudinal stress at the top and bottom, shear, torsion, moment, deflection and fundamental frequency) of box girder bridges for different parameters viz. radius of curvature, span length, span length to

radius of curvature ratio and number of boxes.

Radius of Curvature : Two lane 31 m Single Cell Box Girder (SCBG), Double Cell Box Girder (DCBG) and Triple Cell Box Girder (TCBG) Bridge are analysed for different radius of curvatures to illustrate the variation of longitudinal stresses at the top and bottom, shear, torsion, moment, deflection and fundamental frequency with radius of curvature of box girder bridges. To express the behaviour of box girder bridges curved in plan with reference to straight one, a parameter α is introduced. α is defined as the ratio of response of the curved box girder to the straight box girder. The variation of longitudinal stress at top with radius of curvature of box girder bridges is shown in Figure 3 . As the radius of curvature increases, the longitudinal stress at the top side of the cross section decreases for each type of Box Girder Bridge. Variation of Stress between radius of curvature 100 m and 400 m is only about 2 % and it is same for all the three cases. Stress variation between each type of box girder is only about 1 %. Figure 4 represents a non-dimensional form of the stress variation for all the three types of box girder.
It shows that stress variation pattern is same for all the three types of box girder.

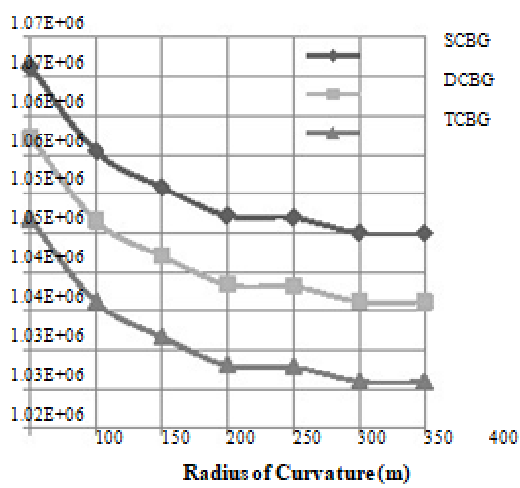

Figure 3 : Variation of Longitudinal Stress with Radius of Curvature at Top of Box Girder

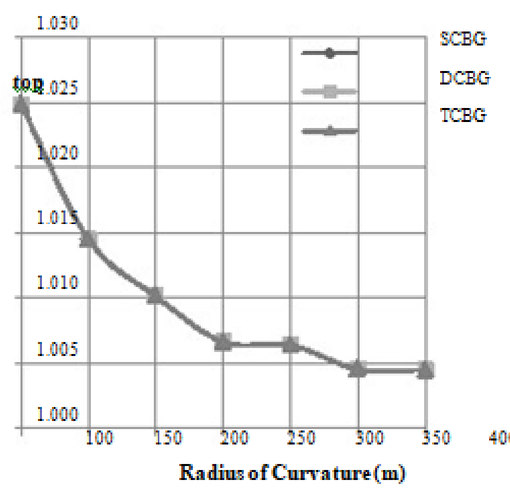

Figure 4 : Variation of $\alpha_{\text{Longitudinal Stress at top}}$ with Radius of Curvature of Box Girder

The variation of longitudinal stress at the bottom with radius of curvature of box girder bridges is shown in Figure 6. As the radius of curvature increases, the longitudinal stress at the bottom side of the cross section decreases for each type of Box Girder Bridge. Variation of stress between radius of curvature 100 m and 400 m is only about 2 % and it is same for all the three cases. Variation of stress between each type of box girder is about 4 %. Figure 7 represents the non-dimensional form of the stress variation for all the three types of box girder. It shows that stress variation pattern is same for all the three types of box girder.

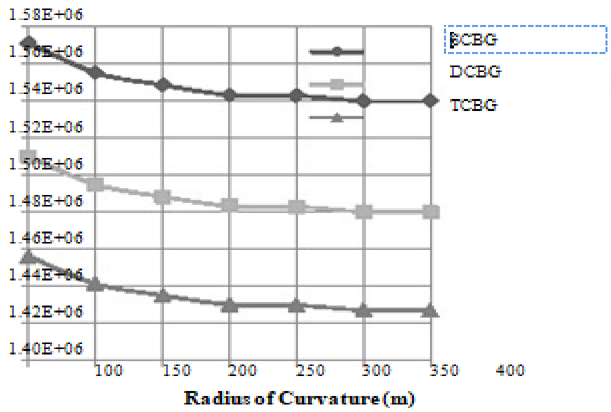

Figure 6: Variation of Longitudinal Stress with Radius of Curvature at Bottom of Box Girder

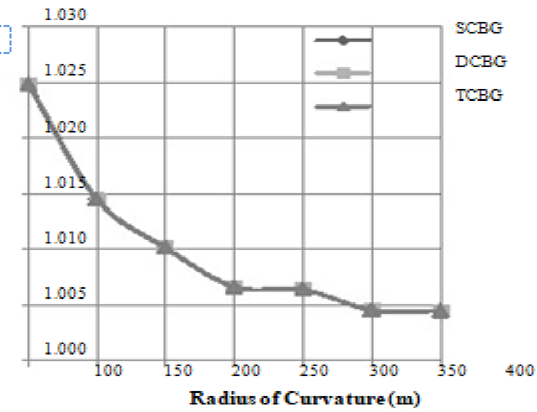

Figure 7: Variation of $\alpha_{\text{Longitudinal Stress at bottom}}$ with Radius of Curvature of Box Girder

The variation of shear force on the radius of box girder bridges is shown in Figure 8. As the radius of curvature increases, the shear force of box girder bridge decreases till radius of curvature 250 m and then it is having a slight increase up to 300 m and then decreases from a radius of curvature 300 m for each type of Box Girder Bridge. Variation of shear force between radius of curvature 250 m and 300 m is only about 0.07 % and it is same for all the three cases. Variation of shear force between radius of curvature 100 m and 400 m for each type of box girder is only about 0.7 %. Figure 9 represents the non-dimensional form of the shear force variation for all the three types of box girder. It shows that the shear force variation pattern is almost same for DCBG and TCBG and for SCBG; it is 1 % more than DCBG and TCBG.

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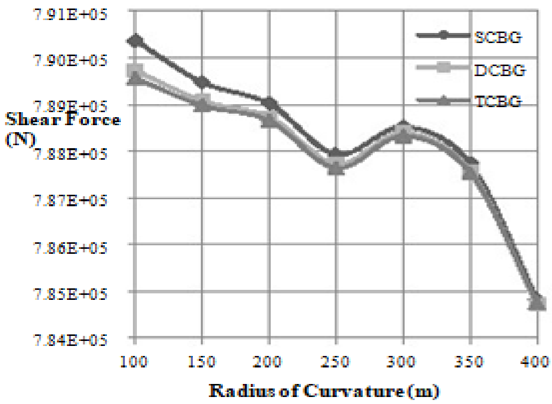

Figure 8: Variation of Shear Force with Radius of Curvature of Box Girder

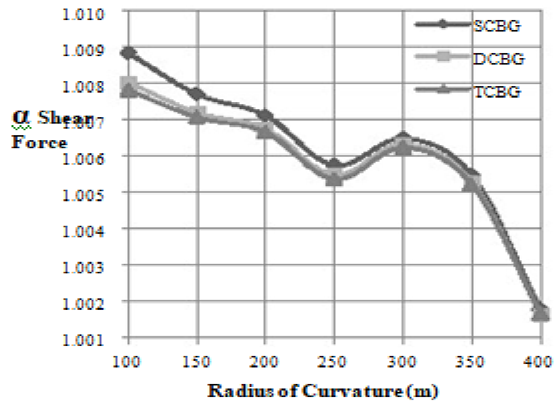

Figure 9: Variation of $\alpha_{\text{Shear Force}}$ with Radius of Curvature of Box Girder

The variation of torsion with radius of curvature of box girder bridges is shown in Figure 10. As the radius of curvature increases, torsion decreases for each type of Box Girder Bridge. Variation of torsion between radius of curvature 100 m and 400 m is about 16-19 % for all the three cases and it shows that the radius of curvature having a significant effect in torsion of box girder bridges. Variation of torsion between DCBG and TCBG is very small and variation of torsion between SCBG and others is about 3 %. Figure 11 represents a non- dimensional form of the torsion variation for all the three types of box girder. It shows that torsion variation pattern is same and has 3 % variation between the three types of box girder.

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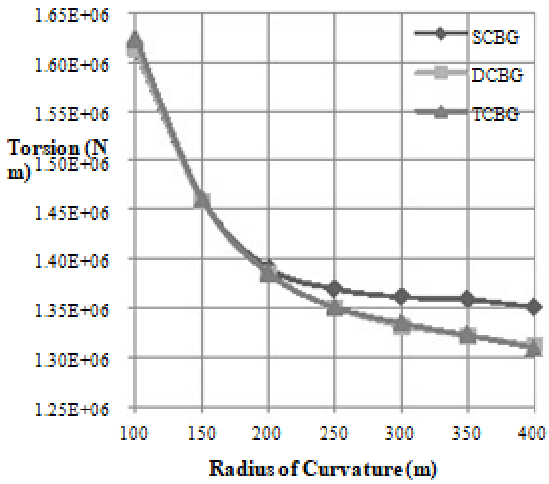

Figure 10: Variation of Torsion with Radius of Curvature of Box Girder

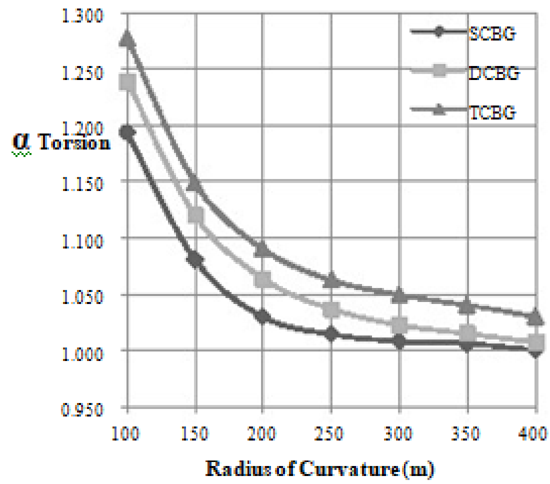

Figure 11: Variation of α Torsion with Radius of Curvature of Box Girder

The variation of moment with radius of curvature of box girder bridges is shown in Figure 12. As the radius of curvature increases, moment decreases for each type of Box Girder Bridge. Variation of moment between radius of curvature 100 m and 400 m is about 2 % for all the three cases. Variation of the moment is very small between three types of box girder. Figure 13 represents a non-dimensional form of the moment variation for all the three types of box girder. It shows that moment variation pattern is same between the three types of box girder.

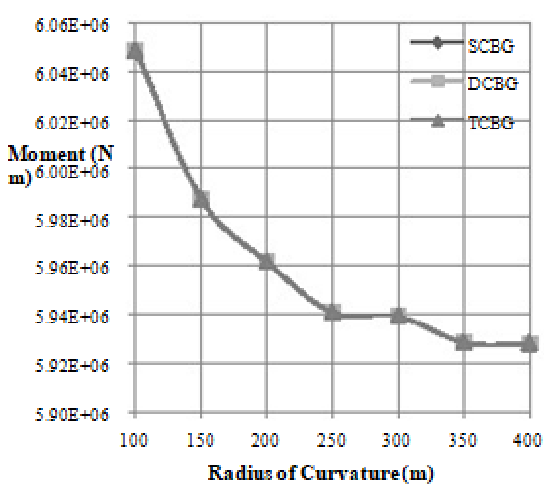

Figure 12: Variation of Moment with Radius of Curvature of Box Girder

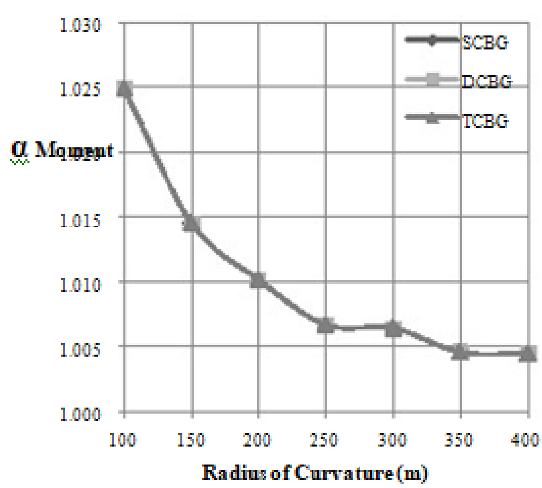

Figure 13: Variation of α Moment with Radius of Curvature of Box Girder

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The variation of deflection with radius of curvature of box girder bridges is shown in Figure 14. As the radius of curvature increases, deflection decreases for each type of Box Girder Bridge. Variation of deflection between radius of curvature 100 m and 400 m is about 13-18 % for all the three cases. Variation of deflection between three types of box girder is about 15 % and this indicates that the effect of radius of curvature on deflection is significant. Figure 15 represents a non-dimensional form of the deflection variation for all the three types of box girder. It shows that the deflection variation pattern is same between the three types of box girder and has a variation of about 5 %.

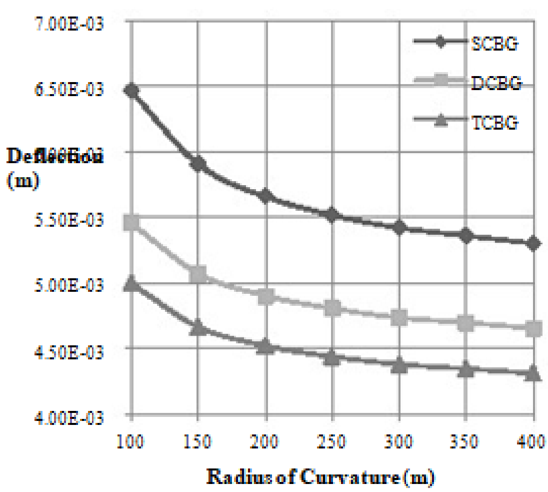

Figure 14: Variation of Deflection with Radius of Curvature of Box Girder

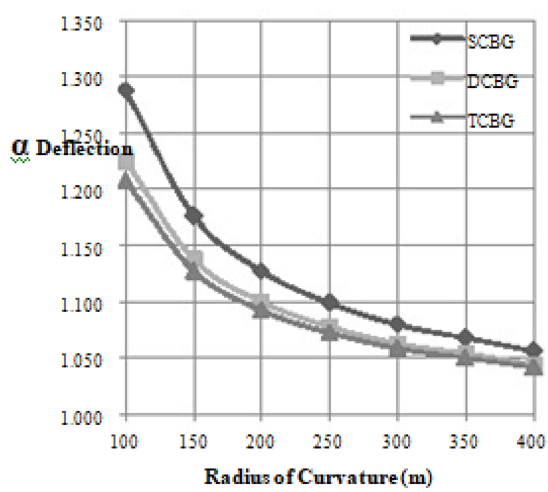

Figure 15: Variation of $\alpha_{\text{Deflection}}$ with Radius of Curvature of Box Girder

The variation of frequency with radius of curvature of box girder bridges is shown in Figure 16. As the radius of curvature increases, the variation of frequency is almost same for all the three cases of Box Girder Bridge. Variation of frequency between three types of box girder is only about 1%. This is due to the same span length. Figure 17 represents a non-dimensional form of the frequency variation for all the three types of box girder. It shows that frequency variation pattern is same between the three types of box girder and has a variation is only about 0.5 %.

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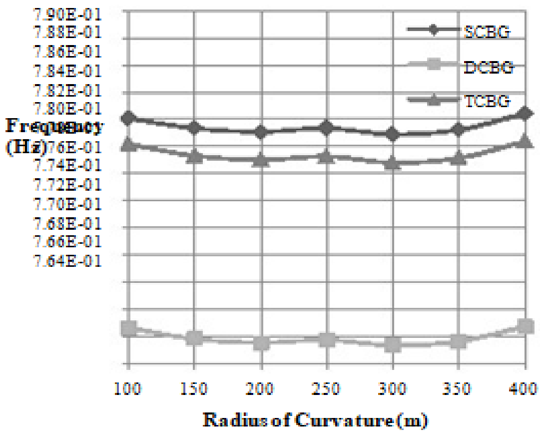

Figure 4.16: Variation of Natural Frequency with Radius of Curvature of Box Girder

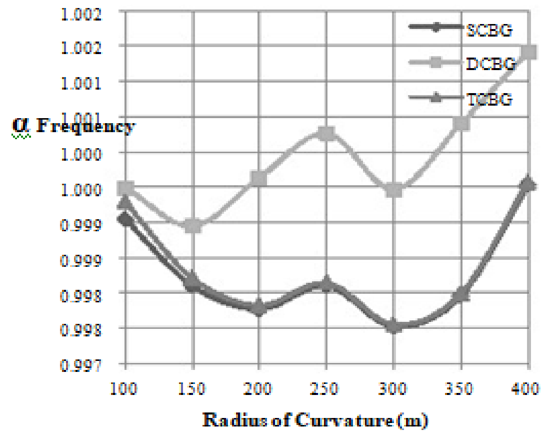

Figure 4.17: Variation of α Frequency with Radius of Curvature of Box Girder

Conclusion :

In this Paper, parametric study on behaviour of box girder bridges is carried out by using finite element method. The numerical analysis of finite element model is validated with model of Gupta et al. (2010). The parameter considered in this paper to present the behaviour of SCBG, DCBG and TCBG bridges are radius of curvature ratio. Theses parameters are used to evaluate the response parameter of box girder bridges namely longitudinal stresses at the top and bottom, shear, torsion, moment, deflection and fundamental frequency of three types of box girder bridges. The results obtained from this parametric study are presented and discussed briefly in this paper . From the parametric study it is found out that as the radius of curvature increases, responses parameter longitudinal stresses at top and bottom, shear, torsion, moment and deflection are decreases for three types of box girder bridges and it shows not much variation for fundamental frequency of three types of box girder bridges due to the constant span length. It is observed that as the span length increases, responses parameter longitudinal stresses at the top and bottom, shear, torsion, moment and deflection are increases for three types of box girder bridges and fundamental frequency decreases for three types of box girder bridges. It is noted that as the span length to the radius of curvature ratio increases responses parameter longitudinal stresses at top and bottom, shear, torsion, moment and deflection are increases for three types of box girder bridges and as span length to the radius of curvature ratio increases fundamental frequency decreases for three types of box girder bridges.

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