

Parametric Study on Behaviour of Rectangular Box Girder Bridges with Varying Skew Angle

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Abstract - In this study analysis of rectangular box girder with various skew angle has been done. The girder has been analyzed using CSI Bridge software. Self-weight and vehicular load were considered. Parameters such as torsional moment, longitudinal moment, stresses and deflection are compared.

Key Words: box girder, prestress, skew angle, bridge analysis

1. INTRODUCTION

Bridges are a very important part of everyday transport. People daily use overpasses, subways, small bridges over the canal or also a large bridge over the river. Bridges, as well as facilitate and accelerate our transport, also help to ensure that the city was beautiful. Many bridges attract attention in major cities around the world.

There are many bridges, some very simple, and some too complex, namely. Bridge skew. When the intersection intersects with an angle other than 90°, due to geometrical and spatial constraints, skewed bridges have proven useful. Thus, as a civil engineer, it is necessary to have in-depth knowledge of the factors that influence the design criteria for a skewed bridge.

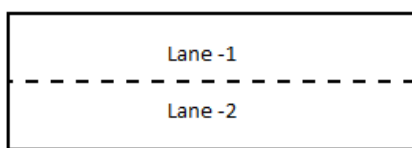


Fig- 1: Right bridge model.

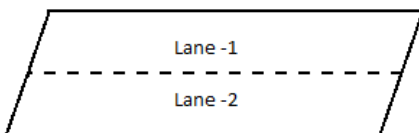


Fig- 2: Right bridge model.

Due to the induction of the angle of inclination in the bridge, the structural characteristics strongly influence, as a torque is created [Kar, 2012]. Bridges with small tilt angles can be designed as straight bridges [Ashebo, 2007]. But a large angle of inclination of bridges requires special attention.

This study is devoted to the parametric study of single-element prestressed concrete box girder bridges with different angles of inclination.

2. MODELING OF RECTANGULAR BOX GIRDER

Simulation of skewed single-cell prestressed reinforced concrete girder bridge is performed by the finite element method. Since the finite element method is considered one of the most powerful tools for solving complex problems. In this study, CSI Bridge software was used to determine the behavior of a skewed girder bridge. The bridge length (40 m), width (9.75 m) and height (2.4 m) are constant in all models. The boundary conditions and material properties specified for all models are the same. Details of cross section are as mentioned below.

Sr. No.	Property	Rectangular Cross-Section
1	Area (A)	8.0 m ²
2	Y bottom	1.4457 m
3	I xx	6.00 m ⁴
4	Z top	6.289 m ³
5	Z bottom	4.152 m ³

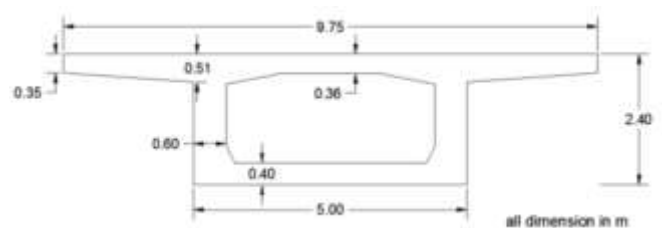


Fig- 3: Typical cross-section of rectangular box girder

Material properties are as mentioned in the table below

Properties	Value
Concrete (Grade M40)	
Characteristic strength, f _{ck}	40 Mpa
Young's modulus, E _c	5000√40 Mpa
Density (normal weight concrete)	25 kN/m ³
Steel reinforcing bar (Fe 415)	
Yield stress, f _y	415 Mpa
Ultimate tensile strength, f _u	485 Mpa

3. LOADING CONDITIONS

Load applied on two-way traffic bridge is dead load, live load according to IRC: 6-2014 specifications are taken into account in the analysis. Self-weight and IRC class A loading is applied.

4. FINITE ELEMENT MODELS

The girder box model was analyzed using an area object using CSI Bridge software. The program uses the method of analysis of the matrix bias based on the idealization of finite elements.

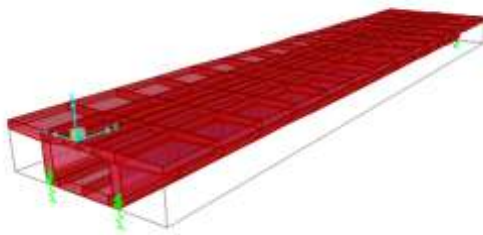


Fig. 4 3D model of rectangular box girder.

5 RESULTS AND DISCUSSION

The behavior of the box girder when the skew angle changes is discussed. Parameters such as longitudinal moment, torsional moment and stress at the top and bottom of the section are compared.

5.1 Required prestressing force

In rectangular box girder 39.6% decrease of prestressing force required with increase in skew angle 0° to 60°.

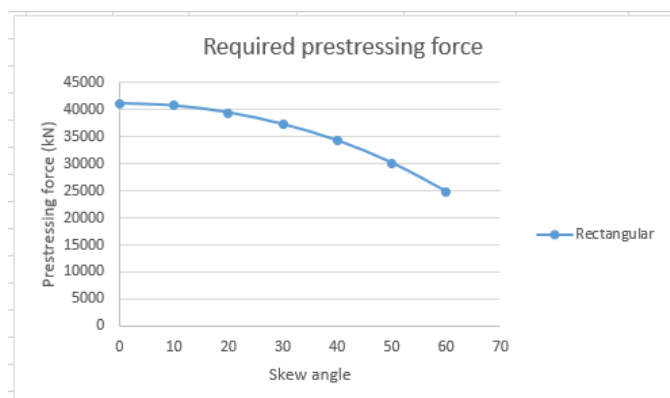


Fig. 5 Required prestressing force.

5.2 Maximum torsional moment

From the fig 6 it can be concluded that as the skew angle increases the torsional moment also increases.

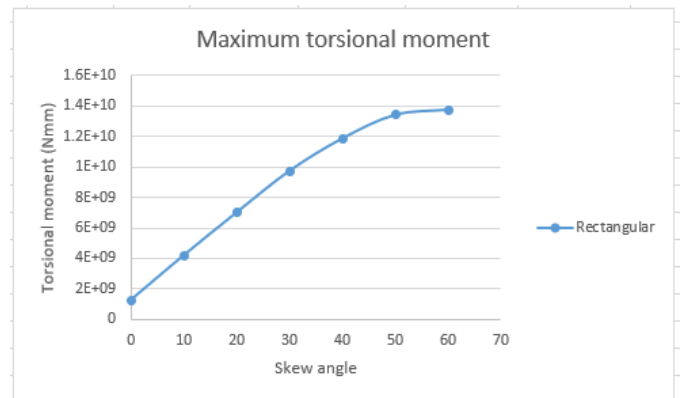


Fig. 6 Maximum torsional moment.

5.3 Maximum deflection

From the graph obtained of the maximum deflection, it is observed that there is a constant decrease when the angle of inclination increases.

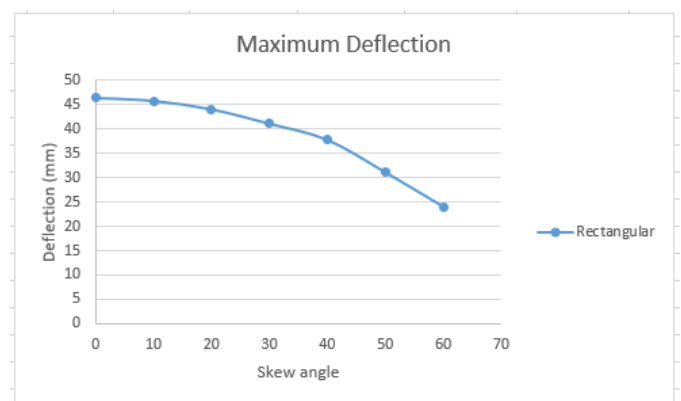


Fig. 7 Maximum deflection.

5.4 Stress

The stresses at the bottom of rectangular girder decrease with increasing skew angle, while the stress change at the top turns out to be insignificant.

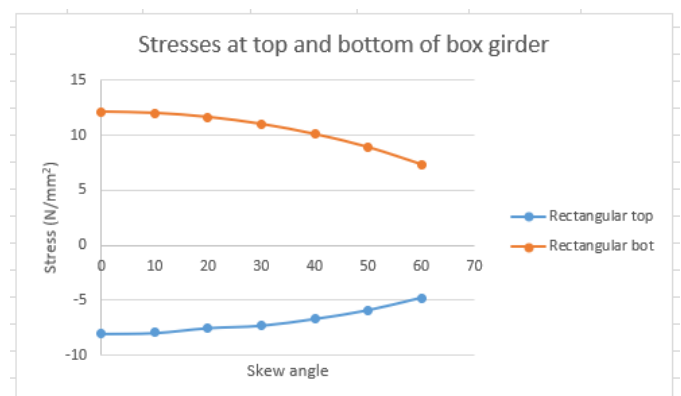


Fig. 8 Stresses at top and bottom.

5.5 Maximum longitudinal moment

From the Fig. 9 it is observed that longitudinal moment decreases with increase in skew angle

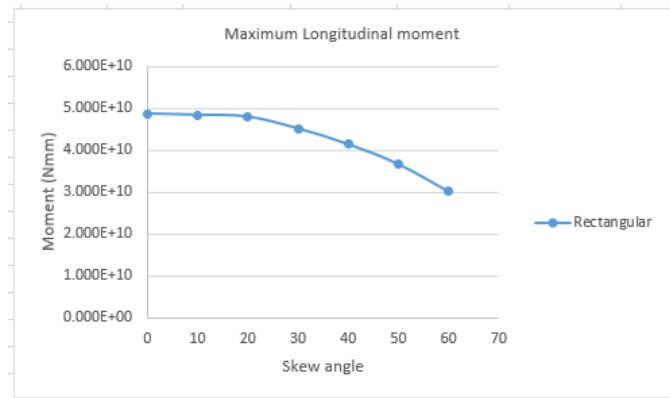


Fig. 9 Maximum longitudinal moment.

6. CONCLUSIONS

- There are insignificant changes in parameters like stresses at top and bottom, longitudinal moment, torsional moment, deflection and required prestressing force for small skew angles i.e. up to 10°.
- For higher skew angles there is great alteration in behavior.
- As skew angle increases from 0° to 60°, torsional moment is observed to be increased by 1000%.

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