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# Comparative Study of An Skew I Girder And Box Girder Bridge

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**ABSTRACT:** Bridges are very special type of structures. They are characterized by their simplicity in geometry and loading conditions. The reinforced concrete bridges usually carried uniformly distributed dead load, vehicular live load to its surface and transfers same to the support by flexure, shear and torsion. Newly designed bridges are often skew. This is due to space constraints in congested urban areas. It can be also needed due to geographical constraints such as mountainous terrains. However force flow in skew bridges is much more complicated than straight bridges. Therefore careful investigation and numerical analysis needs to be performed, in which a skew bridges can be modeled in several ways using Midas Civil. The behavior of bridge is affected considerably with the presence of skew angle in bridge decks. In the present study an attempt has been made to study the skew bridge comparing with the box girder bridge for skew angle 30. The results are presented in terms of Flexural strength, Shear strength and Reaction.

**KEYWORDS:** Skew bridges, skew angle, PSC box girder, span length.

## I. INTRODUCTION

### Skew Bridge:-

A Bridge built obliquely between abutments is called as Skew Bridge. The angle between the normal to the center line of the bridge and the center line of the abutment is known as Skew Angle. Skew bridges are built where geometry cannot accommodate straight bridge. Highway should be straight as long as possible in provision of high speed and safety requirements of the traffic, this resulted in increase in number of skew bridges. Generally bridge with a skew angle less than 20° is designed as normal bridge. If it is more than 20° there is change in the behavior of the skew bridge. Thus Geometry and behavior of skew bridge are affected by the presence of skew angle. The Structural response of skewed bridge to stresses in slab and reactions on abutments can be significantly altered by the skew angle of the substructure.

### Characteristics of Skew Deck:-

- The load tends to take a shortest path to nearest support i.e. obtuse corners of the bridge.
- Increase in reactions and shear forces near obtuse corner.
- Decrease in reactions and possibly uplift in acute corner.
- With increase in skew angle, the stresses, deflections and moment in the bridge deck and reactions on the abutment differs significantly.

### Box Girder Bridge:-

Box Girder Bridge is a structure built to cross obstacles like canal, road, and rail or rock valley. Design of bridge is important and complex approach of civil engineer with rapid growth in field of bridge engineering, the conventional

bridge has been replaced by most efficient and economical ones. The most common and basic type of bridge, that is widely used for roadways is girder bridge. The two most common types of girders that are used in practice are beam and box girders. Though box girder design is more complicated, it has wide acceptance due to their structural efficiency, aesthetic appearance, better stability and serviceability. Over years simple rcc box girders used for short spans resulted in long span pre-stressed concrete bridges. The use of prestressing enables concrete bridge beams to span long distances. Box girders are constructed in single cell, double cell or multicell.

## II. OBJECTIVES

- The objective of present study is to compare skew and box Girder Bridge, with parameter such as displacements, for three spans deck slab by considering various loading.
- To work out various design parameters for Skew and Box Girder Bridge for various spans.
- Compare skew and box Girder Bridge, with parameter such as shear strength flexural strength and reaction, for various loading.

## III. LITERATURE REVIEW

**Mayank Chourasia , Dr. Saleem Akhtar (2015):-** "Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell)". This paper discusses the parametric study of two different cross-sections of box-girder for same loading conditions to find the most economical cross-section. The design standard of India, IRC was followed in design of Box-girder superstructures subjected to IRC class AA loading. Analysis is carried out using the MIDAS Civil Software which is based on finite element method of analysis. A 30 m span length and 10 m width bridge deck is being analyzed in this work. The result shows the multi cell box girders are costlier as compare to the single cell box girder, when the loading and support condition were kept same for both the cross-section. It shows that the single cell pre-stressed concrete box girder is most suitable and economical cross-section for 2 lane Indian national highway bridges.

**Bhawar P.D, Wakchaure M.R, Nagare P.N(2015):-** "OPTIMIZATION OF PRESTRESSED CONCRETE GIRDER". The objective is to minimize the total cost in the design process of the bridge system considering the cost of materials like steel, concrete, tendons etc. For a particular problem the design variables considered for the cost minimization of the bridge system, are depth of girder, various cross sectional dimensions of the girder, number of tendons. MATLAB R2010a software is used.. The proposed cost optimization approach is compared with an existing project which leads to a considerable cost saving while resulting in feasible design. From graph, for conventional and optimal design consideration; it shows that overall cost of structure can be reduced by using optimization technique with stability.

**B.Paval (2015) :-** "Analysis of Multi-Cell Prestressed Concrete Box-Girder Bridge". In this study, the prestressed concrete box girder bridge superstructure is designed and linear, non-linear, time history analysis is performed. The bridge superstructure is subjected to different IRC loadings. The study shows how variations in the bridge geometry, damage scenarios, member properties and bridge continuity affect the redundancy of the superstructure. Specifically, Time History Analysis is used to investigate the sensitivity of the structure to variations in various parameters including: a) boundary conditions; b) damage of prestressed members and Comparison damage scenarios; c) member capacity; d) non-linear effect. SAP 2000 V15 is used in this analysis work. The result concludes that among the both linear and nonlinear analysis the deflection changes up to 30%-40% periodically. between linear and non-linear results shows that the results obtained from non-linear analysis is however more higher than linear analysis but they are quite much more accurate.

**Chetan T Naik , Dr.M M Achar , K Lakshmi(2015) :-** "Analysis and Design of Multi Cell Post-Tensioned PSC Box Girder". In the present work, analysis and design of box girder has been done, considering two different sheathing pipes namely HDPE and corrugated Bright metal pipes. These sheathing pipes have been used to find the economic solution of design of multi-cell box girder. CSI-bridge modular software has been used for carrying out analysis. Various losses that occur due to different phenomena such as elastic shortening, Creep, shrinkage, friction and wobble loss have been considered. It concludes that the design of PSC multi-cell box girder performed is found to be an economical design corresponding critical bending moment and shear forces developed due to various load combinations as per IRC



specifications in comparison with the design of similar span configuration using I girders with Cast In Situ (C.I.S) deck slab. Comparative Study of PSC Box Girder Multi Cell (3-Cell) Bridge of Different Shapes : A Review Paper (GRDJE/ Volume 2 / Issue 6 / 023) All rights reserved by [www.grdjournals.com](http://www.grdjournals.com) 144

**Payoshni Mali , Shilpa Kewate , Savita Lokare (2015) :-** "Comparison of Rectangular and Trapezoidal sections of Post Tensioned Box Girder". In this work, two sections of post-tensioned box girder of same span length; loading and dimensional properties are compared. The cross-sections are Rectangular and Trapezoidal. As per IRC:6-2000 live load combination for one lane of class 70R and for one lane of class A type loading are considered for this analysis. According to this analysis the trapezoidal section of box girder is subjected to less shear force and bending moment than that of rectangular section for same loading, span and dimensional properties due to its geometry. Torsional moment developed in trapezoidal section is also less as compared to that of rectangular section.

#### IV. METHODOLOGY

The steps mentioned below were used in Analysis of performance of 30m span bridges in MIDAS Software.

#### MIDAS SOFTWARE:-

Midas Civil is Bridge Design & Analysis software that combines powerful pre- and post-processing Capabilities with a very fast solver to easily, quickly and effectively model and analyze bridges. There are also several simple parameters change tools available for parametric analysis, resulting in an optimized and economical design. It makes it easy to create nodes and elements as if you were drawing a drawing, using the main features of your CAD program. It offers powerful auto-modeling features such as Auto Mesh Generation and various Bridge Wizards. With Bridge Wizards, you can quickly model your completed bridge. You can make changes to the model to get as close as possible to the actual structure. Other modeling approaches such as CAD import, table format modeling, and code format modeling are also available. It provides linear and non-linear structural analysis capabilities and can handle different types of analysis.

#### V. RELATED WORK

##### MATERIAL PROPERTIES FOR STEEL FE500 GRADE.

MATERIAL PROPERTIES FOR FE500	VALUES
Modulus of elasticity	2.05e+08kN/m <sup>2</sup>
Poisson ratio	0.3
Thermal coefficient	1.2e-05 /C
Weight density	76.98 kN/m <sup>3</sup>
Damping ratio	0.02

**MATERIAL PROPERTIES FOR CONCRETE M40 GRADE.**

MATERIAL PROPERTIES FOR M40	VALUES
Modulus of elasticity	3.16e+07kN/m <sup>2</sup>
Poisson ratio	0.2
Thermal coefficient	1.0e-05 /C
Weight density	23.6 kN/m <sup>3</sup>
Damping ratio	0.05

**MATERIAL PROPERTIES FOR TENDON.**

TENDON PROPERTY	VALUES
Tendon Type	Internal(Post-Tension)
Material	Fe500
Duct Diameter	0.11 m
Ultimate Strength	1.86e+006 kN/m <sup>2</sup>
Yield Strength	1.56e+006 kN/m <sup>2</sup>

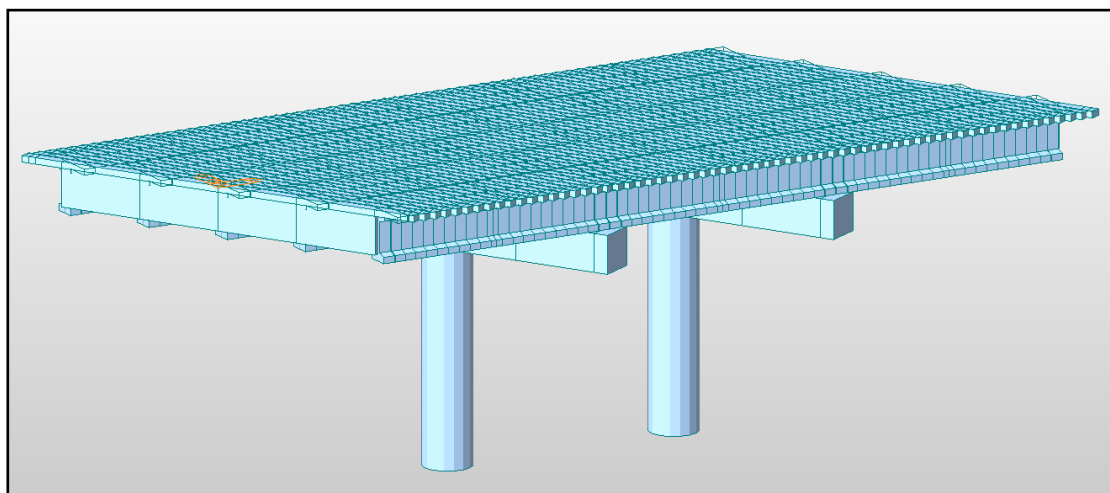


Fig1. 3D View of 30 m Skew Bridge

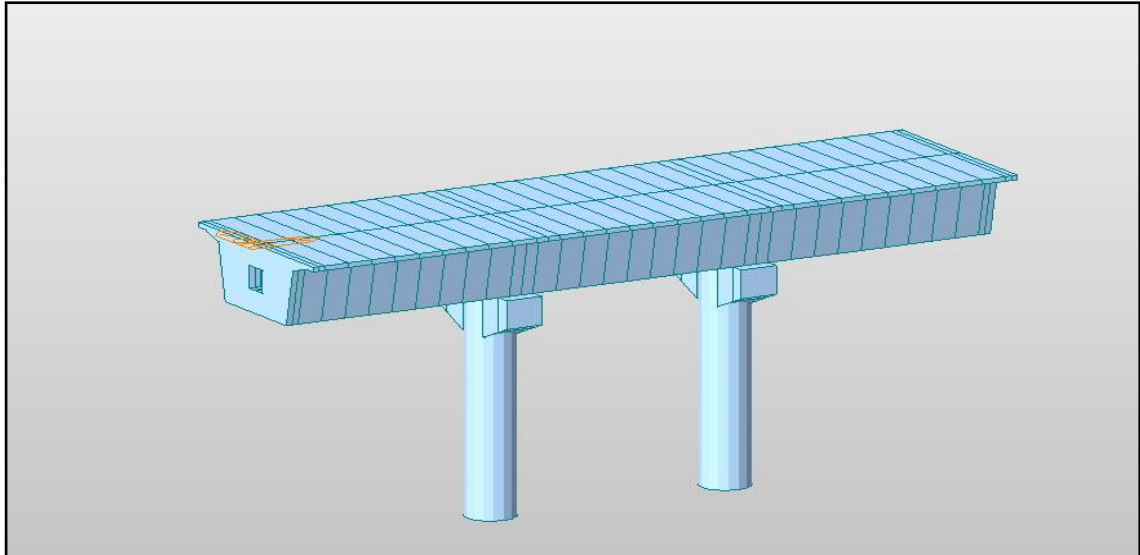
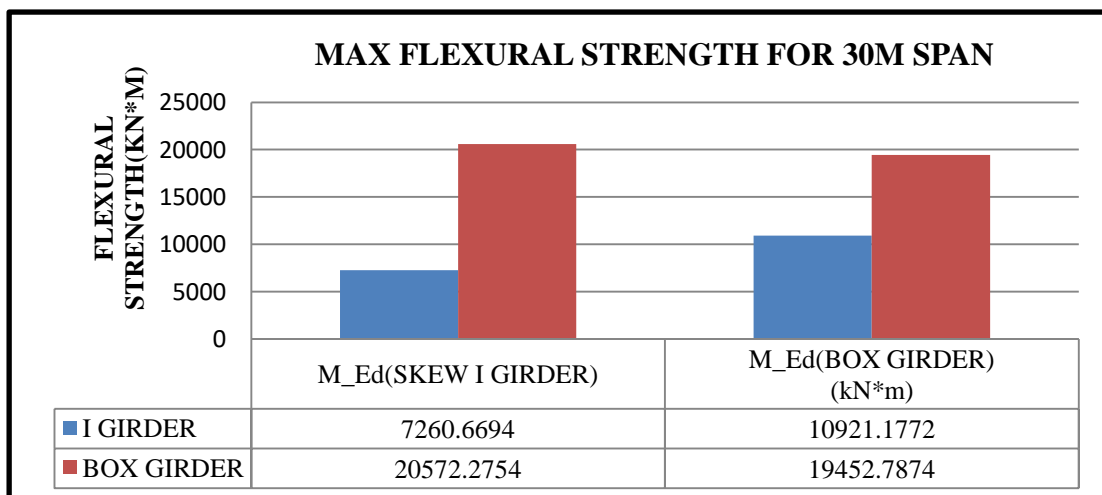
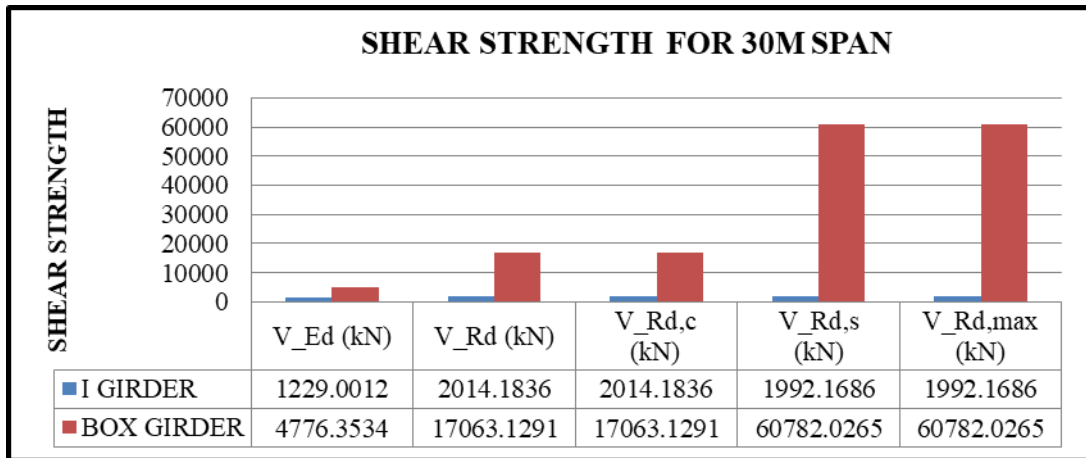


Fig2. 3D VIEW OF 30M PSC BOX GIRDER BRIDGE

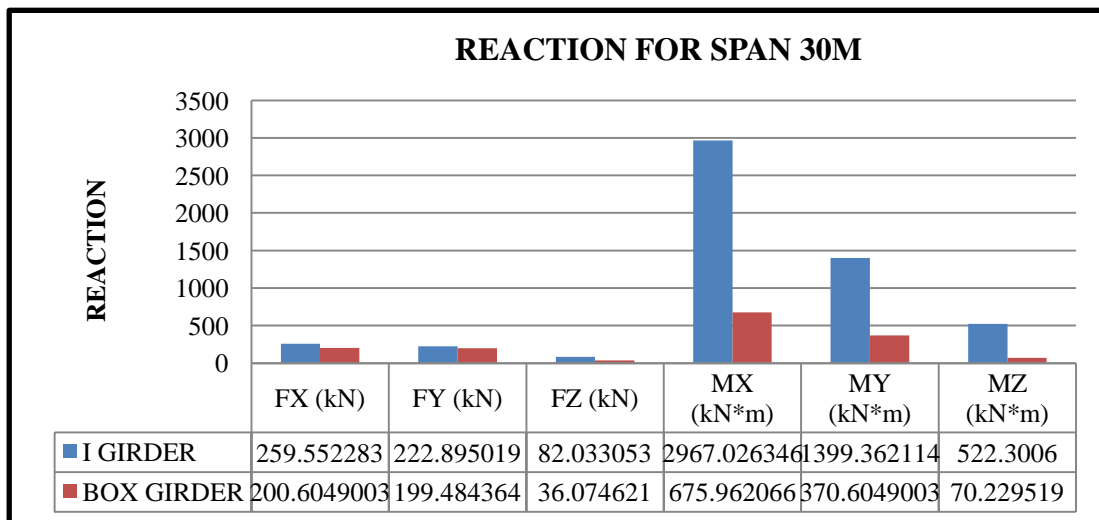
**VI. RESULT AND ANALYSIS**



As we know that flexural strength is the maximum stress in a material just before it yields in a bending test. It is observed that for Box Girder Bridge has more flexural strength than Skew I Girder Bridge for span 30m.



As we know shear strength is the strength of a material. It is observed that shear strength in Box Girder Bridge is more than Skew I Girder Bridge for span 30 and 40m.



### VII. CONCLUSION

Following are the conclusions made from the above study

- A. Flexural strength for Box Girder Bridge is more as compare to Skew I Girder Bridge.
- B. Shear strength strength for Box Girder Bridge is more as compare to Skew I Girder Bridge.
- C. Under various load the reaction and moment is greater in Skew I Girder Bridge as compare to Box Girder Bridge.
- D. After considering all above aspect it is seen that Box Girder Bridge is safer than that of Skew I Girder Bridge.

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