Finite Element Modelling and Dynamic Analysis of Skew Bridge using Staad.Pro

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***Abstract*—Bridge is exceptional type of structures which are characterized by their simplicity in geometry and loading condition. - The presence of skew in a bridge makes the analysis and design of the bridge complex. Design of bridges by using skew angle is becoming more useful in the engineering community, so there is a need for more research to study the effect of skew angle on the behavior of skewed bridges such as shear force, bending moment, torsion and other parameters. Reinforced concrete T – Beam girder of various skew angle (0°, 15°, 30°) with two lane carriageway is considered in this analysis. The analysis is done using STAAD Pro Software. The skew angle is taken at an interval of 15° starting from 0° up to a maximum of 30°. The analysis result is present in teams of bending moment, torsion moment, shear force and deflection for T – Beam girder. After the end of the study conclusion will be made by comparison with a skew bridge with regular bridge.**

Keywords*— *Skew bridge, staad.pro ,skew angle, girder

1. INTRODUCTION

Bridges are great symbols of humanity's conquest of space. They are the enduring expressions of humankind's determination to remove all barriers in its pursuit of a better and more accessible world. Bridges are lifelines to humanity to connect two communities which are separated by streams, valleys, railroads, etc. All the physical forces of nature and gravity should be understood with mathematical precision, such forces have to be resisted by manipulating the suitable materials in the correct pattern. Hence the design and building of bridges require both the inspiration of an artist and the skill of an artisan. Scientific knowledge about materials and structural Behavior has expanded tremendously, and computing techniques are now widely available to manipulate complex theories in innumerable ways quickly.

The Bridge is a structure that covers a gap ; generally these structures will carry a road or railway over an obstacle such as natural or artificial obstacles like a canal, river or roadway or railway. The Bridge is the most significant component of a transporting system and it is corresponding to the responsibilities in carrying a force flow of transport. These structures are classified based on the distribution of forces in the design such as shear, compression, tension and moment.

2. SKEW BRIDGE

Skewed bridges are commonly used to cross roadways, waterways, or railways that are not perpendicular to the bridge at the intersection. Skewed bridges are characterized by their skew angle, defined as the angle between a line normal to the centerline of the bridge and the centerline of support which is shown in Fig. 1.

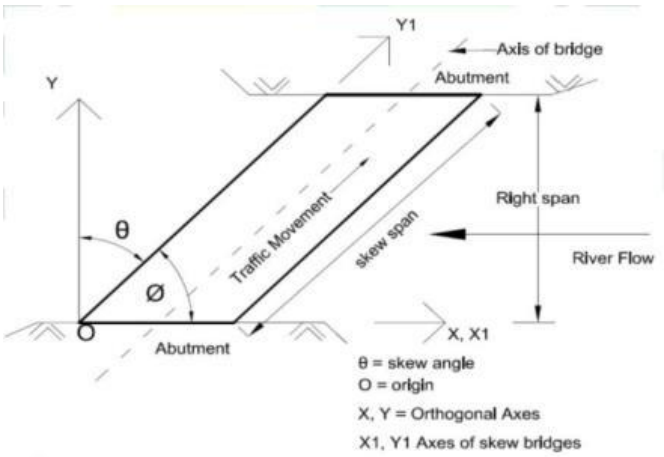


Fig. 1 Skew bridge showing skew parameters

In skew slabs, the load path tends to take a short cut through the strip of the area connecting the obtuse-angled corners and the slab primarily bends along the line joining the obtuse-angled corners. The width of this primary bending strip is a function of skew angle and aspect ratio (skew span: width of the deck). The areas on either side of the strip do not transfer the load directly to supports, but only to the strip as a cantilever. The load is transferred from the strip to the support over a defined length along the support line and then eventually gets redistributed over the whole length. The load transfer mechanism is shown in Fig. 2.

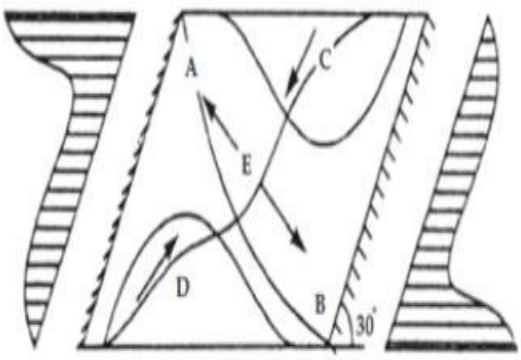


Fig. 2 Load transfer mechanism of skew deck slab

3. ADVANTAGES

1) These bridges are encountered in highway design when the geometry of the structure cannot accommodate straight bridges.

2) These bridges consumes less space compared to other straight bridges

3) Bridges can be constructed even in crowded places if skew bridges are designed adequately.

4) Skew bridges are more efficient in urban areas because the lack of space required constructing traditional non-skewed bridges.

4. DISADVANTAGES

1) In a skew bridge, the force flow is much more complicated as compared to ordinary straight bridges

2) Under service load and seismic load skew bridges makes their behavior more complex

OBJECTIVES

1)To compare and analyze regular and skew bridge with different angles (15º and 30º) for IRC class A loading and 70R loading.

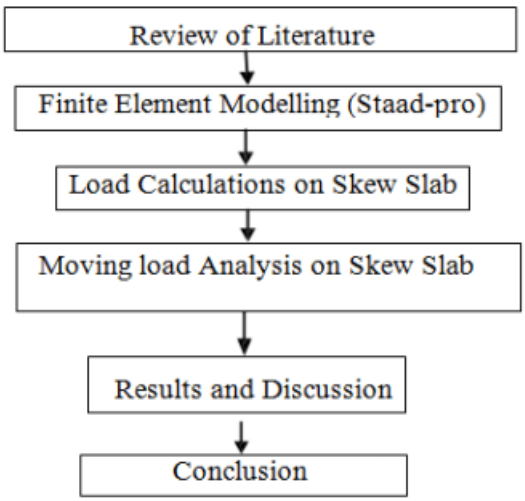
2)To determine deflection, bending moment, absolute plate stress and shear force.

3)Comparison with ordinary bridge and various skew angles is made

4)To evaluate the effectiveness of a skew angle

METHODOLOGY

The detailed methodology adopted for this research is as follows:



ANALYTICAL PROCEDURE

STAAD.PRO

STAAD.PRO V8i is a comprehensive and integrated finite element analysis and design offering, including a state-of-the-art user interface, visualization tools, and international design codes. It can analyze any structure exposed to static loading, a dynamic response, wind, earthquake, and moving loads. STAAD.PRO V8i is the premier FEM analysis and design tool used in any type of project, including towers, culverts, plants, bridges, stadiums, and marine structures.

DESIGN EXAMPLE

1. Overall span of Bridge = 24.0 m
2. Effective Span = 19.20 m
3. Centre-to-Centre of Longitudinal Girder = 2.50 m
4. Center-to-Center of Transverse Girder = 5.0 m
5. Number of Longitudinal Girder = 3 Nos.
6. Depth of Girder = 1.75 m
7. Depth of Slab = 0.250 m
8. Thickness of Wearing Coat = 0.080 m
9. Width of Carriageway = 7.500 m
10. Width of Kerb = 0.375 m
11. Depth of Kerb = 0.550 m
12. Overall width of Super Structure = 8.25 m
13. Grade of Concrete = M35
14. Grade of Reinforced Steel = Fe415
15. Density of Reinforced Concrete As Per IRC = 25 KN/m3

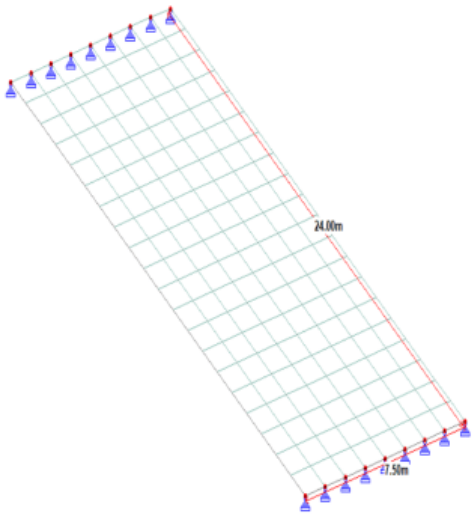


Fig 3. Zero degrees skew bridge modeled in staad.pro

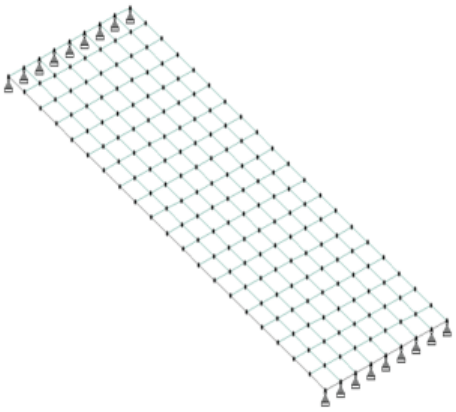


Fig 4. 15degree skew bridge modeled in staad.pro

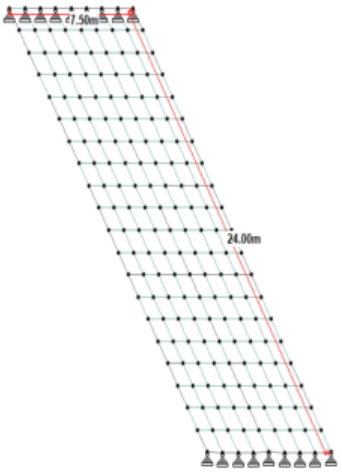


Fig 5. 30degree skew angle modeled in staad.pro

LOAD ON BRIDGES

1. Dead load

AS PER IRC: 6 (2014) – Clause 203

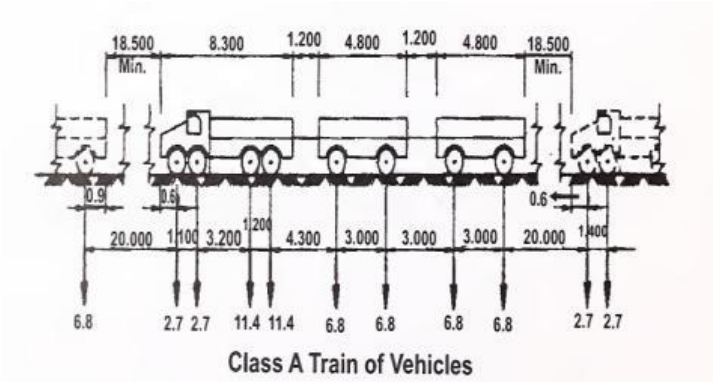
The dead load carried by a girder or member shall consist of the portion of the weight of the superstructure which is supported wholly or in part by the beam or member, including its own weight. The following unit weights of materials shall be used to determining load , unless the unit weights have been chosen by actual weighing of representative samples of the materials in question, in which case the actual weights determined shall be used.

2. Live load

As per IRC: 6 (2014) -Clause 204

IRC Class A Loading

This loading is to be generally adopted on all roads on which permanent bridges and culverts are constructed.



RESULT AND DISCUSSION

The comparison and analysis of the ordinary and skew bridge for deflection, shear force and bending moment and their behavior when moving load is applied on them were discussed below.

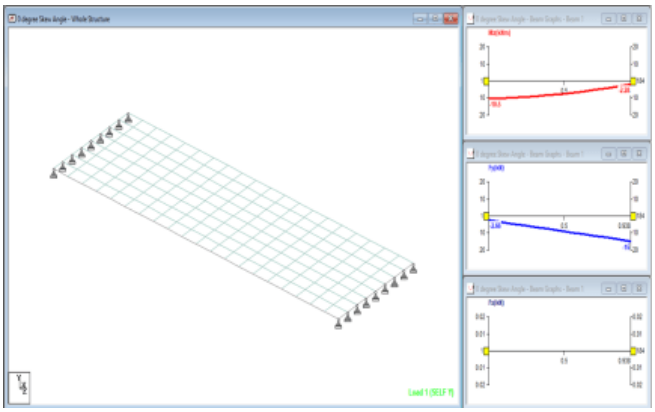


Fig 7. Shear force and bending moment of zero degrees skew bridge

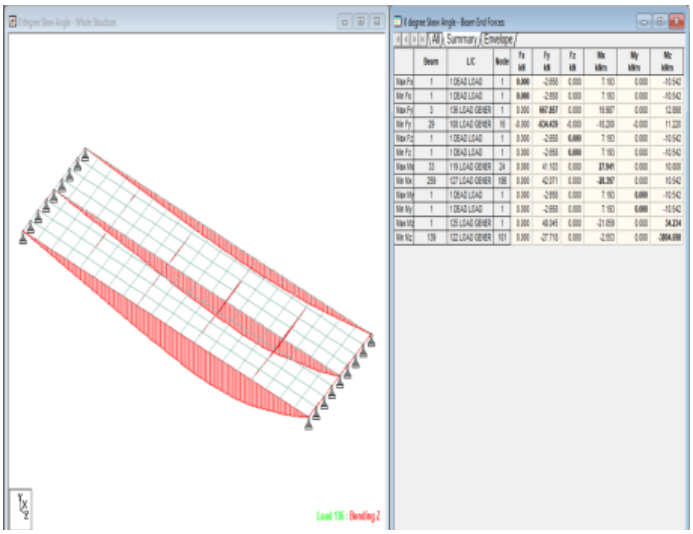


Fig 8. Maximum beam force on the bridge

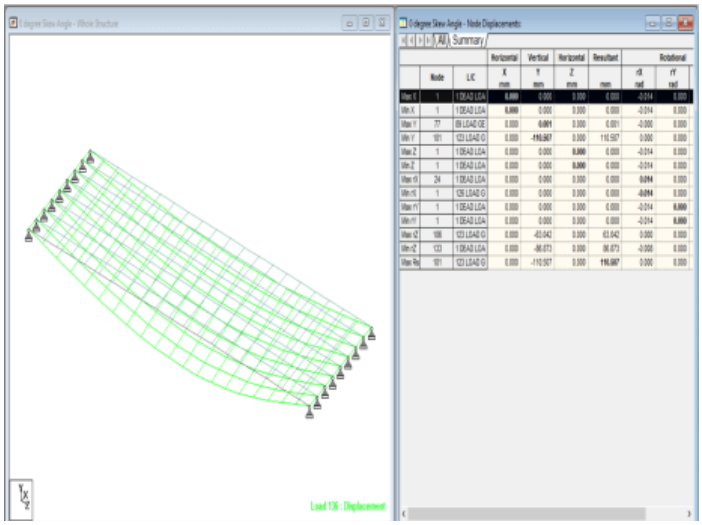


Fig 9. Displacement on the bridge

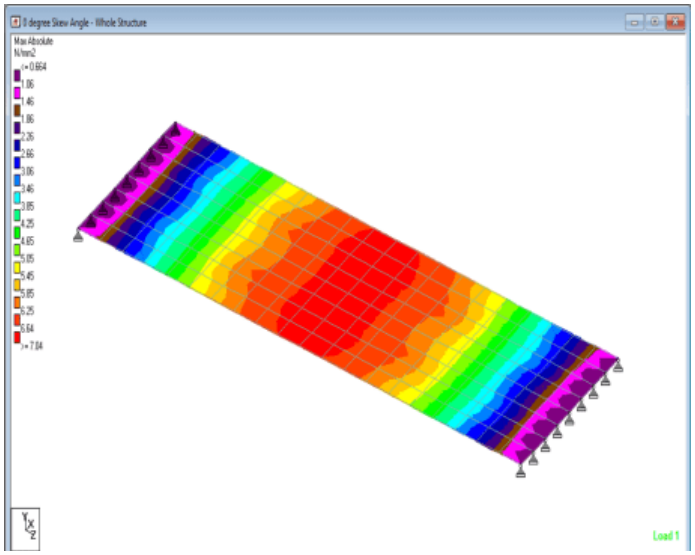


Fig 10. Maximum absolute plate stress on the bridge

CONCLUSION

1. The maximum deflection for skewed deck slabs decreases with the increase in skew angle for all aspect ratios and at 30 degree there was a reduction of 70 percentage is observed.

2. The longitudinal bending moment shows a similar pattern of reduction with increase in skew angle.

3. As the skew angle increases, maximum longitudinal moments gradually shifts towards the obtuse angle

4. The load-carrying capacity of the skew slab significantly depends on the skew angle. Based on this study the skew angle with 30° improved the overall behavior of the bridge compared to standard bridge.

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