Performance Assessment of R.C Girder Bridge Deck For Different Skew Angle

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Abstract- *There is a growing demand for skewed RC beam bridges because the necessities for complex intersection and also the troubles with space constraint in urban and metro city areas arise. When roadway alignment changes don't seem to be feasible then the Skewed bridges are useful or due to the topography of things to maintained economic and moreover at particular areas someplace environmental impact are often an issue. Soon supply high speeds and more safety necessities of the traffic, modern highways are to be straight as far as possible and this has required the provision of rising number of skew bridges. If a road alignment crosses a river or other obstruction at an inclination different from90°, a skew crossing is additionally essential. The inclination of the center line of Roadway to the center line of river just in case of a river bridge or other obstruction is termed the skew angle. The analysis and elegance of a skew bridge are rather more complicated than those for a typical bridge.*

Keywords- Bending Moment RC Beam Skew Angle, Loads, Box Girder, Deck

I. INTRODUCTION

Skew bridges are common at river passage, highway and other grade changes when skewed geometry is extremely important due to restrictions in space there is a growing demand for skewed RC beam bridges because the necessities for complex intersection and also the troubles with space constraint in urban and metro city areas arise. When roadway alignment changes don't seem to be feasible then the Skewed bridges are useful or due to the topography of things to maintained economic and moreover at particular areas someplace environmental impact are often an issue. Soon supply high speeds and more safety necessities of the traffic, modern highways are to be straight as far as possible and this has required the provision of rising number of skew bridges. If a road alignment crosses a river or other obstruction at an inclination different from90°, a skew crossing is additionally essential. The inclination of the center line of Roadway to the center line of river just in case of a river bridge or other obstruction is termed the skew angle. The analysis and elegance of a skew bridge are rather more complicated than those for a typical bridge. The analysis and elegance of bridge decks complicated if skew is present. Bridges with big angle of skew can have a substantial effect on the behavior of the bridge mainly within the several ranges of spans. An oversized number of research studies have examined the performance of skewed highway bridges. However, there don't seem to be any detailed guidelines addressing the performance of skewed high way bridges. Numerous constraints affect the response of skewed bridges which make their behavior complex. Therefore, there's a desire for extra research to figure the effect of skew angle on the performance of beam bridges. Skew during a bridge may result from several factors, including natural or manmade obstacles, intricate intersections, space limitations, or mountainous terrain.

II. OBJECTIVES

- To study the effect of different skew angles.
- To study the effect various types of loads as per IRC 6:2017
- Develop the mathematical model to evaluate the effect of various parameters such as skew angle on the behavior of skewed bridges.
- To observe the effect of skew on maximum Live load, Shear force , and Torsion.
- To study the effect of skewness directly on design parameters i.e. bending moment, shear force, and torsion
- Test a real skewed bridge to understand its behavior of skewed bridges and use the results for determination of safe and economical skew angle

III. EFFECTSOFINCREASEINTHESKEW ANGLE

With increasing the skew angle, the stresses within the slab differ significantly from straight slab. Loads applied on the slab are travels to the support in proportion to the rigidity of the varied possible paths. Hence an important part of load tends to realize the support during a direction normal to the faces of piers and abutments. As a outcome, the planes of max. stress are perpendicular to the center line of the highway and slab tends to twisted. The responses at the obtuse angled slab support are greater than other end, the rise in rate common value ranging from0% to 50% for skew angle of 10º

to 50°.The response are negative for the skew angle quite40°.The reaction on the angle end corner becomes twice the standard reaction, thus creation the angle corner a zero when skew angle reaches about 60°.

IV. CHARACTERISTICS OF SKEW BOX GIRDER BRIDGE DECKS

In normal beam bridges, the deck slab is perpendicular to the supports and so the load placed on the deck slab is transferred to the supports which are placed normal to slab .Load transfer from a skew beam slab bridge is complicated problem because there always remain a doubt on the direction during which the slab and so the way during which the load are visiting be transferred to the supports. Per increasing the skew angle, the pressures within the Beam Bridge and reactions on the abutment vary significantly from those in slab .The intensity and magnitude of these effects to be subjected on the angle of skew, ratio of the slab. The shape and edge details can even influence the direction of maximum moments, the deck slab distance to abutments, the stiff edge beams acts as a line of support for the slab which effectually spans right to abutments across full width. The skew is so extraordinary that the deck is cantilevered off the abutments at the acute corners. The characteristics are mostly significant in solid and slab decks because their high torsional stiffness tries to oppose the twisty of deck. In contrast, the skew may be a smaller amount significant in beam and slab decks, particularly with spaced beams.

V. METHODOLOGY

- Six different cases of models with skew angles 0^0, 15^0, 25^0, 35^0, 45^0, 55^0 and span of 30 m are considered.
- Analysis is performed for dead load and live load on skew bridges.
- The results have contributed to understanding the behavior of skew bridges based on the maximum loads.
- The results are extracted in excel and further used for plotting the graph such as skew angle versus bending moment, shear force, and torsion.

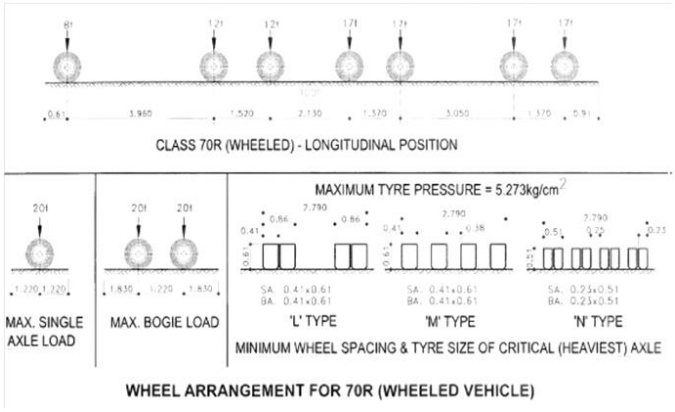
VI. CODAL PROVISIONS AND REVIEW

As per IRC:6-2017, “Standard Specifications and Code of Practice for Road Bridges Section: II Loads and Load Combinations (Seventh Revision)”, Indian Roads Congress, New Delhi.

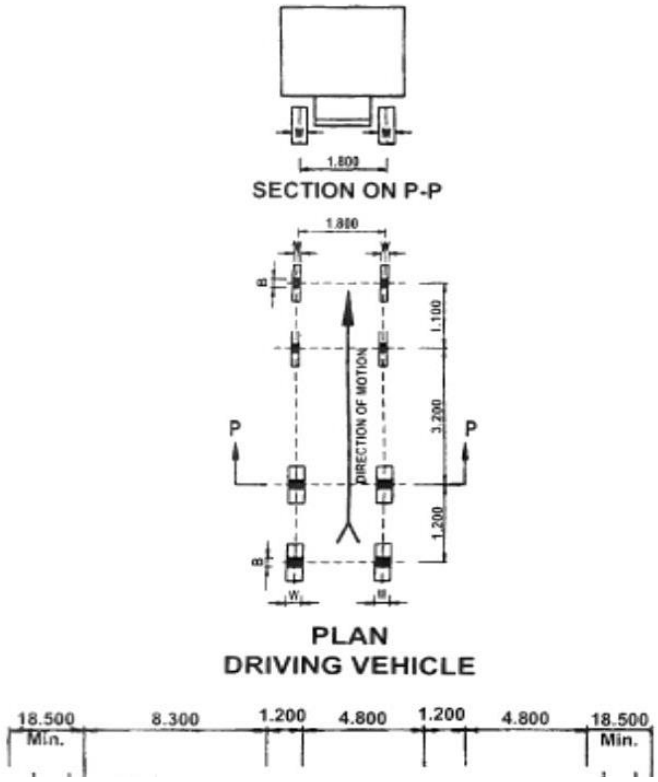
The condition used from the above-mentioned codes is:

i. Clause no.203mostly discusses about the dead load calculations of the bridges.
ii. Clause no.204 mostly discusses about the live load calculations of the bridges.

a) Clause no.204fig.1for Class70R wheeled vehicle.



B) Clause no.204fig.2for Class A wheeled vehicle



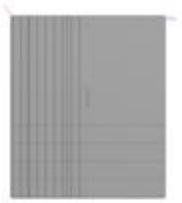
V: Modeling of skew angle box girder bridge deck

In this chapter following six skew angle box girder bridge decks which is starting from 0^0 to 55^0as shown in following figures are modeled and analyzed using STAAD Pro v8i software. A brief summary to the Box girder bridge is also presented. Furthermore the importance of STAAD Prov8i software in structural analysis is also discussed. A

comprehensive review of the steps to be followed to perform analysis in STAAD Pro v8i is also studied. Finally, the results obtained after analyzing the skew angle box girder bridge deck are presented and a comparison of results inform of maximum Shear Force, Bending Moment, Deflection, Torsion and Support Reaction is also given.

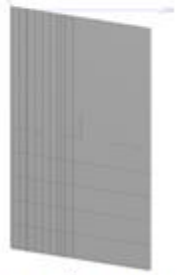
A: ***Skew angle Box Girder Bridge***

The skew angle box girder bridge deck taken for analysis in STAAD Pro v8iis as follows and the size of box Girder Bridge is 30m x13.5m



Planfor0^{0} Skew Angle

Isometric Viewfor0^{0}Skew Angle



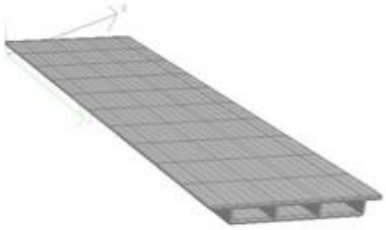
Plan for15^{0} Skew Angle

IsometricViewfor15^{0}SkewAngle

Plan for25^{0} Skew Angle

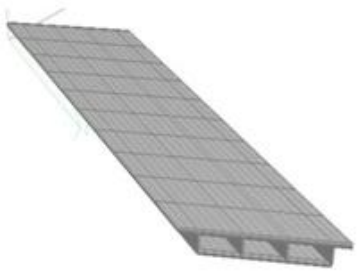
IsometricViewfor25^{0}Skew Angle

Plan for35^{0} Skew Angle

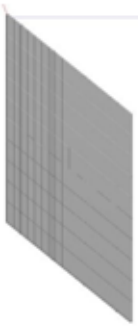


IsometricViewfor35^{0}Skew Angle

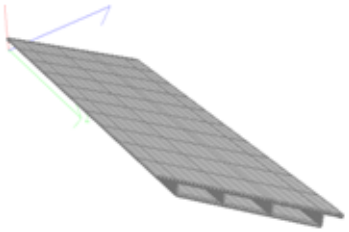
Plan for45^{0} Skew Angle



IsometricViewfor45^{0}SkewAngle



Plan for 55^{0} SkewAngle



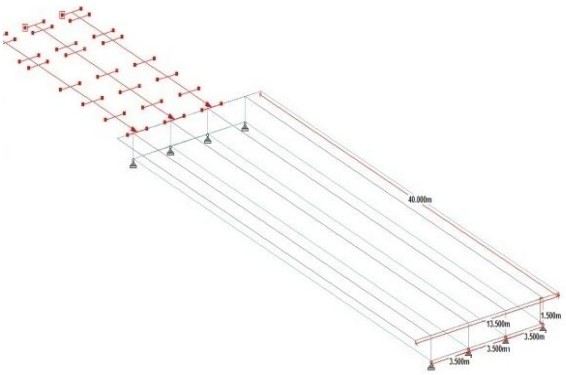
Isometric View for 55^{0} Skew Angle

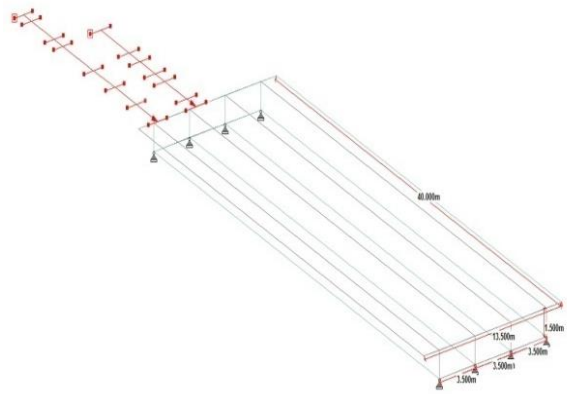
B: ***Details of Box Girder Bridge***

The six skew angle box girder bridge deck selected for analysis are discussed in this section. It is important to note that all the box girder bridge deck have same dimension i.e. 30 m x 13.5 m in X-Z plane and moreover the internal/outer girder of box Girder Bridge deck having equal cross section.

VI. ANALYSIS OF SKEW ANGLE ON BOX GIRDER BRIDGE

Using Staad Pro v8i software six box girder bridges deck are modeled. The dimension, cross-section and material property remains unaffected. The only factor that changes is the skew angle starting from 0^0 to 55^0 with interval of 10^0. The skew angle of the bridges differs only in horizontal direction.



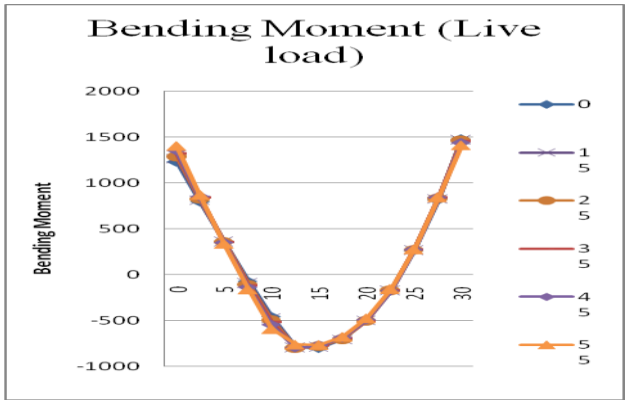


Live Load Combination Case I as per IRC-6: 2017Live Load Combination Case II as per IRC-6 : 2017

VII. ANALYSIS OF RESULTS

Maximum Bending Moment (Outer)
Live Load Bending Moment (Outer)

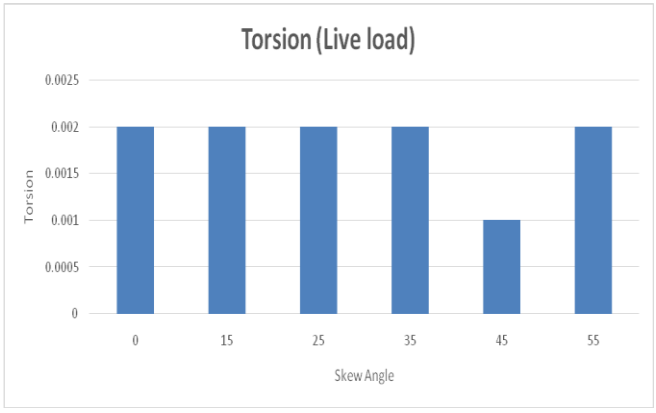
Length (m)	Skew Angle					
	0	15	25	35	45	55
0	1231.07	1265.93	1290.809	1319.177	1353.739	1399.006
2.5	796.628	813.281	824.6	836.839	850.581	865.963
5	362.185	360.631	358.392	354.5	347.424	332.92
7.5	-72.257	-92.018	-107.816	-120.818	-139.688	-164.341
10	-456.557	-478.398	-495.841	-517.914	-548.577	-597.098
12.5	-790.713	-796.718	-802.569	-811.047	-798.101	-766.303
15	-799.864	-789.113	-782.693	-776.774	-771.83	-769.918
17.5	-704.878	-711.161	-707.229	-698.507	-690.107	-681.523
20	-497.343	-499.943	-503.601	-507.279	-494.017	-479.494
22.5	-176.891	-173.874	-173.203	-174.398	-178.991	-158.806
25	262.22	267.726	270.176	272.287	271.791	273.072
27.5	814.261	825.772	832.215	837.631	841.234	840.315
30	1480.105	1473.408	1466.293	1455.578	1438.362	1407.558



VIII. MAXIMUM TORSION (OUTER)

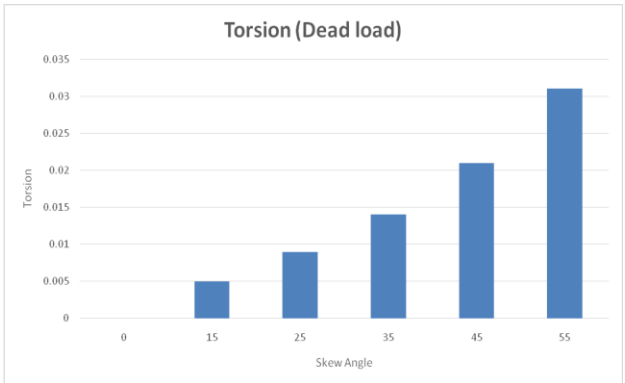
A: Live Load Torsion (Outer)

Skew Angle					
0	15	25	35	45	55
0.002	0.002	0.002	0.002	0.001	0.002



B: Dead Load Torsion (Outer)

Skew Angle					
0	15	25	35	45	55
0	0.005	0.009	0.014	0.021	0.031



IX. CONCLUSION

Variation Bending Moment & Shear Force for skew angle lies between 15^0 to 55^0 are compared with zero degree skew angle, whereas for skew angle greater than 45^0 the Bending Moment & Shear Force value increases more than 50% for different loading combinations.

- Whereas, the variation in Deflection increases with increasing skew angle as compared to zero skew angle, for various loading combinations..
- Whereas, the variation in Torsion & support reaction also increases with increasing skew angle as compared to zero skew angle, for various loading combinations.
- The observed value for various combinations of skew angle includes loading that for skew angle lies between 0^0 to 35^0 are structurally safe and economical for same load conditions.

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