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Effect of skew angles on a multi-cell minor bridge with edge beam

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Abstract
Taking everything into account, spans with a novel person like the slant point is a way forward. In past, a restricted report has been completed on the scaffold with a slant point. In this paper, an insightful investigation of multi-cell minor scaffold with edge radiates utilizing limited component programming STAAD professional. v8i and furthermore plate investigation is directed. The review has been done to find the impact of skewness on the extension parts i.e, top chunk, base section, external pieces and internal chunks. The slant points that have been taken for the review goes from 0º to 70º with a timespan. The heaps taken for the review are live loads (70R wheeled, class AA stacking and SV stacking), Dead loads, surfacing loads, earth pressure, temperature loads, live burden overcharge and their blends according to IRC.6:2019. Effect on plan boundaries was analyzed at basic situations under basic burdens. In this insightful review, plan boundaries like longitudinal minutes, cross over minutes, shear powers and relocations are analyzed. It has been seen that every one of the boundaries show a straight increment with the increment of skewness. A near report, of top piece plan torsional minutes, is additionally completed between models with edge shafts and models without edge radiates. Relative review, results uncover that edge radiates give great outcomes however just when slant points are enormous.

Keywords: Skew angle, edge beams, moments, shear force, displacement

Introduction

Skew Bridges are the structures with a different geometry than that of normal bridges like sides are non-orthogonal i.e, their sides meet at angles other than right angles to each other but having a property that opposite angles are equal, two of them are acute angles and other two are obtuse angles, the longitudinal axis of these bridges is not perpendicular to the abutments and hence transmit their loads to their abutments at angles other than 90º. Mainly there are two types of skew bridges, one with an aspect ratio less than unity and the other with an aspect ratio greater than unity [1].

With the quick development of populace in the agricultural nations like India, where advancement in the field of development is likewise sought after. Spans are one of the significant designs and can be attributed as a life saver of any country. Henceforth, request of extensions with slant point quickly expanding in view of combination, less accessibility of room particularly in the metropolitan regions, presence of complex intersections at places like highways, rivers crossings, railway crossings etc. and are considered as the best option to distribute the traffic without creating any hindrance.

Slant spans are the main intelligent choices at the spots where giving a bend in a road is beyond the realm of possibilities. Slant spans are for the most part given when there is an adjustment of geology in the mountain regions where streets are to be developed in the space of having various territories. In the advanced parkways, it is just conceivable in view of slant extensions to keep up with the arrangement quite far which thus makes the development of roadways practical and furthermore gives a protected approach to rapid vehicles. Slant spans are the sorts of scaffolds which communicate the heap to projections at a point other than 90º. The slant point can be characterized as the point shaped between the middle line of a carriageway and the middle line of a waterway or any deterrent [2]. Plan and development of such sort of scaffolds are more muddled than that of non-slanted spans. The range length, area of deck chunk, length of wharfs additionally changes with the change in the slant point in the extent of Cosec Θ where Θ is the point of slant as displayed in Fig 1.

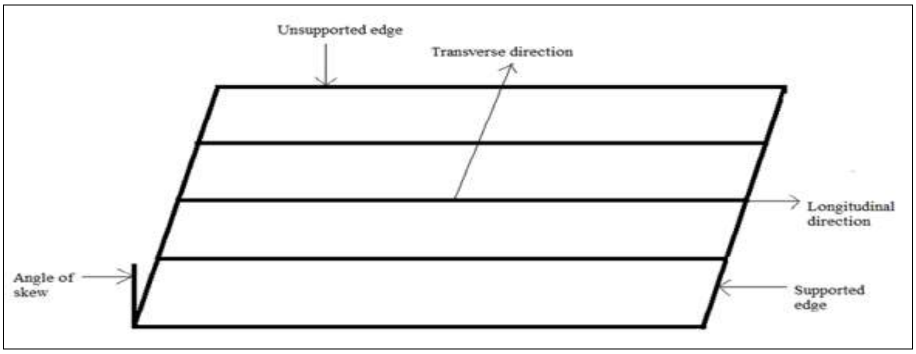

Fig 1: plan of a skew deck slab

The effect of the skew angle above 20º in the single span decks has a considerable effect on the behaviour of the bridge especially in short to medium range of spans where span and width are of same order [3]. With the increase of skew angle uplift at both the acute corners also increases [4]. All the secondary actions (moments, shear force and displacements) increase with an increase of skew angle [9]. The response of skew bridges is quite different from non-skewed bridges and varying with the skew angle [6]. Therefore, there is a need for more research to understand the behaviour of skew bridges under different load situations, skew angles in different conditions. In the present paper, the behaviour of three lanes multi-cell minor bridge with edge beams has been analysed under different loads (both dead loads and live loads) and their combinations. Also, a comparison of top slab torsional moments between models with and without edge beams has been studied. All the loads and their combinations were as per IRC.6:2019. The skew angle taken for the study ranges from 0º to 70º with an interval of 10^0.

Objectives of the research

The objectives of this research are to scout out the effect of skewness on a 3 lane multi-cell minor bridge with edge beams and also effect on top slab torsional moments without edge beams and its comparison with edge beam models. The various parameters considered in this research are:

Parametric Study

A 3-lane multi-cell minor bridge with edge beams of varying skew angles is considered. The various skew angles taken for study ranges from 0º to 70º with an interval of 10º. Edge beams are of depth 1.5m and width 1.5m. Carriageway width is taken 14m, 3-lane as per IRC.6:2019. Span of bridge 25.1m, with each cell having clear span of 8m. The analysis is carried out under critical load at a critical position. The various loads considered for the study are live loads (70R wheeled, Class AA wheeled, SV loading), dead load, surfacing loads, earth pressure, temperature loads, live load surcharge and their combinations. All loads and their combinations were taken as per IRC 6:2019. A total of 8 models were analysed for the research. For each angle, a total of 7 live load models were analysed to find out the critical live load and its critical position.

Modelling of bridge

Modelling and Analysis is carried out using STAAD pro v8i software. Bridge contains various slab components of various thickness as shown in table.1

Table 1: Thickness of bridge slabs

S. No	Parameters	Thickness in mm	Quantity
1	Top slab	700 mm	1
2	Bottom slab	750 mm	1
3	Outer slab	400 mm	2
4	Inner slab	350 mm	2

The edge beams provided are of 1.5 m depth and 1.5 m width. The effect of skewness on the behaviour of 3-lane multi-cell minor bridge with edge beams is analysed. Figure 2, 3 shows final 3D modal and skewed plan in Staad pro respectively.

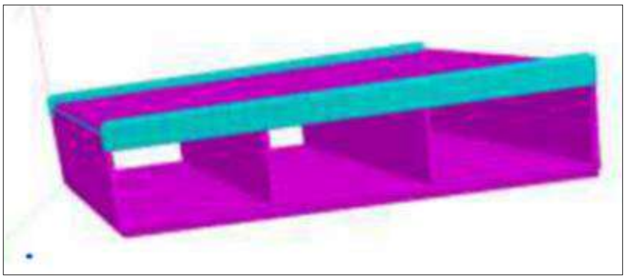

Fig 2: 3d View of a multi-cell minor bridge with edge beams

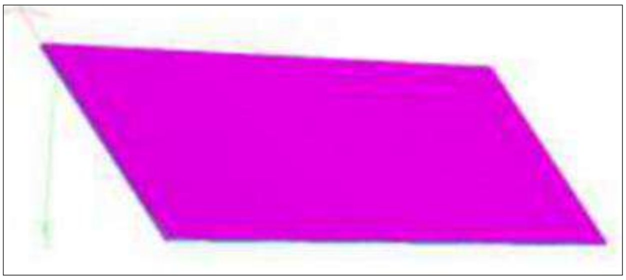

Fig 3: Plan of a skewed bridge

Results and Discussion

The present work is carried out to determine the effect of skewness on a 3lane multi-cell minor bridge with edge beams. The results are obtained based on shear forces, longitudinal moments, transverse moments, torsional moments, and displacements. The maximum values of the above parameters and their variation at different skew angles are represented in the various graphs.

Shear force

The maximum shear force of all slabs under critical load at critical position shows a linear increase with the increase in skewness as shown in figure.4.

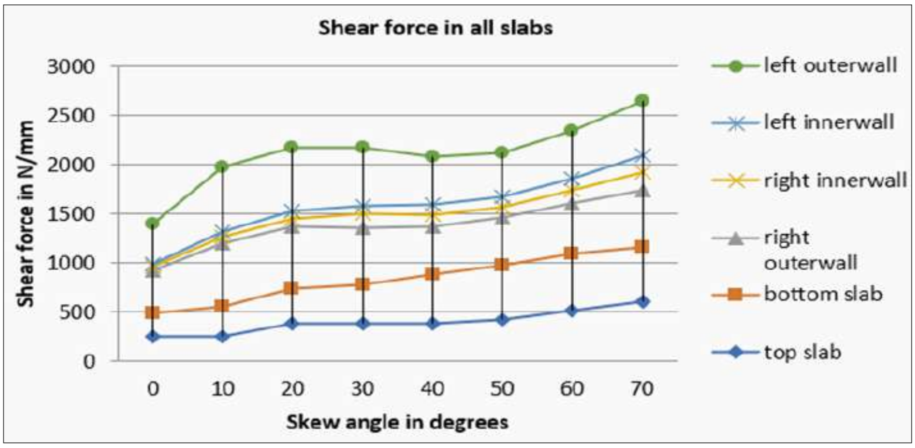

Fig 4: Shear force in models without edge beams v/s skew angle

Moment Results

Top Slab Moments

Longitudinal moments (both sagging and hogging) shows a linear decrease up to an angle of 50º then it starts increasing gradually. Transverse moments and torsional moments both increases with the increase of skew angle as shown in figure 5.

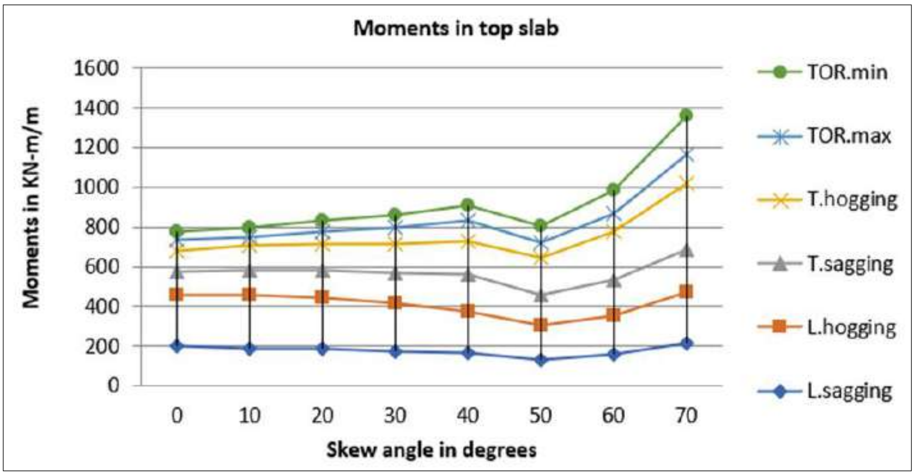

Fig 5: Top slab moments in models with edge beams v/s skew angle

Bottom Slab Moments

All types of moments i.e., longitudinal moments, transverse moments, torsional moments shows a linear increase with the increase in skewness but longitudinal moments (both sagging and hogging) and transverse sagging moments show decrement after 60º skew angle as shown in figure 6.

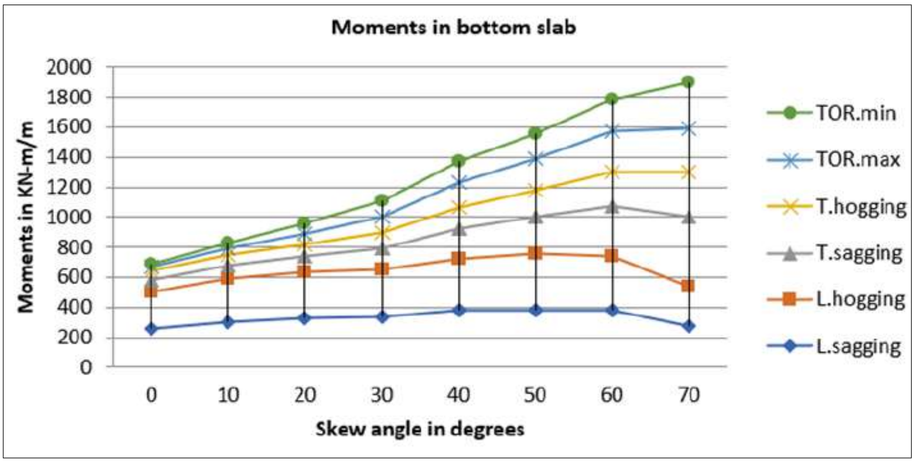

Fig 6: Bottom slab moments in models with edge beams v/s skew angle

Right Outer Wall Moments

All types of moments show a linear increment with the increase in skewness as shown in figure 7.

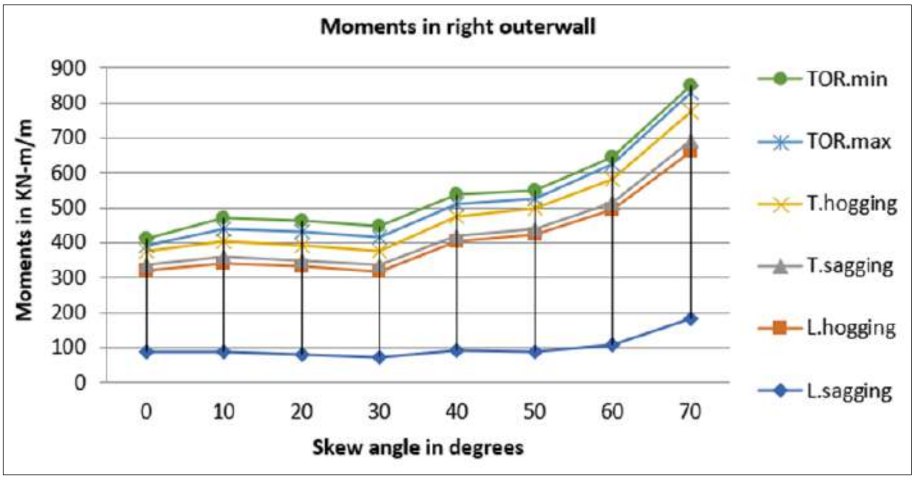

Fig 7: Right outer wall moments in models with edge beams v/s skew angle

Right Inner Wall Moments

All types of moments increase with the increase in skew angle as shown in figure 8.

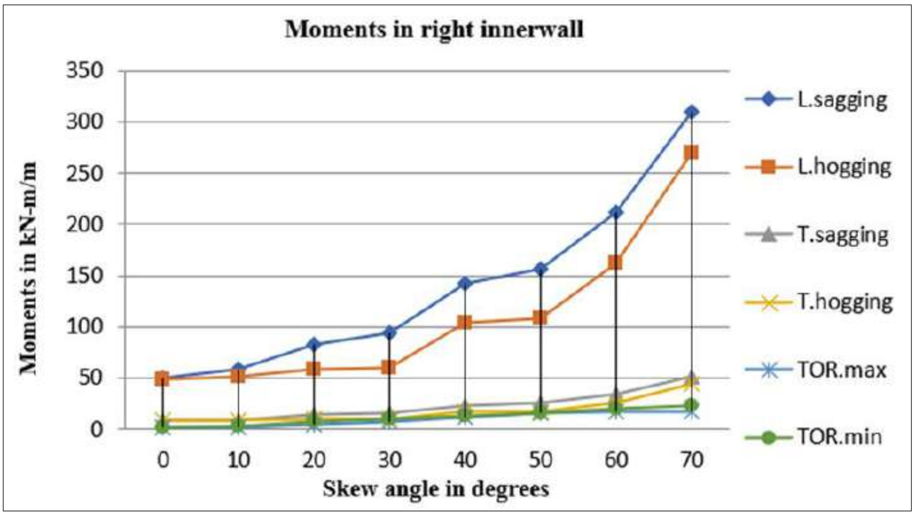

Fig 8: Right inner wall moments in models without edge beams v/s skew angle

Left Inner Wall Moment

Moments show a linear increase with the increase in skewness as shown in figure 9.

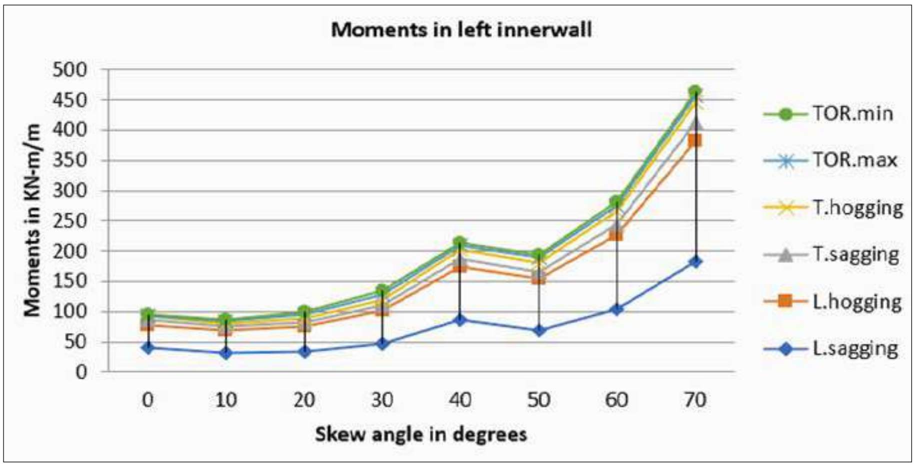

Fig 9: Left inner wall moments in models with edge beams v/s skew angle

Left Outer Wall Moments

With the increase in skewness, all the parameters increase gradually as shown in figure 10.

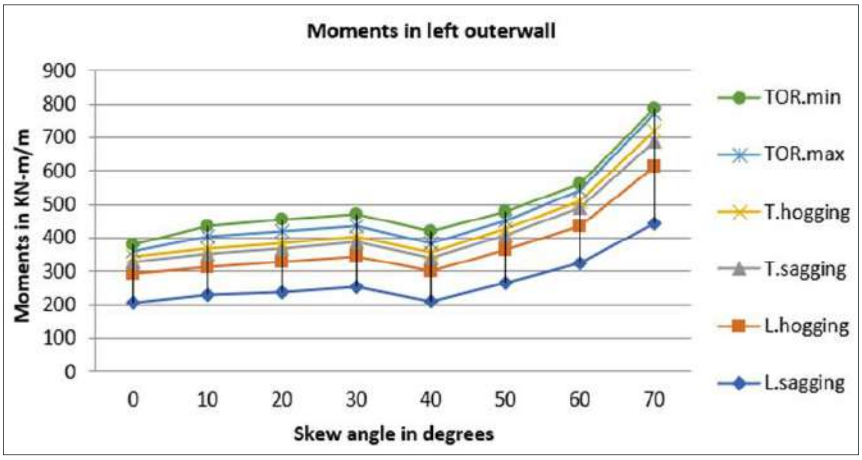

Fig 10: Left outer wall moments in models with edge beams v/s skew angle

Displacements Results

Displacements in all slabs increase with the increase in skew angle as shown below

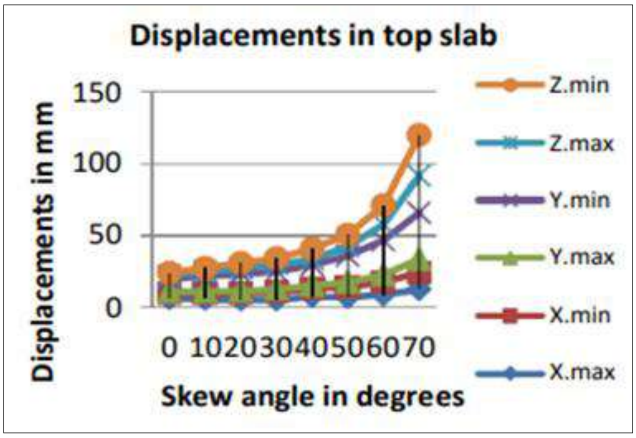

Fig 11: Skew angle V/s top slab displacement

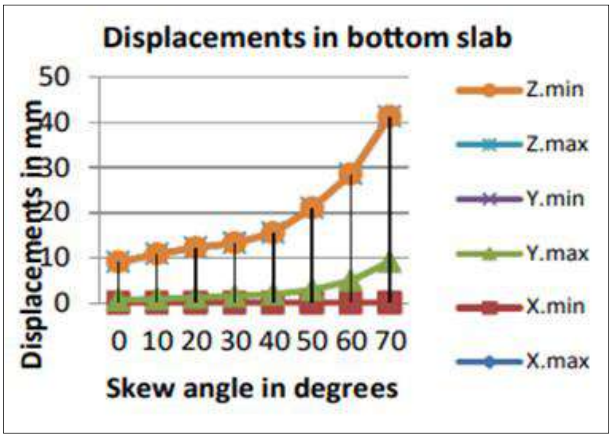

Fig 12: Skew angle V/s bottom slab displacement

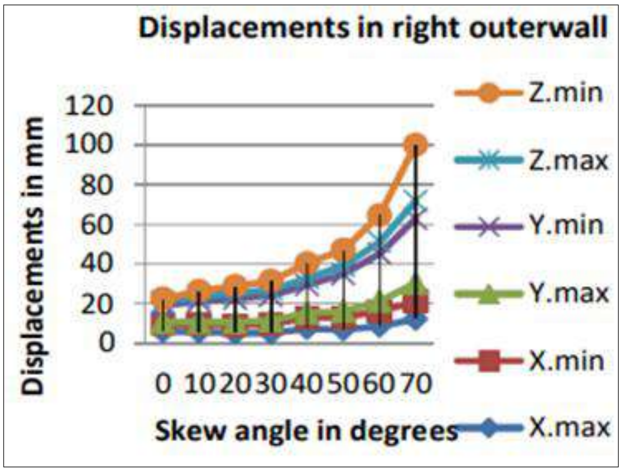

Fig 13: Skew angle V/s Right innerwall slab displacement

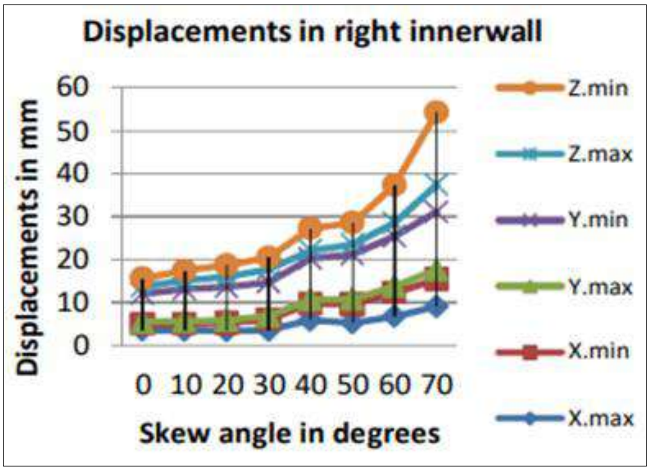

Fig 13: Skew angle V/s Right innerwall slab displacement

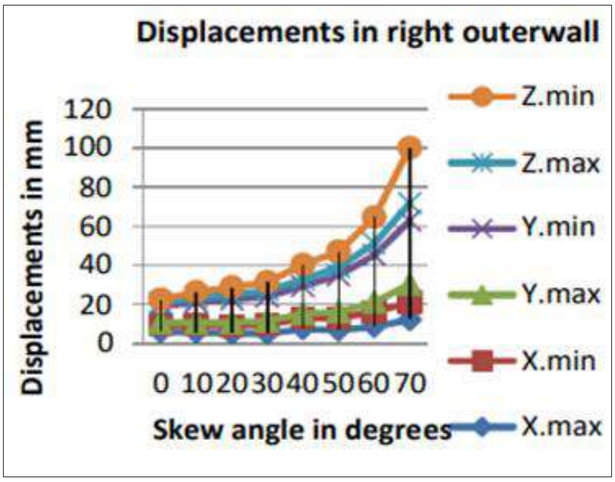

Fig 15: Skew angle V/s left innerwall slab displacement

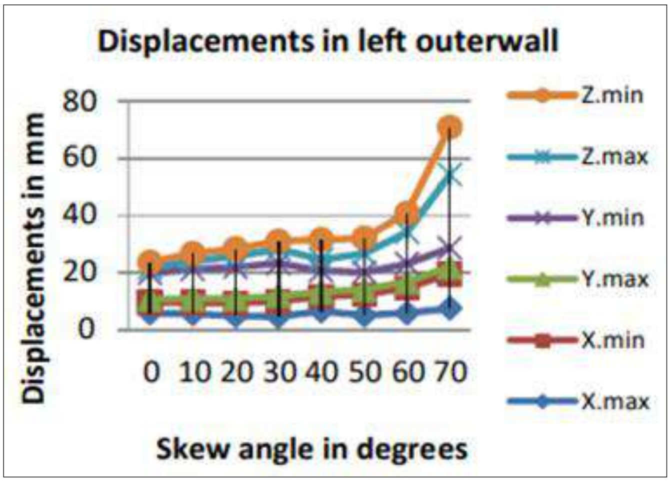

Fig 16: Skew angle V/s left outerwall slab displacement

Comparison of torsional moments of models with and without edge beams

Comparison when all loads are applied

From the result charts, it indicates that torsional moments both positive and negative are more in models with edge beams than models without edge beams at lower angles when all loads are applied as shown in figure.17, 18.

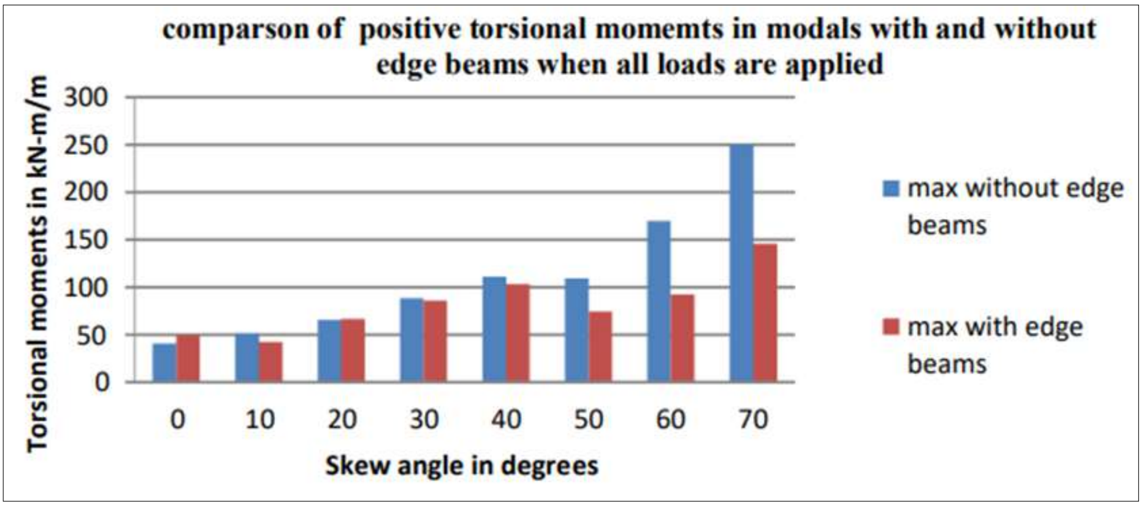

Fig 17: Skew angle V/s positive tor. Moment due to all loads

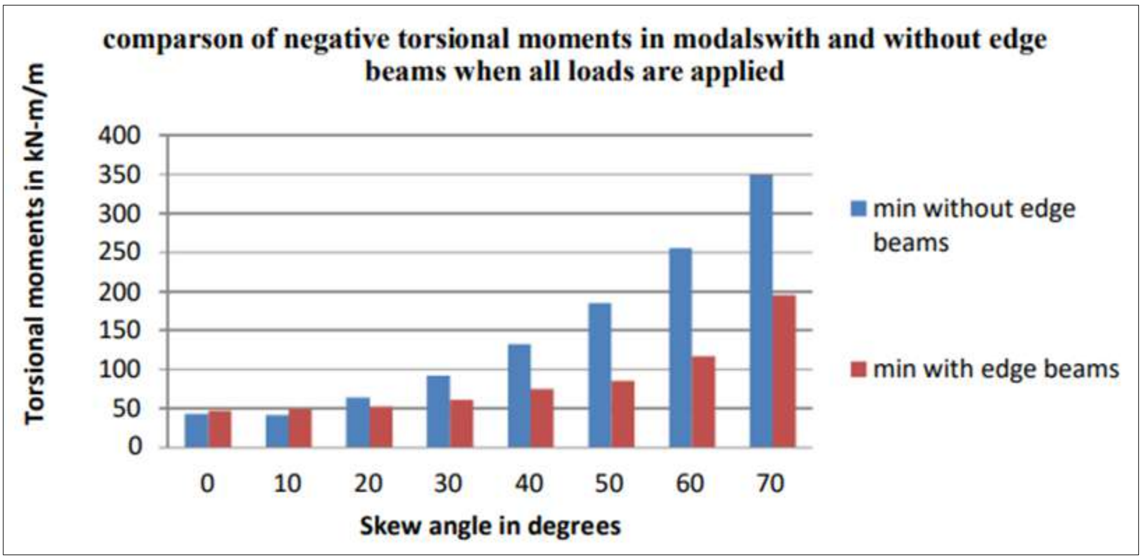

Fig 18: Skew angle vs negative tor moments due

Comparison when Permanent Loads are Only Applied

From the result charts, it indicates that torsional moments both positive and negative are more in models with edge beams than models without edge beams at lower angles when all permanent loads are only applied as shown in figure 19, 20.

Effect of skew angle on a multi-cell minor Bridge with Edge beams

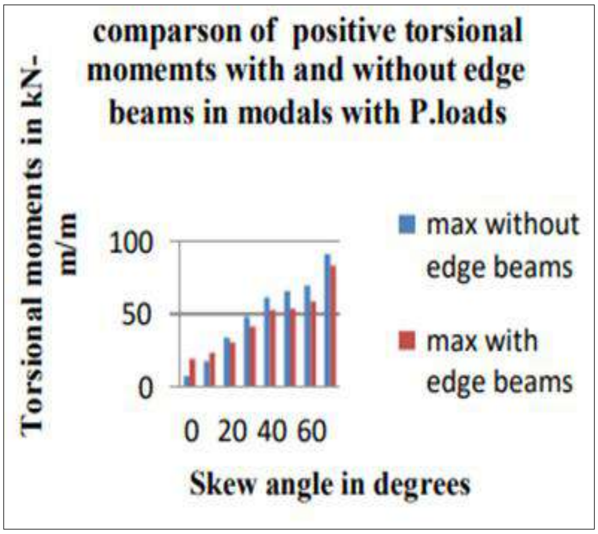

Fig 19: Skew angle V/s positive tor. Moment due to p. loads

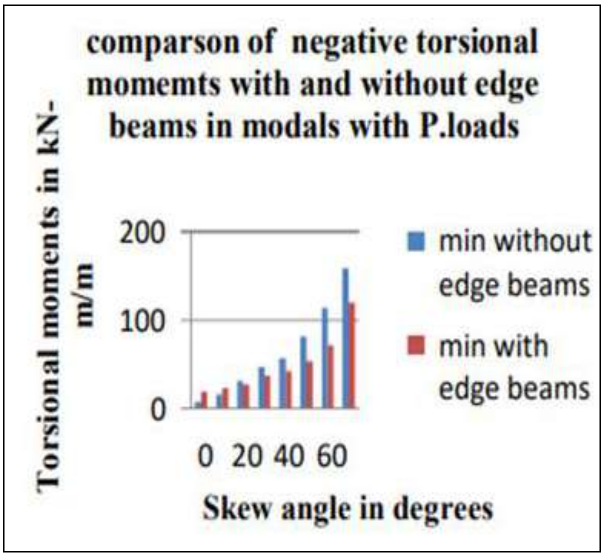

Fig 20: Skew angle V/s positive tor. Moment due to p. loads

6. Conclusion

From the above study, it can be concluded that

- Slant spans show an alternate way of behaving as that of straight extensions and changes constantly with the change in slant point.
- Boundaries like longitudinal minutes show a decrement in top piece up to 60º then begins expanding with the expansion in skewness while different boundaries increment with the expansion in skewness. Boundaries of different chunks show a direct addition with the expansion in skewness.
- From the relative investigation of top piece torsional minutes, one can uncover that edge shafts ought not be given at lower points.

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