EFFECT OF SKEW ANGLES ON A SKEW SLAB BOX CULVERT

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Abstract: In this paper the effect of different skew angle on skew slab bridge is carried out using CSi bridge software. Various skew angle such as 15^0,30^0,45^0 and 60^0 is considered for the anlysis purpose. In the analysis we consider 6m skew slab box culvert which is fixed on the two end and free on the other two side. IRC class 70r tracked is considered for the loading and the analysis is performed on the skew slab only.

Keywords: skew slab box culvert, skew angle, IRC, CSi Bridge.

I. INTRODUCTION

A box culvert is a structure that allows water to flow under a road, railroad and similar obstruction. As per Indian road congress the bridge length is upto 6m called culvert. A culvert may be made from different material like pipe, reinforced concrete or other material. Culverts are used both as cross-drains to relieve drainage of ditches at the roadside, and to pass water under a road at natural drainage and stream crossings. It is a bridge-like structure designed to allow vehicle and pedestrian traffic to cross over the waterway while allowing adequate passage for the water. Culverts come in many sizes and shapes including round, elliptical, flat-bottomed, open-bottomed, pear-shaped, and box-like constructions In present scenario skew slab box culvert are most due to the complex intersection at various places such as highways, river crossing, railway crossing etc. There is a continuous growing demand of skew slab box culvert. Construction of skew slab culvert are mostly common in alluvial region to allow passage of traffic as a underpass or to smooth flow of water of small river through it. Skew angle is the angle between the center line of carriageway and center line of a river. Skew slab box culvert bridge is define as the deck slab of bridge is not right angle with the end condition. Moreover, congestion of traffics also overcomes as alignment of road and bridge kept straight. These have leaded the provision of number of skew slab box culvert. In small skew angle box culvert say up-to 15^0, bridges are considered straight and are typically designed as normal right angle bridges with no considerable modification. Up-to skew angle 15^0, there is no considerable variation in values of parameters like bending moment and torsional moment. However, if the skew angle increases beyond 15^0, then there could be considerable variation in terms of bending moment and torsional moment. Hence there is requirement to study the nature of skew type box culvert to facilitate the various design parameters like bending moment and torsional moment. In this paper graphical representation is done to show the nature of skewed angle when skew angle is increased 15° to 60^0 at 15^0 interval each.

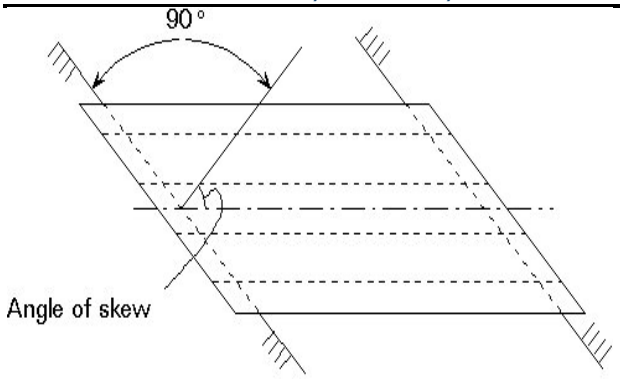


Figure 1: Skew slab box culvert with skew angle.

II. GEOMETRIC PROPERTIES OF SKEW SLAB BOX CULVERT

Width of carriageway	8.5m
Span length of skew slab	6 m
Thickness of skew slab	500mm

Material and loading properties:

Grade of concrete	M40
Loading	IRC70r Tracked

III. MODELLING

To generate the skew slab for a box type culvert model finite element method(FEM) is used to obtain the result. It is a numerical technique for obtaining approximate solution of partial differential equation. FEM helps in producing stiffness and strength visualization, also to minimize the weight of material cost of the structure. FEM indicate the distribution of stress and strains and also it gives detailed visualization of a body. A two dimensional model is generated using CSi bridge. The concrete slab were modelled using thin shell (SHELL) element and the slab is fixed at both the end and other edge remain free. A typical square shape mesh of size generated by dividing area into 100 part and for every skew angle.

For the analysis purpose 4 model on different skew angle (15^0,30^0,45^0 and 60^0) is considered each having span length of 6m each. The behavior of skew slab is studied under the dead load and live load(IRC class 70r) using FEM method are analysed.

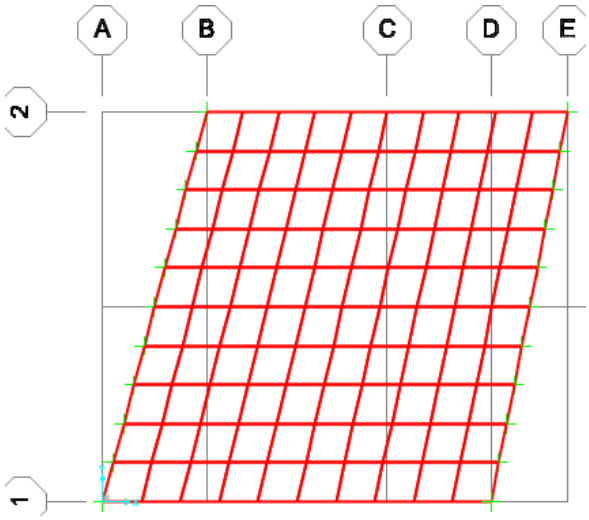


Figure 2: FEM model with 15 degree skew angle

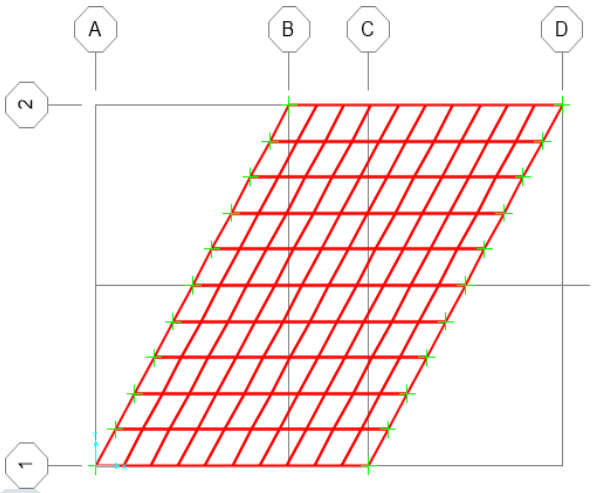


Figure 3: FEM model with 30 degree skew angle

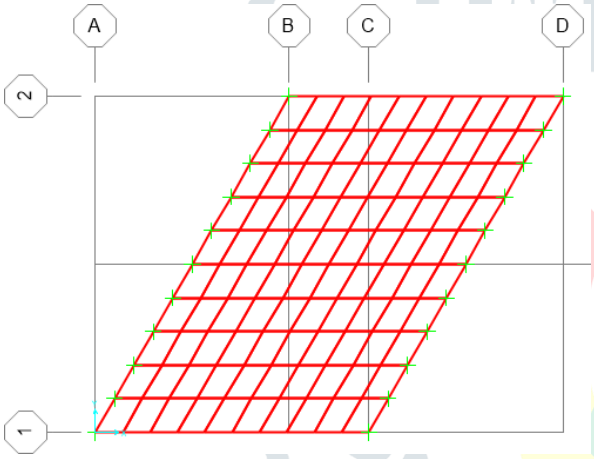


Figure 3: FEM model with 30 degree skew angle

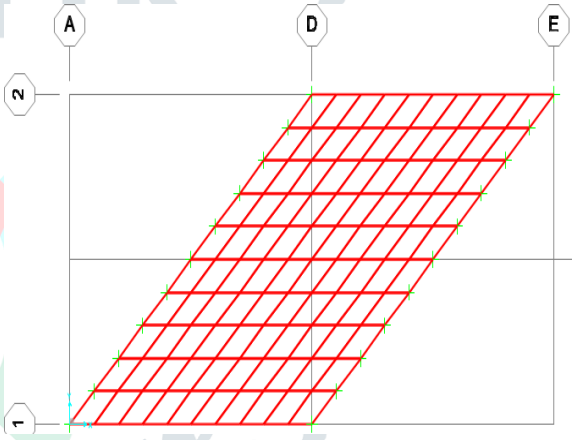


Figure 4:FEM model with 45 degree skew angle

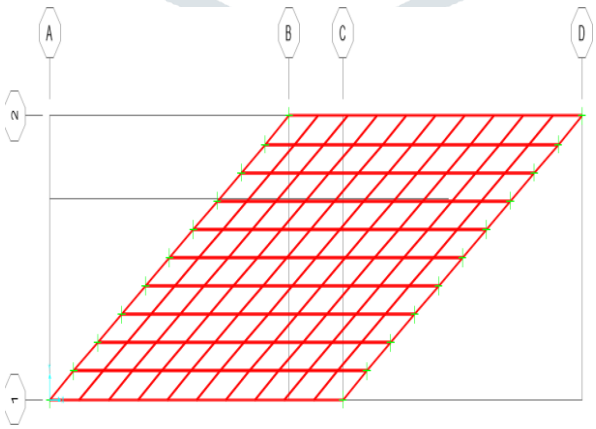


Figure 5: FEM model with 60 degree skew angle

IV. RESULT AND ANALYSIS

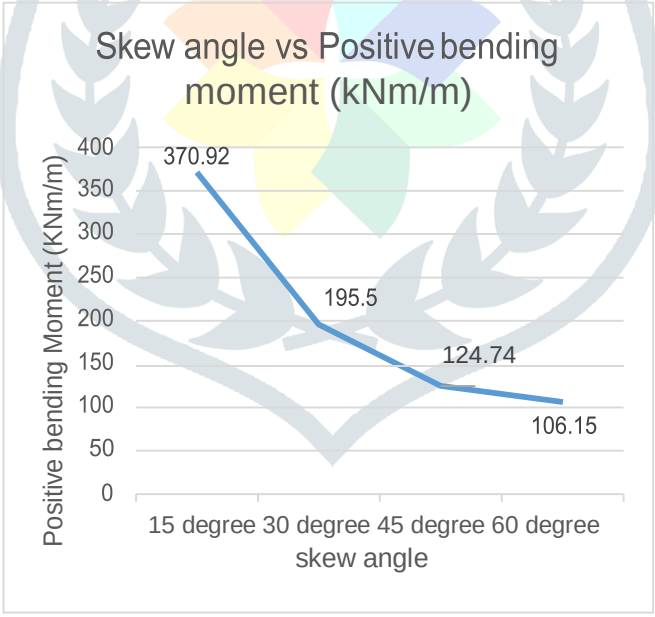
Analysis results of various skewed slab for box type culvert are compared with various skew angle and their behavior pattern have been studied. The results are obtained based on the bending moment, torsional moment and deflection. The critical structural responses are represented by various graph.

The analysis is carried out under the effect of dead load and live load (IRC 70R tracked). The vehicle will move at a distance of 1.2 m from free edge and the effect of various parameter has noted down is shown in table below.

Table 1: Analyzed value of bending moment, torsional moment and deflection with various skew angle

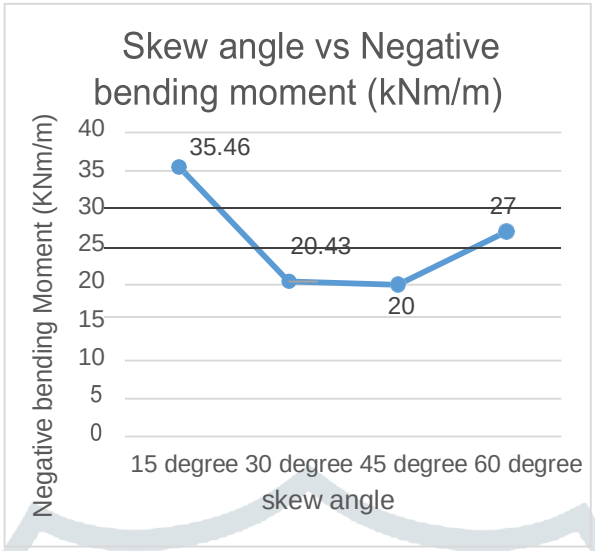
Skew Angle	Positive Bending Moment (kNm/m)	Negative Bending Moment (kNm/m)	Torsional Moment (kNm/m)	Deflection (mm)
15 Degree	370.92	35.46	94.77	3
30 Degree	195.5	20.43	124.85	1.4
45 Degree	124.74	20.0	241.31	1.9
60 Degree	106.15	27.0	475.77	3.7

i. Effect of positive bending moment on different skew angle



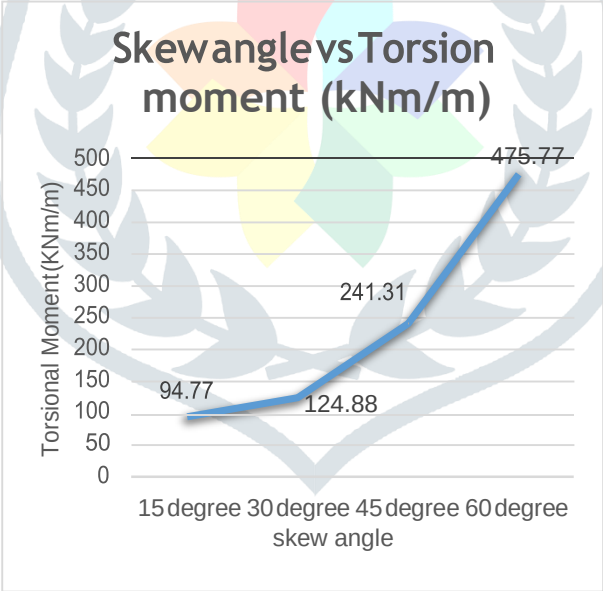
The positive bending moment will decrease as the skew angle increase from 15 to 60 degree. This positively bending moment will lie near the fixed end of the skew slab since its box type culvert the support are fixed. The decrement in values is about 47% from 15 degre to 30 degree, 36 % in case of 30 degree to 45 degree and 15% in case of 45 degree to 60 degree.

ii. Effect of negative bending moment on different skew angle:



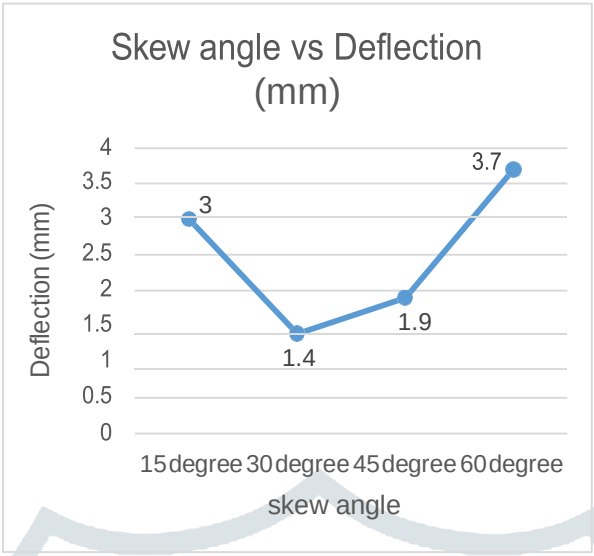
The Negative moment will first decrease upto skew angle 45 degree and than start increasing. The support is fixed at both end of slab so negative moment will lie at mid span. The decrement in values from 15 degree to 30 degree is about 42% and than there is increament in values of 35% upto 60 degree.

iii. Effect of torsional moment on different skew angle:



The variation of torsional moment at obtuse corner will produce maximum among all the value in each case of skew angle. The value of torsional moment increase as the skew angle increase from 15 to 60 degree. From 15 degree to 30 degree the increament will 34% and from 30 degree to 60 degree the increament is about 94% of the given values.

iv. Effect of deflection on different skew angle



Near the free edge strip at mid span will produce maximum deflection in each case of skew angle. It was noticed that deflection will decrease up to 30 degree but later it will start increase as the skew angle further increase.

V. CONCLUSION

From the analysis it can be concluded :

- Positive bending moment will decrease with increase in skew angle
- Negative bending moment will decrease with increase in skew angle upto 45 degree than increase further with increase in skew angle.
- Torsion moment will directly proportional to skew angle, it increase with increase in skew angle.
- Deflection will decrease with increase in skew angle upto 30 degree and increase further with increase in skew angle.

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