ANALYSIS OF BOX TYPE MULTI-BARREL SKEW CULVERT

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Abstract-As the numbers of bridges comes up it has become healthy to provide box type multi-barrel skew culvert where traffic moves on the top of continuous slab and water flows through barrels underneath it. Present situation of traffic requirements demand straight alignment of road in view of the fast traffic and this in turn necessities the use of skew crossings. By providing this type of alternatives, bridge span is in direction of road, we can directly provide skew culvert. So, there is no need for provide approaches on both side in form of curve which will solve land acquisition problem and project becomes faster and economical.

Modelling and analysis of the skew bridge deck and box is to be done in STADD PRO and/or in SAP. For single cell analysis separate worked out manually with considering all load combination guided in IRC-6. The problem consisting of two lane road width (7.5m) and span of 20m. Each barrel is dimension has 5m by 5m. For dead load, live load, earth pressure, water pressures are considering and for various load combination it will be analysed and for critical design will be made. For analysis, Culvert is designed for 0degree skewness for single, two, three and, four barrels. Further comparative study is carried out for different skew angles 10degree, 20degree, 30degree, 40degree, 50degree and, 60degree.Parametric study also done for the given problem statement by considering various skew angles for comparing bending moments. Another study done for different support condition on base slab.

Keyword: Culvert, multi-barrel box culvert, Skew culvert, STADD PRO

1.INTRODUCTION

1. GENRAL

A bridge is a structure which maintains communication such as the road and railway traffic and other moving loads over an obstacle, namely channel, river or a valley. The structure is termed as a bridge when it carries a road and railway traffic or pipe line over a channel or a valley and an Overbridge when it carries the traffic or pipeline over a communication system like roadways or railways.

2. CLASSIFICATION OF BRIDGE

The classification of bridge structures with reference to the size has been done differently by road and rail alignment. The Indian railways consider structures having any span of clear waterway of 12 m or over as a major bridge and those below as a minor bridge. For the purpose of investigation and cross drainage structures can be grouped into three categories as follows,

1. Culvert and Minor bridge (linear water way up to 30m).

2. Major bridge (lineal waterway over 30 m but on stable rivers and canals).

3. Important bridge (lineal waterway over 30 m but on major rivers or tributarieswhich are shifting in nature).

3. culvert

A culvert is a bridge like structure designed to allow vehicle or pedestrian traffic to cross over the waterway while allowing adequate passage for the water. Culverts are commonly used for ditch relief and also to pass water under a road at natural drainage and stream crossings. Culverts come in many sizes and shapes including round, elliptical, flat-bottomed, and box-like constructions.

According to construction a culverts are classified as follows,

- Slab culvert

- Pipe culvert

- Box culvert

Figure 0-1 Box culvert *Figure 2 Pipe culvert*

BOX CULVERT

Box culvert is ideally suitable monolithic structure across a highway, railway embankment, which consist top slab, bottom slab and two vertical side walls.

If the discharge in a drain or channel crossing a road is small, and if the bearing capacity of the soil is low, then a box culvert is an ideal bridge structure. A box culvert is consisting of an RCC box of square or rectangular opening. The top of the box is road level or it may be at a depth below the road level if the road is an embankment. If the design discharge is considerable, a single box culvert becomes uneconomical because of the higher thickness of the slab and walls. In such cases, more than one box cast side by side monolithically.

Box culvert is economical for the reasons mentioned below:

- The box is a rigid frame structure and both the horizontal and vertical members are made of a solid slab, which is very simple in construction.
- In case of high embankments and ordinary culvert will require very heavy abutments that will not only be expansive but also transfer heavy loads to the foundations.
- The box type of structure is suitable for non-perennial streams where scour depth is not significant but subgrade soil is weak.
- The dead load and superimposed load are distributed almost uniformly over a wider area as the bottom slab serves as a raft foundation, thus reducing pressure on soil.

4. NEED OF SKEW CULVERT

Skew bridges are necessary when a stream crosses the road at an angle different from 90 degree. Present situation of traffic requirements demand straight alignment of road in view of the fast traffic and this in turn necessities the use of skew crossings. Bridges in plane form is a parallelogram; the angle obtained subtracting the acute angle of parallelogram from 90degree is termed as skew angle.

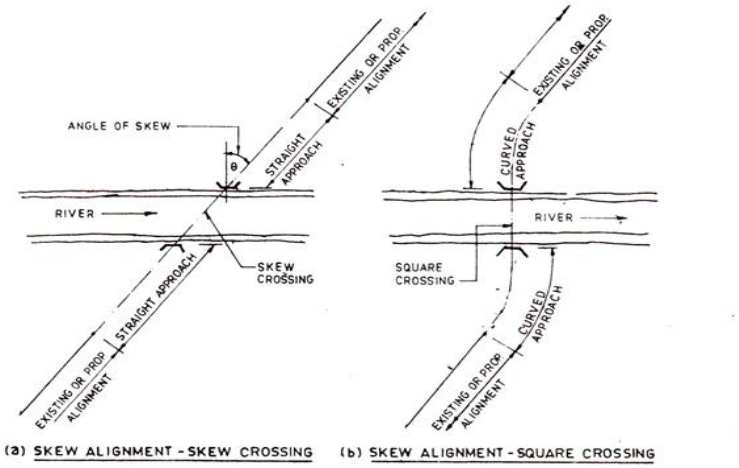


Figure3 Skew crossing

5. Highway bridge loading

The following forces shall have to be considered in the design of road bridges and all members shall be designed to sustain safely the effect of various loads, forces and stress that may act together.

1. Dead Load

2. Live Load (Consider 70R tracked vehicle)

3. Impact Load

4. water Current

5. Earth Pressure

6. Seismic Forc

2. Analysis of box type multi-barrel skew culvert

In present study consists of single, two, three and, four span of box type skew culvert at different skew angle varies from 0 degree to 60 degree at 10 degree interval for analysis. The modelling is done in STADD.pro.

PROBLEM STATEMENT

For sample calculation only single culvert is consider,

Span of a culvert	5 m
Width of carriage way	7.5 m
Footh path	250 mm x 1200 mm
Height of box	5 m
Width of box	5m
Top slab thickness	500 mm
Bottom slab thickness	700 mm
Thickness of side wall	450 mm
Thickness of wearing coat	80 mm
Co-efficient of earth pressure	0.5

M-20 concrete, Fe-415 Steel should be consider.

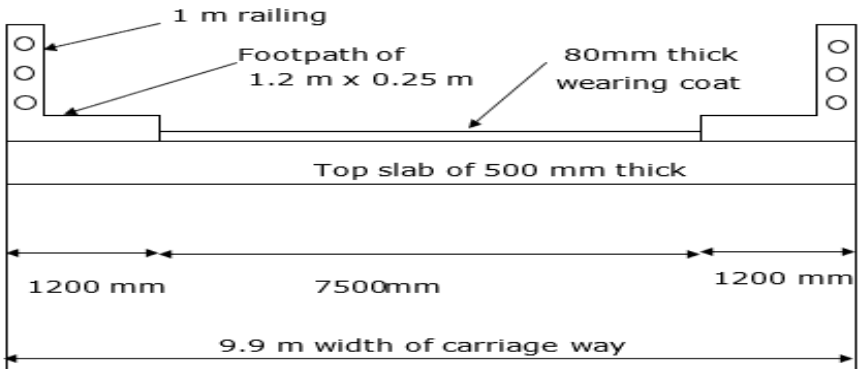


Figure 4 single span box culvert

1. MODELLING STEPS FOR A BOX CULVERT IN STADD.PRO

STADD.pro having nice facility to Model Bridge very easily. It is having step by step bridge modelling option.

- First select the units in which all the loads to be given. Here for three-dimensional modelling global system is selected and kN.m units selected. Then geometry of the modelling will be started.

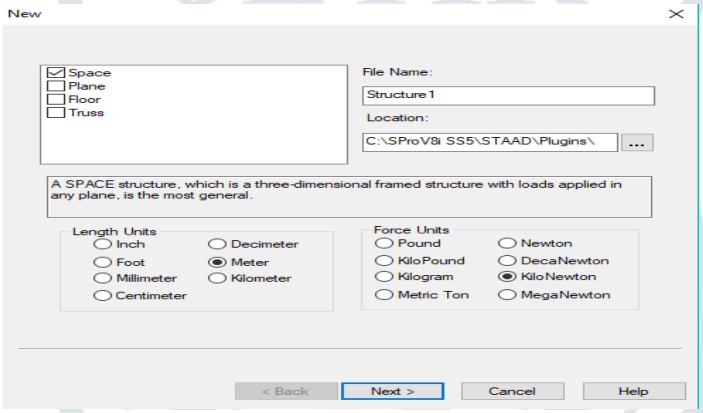


Figure 5 Bridge wizard in STADD.pro

- The second step is, develop a geometry of multi-barrel box culvert.

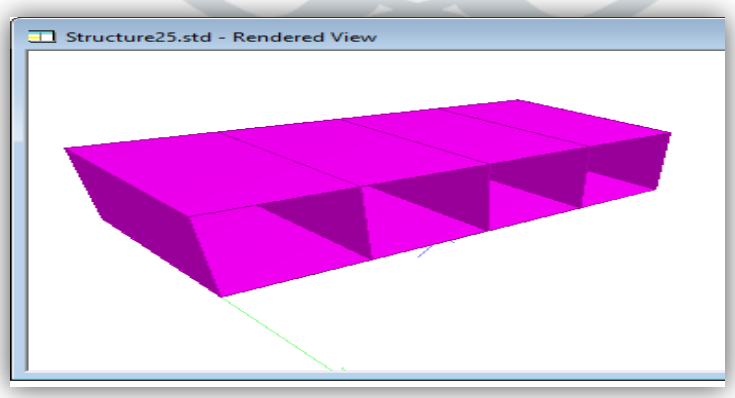


Figure 6 Geometry development for multi-barrel skew culvert

- Third step is to assign the property to the box culvert.

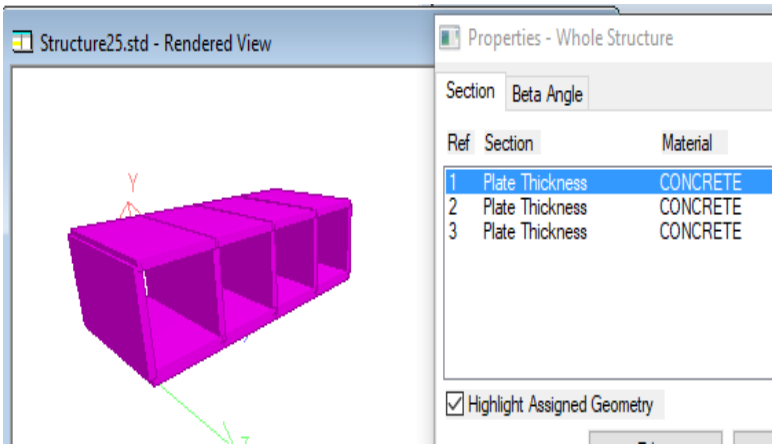


Figure 7 Assign property to box culvert

- The four step is assign a support art base.

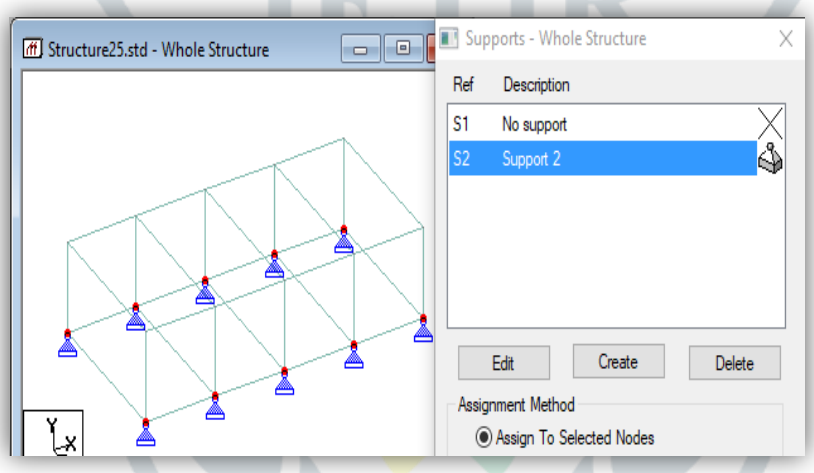


Figure 8 Assign support at base

- The fifth step is assign a load, which acting on a culvert.

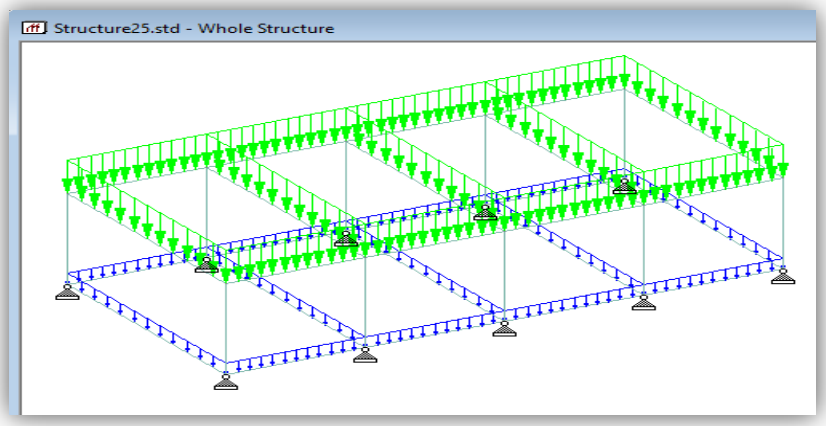


Figure 9 Assign D.L & L.L on top and bottom slab

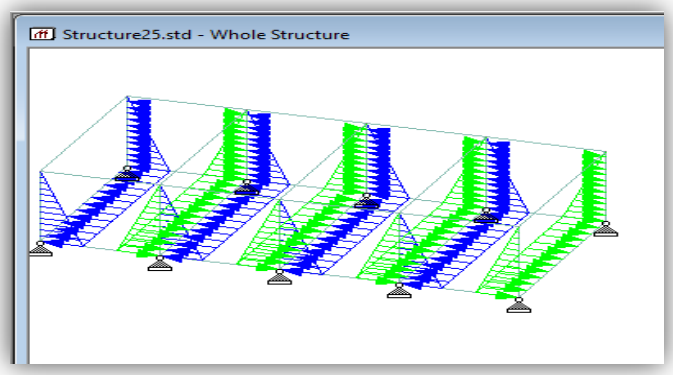
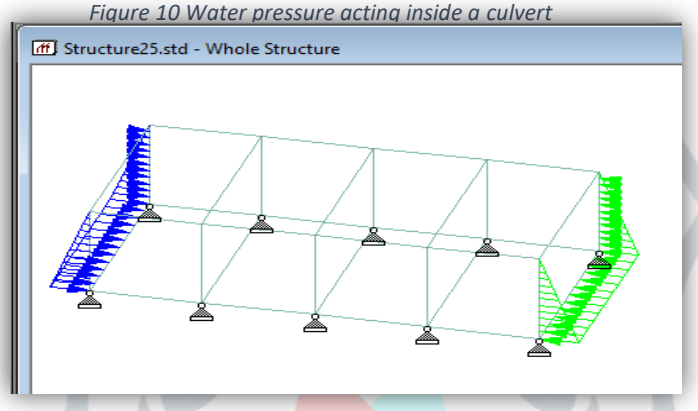


Figure 10 Water pressure acting inside a culvert



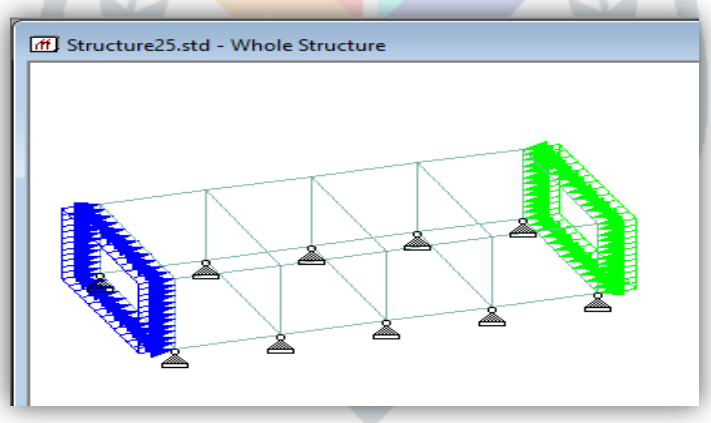


Figure 12 Earth pressure due to surcharge

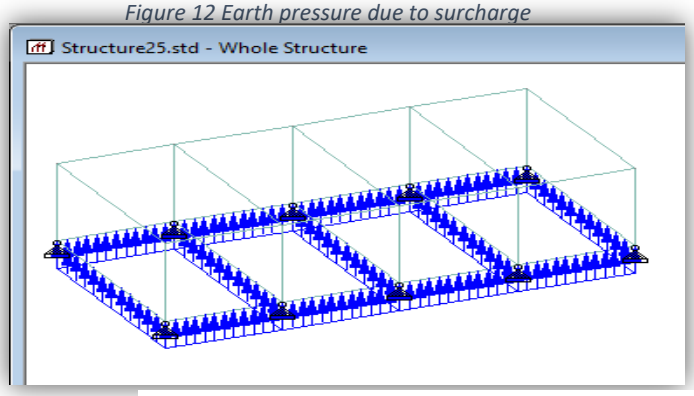


Figure 13 Earth pressure acting at base

3.RESULT

1. DIFFERENT SKEW ANGLES COMPARISONS WITH BENDING MOMENT

A bending moment at a base slab of a culvert is find out for a Dead load, Live load, Earth Pressure and, water pressure for a various skew angle 0degree to 60degree for a single, two, three and, four span box culvert.

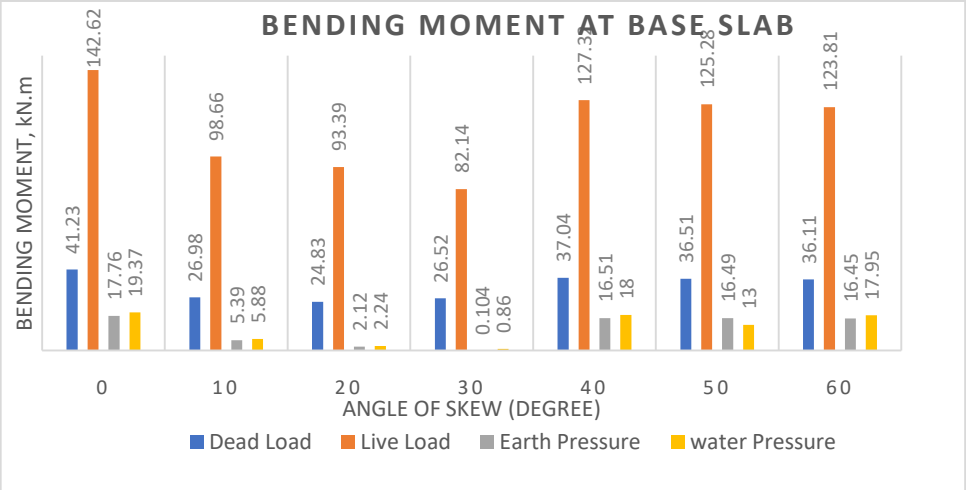


Figure 14 : Bending moment diagram for single span culvert

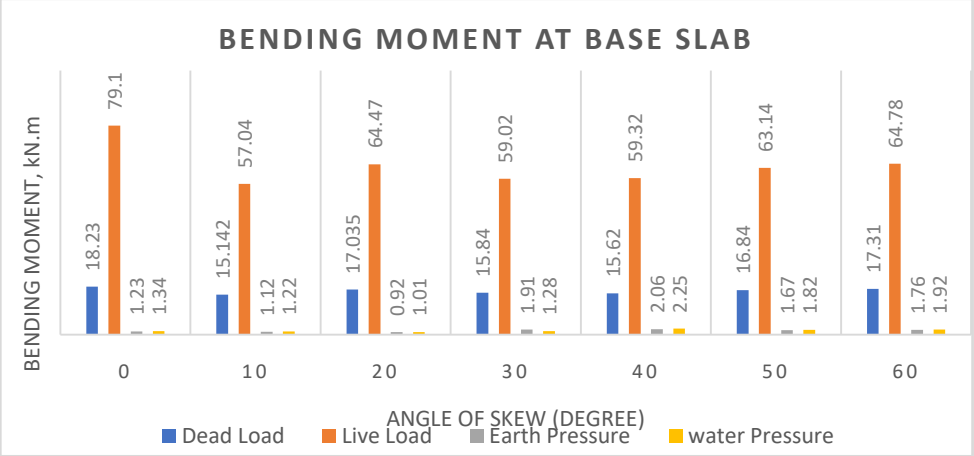


Figure 15 : Bending moment diagram for two span culvert

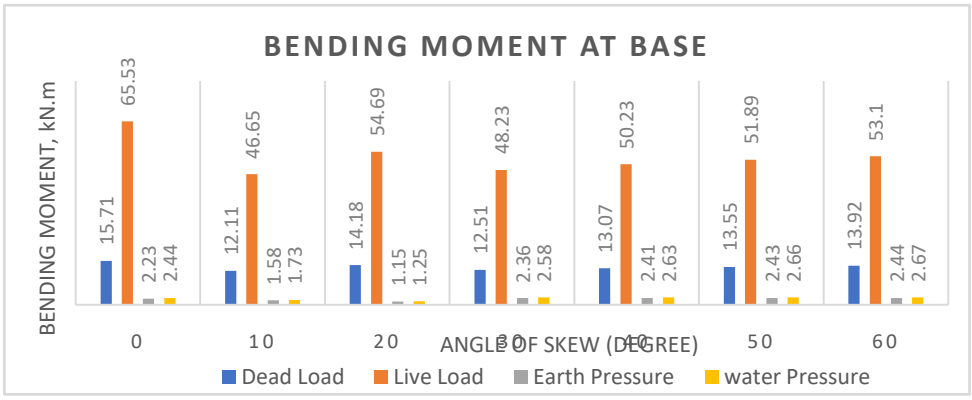


Figure 16 : Bending moment diagram for three span culvert

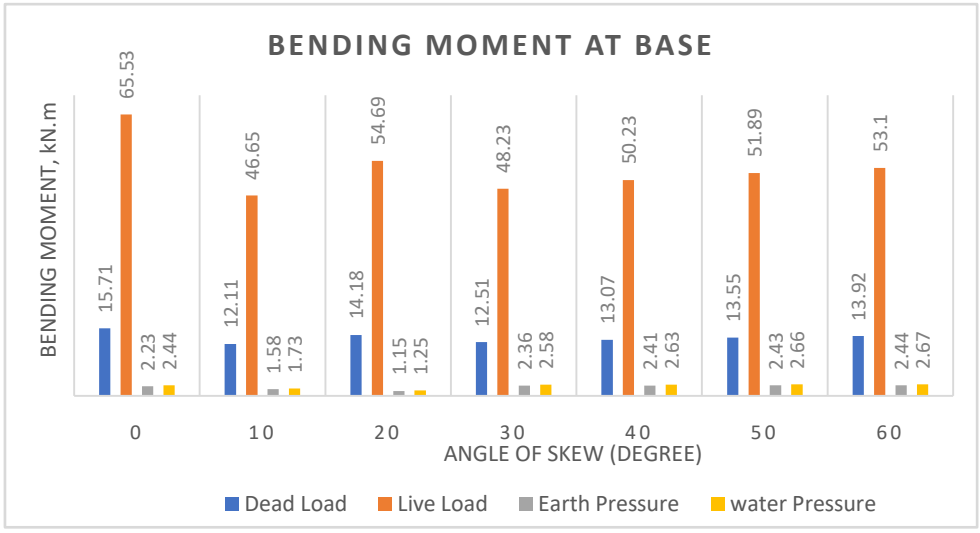


Figure 17 : Bending moment diagram for four span culvert

2. DIFFERENT SKEW ANGLES CMPARISONS WITH DISPLACEMENT

A maximum displacement of a culvert is find out for a various skew angle 0degree to 60degree for a Single, Two, Three and, Four span.

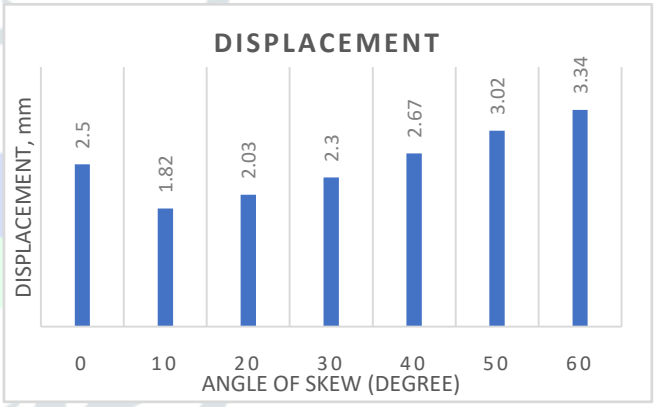


Figure 18 : Displacement diagram for single span culvert

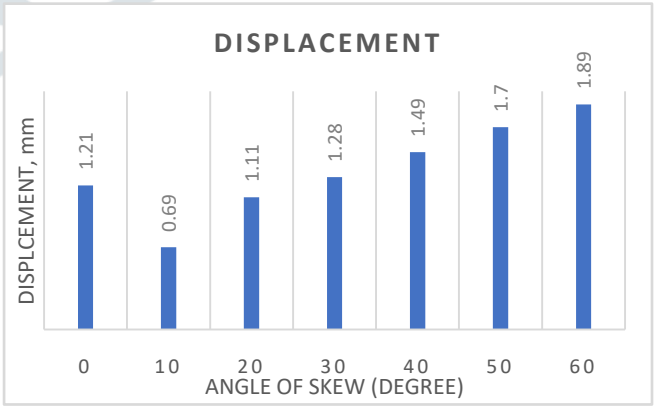


Figure 20 : Displacement diagram for three span culvert

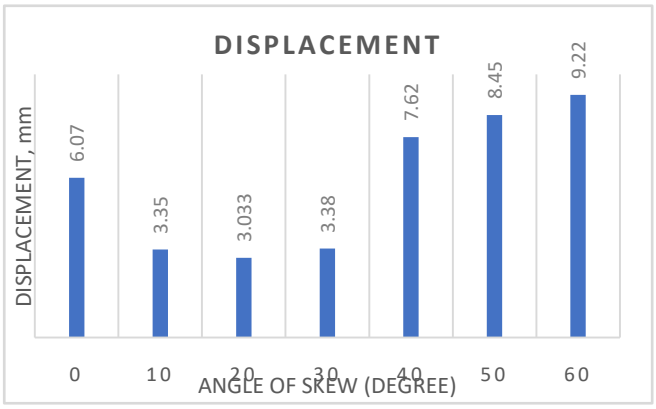


Figure 19 : Displacement diagram for two span culvert

3.PARAMETRIC STUDY FOR A VARIOUS BASE SLAB RIGIDITY

Normally base slab support condition, outer wall is considered as fixed and internal wall considered in hinged condition. So, considering base slab as parameter two different support conditions will be considered. One support condition in which external wall having fixed support and internal walls having hinged condition while on the other hand whole base slab is resting on elastic foundation (Providing spring support).The bending moment and a displacement are find out for a three span and four span box culverts for a Dead load and Live load for both support condition.

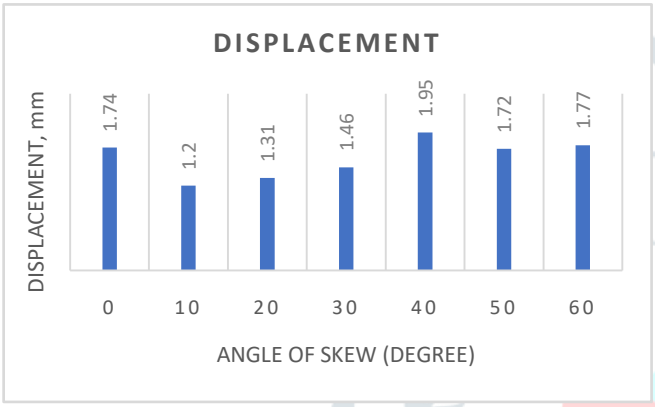


Figure 21 : Displacement diagram for four span culvert

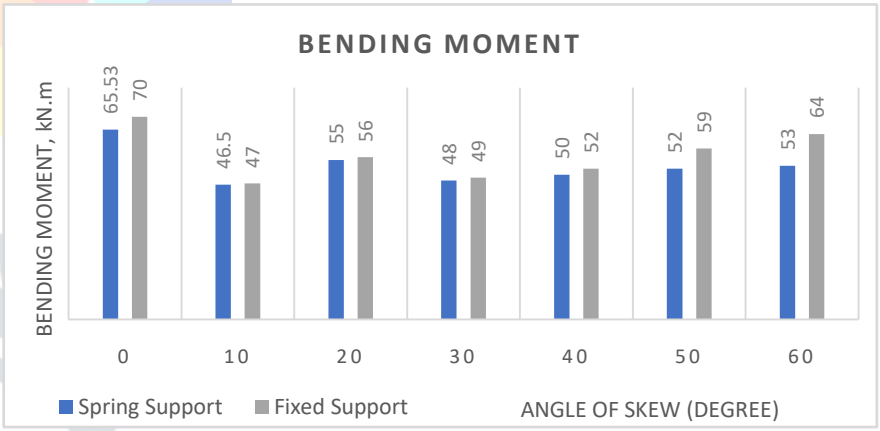


Figure 22 Bending moment diagram for three span culvert due to live load

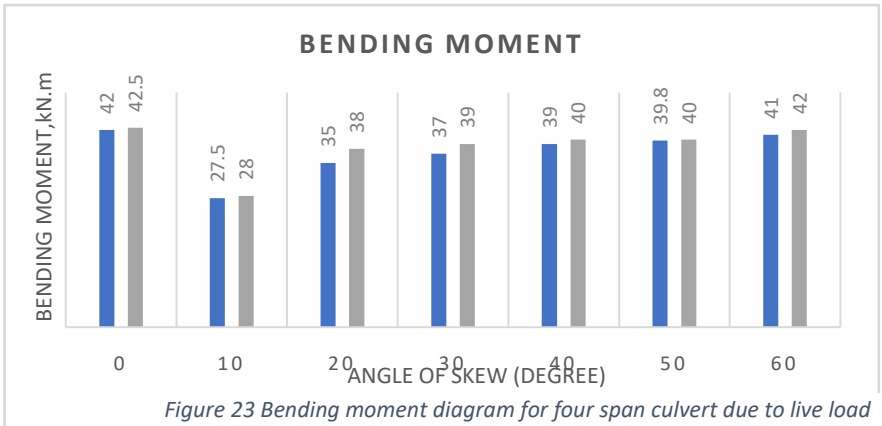


Figure 23 Bending moment diagram for four span culvert due to live load

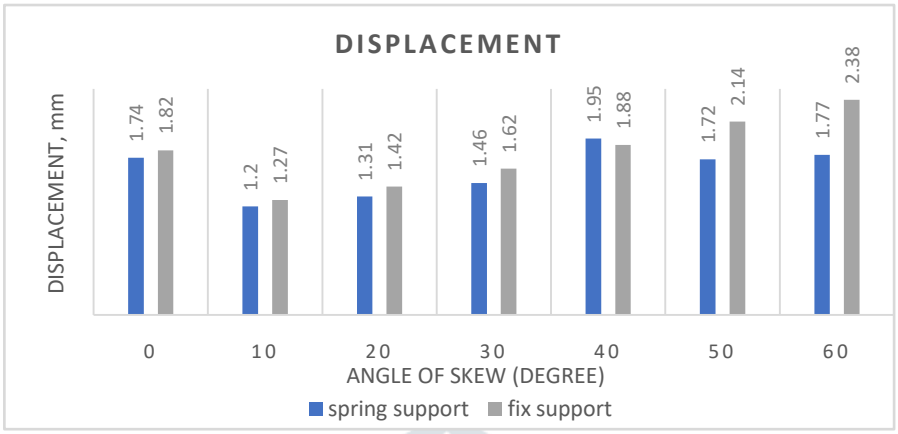


Figure 24 Displacement diagram for three span culvert

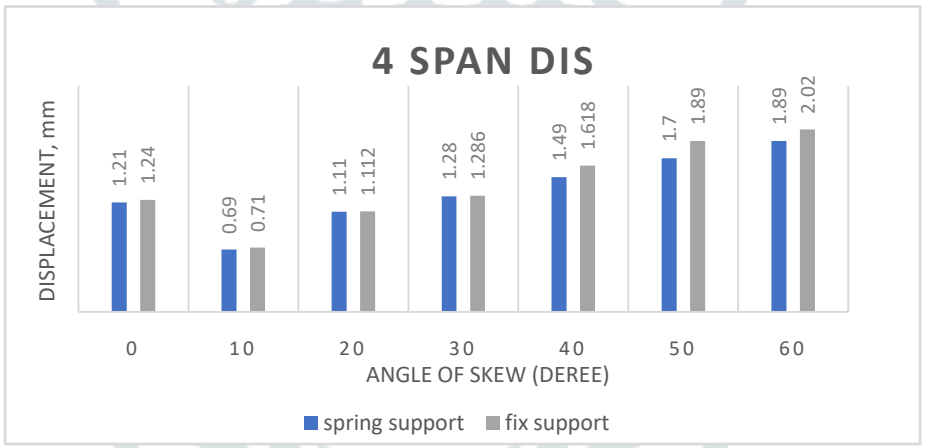


Figure 25 Displacement diagram for four span culvert

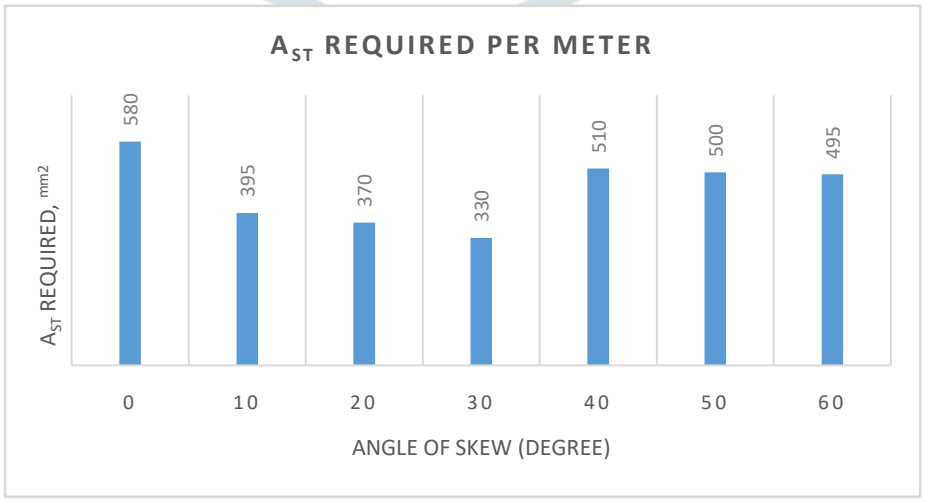


Figure 26 A_{st} required per meter for a single span culvert

4 Conclusion

- From the analysis, we conclude that the value of a bending moment at a base slab for single, two, three and, four span culvert decreases with increase in a skew angle up to 30degree and then increases up to 60degree, but which is less then the value at normal culvert. Thus, reduce the thickness of a base slab.
- The value of a displacement for a culvert decreases with increases in the skew angle up to 30 degree and then increase up to 60 degree, but which is in permissible limit (20mm).
- From the result we conclude that, value of a bending moment and displacement for a spring support condition is less then the value at a fix support condition so, if we consider a base slab on elastic foundation, we reduce the base slab thickness. Thus reduce in the cost of concrete.
- From the table we conclude that, area of steel required per meter for a single, two, three and, four span culvert decreases with increases in skew angle. Thus we can save a steel cost and project becomes economical.
- From the analysis we conclude that if we provide a culvert at a required skewness up to 60 degree ,there is no need to provide a approaches on both side in the form of curve, which will solve land acquisition problem and project become faster and economical.

5. REFERENCES

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