Economical Design Of RCC Culvert By Using STAAD pro.

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Abstract : **A culvert is any structure not classified as a bridge that provides an opening under a roadway, and other type of access or utility. It is monolithic structure having parts are top slab, bottom slab and vertical walls and wing walls. Culverts are provided to allow water to pass through the embankment and follow natural course of flow and road passes and culverts are also provided to balance the water level on both sides of embankment during floods, such culverts are termed as balancers. There are differ types of culverts are used according to its requirement. It is well known that roads are generally constructed in embankment which comes in the way of natural flow of storm water (from existing drainage channels).**

***IndexTerms*–Culvert, STAAD pro, Angle of internal friction, L/H ratio.**

I. INTRODUCTION

A culvert is any structure not classified as a bridge that provides an opening under a roadway, and other type of access or utility. It is well known that roads are generally constructed in embankment which comes in the way of natural flow of storm water (from existing drainage channels). As, such flow cannot be obstructed and some kind of cross drainage works are required to be provided to allow water to pass across the embankment. The culvert covers up to waterways of 6 m (IRC: 5-1981) and can mainly be of two types, namely, box or slab. The box is one which has its top and bottom slabs monolithically connected to the vertical walls. In case of a slab culvert the top slab is supported over the vertical walls (abutments/ piers) but has no monolithic connection between them. A box culvert can have more than single cell and can be placed such that the top slab is almost at road level and there is no cushion. A box can also be placed within the embankment where top slab is few meters below the road surface and such boxes are termed with cushion. Culverts are provided to allow water to pass through the embankment and follow natural course of flow but these are also provided to balance the water level on both sides of embankment during floods, such culverts are termed as balancers, although there is no difference in the design. Sometimes the road alignment may cross a stream at an angle other than right angle; in such situation a skew culvert may be provided. For a smaller span there would be no difference in the design of culvert but it may require an edge beam and the layout of wing walls will have to be planned as per skew angle For a box culvert, the top slab is required to withstand dead loads, live loads from moving traffic, earth pressure on sidewalls, water pressure from inside, and pressure on the bottom slab besides self weight of the slab. The IS: 1893-1984 (Clause 6.1.3) provide that box culverts need not be designed for earthquake forces, hence no earthquake forces are considered. Although box of maximum three cells has been discussed but in practice a box culvert can have more cells depending on the requirements at site.

II. RESEARCH METHODOLOGY

The design of different shapes of culverts includes consideration of loads cases and factors like live load, effective width, dispersal of load through fill, braking forces, co-efficient of earth pressure etc. The relevant codes are required to be referred. The structural parts are designed to withstand the maximum bending and shear force. The work provides full discussion on the provisions given in the codes and all the aspects of design. To study the effect of cushion in RCC culvert by analysis for different cases like traffic condition, Soil condition, hydrological condition. Structural designing of RCC culvert considering various load cases including factors like effective live loads, effective width, and coefficient of earth pressure. The principal objectives of the project are to investigate basic parameters like shear force and bending moments for culvert with and without cushion.

2.1Problem statement

The RCC Culvert is analyzed is for dead load, live load, earth pressure & water pressure using STAAD-Pro software.

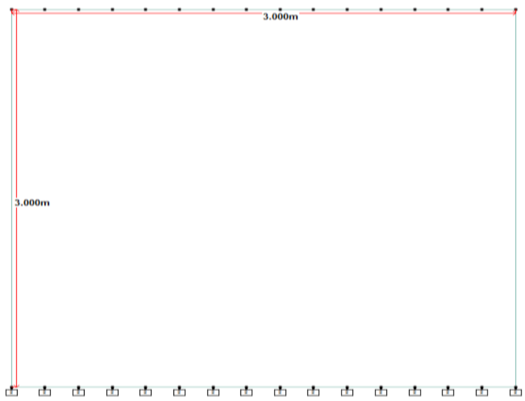

Figure 2.1 Elevation of RCC box culverts

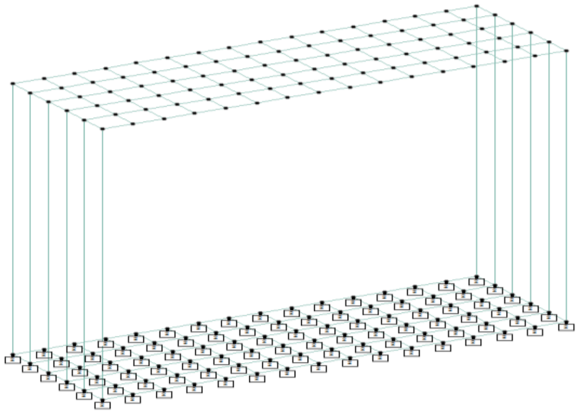

Figure 2.2 Isometric view of RCC box culverts

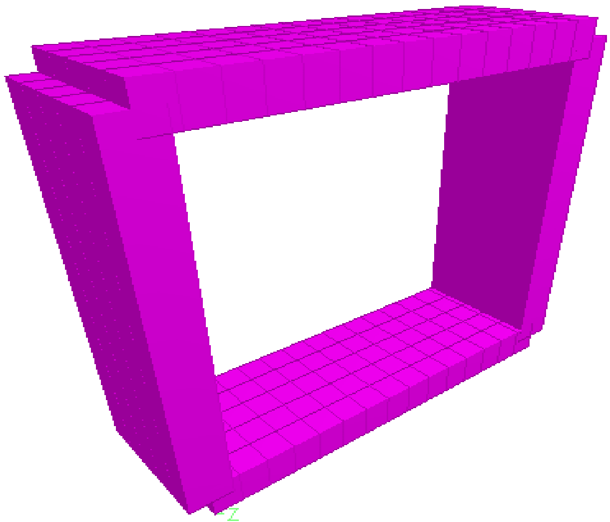

Figure 2.3 3D view of RCC box culverts

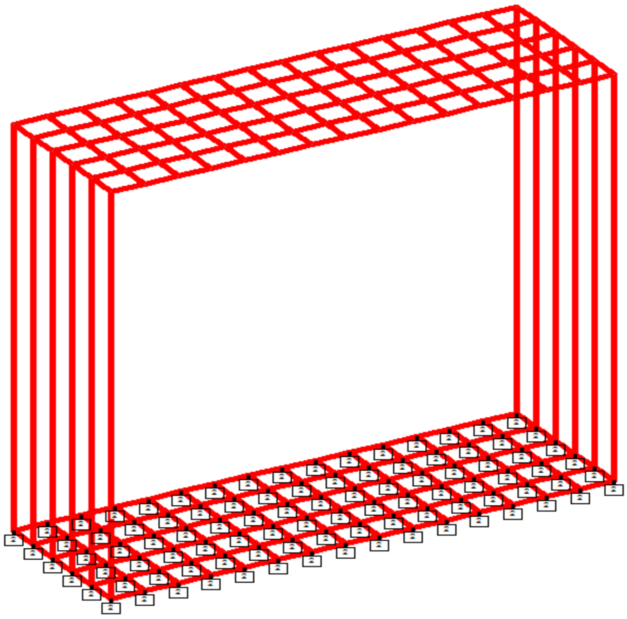

Figure 2.4 Dead load on RCC box culverts

2.2 Properties
Top slab thickness – 300mm
Side wall thickness – 300mm
Bottom slab thickness – 300mm
Grade of concrete – M30
Grade of steel – Fe550

2.3 Loads on culverts
Dead load:: Self weight of culvert
Live load :: 166.5 kN/m²
Dry earth pressure:: 42.7 kN/m²
Submerged earth pressure :: 19 kN/m²
Water pressure :: 30 kN/m²

2.4 Load combinations
Dead load+ Dry earth pressure
Dead load+ Dry earth pressure + Live load
Dead load+ Submerged earth pressure
Dead load+ Submerged earth pressure+Live load
Submerged earth pressure+ Water pressure
Submerged earth pressure+ Water pressure+Live load

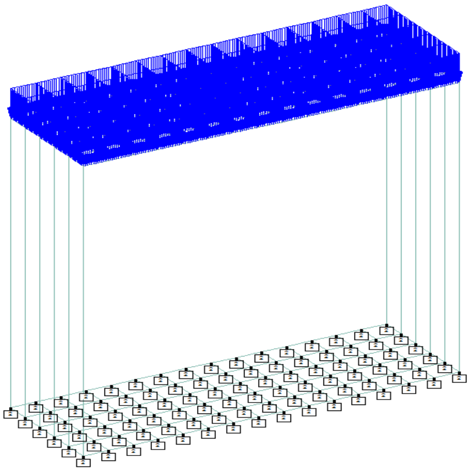

Figure2.5 Live load on RCC box culverts

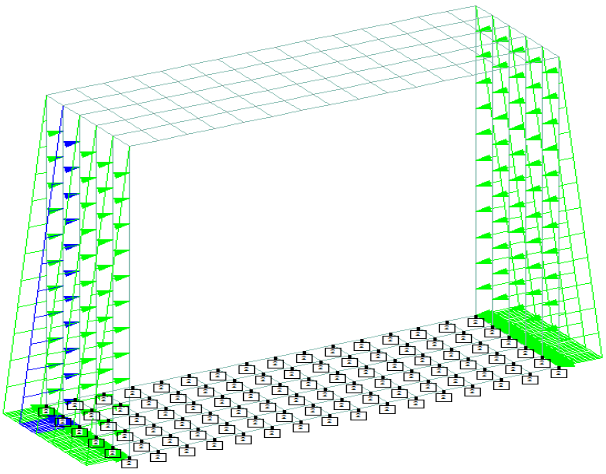

Figure 2.6 Dry earth pressures on side wall of RCC box culverts

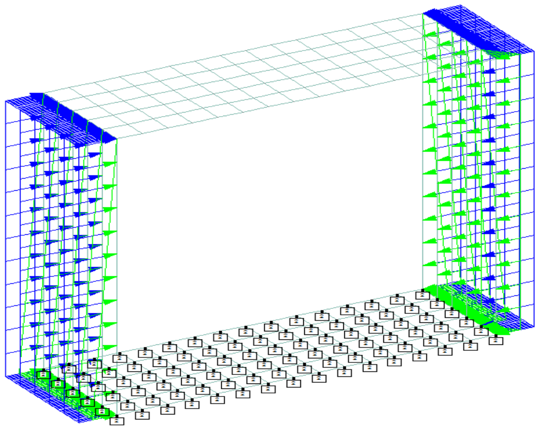

Figure 2.7 Submerged earth pressures on side wall of RCC culverts

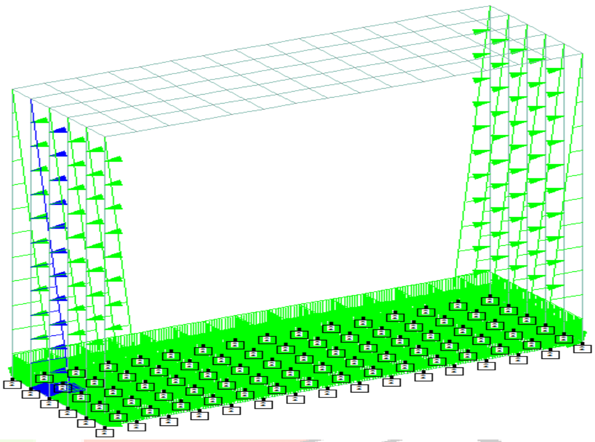

Figure 2.8 Water pressures on side wall of RCC culverts

III. RESULT

Table 3.1:Deck slab Depth required -dreq (mm)

Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	214.81731	225.32314	312.615318
22	214.93748	225.32314	293.997134
25	215.32	225.22928	280.739917
28	215.97877	225.16447	268.065998
30	216.36742	225.12126	259.968749

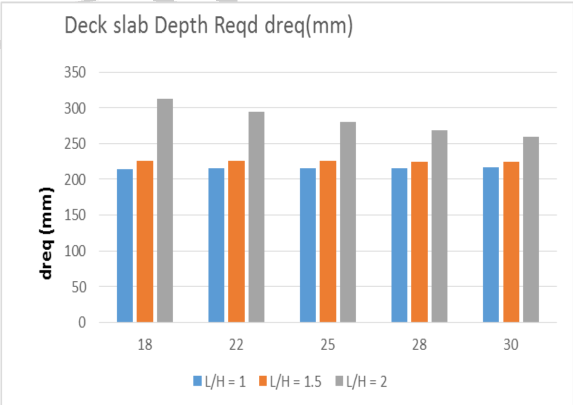

Figure 3.1 Deck slab Depth required -dreq (mm)

Table 3.2 : side wall Depth required -dreq (mm)

Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	141.246	172.934	266.502

22	136.317	166.054	250.247
25	135.44	161.045	294.768
28	134.711	156.327	228.155
30	134.143	153.316	221.205

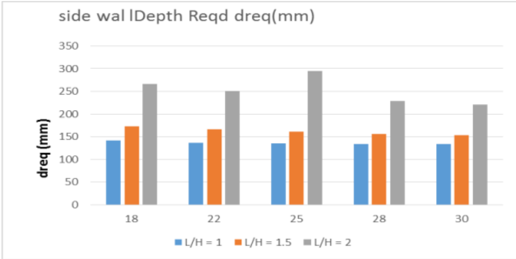

Figure 3.2 side wall Depth required -dreq (mm)

Table 3.3: Base slab Depth required -dreq (mm)

Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	211.367	217.567	325.834
22	212.202	217.567	306.489
25	212.924	216.648	361.015
28	212.952	216.007	279.431
30	213.985	215.583	270.92

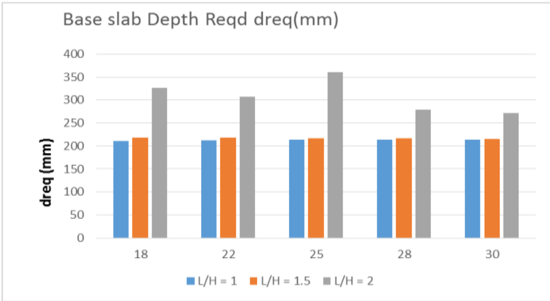

Figure 3.3 Base slab Depth required -dreq (mm)

Table 3.4 : Deck slab Main steel required -Ast +ve (mm^2)

Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	1549.4922	1727.319	1502.44296
22	1551.4494	1727.319	1501.696
25	1518.8848	1725.6682	1501.00656
28	1568.4805	1724.529	1845.87086
30	1574.8708	1723.7697	1844.82708

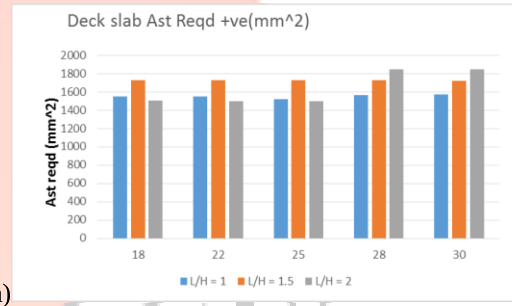

Figure 3.4 Deck slab Main steel required -Ast +ve (mm^2)

Table 3.5 : Side wall Main steel required -Ast +ve (mm^2)

Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	627.396	962.691	2049.5
22	582.573	882.632	1776.5
25	574.796	826.964	2597.08
28	568.378	776.492	1777.66
30	563.396	745.25	1655.96

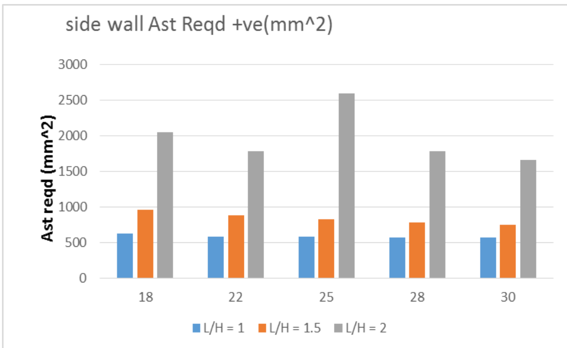

Figure 3.5 Side wall Main steel required -Ast +ve (mm^2)

Table 3.6 : Base slab Main steel required -Ast +ve (mm^2)			
Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	933.777	1500.92	3334
22	858.955	1370.81	2856.1
25	845.736	1281.02	3475.46
28	829.045	1200.07	2913.81
30	826.36	1150.18	2689.82

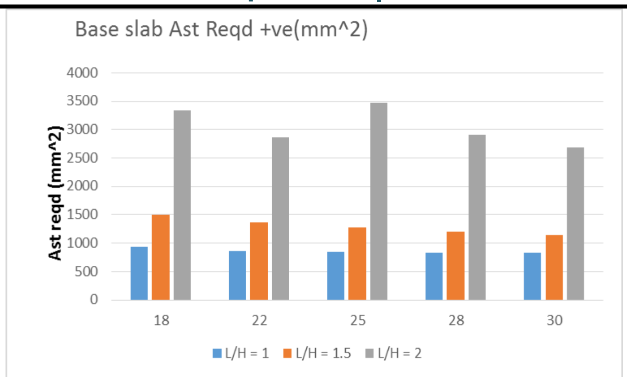

Figure 3.6 Base slab Main steel required -Ast +ve (mm^2)

Table 3.7: Deck slab Main steel required -Ast -ve (mm^2)			
Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	963.35883	1423.8489	3000.16639
22	892.85892	1305.2958	2580.76249
25	845.73556	1227.8615	2312.77942
28	870.59402	1157.6145	2618.47478
30	862.79837	1114.6713	2425.33658

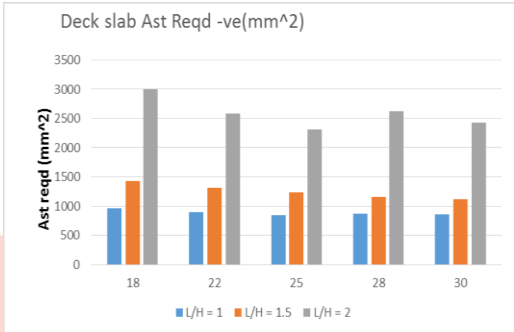

Figure 3.7 Deck slab Main steel required -Ast -ve (mm^2)

Table 3.8: Side wall Main steel required -Ast -ve (mm^2)			
Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	627.396	962.691	2049.5
22	582.573	882.632	1775.68
25	574.796	826.964	1602.56
28	568.378	776.492	1777.66
30	563.404	745.25	1655.96

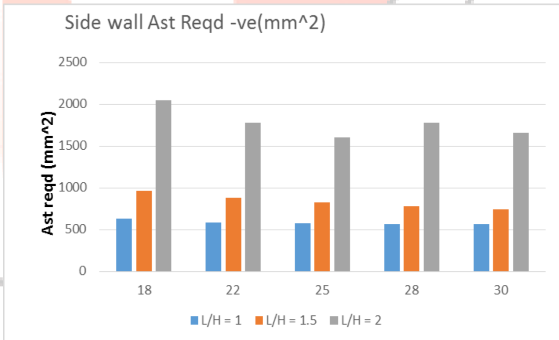

Figure 3.8 Side wall Main steel required -Ast -ve (mm^2)

Table 3.9 : Base slab Main steel required -Ast -ve (mm^2)			
Angle of internal friction Φ	L/H Ratio		
	L/H = 1	L/H = 1.5	L/H = 2
18	1494.03	1594.71	1382.88
22	1507.33	1594.71	1375.72
25	1518.88	1579.5	1465.78
28	1519.34	1568.95	1661.63
30	1535.98	1562	1651.51

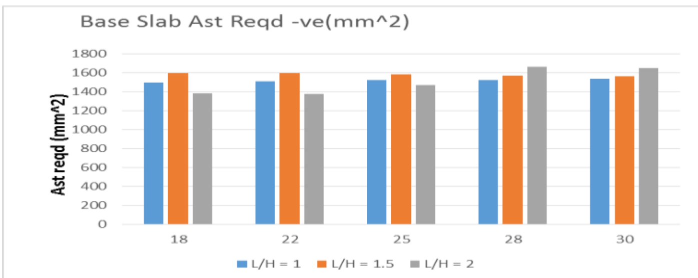

Figure 3.9 Base slab Main steel required -Ast -ve (mm^2)

IV. CONCLUSION

[1] Deck slab Depth required –dreq of box culvert is found to be same as angle of internal friction is increased but it is increased by 10% as L/H ratio is increased.
[2] side wall Depth required –dreq of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[3] Base slab Depth required –dreq of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[4] Deck slab Main steel required -Ast +ve of box culvert is found to be same as angle of internal friction is increased but it is increased by 10% as L/H ratio is increased.
[5] Side wall Main steel required -Ast +ve of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[6] Base slab Main steel required -Ast +ve of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[7] Deck slab Main steel required -Ast –ve of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[8] Side wall Main steel required -Ast –ve of box culvert is increased by 25%as angle of internal friction and L/H ratio are increased.
[9] Base slab Main steel required -Ast –ve of box culvert is found to be same as angle of internal friction is increased but it is increased by 10% as L/H ratio is increased.

V. REFERENCES

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