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ANALYSIS AND DESIGN OF SINGLE VENT BOX CURVET FOR DIFFERENT LOADING CONDITION BY USING STAAD PRO SOFTWARE

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I. INTRODUCTION

The need for a bridge is felt by people and it is communicated to Government through Public representatives or the importance of bridge is felt by Govt. due to the increasedtraffic demand that may be due to various reasons viz. important road, tourist place, pilgrimage center, industries, etc. The government thus decides to construct a bridge at a particular location. Road Project Division is required to carry out a survey for the bridge location and collect the requisite preliminary survey data that is required for bridge planning and design When compared to slab or arch culverts, box culvert offersmany benefits. The structure of the box is sturdy, stable, safe, and simple to assemble. The key benefit is that, unlike other types of culverts, it may be positioned at any elevation within the embankment with adjustable cushion. A multi-cell box may accommodate a big discharge and fit within an embankment with a reduced height. It can be erected on soft soil without the need for a separate elaborate foundation by projecting an appropriate base slab that will lower base pressure within the foundationsoil's safe bearing capacity. No bearings are required. In the event that the roadway needs to be widened in the future, it is easy to expand the current culvert without encountering any design or construction issues. The culvert can be either a box or slaband can span up to 6 metres of waterways (IRC: 5-2016). The box is one whose top and bottom slabs are joined to the vertical walls in a single piece. Although the top slabin a slab culvert is supported over the vertical walls (abutments/piers), there is no monolithic link between them. The placement of a box culvert [1, 3&6] can be such that it has more than one cell and that the top slab is virtually level with the road.

II. ANALYSIS AND DESIGN OF BOX CULVERT

Design of a box culvert must take into account a variety of loads, including Dead load, Live load, Impact load, Longitudinal force/braking force, Soil pressure on the side walls, Surcharge due to Living load, and Water pressure from both inside and outside. Design must be completed using the Limit State Method of IRC Class AA Loading [13&14] and analysis by STAAD Pro Software, with the results of both being finalized. The Indian Road Congress Standards are used as a basis for computing design parameters. In this essay, we also examine the box culvert design and compare various reinforcement features. The culvert's vent size is fixed in accordance with the flood discharge from an upstream side. The box culvert's open size is 3m by 3m. The slab is 300 millimetres thick. M35 is the concrete grade, Fe415 is the steel grade, and 300 is the angle of repose.

Different Analysis Conditions for Box Culvert: A single box culvert is designed by thinking of it as a sturdy frame. The moment distribution method is typically used to calculate final moments at the frame's joints. Critical loading conditions are examined inthe culvert. The following three loading conditions are regarded as critical:

Case 1: There is no water pressure from the inside (no flow in the drain), live load, dead load, and earth pressure are all present.
Case 2: Internal water pressure operating against external live load, dead load, ground pressure, and other forces.
Case 3: There is no lateral pressure because of the live load, but there are dead and live loadsacting on the top slab, and there is internal water pressure.

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III. ANALYSIS AND DESIGN OF BOX CULVERT

1. **Manual Design Considerations:** The loads considered for the analysis of box culverts are Dead load, Live load, Soil pressure on side walls, Surcharge due to living load, and Water pressure from inside, Design BM and SF for top, Bottom slab, and Sidewalls. In a study, we have to consider IRC class AAloadingand Use the limit state method of design is conforming to IRC 112-2011.

2. **Software Design:** The greatest bending and thus the Box Culvert's overall economics depend on the longitudinal girders' optimal spacing. With the advent of computers, many of these issues have been readily resolved by adoptingpertinent software. Manual analysis of various Box Culverts with various longitudinal girder spacing is a time-consuming operation that also encourages human mistake. The same data was used to redesign the Box Culvert in STAAD Pro, and the outcomes are compared. The box culvert modelling process is as follows:

   Step 1: Idealizing slabs into comparable grilling
   Step 2: Adding Properties
   Step 3: Assigning Subgrade modulus for elastic Mat
   Step 4: Assigning Loads on Grillage beams
   Step 5: Results of Bending Moment and Shear forces

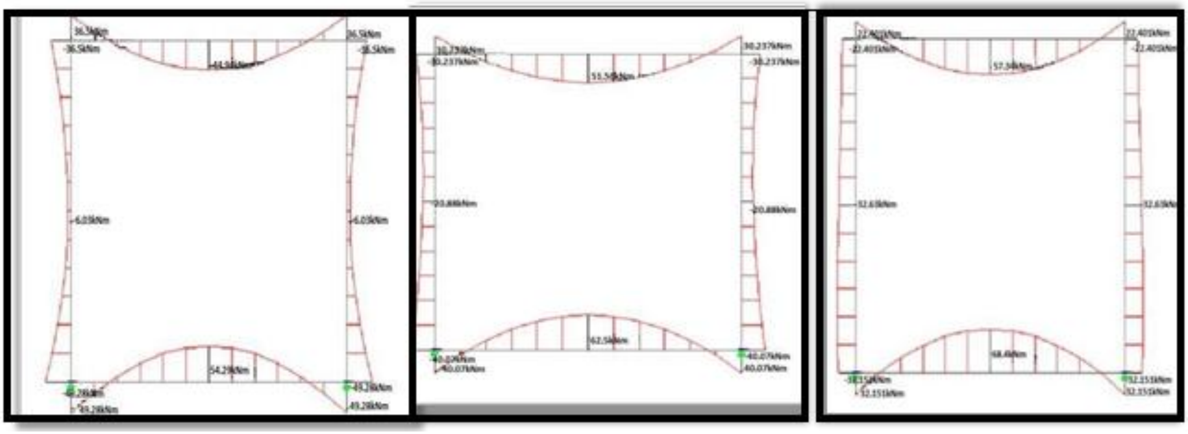
3. **Comparison between Manual and Software Method:** Now that both techniques areused regularly in civil engineering work, we choose which to use depending on factors like cost, strength, and time to finish the assignment. These are the main criteria we use to decide which method to use when designing or analyzing a beam. Therefore, a basic understanding of manual computation is needed, and software must be chosen for design and analysis reasons. In the present era, software is the most useful instrument for creating and analysing.In terms of economy, the structure is more economical if we choose the software for analysis and designate amount of interest provided by the software is much more compared to the manual. He time it takes to design many beams and many columns or other structure component can be done within minutes while it takes huge time for a manual todesign the whole structure.

IV. RESULTS AND DISCUSSION

Researchers in this field have used a number of approaches to study and design RCC box culverts. When comparing this condensed method to the earlier ways, the bending moment and shear force diagrams' values and shapes are thesame. Trial and error are used to install the spring spacing until a sensible gap is discovered. The output values are more accurate when the spacing is closer, especially for inverted members. Due to the symmetry of the sectional features and pressures placed on the culvert barrel, the diagrams for joint displacement, support responses, bending moment, and shear force [2, 4&5] are symmetrical. Tables I, II, and III, which compare the results of the following case studies utilizing the manual methodology and software method, respectively.

Table 1: Compression of Bending Moment

Load Case	Bending Moment (kN-m)					
	Top Slab		Bottom Slab		Side Wall	
	Manual	Staad Pro	Manual	Staad Pro	Manual	Staad Pro
1	43.93	44.94	53.25	54.29	5.726	-6.03
2	50.54	51.56	61.32	62.5	20.40	-20.88
3	56.31	57.34	67.1	68.4	31.96	32.63



Graph 1: Different Bending Moment Case 1, 2&3

Discussion: The above graph shows the bending moment for different Cases compared with manual and Staad pro results of top slab, bottom slab, and side wall the maximum bending moment will be acting in Case 3.The study shows that the maximum positive moment develops at the center of the top and bottom slab for the condition that the sides of the culvert not carrying the live load and the culvert is running full of water which is case 1 condition. The maximum negative moments develop at the support sections of the bottom slab for the condition that the culvert is empty and the top slab carries the dead loadand live load [2, 4&5].

Table 2: Compression of Shear Force

Load Case	Shear Force (kN)			
	Top Slab		Bottom Slab	
	Manual	**Staad Pro**	**Manual**	**Staad Pro**
01	36.24	36.42	53.86	54.22
2	14.71	14.82	10.71	-10.75
3	21.17	-21.34	31.73	32.02

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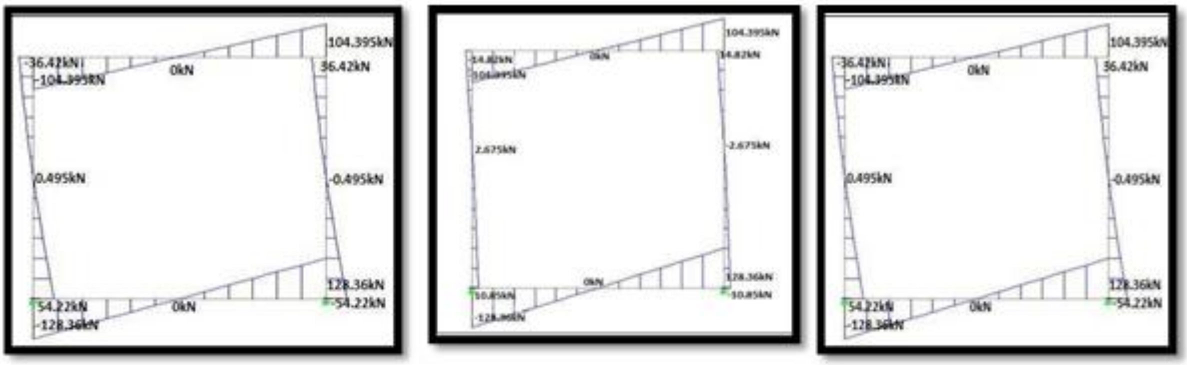
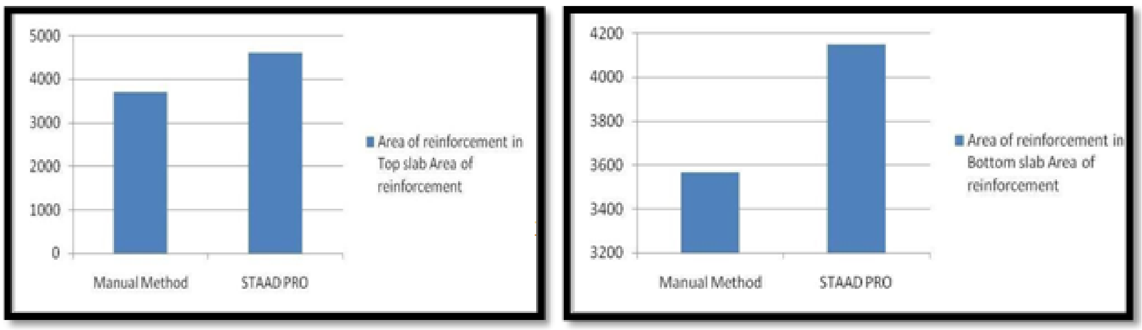


Graph 2: Different Shear Force Diagrams for Case1, 2&3

Discussion: The above graphs and table shows that the Shear force for different Case compared with manualand Staad pro results of top slab and bottom slab the maximum bending moment will be activated at Case Themaximum shear forces develop at the cornersof the top and bottom slab when the culvert is running full and the top slab carries the deadand live load [2, 4&5].

Table 3: Compression Area of Reinforcement

Method of Analysis	Area of Reinforcement	
	Top Slab	Bottom Slab
Manual	3703.00	3565.00
Staad Pro	4608.00	4148.00



Graph 3: Reinforcement Details for Top and Bottom Slab

Discussion: From, Table 3, it has been seen that area of reinforcement for the top slab ofthe Ast is maximum for staad pro. Compare to the manual method and bottom slab the as also increased in the software method compare to the conventional method, [2, 4&5].

V. CONCLUSION

Finding manual and automated methods for box culvert analysis and design was the study's main goal. The box culvert design is covered by three load cases. For the three load conditions, the design moments, shear forces, and other values are slightly higher (or almost the same) than the values obtained by hand calculations. The analysis shows that the largest positive moment moments develop at the centre of the top and bottom slab when the culvert is operating at maximum capacity and when uniform lateral pressure brought on by a superimposed dead load operates alone. In contrast, the largest negative moment moments grow at the centre of the vertical wall. Because they require thinner sections and have lower maximum bending moment and shear force values than single-celled box culverts, the study shows that multi-celled box culverts are more cost-effective for longer spans.

VI. ACKNOWLEDGMENT

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