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# **Comparison of Analysis and Design of Box Culvert for Overburden and Non Overburden Case**

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**ABSTRACT:** Box culverts are like tunnels under roads and railways that let water flow through. Their size is decided by how much water needs to pass during heavy rains, and their strength is designed to handle the weight on top. While they're similar to bridges, they're smaller. Box culverts are good for places where there's not much room for water to flow. This report looks at box culverts made of strong concrete, studying how they behave under different loads and conditions, following safety guidelines. We focus on finding the most challenging situations for the culverts and compare them based on how much they bend under pressure in different situation

**KEYWORDS:** Box culverts, Drainage infrastructure, Structural behaviour

## **I. INTRODUCTION**

Culverts are like tunnels under roads and railways. They let water go through, especially during heavy rains. Some are also made for animals to cross safely. How big they are depends on how much water needs to pass through. And how thick they are depends on how much weight they need to hold. Culverts are kind of like smaller bridges.

Culverts can be made of different materials and are classified based on how strong they are and how much they rely on the soil around them. The ability of a culvert to handle weight depends on factors like the material it's made of, its size and shape, and the support it gets from the surrounding soil. Over time, culverts can get weaker, especially after being repeatedly used by heavy trucks

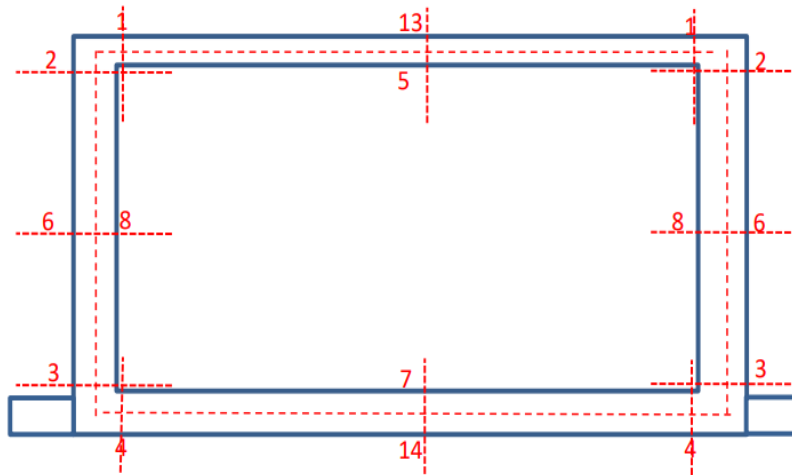
A box culvert can have more than one part and can be put in with the top almost flat with the road. It might not need extra space. Or it can go deeper in the ground with dirt on top. This report looks at box culverts made of strong concrete in different shapes. We look at how these culverts deal with different weights, with and without extra dirt on top, following safety rules. We compare them based on how much they bend under pressure in different situations.

## **II. METHODOLOGY & PROBLEM SOLVING STATEMENT**

1. Fixing of dimension.
2. Calculation of dead load and superimposed dead load.
3. Calculation of live load from vehicles as per lane consideration for various cases which will act on Top slab.
4. Calculation of Braking Force (As per Cl.No.211.2-IRC-6-2016).
5. Calculation of Earth pressure:- At Rest and Sliding condition.
6. Calculation of loads acting on Bottom slab.
7. Uniform temperature.
8. Box culvert distributed into sections.
9. Load combination for verification of ULS – overburden case.
10. Moments for ULS – overburden case.
11. Load combination for verification of SLS – overburden case.
12. Moments for SLS – overburden case.
13. Moment & Shear force summary – overburden case.
14. Load combination for verification of ULS – Non overburden case.
15. Moments for ULS – Non overburden case.
16. Load combination for verification of SLS – Non overburden case.
17. Moments for SLS – Non overburden case.

18. Moment & Shear force summary – Non overburden case.

### III. ANALYSIS



Box culvert distributed into sections

### IV. RCC DESIGN FOR OVERBUDEN CASE

Table-4.1.1 -RCC design for hogging moment

Section	Ultimate moment	Overall depth	Cover to R/F	Depth check	Provided depth	Ast min	Ast Required	Ast adopted
1	25	350	40	87	304	407	192	407
2	51	350	75	124	269	360	451	451
3	31	350	75	97	269	360	270	360
4	18	350	75	74	269	360	156	360

Table 4.1.2 -Reinforcement detailing

Member	Bar1	Spacing	Bar2	Spacing	Ast Prov.	Ast. Max	Xu limit	Xu
1	12	200	10	200	958	7600	139	47
2	12	200	0	0	565	6725	123	28
3	12	200	0	0	565	6725	123	28
4	12	200	10	200	958	6725	123	47

Table4.1.3 -RCC design for Sagging Moment.

Section	Ultimate moment	Overall depth	Cover to R/F	Depth check	Provided depth	Ast min	Ast Required	Ast adopted
5	70	300	40	146	254	340	669	669
6	35	300	75	103	219	293	380	380
7	49	300	75	122	219	293	538	538
8	0	300	75	0	219	293	0	293
13	0	300	40	0	255	341	0	341
14	0	300	75	0	220	294	0	294

Table4.1.4 -Reinforcement detailing

Member	Bar1	Spacing	Bar2	Spacing	Ast Prov.	Ast. Max	Xu limit	Xu
5	12	200	10	200	817	6350	116	40
6	12	200	0	200	958	5475	100	47
7	12	200	0	0	817	5475	100	40
8	12	200	0	0	565	5475	100	28
13	10	200	0	0	393	6375	116	19
14	10	200	0	0	393	5500	100	19

Table 4.1.5-Design of Transverse reinforcement

Member	Ast Prov.	Ast Transverse direc.	Bar dia.	Spacing	Ast prov.	Ast Req.
5	958	192	8	200	251	262
13	393	79	8	200	251	640
1	958	192	8	200	251	262
6	958	192	8	200	251	262
2	565	113	8	200	251	444
8	565	113	8	200	251	444
3	565	113	8	200	251	444
7	565	113	8	200	251	444
14	393	79	8	200	251	640
4	958	192	8	200	251	262

**V. RCC DESIGN OF BOX CULVERT FOR NON OVERBURDEN CASE**

Table 5.1.1-RCC design for hogging moment

Section	Ultimate moment	Overall depth	Cover to R/F	Depth check	Provided depth	Ast min	Ast Required	Ast adopted
1	63	300	40	138	254	340	599	599
2	48	300	75	121	219	293	530	530
3	33	300	75	100	219	293	358	358
4	36	300	75	105	219	293	392	392

Table 5.1.2-Reinforcement detailing

Member	Bar1	Spacing	Bar2	Spacing	Ast Prov.	Ast. Max	Xu limit	Xu
1	12	200	10	200	958	7600	139	47
2	12	200	0	0	565	6725	123	28
3	12	200	0	0	565	6725	123	28
4	12	200	10	200	958	6725	123	47

Table 5.1.3-RCC design for Sagging Moment

Section	Ultimate moment	Overall depth	Cover to R/F	Depth check	Provided depth	Ast min	Ast Required	Ast adopted
5	41	250	40	112	205	274	483	483
6	9	250	75	52	169	226	124	226
7	7	250	75	47	170	228	99	228
8	20	250	75	78	169	226	282	282
13	26	250	40	89	205	274	304	304
14	9	250	75	52	170	228	120.4	228

Table-Reinforcement detailing

Member	Bar1	Spacing	Bar2	Spacing	Ast Prov.	Ast. Max	Xu limit	Xu
5	10	200	0	0	644	5125	93	31
6	12	200	0	0	565	4225	77	28

7	10	200	0	0	393	4250	78	19
8	12	200	0	0	565	4225	77	28
13	10	200	0	0	393	5125	93	19
14	10	200	0	0	393	4250	78	19

Table-Design of Transverse reinforcement

Member	Ast Prov.	Ast Transverse direc.	Bar dia.	Spacing	Ast prov.	Ast Req.
5	644	129	8	200	251	390
13	393	79	8	200	251	640
1	958	192	8	200	251	262
6	565	113	8	200	251	444
2	565	113	8	200	251	444
8	565	113	8	200	251	444
3	565	113	8	200	251	444
7	393	79	8	200	251	640
14	393	79	8	200	251	640
4	958	192	8	200	251	262

## 5.2 RCC design Comparison

Table 5.2.1 RCC design comparison

Section	Overburden			Non overburden		
	Bar 1	Bar 2	Spacing	Bar 1	Bar 2	Spacing
1	12	10	200	12	10	200
2	12	0	200	12	0	200
3	12	0	200	12	0	200
4	12	10	200	12	0	200
5	12	10	200	10	0	200
6	12	0	200	12	0	200
7	12	0	200	10	0	200

8	12	0	200	12	0	200
13	10	0	200	10	0	200
14	10	0	200	10	0	200

## VI. CONCLUSION

1. The load combination with empty box is found to be the critical combination for all values of combinations under consideration for overburden case.
2. Maximum BM occurs within the class A Tracked loading vehicle so this loading is the most crucial case for maximum BM in longitudinal direction.
3. Maximum Shear Force takes place at section 1, 2, 3 & 4.
4. Section 5 & 7 possess maximum bending moment. Maximum Bending moment was found for overburden case in both ULS & SLS method. Hence, it is proved that for long term effect Non overburden case should be preferred.
5. SLS deals with long term effect & with the results obtained through Staad pro software have proved that Non overburden case is always better than overburden case.
6. For Shear force values, class 70 R loading gives maximum values for top slab, bottom slab and side walls for non cushion cases.
7. In both cases same size of Box culvert were taken & from the results obtained in SLS overburden case develops more bending moment than Non overburden case, so Non overburden case should be preferred for making DPR.
8. In overburden case live load gets distributed in cushion loading but in non overburden case live load acts as a point load.
9. Dead load & superimposed dead load acting on non overburden case are very low as compared to overburden case
10. In past many box culverts with overburden have been failed due to extra cushion provided on site with respect to design.
11. In overburden case cushion load generates heavy stresses as compared to non overburden case. So it increases chances of failure in box culvert.
12. For cushion loading we need to provide extra wing wall for stability of cushion on Box culvert.

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