International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

A Research paper on Analysis and Design of Precast Box Culvert with Vehicular loading

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Abstract –

Buried structures serve a variety of purposes. They are typically used for conveying water. At other times they're accustomed provide a grade separated crossing for pedestrian and vehicular traffic . Various structures and material types are used. The most common types are box and pipes culverts. Precast concrete segmental box culverts are one among the foremost versatile and cost-effective pre-cast concrete products, meeting the requirements of fast paced construction projects. Flexibility in design and simple placement at site results in cost savings. There are many uses for pre-cast concrete segmental box sections as they can ease the construction work. These monolithic structures can be used for underpasses, service tunnels, subways, small bridges, storm water culverts, cattle underpass etc. These guidelines are only applicable for Precast Concrete Segmental Box Culverts. A Precast Concrete Box Culvert is an easy construction with segmental construction which is used to provide passage for roads, flowing water below roads, embankment or railways. Precast concrete segmental box culverts are popular in construction where time available for construction is less. With today's technology these precast box culvert can be constructed unto 40 - 60 m length of per day with precast sections available at site. To achieve this productivity at site these segments of finished section of required shape must be available in precast yard. Big size box culverts having transportation issue shall be transported as one unit are constructed from one 'U' sections and top slab casted separately; for on-site assembly. Sometimes two 'U' shapes s also are getting used . These are given rebated joints/V notched to permit sections to be laid open or sealed. Precast head walls and wing walls can also be provided for Precast Concrete Box culverts.

1. INTRODUCTION

Structural design of precast concrete segmental box culvert shall be as per IRC:112 and IRC 122. Designs shall depend upon project requirements and applications. The precast concrete segments shall even be designed for handling and erection stresses supported the tactic of construction or site conditions. Box culverts can be designed to any standard or custom size and strength, including capability for withstanding any loads. Additional features can include toe walls, headwalls, wing walls, and watertight joints where required and shall be designed as per the provisions of IRC: SP:13. The precast concrete segmental box culvert shall be designed with IRC:122-2017 and IRC 112 with the specified forces. The dimensions of top slab, bottom slab and web shall be finalized based on designs and project requirements.

1.1 Advantages of Precast Concrete Segmental Box Culvert

Following are the advantages of Precast box culverts:

i. The entire construction period of a traditional culvert, such as base plate injection, formwork shutter / removal, side walls, ceilings and finishes, can take weeks, but shipping can reduce prefabricated parts to days. Install it.

ii. Flexibility of range: can accommodate almost any size requirement: multicell sections of different shapes.

iii. Ease and rapidity of installation: are often laid as single or in multiple cells.

iv. The length of the culvert are often increased by adjoining the units with each other .

v. By using Precsat box culvert segment we can eliminates need of transport and erection of shuttering and staging on site, to have a economic solution.

vi. As the segments are casted separately in precast yard so the segmental box culverts is known for high quality and uniformity.

vii. The segmental box culverts are aesthetically pleasing, due to uniformity in shape.

viii. If there is a fill in design then approach slab consideration can be avoided. This reduces construction time and reduces cost of structure.

ix. Reduced weather dependency resulting in timely completion of the projects.

x. Precast box culverts are known for Superior strength and durability which increases over time.

2. IRC LIVE LOADING CONSIDERED

As per IRC 6 the live loading on a structure can be categorized as IRC Class 70R, IRC Class AA (tracked and wheeled type), IRC Class A and IRC Class B loading.

Live loads are load which are caused by moving vehicles over deck and its critical location can be accessed by moving the vehicle on carriageway.

There are four types of standard loadings:

•IRC class AA loading

•IRC class 70R loading

•IRC class A loading

•IRC class A loading

•IRC class B loading

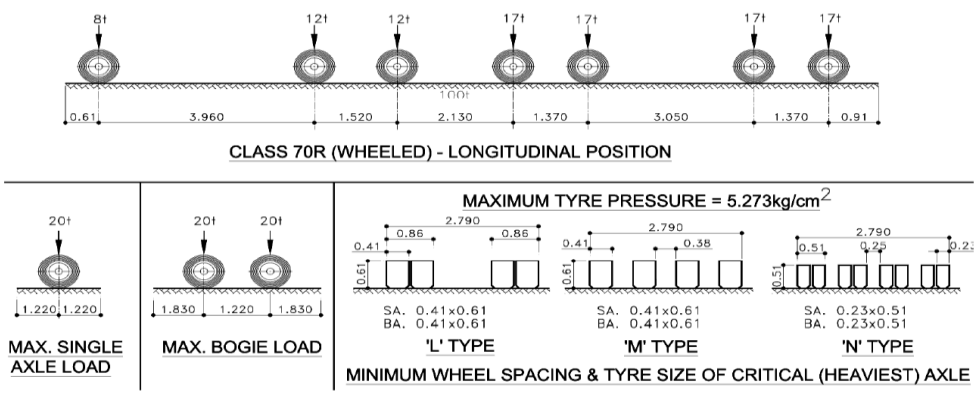


Fig.1 Wheel arrangement for 70R (Wheeled Vehicle)

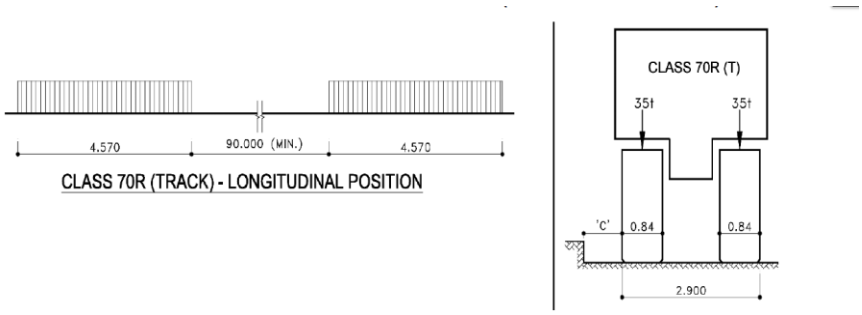


Fig.2 Class 70RWheeled and Tracked Vehicles

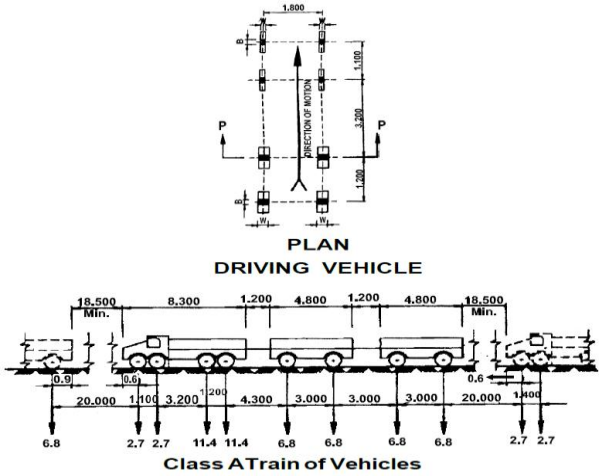


Fig.3 Class A train of Vehicles

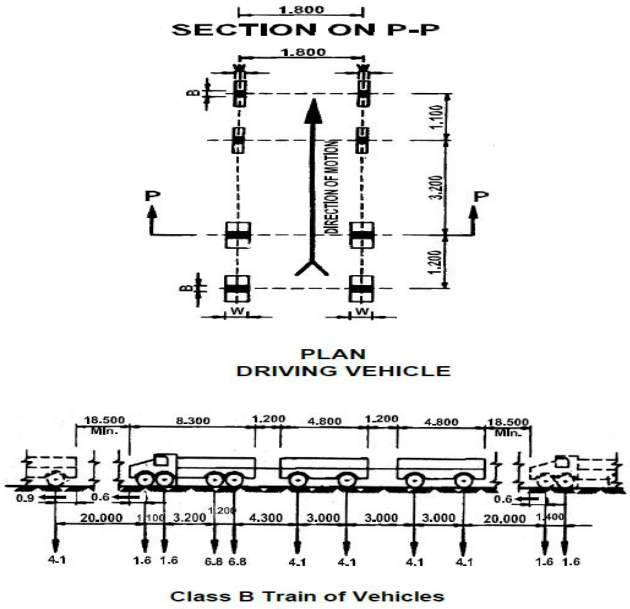


Fig.4 Class B Train of Vehicle

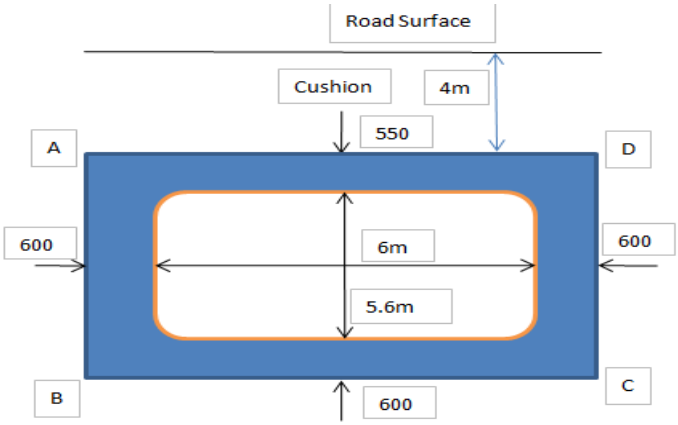


Fig.5 Box culvert with 4m cushion

3. CASES CONSIDERED AND PARAMETER USED

Table.1: -Cases for Box culvert with Top slab Fixed or Simply supported

Condition	Cases	Description
For Box culvert with Top slab fixed and simply supported	Case I	Shear Force at d distance from support, Top slab fixed
	Case II	Bending moment at mid span, Top slab fixed
	Case III	Hogging bending moment at Support, Top slab fixed

Table.2: - Parameters used for designing

Parameters	Values
Clear span	6m
Clear height	5.6m
Top slab thickness	550mm
Bottom slab thickness	600mm
Side wall thickness	600mm
Unit weight of concrete	25 KN/m3
Unit weight of earth	20 N/m3
Coefficient of earth pressure at rest	0.5
Types of cushioning	Earth fill
Thickness of wearing coat	90mm
Carriageway	18m
Concrete grade	M45
Steel grade	Fe550D
Cushion depth	4m

4. RESULTS & DISCUSSION

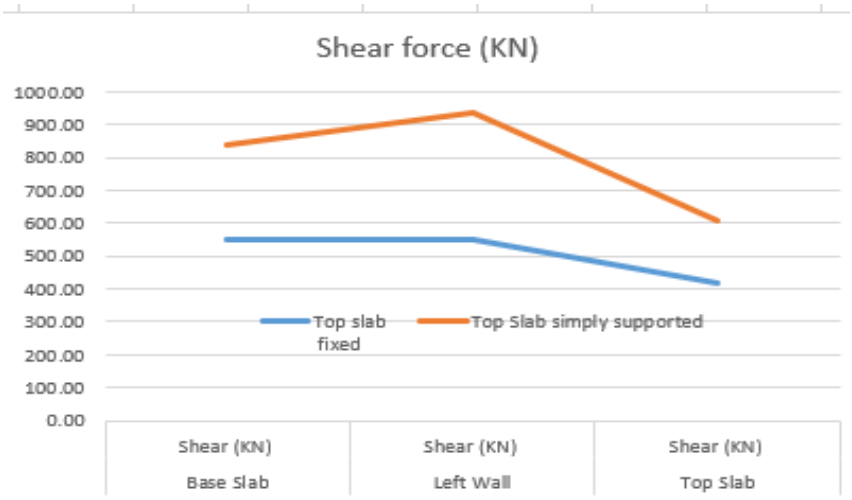
Case -I Shear Force at d distance from support, Top slab fixed

a) Shear force at d distance from support

Table 3: - Values of Shear force (KN)

Shear (KN) at d distance from support	Base Slab	Left Wall	Top Slab
Top slab fixed	551.55	549.07	420.18
Top slab simply supported	840.83	935.78	606.78

Graph 1: - Graphical representation of values of Shear force (KN)



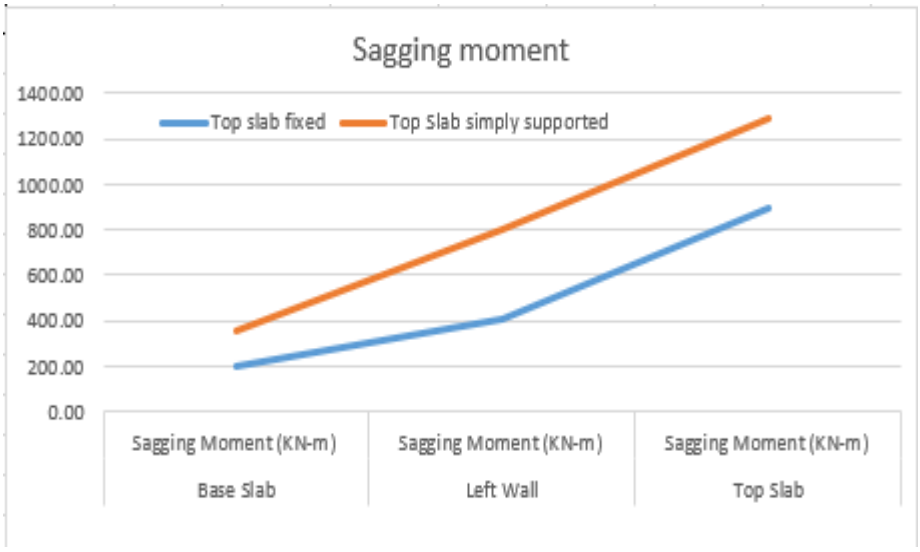
Case-II Bending moment at mid span, Top slab fixed

b) Sagging Bending moment at mid-section

Table 4: -Values of Sagging bending moment (KN-m)

Sagging Moment (KN-m)	Base Slab	Left Wall	Top Slab
Top slab fixed	201.45	410.99	896.72
Top slab simply supported	352.10	797.02	1292.62

Graph 2: - Graphical representation of Values of Sagging bending moment (KN-m)



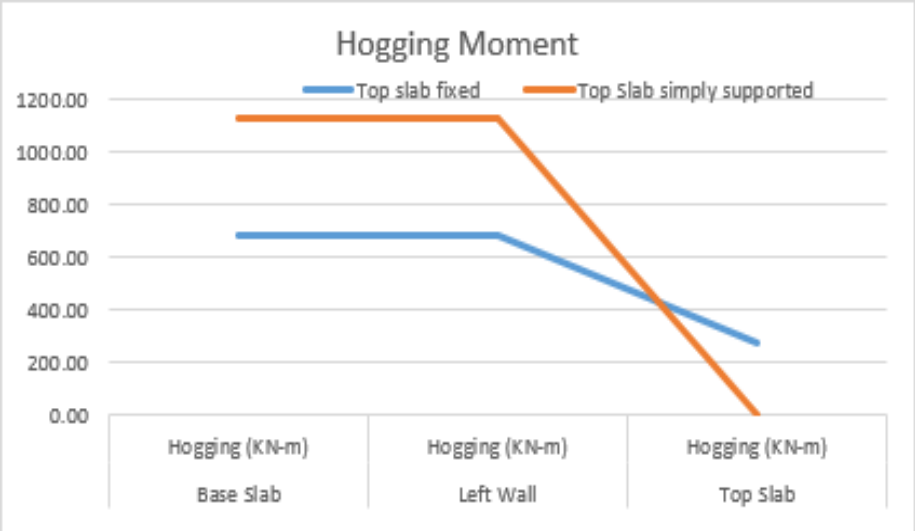
Case III Hogging bending moment at Support, Top slab fixed

c) Hogging bending moment at Support

Table 5: - Values of Shear force (KN), Top slab fixed

Hogging Moment (KN-m)	Base Slab	Left Wall	Top Slab
Top slab fixed	681.03	681.03	273.29
Top slab simply supported	1125.78	1125.78	0.00

Graph 3: - Graphical representation of Values of Hogging bending moment (KN-m)



5. CONCLUSION & RECOMMENDATION

Based on the cases done for top slab simply supported or fixed it is concluded that due to site constraints if the culvert weight is a hindrance, then we can proceed with bottom U of box culvert with simply supported top slab over it. By doing this the wall moments at bottom supports are increased in slab and same is designed for those moments.

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