IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 2, May 2022
Impact Factor: 6.252

Analysis and Design of Multi Cell Box Culvert Considering Effect of Soil Compressibility and Water Current Calculation

Punam Namdeo Doijad[1], Dr. Ankush Mankar[2], Prof. Girish Sawai[3], Prof. Sanjay Denge[4]
PG Student/Research Scholar, Department of Civil Engineering[1], Principal[2]
HOD, Department of Civil Engineering[3]
Assistant Professor, Department of Civil Engineering[4]
VM Institute of Engineering &Technology, Nagpur

Abstract: *The hydrology and hydraulic calculations has been carried out for the proposed box culvert to justify the waterway required for the river crossing the alignment. Structural analysis is a process to analyse a structural system in order to predict the responses of the real structure under the action of expected loading and external environment during the service life of the structure. The present work reflects on the analysis and design of bridges which are the main source of human life which helps to travel from place to place. The modelling and analysis of bridge is carried out by using the software Staad-pro software. The bridge we designed is box culvert bridge. The design loads are considered as per IRC 6. Box culvert is designed by using Staad-pro and results are compared manually.*

Keywords: Reinforced cement concrete box culvert, hydraulics calculation, Multi Cell Box Culvert, earth pressure, Soil Compressibility, structural design, Water Current Calculation, theoretical calculation, staad pro etc.

I. INTRODUCTION

Box culverts are types of bridges used when the discharge in a drain or channel crossing a road is small and when the bearing capacity of the soil is low. Box culverts are very important part of a transportation network as they provide an economical alternative to heavy bridges. Culverts are always cheaper than bridges where the discharge opening is less than 15m2 and particularly where the road crosses the waterway on relatively high embankment. Box culverts are constructed of reinforced concrete and are either cast-in-place or precast. Most of them are square dimensions; but if not a square, usually have the span length exceeding the opening height. Box culverts may have multiple or single cell openings. They control water flow and drainage for irrigation and municipal services, control storm water, and perform many other services. All the reasons above represent a good motivation to researchers in culvert design method and construction technique.

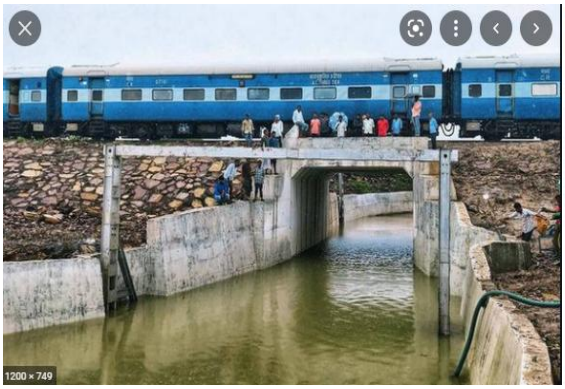

Figure 1: Railway over bridge

Figure 2: Box Culvert

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 2, May 2022
Impact Factor: 6.252

Box culverts do not require a separate extensive foundation system and they are ideally suited for MEDIUM SPANS. Structurally, box culverts are complicated structures as they are buried completely in soil and because of their self-stabilizing nature. Hence, there is need to for a detailed parametric study on multi-cell box culvert structures in order to understand their structural behavior and to study the influence of various parameters effecting its structural behavior. Since culverts are buried across the transverse direction of the road way, they are subjected to the same traffic actions encountered by the pavement. Generically, culverts are subjected to traffic actions from moving vehicles, vertical earth pressure from cushion (earth fill), lateral earth pressure from backfill soil, hydrostatic pressure from ground water, uplift, braking and acceleration forces, partial or full internal water pressure when the culvert is in operation, and other direct and indirect actions. When a culvert is deeply buried under the ground at a depth exceeding 600 mm from the crown of the roadway, traffic wheel load is dispersed on the top slab of the structure as a uniformly distributed load.

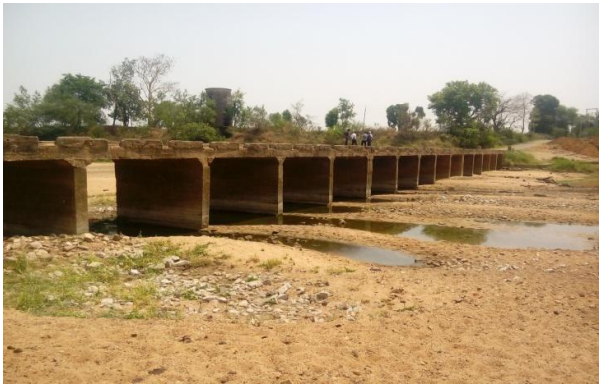

Figure 3: Multi Cell Box Culvert

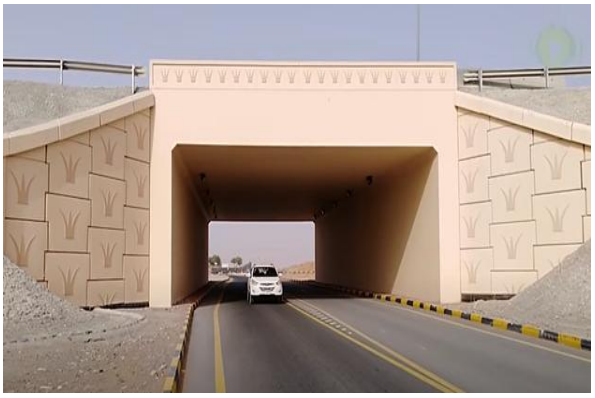

Figure 4: Vehicular Under Pass

II. REVIEW OF LITERATURE

[1]. Sujata Shreedhar and R.Shreedhar (2013),had done the Design of RCC box culvert , studied on design coefficients for single and two cell box culverts that the design coefficients developed for bending moment, shear and normal thrust at critical sections for various loading cases enables the designer to arrive at design forces thus reducing design time and effort. The study showed that the maximum positive moment develop at the center of 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 and 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 load and live load.

[2]. Kattimani, Analysed the box culvert by considering different Parameters Analysed the box culvert by considering different Parameters. The study deals with the design parameters of box culverts like angle of dispersion of live load, effect of co-efficient of earth pressure and depth of cushion provided on top slab of box culverts.

[3]. Malkhare,Analysed the box culvert by considering different Parameters,Analysed box culvert by considering soil structure interaction and the results obtained are compare without considering soil structure interaction. The comparative study of bending moments was presented

[4]. M.G. Kalyanshetti and S.A.Gosavi (2014) ,Design of RCC box culvertThe analysis is done by using stiffness matrix method and a computer program in C language is developed for the cost evaluation. Study is carried out related to variation in bending moment; subsequently cost comparison is made for different aspect ratios. The percentage reduction in cost of single cell, double cell and triple cell based on optimum thicknesses are presented. The optimum thicknesses presented over optimum thicknesses optimum cost per meter width of single cell, double cell and triple cell is evaluated. The study reveals that the cost of here are used to achieve the economical design of box culvert. Based on these box culvert reduces if the optimum thicknesses which are presented in this study .

[5]. Neha Kolate et al (2014), have carried out an analytical study on design of RCC box culvert. In this study, they have given a brief idea about a box culvert and usefulness of the box culvert in reducing the flood level. In this paper, the box of 3mX3m with and without cushion of 5m has been taken. Different load cases are calculated and are checked for shear for the box culvert. The results of analysis and design have discovered that RCC box culvert has many advantages over

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 2, May 2022
Impact Factor: 6.252

slab culvert for cross drainage work across high embankment. In box culvert it's easy to add length for widening of road and is structurally rigid and safe. The examination and analysis revealed that box does not need any elaborate foundation, it's easy to construct, requires no maintenance and small variation in coefficient of earth pressure has little influence on the design of box without cushion.

[6]. Sujata Shreedhar, R. Shreedhar (2013), had find out the coefficients for moment, shear and thrust of single and two cell box culvert by using Staad Pro software. The result is The design of box culvert includes the information regarding the effect different ratio L/H=1.0, L/H=1.25 etc. Also moments and loads are found out

[7]. B.N Sinha and R.P Sharma (2009), have worked with box culverts made of RCC without and with the cushion. In this study, design of RCC box culvert has been done manually and by computer method. RCC box culverts are modeled and analyzed using STAAD Pro. The structural design involves consideration of load cases like box empty, full, surcharge load etc. and factors like live load, effective width, impact force, coefficient of earth pressure. Relevant IRC codes are referred in this paper. The designs are done to withstand maximum bending moment and shear force. Effective width in case of box culvert plays an important role without cushion as the live load becomes the main load on the top slab and effective width should withstand this load. Impact of live load, shear stress, distribution reinforcement, load cases have also been discussed in this paper. It has been concluded that the box culvert have more advantages than slab culvert, easy to add length for widening of roads. Box culvert is structurally strong, rigid and safe and does not need any elaborate foundation.

III. OBJECTIVE

1. To carry out literature survey and with all the references carry out analysis accordingly.
2. To study the parameter needed for Hydrological study.
3. For analysis, the box model is subjected to Dead loads, SIDL, Earth pressures, Surcharge loads on the side walls, and Live Loads.
4. To study the effect of different load combination which will produce worst effect for safe structural design

IV. PURPOSES

1. To study the effect of Soil Compressibility over structure.
2. Culvert is a structure which is built over some physical obstacle such as a body of water, valley, or road, and its purpose is to provide crossing over that obstacle. It is built to be strong enough to safely support its own weight as well as the weight of anything that should pass over it. To save human life and buildings.
3. They easily accommodate both pedestrian and vehicular traffic.

V. METHODOLOGY

1. Literature Survey.
2. Hydrological study.
3. To study the behavior of Multi Cell box culvert with soil compressibility & water current for Multi cell box culvert arrangement.
4. To study all the critical loadings and combinations acting on Multi Cell box culvert.
5. Modeling and Analysis of Multi Cell Box Culvert by STAAD pro.
6. The vertical soil resistance at bottom has been applied in the form of springs. The value of spring constants has been calculated based on the permissible settlement and bearing capacity.
7. Loading calculation & application on model. (SIDL, Earth pressure, surfacing, breaking load)
8. Results found in STAAD pro such as bending moment and shear force at Top Slab, Side Wall, Intermediate Wall and Bottom Slab.
9. Design of Multi Cell Box culvert

REFERENCES

[1]. S.Shreedhar and R. Shreedhar, "Design coefficients for single and two cell box culvert", International Journal Of Civil And Structural Engineering Volume 3 No. 3, pp. 475-494, March 2013.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 2, May 2022
Impact Factor: 6.252

[2]. M.G. Kalyanshetti and S.A. Gosavi, "Analysis of box culvert - cost optimization for different aspect ratios of cell", International Journal of Research in Engineering and Technology, Vol. 03, Issue 04, pp. 508-514, April 2014.
[3]. IRC 6 : 2014 Code of Practice for Road bridges, Sec-II : Loads & Stresses
[4]. IRC 112 : 2011 Code of Practice for Concrete Road bridges
[5]. IRC 78 : 2014 Code for Practice for Road bridges, Sec-VI : Foundations & Substructure
[6]. IRC SP : 13-2004 Code for hydrolics calculation.
[7]. Railway bridge Rule & IRS (Indian railway standred).ISSN no.0976-4399, Vol.03, Issue-03 , p.p. 475-494.
[8]. B.N.Sinha, R.P.Sharma on "RCC Box Culvertmethodology and Design Including Computer Method". Journal of the Indian Roads Congress (JIRC), December 2009, pp 555.