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

Punam Namdeo Doijad

PG student/Research Scholar, Department of Civil Engineering VM Institute of Engineering & Technology, Nagpur.

A B S T R A C T

To justify the waterway necessary for the river crossing the alignment, hydrological and hydraulic calculations were performed for the planned box culvert. Structural analysis is the practice of analyzing a structural system in order to forecast how the real structure will respond to expected loading and the external environment over the course of its service life. The current project examines the research and design of bridges, which are the main source of human life and aid in passage from one location to another. The software Staad-pro is used for modeling and analysis of the bridge. Box culvert bridge is the type of bridge we designed. IRC 6 is used to calculate the design loads. Staad-pro is used to design the box culvert, and the results are manually compared.

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.

1. Introduction

When the discharge in a drain or channel crossing a road is minimal and the bearing capacity of the soil is low, box culverts are employed. Box culverts are an essential feature of any transportation system since they are a cost-effective alternative to big bridges. Where the discharge hole is smaller than 15m2 and the road crosses the canal on a relatively high embankment, culverts are always less expensive than bridges. Box culverts are made of reinforced concrete and can be prefabricated or cast in place. The majority of them have square proportions, but if they don't, the span length frequently exceeds the opening height. Cell holes in box culverts can be many or single. They regulate water flow and drainage for irrigation and municipal services, as well as storm water management. All of the foregoing provide excellent motivation for culvert design method and construction technique researchers.

Box culverts do not require a separate extensive foundation system and they are ideally suited for medium spans. Box culverts are challenging structures structurally since they are totally buried in soil and self-stabilizing. As a result, a full parametric research of multi-cell box culvert structures is required in order to comprehend their structural behavior and investigate the impact of various parameters on that behavior. Culverts are subjected to the same traffic activities as the pavement since they are buried across the transverse direction of the road. Culverts are subjected to traffic, 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 sunk deeper than 600 mm from the roadway's crown, the traffic wheel load is evenly distributed on the top slab of the structure.

2. REVIEW OF LITERATURE

[1] Sujata Shreedhar and R.Shreedhar (2013) studied design coefficients for single and two cell box culverts and found that using design coefficients developed for bending moment, shear, and normal thrust at critical sections for various loading cases, the designer can arrive at design forces faster and with less effort. The maximum positive moments develop at the center of the top and bottom slabs when the sides of the culvert are not carrying the live load and the culvert is full of water, while the maximum negative moments develop at the support sections of the bottom slab when the culvert is empty and the top slab carries both the dead and live load.

[2] Kattimani, Different parameters were used to analyze the box culvert. Different parameters were used to analyze the box culvert. The research focuses on box culvert design characteristics such as angle of live load distribution, effect of co-efficient of earth pressure, and depth of cushion given on the top slab.

[3] Malkhare Analyzed the box culvert using various parameters, including soil structure interaction, and compared the findings to those obtained without considering soil structure interaction.

[4] reported a comparative study of bending moments. Design of RCC box culvert, M.G. Kalyanshetti and S.A.Gosavi (2014) The study is carried out using the stiffness matrix approach, and the cost evaluation is carried out using a computer program written in C. A cost comparison is done for different aspect ratios, and the percentage decrease in cost of single cell, double cell, and triple cell based on optimum thicknesses is shown. The optimum thicknesses of single cell, double cell, and triple cell are evaluated over optimum thicknesses optimum cost per meter width. The cost of here is employed to produce the cost-effective design of box culvert, according to the study. If the optimum thicknesses given in this study are used, the box culvert shrinks.

[5]. Neha Kolate et al. (2014) conducted an analytical study on RCC box culvert design. They have given a brief description of a box culvert and its utility in reducing flood levels in this paper. The box of 3mX3m with and without a 5m cushion has been used in this work. For the box culvert, different load situations are computed and shear is evaluated. RCC box culvert has several benefits over slab culvert for cross drainage work across high embankment, according to the results of analysis and design. It is simple to add length to a box culvert for road widening, and it is physically solid and safe. The study and analysis demonstrated that the box does not require any elaborate foundation, is simple to construct, does not require maintenance, and that slight variations in the coefficient of earth pressure have little impact on the design of the box without cushion.

[6] Sujata Shreedhar, R. Shreedhar (2013) used Staad Pro software to determine the coefficients for moment, shear, and thrust of single and two cell box culverts. As a result, the information about the influence of different ratios L/H=1.0, L/H=1.25, and so on is included in the box culvert design. Moments and loads are also discovered.

[7]. B.N Sinha and R.P Sharma (2009) investigated RCC box culverts without and with a cushion. The design of RCC box culverts was done manually and by computer in this study. STAAD Pro is used to model and analyze RCC box culverts. The structural design includes parameters such as live load, effective width, impact force, and coefficient of earth pressure, as well as load scenarios such as box empty, full, and surcharge load. This paper refers to relevant IRC codes. The designs are made to endure the greatest amount of bending moment and shear force possible. In the case of a box culvert without a cushion, effective width is critical because the live load becomes the primary load on the top slab, and effective width must be able to sustain this load. This research also discusses the effects of live loads, shear stress, distributed reinforcement, and load instances. It has been determined that box culverts have more advantages than slab culverts, including the ability to extend length for road widening. The box culvert is physically sound, stiff, and secure, and it does not require a complex foundation.

3. 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

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.

4.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

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