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ANALYSIS AND DESIGNOF RAILWAY BOX BRIDGE

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ABSTRACT: Bridges are the structural components that are required for the efficient movement of Trains and locomotives and under earth embankment for crossing of water course like streams across the embankment as road embankment cannot be allowed to obstruct the natural water way. Bridges can be of different shapes such as arch, slab and box. These can be constructed with different material such as masonry (brick, stone etc.) or reinforced cement concrete. Since bridge pass through the earthen embankment, these are subjected to same traffic loads as the road carries and therefore, required to be designed for such loads. The cushion depends on rail profile at the bridge location. The structural design involves consideration of load cases (box empty, full, surcharge loads etc.) and factors like live load, effective width, braking force, dispersal of load through fill, impact factor, co-efficient of earth pressure etc. RelevantIRCs are required to be referred. The structural elements are required to be designed to withstand maximum bending moment and shear force. This paper provides discussions on the provisions in the Codes, considerations and justificationof all the above aspects on design.

KEYWORDS: Railway minor Bridge, Box Bridge, analysis and design of Box Bridge

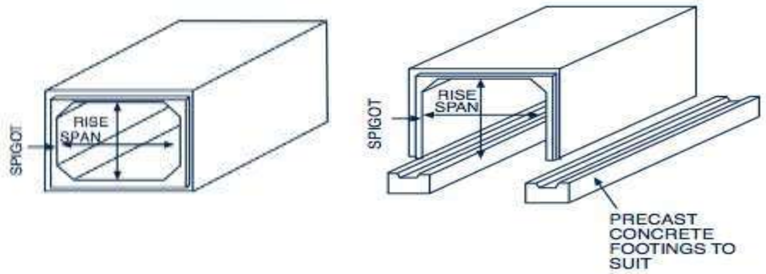
1. INTRODUCTION -

A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for aroad, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. In otherwords, bridge is a structure for carrying the road traffic or other moving loads over a depression or obstruction such as channel, road or railway. A bridge is an arrangement made to cross an obstacle in the form of a low ground or a stream or a river withoutclosing the way beneath. Bridges constitute an essential link of a Railway system. There were 127154 bridges on Indian Railways system as on 31 March 2002. A large number of these bridges are between 80 to 100 years old, and were constructed to handle the lighter standard of loading then prevalent. Indian Railways has seen a tremendous growth in both freight and passenger traffic since the construction of these bridges. From an originating traffic of 93 million tonnes in the early 50s, it has reached 522 million tonnes in 2001-2002. Similarly, passenger traffic has increased from 67 billion passenger kilometres to over 493 billion passenger kilometres. With the introduction of heavier axle loads and higher speeds, clubbed with aging and fatigue, bridges need special attention and care, including rehabilitation where warranted, so as to ensure safety of rail traffic. Any damage to a bridge may take considerable timefor repairs and the financial implications may also be quite severe on account of high cost of repairs and interruptions to traffic. Greater emphasis on maintenance, proper and regular upkeep is, therefore, imperative for trouble-free existence of these bridges. A culvert is defined in the Standard Specifications as any structure, whether of single or multiple-span construction, with an interior width of 6.096 m (20 ft.) or less when the measurement is made horizontally along the centre line of the roadway from face-to-face of abutments or sidewalls.

2. WHY BOX BRIDGE -

Box Bridge which has got its name due to its orientation, shape and the way through which it looks like and its appearance defines its name. Box Bridge is a structure which provided the flexibility for the designer to design it in a very easy way, which is very feasible and easy to construct and design. It is highly capable for taking heavy loads coming on it from upper side without producing any cracks to it and is capable to distribute these loads to a wider area. Foundation requirement is very less and only little bit soil treatment will be required in case if the site consists of a soil having low bearing capacity and soil treatment required to be done as preferred by the site engineer.

FOUR SIDED BOX BRIDGE **THREE SIDED BOX BRIDGE**



. Figure 1: Box Bridge

Two or more lines of box Bridge may be placed side by side to create a twin barrel or multi-barrel installation. A multi-barrel installation provides additional flow capacity, which may be required for larger streams.

3. OBJECTIVES –

- Conceptualization of entire Project.
- Evaluation of various bridge parameters as per IRS codes and RDSO(Research Designs and Standards Organization) drawings.
- To analyze R.C.C box bridge by using STAAD pro software and MDM.
- Comparison of analysis from STAAD pro and MDM to observed that which method is more competent.
- To Design all structural elements of box bridge.
- To check safety of bridge

4. LITERATURE REVIEW –

Dr. Mohankar.R.H, Dr. Ronghe.G.N provided a discussion on "Analysis and Design of underpass RCC bridge" and said that the Underpass RCC Bridge is very rarely adopted in bridge construction but recently the Underpass RCC Bridge is being used for traffic movement. In this paper, the analysis of the underpass RCC bridge is carried out. The analysis of this underpass RCC bridge is done by considering fixed end condition. Finite Element Method (FEM) analysis is performed and results are presented. Comparison of different forces between 2D and 3D models for fixed end condition is provided.

Mahesh Tandon (2005) has studied that with the occurrence of every major earthquake, there has been in the past, almost a world-wide tendency to increase the capacity demand of the structure to counteract such events. It is only in the last decade that new strategies have been successfully developed to handle this problem economically. The current international practice has shifted towards a performance-based engineering design, wherein the accent is on serviceability and safety under different levels of magnitude of earthquakes. And he concluded that There is scope after both „passive‟ control by prescribed detailing procedures as well as „active‟ control by specific devices for earthquake-resistant bridges. The judicious use of these ideas can lead to economical and safe bridge structures.

Y. Vinod Kumar and Dr. Chava Srinivas (2015)[3] have presented a complete study of box culvert by using computational methods such as Grillage analysis and Finite element method. Grillage analysis is versatile in nature and can be applied to verity of bridge decks having both simple and complex configurations with ease and confidence. Grillage analysis has done by most commonly using softwre STAAD Pro. Their main objective was to know the behavior of box culvert and variation of stresses in terms of Shear force and bending moment values.

Lande Abhijeet Chandrakant , Patil Vidya Malgonda (2014)[4] observed that structural design of box culvert involves consideration of load cases and factors like live load, effective width, dispersal of load through fill, impact factor, co-efficient of earth pressure etc. The structural elements are required to be designed to withstand maximum bending moment and shear force. So excel program is developed for analysis and it is compared with software results. So analysis of box culvert is carried out for it for various box conditions and structural design is suggested for critical cases.

Neha Kolate, Molly Mathew, Snehal Mali (2014)[5], studied the analysis and design of box bridge and they have found that Box culvert is easy to add length in the event of widening of the road and Box is structurally very strong, rigid & safe. Box does not need any elaborate foundation and can easily be placed over soft foundation by increasing base slab projection to retain base pressure within safe bearing capacity of ground soil.

Study on the design coefficients for single and two cell box bridge is carried out by Sujata Shreedhar, R.Shreedhar (2013)[6]. The present study makes an effort to evaluate the design coefficients for bending moment, shear force and normal thrust for single cell, two celled and three celled box culvert subject to various loading cases. An attempt is made to provide the information of the effects for different ratios of L/H = 1.0, L/H = 1.25, L/H = 1.5, L/H = 1.75 and L/H = 2.0 for single cell,

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two cell and three celled box culverts.

D.Vamshee Krishna (2015)[7] studied the modelling and analysis of RCC bridge using parametric study of soil structure interactions. In this paper, the analysis of the underpass RCC bridge is carried out. The analysis of this underpass RCC bridge is done by considering fixed end condition and the soil structure interactions at different sections are presented. Comparison of different forces with results at different sections of the model for fixed end condition is provided. In this study a 2D model can be effectively used for analysis purpose for the loading condition mentioned in IRC: 6, "Standard Specifications and Code ofPractice Road Bridges" The Indian Roads Congress and Directorate of bridges & structures (2004), "Code of practice for the design of substructures and foundations of bridges" Indian Railway Standard.

Dr. Abdul-Hassan (2014)[8] has made study on optimal design of reinforced concrete box culvert by using genetic algorithms method. This paper shows the optimal design of reinforced concrete box culvert based on minimum cost (economical design). Itis found that the genetic algorithms GAs optimization method is a suitable method that can be used to obtain the minimum cost (i.e. optimum design) of reinforced concrete box culvert. It is important for any optimization problem using genetic optimization method to carry out the convergence studies to investigate the capability of establishing the optimum design with or without initial population and governing population size.

Mulesh k. Pathak (2014)[9] has carried out study on performance of RCC box type superstructure in curved bridges. The study provides multiplication factors for all the parameters for varying degree of curvature (i.e. 10° to 90°) W.r.t. a straight bridge (0°) and for varying spans (between 15m to 30m). These can be useful to simplify the analysis by considering straight bridge instead of curved bridge, in which multiplication factor is used multiply to the corresponding action of the straight bridge. This can be very much useful in the preliminary design of the section.

5. METHODOLOGY –

- Analysis and design by STAAD pro.
- Analysis method adopted for RCC box is MDM (Moment Distribution Method).
- Designing Box Bridge considering LSM.

Various cases those are to be generally adopted for designing:
Case 1: Dead load and live load acting from outside as well as earth pressure, while no water pressure from inside (i.e. Design of Box Bridge by considering the box as in empty conditions, no water will flow from it)
Case 2: Dead load and live load acting from outside as well as earth pressure, while water pressure acting from inside (i.e. designing the by considering that it is half full)
Case 3: Dead load and live load acting from outside as well as earth pressure, while water pressure acting from inside (i.e. designing the box by considering that it is full.
Considering case one, as it is the worst possible case for designing bridge.
Serviceability Limit State – For the limitations given in 10.2.1.load combination only shall be considered. For the stresslimitations given in 10.2.2, load combinations 1 to 5 shall be considered. The value of Y_{fL} for creep and shrinkage of concrete andprestressed (including secondary effects in statically indeterminate structures) shall be taken as 1.0.

Ultimate Limit State – To check the provisions of 10.3 load combinations 1 to 4 shall be considered. The value of YfL for the effects of shrinkage and, where relevant, of creep
shall be taken as 1.2. In calculating the resistance of members to vertical shear and torsion YfL for the prestressing force shall be taken as 1.15 where it adversely affects the resistance and 0.87 in other cases. In calculating secondary effects in statically indeterminate structures YfL for prestressing force may be taken as 1.0.

6. CONCLUSION –

Box bridge is structurally very strong, rigid & safe. Box bridge does not need any elaborate foundation and can easily be placed over soft foundation by increasing base slab projection to retain base pressure within safe bearing capacity of ground soil. Box Bridge is easy to construct, practically no maintenance. It can have multi cell to match discharge within smaller height of embankment. The designer has option to select the number of cells with desired span to depth ratio suiting to hydraulic conditions at site.

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