A REVIEW ON "STUDY & IMPROVEMENT OF DESIGN AND CONSTRUCTION METHODOLOGY OF PRECAST CONCRETE SEGMENTAL BOX CULVERT (PCSBC)"

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ABSTRACT:

Bridges in today's era play an important role in transportation and connecting the important points of the road. Sometimes due to typical topography and site conditions, it is important to provide the structures through rivers/nala, which avoids obstruction to natural flow of water; such structures are most popularly known as bridges and culverts depending on their span arrangements. The rate of flow through the river is an important factor in the design of major, minor bridges and culverts. The present study is based on the design of precast box culvert by considering total six alternative design modules using fixed and hinged end conditions at top and bottom slab of single & double box cell in order to arrive at the optimum design of components of box culvert.

Keywords: Box Culvert, discharge, design modules, optimum section, economy.

INTRODUCTION:

It is well known that roads are generally developed in combination of road crust and earthwork which comes in the way of natural flow of storm water. As such flow cannot be obstructed and it is necessary to provide cross drainage works to allow water to pass across the earthwork. The structures which satisfy such condition are called culverts, major & minor bridges depending on their span arrangements which in turn depend on discharge. The culverts cover up to waterways of 6m and mainly are of three types, namely slab culvert, box culvert and pipe culvert. The box culvert is one which has its top slab & bottom raft slab which are monolithically connected to the vertical walls. There are various constraints in present practice such as in-situ construction of box culvert for drainage requires large space for stacking of construction materials. There may be difficulty in transporting construction material and equipment/machinery, placement of formwork/shuttering, theft of materials, spillage of concrete and its constituent materials during stacking, improper curing at site which cause much disturbance to public/traffic, more time consuming and need further finishing after construction. Traffic management poses difficulties for safe movement of traffic during construction. Time of construction required is more in case of cast in situ construction. This again aggravates the situation of traffic movement particularly during rainy season. In hilly & forest areas there is no suitable spaces are available for construction of diversion of roads. Quality control of work in remote areas is not meeting the standards. And costs of construction are also increases due to delay in construction.

Fig. 1 precast box culvert on site (google search)

Hence to overcome these constraints, precast concrete segmental box culvert is the modern technology in construction field. Fig. 1 shows the laying of precast box culvert on site with the help of suitable cranes. Precast concrete construction product produced by casting in a reusable mould& cured in a controlled environment at plant & transported to their final location in segments for complete structure. It eliminates elaborate arrangement such as formwork, transportation, handling of raw material, shifting of construction machineries from place to place. Quality of precast concrete construction can be controlled more efficiently in the precast yard. Desired speed of construction can be achieved irrespective of abnormal weather conditions. Construction in remote areas can be handled efficiently. In order to understand the analysis and design of economical culverts, thorough literature study has been carried out.

LITERATURE REVIEW:

Economy plays a major role in the construction of culvert. Hence, analysis and design is carried out in such a manner, that it must results in optimum size of the components of culverts. In order to understand the analysis and design of box culvert, thorough study has been carried out which is as follows:

Neha Kolate, Molly Mathew, Snehal Mali (2014) carried out an extensive analysis and designed box culvert of size 3mx3m with & without cushion and was found that there is no difference in design of single cell and multi cell box with two, or more cells. Finally, it was concluded that steel required is less in the box with no cushion as compared to with cushion and breaking force is required for box without cushion.

A.D. Patil, A.A. Galatage (2016) studied the behavior of box culvert with cushion and without cushion load for different aspect ratio and also the effect of different loading as per IRC codes. In this study, the earth pressure coefficient 0.5 ($\phi=30^0$) has been used, considering the rest condition. For the analysis IRC class 70R tracked loading was considered on the box culvert to produce worst effect for a safe structure. Loading contains live load of class 70R tracked vehicle, dead load of top & bottom slab as well as side walls. Impact of live load and braking force was also considered only for box without cushion load as per IRC 6:2000. Also soil pressure was considered to acting on side walls from outside and water pressure

from inside. Study concluded that, load combination with empty box was found to be critical for all values of aspect ratio.

Siva Rama Krishna, Ch. Hanumantha Rao (2017) analyzed the behavior of box culvert with and without soil structure interaction. Box culverts with different cells and varying cushion was undertaken. Study concluded that the value of bending moment & shear force values has been increased without considering the effect of soil structure interaction.

Saurav, IshaanPandey (2017) carried out comparative study on analysis of conventional method of analyzing and using STAAD software and finite element method using ANSYS software for developing economic design and safety. Therefore this study concluded that, culvert if designed through finite element method rather than conventional method would only save the material and money but also make the design safer.

KetanKishorSahu, Shraddha Sharma (2015) compared different aspect ratio of box culvert with one, two or three cells and varying their operating conditions. The cost has been compared with and without optimum thickness. Accordingly results justifies that optimum thicknesses presented leads to economical design of box culvert. The charts of bending moment for top and bottom members have been generated. Such that from these charts at any intermediate aspect ratio the values of bending moments can be evaluated. The average percentage reduction in the cost for single cell, double cell and triple cell has been presented.

Y. Vinod kumar, Dr. Chava Srinivas (2015) presented a complete study of box culvert by using computational methods such as Grillage analysis and Finite element method. They found that Grillage analysis is versatile in nature and can be applied for verification of bridge decks having both simple & complex configurations with ease and confidence. Grillage analysis has been done by most commonly using software STAAD pro. Finite element method has been done by most accurate and emerging software SAP 2000. IN FEM, modelingof structure is done by using shell element. The action due to loadings such as bending moment and shear force of the structure under railway loading and these stresses were computed by computational methods and also compared with conventional method. Design parameters were also computed based on Indian Railway standards. Design of box culvert and comparative study of reinforcement details is also presented. Finally, it has been concluded that, Finite element method gives less value of stresses than grillage and conventional method.

M.G.Kalyansheti and S.A.Gosavi (2014) made an attempt to evaluate optimum thickness for economical design. In this paper they considered 12 m channel length for analysis with 2m to 6m height variation which is again divided into single cell, double cell and triple cell. IRC class AA tracked live load is considered. The analysis has been done by using stiffness matrix method and coded program in C language for cost evaluation. Variation in bending moment; subsequently cost comparison was made for different aspect ratio. The percentage reduction in cost of single cell, double cell and triple cell based on

optimum thickness was presented. The optimum thickness presented over this paper has been used to achieve the economical design of box culvert. Based on this optimum thickness, optimum cost per meter width of single cell, double cell and triple cell has been evaluated. Optimum thickness reduces the cost of the box culvert.

Komal S. Kattimani and R. Shreedhar (2013) studied some of the design parameters of box culvert like angle of dispersion of live load, effect of coefficient of earth pressure and depth of cushion provided on top slab of box culverts. They presented the end moments & center moments through graph by using effect of variation of angle of dispersion, variation in coefficient of earth pressure and variation of cushion. Therefore from the parametric studies that is by variation of angle of dispersion, coefficient of earth pressure and cushion depth, they concluded that, angle of dispersion increases the intensity of live load but when overall effect of all loads is taken, the moments remain constant. Therefore angle of dispersion as considered in IRC 6-2000 which is 450 can be considered for design. The coefficient of earth pressure has a little influence on the final moments therefore for safer design the coefficient of earth pressure can be taken 0.5 which gives higher result than 0.33 and moments for no cushion are higher than the moments for cushion of 5meters.

Ali Abolmaali and Anil K.Garg (2008) has evaluated the shear capacity of the precast reinforced concrete box culverts. Six full-scale 2.4m (8 ft) span box culverts were tested against failure by subjecting each culvert to the AASHTO HS-20 wheel load. Each test specimen was loaded incrementally up to failure in which crack initiation and propagation were identified and recorded in each load step. In some specimen the top slab compression distribution steel was precluded during specimen fabrication the effect of which was shown to be insignificant to culvert's performance experimentally.

CONCLUSION:

Tremendous research and analysis on the design of box culverts reveals that optimum sectional sizes of the culverts may yield in economical design, which ultimately reduces the handling and transportation expenses. The modelling and the design methodology highly affect the economy of the construction of box culvert.

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