ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 15, March 2017

Analysis, Design and Cost Estimation of T-beam Bridge and a Dual cell Box culvert

Shwetha H Das, Vishnu M M, Varun K Suresh, Arun Joy P
Civil Engineering
Jai Bharath College of Management and Engineering Technology
Arakappady, Ernakulam(Dist.)
Email : shwethahdas1995@gmail.com

Abstract — **A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed, the material used to make it and the funds available to build it.**
This project aims at the analysis, design and cost estimation of two Lane Bridge which is proposed to be constructed across one of the contributories of the Muvattupuzha river branch located at Korikkal, Kottayam district. The proposed bridge is of 12m span and 7.5m wide carriage way.
The proposed study is to design the bridge as a T-beam bridge and also a Dual Cell box culvert. The design is based on the soil properties at the site and as per IRC loadings for highway.
The conventional analysis and design methods are used after norms of IRC, BIS and MoRTH are followed.

Keywords—bridge, T-beam, box culvert, cost comparison.

I. INTRODUCTION

Before a bridge can be built at a particular site, it is essential to consider many factors, such as the need for a bridge, the present and future traffic, stream characteristics, subsoil conditions, alternative sites, aesthetics and cost. The location of bridge site is based on different characteristics. The objectives of the project are

- To plan and design a suitable and economic bridge across the Korrikal river at the given site.
- The study is to analyze, design and compare the cost to determine whether T-beam Bridge or the dual box culvert is more economical for the site selected.

The scope is limited to the commonly used bridges in which T-beam bridge for such a span and a new and not much stressed dual box type culvert.

For the study, the various codes used as literature review for the design of the T-beam bridge and box culvert are given below:

- IRC 5 : 1998

This Code deals with the general features of design of road bridges and the recommendations of this Code shall apply to all types of bridges constructed for use by road traffic or other moving loads.

- IRC 6: 2014

The object of the Standard Specifications and Code of Practice is to establish a common procedure for the design and construction of road bridges in India. This publication is meant to serve as a guide to both the design engineer and the construction engineer.

- IRC 21 : 2000

This code deals deals with the structural use of plain cement concrete and reinforced cement concrete in road bridges.

- IRC 83 : 2014 (Part IV)

This code deals with the requirements for the materials, design, manufacture, testing, installation and maintenance of spherical and cylindrical bearings for bridges.

II. T-BEAM BRIDGE

T beam Bridge is by far the most commonly adopted type in the span range of 10 to 25 m. The structure is so named because the main longitudinal girder is designed as T-beams integral with part of the deck slab, which is cast monolithically with the girder. Simply supported T-beam spans of over 25 m are rare as the dead load then becomes too heavy. However Advai Bridge in Goa of span 35 m is probably the longest span simply supported reinforced concrete T-beam Bridge in India.

Components of a T-beam bridge are deck slab, cantilever portion, footpaths, if provided, kerbs and handrails, longitudinal girders, considered in design to be of T-section, cross beans or diaphragms, wearing course.

Design procedure for T-beam bridge involves the following design procedures, design of cantilever slab, design of internal panel, design of longitudinal girder, design of cross girder, design of bearings, design of abutments, design of foundation,

The general details and the preliminary dimensions of the T-beam Bridge are

- Total span = 12m

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 15, March 2017

- Width of carriage way=7.5m
- Kerb width=600mm
- Height of kerb=300mm
- Thickness of wearing coat=100mm
- Height of hand rails=1.100m
- Width of cross girder=250mm
- Width of longitudinal girder=300mm
- Concrete mix=M25
- Grade of steel=Fe415

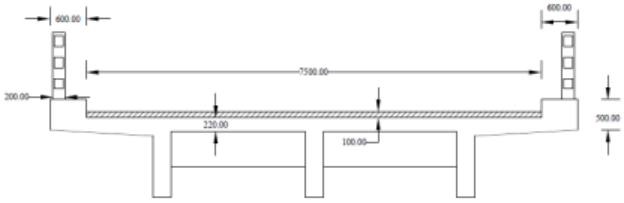

Fig 1 : Cross section of the T-beam bridge

A. Design of the cantilever portion

The cantilever portion was designed as per IRC class A loading. A depth of 200mm is provided at the end and 300mm at the support.

After the design procedure, the reinforcement details obtained are

- Main reinforcement 16mm dia bars @ 100mm c/c
- Distributers of 10mm dia bars @190mm c/c

B. Design of internal panel

The internal panel is of depth 220 mm with dimensions as 3.67m X 2.2m. After designing using Pigauds curve, the reinforcement details obtained are

- Provide reinforcement of 16mm dia bars @ 250mm c/c for short span
- Provide reinforcement of 16mm dia bars @ 200mm c/c for long span

C. Design of longitudinal girder

There are three longitudinal girders provided in the bridge of overall depth 1300mm. The reinforcement details of the longitudinal girder are

- 2 nos of 32mm dia bars and 10 nos of 28mm dia at soffit
- 4 nos of 12mm dia bars provided as side face rft
- 10mm 4 legged stirrups @ 140mm c/c

D. Design of the cross girder

The bridge is provided with four cross girders. The overall depth of the cross girder is 1100mm, with an effective depth of 880mm. the reinforcement details provided after the completion of the design procedures are

- 2 nos of 16mm dia bars and 6 nos of 20mm dia at soffit
- 10mm dia bars provided as side face rft
- 10mm 2 legged stirrups @ 150mm c/c

E. Design of bearings

In the T-beam considered, 6 elastomeric pad bearings are provided, 3 on each of the abutments. The details of each bearing obtained after the design procedure are as follows

- Thickness of individual elastomeric layer=10mm
- The overall thickness of the bearing is obtained as 39mm.
- Each bearing of 250mm X 500mm is to be provided.
- No of internal elastomeric layer = 2
- No of steel laminates = 3
- Thickness of laminate is 3mm
- Thickness of top and bottom cover = 5mm

F. Design of foundation

The foundation is designed for both the t beam bridge and the dual box type bridge using bored piles of 600mm dia.

For the box culvert 16 nos 600mm dia piles are found required. The depth of piles 24 meters.

For the T-beam type bridge also 16nos 600mm piles are found required. For the T-beam type bridge the base slab is the active as pile cap also. For the box culvert the bottom slab will act at pile cap.

III. BOX CULVERT

Culvert is a cross drainage work whose length (total length between the inner faces of dirtwalls) is less than 6m. In any highway or railway project, the majority of cross drainage works fall under this category. Hence culverts collectively are important in any project though the cost of individual structures may be relatively small.

Reinforced concrete box culverts are used for square and rectangular openings with spans usually up to 6 m. The box culvert consists of the following components

- Barrel of box section of sufficient length to accommodate the carriageway and the kerbs.
- Wing walls splayed at 45° to the embankments and also to guide the flow of water into and out of the barrel.

The Loading conditions to be considered in the design of the barrel (per unit length of the barrel) may be classified into the following six categories, concentrated vertical load due to wheel loads, uniform vertical load, weight of walls, pressure from contained water, earth pressure on the outer side.

The design of ventway depends on the discharge to be catered for. Except in the case of buried barrel, the maximum flood level will be below the bottom of top slab allowing a vertical clearance. In this case, the design of ventway will be similar to that of a culvert with RC slab deck. The design of ventway for a buried barrel will be similar to that for a pipe culvert. Usually, the ratio of the height of vent lies between 1:1 and 1.5:1. The top of bottom slab will be at bed level.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Special Issue 15, March 2017

The design of box culvert involves the design of the top slab, the bottom slab and the side walls. For the design purpose three cases are considered, which are:

- case I: live load and dead load acting on the side wall with no water inside the boxes
- case II: live load and dead load acting on the side wall with water inside only one box
- case III: only dead load action on the side wall and there is water inside one box

The general details of the dual box culvert proposed to be designed in this project are:

- No of box = 2
- Internal dimensions of each box = 6m X 6m
- Thickness of box culvert = 600mm
- Thickness of wearing coarse = 80mm
- Density of earth= 18KN/m^3
- Angle of internal friction= 28^0
- Loading= IRC Class A

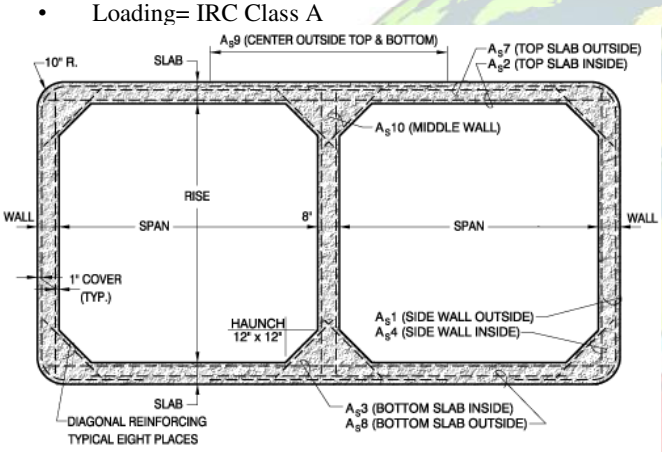

Fig 2 : Cross section of the dual cell box culvert

A. Design of Top Slab (slab thickness = 600mm)

- 16mm bars for main reinforcement and Spacing is 100mm c/c at supports
- 10mm bars for bend up bars and spacing is 200mm c/c in addition to 16mm bars @200mm c/c
- 10mm bars for distribution steel with spacing of 180mm c/c

B. Design of Bottom Slab (slab thickness = 600mm)

- 20mm bars and 16mm alternate bars provided at 100mm c/c at supports
- 16mm bend up bars at 200mm c/c in addition with 16mm bars @ 200mm c/c at mid span.

C. Design of Side Wall (slab thickness = 600mm)

- 20mm bars provided at 100mm c/c on outer force and also 200mm c/c at inner face.
- 10mm bars bend at 150mm c/c as distributers.

IV. Conclusion

Cost estimation is carried out and the following are the findings. The cost of foundation is same for both the type of bridges. But the cost of superstructure and substructure is more for the T-beam Bridge. There is 15% saving in the case of box culvert. After carrying out detailed estimation of the 2 types of structures proposed, it could be concluded that the box culvert proves to be more economical and hence it is suggested to build a dual box culvert at the site in consideration.

Acknowledgment

The authors would like to thank Prof.K.Soman, HOD, Department of Civil Engineering, Jai Bharath College of Management and Engineering Technology, for his valuable support and help.

References

[1] D.Johnson Victor, Essentials of Bridge Engineering. Indian Institute of Technology, Madras, 2001.

[2] N.Krishna Raju, Design of Bridges. M.S. Ramaiah Institute of Technology, Bangalore, 2009.

[3] IRC 5, IRC 6, IRC 21, IRC 83 Bridge codes