Design of Prestressed Pedestrian Bridge at Aluva

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Abstract—Modern day construction prefers prestressed girders over conventional RCC for long span bridge construction. This paper deals with the design of a prestressed pedestrian bridge across river Periyar at Aluva, Kerala. The bridge connects Mahadeva temple of Aluva to Municipal Park. The bridge has an overall length of 210m with a width of 6m and longest span of 50m. In order to prevent the entry of vehicles both ends are provided with stairs. The major goal of this is to validate and recommend details for the design of durable and constructible details to achieve structural continuity between the standard precast, pre-stressed concrete girders for this proposed bridge. Along with it, this paper will be dealing with the design of the piers, foundation parts and stairs.

Index Terms—Prestressed bridge design, I Girder, Long span bridge, pedestrian bridge, pile foundation

I. INTRODUCTION

The purpose of the bridge at this site is to accommodate the heavy pedestrian traffic during the annual Sivarathry Mahotsavam and the Vyapara Mela followed by it during February and March. On Sivarathry eve, over 1 lakh people are expected to cross the river. Till middle of last decade, boats were used as the major means of communication between the shores, but that was found inadequate due to the ever increasing crowd during the festival season each year. At present, a temporary bridge is constructed before Sivarathry and is demolished after the Vyapara Mela. In 2014, the Aluva Municipality spent 3.3 million rupees to construct this temporary structure and also, no traffic is possible through the river, which is National Waterway 3, until the bridge is demolished on March 2014. So, the construction of the proposed bridge will serve as a permanent solution for these problems and in addition to that, the bridge can be used by pedestrians throughout the year and hence, the pedestrian traffic of MarthandaVarma Bridge will be reduced considerably.

II. METHODOLOGY

Site visit and reconnaissance survey was done to prepare the location sketch and fix the alignment and dimensions of the bridge (See Fig 1). Details regarding the requirements were collected from the PWD office, Aluva. IRC codes (IRC 6 and IRC 21) were used to determine various parameters of loading. The breadth of bridge was selected so that a total of 10000 persons can be accommodated at a time over the bridge. This portion of the river being a part of National Waterway 3, the spans were fixed according to the specification of Indian Waterway Council. It specifies a minimum of 40m clear span and 7m clear height. So, clear a span of 46.5m and a clearance of 7m were provided. M50 concrete is to be adopted for construction. Stairs were provided at either side of the bridge. An extension portion of length 80m is suggested along with design so that the bridge will connect Municipal Park to the Temple road, so that the temple will become easily accessible for the people coming from the temple road via Althara. The extension portion is from Althara to Manappuram. Thus, from the preliminary requirements were joined together so that a layout of the bridge was obtained, which is shown in Fig.2. Details regarding the foundation soil conditions were obtained from the bore log reports.

III. OVERVIEW

Table 1: Preliminary description

<table>
<thead>
<tr>
<th>Location</th>
<th>Aluva, Kerala</th>
</tr>
</thead>
<tbody>
<tr>
<td>River</td>
<td>Periyar</td>
</tr>
<tr>
<td>Length</td>
<td>210 m</td>
</tr>
<tr>
<td>Breadth</td>
<td>6 m</td>
</tr>
<tr>
<td>No. of Lanes</td>
<td>2</td>
</tr>
<tr>
<td>Construction Material</td>
<td>Concrete - M20, M30 &amp; M50 Steel - Fe415 &amp; 1250N/mm²</td>
</tr>
<tr>
<td>Type of Girder</td>
<td>I Girder</td>
</tr>
<tr>
<td>Foundation</td>
<td>RCC Pile foundation</td>
</tr>
<tr>
<td>Prestressing system</td>
<td>Freyssinet System</td>
</tr>
</tbody>
</table>
Clearance from HWL* | 7m (for 50m span)  
Slope         | 0 for 50 m span  
Stairs        | Open well stairs

Figure 1: Site Plan

Figure 2: Layout

IV. DESIGN STEPS

4.1 - The following steps were carried out for the design of both 40m span and 50m span.
   4.1.1 - Load calculation (IRC 6:2000)
   4.1.2 - Design of Deckslab (IS 456:2000)
   4.1.3 - Design of cross section of girder (IS1343:1990)
      4.1.3.1 Design of section
      4.1.3.2 Calculation of prestress
      4.1.3.3 Calculation of eccentricity
      4.1.3.4 Design of shear reinforcement
      4.1.3.5 Design of End Block
      4.1.3.6 Design of Bearings
   4.2 - Design of Piers and Abutments (IS456:2000)
   4.3 - Design of Pile Cap (IS456:2000)
   4.4 - Design of Piles (IS456:2000)
   4.5 - Design of Stairs (IS456:2000)

V. RESULTS

5.1 Slab
   - Concrete M20
   - Steel Fe415
   - Total depth of slab=150mm
5.2 I girder for 50m span
- Concrete - M50
- Steel –1250N/mm² and Fe415
- Using Freyssinet system, six ducts each having twelve 12.7 mm diameter bars are provided
- Prestress =1100 N/mm²
- Two legged stirrups of 8mm Ø is provided at a spacing of 300mm as end face reinforcement

5.3 I girder for 40m span
- Concrete - M50
- Steel –1250N/mm² and Fe415
- Using Freyssinet system, five ducts each having twelve 12.7 mm diameter bars are provided
- Prestress = 1100 N/mm²
- Two legged stirrups of 8mm Ø is provided at a spacing of 300mm

5.4 End Block

5.5 Piers and Abutments (Columns)
- Concrete –M20
- Steel –Fe415

Figure 3: I Section details

Figure 4: End Block
- Height = 10m
- Breadth = 1.2m
- Width = 5m
- 88 numbers of 25mm diameter bars as primary reinforcement
- 12mm diameter lateral ties at 50cm spacing

5.6 Pile Cap
- Concrete - M20
- Steel - Fe415
- Length = 6m
- Breadth = 3.5m
- Depth = 0.850m
- 16mm diameter bars at 190mm c/c as distribution steel with a cover of 50mm
- 12mm diameter 8 legged stirrups at 250 mm c/c as shear reinforcement.

5.7 Pile
- Concrete - M30
- Steel - Fe 415
- Length of piles = 21.5 m
- Diameter of pile = 60cm
- No. of piles = 8
- The piles are spaced at 1.2m center to center
- Length of pile above ground level=0.5m
- Longitudinal reinforcement - 8 no. of 25mm diameter Fe 415 steel bars with 40mm clear cover
- Lateral reinforcement - 8mm φ spirals at a pitch of 40mm for a length of 1800mm at top and bottom at 50 cm spacing and 8mm φ spirals at a pitch of 40mm for a length of 1800mm at top of the pile.
5.8 Bearings
- Elastomeric bearing-reinforced pad bearing of neoprene and steel
- Size - 1.5m X 0.5m
- Thickness of steel plates = 3mm
- Thickness of interior layers of neoprene = 10mm
- Cover at top, bottom and sides = 6mm

VI. CONCLUSIONS

The design of the pedestrian bridge proposed at Aluva was completed and all drawings (using AutoCAD 2010) and specifications were prepared. A C++ program (Annexure - I) was created for the tendon profile so that the depth of tendon at any point of cross section can be determined. The program can be used for finding out parabolic tendon layout for any prestressed structure. The program can also be adopted for the design of any parabolic tendon profiles. Stairs were also designed so that the bridge will become easily accessible for the pedestrians and will prevent vehicles from entering. On completion, this project will reduce the pedestrian traffic of Aluva, especially on the eve of Sivarathry.

ACKNOWLEDGMENT

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