Solution to Traffic Problem at Edappally

M.I. Mini¹  V.H. Ameer²  Joseph Paul³  Sandra Jacob⁴  Veena Parameswaran⁵

¹Professor, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala.
², ³, ⁴ & ⁵ UG Student, Dept. of Civil Engineering, Mar Athanasius College of Engineering, Kerala.

Abstract- The present day construction of long span bridges uses prestressed girders instead of conventional RCC. This has led to an increased use of prestressed girders in bridge construction. This paper deals with the design of a prestressed flyover at Edappally junction, Ernakulam, Kerala. The flyover runs over the Edappally intersection though NH 47. The flyover has an overall length of 72m with a width of 15m, 7.5m on each two lane and the longest span is of length 24m. The major objective of this paper is to provide the structural design details of a pretensioned I girder bridge for the proposed flyover. The design includes the design of deck slab, longitudinal girder, pier and foundation.

Keywords: Prestressed bridge, I girder, long span bridge, deck slab, pile foundation.

I. INTRODUCTION

Prestressed concrete bridges are of great importance in present day construction and they have replaced the conventional RCC and steel bridges as they have all the advantages of both RCC and steel bridges and they manage to overcome the weakness of the same. Moreover, they have many more advantages in addition. Prestressed bridges are smaller in size, low in construction cost, suitable for long spans and hence very economical. They are durable, reliable and not vulnerable to corrosion. Ever since the development of prestressed concrete by Freyssinet in the early 1930s, the material has found extensive application in the construction of long span bridges, gradually replacing steel which requires costly maintenance due to the inherent disadvantages of corrosion under aggressive at atmospheric condition.

The purpose of proposing a flyover at Edappally is to reduce the traffic congestion here. Edappally is one of the busiest junctions in Cochin city. Hence the chances of traffic getting congested are very high. With the coming of Lulu shopping mall, the junction has become more congested as over 5000 people visit the mall daily. The Cochin bypass connects Edappally with Aroor which is an industrial town on south end of the city of Cochin. Bypass Junction in Edappally is the north end of the Cochin bypass which extends up to Aroor. This entire route is evolving into a major business hub with big-time stores and five-star hotels. The world-famous museum of Kerala History and sculpture is also located in Edappally. In addition, the presence of two national highways NH 17 and NH 47 shows the importance of the junction at Edappally. Edappally not only has one of the major hospitals in the state but is also the entry-point for vehicles from northern parts of Kerala.

Figure 1: Site map

Being an important junction in Cochin, proper traffic management measures have to be adopted. The proposal of the flyover at this site will improve the traffic situation and also enhance the movement of traffic. It also proves to be a long term solution. The flyover runs over the intersection through NH 17. Earlier temporary measures were adopted to reduce the traffic problems in Edappally which included erecting barricades within the 200-metre radius of the junction, banning pedestrian crossings and U-turn on the stretch. The stretch was also be declared a no-parking zone. Vehicles coming from the Aluva side will have to turn right at the traffic signal, enter NH-17 and then take a U-turn to enter the mall. This road was also widened so as to facilitate free movement of at least two vehicles without holding up traffic. Motorists from Aluva were taken the Container Terminal Road at Kalamassery in order to skip Edappally Junction.
and enter the mall through the entrance on NH-17. Motorists from Ernakulam were to proceed straight at the signal and enter the mall through the entrance facing NH-47. Pedestrian crossings near the mall were also being planned. These do not prove to be a long term solution.

The proposal of flyover at this site proves to be a long term solution to the traffic problems. The flyover is having an overall length of 72m. The bridge has its longest clear span is of 24m. The bridge deck is divided into four lanes of 3.5m width each. A gradient of 1 in 20 is provided for both the end spans. The site map of the intersection is shown in Figure 1.

II. OVERVIEW

The preliminary data collected for the design of the flyover is tabulated below.

Table 1 : Preliminary description

<table>
<thead>
<tr>
<th>Location</th>
<th>Edappally, Kerala</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>72m</td>
</tr>
<tr>
<td>Width</td>
<td>15m</td>
</tr>
<tr>
<td>No. of lanes</td>
<td>4</td>
</tr>
<tr>
<td>Construction material</td>
<td>M25,M30 and M60 concrete</td>
</tr>
<tr>
<td>Girder type</td>
<td>I girder and T beam</td>
</tr>
<tr>
<td>Foundation type</td>
<td>RCC pile foundation</td>
</tr>
<tr>
<td>Prestressing system</td>
<td>Freyssinet system</td>
</tr>
<tr>
<td>Slope</td>
<td>0 for middle 24m span</td>
</tr>
<tr>
<td>Bridge beam type</td>
<td>1 in 20 for 24m end spans</td>
</tr>
<tr>
<td>Bearing type</td>
<td>with cross beams</td>
</tr>
<tr>
<td></td>
<td>Elastometric bearing</td>
</tr>
</tbody>
</table>

III. LITERATURE REVIEW

The research work done by R. G Oesterle and A.F Elremaily gives some relevant guidelines regarding the design of prestressed bridge decks. This report documents results of a study of decked, precast, prestressed concrete bridge girders. This type of bridge provides benefits of rapid construction and improved structural performance. The research was performed to develop guidelines for design and construction and to address issues that significantly influence performance. The first goal was accomplished by development of guidelines for design, construction and geometry control based on successful methodology currently being used. The second goal of the project was to develop an improved longitudinal joint system. The performance of longitudinal joints between the flanges of adjacent decked girders was defined as a major issue inhibiting the general use of decked girders. A study of potential joint systems was used to define trial alternate joints.

According to the research conducted by Amin K. Akhnooukh of University of Nebraska-Lincoln in 2008, high strength materials are improves the design of new girder bridges, with large span-to-depth ratios (greater than 30) and results in labor and material savings. In addition, they reduces the number of intermediate supports and increase the vertical clearance underneath the bridge. The main objectives of this research are: 1. Investigate the effect of confinement on the transfer and development length of prestressing strands and 2. Develop economical self-consolidating high strength concrete with minimum 24-hour strength of 10 ksi and minimum 28-day strength of 15 ksi.

Modjesky and Masters consulting engineers presented a paper on the design of prestressed bridges. This example is part of series of design examples sponsored by the Federal Highway Administration. The design specifications used in these examples is the AASHTO LRFD Bridge design Specifications. The intent of these examples is to assist bridge designers in interpreting the specifications, limits, differences in interpretations between designers, and to guide the designers through the specifications and to allow easier navigation through different provisions. For this example, the second edition of the AASHTO- LRFD Specification with interims upto and including the 2002 interim is used.

IV. METHODOLOGY
Site visit and preliminary survey was conducted to prepare the location sketch and fix the alignment and dimensions of the bridge. Details regarding the span and width of the flyover, reduced level were collected from DMRC office at Ernakulam as the project was about to be constructed along with the construction of the Metro Rail. IRC 21-2000, IRC 18-2000 were used to determine various parameters of loading. The breadth of the beam was so selected that 2 lanes were provided in each directions of flow of traffic. The design was done based on IRC class AA tracked vehicle as the span is quite large enough and the maximum bending moment and shear force occurs when IRC class AA tracked vehicle is considered. The total length of the flyover was 72m. It was divided into 3 spans of 24m length. The design was done by considering one span and the same was the case for the other two spans. The width of the span was 7.5m in one direction of flow. M25 concrete was used for the design of deck slab and M60 concrete was used for the prestressed I girder. The preliminary data was used to prepare the layout of the flyover and it is shown in Fig. Then the design of deck slab, longitudinal girders, piers and cross beams were carried out for the 24m span based on this preliminary data and also some data from the Indian Road Congress and the Indian Standards. Details regarding the foundation soil were obtained from the borelog reports. Pile foundation was used for construction. The detailed layout of the flyover is shown in Figure 2.

![Figure 2: Layout of the flyover](image-url)

**V. DESIGN STEPS**

The procedure for the design of flyover is described below step by step.

1) Preliminary data collection
2) Load calculation (IRC 6-2000)
3) Computation of permissible stresses
4) Cross section of bridge deck (IS 456-2000)
5) Design of interior slab panel (IRC 21-2000), (IRC 6-2000)
6) Design of cantilever portion (IS 456-2000)
7) Design of longitudinal girder (IRC 18-2000)
8) Design of prestressing force (IS 6006-1983)
   i) Check for stresses at service loads (IRC 18-2000)
   ii) Check for ultimate flexural strength (IRC 18-2000)
   iii) Check for ultimate shear strength (IRC 18-2000)
9) Design of supplementary reinforcements (IRC 18-2000)
10) Design of intermediate cross beams (IS 456-2000)
11) Design of bearing (IS 456-2000)
12) Design of pier cap (IS 456-2000)
13) Design of pier (IS 456-2000)
14) Design of pile foundation (IS 2911-1971 Part 1)
   i) Check for structural capacity
   ii) Size of pile and reinforcement
   iii) Lateral reinforcement
15) Design of pile cap

**VI. DESIGN RESULTS**

The detailed design results of each component are given below.

**A. Deck slab**
- Concrete = M25
- Steel = Fe 415
- Slab panel = 2.5m x 5m
- Thickness of slab = 250mm
- Kerb = 600mm x 300mm
- Nominal cover = 40mm
Provide 16mm diameter bars at 180mm spacing as primary reinforcement
Provide 10mm diameter bars at 200mm spacing as secondary reinforcement
Figure 3 shows the cross section of the bridge deck.

Figure 3: Cross section of deck slab

B. Longitudinal girders
I girder of span 24m
Concrete – M60
Steel – 1250 N/mm² and Fe 415
Using Freyssinet system, 4 ducts each of 7 strands of 15.2mm diameter are provided
Prestressing force = 5936kN
Provide 12 bars of 12mm diameter as supplementary reinforcement
Figure 4 shows the section of the I girder.

Figure 4: I girder

C. Bearings
Elastomeric bearings- reinforced pad bearing of neoprene and steel
Length = 1m
Breadth = 0.8m
Thickness = 50mm
Thickness of steel plate = 3mm
Thickness of interior layers of neoprene = 10mm
Cover at top, bottom and sides = 6mm

D. Pier cap
Depth of pier cap = 1200mm
Width of pier cap = 2100mm
Length of pier cap = 8500mm
Concrete – M30
Provide 25mm diameter bars at 110mm spacing as primary reinforcement
Provide 8 legged 20mm vertical stirrups
The section of the pier cap is shown in Figure 5.

Figure 5: Section of pier cap

E. Piers
Concrete – M30
Steel – Fe 415
Size of pier = 1.5 m diameter
Provide 64 bars of 30 mm Φ as primary reinforcement
Provide 16mm Φ bars at 45mm pitch
Figure 6 shows the section of pier

Figure 6: Section of pier

F. Pile (under each pier)
Concrete – M25
Steel – Fe 415
Diameter of the pile = 1.2 m  
Length of the pile = 34 m  
Length of pile above the ground = 0.6m  
Longitudinal reinforcement – 28 bars of 25mm \( \Phi \) are with a cover of 40mm  
Lateral reinforcement - 8 mm \( \Phi \) spiral at a pitch of 30 mm are provided for a length of 3.6m near the pile head  
- 8mm \( \Phi \) bars are provided at 80mm centre to centre near the pile end

Figure 7(a): Reinforcement in pile  
Figure 7(b): Section of pile

VII. CONCLUSION

The design of flyover at Edappally was completed and all drawings (using Auto CAD 2010) and specifications were prepared. The design includes all the major components of a bridge. With this project, the problem of traffic congestion at the proposed site can be reduced to a great extent. With the coming of the Lulu Mall and other significant development works, the traffic at this site has increased proportionally. Hence this project ensures a long term solution to the traffic problems at Edappally. This flyover runs over the Edappally intersection through NH 17. The proposal of this flyover also enhances the smooth movement of Kochi Metro Rail.

REFERENCES