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Preliminary Design and Drawing of Widening of an Existing Road Bridge from 2 to 3 Lane

Mitaali Jayant Gilbile[1], Vivek Sangramsingh Ghatage[2], Gaurav Sampat Patil[3], Pradip Hindurao Patil[4], Shweta Shivaji Nikam[5]

[1]Assistant Professor, Department of Civil Engineering, D. Y. Patil Technical Campus, Talsande, Kolhapur
[2,3,4,5] UG Students, Department of Civil Engineering, D. Y. Patil Technical Campus, Talsande, Kolhapur

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Abstract - *The growth in India's population and economy has increased traffic volume, straining roads and bridges. Adequate infrastructure is vital for attracting investment. Many bridges can't handle current traffic and engineers must decide between replacing or widening them. Widening is often chosen for its cost-effectiveness and minimal traffic disruption. This study focuses on a functionally obsolete bridge on National Highway 48 over the Panchganga river near Kolhapur, India. It proposes widening the two-lane bridge to three lanes with a sidewalk. Various widening and strengthening methods are reviewed, and an optimal technique is suggested based on data analysis and visual inspection. Preliminary designs and drawings for the bridge modification are included.*

Key Words: Preliminary design, visual inspection, extra piers

1.INTRODUCTION

The National Highway 4 (NH 4), now renumbered as National Highway 48, was a major route connecting Mumbai, Pune, Bangalore, and Chennai. As part of the Golden Quadrilateral project, NH 48 was expanded to 4 lanes by August 2011. Currently, an upgrade to 6 lanes is in progress and expected to finish by 2025.Our project focuses on road bridges in Package 1 (Kagal to Peth) of the Kagal-Satara section of NH 48, specifically those over the Panchganga and Warana Rivers. The Panchganga bridge has 2 lanes in the northbound direction and 3 lanes in the southbound direction, while the Warana bridge follows the same pattern. The proposed plan of concerned authority for existing bridges is to maintain the southbound bridges at 3 lanes but replace the northbound bridges with new 3-lane structures. However, these northbound bridges are functionally obsolete, suggesting a widening approach instead of reconstruction. This study aims to identify the most suitable widening technique for these bridges to optimize cost-effectiveness.

1.1 Problem statement

The existing road bridge located in the northbound direction over the Panchganga River near Kolhapur city on National Highway 48 has two lanes, with no sidewalk for pedestrians. Due to the increase in traffic volume, this bridge is now inadequate to meet the current traffic demand. Therefore, it is necessary to widen this bridge from two lanes to three lanes and include provision for a pedestrian sidewalk.

1.2 Aim

Engineers face complex decisions in projects, balancing regulations with what best fits project expectations. Experience plays a key role, but unforeseen factors can arise. To make informed choices, multiple preliminary designs are often explored, saving time and costs, especially in large projects. This project focuses on widening an existing road bridge, specifically the Panchganga Road bridge, Kolhapur, India built in 2002. The original bridge has two lanes with no sidewalk. The goal is to widen it to three lanes for vehicles and include a sidewalk. This case study aims to design a technical solution for this expansion.

2.OBJECTIVES

1.To know the current scenario and future plan of existing road bridges.
2.To study various techniques can be used to widen an existing road bridge.
3.To carry out visual inspection and collect necessary information of actual site which is under consideration and provide an optimal widening technique for the existing bridge.
4.To design the solution that will be preliminary and should be sufficient to ensure that the solution is realistic and solve the problem of widening.

3.METHODOLOGY

1.Literature review- Review of the works done for the widening of existing bridges.
2.Study of techniques- A study of widening techniques that can be used for existing bridges.
3.Comparison of techniques- The difference between widening techniques.

4.Detailed study of existing bridge- The detailed survey of the existing bridge which involves visual inspection of bridge, measuring the dimensions of bridge, collecting information relevant to existing bridge from concerned office.
5.Design and drawing- Design of the widening of bridge as per IRC standards along with its drawing.

4.REVIEW OF WIDENING TECHNIQUES

1.Widening of the deck with extra prestressed beams and enlargement of existing pier

This solution can seem to be the most natural one since the existing beams are generally made of prestressed concrete. The design should be made with beams of same dimensions, same concrete, same reinforcements and same initial prestressing as the existing beams. Consequently, the piers heads must also be enlarged in order to support these new beams. The piers heads are enlarged of the same amount as the deck. To support cantilever portions of pier head, enlargement of pier by rebarring is also necessary.

2.Widening of the deck with extra composite beams and enlargement of existing pier

Another solution can be to add extra steel beams instead of prestressed ones. Advantages are numerous: steel beams do not need any formworks, they are also less heavy than concrete ones, and are less time consuming to build. On the other side, this option might cost more money and require more maintenance. In this method also piers heads are enlarged in order to support these new beams. The piers heads are enlarged of the same amount as the deck. To support cantilever portions of pier head, enlargement of pier by rebarring is also necessary.

3.Widening of the deck with extra prestressed beams and extra piers

This method is similar to the first method, but instead of enlarging the existing pier, new additional piers are constructed beside the existing pier to support the new prestressed beams and cantilever pier cap.

4.Widening of the deck with extra composite beams and extra piers

This method is similar to the second method, but instead of enlarging the existing pier, new additional piers are constructed beside the existing pier to support the new prestressed beams and cantilever pier cap.

Table No.1 Comparison between techniques

Widening of the deck with extra beams (Prestressed concrete / Composite) and enlargement of existing pier	Widening of the deck with extra beams (Prestressed concrete / Composite) and extra piers
1. Only useful for concrete bridges.	1. Useful for all types of bridges.
2. Width limitation.	2. Width can be increased up to any requirement.
3. Needs more strengthening to the existing bridge.	3.Needs less strengthening to the existing bridge.
4. Traffic might be affected.	4. Traffic might be affected.
5. Complete demolition of structure is required at the end of design period.	5. Demolition of existing structure can be easily done without affecting widening part.

5. CASE STUDY OF EXISTING BRIDGE

5.1 Location of existing bridge

There are three existing bridges over the Panchganga river. In the image, the bridge marked in blue on the left has been demolished. The bridge marked in purple on the right has three lanes heading southbound, while the bridge marked in red in the middle has two lanes and is the focus of our case study.
Coordinates of existing bridge- 16°42'42.7"N 74°16'50.9"E

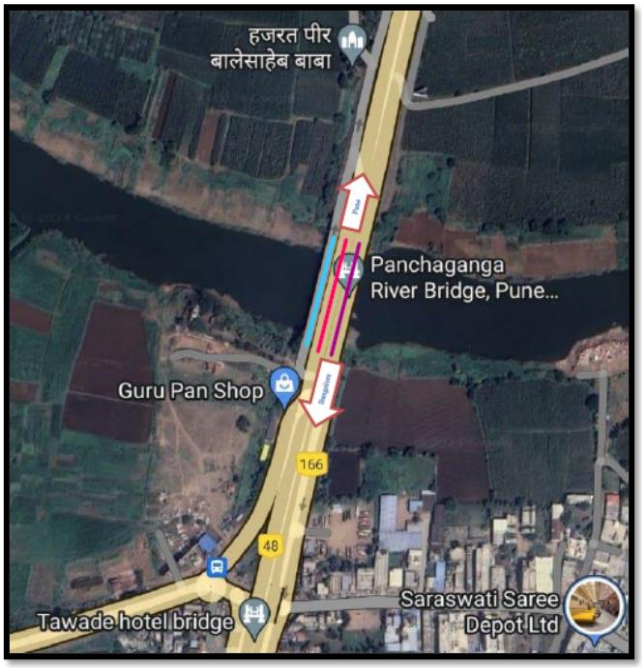

Fig.1 Google map image of existing bridge

5.2 Visual inspection of existing bridge

Table No.2 Existing bridge details

Type of Bridge	Major bridge
Construction completed year	2002
Total length of bridge	140 m
Length of span	20 m
No. of spans	7
No. of piers	6
Width of carriageway	8.5 m
Superstructure type	Prestressed Multi girder
Substructure type	Solid stone piers
Type of foundation	Well foundation

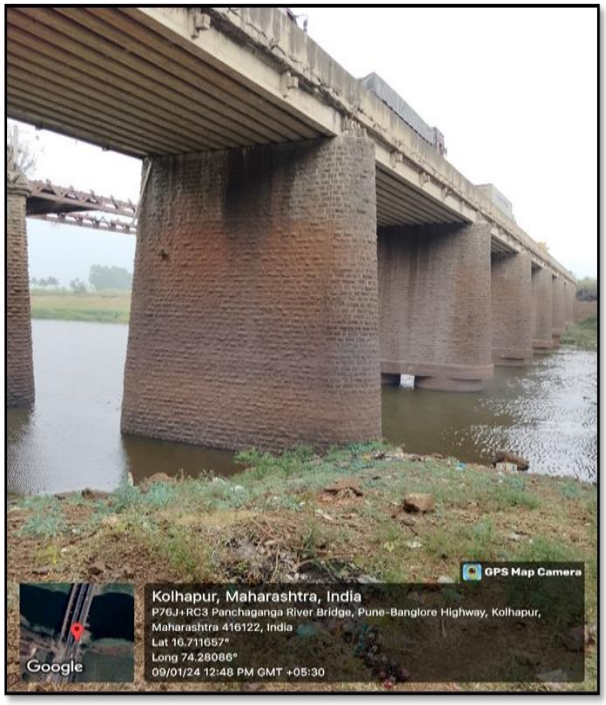

Fig.2 Panchganga bridge

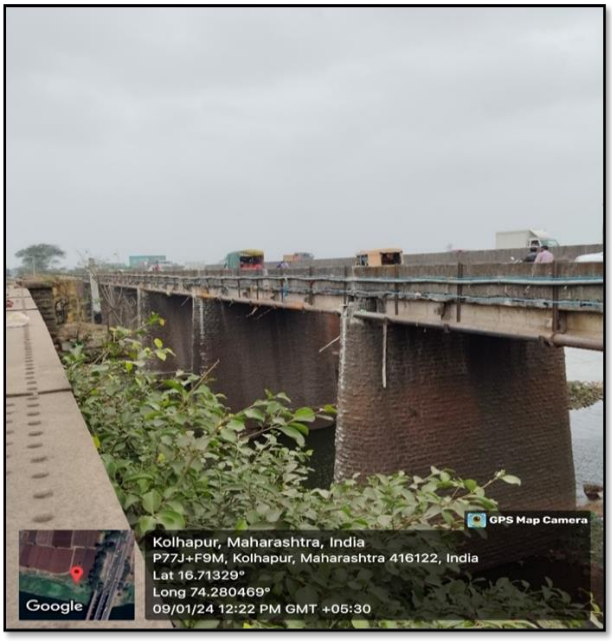

Fig.3 Substructure of bridge

5.3 Optimal method of widening for existing bridge

For this bridge, widening the deck with extra prestressed beams and additional piers is the most suitable and economical method. Since the bridge has stone piers, modifying or enlarging the existing piers is not feasible. Therefore, adding extra piers beside the left side of the existing piers is possible.

Table No.3 Proposed widening work details

No. of lanes to be increased	1
No. of sidewalk to be given	1
Width of carriageway for new lane	3.5m
Width of sidewalk	1.5m

6.DESIGN AND DRAWING

When designing any structure, challenges are always present. Since we don't have information about the soil condition of the riverbed, therefore we have only designed the superstructure of the bridge. The design of the substructure is ignored due to the unknown soil condition. We have manually designed only superstructure of widening part of bridge by using IRC standards. This design is preliminary design. For widening portion we have designed Prestressed Concrete elements.

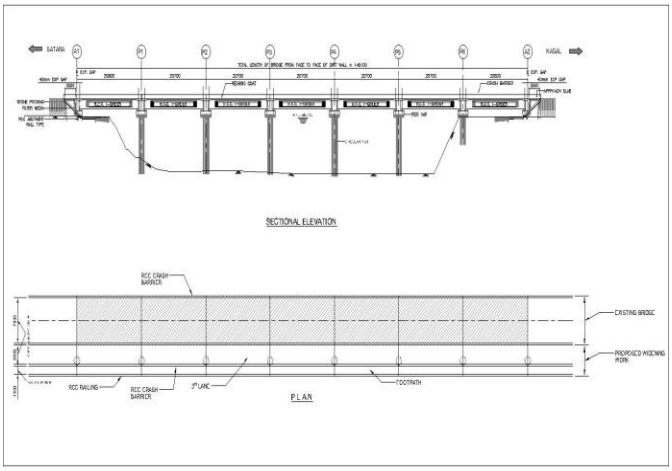

Fig.4 Plan and elevation of proposed bridge

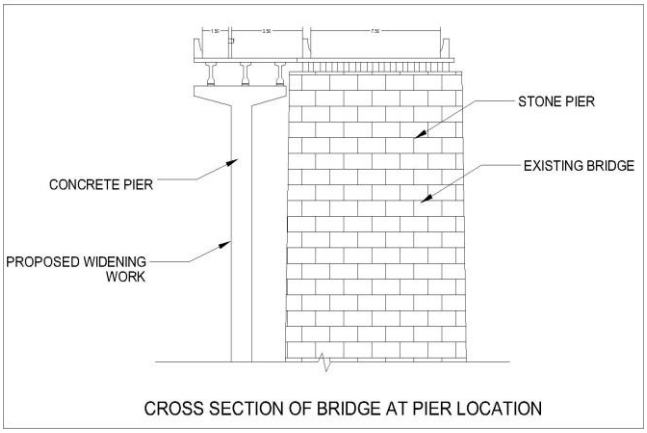

Fig.5 Cross section of proposed bridge

7.RESULTS

Following results are obtained from the preliminary design of superstructure of widening part of existing bridge-

- Deck slab-

Thickness-250mm
Reinforcement-
Main steel- #12 @ 150 c/c
Distribution steel- #10 @ 200 c/c

- Longitudinal girders-

Size- Top flange-1200mm x 250mm
Web-1150mm x 200mm
Bottom web-400mm x 500mm
Reinforcement at support section-
Cables- 3 cables of 7 strands of 15.2mm high tensile wires
Reinforcement at center of span section-
Cables- 8 cables of 7 strands of 15.2mm high tensile wires

- Cross girders

Size- Width-200mm
Depth-1250mm
Reinforcement-
Nominal reinforcement- 2 # 12 top + 2 # 12 mid depth + 2 # 12 bottom & stirrups- #10 @ 200
Cables- 2 cables of 12 Nos. of 7mm high tensile wires

- Elastomeric pad bearing-

Size-400 x 630mm
Thickness-45mm

8.CONCLUSIONS

In this study, we gathered information on existing bridges in the selected NH48 section and conducted a detailed study of widening techniques. After evaluating options, we chose an optimal method: widening the deck with extra prestressed beams and additional piers. This method is considered most suitable and feasible for the bridge due to its minimal interference with the existing structure, effective support for new live loads, and lower need for strengthening compared to other method like widening the deck with extra prestressed beams and enlarging existing piers.

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