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ANALYSIS OF A RIVER BRIDGE PIER UNDER COMPRESSION AND BENDING

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ABSTRACT

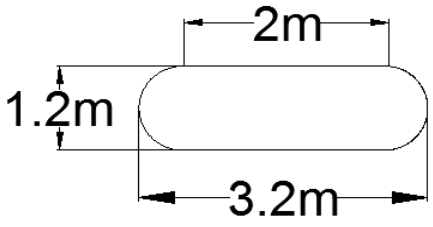
Bridge piers are integral parts of a bridge and are present between the superstructure and the foundation. Piers are designed to resist the vertical loads from the superstructure, as well as the horizontal loads such as wind load. In case, the bridge is constructed on a river, the horizontal loads will include water pressure. The data published in the Indian standard codes contains interaction curves for circular and rectangular columns. This paper employs a methodology which generates interaction curves for different shapes of columns(piers) and not just circular and rectangular RCC columns, thus, it enables a more precise description of the capacity of the axial and lateral loads. Interaction curves and strength envelopes for oval shaped RCC bridge piers have been generated and presented here.

Keywords: Bridge Pier, Columns, Interaction Curves, RCC, Strength Envelope.

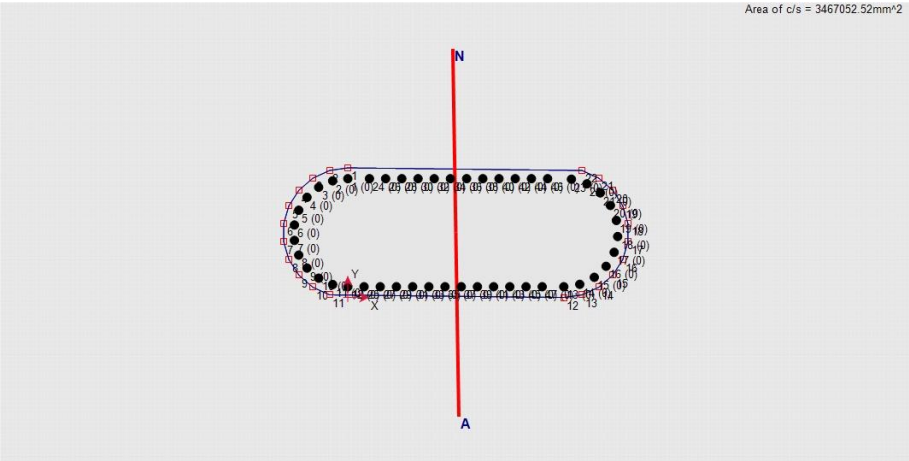
I. INTRODUCTION

The analysis of pier of an RCC river-bridge is shown here. A pier is to be designed to resist axial compression and bending caused by the vehicular loads and horizontal loads such as wind load, water pressure, etc. Here a methodology is used, where the VB scripting gives the cross section of the pier (column) and interaction curves and strength envelope can be generated for the same which are not available for different shapes of columns in the published literature for axial compression and bending moments on the section. A software 'RCColumn' developed for the purpose has been employed. RCColumn is a software which helps structural engineers analyse and design RCC sections such as columns and shear walls under a combination of axial compression and bending as per IS:456[1]. It is developed with an intention of being an aid to practising engineers and researchers in their endeavour of designing columns and shear walls having complex cross-section shapes. In absence of design charts for columns having arbitrary shapes, RCColumn aims to provide a reliable solution, based on IS:456[1].

II. ANALYSIS

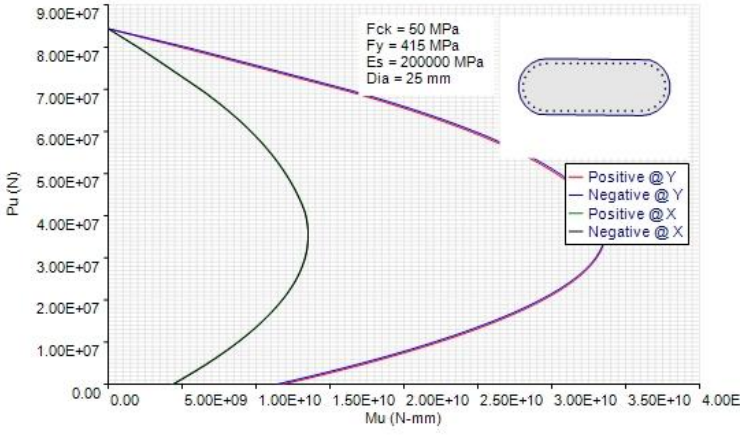


(Figure 2.1 Schematic of the Bridge Pier)



(Figure 2.2 Section of Bridge Pier)

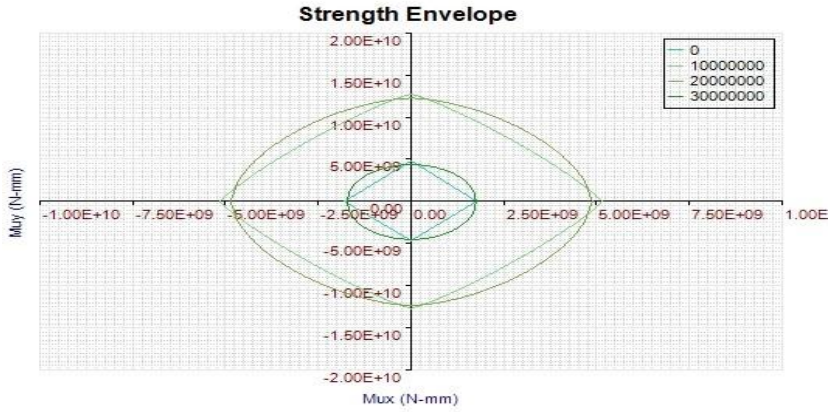
Here, figure 2.2 shows the cross section of an oval shaped bridge pier. Bars of diameter 25mm have been used. The main steel bars are considered to be of grade Fe415 and high strength concrete of grade M50 has been assumed. The interaction curves are dependent on the direction about which bending actions are considered. This is primarily due to the fact that the moment capacity depends on the moment of inertia about any given axis. Therefore, the section has different moment resisting capacity in x and y directions. The interaction curves [3] present in SP:16 [3] are given for circular and rectangular columns [4]. Here, the methodology used, generatedthe interaction curves for an oval shaped pier (column). Hence, we wouldget four interaction diagrams for any unsymmetrical section. Along all four axes(positive x, negative x, positive y, and negative y), interaction curves have been generated. However, as the section is symmetric, only two curves have been reproduced here. The curves in the plot to be considered depend upon the design problem at hand. Since these interaction curves have been generated for the particular section, the values are not normalized for the section parameters, but are reported in force and moment units. The interaction curves generated for the section are shown in Figure 2.3.



(Figure 2.3 Interaction Curves)

The interaction curves present in SP: 16[3] are for circular and rectangular columns, and are normalized with the dimensions of the cross-section considered. While such normalization makes the charts generalized for any cross-section having the shape considered while generation, such normalization is not possible here because of the irregularity in shape of the cross section. The strength envelope is another very important aspect of the

column capacity. The envelope obtained for a given value of axial compression Pu with varying directions of neutral axis, can be said to be the strength envelope. Figure 2.4 shows the strength envelopes for various values of Pu obtained for the section considered.



(Figure 2.4 Strength Envelope)

III. VALIDATION

For validation purpose, interaction curves generated by the methodology shown above for rectangular cross-section with all around placement of bars have been compared with the standard results for standard sections published in SP: 16. The curves match with extreme precision. This is because the equations incorporated in the above algorithm are the same as those used for the standard results published in SP: 16. The only variation considered here is the difference in shape. Thus, the methodology and algorithm developed for division of the section and subsequent calculation of stress blocks can be considered to be appropriate.

IV. CONCLUSION

Presented here is a methodology developed for generation of interaction curves and strength envelope of bridge pier (columns) sections. The methodology appears to be promising and tries to give a better technique making the design process of bridge piers more definitive. The design must take many more actions into considerations. However, the approach described here enables us to arrive at an appropriate section to begin various checks. Using the continued methodology, it is expected that the design of bridge piers could be simplified while achieving to all stringent checks.

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