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DESIGN AND ANALYSIS OF I-BRIDGE GIRDER USING IRC CODE AND AASHTO CODE

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ABSTRACT

Bridges serve as elevated pathways that allow for uninterrupted travel over obstacles while maintaining the alignment of the underlying road or pathway. This study focuses on the design of I-bridge girders, specifically longitudinal and cross girders. The bridge in question has a span of 22m, and the girders are constructed accordingly. The longitudinal girders have dimensions of 1800 * 1000 mm, while the cross girders measure 1800x1000 mm. The bridge consists of four longitudinal girders spaced at 3000 mm c/c, and four cross girders. The design of these girders is carried out using the CSI Bridge software. Two identical models are created in CSI Bridge for the purpose of this study, with loadings adjusted to comply with IRC codes and AASHTO-LRFD specifications, respectively. By applying these different loadings, the shear force, bending moment, and average rotation in both the longitudinal and cross girders are determined. The analysis is conducted using the CSiBridge model, and the results are compared with relevant tables.

Keywords: IRC Code, AASHTO-LRFD Code, Bridge Girder, Staad Pro., Csibridge, Etc.

I. INTRODUCTION

A bridge is a man-made structure that is built to provide a means of crossing obstacles such as roads, rivers, railways, or valleys. The design of a bridge is determined by its intended use and the specific conditions of the region where it is to be constructed. Factors such as site conditions, construction materials, construction methods, and financial considerations also play a role in the design process. With the rapid advancement of technology, traditional bridges are being replaced by more cost-effective and aesthetically pleasing designs. Structural engineers have developed two reinforced cement concrete structural systems as a solution to this problem. These are:

- Girder bridges
- Prestressed Bridges
- Arc Bridges
- Rigid Frame Bridges

The geometric characteristics of girders are characterized by their simplicity and ease of construction. The design of bridge structures is a crucial responsibility for structural engineers, as it entails a complex set of tasks. Various factors, including span, live load, dead load, length, and height, play a significant role in the design process. These factors have a profound impact on the overall design concept, making the selection of the structural system and the scope of research crucial considerations. For the purposes of this study, a span length of 22 meters has been chosen, highlighting the importance of adhering to codal provisions and incorporating detailed design specifications. The girders are designed in accordance with the IRC codes and AASHTO-LRFD specifications using CSI Bridge software. This research examines the impact of various loading conditions, as specified by the IRC codes and AASHTO-LRFD specifications, on the shear force, bending moment, and average rotation in the design of both longitudinal and cross girders for bridge construction.

II. METHODOLOGY

Description of Bridge Superstructure:

The bridge structure examined in this particular case study possesses a span of 22 meters and is supported by piers or abutments within the bridge substructure. The deck slab has a uniform thickness of 12.25 meters, and

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the carriageway measures 6 meters in width. The longitudinal girders and cross girders are specified to have dimensions of 1800x1000 mm and 1800x1000 mm, respectively.

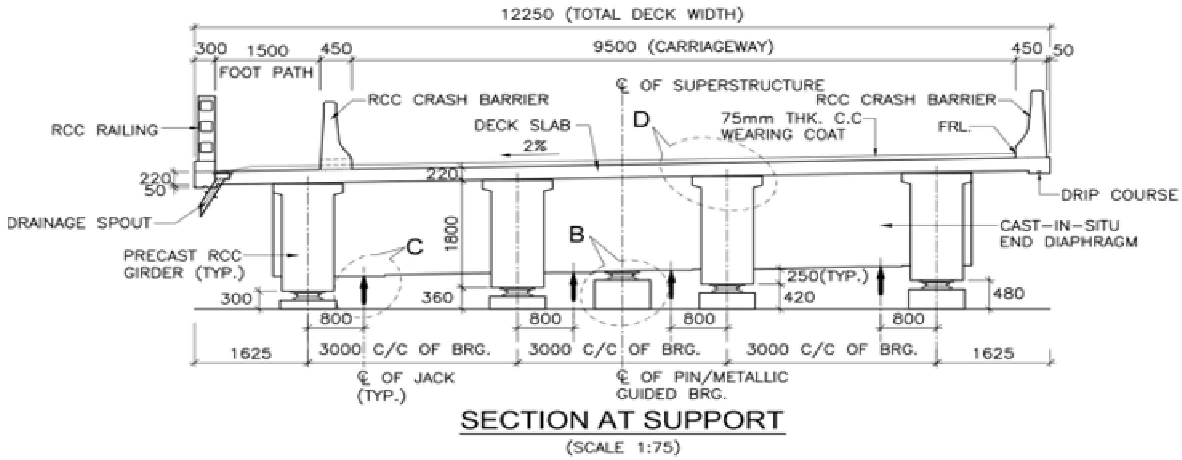

Figure 1: Cross section of Superstructure

Design Analysis:

The structural analysis and design of I-bridge girders have been conducted to account for both dead and live loads. The dead load of the members is taken into consideration using the Staad Pro software, while the live loads are determined based on the guidelines provided by the IRC code and AASHTO-LRFD specifications. The model of the bridge has been created using the STAAD Pro software, and the schematic diagrams and loadings have been derived from the IRC codes and AASHTO Specifications, as depicted below:-

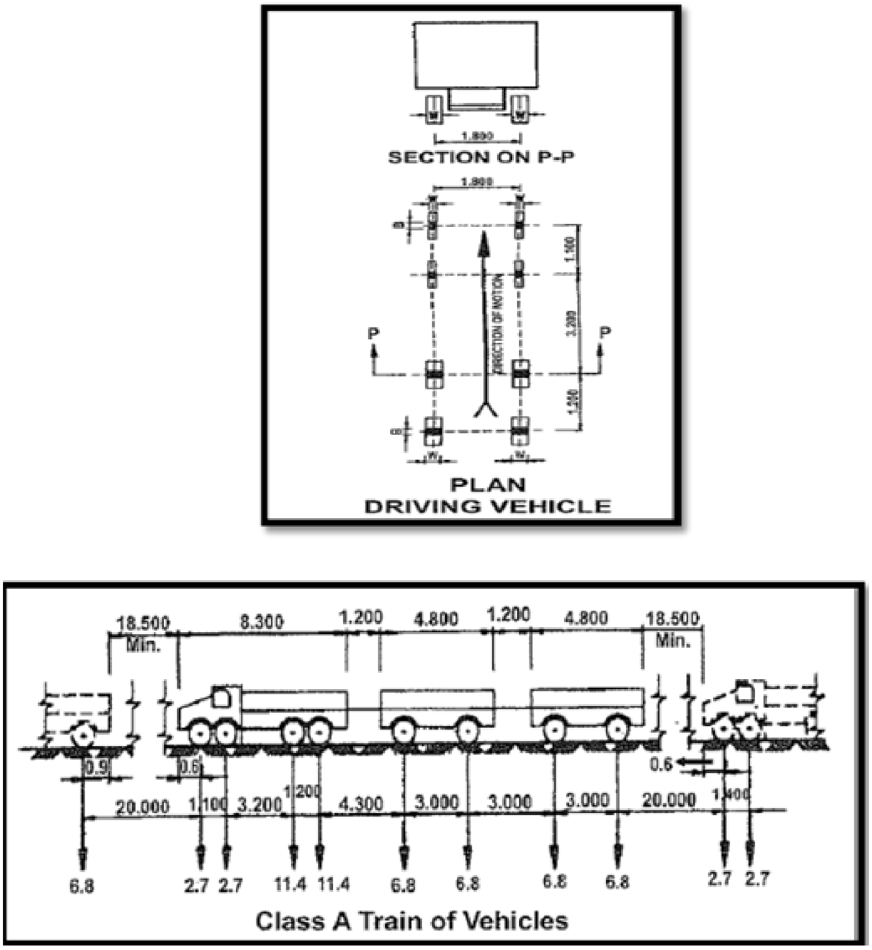

Figure 2: IRC Class A Loading (Extracted from IRC 6-2017)

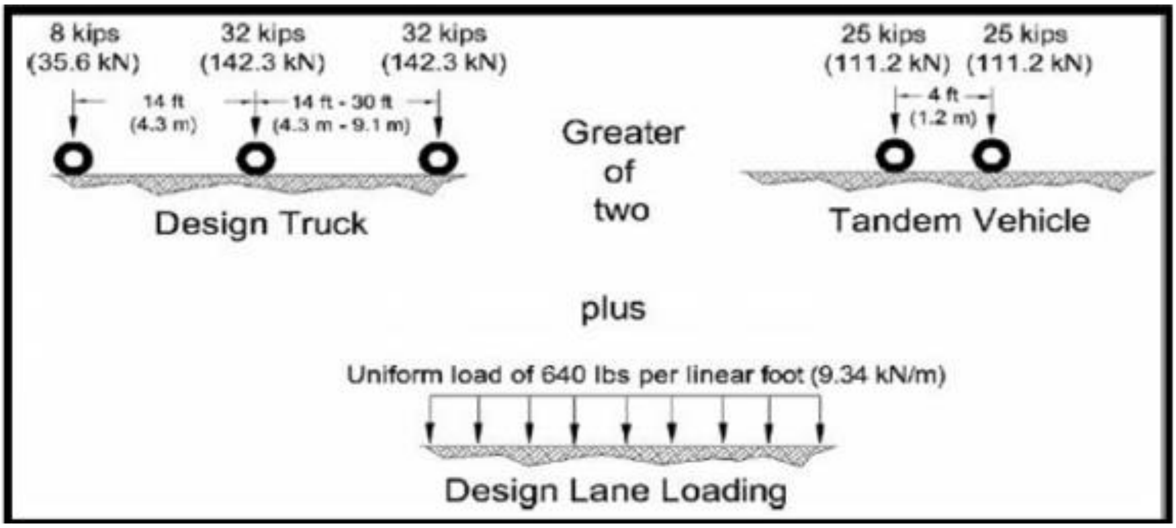

Figure 3: HL-93 Loading from AASHTO LRFD bridge design specification

Reinforcement Details:

- Dimensions

Top width = 1000 mm

Bottom width = 750 mm

Length = 1800 mm

- Material : RCC
- c/c spacing : 300 mm

III. RESULTS AND ANALYSIS

Figures below shows envelopes of vertical shear force. The results show that IRC codal provisions produced a minimum shear vertical force of -1318.527 KN and a maximum shear force across the longitudinal girder at the beginning of the span (Fig 4). Hence among the two codes IRC code produced maximum shear vertical force.

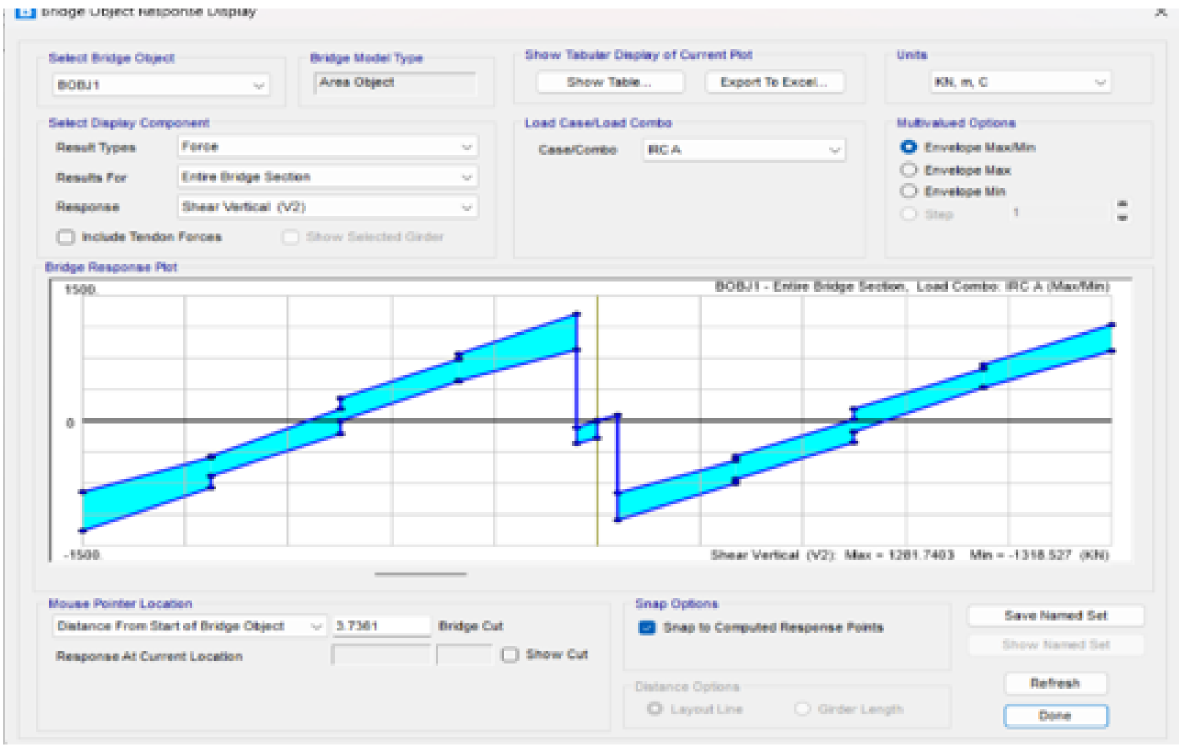

Figure 4: Shear force for IRC code

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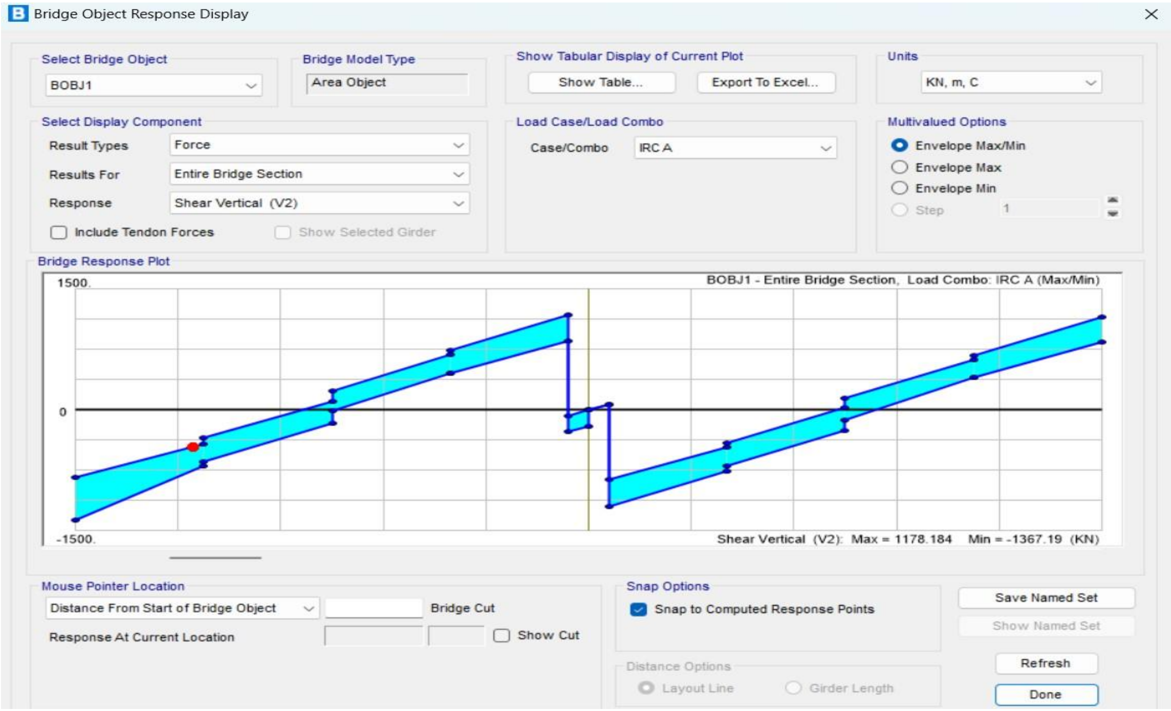

Figure 5: Shear force for AASHTO-LRFD

The figure 6 and 7, presented in this study depict the envelopes representing moments about the vertical axis. The application of AASTHO LRFD combined loading on the longitudinal girder led to a maximum bending moment of 191.3652 KN-m at a distance of 6.3301m, as illustrated in Figure 7. Conversely, the application of IRC combined loading resulted in the longitudinal girder experiencing its maximum bending moment at the beginning of the span, approximately measuring 339.7918 KN-m, as shown in Figure 6. It is noteworthy that, among the two loading scenarios, IRC loading exhibited the highest bending moment.

Total main reinforcement required for Bending in I-girder (as per IRC code) = 13215 mm

Total main reinforcement required for Bending in I-girder (as per AASHTO-LRFD) = 14448 mm

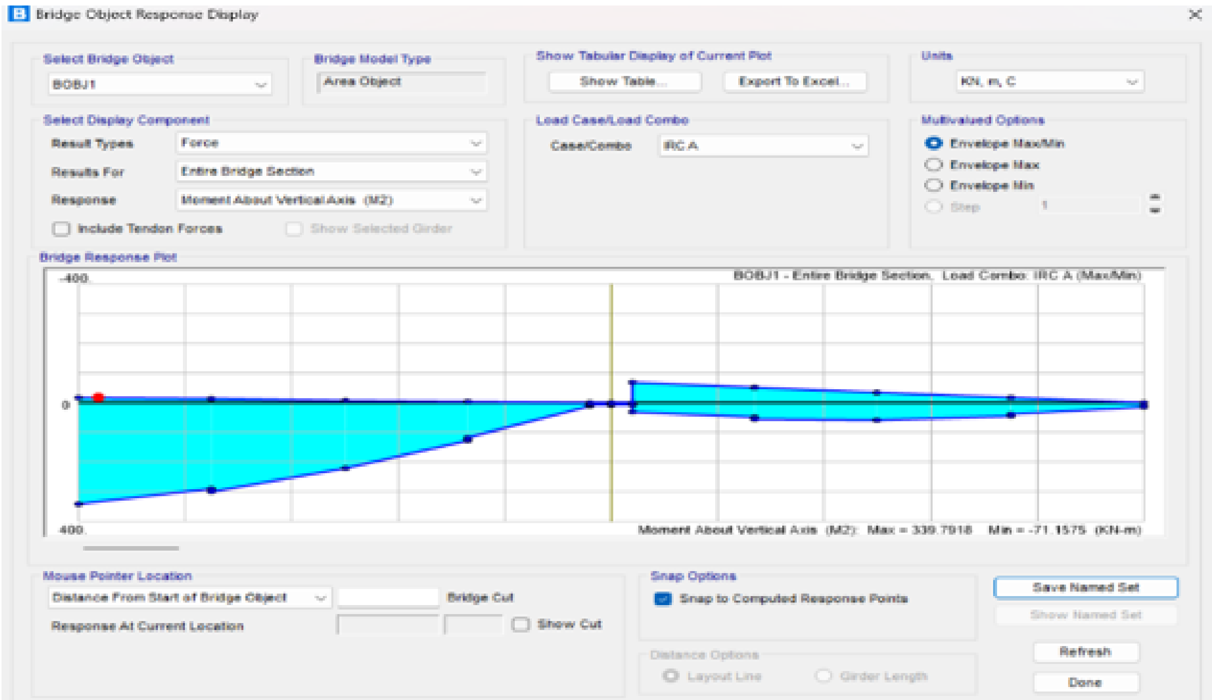

Figure 6: Moment about vertical axis (IRC code)

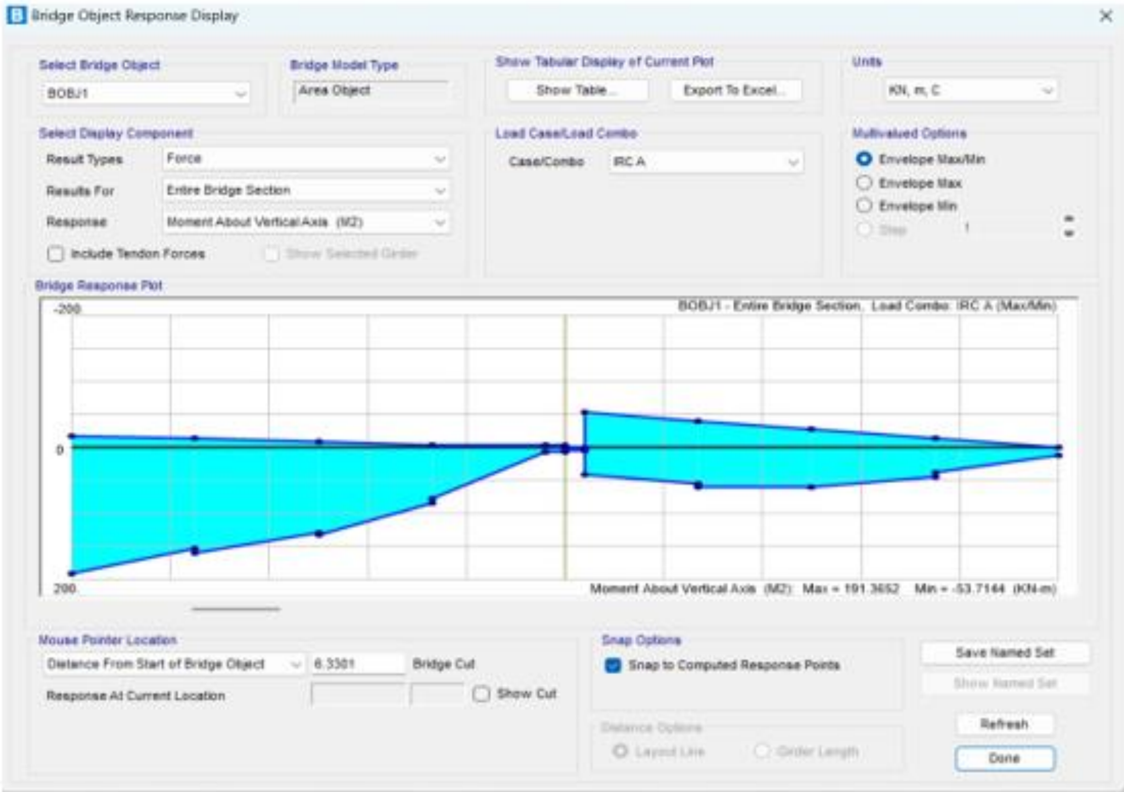

Figure 7: Moment about vertical axis (AASHTO-LRFD)

Figure no. 8 and 9 below shows average longitudinal rotation of I-girder bridge. Analysis shows that IRC class A loading produces maximum average longitudinal rotation i.e. 4.194E-05 radians while AASHTO-LRFD loading generates 3.014E-05 radians.

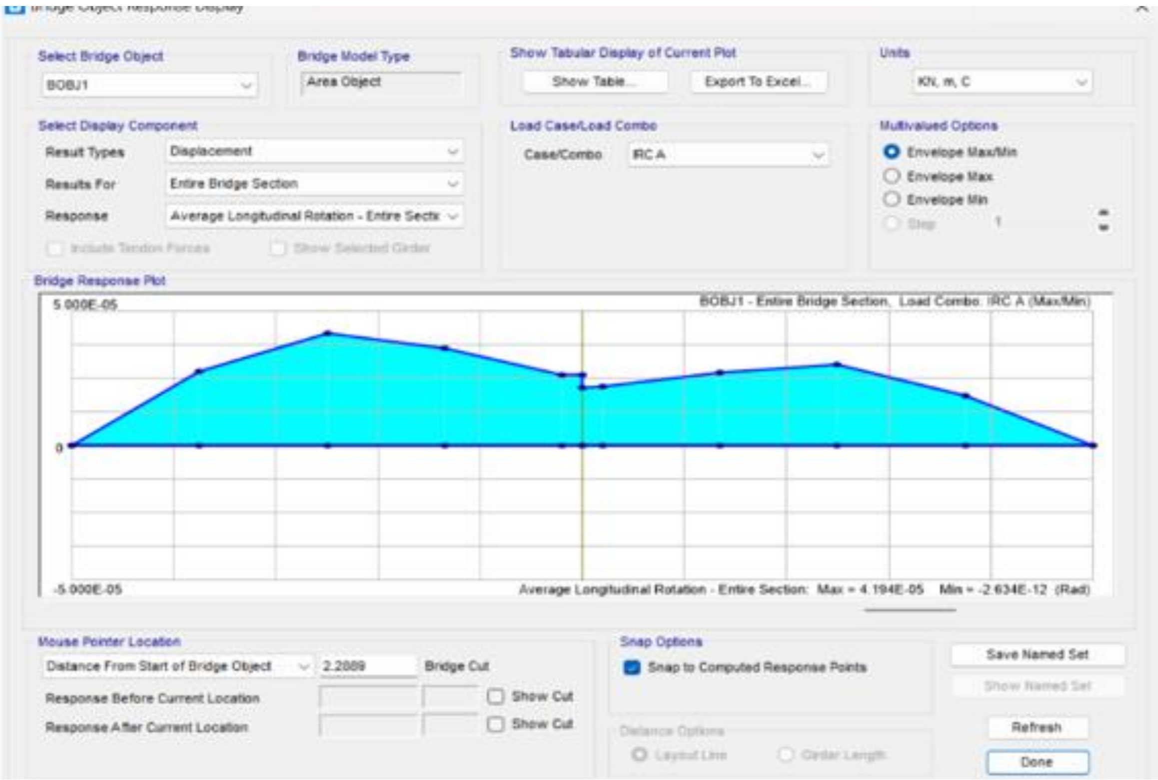

Figure 8: Average rotation (IRC code)

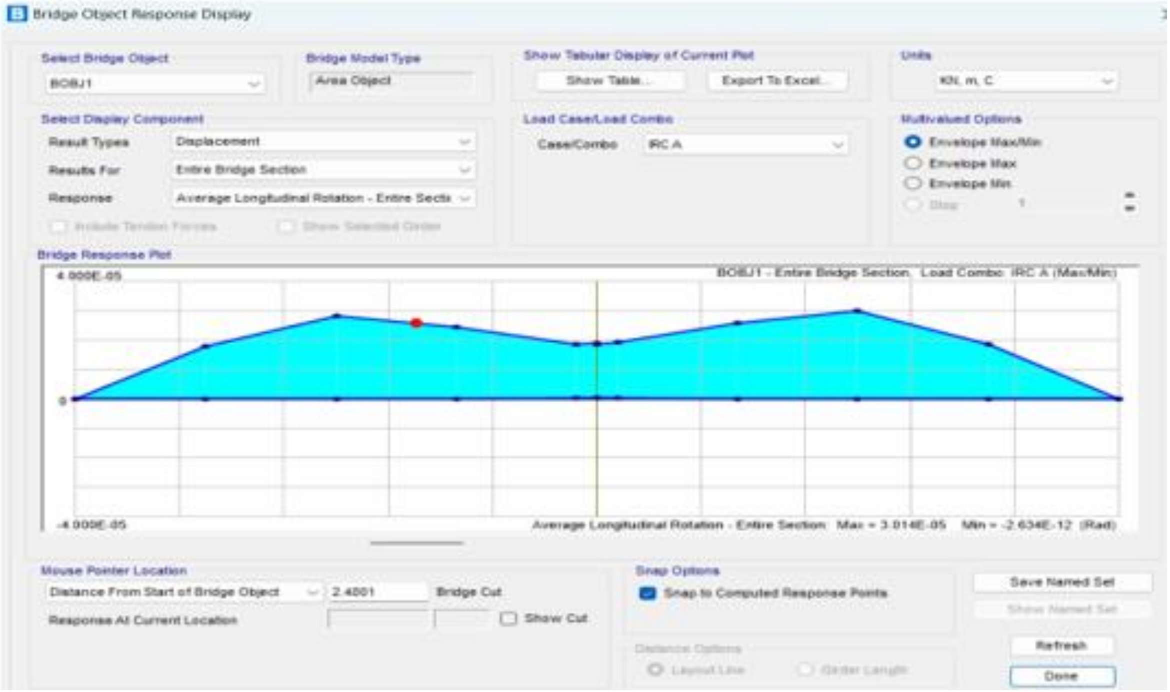

Figure 9: Average rotation (AASHTO-LRFD)

Table 1. Comparison of Responses

Items	IRC CODE	AASHTO LRFD
Max. bending moment at I- girder by live load (KN-m)	3225.75	3525.60
Max. shear force at I-girder by live load (KN)	1178.18	1281.74
Average rotation (Rad)	4.194E-05	3.014E-05

IV. CONCLUSION

There may exist variations in the structural criteria employed for the construction of bridges, as different countries have adopted their own bridge design codes. Consequently, the comprehensive analysis of the I-Girder Bridge in CSiBridge 2020 v21.1.0 takes into account two bridge design codes in order to generate a comparative assessment of structural parameters. In terms of loading and design methods, IRC codes demonstrate a superior combination when compared to AASTHO specifications. The utilization of IRC codes for the design of bridge girders results in minimal deflection and bending moment, making IRC class AA and 70R loading the most cost-effective and optimal choice for bridge girder design in India.

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