OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

# Analysis and Design of Steel I-Girder Bridge Using CSI-Bridge Software

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***Abstract: This research investigates the analysis and design of a Steel I-Girder Bridge using CSI-Bridge software, in accordance with IRC and AASHTO codes. A two-span composite bridge of 40 meters is modeled, incorporating detailed material properties, vehicle classes, and standard load combinations. The structural behavior is examined in terms of bending moments, shear forces, axial forces, stress distribution, and torsional effects for varying span lengths and concrete grades (M30, M35, M40). Results indicate that increasing concrete grade improves performance by reducing bending moments and stress levels. IRC loading yielded higher stress values compared to AASHTO, making it more conservative. The use of CSI-Bridge software enhanced design accuracy, reducing manual effort and time.***

***Keywords: Steel I-Girder Bridge, CSI-Bridge Software, IRC Loading, Bending Moment, Torsional Analysis, Structural Design***

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## I. INTRODUCTION

Bridge has mainly two sections the superstructure and the substructure. The superstructure has deck slab, I-Girder and shear connectors though substructure has of the footer, stem and the cap. Composite construction consists of two unique materials which are strongly bound to form a solitary unit.

"Composite" implies that the concrete portion of the deck is associated with the steel portion of the bridge by shear connectors [iv]. Shear connectors are fundamentally fixed on steel beams and then they are embodied in the concrete slab. Shear connectors can be associated by welding, or utilizing nut and bolts [v].A steel beam which is assembled composite by utilizing the shear connectors and concrete which is more strong and stiff as compared to beam. A bridge is a structure which provides a passage over an obstacle without closing the way beneath. There are six basic forms of bridge structures: beam bridges, truss bridges, arch bridges, cantilever bridges, suspension bridges and cable stayed bridges.

The importance of composite bridges has increased significantly due to their cost-effectiveness, reduced self-weight, improved performance, and construction efficiency. The superstructure typically consists of steel I-girders, cross girders, deck slabs, and shear connectors, while the substructure includes abutments, piers, and foundations. With modern software tools such as CSI-Bridge, engineers can simulate real-life loading conditions, perform parametric studies, and generate detailed structural responses with a high degree of precision. This research focuses on the analysis and design of a two-span steel I-girder bridge using CSI-Bridge software. The modeling process includes the incorporation of Indian Road Congress (IRC) and American Association of State Highway and Transportation Officials (AASHTO) design codes. Key objectives include the evaluation of bending moments, shear forces, axial stresses, and torsional effects across various span lengths and concrete grades. This investigation also compares the influence of IRC and AASHTO loading on the structural response of the bridge, providing insights into code-specific performance standards.

## II.OBJECTIVE

**The main objectives of this study are –**

- To review the modeling of the bridge using CSI-BRIDGE 2000 (software) and establish an object based modeling approach. It assigns bridge composition as an assembly of objects.

- Application of load and its combination to further analyze the bending moment and shear force. Software gives different building code (AASTHO, IRC), by using those vehicle, wind, seismic loading can be calculated.

- To determine all the variables of design, construction and material relative to the basic structural calculations.

## III.METHODOLOGY AND MODELLING APPROACH

### 3.1 Standard Specification For Loading Using IRC

- IRC Class AA loading: - Within certain municipal limits in certain existing or industrial areas, in other indicated zones and along certain predefined roadways this loading is adopted. In order to design Bridge for class AA loading, it is ought to be checked for class A loading as well, Heavier stresses may be taken under class A loading under specific conditions.

- IRC class A loading: - On permanent bridges and culverts this loading is applied.

- IRC class B loading: - Temporary structure and bridges in specified areas this loading is adopted.

### 3.2 Load Combinations :-

- DL +(LL+IL)
- DL +(LL+IL)+ BRAKING LOAD
- DL +(LL+IL) + BRAKING LOAD + WIND LOAD
- DL + VLL
- DL+VLL+BRAKING LOAD
- DL+VLL+BRAKING LOAD +WIND LOAD

### 3.3 Modelling

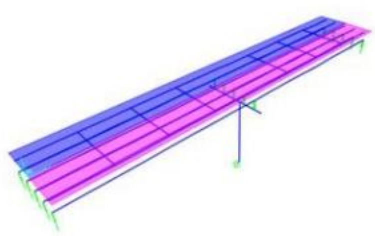

*Figure 3.1 Bridge Model*

### 3.4 Design Data :

TABLE 3.1 Material And Its Properties

| | | | |
|---|---|---|---|
| 1. | Characteristic strength | fck | 25 MPa |
| 2. | Permissible direct compressive strength | σc | 6.2 MPa |
| 3. | Permissible flexural compressive strength | σcbc | 8.3 MPa |
| 4. | Maximum permissible shear stress | τmax | 1.75 MPa |
| 5. | Permissible flexural tensile stress | σst | 200 MPa |
| 6. | Permissible direct compressive stress | σco | 170 MPa |
| 7. | Self weight of material concrete | | 24 kN/m$^3$ |
| 8. | Self weight of binder mix | | 22 kN/m$^3$ |

**TABLE3.2:Geometrical Properties**

| | | |
|---|---|---|
| 1. | Effective span of bridge | 40 m |
| 2. | Number of span | 2 |
| 3. | Number of longitudinal girders | 4 |
| 4. | Spacing of the girder | 1.8m |
| 5. | Overall depth of main girder | 0.2 m |
| 6. | Depth of kerb above the deck | 0.2 m |
| 7. | Number of cross girder | 3 |
| 8. | Spacing of cross girder | 0.5m |
| 9. | Thickness of wearing coat | 0.80 m |

TABLE 3.3 Bridge Width

| Layout Line Distance (L) | Shear Force (V) |
|---|---|
| m | kN |
| 0 | -36.907 |
| 5 | -36.907 |
| 10 | -36.907 |
| 15 | -36.907 |
| 20 | -36.907 |
| 25 | 36.907 |
| 30 | 36.907 |
| 35 | 36.907 |
| 40 | 36.907 |

## IV.RESULT AND DISCUSSION

### 4.1Shear Force of Entire Bridge

TABLE 4.1. Shear Force of Entire Bridge

| Layout Line Distance (L) | Shear Force (V) |
|---|---|
| m | kN |
| 0 | -36.907 |
| 5 | -36.907 |
| 10 | -36.907 |
| 15 | -36.907 |
| 20 | -36.907 |
| 25 | 36.907 |
| 30 | 36.907 |
| 35 | 36.907 |
| 40 | 36.907 |

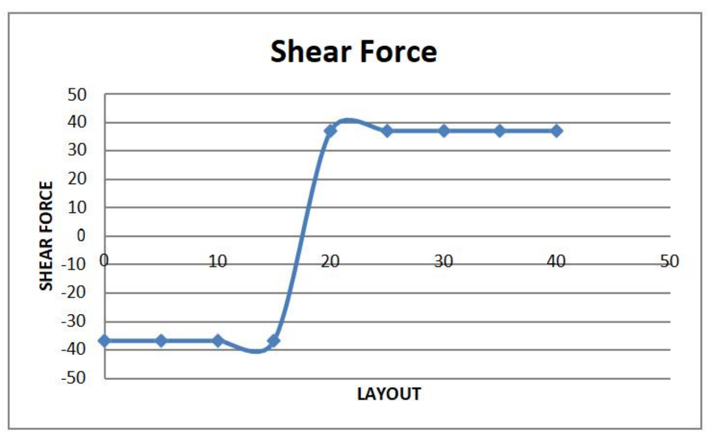


Figure 4.1. Shear Force

### 4.2Bending Moment of Entire Bridge

TABLE 4.2 Bending Moment of Entire Bridge

Layout Line

| Layout Line Distance | Moment (M) |
|---|---|
| M | kN-m |
| 0 | -220.646 |
| 5 | 1966.252 |
| 10 | 2179.283 |
| 15 | 418.4461 |
| 20 | -3316.26 |
| 25 | 418.4461 |
| 30 | 2179.283 |
| 35 | 1966.252 |
| 40 | -220.646 |

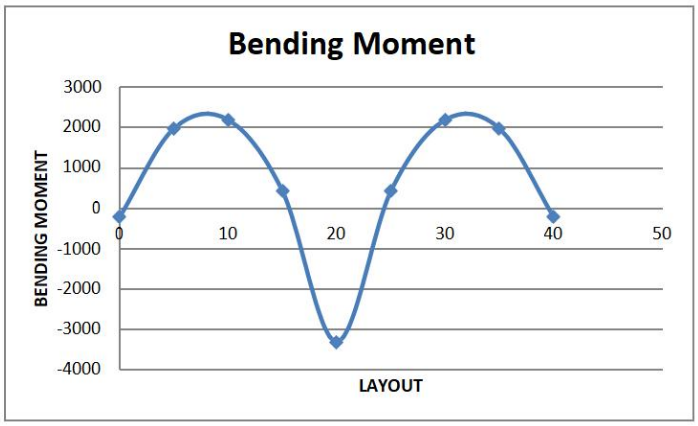


*Figure 4.2. Bending moment of entire bridge*

**4.3Axial Force and Shear Force at Different Girders**

The principal motive is to compare the shear force and bending moment using the AASHTO and IRC codes. We have considered two span Steel I- Girder Bridge having span of 20 m each. In AASHTO HL-93K and HL -93M and in IRC code class A loading is used. After analyzing as shown in the Figure 5.12, that axial force for IRC code is more than that of AASHTO code. In Figure 5.13, variation in shear force is explained in the graph.

**TABLE 4.3 Comparison of IRC and AASHTO codes**

| Forces | Left Ext. Girder | | Int. Girder 1 | | Int. Girder 2 | | Int. Girder 3 | | Right Ext. Girder | |
|---|---|---|---|---|---|---|---|---|---|---|
| | IRC | AASTHO | IRC | AASTHO | IRC | AASTHO | IRC | AASTHO | IRC | AASTHO |
| Axial Force | 61.14 | 6.19 | 68.54 | 34.26 | 65.884 | 49.96 | 96.084 | 34.26 | 77.5 | 6.91 |
| Shear Force | 126.60 | 78.486 | 179.47 | 98.85 | 232.401 | 125.63 | 218.429 | 125.634 | 168.324 | 78.48 |

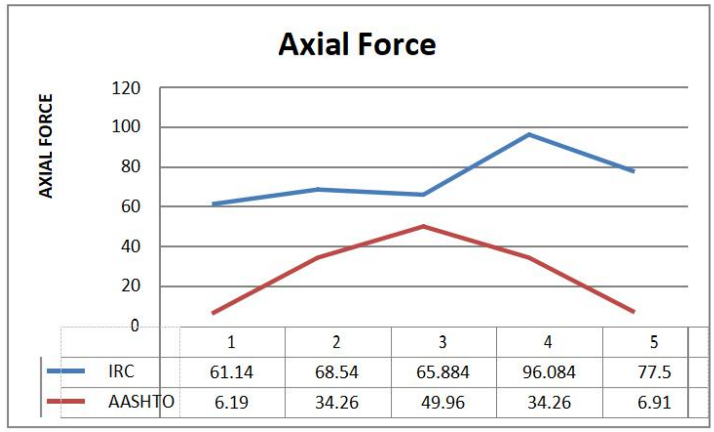


*Figure 4.3 Comparison of Axial force For IRC and AASHTO codes*

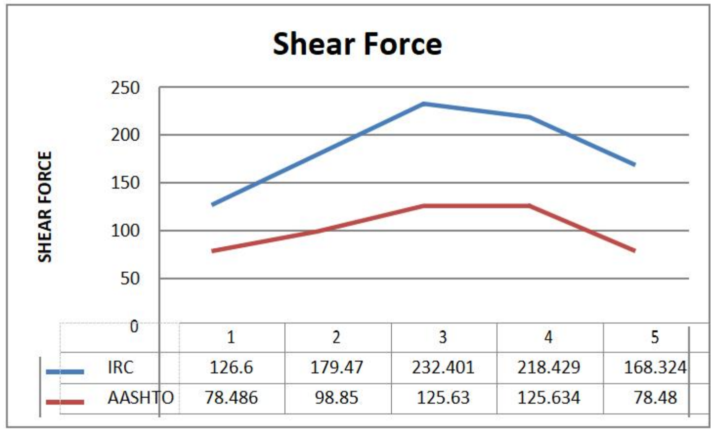


*Figure 4.4 Comparison of Shear Force for IRC and AASHTO codes*

## V.CONCLUSION

Therefore, the different trial sections were taken in order to calculate the bending moments and deflections. However, some conclusions were drawn as follow.

1. Bending moment increases with span length but decreases with the increase in concrete grade, highlighting the importance of selecting optimal material strength for long-span bridges.

2. Comparative analysis between IRC and AASHTO codes revealed that IRC loading induces higher axial and shear forces across all girders, indicating more conservative design demands under Indian standards.

3. Through the graphical and tabulated data, it was evident that manual calculations aligned closely with software analysis, validating the reliability of CSI-Bridge for practical structural bridge design applications.

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