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Analysis of Eccentrically Braced Steel Bridge

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ABSTRACT

Bridges are a key component in any road network for infrastructure development. For use of steel bridges become popular for the reason that of its stability, economy, serviceability, aesthetic appearance and structural competence. Analysis of steel structure bridges are carried out using relevant IRC codes and IS codes. The bridge deck is analyzed by using STAAD Pro Software. Themembers are designed for maximum shear forces & bending moment. The present study Eccentric and Concentric bracing system has been investigated for mild Steel (Fe250) Bridge structure by using STAAD Pro Software, the span of bridge 6m and length of bridge18m. Design & Analyzed result obtained in STAAD pro software for efficient bracing system. The aim of present study is to compare seismic performance of eccentric bracing and concentric bracing steel Bridge with different locations of bracing. All frames are designed under same gravityloading. STAAD Pro software is used and the results are compared. The aim of present study is to compare seismic performance of eccentric bracing and concentric bracing steel Bridge with different locations of bracing. All frames are designed under same gravityloading. STAAD Pro software is used and the results are compared.
The results were obtained in the form of Lateral story displacement, Base shear and total weight.

***Keywords:* Bracing system, eccentric bracing, lateral storey displacement, Base share and Total Weights.**

1. INTRODUCTION

A steel bridge is a type of bridge structure primarily constructed using steel as the primary material for its components. Steel bridges are prevalent in modern civil engineering due to the material's high strength, durability, and versatility. These bridges can be found in various forms, designed to span different types of obstacles, including rivers, valleys, roads, or other geographical features.
The components of a steel bridge typically include steel beams, trusses, girders, and plates. The choice of the specific design depends on factors such as the length of the span, the expected load-bearing requirements, and the environmental conditions of the site.

1.1 Bracing

Steel bracing is a structural component used in buildings and other structures to provide stability and resist lateral forces such as wind or seismic loads. Bracing is essential for maintaining the overall integrity and stability of a structure, particularly in tall or slender buildings. Steel is often chosen for bracing systems due to its high strength, ductility, and ease of fabrication.

1.2 Two different kinds of bracing systems exist.

- The Concentric Bracing System and
- The Eccentric Bracing System

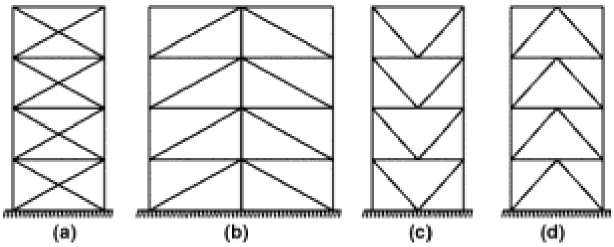

Fig -1: Concentric Bracing

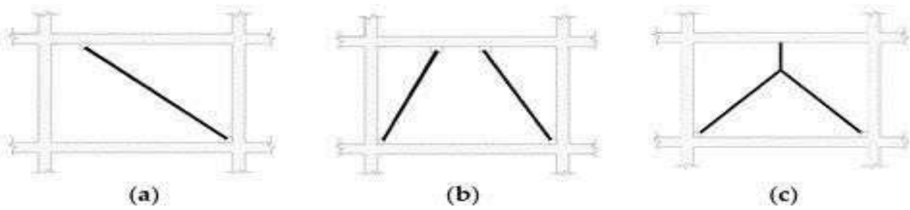

Fig -2 Eccentric Bracing

1.3 Aim:
The aim of this study to analyze Eccentrically Braced steel Bridge structure by using different type of loading to achieve the most economical and stable structure.

1.4 Objective:

- To analysis and design of steel Bridge structures by using Staad Pro Software.
- To analyze the result obtained in Staad Pro for efficient bracing system and behavior of steel Bridge structure in different load conditions.
- To Compare concentrically and eccentrically placed lateral load resistingsystems at different locations.
- To compare various structural behavior like Lateral displacement, Base shear, Total weight

2. METHODOLOGY

Finite Element analysis is advantageous for structures that experience considerable influence from modes other than the fundamental mode. By employing the finite element method, the response of a system with numerous degrees of freedom is represented. This involves integrating the modal responses, which are acquired from the spectral analysis of distinct single-degree-of-freedom systems, in order to assess the overall response. A modal analysis is performed to investigate the structural response of a structure to a certain ground motion. However, it is customary to also use a finite element in combination with this approach .

2.1 Standard Protocol for IRC-Based Loading
1. IRC Class AA loading: - This loading is adopted within certain municipal bounds, in specific existing or industrial districts, in other stated zones, and along specific established routes. Bridges should be assessed for class A loading as well as class AA loading when they are designed. Under some circumstances, heavier strains may be accepted under class A loading.
2. IRC class "A" loading: This loading is used on culverts and permanent bridges.

2.2 Seismic Base Shear
$Vb = Ah \text{ x } W$
Where, Ah is the design horizontal acceleration spectrum and W is the seismic weight of building

2.3 Seismic Coefficient of Design Horizontal
$$Ah = \left(\frac{Z}{2}\right) \text{ x } \left(\frac{I}{R}\right) \text{ x } \left(\frac{Sa}{2g}\right)$$

2.4 Load Types
Dead load (DL), LL: Live load, EQ: Earthquake magnitude, Wind Load (WL)

3. PROBLEM STATEMENT:

Analyze the Steel bridge structure, considering the length of the bridge 21m, width as 6m and overall height of the bridge is 8m. It is assumed that the foundation stratum for the bridge is medium and available at 1m below ground level. The structure is analyzed for eccentric and concentric bracing. An earthquake and wind load is applied to a structure. The bridge with effective bracing is analyzed.

Table -1: Detail Features

Sr .No	Parameters	Values
1	Grade of steel	Steel Grade Fe-250
2	Plan Size	6m X 21m
3	The bridge's overall height	8m
4	Steel unit weight	78.50 kN/m^3
5	Ratio of Poisson	0.2-Concrete And 0.15-Steel
6	Adopted Code of Practice	IS800:2007 , IS1893:2002, IS875-part -III
7	Zone of Seismic for IS1893:2002	III
8	Importance Factor	1.5
9	Response Reduction Factor	5
10	Base Soil	Medium
11	Earthquake Load	As Per IS 1893-2016
12	Ductility Class	IS1893:2002 SMRF

3.1 IRC Load application

IRC Class A & IRC Class AA Load in applied on the bridge.

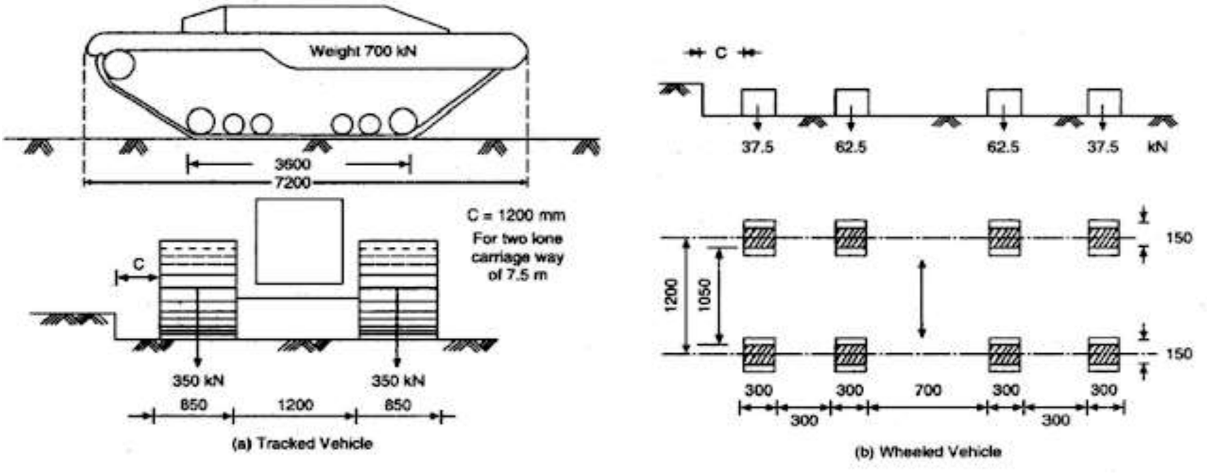

Fig -3: IRC Class AA loading and wheeled vehicles

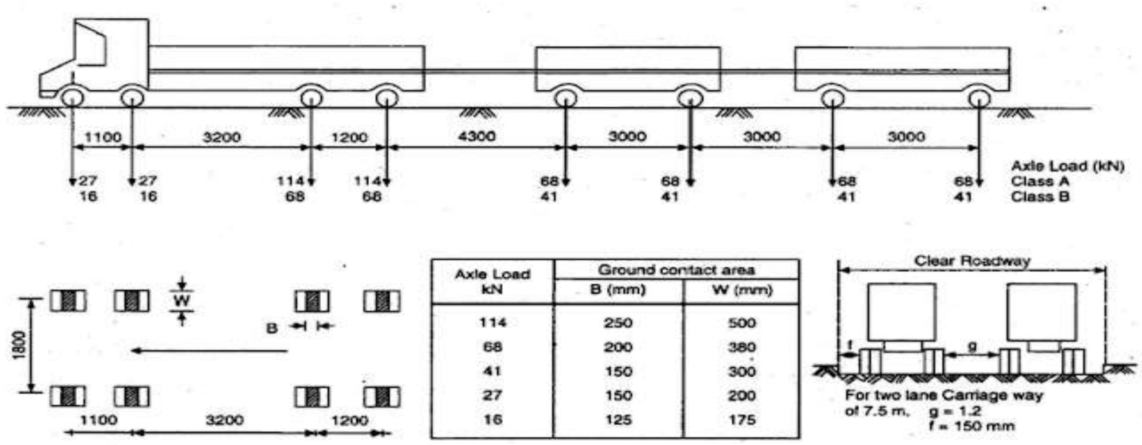

Fig -4: IRC Class A & B loading

4. RESULTS AND DISCUSSIONS

4.1 Displacement results for Class A & Class AA

MAX DISPLACEMENT mm			
ECCENTRIC		CONCENTRIC	
IRC CLASS AA	IRC CLASS A	IRC CLASS AA	IRC CLASS A
0.961	0.987	1.125	1.571

4.2 Base Shear result for Class A & Class AA

BASE SHEAR kN			
ECCENTRIC		CONCENTRIC	
IRC CLASS AA	IRC CLASS A	IRC CLASS AA	IRC CLASS A
131.5	102.9	139.52	128.1

4.3 Support reaction at Base

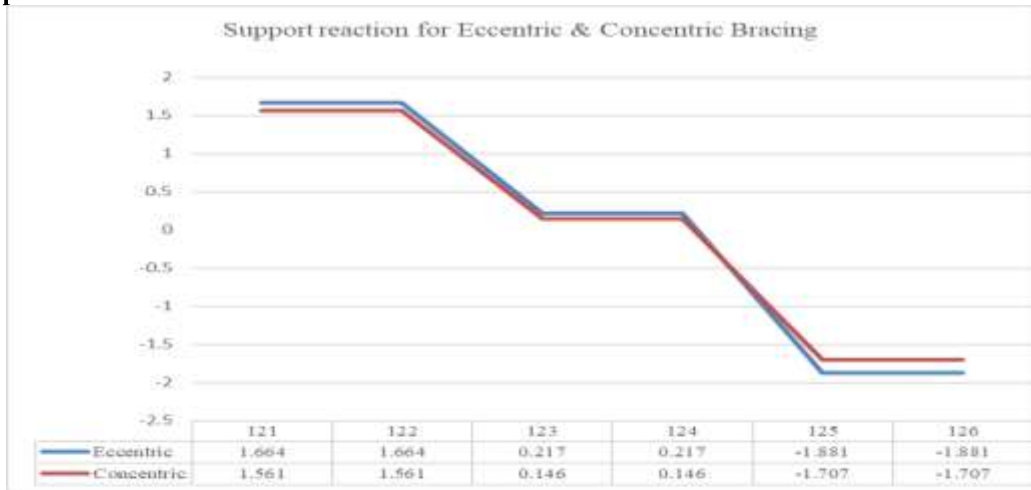

Fig -5: Eccentric Bracing

4.4 Weight Comparison

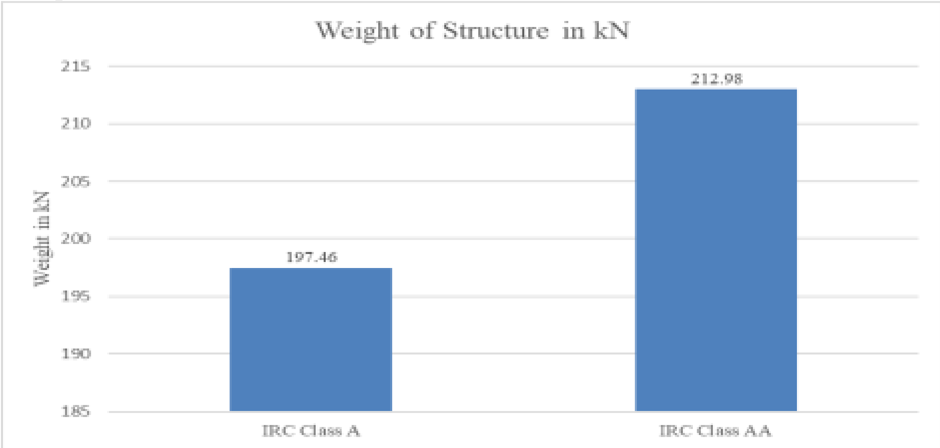

Fig -6: Weight Comparison

5 CONCLUSIONS

The structures are analyzed for earthquake zone III with Medium Soil and Results Compared using equivalent static analysis method. It has been made on different structural parameters viz. Base Shear, Maximum Displacement, Support Reactions Weight of Structure etc. Grounded on the analysis results following conclusions are drawn.

- Bridge Structure Analysis of “IRC class “A” loading” and “IRC Class AA loading” Conditions with concentric and eccentric bracing, the displacement results of Eccentric bracing for “A” class loading gives minimum displacement that is 59.16% as compared to Concentric Bracing for “A’ class loading & the displacement result of Eccentric bracing for “AA” class loading gives a minimum displacement that is 17.06% as compared to Concentric Bracing for “AA’ class loading. From the above result, it is clear that the Eccentric bracing gives minimum displacement with IRC Class A Loading because of greater energy dissipation, ductility, and a more efficient transfer of lateral forces compared to concentric bracing. Additionally, eccentric bracing combines the features of a moment frame and a concentrically braced frame. This makes eccentric bracing a favourable choice for seismic performance and overall structural integrity.
- Steel bridge structure, In "IRC class "A" loading" and "IRC class "AA" loading," IRC class A loading weighs 7.85% less than IRC Class AA Loading. Due to the severity of the IRC Class, A Loading is smaller than AA Loading.
- Base shear is highest in concentric bracing (139.52 kN) and lowest in eccentric bracing (102.9 kN). The cause behind it is the distribution of lateral pressures inside the structure. The concentric bracing configuration causes a less effective distribution of stresses than eccentric bracing, resulting in increased base shear.

6. REFERENCES

[1] Harsha Vardhan.G, A. Venkateswara Rao (2021) "Analysis and Design of Fly Over". International Conference on Advances in Civil Engineering (ICACE 2021) IOP Conf. Series: Materials Science and Engineering 1197 (2021) 012048 IOP Publishing doi:10.1088/1757-899X/1197/1/012048.

[2] Bharat Jeswani, Dilip Budhlani (2020) "Analysis And Design Of Bridge Component Using Staad Pro". International journal of creative research thoughts (IJCRT) © 2020 IJCRT | Volume 8, Issue 9 September 2020 | ISSN: 2320-2882.

[3] Mrs Tina Jose, Edwin Jolly, Eldho Stanly, Manu Biju, Mareetta Thaus (2021) "Structural Analysis and Reinforcement Design of a Simply Supported Bridge at Edayar using CSI Bridge Software". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 08 Issue: 09 | Sep 2021 www.irjet.net p-ISSN: 2395-0072.

[4] Viswanadham Rajesh, M.Vishnu Prasanna Kumar, R.Sai Charishma, K.Vijay Kumar, K.Vijay Babu. (2019). "Analysis And Design Of Prestressed Box Girder Bridge By Using CSI Bridge Software". © 2019 JETIR March 2019, Volume 6, Issue 3 www.jetir.org (ISSN-2349-5162).

[5] Praful Razdan "Analysis of Concentric and Eccentric Braced Steel Structures". Civil Engineering Department Delhi Technological University.

[6] M. A. Akinpelu, A. M. Salman and J. O. Adeiza (2022) "CSI bridge Modelling, Analysis and Design of Prestressed Concrete I-girder Bridge". Akinpelu USEP: Journal of Science and Engineering Production, Vol. 4, No. 1, 2022 et al pp386- 405 Tech Publications, Nigeria.

[7] D Naveen Kumar, S B Shankar Rao, P Mallesham (2016) "Design and Analysis of Bridge Design Using Sap 2000". International Journal of Research Sciences and Advanced Engineering [IJRSAE] TM Volume 2, Issue 16, PP: 266 - 277, OCT-DEC' 2016.

[8] S. Basilahamed (2018) "Comparative Analysis and Design of T Beam Bridge Deck by Courbon's Method and Finite Element Method". © 2018 JETIR August 2018, Volume 5, Issue 8 www.jetir.org (ISSN-2349-5162).

[9] Sonia S, S Devi, S Suresh Babu (2020) "ANALYSIS AND DESIGN OF STEEL BOX GIRDER BRIDGE USING TEKLA STRUCTURES". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072.

[10] Akshi Dhanotia (2018) "Analysis And Design Of Steel I-Girder Bridge Using Csi-Bridge Software". Jaypee University of Information Technology Waknaghat, Solan – 173 234 Himachal Pradesh, India.

[11] Abdul Rashid, P.Veerabhadra Rao (2017) "Analysis of Girder Bridge with IRC and IRS Loadings – A Comparative Study". International Journal of Innovative Research in Science, Engineering and Technology (A High Impact Factor & UGC Approved Journal) Website: www.ijirset.com Vol. 6, Issue 8, August 2017.

[12] Bharat Jeswani, Dilip Budhlani (2020) "ANALYSIS AND DESIGN OF BRIDGE COMPONENT USING STAAD PRO". International journal of creative research thoughts. www.ijcrt.org © 2020 IJCRT | Volume 8, Issue 9 September 2020 | ISSN: 2320-2882.

[13] Prof. Sanjay K. Bhadke, Ashay S. Shete (2021) "Comparative Design and Analysis of RCC T-Beam Bridge Superstructure for Different Codes & Load Combinations". © 2021 JETIR June 2021, Volume 8, Issue 6 www.jetir.org (ISSN-2349-5162).

[14] Gizachew Legesse Wakjira (2018) "Comparative Study Of Concentric And Eccentric Bracing System For Lateral Loads On High Rise Irregular Steel Building". A thesis submitted to the School of Graduate Studies in Partial fulfilment of the Requirements for the Degree of Master of Science in Structural Engineering.

[15] Mohd Mubeen, Khalid Nayaz Khan, Mohammed Idrees Khan (2015) "Seismic Analysis of Steel Frames With Eccentric Bracings Using Pushover Analysis". International Journal of Advanced Technology in Engineering and Science www.ijates.com Volume No.03, Issue No. 06, June 2015 ISSN (online): 2348 – 7550.

[16] C.C. Jacob (2014) "Eccentric Braced Frame System Performance". Research gate.