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Earthquake Analysis and Design of RCC Deck Type T Beam Bridges

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Abstract: Bridges are the structures which are constructed to connect the way separated by river or valley. In India, there are different codes which are used to design bridges. Each code have different design provisions and methods. This study IRC codes which are used to design bridges which is based on limit state method. In this study, three single span of T-beam bridge of 10m, 15m and 20m length are designed as per IRC codes and analyzed with the help of STAAD pro software for moving load & Seismic loads. The IRC Class AA loading is considered for applying the moving load where as the seismic load for different zones with different soil type are considered. It has be concluded that e more or less similarities were found in the results as the span increases the results also gets increased

Index Terms: T-beam Bridge, Slab Bridge, Class AA Loading, Staad pro, Seismic Analysis.

I. INTRODUCTION

A bridge is a structure built to span a physical obstacle (such as a body of water, valley, road, or rail) without blocking the way underneath. It is constructed for the purpose of providing passage over the obstacle, which is usually something that is otherwise difficult or impossible to cross. There are many different designs of bridges, each serving a particular purpose and applicable to different situations. Designs of bridges vary depending on factors such as the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, and the material used to make it, and the funds available to build it. Highway bridges have been designed and built since the advent of the wagon, and the general structure types used and described in this chapter are not likely to change. There are many areas where these structure types can be improved—hence the need for future research.

The research needs for highway bridges (and for that matter, bridges of all uses) fall into five general areas:

1) Optimize structural systems
2) Develop ways to extend service life
3) Develop systems to monitor bridge conditions
4) Develop details and methods to accelerate bridge construction
5) Develop a full life cycle approach to bridge data management

II. T- BEAM BRIDGES

T- beam bridges have cast-in-place, reinforced concrete beams with integral deck sections to either side of the tops of the beams. In cross section the beams are deeper than their deck sections, which produces the T-shape that gives them their names. The primary reinforcing steel is placed longitudinally in the bottom of the beam to resist the tension (the forces that would pull apart) on the beam. The deck that forms the top part of the T-shape is subject to compression (forces that squeeze or push it together). As concrete resists compression, it is concentrated in the deck along with less substantial reinforcing steel laid across the width of the bridge.

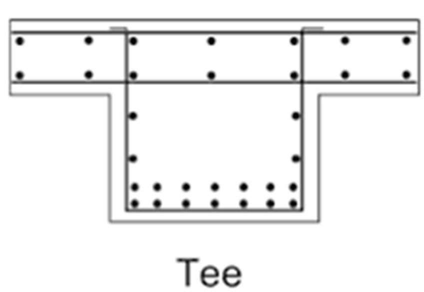

Figure 1:- Showing T-Beam Bridge

III. OBJECTIVES

The objectives of the present study are-

1) To analyse deck type T beam Slab Bridge.
2) Seismic analysis of deck type T beam slab bridges
3) Design the same with the help of STAAD Pro. software.

IV. METHODOLOGY

Below is the following methodology used.

1) Study of IRC Codes and IS codes for design & analysis of Bridge
2) Modelling of T-beam bridge on STAAD Pro Software.
3) Analyzing the Structure for moving Load & Seismic Load
4) Computing the result & comparing
5) Concluding the best type of bridge.

V. DETAILS OF THE STRUCTURE

This includes all the details required by the designer for carrying out analysis

1) Grade of concrete (Superstructure)-M30
2) Grade of steel-HYSD Bar as per IS 1786 Fy=500MPa
3) Length of Bridge- 30m
4) Span – 10m, 15m & 20 m
5) Overall Width – 12 m
6) Percentage of camber- 2.5%
7) Cover-75 mm for foundation and 40mm elsewhere
8) Nature of traffic (live load)

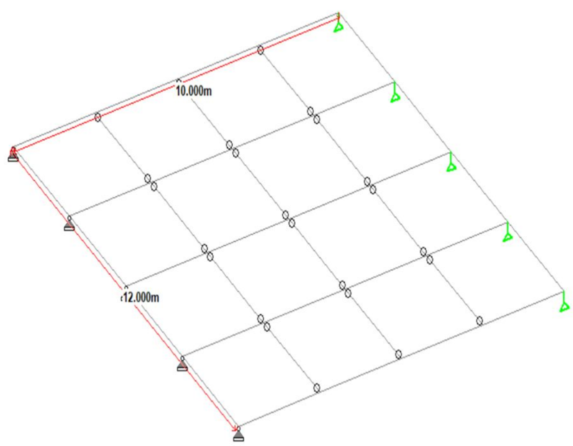

Figure 2:- Plan of T-beam bridge

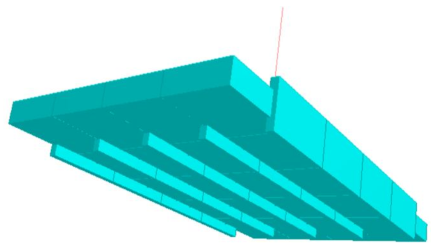

Figure 3:- 3D Model of T-Beam Bridge

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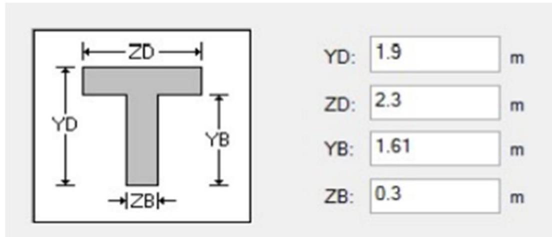

Figure 4:- Cross-section of T-beam bridge

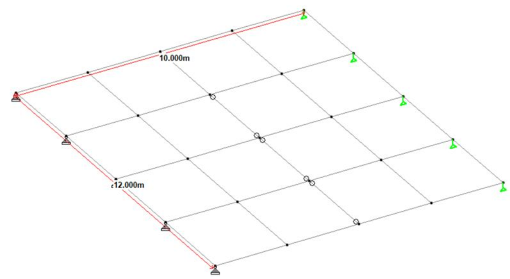

Figure 5:- Plan of Slab bridge

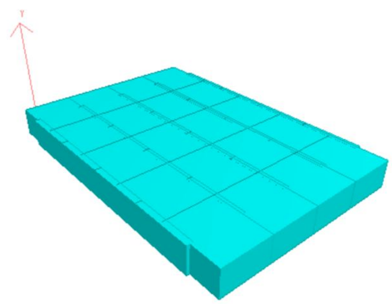

Figure 6:- 3D Model of Slab Bridge

VI. LOAD APPLIED

The Loads applied on the structure is

1) *Dead Load*
   a) Self-weight
   b) Crash Barrier Load: - 15.636 KN/m

2) *Moving Load:* As per IRC Class AA Loading

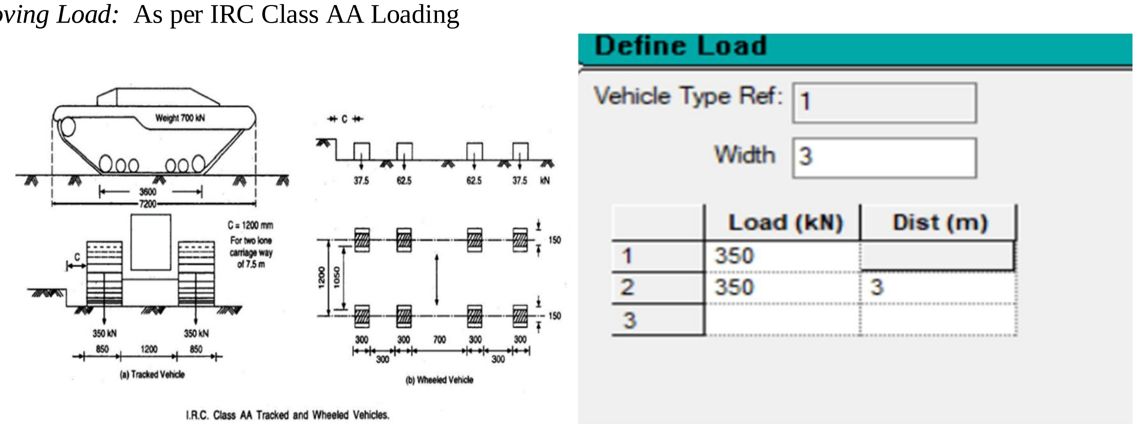

Figure 7:- Moving Load Applied on Staad Pro.

VII. SEISMIC LOAD PARAMETERS

The seismic parameters are applied as per IS 1893:2016

1) Zone: - Zone II, III, IV, V (Factor: 0.16)
2) Response Reduction Factor: - 5
3) Importance factor: - 1.5
4) Type of soil: - Hard Soil, Medium Soil, soft soi.
5) Type of Structure: - RCC structure.

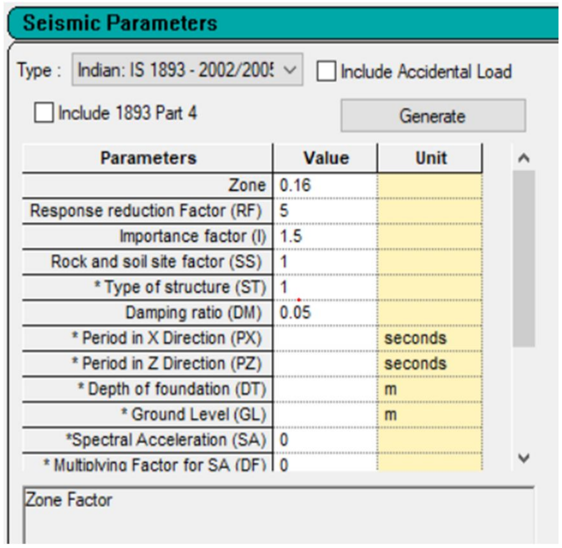

Figure 8:- Seismic Parameters applied in STAAD pro.

VIII. RESULTS

The following are the results obtained from the analysis of T-beam bride & Slab bridge.

1) Comparison of Maximum bending Moment

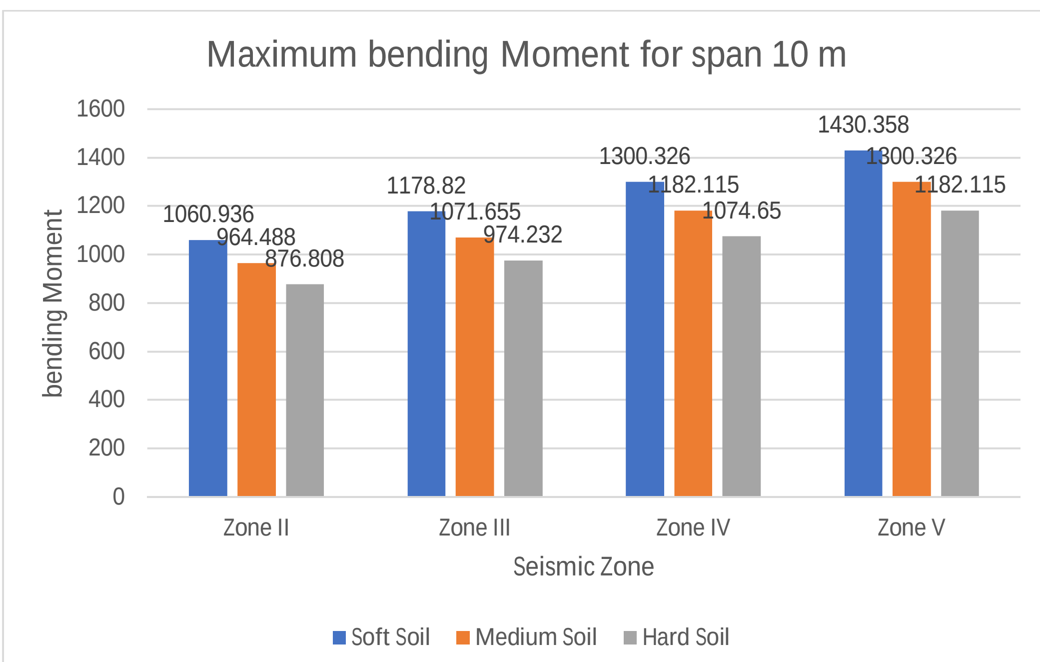

Figure 9:- Graph of Maximum bending Moment for span 10 m

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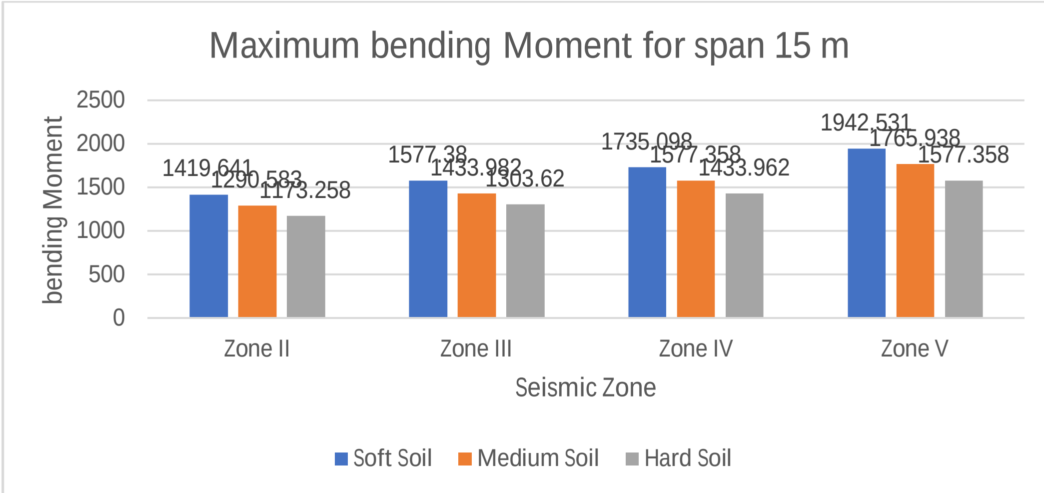

Figure 10:- Graph of Maximum bending Moment for span 15 m

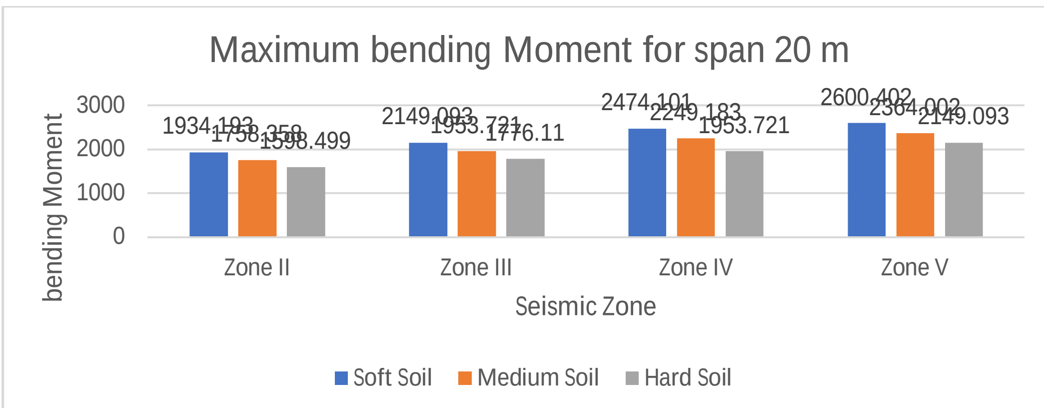

Figure 11:- Graph of Maximum bending Moment for span 20 m

2) Comparison of Maximum Shear force.

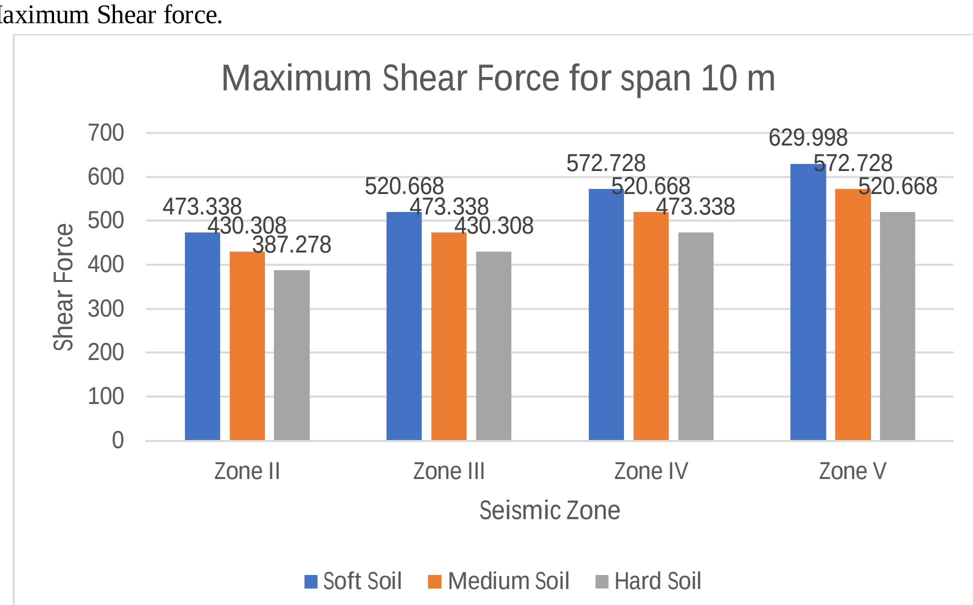

Figure 12:- Graph of Maximum Shear Force for span 10 m

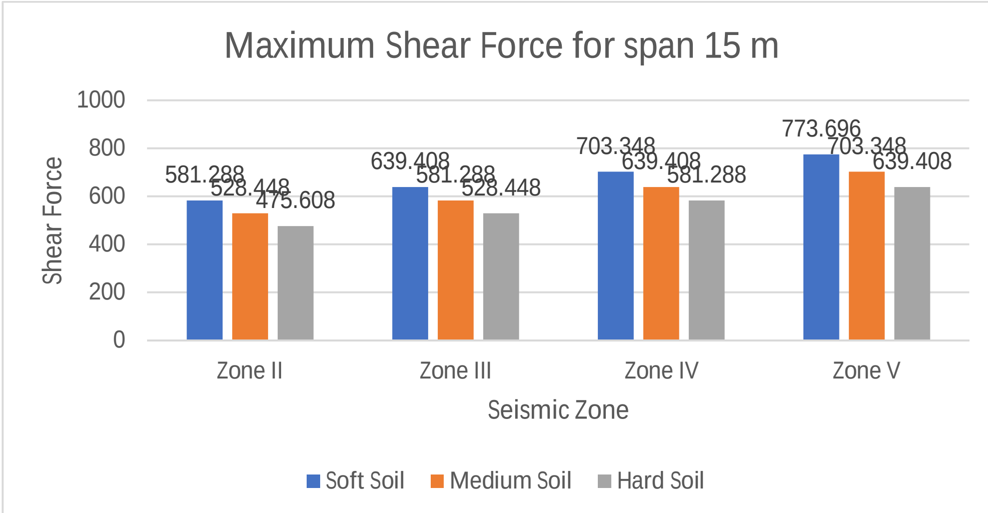

Figure 13:- Graph of Maximum Shear Force for span 15 m

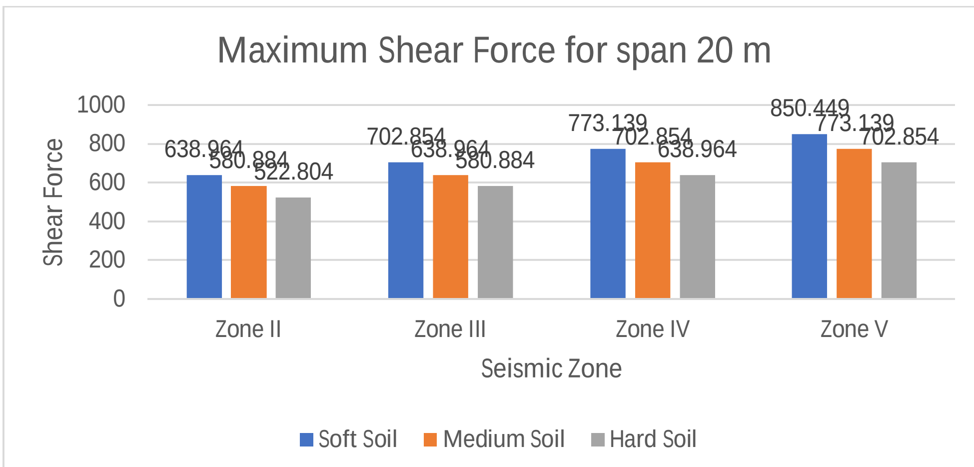

Figure 14:- Graph of Maximum Shear Force for span 20 m

3) Comparison of Deflection

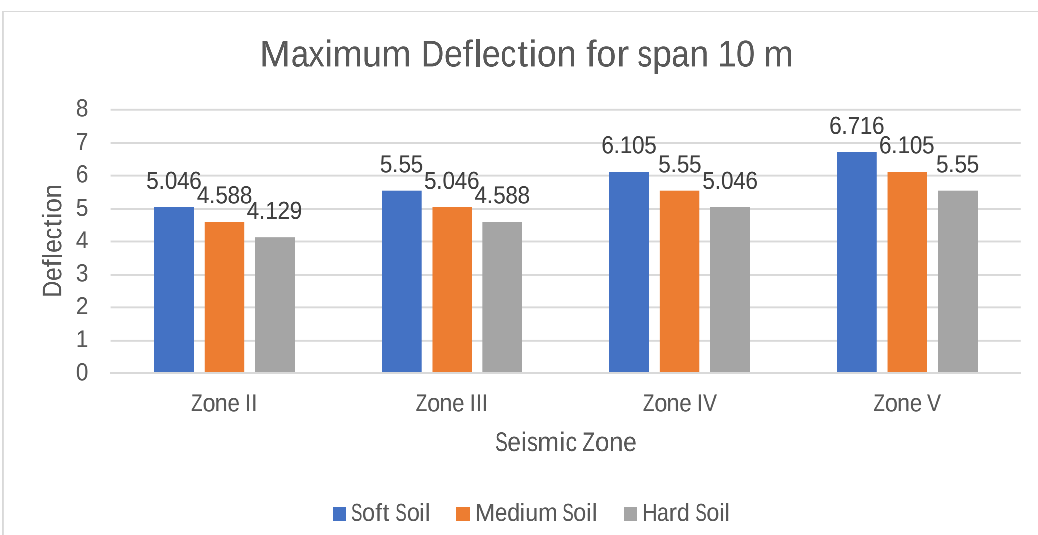

Figure 15:- Graph of Maximum Deflection for span 10 m

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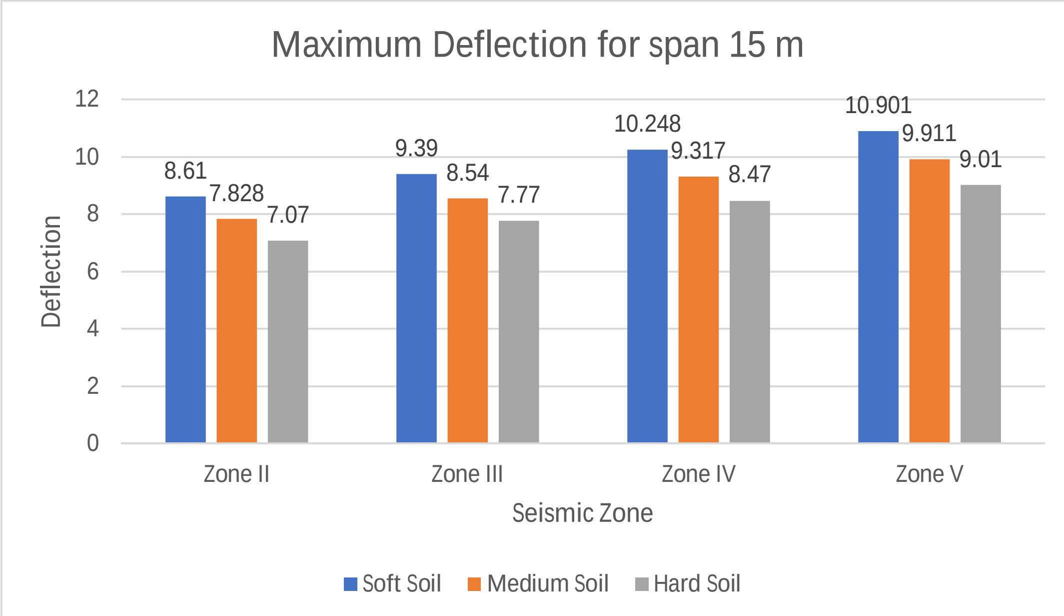


Figure 16:- Graph of Maximum Deflection for span 15 m

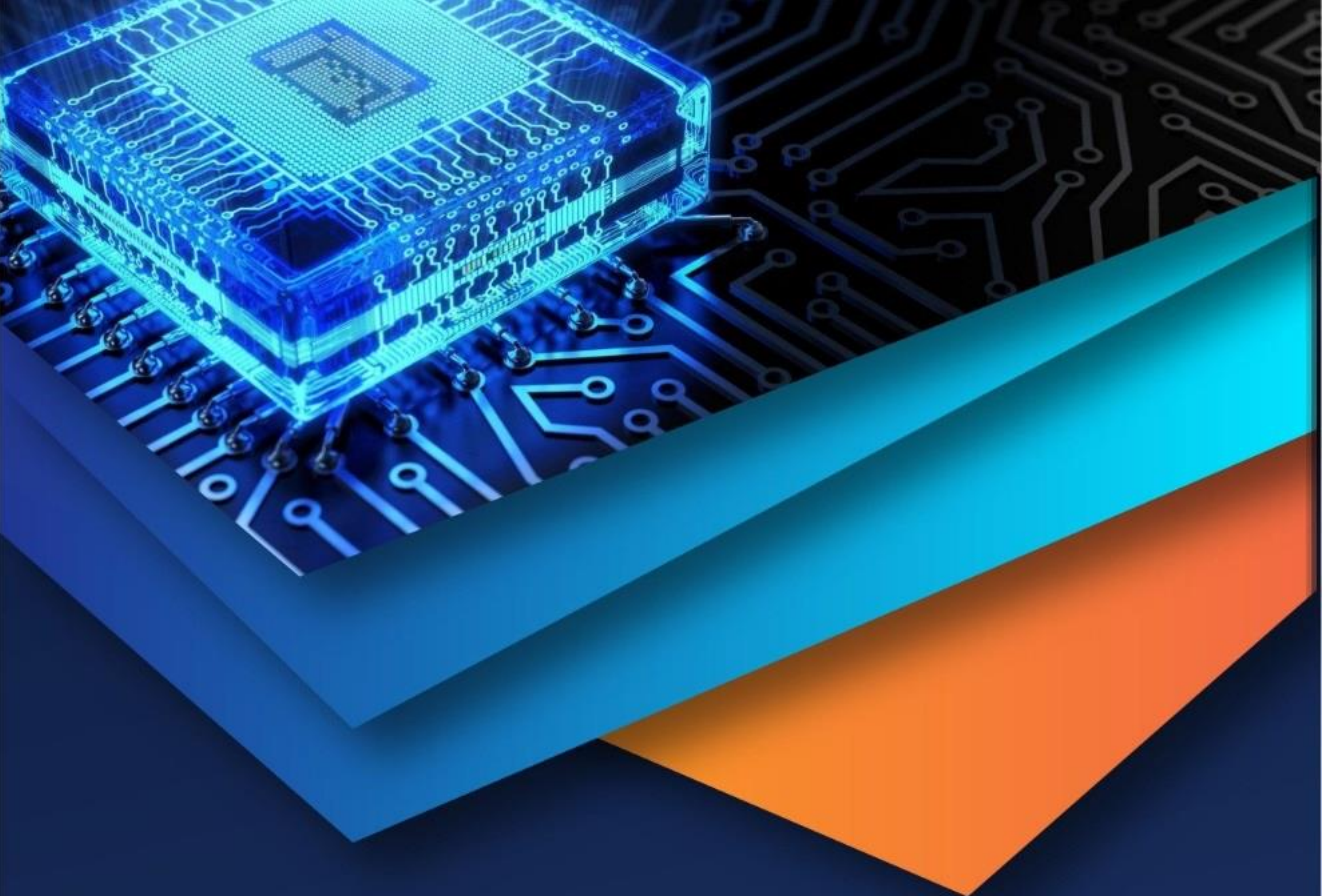
IX. CONCLUSION

After designing and analyzing the 10m, 15m and 20m single span of RCC T- beam bridge using IRC Class AA Loading, the results are compared. The models are compared toward every zone and different types of soil. All codes have varying design philosophy. Therefore, conclusions which are made from the above comparisons are as follow.

1) It can be seen from all the figs that Bending Moment for 10m span is less as compared to the 15m or 20m span
2) This same case implies for the all the result conditions in case or maximum shear force, maximum reaction force.
3) The variation in each span gives a difference of around 26 % for 15m and 40% for 20m span
4) The value of bending moment denotes the amount of steel reinforcement required in the bridge.
5) As the span increases the amount of steel reinforcement will also increase which can go around 20mm dia to 40mm dia
6) The shear forces denote the amount of shear reinforcement required for the structure if the amount of shear reinforcement decrease this will results in shear crack in bridge and results in collapse.
7) The amount of deflection gives a proper idea about the sagging when the span increases.
8) So, the overall length of bridge girder should be less to withstand the forces and to have a economical design.
9) As we start comparing the models of different zones and we move to zone II to zone III and so on the maximum bending moment goes on increasing.
10) Similarly, when we compare three different types of soil in a particular zone then the maximum bending moment is for soft soil and and minimum is for hard soil and it gets applied for all spans.
11) This same case implies for the all the result conditions in case or maximum shear force, maximum reaction force.

X. FUTURE SCOPE

A. Further the same study can be applied for the different types of bridges
B. Comparison can also be done on the basis of loading combinations and its effect on different parameters
C. Analysis can also be done using different software's like ETAB, SAAP
D. Analysis can also be done on the foundation of bridges
E. Comparisons on the effect of foundation in case of different zones
F. Comparisons on the effect of foundation in case of different types of soil



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