Performance of High Rise Steel Structure Against Seismic Forces for Different Soil Classes Using X-Bracings

Y. Abilash[1], K. Prudvi[2]

[1]M.Tech student, Structural Engineering, VITAM College of Engineering, Anandapuram, Visakhapatnam, India

[2]Assistant Professor, VITAM College of Engineering, Anandapuram, Visakhapatnam, India

Abstract: ***The most suitable choices in improvement of steel structures against lateral loading are to provide steel bracing system. The use of steel bracing has potential advantage over other scheme like higher strength and stiffness, economical, occupies less space, adds much less weight to existing structure. In this study, the analysis of a I-section building for 20storey +2Cellars +1Ground floor and plan area 38mx50m and Box-shaped type of Building for 20storey +2Cellars +1Ground floor and area of 44mx44m with outside panels are provided with X - bracings and the interior panels of the building are without bracings and for Beams ISMB 400, Columns ISHB 450 and for Bracing ISLB 100 are modeled of this problem using STAAD Pro-2007 software. For this purpose for different soil conditions is taken into consideration and results are obtained in STAAD PRO. The buildings are located in all four zones from zone-1 to zone-5 region.***

Keywords: Steel Bracing Systems, Joint Displacements, Storey Drift, X-Bracing, High rise steel structure buildings

1. Introduction

The tallness of a building is relative and cannot be defined in absolute terms either in relation to height or the number of stories. But, from a structural engineer's point of view the tall building or multi-storeyed building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent that they play an important role in the structural design.

In this study I used braced connections for the Simple and economic approach of bracings in braced frame system as a control system has been proposed. An effective and efficient a configuration of the bracings has been presented for the buildings structure. The proposed approach has been applied to both the 2D and 3D models of the building subjected to earthquake and wind excitation. The Safety of the structure mainly depends on the displacement and rotational response, while the comfort level of the occupants depends on the acceleration response. To ensure the structural safety and serviceability (Occupant's comfort), a multi objective optimal design strategy has been formulated to minimize the roof. Displacement, storey displacement, storey displacements, drift ratios, acceleration and base shear as response parameters of the Structures.

2. Objectives

Following are the objectives of this study.
1) To understand modeling of buildings/frame braced with and without bracing Staad pro 2007 Software.
2) The deflections for different shapes of buildings for different soil classification.
3) To study and determine the effect of aspect ratio of braced steel buildings to minimize the structural damage.
4) The responses of unbraced and braced models are investigated through the results and observations of steel building.

3. Literature Survey

Manish S. Takey, Prof. S.S Vidhale, presented a seismic Response of Steel Building with Linear Bracing System as a compare to the Reinforced cement concrete (RCC) the steel has got some important physical properties like the high strength per unit weight and ductility. The high yield and ultimate strength result in slender sections. Being ductile the steel structures give sufficient advance warning before failure by way of excessive deformations. These properties of steel are of very much vital in case of the seismic resistant design.

4. Methodology

In the present problem the 20storey +2Cellars +1 Ground building with steel elements as columns and beams, those building outside panels are provided with X - bracings and the interior panels of the building are without bracings are modeled of this problem. The model is prepared using STAAD Pro analysis software. All features like dead load, live load and seismic load. The loads on various structural components like vertical, horizontal and inclined members are evaluated and the members are designed as per the IS specifications. The node displacements of buildings having with and without bracings of earthquake effect of Zone II to Zone V for various soil conditions. By comparing nodal displacements for I-section type of building and Box-type section type of building.

4.1 Design Approach for Braced frame

1) Resisting lateral loads
2) Preventing Frame buckling and
3) Improving sway behavior.

4.2 Braced Frames

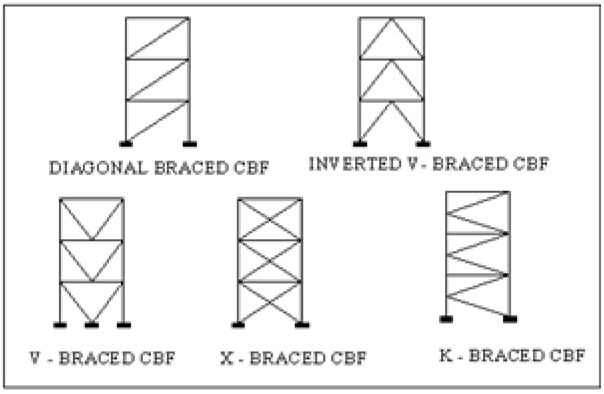

Figure 1: Types of concentrically braced frames

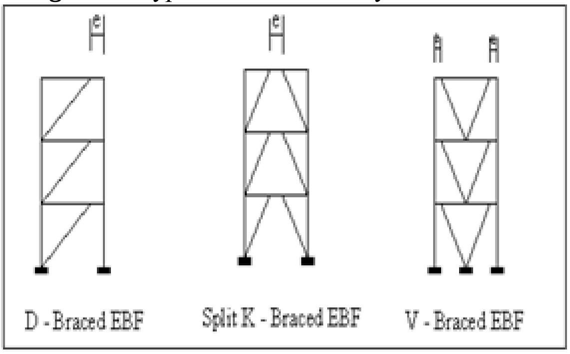

Figure 2: Types of Eccentrically Braced Frames

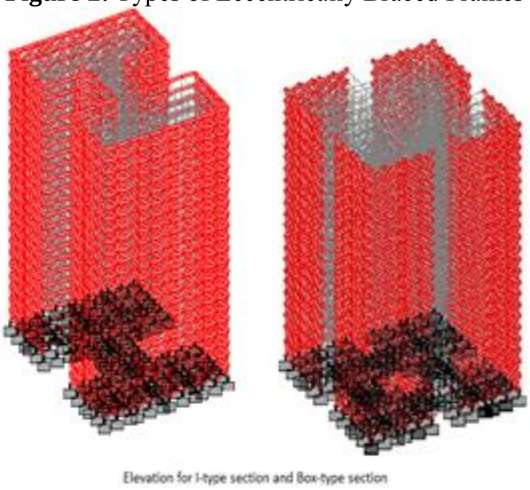

Figure 3: STAAD model with bracings isometric view for I-section and Box-type section

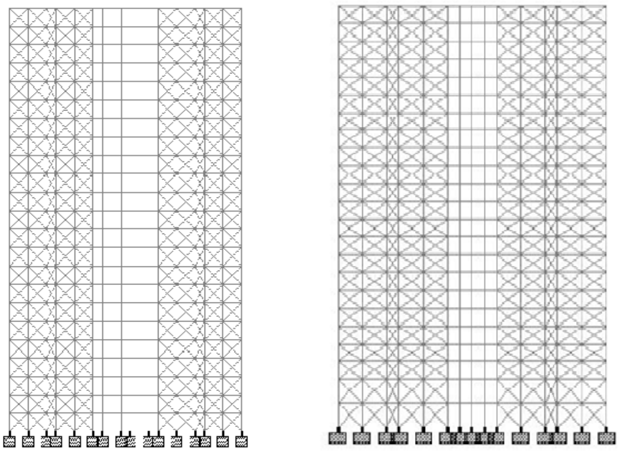

Figure 4: X-Bracing patterns for I-section type of building and for box section type of building elevation views

5. Structural Properties

- Columns: ISHB 450
- Beams: ISMB 400
- Bracing:ISLB100
- Slab: 150mm
- Span: 4.00m and 2.00m at corridor
- Floor height: 3.00m

6. Results

6.1 The variation of nodal displacements for zone-2 &5 soils conditions with and without bracings for I-section type building and box section type of building (soft soil) from STAAD Pro-2007 are shown below

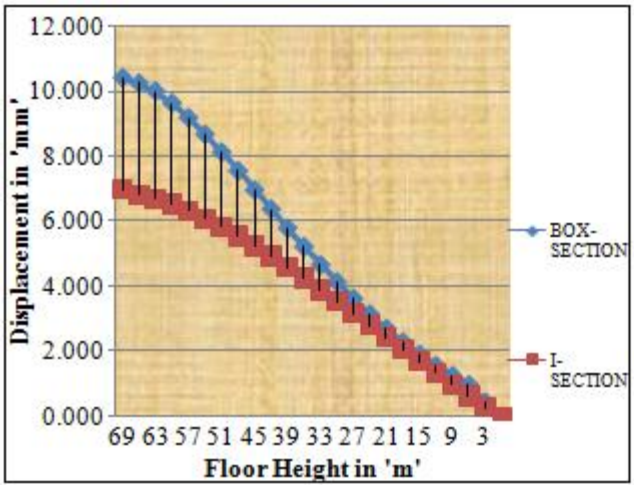

Figure 4: comparing I-section with Box type of section in zone-2 for finding node displacements with respect to heights for the column in z-direction for soft soil (without bracings)

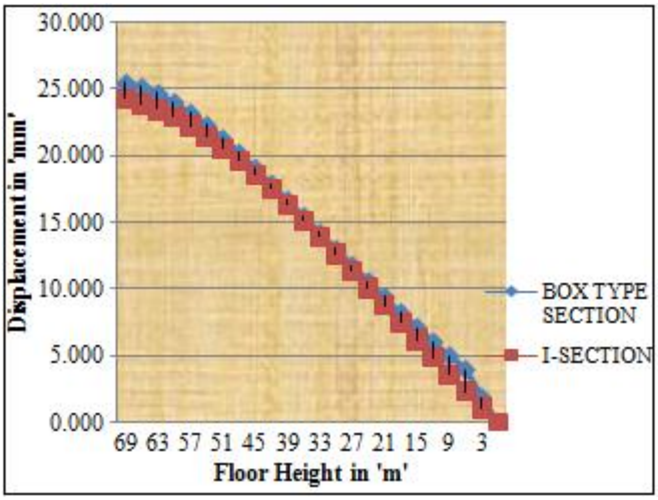

Figure 6: comparing I-section with box type of section in zone-5 for finding node displacements with respect to heights for the column in z-direction for soft soil (without bracings)

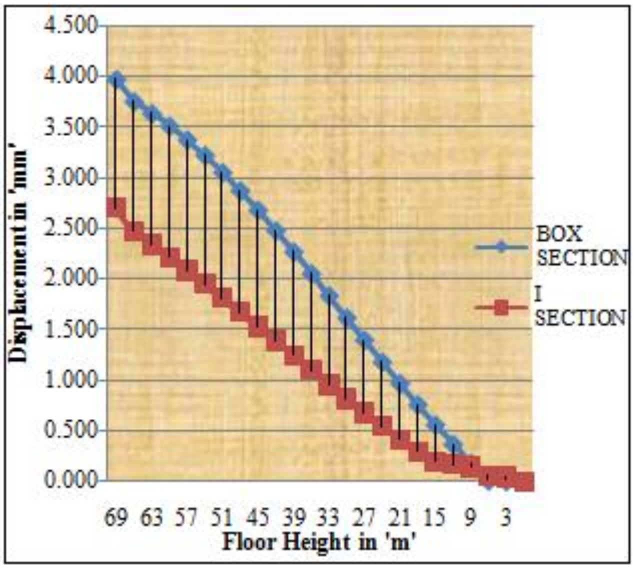

Figure 7: comparing I-section with Box type of section in zone2 for finding node displacements with respect to heights for the column in z-direction for soft soil (with bracings)

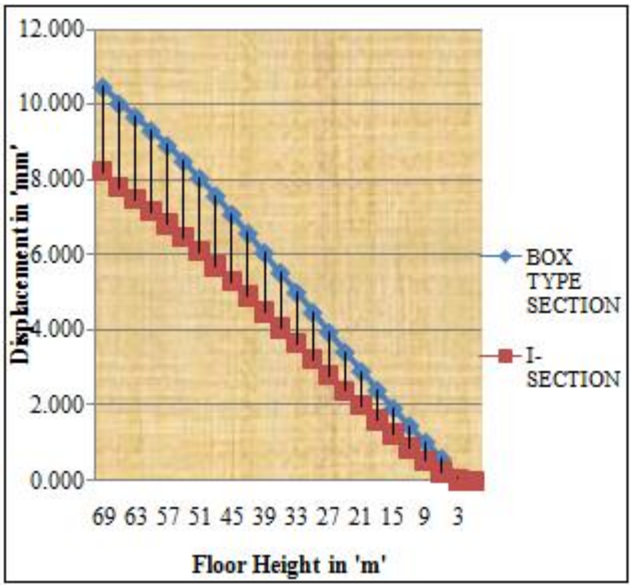

Figure 8: comparing I-section with Box type of section in zone-5 for finding node displacements with respect to heights for the column in z-direction for soft soil (with bracings)

6.2 The variation of nodal displacements for zone-2 &5 soils conditions with and without bracings for I-section type building and box section type of building (Hard soil)

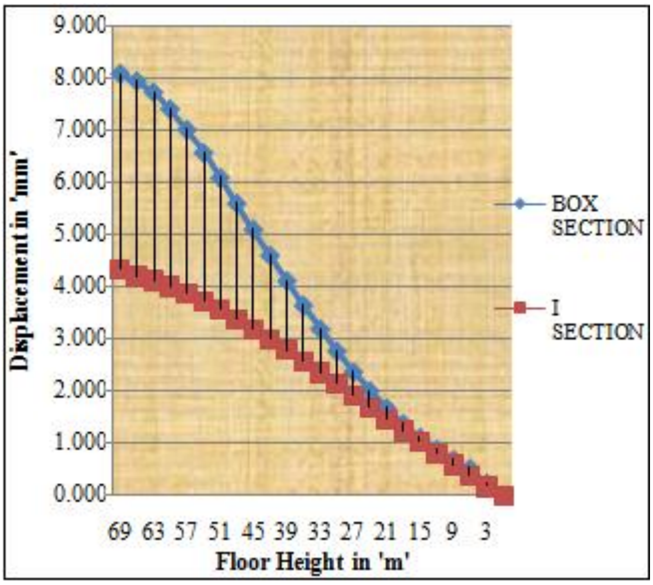

Figure 8: comparing I-section with Box type of section in zone-2 for finding node displacements with respect to heights for the column in z-direction for hard soil (without bracings)

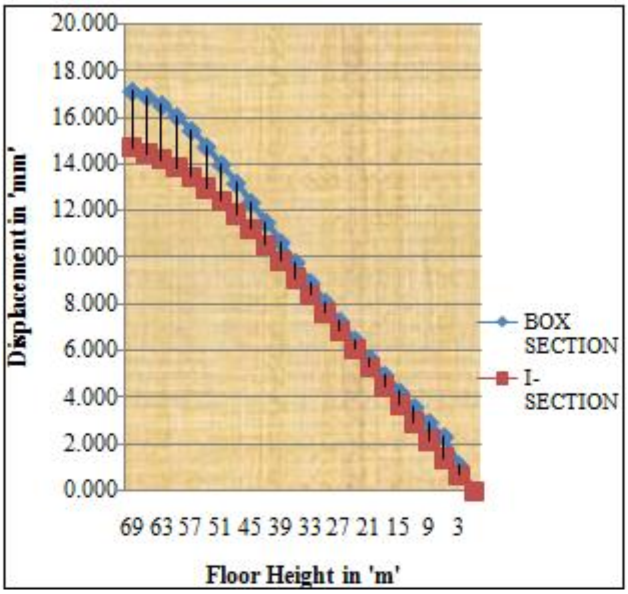

Figure 9: comparing I-section with Box type of section in zone-5 for finding node displacements with respect to heights for the column in z-direction for hard soil (without bracings)

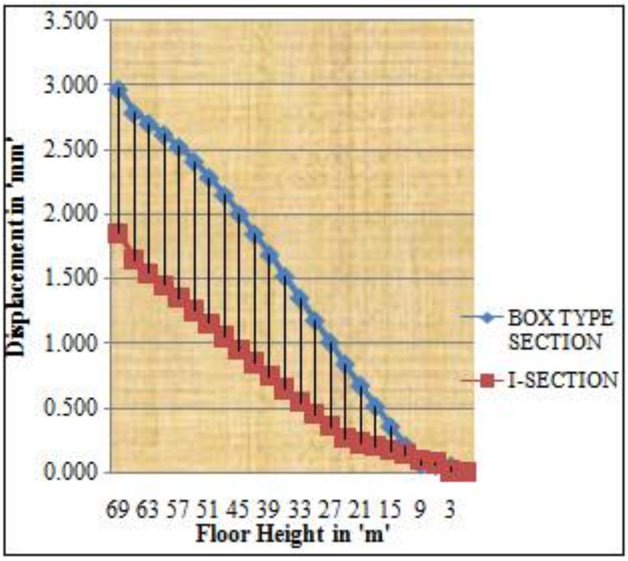

Figure 10: comparing I-section with Box type of section in zone-2 for finding node displacements with respect to heights for the column in z-direction for hard soil (with bracings)

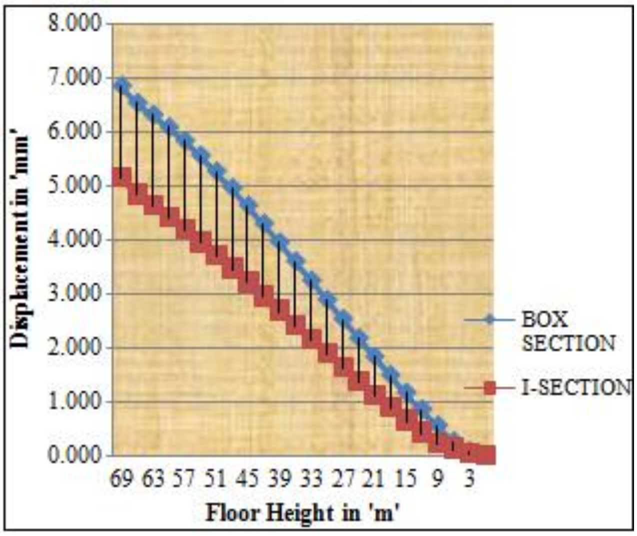

Figure 11: comparing I-section with Box type of section in zone-5 for finding node displacements with respect to heights for the column in z-direction for hard soil (with bracings)

6.3 Tables

Table 1: Comparison of Percentage Variation (%) Of Deformations for Box Section to I-Section by With and Without Bracing System (Soft Soil)

Comparison of Percentage Variation (%) of Deformations for Box Section To I-Section By With and Without Bracing System (Soft Soil)		
Zone's	With Bracing	Without Bracing
Zone-2	47.09	48.99
Zone-3	37.88	26.54
Zone-4	31.99	13.70
Zone-5	27.75	4.99

Table 2: Comparison of Percentage Variation (%) Of Deformations for Box Section to I-Section by With and Without Bracing System (Soft Soil)

Comparison of Percentage Variation (%) of Deformations for Box Section To I-Section By With and Without Bracing System (Hard Soil)		
Zone's	With Bracing	Without Bracing
Zone-2	60.31	87.15
Zone-3	48.08	51.54
Zone-4	39.71	30.84
Zone-5	33.38	16.63

7. Comparing Performance of Nodal Displacements for I-Section Building and Box Type Section Building

7.1 Nodal Displacements for Soft Soil

The Earth quake effect that nodal displacements in the exterior columns in Z-direction for unbraced structures and braced structures for I-section is low when compared Box section type of building for the soft soil conditions.

The percentage variation of nodal displacement is non-linear from bottom to top level for earth quake zones for unBracing system soft soil, at the top variation is 48.99% for zone-2 and 4.99% for zone-5.

The percentage variation of nodal displacement is non-linear from bottom to top level for earth quake zones for Braced system soft soil, at the top variation is 47.09% for zone-2 and 27.75% for zone-5.

7.2 Nodal Displacements for Hard Soil

The Earth quake effect that nodal displacements in the exterior columns in Z-direction for unbraced structures and braced structures for I-section is low when compared Box section type of building for the hard soil conditions.

The percentage variation of nodal displacement is non-linear from bottom to top level for earth quake zones for UnBracing system hard soil, at the top variation is 87.15% for zone-2 and 16.63% for zone-5.

The percentage variation of nodal displacement is non-linear from bottom to top level for earth quake zones for Braced system hard soil, at the top variation is 60.31% for zone-2 and 33.38% for zone-5.

8. Conclusion

1) In high rise buildings the stability can be achieved by suitably adding the dimensions of the external columns with diagonal X-bracings. Provision of X-bracings reduces the amount of displacements in structure.
2) The braced building of the storey displacement decreases as compared to the un braced building which indicates that the overall response of the building decreases.
3) The Earth Quake Effect that nodal displacement in Braced and Un Braced Structures by comparing with Loose Soil having the More Deflection than Hard Soil for Different Zones.

4) I-section type of buildings having lower displacements compared to Box section type of buildings for the different soil conditions.

9. Scope for Further Work

The present work is an approach to carry out to study the response of very large complicated tall structures with respect to different soil conditions. The work may be extended to aspects like condition monitoring of these structures due to moments and time period of earth quake motions. The following challenging case studies can be taken up with recent developments in finite element analysis and sap software.

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