Study on effective Seismic Retrofitting for high rise steel frame with Different shapes of steel section

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Abstract –The effective design & construction of earthquake resistant structure have much importance factor all over the world. Raipur is emerging as one of the most populated cities in recent years in Chhattisgarh state of India and demand of high rise steel structures which requires earthquake stability check. The object of the present paper is to compare the seismic behavior of multi-storey steel buildings without bracing systems and with bracing system such as diagonal bracing, X-bracing and V-bracing system having seismic regularities under seismic forces and for bracing using angle section tube section of same area in bracing system observe the effect on the parameters as Nodal displacement, Drift displacement and Drift ratio. For these purpose seven cases of G+8 steel structures were considered in different cases having without bracing and with diagonal bracing , X-bracing and V-bracing system, using angle section and tube section for bracing and also analyzed for seismic zone III by using STAAD Pro. Present paper provides good information on the result parameters lateral nodal displacement, drift displacement and drift ratio in the G+8 steel building having different types of bracing.

Key Words: Angle section, Tube section, Diagonal bracing, X-bracing, V-bracing, G+8, Seismic Zone-III, STAAD Pro, Nodal displacement, Drift displacement, Drift ratio

1. INTRODUCTION

In last decades steel structure plays an important role in the construction industry. It is necessary to design a structure to perform well under seismic load. Shear capacity of the structure can be increased by introducing steel bracing in the structural system. Steel section may be angle and tube. Bracing can be Retrofit as well. STAAD Pro stands for Structural Analysis and Design Program which is commonly used for civil engineering structural design. The case study in this paper mainly emphasizes on structural and seismic behavior of building for different bracing pattern such as Diagonal bracing, V-bracing and X-bracing. These bracing patterns use types of section such as angle and tube section. The modeling of G+8 storey moment resisting steel framed buildings is done on the STAAD Pro software for seismic analysis.

1.1 METHODS OF ANALYSIS

In the present paper, I.S. Code (1893:2016) based Dynamic Analysis (Response Spectrum Analysis) is performed. This study includes comparative study of behavior with and without bracing and also study the behavior of different types of bracing with angle section and tube section in steel structure. Following steps of methods of analysis are adopted in this study:

Step-1: Selection of models having without bracing and after with bracing model prepare which have different bracing pattern (Diagonal, X and V bracing) by using angle section and tube section.

Step-2: Selection of seismic zone. (III)

Step-3: Formation of load combination.

Step-4: Modeling of building frames Using STAAD Pro software.

Step-5: Analyses each models considering each load combinations for (7 Model Cases) by Response Spectrum Analysis.

Step-6: Comparative study of results in terms of nodal displacement Storey drifts ratio and Storey displacement.

1.2 MATERIAL PROPERTIES USED

Material used –Steel frame structure

1.3 BUILDING SPECIFICATION

The building with different storeys steel framed having live load of 2 kN/m² are to be analyzed in STAAD Pro. It lies in zone III .

1.4 FORMULATION OF MODELS

- To study the effect of with bracing and without bracing in steel model
- To study the effect of bracing includes such as Diagonal bracing, X-bracing and V- bracing with using tube section in steel model to without bracing in steel model.
- To study the effect of bracing includes such as Diagonal bracing, X-bracing and V- bracing with using angle section in steel model to without bracing in steel model.

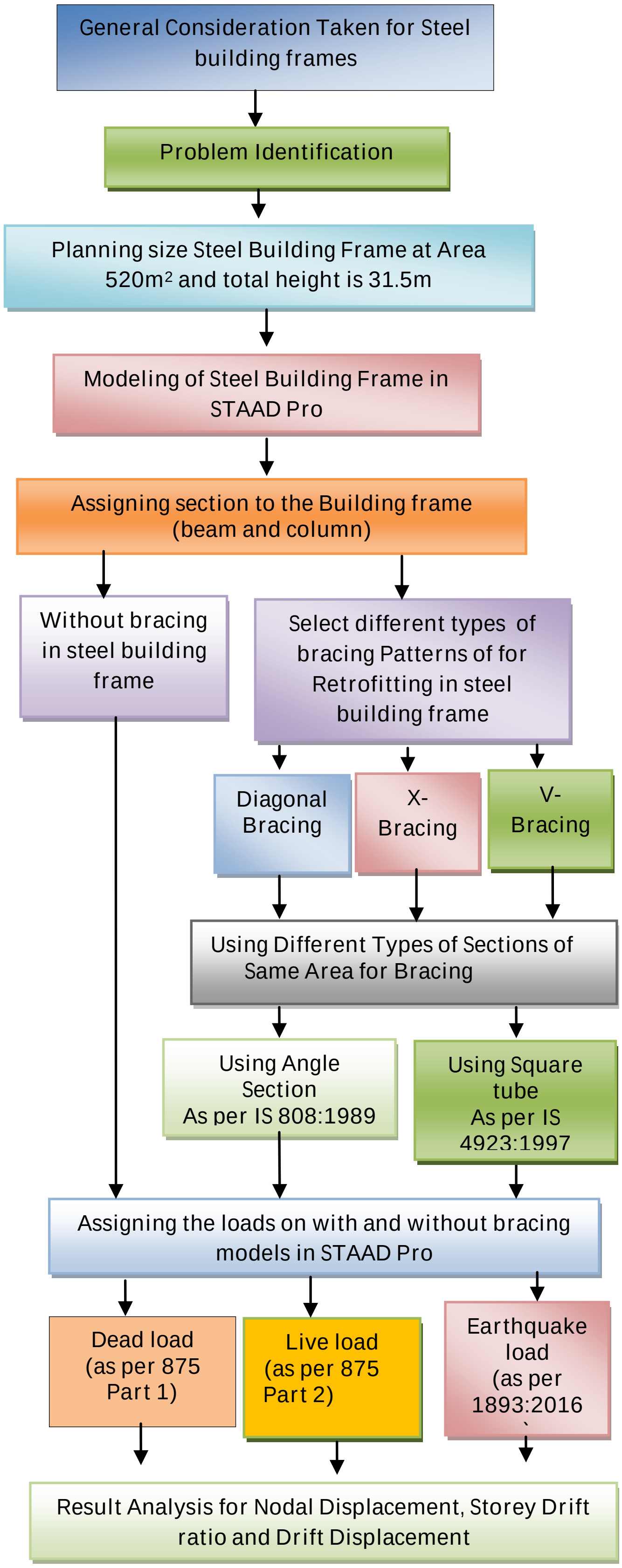
Table-1: SPECIFICATION

Model No.	Specifications
Case 0	Model without bracing
Case 1	Model with Diagonal bracing using angle section
Case 2	Model with X- bracing using angle section
Case 3	Model with V- bracing using angle section
Case 4	Model with Diagonal bracing using Tube section
Case 5	Model with X-bracing using Tube section
Case 6	Model with V- bracing using Tube section

The following assumptions were made before the start of the modeling procedure so as to maintain similar conditions for all the models:

- Only the main block of the building is considered. The staircases are not considered in the design procedure.
- The beams are resting centrally on the columns so as to avoid the conditions of eccentricity. This is achieved automatically in STAAD Pro.
- For all structural elements Fe410 are used.
- The footings are not designed. Supports are assigned in the form of fixed supports.
- Seismic loads are considered in the horizontal direction only (X & Z) and the loads in vertical direction (Y) are assumed to be insignificant.

METHODOLOGY



Flow Chart-1: Methodology

Table-2: Loading & Sectional properties of Model

Loading		
1	Live load	2.00 KN/ m²
2	Floor finish	1.5 KN/ m²
3	Specific wt. of Steel	78.50KN/ m³
Sectional properties		
5	Size of beam (all floors)	ISMB 100
6	Size of column (Ground Floor)	ISHB300
7	Size of Column (First & Second Floor)	ISHB250
8	Size of column (Third &Forth Floor)	ISHB225
9	Size of column (Fifth & sixth Floor)	ISHB 200
10	Size of column (Seventh & Eighth Floor)	ISHB150
11	Size Bracing for each pattern (as Tube section)	TUB 80x40x4
12	Size Bracing for each pattern (as Angle section)	ISA 90x 60x 6

Table-3: Specification for seismic load calculation

Seismic Parameters	
Seismic Zones	III
Earthquake load	As per IS-1893-2016
Type of soil	Type – I, Hard soil as per IS – 1893
Dynamic Analysis	Response Spectrum Analysis.
Software used	STAAD. PRO.
Zone Factor (Z)	(Zone III)
Response Reduction Factor (RF)	5.0(SMRF Structure)(Table 7 of IS:1893-2016)
Importance Factor (I)	1.00 (Table 6 Clause 6.4.2 of IS:1893-2016)
Damping	5%
Fundamental Natural period of building	Ta = 0.085 h for moment resisting Steel Frames , where h = height of building ,d = base dimension of building at plinth level in m
Sa/g	2.5

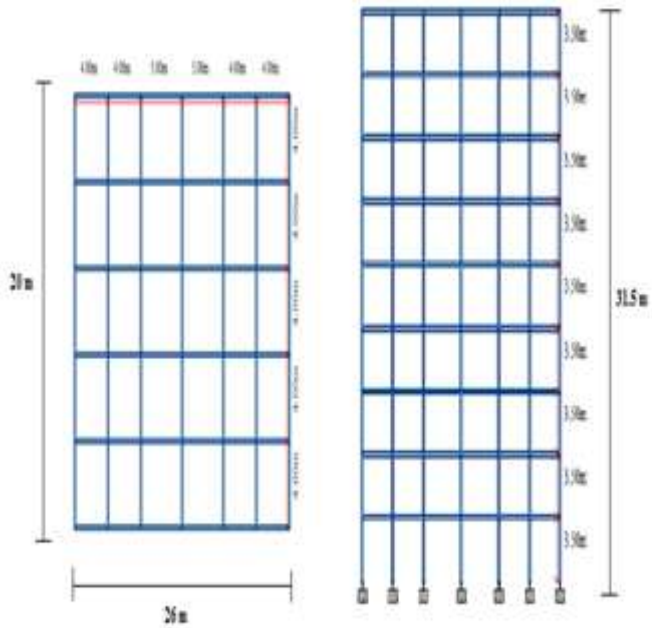


Fig-1: Plan and Elevation of Steel model

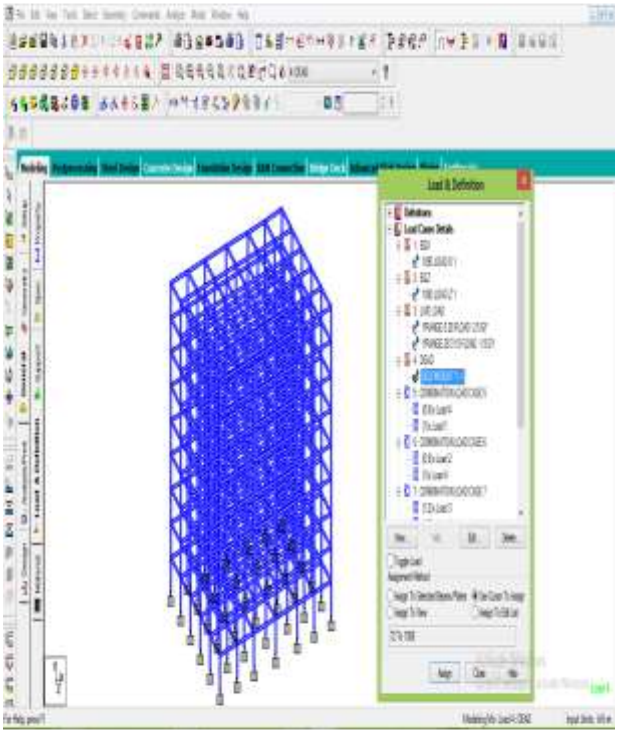


Fig-1: Modeling in STAAD Pro Software

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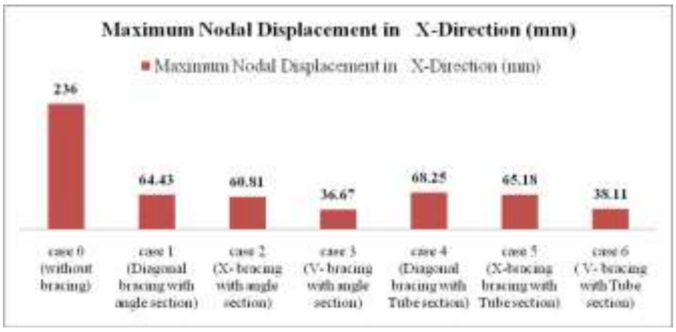
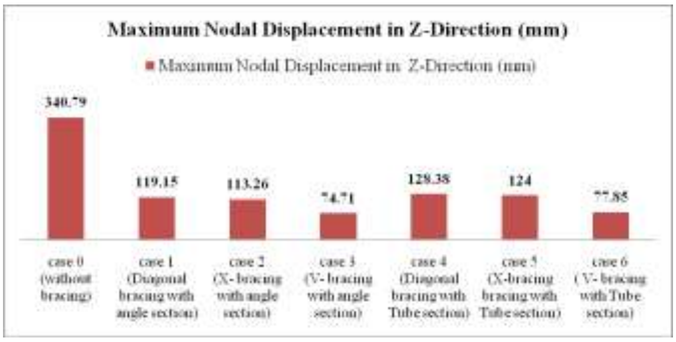
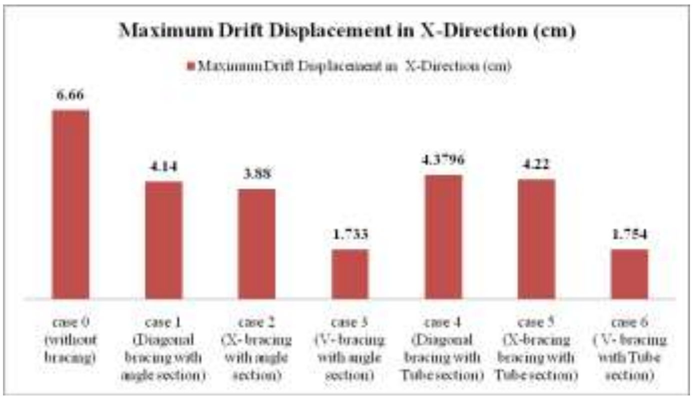
3. RESULT



Graph-1: Maximum Nodal Displacement in X-Direction for all cases

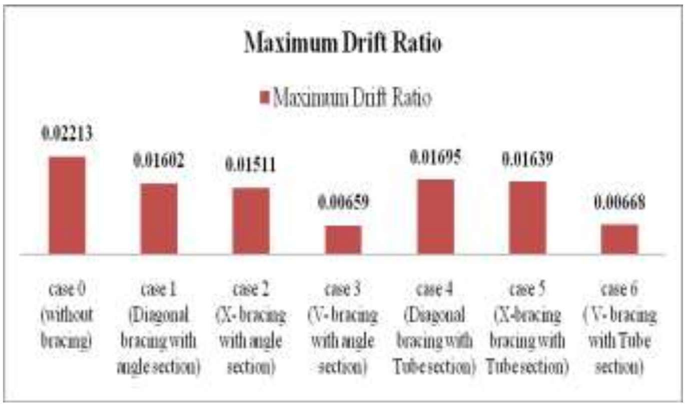


Graph-2: Maximum Nodal Displacement in Z-Direction for all cases



Graph-3: Maximum Drift Displacement in X-Direction for all cases

Graph-4: Maximum Drift Displacement in Z-Direction for all cases



Graph-5: Maximum Drift Ratio for all cases

4. CONCLUSIONS

After the analysis of the structure with different types of Bracings pattern and sections used such as angle and tube section, it has been concluded that the displacement of the structure decreases after the application of bracing system with different section. Apart from the reduction of nodal displacement, drift displacement and drift ratio, an effective bracing system with section should transfer the lateral force in the structural frame effectively from column to the sub structure. Hence it reduces flexure and shear demands on columns of the frame structure. The following conclusions can be made after the seismic analysis of the steel model:

1) It can be concluded that V-bracing with angle and tube section of steel frame have maximum nodal displacement is less in both directions as compared to non braced steel frame of reduction of approx 80%
2) It can be concluded that V-bracing with angle and tube section of steel frame have maximum drift displacement is less in both directions as compared to non braced steel frame of reduction of approx 72%
3) It can concluded that V-bracing with angle and tube section of steel frame have maximum drift ratio is less in both directions as compared to non braced steel frame of reduction of approx 70%
4) It is observed for all the cases that values of maximum nodal displacement, drift displacement and drift ratio is less for V-bracing with angle and tube section with steel frame as compared to diagonal and X- bracing.
5) Finally above results indicate that maximum nodal displacement, drift displacement and drift ratio of V-bracing with angle and tube section is more suitable as compare to non braced steel frame.
6) Use of bracing system can increase ductility and also permit to buckle elastically in compression zone. Drift observed in all cases is less by providing bracing system but drift when needed can also be minimized by increasing horizontal stiffness.
7) It can be concluded that angle section is more suitable as compare to tube section of same area for bracing systems.

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