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Performance Analysis and Behavior of Steel Framed Building with reference to Variation in Bracing Type

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Abstract - A typical ten-story steel frame building is analyzed for various types of concentric bracings as per the IS 800- 2007. Diagonal bracing, X-bracing and Chevron bracing are the different types of concentric bracings considered for the present study. Performance of each frame is studied through Response Spectra analysis is carried out for steel moment resisting building frame having (G+9) storey situated in zone IV using Staad Pro (v8i) and to identify the suitability of the bracing system to resist the seismic loads efficiently and also to compare the response of braced and unbraced building which subjected to horizontal or lateral loading system.
Key Word - Seismic, Response spectra, Steel Framed building, Concentric Building.

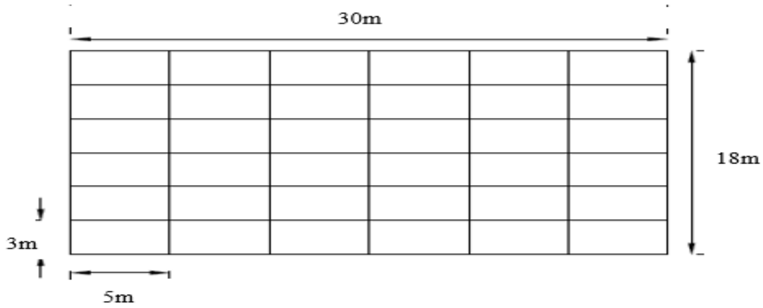
1. INTRODUCTION

There is scope to do Earthquake analysis having more number of stories with 3D modeling (i.e. high rise framed building) for different kind of loading and to see the effect on both conditions i. e. with and without different bracing style. In this paper Earthquake analysis of a high rise moment resisting steel framed building is carried out for Zone IV. The results are considered in terms of joint displacement, base shear reaction, modal period and checked against permissible values. The same steel frame building analyzed with different type of bracing patterns.

2. METHODOLOGY

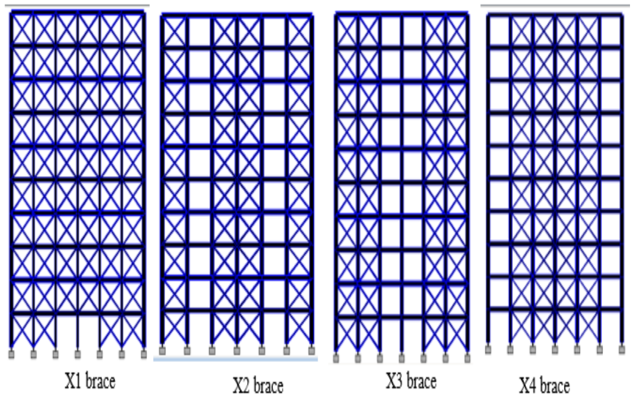
Following steps have been adopted in this study:
Step 1.selection of plan of building 10 storey (30mx18m)
Step 2. Generate the structure in staad pro. Application of seismic load on structure and analysis for seismic load by response spectra method using IS 1893-2002
Step 3. Application of different bracings system and different patterns for each bracings. X bracing, Chevron bracing, D bracing
Step 4. Analysis of structure for zone IV soil type is medium concentric bracings. After analysis different comparison of different types of bracings is carried out on basis of displacements, storey drift, axial forces and bending moments.
Step 5. Search for best bracing systems.

3. STRUCTURE MODELLING AND ANALYSIS

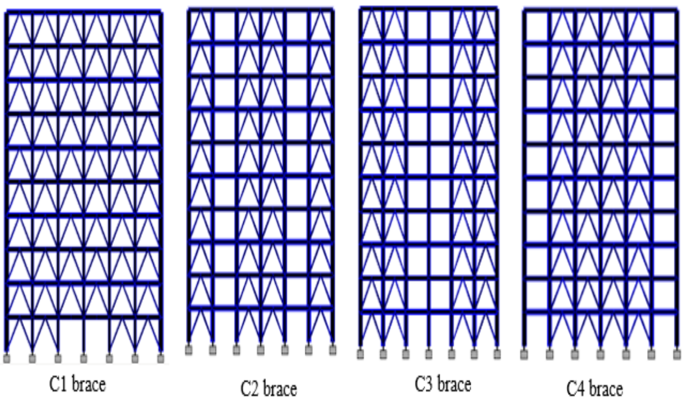


Plan of building

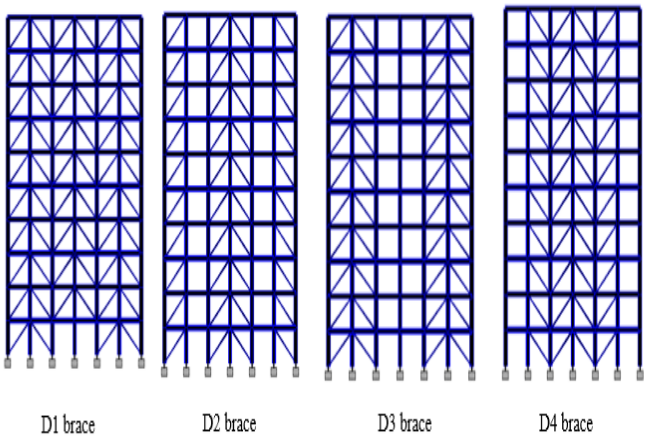
Bracings patterns



X-bracing



Chevron Bracing



Diagonal Bracing

Table3.1 Building Discription.

Description	parameter
Floor to floor height	3.5m
Beams	ISMB 500
Columns	I80012B50012
Bracings	ISMC 200 ISMC 250 ISMC 300
Slab thickness	120 mm
Seismic Zone	IV
Soil type	Medium
Bracings type	concentric
Wall thickness	230mm
Unit weight of masonry wall	18 KN/m^3

STAAD utilizes the following procedure to generate the lateral seismic loads.

- User provides the value for $\frac{Z}{2}x\frac{I}{R}$ as factors for input spectrum
- Program calculates time periods for first six modes or as specified by the user.
- Program calculates Sa/g for each mode utilizing time period and damping for each mode.
- The program calculates design horizontal acceleration spectrum A_k for different modes.
- The program then calculates mode participation factor for different modes.
- The peak lateral seismic force at each floor in each mode is calculated.
- All response quantities for each mode are calculated.
- The peak response quantities are then combined as per method (CQC or SRSS or ABS or TEN or CSM) as defined by the user to get the final results.
- The design base shear VB (calculated from the Response Spectrum method) is compared with the base shear Vb (calculated by empirical formula for the fundamental time period).
- If VB is less than Vb, all of the response quantities are multiplied by Vb /VB as per Clause 7.8.2.

Loading calculations

Brick masonry wall load	= 0.23*18*(3.5-0.50)
	= 12.42 KN/m
Dead load of slab	= 0.12*25
	= 3 KN/m^2
Floor finish	= 1 KN/m^2
Live load	= 2.5KN/m^2

Table3.2 Load combinations

No.	Title
1	1.5(DL+LL)
2	1.2(DL+LL)
3	1.2(DL+LL+ELX)
4	1.2(DL+LL-ELX)
5	1.2(DL+LL+ELZ)
6	1.2(DL+LL-ELX)
7	1.5(DL+ELX)
8	1.5(DL+ELZ)
9	1.5(DL-ELX)
10	1.5(DL-ELZ)
11	0.9DL+1.5ELX
12	0.9DL+1.5ELZ
13	0.9DL-1.5ELX
14	0.9DL-1.5ELZ

GRAPHS OF DISPLACEMENTS

X-Bracing System

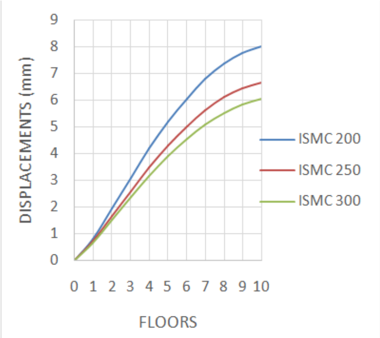


Fig. 3.1 Lateral Displacement in X direction

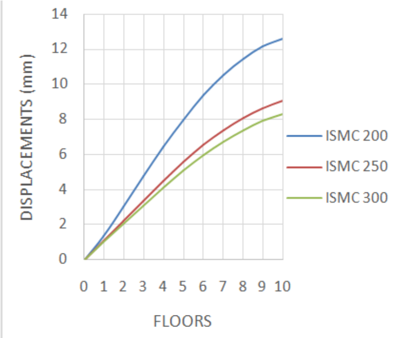


Fig. 3.2 Lateral Displacement in Z direction

Chevron Bracing

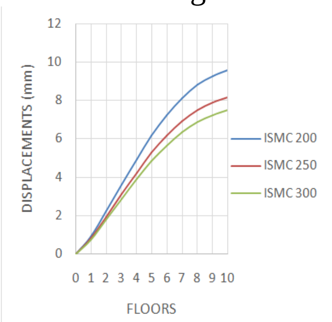


Fig. 3.3 Lateral Displacement in X direction

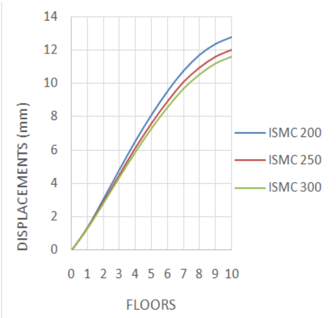


Fig. 3.4 Lateral Displacement in Z direction

Diagonal Bracing

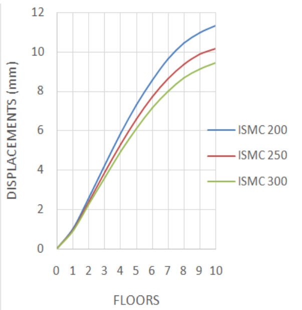


Fig. 3.5 Lateral Displacement in X direction

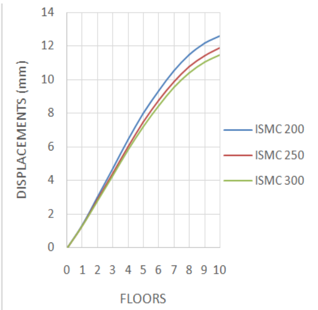


Fig.3.6 Lateral Displacement in Z direction

GRAPHS OF STOREY DRIFT

X-Bracing System

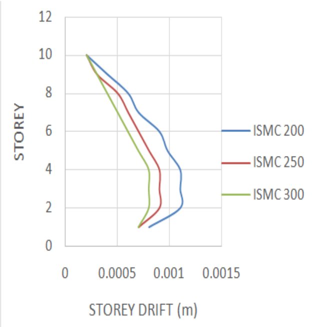


Fig. 3.6 Story Drift in X direction

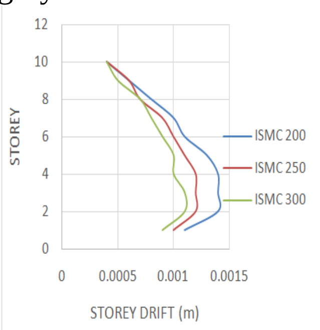


Fig. 3.7 Story Drift in Z direction

Chevron Bracing

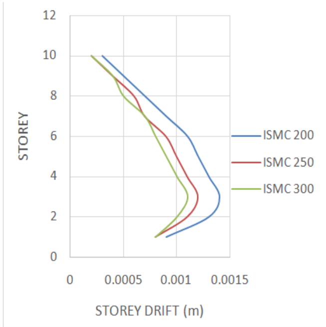


Fig. 3.8 Story Drift in X direction

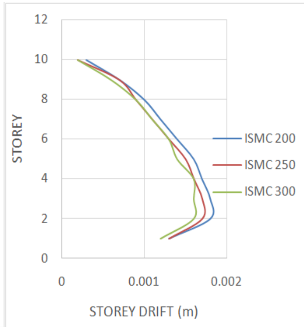


Fig. 3.9 Story Drift in Z direction

Diagonal Bracing

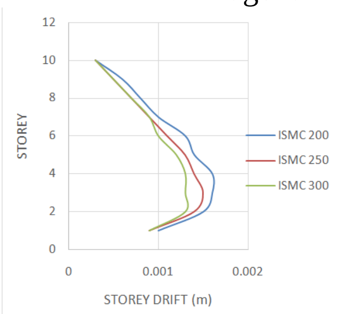


Fig. 3.10 Story Drift in X direction

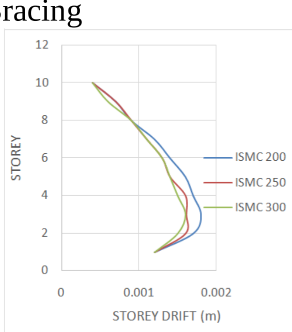


Fig. 3.11 Story Drift in Z direction

GRAPHS OF BASE SHEAR

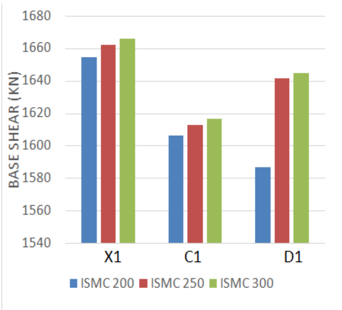


Fig. 3.12 Base Shear in X direction

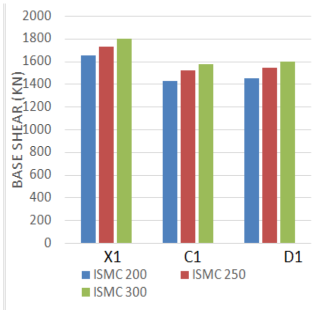


Fig. 3.13 Base Shear in Z direction

GRAPHS OF BENDING MOMENT

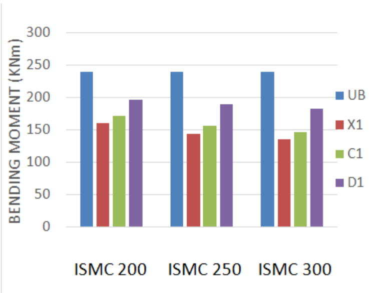


Fig. 3.14 Bending Moment in X direction

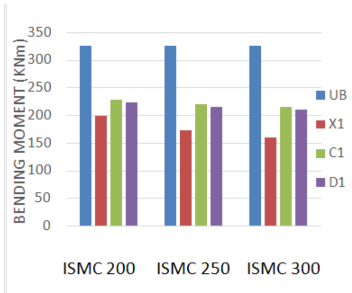


Fig. 3.15 Bending Moment in Z direction

4. RESULTS AND DISCUSSION

1. For storey displacement in all types of structures X-Bracing is effective for all cases in both X and Z direction. Chevron and Diagonal bracings are less effective as compared to X-Bracing.
2. Bracings increases the later stiffness of the building, measured in terms of first story displacement there by reducing displacement in all storey levels compared to unbrace building model.
3. The displacement of the building decreases depending upon the different bracing system employed and the bracing sizes.
4. Bending moment in building with X bracing system is 30 to 50% less from unbrace system and 8 to 9% less from chevron system and 15 to 30% less from diagonal bracing system in X and Z direction.
5. The bending moment in structural members of frame decreases as the size and stiffness of bracing increases.
6. The design base shear increases with increase in mass and stiffness of steel building.
7. The story drift in braced building decreases as compared to unbrace building which indicates that overall response of building decreases. The maximum drift at the third story in X direction reduces by 60.71% to 40% and in X and Z direction compared to Chevron Bracing, and Diagonal bracing respectively.
8. As the size of bracings increases the storey drift reduces.
9. About the whole of performance of X braced building better than other two types of braced building and whole performance of X1 brace is better among the other patterns.
10. The 4th pattern is economical having least force induced in structure and produces more displacement as compared to 1st pattern but within limit.
11. It seems that watch them carefully also observed that as the size bracing section increases the displacements, bending moment and storey drifts decreases for the braced buildings.

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