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# Seismic Evaluation of RC Building with Different Arrangement of Steel Bracing

**Sarang H. Kshirsagar[1], Abhijeet A. Galatage[2]**

*[1]P.G student, Department of Civil Engineering, Savitribai Phule Pune University, Maharashtra, India*
*[2]Assistant Professor, Department of Civil Engineering, Savitribai Phule Pune University, Maharashtra, India*

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**Abstract** -*The most suitable way to improve the reinforcement concrete frame which is laterally loaded is to use steel bracing. The use of steel bracing has advantage of higher strength and stiffness, it is economical also occupies less space and adds much less weight to the existing structure. In this Study the seismic analysis of reinforced concrete buildings with different type of bracing (Diagonal, V type, inverted V type, K type, X bracing) is studied. The bracing is provided for outer peripheral columns. A thirteen storey (G+12) building is situated at seismic zone IV. The building models are analyzed by response spectrum method and time history method using ETABS software. The main parameters consider in this paper to compare the seismic analysis of buildings are lateral displacement, storey drift, storey shear, base shear. It is found that the X type of steel bracing significantly contributes to the stiffness and reduce the maximum storey displacement of RC building.*

***Key Words:*** **Bracing, ETABS2013, Response Spectrum Analysis..**

## 1. INTRODUCTION

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist to resist lateral forces. Retrofitting of structures proves to be a better option catering to the economic consideration and immediate shelter problems rather than replacement of the building, Moreover it has been often seen that retrofitting of building is generally more economical as compared to demolition. Therefore, seismic retrofitting or of building structures is one of the most important aspects for mitigating seismic hazards especially in earthquake prone areas. Steel bracing is highly efficient and economical method of resisting horizontal forces in a frames structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum number sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling wall, adding wall to existing columns, encasing columns, and adding steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems of building subjected to seismic or wing lateral loading. Therefore, the use of steel bracing systems for retrofitting reinforces concrete frames with inadequate lateral resistance is attractive.

### 1.1 Research Objectives

a) To analyze the building model with different arrangement of steel bracing system by response spectrum method and time history method using ETABS software

b) To study most efficient section of steel bracing , inclined bracing, V bracing, Inverted V type bracing, Combine V type bracing, K type bracing and X type of bracing.

c) To evaluate various response of RC multi-storey building such as Base shear, lateral displacement, storey drifts etc. for different type of bracing system

d) Recommendation of best type of bracing based on various responses.

## 2. MODELING &ANALYSIS

### 2.1 Building Configuration

In this study, G+12 RC building with different types of bracing is analyzed using the finite elements analysis based software ETABS 2013. The displacement value of different storey level (storey drift) is obtained for all the structure. In this study RC buildings G+12 with special moment resisting frame is consider in the analysis and building different types of steel bracing like diagonal, V, inverted V, combined V, K and X is been provided. Modelling of G+12 RC multi-story framed building with different type of steel bracing system is done. The building is analyzed by two analysis methods i.e. Response Spectrum and Time History method and different parameters such as story shear, story displacement and story drift are evaluated. Modeling of building involves model configuration by forming grid, defining material properties of model, defining of section properties and assigning of it to model at specific location i.e. beam, column and slab. Loading and load combinations as per IS 1893:2002 (Part-I) and (IS 875-Part-I, II) are defined to model. Defining Time History function and Response Spectrum function as per analysis method are used.

### 2.2 Structural Details

The RC Buildings used in this study is thirteen storied (G+12). Building have floor plan with 4-4 m bays along longitudinal (X-Direction) and 3-4m bays along transverse direction (Y-Direction) as shown in fig. 2.1

Following data is considered for analysis :

1. Type of frame – Special Moment Resisting Frame
2. No. of Stories – 13
3. Zone (Z) – IV
4. Importance factor (I) – 1
5. Response reduction factor (R) - 5
6. Slab thickness – 150 mm
7. Thickness of Wall – 230 mm
8. Size of beam – 300 x 500 mm
9. Size of column – 300 x 600 mm
10. Live load – 3 kN/m³
11. Height of floor – 3.2 m
12. Type of building – Residential
13. Soil strata – Medium
14. Density of brick – 20 kN/m³
15. Density of concrete – 25 kN/m³
16. M-25 Concrete and Fe-415 steel is used
17. The modulus of elasticity of concrete and steel are 25000 N/mm² and 2 x 10⁵ N/mm² respectively.
18. Size of steel bracing – 110 x 110 x 10 mm

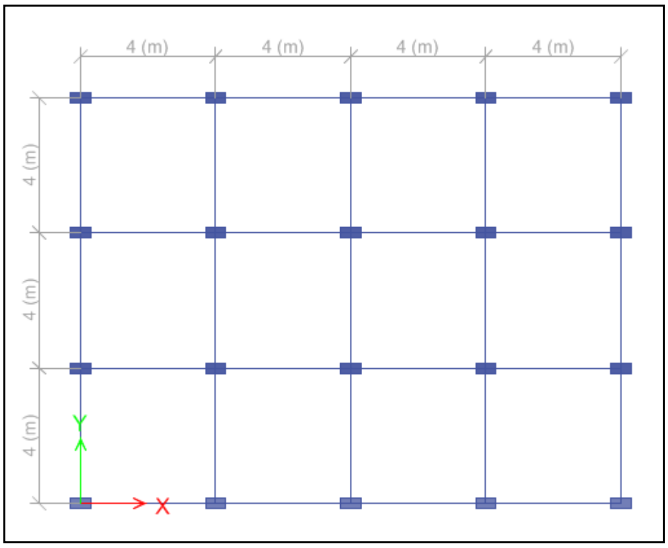


**Fig-2.1:** Plan showing RC frame structure

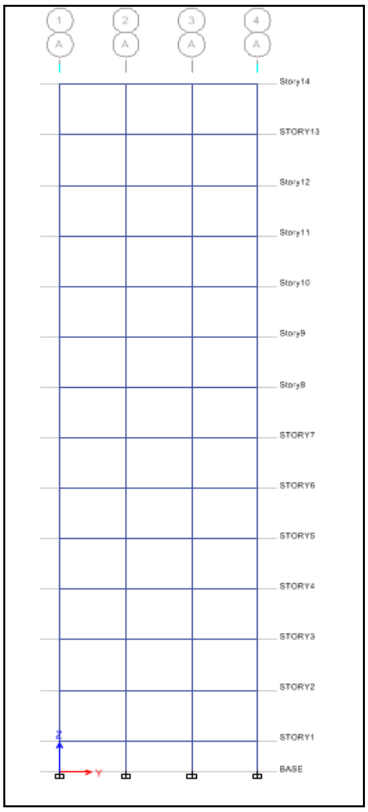


**Fig-2.2:** Elevation showing RC frame structure

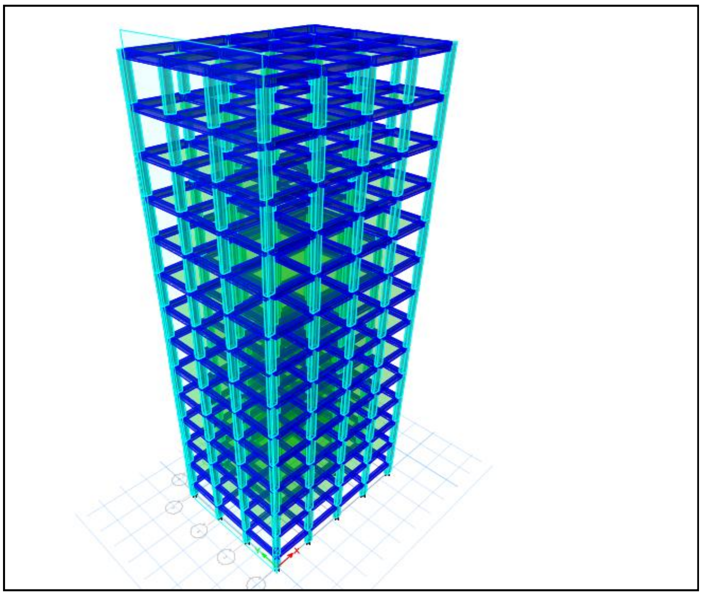

**Fig-2.3:** 3D view of RC frame structure

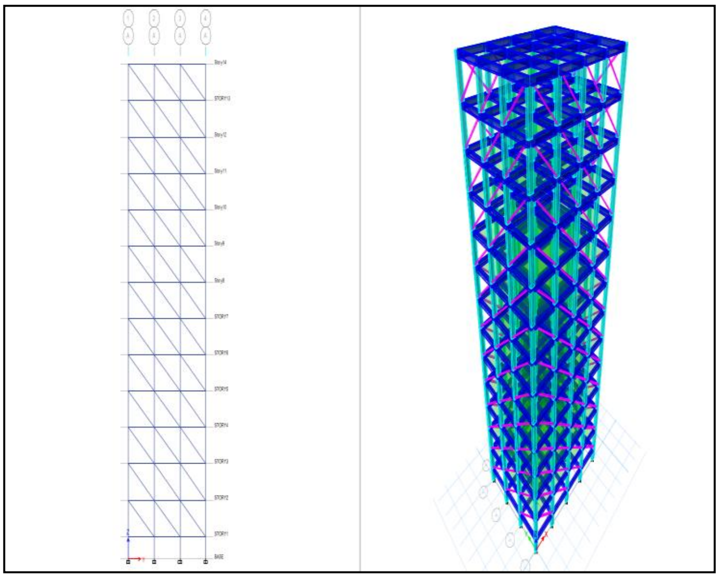

**Fig-2.4:** Elevation and 3D view of RC frame structure with diagonal bracing

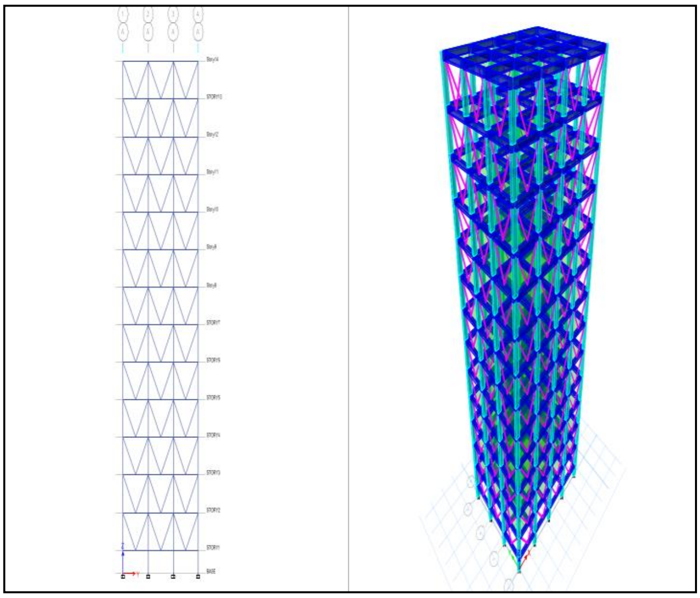

**Fig-2.5:** Elevation and 3D view of RC frame structure with V type bracing

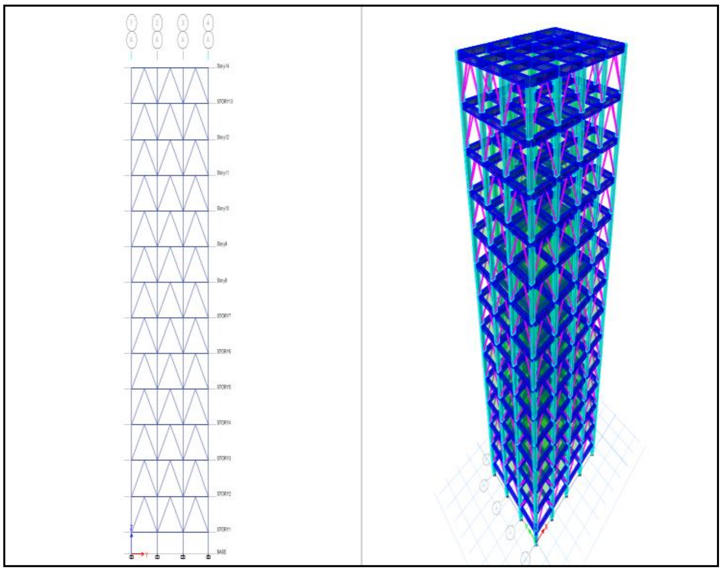

**Fig-2.6:** Elevation and 3D view of RC frame structure with inverted V type bracing

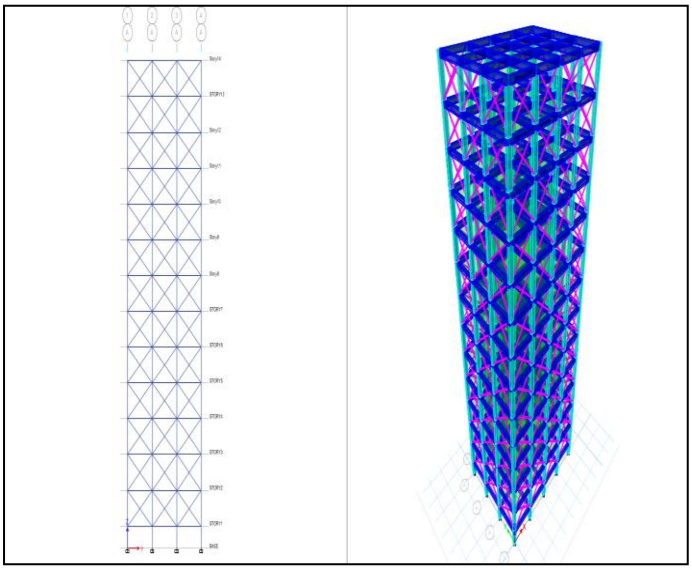

**Fig-2.7:** Elevation and 3D view of RC frame structure with X type bracing

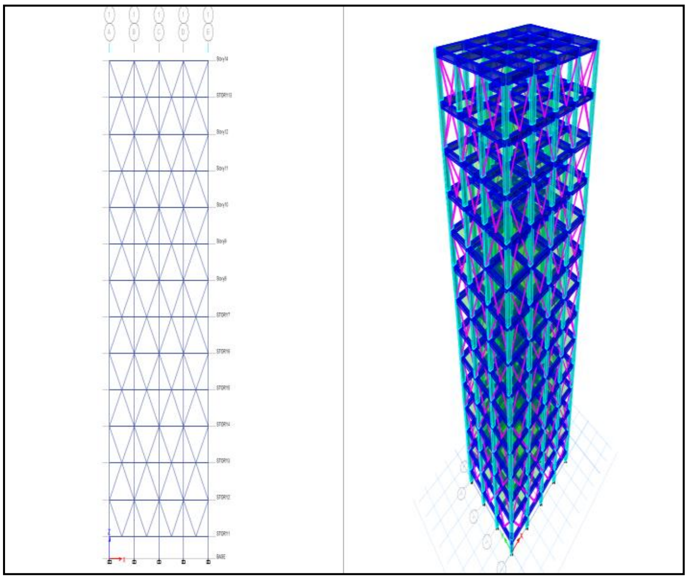

**Fig-2.8:** Elevation and 3D view of RC frame structure with combine V type bracing

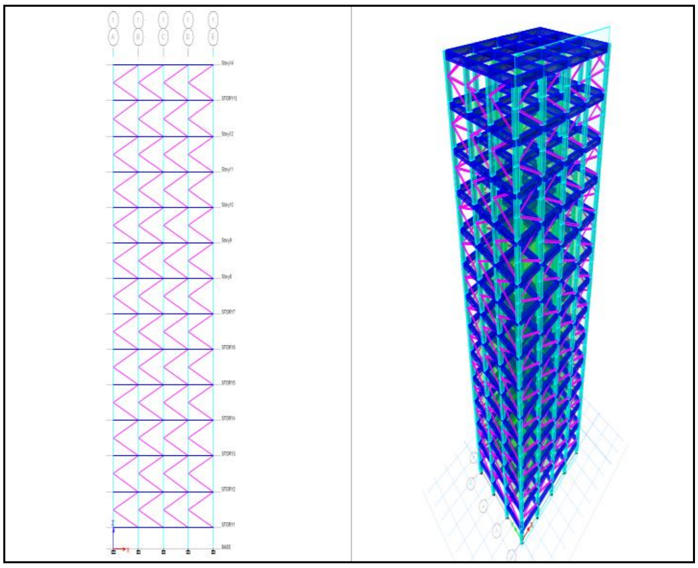

**Fig-2.9:** Elevation and 3D view of RC frame structure with K type bracing

## 3. RESULTS AND DISCUSSION

The results are obtained from the analysis of G+12 RC multistoried framed building by using response spectrum method and time history method for different parameters such as story shear, story displacement, story drift and base shear.

### 3.1 Comparision of Different Bracing Systems for G+12 Building By Response Spectrum Method

#### 3.1.1 Lateral Displacement

It is observed from the graph that lateral displacement is reduced to largest extent for X type of bracing systems, while the displacement is maximum for the system without bracing. The displacement are reduced sequentially for bracing type K, diagonal, V and inverted V, combined V. these pattern are observed due to increased stiffness provided by the respective bracings. Top roof displacement is reduced by 69.09 % in X direction as compared to that of bare frame structure.

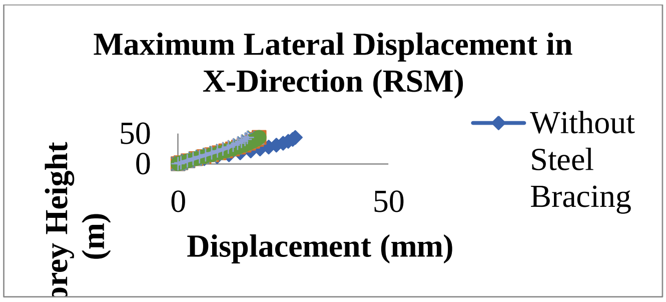


**Chart-1:** Maximum lateral displacement (mm) in X direction for G + 12 building model

It is observed from the graph that lateral displacement is reduced by 69.34 % in Y direction as compared to that of bare frame structure.

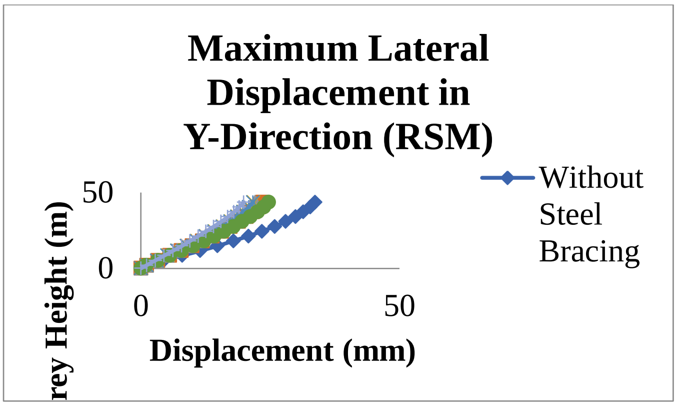


**Chart-2:** Maximum lateral displacement (mm) in Y direction for G + 12 building model

### 3.1.2 Storey Drifts

It can be observed from the graph that the story drifts are reduced to largest extent for X type bracing systems, while these are maximum for the system without bracing.

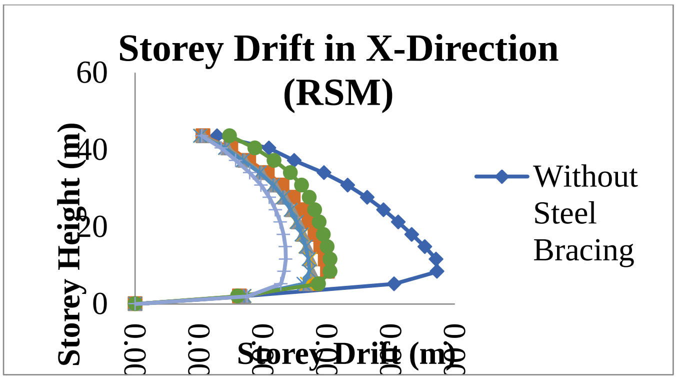


**Chart-3:** Storey drifts (m) in X Direction for G + 12 building model

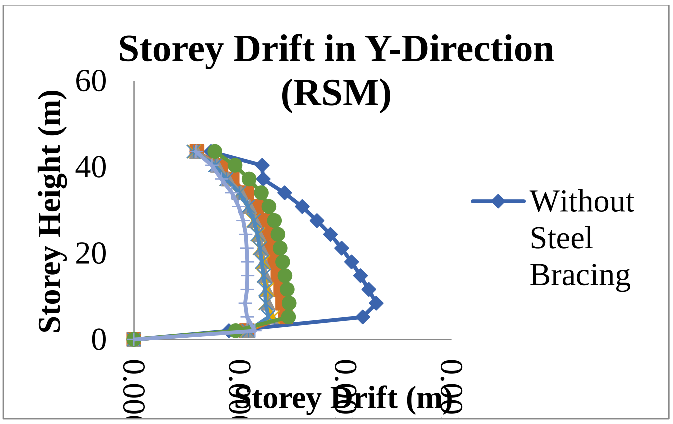


**Chart-4:** Storey drifts (m) in Y direction for G + 12 building model

### 3.1.3 Storey Shear

It can be observed from the graph that the story shear is increased for x type bracing systems.

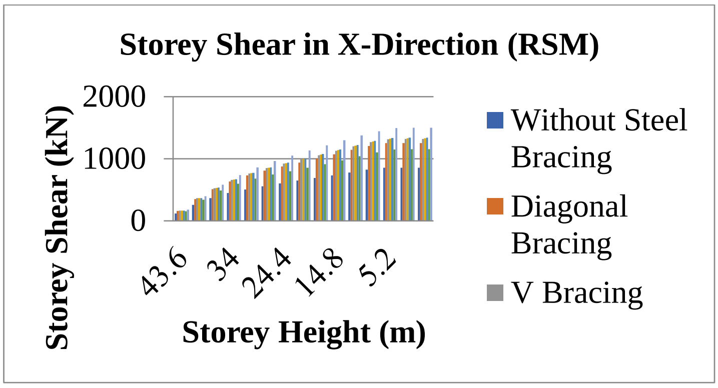


**Chart-5:** Storey shear (kN) in X direction for G + 12 building model

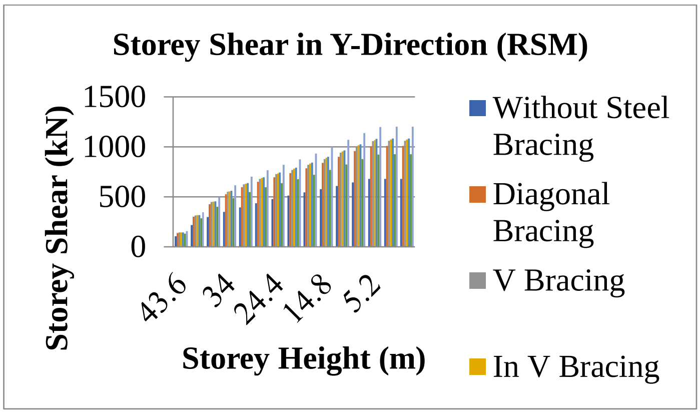


**Chart-6:** Storey shear (kN) in Y direction for G + 12 building model

### 3.1.4 Base Shear

It can be observed from the graph that base shear is increased for X type of bracing

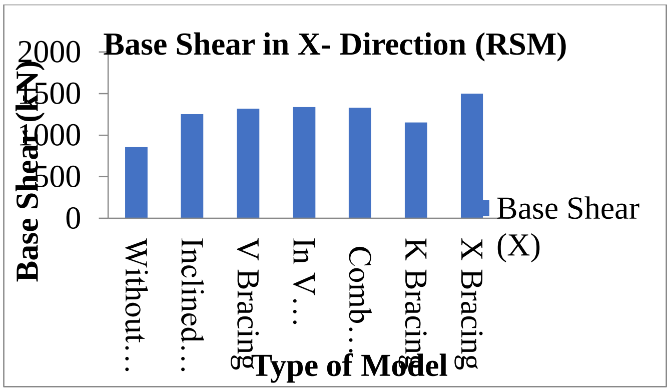


**Chart-7:** Base shear (kN) in X direction for G + 12 building model

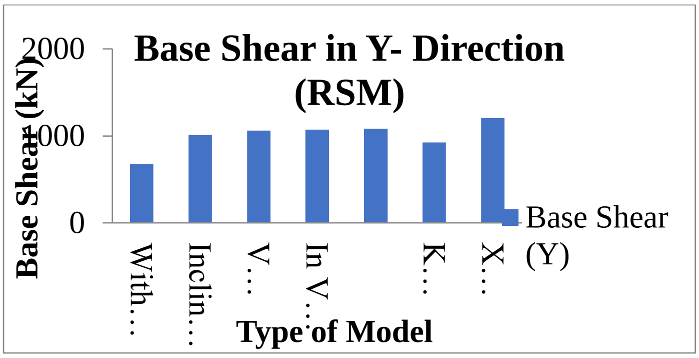


**Chart-8:** Base shear (kN) in Y direction for G + 12 building model

### 3.2 Comparision of Different Bracing System for G+12 Building By Time History Method

#### 3.2.1 Lateral Displacement

It is observed from the graph that the lateral displacement is reduced by 74.428 % in X direction as compared to that of without bracing system.

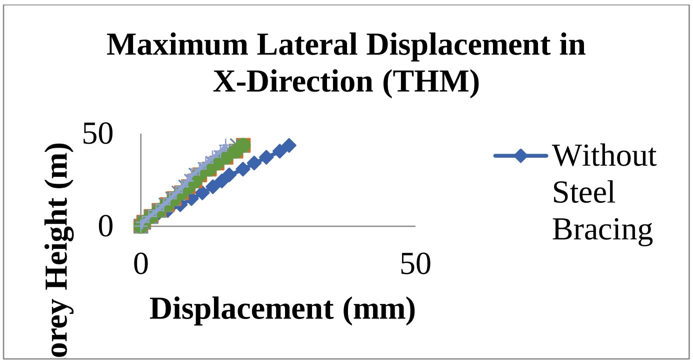


**Chart-9:** Maximum lateral displacement (mm) in X direction for G + 12 building model

It is observed from the graph that the lateral displacement is reduced by 75.155 % in Y direction as compared to that of without bracing system.

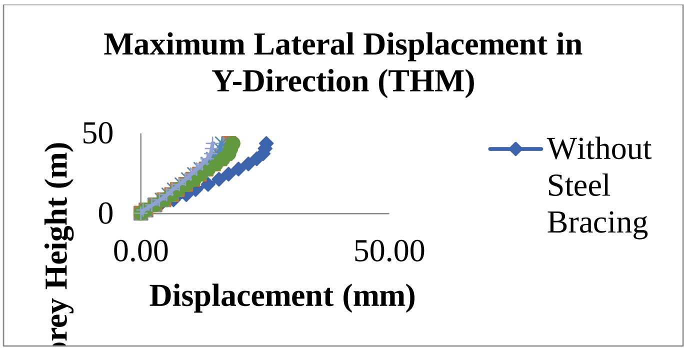


**Chart-10:** Maximum lateral displacement (mm) in Y direction for G + 12 building model

#### 3.2.2 Storey Drifts

It can be observed from the graph that the story drifts are reduced to largest extent for X type bracing systems, while these are maximum for the system without bracing.

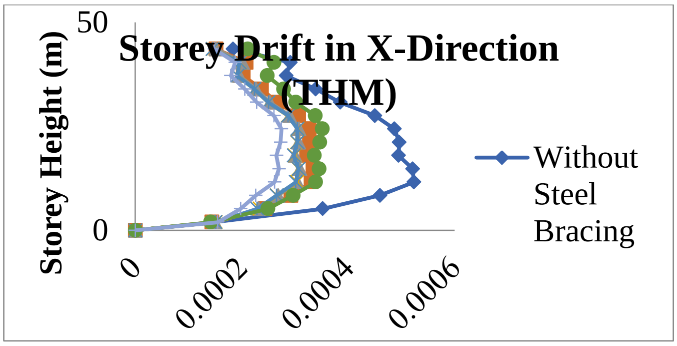


**Chart-11:** Storey drifts (m) in X direction for G + 12 building model

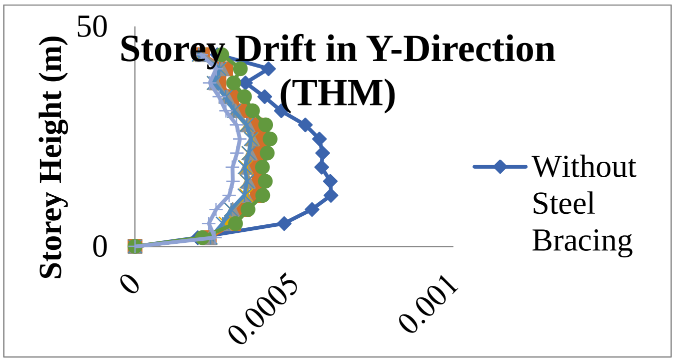


**Chart-12:** Storey drifts (mm) in Y direction for G + 12 building model

#### 3.2.3 Storey Shear

It can be observed from the graph that the story shear is increased for X type bracing systems.

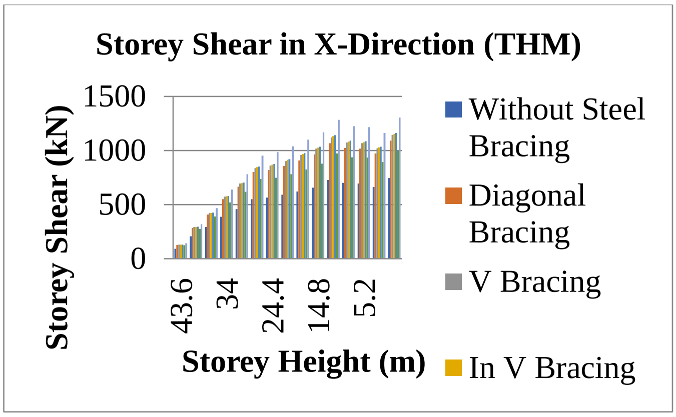


**Chart-13:** Storey shear (kN) in X direction for G + 12 building model

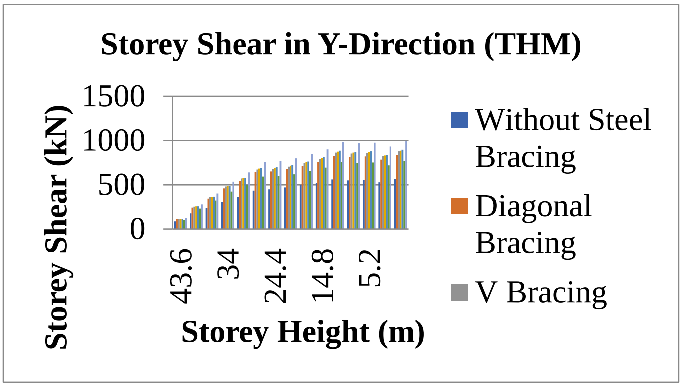


**Chart-14:** Storey shear (kN) in Y direction for G + 12 building model

### 3.2.4 Base Shear

It can be observed from the graph that base shear is increased for X type of bracing

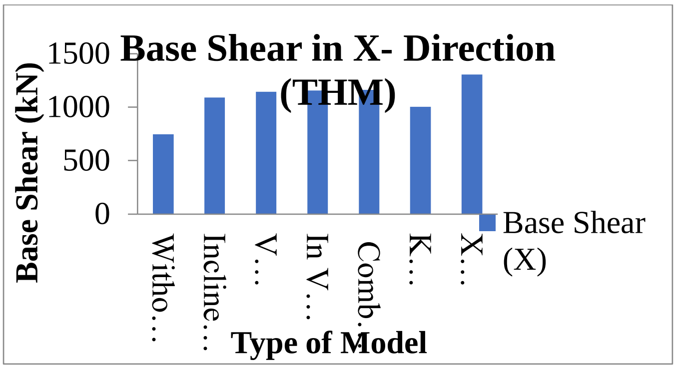


**Chart-15:** Base shear (kN) in X direction for G + 12 building model

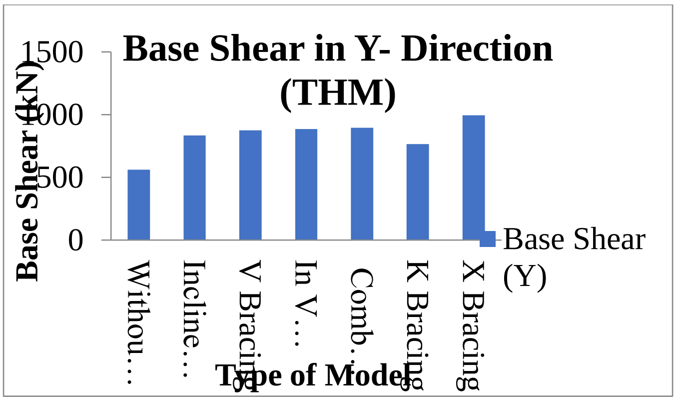


**Chart-16:** Base shear (kN) in Y direction for G + 12 building model

## 4. CONCLUSIONS

Analysis of RC multistoried building is carried out by using response spectrum method and time history method. Following conclusions are drawn based on present study.

- The lateral displacement of building is reduce by the use of diagonal, V type, inverted V type, combined V type, K type, X type of bracing system respectively and X type of bracing reduced maximum displacement.
- The lateral displacement obtained from THM is 33% less than that compared to RSM for bare frame structure.
- The percentage reduction in the top floor displacement for structure with X Bracing is 69.09% in X-direction and 69.34% in Y-direction than bare frame structure for G + 12 stories building by RSM.
- The percentage reduction in the maximum displacement for structure with X Bracing is 9.69% in X-direction and 9.04% in Y-direction than combine V type bracing frame structure for G + 12 storey building by RSM.
- The storey drift of X type braced building is 23.557% less in X-direction and 24.315% less in Y-direction than that compared to the bare frame building.
- The storey drift is within permissible limit specified as per IS: 1893-2002 (Part I).
- The steel braced building of base shear increases as compare to bare frame which indicates that stiffness of building increases. The base shear for X type bracing structure is 75% to 77 % more than bare frame structure.

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