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# COMPARATIVE ANALYSIS OF VARIOUS TYPES OF BRACING PATTERNS IN G+10 RCC BUILDING IN ZONE V

**Kahkasha Tabassum [1]*, Dinesh Sen [2]**

[1] *M. Tech Scholar, Department of Civil Engineering, Vishwavidyalaya Engineering College, Ambikapur*
[2] *Assistant Professor, Department of Civil Engineering, Vishwavidyalaya Engineering College, Ambikapur.*

## Abstract

Bracing systems are a rather unusual feature in RCC projects in India, whether it be a high-rise construction, a low-rise public building, or a residential building. This characteristic is quite desired in buildings built in seismically active areas. To minimize or lessen the effects of an earthquake brought on by a discontinuity in the load path and non-uniformity of stiffness, this study offers a strategy for maintaining the structure under the bracing system using a variety of strengthening technologies. To resist the lateral load acting on buildings, various steel or RCC bracing methods are available. Greater stiffness and stability are two potential benefits of RCC bracing over other types of braces. In this study, the seismic behavior of high-rise structures was compared to that of normal structures and structures with various steel-bracing RCC buildings. The perimeter bracing systems are put in place for the structure. The frame models are analyzed using STADD.ProV8i in compliance with IS 1893: 2000 using Response spectrum method for G+10 RCC building in zone V. The variables that will be studied in this study to compare the seismic impact of constructions are base shear, Storey lateral force, Storey drift, and storey displacement. The expected results indicated that X- braced frames are more efficient and secure during earthquakes when compared to moment-resistant frames, V-braced frames, and other frames.

***Keywords:*** *Comparative analysis, Bracing, RCC building, G+10 building, Seismic zone v, Response spectrum.*

* *Corresponding author*

## 1. INTRODUCTION

Today's tall buildings are constantly getting more thin in compared to prior highrise structures, which allows for the possibility of greater sway. Because of their height and seismic zone, engineers have taken care of the lateral stresses brought on by earthquake and wind forces. Earlier structures were designed for gravity loads. This has made it more difficult for engineers to accommodate both gravity loads and lateral loads. The seismic zone is important in the construction of earthquake-resistant building structures because the zone factor alters as the seismic strength changes from low to very severe. Construction of earthquake-resistant structures must take soil type into account because it affects the structure's overall behavior and design. Therefore, we must build the building in a particular method that will enable it to endure for the longest amount of time without harming society to accommodate all lateral stresses.

The steel-braced frame is one of the structural methods used in multistory buildings to resist lateral loads. Steel bracing is less expensive, easier to install, takes up less space, and may be constructed in several different ways to get the appropriate strength and stiffness. Braced frames are widely used to resist lateral stresses even if they can obstruct architectural features.

The column serves as the chords, and the braces and girders serve as the web elements of the truss. Because the diagonals operate under axial stress, bracing is effective because it only requires the smallest possible member sizes to provide stiffness and strength against horizontal shear. The bracing techniques used in the past can be divided into two groups: exterior bracing and interior bracing.

A local or global steel bracing system is attached to the exterior frames of existing buildings as part of the external bracing system to retrofit them. By installing a bracing mechanism inside each bay of the RC frames, the buildings are braced using the internal bracing technique. Bracing is a structural component that can be eccentric or concentric. If the aforementioned criteria are not met, the bracing is considered to be eccentric if it is not attached at the center of the beam with the column beam junction or directly with the column beam. The primary goal of the research was to determine the kind of bracing that results in the least amount of storey displacement and increases the lateral rigidity of the structure. This report presents and discusses the analysis's methodology. To determine the optimal structural performance of RCC buildings under lateral loads, comparison research has finally been presented.

**The objective of The Work**

1) To study the role of the bracing system in high-rise RCC structure
2) To analyze different parameters in high-rise RCC structure
3) To investigate the efficient bracing system in high-rise RCC structures by following the point of view
    a) Base shear
    b) Lateral force
    c) Storey displacement
    d) Storey drift

## 2. METHODOLOGY

### A) Structural Details

The structure will be G+10 storey structure is symmetrical. 3 bays will be constructed along the X direction. Storey height will be 3 meters. The Bay width will be 3 m along both X and Z directions. The total height of the structure is 15 m. size of the columns is ‘0.4x 0.4’ and the size of the beams is ‘0.3x0.3’. Bracings are provided using ‘ISA 150x150 x20’angle sections. The structure is situated in medium soil conditions.

This report presents and discusses the analysis's methodology. To determine the optimal structural performance of RCC buildings under lateral loads, comparison research has finally been presented.

| **Description** | **Values** |
|---|---|
| Number of storey | G+10 |
| number of bays in the X-direction | 5 |
| number of days in Y -the direction | 5 |
| height of each story | 3m |
| Bay width in the X direction | 4m |
| Bay width in the Y direction | 4m |
| size of beam | 0.3mx0.3m |
| size of column | 0.4mx0.4m |
| the thickness of the RCC slab | 0.15m |
| steel bracing size | ISA 150x150x20 |
| (floor load + floor finishing) | 4.5KN/$m^2$ |
| wall load | 12.5KN/m |
| live load | 4 KN/m |
| grade of concrete | M30 |
| grade of steel | Fe415 |
| seismic zone | V |
| Type of soil | Medium |
| importance factor | 1.0 |

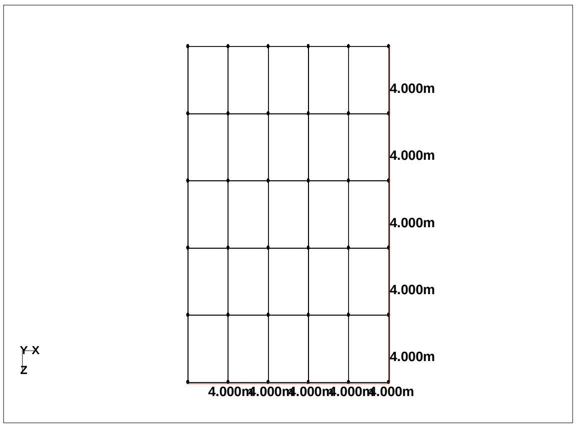


Fig. 1. Plan of the Building

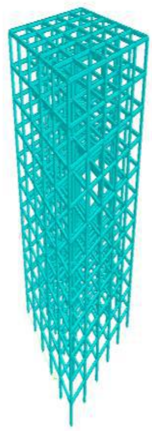

Fig:2 3D view of G+4 RCC MRF building

Fig:3 3D view of G+4 RCC X bracing building

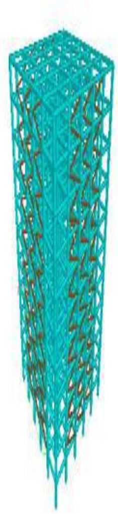

Fig:4 3D View of K Bracing Frame

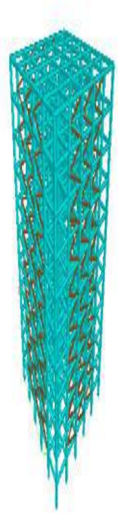

Fig:5 3D view of V Bracing frame

## B) WEIGHT OF THE STRUCTURE

Table:2 Weight of the frame structure

| Bracing frame | Total Weight(KN) |
|---|---|
| MRF Frame | 37773.17 |
| X bracing frame | 10594.90 |
| K bracing frame | 69946.56 |
| V bracing frame | 68016.27 |

## C) BASE SHEAR COMPARISON

Table:3 Base shear of the building frame

| Types of frame | Base shear(KN) |
|---|---|
| MRF frame | 1790.93 |
| X-bracing frame | 502.33 |
| K-bracing | 3316.36 |
| V-bracing | 3224.84 |

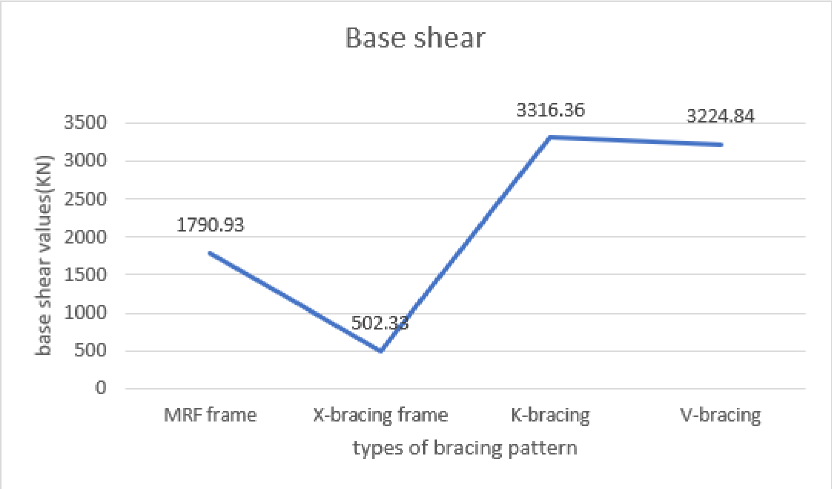


Figure: base shear for every type of bracing frame

Fig:6 Base shear Comparison for different bracing frame

### D) LATERAL FORCE COMPARISON FOR EVERY TYPE OF FRAME

Table:4 LATERAL FORCE COMPARISION FOR EVERY TYPE OF FRAME

| STOREY NO. | FRAME TYPE | | | |
|---|---|---|---|---|
| | MRF Frame | X-bracing frame | K-bracing frame | V-bracing frame |
| Ground floor | 3.660 | 1.024 | 5.772 | 6.074 |
| 1st floor | 14.638 | 4.210 | 24.061 | 26.500 |
| 2nd floor | 32.936 | 9.9472 | 54.138 | 59.625 |
| 3rd floor | 58.552 | 16.840 | 96.245 | 106.00 |
| 4th floor | 91.488 | 26.312 | 150.383 | 165.624 |
| 5th floor | 131.743 | 37.889 | 216.552 | 238.500 |
| 6th floor | 179.317 | 51.571 | 294.751 | 324.625 |
| 7th floor | 234.210 | 61.359 | 384.981 | 424.00 |
| 8th floor | 296.421 | 85.251 | 487.242 | 536.625 |
| 9th floor | 365.952 | 105.243 | 601.534 | 662.500 |
| 10th floor | 382.012 | 97.156 | 638.118 | 674.761 |

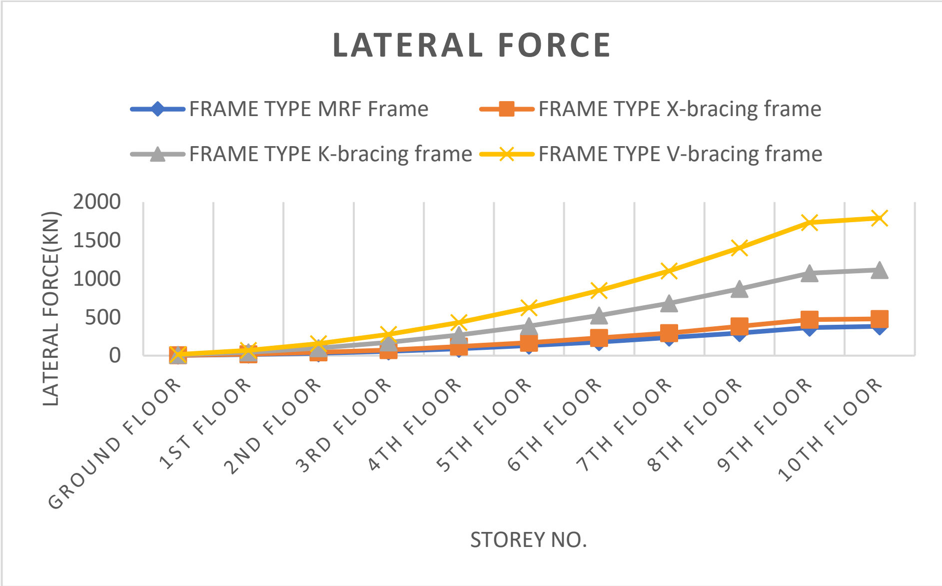


Fig:7 Lateral force comparison for every type of bracing frame

## E) STOREY DISPLACEMENT AND STOREY DRIFT COMPARISON FOR EVERY TYPE OF FRAME:

Table:5 storey displacement and storey drift comparison for every type of frame:

| STOREY N0. | STOREY DISPLACEMENT(mm) | | | | STOREY DRIFT(mm) | | | |
|---|---|---|---|---|---|---|---|---|
| | MRF Frame | X-bracing | K-bracing | V-bracing | MRF Frame | X-bracing | K-bracing | V-bracing |
| Base | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| ground floor | 1.0966 | 0.1947 | 1.3575 | 1.3516 | 1.0966 | 0.1947 | 1.3575 | 1.3516 |
| 1st floor | 3.0832 | 0.3452 | 2.6010 | 2.4314 | 1.09867 | 0.1505 | 0.4716 | 1.0798 |
| 2nf floor | 5.2752 | 0.4905 | 3.7920 | 3.4977 | 2.1920 | 0.1453 | 0.5757 | 1.0663 |
| 3rd floor | 7.4836 | 0.6354 | 4.9943 | 4.5671 | 2.2083 | 0.1449 | 0.6551 | 1.0694 |
| 4th floor | 9.6336 | 0.7798 | 6.1980 | 5.6325 | 2.1500 | 0.1445 | 0.7107 | 1.0654 |
| 5th floor | 11.6721 | 0.9241 | 7.3641 | 6.6901 | 2.03s85 | 0.1443 | 0.7659 | 1.05706 |
| 6th floor | 13.5445 | 1.0660 | 8.4913 | 7.7229 | 1.8723 | 0.1419 | 0.7955 | 1.0328 |
| 7th floor | 15.1893 | 1.2011 | 9.546 | 8.7006 | 1.6449 | 0.1351 | 0.7934 | 0.9777 |
| 8th floor | 16.5401 | 1.3226 | 8.3826 | 9.5791 | 1.3508 | 0.1214 | 0.78885 | 0.8784 |
| 9th floor | 17.5338 | 1.4218 | 11.2406 | 10.3035 | 0.9937 | 0.0993 | 0.7207 | 0.7245 |
| 10th floor | 18.1521 | 1.4921 | 11.7501 | 10.9012 | 0.6182 | 0.0703 | 0.6124 | 0.5977 |

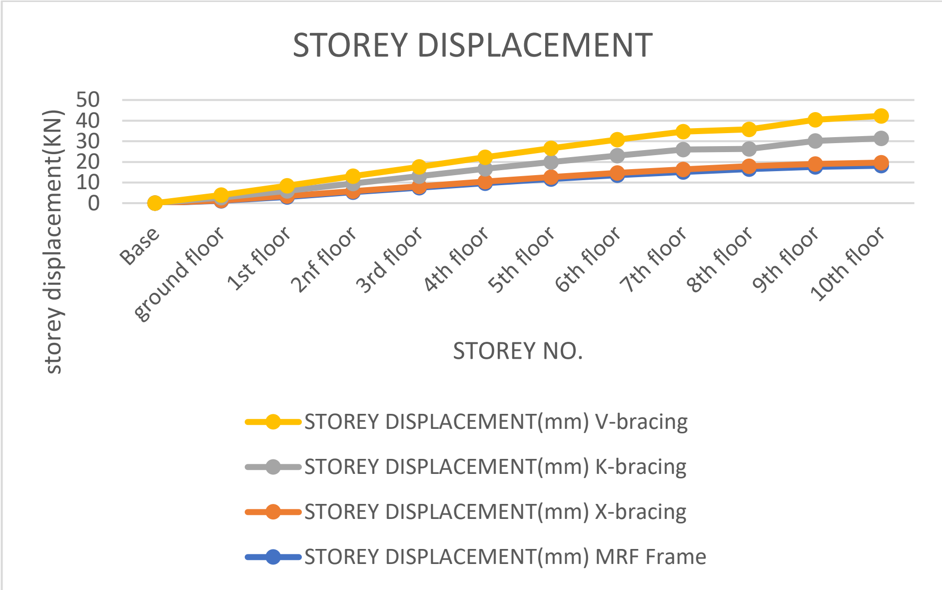


Fig:8 storey displacement comparison for every type of bracing frame

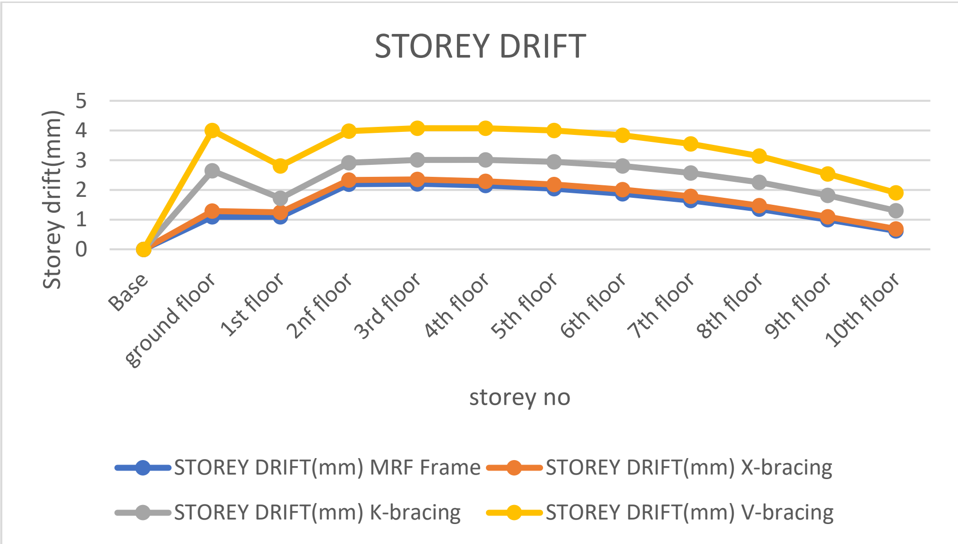


Fig:9 Storey drift comparison for every bracing frame

## 3. RESULT & DISCUSSION

Bracing is essential for maintaining the stability of a structure. Structures are subject to inertial forces during earthquakes. On a structure, these inertial forces manifest as base shear. Along the height of the building, base shear is distributed among various floors. This force causes the structure to shift later. Because of towing loading, lateral displacements in high-rise buildings are common. A high-intensity earthquake, however, has the potential to be disastrous. Bracings are crucial in distributing this force among the columns and beams. In this project, we have examined various bracing types on unbraced structures. X-bracing system has shown good results when it comes to reducing lateral displacements. Base shear values are the same in both directions. Since the number of bracings along X-directions was more, Bracings performed well when there were lateral displacements along the

X-axes. The structure's weight is nearly unchanged. The structure's weight cannot change by more than 2%. Base shear is influenced by weight, hence base shear also stays consistent.

## 4. CONCLUSION

Lateral forces are distributed to beams and columns by bracings. In this project, a comparative analysis of unbraced structures with structures having different bracings has been done using the Response spectrum method for G+10 RCC building.

Based on the present study the following conclusions can be drawn:

1) The concept of using Steel bracing is one of the advantageous Concepts which can be used to strengthen or retrofit existing and new structures and also resist seismic force.
2) In the braced building, the story drifts decrease as compared to the unbiased building.
3) the story displacement is reduced in buildings after providing an embracing system.
4) The base shear of the building with the bracing system is increased as compared to the building without the bracing system.
5) Storey lateral force also reduces after providing a bracing system.
6) The X-braced system gives a good performance as compared to the V bracing & K bracing.

### FUTURE SCOPE OF WORK

Concentric bracings were the primary focus of this study. Concentric bracings come in so many varieties. Only four of them are used in this project. Additionally, there are several kinds of eccentric bracings. When the direction of the lateral loads is known, eccentric bracings can be advantageous. This analysis can be used as a source of information for additional analysis in subsequent research. There could be several configurations. Only one form of arrangement has been the topic of this article. It is possible to continue working on this project in various ways. Bracing types can be compared using a variety of other factors.

Additionally, the project can be tested for wind loads and dynamic loading. The work is done by using the response spectrum method. It can be recreated with the Time history analysis and pushover analysis. This construction is symmetrical. The development of irregular structures is a future endeavor. Unexpected forces can be produced in a structure through irregularity.

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