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DYNAMIC BEHAVIOUR OF MULTI-STORIED BUILDING IN SEISMIC ZONE WITH DIFFERENT BRACINGS

Comparison of efficiency of different types of bracings.

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ABSTRACT: The Present investigation aims to study the dynamic behavior of Multi-Storied Building in seismic Zone with Different Bracings. The present work is carried out on multi storied building located in Zone V for three different stories 12, 20 and 30. For each story the investigation was carried out with X, K, V, O and X-O, V-O, K-O bracings. This analysis is carried out by Non-Linear Time history analysis through FEM using SAP 2000 (CSI Ltd). And we determined various parameters such as story displacement and Story drift. It has been observed that combination of K-O bracing has given 12% less story displacement and 11% less story drift compared to other types of combinations of bracing and individual bracings.

INDEX TERMS – Tall Building, Nonlinear Time History analysis, O-grid, Story Drift, Story Displacement.

I. INTRODUCTION

1.1 GENERAL

Buildings with multiple floors often use bracing as a means of resisting lateral loads from the outside. Using bracing to resist horizontal forces in a frame structure is a highly effective and cost-effective solution. Structures with braced frames are designed to resist wind loads and earthquake forces. The high stiffness of braced frames makes them ideal for seismic retrofit.

When structures are designed and constructed according to excellent codes, and the earthquake is proportional to the projected seismicity, the damage in these regions is far more minor than attentive work during design and construction can lessen earthquake damage. The ultimate goal of preventing earthquakes from becoming disasters is still a long way off. There is a way to reduce earthquake reactions by including energy-absorbing elements coupled to external support points. In RCC structures, to resist lateral forces like earthquake and wind pressure, bracings are provided. There are many conventional types of bracings used till now. Here we are supposed to study on a recently proposed bracing called O- bracing provided with Moment Resisting frame and its combination with different types of other bracing, in order to get an efficient combination of bracing.

1.2 NEED OF THE WORK

The need of the present work is to make a building seismically retrofit, and it can resist wind pressure lateral forces etc. In past years different types of bracings were used to make the building suitable to resist all types of forces. Some cases we may have not got the best results. For that purpose, here we have studied on recently proposed bracing called O- bracing. As it is circular in shape it can resist lateral forces effectively. Previously work is carried out on only O bracing and it may not give good results. To get high effectiveness and cost-effective solutions it is necessary to study on different combinations of the bracings.

1.3 OBJECTIVE OF THE WORK

- To identify the most effective and suitable lateral load resistant bracing type.
- To identify the bracing system which gives minimum story displacement and story drift from the selected groups of bracings types like O-bracing, V-bracing, K- bracing, K-O, V-O, X-O bracing combinations.
- To study of seismic demands of RC Buildings.

1.4 SCOPE OF THE WORK

- The primary goal of this thesis is to provide valuable insights into the current development of high-performance braces.
- The building studied in this work is a 12, 20 and 30 reinforced concrete moment resisting frame Designed for Gravity and Seismic Loads, for each story the investigation was carried out with X, K, V, O and X-O, V-O, K-O bracings.
- The structure is evaluated following seismic code IS-1893:2016 using Nonlinear time history analysis with the help of the SAP 2000 software (CSI Ltd) analysis engine.

II.METHODOLOGY

2.1 GENERAL

The following chapter presents the geometrical properties and analysis parameters of the three building models. By using SAP 2000 software, which helps to analyze and design the models, the analysis method used for this study is the Nonlinear dynamic Time History analysis for providing story vs displacement curves of the structure.

2.2 MODELLING ASSUMPTIONS

The base of all the building models is assigned as fixed at the base. All the floor diaphragms are assigned as rigid. The material properties for all the structural elements are kept same i.e., M30 and Fe500.

Table 2.1 Assumed preliminary data required for the analysis of the Frame

Sl.no	Variable	Data
1	Type of structure	Moment Resisting Frame
2	Number of Stories	12, 20, 30
3	Floor height	3m
4	Live Load	3.0 kn/m^2
5	Dead load	1.0 kn/$m^2$and wall load of 10KN/m
6	Materials	Concrete (M30) and Reinforced with HYSD bars (Fe500)
7	Size of Columns	500 × 500 mm
8	Size of Beams	230 × 450 mm in longitudinal direction 230× 450 mm in transverse direction
9	Depth of slab	150 mm thick
10	Specific weight of RCC	25 kn/m^3
11	Zone	V
12	Importance Factor	1
13	Response Reduction Factor	5
14	Type of soil	Medium

2.3 STRUCTURAL SYSTEMS OF THE BUILDING

The foundation system consists of independent footings with a 3 m foundation depth.

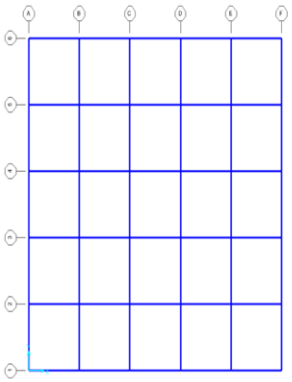
Fig. 2.1 Geometry of the Structure and also the sections assigned.

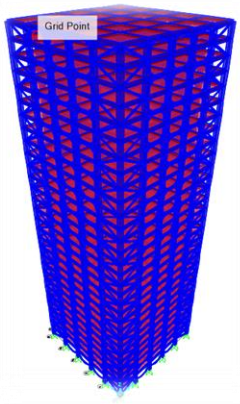
2.4 DATA COLLECTION

The building models are of 12,20 and 30 stories located in zone V.

Table 2.2 General data collection and condition assessment of building

Sl. No	Variable	Data
1	Type of structure	Moment Resisting Frame
2	Number of Stories	12,20 and 30
3	Floor height	3m
4	Live Load	3.0 kn/m^2
5	Dead load	1.0 kn/$m^2$and wall load of 10KN/m
6	Materials	Concrete (M30) and Reinforced with HYSD bars (Fe500)
7	Size of Columns	500 × 500 mm
8	Size of Beams	230 × 450 mm in longitudinal direction 230× 450 mm in transverse direction
9	Depth of slab	150 mm thick
10	O- grid V-brace K-brace X-brace	ISMB 300 ISMB 300 ISMB 300 ISMB 300
11	Specific weight of RCC	25 kn/m^3
12	Zone	V
13	Importance Factor	1
14	Response Reduction Factor	5
15	Type of soil	Medium





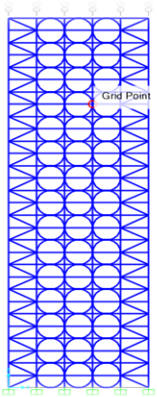


Fig. 2.2 Plan **Fig. 2.3 Isometric View** **Fig 2.4 Elevation**

2.5 NONLINEAR TIME HISTORY ANALYSIS

There are several approaches for predicting the behavior of structures that are subjected to earthquake forces. A history of responses to dynamic loads, such as an earthquake ground acceleration record, is tracked until the structure achieves its limit state. In order to determine a structure's peak reaction, a seismic ground acceleration Record of lateral loads is applied to a model that represents the material nonlinearity of an existing or previously built structure, and those loads are monotonically increased over time.

III. RESULTS AND DISCUSSION

3.1 STORY DISPLACEMENT IN X-DIRECTION:

Based on the results obtained from SAP 2000 software graphs were plotted between displacement and number of stories of the building with equal interval. Graphs are plotted for displacement in X direction for both, different bracings and combination of bracings

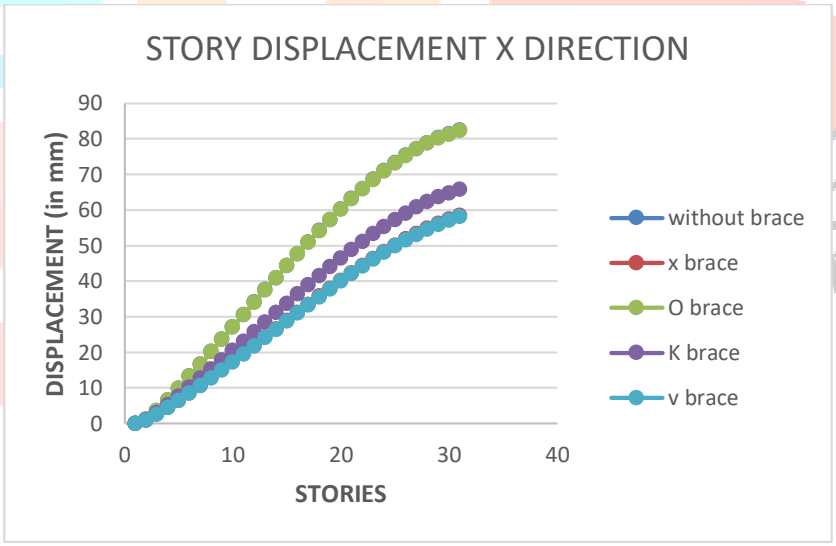


Fig. 3.1 Story Displacement in X- Direction with different bracing

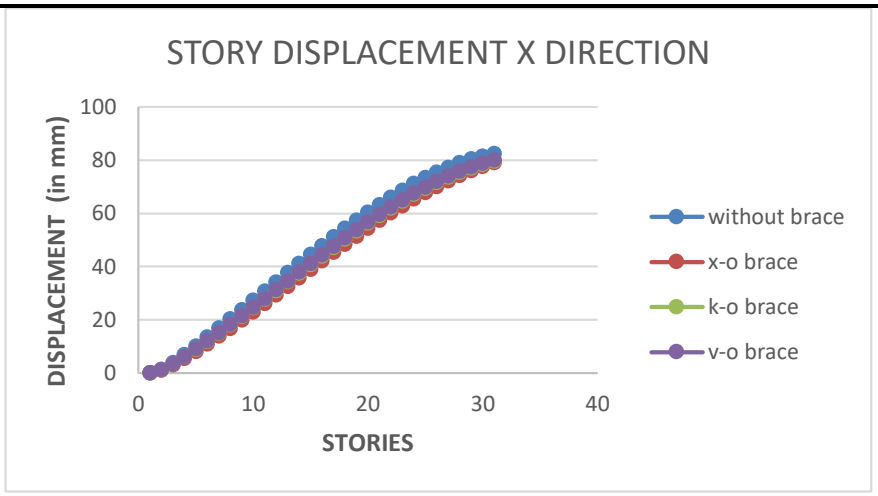


Fig. 3.2 Story Displacement in X- Direction with Combination of bracing

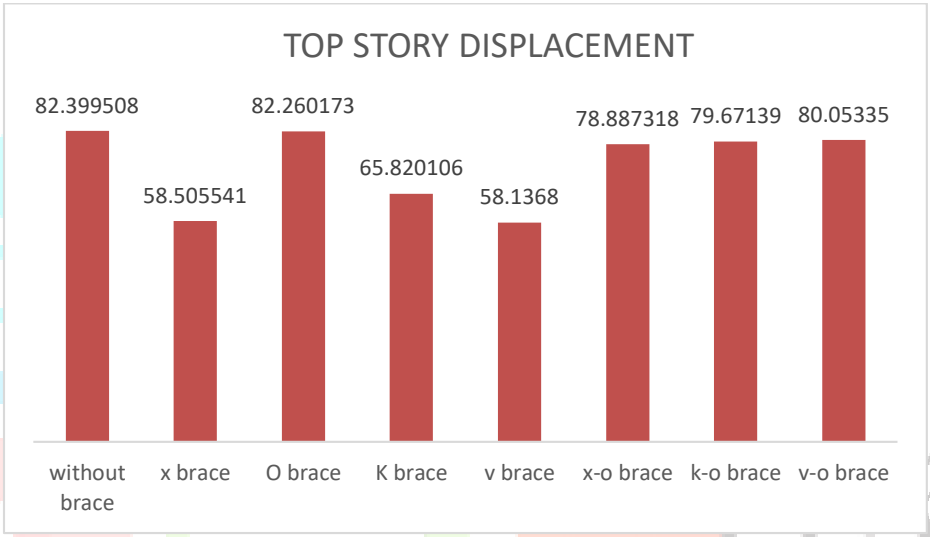


Fig. 3.3 Story Displacement in X- Direction for Top story

DISCUSSIONS:

- Above graph shows that displacement using O grid is high compared to other type of bracings.
- But using O bracings as a combination with other type of bracings gives effective results and combination of bracings is also economical compared to individual bracings.

3.2 STORY DISPLACEMENT IN Y-DIRECTION:

Based on the results obtained from SAP 2000 software graphs were plotted between displacement and number of stories of the building with equal interval. Graphs are plotted for displacement in Y direction for both, different bracings and combination of bracings

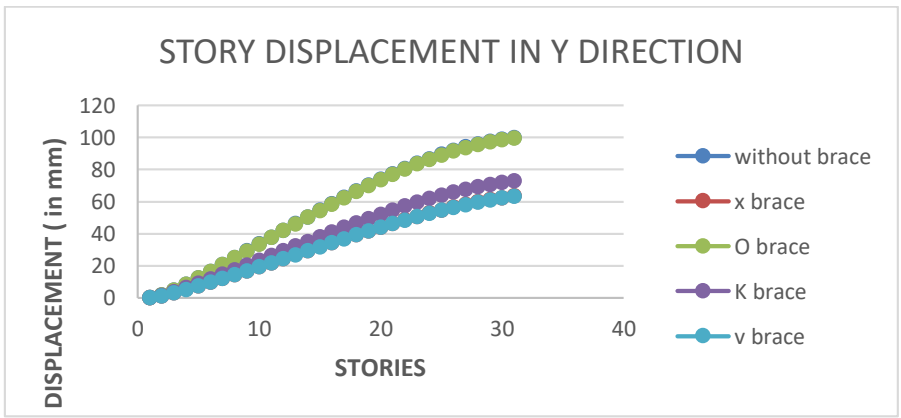


Fig. 3.4 Story Displacement in Y-Direction with different bracing

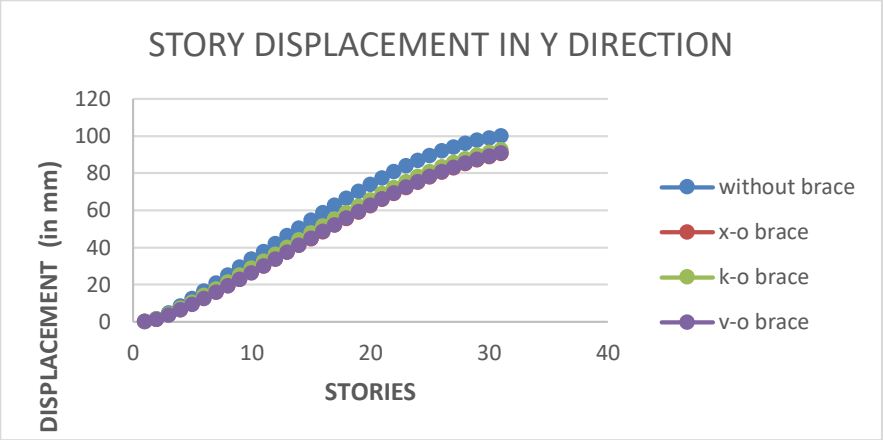


Fig. 3.5 Story Displacement in Y-Direction with combination of bracing

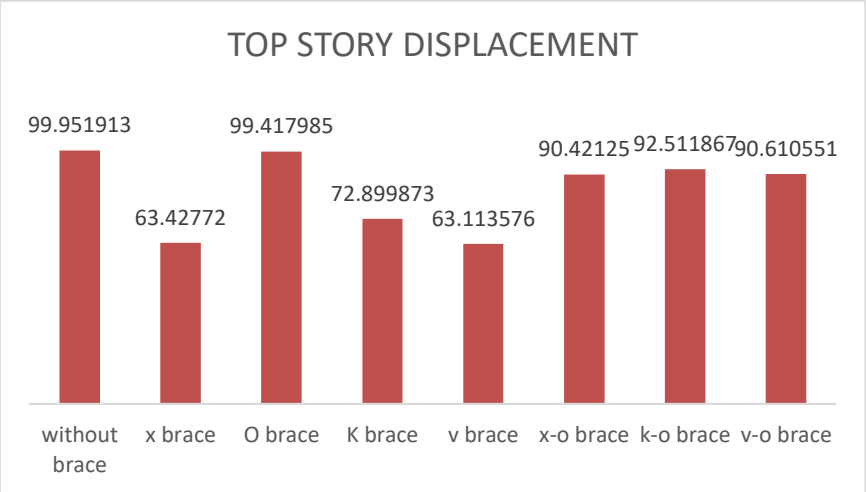


Fig. 3.6 Story Displacement in Y- Direction for top story

DISCUSSIONS:

- Above graph shows the top story displacement in Y-direction, which shows using only O bracings leads to more displacement compared to other types of bracings.
- X-bracings give less displacement compared to other types of bracings.
- But installation of X-bracings is difficult compared to o bracings and it is not a cost-effective solution.

3.3 STORY DRIFT IN X-DIRECTION

Based on the results obtained from SAP 2000 software graphs were plotted between story drift and number of stories of the building with equal interval. Graphs are plotted for displacement in X direction for both, different bracings and combination of bracings

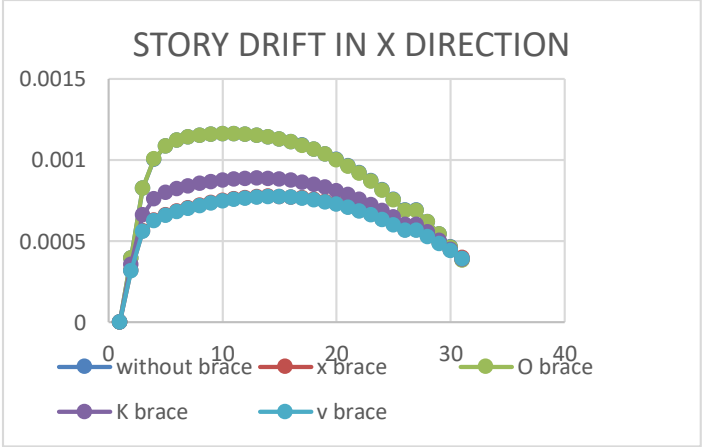


Fig. 3.7 Story Drift in X- Direction with different bracing

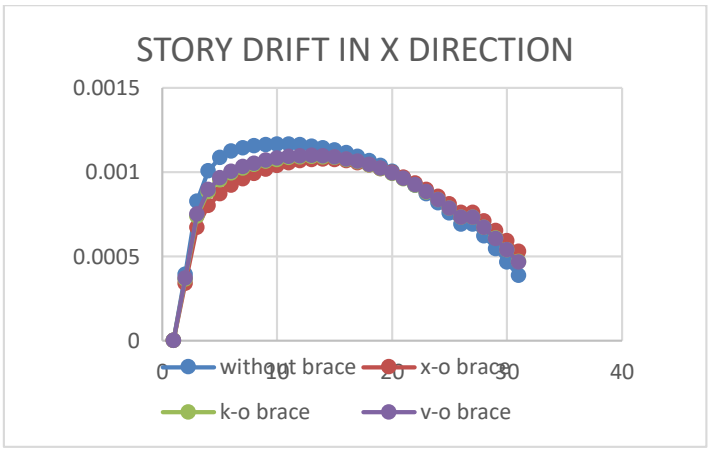


Fig. 3.8 Story Drift in X- Direction with a combination of bracing

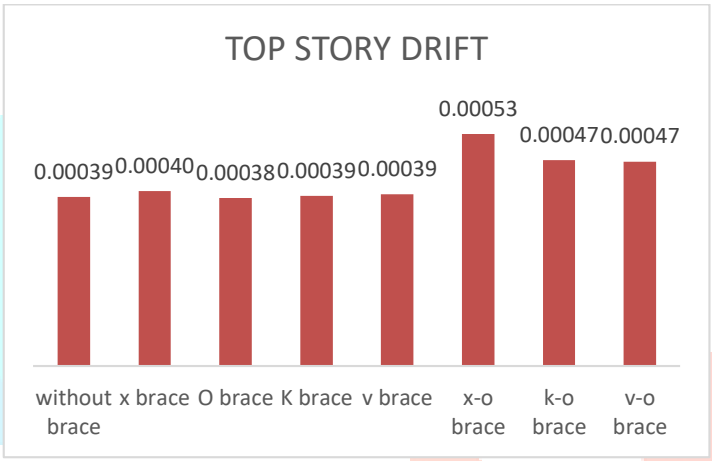


Fig. 3.9 Story Drift in X- Direction for the top story

DISCUSSIONS:

From the above results we can observe that the O grid has less story drift compared to other types of braces and combination of K-O and V-O gives less story drift compared to other combinations of braces.

3.4 STORY DRIFT IN Y-DIRECTION

Based on the results obtained from SAP 2000 software graphs were plotted between story drift and number of stories of the building with equal interval. Graphs are plotted for displacement in Y direction for both, different bracings and combination of bracings

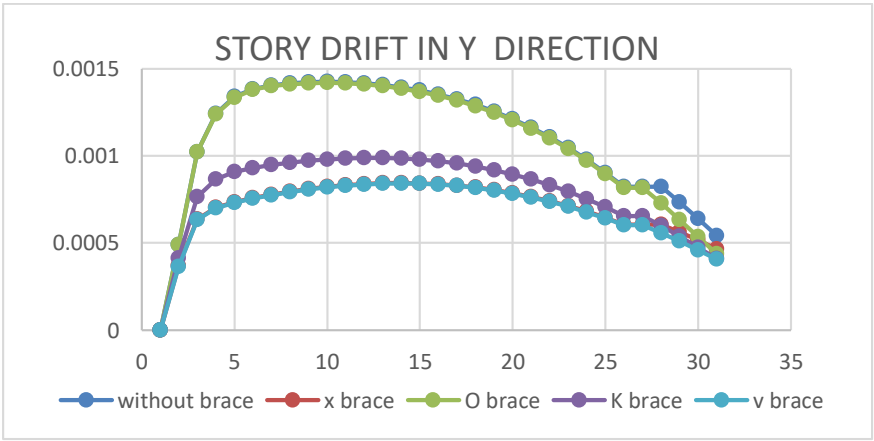


Fig. 3.10 Story Drift in Y-direction with different bracing

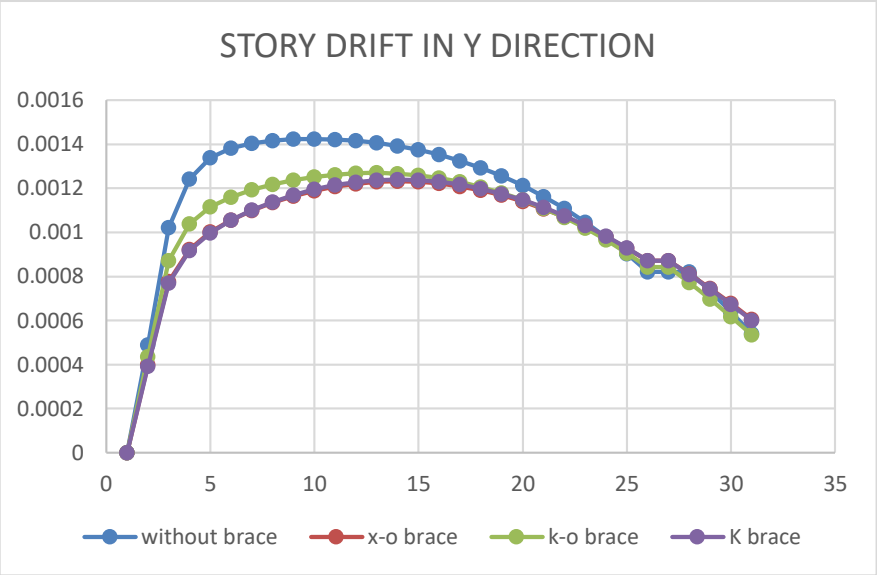


Fig. 3.11 Story drift in Y- Direction with a combination of bracing

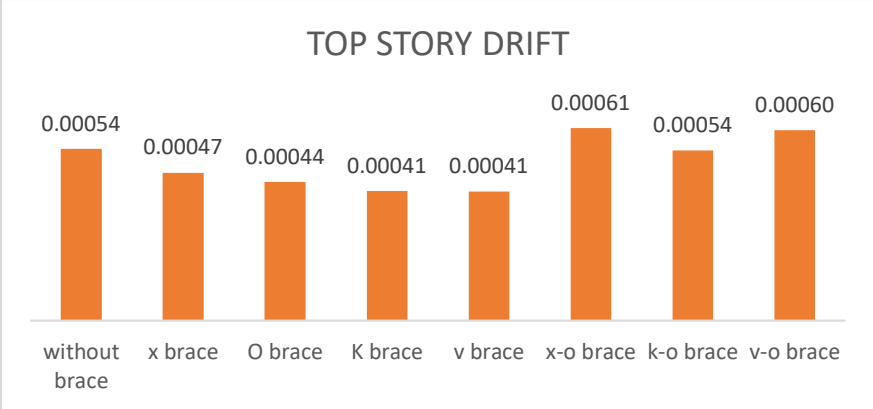


Fig. 3.12 Story drift in Y- direction for the top story

IV.CONCLUSIONS

4.1 CONCLUSIONS

Based on the observations and the results obtained during the course of this study, the following conclusions can be arrived:

- As per the results obtained from the analysis of different bracing method, K brace (65.8 mm) are less effective when compared with X (58.5 mm) and V (58.13mm) brace, as displacement due to K brace is 1.2 times of the displacement due to V brace.
- K-O brace combination is effective as the displacement is less compared to other combination as V-O brace system.
- On the basis of above results, it is concluded that concentrically braced frames had high ductility performance. Concentrically bracing system can easily retrofit with framed structures and can effectively control the various responses of the buildings such as story drift, displacement etc.
- Story displacement is also reduced to a great level such as X bracing reduces up to 58 mm, V bracing reduces up to 58 mm, K bracing reduces up to 65 mm, when compared to un braced structure with 82 mm. X bracing and V bracing are found to be more effective to control the story displacements
- This study proposed new type of bracing system O-Grid bracing system, a braced frame with a circular brace attached to a moment-resistant frame (MRF) with a joint connection to resist lateral forces. O-Grid braces, unlike other braces, have a structure and form that allows them to be employed in any portion of the structure without sacrificing architectural space or architectural form. The O-Grid bracing system is ductile and rigid

4.2 CRITICAL CONCLUSION

- Providing the combination of K-O grid is more effective and economical compared to other combinations and also individual O grid is not much effective compared to combinations of bracings

4.3 SCOPE FOR FURTHER STUDY

- The present work on the RCC structure has been studied. Further, the effect of O-Grid can be studied in steel and composite structures.
- The effect of o-grid bracing can be studied if they are models in the interior part of the building as in this study, the only external periphery is considered.
- The effect of o-grid can also be studied for o-grid encased by different bracing systems and different section properties.

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