# Seismic Analysis and Retrofitting of Existing R.C.C Building

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**Abstract- Seismic Analysis is a part of structural analysis and it deals with the calculation of the response of a building structure to earthquakes. Retrofitting of an existing building is often considered to be more cost-effective than constructing a new building. It represents an opportunity to upgrade the overall performance, sustainability and efficiency of an existing building. Seismic retrofitting is mainly done to provide existing structures with more resistance to seismic activity due to earthquake. Most losses of lives in the earthquakes in developing countries have occurred due to collapse of buildings that are mostly non-engineered. However, not designed and constructed to meet the seismic requirements. In this study, the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (Diagonal, V type, and inverted V type, X type) is studied. The bracing is provided for peripheral columns. A six-storey (G+5) building is situated at seismic zone III. The building models are analyze by equivalent static analysis as per IS 1893:2002 using Staad Pro V8i software. The main parameters consider in this paper to compare the seismic analysis of buildings are lateral displacement, storey drift, axial force, base shear. It is found that the X type of steel bracing significantly contributes to the structural stiffness and reduces the maximum interstorey drift of R.C.C building than other bracing system.**

***Keywords:*** **seismic analysis, base shear, retrofit, bracing, storey drift, etc.**

## I. INTRODUCTION

### General

Earth quake is a sudden shaking of the ground caused by movement of the tectonic plates relative to each other, both in direction and magnitude [3]. Most of the multi-storey buildings are made of RCC frame building so it's great importance given to make the structure safe against lateral load produce due to wind, earthquake. There are various lateral resisting systems and steel bracing is one of them. Due to their high strength, stiffness and lateral load capacity, steel bracing are an ideal choice for lateral load resisting system in a reinforced concrete structures [4]

### Types of Bracings

There are two types of bracing systems 1) Concentric Bracing System and 2) Eccentric Bracing System
The steel braces are usually placed in vertically aligned spans. This system allows to obtaining a great increase of stiffness with a minimal added weight.
1) Concentric bracings increase the lateral stiffness of the frame thus increases the natural frequency and also usually decreases the lateral storey drift. However, increase in the stiffness may attract a larger inertia force due to earthquake. Further, while the bracings decrease the bending moments and shear forces in columns and they increase the axial compression in the columns to which they are connected.
2) Eccentric Bracings reduce the lateral stiffness of the system and improve the energy dissipation capacity. The lateral stiffness of the system depends upon the flexural stiffness property of the beams and columns, thus reducing the lateral stiffness of the frame. The vertical component of the bracing forces due to earthquake causes lateral concentrated load on the beams at the point of connection of the eccentric bracings [4]

### Retrofit

Retrofit is the enhancement of the structural capacities of a building that is found to be deficient or vulnerable. Since it is carried out in enhancing the resistance of a vulnerable building to earthquakes, the term seismic retrofit is used. The retrofit is intended to reduce the effect of a future earthquake in the structure.
Seismic retrofit can effectively raise the performance of a building against earthquakes to a desired level, and even to satisfy the requirements of an upgraded seismic design code. [3]

### Retrofitting Techniques

Structural or Global retrofitting when the entire structural lateral load resisting system is deemed to be deficient, Structural level retrofitting is applied. Common approaches in this regard are employed to increase stiffness and strength with limited ductility. [3]

### Member or local retrofitting

Member or local retrofitting deals with an increase of the components with adequate capacities to satisfy their specific limit states. [3]

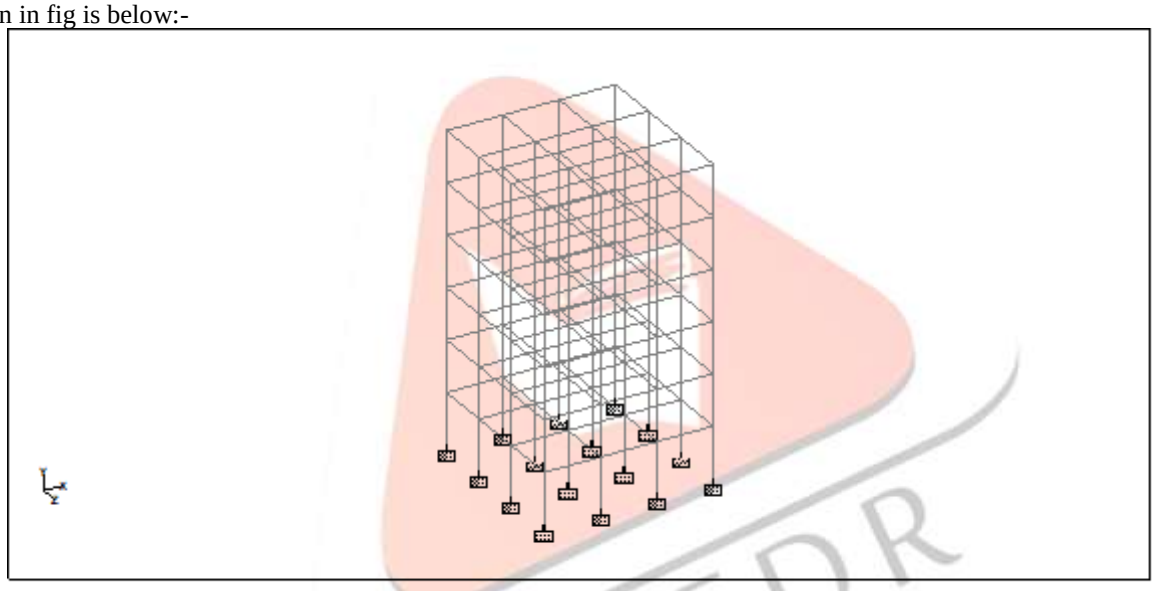
| GLOBAL | LOCAL |
|---|---|
| 1. Adding shear wall | 1. jacketing beams |
| 2. Adding infill wall | 2. Jacketing of columns |
| 3. Adding bracing | 3. jacketing of beam – column joints |
| 4. Adding wing wall/ buttresses | 4. strengthening individual footing |
| 5. Wall thickening | |
| 6. Mass reduction | |
| 7. Supplement damping and base isolation. | |

## II. MODELLING AND ANALYSIS

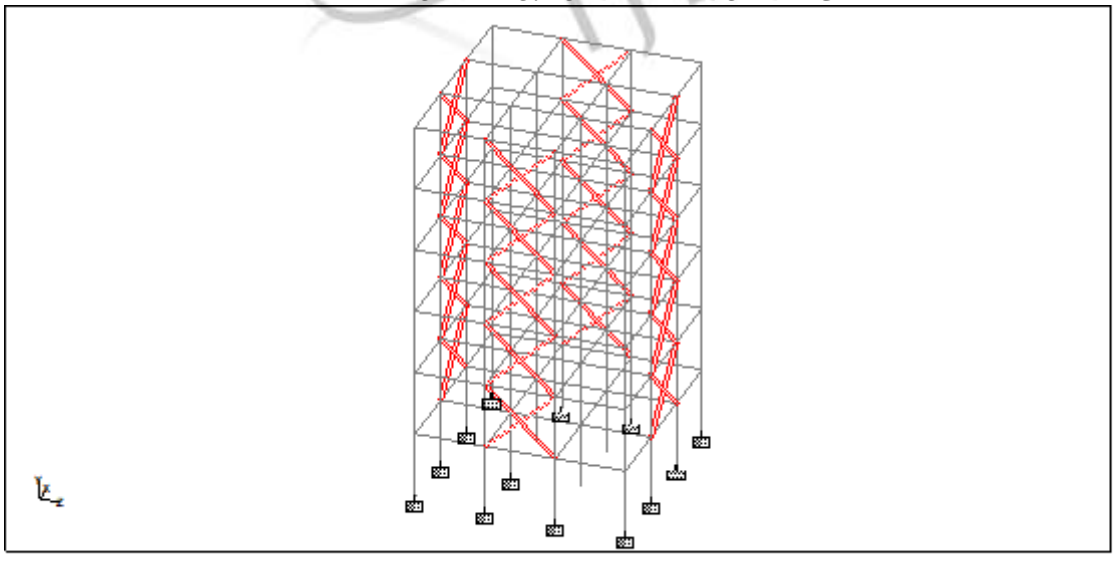
The structure is 6- storey (G+5) R.C building Frame modelled using software as a tool.

### Modelling

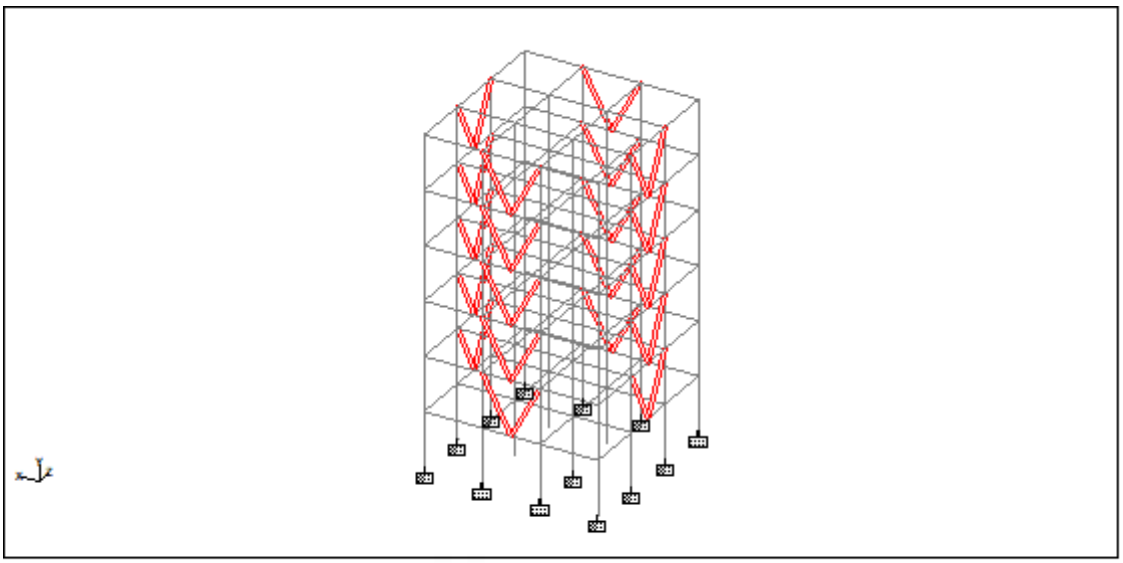
The STAAD Pro. Software is used for modelling and carrying out static analysis. The lateral loads subjected to the building are considered as per Indian standard codes. The different types of bracing added in building frames are considered for analysis as shown in fig is below:-



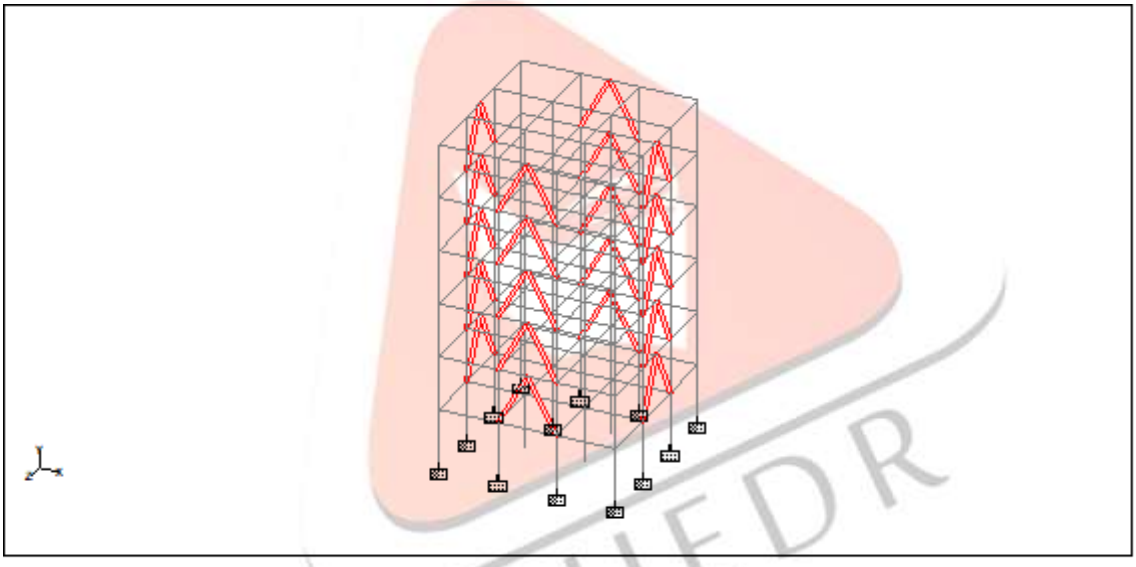
*MODEL NO.1 ORDINARY BUILDING*



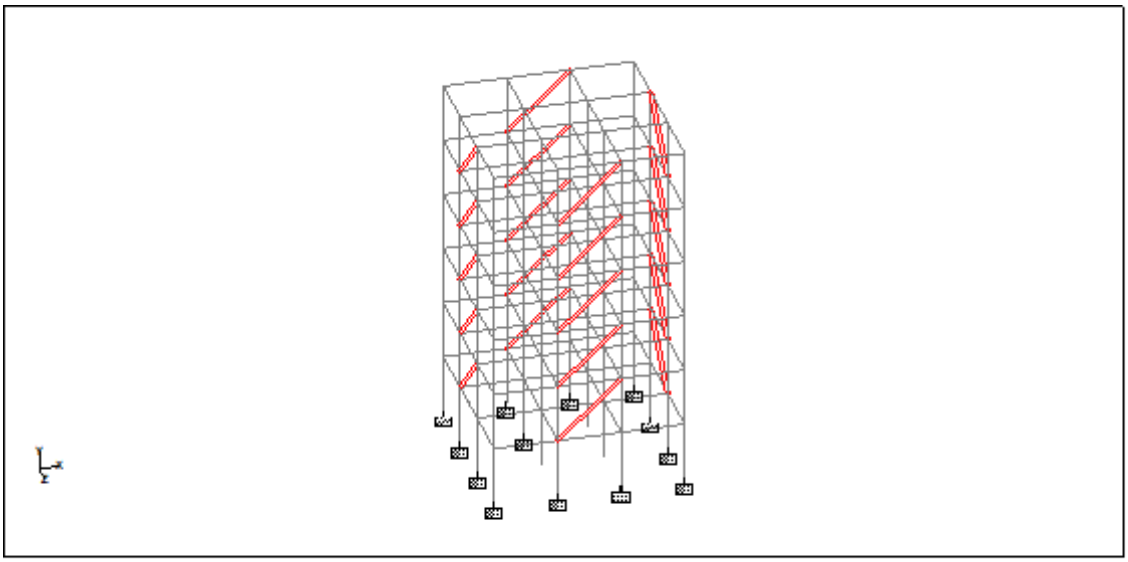
*MODEL NO.2 X-BRACING*



***MODEL NO.3 V-BRACING***



***MODEL NO.4 V-INVERTED BRACING***



*MODEL NO.5 DIAGONAL BRACING*

**Analysis**

The following data are considered:

**Preliminary data:**

Type of structure= Apartment building
Number of stories= G+5
Ground floor height= 3.0m
1 to 5$^{th}$ floor height= 3.0m

**Load combination**

As per IS 1893 (Part 1): 2002, in the limit state design of reinforced concrete structures, the following load combinations shall be accounted for: [2]

1. 1.5 (DL + LL)
2. 1.2 (DL + LL + EL)
3. 1.2 (DL + LL – EL)
4. 1.5 (DL ± EL)
5. 0.9 DL ±1.5 EL

## III. RESULTS AND DISCUSSION

**Lateral displacements**

The graph of lateral displacement versus no of storey is plotted in X- direction and Z- direction for ordinary building and with different bracing systems.

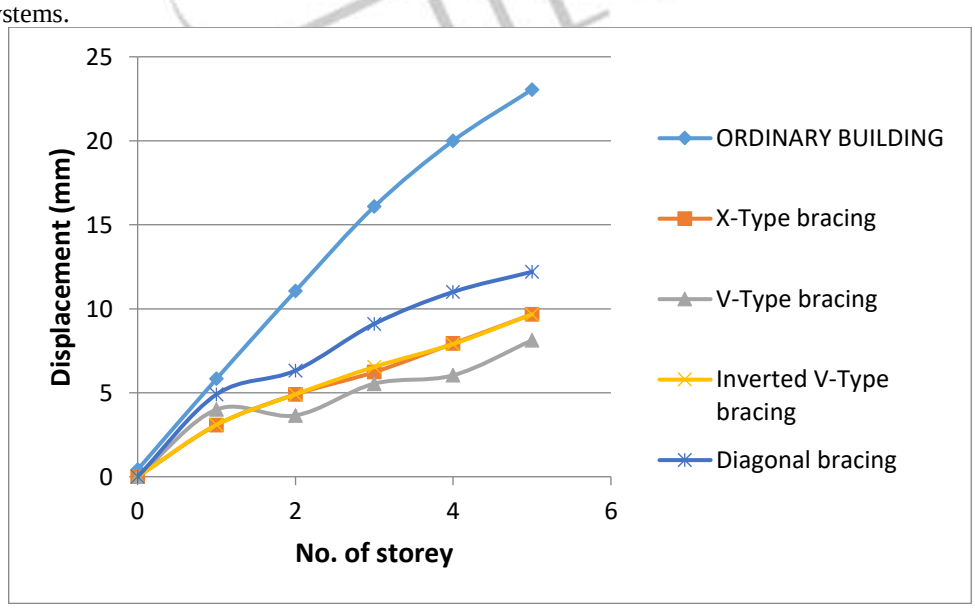



*Fig.3.1 Maximum Lateral Displacements (mm) in X- Direction*

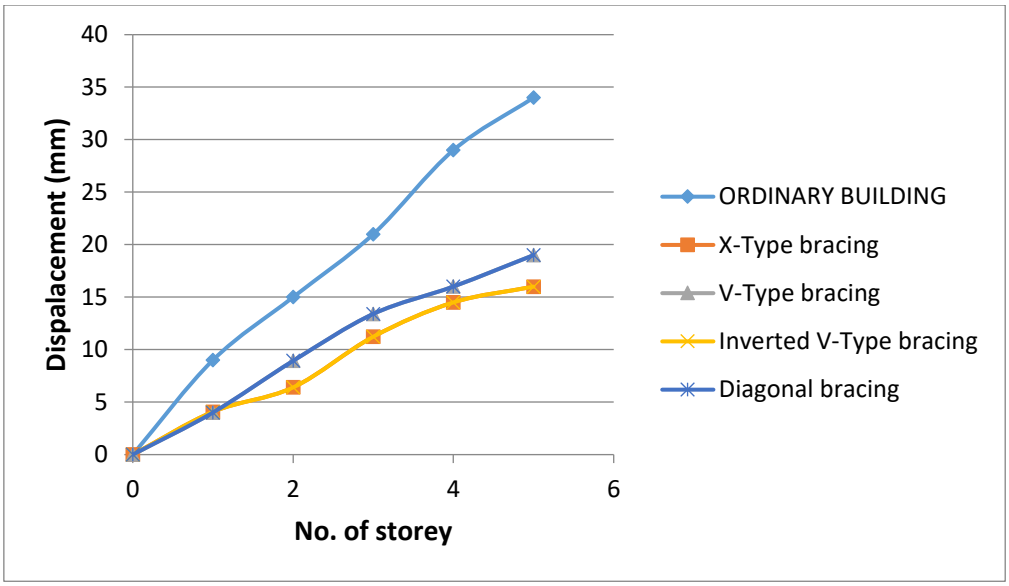



*Fig.3.2 Maximum Lateral Displacements (mm) in Z- Direction*

From fig 3.1 and 3.2, it is observed that the lateral displacement are reduced to largest extent for x-type of bracing system without bracing systems, while the displacement is maximum for the ordinary building.

**3.2 Storey Drifts**

The graphs of storey drift versus storey level are plotted in X-direction and Z- direction for the ordinary building and different bracing systems.

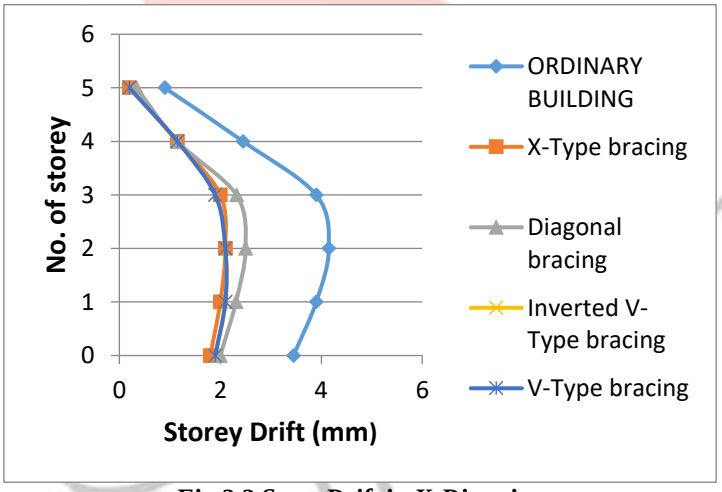



*Fig.3.3 Story Drift in X-Direction*

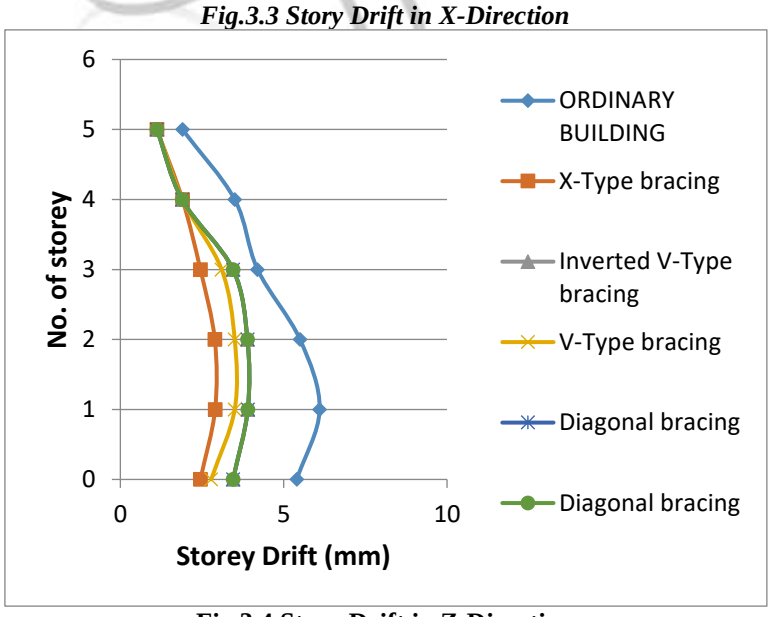



**Fig.3.4 Story Drift in Z-Direction**

From the fig 3.3 and 3.4, it can be seen that storey drift in X- braced building in both X and Y direction are reduced in comparison with the ordinary building and different types of bracing building.

**3.2 Axial Force**

The graph shows maximum axial forces in column for the ordinary building and different bracing systems in fig.

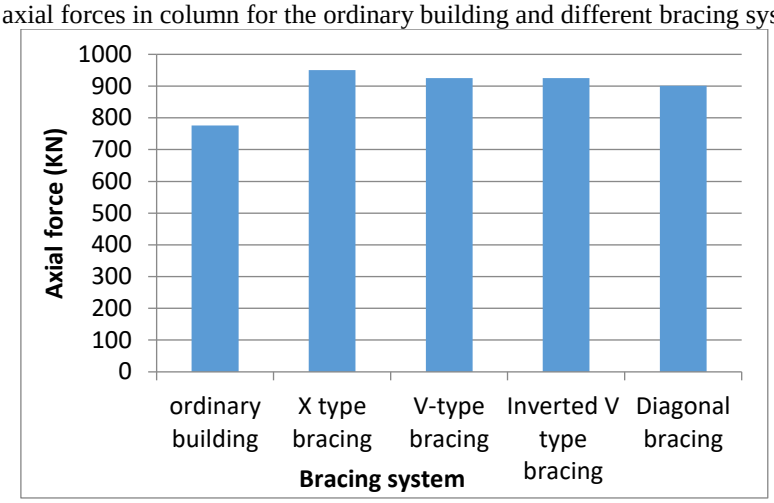



**Fig.3.5 Axial force (KN) in column**

From the graph in fig 3.5, it is observed that the axial forces are maximum for X-type bracing systems, while these are minimum for the ordinary buildings.

**3.2 Base shear**

The maximum base shears at the base for ordinary building and with different bracing system as shown in fig.

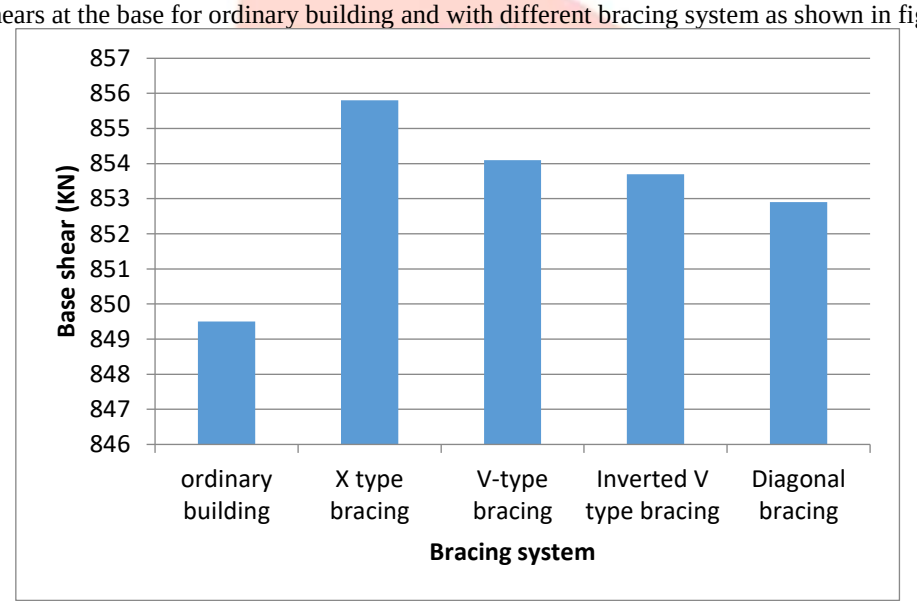



***Fig.3.6 Story Drift in X-Direction***

From the fig 3.6, it can be observed that the base shear in X bracing system is more as compared to other diagonal, V bracing system and inverted V bracing system.

## IV. CONCLUSION

The analysis of G+5 R.C.C frame structure is done and the following conclusions are drawn based on the analysis:

1. Different types of bracing system are used for strengthening or retrofitting techniques from which X-Type of bracing can be used effectively.
2. Using X- type of bracings the total weight on the existing building will not change significantly.
3. The lateral displacement of the building is reduced by 50% to 56% by the use of X Type of bracing and X Type of bracing reduces maximum displacement.
4. The building with X type of bracing increases its base shear as compared with ordinary building.

## V. REFERENCES

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