

# **RESPONSE SIMULATION OF G+16 COMMERCIAL BUILDING WITH DIFFERENT TYPES OF BRACING SYSTEM USING ETABS**

## **ABSTRACT**

Multistory structures are mostly affected by tremor compel in seismic inclined zone. The real issue in the plan of multi story structure is the buildings mostly has enough horizontal solidness and opposes sidelong powers to control lateral float of the structures. The structural analysis is the branch where it involves modelling of structure, assign respective loadings and analyse the behaviour of structures and to predict the responses of each and every structural components due to external loads. Our project “Response simulation of G+16 Commercial Building with different types of bracings like single diagonal, V bracing, inverted V bracing, X bracing and K bracing using ETABS Software” is one of the attempts made to analyze and design a commercial building using ETABS. Steel bracings are economical with easy erection, occupy less space and have flexibility to design to meet the required strength parameter and stiffness. In the model, considered the building model with different types of bracing systems based on the journals I have come across with, so the project concentrated with some of the design factors like Storey Displacement, Drifts and story stiffness.

## **1. INTRODUCTION**

Structures are constructed to give the specific performance of various activities connected with residential, offices, educational field, health cares unit, sports and recreation transportations, storage bins, electric generation, etc. Everyone of the structures ought to maintain the heaps going ahead them amid their administration life by having satisfactory quality and further more confine them is happening by having enough solidness. Quality of a structure relies upon attributes of the material with which it developed and Stiffness relies on the cross sectional and geometrical property of the structure. Tall building or multistoried building characterized a side also fits statue (in excess of 30m), is influenced by horizontal forces because of wind or seismic tremor or both to a degree that they assume a critical part in the basic plan. Auxiliary examination manages the instrument of recovery of burdens connected on the framework into nearby component drive, utilizing different hypothesis and hypothesis articulated by famous specialists and agents.

Probably, reason for the high rise buildings is to transfer primary gravity load safely to the components on small area. The commonly considered gravity loads are dead load and live load. Additionally the structure also should withstand the lateral loads caused by earthquake and wind depending on terrain category and zone. Lateral loads produces sway moment and then reduces the stability of structure and inducing high stresses to the structure. In such cases stiffness also plays more important role than strength to resist lateral loads buildings.

The different types of bracing configurations used are: Cross bracing (X), V bracing, Diagonal bracing, K bracing and inverted V bracing. Each bracing configuration possess its own merits and demerits as compared to each other.

### **1.1 ETABS**

ETABS offers the widest application of analysis and design tools available for the structural engineering works on building structures.

The following lists indicates a portion of the types of systems and analyses that ETABS can handle easily:

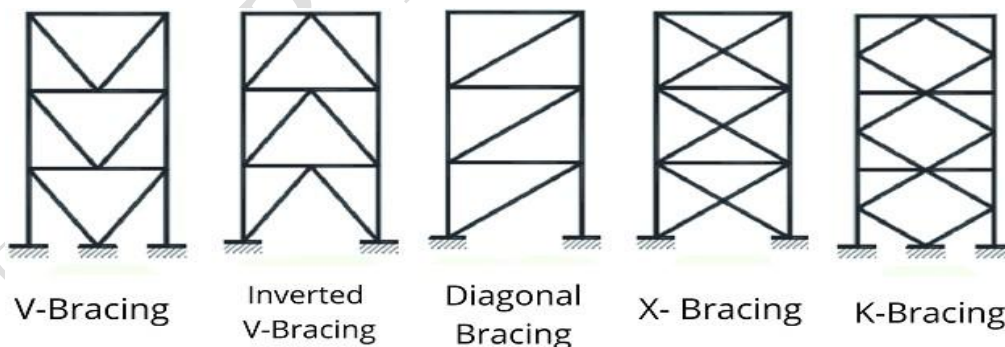
- Multi-story residential, commercial and health care buildings and facilities.
- Parking lots or garages with linear and circular ramps

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- Staggered truss buildings
- Buildings with concrete, steel, composite framing.
- Static and dynamic analysis of moment frames and shear walls.
- Explicit design and analysis of frames and shell elements of irregular shapes.
- Buildings based on multiple rectangular and/or cylindrical grid systems
  - Flat and ribbed slab buildings
  - Vertical loads are transferred automatically to frames.
  - P-Delta analysis with static or dynamic analysis
  - Construction sequence loading analysis

## 1.2 Bracings

- Bracing system enhances stiffness and capacity of structure and upgrades seismic performance of the frame.
- Braces supports the resistance towards lateral loads with bracing action.
- The braces simulate force with the associated beams and columns, so that all work together as onetrussmember.
- These are of less weight compared to the concrete material.
- Steel bracing systems provide openings and easy to erect.
- In this thesis steel bracing of ISMB350 is used



## 2. OBJECTIVE

- Analysing 16 story building using ETABS software without bracings and with bracings of different configurations.
- Comparing the response of different braced and unbraced building subjected to gravity and lateral loads.

- c. Identifying the suitable bracing system to resist the lateral loads effectively.
- d. In this thesis, X, K, diagonal, V and inverted V bracing systems are used.

## 2.1. Description of the Building

In this thesis 16 story building of having four bays each are having the four meter length. The following are the description of the building.

- Type of the frame: Special moment resisting frame
- Number of stories: 17
- Zone: 2
- Importance factor(I): 1
- Response reduction factor (R): 5
- Slab thickness: 150mm
- Live load: 5.0KN/m<sup>2</sup>
- Height of the floor: 3m.
- M40 grade concrete is used
- Fe500 steel is used.
- ISMB350 is used for steel bracing.

## 2.2 Modelling of building:

A sixteen story building with parking lot upto 7 stories and commercial area for 9 stories is analysed without bracing systems and with X- type bracing, V- bracing system, inverted V- type bracing system and their comparison of storey displacements, storey drifts and story stiffness results.

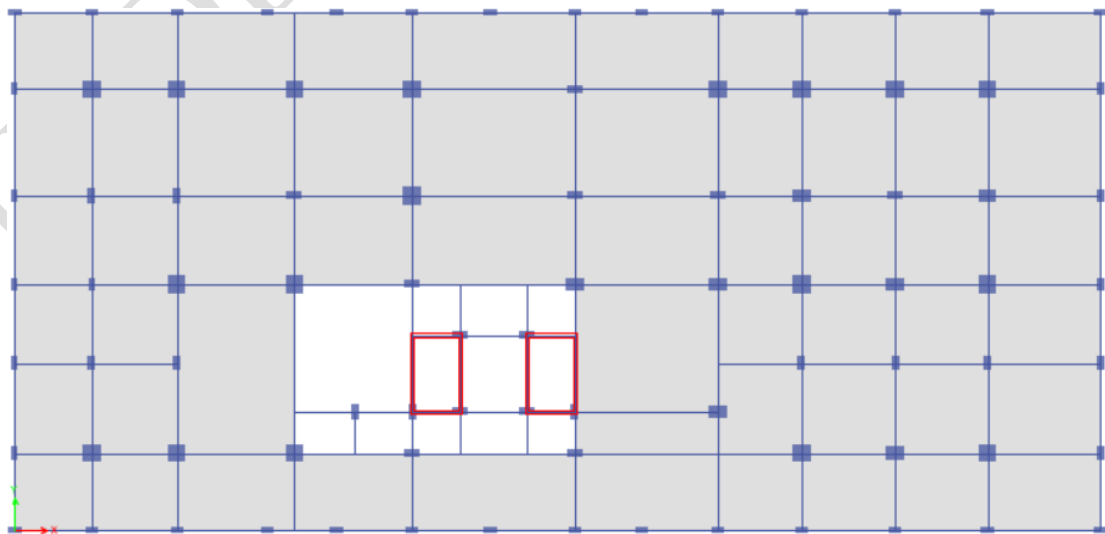


Figure 1 : Plan of the building

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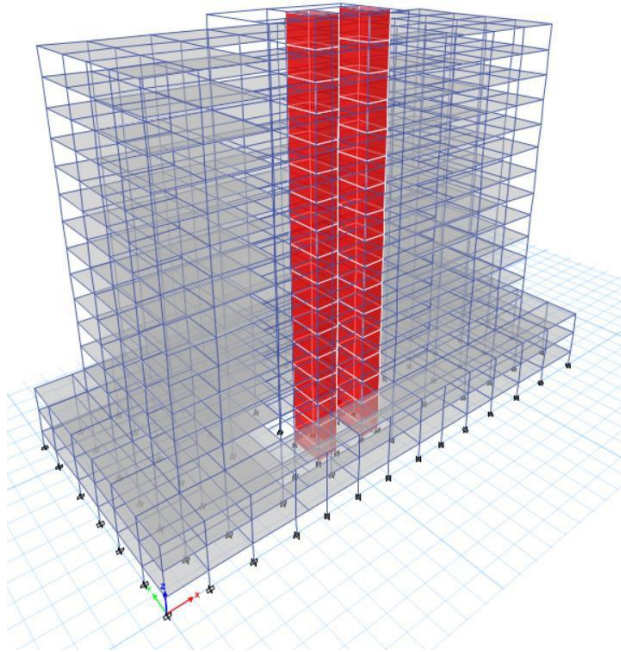


Image a. Bareframe

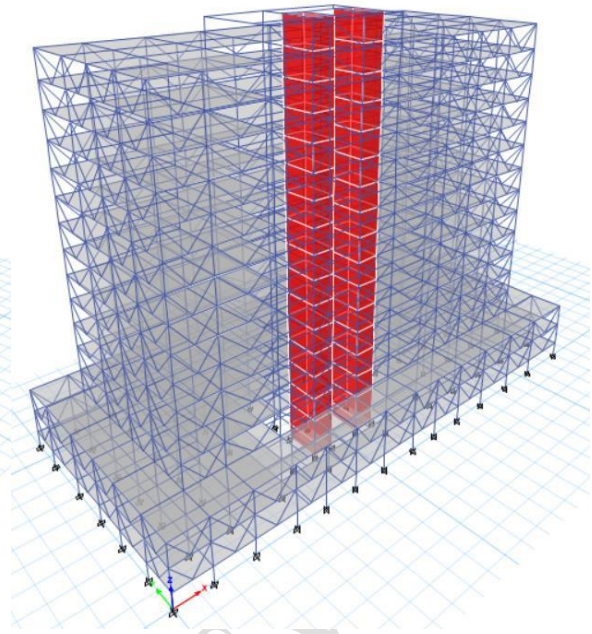


Image b. V bracings

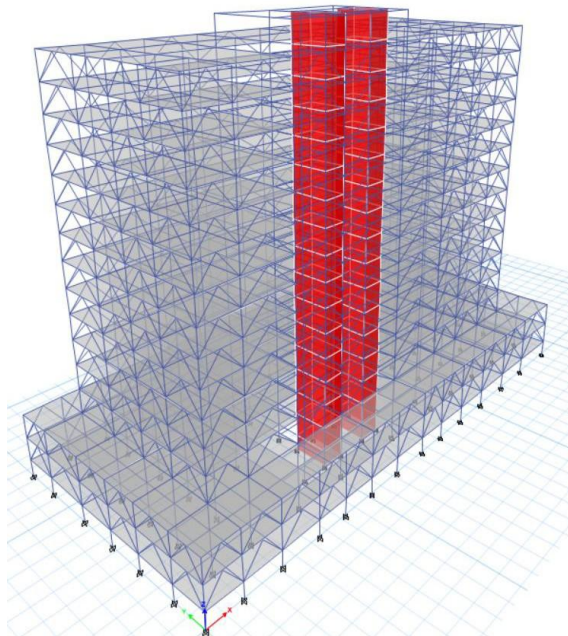


Image c. Inverted Vbracings

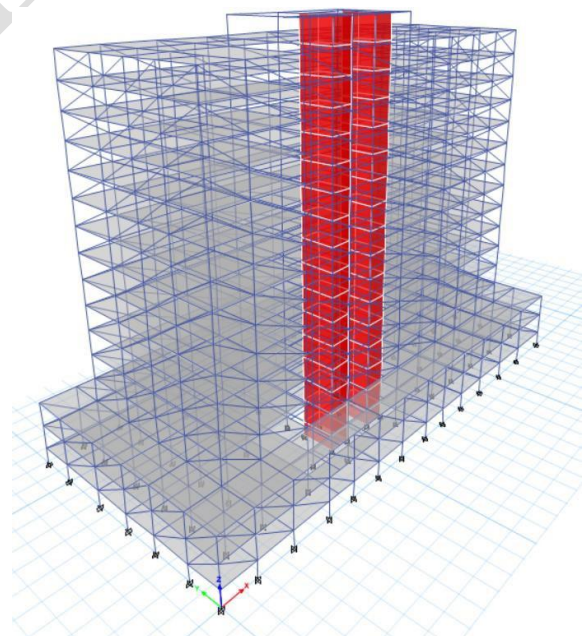


Image d. Diagonalbracings

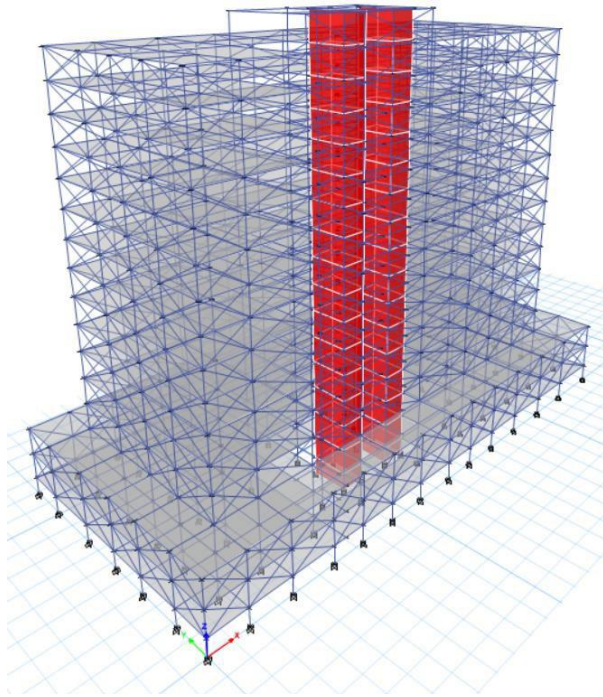


Image e. X bracings

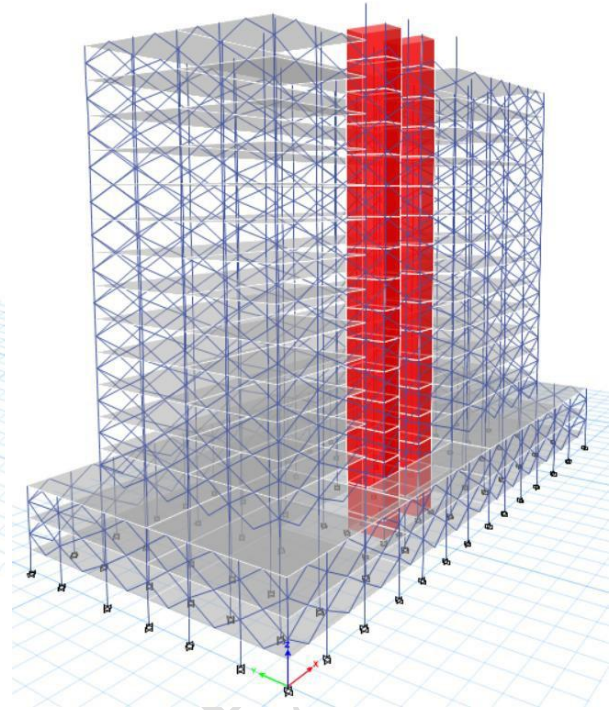


Image k . K bracings

### 3.6 Loading Cases

The kinds of loads that impose on buildings and other structures can be classified broadly as vertical, horizontal and longitudinal loads. The vertical load consists of dead, live and impact loads. Horizontal loads consist of wind and seismic load. In this case of outrigger structure all the aforementioned loads have been taken into consideration. The anticipated types of loads imposing on the structure are dead, live, wind and seismic loads. Based upon these loads, load combinations have been generated with the model created in ETABS.

#### 3.6.1 Dead Loads

Dead loads are vertical loads that are permanent and stationary during the lifespan of structure. Dead load is majorly because of self-weight of structural elements, fixed partition walls, fixed equipment and weight of various materials. It mostly comprises the weight of roofs, beams, walls and column etc. which otherwise are the permanent components of the structure. In this particular project the estimated dead loads are mentioned below.

Self-weight of members

1. Floor and finishing loads =  $1.5 \text{ kN/m}^2$
2. Wall load used according to codes

#### 3.6.2 Live Loads

The next loads taken for design of structure are live loads are imposed loads. Live loads are both movable and moving loads except occurrence of acceleration or impact. These loads are presumed to be formed by the purposeful use and occupancy of the building incorporating weight of portable furniture and partitions. Live loads keep on altering at certain time periods. All these loads are to be

presumed by the structural designer since it is one of the crucial loads in the design. Since the project is according to Indian standards, the least values of live loads as given in IS 875 (Part 2):1987. 1. Live load on floors/slabs =4 kN/m<sup>2</sup>

### **3.6.3 Earthquake Load**

Further earthquake forces are engendered by inertial virtue of buildings as they respond dynamically to ground motion. This natural dynamic response keeps earthquake loads pointed distinctly from other variant building loads. Seismic loads upon the structure are computed specified in the design memorandum and conforming to the terms of IS 1893-2002(Part1). The analysis is executed by Static analysis method in ETABS 2015. The structure is analyzed with other loads with seismic combination in both transverse and longitudinal directions and also in the opposite sense by reversing the sign in the load combination. Based on the Indian code of practice for earthquake loads, the seismic parameters looked into the analysis process areas follows.

#### **Seismic Zone**

Seismic zone is a certain zone where in the rate of seismic function prevails quite consistent. This means that seismic activity is immensely peculiar, or that it is acutely common. The main zones in India are four and they are called Zone II, III, IV and V.

#### **Seismic Zone Factor (Z)**

This parameter obtains the spectrum design dependent on discerned superlative seismic threat constituted by maximum considered earthquake (MCE) in zones where structures are present. Effective peak ground acceleration is of a standard reasonable estimate wherein the basic zone factors are included.

#### **Response Reduction Factor(R)**

This factor by which the actual base shear force, that will be generated if the structure is to stay elastic during its response to the Design Basis – Earthquake (DBE) shaking should be contained to obtain design lateral force.

#### **Importance Factor (I):**

This factor is used to achieve the design seismic force which is dependent on functional use of structure, constituted by dangerous repercussions of its failure, its post-earthquake function, historic and economic importance.

#### **Structural Response Factor (Sa/g)**

This parameter denotes the acceleration response spectrum of structure exposed to earthquake ground vibrations, even dependent on natural period of vibration and damping. Damping (%) Results of internalized friction and imperfections in material elasticity, sliding and slipping in decreasing the amplitude of vibration is further more characterized as damping percentage

#### **Natural Period (T)**

Natural period of structure is defined as time period of undamped free vibration.

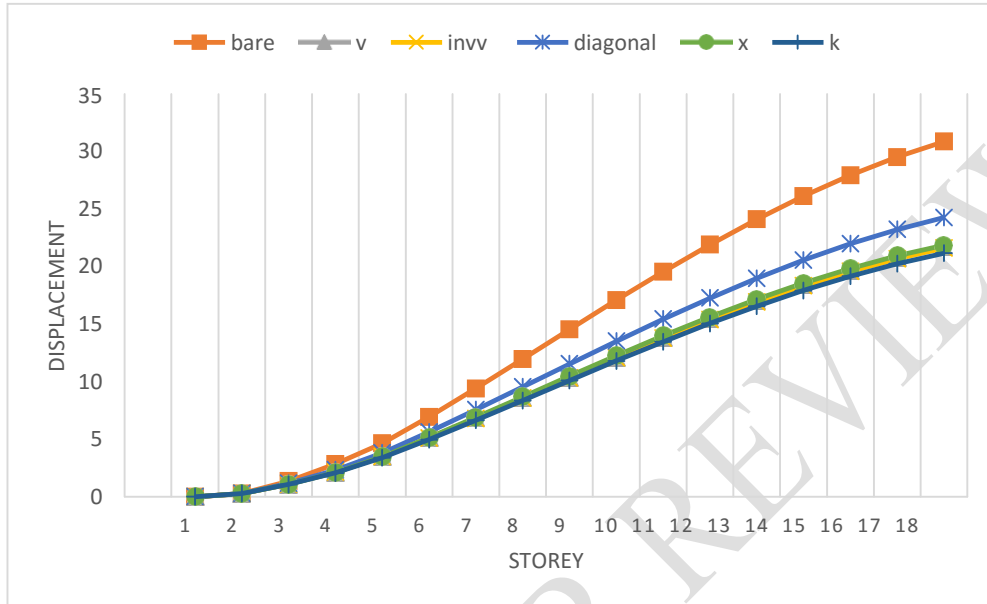
### **3.6.4 Wind Load**

The anticipated wind loads acting on the proposed building are discussed further in this section. Wind loads constitute dynamic and static components. Loads given in code are the corresponding static wind loads; under the static deformation of structure is equivalent to the sum of dynamic and static deformations introduced by wind. The final wind load over the principle load bearing system of the structure is equivalent to vector total of all wind loads exploiting on all surfaces of the structure. Calculations for wind loads for the project was done in precedence with clauses of ARE 875:1987(Part3).

### 3. RESULTS AND DISCUSSION

#### 3.1 STOREY DISPLACEMENT:

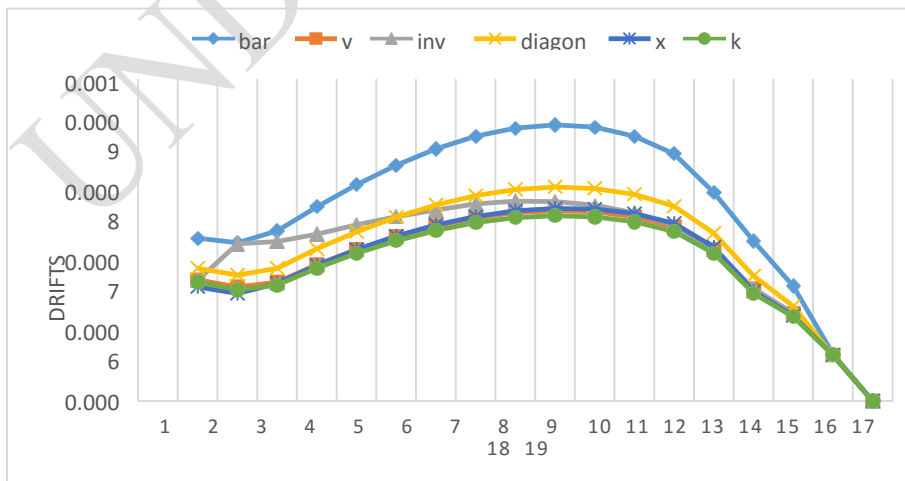
Storey displacement is displacement with respect to base of the structure. It is total displacement of *i*th storey and maximum permissible limit prescribed in IS codes for buildings is  $H/500$  where *H* is the building height.



**Graph 1 : Displacement variation for different types of bracings in Zone 2**

#### 3.2 STOREY DRIFT:

Storey drift is a useful engineering lateral load response measurement and indicates structural performance, especially for high-rise buildings. Drift is defined as relative lateral displacement. Storey drift is the ratio of relative displacement difference with the storey height. Storey drift is the relative displacement between adjacent two stories of a building during earthquake.

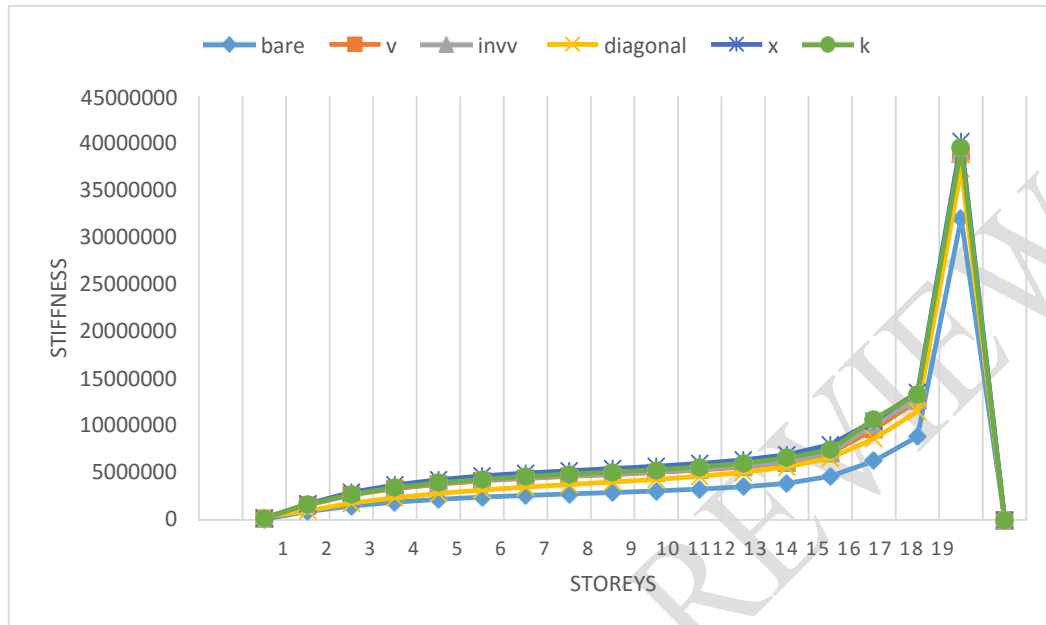


**Graph 2 : DriftvariationfordifferenttypesofbracingsinZone2**

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### 3.3 Storeystiffness:

Stiffness of the building is more having the lesser in deflection. The following graph shows graphical representation of buildings with different bracings.



**Graph 3 : Stiffnessvariationfordifferenttypesof bracingsinZone2**

### 4. CONCLUSIONS:

1. Strength of the building will increase on adding of the bracings, more in X bracing compared to others. Stiffness will be less so that behave flexibly so that safe condition achieved.
2. All the storey displacement values are in limitations as per IS codes, for the different bracing conditions.
3. Storey drift of K bracing is 32% less than compared to bare frame system.
4. The performance of K – bracing and inverted V bracing is better than other specified bracing systems.

### REFERENCES:

[1] Nauman Mohammed, Islam Nazrul, "Behaviour of Multistorey RCC Structure with Different Type of Bracing System", Vol. 2, Issue 12, December 2013.

[2] IS 1893(Part-I) 2002: Criteria for Earthquake Resistant Design of Structures, Part-I General Provision and Buildings (Fifth Revision). Bureau of Indian Standards, New Delhi

[3] IS 875: Part III – Code of Practice for design loads (other than earthquake) for buildings and structures.

[4] Nauman Mohammed and Islam Nazrul, Behaviour of Multi-storey RCC Structure with Different Type of Bracing System (A Software Approach), IJRSET, New Delhi, 2013, pp 7465-7478.

[5] Rishi Mishra et al (2014), "Analysis of RC Building frames for seismic for using different types of Bracing systems in this study analysis of high rise rc building frames have been carried out with +10 floors in staad".

[6] A. Moein Amini, "A Study on the Effect of Bracing Arrangement in the Seismic Behavior Buildings with Various Concentric Bracings by Nonlinear Static and Dynamic Analyses"

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