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SEISMIC ANALYSIS OF PLAN REGULAR AND IRREGULAR BUILDINGS

Prof. Sujeet Patil[1], Pooja Matnalli[2], Priyanka S V[3], Rooparani[4], Rajamma[5]

[1]*Assistant Professor, Department of Civil Engineering, PDA College of Engineering, Kalaburagi, Karnatka, India 585102.*

[2,3,4,5]*B.E Students, Department of Civil Engineering, PDA College of Engineering, Kalaburagi, Karnatka, India 585102.*

Abstract - *Reinforced concrete structures are mostly used in India since this is the most convenient and economic system for low rise buildings. However, for medium to high rise building this type of structure is no longer economic because of increases dead load, less stiffness, span restriction. So the structural engineers are facing the challenge of striving for the most efficient and economic design solution. This paper is an attempt to evaluate and compare seismic performance of G+14 Storey with 7 bays X 9 bays plan irregular and Regular building using ETABs 2015 software. The building is analyzed in the region of earthquake zone IV on a medium soil. Equivalent static analysis (ESA) and Response spectrum analysis (RSA) method is used. Storey displacement, Storey drift and Base shear are considered as parameters.*

Key Words*: *Seismic force, Plan regular & irregular buildings, Staorey displacement, Storey drift, Base shear, Equivalent static method, Response spectrum method.

1. INTRODUCTION

Nowadays, the increase in population of cities demands more houses and space of land for living. The multistory residential buildings can provide higher number of houses and requires less space of land. Most buildings are constructed by irregular in both plan and vertical configuration. Buildings suffer much less damages in earthquake than buildings with irregular configurations having simple regular geometry and uniformly distributed mass and stiffness in plan as well as elevation.

Irregularities in buildings causes eccentricity between the building mass and stiffness centers, give rise to damaging effect on building. Moreover to design and analyze an irregular building a significantly high level of engineering and designer effort are needed, whereas a regular building can be easily analysed and designed without much difficulties.

To analyze and design a multistorey building safe against earthquakes we need a

1. Good structural configuration.
2. Selection of lateral load resisting system.
3. Dynamic characteristics.
4. Construction quality.

Plan irregularity typically refers to the uneven distribution of stiffness or strength in the plan of a structure. Structure with plan irregularity quite often suffer severe damage in earthquake events.

2. METHODOLOGY

It is an attempt to investigate the effect of irregular plan configuration for multistoried reinforced concrete building model. This project mainly emphasizes on analysis of a multistorey building (G+14) which is irregular in plan. Modelling of 15 storeyes R.C.C. building will be done on the ETABs 2015 Software for analysis. The analysis of structures such as Maximum Storey displacement, Base Shear & Storey Drift.

Here the Study is carried out for the behavior of G+14 Multistory Buildings, Floor height provided as 3m and also the properties are defined for the building structure. The model of the buildings is created in ETABs Software. The Seismic Zone considered is Zone IV and soil type is medium. The modeling of Building is done for the Indian seismic zone IV, IS 1893-2002 for the given structure, loading with the applied loads includes Live load, Earthquake Load and Dead load. Analysis is carried out by the Response spectrum analysis using ETABs software. The analysis is carried out to determine maximum storey displacement, storey drift and base shear. After analysis, results are obtained in the form of graphs which are in tern observed to form conclusion.

2.1 METHODS OF SEISMIC ANALYSIS

The seismic analysis method can be divided into linear methods (linear static or equivalent force method and Linear Dynamic Response Spectrum method) and non linear methods (Nonlinear static method or pushover analysis and non linear dynamic or Time history method).

2.2.1 The analysis performed in this study is discussed below.

1. EQUIVALENT STATIC ANALYSIS METHOID

This method of finding design lateral force is also known as equivalent static method or linear static method. This method is found to be simple method as it requires less computational effort and is based on the formulae as per the

coad of practice. First the design base shear is computed for the whole building and then the resulted base shear is distributed all along the hight of the building.

2. RESPONSE SPECTRUM METHOD

Response spectrum analysis is linear dynamic analysis method which measures the contribution from each natural mode of vibration to indicate the maximum seismic response of an elastic structures. Response spectrum analysis is mainly used to determine the response to random or time dependent loading condition such as Earthquake and wind load. This method is also known as a linear dynamic analysis. In this method the Earthquake response spectrum directly gives the peak response of a structure during an earthquake. For the structural design applications this method gives quite accurate results. In this method, multiple modes of response of a building to an earthquake are taken into account. Then for each mode, a response is read from the design spectrum, based on the modal frequency and the modal masses. The response of the different modes are then combined to provide an estimate of the total response of the structure using the modal combination methods.

3. OBJECTIVES:

1. Creation of 3-D Building model for both elastic and inelastic method of analysis.
2. To know the behavior of building when subjected to Seismic loading.
3. Study and Comparison of parameters such as the Storey displacement, storey drift and base shear of both plan irregular and regular building using equivalent static method & response spectrum method.

4. METHOD OF ANALYSIS

This study is conducted to understand the structural behavior of plan irregular building in comparison to regular building under seismic loading. It is recommended that for analysis of plan irregular building dynamic analysis need to be carried out, equivalent static method being more suitable for regular buildings. Hence response spectrum method of dynamic is chosen for analysis by utilizing software 2015.

4.1 Description of the Models

A 15 storey building of 7 X 9 bays in both X and Y direction with typical storey height of 3 m is considered for both plan irregular and irregular building. Two buildings (Irregular in plan) are considered to study the effect of irregularity on seismic behaviour.

We have considered three models for the study.

- Model 1 :- Plan Regular building
- Model 2 & 3 :- Plan Irregular building

Table -1: RCC Building details

General specification	
No. of stories	15
Total height of building	45.1 m
Storey height	3m
Bottom storey height	3.1 m
Thickness of wall	230 mm
Live load	4 KN/m2
Wall load	12.42 KN/m
Floor load	1 KN/m2
Roof live load	1.5 KN/m2
Grade of concrete	M30
Grade of reinforced steel	Fe 415
Density of Brick masonry	18 KN/m3
Size of column	500 x 500 mm
Size of beam	400 x 400 mm
Thickness of Slab	120 mm
Zone	IV
Soil type	Medium
Importance factor	1
Seismic zone factor	0.24

4.2 Modeling different models in ETABS Software

1. **Regular building**

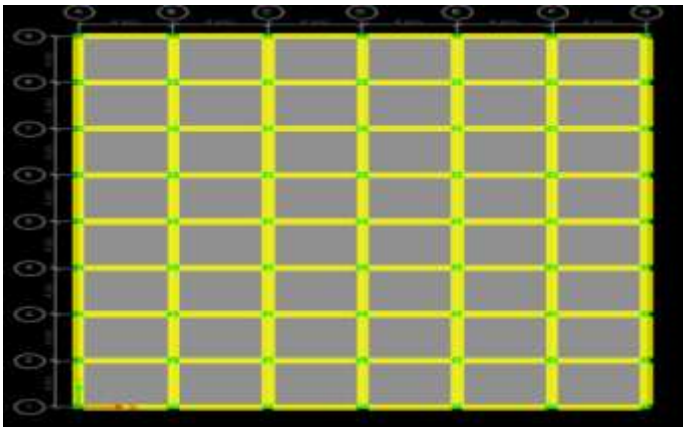

Fig -1: Plan of model 1

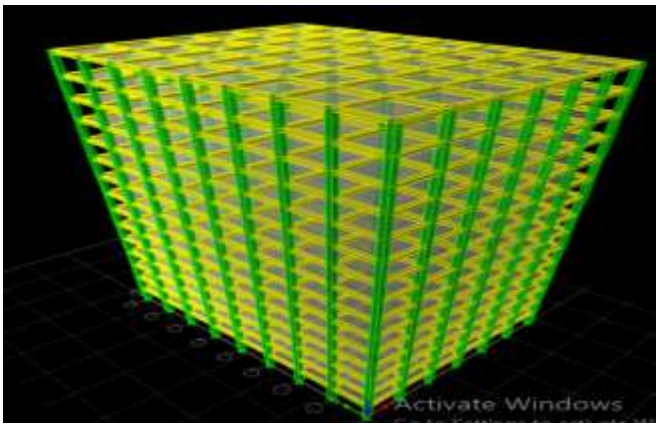

Fig -2: 3D Elevation of model 1

2. Plan Irregular building

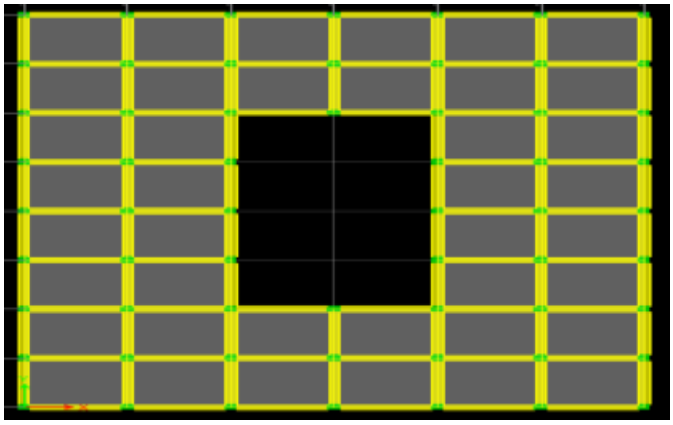

Fig -3: Plan of model 2

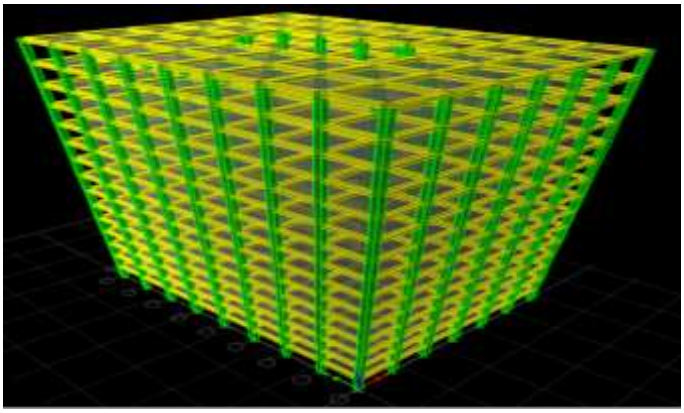

Fig -4: 3D Elevation of Model 2

3. Plan Irregular building

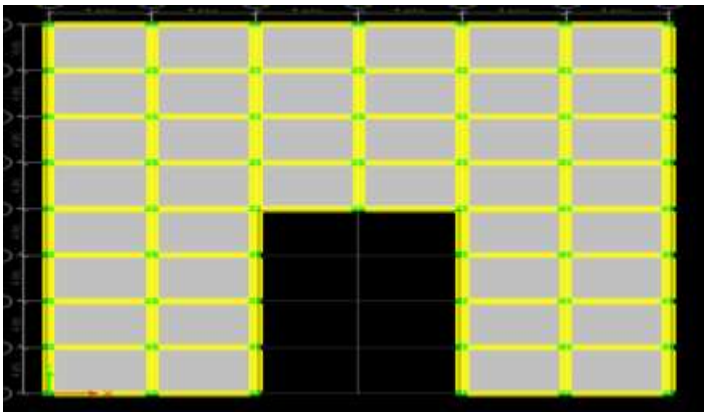

Fig -5: Plan of model 3

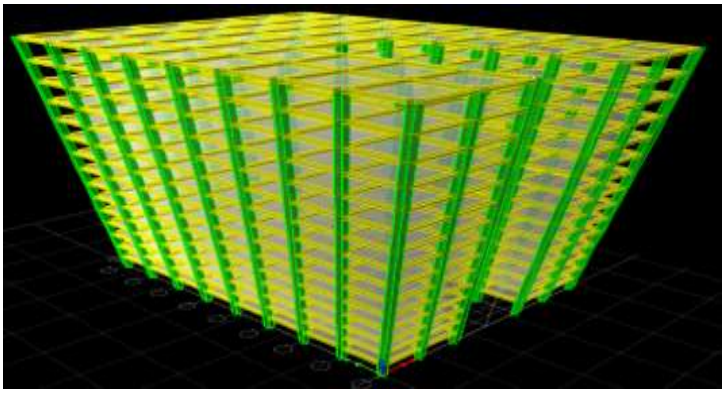

Fig -6: 3D Elevation of Model 3

5. RESULT AND DISCUSSION

1. MAX STOREY DISPLACEMENT:

- **Storey displacement of different RCC models along X direction (EQ-X) for Equivalent static analysis**.

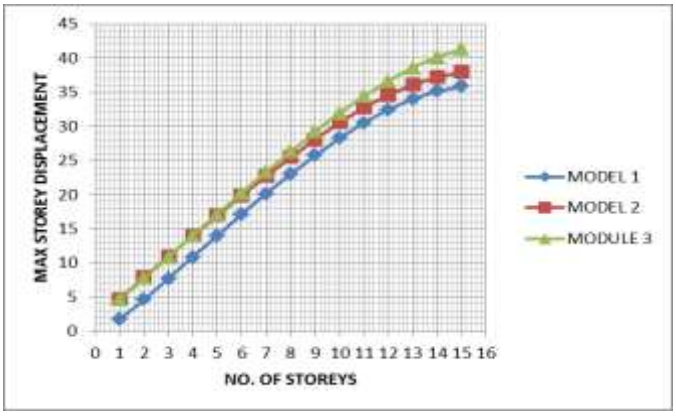

Chart -1: From the chart it is observed that the Storey displacement is maximum for model 3 compare to model 1 & 2.

- **Storey displacement of different RCC models along Y direction (EQ-Y) for Equivalent static analysis**

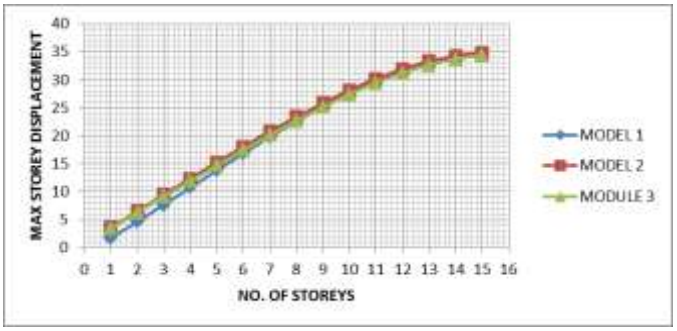

Chart -2: From the chart it is observed that the storey displacement is maximum for model 2 compare to other models.

- **Storey displacement of different RCC models along X direction (RSA-X) for response spectrum analysis**

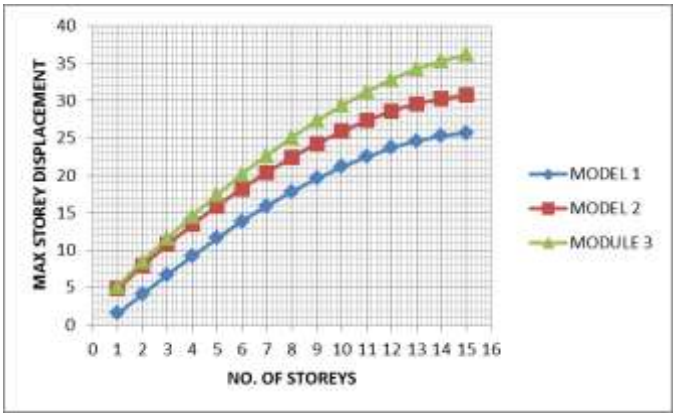

Chart -3: From the chart it is observed that the storey displacement is maximum for model 3 compared to model 1 & 2.

- **Storey displacement of different RCC models along Y-direction (RSA-Y) for response spectrum analysis.**

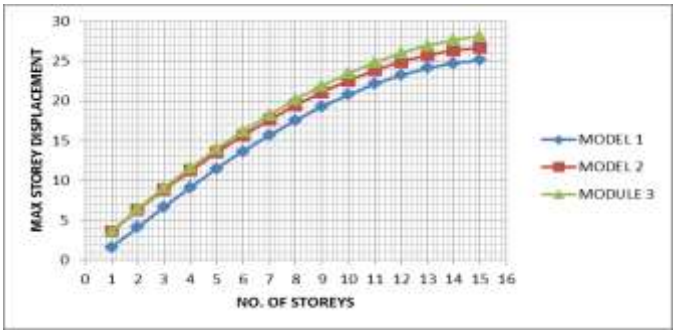

Chart -4: From the chart it is observed that the storey displacement is maximum for model 3 compare to model 1 & 2.

2. BASE SHEAR

- **Base shear of different RCC models along X direction(EQX) for equivalent static analysis.**

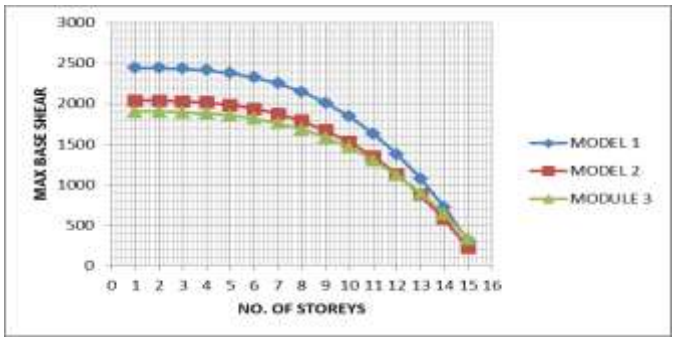

Chart -5: From the chart it is observed that base shear is maximum for model 1 i.e. Regular building compared to model 2 & 3.

- **Base shear of different RCC models along Y direction (EQY) for equivalent static analysis.**

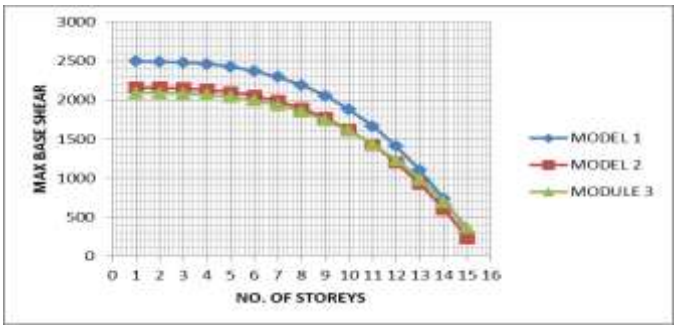

Chart -6: From the chart it is observed that Base shear is maximum for model 1 i.e., Regular building compared to model 2 & 3.

- **Base shear of different RCC models along X direction (RSA-X) for response spectrum analysis.**

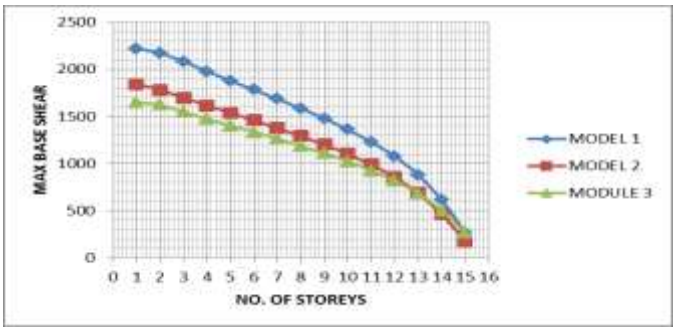

Chart -7: From the chart it is observed the Base shear is maximum for model 1 i.e., Regular building compared to model 2 & 3.

- **Base shear of different RCC models along Y direction (RSA-Y) for response spectrum analysis.**

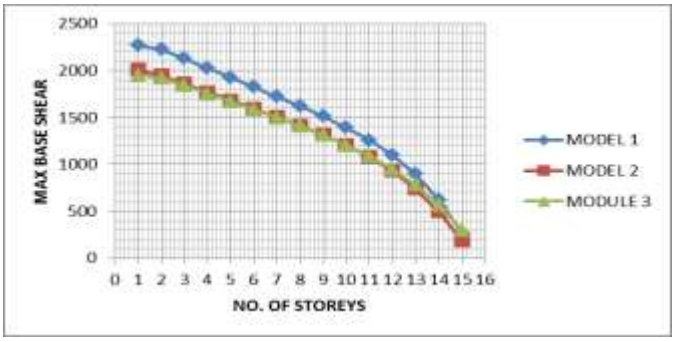

Chart -8: From the chart it is observed the Base shear is maximum for model 1 i.e., Regular building compared to model 2 & 3.

3. STOREY DRIFT

- **Storey drifts of various RCC models along X direction (EQX) for equivalent static analysis**.

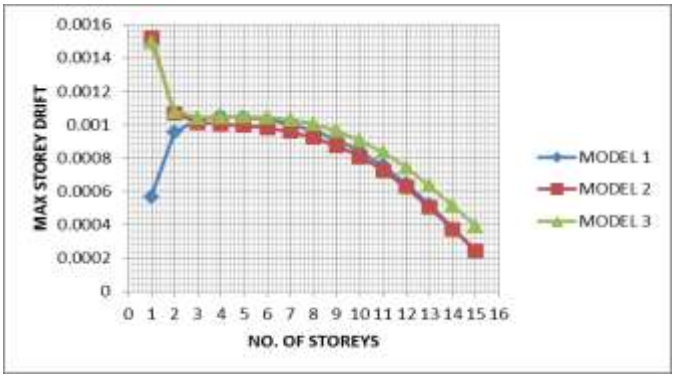

Chart -9: From the chart it is observed that the Storey drift is maximum for model 3 compare to model 1 & 2.

- **Storey drifts of various RCC models along Y direction(EQY) for equivalent static analysis.**

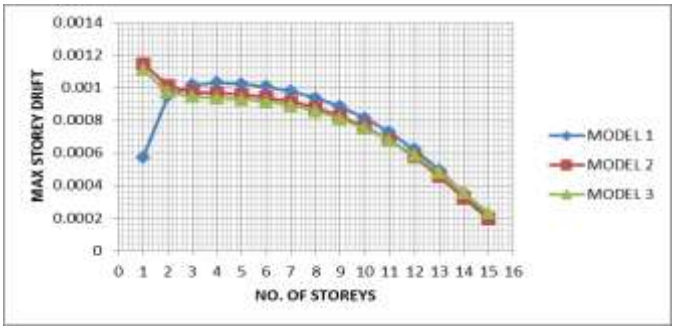

Chart -10: From the chart it is observed that the Storey drift is maximum for model 2 compare to model 1 & 3

- **Storey drifts of various RCC models along X direction (RSA-X) for response spectrum analysis.**

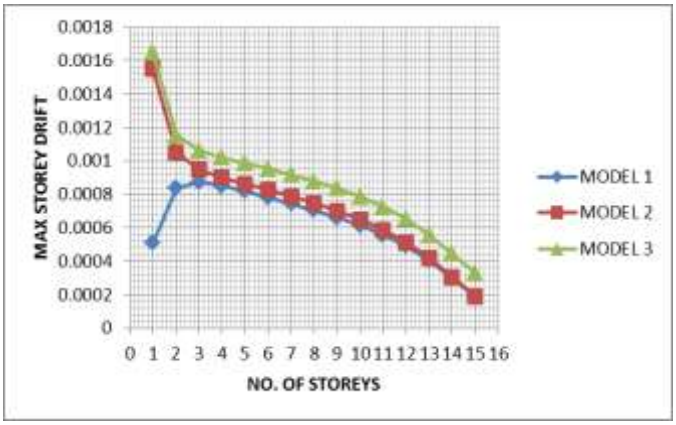

Chart -11: From the chart it is observed that the Storey drift is maximum for model 3 compare to model 1 & 2.

- **Storey drifts of various RCC models along Y direction (RSA-Y) for response spectrum analysis.**

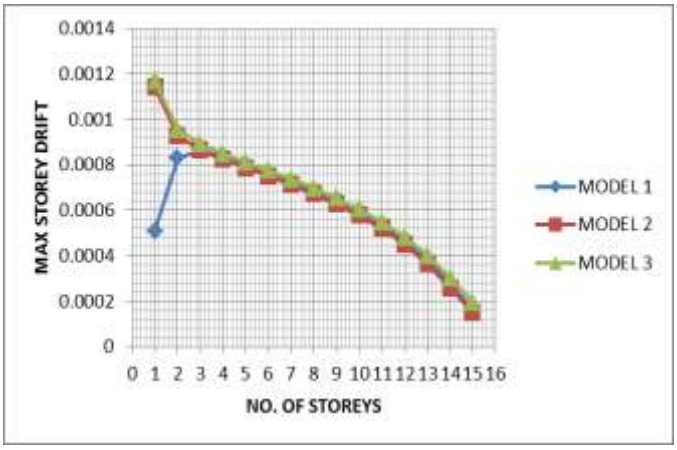

Chart -12: From the chart it is observed that Storey drift is maximum for model 3 compare to model 1 & 2.

6. CONCLUSIONS

1. From the analysis of ESA & RSA for both Plan Regular & Irregular Building, Storey Displacement & Storey drift is maximum for Plan irregular building compare to plan regular building.

2. Base shear is maximum for Regular Building Compare to Irregular Building.

3. In regular Building reduction in displacement and Storey drift is due to Infill action because of the lateral stiffness of frame.

4. As the Plan Irregularity Increases Both Displacement and Storey drift Increases.

5. As the Plan Irregularity Increases Base Shear decreases and Increases In Plan Regular Building.

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