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Study of irregular multi-storey RC frame subjected to seismic condition analysis with STAAD Pro V8i software

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ABSTRACT

These analyses intend to the seismic response of different vertical irregularity structures. The study of this project is done by Response spectrum analysis (RSA) of vertically irregular RC structure. This study includes the modelling of regular and various irregular structure having area of 20 m X15 m and height of 3.2 m from each except ground floor for G+7 storey .The performance of this structure during this study seismic activity motions depends on the distribution of stiffness, strength, and mass in both the horizontal and vertical planes of the structure. The main aim of this work is comparative study of the stiffness of the structure by considering the three models in Regular Structure and three models in Plan irregular structure with different Vertical irregular structure. All models are analyzed with dynamic earthquake loading for the Zones V. Result found from the response spectrum analysis that in irregular shaped structure displacements are more than that of regular shaped building. All building frames are modelled & analyzed in software Staad. Pro CE. Various seismic responses like base shear; frequency, node displacement, etc. are obtained. The overall performance of regular building is found better than irregular building .The seismic performance of multi-storey regular building is determined by Response Spectrum analysis in STAAD Pro. Software.

Keywords: *Irregular frame, stiffness, Spectrum analysis, Modeling, Dynamic earthquake loading, STAAD PRO.*

1. INTRODUCTION

The component of the building, which resists the seismic forces, is known as lateral force resisting system (L.F.R.S). The L.F.R.S of the building may be of different types. The most well known types of these systems in a structure are special moment resisting frames, shear walls and frame-shear wall dual systems. The damage in a structure generally initiates at location of the structural weak planes present in the building systems. These weaknesses cause further structural worsening which leads to the structural fall down. These weaknesses often take place due to occurrence of the structural irregularities in stiffness, strength and mass in a building system. The RC frame irregularity can be mostly classified as plan and vertical irregularities. A structure can be classified as vertically irregular if it contains irregular distribution of mass, strength and stiffness along the building height. As per IS 1893:2002, a multi storey building is said to contain mass irregularity if its mass exceeds 200% than that of the adjacent storey. If stiffness of a storey is a lesser amount of than 60% of the adjacent storey, then a storey is termed as „weak storey". If stiffness of a storey is less than 70% or above as compared to the adjacent storey, then the storey is termed as „soft storey.

2. LITRETURE REVIEW

Garcia *et al* [10] (2010) tested a full-scale two-storey RC building with poor detailing in the beam column joints on a shake table as part of the European research project ECOLEADER. After the initial tests, which damaged the structure, the frame was strengthened using carbon fibre reinforced materials (CFRPs) and re-tested. This paper investigates analytically the efficiency of the strengthening technique at improving the seismic behaviour of this frame structure. The experimental data from the initial shake table tests are used to calibrate analytical models. To simulate deficient beam-column joints, models of steel concrete bond slip and bond-strength degradation under cyclic loading were considered. The analytical models were used to assess the efficiency of the CFRP rehabilitation using a set of medium to strong seismic records. The CFRP strengthening intervention enhanced the behaviour of the substandard beam-column joints, and resulted in substantial improvement of the seismic performance of the damaged RC frame. It was shown that, after the CFRP intervention, the damaged building would experience on average 65% less global damage compared to the original structure if it was subjected to real earthquake excitations.

Niroomandi, Maheri, Maheri & Mahini [18] (2010) retrofitted an eight-storey frame strengthened previously with a steel bracing system with web- bonded CFRP. Comparing the seismic performance of the FRP retrofitted frame at joints with that of the steel X-braced retrofitting method, it was concluded that both retrofitting schemes have comparable abilities to increase the ductility reduction factor and the over-strength factor; the former comparing better on ductility and the latter on over-strength. The steel bracing of the RC frame can be beneficial if a substantial increase in the stiffness and the lateral load resisting capacity is required. Similarly, FRP retrofitting at joints can be used in conjunction with FRP retrofitting of beams and columns to attain the desired increases.

Sukumar Behera [22](2012), The behaviour of multi-storey building with and without floating column is studied under different earthquake excitation. It is concluded that with increase in column the maximum displacement, inter storey drift values are reducing. The base shear and overturning moment vary with the change in column dimension incorporates connection flexibility as well as geometrical and material nonlinearities in the analyses and concluded that the study indicates that connection flexibility tends to increase upper stories' inter-storey drifts but reduce base shears and base overturning moments for multi-story frames.

3. STRUCTURAL ANALYSES & MODELING

The vertical irregularity can be subdivided into irregularities due to mass, stiffness, strength and setback irregularity. The details of the building models are similar to as described in the previous section except the aspect of irregularity. the irregularity has been generated in terms of variation of mass, stiffness, strength and setback along the building

3.1 Building models with vertical setback irregularity

The setback generally represents the simultaneous reduction of mass and stiffness. The present study is based on frames that are plane and orthogonal with bay widths and storey heights equal to 4m and 3m respectively. Moreover, the fundamental time period of the buildings considered in the analytical study has been kept within limits proposed by Goel and Chopra to ensure that these frames are representative of general moment resisting RC frames.

3.2 Structural Modelling

Modelling a building involves the modelling and grouping of its various load-carrying elements. The model must ideally represent the mass distribution, strength, stiffness and deformability. Modelling of structural elements and the material properties used in the present study is discussed below.

Table 1: Material properties of concrete, Steel & Brick Masonry

Properties of Material	
Grade of concrete	M 30
Modulus of elasticity (concrete)	2.7 X10^7 KN/m^2
Poisson ratio	0.22
Tensile strength of concrete	3 N/mm^2
Flexural strength	3.83 N/mm^2
Grade of Steel	Fe-415
Modulus of elasticity E(Steel)	2 X10^7 KN/m^2
Poisson ratio	0.3
Tensile strength of Steel	415 N/mm^2

3.3 Problem

Consider G+7 storey concrete buildings of different shape (regular , T , L&U) in plan as shown in figure. The buildings are located in seismic zone V. The soil are medium stiff and entire building is supported by fix support. Description Of Structure

- Height of Building = 26.6 m
- Plan Area = 300 m^2
- Size Of Beam = 500*400 mm
- Size Of Column = 400*400 mm
- Thickness Of Slab = 150 mm

Grade Of Concrete = M20 Seismic **Loading**

1. Self Load With Factor 1
2. Floor Weight or Lump Weight Dead **Load**

1. External Wall Load = 0.23*.20 = 4.6 KN/m^2
2. Load of Plaster on external side = 0.016*21 = 0.336 KN/m^2
3. Load of Plaster on Internal side= 0.012*21=0.0252 KN/m^2
4. Internal Wall Load=0.115*20=2.3 KN/m^2
5. Load of Plaster on external side =0.016*21=0.336 KN/m^2
6. Load of Plaster on Internal side=0.012*21=0.0252 KN/m^2
7. Load of Floor Finish=0.05*24=1.24 KN/m^2
8. Load of slab = 0.150*25 = 3.75 KN/m^2

1. Residential buildings = 2 KN/m^2
2. Commercial buildings = 3 KN/m^2

Lump Weight =DL+(0.25 or 0.50) LL

Lump Weight on Floors = 13.026+0.50*3=14.026 KN/m^2

Lump Weight on Roof = 13.026+0.25*1=13.562 KN/m^2

G+7 Regular shape building

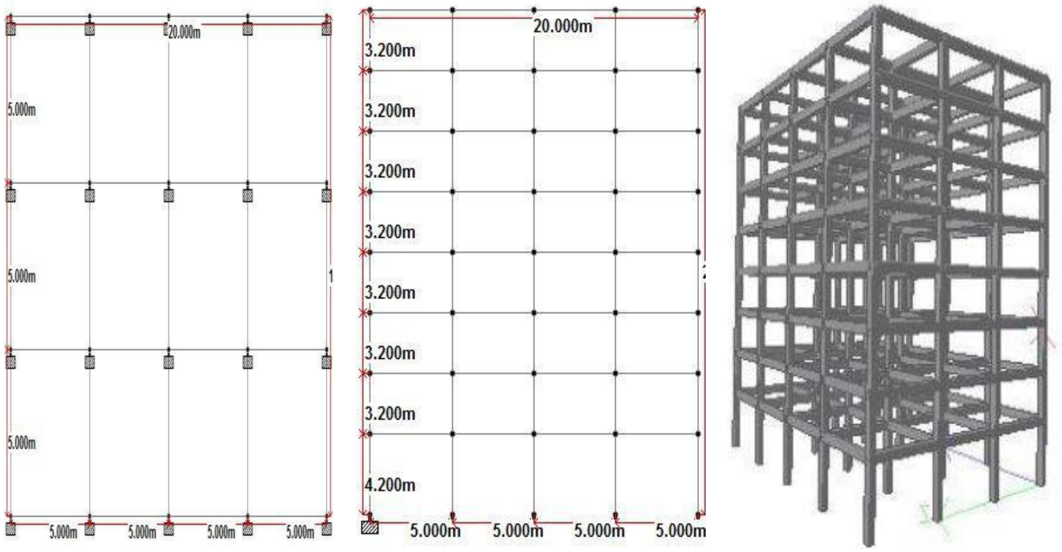


Fig. 1: Plan, Elevation & 3d view of regular structure

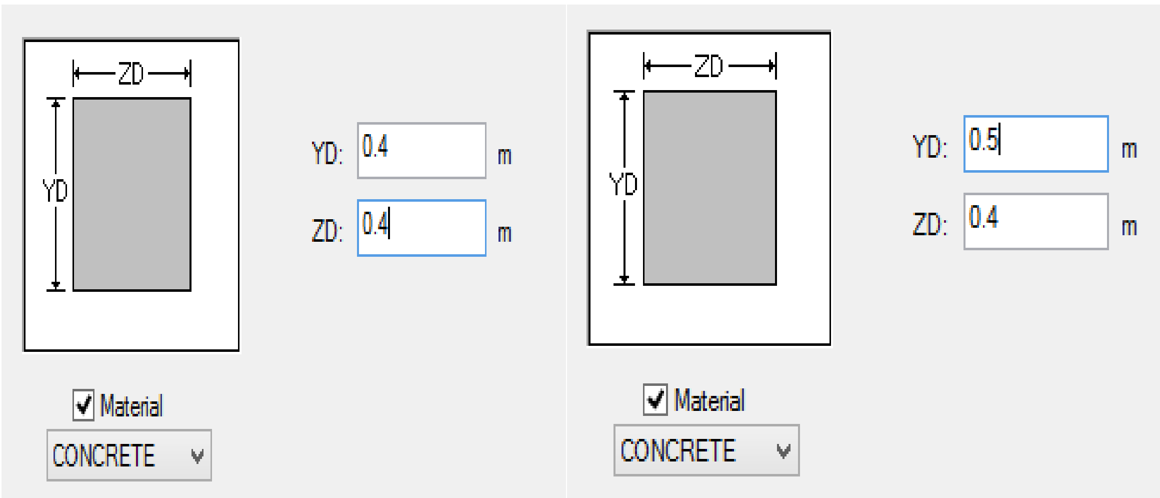


Fig. 2: Beam Section of Regular Structure

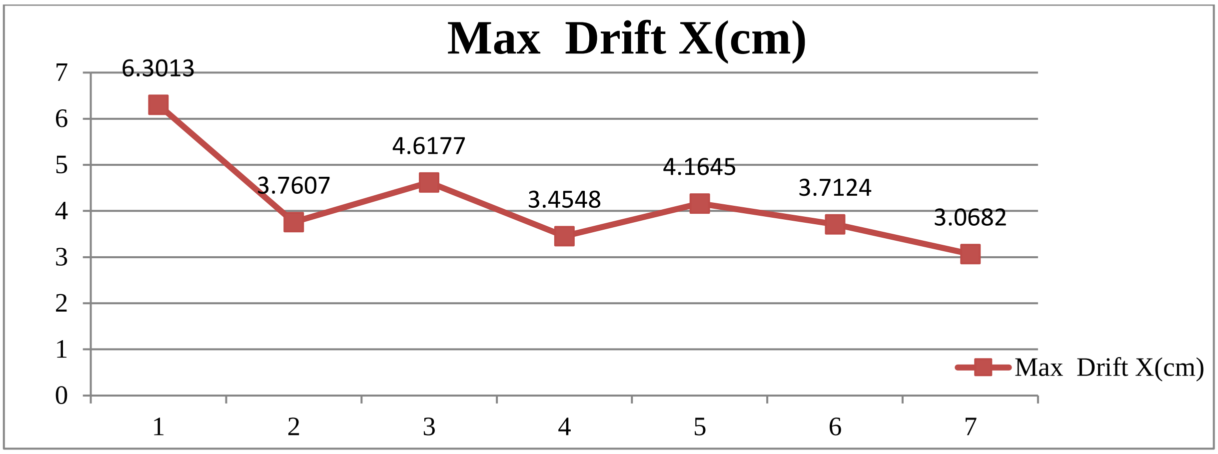
4. RESULTS AND DISCUSSION

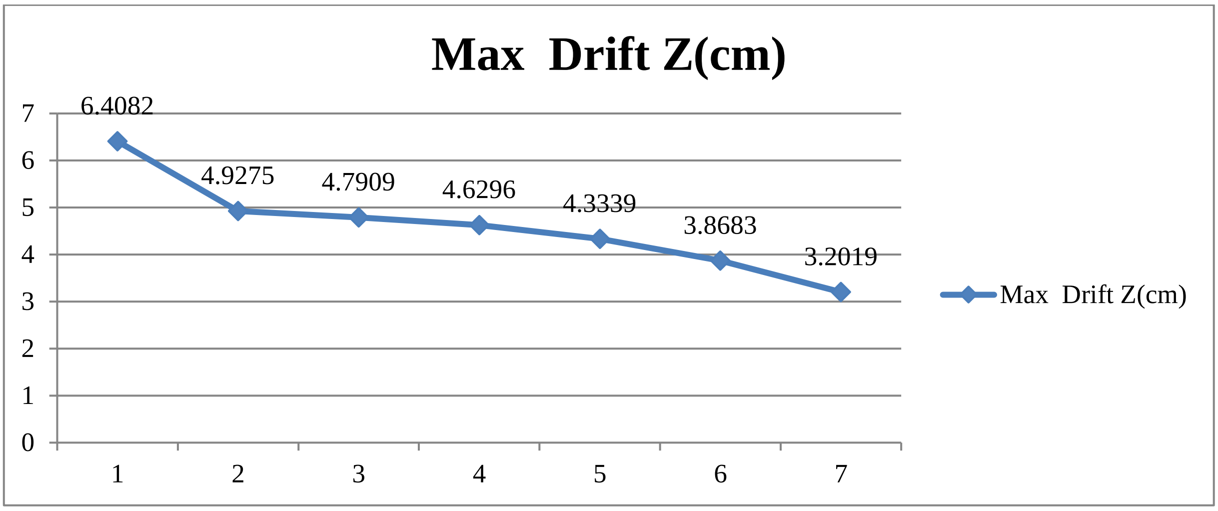
The performance of building frame with soft story is a studied for various condition in previous chapter different models for the present study with different cross section with constant area various method and strategy, code recommendation etc. have been described various model considered in the present study have been analysed by a Staad.Pro,CE software .this chapter presents Calculation and results obtained for the duration of analysis.

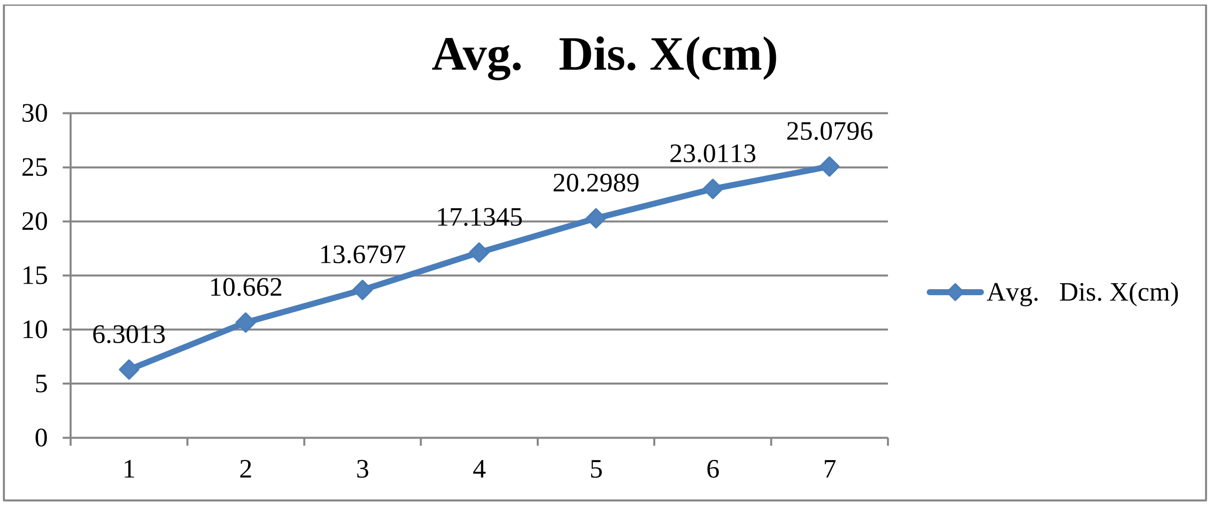
Drift and Average Displacement at Each Floor Level for G+7 Regular Shape Building.

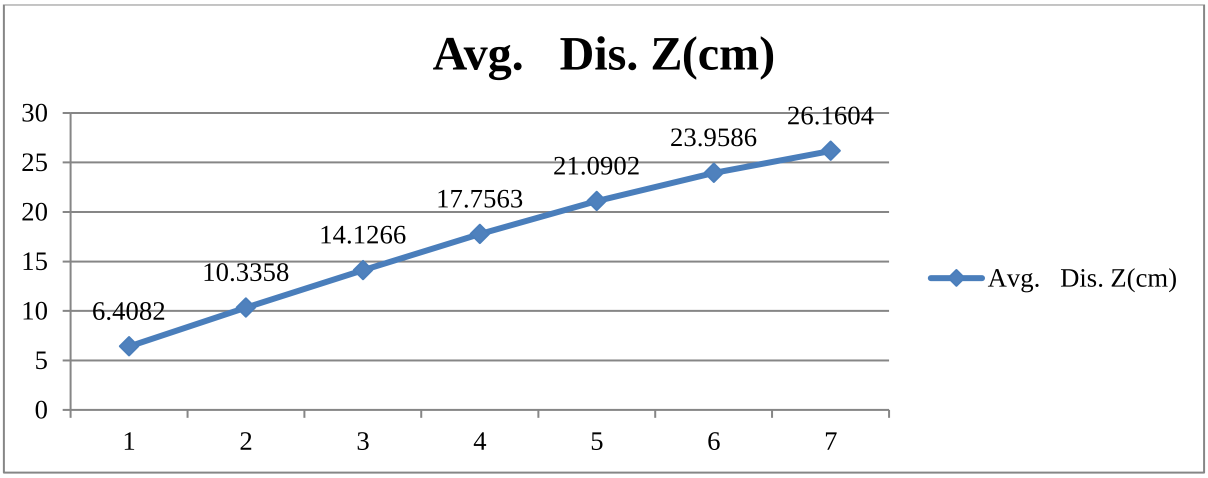
Table 2: G+7 Regular Shape

Height (m)	**Max Drift** X(cm)	**Max Drift** Z(cm)	**Avg. Dis.** X(cm)	**Avg. Dis.** Z(cm)
4.2	6.3013	6.4082	6.3013	6.4082
7.4	3.7607	4.9275	10.662	10.3358
10.6	4.6177	4.7909	13.6797	14.1266
13.8	3.4548	4.6296	17.1345	17.7563
17	4.1645	4.3339	20.2989	21.0902
20.2	3.7124	3.8683	23.0113	23.9586
23.4	3.0682	3.2019	25.0796	26.1604

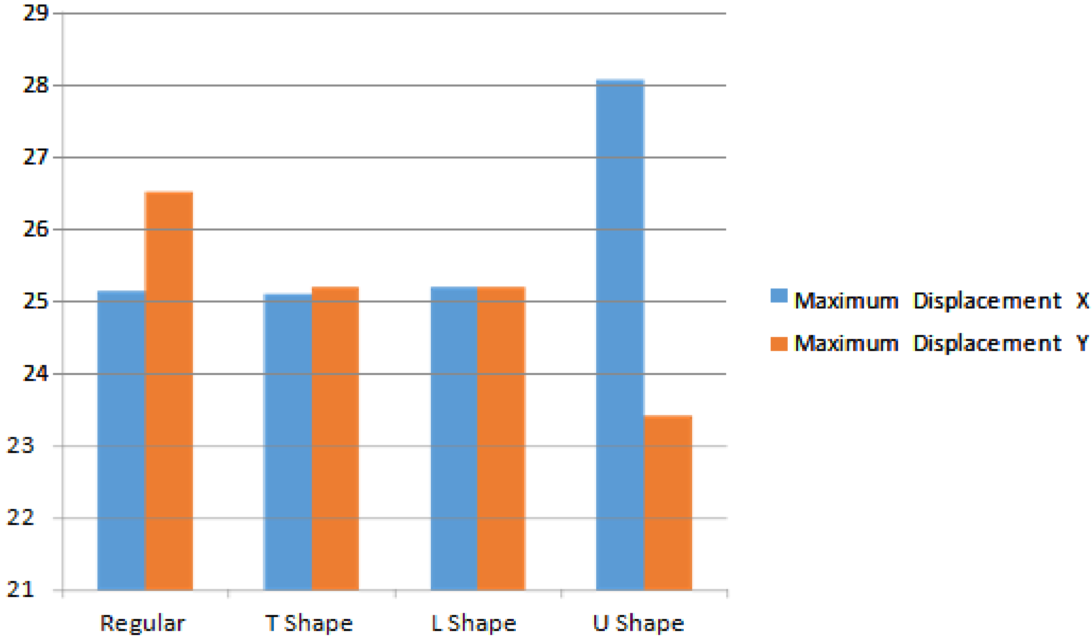

Max Drift X(cm)
6.3013
3.7607
4.6177
3.4548
4.1645
3.7124
3.0682
Max Drift X(cm)


Max Drift Z(cm)
6.4082
4.9275
4.7909
4.6296
4.3339
3.8683
3.2019
Max Drift Z(cm)

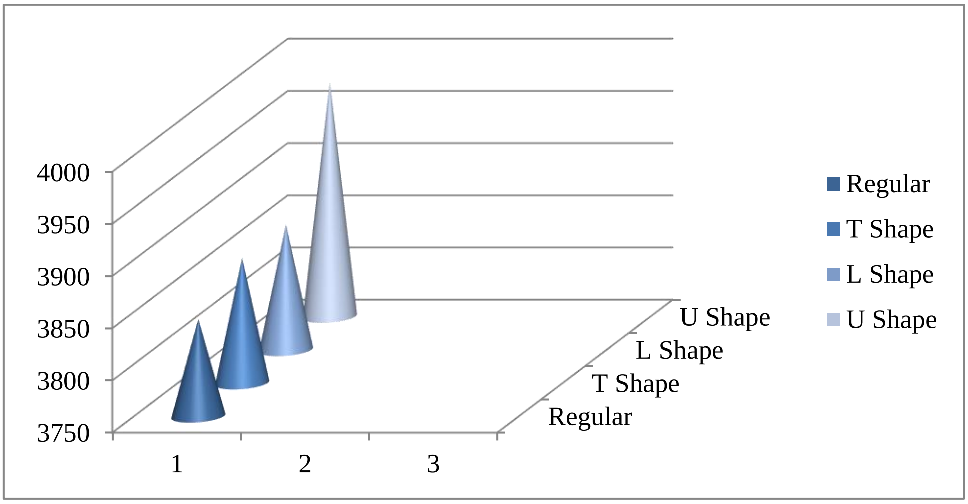

Avg. Dis. X(cm)
6.3013
10.662
13.6797
17.1345
20.2989
23.0113
25.0796
Avg. Dis. X(cm)


Avg. Dis. Z(cm)
6.4082
10.3358
14.1266
17.7563
21.0902
23.9586
26.1604
Avg. Dis. Z(cm)

COMPARISON OF MAX DISPLACEMENT



COMPARISON OF BASE SHEAR OF STRUCTURES



5. CONCLUSIONS

In the current study a systematic examination of both regular and irregular shaped structure is done utilizing response spectrum method. It is performed on the structure model g+7 story of various shapes to consider and distinguish the seismic nature of the structure. From the past investigation it is seen that as the state of building changes lateral load carrying capacity likewise displacement increases. As the irregularities of building continues expanding contrasted with regular structure base shear decreases however displacement stays consistent.

Now in this study we found if height of structure and area of building remains same but shape of building changes it is found that the maximum displacement of the structure depend upon the orientation of structure and percentage of irregularity. The base shear of multi story building is different in x and z directions. But base shear of t and l shape buildings is unchanged. This is for the reason that the orientation of building and percentage of irregularity. It is also easily seen that from all the arrangement the base shear goes increasing as the percentage of irregularity increases.

- Out of all the structure maximum base shear of that building which have maximum percentage of irregularity.
- Maximum displacement is in X direction for U shaped structure.
- Maximum displacement is in Z direction for regular shaped structure.
- Base shear in irregular shaped building is more than in regular shaped building.

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