International Journal For Advanced Research In Science & Technology
A peer reviewed international journal www.ijarst.in
ISSN: 2457-0362

COMPARISON AND ANALYSIS OF REGULAR AND IRREGULAR CONFIGURATION OF MULTISTOREY BUILDING INVARIOUS SEISMIC ZONES AND VARIOUS TYPE OF SOIL

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ABSTRACT

Multistory RC Structure subjected to most dangerous earthquakes. It was found that main reason for failure of RC building is irregular distributions of mass, stiffness and strength or due to irregular geometrical configurations. In reality, many existing buildings contain irregularity due to functional and aesthetic requirements. However, past earthquake records show the poor seismic performance of this structure. This is due to ignorance of the irregularity aspect in formulating the seismic design methodologies by the seismic codes (IS 1893:2002, UBC 1997, NBCC 2005 etc.). The review of seismic design codes and reported research studies show that the irregularity has been quantified in terms of magnitude ignoring the effect of location of irregularity. The principle objective of this project is to study the structural behavior of multistory RC Structure for different plan configuration such as rectangular building along with L- shape and C- shape and H-shape in accordance with the seismic provisions suggested in IS: 1893-2002 using STAAD Pro V8i. The analysis involves load calculation and analyzing the whole structure on the STAAD Pro V8i version for dynamic analysis i.e. Response Spectrum Analysis & Time History Analysis confirming to Indian Standard Code of Practice. For time history analysis past earthquake ground motion record is taken to study response of all the structures. These analyses are carried out by considering different seismic zones (II, III, IV and V) and for each zone the behavior is assessed by taking hard, medium and soft soil. Post analysis of the structure, different response like maximum storey displacement, maximum storey drift, storey shear and maximum overturning moment are plotted in order to compare the results of the linear and non-linear dynamic analysis.

Keywords: Irregularities, Configuration, Geometry.

1. INTRODUCTION

Earthquakes are most unpredictable and devastating of all-natural disasters. Earthquakes have the potential for causing the greatest damages among all the natural hazards. Since earthquake forces are random in nature and unpredictable. They not only cause great destruction in human casualties, but also have a tremendous economic impact on the affected area. The concern about seismic hazards has led to an increasing awareness and demand for structure designed to withstand seismic forces. When a structure is subjected to ground motions in an earthquake, it responds by vibrating. Those ground motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. During an earthquake, the damage in a structure generally initiates at location of the structural weakness present in the building systems. High-Rise RC structures are a special class of structures with their own peculiar characteristics and requirements. These structures are often occupied by a large number of people. Thus, their damage, loss of functionality, or collapse can have very severe and adverse consequences on the life and on the economy of the affected regions.

Each high-rise structure represents a significant investment and as such high-rise structure analysis is generally performed using more sophisticated techniques and methodologies. Thus, to understand modern approaches for seismic analysis of high-rise RC structures are valuable to structural engineers and researchers. In the modern era, most of the structures are delineated by irregular in both plan and vertical configurations. Moreover, to analyze or design such irregular structures high level of effort is needed. In other words, damages or loss in those structures with irregular options are over those with regular one. Thus, irregular structures would like careful structural analysis to succeed in an acceptable behavior throughout a devastating earthquake. In most of the situations the shape of the plot for the construction of a structure may not be a regular one. Thus, the shape of the structure may be influenced by the plot configurations. Further it will be interesting to study the stability of buildings with different geometry of shape and their behavior against seismic and other forces. No any structural engineer can design 100% earthquake proof structure, only its resistance to earthquake can be increased. Proper design or maintenance to be given depends on the zone in which structure is situated. It is necessary to check or think right from the planning stage to the completion of the structure to avoid failure of structure or to overcome loss of property.

1 Classification of Irregularity

The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of the building. When such buildings are constructed in high seismic zones, the analysis and design become more complicated. There are two types of irregularities;

1. Plan Irregularity
2. Vertical Irregularity

2. LITERATURE REVIEW ON IRREGULARITIES

Reviewing a literature lets us to see what came before and what did and didn’t work for other researchers and to demonstrate my understanding and my ability to evaluate research. Literature review is done to take some references and support. Conducting literature review involves collecting, evaluating and analyzing publications that relate my research.

4. B. Ajitha et. al. in their paper titled “The analysis and design of G+40 story regular structure with different shear wall for lose soils” studied optimum location of different shapes of shear walls i.e. Box, U, L shape in G+40 symmetrical high rise building. The structure is analyzed for displacement, torsion, strength and stability for zone 2, 3, 4 and 5. Torsion, displacement are less in U shaped model as compared to other models.

Ravindra N. Shelke et.al [1] studied the effects of various vertical irregularities on the seismic response of a structure. He concluded that, base shear and lateral displacement with height of the structure as the seismic intensity increases from zone-2 to zone-5 which indicates more seismic demand the structure should meet.

Ravikumar C. M., Babu Narayan K. S., Sujith B. V. and Venkat Reddy D. [6], (2012), presented a paper to study two kinds of irregularities in the building models namely plan irregularity with geometric and diaphragm discontinuity and vertical irregularity with setback and sloping ground. These irregularities are created as per Indian Standard code,IS 1893: 2002 (Part I). In Oder to identify the most vulnerable building among the models considered, the various analytical approaches are performed to identify the seismic demands in both

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ISSN: 2457-0362

linear and nonlinear way. It is also examined the effect of three different lateral load patterns on the performance of various irregular buildings in pushover analysis.

Mohammed Rizwan Sultan and D. Gouse Peera [15], (2015), presented a paper on „Dynamic Analysis of Multi- Storey Building for Different Shapes". The main objective of this study is to grasp the behavior of the structure in high seismic zone and also to evaluate Storey overturning moment, Storey Drift, Displacement, Design lateral forces. In this paper 15 storey-high building on four totally different shapes like Rectangular, L-shape, H-shape, and C-shape are usedas a comparison.

3. MODELLING OF R.C.C. FRAMES

An R.C.C. framed structure is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. The load transfer mechanism in this structure is from slabs to beams, from beams to columns, and then ultimately from columns to the foundation, which in turn passes the load to the soil. In this structural analysis, study, we have adopted four cases by assuming different shapes for the same structure, as explained below.

1. Rectangular plan
2. C-shape plan
3. L-shape plan
4. H-shape plan

4. STAAD PRO INTRODUCTION

If you're from the field of Civil engineering, it is very rare to find that you haven't heard about STAAD Pro software in your academic or professional life. There are so many people who heard about this software; however, they don't have much knowledge of it. Therefore, our blog will discuss everything about STAAD Pro software, its features, capabilities, advantages, limitations, and most importantly its use in Civil Engineering.

Few Limitations of STAAD Pro Software

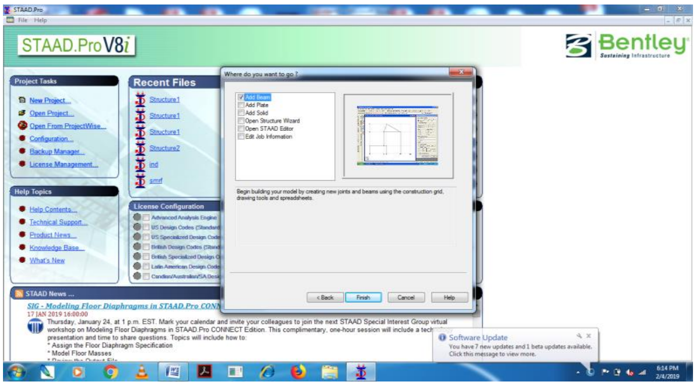
It is not suitable for brick masonry work

It will not show the projected amount of material used

Is not useful for costing and getting estimates

You need proper skills such as civil engineering degree for typical designs.

And few others



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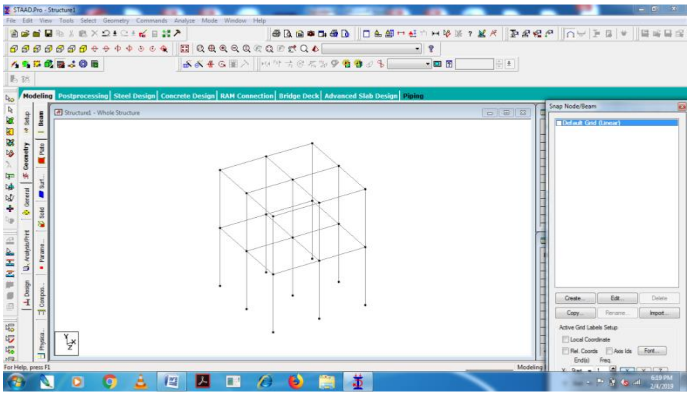

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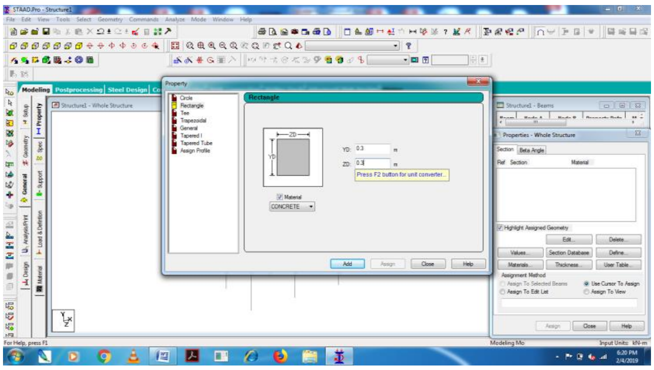

STAAD Pro Software add concrete

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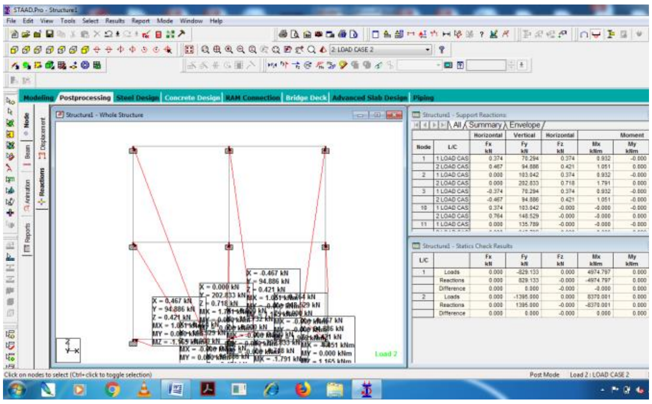


5. COMPARISION AND ANALYSIS

5.1 Modeling of building frames

The R.C.C. Structures is mainly an assembly of Beams, columns and slabs and foundation -connected to each other as a single unit. Generally the transfer of load in these structures is from slab to beam, from beam to column and finally column to foundation which in turn transfers the entire load to the soil. In this study, we have adopted 4 cases by assuming different plan shapes such as Rectangular shape, C-shape L-shape H- shape Detail of buildings considered in this work is as follows Type of structure- Residential building

Shape of building – Rectangular, C-Shape, L-Shape, H-Shape Buildings,

Number of stories	15
Height of typical floor:	3.3m
Column size:	300mm X750mm
Beam size:	300 mm X 450mm
Slab thickness:	125 mm
Masonry wall thickness:	230 mm
Live load :	2 Kn/m^2
Floor finish :	1 Kn/m^2

All the columns are assumed to be fixed at their base. Characteristic compressive strength of concrete, f_{ck}: 25N/mm^2 Grade of steel : 500 N/mm^2 Density of concrete : 25N/mm^2 Modules elasticity of concrete : 2500N/ mm^2 poison‟s ratio of concrete: 0.3 Density of brick masonry : 19.2 KN/m^3 Modulus elasticity of brick masonry: 14000N/mm^2 Poison‟s ratio of brick masonry : 0.2

LIVE LOAD

Live loads are temporary loads they are applied to the structure on and of over the life of the structure

- Banquet hall $5\frac{KN}{m^2}$
- Other areas $3\frac{KN}{m^2}$

DEAD LOAD

Dead loads are permanent loads which result from self weight of the structure.

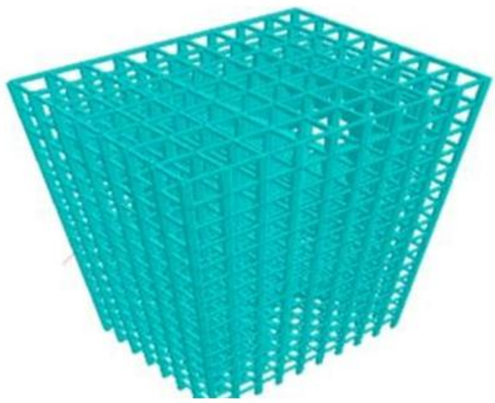
- Dead load for concrete $25\frac{KN}{m^3}$
- Dead load for brick wall $22\frac{KN}{m^3}$

FLOOR AREA RATIO (FAR) CRITERION

$$\text{Floor Area Ratio} = \frac{\text{Total floor area on all floor}}{\text{plot area}}$$

COVERAGE CRITERION

$$\text{Coverage} = \frac{\text{Plinth area}}{\text{Plot area}}$$



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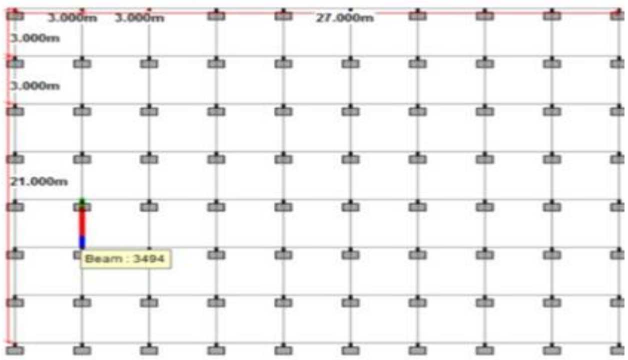


Fig.No.5.1 3D Elevation and plan of of Rectangular Building

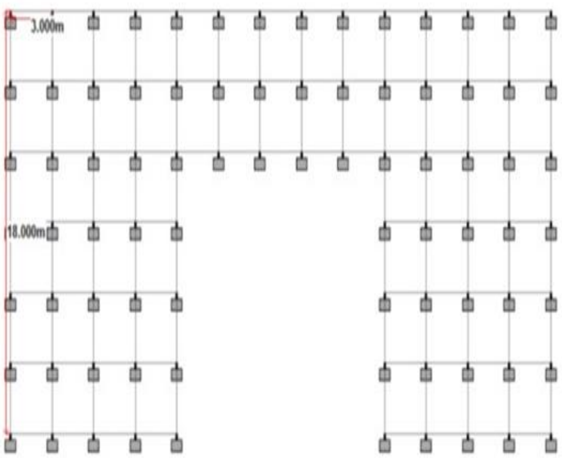
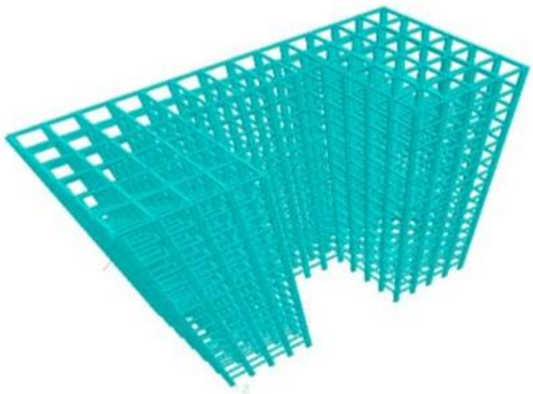


Fig No. 5.2 3D Elevation and plan of C-shape building



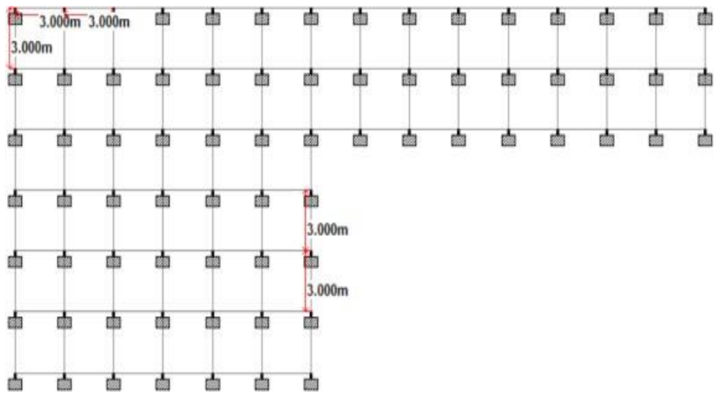


Fig. No. 5.3 3D Elevation and plan of L- Shape Building

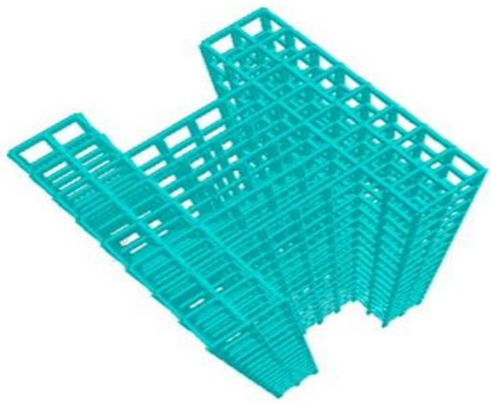


Fig.No.5.4. 3D Elevation and plan of H- shape building

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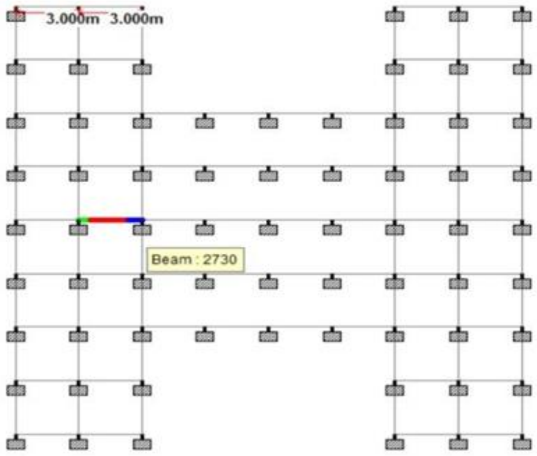

RESULT AND DISCUSSION FOR ALL SHAPES OF BUILDINGS

The four types of RCC building frames viz.(1) Rectangular (2)C-shape (3) L-shape (4) H-shape. The result obtained by the analysis regarding the structural behavior of each building is tabulated and explain as follows.

Table. No. 6.1 Comparison of Maximum Lateral/Storey Drift for various Shape of Building

Storey	Lateral Drift (mm)			
	Rectangular	C-Shape	L-Shape	H-Shape
0	0	0	0	0
1	3.9	3.8	3.7	3.8
2	7.2	7.4	7.2	7.2
3	7.9	8.3	8.4	8
4	8.1	8.9	8.6	8.1
5	8.2	10.02	8.9	8.2
6	8.2	10.01	10.02	9.6
7	9.3	9.7	10	9.6
8	9.1	8.9	9.7	9.7
9	9	8.5	9.4	9.2
10	7.9	9	8.8	8.3
11	6.2	8.2	8	7.6
12	5	7.3	7.2	6.1
13	3.7	6.5	6.2	5.4
14	2.4	5	4.8	4.3
15	2.6	3.9	3.8	3.2

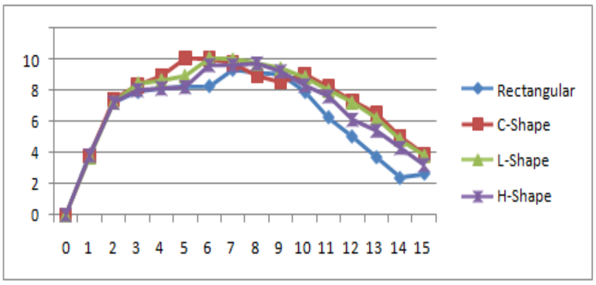

Fig. No. 6.1 Showing results of Maximum Lateral/Storey Drift for Various Shapes of Buildings

2) For determining most stable structure among all models that we have studied, graphs and tables have drawn for different shapes. Results for maximum bending moment and shear force of beam and column for different shapes of thebuilding are shown here.

Table.No.6.2 Comparison of Maximum B.M and Shear Force.

Maximum B.M and Shear Force of Beam				
Force	Rectangular	C-Shape	L-Shape	H-Shape
B.M. M_Y	88.75	95.86	112.07	99.52
B.M. M_Z	0.112	1.12	1.246	0.64
Shear Force F_Y	159.12	157.24	158.07	154.23

Maximum B.M. and Shear Force of Column				
Forces	Rectangular	C-Shape	L-Shape	H-Shape
Axial Force F_X	383.73	430.18	430.18	392.40
Shear Force F_X	86.01	85.12	86.12	90.15
Shear Force F_Z	88.54	87.23	94.33	94.23
B.M. M_Y	174.23	174.18	175.18	173.22
B.M. M_Z	173.46	176.12	154.2	168.54

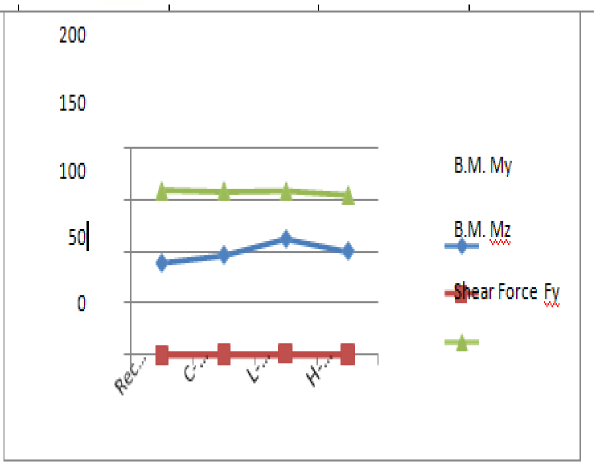

Fig. No. 6.2 Shows result of Maximum Bending Moment along Y and Z Direction and Maximum Shear Force. Fromabove Table we can see that the maximum bending moments and Shear force occur in H-shape building while less inRectangular shape of building.

Table.No.6.3 Comparison of Maximum Displacement on top storey for all zones

Zone	Displacement (mm)			
	Rectangular	C-Shape	L-Shape	H-Shape
2	22	19	26	18
3	35.2	36.2	42.8	23
4	52.8	58.6	62.6	58.13
5	79.1	87.5	84.3	80.57

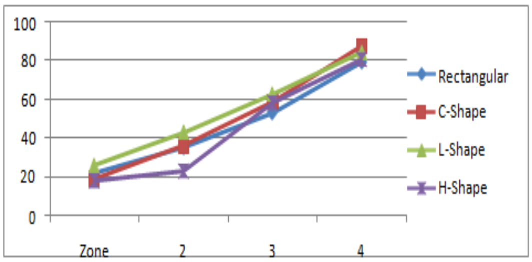

Fig.No.6.3 Showing results of Comparison of Maximum Displacement for all zones

Above figure No.6.3 Shows that maximum storey displacement increases with the increasing in zone and height of thestorey. Displacement for rectangular shape of building is less as compare to other shape of building.

Table.No.6.4 Comparison of Base Shear

	Zone	Base Shear (kn)		
		Hard Soil	Medium Soil	Soft Soil
Rectangular	2	442.15	515.64	623.14
	3	512.63	614.23	715.23
	4	546.28	724.68	715.23
	5	675.43	812.24	956.18
C-Shape	2	527.16	617.23	684.23
	3	564.13	738.82	715.26
	4	612.68	725.23	802.36
	5	675.43	816.23	1038.25
L-Shape	2	612.54	620.23	736.15
	3	610.44	756.58	856.46
	4	689.58	812.62	802.19
	5	712.65	912.25	1102.25
H-Shape	2	565.56	617.28	512.36
	3	568.29	738.96	716.23
	4	613.58	819.56	725.23
	5	712.36	896.32	1023.56

Above Table No.6.4 shows that in rectangular shape of building the base is less as comparative other shape of buildings. Maximum base shear occurred in L-Shape building in zone no.5.

CONCLUSION

Irregular shapes are severely affected during earthquakes especially in high seismic zones. Maximum storey drift is occurring on top storey of L-shape building while the minimum storey drift occur on Rectangular shape of building. Maximum bending moment is occur on H-shape of building. Maximum axial force imposed on H-shape of building. Minimum Displacement is occurring on Rectangular shape of building. Base shear is calculated by using IS 1893-2002 method for all four models in (Table No.4.28) illustrate the comparison of base shear using response spectrum method. The lower base is getting in rectangular shape building and the higher base shear is getting in H-Shape building. The table No.4.28 Shows that irregular shape building undergoes more deformation and hence regular shape building must be preferred. Result has been proved that C-Shape building is more vulnerable compare to all other different shapes ofbuilding.

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