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DYNAMIC ANALYSIS OF MULTI-STOREY BUILDING FOR DIFFERENT SHAPES

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Abstract— ***Background: Extinct earthquakes events demonstrate that, buildings with irregularity is vulnerable to earthquake damages. So as it's essential to spot the seismal response of the structure even in high seismic zones to cut back the seismic damages in buildings. Objective: The most important objective of this study is to grasp the behaviour of the structure in high seismic zone and also to evaluate Storey overturning moment, Storey Drift, Displacement, Design lateral forces. During this purpose a 15 storey-high building on four totally different shapes like Rectangular, L-shape, H-shape, and C-shape are used as a comparison. The complete models were analysed with the assistance of ETABS 9.7.1 version. In the present study, Comparative Dynamic Analysis for all four cases have been investigated to evaluate the deformation of the structure. Results & Conclusion: The results indicates that, building with severe irregularity produces more deformation than those with less irregularity particularly in high seismic zones. And conjointly the storey overturning moment varies inversely with height of the storey. The storey base shear for regular building is highest compare to irregular shape buildings.***

Keywords— Different shapes, Dynamic analysis, Multi-storey, Building and ETABS.

I. INTRODUCTION

Nowadays, most buildings are delineated by irregular in both plan and vertical configurations. Irregularities in arrange and lack of symmetry might imply vital eccentricity between the building mass and stiffness centers, give rise to damaging coupled lateral response (Giordano,Guadagnuolo and Faella, 2008) [1]. Moreover to design and analyze an irregular building a significantly high level of engineering and designer effort are needed, whereas a poor designer will design and analyze an easy subject field options. In different words, damages in those with irregular options are over those with regular one. Therefore, Irregular structures would like an additional careful structural analysis to succeed in an acceptable behavior throughout a devastating earthquake (Herrera, Gonzalez and soberon, 2008) [2].

Plan and also elevation irregularities in Indian standard code (IS 1893):
The irregularity of the structure might will classify in 2 sorts i.e. Plan and vertical, these are often characterized by 5 differing types like torsional, re-entrant corners, diaphragms separation, out of arrange offset and non-parallel system for plan irregularity likewise as vertical irregularity like stiffness (soft storey), mass, vertical geometric, in plane separation in vertical components resisting lateral force and separation in capability (weak storey) (IS 1893(Part I): 2002)

The code, IS 1893 (Part I): 2002 outlined the re-entrant corners irregularity:
Re-entrant corner irregularity arrange configurations of a building and its lateral force resisting system contain re-entrant corners, wherever each projections of the structure document is a template. An electronic copy can be downloaded from the Journal website. For questions on paper guidelines, please contact the journal publications committee as indicated on the journal website. Information about final paper submission is available from the conference website.

A. Objectives of the study

Main objectives of the thesis is to perform Dynamic analysis and to obtain Seismic performances of different shape of structures located in severe earthquake zone (V) of India and to evaluate lateral forces, overturning moment, deflections and storey drift.

B. Methodology

The method of analysis used for the present study are

1. Equivalent static force analysis
2. Response spectrum method

1) *Equivalent static force analysis:* The equivalent static force analysis for an earthquake is a exceptional concept which is used in earthquake resistant design of structure. This concept is useful since it converts a dynamic analysis into a partly static & dynamic analysis to evaluate the maximum displacements produced in the structure because of earthquake due to ground motion. For earthquake resistant design of structures, only these maximum displacements are of interest, but not the time history of stresses. Equivalent lateral force for an earthquake is defined as a set of static lateral forces which produces the similar peak responses of the structure as that have been produced in the dynamic analysis of the building under the similar ground motion. This concept has drawback since it uses only a single mode of vibration of the structure.

2) *Response spectrum method:* In this concept the multiple modes of vibration of a structure can be used. This analysis can be used in many building codes for all except for simple or complex structures. The vibration of a building is defined as the combination of many special modes that are in a vibrating string corresponding to the "harmonics". Computer aided structural analysis is used to determine these mode shapes for the structure. For every mode shape, from design spectrum responses are studied, with the help of parameters such as modal participation mass and modal frequency, and then they are combined to provide an evaluation of the total responses of the structure.

II. PROBLEM FORMULATION

The structures are acted upon by different loads such as dead load (DL), Live load and Earthquake load (EL).

A. *Self-weight* of the structure comprises of the weight of the beams, columns and slab of the structure.

B. *Dead load* of the structure consist of Wall load, Parapet wall load and floor load, according to (IS 875(Part1)).

1) Wall load: weight unit of brick masonry x thickness of wall x height of the wall = 20 KN/m^3 x 0.230m x 3m= 13.8 KN/m.

2) Wall load (of Parapet wall at top floor): weight unit of brick masonry x thickness of wall x height of the wall = 20 KN/m^3 x 0.115m x 0.90m= 2.07 KN/m.

C. *Live load*: It consist of Floor load which is taken as 4KN/m^2 and Roof load as 2 KN/m^2, according to (IS 875 (Part 2).

D. *Seismic Load*: The different seismic parameters are taken as follows, IS 1893(Part-1):2002.

- Seismic zone: V (Z=0.36).
- Soil type: II.
- Importance factor: 1.
- Response reduction factor: 5.
- Damping: 5%.

III. PLAN DETAILS

The structure is 32m in x-direction & 24m in y-direction with columns spaced at 4m from center to center. The storey height is kept as 3m. Basically model consists of multiple bay fifteen storey building, each bay having width of 4m. The storey height between two floors is 3.0m with beam and column sizes of 0.45x0.45m respectively and also the slab thickness is taken as 0.125m.Shape of the building for all the cases is shown in figure.

A. The material properties and geometry of the model are described below

1) Length X width: 32m X 24m
2) Number of stories: 15
3) Support conditions: Fixed
4) Storey height: 3 m
5) Grade of concrete: 30 Mpa
6) Grade of steel: Fe415
7) Size of columns from 1-5 storey: 650mm x 650mm
8) Size of columns from 6-15 storey: 500mm x 500mm
9) Size of beams: 450mm x 450mm
10) Height of parapet wall: 0.9m
11) Thickness of main wall: 230mm
12) 12 Thickness of parapet wall: 115mm

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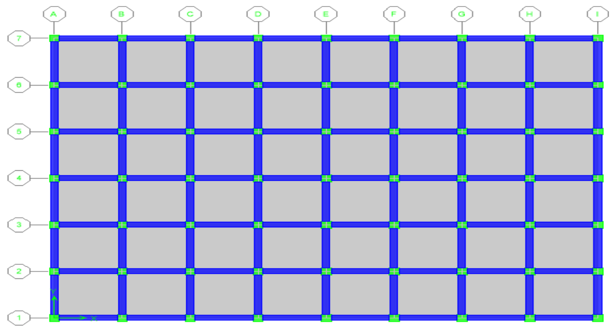


Fig. 1 Rectangular shape

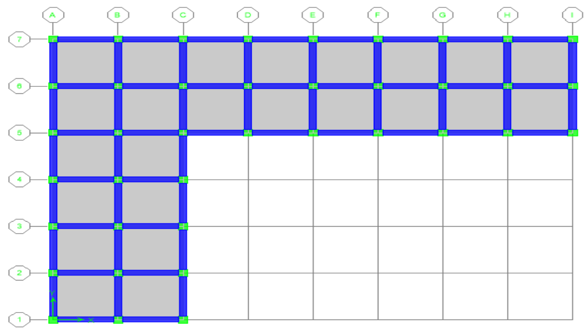


Fig. 2 L-shape

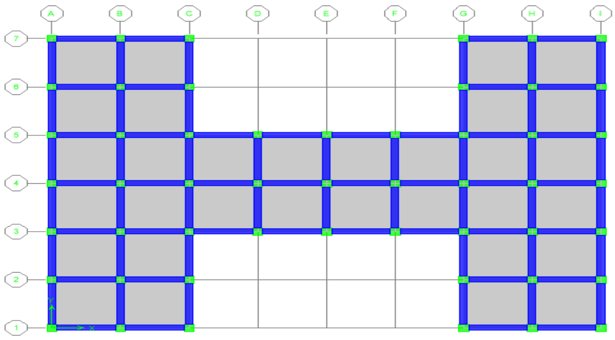


Fig. 4 C-shape

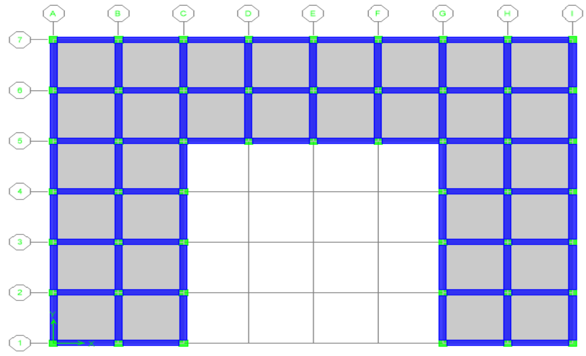


Fig. 3 H-shape

IV. RESULTS AND DISCUSSION

For determining the 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 the buildings are shown here.

TABLE I

MAX B.M. AND SHEAR FORCE OF BEAM & COLUMN

Max B.M. and Shear Force of Beam				
Forces	Rectangular	L-shape building	H-shape building	C-shape building
B.M. M_y	91.77	112.07	101.54	98.861
B.M. M_z	0.115	1.556	0.64	1.117
Shear Force F_y	161.1	159.17	158.18	159.28
Max B.M. and Shear Force of Column				
Forces	Rectangular	L-shape building	H-shape building	C-shape building
Axial Force F_x	393.73	436.96	400.40	431.79
Shear Force F_y	87.01	87.08	91.15	89.93
Shear Force F_z	88.89	95.33	95.24	88.47
B.M. M_y	178.93	178.78	174.40	175.85
B.M. M_z	178.46	178.4	173.64	178.84

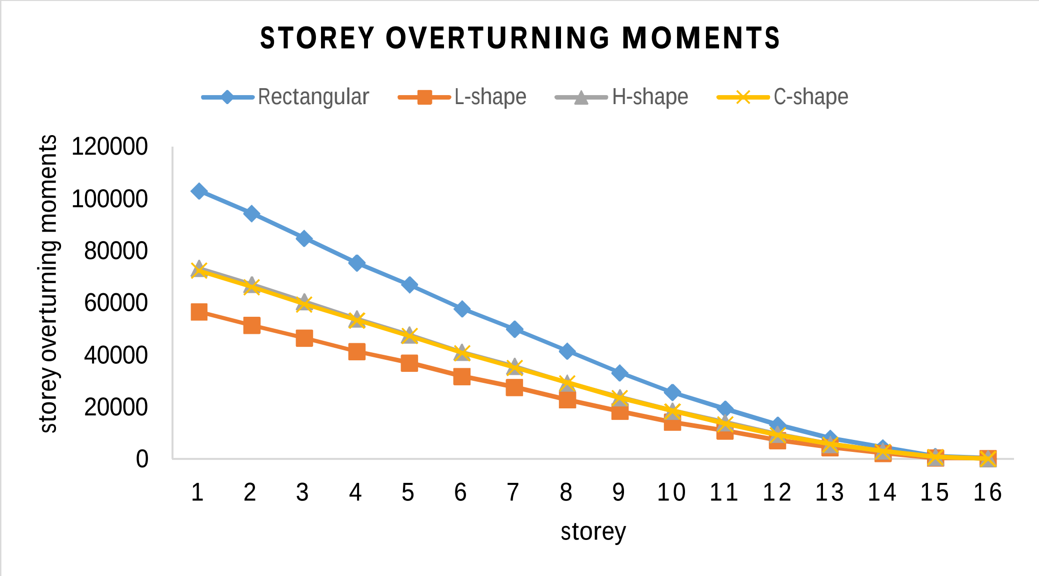


Fig. 5 Height of the story Vs Overturning Moments

- The above figure shows that the overturning moment varies oppositely with height of the storey. In case of rectangular shape building, a moment produced is higher than other shapes of the building. Storey overturning moment decreases with increase in height of the storey for all cases.

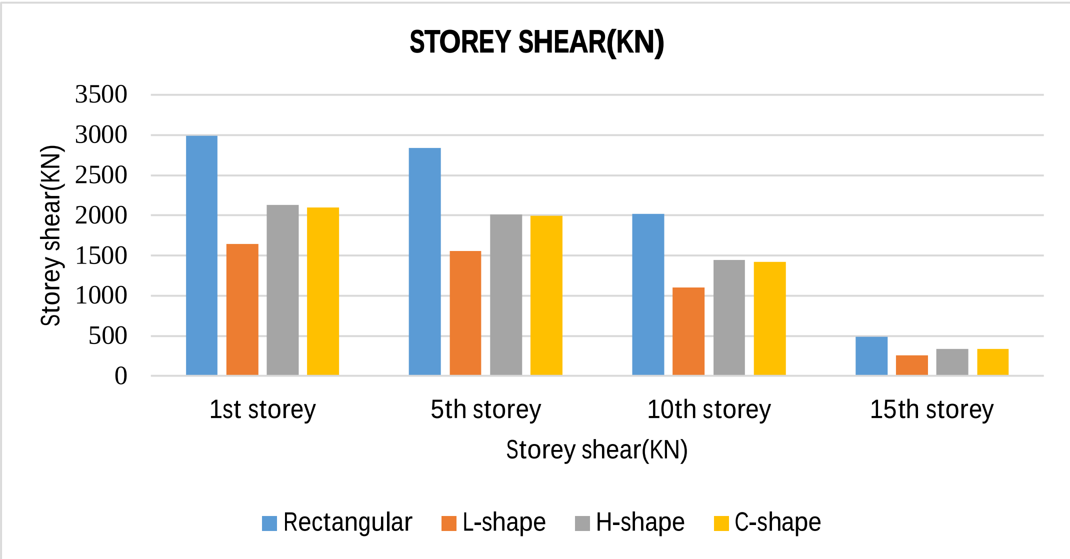


Fig. 6 Graph of Storey Shear for different shape of the buildings

- The above Fig. 6 shows the, Comparison of Base Shear for 1st, 5th, 10th, 15th storey for different shape of the building. It has been concluded that the storey shear tends to decrease with the increase in height of storey. L-shape building has less Storey compare to all the cases.

- The Fig. 7 shows the Storey shear for 5th Storey for different shapes of the building.

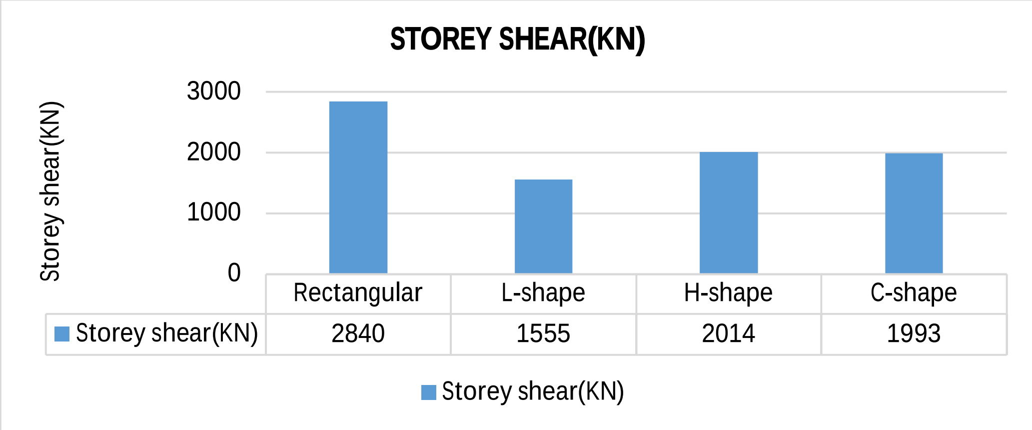


Fig. 7 Storey Shear for 5th floor

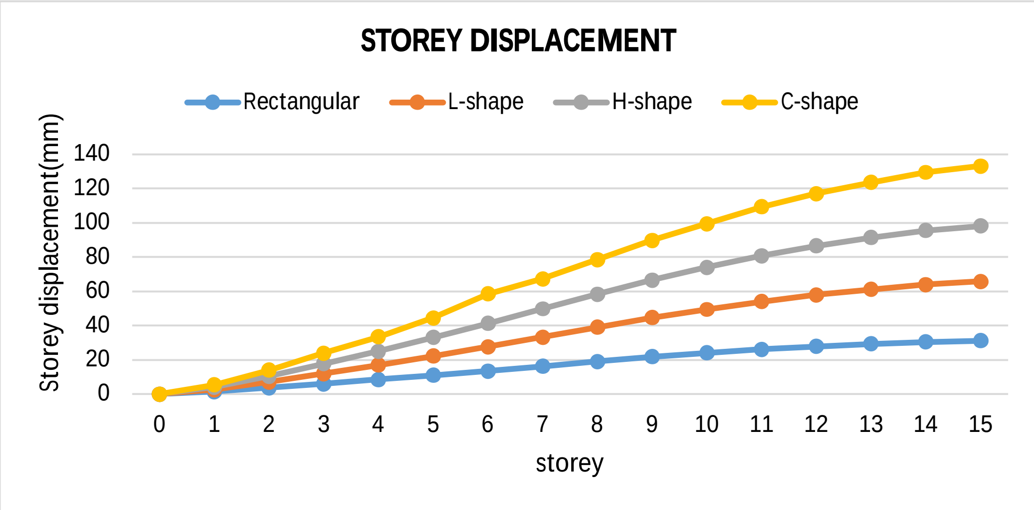


Fig. 8 Storey displacement Vs Height of storey

- Above Fig. 8 shows that the maximum storey displacement increases with the increase in height of the storey. Displacement for rectangular shape of the building is less compare to other shapes of the building.

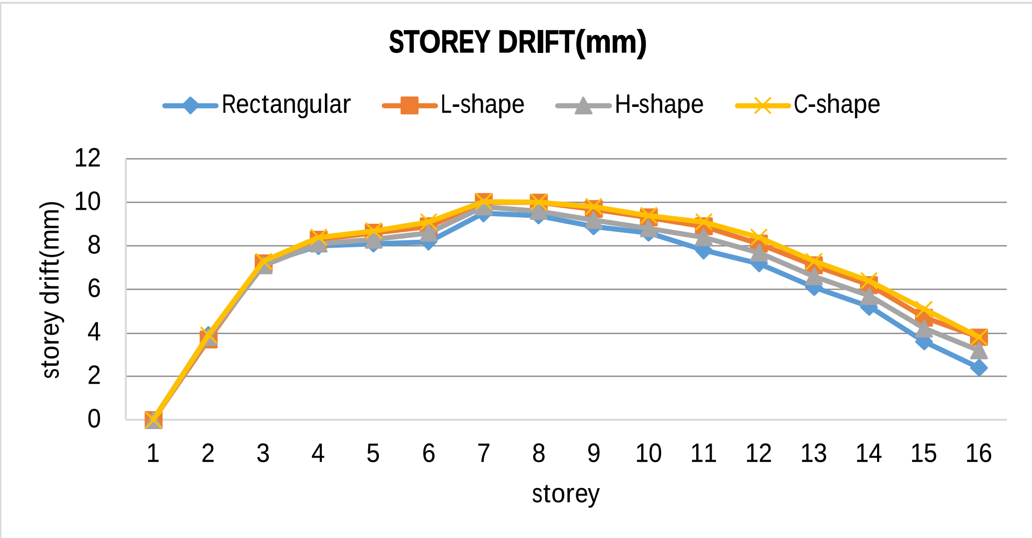
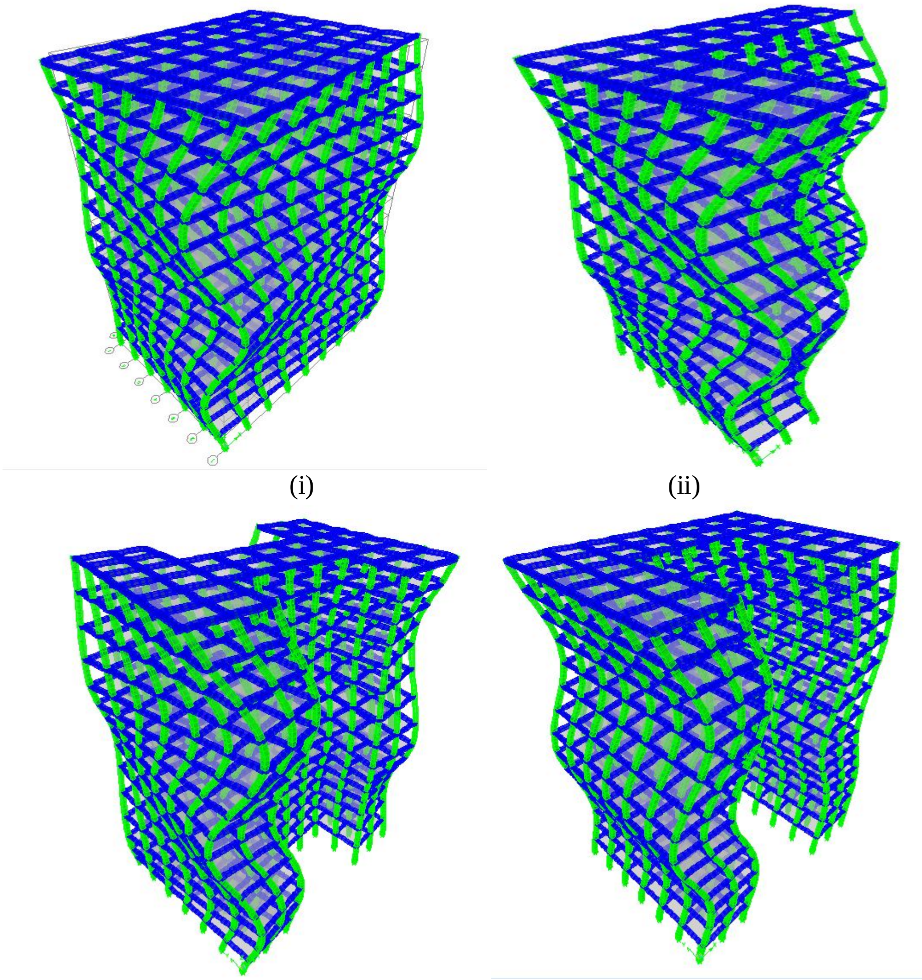


Fig. 9 Shows variation of Storey Drift with Height of storey

- Storey drift increases with increase in height of the storey up to 7th storey reaching to maximum value and then it again started decreasing. The maximum storey drift permitted is 0.004 times the height of storey i.e. 0.004 x 3000=12mm for all storey.



(i) (ii) (iii) (iv)

Fig. 10 Mode shapes for 12th mode for (i) Rectangular (ii) L-shape (iii) H-shape (iv) C- shape of the building

TABLE II
DATA FROM DYNAMIC ANALYSIS (RECTANGULAR SHAPE MODEL)

Modes	Time Period	Frequency	Modal Mass Participating Ratios		
			X - Trans	Y - Trans	Rz - Rot
1	1.332729	0.750340	0	77.0963	0
2	1.303713	0.767039	77.3483	0	0
3	1.200129	0.833243	0	0	77.5231
SUM OF 12 MODES			94.6027	94.5646	94.5829

TABLE III
DATA FROM DYNAMIC ANALYSIS (L SHAPE MODEL)

Modes	Time Period	Frequency	Modal Mass Participating Ratios		
			X - Trans	Y - Trans	Rz - Rot
1	1.385034	0.722000	4.0295	49.4071	22.0254
2	1.30425	0.766724	54.4164	15.0592	6.9056
3	1.217258	0.821518	18.2248	11.6847	47.2617
SUM OF 12 MODES			94.4977	94.4308	94.4025

TABLE IV
DATA FROM DYNAMIC ANALYSIS (H SHAPE MODEL)

Modes	Time Period	Frequency	Modal Mass Participating Ratios		
			X - Trans	Y - Trans	Rz - Rot
1	1.327695	0.753185	76.4337	0	0
2	1.288952	0.775824	0	76.7743	0
3	1.228221	0.814185	0	0	76.7714
SUM OF 12 MODES			94.4575	94.503	94.4919

TABLE V
DATA FROM DYNAMIC ANALYSIS (C SHAPE MODEL)

Modes	Time Period	Frequency	Modal Mass Participating Ratios		
			X - Trans	Y - Trans	Rz - Rot
1	1.346009	0.742937	68.603	76.7477	7.4253
2	1.289948	0.775225	0	0	0
3	1.206957	0.828529	7.7522	0	69.5606
SUM OF 12 MODES			94.3943	92.5076	92.6113

- From the dynamic analysis, mode shapes are generated and it is concluded that L, H & C shape building undergoes more deformation than rectangular building.

V. CONCLUSION

- Irregular shapes are severely affected during earthquakes especially in high seismic zones.
- Base shear is calculated by using IS 1893-2002 method for all four models in (Fig. 6) illustrate the comparison of base shear using Equivalent static method. The lower base shear is getting in L shape building and the higher base shear is getting in Rectangular shape building.
- The Fig. 10 shows that irregular shape building undergo more deformation and hence regular shape building must be preferred.
- Results have been proved that C shape building is more vulnerable compare to all other different shapes.

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