Comparative Study on the Behaviour of a Multi-Storeyed Building for Regular & Irregular Plan Configuration

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Abstract **- The performance of a high rise building during strong earthquake motions depends on the distribution of stiffness, strength and mass along both the vertical and horizontal directions. If there is discontinuity in stiffness, strength and mass between adjoining storeys of a building then such a building is known as irregular building. The present study focuses on the performance and behaviour of regular and vertical irregular G+11 storied buildings under seismic loading. Two types of irregularities namely vertical irregularities and horizontal irregularities are considered in this study. Total ten regular and irregular buildings are modelled and seismic analysis is carried out in Staad Pro and the results are compared.**

Index Terms **- Horizontal irregularities, Mutli storeyed Building, Seismic analysis, Vertical irregularities.**

I.INTRODUCTION

An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter -connected to each other as a unit. The floor area of a R.C.C framed structure building is 10 to 12 per cent more than that of a load bearing walled building. Monolithic construction is possible with R.C.C framed structures and they can resist vibrations, earthquakes and shocks more effectively than load bearing walled buildings. During an earthquake, the collapse of the building is mainly due to discontinuity in geometry, mass and stiffness. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. Geometric irregularity also introduces discontinuity in the distribution of mass, stiffness and strength along the vertical direction. The behaviour of these types of building is something different. So this paper is an attempt to study about the structural behavior of various types of building configuration. The main objective of this work is to study the flexural and seismic behaviour of regular & irregular shape building and to identify the best building configuration from this analysis.

II. LITERATURE REVIEW

Akhil R, et.al (2017) This analysis aims to the seismic response of various vertical irregularity structures. The project is done by Response spectrum analysis (RSA) of vertically irregular RC building. This study includes the modelling of regular and H-shape plan irregular building having area of 25x25m and height of 3.5 m from each G+10 storey. The performance of this framed building during study earthquake motions depends on the distribution of stiffness, strength, and mass in both the horizontal and vertical planes of the building. 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 analysed with dynamic earthquake loading for the Zones V. Result found from the response spectrum analysis that in irregular shaped building displacements are more than that of regular shaped building

Anil Kumar et.al (2012) -The structural irregularities cause non-uniform load distribution in various members of a building. There have been several studies on the irregularities, viz., evaluation of torsional response of multi-storey buildings using equivalent static eccentricity, three-dimensional damage index for RC buildings with planar irregularities, seismic response of vertically irregular frames with pushover analysis and evaluation of mass, strength and stiffness limits for regular buildings specified by UBC. In this paper, response of a 10-storeyed plane frame to lateral loads is studied for mass and stiffness irregularities in the elevation. These irregularities are introduced by changing the properties of the members of the storey under consideration. Various irregularities include soft storey, heavy loads on top floor, floating columns as well as unusually tall first storey. Effects on storey-shear forces, storey drifts and deflection of beams is studied.

Aruna Rawat et.al (2017)-The present study focuses on the performance and behaviour of regular and vertical irregular G+10 reinforced concrete buildings under seismic loading. Two types of vertical irregularities namely stiffness and setback are considered in this study. Total eight regular and irregular buildings are modelled and seismic analysis is carried out using response spectrum analysis method. Different seismic responses like storey displacement, storey drift, overturning moment, storey shear force, and storey stiffness are obtained. By using these responses, a comparative study has been made between regular and irregular buildings. The result remarks the conclusion that, a building structure with stiffness and setback irregularity provides instability during seismic loading. To control the instability, a proportionate amount of stiffness is beneficial in RC building

III. METHODOLOGY

An RCC framed structure is basically an assembly of slabs, beams, columns and foundation inter-connected to each other as a unit. Here the study is carried out for the behavior of G+11 Storied Buildings, Floor height provided as 3m and also properties are defined for the building structure. The model of buildings is created in Staad.pro software. The seismic zone considered is zone III and soil type is medium. Ten models of buildings are prepared. Two types geometry are adopted for this analysis regular and irregular shaped building with and without stepped. The building description were given in table I.

Case I: Regular Building- A 32m x 20m with 12-storey regular structure is considered for the study. Size of each grid portion is 4m x 4m. Height of each storey is 3m and total height of the building is 36m.

Table. I Building description

SL. No	Item	Description
1	Length x Width	32 x 20m
2	No. of storeys	12
3	Storey height	3m
4	Beam along length	250 x 450mm
5	Beam along width	250 x 450mm
6	Column	600 x 600mm
7	Interior Column (7th to 12th storey)	450 x 450mm
7	Slab thickness	120mm
8	Thickness of main wall	230mm
9	Height of parapet wall	1m
10	Thickness of parapet wall	115mm

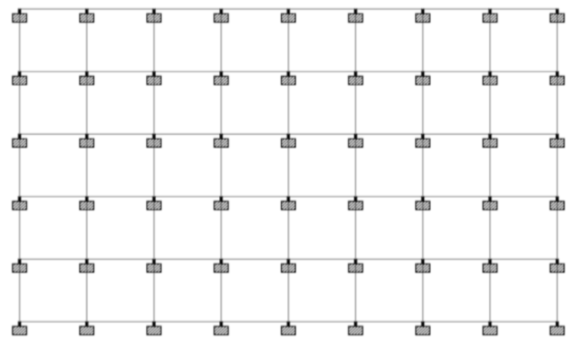

Fig.1 Plan of Regular Building

Case II: Irregular Building-A 32m x 20m 12-storey irregular structure is considered for the study. Size of each grid portion is 4m x 4m. Three different irregular building such as in H, L, C shape with and without setback are modeled.

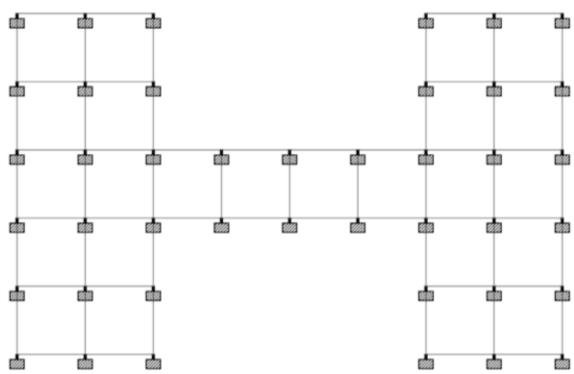

Fig.2 Plan of Irregular (H Shape) Building

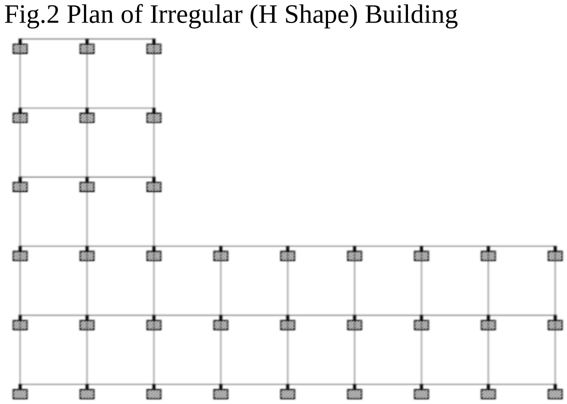

Fig.3 Plan of Irregular (L Shape) Building

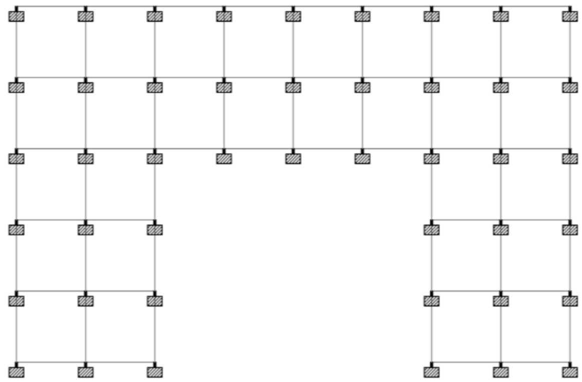

Fig.4 Plan of Irregular (U Shape) Building

3.1 Loading

Dead Load

The dead load consists of self-weight of the structure, wall load, weight of parapet walls, floor slabs and floor finish.

Wall load: Full brick load = 11.5 kN/m (Full brick load is given only to the outer walls of both type building)

Half brick load = 5.75kN/m (half brick load is given to the inner walls of both type building)

Weight of parapet = 2.3kN/m.

Self-weight of slab = 3kN/m^2.

Floor finish load =1kN/m^2

Live Load: Live load of 3 kN/m^2 is given in all floors.

Seismic Load: The building was analysed for earthquake load also. Seismic parameters used for modeling was as per IS 1893-2002 is shown in Table. II

Table. II Seismic parameters

Sesmic Zone	3
Zone Factor, Z	0.16
Soil Type	Type 2 (medium)
Importance factor, I	1
Response reduction factor, R	5
Damping	5%
Period in X direction	0.57
Period in Z direction	0.72

Wind Load: As per IS 875 (Part 3) - 1987

Design Wind Speed $Vz = V_b \times K_1 \times K_2 \times K_3$

Basic wind speed, Vb =39 m/s

K_1 =1, K_3 = 1+ Cs (s=0) = 1, K_2 (Category 3, Class B)

Table. III Wind Load Parameters

Height (m)	K_2	Vz (m/s)
12	0.904	35.256
15	0.94	36.667
18	0.964	37.596
21	0.985	38.415
24	1	39
27	1.015	39.585
30	1.03	40.17
33	1.039	40.521
36	1.048	40.872

The structure was analysed for various load combination as shown below.

1. 1.5 DL
2. 1.5(DL+LL)
3. 1.2(DL+LL+EQX)
4. 1.2(DL+LL+EQ-X)
5. 1.2(DL+LL+EQZ)
6. 1.2(DL+LL+EQ-Z)
7. 1.5(DL+EQX)
8. 1.5(DL+EQ-X)
9. 1.5(DL+EQZ)
10.1.5(DL+EQ-Z)
11.0.9DL+1.5EQX
12.0.9DL+1.5EQ-X
13. 0.9DL+1.5EQZ
14. 0.9DL+1.5EQ-Z
15. 0.9DL+1.5WLX
16. 0.9DL+1.5WL-X
17.0.9DL+1.5WLZ
18. 0.9DL+1.5WL-Z
19. 1.5(DL+WLX)
20. 1.5(DL+WL-X)
21. 1.5(DL+WLZ)
22. 1.5(DL+WL-Z)
23.1.2(DL-IL WLX)
24. 1.2(DL+LL+WL-X)
25.1.2(DL-LLWLZ)
26.1.2(DL LL WL-2)

IV. MODELLING IN STAAD PRO

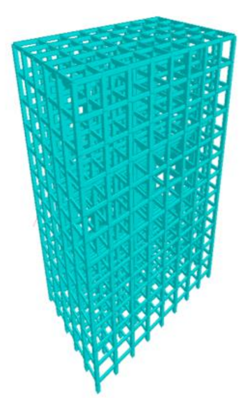

Fig. (a)[5]

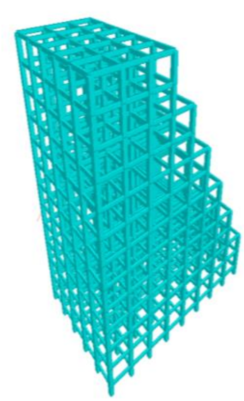

Fig. (b)[5]

Fig.5 Regular Building with and without setbacks

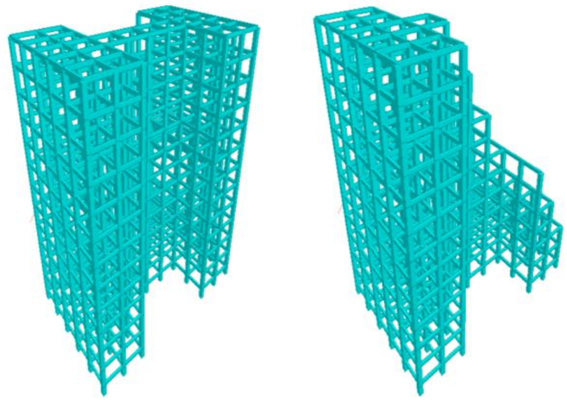

Fig. (a)[6] Fig. (b)[6]

Fig.6 Irregular Building (H Shape) with and without Setbacks

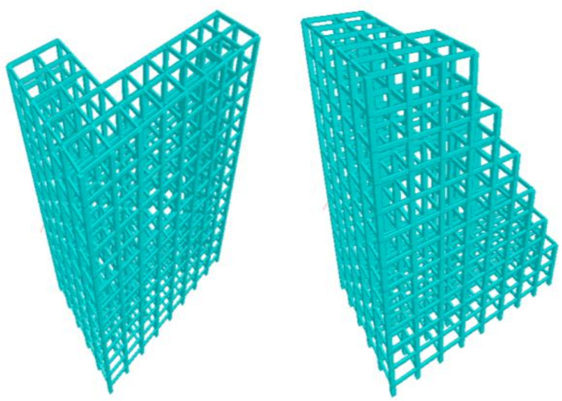

Fig. (a)[7] Fig. (b)[7]

Fig.7 Irregular (L Shape) Building with and without setback

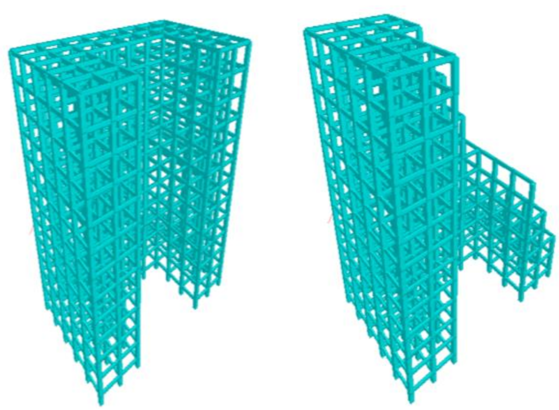

Fig. (a)[8] Fig. (b)[8]

Fig.8 Irregular (U Shape) Building with and without setback

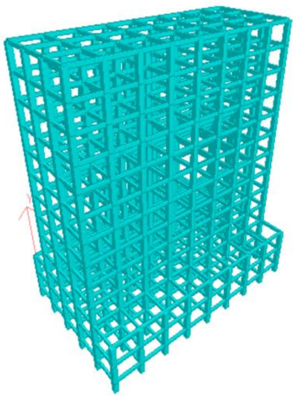

Fig.9 Inverted T shaped Building

V. RESULT AND DISCUSSION

The parameters which are considered for this study are shear force, bending moment, storey displacement. The critical maximum values are taken in all the cases. The maximum node displacement values for each model are tabulated below.

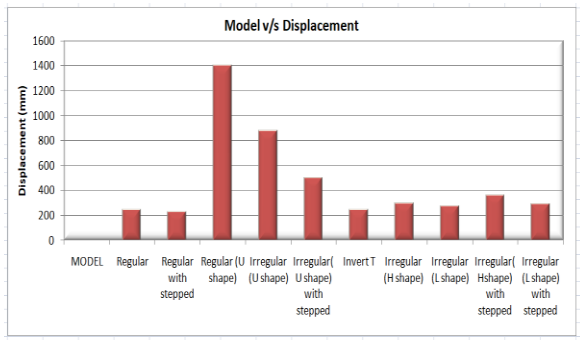

Fig.10 Comparison of maximum node displacement for each model

Comparing the node displacements for both regular and irregular building the maximum displacement is obtained for Regular (U Shape) and minimum is obtained for Regular with stepped.

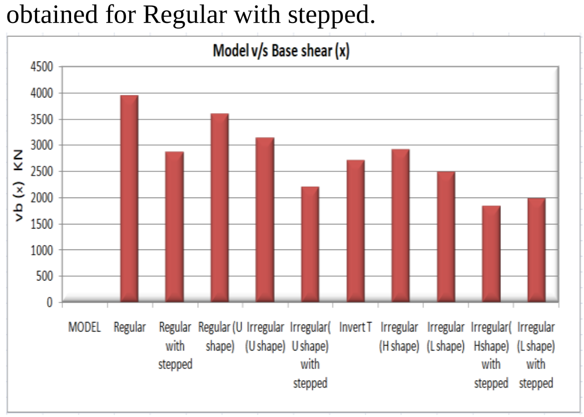

Fig.11 Base shear for each model

Comparing the base shear for both regular and irregular building the maximum is obtained for Regular and minimum is obtained for Irregular H shape with stepped.

Comparing the Shear force for both regular and irregular building the maximum is obtained for Irregular (U shape) and minimum is obtained for regular with stepped due to severe effect of wind load.

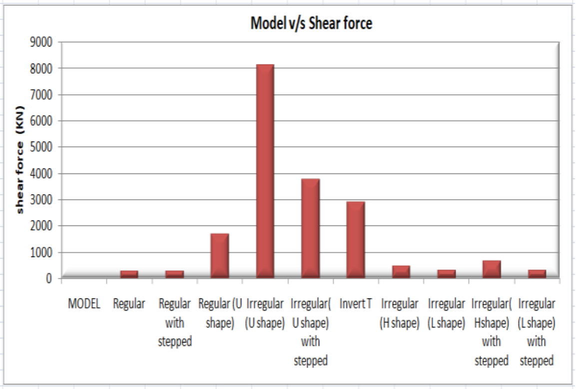

Fig.12 Comparison of shear force for each model

Comparing the bending moment (+ve) for both regular and irregular building the maximum is obtained for Regular (U shape) and minimum is obtained for regular with stepped.

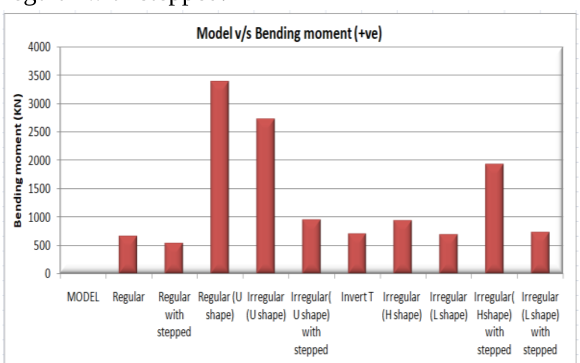

Fig.13 Comparison of (+ve) bending moment for each model

Comparing the bending moment (-ve) for both regular and irregular building the maximum is obtained for Regular (U shape) and minimum is obtained for Invert T.

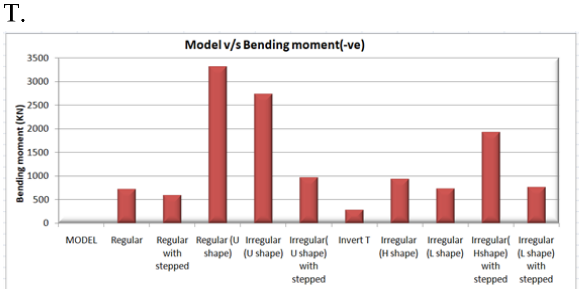

Fig.14 Comparison of (-ve) bending moment for each model

VI. CONCLUSIONS

After conducting the analysis of all the building configurations, behaviour of the structure is different for the different shape of the structure. After discussion of results and observation some of results are summarized.

It is concluded that as the amount of setback increases, the critical shear force also increases. The regular building frames possess low shear force compared to setback irregular frames.

The critical bending moment of irregular frames is more than the regular frame for all building heights. This is due to decrease in stiffness of building frames due to setbacks. Thus there is need for providing more reinforcement for irregular frames.

Comparing the maximum base shear for both regular building and irregular building the maximum shear is obtained for regular building.

Compared to irregular model lateral displacement is less in regular model. Comparing the node displacements for both regular and irregular building the maximum displacement is obtained for Regular (U Shape) and minimum is obtained for Regular with stepped.

The seismic performance of regular frame is found to be better than corresponding irregular frames in nearly all the cases. Therefore, it should be constructed to minimize the seismic effects. Among irregular frames, H shaped building configuration is found superior than others.

REFERENCE

[1] D. Rana and J. Raheem, Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building, International Research Journal of Engineering and Technology, vol.02, Issue 04, July-2015.

[2] H. Bansal and Gagandeep. Seismic Analysis and Design of Vertically Irregular RC Building Frames, International Journal of Science and Research, vol. 3, Issue 8, August 2014.

[3] Hiten L. Kheni,and Anuj K. Chandiwala, Seismic Response of RC Building with Soft Stories, International Journal of Engineering Trends and Technology – vol. 10 ,Issue 12 - Apr 2014

[4] Mr.D.Dhandapany, Comparative Study of and Analysis of Earthquake G+5 Storey Building with RC Shear Wall, Int.J.Engineering Research and Advanced Technology, vol 2, pp167-171

[5] S. Mahesh and B. P. Rao, Comparison of Analysis and Design of Regular and Irregular Configuration of Multi Storey Building in Various Seismic Zones and Various types of Soils using ETABS and STAAD, International Journal of Mechanical and Civil Engineering, vol 11, Issue 6, Dec 2014.