# Effect of Geometrical Plan Irregularities on RCC Multi-Storey Framed structure

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***Abstract* —** *In these modern days, the structures are involved with architectural importance and it is highly difficult to plan with regular shapes. This leads to planning with irregularity in the structure. These irregularities are responsible for structural collapse during earthquake. It is observed that in the regular frame, there is no tensional effect in the frame because of symmetry. But in case of irregular structures due to the tensional effect between the beam column joints failure occurs. Among the different types of analysis, pushover analysis comes forward because of its optimal accuracy, efficiency and ease of use. In the present study, the behaviour of G+10 storied R.C frame buildings with different geometrical irregularities subjected to earthquake load considered and volume of all building kept same means all total number of rooms kept same in all building models. Also total height of building 33m kept for all shape building model. Located in seismic zone III is discussed briefly using ETABS software. Gravity loads and laterals loads as per IS 1893-2002 are applied on the structure and it is designed using IS 456-2000. Displacement control pushover analysis is carried out.*

**Keywords** — *Pushover analysis, irregular frame, same volume, ETABS.*

## I. INTRODUCTION

Earthquakes are one of the most life threatening, environmental hazardous and destructive natural phenomenons that causes shaking of ground. This result in damage to the structures, hence we need to design the buildings to withstand these earthquakes which may occur at least once in the life time of the structure. Structures possess less stiffness and strength in case of irregular configured frames; to enhance this, lateral load resisting systems are introduced into the frames.

In the present study G+10 storied R.C. frame building with different geometrical irregularities subjected to earthquake load considered. In this study volume of all building models kept same. And for the study the effect of different types geometrical irregularities pushover analysis carried out by using ETABS software.

In this study four models considered, first one is regular and other three are irregular in plan. In that irregular in plan with H shape, irregular in plan with L shape, irregular in plan with O shape. Gravity loads and laterals loads as per IS 1893-2002 are applied on the structure and it is designed using IS 456-2000. Displacement control pushover analysis is carried out

## II. MODELLING USING ETABS

The building is columns spaced at 4m from center to center. Floor to floor height of 3m, and volume of all building kept same means all total number of rooms kept same in all model. Also total height of building 33m kept for all shape building model.

1. Regular model (square)
2. H –shape plan
3. L–shape plan
4. Rectangle with core

**TABLE I**

| SR. NO | Component | Values |
|---|---|---|
| **Geometric Data** | | |
| 1 | Model | G+10 |
| 2 | Floor Height | 3m |
| 3 | Base Floor Height | 3m |
| 4 | Total Building Height | 33m |
| 5 | Wall Thickness-<br>Internal-<br>External- | <br>150mm<br>230mm |
| 6 | Slab Thickness-<br><br>Beam-<br><br>Column- | 150mm<br><br>350X600mm<br><br>C1-450X450mm<br>C2-430X430mm<br>C3-410X410mm |
| 7 | Material<br>Concrete-<br>Reinforcement- | <br>M30<br>Fe415 |

| Seismic data | | |
|---|---|---|
| 1 | Seismic Zone | III |
| 2 | Importance factor | 1 |
| 3 | Type of soil | Medium soil |
| 4 | Type of structure | All general RC frame |
| 5 | Response reduction factor | 5[SMRF] |
| 6 | Time period | Program Calculated |
| 7 | Poison's Ratio | 0.15 |
| **Load Data** | | |
| 1 | Live Load | $3kN/m^2$ |
| 2 | Floor Finish Load | $1kN/m^2$ |

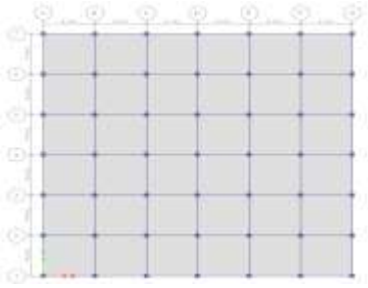

Fig.1 Regular model

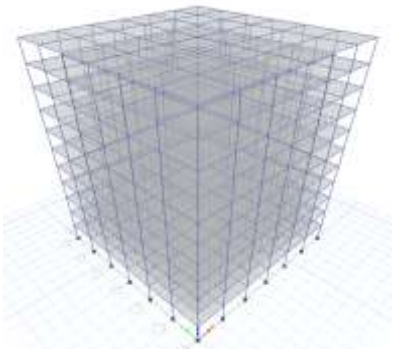

Fig.2 3D view of regular (square) shape model

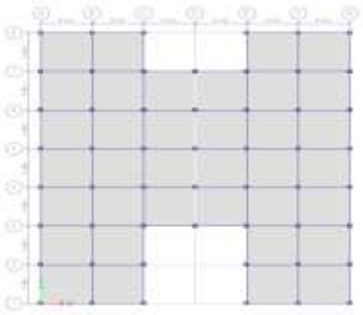

Fig.3 H –shape plan

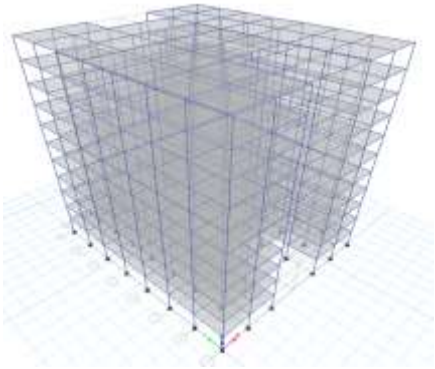

Fig.4 3D view of H shape model

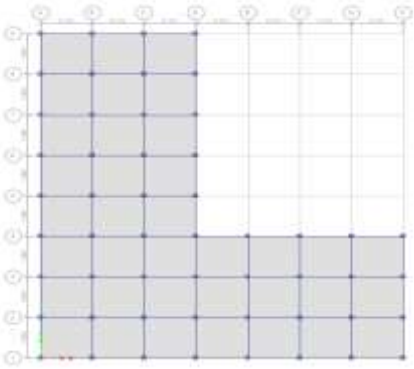

Fig.5 L–shape plan

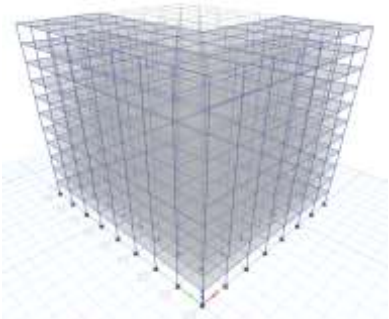

Fig.6 3D view of L shape model

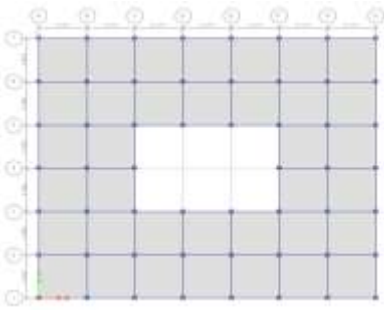

Fig.7 Rectangle with core

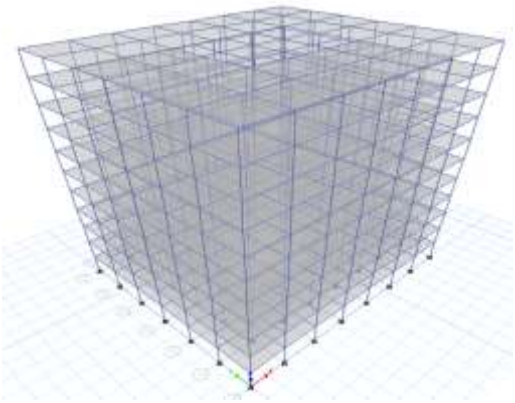

Fig.8 3D view of Rectangle with core

### III. Results and Observations

In this study tables II shows the results obtained from pushover analysis of regular building model, irregular of shape-H, irregular of shape-L, irregular of shape-O respectively. In this tables result shows model type, monitored displacement, base force and total hinges. And respective graphs plotted below the tables.

**TABLE II**

| Sr. No. | Model type | Maximum Monitored displacement (mm) | Base force (KN) | Total hinges |
|---|---|---|---|---|
| 1 | Regular | 176.666 | 5443.08 | 5852 |
| 2 | Shape-H | 121.389 | 5166.57 | 6028 |
| 3 | Shape-L | 78.453 | 5925.15 | 6116 |
| 4 | Shape-O | 144.254 | 5762.86 | 6336 |

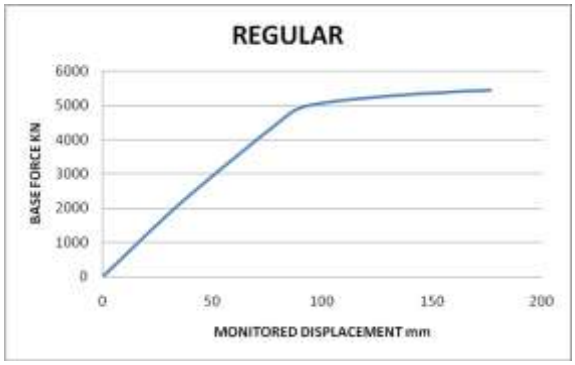


Fig.9 Monitored displacement vs. base force for regular shape

Fig. 9 shows results obtained from pushover analysis of regular model. In this analysis maximum monitored displacement is 176.666 mm and relative base force is 5443.08 KN with total hinges 5852 and for this total 39 steps are obtained.

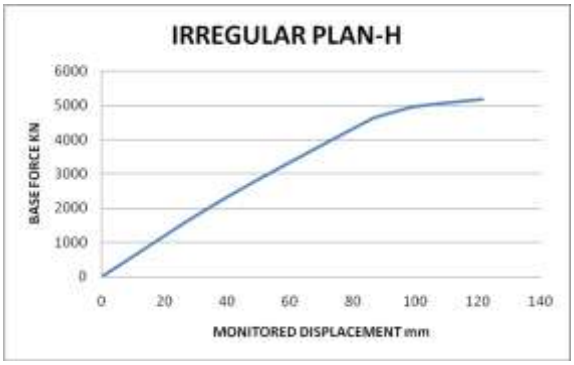


Fig.10 Monitored displacement vs. base force for irregular shape-H

Fig. 10 shows results obtained from pushover analysis of irregular model shape-H. In this analysis maximum monitored displacement is 121.389 mm and relative base force is 5166.57 KN with total hinges 6028 and for this total 25 steps are obtained.

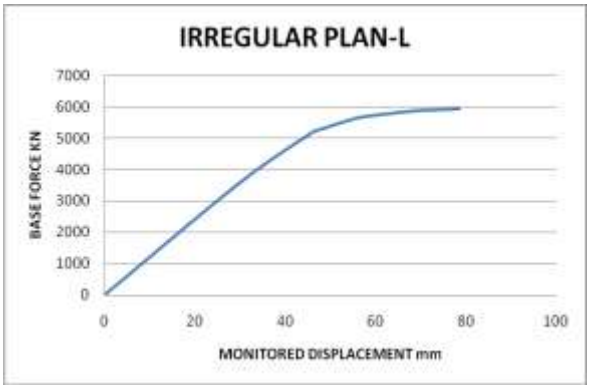


Fig.11 Monitored displacement vs. base force for irregular shape-L

Fig. 11 shows results obtained from pushover analysis of irregular model shape-L. In this analysis maximum monitored displacement is 78.453 mm and relative base force is 5925.15 KN with total hinges 6116 and for this total 33 steps are obtained.


Fig.12 Monitored displacement vs. base force for irregular shape-L

Fig. 11 shows results obtained from pushover analysis of irregular model shape-O. In this analysis maximum monitored displacement is 144.254 mm and relative base force is 5762.86 KN with total hinges 6336 and for this total 35 steps are obtained.

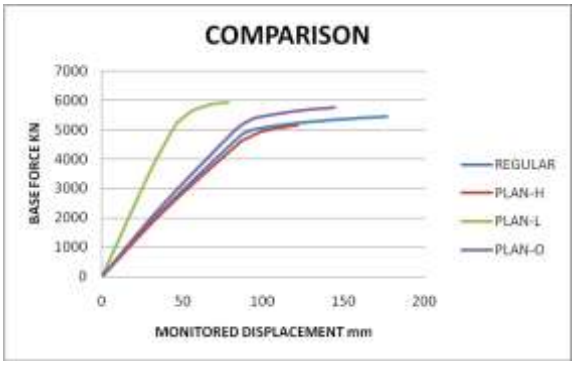


Fig.13 Monitored displacement vs. base force for comparison of all model

Fig. 13shows comparison of all models results considered in this paper. From the above graph it can be seen that the building with regular shape resists all earth quake forces for a longer time than other buildings.

## IV. CONCLUSIONS

The performance of R.C framed structure with and without considering plan irregularities was investigated using the non-linear static analysis. Following were the major conclusions drawn from the study.

A. Regular building model collapse after all building model. It means regular building resist earth quake forces longer time and withstand for longer time.
B. Irregular building model shape-H having less resistance to earth quake forces. And it will collapse before regular building and O shape building.
C. Irregular building model shape-L having very less resistance to earth quake forces compared with other all building models. And it will collapse before all other models.
D. Irregular building model shape-O having less resistance to earth quake forces only compare to regular building. And it will collapse after H and L shape building and before regular building model.

Therefore, if there is an increase in the irregularity of a building having the same volume then buildings performance will decrease.

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## REFERENCES

[1] Hamraj. Mohd, "Performance Based Pushover Analysis of R.C.C Frames for plan Irregularity." ISSN: 2348-4098 Volume 2 Issue 7 SEP-OCT 2014.

[2] Himaja Sai G.V., Ashwini .L.K, N. Jayaramappa. "Comparative Study on Non-Linear Analysis of Infilled Frames for Vertically Irregular Buildings." International Journal of Engineering Science Invention ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726 Volume 4 Issue 6 June 2015 PP.42-51.

[3] Rana Nishant, Rana Siddhant, "Non-Linear Static Analysis (Pushover Analysis) A Review." International Journal of Engineering and Technical Research (IJETR) ISSN: 2321-0869 (O) 2454-4698 (P), Volume-3, Issue-7, July 2015.

[4] Akhare Ashish , Bhende Sneha. " Modal Pushover Analysis to Estimate the Seismic Demand of Vertically Irregular Structures." International Journal of Pure and Applied Research in Engineering and Technology. ISSN: 2319-507X IJPRET, 2015; Volume 3 (8): 40-50.

[5] Anwaruddin Mohommed, Mohd. Akberuddin, Mohd. Zameeruddin, Saleemuddin. "Pushover Analysis of Medium Rise Multi-Story RCC Frame With and Without Vertical Irregularity." Int. Journal of Engineering Research and Applications Vol. 3, Issue 5, Sep-Oct 2013, pp.540-546.

[6] Chore H. S., Patil S. B., Pednekar S. C. "Pushover Analysis of Reinforced Concrete Structures." International Journal of Computer Applications (0975 – 8887) (ICQUEST2015).

[7] Srinivasu. , Panduranga Rao. "Non-Linear Static Analysis of Multi-Storied Building." International Journal of Engineering Trends and Technology (IJETT) – Volume 4 Issue 10 - Oct 2013.

[8] K.Vamsi Satyanarayana, Vinodh kumar, "Seismic Response of Rc Frame Building With Soft Storey At Different Floor Levels." International Journal of Engineering Trends and Technology (IJETT) – Volume-42 Number-4 - December 2016.