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Seismic analysis of plan and vertical irregularity of building with and without infill action using ETABS

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ABSTRACT

Earthquake is the most expensive natural disasters human face. Strong earthquake in the wrong place at the wrong time can cause great financial damage and cost. And in the present stage, many buildings are irregular in shape means both plan and elevation irregularities earthquake effect on high rise building is more dangerous as compared to a regular building. To overcome the effect on the earthquake on a regular building, it is necessary to identify the performance of the structure to withstand against disaster against both new and existing one. In this paper, the behavioral study of 5 bays X 5 bays 8m each of G+7 building with a provision of lift core walls are done. The height of each storey is 3.2m and have irregular plan and elevation. In this study, cases like a bare frame, boundary infill, complete infill and soft storey at ground floor for each model are considered. All buildings are located in zone III. Linear dynamic analysis using response spectrum method of irregular building is carried out using ETABS 2016 Ultimate 16.2.0 by considering mainly three irregularities (1) Mass irregularity 2) Stiffness irregularity (3) Geometric irregularity. For this study, behavior parameter considered are (1) Eccentricity (2) Maximum storey displacement (3) Time period (4) Maximum storey acceleration (5) Storey shear.

Keywords: *Eccentricity, Stiffness, Irregularity, Dynamic analysis, Response spectrum*

1. INTRODUCTION

Earthquake is a sudden violent shaking of the ground, resulting in great destruction, is a result of the moment within the earth's crust or volcanic action which is caused by natural and manmade cause. In modern infrastructure, different types of irregularities are used namely plan irregularity and vertical (elevation) irregularity. Because of vertical irregularity sudden failure at a weak junction structure may occur. This is mainly due to disruption of mass, stiffness, and geometry. The structure with such nonuniformity is called as irregular structure. Failure of the structure due to vertical irregularity is one of the main reason for the earthquake. Now a day construction of high rise building is preferred because of land use planning and some irregularly shaped buildings are constructed with some special features for good aesthetic appearance. In irregular structure response of the structure is not only translational, but also torsional. In irregular structure, torsion will be developed because of irregularity of mass.

2. METHOD OF ANALYSIS

This study is conducted to understand the behavior of the plan and vertical irregular building in comparison to a regular building under seismic loading. The equivalent static method is the static method of analysis which is more suitable for regular building and height of the building is less than 15m and response spectrum method is the dynamic analysis method used for irregular buildings as well with height more than 15m. Hence response spectrum method is used for the analysis of irregular building by using software ETABS 2016(version 16.2.0).

For the analysis, consider Zone factor (Z) III, Importance factor (I) 1.00, Response reduction factor (R) 5.00 and condition of the soil are taken as Medium soil.

In G+7 storey building, 5 X 5 bays of 8m each are considered. The height of each storey is 3.2 m for all models. One regular building and three irregular buildings containing lift core shaft are considered for seismic behavior.

Types of analysis carried out are:

(1) Analysis of bare frame. (Considering wall load but without infill action)
(2) Analysis of boundary infill. (Considering only boundary infill action)
(3) Analysis of complete infill.
(4) Analysis of soft storey. (Considering no infill action on the ground floor)

2.1 Cross-Sectional Properties and Material Constants

Number of storeys	: G+7(h=27.1)
Column size	: 800 X 800
Beam size	: 300 X 800
Plinth beam size	: 300 X 450
Masonry wall thickness	: 230 mm
Slab thickness	: 230 mm
Height of typical floor	: 3.2 m
Depth of foundation	: 1.5 m
Lift core size	: 2 m X 2 m
The thickness of lift core	: 230 mm
Number of lift core	: 4 NO
Grade of steel	: Fe 415
Grade of concrete	: M2
Density of concrete	: 25 KN/m^3
Characteristic strength of concrete	: 25 Mpa
Modulus of elasticity of concrete	: 25000 Mpa
Poisson's ratio of concrete, μ	: 0.20
The density of brick masonry, ϱ	: 19.2 KN/m^3
Modulus of elasticity of brick masonry, E_{me}	: 1.8 X 10^6 KN/m^2
Poisson's ratio of brick masonry	: 0.20

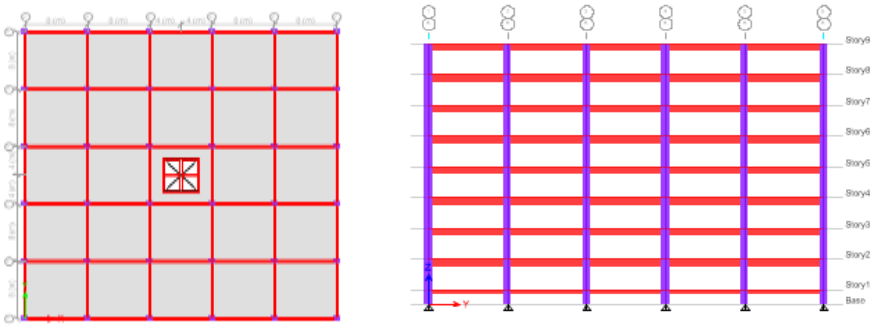


Fig 1.1: Model 1

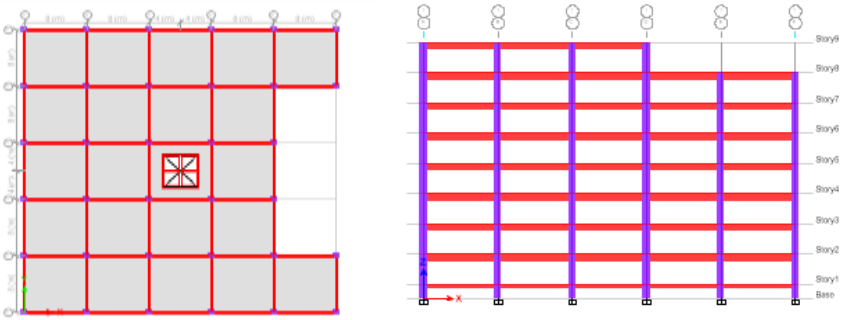


Fig 1.2: Model 2

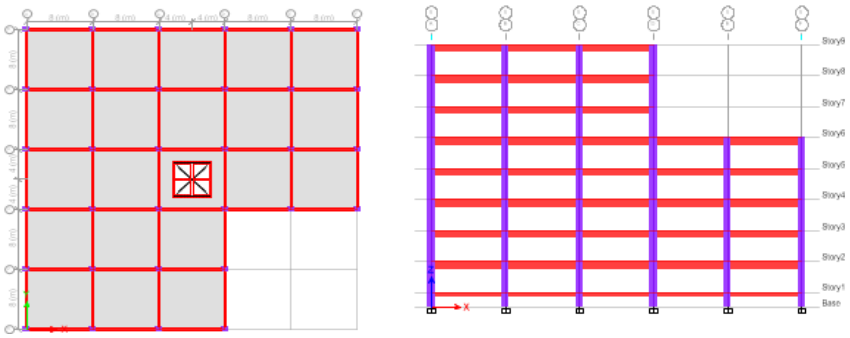


Fig1.3: Model 3

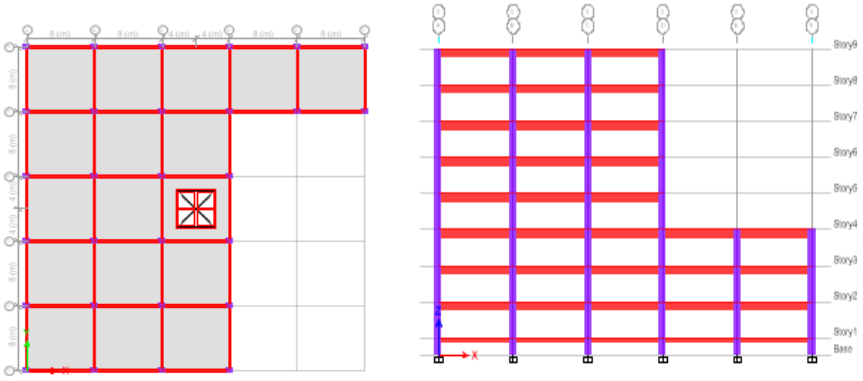


Fig1.4: Model 4

a. Primary loads

As per provision of Indian Standard Code of Practice for the Structural safety of Buildings, loadings standards IS 875-1987(Part-1), all the models are subjected to 4 types of primary load cases, they are as follows:

1. Dead Load case, denoted as "DL" (Vertical or Gravity load).
2. Live Load case, denoted as "LL" (Vertical or gravity load).
3. Seismic Load in X-direction denoted as "EQ X" (Lateral or Earthquake load).
4. Seismic Load in Y-direction denoted as "EQ Y" (Lateral or Earthquake load).
5. Response spectra in X-direction as "RSX".
6. Response spectra in Y-direction as "RSY".

b. Load Combinations

The structural system has 19 types of load combination as per IS1893 (Part 1):

a) Non-Seismic Load combination: 1.5(DL+LL)

b) Seismic Load combination:

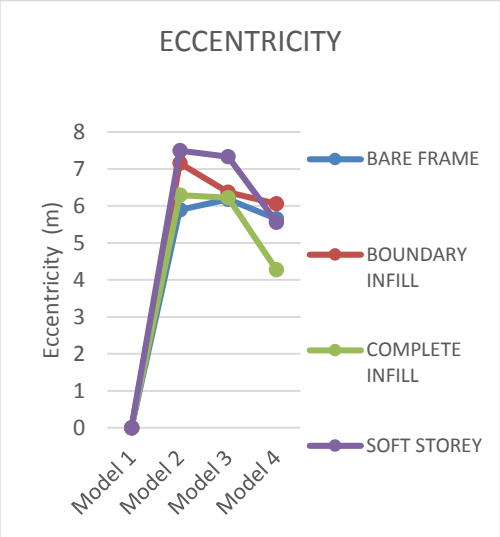
1.2(DL+LL+EQX)
1.2(DL+LL-EQX)
1.2(DL+LL+EQY)
1.2(DL+LL-EQY)
1.5(DL+EQX)
1.5(DL-EQX)
1.5(DL+EQY)
1.5(DL-EQY)
(0.9DL+1.5EQX)
(0.9DL-1.5EQX)
(0.9DL+1.5EQY)
(0.9DL-1.5EQY)
1.2(DL+LL+RSX)
1.2(DL+LL+RSY)
1.5(DL+RSX)
1.5(DL+RSY)
(0.9DL+1.5RSX)
(0.9DL+1.5RSY)

3. RESULTS

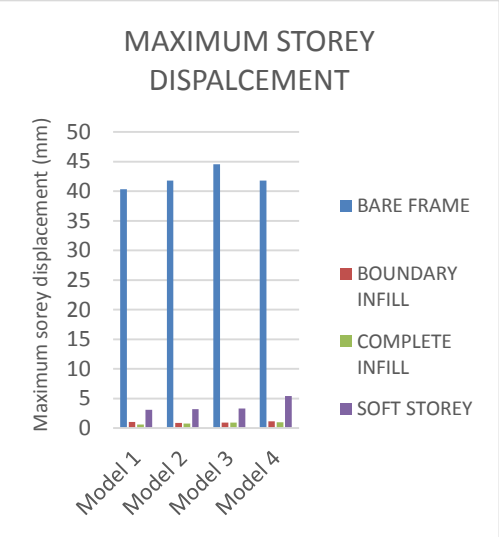
In the present study, an attempt has been made to study the effect of the plan as well as vertical irregularity and effect of infill frame action of a G+7 storey building with lift core provided. The seismic analysis is done by response spectrum analysis.

The parameters given below are considered and analyzed for the study.

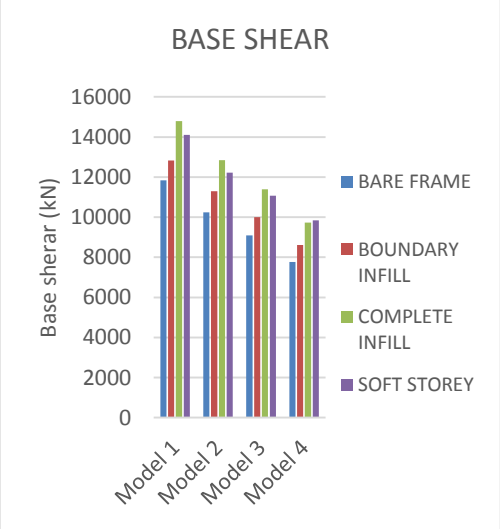
A. Eccentricity.
B. Maximum critical storey displacement.
C. Base shear.
D. Model time period.
E. Maximum storey acceleration (X & Y-Direction).



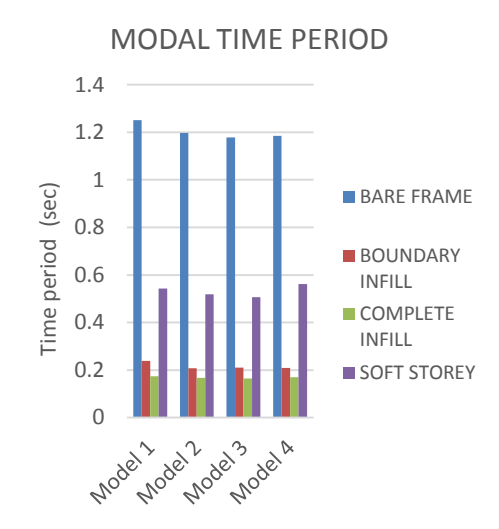
Graph-1: Eccentricity



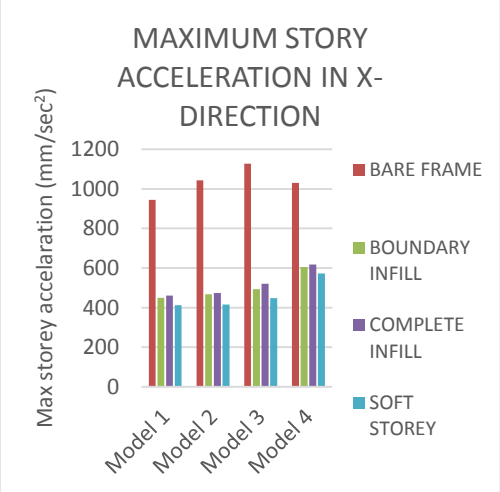
Graph-2: Max. Storey displacement



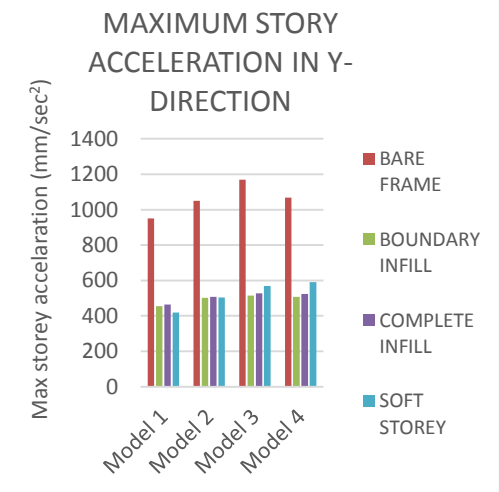
Graph-3: Base shear



Graph-4: Modal time period



Graph-5: Max. Storey acc. (X-dir.)



Graph-6: Max. Storey acc. (Y-dir.)

In Boundary infill frame and ground floor soft storey have a higher value of eccentricity than the bare frame and complete infill frame due to the irregularity of mass.

Regular model has less storey displacement. More the irregular structure more will be the storey displacement. Complete infill has minimum storey displacement due to the presence of strut throughout the structure. The soft storey has maximum storey displacement because of irregularity of stiffness.

The regular building has maximum base shear value. Base shear depends on the mass of the building.

In regular building model, time period is maximum with respect to the irregular building. The bare frame has maximum modal time period because of the absence of strut in the frame. Complete infill has a least modal time period since it has strut at every panel.

Regular model has less storey acceleration. It has a relationship with eccentricity. If eccentricity increase storey acceleration increase.

4. CONCLUSION

More the regular model lesser will be the maximum storey displacement. In regular models, complete infill has lowest maximum storey displacement value due to infill action throughout the frame.

Base shear depends upon the mass of the structure. Therefore, complete infill frames have maximum base shear values. Regular model (Model 1) has maximum plan area. Hence, it has more mass, so it has maximum base shear value.

Eccentricity in a regular model is zero due to symmetry. In the irregular model, due to irregularity in plan and elevation, boundary infill frame and the soft storey have a high value of eccentricity.

The modal time period is more for regular building compare to irregular. The modal time period is more in the bare frame due to lack of infill action.

Regular models have less storey acceleration than irregular models in both X and Y direction. More will be the eccentricity more will be the acceleration.

5. REFERENCES

[1]. T.Sruti Sai. & Dr.T.Chandrasekhar Rao & B.Vasudev, "Seismic response of RC framed structure having plan & vertical irregularities with & without infill action." International Research Journal of Engineering and technology, Volume 3 Issue 2, Feb 2016.

[2]. Nonika N. & Gargi Dande D., "Seismic analysis of vertical irregular multi-storeyed building" International Journal for Research in Applied Science and Engineering Technology, EISSN 2319-1163 Volume 4 Issue 9, September 2015.

[3]. Oman Sayyed &Suresh Singh Kushwah & Aruna Rawat, "Seismic analysis of vertically irregular RC buildings with stiffness & setback irregularities" IOSR Journal of Mechanical & Civil Engineering, Volume 14 Issue 1, Jan 2017 ISSN online.

[4]. Ravindra n. Shelke & u.S. Ansari," Seismic analysis of vertically irregular RC building frames" International Journal of Civil Engineering and Technology, Volume 8 Issue 1, Jan 2017

[5]. Rakshith Gowda K.R. & Bhavani Shankar, "Seismic analysis comparison of regular and vertically irregular RC building with soft story with different level" International Journal of Emerging Technology and Engineering, volume 1 Issue 6, July 2014.

[6]. Akhil R. & Aswthy S. Kumar, "Seismic analysis of irregular buildings with vertical irregularity" International Research Journal of Engineering and Technology, Volume 4 Issue 6, June 2017.

[7]. Mrs. Gargi Danda Dey,"Comparision studies on seismic analysis of regular and vertical irregular multi-storeyed buildings." International Journal of Research in Applied Science and Engineering Technology, volume 3 issue 7, July 2015.

[8]. Shivkumar Hallale & H. Sharda Bai, "Seismic behaviour of buildings with plan irregularity with or without infill action." International Journal of Recent Advances in Engineering and Technology, ISSN (online):2347-2812 Volume 4 Issue 4, 2016.

[9]. Girum Mindaye & Dr. Shaik Kajdani, "Seismic analysis of multi-storey RC frame building in different seismic zones." International Journal of Innovative Research in Science, Engineering and Technology, Volume 5 Issue 9, sept. 2016.

[10]. Wakchure M.R. & Ped S.P., "Earthquake analysis of high rise building with or without infill walls." International Journal of Engineering and Innovation Technology, Volume 2 Issue 2, August 2012.

[11]. Pankaj Agarwal & Manish Shrikhande, (2006) "Earthquake resistant design of strcture PHI learning Pvt. Ltd.", New Delhi, India.

1) Codes and Standards Indian standard, IS 456-2000 "Plain and reinforced concrete-code of practice." BIS, New Delhi, India.
2) Indian standard, IS 1893-2016 "Criteria for earthquake resistant design of structures", Part 1: general provisions and buildings, Sixth revision, BIS, New Delhi, India.
3) Indian standard, IS 875-1987 "Code of practice for design loads for building and structures." BIS, Manak Bhavan, New Delhi, India.

