PERFORMANCE OF RCC FRAMED BUILDINGS UNDER LATERAL LOAD BASED ON EURO CODE

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ABSTRACT *Lateral loads are random in nature and unpredictable, the static and dynamic analysis of the structures have become the primary concern of structural Engineering. The feature of the regularity and symmetry in the overall shape of the building in plan affects the response of the building under lateral loading. Therefore these types of structures should be well analyzed under lateral loading accounting the specified seismic design philosophies and seismic codes so that they can sustain moderate to maximum lateral loading. In recent years number of studies has been made in the performance of RCC framed regular and irregular buildings separately under static and dynamic analysis method with the help of civil engineering software based on different standards. In this study the performance of regular and irregular RCC framed buildings under both static and dynamic analysis method with the help of ANSYS software are studied. The objective of this paper is to study the performance of RCC regular and irregular framed buildings under static and dynamic analysis under lateral and normal loads. Various structural responses like shear force, bending moment, stress and lateral displacement are obtained. From the analyzed results it has been found that these parameters are high for irregular building in both static and dynamic analysis method compared to regular building.*

Key Words: *Static Analysis, dynamic analysis, Regular building, Irregular building, Structural Response, lateral load*

1. INTRODUCTION

Lateral loads are random in nature and unpredictable, the static and dynamic analysis of the structures have become the primary concern of structural Engineering. R.C.C framed buildings are considered as main structural which are subjected to variety of loads, where lateral loads are always predominant. The analysis of lateral forces on RCC a framed building can be calculated by static and dynamic analysis method. The dynamic and static analysis method can be performed by Response spectrum method and Equivalent lateral force method respectively. The behavior of a building during a lateral loading depends on several factors, stiffness, adequate lateral strength and ductility, simple and regular configurations. The structures having this discontinuity are termed as irregular structures. Irregularities are one of the major reasons of failures of structures during lateral loading. Among all the factors configuration of a building is an important feature which has huge influence on the damage during lateral loading. Therefore these types of structures should be well analyzed under lateral loading accounting the specified seismic design philosophies so that they can sustain moderate to lateral loading. The objective of this work is to study the performance of RCC regular and irregular framed buildings under static and dynamic Analysis method based on Euro Code 8 with the help of ANSYS software. This study compares important provisions related to the structural response of RCC framed buildings in static analysis and dynamic analysis method. The structural responses of the buildings have been obtained by using equivalent static and response spectrum analysis.

1.1. OBJECTIVES

This study is focused on the performances of RCC regular and plan irregular framed buildings which are most commonly used in all over the world. The goal of this study is to investigate various structural responses of RC framed regular and plan irregular buildings under lateral loading. The performances were estimated through the comparison between various parameters obtained by static and dynamic methods of analysis. More specifically, the main objectives of this study are:

- To do the static and dynamic analysis for regular and irregular RCC Framed building under lateral loading according to Euro Code 8
- To assess the performance of regular and irregular RCC Framed buildings

under lateral and normal load with the help ANSYS software

- To compare the structural response of the RCC framed buildings with respect to Static and Dynamic analysis method on the basis of shear force, bending moment, stress & displacement

2. LITERATURE REVIEW

In recent years number of studies has been made in the performance of RCC framed structures under both or separately static and dynamic analysis method with the help of civil engineering software based on different standards. In this study the performance of regular and irregular RCC framed buildings under static and dynamic analysis method with the help of ANSYS software studied.

Anirudh Gottala and Shaik Yajdhani(2015) Studied static and dynamic analysis of G+9 multistoried building. Analysis was done by static method and dynamic method (Response Spectrum Method) using STAAD-Pro as per the IS-1893-2002. Parameters such as Bending moment and Displacement were calculated. The authors concluded that,

- The values for Moments were higher for Dynamic analysis than the values obtained for Static analysis.
- The values of Nodal Displacements were higher for Dynamic analysis than the values obtained for Static analysis.

Arvindreddy and R.J.Fernandes (2015) conducted Seismic analysis of RC regular and irregular frame structures. In this paper reinforced concrete regular and irregular multistory 15 storey buildings were considered and the buildings are analyzed by using Time history method and Response spectrum method based on IS 1893-2002 (part1). In this study displacement and storey drift found in irregular structures were less as compared to regular structures in both static and response spectrum method.

Dileshwar Rana and Juned Raheem (2015) conducted Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building. This work shows the performance & behavior of regular & vertical geometric irregular RCC framed structure under seismic motion. Five types of building geometry were taken in this project. A comparative study is made between all these building configurations height wise and bay wise. All building frames were modeled & analyzed in software Staad.Pro V8i according to IS 1893:2002. Various seismic responses like

shear force, bending moment, storey drift, storey displacement were obtained. This study concluded that the regular building frames possess very low shear force and bending moment compared to irregular frames.

Gauri G. Kakpure and Ashok R. Mundhada (2016) the paper conducted Comparative Study of Static and Dynamic Seismic Analysis of Multistoried RCC Building by ETABS. In this study Design parameters Displacement, Bending moment, Base shear, Storey drift, Torsion, Axial Force were studied. The study concludes that the irregular shape building undergoes more deformation and hence regular shape building must be preferred and the results of equivalent static analysis were approximately uneconomical because values of displacement are higher than dynamic analysis.

Mohit Sharma and Savita Maru (2014) This paper conducted Dynamic Analysis of Multistoried Regular Building. Modeling And Analysis for G+30 building was done by using STAAD-Pro software. The static and dynamic analysis had done with the help of STAAD-Pro software as per the IS-1893-2002-Part-1 for the zones- 2 and 3. The values of displacement were higher for Dynamic Analysis than the values obtained for Static Analysis For both zone II and zone III at the same points.

Mahesh S. and B. Panduranga Rao (2014) studied residential building of (G+11) regular and irregular configuration for earthquake and wind load using ETABS and STAAD PRO V8i. static and dynamic analysis was performed. This analysis was carried out by considering different seismic zones and for each zone; the behavior was assessed by taking three different types of soils namely Hard, Medium and Soft. In this paper the following conclusion was made

- The base shear values and story drift values were more in regular configuration than irregular configuration.
- Base shear value was more in zone 5 and that in the soft soil in regular configuration.
- Story drift value was more in the story 13 in the regular configuration.

Mohaiminul Haque, Sourav Ray, Amit Chakraborty, Mohammad Elias and Iftekharul Alam(2016) Studied Seismic Performance Analysis of RCC Multi-Storied Buildings with Plan Irregularity. In this study, four different shaped (W-shape, L-shape, Rectangle, Square) ten storied RCC building frames are analysed using ETABS

v9.7.1 and SAP 2000 v14.0.0 for seismic zone 3. For static analysis effects of earthquake force found approximately same to all models except model-1(W-shape). It was also found from the response spectrum analysis that the displacements for irregular shaped building frames are more than that of regular shaped building.

3. METHODOLOGY

The methodology worked out to achieve mentioned objectives and the steps undertaken in the present study to accomplish the these objectives are as follows

- ✓ The project begins from collecting some previous work done related to this project and reviews these papers.
- ✓ Select an exhaustive set of regular and irregular frame building models with 12 m height (4 storeys), assuming equal bay width of 5 m in both horizontal direction and plan irregularities.
- ✓ In this project manual Analysis is done for both static and dynamic Analysis method based on Euro Code 8 EN 1998-1:2004 in order to find lateral loads of the buildings
- ✓ Analysis is done using ANSYS APDL 16 for both static and dynamic Analysis method in order to find response of the building when the building is subject to lateral load.
- ✓ Comparison of the results with respect to static and dynamic analysis for framed RCC buildings is done.
- ✓ Based on the results summary and conclusions are done.

Table 1 PROBLEM DESCRIPTION

Type of building	OMRF school building
The building locate in Seismic Zones	V
Floor height	3m
Height of the Building	12m
Plan dimension of the building	$20m \times 20m$
Total floor area	400m^2
Size of columns	$0.35m \times 0.35m$
Column height	3m
Size of beams	$0.35m \times 0.35m$
Span of the beam	5m
Thickness of infill Walls	0.25m

Height of infill Walls	2.65m
Width of infill Walls	4.65m
Dead load of the floor	4KN/m2
Live load on each floor	3KN/m^2
Live load on the roof	1.5KN/m^2
Specific wt. of RCC	25KN/m^3
Specific wt. of infill	20KN/m^3

3.1. Modeling using ANSYS

ANSYS is finite element software. It is the best tool for analyzing structural aspect very efficiently. The primary unknowns calculated in structural analysis are displacements. Other quantities such as stress, strains and reaction forces are then derived from nodal displacements. For generating a structure in ANSYS we require creation of model geometry, selection of appropriate element type and material properties. In the next step we need to assign them to the various elements. The next is the pre-processing work. In this stage we have to discretize the element in to finite elements.

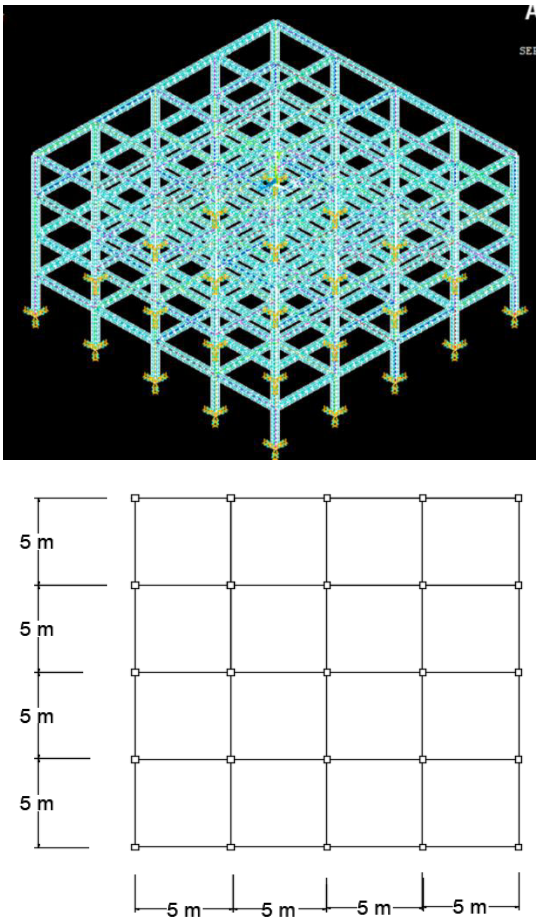
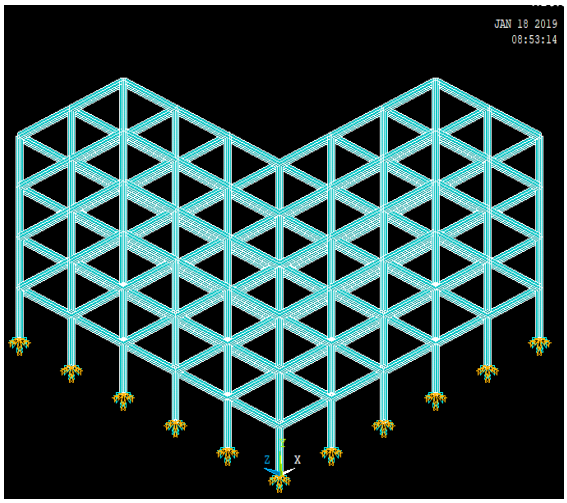


Fig. 1 Three dimensional and plan view of regular building



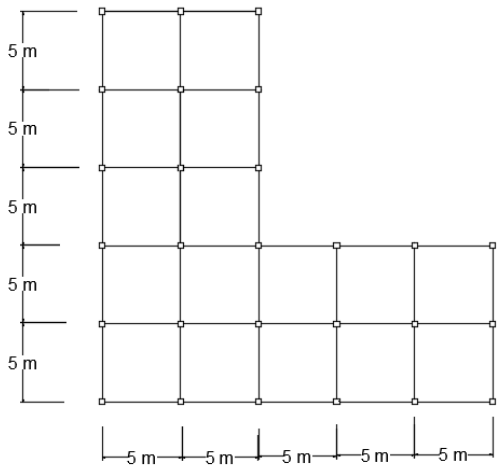


Fig. 2 Three dimensional and plan view of irregular building

3.2. Materials Used

Concrete: M 30 Grade of concrete

Poisson's ratio is taken as 0.3 as per codes.

E = $22000*(f_{ck}/10)^{0.3}$ in MPa Modulus of elasticity for modeling is taken from (Table 3.1)

Table 2 Seismic parameters used during lateral load analyzing

Parameter	**Value**
Ground type	C
Seismic Zone.	D
Important class	3
Peek ground acceleration.	0.24g
Approximate fundamental time period	0.485
Elastic response spectra $S_d(T_1)$	2.086

4. RESULT AND DISCUSSION

In this paper RCC frame buildings are analyzed both statically and dynamically based on Eurocode 8 with the help of ANSYS APDL 16 software. The results are five categories namely Maximum base shear, lateral displacement, bending moment, shear force and shear stress.

4.1. EQUIVALENT STATIC LATERAL FORCE METHOD

The equivalent static lateral force method is done with an estimation of base shear and its distribution on each story calculated by using formulas given in the code. The base shear which is the total horizontal force on the buildings is calculated on the bases of structure mass and fundamental period of vibration. The base shear distributed along the height of the buildings in terms of lateral load.

Table 3 Lateral load and story shear force for regular building

Floor	z_i	m_i	$\frac{z_i m_i}{\sum z_i m_i}$	$F_i = \frac{F_b \cdot z_i m_i}{\sum z_i m_i}$	F_{bi}
4	12	343.5	0.39	483	483
3	9	355	0.304	376	859.5
2	6	355	0.203	252.4	1111.9
1	3	355	0.102	126	1238

Table 4 Lateral load and story shear force for irregular building

Floor	z_i	m_i	$\frac{z_i m_i}{\sum z_i m_i}$	$F_i = F_b \cdot \frac{z_i m_i}{\sum z_i m_i}$	F_{bi}
4	12	347	0.38	488	488
3	9	378	0.31	398	886
2	6	378	0.207	265	1151
1	3	378	0.104	133	1284

Table 5 Lateral displacements of Regular and Irregular framed buildings

Storey ht.(m)	Displacement(mm)	
	Regular	Irregular
0	0	0
3	7.33	14
6	18	35
9	25	49
12	33	63

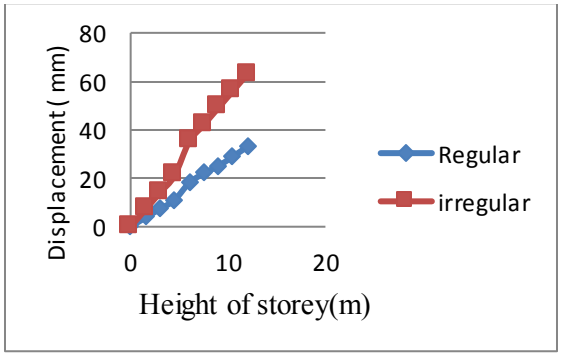


Fig. 3 displacement vs storey height

Table 6 Shear stress of Regular and Irregular framed buildings

Storey ht.(M)	Shear stress (kN/m²)	
	Regular	Irregular
0	0.0019	0.012
3	5.5	8.6
6	13.76	21.58
9	19.27	30
12	24.78	38.83

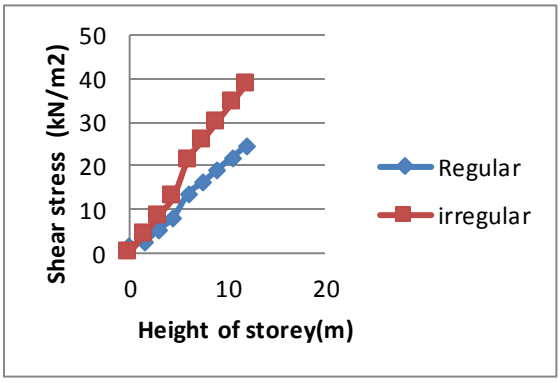


Fig. 4 Stress vs storey height

4.2.RESPONSE SPECTRUM ANALYSIS METHOD

Applied on those Buildings where mode other than the fundamental one affects the response of the buildings. In this method the response of multi degree of freedom system is expressed as the superposition of modal response, each modal response being determined from the spectra analysis of single degree freedom system which are then combined by SRSS method to find the total response of the building.

Table 7 Lateral load and story shear force calculation

Floor	Floor ht(m)	m_i	F_i	F_{bi}
4	12	343.5	554.7	554.7
3	9	355	962.5	1517.2
2	6	355	798.2	2315.4
1	3	355	518.1	2833.5

Table 8 Lateral displacement Regular and Irregular buildings

Storey ht.(m)	**Displacment(mm)**	
	Regular	**Irregular**
0	0	0
3	13	26
6	34	65
9	48	91
12	62	117

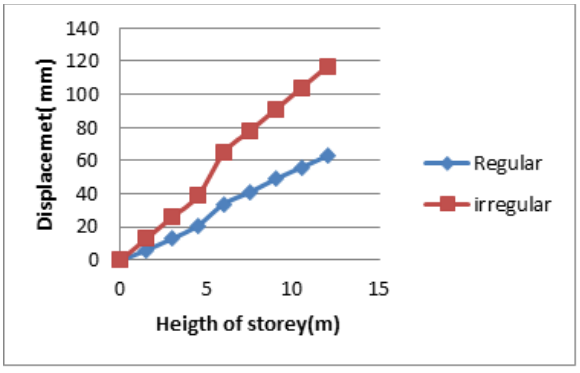


Fig. 5 Displacement vs storey height.

Table 9 Shear stress Regular and Irregular buildings

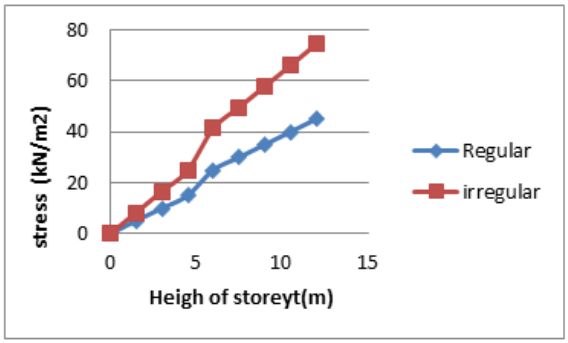


Fig. 6 Stress vs storey height

5. CONCLUSIONS

In present work base shear and lateral forces at various levels of storey, Maximum lateral displacement, bending moment, shear force and shear stress have been tabulated for both static and dynamic analysis method. Based on the above results it is found that

- The lateral displacement is found high for irregular in both static and dynamic analysis method compared to regular building.
- Base shear is found approximately the same for both regular and irregular buildings in dynamic analysis method, but is found high for irregular building in static analysis method.
- Stress is found high for irregular in both static and dynamic analysis method compared to regular building.

- As a result of comparison between static and dynamic analysis it is observed that the Shear force, bending moment, displacement, stress and Base shear obtained by static analysis are lower than dynamic analysis.

REFERENCES

1. Anirudh Gottala and Shaik Yajdhani (2015) 'Comparative Study of Static and Dynamic seismic Analysis of Multistoried Building'. *International Journal of Science Technology & Engineering*, Vol.2 , Issue 01, pp. 173-183

2. Arvindreddy and R.J.Fernandes(2015). 'Seismic analysis of RC regular and irregular frame structures' *International Research Journal of Engineering and Technology (IRJET),* Vol. 2, Issue 5, pp. 44 - 47

3. Dileshwar Rana and Juned Raheem(2015), 'Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building' *International Research Journal of Engineering and Technology (IRJET),* Vol. 2, Issue 4, pp. 1396 - 1401

4. European Standard, E. (1998-1:2004). Eurocode 8: Design of structures for earthquake resistance. Part 1: General rules, seismic actions and rules for buildings.

5. Gauri G. Kakpure , Ashok R. Mundhada (2016). 'Comparative Study of Static and Dynamic Seismic Analysis of Multistoried RCC Building by ETAB'. *International Journal of Emerging Research in Management &Technology*, Vol. 5, Issue-12.(pp.16-20).

6. Mahesh N. Patil, Yogesh N. Sonawane (2015) 'Seismic Analysis of Multistoried Building', *International Journal of Engineering and Innovative Technology (IJEIT),* Vol. 4, Issue 9, pp. 123 -130

7. Mahesh S. and Panduranga Rao (2014)B.'Comparison of analysis and design of regular and irregular configuration of multi-Story building in various seismic zones and various types of soils using ETABS and STAAD'. *Journal of Mechanical*

and Civil Engineering (IOSR-JMCE), Vol, 11, Issue 6 pp. 1-6

8. Mohaiminul Haque, Sourav Ray, Amit Chakraborty, Mohammad Elia and Iftekharul Alam. (2016). 'Seismic Performance Analysis of RCC Multi-Storied Buildings with Plan Irregularity'. *American Journal of Civil Engineering,* Vol. 4, Issue3. pp. 68-73.

9. Mohit Sharma and Savita Maru (2014). 'Dynamic Analysis of Multistoried Regular Building'. *Journal of Mechanical and Civil Engineering (IOSR-JMCE),* Vol. 11, Issue 1, PP 37-42.

10. Shital A. Navghare1, and Amey Khedikar (2017). 'Analysis of RCC Framed Structure for Column with Modelling Irregularities'. *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 6, Issue 11.pp. 217 – 224.

11. Shrikhande, P. A. (2013). 'Earthquake Resistant Design of Structures'. PHI Learning private Limited, Delhi

12. Siluveri Shivaji, A. Sravan, P. Rama Krishna (2017). 'Analysis of Seismic Forces for A Multi-Storied(G+15) Residential Building by Using STAAD.Pro'. *International Journal of Ethics in Engineering & Management Education*,Vol. 4, Issue 2, pp.1-4.