2018 Scienceline Publication

Journal of Civil Engineering and Urbanism

Volume 8, Issue 1: 01-05; Jan 25, 2018 ISSN-2252-0430

Studies on Regular and Irregular Tall Structures Subjected to Earthquake Loading

Miss Chaya[1] and Naveen GM[2]

[1]*Assistant Professor, Department of Civil Engineering, EIT, Chamarajanagar-571313, Karnataka 571313, India*
[2]*Assistant Professor, Department of Civil Engineering, Government .Engineering College, Chamarajanagara-571313, Karnataka 571313, India*
Corresponding author's E-mail: naveengm.gowda@gmail.com

ABSTRACT: Multi storey buildings are constructed by Reinforced concrete are subjected to earthquake forces are affected dangerously, they get failure during earthquake. The main reason for this failure is that the irregularity in building structures. In this paper study is made to find the response of regular and irregular building structures having plan irregularity located in seismic zone V. In this present study Analysis has been made by taking 10 storey building by Response Spectrum Method using ETABS 2015 and code IS 1893:2002 (part 1). Analysis is carried out for Regular and Irregular buildings at a height of 35.5 m in zone V. Behavior of structures are comparing the responses in the form of maximum storey displacement, storey drift, storey stiffness, periods and frequencies of modes during earthquake. Presently there are four models. One is Regular structure and remaining are Irregular structural models, all models have different shape but having same area. An attempt is made to study the Response of building structures with respect to the loads and their combinations. The results comparison is made by taking maximum load combinations considering the primary loads (LL, DL, WL, and EQL). Totally four Configuration models are considered for the analysis.

Keywords: Horizontal irregularity, Earthquake load, Storey shear, Maximum storey displacement, Maximum storey drift.

ORIGINAL ARTICLE

PII: S2252043018000001-8

Received 28 Oct. 2017

Accepted 30 Dec. 2017

INTRODUCTION

Structure is subjected to seismic forces during earthquake, structures undergo displacements at the base and the components of the structure are also get displaced and damaged during the earthquake. During earthquake seismic forces are developed, Structure is experienced there seismic forces. Seismic forces developed the seismic waves and a wave reaches the structure during earthquake. The waves generated from the earthquake epicenter disturb the structure during earthquake. They can produce ground motions in the structure. Earthquake is the natural phenomenon; it is the Rapid movement of the earth surface taking place at or below the surface of the earth. When the earthquake takes place the layers of the soil in the earth also displace the structure components of the building are get vibrated by this ground motions. When the ground motions are occurred, the structures are affected in three dimensions in the three directions, one is vertical direction (Z) and other two are horizontal directions (X, Y) .The structure is mostly affected by the horizontal direction of vibrations. All the structures are designed to satisfy the gravity loads acted in vertical direction. In the design specifications safety factors are to be considered, because of this most of the structure are tended to be adequately protected against vertical shaking. But its affects should be considering in design of the R.C.C Structures. When we are considering design of building by considering vertical ground motions is not safe. It is to be considering the horizontal displacement of the building. Generally, forces acted in the horizontal ground motions of the earthquake are taken important for the design of the structures. Therefore the building structures must be designed to resist the horizontal forces acted due to the earthquake.

Objectives of the study

• This study focus is on the behavior of structures during earthquake having irregularities in plan and having same area.

• To study the parameters of storey shear, storey displacements, maximum storey drift of all models during earthquake.

• To study the frequencies and periods in different modes.

MATERIALS AND METHODS

Model of the structures

Parameters consider. In the present study four different buildings are considered, one is horizontal regular and other three are irregular buildings. Buildings are modelled using ETABS package and analyzed. The properties of the considered building configurations in the present study are summarized below.

Table 1. Parameters considered for the building design

Parameter	Type\Value
Structure Type	RCC Building Structure
Number of Stories	10
Bottom Storey Height(Basement)	4m
Storey's Height(Ground+ Floors)	3.5m
Type of Structure	Regular , Irregular Building Structure
Area of Structure	1600 m^2
Bay Width in both direction	5m
Beam Size Grade of Concrete	0.2mX0.45m M_{20}
Column Size Grade of Concrete	0.3mX0.9m M_{25}
Thickness of Slab	0.12m
Concrete Brick Thickness	0.2m
Live Load	4 KN\m^2
Seismic Zone	V (Z=0.36)
Importance Factor	1.5
Response Reduction Factor	5
Soil Type	II

ANALYSIS OF THE STRUCTURES

Following models are analyzed as special moment resisting frame using response spectrum analysis.

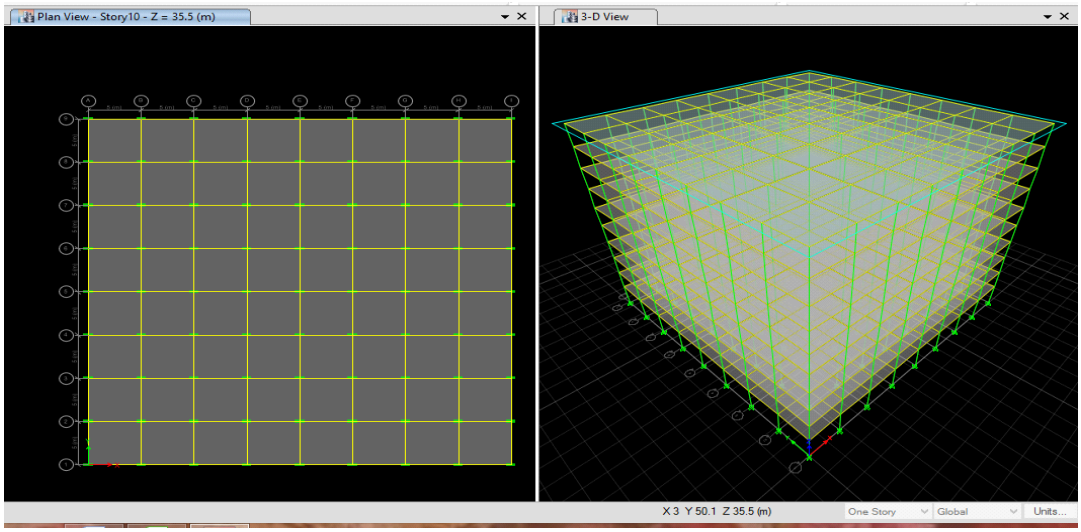

Figure 1. Plan and 3d view of model 1

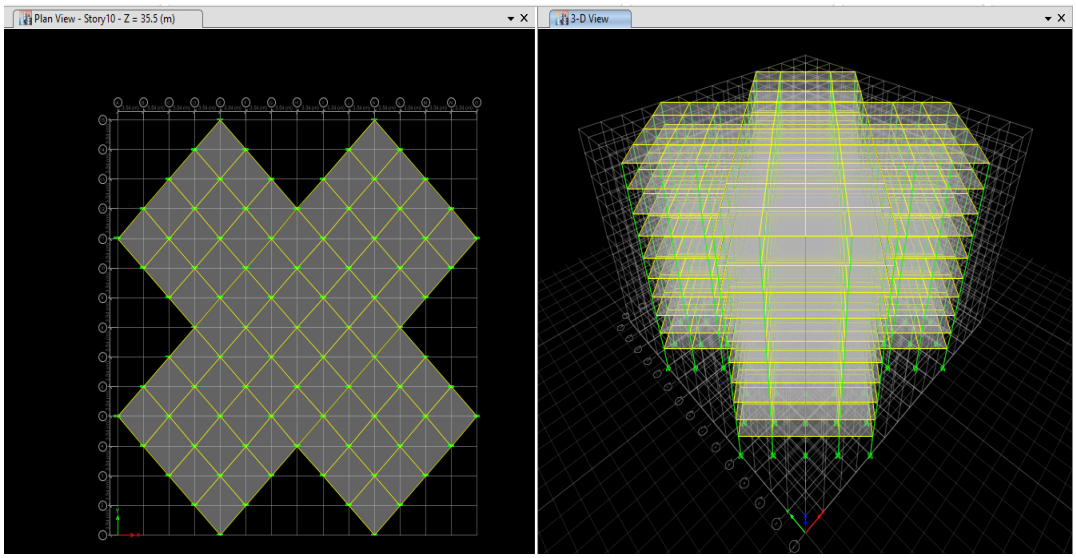

Figure 2. Plan and 3d view of model 2

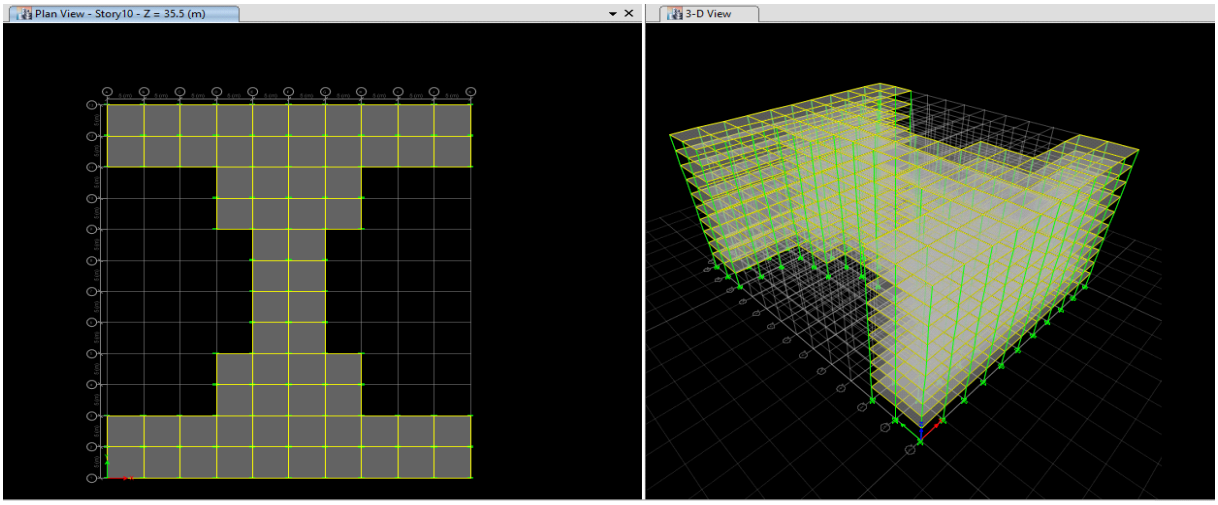

Figure 3. Plan and 3d view of model 3

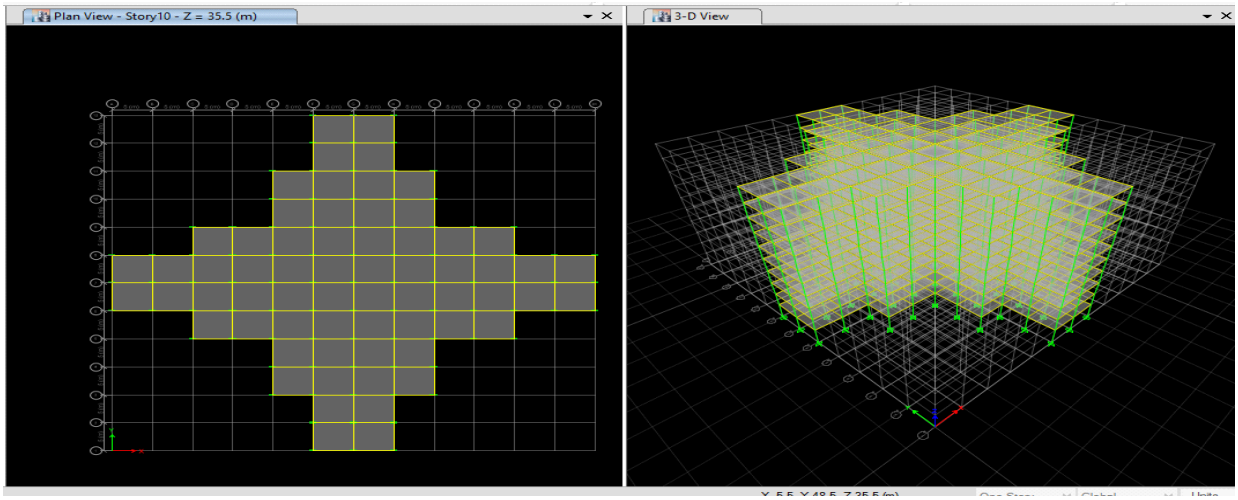

Figure 4. Plan and 3d view of model 4

Load combinations

Analysis is done for all the loads of 20 combinations by using ETABS, out of which the critical load combination is, (1.2DL+1.2LL+1.2EQY)

RESULTS AND DISCUSION

The results are presented by plotting the graph for each models considered in the study. The analysis carried out by the Response spectrum analysis. The result of periods and frequencies, maximum storey drift, storey maximum displacements, storey shear is presented for all models. In this study regular building is compared with irregular building; the performance of the models is observed in high seismic zone V.

Figure 5 shows the variation of models for different periods in different number of modes. It is observed that the periods of vibrations are decreases with increases in number of modes. Model 1 has greater period of vibration as compared to other models.

From the figure 6 it is observed that frequency is increases with increases in modes number. In the beginning of the vibrations the frequency is more in model 4 (Irregular building) and the ending frequency is greater in model 3.

The figure 7 shows the variation in the storey drift. It is less in storey 1 and increases up to storey 3, after 3 storeys it is decreases up to last storey.

In this figure 8 it is observed that storey displacement is increases with increases in the number of storey. From the table model 2, 3, 4 (irregular buildings) have similar displacement. Model 1 has greater displacements.

In figure 9 storey shear increases with decrease in number of stories. Storey shear is maximum in Irregular building structure. Model 3 has greater storey shear. Shear force is greatly affected the base.

- Periods of modes of vibration
- Frequencies of all models
- Maximum storey drift of all models of (1.2DL + 1.2LL + 1.2EQY)
- Storey displacement in (1.2DL + 1.2LL + 1.2EQY)
- Storey shear in kn of all models in (1.2DL + 1.2LL + 1.2EQY)
- Storey shear in kn of all models in (1.2DL+1.2LL+1.2EQY)

Table 2. Periods of modes of vibration in seconds

Mode no	Model 1	Model 2	Model 3	Model 4
1	2.794	2.767	2.763	2.751
2	2.212	2.251	2.098	2.277
3	2.139	2.133	2.056	2.11
4	0.914	0.905	0.902	0.899
5	0.686	0.695	0.639	0.699
6	0.643	0.64	0.617	0.632
7	0.53	0.524	0.52	0.52
8	0.366	0.368	0.354	0.367
9	0.363	0.359	0.332	0.356
10	0.329	0.327	0.315	0.322
11	0.27	0.267	0.262	0.264
12	0.23	0.229	0.205	0.227

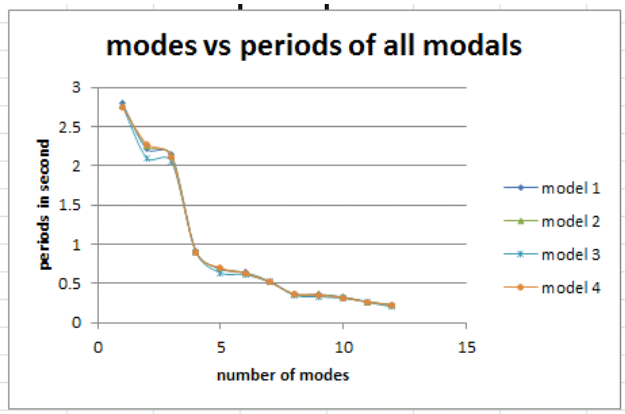

Figure 5. Variation of periods

Table 3. Frequencies of models in cycles per seconds

Mode No	Model 1	Model 2	Model 3	Model 4
1	0.358	0.361	0.362	0.364
2	0.452	0.444	0.477	0.439
3	0.468	0.469	0.486	0.474
4	1.094	1.105	1.109	1.112
5	1.458	1.44	1.565	1.432
6	1.555	1.562	1.622	1.582
7	1.888	1.909	1.925	1.923
8	2.73	2.716	2.822	2.725
9	2.755	2.788	3.008	2.812
10	3.039	3.063	3.18	3.105
11	3.704	3.751	3.813	3.787
12	4.354	4.359	4.88	4.401

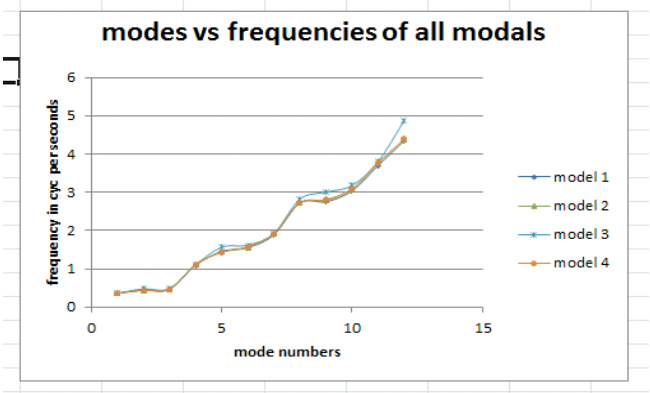

Figure 6: Frequencies of vibrations

Table 4. Maximum storey drift of all models of (1.2dl+1.2ll+1.2eqy)

Storey	Model 1	Model 2	Model 3	Model 4
10	0.000935	0.000932	0.000976	0.000938
9	0.00176	0.001749	0.001781	0.001747
8	0.002506	0.002487	0.002516	0.002481
7	0.003093	0.003068	0.003096	0.003058
6	0.003529	0.0035	0.003526	0.003488
5	0.003835	0.003803	0.003826	0.003788
4	0.004031	0.003997	0.004016	0.00398
3	0.004128	0.004091	0.004101	0.004072
2	0.004066	0.004024	0.004012	0.004001
1	0.002968	0.002925	0.002844	0.002888

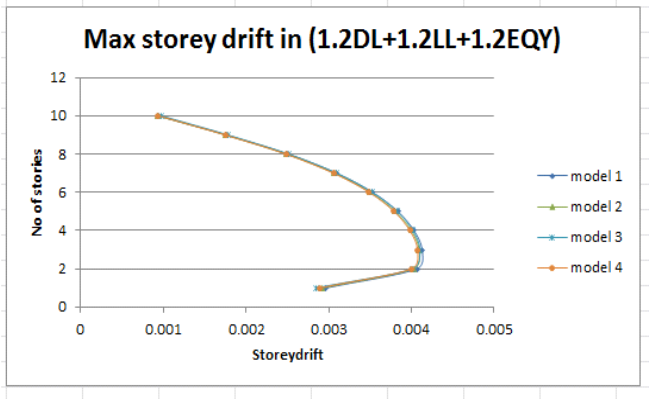

Figure 7. Maximum storey drift

Table 5. Storey displacement in mm (1.2dl+1.2ll+1.2eqy)

Storey	Model 1	Model 2	Model 3	Model 4
10	109.5	108.5	108.9	108
9	106.2	105.2	105.4	104.7
8	100	99.1	99.2	98.6
7	91.3	90.4	90.4	89.9
6	80.4	79.7	79.6	79.2
5	68.1	67.4	67.2	67
4	54.7	54.1	53.8	53.7
3	40.5	40.1	39.8	39.8
2	26.1	25.8	25.4	25.6
1	11.9	11.7	11.4	11.6
0	0	0	0	0

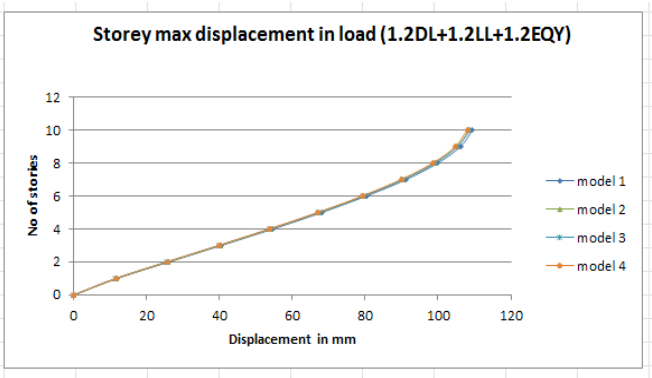

Figure 8. Variation of displacement of stories

Table 6. Storey shear of all models in kN (1.2dl+1.2ll+1.2eqy)

Storey	Model 1	Model 2	Model 3	Model 4
10	-914.154	-939.558	-974.938	-957.66
9	-2006	-2062	-2142	-2103
8	-2872	-2953	-3068	-3012
7	-3538	-3638	-3780	-3711
6	-4031	-4144	-4307	-4228
5	-4377	-4500	-4677	-4590
4	-4601	-4730	-4916	-4825
3	-4730	-4863	-5054	-4961
2	-4790	-4924	-5118	-5023
1	-4790	-4942	-5137	-5041
0	-4807	-4942	-5137	-5041

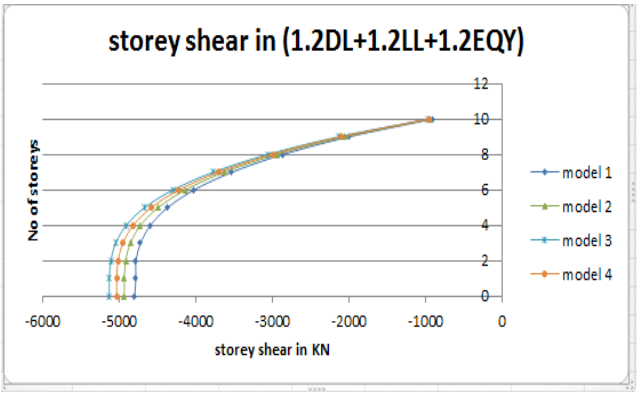

Figure 9. Storey shear along number of stories

CONCLUSION

1. In general it is observed that period of modes of vibrations decreases with increase in number of mode. Model 1 has greater period of vibration.

2. Frequencies of modes increase with increasing in number of modes. Model 3 has greater frequency.

3. Maximum storey drift is less in bottom storey, after bottom storey that it increases with increase in up to storey 7 again it is decreases.

4. Storey displacement increases with increases in storey height. Displacement is greater in regular building.

5. Storey shear increases with decreases in number of storey and shear is maximum at the base of the building. Storey shear is maximum in model 3.

6. Considering the above conclusion results we conclude that plan asymmetry like horizontal irregularity has slight differences in results of all parameters.

Author's contribution

All authors contributed equally to this work.

Competing interests

The Authors declare that they have no competing interests

REFERENCES

Konakalla R, Dutt chilakapati R, Babu Raparla H (2014). Effect of vertical irregularity in multi-storied buildings under dynamic loads using linear static Analysis. International Journal of Education and Applied Research (IJEAR). Vol. 4, Issue SPL-2.

Naveen GM and Suresh GS (2012). Behaviour of Light weight Ferrocement Beam under Monotonic Flexural loading. Journal of Structural Engineering (JOSE), Vol. 39, No.4.

Bagheri B, Salimi Firoozabad E and Yahyaei M (2012). Comparative Study of the static and Dynamic Analysis of Multistorey Irregular Building. International Journal of Civil, Environmental, Structural Construction and Architectural Engineering, Vol.6, No.11.

Naveen GM and Suresh GS (2015). Experimental Study on the Ductile Characteristics of Light Weight Ferrocement Beams under Monotonic and Repeated Loading. International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, No.3.

Agarwal P and Shrikande M (2011). Earthquake Resistant Design of Structures. Prentice Hall of India Private Limited, New Delhi, India

Duggal SK. Earthquake Resistant Design of Structures, Oxford University Press.

Prashanth P, Anshuman S, Pandey RK, Herbert A (2012) Comparision of design Results of a structure designed using STAAD and ETABS software's. International Journal of Civil And Structural Engineering. Vol.2, No.3.

BIOGRAPHIES

Dr. Naveen G M, is working as Assistant Professor in Government Engineering College Chamarajanagara, Karanataka, India-571313, received his BE degree from UBDT college Davangere; M.Tech in MCE, Hassan and PhD at National Institute of Engineering, Mysore under VTU. Research interests include the Reinforced Concrete Structure and steel structure Analysis and design in civil structures.

Miss. Chaya S, assistant professor of civil engineering Department, EIT Chamarajanagar, have an experience in teaching and research in structural Engineering field. Research interests include the Reinforced Concrete Structure design in civil structures.