International Advance Journal of Engineering Research (IAJER)
Volume 2, Issue 5 (May- 2019), PP 01-08
ISSN: 2360-819X
www.iajer.com

Research Paper **Open Access**

Comparison of Rectangular shape, L shape and C shape Multistorey Structure Under the Effects of Earthquake

[1]Sanjay Naik, [2]Thushar S Shetty
[1]*Post Graduate student Department of Civil Engineering NMAM Institute of Technology, Nitte Karkala Taluk, Udupi District, India 574110*
[2]*Assistant Professor Department of Civil Engineering NMAM Institute of Technology, Nitte Karkala Taluk, Udupi District, India 574110*
**Corresponding author: Sanjay Naik*

ABSTRACT—The modern day civil engineering has progressed to such a level that construction of multistoried structures around the world has been going on in a very rapid process. Most of the engineers prefer the easy and suitable plan according to the economy and ease of construction. But due to some desired requirements of the place or due to its functionality different shape buildings are considered. Not all the buildings lie in a safe zone. Some region in the world comes under seismic zone. The research paper involves the modeling and analysis of G+10 storied building of Rectangular shape, L shape snd C shape structure using ETABS 2016 software. The parameters such as displacement, drift, shear and overturning moment are compared and it was found that Rectangular shape is the best suited and L shape structure is the least desired shape for construction in seismic zone.

Keywords—dynamic analysis, reentrant corner, response spectrum, functionality

I. INTRODUCTION

The geographical feature of earth is such that nobody can predict the consequences or wraith of mother nature on its users. One of the natural disaster among the many in the list is earthquake. All the region in the world is categorized according to the zones based on the seismic activity in the region. The lethal effects of earthquake is induced in the multistoried structures when earthquake occurs. Commonly the preferred shape is rectangular plan because of ease in construction and also due to its high stiffness. But sometimes there comes a situation when other different irregular plan shapes has to be considered for various uses such as functional, spatial, conceptual, formal etc. The irregular buildings are built according to the desires and needs of the users. The results of earthquake on the rectangular and irregular shapes (C shape and L shape) are compared after making the models and carrying out analysis. The research work deals with analysis and design of G+10 storey rectangular shape, L shape and C shape structure. The plan consists of 30m x 21m dimension. The storey height is taken as 3 meter. The total height of the structure is 36m. The loads considered are taken according to IS 875 part I and part II. The software used for the purpose of analysis is ETABS 2016. The research work is carried out under zone 3. The research work includes the comparison of parameters such as storey displacement, storey drift and storey shear and storey overturning moment.

II. LITERATURE REVIEW

Dhananjay (2017) carried out work on G+25 storey rectangular shape, L shape and I shape building using STADD pro software in zone III and zone IV for hard and medium soils. It was found out that L shape had less maximum bending moment and maximum displacement in z direction.

Upendra (2017) carried out design and analysis on G+12 storey building having rectangular shape, T shape, C shape and O shape using ETABS software. The main aim of the research was to investigate the effect of seismic properties on these buildings in zone V. after the analysis it was found that minimum drift in x direction was found to be more in C shape while in Y direction, O shape building was found to have less drift.

Pushkar and Rahul (2017) this paper aims to study the consideration of type of structures under earthquake areas. A 15 storied building having rectangular shape, T shape, I shape and L shape building were modelled and analyzed and also to find out the mode shape of the structure. The results obtained from the models showed that storey stiffness increases until 6thstorey and thereafter it starts to decrease. Storey shear inversely varies with increase in storeyheght.

Rizwan (2015) in this paper the work involved four 15 storied building of totally different configuration rectangular shape, L shape, H shape and C shape building. The models were analysed using ETABS 9.7.1 software. It was found out that results yielded more deformation in plan irregularity buildings than regular plan.
Arvind and fernandes (2015) carried out work on reinforced regular and reinforced irregular structures in zone IV and zone V. the results found out from the analysis included lesser storey displacement values in static analysis method as compared to dynamic analysis method.
floor level column increases continuously from negative towards positive value.

III. OBJECTIVES OF THE WORK

- To study the effects of plan irregularity of different building by carrying out dynamic analysis.
- Comparison between regular structure and irregular structure.
- To study the various parameters such as storey displacement, storey shear, storey drift and storey overturning moment.
- To conclude which is the least desired shape for building in seismic zone.

IV. METHODOLOGY

Normal dynamic analysis is carried out for the buildings which has least resistance to earthquake forces. Dynamic analysis considers acceleration and velocity as a function of analysis due to which the accurate analysis sometimes becomes complex. Although normal plan regular structures only require equivalent linear static analysis, this method is used for low rise buildings and regular structures and gives good results. Dynamic analysis is executed as per the code requirements of IS1893-2002. In this paper dynamic analysis is carried out through response spectrum method.

Table 1member Property

Property	Specification
Length × Width	(30 × 21) m
Number of storeys	10
Storey height	3m
Beam dimension	(0.45 × 0.75) m
Column size (1-7 storey)	(0.9 × 0.9) m
Column size (8-19 storey)	(0.75 × 0.75) m
Thickness of main wall	0.2m

TABLE II Material Specifications

Material Property	Specification
Grade of concrete for column	f_{ck} = 60 N/mm^2
Grade of concrete for beam	f_{ck} = 40 N/mm^2
Grade of concrete for slab	f_{ck} = 30 N/mm^2
Grade of steel	f_y = 500 N/mm^2
Density of concrete	γ_c = 25 kN/m^3
Density of brick wall	γ_{brick} = 11 kN/m^3

TABLE III Properties For Seismic Analysis

Property	Specification
Seismic Zone (Z)	III (0.16)
Response reduction factor, R	5
Soil Type	2
Damping	5%
Importance factor, I	1

The load combinations used in the analysis are as follows:
i) 1.5 (DL+LL)
ii) 1.5 (DL ± EQX)
iii) 1.5 (DL ± EQY)
iv) 1.2 (DL+LL ± EQX)
v) 1.2 (DL+LL ± EQY)

MODELLING

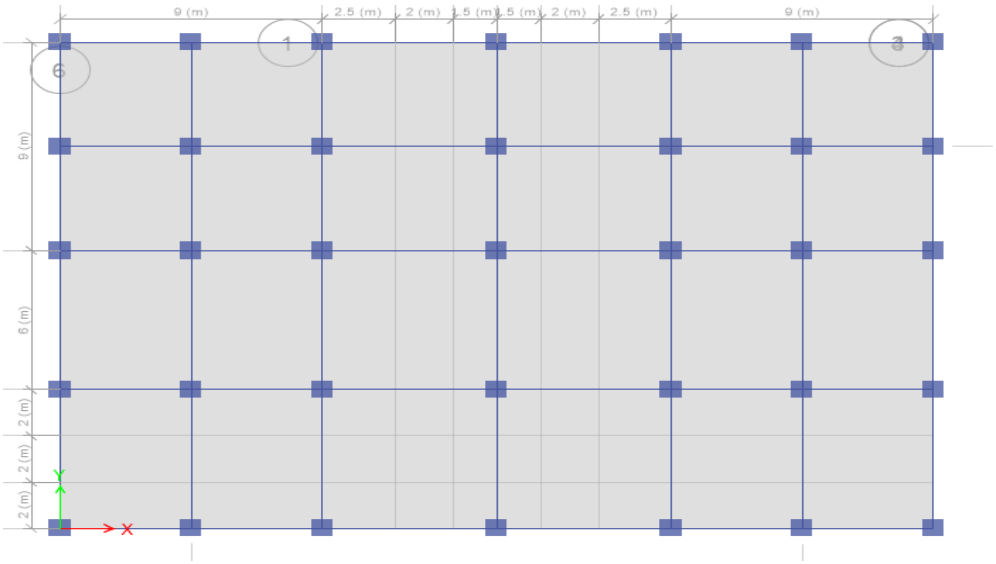

Fig1.1 Plan of Rectangular shape building

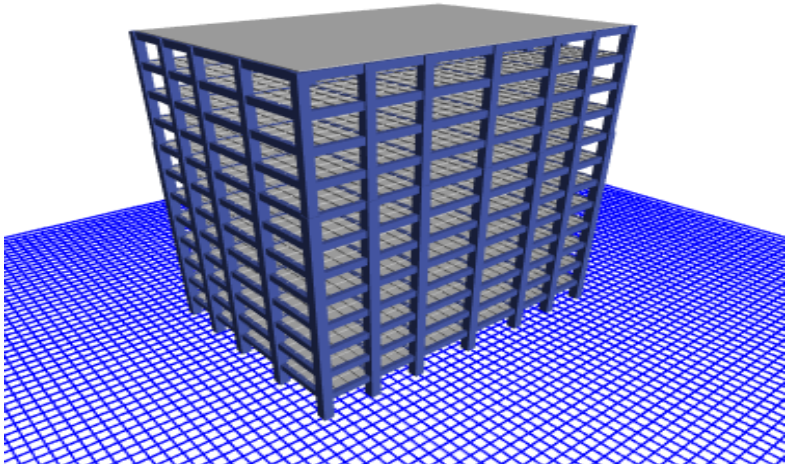

Fig 1.2 Rendered view of rectangular shape building

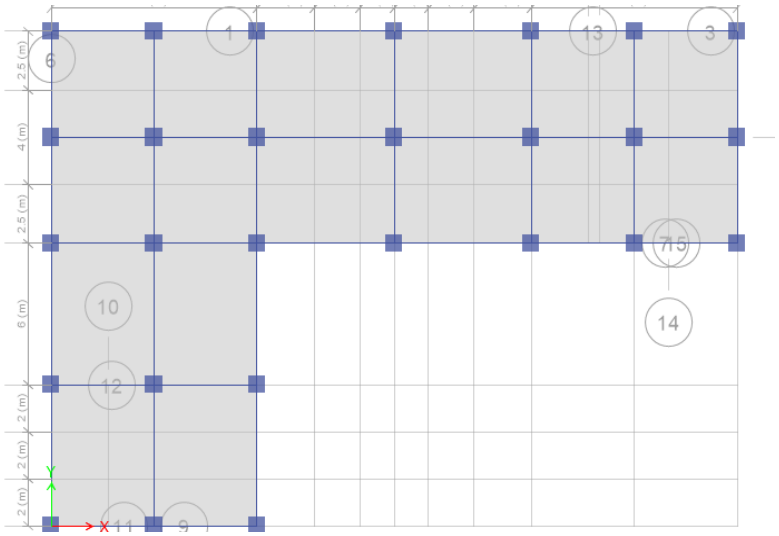

Fig1.3 Plan of L shape building

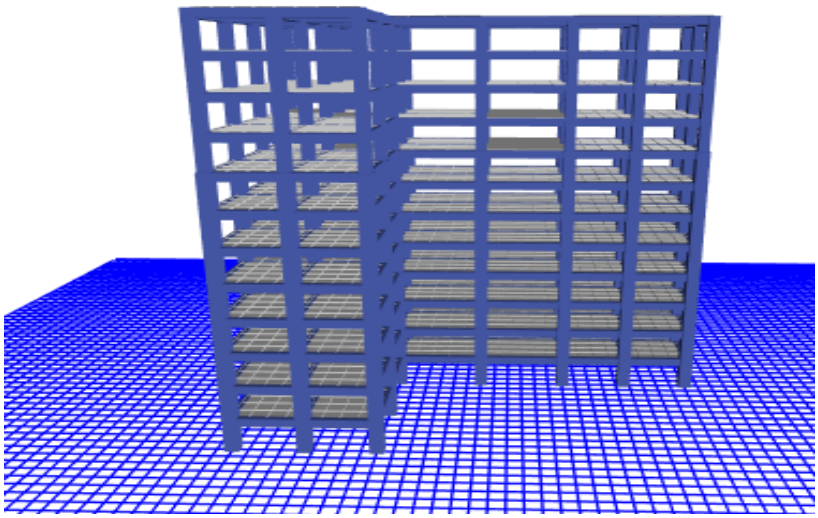

Fig 1.4 Rendered view of L shape building

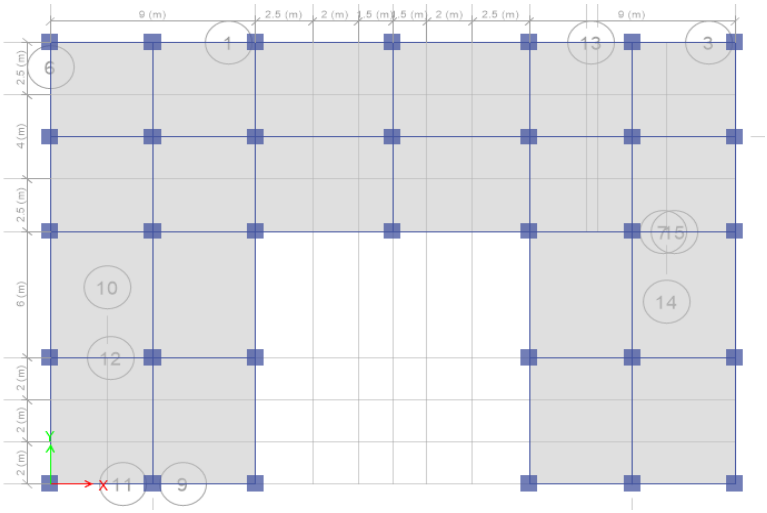

Fig1.5 Plan of C shape building

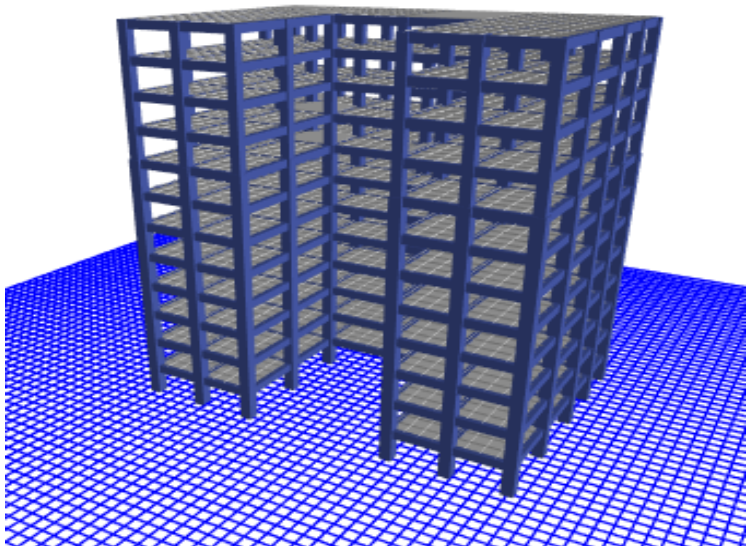

Fig 1.6 Rendered view of C shape building

V. ANALYSIS

When the earthquake acts along the width of the buildings, the results that are obtained are given below Storey displacement is the displacement of i^{th}storey with respect to the ground. The maximum storey displacement is given by formula H/250 where H is the total height of building.

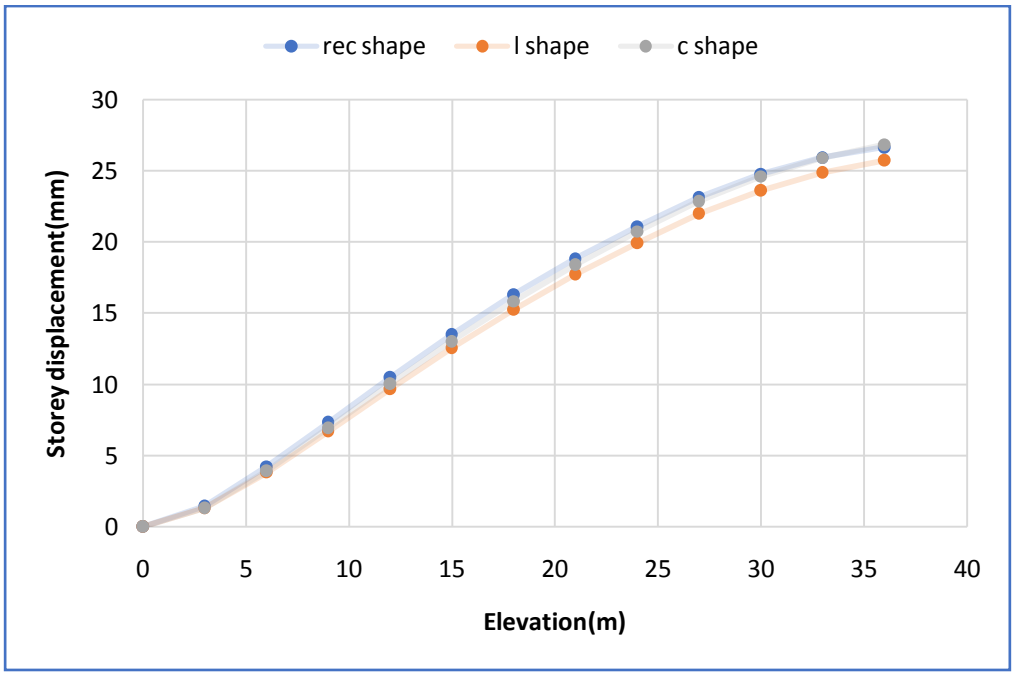

Fig 2.1 Comparison of storey displacement values

TABLE IV STOREYDISPLACEMENT VALUES

Elevation	Rec Shape	L Shape	C Shape
36	26.654	25.747	26.833
33	25.935	24.872	25.907
30	24.779	23.638	24.604
27	23.158	21.994	22.873
24	21.072	19.945	20.722
21	18.831	17.73	18.404
18	16.297	15.266	15.83
15	13.497	12.57	13.023
12	10.482	9.694	10.034
9	7.335	6.72	6.95
6	4.208	3.803	3.931
3	1.449	1.283	1.325
0	0	0	0

From the above graph it can be said that when compared with rectangular shape, L shape structure has less displacement while C shape structure has more displacement. The displacement values correspondingly increases with the increase in storey height.

Storey drift is defined as the ratio of displacement of two consecutive floors to the height of that floor. The maximum drift is given by 0.004xh where h is equal to the height of the floor.

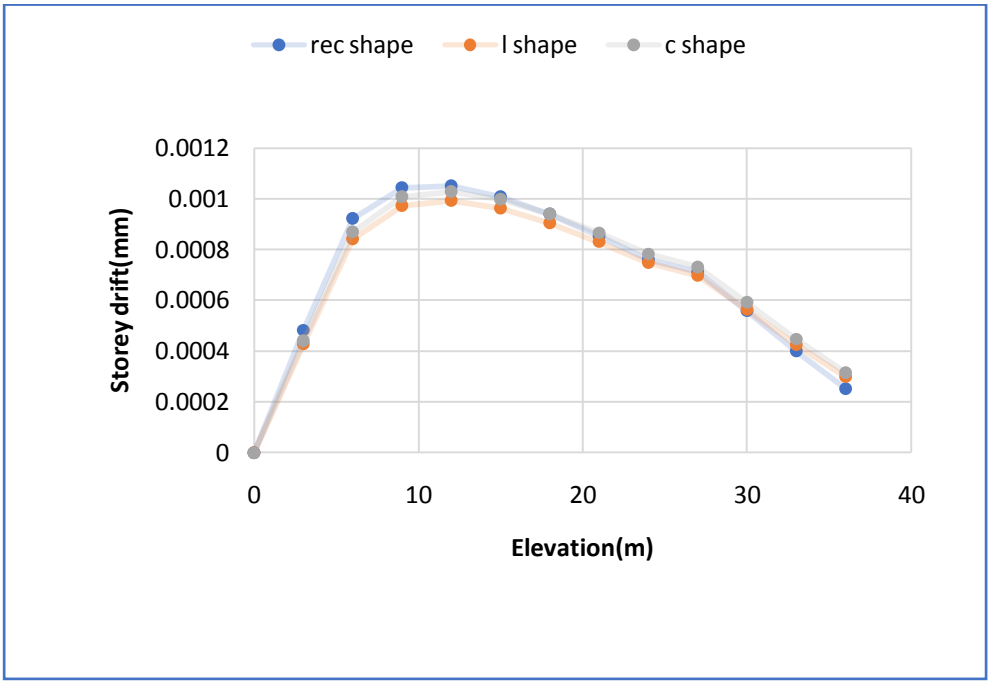

Fig 2.2 Comparison of storey drift values

TABLE V STOREY DRIFT VALUES

ELEVATION	REC SHAPE	L SHAPE	C SHAPE
36	0.000253	0.000299	0.000316
33	0.0004	0.000425	0.000448
30	0.000558	0.000564	0.000592
27	0.000712	0.000698	0.000732
24	0.000761	0.000749	0.000783
21	0.000853	0.00083	0.000866
18	0.000939	0.000904	0.000941
15	0.001008	0.000962	0.000999
12	0.001051	0.000993	0.001029
9	0.001044	0.000973	0.001008
6	0.000922	0.000842	0.00087
3	0.000483	0.000428	0.000442
0	0	0	0

From the above graph it can be said that when compared with rectangular shape structure both L shape and C shape structure has less storey drift values. It can be seen that maximum drift values in all the cases has been occurred in 4th floor of the structure.

Storey shear can be defined as te ratio of the storey shear force when collapse occurs to the storey shear force when total collapse occurs.

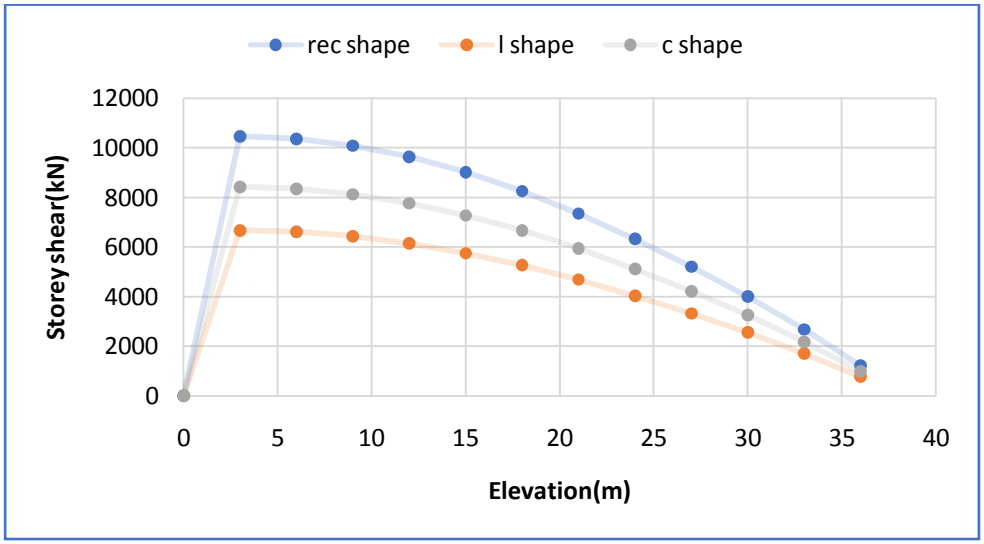

Fig 2.3 Comparison of storey shear values

TABLE VI STOREY SHEAR VALUES

Elevation	Rec Shape	L Shape	C Shape
36	1223.5507	776.7396	991.8077
33	2681.0919	1713.8661	2180.0842
30	4006.1708	2564.0881	3255.8223
27	5210.7441	3327.6634	4220.1524
24	6323.1572	4035.9793	5112.5008
21	7353.8199	4698.6551	5945.0234
18	8256.5825	5276.1458	6669.5935
15	9020.9598	5762.4357	7279.1589
12	9633.5263	6154.387	7770.1244
9	10085.57	6444.7515	8133.5333
6	10364.76	6621.393	8354.2748
3	10467.134	6684.5183	8432.9323
0	0	0	0

From the above graph and table it can be noted that storey shear values of rectangular shape building is much greater than l shape and c shape structures.

Overturning moment

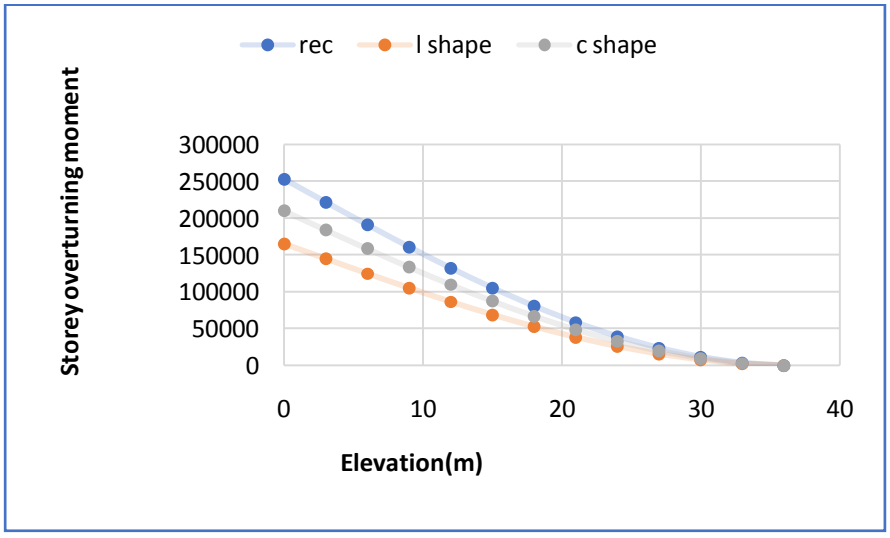

Fig 2.4 Comparison of storey overturning moment values

TABLE VII STOREY OVERTURNING MOMENT VALUES

Elevation	Rec	L Shape	C Shape
36	0	0	0
33	3731.8628	2462.7515	3065.3555
30	11885.461	7832.3983	9810.782
27	24020.421	15804.141	19886.327
24	39741.651	26106.911	32927.595
21	58766.757	38557.123	48688.998
18	80839.617	52991.095	66980.205
15	105562.99	69144.769	87477.755
12	132518.9	86743.78	109829.28
9	161259.24	105496.77	133662.65
6	191311.72	125098.56	158590.83
3	222194.32	145238.8	184211.82
0	253450.52	165624.14	210141.12

VI. CONCLUSIONS

- The displacement values is found to be more in the rectangular shape when compared with L shape and C shape structure during earthquake.
- The drift values were also found to be more in rectangular shape when compared to L shape and C shape structure.
- The storey shear values were less in L shape structure and C shape structure which indicates that shear force carrying capacity is less in these structures.
- The storey overturning moment is also more in rectangular shape which indicates that more moment is required to overturn the storey.
- From all the results it can be said that rectangular shape is the best desired and L shape is the less desired shape for construction in seismic zone.

REFERENCE

[1]. Dhananjay Shrivastava, Dr. Sudhir Singh Bhaduria "Analysis Of Multi-Storey Rcc Frames Of Regular And Irregular Plan Configuration Using Response Spectrum Method", SSRG International Journal of Civil Engineering (SSRG-IJCE) – Volume 4, Issue 6, pp. 72-78, June 2017.

[2]. K.Upendra Reddy and Dr.E.Arunakanthi, "Dynamic Analysis of Multistorey Structure for Different Shapes", International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES)-Volume 3, Issue 12, pp. 8-17, December 2017.

[3]. Pushkar Rathod and Rahul Chandrashekar, "Seismic analysis of multistoried building for different plans using ETABS 2015", International Research Journal of Engineering and Technology(IRJET) Volume: 04 Issue: 10, pp. 1101-1108, October 2017.

[4]. Mohammed Rizwan Sultan and D. Gouse Peera, "Dynamic Analysis of Multistorey Structure for Different Shapes", International Journal of Innovative Research in Advanced Engineering (IJIRAE), Volume 2,Issue 8, pp. 85-91,August 2015.

[5]. Arvind Reddy and R.J.Fernandes, "Seismic Analysis of RC Regular and Irregular Frame Structures", International Journal of Engineering Research and Technology, Volume 2,Issue 5, pp. 44-47, August 2015.

[6]. IS 1893 (Part 1): 2002 Indian Standard Criteria for Earthquake Resistant Design of Structures, Part 1 General Provisions and Buildings, (Fifth Revision)

[7]. IS 875 (Part 2): 1987 Indian Standard Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures, Part 2 Imposed Loads. (Second Revision)