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Seismic Analysis of RC Building with Different Plan Shape

Deepesh Goyal [1], Dheeraj Patidar [2], Dheeraj Patidar [3], Gaurav Dadhe[4], Kirti Gupta[5]

[1]*UG student, Department of Civil Engineering, Shree Vaishnav Vidhyapith Vishwavidyalya Indore,*
[2]*UG student, Department of Civil Engineering, Shree Vaishnav Vidhyapith Vishwavidyalya Indore,*
[3]*UG student, Department of Civil Engineering, Shree Vaishnav Vidhyapith Vishwavidyalya Indore,*
[4]*UG student, Department of Civil Engineering, Shree Vaishnav Vidhyapith Vishwavidyalya Indore,*
[5]*Assistant Professor, Department of Civil Engineering, Shree Vaishnav Vidhyapith Vishwavidyalya Indore,*

Abstract— Due to irregular geometrical configurations of a building with irregular distributions of mass, stiffness and strength leads to damage at weak zone of the building. In reality, many existing buildings contain irregularity due to aesthetic and functional requirements. Damage to irregular structures caused by asymmetry in plan has been observed during many major past earthquakes. In the present study plan irregularity of high-rise building and seismic effect for these building is discussed. The structural analysis of reinforced concrete irregular frame building is done with the help of ETAB 2016. G+12 story buildings with plan of shape L, C, T, I and Y is selected. Equivalent static analysis is done for selected buildings. Lateral load analysis is done for seismic zone V. Comparative study of maximum displacement, maximum story drift and maximum base shear is done for all type of buildings. The results shows that the shape of building has significant effect in minimizing the displacement and drift of the building.

Keywords— Seismic load, geometric irregularity, shape of building, story drift, equivalent static

I. INTRODUCTION

The behaviour of RCC building during earthquake varies with geometrical configuration in terms of plan irregularity as well as vertical irregularity. Structural configuration under seismic effect includes some main aspects which consist of shape, size of the building, location and size of structural elements, location and size of significant non-structural elements. It has been observed that buildings with regular geometry in plan as well as in elevation undergoes less damage as compared to irregular configurations. But as per need and demand of the new generation and growing population, the architects or engineers are planning complex and irregular building configurations. The Elastic behavior under earthquake is primarily controlled by configuration and stiffness. The total lateral force is distributed over the building height and plan using provisions given in the *Indian Seismic Code IS:1893 (Part 1) - 2016*. Buildings with irregular and complex shapes, mainly with large projections or re-entrant corners, exhibit modes of oscillation different from translatory (pure or diagonal) or torsional modes. In buildings with plan irregularity centre of mass and centre of stiffness in a structure do not coincides which causes torsional vibration which results in severe damage to structural components. The aim of the present study is to compare the effect of various type of building plan shape under the effect of seismic load. Equivalent static method is used for the analysis, as per IS1893:2002. In present study buildings with plan shape I, L, C, T and Y is selected with same floor plan area.

II. ANALYSIS METHODOLOGY

The various steps involved in present study are as followed:

(a) Buildings of different plan of shape I, C, L, T and Y is selected. The plan size of all the building plan is 750 m^2 having storey G+12 and single storey height as 3m.

(b) The 3D Modeling and load consideration of different shape of high-rise building is done in ETAB 2016.

(c) Analysis of building under seismic loading in both X and Y direction. Equivalent static analysis is carried out for selected buildings as per IS1893:2002.

(d) Evaluation of maximum displacement and story shear in various shapes of building in seismic zone V.

Structural Modeling

Equivalent static method of analysis is used for analysis in which dynamic effects are approximated by horizontal lateral earthquake static force. The equivalent static lateral force method is a simplified technique to substitute the effect of dynamic loading of an expected earthquake by a static force distributed laterally on a structure for design purposes. The total applied seismic force is evaluated in two horizontal directions. It also assumes that the building mainly responds in its fundamental lateral mode. Seismic Loading is applied as per IS1893:2002. Following are the structural details of all the building.

Table 1 Specification details of model

Plan Area	750 m^2
Number Of Storey	G+12
Height of each Grid	3 meters
Size of Grid	5m X 5m
Beam (in mm)	200X500
Column (from base to 3rd storey) (in mm)	500X500
Column (from 3rd storey to 12th storey) (in mm)	300X500
Slab Thickness	150mm
Concrete Grade	M30
Reinforcement Bar	HYSD500

Total five types of buildings are considered for modeling. Linear static analysis is done as per IS1893:2002. Seismic zone V is considered for analysis. Medium type Soil and Importance factor 1 is considered. Special moment resisting frame with Response reduction factor (R) as 5 is assumed for seismic analysis. Gravity load includes dead load and live load. Dead weight of members is program calculated. Live load of 3kN/m^2 is considered for analysis.

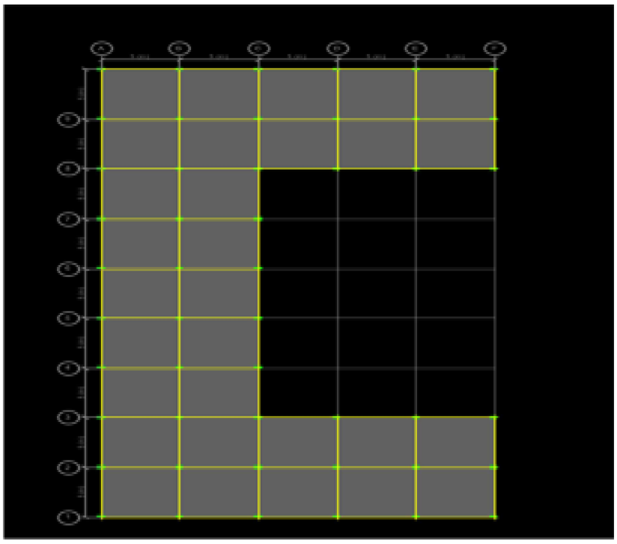
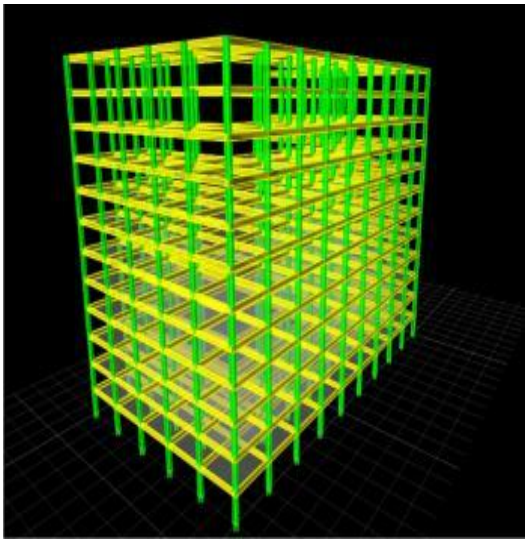


Fig.1 Plan view of C shape building



3-D View

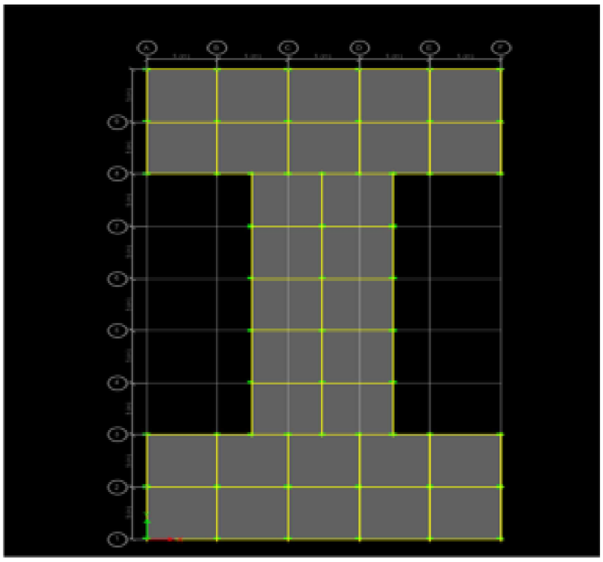
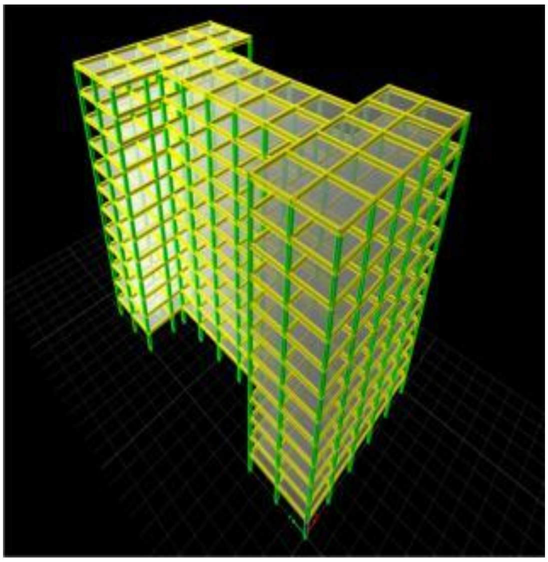


Fig.2 Plan view of I shape building



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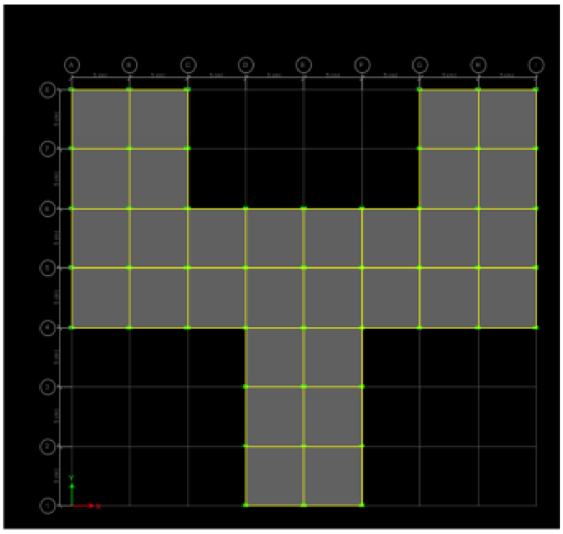
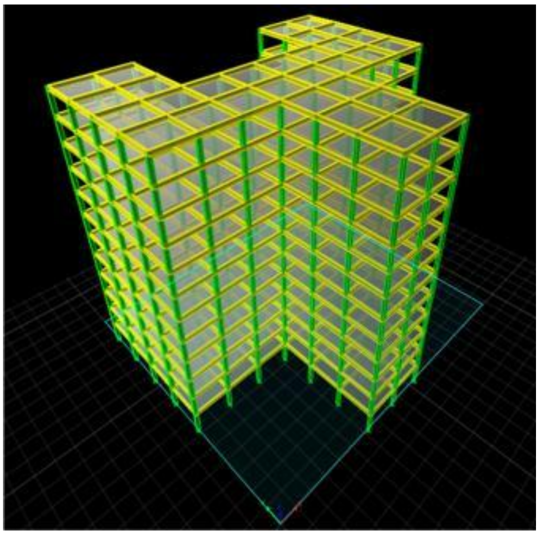


Fig.3 Plan view of Y shape building



3-D View

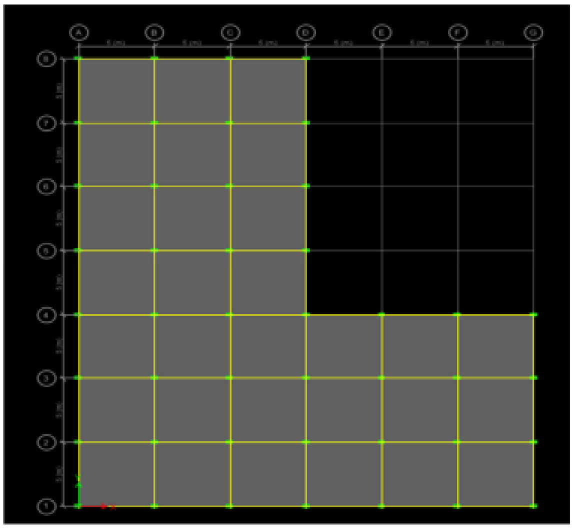
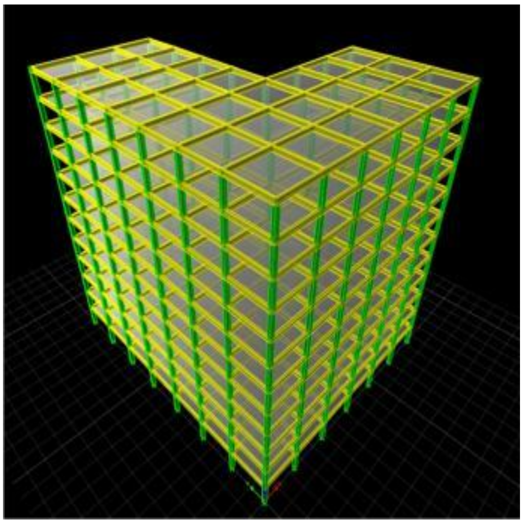


Fig.4 Plan view of L shape building



3-D View

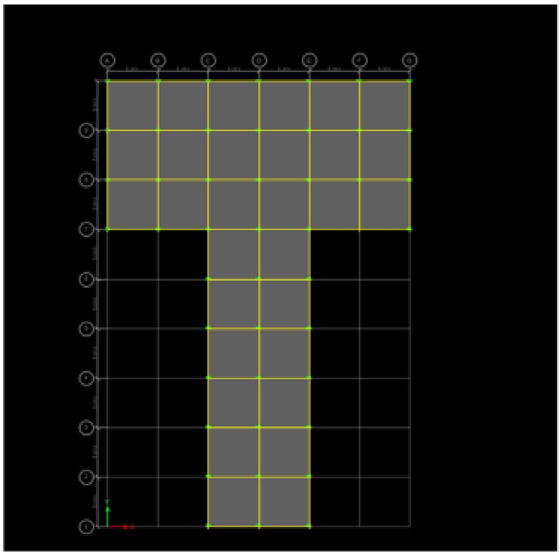
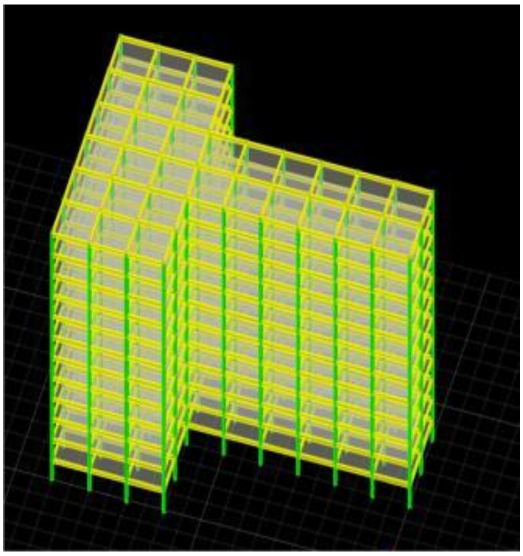


Fig.5 Plan view of T shape building



3-D View

III. RESULTS AND DISCUSSION

After analysis of various building geometry, seismic parameters like story drift and maximum displacement is compared.

Table 2 Variation in Story Drift due to earthquake load in X direction in Zone V

Story	Building C	Building I	Building L	Building T	Building Y
Story 12	0.000414	0.000308	0.00042	0.000395	0.000442
Story 11	0.000636	0.000481	0.000646	0.00056	0.00072
Story 10	0.000834	0.000635	0.000851	0.00071	0.000959
Story 9	0.000994	0.00076	0.001018	0.000832	0.001152
Story 8	0.00112	0.000858	0.001148	0.000926	0.001302
Story 7	0.001214	0.00093	0.001245	0.000993	0.001414
Story 6	0.001279	0.000981	0.001312	0.001038	0.001493
Story 5	0.00132	0.001012	0.001354	0.001078	0.001543
Story 4	0.00134	0.00103	0.001372	0.001104	0.001569
Story 3	0.001334	0.00105	0.001364	0.001135	0.001573
Story 2	0.001257	0.001195	0.001283	0.001297	0.001537
Story 1	0.000787	0.002258	0.000799	0.002388	0.001129

Table 3 Variation in Story Drift due to earthquake load in Y direction in Zone V

Story	Building C	Building I	Building L	Building T	Building Y
Story 12	0.000421	0.000325	0.000412	0.000329	0.000375
Story 11	0.000692	0.00055	0.000695	0.000564	0.000605
Story 10	0.000923	0.000744	0.000937	0.000765	0.000811
Story 9	0.001109	0.0009	0.001132	0.000928	0.00098
Story 8	0.001254	0.001023	0.001285	0.001055	0.001112
Story 7	0.001363	0.001116	0.0014	0.001152	0.001211
Story 6	0.001439	0.001182	0.001482	0.001221	0.001282
Story 5	0.001489	0.001226	0.001536	0.001267	0.001328
Story 4	0.001515	0.001251	0.001566	0.001294	0.001352
Story 3	0.001521	0.00127	0.001575	0.001314	0.001351
Story 2	0.00149	0.001423	0.001547	0.001463	0.001281
Story 1	0.00111	0.003345	0.001161	0.003572	0.000814

Table 4 Variation in maximum displacement due to earthquake load in X direction in Zone V

Story	Building C	Building I	Building L	Building T	Building Y
Story 12	37.586	34.5	38.4	36.387	44.499
Story 11	36.344	33.6	37.2	35.51	43.173
Story 10	34.436	32.1	35.2	34.066	41.012
Story 9	31.935	30.2	32.7	32.115	38.134
Story 8	28.951	27.9	29.6	29.749	34.678
Story 7	25.591	25.4	26.2	27.057	30.772
Story 6	21.95	22.6	22.5	24.12	26.53
Story 5	18.112	19.6	18.5	21.005	22.051
Story 4	14.151	16.6	14.5	17.772	17.422
Story 3	10.131	13.5	10.3	14.461	12.715
Story 2	6.131	10.4	6.2	11.055	7.997
Story 1	2.361	6.8	2.4	7.163	3.387

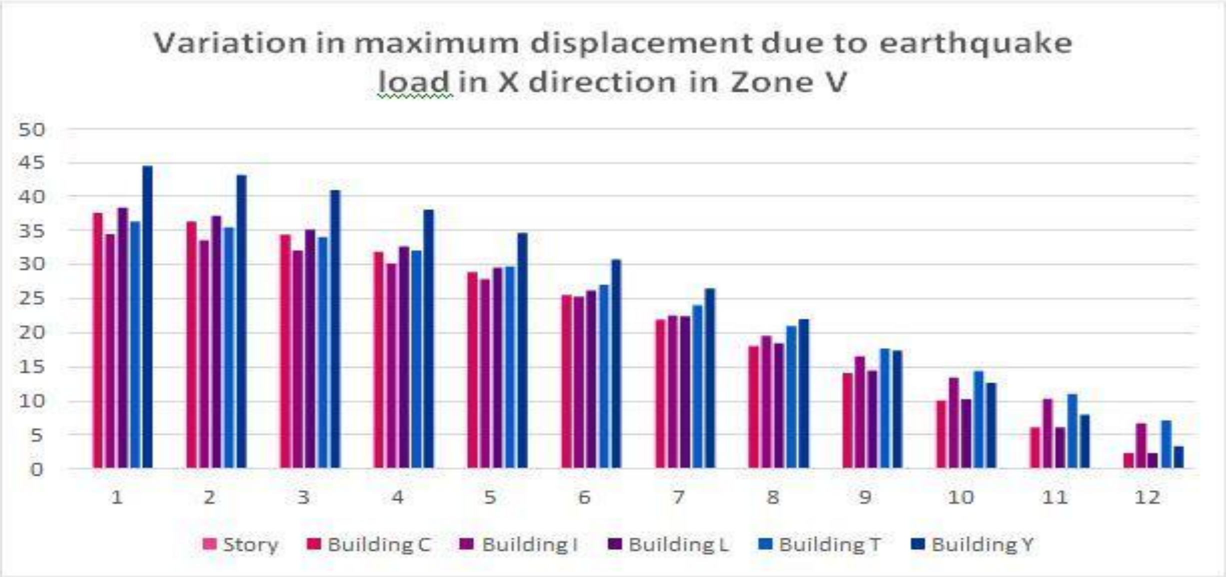


Fig.6 Variation in maximum displacement due to earthquake load in X direction in Zone V

Table 5 Variation in maximum displacement due to earthquake load in Y direction in Zone V

Story	Building C	Building I	Building L	Building T	Building Y
Story 12	42.967	43.1	44.2	44.771	37.508
Story 11	41.706	42.1	42.9	43.783	36.383
Story 10	39.631	40.4	40.9	42.092	34.568
Story 9	36.863	38.2	38.1	39.797	32.135
Story 8	33.538	35.5	34.7	37.014	29.196
Story 7	29.776	32.4	30.8	33.849	25.86
Story 6	25.689	29.1	26.6	30.393	22.226
Story 5	21.37	25.5	22.2	26.731	18.379
Story 4	16.905	21.9	17.5	22.93	14.395
Story 3	12.36	18.1	12.8	19.046	10.338
Story 2	7.798	14.3	8.1	15.104	6.285
Story 1	3.329	10	3.5	10.715	2.441

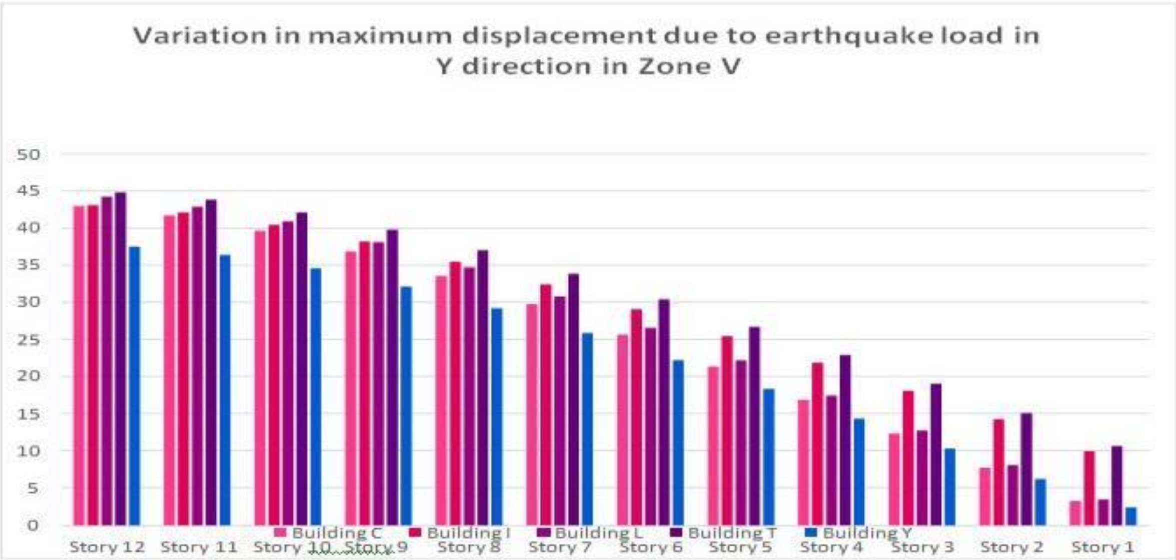


Fig.7 Variation in maximum displacement due to earthquake load in Y direction in Zone V

Table 6 Variation in Base shear earthquake load in Zone V

Direction	Building C in kN	Building I in kN	Building L in kN	Building T in kN	Building Y in kN
X Direction	-1625.7348	-1625.7115	-1553.9367	-1364.7763	-1542.3018
Y Direction	-1322.3908	-1191.3231	-1269.9668	-1117.8753	-1961.4474

After analysing various models following results are obtained:

1. Maximum displacement due to earthquake load in X direction in Zone V is observed in **Y shape** building plan with value 44.499 mm whereas maximum displacement due to earthquake load in Y direction is observed in **T shape** building plan with value 44.771mm.
2. Minimum displacement due to earthquake load in X direction in Zone V is obtained in **I shape** building plan with value 34.5mm whereas minimum displacement due to earthquake load in Y direction in Zone V is obtained in **Y shape** building plan with value 37.508 mm.
3. Maximum story drift due to earthquake load in X direction in Zone V is obtained in Y **shape** building plan with value 4.42mm whereas maximum story drift due to earthquake load in Y direction is obtained in C **shape** building plan with value 4.21mm.
4. Minimum story drift due to earthquake load in X direction in Zone V is obtained in I **shape** building plan with value 3.08mm whereas minimum in story drift due to earthquake load in Y direction is obtained in I **shape** building plan with value 3.25mm.
5. Maximum Base shear in Zone V in X direction is obtained in C **shape** building plan with value 1625.7348 kN whereas in Y direction, maximum base shear is obtained in Y **shape** building plan with value 1961.447kN.

IV. CONCLUSIONS

Based on the analysis on different plan shape of buildings, following are the conclusions are made

1. Based upon the above results, it is concluded that shape of the structure plays an important role in resisting earthquake loads.
2. I shaped building has lesser storey drifts, lesser lateral displacements at the points as compared to T, L, Y and C shaped building.
3. It has been observed that displacement and storey drift in T, C, Y and L shaped buildings is more than I shaped building. This may due to asymmetry of T, C, Y and L type buildings.
4. It can be concluded from the above result that buildings with large plan aspect ratio and buildings with large projections are more vulnerable during earthquake.
5. It is preferred to distribute lateral inertia force developed due to earthquake to various lateral load resisting systems in proportion to their lateral load resisting capacities.

REFERENCES

[1] A. A. Kale, S. A. Rasal, *Seismic & Wind Analysis of Multistory Building: A Review*, International Journal of Science and Research (IJSR), Volume 6 Issue 3, March 2017.

[2] N.Veerababu, B Anil Kumar, *Design of Earthquake Resistant Building Using Response Spectra*, International Journal of Mechanical Engineering and Computer, Vol 4, No. 1, 2016..

[3] Sanjay Kumar Sadh, Dr. UmeshPendharkar, *Effect of Aspect Ratio & Plan Configurations on Seismic Performance of Multistoreyed Regular R.C.C. Buildings: An Evaluation by Static Analysis*, International Journal of Emerging Technology and Advanced Engineering, Volume 6, Issue 1, January 2016.

[4] Pardeshisameer, Prof. N. G. Gore, *Study of seismic analysis and design of multi storey symmetrical and asymmetrical building*, International Research Journal of Engineering and Technology (IRJET), Volume: 03 Issue: 01, Jan-2016.

[5] Gauri G. Kakpure, Ashok R. Mundhada, *Comparative Study of Static and Dynamic Seismic Analysis of Multistoried RCC Building by ETAB: A Review*, International Journal of Emerging Research in Management &Technology, Volume-5, Issue-12, 2016.