Result Of Plan Geometry And Indiscretions On Seismic Excitation For Multi Story Structures - An Appraisal

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Abstract:

The fundamental objective of earthquake resistance design is to avoid building collapse during earthquake, limiting the danger of death or damage to individuals in or around those structures. Since Earthquake forces are irregular in nature and unpredictable, the static and dynamic investigation of the structures have turned into the essential worry of structural Engineer. Load carrying capacity, ductility, stiffness, damping and mass are the principle parameters of the seismic investigation. The tendency of resisting earthquake force for various shaped building are different with respect to their torsional and mass irregularities, re-entrant corners, structural systems, diaphragm and acceleration.

IndexTerms - plan, vibration, earthquake, displacement, torsional behaviour, stiffness, mass, storey drift, time period, software

INTRODUCTION

In accordance to prevent the earthquake, shape of the building is also a great option. The plan of highrise buildings are often regular in shape, most of the buildings have irregular shape. This is the most constitutive point to look about, there have been several attempts done by the researchers globally.

use all through its service life. These design in the structures leads to the non-uniform distributions in their masses, stiffness and strength due to which the structure are prone to damage during earthquake.

Raul Gonzalez et al. (2008) have selected the basic geometric figures and some of its eccentricity variations from the plans which were extracted through the google earth. Shown irregular plans in figure, present rectangular, square, and sections L-1, T, U and L-2, The elastic models were made in program SAP2000 v10.0.1 Advanced and with ten accelerograms signal registered in the Mexican Pacific Coast.

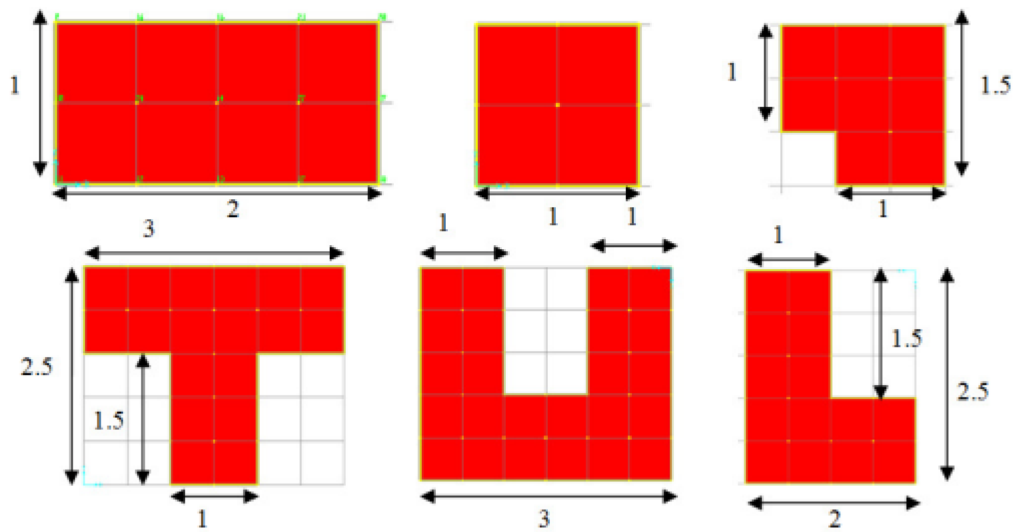


Figure : Relation of geometric forms selected in analysis and its general dimensions standardizing in reference to the square plan. In the paper call the forms like: rectangular, square, L-1, T, U and L

By considering asymmetric section T, U and L in both axes, they analyze that the demand is smaller in all the length of the longest arm with respect to the demand in the projection of the short side. a concentration is observed of high stress level, although in the majority of the cases the inertial mass of the projection of the short side is minor who stops the connection of the long side. they have also given that the linear analyses provide important information for torsion behavior of weak structures like the studied. Despite we can understand that elastic analysis underestimates the interstory drifts when the superstructure enters in nonlinear performance, and the behavior is adopted torsion mode.

Milind V. Mohod (2015) has considered 9 models with plan shape irregularities and the area of the plan is same but the geometry is different. Each model is of 12 storeys. The elevation also same for the all models. Shape of the geometries are shown in figure.

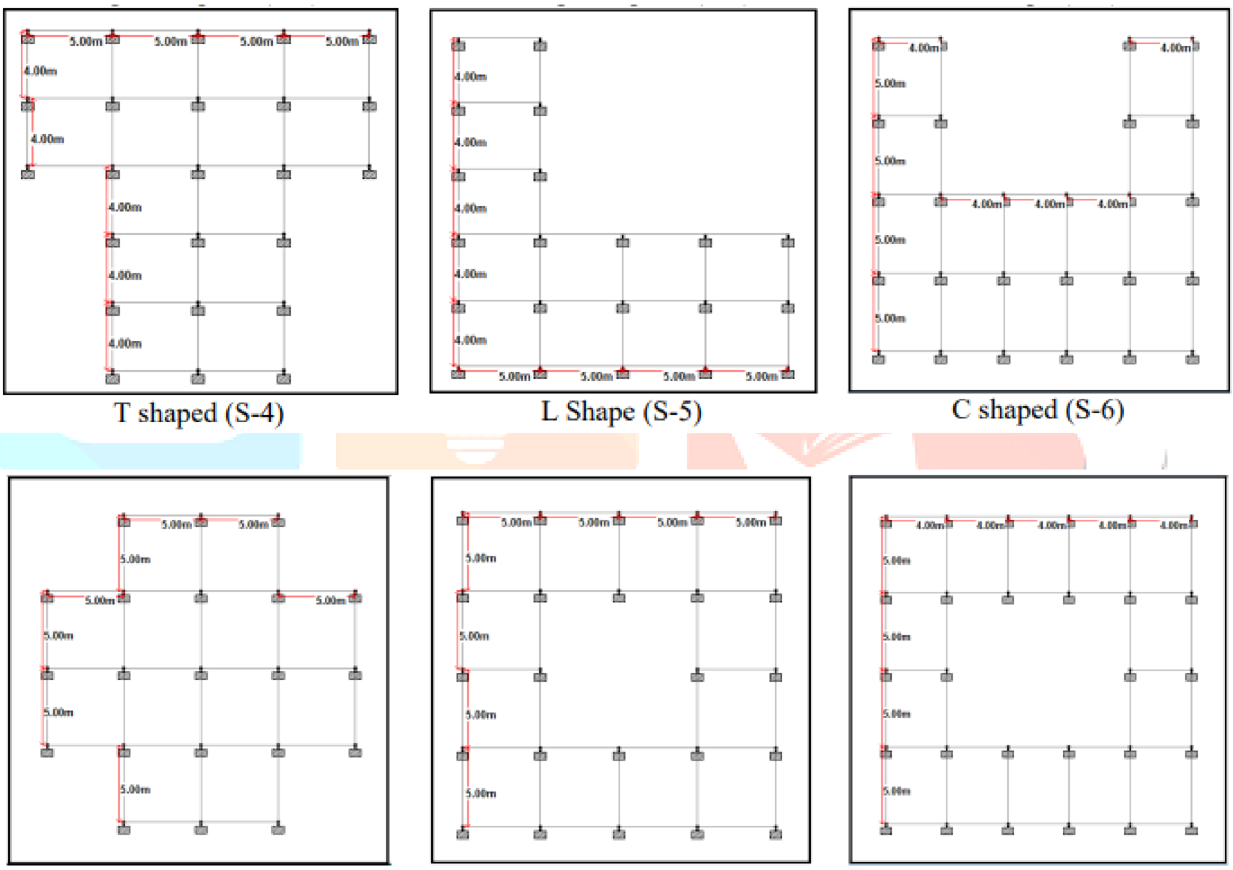


Figure : Plan geometry of the models used for analysis

Jereen Ann Thomas et al. To attain this a comparative study of structure with rigid and semi-rigid diaphragm is considered. In the study four models with E, H, plus and swastika shape plan configuration is considered.

The various loads considered are self-weight , wall load, live load of 3 kN/m, roof live load of 1.5 kN/m2 , floor finish of 1 kN/m2 and earthquake load as per IS 1893(part 1):2002 is calculated. The zone factor taken is 0.16 with hard rock condition and response reduction factor 5. Fe 415 steel is used. The analysis results is shown below in graph below.

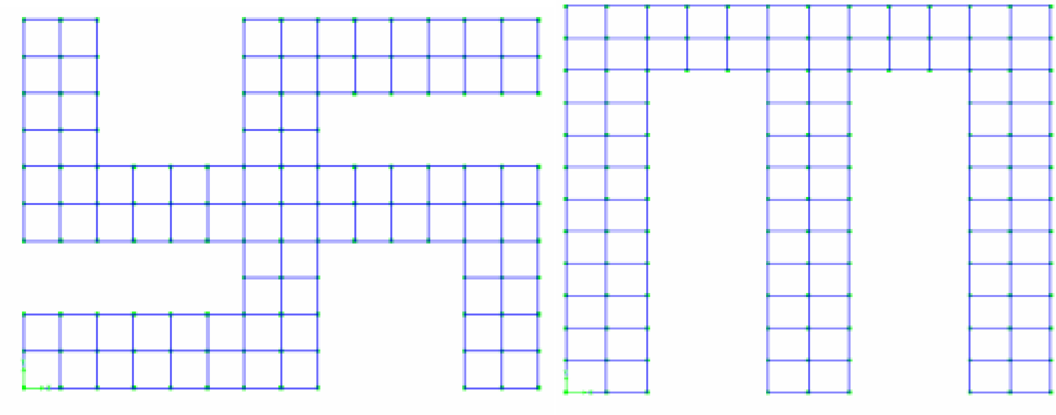


Figure: Plan configurations

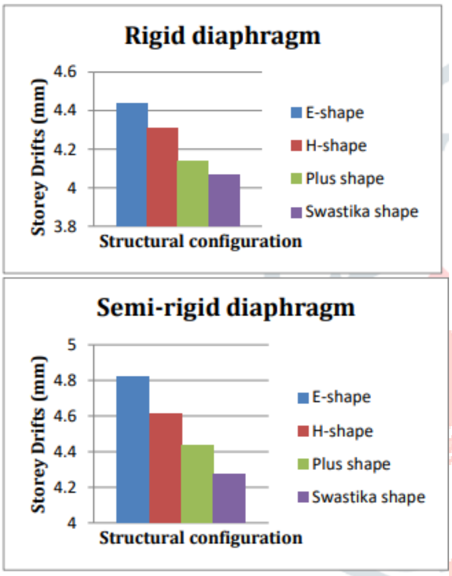


Figure : Storey drifts and displacements graphs of structural configuration

Ahmed et al. (2016) have studied the effect of seismic response of L shaped buildings. Equivalent static and response spectrum methods were performed using ETABS software. They observed that the response of L shaped building is higher than that of the regular frame due to torsion. Patil et al. (2017) studied the dynamic response of multi-storey buildings with plan asymmetry. They have numerically analyzed multistoryed frames having different plan shapes. They have reported that the increase in height of T and L shaped buildings increases the displacement response and stress at the re-entrant corners.

Md Shehzad Choudhary et al. (2017) addressed the difference between a building without diaphragm discontinuity and a building with diaphragm discontinuity. In this project a regular 15 and 20 storey RC buildings having shear wall are modelled with and without diaphragm discontinuity and are analysed by ETABS (2013). For 15 storey building, when there is increase in percentage area of slab openings it is found that there is decrease in the storey displacement, storey drift, storey shear and modal period in both x & y direction. Also for 20 storey building, when there is increase in percentage area of slab openings it is found that there is decrease in the storey displacement, storey drift, storey

Dileshwar Rana, Prof. Juned Raheem performance & behavior of regular & vertical geometric irregular RCC framed structure under seismic motion. This work is based on three dimensional reinforced concrete building with varying heights and widths. These building configurations represent different degree of vertical irregularity or amount of setback. The same bay width of 3m is taken in both the horizontal direction .Two cases are considered for the bays. In first case, the numbers of bays are four and in second case, these are eight. The uniform storey height of 3.5m is considered in all the cases.

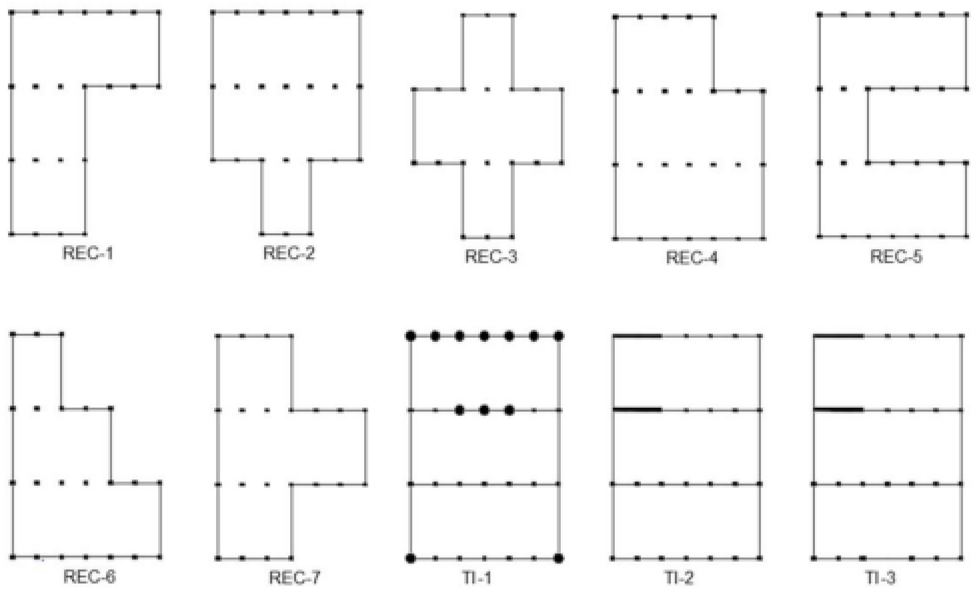
The unit weight of brick is taken as 20Kn/m3 and concrete as 25kN/m3 . All supports are taken as fixed.

The structures are modeled by using computer software Staad.Pro V8i. The storey drift and maximum storey nodal displacement of both the horizontal direction X & Z are noted down. Four bay frames have less critical bending moment than eight bay frames for both four storey and eight storey building. There is not much change for the bending moment of regular frames. It is concluded in this paper that as the amount of setback increases, the critical shear force also increases. The critical bending moment of irregular frames is more than the regular frame for all building heights. This is due to decrease in stiffness of building frames due to setbacks. The critical seismic parameter of 4 bay building frames up to eight storey building height is less than corresponding 8 bay building frames . Therefore 4 bay building is appropriate for lower building heights. The higher storey building (twelve & sixteen storey) 8 bay configurations should be preferred because they have generally lesser values of critical seismic parameters than 4 bay.

Siva Naveen E et al. (2017) have presented effect of irregularities in various form of plan and elevation form. They have studies about 34 configurations with single irregularity and 20 cases with combination of irregularities. Along with regular configuration, 54 irregular configuration are analyzed and compared. The magnitude of variation in response depends on the type, degree and location of irregularities present. The judicious choice of these parameters in the design of structures improves performance of the structure.

Type of irregularity	Classification	Limits
Mass (M)	Vertical irregularity	$M_i < 1.5M_a$
Stiffness (S)	Vertical irregularity	$S_i < S_{i+1}$
Vertical geometry (VG)	Vertical irregularity	$VG < 1.25\ VG_a$
Re-entrant Corner (R)	Horizontal irregularity	$R_i <= 15\%$
Torsion (T)	Horizontal irregularity	$\Delta_{max} <= 1.5\Delta_{avg}$

The dimension of each bay in the direction of length and width are 0.305 m and 0.914 m respectively. Each floor carries a lumped mass of 2760 kg. The irregularities are incorporated by changing the vertical and horizontal configurations of the regular frame. Apart from the regular case, 54 irregular configurations are analyzed, out of which, 34 cases possess single irregularity and 20 possess combination of irregularities. The models have mass irregularities (MI), stiffness irregularities (SI), vertical geometric irregularities (VGI), re-entrant corners irregularities (REC) and torsional irregularities (TI).



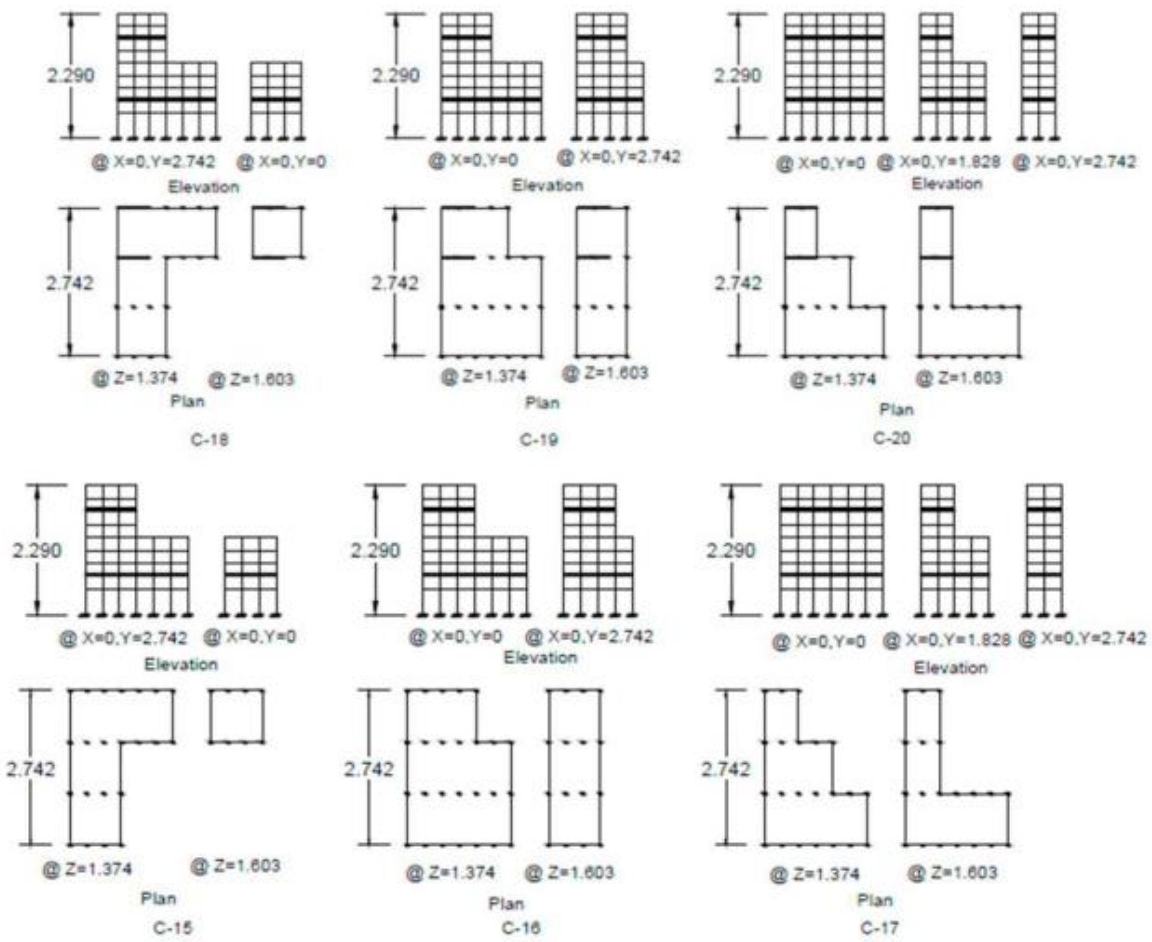


Figure : Cases with different combinations of irregularities: elevation is shown for C-1 to C-11, both plan and elevation are shown for C-12 to C-20 (All dimensions are in m).

The study concluded that irregularity considerably affects the structural response. The study indicates that the presence of irregularities does not always amplify the response. Certain combinations of irregularities bring down the structural response. All the single irregularity cases analysed have shown an increase in response when compared to the regular configuration under seismic loads. The combination of stiffness and vertical geometric irregularities has shown maximum displacement response whereas the combination of reentrant corner and vertical geometric irregularities has shown less displacement response. In the modern world, where people are not ready to compromise with their needs, incorporation of combinations of irregularity in structures is inevitable.

As the structural response depends on the type, location and degree of irregularity, these factors need to be taken care while designing any structure. Shaikh Abdul Aijaj et al (2017) have presented the earthquake results for structural irregulaties in the buildings as per IS 1893:2002. The study also adopted mass irregularity i.e. re the effective mass of any storey is more than 150% of effective mass of an adjacent storey. The effective mass includes dead weight of the floor and actual weight of partition and equipment. Vertical geometry irregularity can also be seen in structures. Setback also can be visualized as vertical re-entrant corner. The authors have modeled SMRF RCC buildings of G+10 storeyed. Table shows the details of analysis models. The equivalent static analysis has been carried out using ETABS software.

CONCLUSION

The study from the papers included in this article give reports on research and development on the effect plan geometry and irregularities on earthquake response for multistoreyed buildings. The high-rise buildings have complex behaviour under seismic excitations which were shown in many research articles. The response depends on many characteristics of the buildings such as plan geometry, setback, diaphragm, mass, stiffness, re-entrant corners and torsional irregularities. The buildings which having regular plan give better response as well as can be used for the regions having severe zone of earthquake. The plan which was having setbacks and re-entrant corners in the floor plan gives large storey drifts. In the recent world the aesthetic view is very demanding for the people, for this reason the engineer has to design the buildings according the demand.

In many cases the response of the buildings are not in the limit than he should apply the respective solution such as structural arrangements and stiffness to the structure so that the buildings give good response in lateral loads. Mass of the storey with respect to the adjacent can affect the drift of that storey. It is observed that storey shear also increases if there are any irregularities in the stiffness. High rise buildings response is very simple when these are analyse under static methods. So, for the buildings which were having any irregularities such as plan, mass, stiffness and torsion than designer should prefer dynamic analysis such as response spectrum, pushover analysis and time history analysis. Dynamic analysis gives the actual response of the building in the seismic vibration as these functions have actual acceleration of the waves with respect to the time. So, the effect of these acceleration can be seen on the buildings. In conclusion, research activity on the effect of plan geometry and irregularities on seismic excitation for multistorey buildings is very much lively, as obtained by the impressive number of papers published. Main issues of both building response and irregularities are clarify in the best manner.

REFERENCES

[1] Raúl González Herrera, Consuelo Gómez Soberón "Influence Of Plan Irregularity Of Buildings" The 14 World Conference on Earthquake Engineering, 2008, Beijing, China [2] Milind V. Mohod "Effect Of Shape And Plan Configuration On Seismic Response Of Structure" International Journal Of Scientific & Technology Research Volume 4, Issue 09, September 2015 [3] IS 1893-1 (2002): Criteria for earthquake resisting design of structures part 1: General provisions and buildings [4] Jereen Ann Thomas, Soumya Anand, Binu M Issac "Seismic Evaluation of Buildings with Plan Irregularity" Applied Mechanics and Materials, ISSN: 1662-7482, Vol. 857, pp 225-230 [5] Momen, M. M., Ahmed, Shehata., E. Abdel Raheem., Mohamed, M., Ahmed and Aly, G.A., Abdel, shafy. "Irregularity Effects on the Seismic Performance of L-shaped Multi-story Buildings". Journal of Engineering Sciences 44(5)-2016, 513- 536. [6] Patil, SS., Ajim Mujawar, G., PrritamMali., Murugesh Katti, R. "A Study of Torsional Effect on Multi-storied Building with Plan Irregularity". International Journal of Advanced Research 5(1)- 2017, 1625-1632. [7] Md. S. Choudhary, S. Arfath, M. Ahmed, N. Pasha, "Comparative Study on Seismic Analysis of Multi Storey Building Having Diaphragm Discontinuity Using Etabs", International Journal of Research in Advent Technology, 6(5), (2017). [8] Vincle Mable Vas, Prajwal Nagaraja, and Katta Venkataramana, "Effect of Diaphragm Discontinuity on the Seismic Response of an RC Building", Trends in civil engineering and challenges for sustainability, Select proceedings of CTCS 2017, Springer[9] Ravikumar C M et.al "Effect of Irregular Configurations on Seismic Vulnerability of RC Buildings ", Journal of Architecture Research 2(3): 20-26 [10]Dileshwar Rana, Prof. Juned Raheem "Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building" International Research Journal of Engineering and Technology (IRJET), Volume: 02 Issue: 04, July-2015 [11]Siva Naveen E, Nimmy Mariam Abraham, Anitha Kumari S D "Analysis of Irregular Structures under Earthquake Loads". 2nd International Conference on Structural Integrity and Exhibition 2017, Procedia Structural Integrity 14 (2017) 806– 819. [12]IS 1893-1 (2016): Criteria for earthquake resisting design of structures part 1: General provisions and buildings [13]Shaikh Abdul Aijaj Abdul Rahman, Ansari Ubaidurrahman Salik "Seismic analysis of vertically irregular buildings" Current Science association , 25 November 2016, Vol. 111, No. 10 (25 November 2016), pp.1658-1663 [14]Ravikanth Chittiprolu (2014) "Significance of Shear Wall in High-rise Irregular Buildings", International Journal of Education and applied research",Vol.4:35-37 [15]Sandesh N. Suryawanshi, Prof. S. B. Kadam, Dr. S. N. Tande (2014), "Torsional Behaviour of Asymmetrical Buildings in Plan under Seismic Forces", International journal of emerging engineering research and Technology, Vol.2 (4): 170-176 [16]M. Mouzzoun (2013), "Seismic performance assessment of reinforced concrete buildings using pushover analysis", IOSR Journal of Mechanical and Civil Engineering, Vol.5 (1):4449 [17]Abhilash R, Biju V, Rahul Leslie "Effect of lateral load patterns in Pushover analysis", 10th National Conference on Technological Trends (NCTT09) 6-7, India, 2009. [18]Birajdar.B.G, "Seismic analysis of buildings resting on sloping ground", 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada, Paper No. 1472, 2004 [19]Murty C.V.R., "Earthquake tips", Indian institute of Technology, Kanpur 2005 [20]G. Kumar, V. R. Singh, "Effect of Irregular Configurations on Seismic Behavior of RC

Buildings", International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE), 3(4), 2456-1290, (2017)