Nonlinear time history Analysis of Regular shaped, C-shaped and L-shaped building by using ETabs

Sawankumar S Toshniwal and Prof L. G. Kalurkar, *Department of civil engineering, Jawaharlal Nehru Engineering College, Aurangabad(M.S),* sawantoshniwal2311@gmail.com, lgkalurkar111@gmail.com

***Abstract*— We all know that earthquake is one of the very important aspect to be considered During planning of any structure. In past time Lots of work has been reported by many researchers who worked to study the effect earthquake on structures with Different types of irregularities. By referencing their works the project is done using Non linear dynamic analysis using time history analysis in E Tabs 2015. In this paper three models of rectangular shape and L-shape and C-shape each of G+5 are taken for analysis. Each of the buildings are assumed to be in Zone V and having medium soil type. For time history analysis previous Elcentro earthquake 1940 data has been taken. In this study listed parameters are considered namely Maximum displacement and drift, Base shear, Maximum storey acceleration and Time period. From the study we come to know that Irregular shaped building leads to increase in displacement, story drift, storey acceleration, time period and member forces, but it reduces the base shear.**

I. INTRODUCTION

Earthquake means the sudden movement of earth which is caused by movement of tectonic plates. We also know that now a day there are different types of irregularities in buildings are used in modern infrastructure. At the time of earthquake, due to ground movement the building is tends to fail. The main reason behind this is due to different types of irregularity, discontinuity in geometry, mass and stiffness or some of different geometrical or structural factors. This discontinuity is termed as Irregular structures. One of the major reasons of failures of structures during earthquakes is plan irregularity. In recent day's different types of irregular shape of buildings are of higher demand in construction Industry. So to fulfill their demand of irregular shapes we have studied different parameters during planning stage. Also Along with self weight and live load coming on structure it should withstand the lateral earthquake forces coming on it. So to understand the response of different shapes of building during an earthquake this study is done. In this study The earthquake data of Elcentro earthquake 1940 is taken for analysis, all the buildings are considered to be in Zone V, with medium type of soil. We had used rectangular shaped, C-shaped, and L-shaped buildings for analysis. While considering irregularities one may consider following types of irregularities in structure;

1. Vertical Irregularities
2. Plan Irregularities

. Vertical Irregularity: - there are generally following types of vertical irregularities;

a) Stiffness irregularity
i) Stiffness Irregularity —Soft Storey
ii) Stiffness Irregularity —Extreme Soft Storey
b) Mass irregularity
c) vertical geometric irregularity
d) In-Plane Discontinuity in Vertical Elements Resisting Lateral Force.
e) Discontinuity in capacity – weak storey

2. Plan Irregularity: There are generally following types of plan irregularities;

a) Torsional Irregularity
b) Re-entrant corners
c) Diaphragm Discontinuity
d) Out of Plane offsets
e) Non parallel system

For this study we had considered Non parallel system of irregularity which states that The vertical elements resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements.

II. METHODOLOGY

A. Non-Linear dynamic analysis

Dynamic analysis may be performed either by the Time History Method or by the Response Spectrum Method. In this paper, the seismic response of the structure is calculated by using time history analysis. The main methodology of this procedure is almost similar to the static method of analysis. However, this approach differs in the concept that the design displacements are not established using the target displacement; but, is estimated through dynamic analysis by subjecting the building model to an ensemble of the ground motions. The calculated seismic response is very sensitive to the ground motion characteristics, and the analysis is carried out for more than one ground motion record. So for this

study Elcentro earthquake 1940 data is utilized.

B. Objective of study

-- The main objective of the proposed work is to study the behavior of regular shaped, C-shaped and L-shaped buildings each of G+5 models are used under earthquake load by adopting Non-linear Time history analysis to evaluate and study the differentiation in Base shear, storey displacement also storey drifts using Etabs 2015 software.

III. PERFORMANCE ANALYSIS

in this study we have studied the base shear, displacement and storey drift of each of the models with respect to each other in Etabs 2015 software. By comparing the results one any can easily understand the response of structure and can predict the good shape structure which performs well against earthquake forces. Detailed study of mentioned factors is as shown further. All the models are shaped by considering Plan irregularities i.e. the plan area for each structure is same only there is difference of geometry. For each type of structure total numbers of storey are 5 and elevation is also same. The specifications of models used for analysis are as further.

TABLE I. DETAILS OF STRUCTURE

PARAMETER	REGULAR SHAPED BUILDING	C-SHAPED BUILDING	L-SHAPED BUILDING
HEIGHT OF EACH FLOOR	3 M	3 M	3 M
GRADE OF CONCRETE	M25	M25	M25
GRADE OF STEEL	HYSD 500	HYSD 500	HYSD 500
DEPTH OF SLAB	150 MM	150 MM	150 MM
SIZE OF BEAMS	300 X 450	300 X 450	300 X 450
SIZE OF COLUMN	300 X 500	300 X 500	300 X 500
THICKNESS OF WALL	230 MM	230 MM	230 MM

TABLE II. SEISMIC DATA USED FOR ANALYSIS

EARTHQUAKE ZONE	V
DAMPING RATIO	5 %
IMPORTANCE FACTOR	1
TYPE OF SOIL	MEDIUM
RESPONSE REDUCTION FACTOR	5
TIME PERIOD	PROGRAM CALCULATED
POISONS RATIO	0.15

TABLE III. LOAD CASES

DEAD	LINEAR STATIC
LIVE	LINEAR STATIC
EQX	LINEAR STATIC
EQY	LINEAR STATIC
WALL	LINEAR STATIC
THA-X	NONLINEAR MODAL HISTORY (FNA)
THA-Y	NONLINEAR MODAL HISTORY (FNA)

After using above data for modeling we got following types of diagrams of shapes of building in e tabs software.

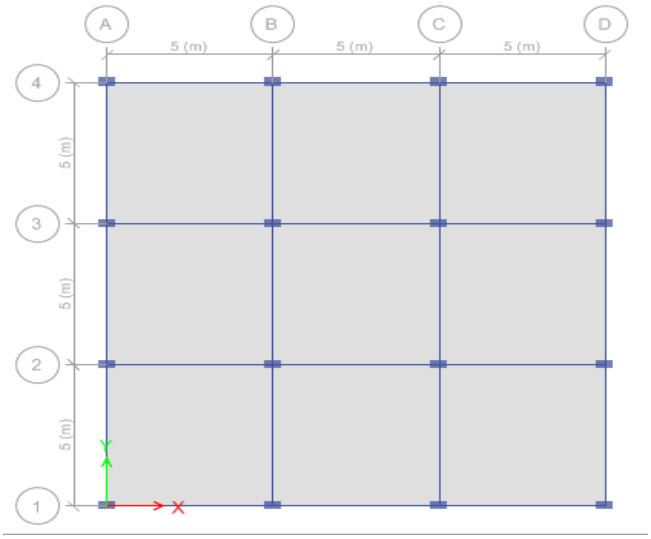

Fig. 1. Regular shaped building

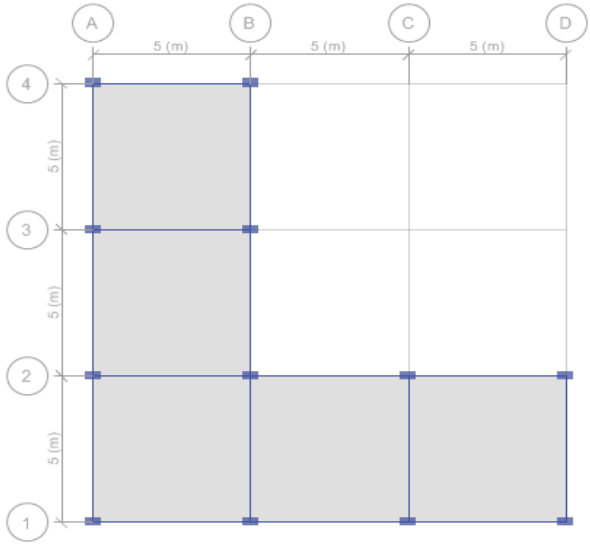

Fig. 2. L-shaped building

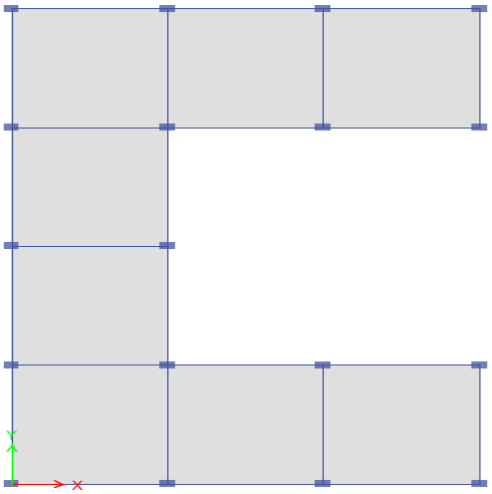

Fig.3. C-shaped building

IV. RESULTS

On the basis of above modeling work following results were obtained.

1. Base Shear :- Comparison of weight of building and base shear evaluated for both the models in both the direction.

TABLE IV. BASE SHEAR IN X & Y DIRECTION

PARAMETER	REGULAR SHAPED MODEL	C-SHAPED BUILDING	L-SHAPED MODEL
WEIGHT OF BUILDING	10480.6027 KN	9977.6334 KN	6330.9569 KN
BASE SHEAR IN X-DIRECTION	552.6018 KN	601.514 KN	376.5765 KN
BASE SHEAR IN Y-DIRECTION	450.023 KN	475.4691 KN	308.3596 KN

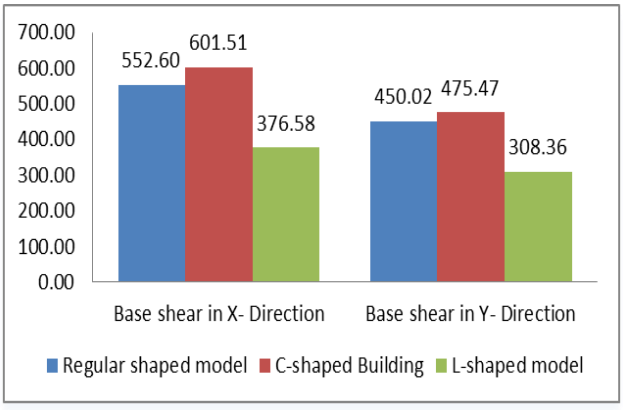

Fig. 4. Variation of Base Shear in X & Y direction

2. Storey displacement in both X & Y direction

TABLE V. STOREY DISPLACEMENT IN X DIRECTION

STOREY	REGULAR SHAPED MODEL	C-SHAPED MODEL	L-SHAPED MODEL
STORY7	2.03E-06	1.565E-05	0.002
STORY6	2.06E-06	8.12E-05	0.002
STORY5	1.76E-06	0.000142	0.002
STORY4	1.43E-06	0.0001688	0.001
STORY3	1.00E-06	0.0001576	0.001
STORY2	8.16E-07	0.0001071	0.0004239
STORY1	5.11E-08	1.992E-05	6.70E-05
BASE	0	0	0

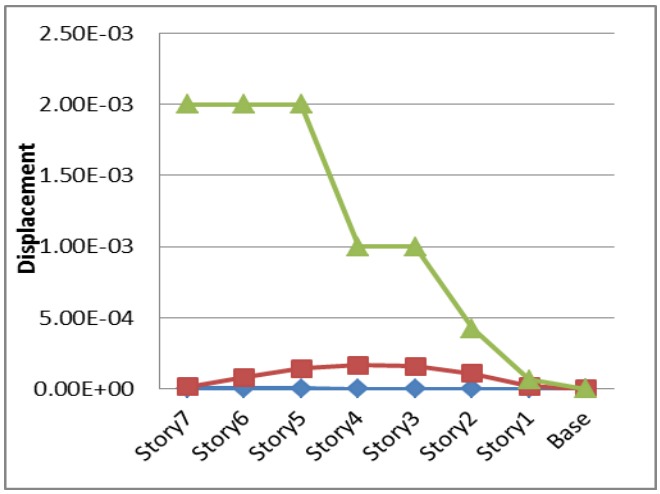

Fig. 5. Variation story displacement in X direction

TABLE VI. STOREY DISPLACEMENT IN Y DIRECTION

STOREY	REGULAR SHAPED MODEL	C-SHAPED MODEL	L-SHAPED MODEL
STORY7	0.0424	0.044	0.057
STORY6	0.0399	0.041	0.053
STORY5	0.0351	0.036	0.047
STORY4	0.0283	0.029	0.038
STORY3	0.0199	0.021	0.027
STORY2	0.0105	0.011	0.014
STORY1	0.0015	0.002	0.002
BASE	0	0	0

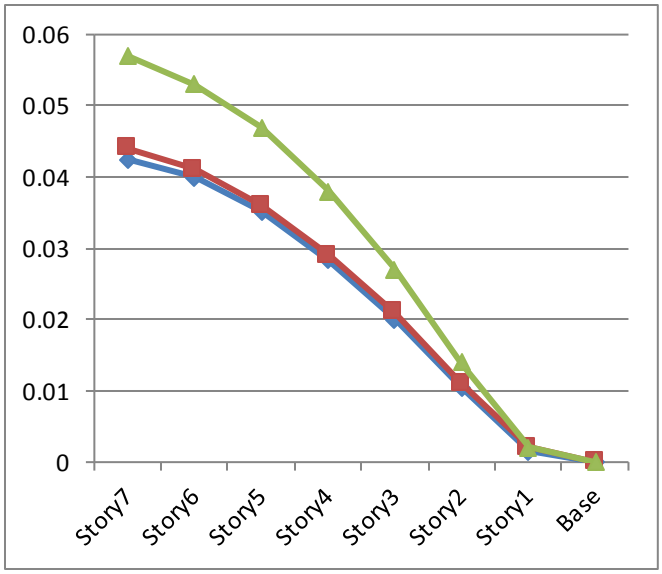

Fig. 6. Variation story displacement in Y direction

3. Story Drift in both X & Y direction
From the above analysis we got following values of story drift in both X & Y direction

TABLE VII. STORY DRIFT IN X DIRECTION

STOREY	REGULAR SHAPED MODEL	C-SHAPED MODEL	L-SHAPED MODEL
STORY7	0	2.95E-08	7.92E-08
STORY6	0	2.09E-08	1.09E-07
STORY5	0	9.52E-09	1.29E-07
STORY4	0	0	1.40E-07
STORY3	0	1.848E-08	1.39E-07
STORY2	0	2.906E-08	1.19E-07
STORY1	0	1.328E-08	4.47E-08
BASE	0	0	0

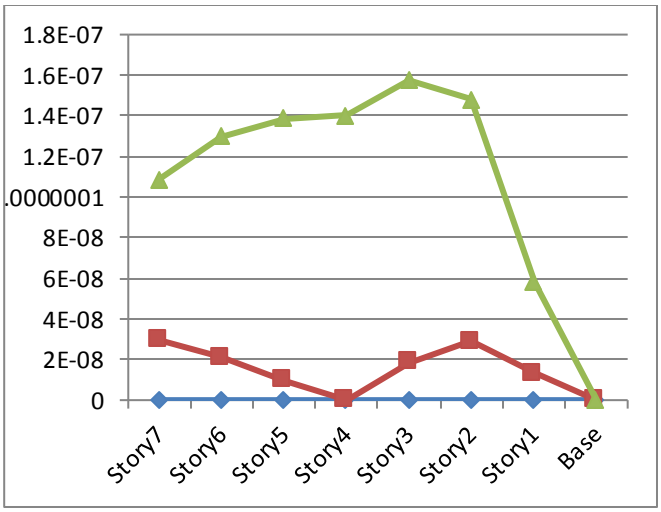

Fig. 7. Variation story drift in X direction

TABLE VIII. STORY DRIFT IN Y DIRECTION

STOREY	REGULAR SHAPED MODEL	C-SHAPED MODEL	L-SHAPED MODEL
STORY7	1.00E-06	1E-06	1.00E-06
STORY6	2.00E-06	2E-06	2.00E-06
STORY5	2.00E-06	2E-06	3.00E-06
STORY4	3.00E-06	3E-06	4.00E-06
STORY3	3.00E-06	3E-06	4.00E-06
STORY2	3.00E-06	3E-06	4.00E-06
STORY1	1.00E-06	1E-06	1.00E-06
BASE	0	0	0

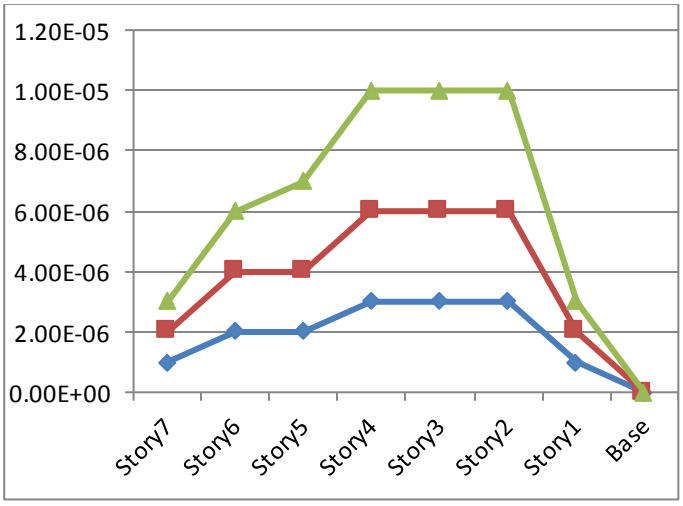

Fig. 8. Variation story drift in Y direction

V. CONCLUSION

From the above study following conclusions are made,

1. Considering the calculated base shear we can say that maximum base shear is observed in C-shaped building which is 8% to 9% more than that of regular shaped building.
2. Storey displacement is observed in all the models, in case of L-shaped building the displacement is more as compared to regular shape building and C-shaped building in both X and Y direction.
3. Considering story drift L-shaped building shows more story drift as compared to C-shaped and regular shaped building.
4. As per IS 1893: 2002 clause no. 7.11.1 pg no. 27, which states the limiting value of storey drift is 0.004 times floor height, the storey drift of all the building are not exceeding the given limit.
5. From all the above parameters we can say that response of L-shaped building is not satisfactory as compared to C-shaped and regular shaped building.
6. So from above obtained results we can conclude that regular shaped building is good for construction but as far as someone goes for different shape can go for C-shaped building instead of L-shaped building.

VI. ACKNOWLEDGMENT

I would like to thank my guide respected Prof. L. G. Kalurkar sir for is timely guidance. Also I would like to thank our HOD Prof. Shinde S. B. for her continuous support. Last but not the least thank you everyone who directly or indirectly supported me. Thank you"

REFERENCES

1. Shivkumar Hallale, H Sharada Bai , "Seismic Behavior of Buildings with Plan Irregularity with and Without Structural Infill Action", ISSN (Online): 2347 - 2812, Volume-4, Issue -4, 2016.
2. G. Nagasai , B.D.V. Chandra Mohan Rao, "comparative study on time history analysis of plan irregular RC buildings", i-manager's Journal on Structural Engineering, Vol. 6 1No. 1 1March - May 2017
3. 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 Issn 2277-8616.
4. Pradeep Pujari, Amaresh, " Seismic plan irregular multi storied building with and without shear wall", IRJET, Volume: 04 Issue: 08 | Aug -2017, ISSN: 2395-0056.
5. Prajwal T P, Imtiaz A Parvez, Kiran Kamath, "Non linear analysis of irregular buildings considering the direction of seismic wave", 2214 - 7853©2017 published by Elsevier Ltd.
6. Chetan Chhindam, Pankaj Autade, "SEISMIC TIME HISTORY ANALYSIS OF SIX STORY SHEAR BUILDING WITH NEWMARK-β METHOD AND ETABS", IJRET, doi.org/10.15623/ijret.2018.0703009, eISSN: 2319-1163.
7. Pruthviraj N Juni, S.C. Gupta, et al, " Nonlinear Dynamic Time History Analysis of Multistoried RCC Residential G+23 Building for Different Seismic Intensities", International Journal of Engineering Research & Science, Vol-3, Issue-3, March- 2017, ISSN: [2395-6992]
8. G. Magliulo " seismic perfomance of r/c frames with regular and irregular strength vertical distributions" the 14th world conference on earthquake engineering october 12-17, 2008, beijing, china
9. Ravi Kiran , ET .AL," COMPARATIVE STUDY OF REGULAR And VERTICALLY IRREGULAR BUILDING UNDER SEISMIC LOADING" IJRET : International Journal of Research in Engineering and Technology VOLUME:05 ISSUE:09/SEP-2016
10. Dileshwar Rana , "Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building "International Research Journal of Engineering and Technology (IRJET) Volume: 02 Issue: 04 | July-2015