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Research Study on Dynamic Analysis of RCC Building with Different Geometry

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ABSTRACT: The important objective of earthquake engineers is to design and build a structure in such a way that damage to the structure and its structural component during the earthquake is minimized. This report aims towards the non-linear dynamic analysis of a multi-storey RCC building with Varying Geometry. For the analysis purpose model of G+15 RCC with Varying Geometry plan is considered. The analysis is carried by using finite element based software ETABS. Various response parameters such as lateral force, base shear, story drift, Displacement can be determined. For dynamic analysis time history method or response spectra method can be used .Time-history analysis is a step-by-step analysis of the dynamical response of a structure to a specified loading that may vary with time. The analysis may be linear or non-linear. Dynamic analysis can be performed for unsymmetrical building. Dynamic analysis can be in the form of nonlinear dynamic time history analysis. In this paper, a nonlinear time history analysis is performed on a G+15 RCC building frame considering time history of El Centro earthquake 1940 using ETABS. The various response parameters like base shear, storey drift, storey displacements etc are calculated. The storey drift calculated is compared with the minimum requirement of storey drift as per IS 1893:2002.

KEYWORDS*:* Non-linear Dynamic analysis, ETABS, Varing Geometry

I. INTRODUCTION

Structural response to earthquakes is a dynamic phenomenon that depends on dynamic characteristics of structures and the intensity, duration, and frequency content of the exciting ground motion. Although the seismic action is dynamic in nature, building codes often recommend equivalent static load analysis for design of earthquake-resistant buildings due to its simplicity. This is done by focusing on the predominant first mode response and developing equivalent

Seismic analysis is a subset of structural analysis and is the calculation of the response of a building (or nonbuilding) structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit (see structural engineering) in regions where earthquakes are prevalent.

A. Nonlinear dynamic analysis

Nonlinear dynamic analysis utilizes the combination of ground motion records with a detailed structural model, therefore is capable of producing results with relatively low uncertainty. In nonlinear dynamic analyses, the detailed structural model subjected to a ground-motion record produces estimates of component deformations for each degree of freedom in the model and the modal responses are combined using schemes such as the square-root-sum-of-squares. In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous, and is required by some building codes for buildings of unusual configuration or of special importance.

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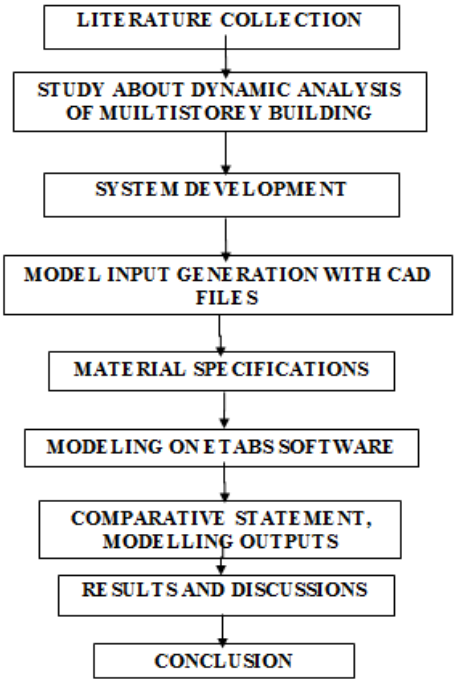
B. Aim Of The Present Work

The main aim is study of Seismic Response of G+15 Storey R.C.C Buildings with Plan Varying Geometry.

C. Objectives: Labour Productivity And Uses

- To study seismic response of the multi-storey buildings (G+15) by Nonlinear dynamic analysis method.
- Study of Linear and Non-linear Dynamic Analysis of structure having using Etabs computer programming according to IS 1893 (part-1):2016.
- To study the seismic response of buildings in terms of storey displacement and storey drift to find out and compared within the considered configuration.

II. METHODOLOGY WORK STUDY



- The study is carried out for the behavior of G+15 storied R.C frame buildings with a regular plan having rectangular, square and circular plan varying geometry.
- Floor height provided as 3.2 m. And also, properties are defined for the frame structure. Models are created in ETABS software.
- Various types of load are considered. For static behavior dead load of the building is considered as per IS 875 Part 1 and live
- load is considered as per IS 875 Part III, lateral load confirming IS 1893(part 1) 2016.
- The three-dimensional reinforced concrete structures with G+15 storey were analyzed by Response spectrum analysis using ETABS software.
- The analysis results will show study the seismic response of buildings in terms of storey shear, storey drift, storey displacement, time period, base shear, base moments, storey displacement, etc. find out compared within the considered configuration.

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III. PROBLEM STATEMENT

Following varying geometry models are used for the analysis by using given property Data

- Rectangular Geometry (18m x 24m)
- Square Geometry (18m x18m)
- Circular Geometry (Dia. – 24m)

Table 1. Parameters to be consider

Sr. No.	Parameter	Values
1.	Number of storey	G+15
2.	Base to plinth	1.5m
3.	Floor height	3.2m
4.	Infill wall	200 mm thick
5.	Materials	Concrete M40 and Reinforcement Fe 500
6.	Frame size	18m X 24m building size
7.	Grid spacing	4.5m grids in X-direction and 6m grids in Y-direction.
8.	Size of column	600 mm x 600 mm
9.	Size of beam	300mm x 600 mm
10.	Depth of slab	150 mm
11.	Total height	49.5m
12.	Plan area	432 m^2

IV. ANALYSIS

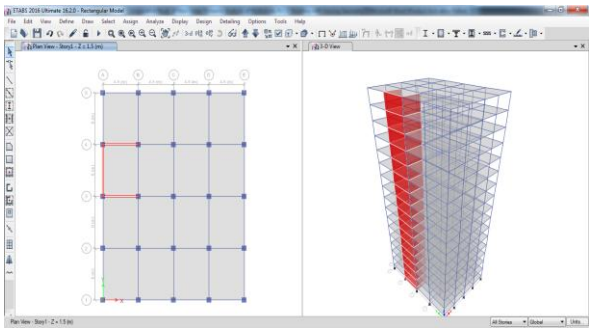

Fig 1 Model 1 - Rectangular Geometry

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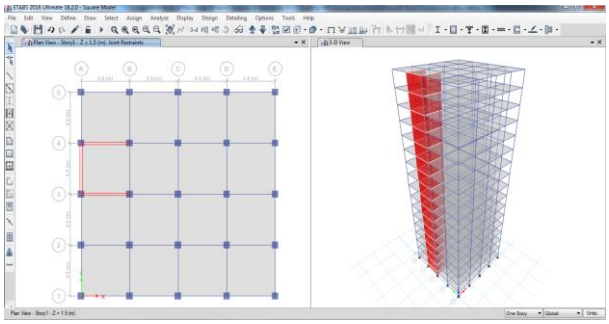

Fig 2 Model 2 - Square Geometry

V. RESULT AND DISCUSSION

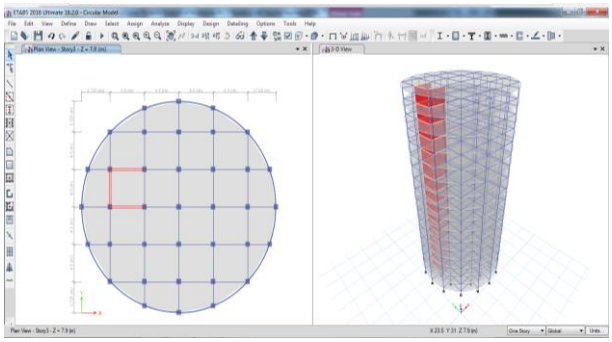

Fig 3 Model 3 - Circular Geometry

V. RESULT AND DISCUSSION

A. Story displacement

Table 2 Storey Displacement EQX

STORY	RECTANGULAR	SQUARE	CIRCULAR
17	32.311	28.276	78.642
16	31.492	27.599	76.879
15	30.383	26.667	74.444
14	28.985	25.475	71.319
13	27.336	24.056	67.577
12	25.474	22.441	63.305
11	23.435	20.664	58.59
10	21.253	18.756	53.513
9	18.962	16.745	48.151
8	16.591	14.657	42.576
7	14.168	12.518	36.855
6	11.716	10.349	31.047
5	9.26	8.169	25.208
4	6.82	5.999	19.386
3	4.423	3.866	13.627
2	2.138	1.845	7.974
1	0.294	0.252	2.48

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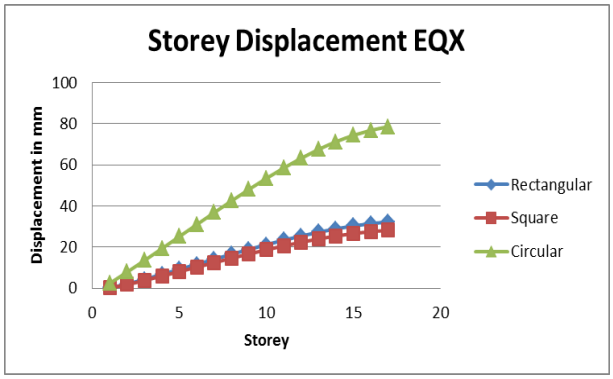
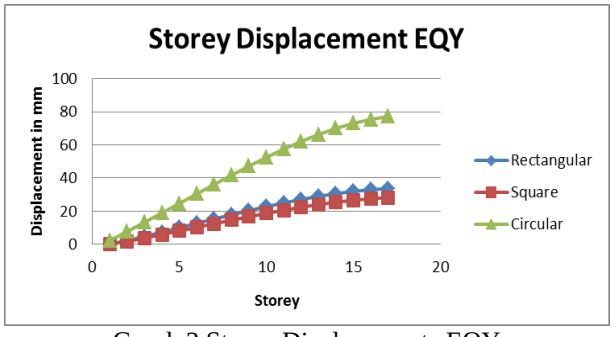


Graph 1 Storey Displacements EQX

From the above table & graph, we can observe that percentage variation for Storey Displacement EQX for square geometry is less than rectangular and circular geometry. The variation is found to be 5-9 % for square to Rectangular and on further variation FOR Rectangular to Circular is found to be 20-30 %

Table 3 Storey Displacement EQY

STORY	RECTANGULAR	SQUARE	CIRCULAR
17	33.693	28.276	77.128
16	33.004	27.599	75.414
15	31.991	26.667	73.035
14	30.651	25.475	69.977
13	29.023	24.056	66.313
12	27.147	22.441	62.127
11	25.063	20.664	57.505
10	22.809	18.756	52.527
9	20.419	16.745	47.27
8	17.924	14.657	41.803
7	15.354	12.518	36.19
6	12.733	10.349	30.493
5	10.084	8.169	24.762
4	7.43	5.999	19.048
3	4.805	3.866	13.393
2	2.3	1.845	7.839
1	0.315	0.252	2.438



Graph 2 Storey Displacements EQY

From the above table & graph, we can observe that percentage variation for Storey Displacement EQY for square geometry is less than rectangular and circular geometry. The variation is found to be 8-10 % for square to Rectangular and on further variation FOR Rectangular to Circular is found to be 20-30 %

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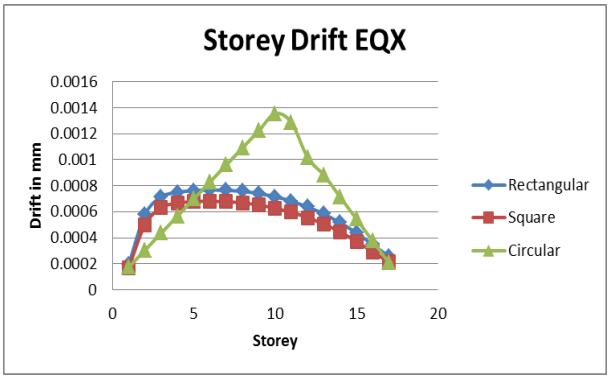
B. Storey Drift

Table 4 Storey Drift EQX

STORY	RECTANGULAR	SQUARE	CIRCULAR
17	0.000256	0.000212	0.0002058
16	0.000347	0.000292	0.0003746
15	0.000437	0.000372	0.0005434
14	0.000515	0.000444	0.0007122
13	0.000582	0.000505	0.0008810
12	0.000637	0.000555	0.0010165
11	0.000682	0.000596	0.0012853
10	0.000716	0.000628	0.0013541
9	0.000741	0.000652	0.0012229
8	0.000757	0.000669	0.0010917
7	0.000766	0.000678	0.0009605
6	0.000768	0.000681	0.0008293
5	0.000763	0.000678	0.0006981
4	0.000749	0.000666	0.0005669
3	0.000714	0.000632	0.0004357
2	0.000577	0.000499	0.0003045
1	0.000196	0.000168	0.0001733



Graph 3 Storey Drift EQX

From the above table & graph, we can observe that percentage variation for Storey Drift EQX for square geometry is less than rectangular and circular geometry. The variation is found to be 10-15% for square to Rectangular and on further variation FOR Rectangular to Circular is found to be 30-35 %

Table 5 Storey Drift EQY

STORY	RECTANGULAR	SQUARE	CIRCULAR
17	0.000215	0.000212	0.0001531
16	0.000317	0.000292	0.0002356
15	0.000419	0.000372	0.0003181
14	0.000509	0.000444	0.0004006
13	0.000586	0.000505	0.0004831
12	0.000651	0.000555	0.0005656
11	0.000704	0.000596	0.0006481
10	0.000747	0.000628	0.0007306
9	0.00078	0.000652	0.0008131
8	0.000803	0.000669	0.0008956

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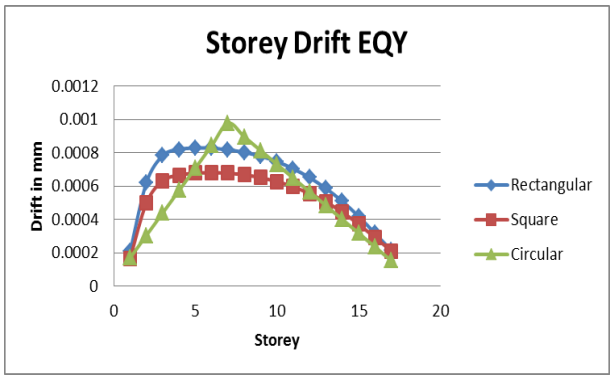
7	0.000819	0.000678	0.0009781
6	0.000828	0.000681	0.0008435
5	0.000829	0.000678	0.0007089
4	0.00082	0.000666	0.0005743
3	0.000783	0.000632	0.0004397
2	0.000621	0.000499	0.0003051
1	0.00021	0.000168	0.0001705

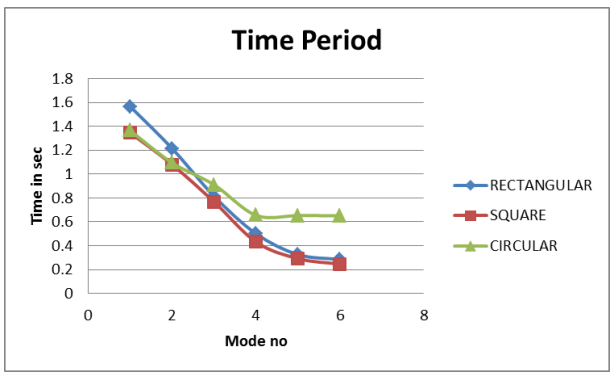


Graph 4 Storey Drift EQY

From the above table & graph, we can observe that percentage variation for Storey Drift EQY for square geometry is less than rectangular and circular geometry. The variation is found to be 5-10% for square to Rectangular and on further variation for Rectangular to Circular is found to be 10-20 %.

Table 6 Time Period

MODE	RECTANGULAR	SQUARE	CIRCULAR
1	1.567	1.347	1.365
2	1.215	1.08	1.095
3	0.815	0.768	0.911
4	0.501	0.432	0.655
5	0.326	0.292	0.653
6	0.285	0.246	0.652



Graph 5 Time Period

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From the above table & graph, we can observe that percentage variation for Time Period for square geometry is less than rectangular and circular geometry. The variation is found to be 1-5% for square to Rectangular and on further variation FOR Rectangular to Circular is found to be 10-15 %

VI. CONCLUSION

For high rise buildings static analysis is not enough it's necessary to provide dynamic analysis. In proportional static examination, the outcomes are roughly uneconomical on the grounds that the estimations of removals are higher than, dynamic investigation. From the following study it conclude that square RCC geometry is preferable for the dynamic analysis than rectangular and circular geometry

- We can observe that percentage variation for Storey Displacement EQX for square geometry is less than rectangular and circular geometry. The variation is found to be 5-9 % for square to Rectangular and on further variation for Rectangular to Circular is found to be 20-30 %.
- We can observe that percentage variation for Storey Displacement EQY for square geometry is less than rectangular and circular geometry. The variation is found to be 8-10 % for square to Rectangular and on further variation for Rectangular to Circular is found to be 20-30 %.
- We can observe that percentage variation for Storey Drift EQX for square geometry is less than rectangular and circular geometry. The variation is found to be 10-15% for square to Rectangular and on further variation for Rectangular to Circular is found to be 30-35 %.
- We can observe that percentage variation for Storey Drift EQY for square geometry is less than rectangular and circular geometry. The variation is found to be 5-10% for square to Rectangular and on further variation for Rectangular to Circular is found to be 10-20 % .
- We can observe that percentage variation for Time Period for square geometry is less than rectangular and circular geometry. The variation is found to be 1-5% for square to Rectangular and on further variation for Rectangular to Circular is found to be 10-15 %.

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Etabs software

Structural and Earthquake Engineering Software, "ETABS 2016", Computers and structures, Inc.

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