International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 08 | Aug 2020 www.irjet.net p-ISSN: 2395-0072

EFFECT OF IRREGULAR CONFIGURATION ON SEISMIC PERFORMANCE OF BUILDINGS

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Abstract - *Behavior of a building during strong earthquake motion depends on structural configuration. Irregular configuration either in plan or in elevation is recognized as one of the major causes of failure during earthquakes.In the present work the RC buildings with +, C, L & Square shaped plan have proposed attempts to evaluate the effect of plan configurations on the response of structure by Time History Analysis.The Indian Standard Code (IS-Code) of practice IS-1893 (Part I: 2002) guidelines and methodology are used to analyze the buildings. In this project,the comparisons between the four RCC buildings with different plan shape (Square, C, L, +) having same height with different storeys (G+11) & (G+14) of buildings is considered to analysis. The time history analysis method has been used to evaluate seismic performance of building. The analysis is carried out using Etabs. This method determines maximum story drift, overturning moment & natural period. The C shape building is more vulnerable than other shapes.*

***Key Words*: Time history analysis, irregularity, story drift, overturning moment**

1. INTRODUCTION

The behavior of any building depends on the arrangement of structural elements present in it. The important aspects on which the structural configuration depends are geometry, shape and size of the building. When a building is subjected to dynamic loads, inertia forces are developed and gets concentrated at the center of mass of the structure. Usually, the vertical members such as columns resist the horizontal inertia forces and the resultant of these forces gets concentrated at a point called center of stiffness. When the center of mass does not coincide with the center of stiffness, eccentricity develops in the structure. Eccentricity occurs due to the irregular arrangement of structural configuration which in turn induces torsion in the structure. Location and size of structural elements have significant effect on torsional coupling which results in damage of structures. Regular structures have no significant discontinuities in plan or in vertical configurations. Irregular structures have certain physical discontinuities either in plan or in elevation or both which affect the performance of the structure subjected to lateral loads. Irregularities in the distribution of mass, stiffness and geometry along the height of any building are grouped as vertical irregularities.

Objectives of study:-

1) To analyze a multistoried RC framed building for four irregular shapes i.e. a) + Shape, b) C Shape, c) L Shape, d) Square Shapes for

i) 12 Storey

ii) 15 storey

2) To compare seismic behavior of multistoried RC framed building for earthquake intensity by time history analysis in terms of various responses such as story drift, overturning moment and natural period.

3) Study behaviour of these models on basis of storey drift.Obtain results for each shape of building in case of maximum storey drift.

4) Study behaviour of these models on basis of storey overturning moment. Obtain results for each shape of building in case of overturning moment.

5) Study behaviour of these models on basis of fundamental natural period.Obtain results for each shape of building in case of fundamental natural period.

2. MODELLING AND ANALYSIS

The layouts of the plans having 8 x 8 bays of equal length of 6m are considered. The building considered is an ordinary moment resisting frame of 12 &15 storeys with different irregular configurations. The storey height is uniform throughout for all the building models considered for analysis. The software used for analysis by time history analysis of the frame models is ETABS.

The details of the model building for + Shape, C shape, L shape & Square shape structure are given below:

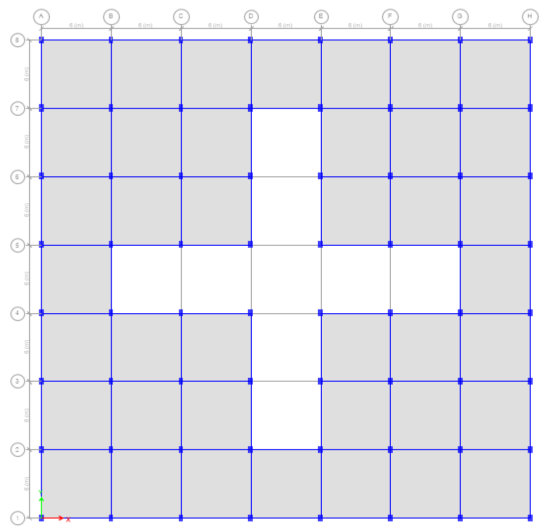


Fig -1: Model 1 – + Shape

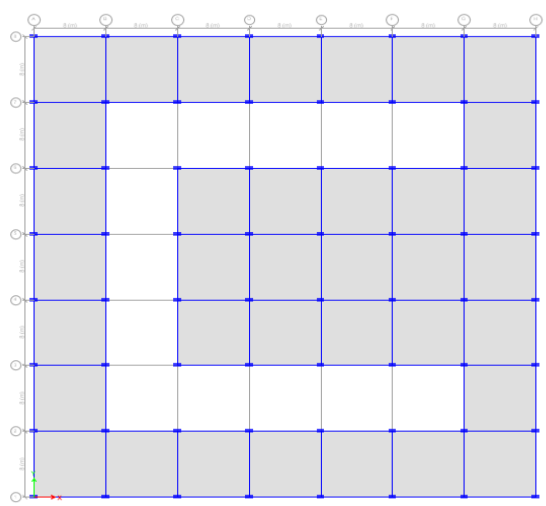


Fig -2: Model 2 – C Shape

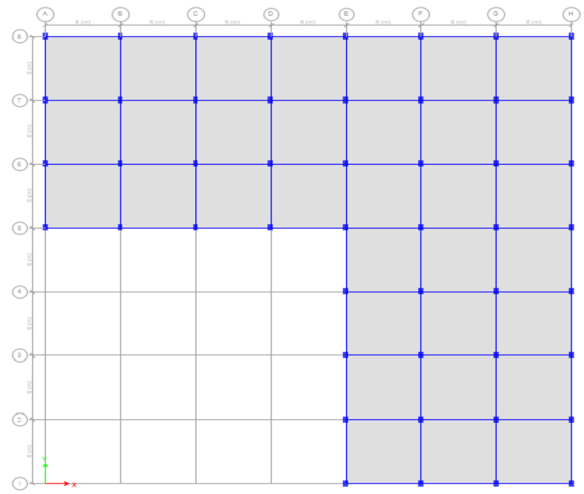


Fig -3: Model 3 – L Shape

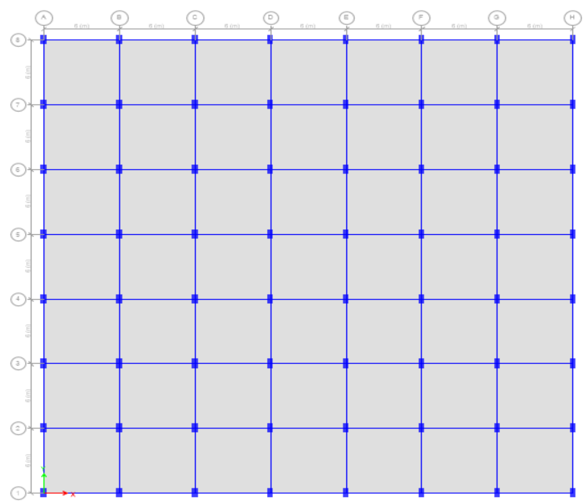


Fig -4: Model – Square Shape

Table 1: Parameters Considered for Analysis

Type of Model	G+11 Storey	G+14 Storey
Floor to floor height (in mm)	3000	3000
Beam size (mm x mm)	650x350	650x350
Column size (mm x mm)	850x450	850x450
Slab thickness (in mm)	150	150
Grade of concrete	M30	M30
Grade of steel	Fe500	Fe500
Seismic Zone (z)	V	V
Importance factor (I)	1	1
Response reduction factor (I)	5	5

2.1 Different Loads :-

i. Dead Load (DL) = 1.5 kN/m2

ii. Live load (LL) = 3 kN/m2

iii. Super dead load (SDL)

a. Floor finish = 1.5 kN/m2

b. Masonary = 1.2 kN/m2

iv. Time History data = Taken from PEER Ground Motion Database

2.2 Load combinations :-

Based on IS 1893-2002,

i. 1.5 (DL + LL + SDL)

ii. 1.2 (DL + LL + SDL ± EQX)

iii. 1.2 (DL + LL + SDL ± EQY)

iv. 1.5 (DL + SDL ± EQX)

v. 1.5 (DL+ SDL ± EQY)

vi. 0.9 DL + 0.9 SDL ± 1.5 EQX

vii. 0.9 DL + 0.9 SDL ± 1.5 EQY

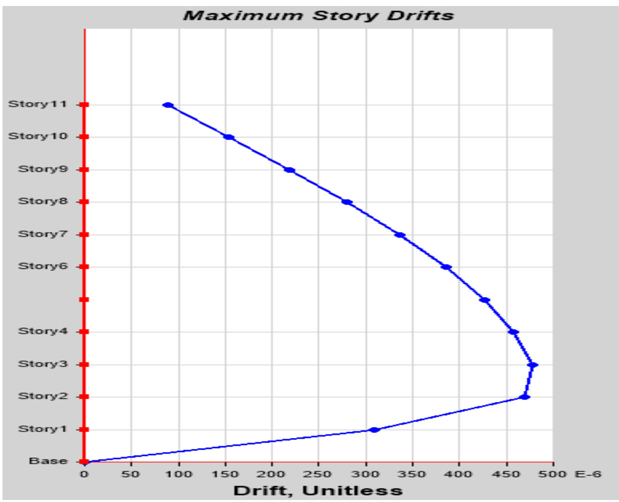
2.3 Methodology:-

i. Modeling of structure in Etabs. Defining Material properties for concrete and Reinforcement bars.
ii. Defining Section properties to all sections of proper size with proper properties.
iii. Assign supports to structure.
iv. Define mass source.
v. Define and Assign Loads to respective members.
vi. Define time history function. Use proper time history data with required number of steps. Assign time history function in load cases.
vii. Checking the Model. Then performing analysis on model.
viii. Obtain required parameters like maximum storey drift, maximum storey overturning moment, & natural period.

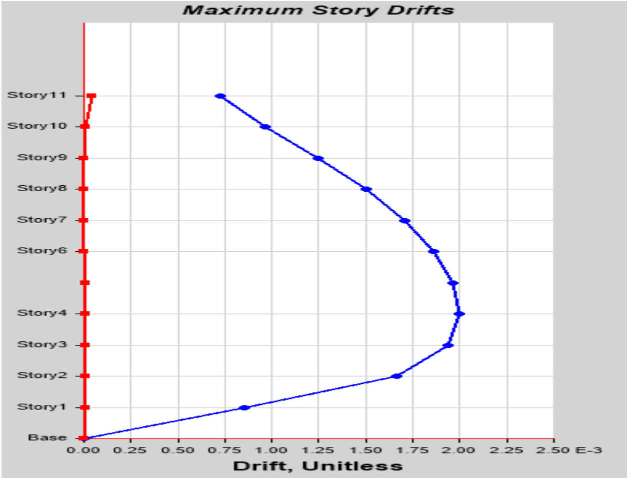
3. RESULT AND DISCUSSION

3.1 Maximum Storey Drift

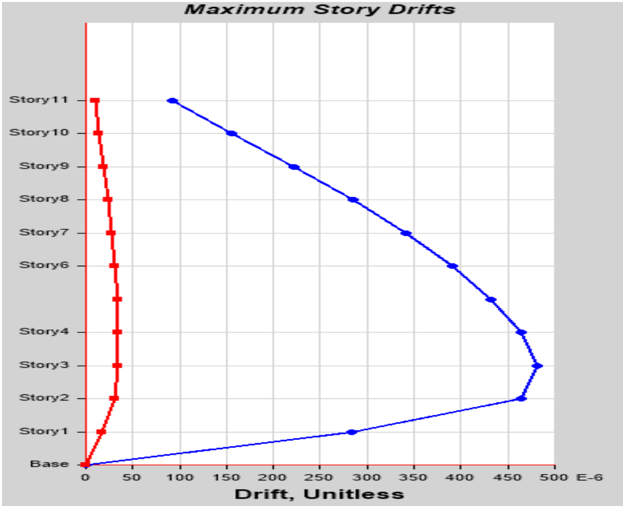
The storey drift is the displacement of one level relative to the other level above or below. The results obtained by analysis in Etabs are shown below:



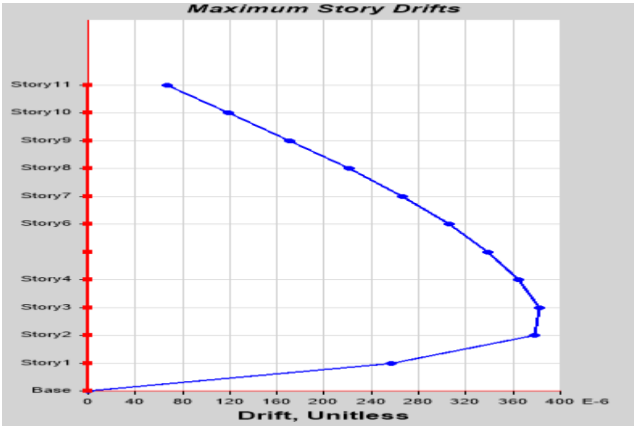
Model 1 - + shape



Model 2 - C shape



Model 3 - L shape



Model 4 - Square shape

Fig -5 Max Story drift for (G+11) storey for Different shapes of buildings

For G+11 Storey structure Maximum Story Drift can be obtained From above graphs, similarly for G+14 structures Maximum Story Shear is obtained and shown in table below,

Table 2: Maximum Story Drift

MODEL	STOREY DRIFT	
	G+11	G+14
1	0.7	1
2	0.8	3
3	0.7	4.2
3	0.6	2

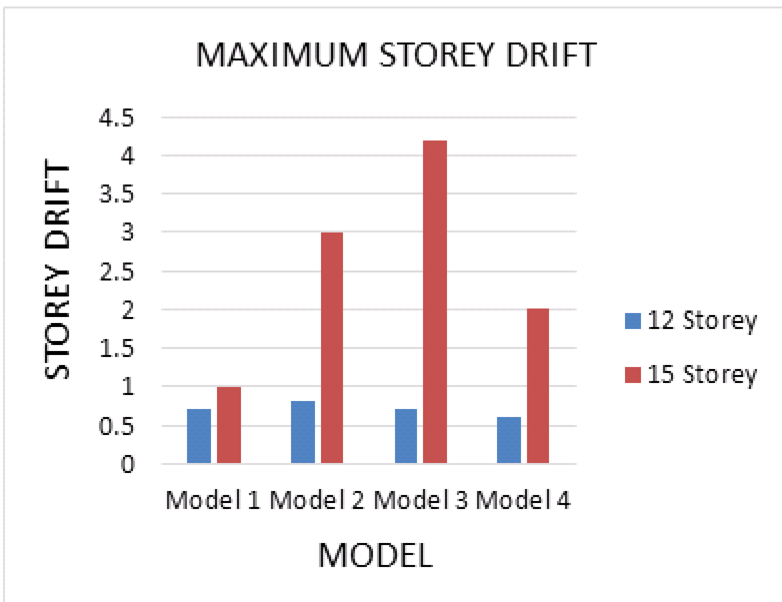
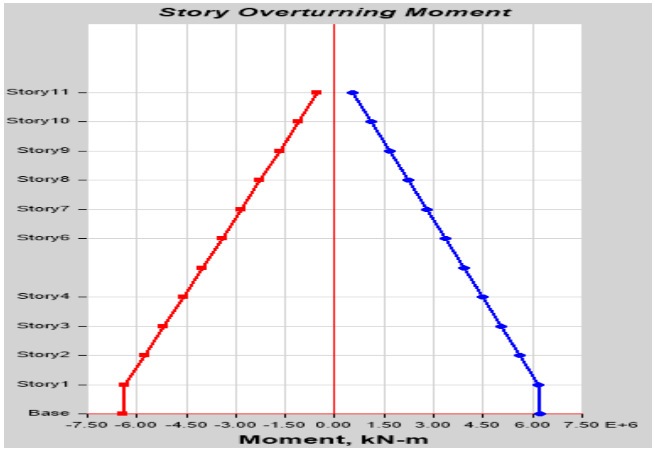


Fig -6 Maximum Storey Drift of G+11 & G+14 structure for different shapes of building

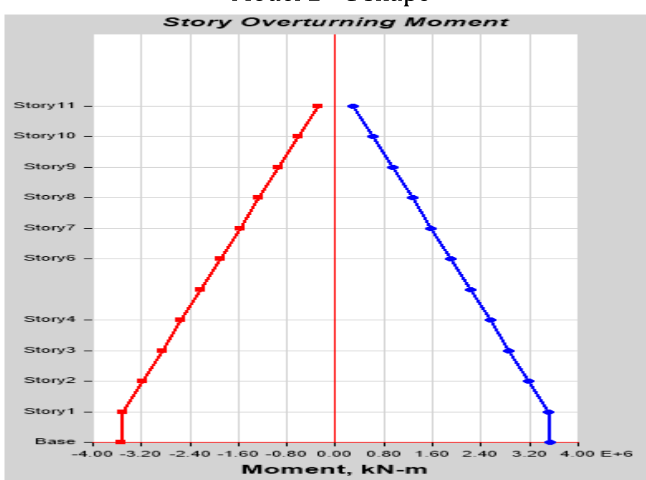
3.2 Maximum Storey Overturning Moment

Overturning moments are moments or shear forces applied on storey which causes unstability of storey. Overturning moment plays major role in design of any structure. The results obtained in analysis by using Etabs are shown below:

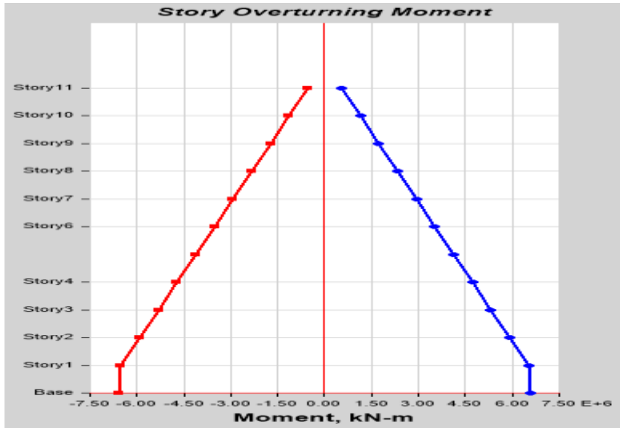


Model 1 - + shape

Model 2 - C shape



Model 3 - L shape



Model 4 - Square shape

Fig 7- Max Story overturning moment (G+11) storey for Different shapes of buildings

For G+11 Storey structure Maximum Positive and Negative Story Overturning Moment can be obtained From above graphs, similarly for G+14 structures Maximum Positive and Negative Story Overturning Moment is obtained and shown in table below,

Table 3 : Maximum Positive and Negative Story Overturning Moment (10^5 kNm)

MODEL	STOREY OVERTURNING MOMENT	
	G+11	G+14
1	6.2 -6.2	3.5 -3.5
2	5 -5	6.5 -6.5
3	3.5 -3.5	2.6 -2.6
3	6.2 -6.2	4.0 -4.0

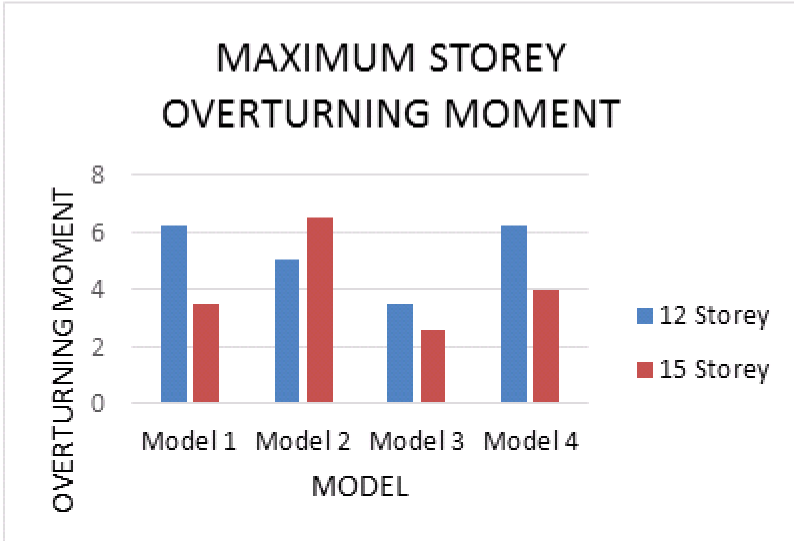
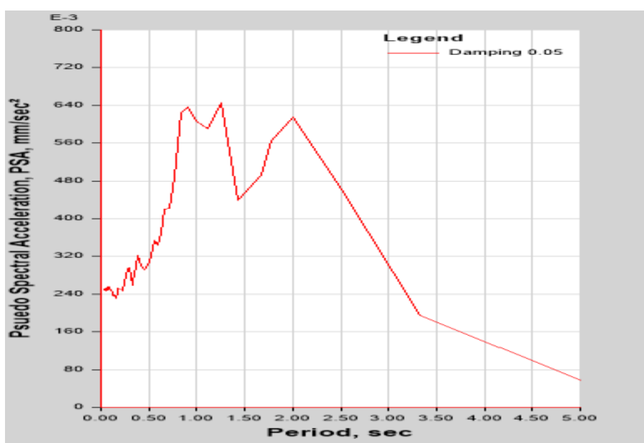


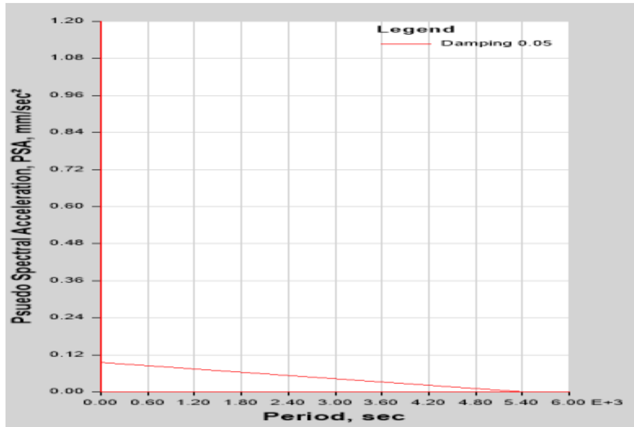
Fig 8- Maximum overturning moment of G+11 & G+14 structure for different shapes of building

3.3 Fundamental Natural Period

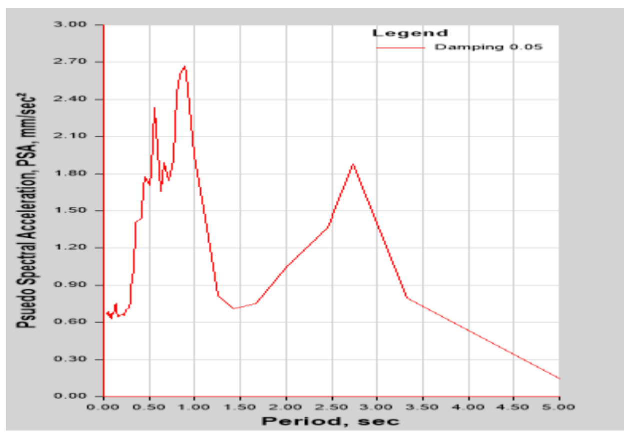
When the ground shakes, the base of a building moves with the ground, and the building swings back and forth motion.The time taken (in seconds) for each complete cycle of oscillation is Fundamental Natural Period of the building. The results obtained in analysis by using Etabs are shown below:



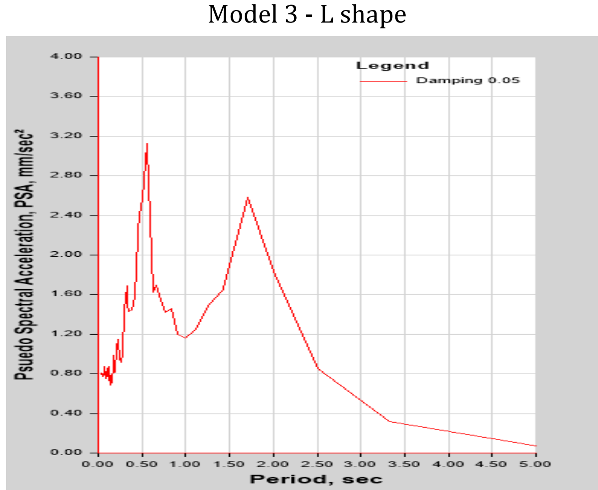
Model 1 - + shape



Model 2 - C shape



Model 3 - L shape



Model 4 - Square shape

Fig 9-Fundamental Natural period (G+11) storey for different shapes of buildings

For G+11 Storey structure Fundamental Natural Period can be obtained From above graphs, similarly for G+14 structures Fundamental Natural Period is obtained and shown in table below,

Table 4: Fundamental Natural Period in sec

MODEL	NATURAL PERIOD	
	G+11	G+14
1	1.3	2.51
2	5.4	4
3	1	1
3	0.8	1

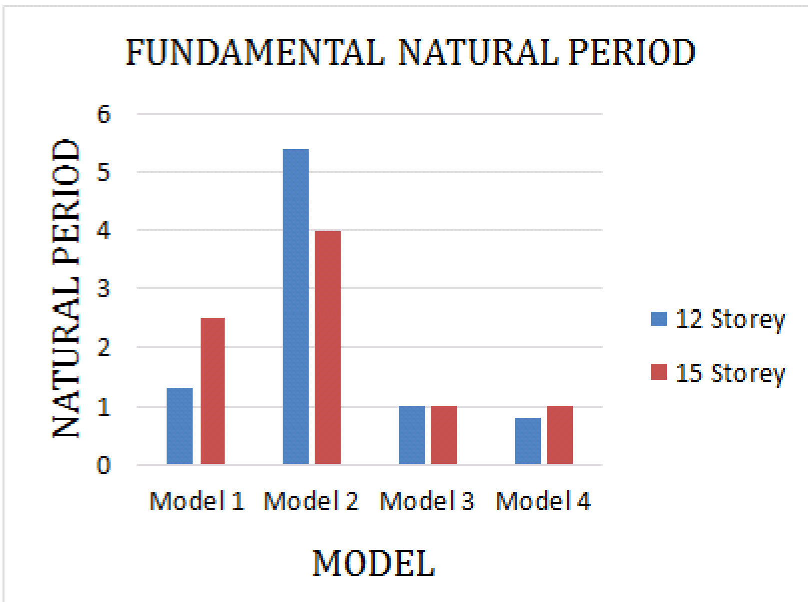


Fig 10- Fundamental Natural Period of G+11 & G+14 structure for different shapes of building

Results of analysis are discussed in terms of parameters such as story drift, overturning moment and natural period.

- Storey Drift gradually increases at the base then maximum at the middle of the storey & minimum at the top of the storey.
- Storey overturning moments is maximum near the base and 1st storey of structure and gradually decreases to top of structure. There are two types of overturning moments, positive and negative, considered in designing.
- For damping of 5%, natural period increases as the acceleration increases.
- The natural period is more in Irregular buildings as compare to regular building of square shape.
- It is observed that, for G+11 structure storey drift is less than that for G+14 structure.
- The storey drift is more in Irregular buildings as compare to regular building for both G+11 & G+14 structure.
- The storey overturning moment is more in irregular buildings as compare to regular building.

- As compared to regular building ,irregular structural configurations are affected severely during earthquakes especially in high seismic zones.

4. CONCLUSIONS

- The story drift is more at the bottom & less at the top.
- The storey overturning moment increases at the bottom and decrease at the top.
- In this, the analytical method give more accurate results as the time period is calculated on the basis of mass and stiffness of the building.
- The results obtained from time history analysis are accurate, when compared with results of equivalent static method, since the method is based only on empirical formula.
- The results of fundamental natural periods have proved that, the code IS 1893:2002 doesn't consider the irregularity of buildings
- Irregular structural configurations are affected severely during earthquakes especially in high seismic zones.
- The performance of model C and L was more vulnerable to earthquake than rest of the models for G+11 & G+14 structures.

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