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ANALYSIS ON SEISMIC PERFORMANCE OF HIGH RISE IRREGULAR RC FRAMED BUILDINGS

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Abstract -In the modern world many buildings have irregular configurations both in elevation and plan. Such types of buildings are more susceptible in earthquake forces. Structural irregularities are more important factors which decrease the seismic behavior of the structures. During recent earthquakes, the structures have been seriously damaged or destroyed and hence question has been raised against the seismic adequacy of existing building. During earthquake, the behavior of the building depends heavily on the size, shape and geometry.

In this project the four RCC buildings with different plan shape (+, C, L,Square) having same storey (G+19) is considered for analysis. The time history analysismethod has been used to evaluate seismic performance of building. The analysis is carried out using Etabs.This method determines displacement, base shear and natural period. For C shape building the displacement value is higher than other shapes and it is the most vulnerable building among the other building.

***Key Words*:**Irregular Buildings,Time History Analysis,Storey Displacement,Storey Shear,Natural Period

1.INTRODUCTION

Earthquakes are the most unpredictable and devastating of all natural disasters, which are very difficult to save over engineering properties and life, against it. Hence in order to overcome these issues we need to identify the seismic performance of the built environment through the development of various analytical procedures, which ensure the structures to withstand during frequent minor earthquakes and produce enough caution whenever subjected to major earthquake events. So that can save as many lives as possible. There are several guidelines all over the world which has been repeatedly updating on this topic. The analysis procedure quantifying the earthquake forces and its demand depending on the importance and cost, the method of analyzing the structure varies from linear to non linear. The behaviour of a building during an earthquake depends on several factors, stiffness, adequate lateral strength, ductility, simple and regular configurations.

For a structure to perform well in earthquake, the structure should possess four main attributes, namely simple and regular configuration, adequate lateral strength, stiffness and ductility.But nowadays, with the advancement in rapid growth of urbanization and for aesthetic purpose buildings with irregular structural configurations are widely constructed. These configurations in buildings leads to non-uniform distributions in their masses, stiffness and strength therefore they are prone to damage during earthquakes. Hence in present study an attempt has been made to study the behaviour of such structures located in severe seismic zone.The buildings with regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation suffer much less damage compared to irregular configurations. But nowadays need and demand of the latest generation and growing population has made the architects or engineers inevitable towards planning of irregular configurations.

1.1 Objective of study

1) To analyze a multistoried RC framed four irregular shape i.e. a) Regular Shape, b) C Shape, c) L Shape, d) + Shapes of building for 20 Storey.

2)To obtain the Seismic performances of different irregular buildings located in severe earthquake zone (V) of India, and also identify the most vulnerable building among them.

3) To compare behavior of multistoried RC framed G+19 building for earthquake intensity by time history analysis in

terms of various responses such as maximum storey displacements,maximum story shear andnatural period.

2.PROBLEM STATEMENT

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 20 storey with different irregular configurations. The storey height is uniform throughout for all the building models considered for analysis. The software used for analysis of the frame models is ETABS by using Time History Analysis

2.1Geometric Properties of Building Frame

1. Number of stories: 20 Storey
2. Seismic zone: V
3. Floor height: 3 m
4. Grade of concrete: 30 Mpa
5. Grade of steel: Fe500
6. Size of columns: 450mm x 850mm
7. Size of beams: 350mm x 650mm
8. Depth of slab: 150mm
9. Dead load: 1.5 Kn/m2
10. Imposed load: 3 Kn/m2
11. Roof finish: 1.0 KN/m2
12. Floor finish: 1.0 KN/m2
13. Importance factor: 1
14. Response reduction factor: 5

2.2 Methodology:-

1. Modelling of structure in Etabs. Defining Material properties for concrete and Reinforcement bars.

2. Defining Section properties to all sections of proper size with proper properties.

3. Assign links as per requirement of damper or base isolation or bracing. Assign supports to structure.

4. Define mass source.

5. Define and Assign Loads to respective members.

6. Define time history function. Use proper time history data with required number of steps. Assign time history function in load cases.

7. Checking the Model. Then performing analysis on model.

8. Obtain required parameters like maximum storey displacement, maximum base shear and natural period.

MODELLING

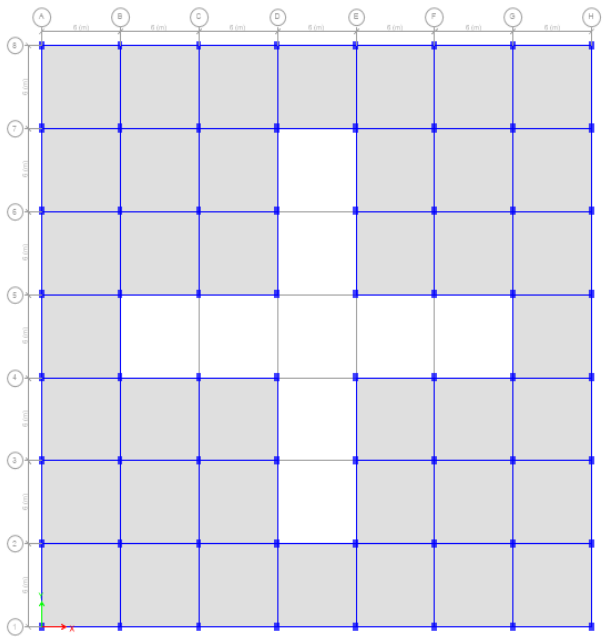

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Figure 1 : Model 1 - + shape

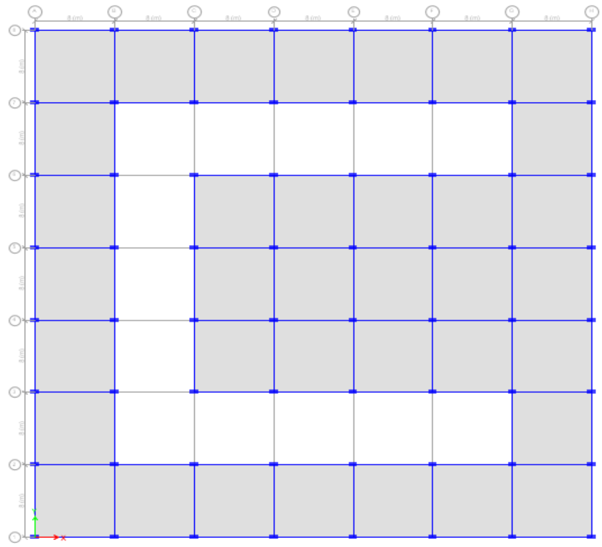

Figure 2 : Model 2 - C shape

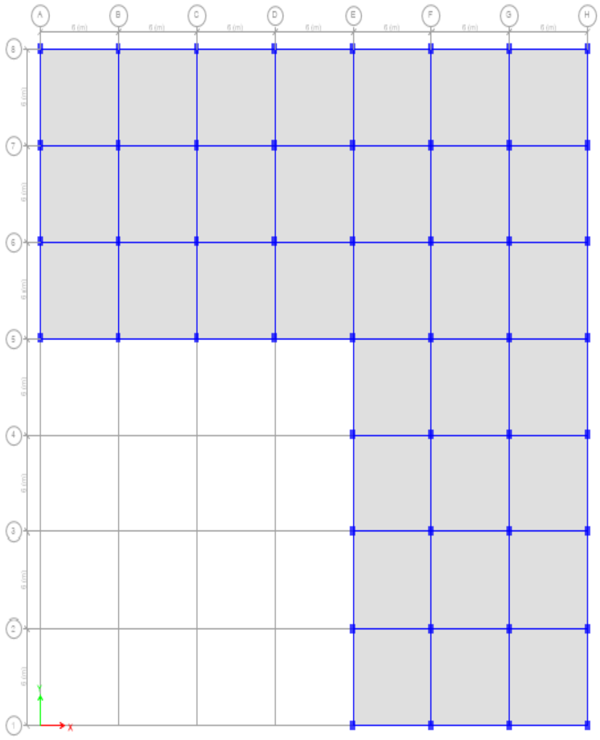

Figure 3 : Model 3 - L shape

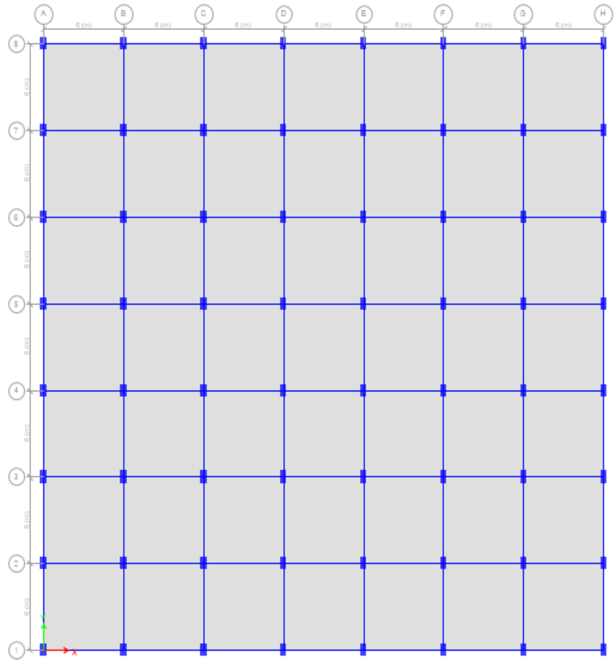

Figure 4 : Model 4 - Square shape

2.3 Analysis Methods

Analysis methods used in this present study are broadly classified as

1. Equivalent static method
2. Time History Analysis

2.3.1Equivalent Static Method

Equivalent static method of analysis is a linear static procedure, in which the response of building is assumed as linearly elastic manner. The analysis is carried out as per IS1893-2002 (Part 1). This procedure does not require dynamic analysis, however, it account for the dynamics of building in an approximate manner. The static method is the simplest one-it requires less computational efforts and is based on formulate given in the code of practice. First, the design base shear is computed for the whole building, and it is then distributed along the height of the building. The lateral forces at each floor levels thus obtained are distributed to individuals lateral load resisting elements.

2.3.2 Time History Analysis

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Time-history analysis provides for linear or nonlinear evaluation of dynamic structural response under loading which may vary according to the specified time function.

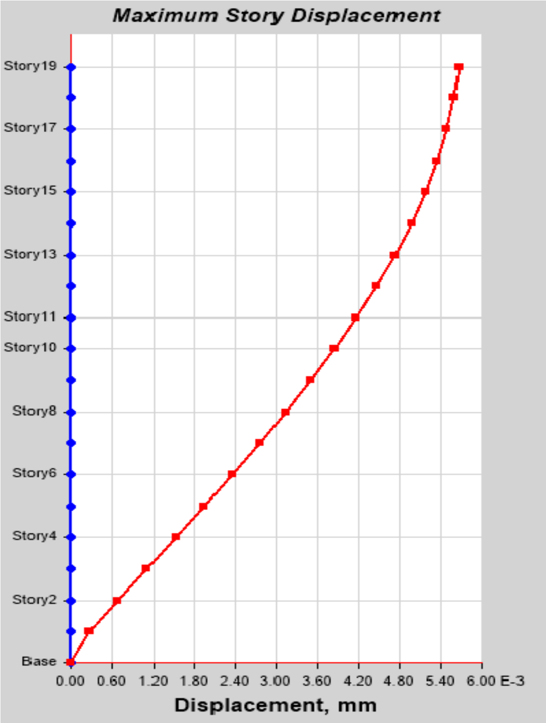
Time Functions:

A description is as follows:

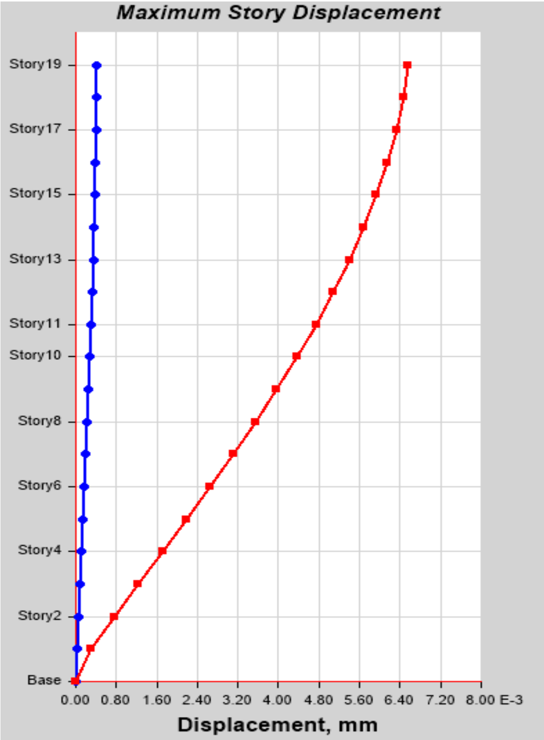
- **Linear cases** always start from zero, therefore the corresponding time function must also start from zero.
- **Nonlinear cases** may either start from zero or may continue from a previous case. When starting from zero, the time function is simply defined to start with a zero value. When analysis continues from a previous case, it is assumed that the time function also continues relative to its starting value

3. RESULT & DISCUSSION

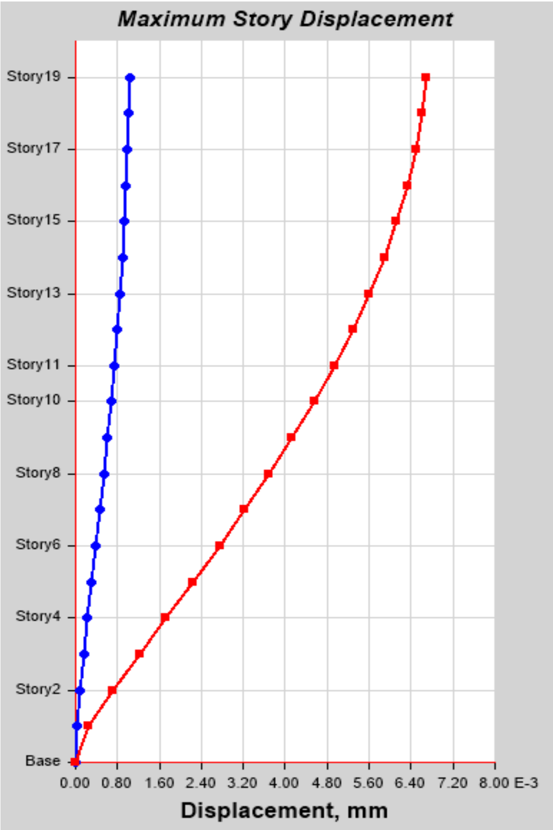
3.1MAXIMUM DISPLACEMENT: Total displacement of any storey is with respect to ground and there is maximum permissible limit as per IS codes.The result obtain in Etabs are given below:



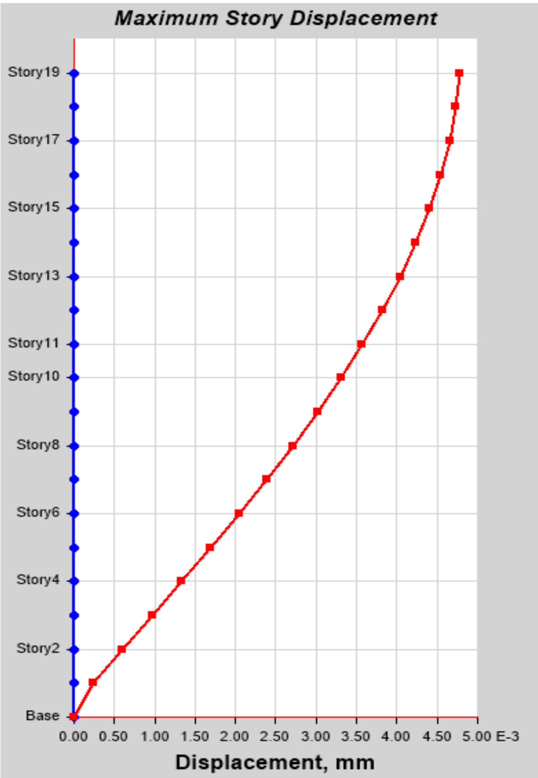
Model 1 - + shape



Model 2 - C shape



Model 3 - L shape



Model 4 - Square shape

Fig 5 : Max. Storey Disp for G+19 Storey of Different Shapes of Building

After analysing the graphs we get the maximum displacement for different models at G +19 Storey of Building as shown in table:

MODELS	DISPLACEMENT
1	5.8
2	7.0
3	6.5
4	4.8

Table 1: Maximum Storey Displacement (in mm)

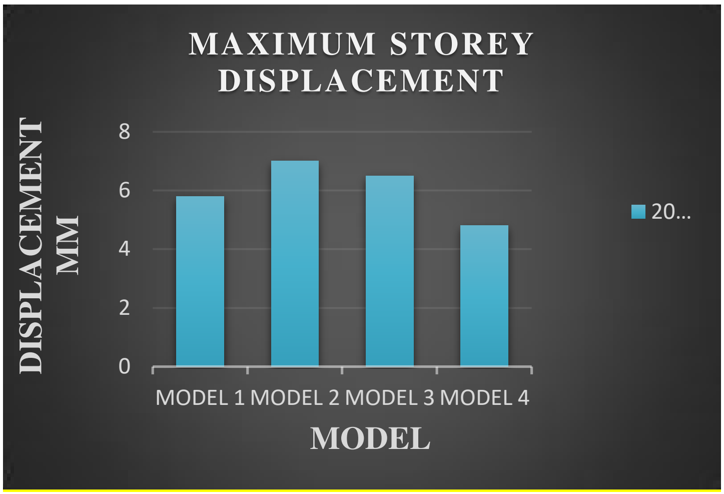
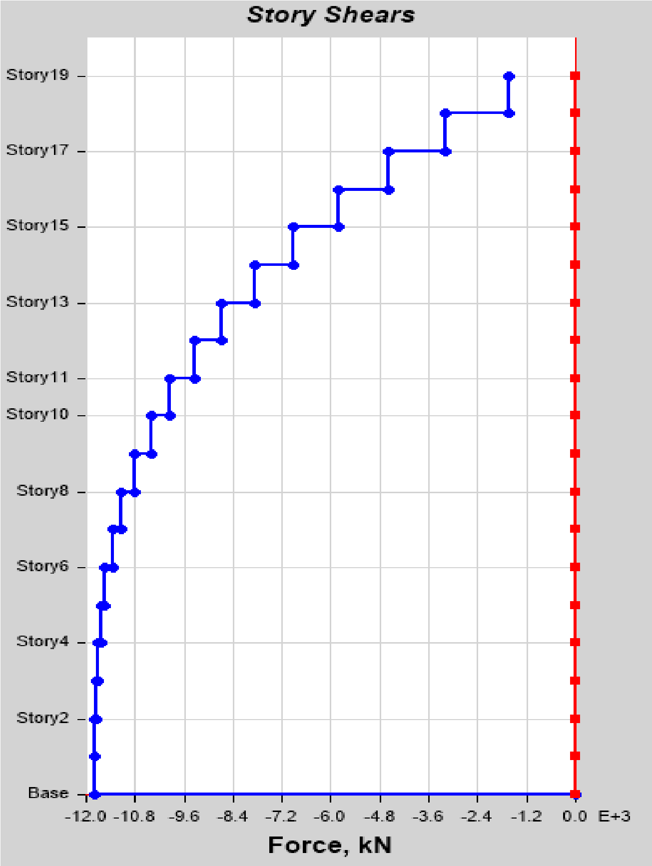


Figure 6 : Variation of maximum storeydisplacement for different model

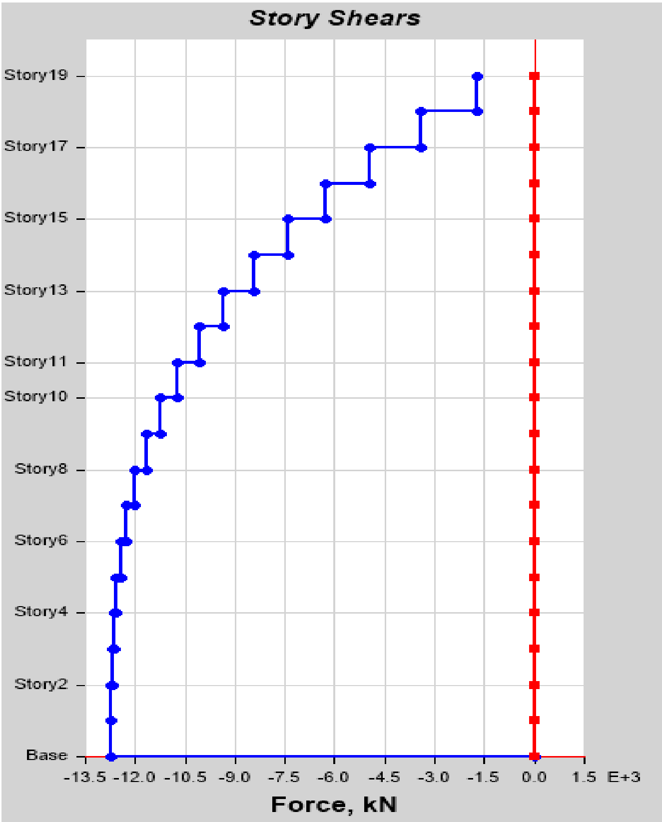
From above charts and graphs, we can clearly observe that,

- Storey displacement is minimum near the base of structure and gradually increases to top of structure.
- When comparing static and dynamic method the magnitude of displacement is more in static as the response of the building is assumed to behave in a linear elastic manner. Hence the results are more accurate in nonlinear dynamic analysis.
- The displacement is more in Irregular buildings as compare to regular building.

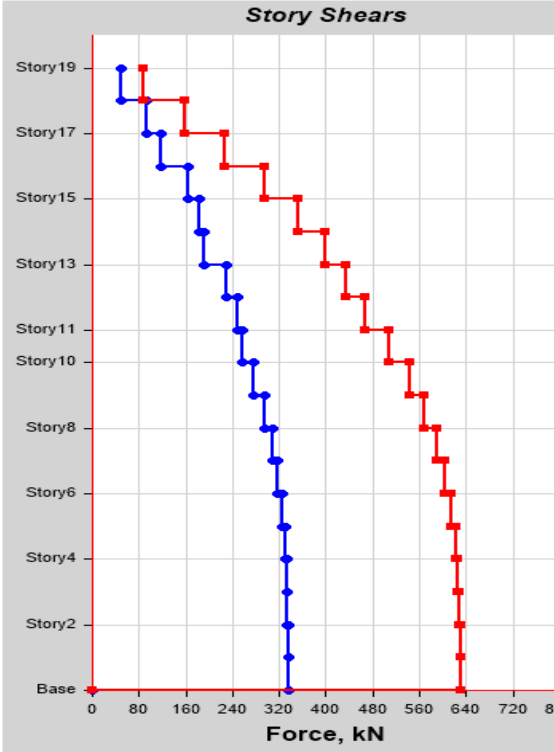
3.2 MAXIMUM STOREY SHEAR: The design seismic force to be applied at each floor level is called storey shear.The result obtain in Etabs are given below:



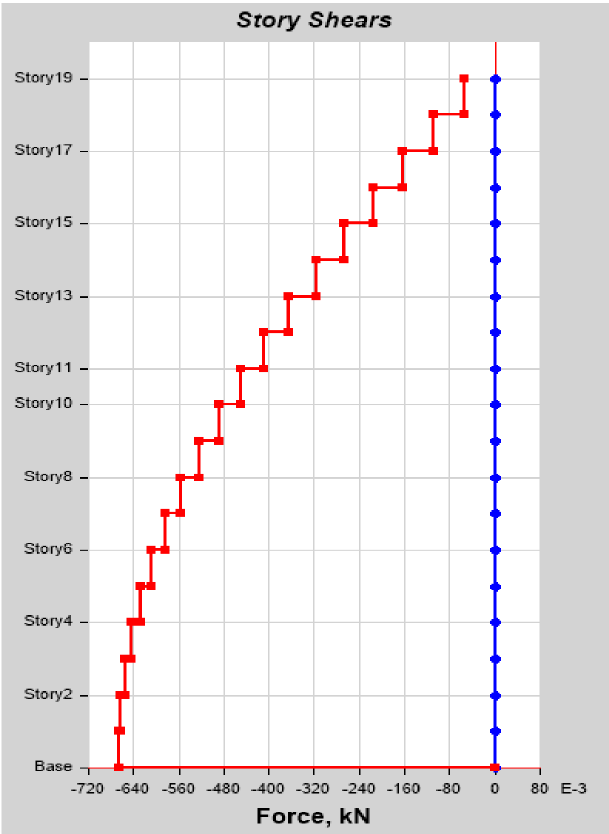
Model 1 - + shape



Model 2 - C shape



Model 3 - L shape



Model 4 - Square shape

Fig 7 : Max Storey Shear for G+19 Storey of Different Shapes of Building

After analysing the graphs we get the maximum storey shear for different models at G +19 Storey of Building is shown as

Table 2: Maximum Storey Shear (in kN)

MODELS	Storey Shear
1	1500
2	2000
3	1000
4	800

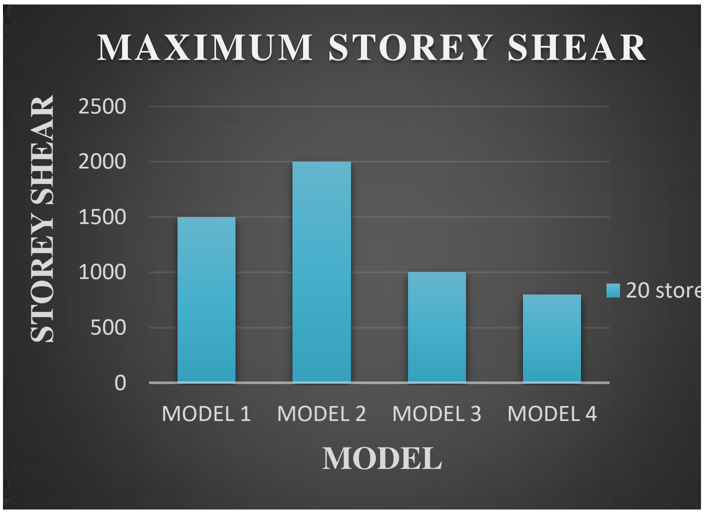


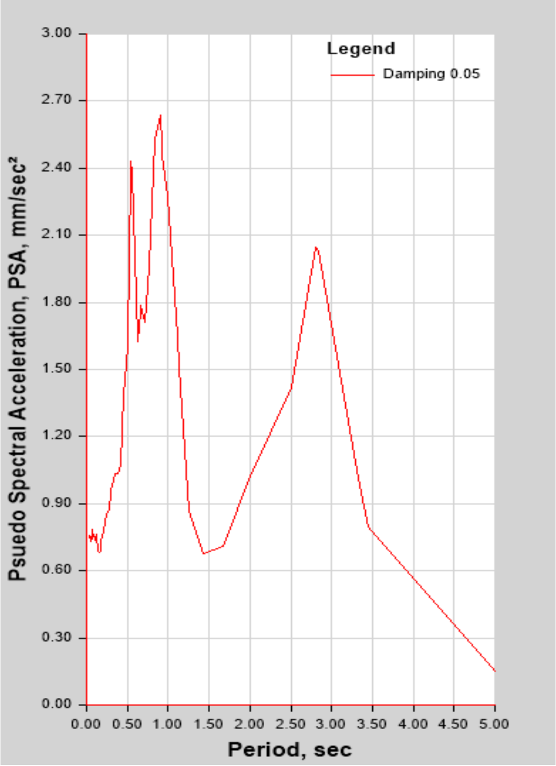
Figure 8 : Variation of MaximumStorey shear for different model

From above charts and graphs, we can clearly observe that,

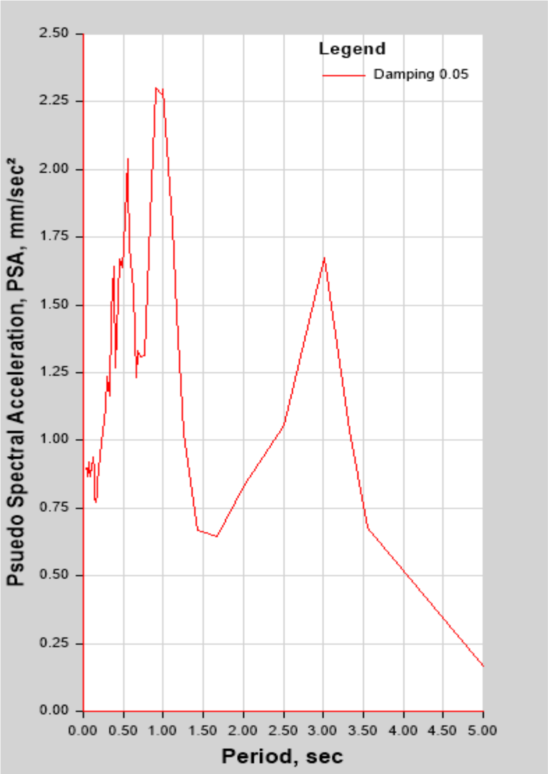
- Storey shear is maximum near the base of structure and gradually decreases to top of structure.
- The storey shear is more in Irregular buildings as compare to regular building.

It is observed that comparing all the models with regular model (4), it is seen that model 2 (C shaped) has the maximum variation.

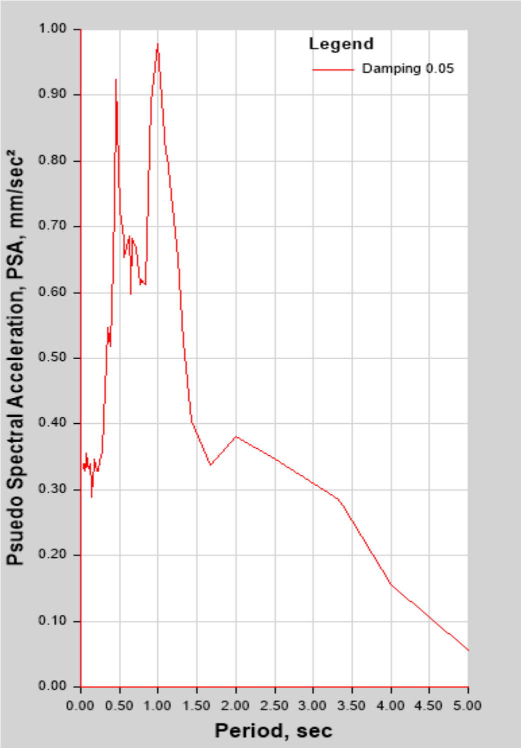
3.3 NATURAL PERIOD: Natural Period is the time taken (in seconds) for each complete cycle of oscillation.The result obtained in Etabs are given below:



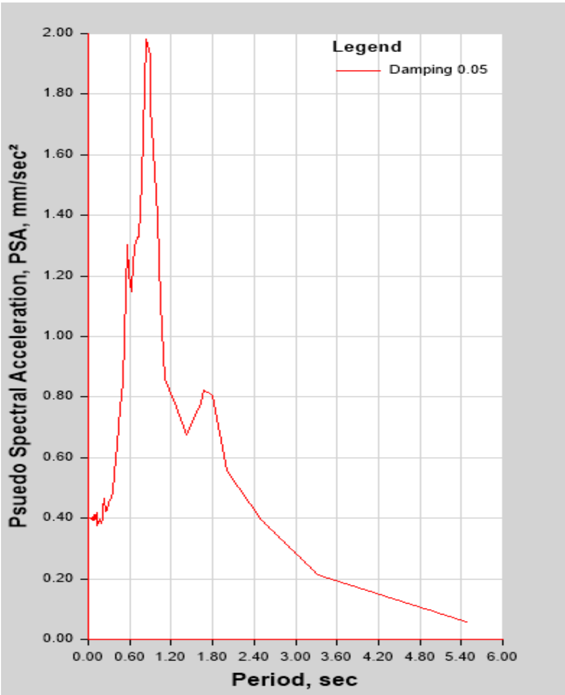
Model 1 - + shape



Model 2 - C shape



Model 4 - Square shape



Model 3 - L shape

Fig 9 : Natural Period for G+19 Storey of Different Shapes of Building

After analysising the graphs we get the Natural Period for different models at G +19 Storey of Building as shown in table:

MODELS	Natural Period
1	2.6
2	3
3	2.0
4	1.0

Table 3: Maximum Natural Period (in sec)

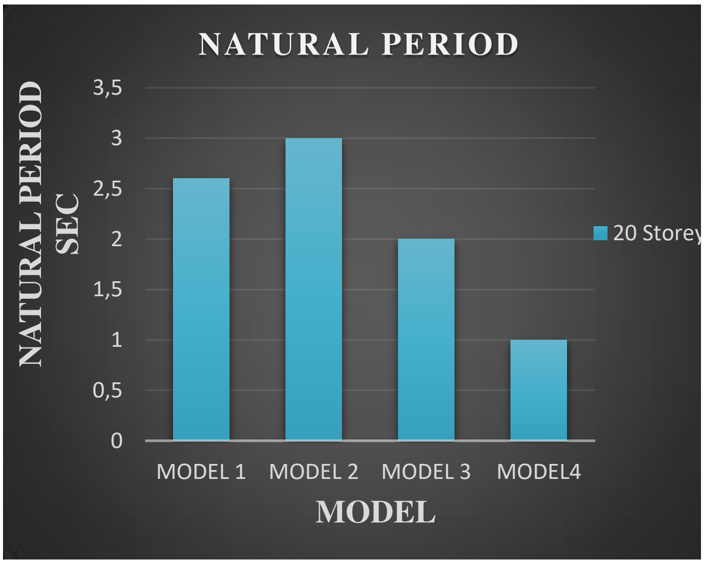


Figure 10: Variation of natural periodfor different model

From above charts and graphs, we can clearly observe that,

- Natural Period decreases as the acceleration increases for damping of 5%.
- The Natural Period is more in Irregular buildings as compare to regular building.
- 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.

4. CONCLUSIONS

In this project from the analysis of Irregular Building (G+19 storey) the following conclusions are observed that

- The maximum storey displacement is minimum near the base of structure and gradually increases to top of structure.
- The maximum Storey shear decreases with increase in storey level.
- The natural period decreases as the acceleration increases for each storey.
- 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 performance of model C was more vulnerable to earthquake than rest of the models.
- The irregular building takes more period than that of regular building.
- As compared to regular building ,irregular structural configurations are affected severely during earthquakes especially in high seismic zones.

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