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# Dynamic Response Characteristics of RC buildings with different Horizontal Irregularities in zone III

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**ABSTRACT:** This research paper is about to study and understand various seismic responses of RC framed regular and horizontal irregular structures. Irregular building construction have been rapidly increased in these days due to its better aesthetic appearance, irregular land aspects and for better connectivity. Now a days according to people mind set architectural aspect of building got more attention than structural safety of building. So, it's important to study and understand the seismic behavior of irregular buildings. The main factor of failure of irregular building is its unsymmetrical plans, re-entrant corners, discontinuities in diaphragm of building etc. In the present study, single parameter to quantify mass, stiffness and strength irregularity in terms of both magnitude and location is proposed on the basis of the dynamic characteristic of the building. In all the studied systems is chosen for analysis and studying its effect of different irregularities in which analysis is based on the variation of displacement, storey drift, storey shear, corner stresses with respect to structural systems. The work describes to the irregular plan geometric forms that are T-section, L-section, U-section. These Regular and Irregular plans were modelled in ETABS.

**KEYWORDS:** RESPONSE SPECTRUM ANALYSIS, STOREY DRIFT, STOREY SHEAR, STOREY DISPLACEMENT, STOREY STIFFNESS, CORNER STRESSES.

## I. INTRODUCTION

A large portion of modern urban infrastructure is made up of buildings with structural irregularities. While often desired by owners for their unique attribute, these irregular structures have architectural and aesthetic considerations which often require irregularities in mass, strength, stiffness, or structural form. Through the study of these structures performance during earthquakes, it has also been found that irregular structures exhibit significantly different behaviour than their regular counterparts during seismic activity. The determination of the fundamental period of vibration of structures is essential to earthquake design and assessment. A reasonably accurate estimation of the fundamental period in such irregular structures is necessary in both response- spectrum and static earthquake analysis of structures. An accurate estimation would allow for an improved estimation of the global seismic demands on an irregular structure. As such, the goal of this research is to investigate the accuracy of existing code based equations for estimation of the fundamental period of irregular building structures and provide suggestions to improve their accuracy.

1. To perform a parametric study of the fundamental period of different types of structures, L-Shaped, T-Shaped, U-Shaped in terms of number of stories, number of bays, configuration, and types of irregularity.
2. Types of irregular structures are examined in this study: Structures with re-entrant corner irregularity (horizontal irregularity), and Also examined is the regular counterpart of each irregular structure. Each structure is designed and analyzed using the program ETABS v.18.0.2.

**1.1 INTRODUCTION TO ETAB:** ETABS is the ultimate integrated software package for the structural analysis and design of buildings. ETABS offers a single user interface to perform modelling, analysis, design and reporting. There is no limit to the number of model windows, model manipulation views, and data views. ETABS has a wide selection of templates for starting a new model quickly. At this model template stage, one can have the ability to define grid and grid spacing, the number of stories, the default structural system sections, default slab and drop panel sections, and uniform loads (specifically dead and live loads). One of the most powerful features that ETABS offers is the recognition of story levels, allowing for the input of building data in a logical and convenient manner. The designer can define the models on a floor-by-floor, story-by-

story basis, analogous to the way a designer works when laying out building drawings.

ETABS has a built-in library of standard concrete, steel, and composite section properties of both US and International Standard sections. "Section Designer" is an integrated utility built into ETABS that enables the modelling and analysis of custom cross sections. Design of steel frames, concrete frames, concrete slabs, concrete shear walls, composite beams, composite columns and steel joists can be performed based on a variety of international design codes. Users can view moment diagrams, load assignments, deflected shapes, design output and reports all in a single screen. The output tables have been enhanced to tabulate the demand-capacity ratio (D/C ratio) for the whole model, as well as for each object individually. Finalized member design, deformed geometry, moment, shear, and axial-force diagrams, section-cut response displays, and animation of time-dependent displacements outline a few of the graphics available upon conclusion of analysis.

## **1.2 METHODS OF SEISMIC ANALYSIS:**

The seismic analysis method can be divided into linear methods (linear static or equivalent force method and Linear Dynamic Response Spectrum method) and nonlinear methods (Nonlinear static method or pushover analysis and nonlinear dynamic or Time history method).

### **I. EQUIVALENT STATIC ANALYSIS METHOD**

Static analysis is a linear analysis method. In the equivalent static method, the lateral force equivalent to the design basis earthquake is applied statically. The Equivalent lateral forces at each floor are applied to the design centre of mass.

### **II. RESPONSE SPECTRUM METHOD**

Response-spectrum analysis determines the statistically-likely response of a structure to seismic loading. This linear type of analysis uses response-spectrum ground-acceleration records based on the seismic load and site conditions, rather than time-history ground motion records. This method is extremely efficient and takes into account the dynamical behavior of the structure. In order to perform the seismic analysis and design of a structure to be built at a particular location, the actual time history record is required. However, it is not possible to have such records at each and every location. Further, the seismic analysis of structures cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational

cannot be carried out simply based on the peak value of the ground acceleration as the response of the structure depend upon the frequency content of ground motion and its own dynamic properties. To overcome the above difficulties, earthquake response spectrum is the most popular tool in the seismic analysis of structures. There are computational advantages in using the response spectrum method of seismic analysis for prediction of displacements and member forces in structural system

## **II.OBJECTIVES**

1. The goal of this research is to investigate various seismic responses of RC framed regular and horizontal Re-entrant corner irregular structure.
2. Creation of 3-D Building regular model for both elastic and inelastic method of analysis
3. Comparison between regular and various horizontal irregular frame on the basis of shear force, bending moment, storey drift & node displacement etc.
4. To compare the performance of building with L-shape, T-shape and U-shape and propose the best suitable building configuration

## **III.METHODOLOGY**

It is an attempt to investigate the effect of irregular plan configuration for multistorey reinforced concrete building model. This project mainly emphasizes on analysis of a multistorey building (G+9) which is irregular in plan. Modelling of 10 storeys R.C.C. building will be done on the ETABS 2018 Software for analysis. The analysis of structures such as Maximum Storey displacement, Base Shear & Storey Drift. A reduced-order model of the system dynamics. Experimental results show dynamic behaviour under various operating and environmental conditions and demonstrate advantages of adaptive control over the non-adaptive type.

Here the Study is carried out for the behavior of G+9 Multistorey Buildings, Floor height provided as 3.5m and also the properties are defined for the building structure. The model of the buildings is created in ETABS Software. The Seismic Zone considered is Zone III and soil type is medium. The modeling of Building is done for the Indian seismic zone III, IS 1893-2002 for the given structure, loading with the applied loads includes Live load, Earthquake Load and Dead load. Analysis is

carried out by the Response spectrum analysis using ETABs software. The analysis is carried out to determine maximum storey displacement, storey drift and base shear. After analysis, results are obtained in the form of graphs which are in turn observed to form conclusion.

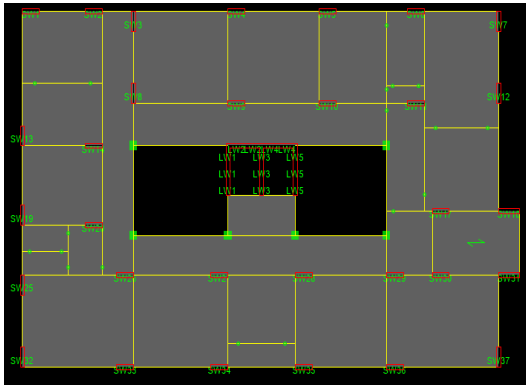
#### IV.PROBLEM STATEMENT

The building considered here is a Commercial building Having G + 10 storied located in seismic zone III and for earthquake loading, the provisions of the IS:1893(Part1)- 2002 is considered. The plan of building is shown in figure. The plan dimension of the building is 29.21 m X 17.73 m. Height of each storey is 3m. This study is conducted to understand the structural behavior of plan irregular building in comparison to regular building under seismic loading. It is recommended that for analysis of plan irregular building dynamic analysis need to be carried out, equivalent static method being more suitable for regular buildings. Hence response spectrum method of dynamic is chosen for analysis by utilizing software 2018.

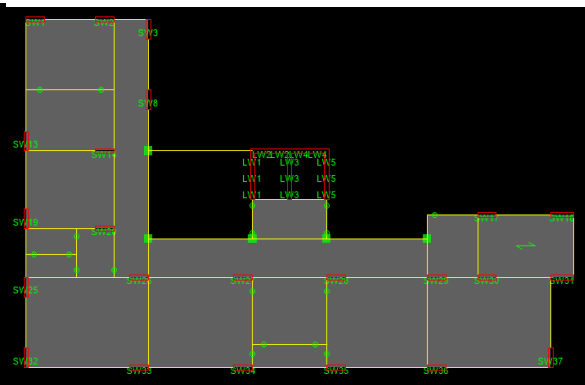
PARAMETERS	VALUE
No. of stories	10
Total height of building	30.25 m
Floor Area	518 m <sup>2</sup>
Dimension of Beam	200 X 600
Dimension of Column	450 X 450 600 X 600
Importance Factor	1.2
Thickness of Slab	125mm
Grade of Concrete	M30
Grade of Steel	Fe500
Response Reduction Factor	4
Live load	3 KN/m <sup>2</sup>
Floor Finish	1.5 KN/m <sup>2</sup>
Zone Factor	0.16
Damping Ratio	5%



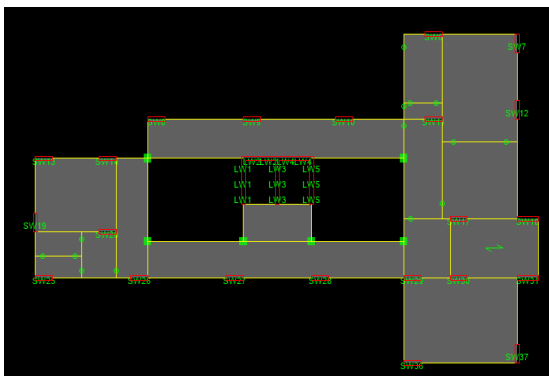
#### 4.1 Modeling of different buildings in ETABS Software.



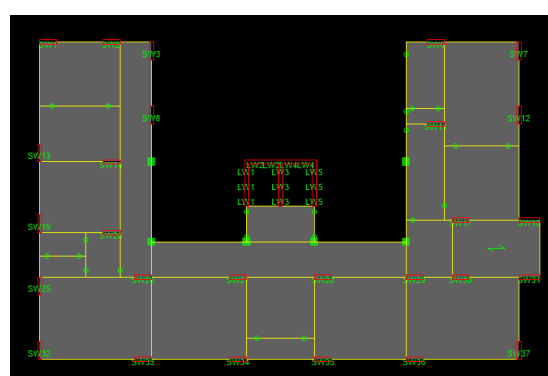
**Fig.no.1:** Plan view of G+9 RC Regular building.



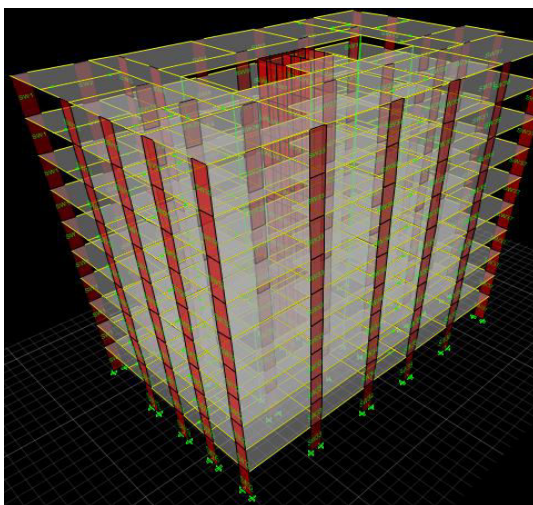
**Fig.no.2:** Plan view of G+9 RCL-shape building.



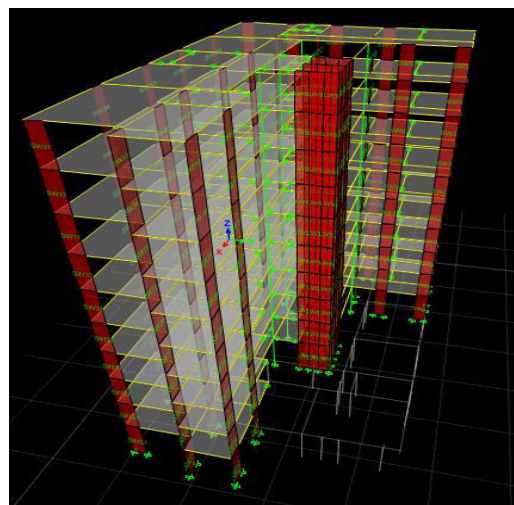
**Fig.no.3:** Plan view of G+9 RC T-Shape building.



**Fig.no.4:** Plan view of G+9 RC U-Shape building.



**Fig.no.5:** 3D view of G+9 RC Regular building.



**Fig.no.6:** 3D view of G+9 RC L-shape building.

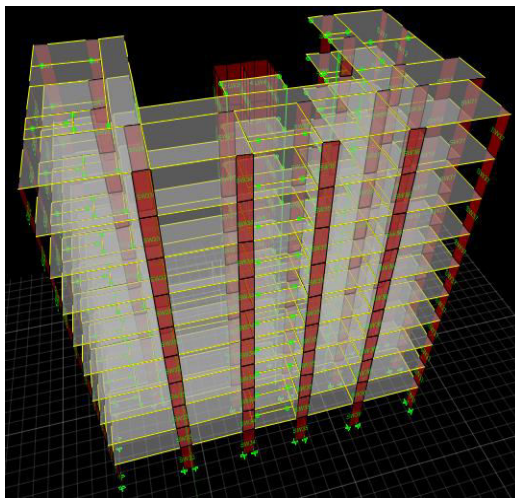


Fig.no.7:3DviewofG+9 RC U-shape building.

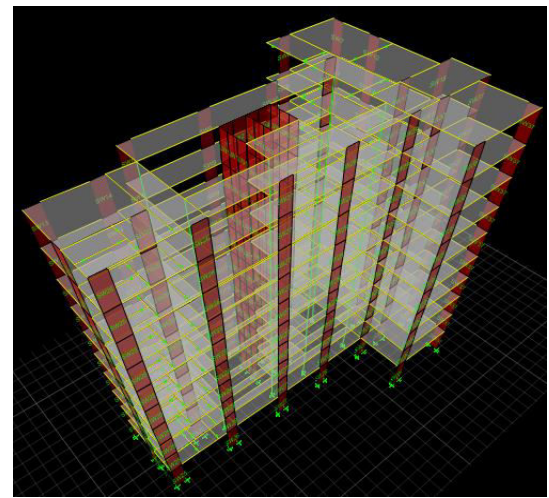


Fig.no.8:3DviewofG+9 RC T-shape building.

## V. SOFTWARE RESULTS

Tableno2:Storey Displacement

TABLE: STOREY DISPLACEMENT				
storey	symmetric	L shape	U shape	T shape
	mm	mm	mm	mm
10	18.444	21.524	18.396	14.806
9	17.269	20.021	17.242	13.839
8	15.777	18.122	15.769	12.627
7	14.029	15.92	14.023	11.206
6	12.1	13.556	12.09	9.636
5	10.033	11.108	10.028	7.958
4	7.863	8.626	7.873	6.208
3	5.64	6.159	5.665	4.431
2	3.433	3.75	3.461	2.684
1(G)	1.326	1.453	1.342	1.032
Base	0	0	0	0

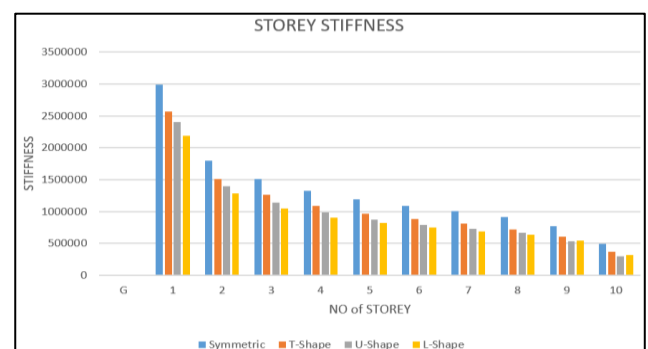
Fig.no.9: Graph of Storey Displacement



Tableno3:Storey Stiffness

TABLE: STOREY STIFFNESS				
	Symmetric	T-Shape	U-Shape	L-Shape
	KN/m2	KN/m2	KN/m2	KN/m2
10	497688.224	370632.028	303166.158	319273.587
9	772599.017	601261.077	538302.751	549272.342
8	915449.98	724100.834	672815.92	633351.671
7	1003832.383	808922.554	726923.581	691022.816
6	1085655.898	881422.674	787758.511	750267.583
5	1187662.118	969506.599	872846.674	820687.795
4	1321752.975	1090825.733	987687.016	905906.511
3	1513603.406	1263206.537	1142267.688	1047233.216
2	1800735.539	1514635.991	1392905.266	1279262.255
1	2986863.459	2570879.676	2398874.703	2187662.31
G	0	0	0	0

Fig.no.10: Graph of Storey Stiffness



STOREY	TABLE: STOREY SHEAR			
	Symmetric	T-Shape	U-Shape	L-Shape
	KN	KN	KN	KN
10	325.1895	224.8159	242.6731	232.143
9	645.9864	449.7092	487.217	455.7192
8	886.7736	629.4975	672.1145	627.3752
7	1067.0135	769.3834	809.655	756.6584
6	1216.698	882.4154	922.6097	863.3789
5	1354.4543	983.1105	1026.0316	961.7031
4	1483.4849	1078.3514	1123.28	1052.863
3	1604.1844	1162.0662	1215.5217	1134.7795
2	1704.2317	1221.9663	1290.8822	1202.102
1	1752.1928	1267.0152	1342.4429	1244.5225
G	0	0	0	0

Tableno4:Storey Shear.

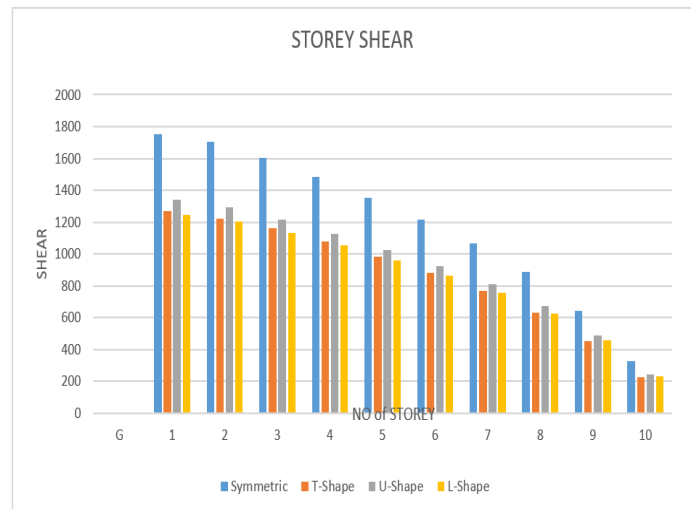


Fig.no.11: Graph of Storey Shear

## VI. MANUAL CALCULATIONS

### Base shear of symmetric building:

$V_b = A_h \times W$  Where,

$$A_h = \frac{Z I S_a}{2 R g} = (0.16 \times 1.2 \times 1.5) / (2 \times 5) = 0.0288$$

W=Total Seismic Weight

$$V_b = A_h \times W = 0.0288 \times 52392.7 = 1508.909 \text{ KN}$$

### Base shear of L-shape building:

$V_b = A_h \times W$  Where,

$$A_h = \frac{Z I S_a}{2 R g} = (0.16 \times 1.2 \times 1.5) / (2 \times 5) = 0.0288$$

W=Total Seismic Weight

$$V_b = A_h \times W = 0.0288 \times 44321.2 = 1276.45 \text{ KN}$$

### Base shear of U-shape building:

$V_b = A_h \times W$  Where,

$$A_h = \frac{Z I S_a}{2 R g} = (0.16 \times 1.2 \times 1.5) / (2 \times 5) = 0.0288$$

W=Total Seismic Weight

$$V_b = A_h \times W = 0.0288 \times 45798.77 = 1319.004 \text{ KN}$$

#### Base shear of T-shape building:

$V_b = A_h \times W$  Where,

$$A_h = \frac{Z I S_a}{2 R g} = (0.16 \times 1.2 \times 1.5) / (2 \times 5) = 0.0288$$

W=Total Seismic Weight

$$V_b = A_h \times W = 0.0288 \times 43194.51 = 1244.001 \text{ KN}$$

### VI. CONCLUSIONS

5. From the analysis of RSA for both Plan Regular & Irregular Building Storey Stiffness and Storey Shear is maximum for Plan regular building compare to plan irregular building..
6. Storey Displacement is maximum for L-shape Building Compare to other Irregular Buildings.
7. In regular Building reduction in displacement is due to Infill action because of the lateral stiffness of frame.
8. As the Plan Irregularity Increases Storey Stiffness Decreases.
9. As the Plan Irregularity Increases Base Shear decreases and Increases In Plan Regular Building.

### VII. ACKNOWLEDGEMENT

I AM VERY THANKFUL TO PROF. S.M. KAZI MY ADVISOR AND GUIDE, FOR MOTIVATION, GUIDANCE AND PATIENCE THROUGHOUT THE WORK . I AM VERY MUCH THANKFUL FOR HIS VALUEABLE GUIDANCE AND ENCOURAGEMENT THROUGHOUT THE COMPLETION OF MY WORK.

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