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"ANALYSE THE 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, irregularly and aspects and for better connectivity. Now a days according to people mindset 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 buildingetc.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 modeled 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 behavior than the irregular 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 ETABSv.18.0.2.

1.1 Introduction to ETAB

ETABS is the ultimate integrated software package for the structural analysis and design of buildings.

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ETABS offers a single user interface toper form 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 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.

2. 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 in to 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 systems.

1.3 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 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.

2. Literature Review

[1].Georgoussis,G.,Tsompanos, A.,& Makarios,T.Approximate seismic analysis of multistory buildings with mass and stiffness irregularities.ProcediaEngineering,125,(2015) 959-966 .This methodology is based on South well's formula and the concept of the equivalent single story system. This has been introduced by the authors in earlier papers for assessing the response of uniform along the height of buildings. At present, the accuracy of this procedure is examined in asymmetric tall buildings with a mass or stiffness irregularity. As basic data of the dynamic response of elastic multi-story building systems can be derived by analyzing simple (equivalent) single story systems, a structural layout of minimum elastic torsional response can easily be constructed. The behavior of such structural configurations, which is basically translational in the elastic phase, is also examined in the post elastic phase when the strength assignment of the various bents is stiffness proportional.

[2].DeStefano,Mario,Edoardo Michele Marino, and Pier Paolo Rossi."Effect of over strength on the seismic behavior of multi storey regularly a symmetric buildings. "Bulletin of Earthquake Engineering4,no.1(2006):23-42In past years, seismic response of asymmetric structures has been frequently analysed by means of single-storey models, because of their simplicity and low computational cost. However, it is widely believed that use of more realistic multi-storey models is needed in order to investigate effects of some system characteristics (such as over strength, higher modes of vibration, etc.) that make behaviour of multi-storey schemes different from that of single-storey systems. This paper examines effects of the over strength in element cross-sections on the seismic behavior of multi-storey asymmetric buildings. It is shown that in actual buildings this characteristic, which is sometimes very variable both in plan and along the height of the building, may lead to distributions of ductility demands different from those expected according to the results from single-storey models. Consequently, torsional provisions, which aim at reducing ductility demands of single-storey asymmetric systems to those of the corresponding torsionally balanced systems, should be re-checked in light of the behaviour of realistic multi-storey buildings

[3]Albert Philip and Dr. S. Elavenil, Seismic Analysis of High Rise Buildings the Plan Irregularity. International Journal of Civil Engineering andTechnology,8(4),2017,pp.
1365–1375. A high rise building has to be designed to resist lateral loads due to wind or earthquake. Interior structural system or exterior structural system provides the lateral load resistance to the structure. The shape, structure and material used also influence the behaviour of structure against lateral loading. In this study three dimensional analytical models of G+12 storied buildings have been generated for regular and irregular buildings and analysed using CSI ETABS software (2015 version) for earthquake zone III in India. The objective of the project is to carry out seismic analysis (RSA) of regular and irregular reinforced concrete buildings and to carry out the ductility based design using IS 13920. Results of this analysis are discussed in terms of story displacements, story drifts, story shear and stiffness. From the results it is concluded that story displacements increases linearly with height of the building; maximum storey drift is observed at second floor for irregular structure and at fourth floor for regular structure; maximum storey shear force was observed between ground floor and second floor for regular structure and at ground floor for irregular structure and the value decreases linearly with height; storey stiffness varies non - linearly for both the structures with maximum values at ground floor. © IAEME Publication.

[4].Ravindra N. Shelke (2017) Seismic Analysis of Vertically Irregular RC Building Frames International Journal of Civil Engineering and Technology (IJCIET) 8 (1),January 2017,pp.155- The objective of the paper is to carry out Response spectrum analysis (RSA) and Time history Analysis (THA) of vertically irregular RC building frames and to carry out the ductility based design using IS 13920 corresponding to Equivalent static analysis and Time history analysis. Three types of irregularities namely mass irregularity, stiffness irregularity and vertical geometry irregularity were considered. According to our observation, the storey shear force was found to be maximum for the first storey and it decreases to minimum in the top storey in all cases. The mass irregular structures were observed to experience larger base shear than similar regular structures. The stiffness irregular structure experienced lesser base shear and has larger inter-storey drifts. The absolute displacements obtained from time history analysis of geometry irregular structure at respective nodes were found to be greater than that in case of regular structure for upper stories but gradually as we moved to lower stories displacements in both structures tended to converge. Lower stiffness results in higher displacements of upper stories. In case of a mass irregular structure, time history analysis gives slightly higher displacement for upper stories than that in regular structures whereas as we move down lower stories show higher displacements as compared to that in regular structures. When time history analysis was done for regular as well as stiffness irregular structure, it was found that displacements of upper stories did not vary much from each other but as we moved down to lower stories the absolute displacement in case of soft storey were higher compared to respective stories in regular structure. If a high rise structure (low natural frequency) is subjected to high frequency ground motion then it results in small displacements. Similarly, if a low rise structure (high natural frequency) is subjected to high frequency ground motion it results in larger displacements whereas small displacements occur when the high rise structure is subjected to low frequency ground motion.

3. Methodology

It is an attempt to investigate the effect of irregular plan configuration for multi storey 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 ETABs2018Software 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 Multistory 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 intern observed to form conclusion.

3.1 Method of analysis

This study is conducted to understand the structural behavior of plane irregular building in comparison to regular building under seismic loading. It is recommended that for analysis of plane irregular building dynamic analysis is 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 software2018.

3.1.1 Description of the Models

A 10 storey building of size 21.21 X 17.73 in length and width with typical storey height of 3.5m is considered for both plane irregular and irregular building. Two buildings (Irregular in plan) are considered to study the effect of irregularity on seismic behavior.

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We have considered three models for the study.Model1:-Plane Regular building
Model 2, 3, 4:-Plane Irregular building

PARAMETERS	VALUE
No. of stories	10
Total height of building	30.25 m
Floor Area	518 m²
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/m²
Floor Finish	1.5 KN/m²
Zone Factor	0.16
Damping Ratio	5%

Table no 1: Specification of building model

3.2 Modeling different models in ETABS Software

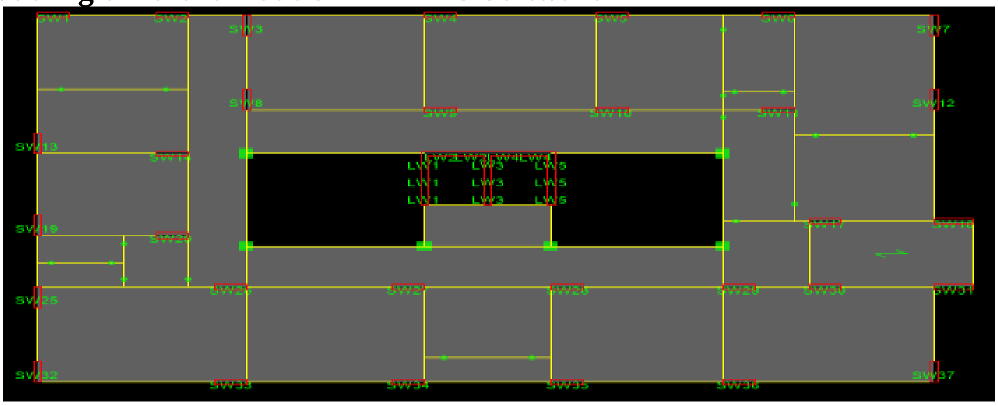

Fig.no.1:Plan view of G+9 RCRegular building.

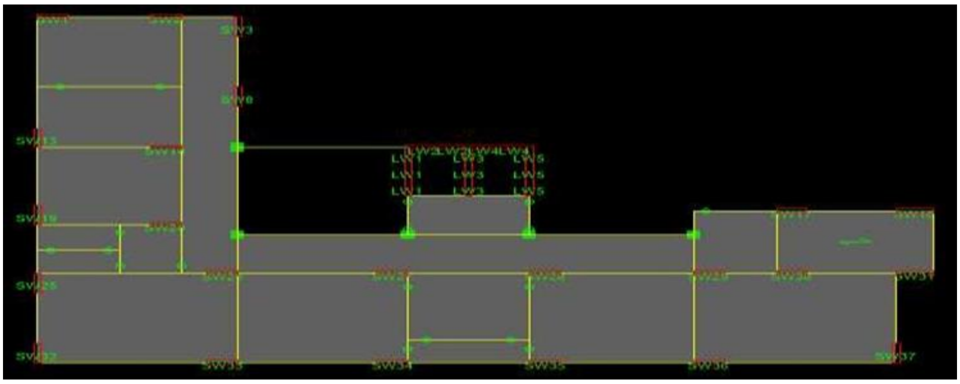

Fig.no.2: Plan view of G+9RC

L-shape building.

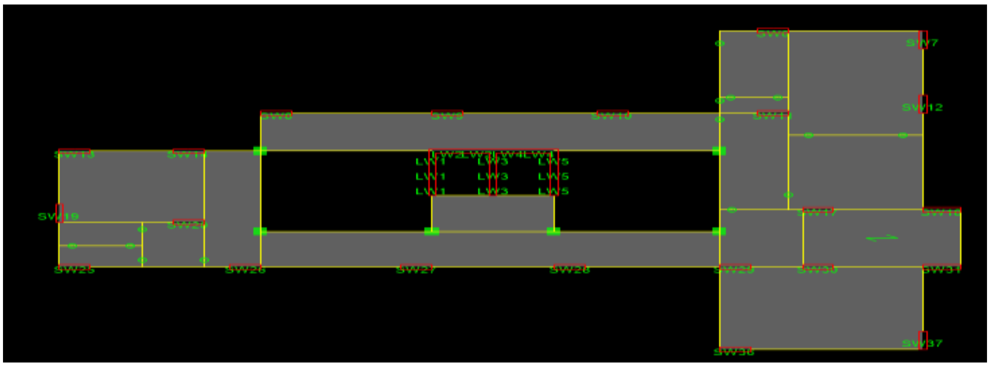

Fig.no.3: Plan view of G+9RC

T-Shape building.

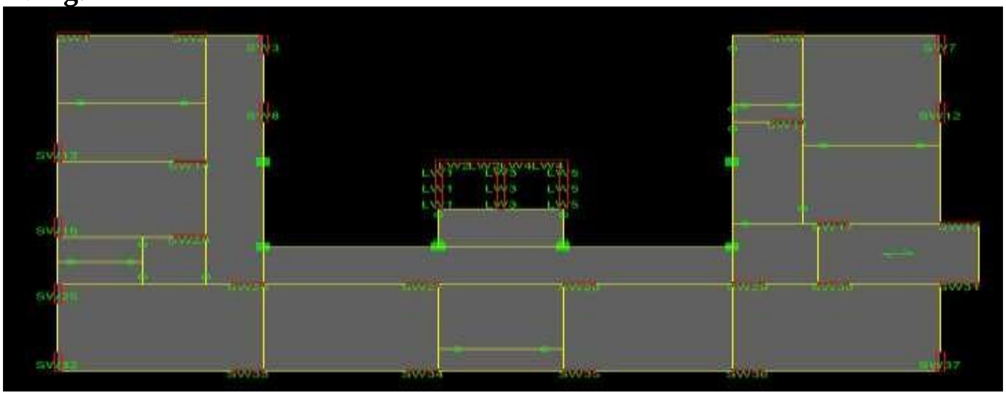

Fig.no.4:Plan view of G+9 RC

U-Shape building.

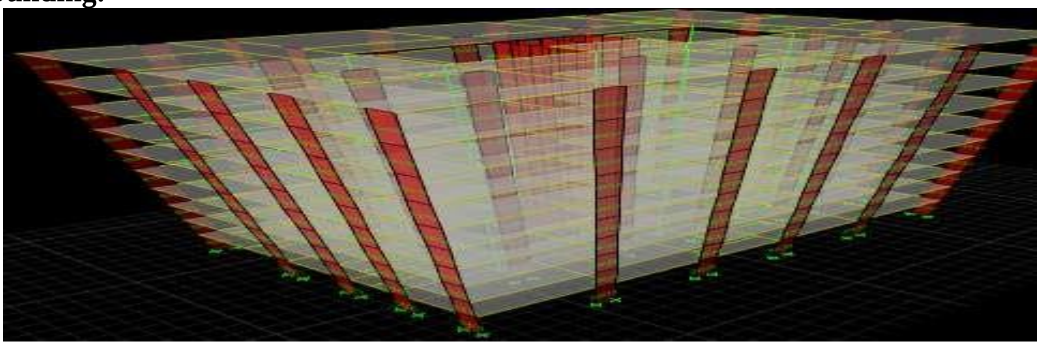

Fig.no.5:3D view of G+9RC Regular building.

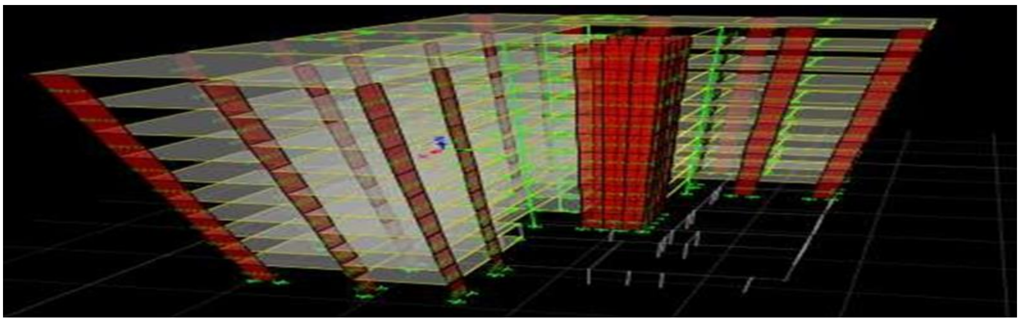

Fig.no.6:3D view of G+9RC L-shape building.

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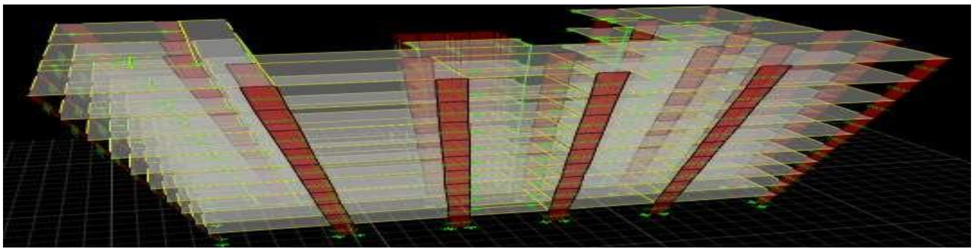

Fig.no.7:3D view of G+9 RC U-shape building.

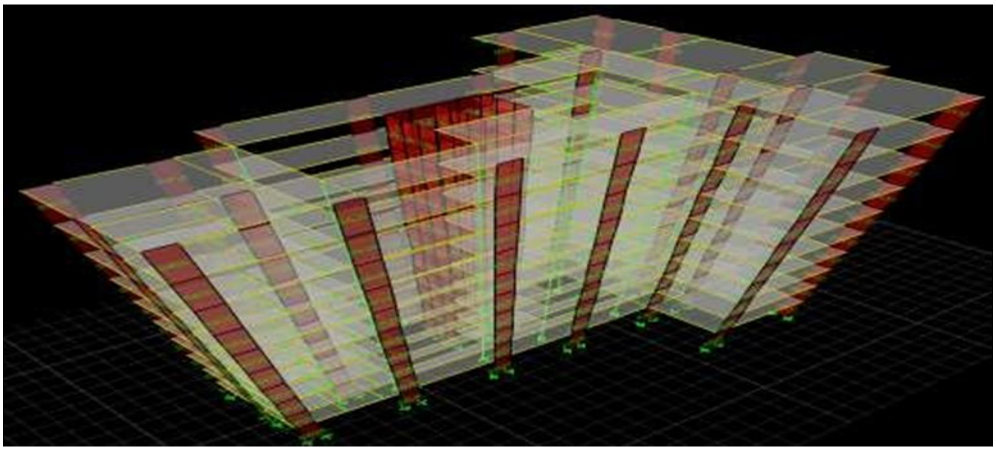

Fig.no.8:3D view of G+9 RC T-shape building.

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

Table no 2: Storey Displacement

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Fig.no.9: Graph of Storey Displacement.

	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

Table no 3: Storey Stiffness

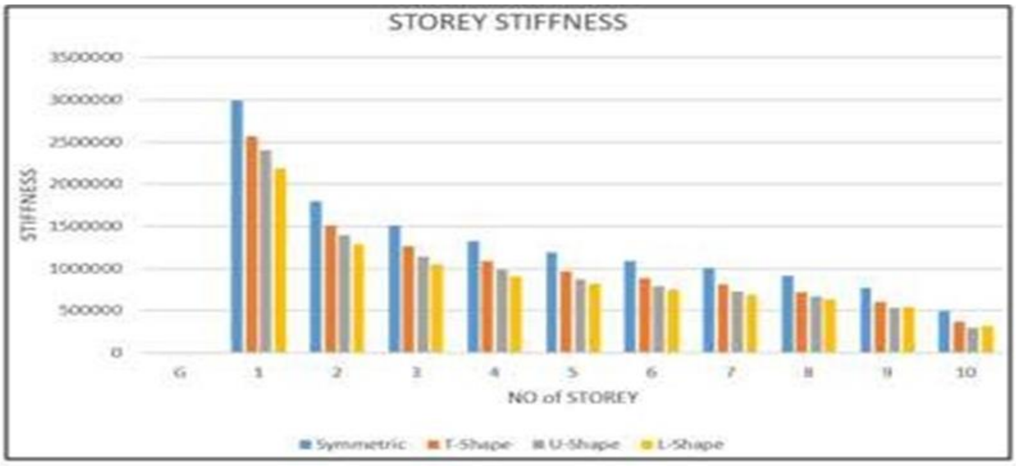

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Fig.no.10: Graph of Storey Stiffness

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

Table no 4: **Storey Shear.**

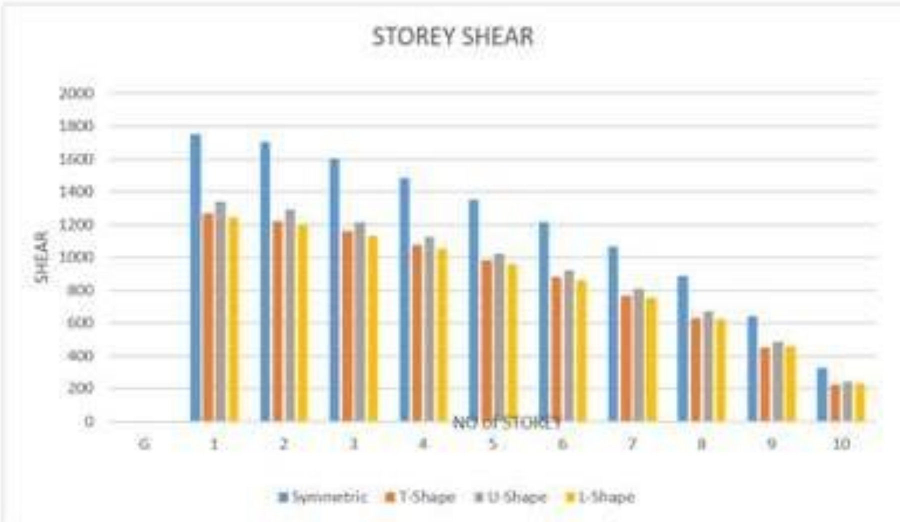

Fig.no.11: Graph of Storey Shear

5. Conclusions

1. From the analysis of RSA for both Plan Regular& Irregular Building Storey Stiffness and Storey Shear is maximum for Plane regular building compare to the plane irregular building.

This statement suggests that in the analysis of Response Spectrum Analysis (RSA), both storey stiffness and shear are higher in plane regular buildings compared to plane irregular ones. This could imply that regular buildings may offer better structural stability and resistance to lateral forces

2. Storey Displacement is maximum for L-shape Building Compare to other Irregular Buildings.

Here, it's indicated that in the case of irregular buildings, specifically L-shaped ones, storey displacement is the highest compared to other irregular building shapes. This suggests that the L-shaped configuration might result in greater lateral movement or deformation during seismic events

3. Irregular Building reduction in displacement is As the Plane Irregularity Increases Storey Stiffness Decreases.

This statement suggests a correlation between the reduction in displacement of irregular buildings and the decrease in storey stiffness as plane irregularity increases. In simpler terms, irregular buildings tend to become less stiff (more flexible) as their plan irregularity increases, leading to a reduction in displacement during seismic events

4. As the Plan Irregularity Increases Base Shear decreases and Increases in Plane Regular Building This statement indicates that as the plan irregularity of a building increases, the base shear (the total shear at the base of the building) decreases. Conversely, in plane regular buildings, as the irregularity decreases, the base shear increases. This could imply that irregular buildings distribute seismic forces differently, resulting in lower overall base shear compared to regular buildings

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