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A Comparitive study on Regular and Irregular configuration of multistorey building using ETABS.

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Abstract - *Structural Analysis and design are predominant in finding out significant threats to integrity and stability of a structure. Multi storied structures, when designed, are made to fulfil basic aspects and serviceability. Since Robustness of structure depends on loads imposed, it requires attention. All the challenges faced by structural engineers were taken as opportunities to develop software's such as STAAD PRO, ETABS & SAFE, SAP etc., with ease of use. Software such as ETABS is a leading commercial software's worldwide for structural analysis. The design results using ETABS of G+9 multistorey building, for both regular and irregular plan configuration, are obtained and compared.*

Key Words: Regular buildings, Irregular buildings, Base Shear, Storey drift, Displacement.

1. INTRODUCTION

The Structure should be designed, like it should withstand and resist natural disasters like earthquake, landslides and floods. Among all the forces earthquake forces are the most prominent and destruction type causing major impact to the structure. Earthquakes is a rapid shaking of earths due to the motion of tectonic plates and the forces occurred are complex and can vary depending on many factors like magnitude and location of the earthquake, the soil and rock properties at the site, and the characteristics of the structure Structural engineers use sophisticated computer models and analysis techniques to determine the seismic loads and design structures to withstand them. This includes designing the structural elements and connections to resist the forces occurred due to earthquake, and selecting appropriate materials and detailing to ensure that the structure remains stable and safe.

1.1 Regular buildings

A regular multi-storey building refers to a building, with a regular and repeating floor plan, where the floor-to-floor height is typically constant throughout the building. Regular buildings are typically rectangular or square in shape, with a consistent number of floors and a regular column and beam grid layout. The regularity floor plan and column layout is important in ensuring that it resists lateral forces such as wind and earthquake loads. Regular buildings serve uniform distribution of lateral forces throughout the building, which reduces risk of structural irregularities and enhances the overall structural stability and safety of it.

1.2 Irregular buildings

Irregular building differ to the regular and repeating floor plan and column layout of a typical building. Irregularities in building shape and layout can increase the complexity of the building's structural design, particularly withstanding lateral loads such as wind and earthquake forces. irregular buildings can take on a variety of shapes and forms, and can result from a range of factors such as site constraints, architectural requirements, or functional needs. Irregular buildings require specialized engineering abilities to ensure their structural safety and stability.

1.3 Classification of irregular buildings

1.T-shaped or L-shaped buildings: These buildings have wings or projections that extend from the main building mass, creating an irregular footprint. This can result in irregular column spacing and floor plan layouts.

2.Setback buildings: These buildings have stepped or terraced floors, creating a variation in floor plan and column layout. This can result in non-uniform column spacing and an irregular distribution of structural loads.

3.Skewed buildings: These buildings have a non-orthogonal (non-perpendicular) orientation, creating an irregular building footprint. This can result in non-uniform column spacing and increased complexity in the lateral force resistance system.

4.Buildings with irregular mass distribution: These buildings have an uneven distribution of mass or weight, such as buildings with large cantilevered elements or buildings with significant height variations. This can result in non-uniform load distribution and increased complexity in the structural design.

5.Buildings with non-structural components: These buildings have significant architectural features, such as large atriums or curtain walls, that can impact the building's structural behaviour and load distribution. This can result in increased complexity.

1.4 Types of irregularities

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1.5 ETABS

ETABS is a powerful and popular software used by engineers and architects for designing buildings. ETABS stands for "Extended 3D Analysis of Building Systems," developed by Computers and Structures, Inc. (CSI). ETABS allows for the modeling, analysis, design of complex building structures, including high-rise buildings, low-rise buildings, and even individual structural components such as shear walls and foundations.

ETABS has a user-friendly interface and offers a variety of tools for modeling, analyzing, and designing structural systems. It also provides advanced capabilities such as dynamic analysis, seismic analysis, and nonlinear analysis.It is widely used to examine the building stability and efficiency. Additionally, ETABS has the ability to integrate with other CSI products, such as SAP2000 and SAFE, for even more advanced design.

1.6 Different methods used for analysis

- Static Analysis
- Dynamic Analysis
- Buckling Analysis
- Nonlinear Analysis
- Response spectrum method

2. METHODOLOGY

2.1 Load Consideration

1.Dead Load: Dead load includes walls, roofs, floors, and any permanent fixtures. This load is generally constant and is not subject to change.

2.Live Load: Live load involves mass of people, furniture, and other movable loads that the building will support. This load is not constant and varies on the usage.

3. Wind Load: Wind load is the force exerted by the wind on the building. The wind load is determined based on the location of the building and the wind speed in the area.

4.Seismic Load: Seismic load is the force exerted on the structure due to motion of earth surface. The seismic load is determined by the seismicity of the location where the building is being constructed.

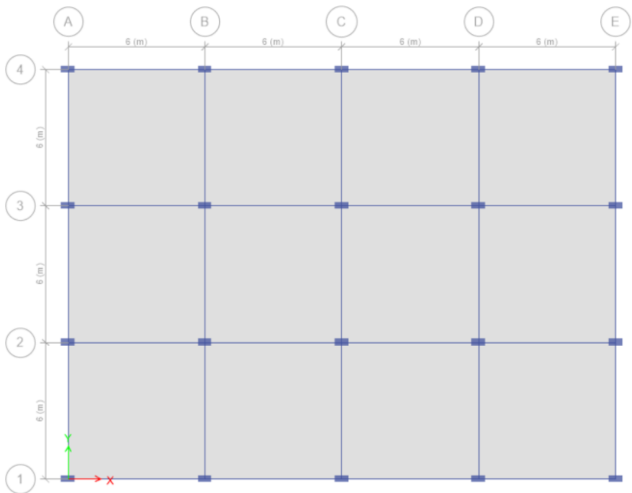

Fig 2.1 G+9 storey regular building

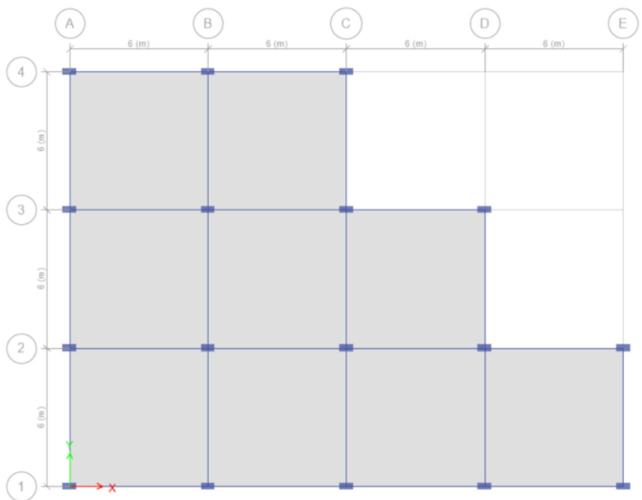

Fig 2.2 G+9 storey Irregular building.

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Building Parameters	Values
No. of storey	9
Floor Height	3m
Beam Dimensions	300 x 750 mm
Column Dimensions	300 x 600 mm
Slab Thickness	175 mm
Height of Parapet Wall	1 m
Floor Finish	1 kN/m^2
Live Load on Floor	3 kN/m^2
Live Load on Roof	1.5 kN/m^2
Density of Concrete (fck)	25 kN/m^3
Density of Brick Wall	22 kN/m^3
Density of Steel (fy)	Fe 415
Seismic Zone	III
Type of Soil	Medium
Type of Structure	SMRF
Importance Factor (I)	1.0
Seismic Zone Factor (Z)	0.16
Response Reduction Factor (R)	5.0

3.RESULTS

Case 1 Regular buildings

Storey Displacement

Storey	X	Y
9	59.94	131.504
8	57.875	127.575
7	54.434	120.652
6	49.636	110.815
5	43.55	98.17
4	36.242	82.818
3	27.776	64.851
2	18.234	44.358
1	7.942	21.497
Base	0	0

Table – 1 Storey Displacement values in 'X & Y' direction.

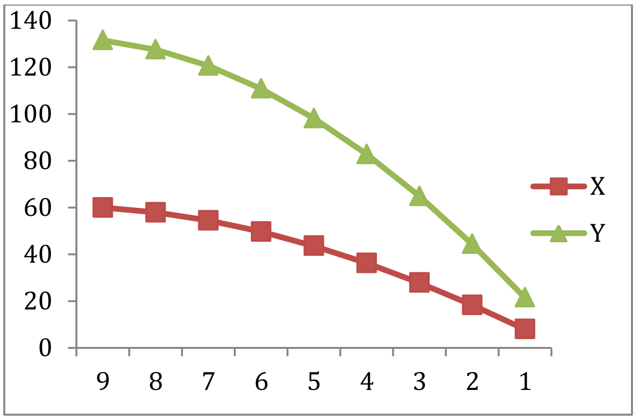

Fig 3.1 Storey Displacement values for in 'X' & 'Y' Directions.

Storey Drift

Storey	X	Y
9	0.000688	0.00131
8	0.001147	0.002307
7	0.001599	0.003279
6	0.002029	0.004215
5	0.002436	0.005117
4	0.002822	0.005989
3	0.003181	0.006831
2	0.003431	0.00762
1	0.002647	0.007166
Base	0	0

Table – 2 Storey Drift values in 'X & Y' direction.

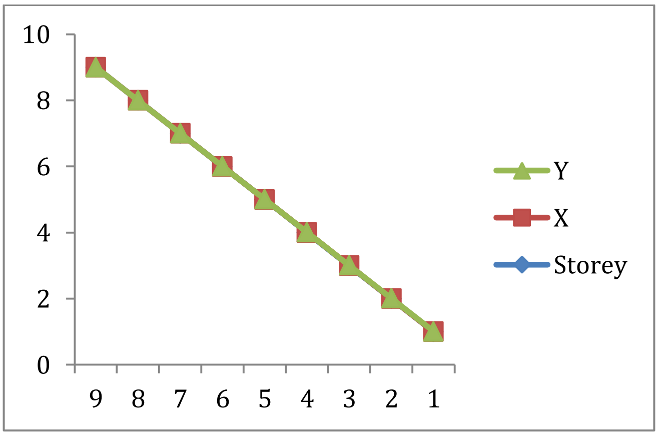

Fig 3.2 Storey Drift values for regular buildings in 'X' & 'Y' Directions.

Storey shear

Storey	X	Y
9	713.58	653.52
8	1396.91	1287.26
7	2046.66	1899.03
6	2667.28	2491.76
5	3263.28	3068.38
4	3839.11	3631.81
3	4399.27	4185
2	4948.23	4730.86
1	5490.47	5272.32
Base	0	0

Table – 3 Storey Shear values in 'X & Y' direction.

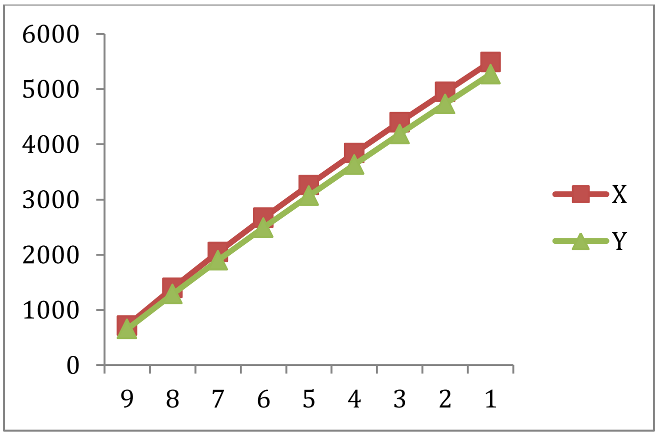

Fig 3.3 Storey Shear values for regular buildings in 'X' & 'Y' Directions.

Case 2 Irregular buildings

Storey Displacement

Storey	X	Y
9	53.475	116.741
8	51.647	113.17
7	48.586	107.083
6	44.313	98.391
5	38.891	87.211
4	32.384	73.639
3	24.852	57.762
2	16.368	39.664
1	7.184	19.574
Base	0	0

Table –4 Storey Displacement values in 'X & Y' direction.

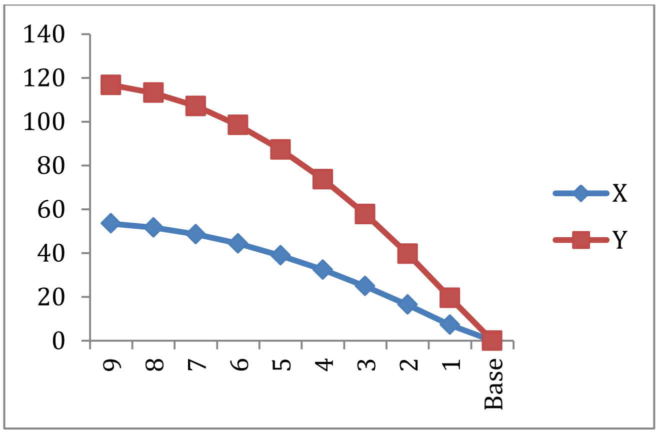

Fig 3.4 Storey Displacement values for irregular buildings in 'X' & 'Y' Directions.

Storey Drift

Storey	X	Y
9	0.000609	0.00119
8	0.00102	0.002029
7	0.001424	0.002897
6	0.001807	0.003727
5	0.002169	0.004524
4	0.002511	0.005292
3	0.002828	0.006032
2	0.003061	0.006697
1	0.002395	0.006525
Base	0	0

Table – 5 Storey Drift values in 'X & Y' direction.

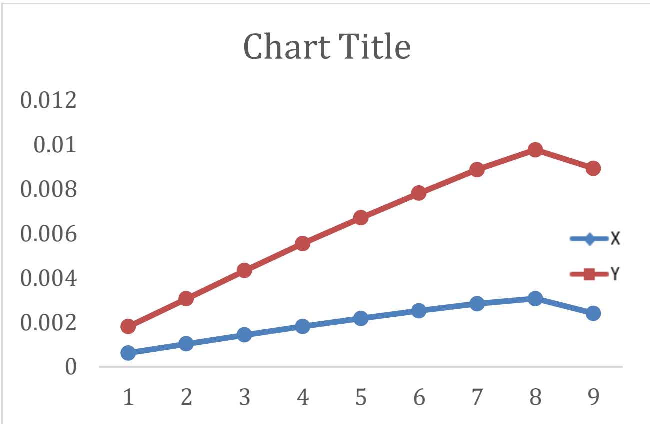

Fig 3.5 Storey Drift values for irregular buildings in 'X' & 'Y' Directions.

Storey shear

Storey	X	Y
9	553.89	499.61
8	1092.34	989.42
7	1600.28	1459.84
6	2080.91	1912.90
5	2538.43	2351.28
4	2977.04	2777.64
3	3400.94	3194.65
2	3814.35	3604.65
1	4221.45	4011.33
Base	0	0

Table – 6 Storey Shear values in 'X & Y' direction.

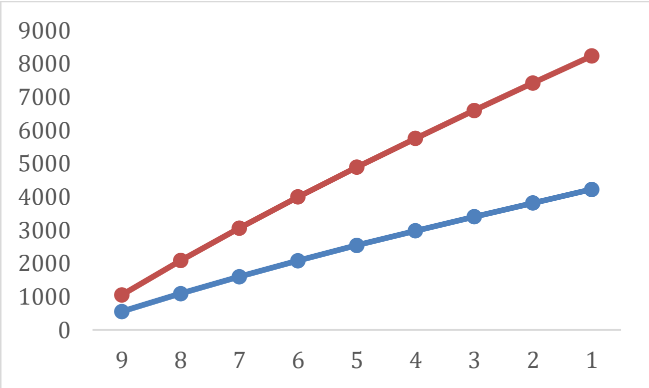

Fig 3.6 Storey Shear values for regular buildings in 'X' & 'Y' Directions.

4. CONCLUSIONS

- The behaviour of the structure vary depending upon the type and shape of structures.
- From the results we can conclude that, Storey displacement of irregular building in 'X' direction is 10.79% less than regular building and in 'Y' direction 11.22% less than regular building.
- In a similar way, Storey drift of irregular building in 'X' direction is 11.48% less than regular building and in 'Y' direction 8.53% less than regular building.
- From the results we can conclude that, Storey shear of irregular building in both 'X' & 'Y' directions are 23% less than regular building.

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