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Comparison of a Regular G+7 Structure with Mass and Stiffness Irregularity by Response Spectrum Analysis Using Staad Pro

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ABSTRACT: This project performed seismic analysis of the G+7 structure and compared it to the structure containing irregularity such as Stiffness and Mass. This study uses STAAD Pro to evaluate the Seismic impact of these parameters using the response spectrum analysis. This study includes base storey shear, time period and peak storey shear for a complete analysis of structure. Response Spectrum analysis is used for the project as it is a method for predicting the response process for short-term, uncertain dynamic conditions. Examples of such events are earthquakes and shocks. The analysis concluded by showing there is a significant increase of seismic demand for the irregular structures. Research shows the importance of taking these factors into account in the design and reconstruction of buildings to increase their earthquake resistance and contribute to safe design in seismically active areas. The plan emphasizes the need to strictly monitor and monitor breaches to reduce seismic risk. The methods used in this study and the information obtained may provide useful information for future research and practical applications in seismic design.

KEYWORDS: Regular Structure, Irregular Structure, Mass Irregularity, Stiffness Irregularity, Response Spectrum Analysis.

I. INTRODUCTION

The weakness during earthquake is caused by inconsistencies in the geometry, stiffness and mass of the structure. This inconsistency in structure are called irregular structures. Irregular structures contribute to much of the urban infrastructure. Vertical irregularities are one of the main reasons for decreased performance during an earthquake. Seismic integrity of structures is an important issue, especially for high-rise buildings developing in urban landscapes. This study begins the analysis by carefully examining the seismic response of the G+7 model under the influence of seismic forces and comparing it with other models. In the research, STAAD.Pro's powerful simulation capabilities were used for response spectrum analysis to see the impact of different energy sources on the structure against seismic effects. By revealing the effects of mass and stiffness irregularity, this study attempts to explain their important role in seismic response and provide better design strategies to strengthen structures to withstand the variability of earthquakes. This research not only aims to broaden the earthquake engineering base, but also highlights the need for advanced computational tools for predictive testing and design improvement. It is hoped that the information collected will help guide the future of building safety measures and earthquake planning.

Paper is organized as follows. Section II describes automatic text detection using morphological operations, connected component analysis and set of selection or rejection criteria. The flow diagram represents the step of the algorithm. After detection of text, how text region is filled using an Inpainting technique that is given in Section III. Section IV presents experimental results showing results of images tested. Finally, Section V presents conclusion.

II. OBJECTIVE

- To study two irregularities in structures namely mass and stiffness irregularities.
- To calculate the design lateral forces on regular and irregular structures using response spectrum analysis and to compare the results of different structures.
- Compare the structural responses such as Time Period and base shear of the regular and irregular structures to identify the impact of irregularities on the overall seismic performance.

III. METHODOLOGY

1. MODELLING OF BUILDING

Here, the performance of G+ 7 storey reinforced concrete frame in regular and irregular plans was examined. Its height from the ground is 11'. Here 3 models were created in STAAD Pro software which are Regular, Mass Irregular and Stiffness Irregular structure. STAAD Pro is used as it's a versatile program that provides various features such as static and dynamic analysis.

2. Structure Details

The regular and irregular buildings of plan area 268m² and height of each floor is 3.35m is considered with G+7 storey in zone. A medium soil stratum is considered at the location.

Particulars	RCC Structures
Earthquake zone	V
Importance factor	1
Type of soil	Medium
Damping Ratio	0.05
Density of RCC	25 kN/m ³
Thickness of slab	150 mm

All the three models are modelled in STAAD Pro 2023 software according to the codal provisions.

3. Building Models

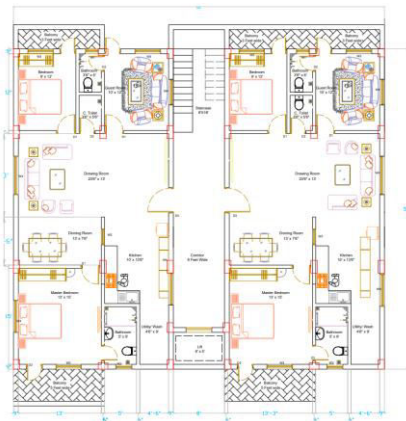


Fig 1: Floor Plan of Regular Building for all floor

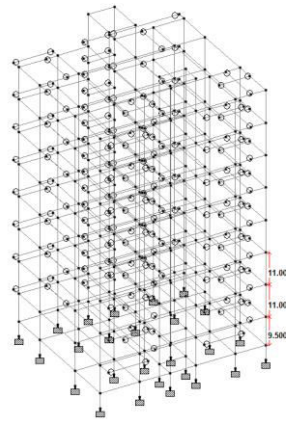


Fig 2: Structural Drawing of Regular Building

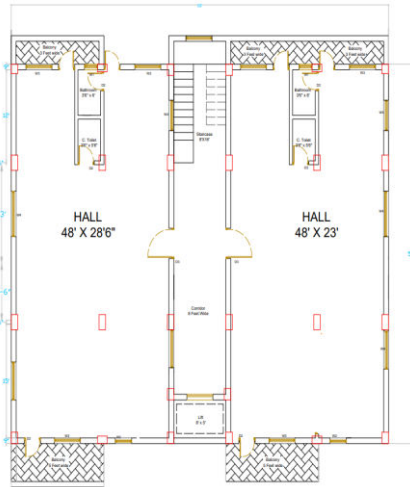


Fig 3: Ground Floor Plan of Stiffness Irregular Structure

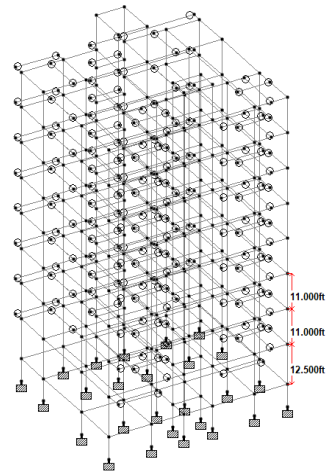


Fig 4: Structural Drawing of Stiffness Irregular Building

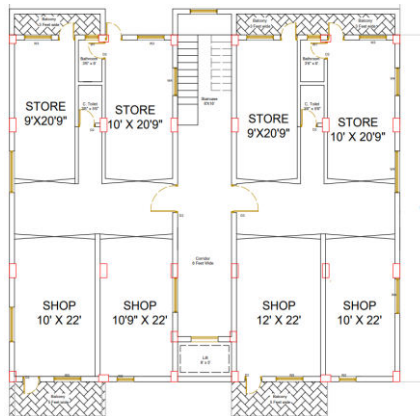


Fig 5: 5th Floor Plan of Mass Irregular Structure

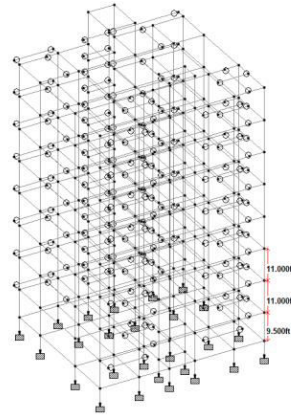


Fig 6: Structural Drawing of Mass Irregular Building

Live load on all the structures is taken as 2 KN/m^2 on floor levels and roof level 1.5 KN/m^2 . And slab thickness as 150mm. Stiffness irregularity is created by rising bottom storey height to 12.5' with respect to regular building. Mass irregularity the slab thickness is 300mm and live load in 5th floor is 4 Kn/m^2 and other parameter are according to IS code.

IV. EXPERIMENTAL RESULTS

1. BASE SHEAR

Models	Base Shear in X direction	Base Shear in Z direction
Regular	1583	1383
Stiffness Irregular	1804	1571
Mass Irregular	1753	1548

Table 1: Base Shear in X & Z direction

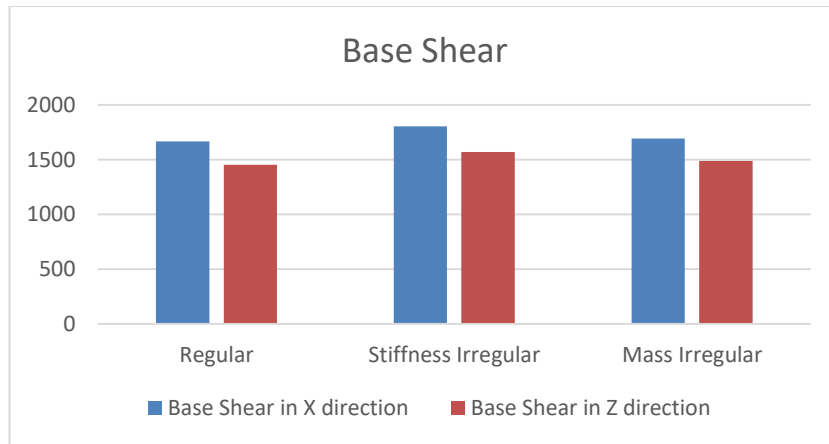


Fig 7 Base Shear

Regular Model:

Base Shear in X direction: 1667 kN
 Base Shear in Z direction: 1453 kN

Stiffness Irregular Model:

Base Shear in X direction: 1804 kN
 Base Shear in Z direction: 1571 kN

Mass Irregular Model:

Base Shear in X direction: 1743 kN
 Base Shear in Z direction: 1548 kN

2. Time Period

Model	Time Period in X direction	Time Period in Z direction
Regular	0.56	0.61
Stiffness Irregular	0.589	0.63
Mass Irregular	0.57	0.618

Table 2: Time Period in X & Z Direction

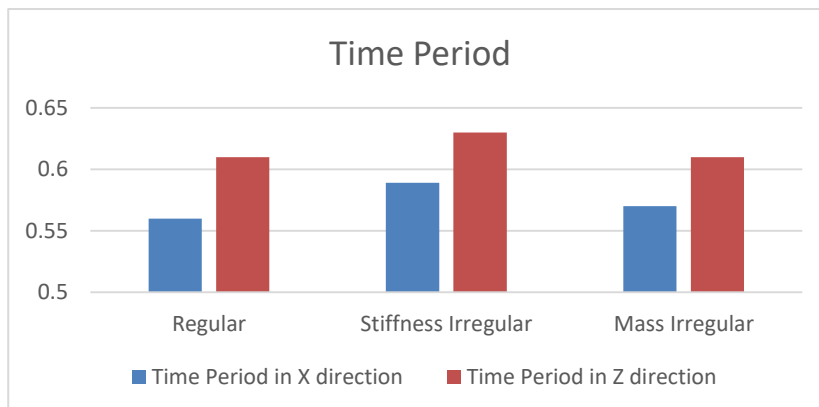


Fig 8: Time period



Regular Model:

Time Period in X direction: 0.56 seconds

Time Period in Z direction: 0.61 seconds

Stiffness Irregular Model:

Time Period in X direction: 0.589 seconds

Time Period in Z direction: 0.63 seconds

Mass Irregular Model:

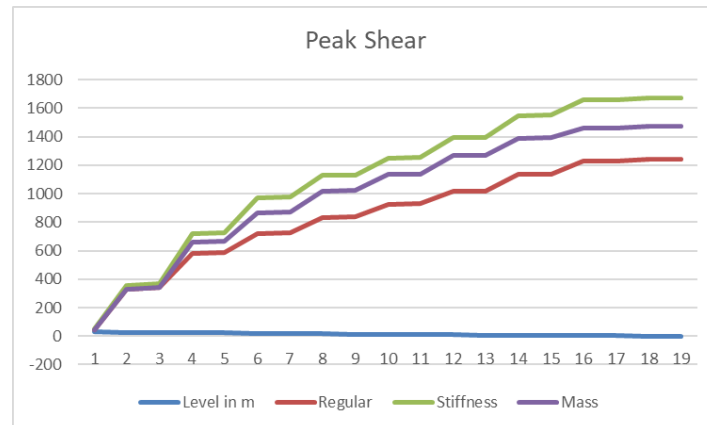
Time Period in X direction: 0.57 seconds

Time Period in Z direction: 0.61 seconds

3. Peak Storey Shear

Level in m	Regular	Stiffness	Mass
29.72	46.23	47.88	47.29
26.37	355.27	354.59	340.47
24.69	365.32	367.85	352.12
23.01	656.71	716.5	667.39
21.34	664.2	726.5	657.07
19.66	837.85	968.43	866.04
17.98	842.44	974.77	870.75
16.31	969.99	1126.91	1057.5
14.63	972.9	1131.09	1062.05
12.95	1079.29	1250.22	1197.76
11.28	1082.56	1254.35	1202.15
9.6	1188.81	1391.69	1336.05
7.92	1193.02	1396.63	1340.26
6.25	1323	1545.77	1456.11
4.57	1326.47	1550.32	1459.15
2.9	1421.94	1660.12	1522.51
1.45	1423.3	1662.29	1523.7
0	1437.25	1675.24	1532.88
-2.13	1437.25	1675.24	1532.88

Table 3: Peak Storey Shear

**Fig 9: Peak Storey Shear**

V. CONCLUSION

The project aimed to compare the seismic response of a G+7 (ground plus seven stories) regular structure against the same structure with introduced mass and stiffness irregularities. The analysis was conducted using response spectrum analysis in STAAD.Pro, which is a sophisticated engineering software used for designing and analyzing structures under various loading conditions.

Base Shear Results: The base shear values, which represent the total horizontal force that the structure must resist during an earthquake, were found to be significantly higher in the stiffness irregular model compared to the regular and mass irregular models. This indicates that stiffness irregularities, such as changes in the rigidity of structural elements, can lead to an increased demand on the structure's lateral force-resisting system.

Time Period Findings: The analysis of time periods, which are indicative of the structure's natural vibration frequency, revealed that both mass and stiffness irregularities lead to an increase in the time period. However, the increase was more pronounced in the stiffness irregular model. Longer time periods suggest that the structure is more flexible, which can be detrimental during seismic events as it may resonate with the ground motion.

Peak Storey Shear Analysis: The peak storey shear values, which measure the maximum shear force experienced by each story during seismic activity, were highest at the base and decreased towards the top of the structure. The stiffness irregular model consistently showed higher peak storey shear values than the regular and mass irregular models, emphasizing the critical impact of stiffness distribution on seismic performance.

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