PARAMETRIC STUDY ON TORSIONAL EFFECTS OF IRREGULAR BUILDING WITH STIFFNESS AND MASS IRREGULARITY UNDER SEISMIC ZONE

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Abstract - Due to the expanding population all throughout the world, there is an enormous need for the construction of high-rise structures. One of the most crucial ways to prevent damage from future earthquakes is the construction of engineering structures that are earthquake-resistant. Earthquake forces are irregular forces that may or may not cause structural damage. Failure starts in the weakest area during an earthquake. This weakness might be brought on by the structure's discontinuity in mass, stiffness, and shape. According to (IS: 18933, 2002), a story inside a building is considered to have mass irregularity only if its mass is greater than 200% of the story next to it. Average lateral stiffness or less than 70% of the stiffness in the level above. This paper presents the analysis conducted on the G+10 RC frame structure from zones II to V with mass and stiffness irregularities (response spectrum). The results show that the mass at the top floor was critical compared to other floors, whereas the stiffness at the ground floor was critical compared to other floors.

Key Words: Earthquake, Response Spectrum, Mass and Stiffness Irregularity.

1. INTRODUCTION

During an earthquake, waves arise from the cause of ground disruption as just a consequence of the energy generated from the earth's crest. These waves cause the earth's surface to shake. Earthquakes may be categorized into two groups based on their origins: tectonic earthquakes and volcanic earthquakes. Volcanic earthquakes have a small field and are linked to volcanic eruptions. Tectonic earthquakes are caused by huge rock masses abruptly dislocating along a geological fault. Because rocks are an elastic substance, they store strain energy during deformation caused by massive tectonic plate motions (slide of the earth's bulk in chunks) that occur on the planet. During this process, a substantial quantity of strain energy trapped in the rock is abruptly released, causing shock waves to begin and travel in all directions. In most cases, the horizontal component is stronger than the vertical component.

Figure 1: Building collapse due to earthquake

Plan irregularities.

a) **Vertical irregularities -** Stiffness irregularity, mass irregularity, and vertical geometric irregularity are the three basic categories of vertical irregularities.

i. **Mass irregularity -** Anywhere a building's seismic weight exceeds 200% of its neighbouring levels, mass irregularity is found to develop.

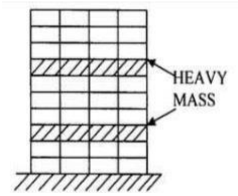

Figure 2: Mass irregularity

ii. **Stiffness irregularity (soft storey) -** A soft storey is one in which the lateral stiffness of the three stories above is less than 70% or less than 80 % of the average lateral stiffness.

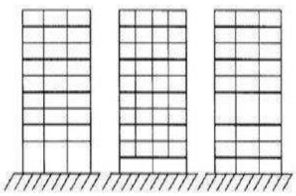

Figure 3: Stiffness Irregularity

iii. **Vertical geometric irregularity -** A structure is considered to be vertical geometri irregular when in its adjacent storey the horizontal dimension of the lateral force resisting system is more than 150%.

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2. OBJECTIVES

1) To develop the model of a G+10 storied RC frame in seismic zones II to V with mass and stiffness irregularities.
2) To study the model with mass and stiffness irregularity by dynamic analysis (response spectrum) and static analysis.

3. METHODOLOGY

Model with Mass & Stiffness Irregularity on the Ground, Mid & Top Floor for zone II to V

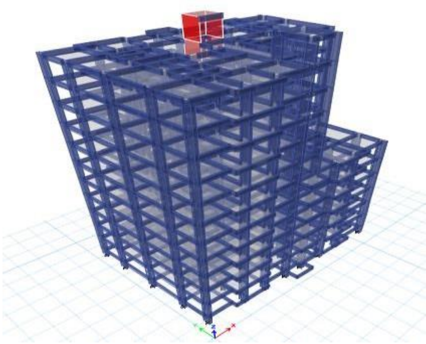

Figure 4: 3D Regular Model of Building

4. MODELLING

Section Characteristics.
Beams size = 200X600, Columns size = 300X900, Slab thickness = 125mm.

Design loads.
Self-weight, Floor finish, Wall load, Typical live load, Roof live load, Seismic load.

a. Dead load as per IS: 875 (Part I)-1987. Self-weight of slab - 3.125 kN/m2,Loading due to Floor Finish - 1.50 kN/m2 ,masonry walls – 4.29kN/m 3.
b. Live load as per IS: 875 (Part-II)-1987,Live load on floor – 2.00, 3.00 kN/m2 ,Live load on roof - 1.50 kN/m2
c. Earthquake load. IS: 1893-2016, Zone factor – II,III,IV,V, Soil type –Medium

5. RESULTS

Table-1**:** Maximum displacement values for various models of storey mass & Stiffness irregularity (Static analysis in X direction EQX)

Sl No.	Model	Zone II EQX	Zone III EQX	Zone IV EQX	Zone V EQX
1	Mass IR @ ground floor	38.125	61.063	91.656	137.562
2	Mass IR @ mid floor	37.428	60.165	90.178	135.235
3	Mass IR @ top floor	40.467	64.672	97.036	145.520
4	Stiffness IR @ ground floor	38.223	61.379	92.186	138.189
5	Stiffness IR @ mid floor	39.859	63.858	95.820	143.979
6	Stiffness IR @ top floor	38.586	61.489	92.285	138.485

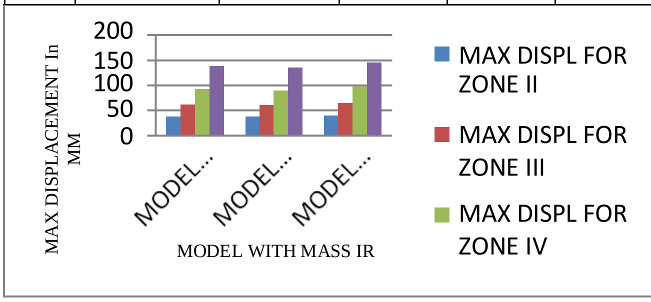

Figure 1 Graph of maximum displacement

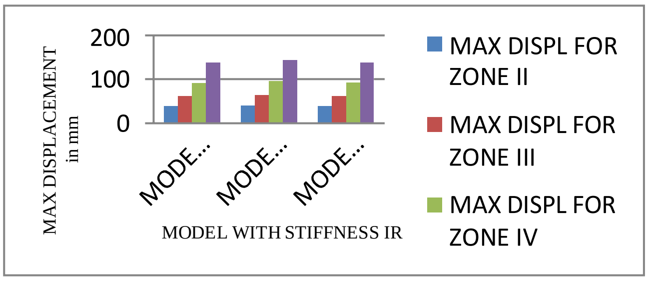

Figure 2 Graph of Maximum Displacement

Table-2: Maximum Displacement Values for Various Models of Storey Mass & stiffness Irregularity (Response spectrum analysis in X direction SPEC-X)

Sl No	Model	Zone II SPEC-X	Zone III SPEC-X	Zone IV SPEC-X	Zone V SPEC-X
1	Mass IR @GF storey	31.796	50.792	76.563	114.578
2	Mass IR @ mid storey	32.812	52.523	78.686	118.102
3	Mass IR @ top storey	34.125	54.653	82.159	123.189
4	Stiffness IR @ GF storey	34.758	55.789	83.601	125.402
5	Stiffness IR @ mid storey	34.156	54.798	82.312	123.567
6	Stiffness IR @ top storey	32.692	52.567	78.359	117.695

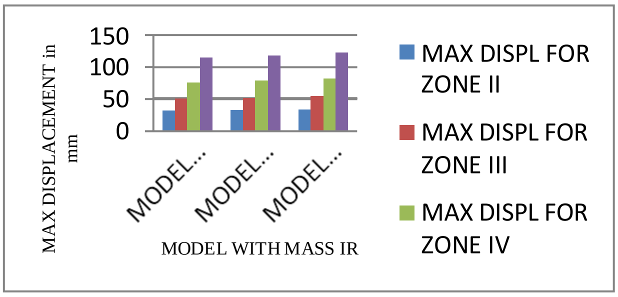

Figure 3 Graph of Maximum Displacement

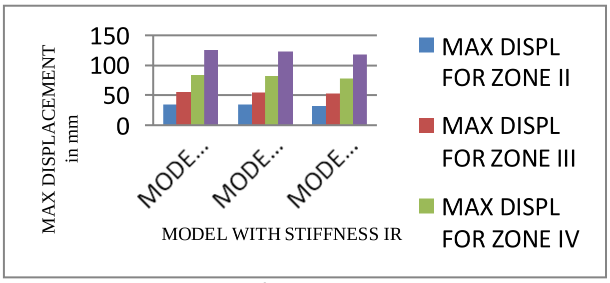

Figure 4 Graph of Maximum Displacement

Joint displacement or torsion irregularity

Table 3: Joint displacement

Direction	Joint displacement (Mass)		
	At GF	At 5th	At Top
X_1,X_2	1.05	1	1.02
Y_1,Y_2	1.25	1	1.37

Table 4: Joint displacement

Direction	Joint displacement (Stiffness)		
	At GF	At 5th	At Top
X_1,X_2	1.06	1.05	1.06
Y_1,Y_2	1.26	1.27	1.29

6. CONCLUSIONS

In this work, 24 models were used to analyse a G+ 10 structure.

1. **Displacement.**
   - **Static Analysis:** The structure was analysed for static analysis and stiffness irregularity, and as the analysis was concentrated on three floors, that is, the middle, top and ground floor, the results as discussed above for the stiffness irregularity structure were observed to give a lower percentage of values compared to static analysis.
   - **Response Spectrum Analysis:** The structure was analysed for mass irregularity and stiffness irregularity, and as the analysis was concentrated on three floors, that is, the middle top and ground floor, the results as discussed above for the stiffness irregularity structure were observed to give a lower percentage of values compared to static analysis.

2. **Joint Displacement or torsion irregularity.**
   - All the joints in both X_1, X_2 and Y_1, Y_2 direction was observed to below 1.5.

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