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Effect of Mass Irregularity on Building

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Abstract: The failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. The Analysis and design becomes complicated when these structures are constructed in high seismic zones. Hence seismic performance of irregular structures becomes very much important. In the present work an effort has been made to find the most efficient building model amongst all having mass irrgulatiy at different floor levels. After analysing it was found that change in mass irregularity effects seismic behaviour of building

Keywords: Staad Pro. Dynamic Analysis, Mass Irregularity, Displacement, Axial forces

I. INTRODUCTION

It is well known that failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. The structures having this discontinuity are termed as Irregular structures. Vertical irregularities plays major role in of failures of structures. Height-wise changes in stiffness and mass render the dynamic characteristics of these buildings different from the ‗regular' building. The irregularity in the building structures may be due to irregular distributions in their mass, strength and stiffness along the height of building.

There are two types of irregularities-

A. Plan Irregularities
B. Vertical Irregularities.

Vertical Irregularities are mainly of five types:

1) Stiffness Irregularity -
a) Soft Story- A soft story is one in which the lateral stiffness is less than 70 percent of the story above or less than 80 percent of the average lateral stiffness of the three story's above.
b) Extreme Soft Story- An extreme soft story is one in which the lateral stiffness is less than 60 percent of that in the story above or less than 70 percent of the average stiffness of the three story's above.
2) Mass Irregularity- Mass irregularity shall be considered to exist where the weight of any story is more than 200 percent of that of its adjacent story's. In Case of roofs irregularity need not be considered.
3) Vertical Geometric Irregularity- A structure is considered to be Vertical geometric irregular when the horizontal dimension of the lateral force resisting system in any story is more than 150 percent of that in its adjacent story.
4) In-Plane Discontinuity in Vertical Elements Resisting Lateral Force-An in-plane offset of the lateral force resisting elements greater than the length of those elements.
5) Discontinuity in Capacity — Weak Story-A weak story is one in which the story lateral strength is less than 80 percent of that in the story above.

II. DETAILED METHODOLOGY

A. General Data Collection

Before starting and deciding the actual work path some general data related to materials, types of framing systems, types of irregularities, various types of seismic analysis methods were collected and studied. Based on the above said collected data various parameters will be decided in the further chapters.

B. Literature Study

After collecting basic data various literatures were collected and studied to decide the case consideration and variable to be compared to get the most efficient model with varying mass locations. Various literatures were studied related to effect of irregularity, mass variation, effect of infill, effect of framing systems, from which it is found that any type of irregularity makes severe effects on building during the action of earthquake, which are to be action in consideration to save the lives during any earthquake damage.

C. Materials and Model

To get the future fruitful results which will help the society from making lives more safe during occurrence of earthquake various combinations will be tried to get the most reliable material framing and, also framing pattern according to seismic zones. A G+10 RCC framed model is considered for analysis having a symmetric geometry. The structural size were decided on the basis of the various literates studied and considering practical site considerations.

D. Loading and Analysis

For the detail study of work it is required to consider all possible and important loads which are likely to be acting on building during gravity and seismic action. For this purpose types of loads and their intensities will be considered as per the particular Indian code such as IS 875 part-01 and 02 for dead load and live load and IS 1893 part 01 for seismic loading on building. All loadings and their combinations will be studied as load combinations make more significant effect on the seismic loading and behavior of building. As these loading and loading combinations will be tedious will manual calculations structural design software Staad Pro. will be used for analysis and design.

E. Method of Analysis

As per the prevailing Indian code Is 1893 there are two basic types of analysis method 1) Equivalent Static or seismic coefficient method and 2) Dynamic analysis. In dynamic analysis there are two more options 1) response spectrum and 2) Time history analysis. In the present work all models will be analyzed using seismic coefficient method according to the guidelines given in code.

F. Result Comparison And Conclusions

After analyzing all models comparative charts and tables will be plotted to study the details behavior of every model and comparative study will be focused to find the most efficient storey level irregularity.

III.MODELLING AND ANALYSIS

A. Design Parameters

Table 1.1 below gives all the parametric values of loads materials, and structural elements which are going to be use in the present work.

Table 1 Design parameters

Parameter	Values
Live load	2.0 kN/m2 at typical floor
Irregular mass Load	4.0 kN/m2
Floor finish	0.50 kN/m2
Water proofing	2.0 kN/m2
Terrace finish	1.0 kN/m2
Location	ZONE II
Earthquake load	As per IS-1893 (Part 1) – 2002
Depth of foundation below ground	1.8 m
Type of soil	Type I, Hard as per IS:1893
Storey height	Typical floor: 3.35 m,
Floors	G.F. + 10 upper floors
Beam Size	300mm x 450 mm
Column	300mm x 450mm
Slab thickness	125 mm
Type of frame	SMRF
Importance factor	1.5
Response reduction factor	5
Damping ratio	0.05

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B. Model Nomenclature

Table 4.2 below gives the details regarding model label and number of models to be analysed

Table 2 Model Nomenclature

Sr No	Model Description	Label
01	Mass irregularity on 1st floor in Zone II	M1
02	Mass irregularity on 3rd floor in Zone II	M2
03	Mass irregularity on 5th floor in Zone II	M3
04	Mass irregularity on 8th floor in Zone II	M4
05	Mass irregularity on 10th floor in Zone II	M5

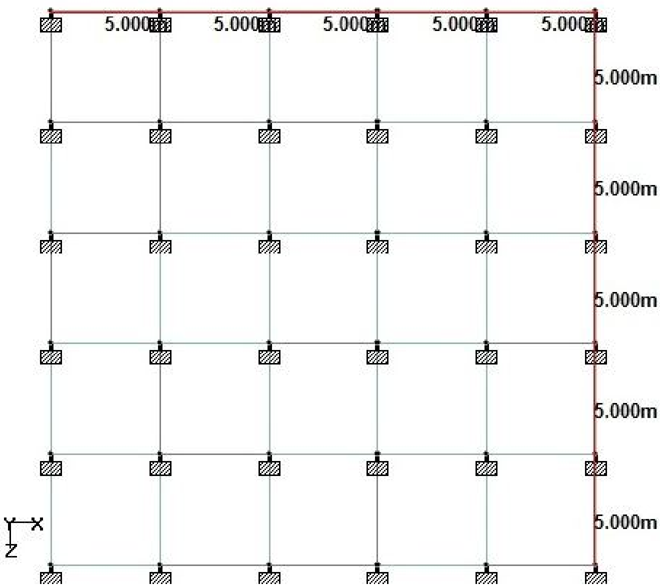


Fig. 1 Plan of Model

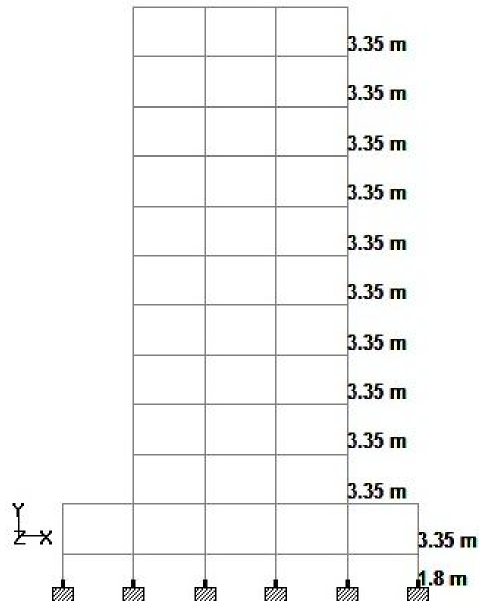


Fig 2 Section for model M1

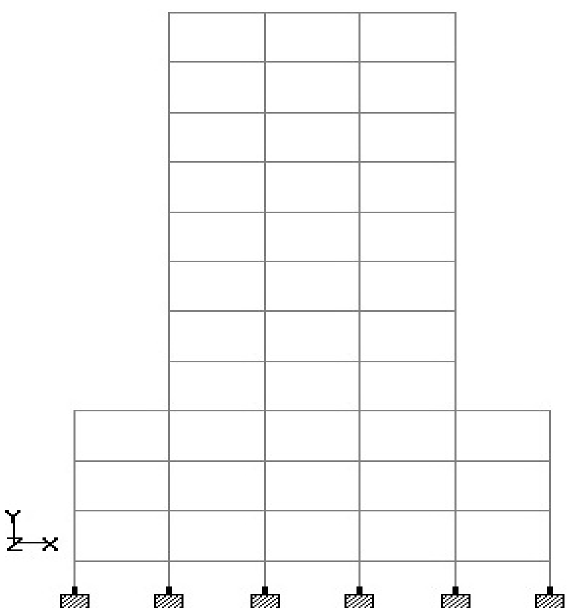


Fig 3 Section for model M2

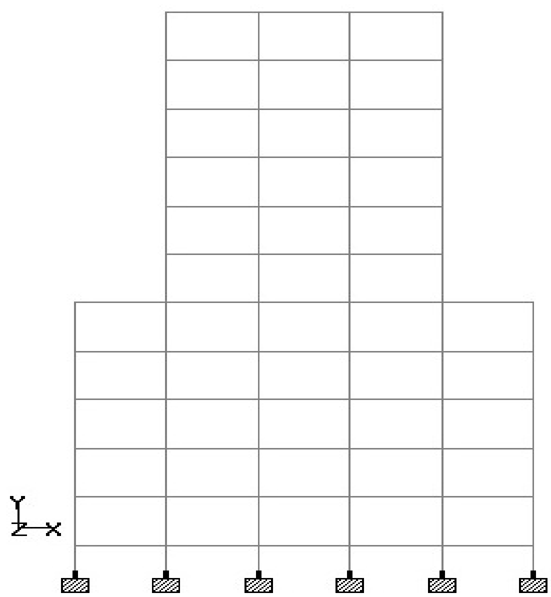


Fig 4 Section for model M3

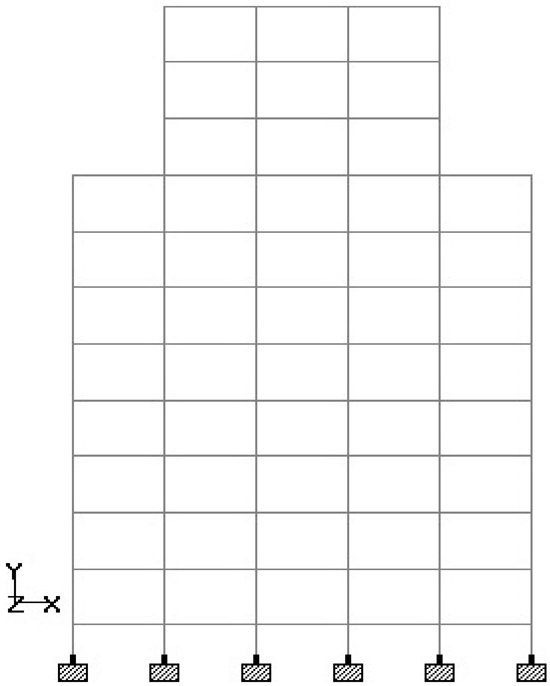


Fig 5 Section for model M4

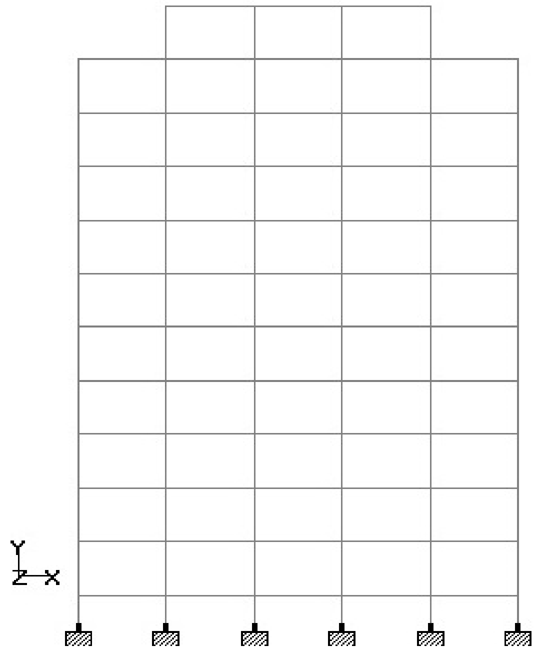


Fig 6 Section for model M5

IV. RESULTS AND COMPARISONS

Table 3 Axial force and bending moment comparison

Sr. No	Model	Max. Axial Force (KN)			Max. Bending Moment (KN.M)		
		FX	FY	FZ	MX	MY	MZ
1	M1	3056.46	61.81	38.45	2.63	64.74	78.74
2	M2	3109.29	69.10	42.92	3.60	71.97	98.47
3	M3	3181.94	73.24	41.63	3.99	77.20	112.27
4	M4	3311.59	73.83	39.78	3.45	73.29	112.26
5	M5	3408.52	71.48	37.45	2.63	68.75	102.44

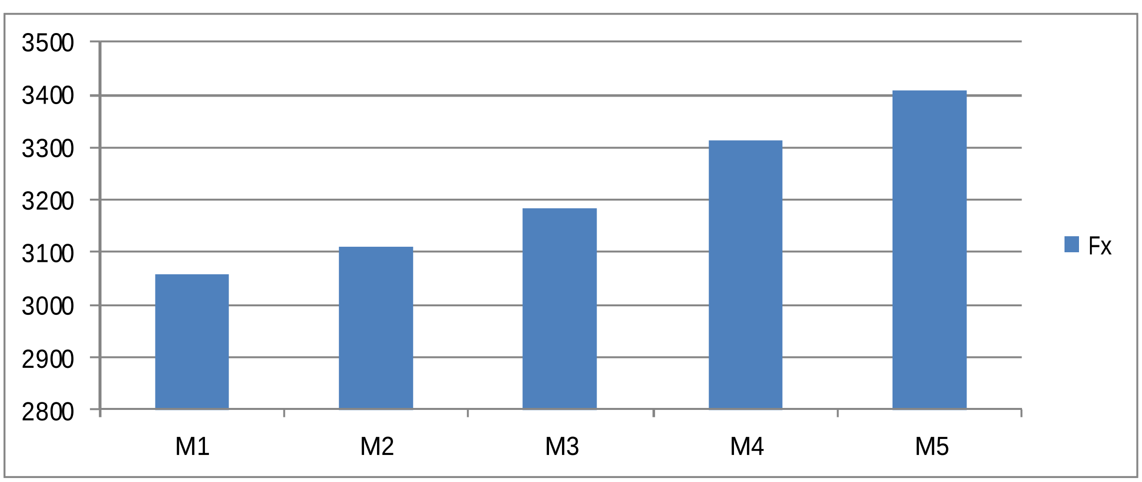


Table 4 Displacement Comparison

Sr. No	Model	Direction (MM)			Resultant
		X	Y	Z	
1	M1	35.19	0.77	53.42	55.92
2	M2	34.57	0.75	53.00	55.59
3	M3	30.66	0.54	47.66	50.66
4	M4	27.49	0.46	43.32	46.92
5	M5	31.05	0.64	48.80	52.27

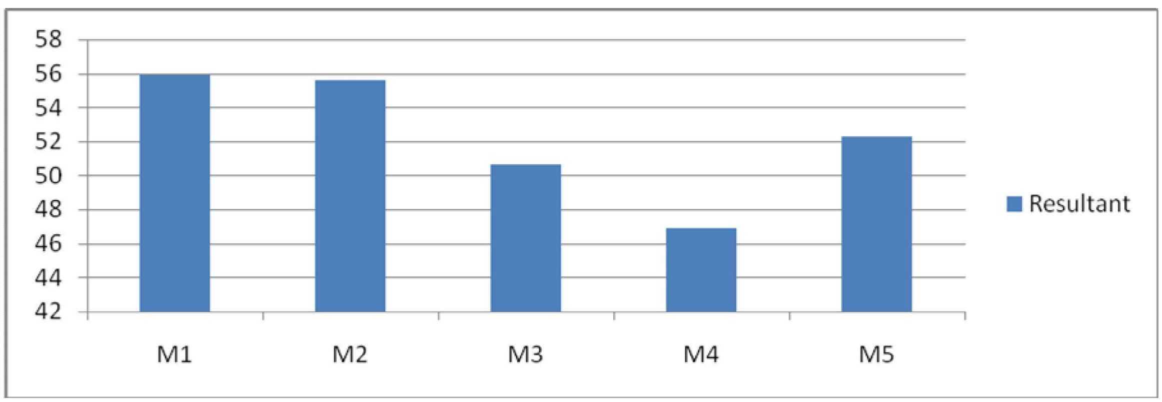
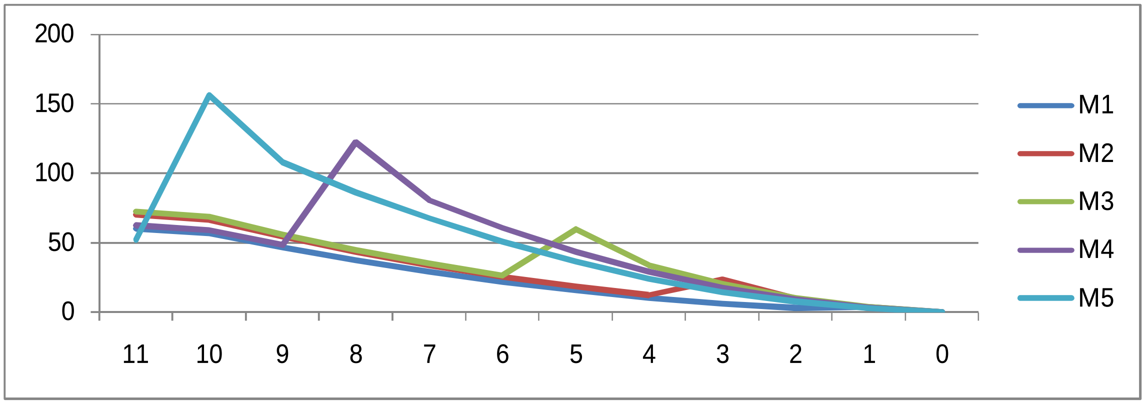


Table 5 Base Shear Distribution Comparison

Sr. No	Storey Height (M)	Storey No.	Model				
			M1	M2	M3	M4	M5
1	41.85	11	60.18	70.13	72.46	62.62	52.37
2	38.50	10	56.87	66.28	68.48	59.18	156.13
3	35.15	9	46.59	54.30	56.10	48.48	107.91
4	31.80	8	37.33	43.51	44.95	122.55	86.47
5	28.45	7	29.10	33.91	35.04	80.59	67.40
6	25.10	6	21.89	25.51	26.36	60.62	50.70
7	21.75	5	15.71	18.30	59.66	43.49	36.38
8	18.40	4	10.55	12.29	33.79	29.20	24.42
9	15.05	3	6.41	23.56	20.54	17.75	14.84
10	11.70	2	3.30	10.23	10.57	9.13	7.64
11	8.35	1	3.82	3.76	3.88	3.35	2.80
12	5.00	0	0.11	0.13	0.13	0.11	0.10



V. CONCLUSIONS

From all above results and comparative tables following conclusions were drawn

A. Horizontal moments in mass irregularity vary by 20 % for each model.
B. As the heavier mass goes upward it results in lowering value of displacement, building having heavier masses at top shows 5% lower displacement than buildings having heavier masses at lower storey.
C. Buildings with heavier masses at top level shows comparatively drastic storey shear distribution than buildings having mass irregularity on lower storey level
D. Compared to beams, column shows 3 to 4 times lower bending moment value.

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