IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 1, June 2022
Impact Factor: 6.252

Comparative Seismic Analysis of Structure Having Vertical Irregularities and Varying Configuration

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Abstract: *Linear dynamic analysis is an improvement in linear static analysis, as this analysis gives the effect of higher vibration modes and the actual distribution of forces in the elasticity range in the best way. The houses are designed according to the design-based earthquake (DBE), but the actual forces acting on the structure are much larger than those of the DBE. Thus, in higher seismic zones, a plastic-based approach is preferable because the plasticity of the structure narrows the gap. This work is related to the analysis of a structure that has inequality, different models are compared graphically, and a tabular comparison is prepared. Various models include a structure 24 m, 33 m and 45 m high. The earthquake zone also varies from II, III, IV and V for those structures with inequalities. The 9 to 12 model gives the maximum time period (sec), while the 1 to 4 models give the minimum time period value (sec). Maximum participation in the mass, while the models 1 to 4 give a minimum value of mass participation. Maximum frequency (Hz), while models 9 up to 12 give a minimum frequency value (Hz).*

Keywords: Base Shear; base shear; displacement; time period; Vertical Irregularity

I. INTRODUCTION

Inequality of building structures may be due to incorrect distribution of their mass, strength and rigidity by height of the building.

1. Irregularity plan 2. Vertical disorders. Vertical disorders mainly consist of five types -

1) a) Fault is a soft, superficial soft, in which the lateral stiffness is less than 70 percent of the floor above or less than 80 percent of the average lateral stiffness of the three floors above.

b) Firmness - Extreme Soft Storey-An extreme moft story - this is the one, in which the lateral rigidity is less than 60 percent of that in the store above or less than 70 percent of the average rigidity of the three floors above.

2) Mass irregularity-mass inequality is considered to be when the seismic mass of any floor exceeds 200 percent of the weight of the adjacent floors. In case of uneven roofs should not be considered.

3) Vertical geometric irregularity - A structure is considered to be vertically geometric irregular when the horizontal size of the resisting lateral force system on any floor exceeds 150 percent of that on its adjacent floor.

4) Continuity on the plane in vertical elements that resist the lateral displacement of the force-plane of the lateral force, which resists the elements greater than the length of these elements.

5) Capacity continuity - a weak floor - is one in which the root lateral strength is less than 80 percent of that in the store above.

According to IS 1893, Part 1 Linear static analysis of structures can be used for regular structures of limited height, because in this process lateral forces are calculated according to the main period of time of the structure based on code.

II. LITERATURE REVIEW

AND. IS. Hassaballa et al. (2013) seismic analysis of the RC multi-storey frame in Khartoum was analyzed under moderate earthquake loads as a seismic hazard and in accordance with the seismic provisions, proposed for Sudan examines the effectiveness of existing buildings if they are exposed to seismic loads. The frame was analyzed using a reaction spectrum method to calculate seismic displacements and stresses. The results apparently show that the movement of nodes caused drifts in excess of approximately 2 to 3 times the allowable drifts. Horizontal motion has a greater effect

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on the axial compression loads of the outer columns compared to the inner columns, and the compressive stresses in the columns of the first floor were approximately 1.2 - 2 times the tensile stress.

Himanshu Bansal et al. (2012) analyzed the response spectrum (RSA) and analyzed the history of time (THA) of vertically irregular frames of RC buildings and made a design based on plasticity using IS 13920, corresponding to the equivalent of static analysis and analysis of time history. Three types of violations were considered, namely mass inequality, rigidity inequality and inequality of vertical geometry. Observations have shown that the shear force in the store is maximum for the first floor, and it is reduced to a minimum on the top floor in all cases.

III. METHODOLOGY

The following models are analyzed using STAAD-PRO software

1. Model-1: Irregular building – 24 m (EQ-2)
2. Model-2: Irregular building – 24 m (EQ-3)
3. Model-3: Irregular building – 24 m (EQ-4)
4. Model-4: Irregular building – 24 m (EQ-5)
5. Model-5: Irregular building – 33 m (EQ-2)
6. Model-6: Irregular building – 33 m (EQ-3)
7. Model-7: Irregular building – 33 m (EQ-4)
8. Model-8: Irregular building – 33 m (EQ-5)
9. Model-9: Irregular building – 45 m (EQ-2)
10. Model-10: Irregular building – 45 m (EQ-3)
11. Model-11: Irregular building – 45 m (EQ-4)
12. Model-12: Irregular building – 45 m (EQ-5)

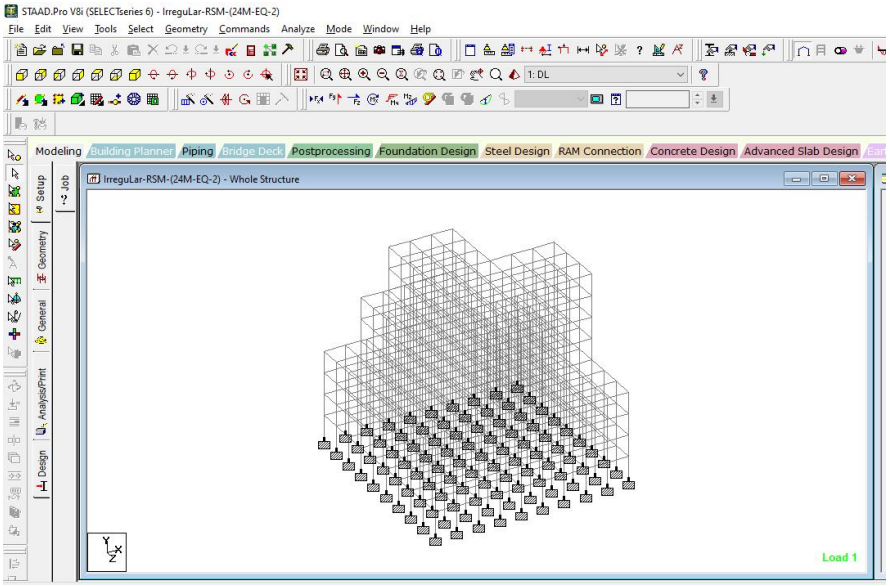

Figure 1: **Geometry of the model**

The above figure is generated in the STAAD-PRO software, the geometry of the model is mentioned in this diagram.

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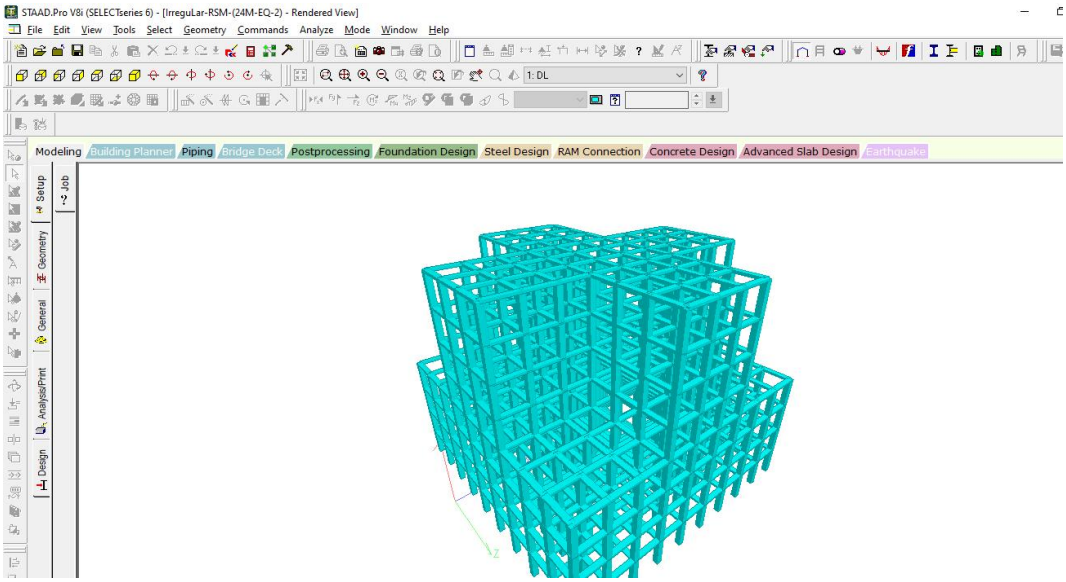

Figure 2:3D view of the model

The above figure is generated in the STAAD-PRO software, the 3D view of the model is mentioned in this diagram.

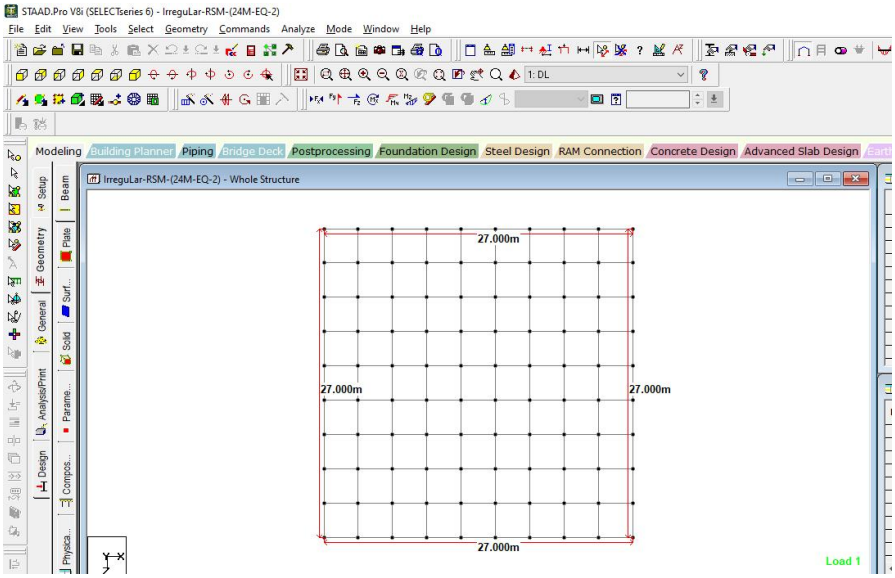

Figure 3:Plan of the model

The above figure is generated in the STAAD-PRO software, the plan of the model is mentioned in this diagram.

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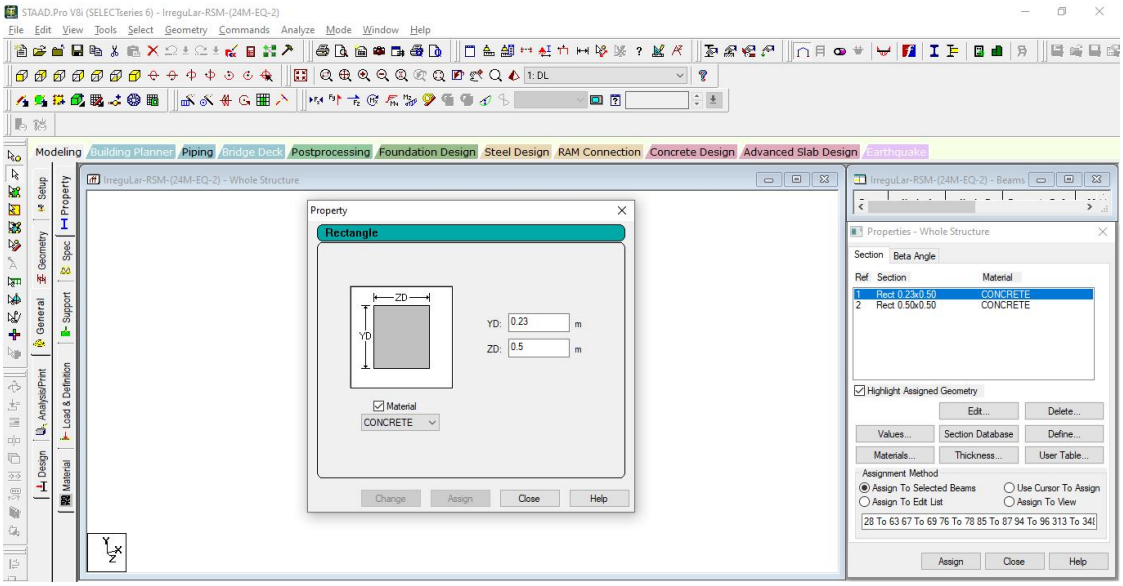

Figure 4:Property assignment of the model

The above figure is generated in the STAAD-PRO software, the Property assignment of model is mentioned in this diagram.

III. RESULTS & DISCUSSIONS

The following results are obtained from the different models and the graphs and tables are mentioned as follows.

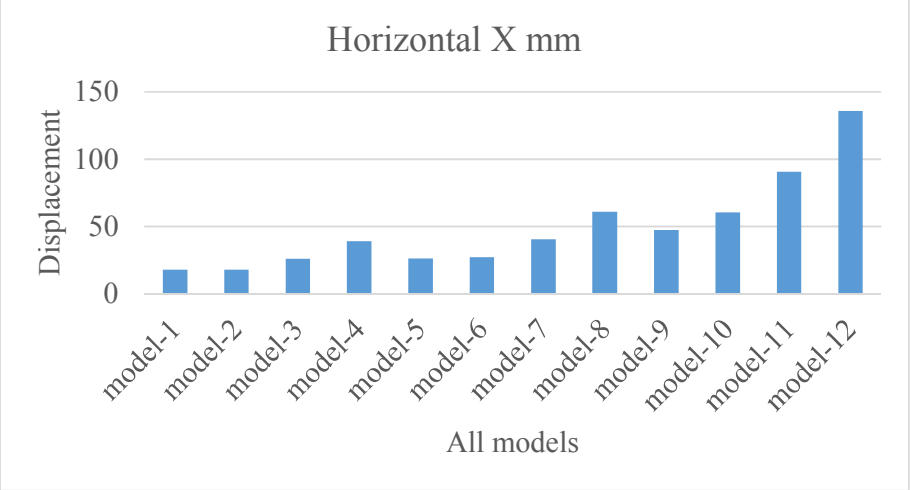

Figure 5:Horizontal Displacement (X) for all the model

The above graph is generated for the Horizontal Displacement (X) for all the model, from the graph it is observed that the model-12 (Irregular building – 45 m (EQ-5)) has the maximum value of the displacement while the model-1 (Irregular building – 24 m (EQ-2)) has minimum value of the displacement.

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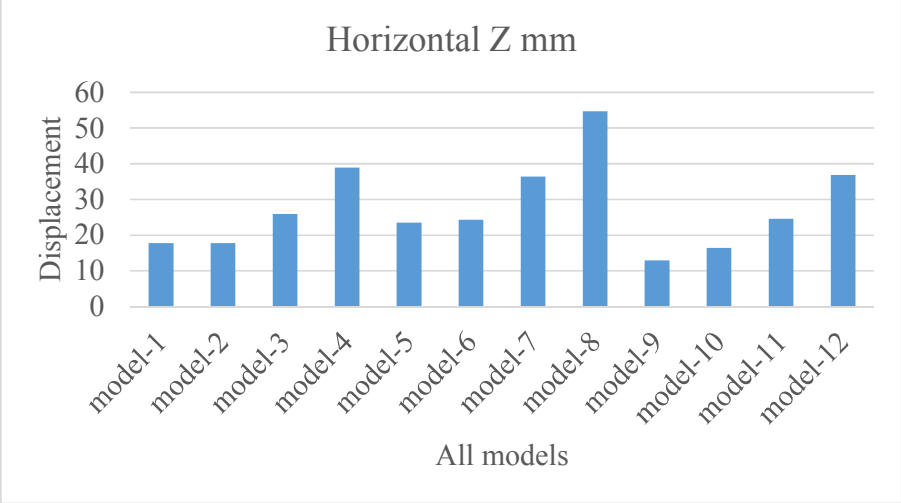

Figure 6:Horizontal Displacement (Z) for all the model

The above graph is generated for the Horizontal Displacement (Z) for all the model, from the graph it is observed that the Model-8: Irregular building – 33 m (EQ-5) has the maximum value of the displacement while the Model-9: Irregular building – 45 m (EQ-2) has minimum value of the displacement.

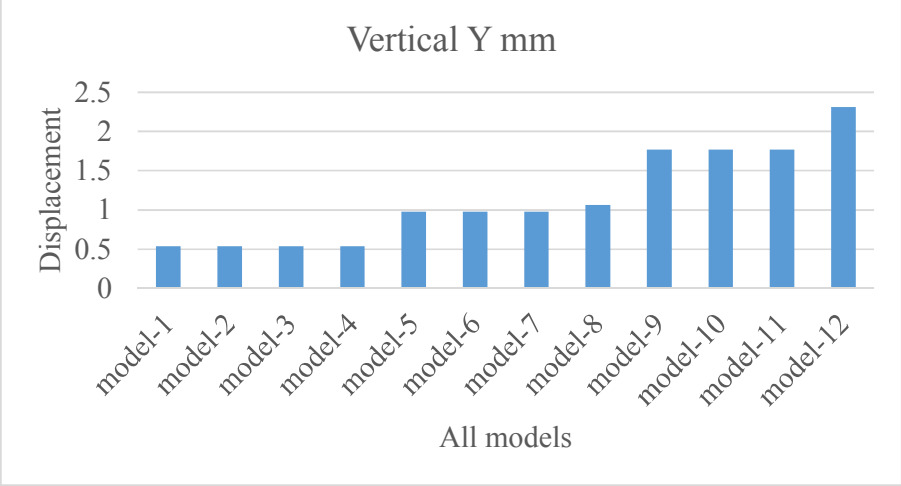

Figure 7:Vertical Displacement (Y) for all the model

The above graph is generated for the Vertical Displacement (Y) for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the displacement while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement.

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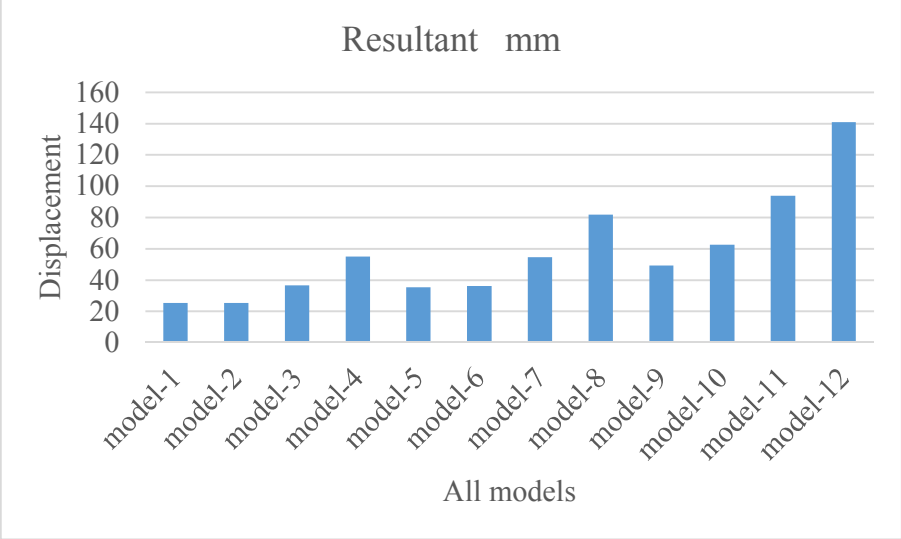

Figure 8:Resultant Displacement for all the model

The above graph is generated for the Resultant Displacement for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the displacement while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement.

Table 0.1: Reaction forces for all the models

All models	Horizontal Fx kN	Vertical Fy kN	Horizontal Fz kN
model-1	15.993	215.826	15.985
model-2	15.993	215.826	15.985
model-3	23.271	215.826	23.259
model-4	34.906	215.826	34.889
model-5	15.667	296.046	14.465
model-6	16.17	296.046	14.929
model-7	24.255	296.046	22.393
model-8	36.382	305.449	33.59
model-9	19.028	401.443	8.268
model-10	24.272	401.443	10.547
model-11	36.408	401.443	15.82
model-12	54.612	558.209	23.73

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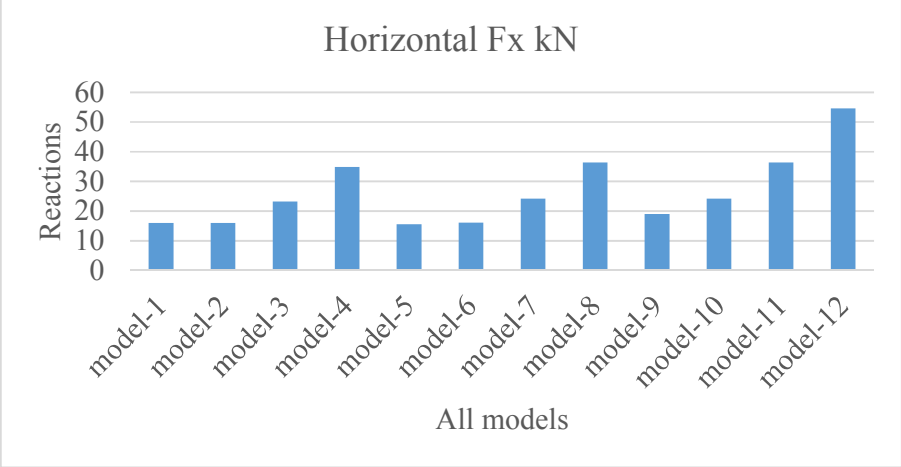

Figure 9:Horizontal Reaction (Fx) for all the model

The above graph is generated for the Horizontal Reaction (Fx) for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the Horizontal Reaction (Fx) while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

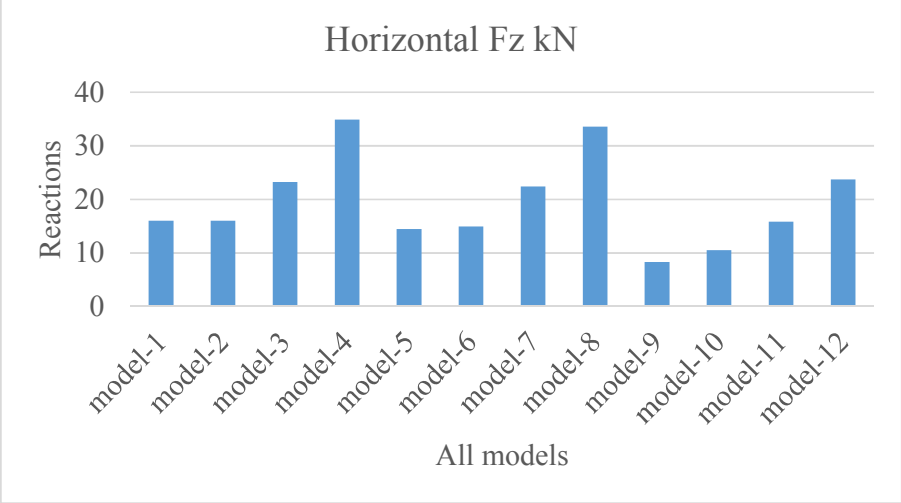

Figure 10:Horizontal Reaction (Fz) for all the model

The above graph is generated for the Horizontal Reaction (Fz) for all the model, from the graph it is observed that the Model-4: Irregular building – 24 m (EQ-5) has the maximum value of the Horizontal Reaction (Fz) while the Model-9: Irregular building – 45 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

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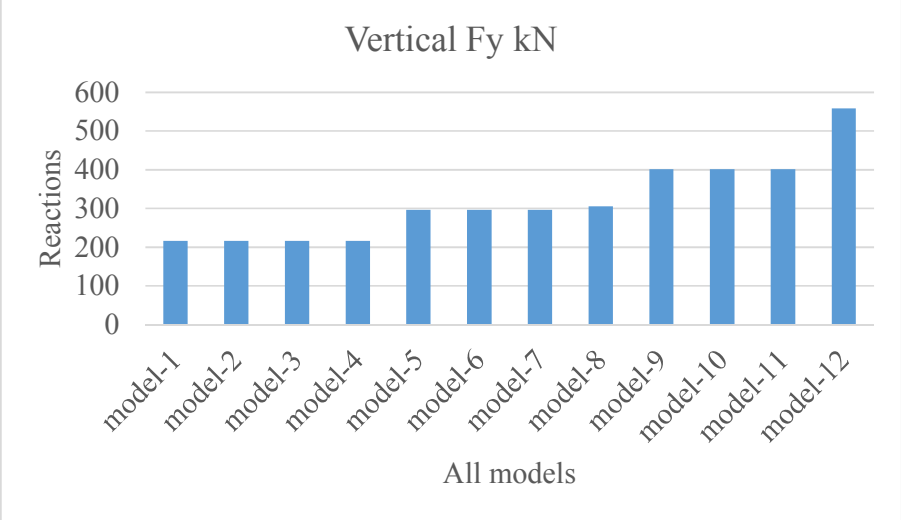

Figure 11:Vertical Reaction (Fy) for all the model

The above graph is generated for the Vertical Reaction (Fy) for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the Vertical Reaction (Fy) while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

Table 0.2: Reaction moment for all the models

	Moment		
All models	Mx kNm	My kNm	Mz kNm
model-1	49.171	0.234	49.196
model-2	49.171	0.234	49.196
model-3	71.546	0.341	71.582
model-4	107.319	0.511	107.373
model-5	45.22	0.14	49.142
model-6	46.671	0.144	50.719
model-7	70.006	0.216	76.078
model-8	105.009	0.324	114.117
model-9	25.722	0.069	60.628
model-10	32.81	0.088	77.335
model-11	49.215	0.132	116.002
model-12	73.823	0.197	174.003

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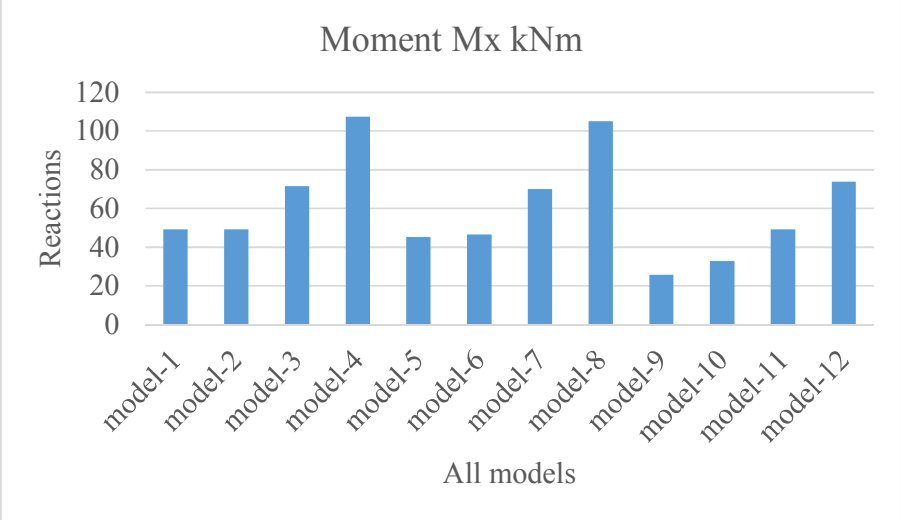

Figure 12:Moment (Mx) for all the model

The above graph is generated for the Moment (Mx) for all the model, from the graph it is observed that the Model-4: Irregular building – 24 m (EQ-5) has the maximum value of the Moment (Mx) while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

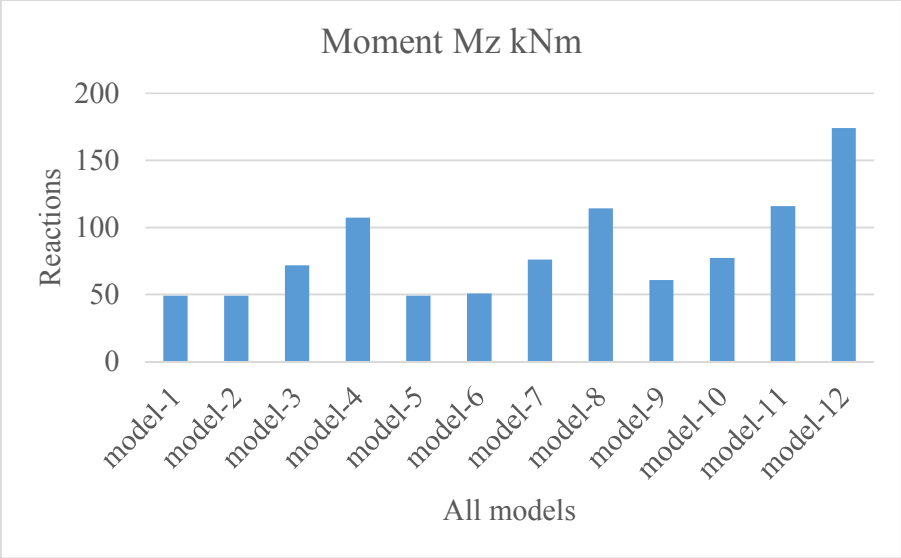

Figure 13:Moment (Mz) for all the model

The above graph is generated for the Moment (Mz) for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the Moment (Mz) while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

Table 0.3: Beam forces for all the models

All models	Fx kN	Fy kN	Fz kN
model-1	215.826	17.081	17.072
model-2	215.826	17.081	17.072

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model-3	215.826	24.854	24.841
model-4	215.826	37.281	37.261
model-5	296.046	18.262	16.675
model-6	296.046	18.847	17.21
model-7	296.046	28.271	25.815
model-8	305.449	42.407	38.723
model-9	401.443	23.021	10.458
model-10	401.443	29.364	13.34
model-11	401.443	44.046	20.009
model-12	558.209	66.069	30.014

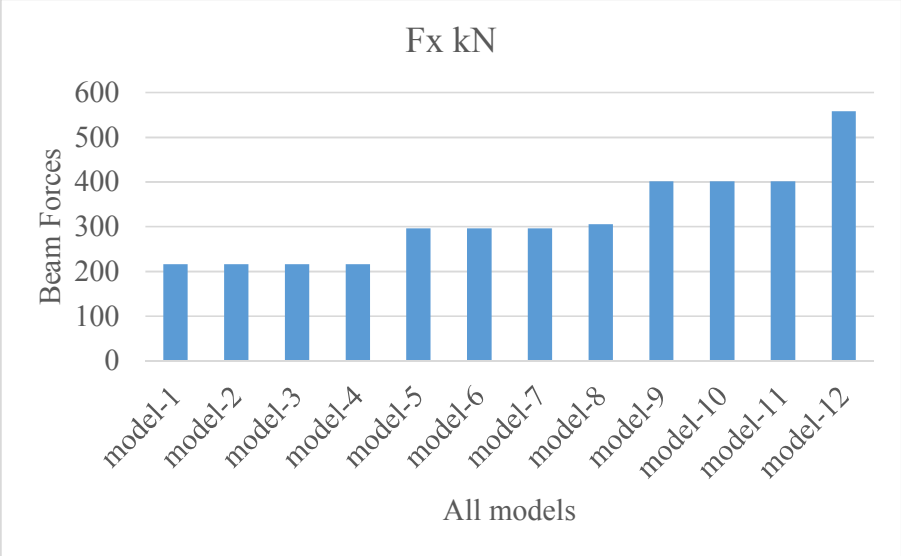

Figure 14:Beam forces (Fx) for all the model

The above graph is generated for the Beam forces (Fx) for all the model, from the graph it is observed that the Model-12: Irregular building – 45 m (EQ-5) has the maximum value of the Beam forces (Fx) while the Model-1: Irregular building – 24 m (EQ-2) has minimum value of the displacement Horizontal Reaction.

IV. CONCLUSION

The present work is related to the analyzing the structure having irregularity, the different models have been compared graphically and tabular comparison is also prepared. The different models includes the structure with heights of 24m, 33m & 45m. The earthquake zone is also varied from zone II, III, IV & V for those structures with irregularities. The following conclusions are made.

1. The model 9 to 12 gives the maximum Time period (sec) while the models 1 to 4 gives the minimum value of Time period (sec).
2. The maximum Mass Participation while the models 1 to 4 gives the minimum value of Mass Participation.
3. The maximum frequency (Hz) while the models 9 to 12 gives the minimum value of frequency (Hz).

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