"SEISMIC ANALYSIS OF MULTISTOREY RC BUILDING WITH MASS IRREGULARITY USING ETABS"

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Abstract - The comparison of the seismic evaluation of RC buildings with and without mass irregularity. In this analysis for mass irregular buildings with floor mass is varied by considering the slab thickness and thickness is varied from 0.125m to 0.25m and analysis is done by using ETAB 2015 version. The analysis has been carried out for various parameters like storey displacements, storey drift, Storey shear . The results shows that The displacement is high in model IV compared to remaining models and is minimum in model V. The storey drift is high in the model II compared to remaining models and is minimum in model V. Shear is high in model IV compared to remaining models and is minimum in model V.

Key Words: ETABS-2015, Storey Displacement, Storey Drift, Storey Shear, Seismic Evaluation.

1. INTRODUCTION

Earthquakes are one of the most destructive of natural hazards. Earthquake occurs due to sudden transient motion of the ground as a result of release of elastic energy in a matter of few seconds. The impact of the event is most traumatic because it affects large area, occurs all on a sudden and unpredictable. Earthquake not only damage villages, towns and cities but also leads to economic and social system of a country. The vibration can affects settlement. Some of the soil types like, alluvial or sandy, silts get fail during earthquake when compare to other soils. Earthquake can be measured by Magnitude (M) which was obtained by recording the data of motions on seismograms. But shaking of the ground surface will have different intensities at different locations for the same magnitude. This can be measured by MMI scale.

1.1 FLOOR MASS IRREGULARITY

Floor mass irregularity is the occurrence of large mass on a floor or when one floor is much more when compare to other floors, e.g., heavy structures like machinery or a swimming pool installed on an intermediate floor of a building. In case of unavoidable situations or non-compliance the ratio of mass to stiffness of two adjacent Storey's should be made equal. Mass irregularities cause the dynamic response of the structure by increasing ductility demands at a few locations and lead to unexpected higher mode effects.

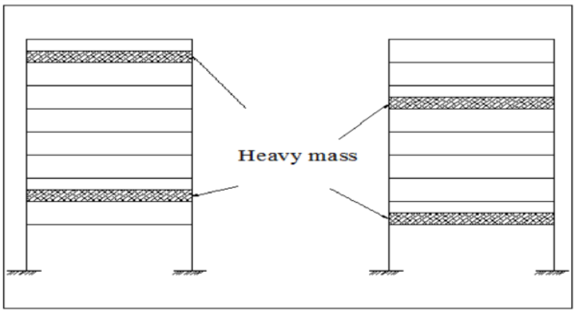

Figure 1. Mass Irregularities

1.2 OBJECTIVES OF PRESENT WORK

- To study the seismic performance of building without mass irregularity.
- To study the seismic performance of building with mass irregularity.
- To compare the behavior of building without mass irregularity and with mass irregularity.

1.3 SCOPE OF WORK

Considering the observations a project study was undertaken with a view to determine the extent of possible changes in the seismic performance of low, medium and high rise RC framed buildings. For the seismic performance of a different height RC framed building has been considered with mass irregularity G+10 building with increase in floor mass. Regular configurations of such buildings taken for study are provided. The effect mass irregularity in the buildings is studied in terms of variations in storey drift, base shears, top roof displacements and performance point.

2. MATERIALS AND METHODOLOGY

Here the layout of the building is regular; hence the building has been analyzed by a 3D space frame model. Which consisting of assemblage of slab, beam, and column elements. Any tensional effects are automatically considered in this model. The buildings will be designed for gravity loads and evaluated for seismic forces.

2.1 MODELLING CONSIDERATION

This is based on the following assumptions:

- The floors are rigid in their planes having 3 DOF‟s, to horizontal translations and a single rotation about a vertical axis.
- The mass of building and mass moment of inertia are lumped at the floor levels at the corresponding degrees of freedom.

2.2 DISCRIPTION OF BUILDING MODEL

General details of building

Number of Stories: G+10
Bottom storey height: 3.0 m
Storey height: 3.0 m
Building frame system: Special Moment Resisting Frames (SMRF) Building use: Commercial
Seismic zone: Zone IV
Soil type: Medium soil

Material Properties

Grade of Concrete for column: M25
Grade of Concrete for beam: M25
Grade of Steel: Fe 500
Density of Concrete: 25 kN/m^3

Load Intensities

Floor finish: 1 kN/m^2
Live Load at Floor: 3.5 kN/m^2
Beam size: 250x400mm
Column size: 350x750
Slab thickness: 125mm (for regular building), 250(for mass irregular building)

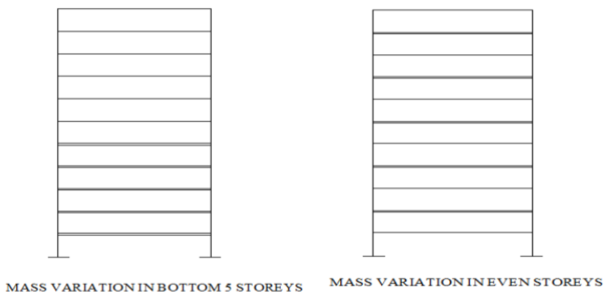

Figure 2. Bottom 5 Storey and even floor mass irregular

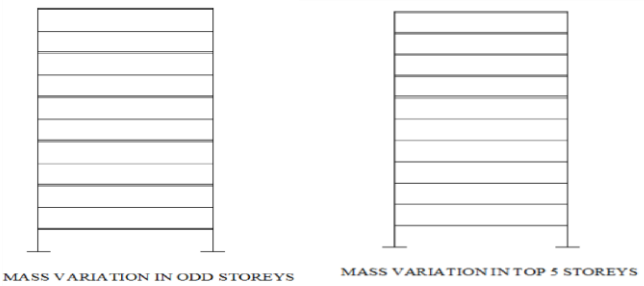

Figure 3. Bottom 5 Storey and even floor mass

In the present study reinforced concrete moment resisting frame building of G+ 10 storeys is considered. The considered five models which are having different loading criteria in which four having mass irregularity criteria and one having regular building, the plan layout, elevations and 3D as depicted below for buildings with and without floor mass irregularity are as shown in the below Figures. The different configurations of buildings are modeled by considering only by varying the slab thickness and nonlinear behavior of seismic demands. The first model comes up with G+10 and the difference is that the first 5 storey‟s having slab thickness 250mm and all remaining storey‟s having 125mm thick slab. Second model comes with top 5 floor slab thickness with 250mm thick and remaining floors having 125mm thick slab. Third model is having slab thickness has been varied in even floors only means in 2, 4, 6, 8,10th floors slab having 250mm thick. Fourth model is having slab thickness has been varied in odd floors that is in 3, 5, 7, 9,11th floors the slab is having 250mm thick. And the last model that is the regular building with uniform slab thickness 125mm through. Each storey height has kept to 3m and is same for all kind of building models. The building is considered to be located in the seismic zone IV and intended for commercial purpose.

- Model-I –Building with floor mass irregularity i.e., increase the slab thickness for first 5 bottom floors in building.
- Model-II-Building with floor mass irregularity i.e., increase the slab thickness for top 5 floors in building.
- Model-III-Building with floor mass irregularity i.e., increase of slab thickness in even floors only and in other floors it will be kept to 125mm thickness.
- Model-IV-Building with floor mass irregularity i.e., increase of slab thickness in odd floors and in other floors it will be 125mm thick.
- Model-V – Building without mass irregularity i.e., building assemblage of regular.

METHODOLOGY

This is based on the following assumptions

- The floors are rigid in their planes having 3 DOF‟s, to horizontal translations and a single rotation about a vertical axis.
- The mass of building and mass moment of inertia are lumped at the floor levels at the corresponding degrees of freedom.

3.0 RESULTS AND DISCUSSION

An effort in made to study the behavior of regular RC buildings in comparison with RC buildings having mass irregularity at different floor levels. Here in the present study, the behavior of each models are captured and the results are tabulated in the form of Base shear, top displacements and inter Storey drifts, Storey shear in linear analysis.

3.1. STOREY DISPLACEMENT

3.1.1 DISPLACEMENT IN X- DIRECTION

Table 1: Storey Displacement in X-Direction

Height of the Building (m)	Model I Displacement (mm)	Model II Displacement (mm)	Model III Displacement (mm)	Model IV Displacement (mm)	Model V Displacement (mm)
33	106.9	110.9	109.1	114.3	100.8
30	102.6	106.1	104.7	109.4	96.6
27	96.8	99.7	98.7	103	91.1
24	89.5	91.6	91.1	94.8	84
21	80.6	81.7	81.8	85	75.4
18	70.3	70.3	70.9	73.7	65.4
15	58.6	57.7	58.6	60.9	54.1
12	45.6	44.1	45.2	47	41.7
9	31.6	30.1	31.0	32.3	28.6
6	17.6	16.5	17.1	17.8	15.8
3	5.6	5.2	5.4	5.7	5

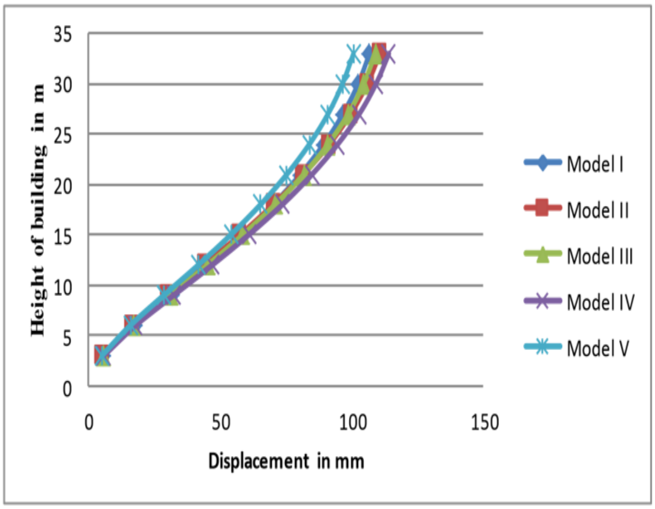

Figure 4. Displacement in X-Direction

3.1.2 DISPLACEMENT IN Y-DIRECTION

Table 2: Storey Displacement in Y-Direction

Height of the Building (m)	Model I Displacement (mm)	Model II Displacement (mm)	Model III Displacement (mm)	Model IV Displacement (mm)	Model V Displacement (mm)
33	128.1	133.2	130.3	131	120.5
30	124.6	129.1	126.8	126.9	117.2
27	119	122.7	120.9	120.8	111.7
24	111.3	113.9	112.8	112.3	104.2
21	101.6	102.9	102.6	101.9	94.7
18	90.2	90	90.5	89.8	83.5
15	77.1	75.6	76.7	76.1	70.8
12	62.2	60	61.3	60.8	56.6
9	45.6	43.3	44.5	44.2	41.1
6	27.6	25.9	26.8	26.6	24.7
3	10.1	9.4	9.7	9.7	9

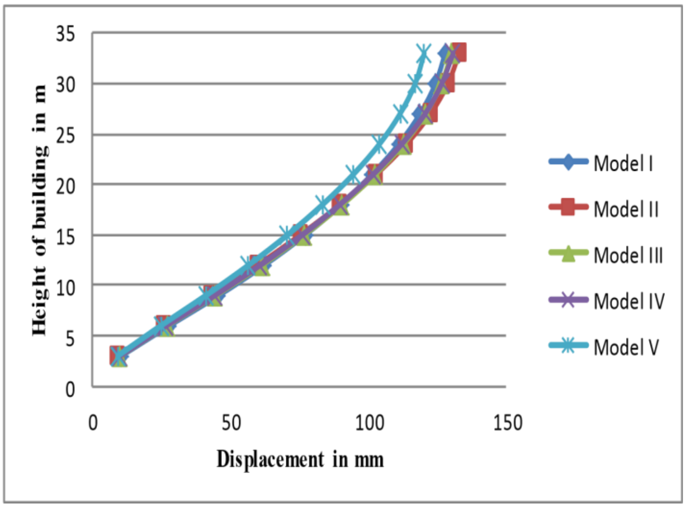

Figure 5. Displacement in Y-Direction

3.2 STOREY DRIFTS

Inter Storey drifts for different models are obtained from the analysis are shown in Table below. Inter Storey drifts profile can also be observed in Figure.

According to IS 1893(Part 1):2002 clause 7.11.1 Storey drifts limitations are explained that the Storey drifts in any storey due to the minimum specified design lateral force, with partial load factor of 1.0 shall not exceed 0.004,(0.004h) times the storey height.

3.2.1 STOREY DRIFT IN X – DIRECTION

Table 3: Storey Drift in X-Direction

Height of the Building (m)	Model I Drift	Model II Drift	Model III Drift	Model IV Drift	Model V Drift
33	0.0018	0.0020	0.0018	0.0020	0.0017
30	0.0024	0.0026	0.0025	0.0026	0.0023
27	0.0030	0.0032	0.0031	0.0032	0.0028
24	0.0035	0.0037	0.0036	0.0037	0.0033
21	0.0039	0.0041	0.0040	0.0041	0.0037
18	0.0042	0.0044	0.0043	0.0045	0.0040
15	0.0045	0.0046	0.0046	0.0048	0.0042
12	0.0047	0.0047	0.0047	0.0049	0.0044
9	0.0047	0.0045	0.0046	0.0048	0.0042
6	0.0039	0.0037	0.0039	0.0040	0.0035
3	0.0018	0.0017	0.0018	0.0019	0.0016

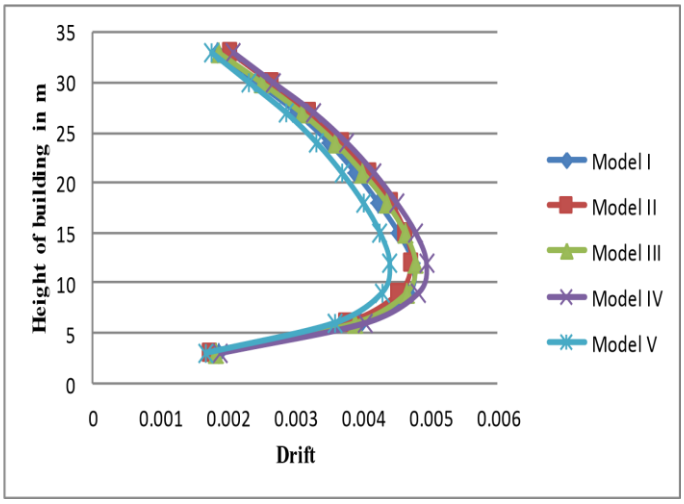

Figure 6. Storey Drift in X-Direction

3.2.2 STOREY DRIFT IN Y – DIRECTION

Table 4: Storey Drift in Y-Direction

Height of the Building (m)	Model I Drift	Model II Drift	Model III Drift	Model IV Drift	Model V Drift
33	0.0016	0.0019	0.0016	0.0019	0.0016
30	0.0026	0.00289	0.00271	0.00284	0.00247
27	0.0033	0.00364	0.00346	0.00357	0.00319
24	0.0039	0.00424	0.00408	0.00412	0.00376
21	0.0044	0.00476	0.00458	0.0046	0.00423
18	0.0048	0.00516	0.00506	0.00502	0.00465
15	0.0053	0.00547	0.00544	0.00541	0.00501
12	0.0057	0.00571	0.00578	0.00573	0.00532
9	0.0060	0.00585	0.00598	0.00594	0.0055
6	0.0058	0.0055	0.0057	0.0056	0.0052
3	0.00337	0.00312	0.00325	0.00323	0.00299

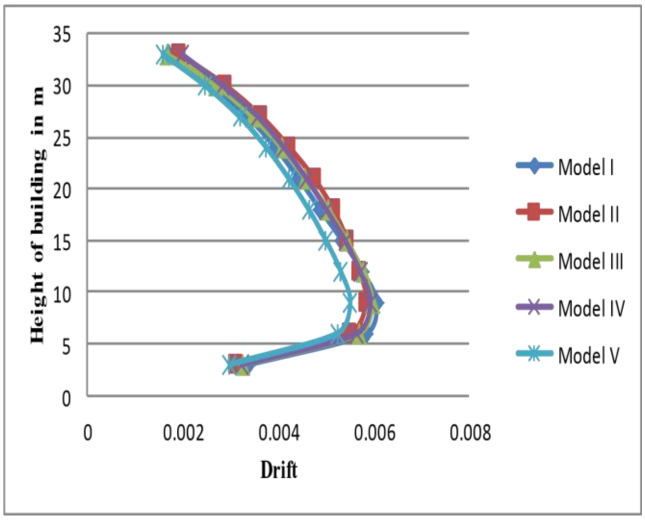

Figure 7. Storey Drift in Y-Direction

4.3 STOREY SHEAR

1) STOREY SHEAR IN X – DIRECTION

Table 5: Storey Shear in X-Direction

Height of the Building (m)	Model I Shear (KN)	Model II Shear (KN)	Model III Shear (KN)	Model IV Shear (KN)	Model V Shear (KN)
33	304.27	371.75	277.01	397.60	292.18
30	608.56	678.71	652.05	641.05	580.16
27	798.17	849.04	812.71	839.80	756.65
24	915.16	958.72	947.27	933.42	865.79
21	1009.7	1069.0	1031.0	1032.0	955.68
18	1094.7	1143.6	1142.5	1108.5	1040.0
15	1199.6	1207.9	1213.8	1205.5	1118.9
12	1315.1	1283.1	1321.7	1284.8	1208.3
9	1458.2	1375.0	1418.9	1417.5	1314.5
6	1586.7	1452.5	1536.0	1501.1	1404.0
3	1640.5	1483.5	1571.5	1547.3	1440.1

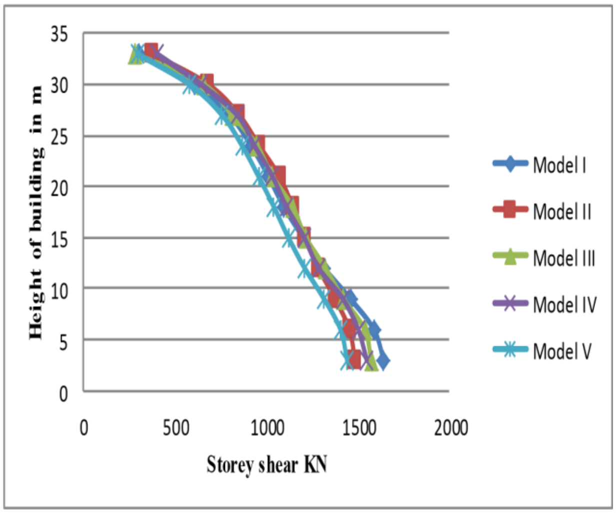

Figure 8. Storey Shear in X-Direction

2) STOREY SHEAR IN Y – DIRECTION

Table 6: Storey Shear in Y-Direction

Height of the Building (m)	Model I Shear (KN)	Model II Shear (KN)	Model III Shear (KN)	Model IV Shear (KN)	Model V Shear (KN)
33	266.281	326.697	239.089	352.823	251.249
30	499.544	557.035	533.124	532.415	469.551
27	634.764	690.174	648.914	681.983	601.634
24	737.241	793.419	770.239	767.08	701.618
21	825.508	892.398	847.564	857.167	785.919
18	908.776	960.672	952.239	932.001	866.815
15	1009.89	1016.42	1016.95	1018.96	936.74
12	1100.54	1071.8	1097.56	1077.76	1003.72
9	1188.49	1130.4	1158.22	1160.44	1072.02
6	1287.65	1197.27	1252.72	1230.62	1145.12
3	1356.93	1238.61	1298.7	1293.17	1190.98

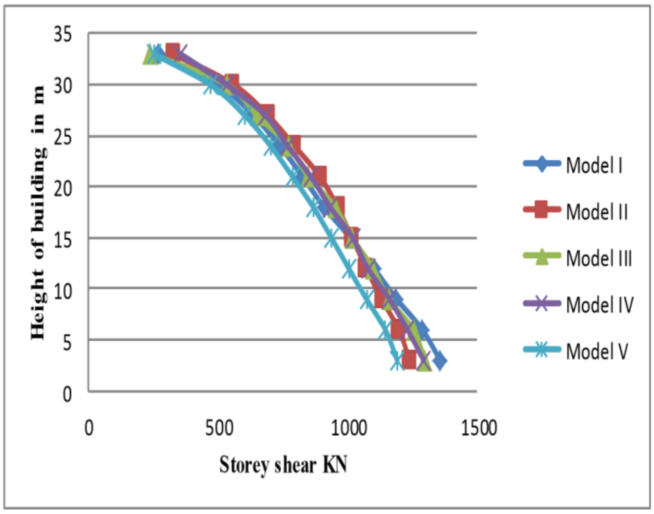

Figure 9. Storey Shear in Y-Direction

3. CONCLUSIONS

RCC structures with irregular masses, different stiffness and irregular vertical geometry are been studied and analyzed in this project. The analysis for five different models has been carried out and various results are obtained. The different parameters are studied in detail for each building, such parameters include displacement, storey drift, Storey shear. After the study we come up with following conclusions,

- When the models are imposed with loads they tend to displace. The displacements are different for each storey‟s and each model. Model II possess more displacements compare to Model I in both axes. The model provided with irregular masses for odd floors in Model IV shows more displacements whereas regular models have minimum displacements.

Storey drifts vary with the floors irregularly the drift value is more for the models where thicker slabs are provided for odd floors and it can be seen that minimum storey drifts occur in regular building in both axes.

- Shear forces occur more in model I compare to model II and model IV,irregular models have more shear values compared to regular model and the regular model have minimum shear value in both the axes.
- Considering all the parameters, regular building exhibit better performance with lesser failure values than the mass irregular models.
- Among the mass irregular models the models provided with thicker slabs at odd floors that is model IV finds to be more inefficient and the buildings provided with thicker slabs for top five floors that is model II scores out as the efficient one among irregular buildings.

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BIOGRAPHIES

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