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Seismic Evaluation of RC Multi Storey Bare Frame Buildings With & Without Irregularities

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ABSTRACT

In General, the structure in high seismic areas may be susceptible to the severe damage. Along with gravity load structure has to withstand to lateral load which can develop high stresses. A analytical study is made of the response to strong base motions of reinforced concrete structures having regular and irregular vertical configurations. In the study, four frame-wall structures are constructed at small scale and responses computed by several conventional analysis methods. The methods include inelastic dynamic response history analysis, inelastic static analysis, elastic modal spectral analysis, and elastic static analysis. Based on the data presented, it is concluded that the main advantage of the dynamic methods was that they were capable of estimating maximum displacement responses, whereas the static methods cannot be used for this purpose. In all other regards, the dynamic methods offered no clear advantage over the corresponding static method. The inelastic static and dynamic methods were superior to the elastic methods in interpreting effects of the structural discontinuities.

Keywords- Analytical techniques; Brick masonry; Earthquakes; Predictions; Seismic analysis; Vertical irregularity; Reinforced concrete; Frames..

I. INTRODUCTION

In the last few decades, a dramatic increase in the losses caused by natural catastrophes has been observed worldwide. Reasons for the increased losses are manifold though these certainly include the increase in world population, the development of new super cities (with a population greater than 2 million), many of which are located in high seismic hazard, and the high vulnerability of modern societies and technologies. The rapid growth of Indian cities in the recent, have accelerated pressure on housing industry, especially in high seismic zone-IV,V & III. The built-up environments in these zones have been seismically found vulnerable as most of these constructions are without earthquake resistant measures. The Indian cities are dotted with all kinds of buildings and infrastructural facilities comprising of very good construction to poor designed & constructed ones. Assessment of seismic vulnerability in urban areas would help in disaster mitigation. Reinforced Concrete (R/C) buildings make up an increasing proportion of the building stock of many countries all over the world. In India and in other countries they currently represent about 50% of the total. Many of them were built before the advent of seismic codes or with the utilization of old and inadequate anti seismic design criteria. During past earthquakes, Reinforced Concrete buildings often displayed unsatisfactory seismic behavior, particularly when their design included only vertical loads and ductile detailing was not explicitly provided. Thus, the evaluation of seismic vulnerability Reinforced Concrete of building structures has a key role in the determination and reduction of earthquake impact.

Seismic vulnerability is a measure of the seismic or capacity of a structure hence it is found to be the main component of seismic risk assessment. Ideally all of the possible hazards from earthquakes: amplified ground shaking, landslides, liquefaction, surface rupture, and tsunamis.

II. METHODOLOGY

4 models of with different storeys (G+3, G+5, G+7) buildings different measurements in plan and elevation are modeled in ETABS. There are 4 models analysed in the present study by considering SMRF with shear wall and flat slab as dual system. Shear wall is used for E-shaped and diaphragm discontinuity models at different locations.

A. Description of Building Structure

The details of the building is given in below Table 1

STRUCTURE	DESCRIPTION
NoofStories	G+3,G+5,G+7
Height of one storey	3.6 m
Height of Base Storey	4.8 m
Soil Type	MediumSoil
Seismic Zone	III
ImportanceFactor	1
GradeofConcrete	M30 (Column) M25 (Beam and Slab)
GradeofSteel	Fe 415
Size of the Beam	300mmX400mm
Size of the Column	500mmX500mm
Slab Thickness	150 mm
Live Load	3 kN/m^2
Live LoadonRoof	2.5 kN/m^2
FloorFinish	1 kN/m^2
ColumnDrop	300mm

III. MODELING AND ANALYSIS

There are 4 models considered for the present study which include both regular and irregular buildings. Equivalent static analysis and Response spectrum analysis are performed on models. Based on the analysis, various parameters such as base shear, storey shear, storey drift curves are obtained.

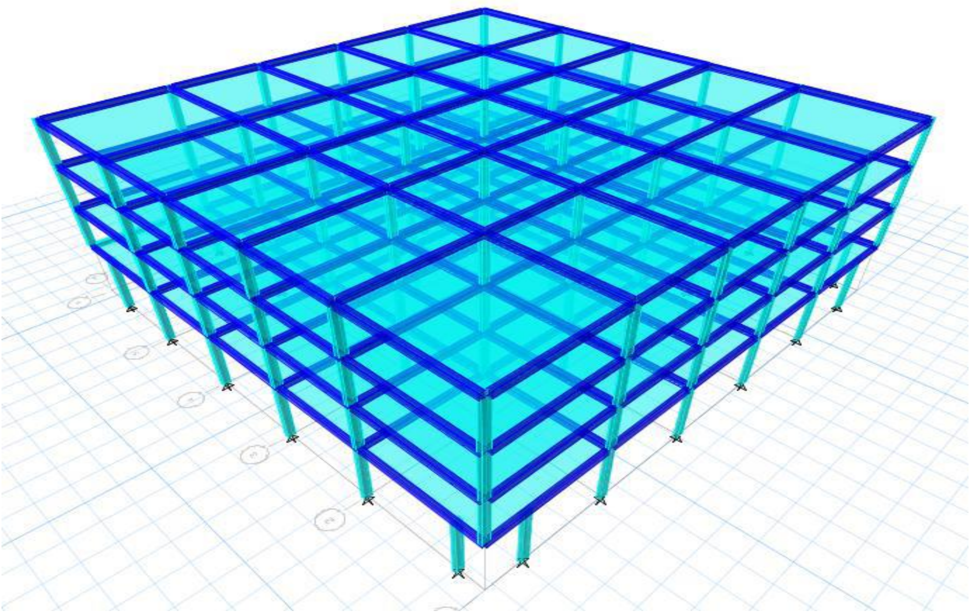


Fig 1 3D view of G+3 Model I

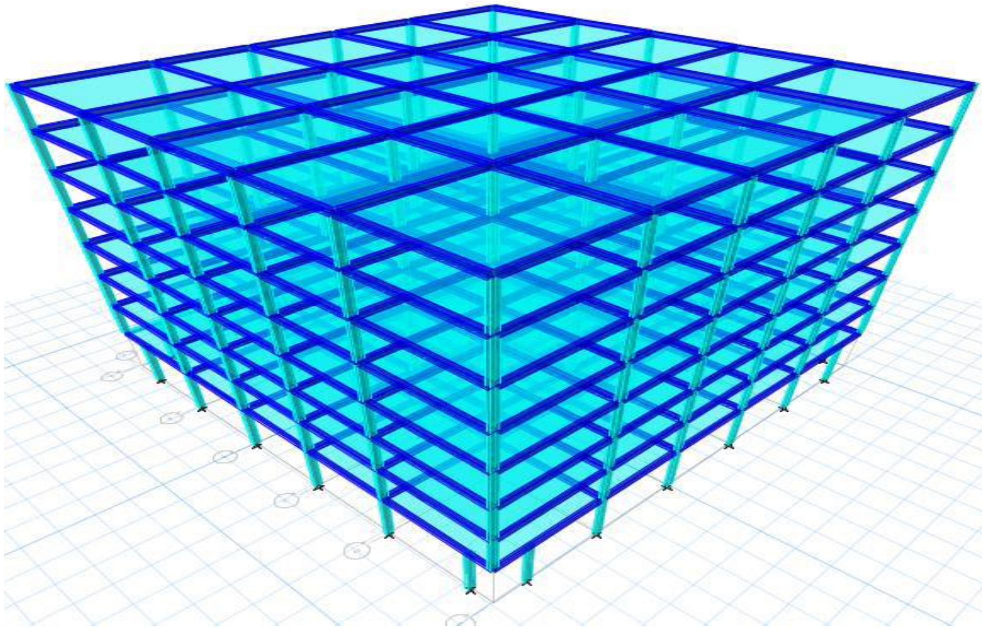


Fig 2: 3D view of G+7 Model I

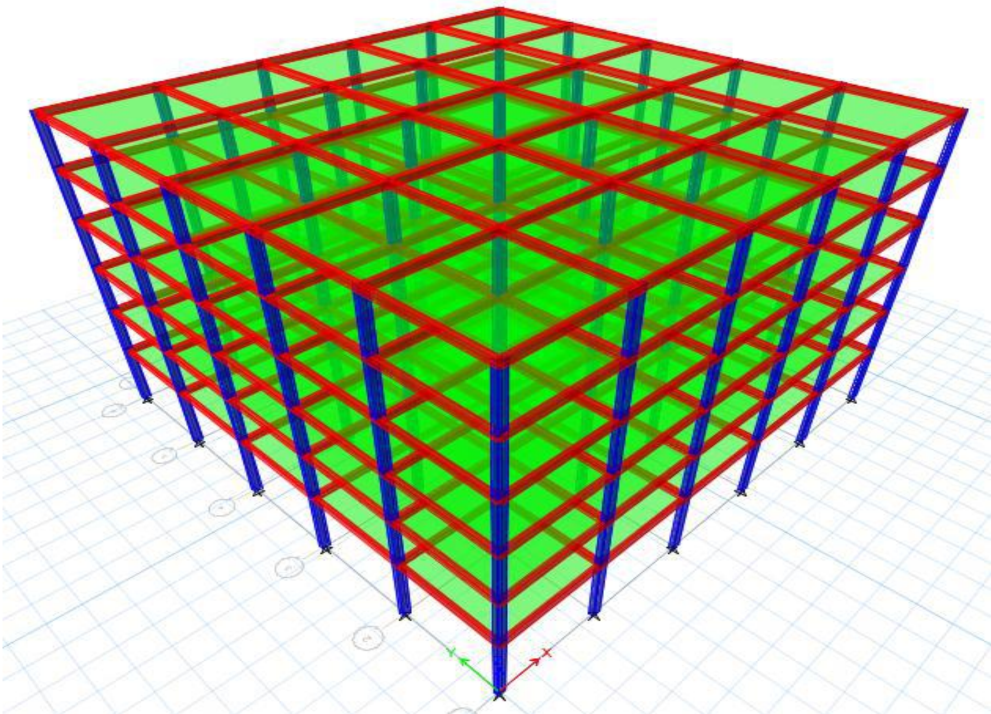


Fig. 3. 3D view of G+5 model II

IV. RESULTS

The following results for linear static or equivalent static and response spectrum analysis are tabulated for both the considered models under various load combination as per IS 1893 Part-I 2002.

A. Lateral displacement

Table2. Lateral displacement in mm

Storey	Equivalent static method				Response spectrum method			
	Model				Model			
	I	II	III	IV	I	II	III	IV
8	126.70	30.05	130.39	33.48	101.65	26.75	104.69	29.46
7	114.05	28.30	119.08	31.64	92.97	25.68	96.34	28.23
6	96.39	26.09	99.43	29.27	80.69	24.25	82.67	26.57
5	80.38	23.66	84.15	26.52	69.11	22.56	71.90	24.55
4	62.58	21.04	67.08	23.52	55.55	20.59	59.29	22.22
3	43.69	18.31	49.29	19.38	40.18	18.37	45.35	19.63
2	27.65	15.81	32.73	17.18	26.14	16.17	31.47	16.82
1	12.59	12.36	12.66	14.20	12.16	12.80	12.54	14.08

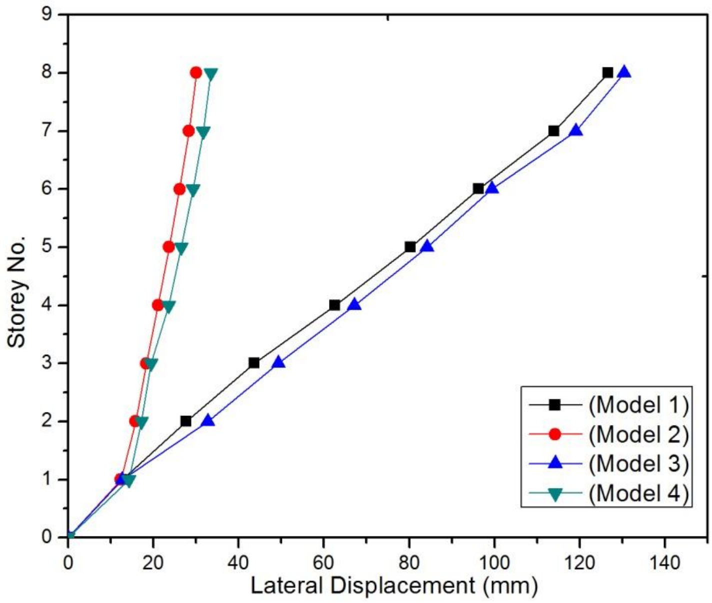


Fig4. Lateral displacement for Model 1 to Model 4

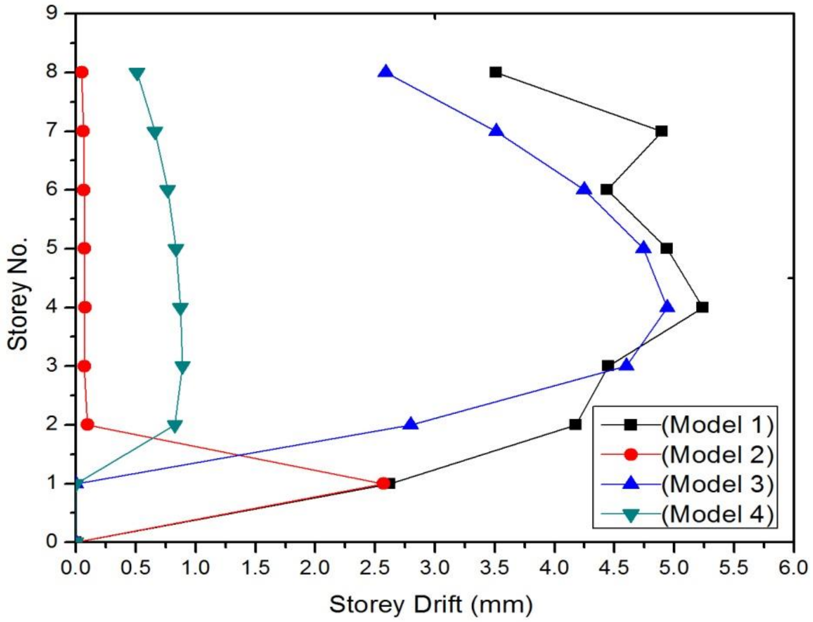
B. Storey drift

Table3. Storey drift for Model 1 to Model 4

Storey	Equivalent static method				Response spectrum method			
	Model				Model			
	I	II	III	IV	I	II	III	IV
8	3.51	0.048	2.587	0.509	3.23	0.031	2.295	0.367
7	4.90	0.061	3.513	0.659	4.12	0.041	2.872	0.489
6	4.44	0.067	4.245	0.765	3.63	0.048	3.348	0.588
5	4.94	0.072	4.742	0.834	4.08	0.005	3.733	0.668
4	5.24	0.075	4.942	0.872	4.45	0.062	3.997	0.731

3	4.45	0.069	4.601	0.889	3.94	0.061	3.895	0.786
2	4.18	0.096	2.796	0.826	3.89	0.093	2.490	0.764
1	2.62	2.57	0	0	2.53	2.667	0	0

Fig5. Storey drift for Model 1 to Model 4



C. Base shear

Table4. Base shear for Model 1 to Model 4

Model	EQX	RSX	Scale factor
I	3923.31	762.25	5.147
II	6910.50	1971.61	3.505
III	4501.43	997.171	4.5142
IV	8661.41	2781.45	3.1139

V. CONCLUSIONS

1. The analytical natural periods do not agree with the natural periods obtained from the empirical expressions of the code for all type of buildings, therefore to design such buildings dynamic analysis should be carried out.
2. The difference in lateral displacement between Model II and Model IV is more for four storey buildings, and it gradually decreases for six and eight storey buildings.
3. The inter storey drifts for Model IV are within the prescribed limit mentioned in Clause No. 7.11.1, IS 1893 (Part 1): 2002 for both gravity and seismic design of buildings.
4. Base shear increases with the increase in mass of building, hence for the buildings with irregularities base shear is more than regular buildings.
5. Irregularities should be avoided as much as possible and regularity should be maintained so that every member will have equal distribution of loads.
6. In irregular in plan and elevation should be avoided because it will create more torsion in lesser mode shapes.

7. Regular building gives a clear path to transfer the seismic load.

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