COMPARATIVE STUDY ON SEISMIC ANALYSIS OF TWO RC BUILDINGS WITH IRREGULARITIES UNDER VARYING SEISMIC ZONES

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Abstract - *An Construction of high rise structures is carried by the owner, structural engineers, architect also the contractor. Architects as well as structural design engineer's plays vital role in construction of tall RC structures, Engineers build good infrastructures in metro political cities under various seismic zones. Structural design engineers have to understand seismic performance of buildings to carryout analysis also to carryout design for various structural elements in tall structures, also they are very challenged to make decision making while designing the elements under different seismic zones. Structural engineer's community need to build the structures respond to dynamic behavior, they have better understanding as well as aim for seismic design. The discussion work is complicated with contrast of the seismic evaluation of RC building with vertical as well as mass irregularities under seismic zones II and zone IV, the linear static method of analysis remains approved out according IS 1893:2016 (Part 1). Outcome of this analysis is discussed in terms of lateral displacement, story drift as well as story shear.*

***Key Words*: Lateral displacement, story drift, story shear, ETABS.**

1.INTRODUCTION

Earthquakes are carefully studied by many scholars in previous years, took much time to estimate the earthquakes also these earthquakes are most anticipated. Most of the structural design engineers design the structures mainly to assess the safety, stiffness also parameters performance of structures under various seismic zones. Special codes provisions and guidelines are used to design the buildings. Earthquakes may be due to energy released at focus in rocks for the movements. Many researchers had worked a lot to resist the seismic structures without causing any damage to structures also loss of life, under seismic force many structures are failed due to presence of irregularities but regular configuration structures are performed better during seismic loading. Vertical irregularities will be relevant reason to gradual modification of strength, stiffness, mass also the geometry of the building that is oriented vertically, it is the point for weakness where there will be discontinuity in dynamic characteristic mass, stiffness, geometry also strength of building also the presence of uneven scattering of mass, toughness, strength of structure along elevation of structure. These may lead to discontinuity of elements also tend to give gap and those gaps between the elements initiates the weakness in the structure, thus weakness leads to collapse of the building beneath the earthquake loads.

1.1 SCOPE OF STUDY

The Reinforced concrete building is performed under the action of seismic analysis mainly the enactments of those buildings be subject to the classification of building as well as configuration of the building. Regular building is symmetric in plan will perform well under the seismic loading without creating the complications in designing of elements of the regular building, whereas the building with vertical irregular building will not perform well under earthquakes thus it may create weakness between elements in adjacent storey of the building which leads to severe damage of the building, to avoid the collapsing of building it is better to build the structure in simple in plan, regular configuration, minimum lateral strength thus provides lateral stiffness to the building so that sectional properties are uniformly distributed along height of the structure. Many architectures are to create the building in simple manner as well as to avoid the complicated designs for structural engineers. Main intension of structural engineers is to resist the structural collapse of buildings under the action of dynamic loads. Nowadays in urbanization the construction of vertical irregularities configuration must be resisted in modelling as well as analyzing the irregular building these irregularities in structures may create loss of economy also loss of life's, therefore the structural engineers take challenge for construction building with different configurations during the expected earthquakes.

1.2 DISPASSIONATE OF STUDY

The succeeding leading dispassionate of thesis:

a. In present thesis the two irregular tall RC building of G+10+H is modelled with combine of soft story of height 3.5m for the ground floor also with mass irregularity mainly i.e. swimming pool at top floor of the building.

b. Study the combined effect of stiffness vertical irregularity-soft story as well as mass irregularity of tall RC building under dynamic loading.

c. Linear static analysis method is conducted for seismic zone-II and zone-IV according to IS 1893:2016 (part 1), for medium type soil (Type 2).

d. Two models are modeled for different zones also analyzing by Linear Static analysis with help of ETABs software.

e. Combine effect of stiffness irregularity as well as mass irregularity on lateral displacement, story drifts, also story shear are studied.

f. Comparisons is made between two models of different zone-2 as well as zone-5 in X and Y directions based on, lateral displacement, story drifts, story shear.

g. To know the presentation of the structure.

3.NARRATIVE OF MODEL

Two Reinforced concrete buildings of G+10+H storey of area (20*30) mare modeled, this model consist of Staircase, Lifts, at top floor the structure consist of head room and provided with swimming pool. In this method of seismic analysis is performed with help of ETABS software. those building contains stiffness irregularity mainly soft story height 3.5m at ground floor, typical floors height as 3.0m as well as mass irregularity mainly swimming pool 12.26kN/m² at top floor presumptuous bays in X- direction is 5m, bays in Y direction is 6m in horizontal ways, all columns are fixed at ground, linear static analysis is performed under seismic zone-II and zone-IV.

3.2BUILDING DESCRIPTIONS

a. Material assets

Young's modulus of (M25) concrete	25*1000 kN/m³
Density of reinforced concrete	25kN/m³
Young's modulus of steel	2*10⁵ kN/m²
Density of steel	Fe500
Density of Masonry	20 kN/m³
Poisson's ratio	0.2
Compressive strength of concrete at 28th days	25 N/mm²

b. Details of building

Plan area dimension	(20*30) m
No. of floors in two models	G+10+H
Type of building	Residential building
Story height at ground floor	3.5m
Typical floor height	3.0m
Height of the building	36.5m
Span between bays in X-direction	5m
Span between bays in Y-direction	6m
Swimming pool is provided on terrace floor	33.5m
Swimming pool area	(10x6) m
Depth of swimming pool	1.25m
Volume of swimming pool	(10x6x1.25) = 75m³

c. Member properties

Thickness of slab	150mm
Thickness of swimming pool slab	200mm
Columns size for the building	(800x600) mm
Beam dimensions for the building, B1	(600x300) mm
Beam dimensions for the building, B2	(400x250) mm
Thickness of wall	250mm

d. Loads considered

Typical Imposed load	3kN/m²
Percentage of imposed load	25%
Floor finish	2kN/ m²
Roof live load	3kN/m²
Roof live load above staircase and lifts	0.75kN/m²
Lift roof live load	5kN/m²
Lift mechanical roof load	10kN/m²
Staircase dead load	12.5kN/m²
Staircase floor load	5kN/m²
Staircase live load	7.5kN/m²
Wall load under beam depth 600mm,W1	12kN/m
Wall load under beam depth 400mm,W_2	13kN/m
Parapet wall load, W_3	4.5kN/m
Wall load for swimming pool as shear wall load,W4	8kN/m

e. Seismic forces

Importance factor, I	1.0
Type of structure	OMRF
Response reduction factor	3
Seismic zones	II and IV
Seismic zone factor	0.10 and 0.24
Type of soil	Medium soil

3.4ETABS MODEL GENERATION

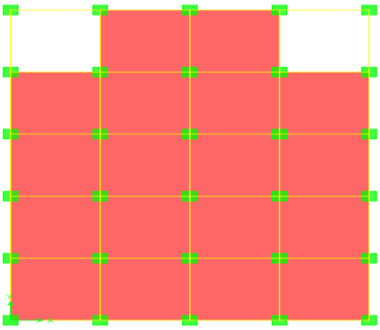

Figure 1: Plan view under zone II c

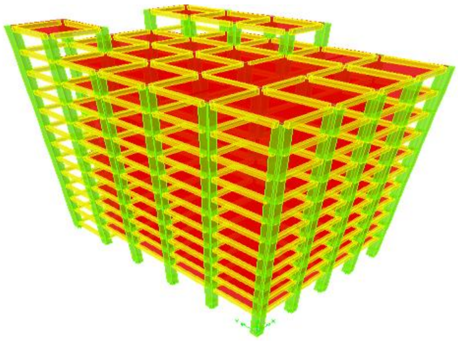

Figure 2: Elevation of RC building model 1 under zone II

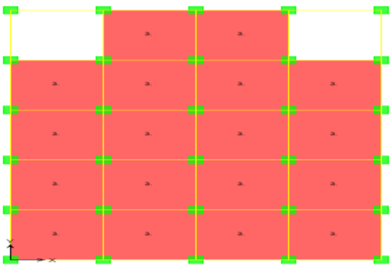

Figure 3: Live load 3kN/m² under zone II and zone IV

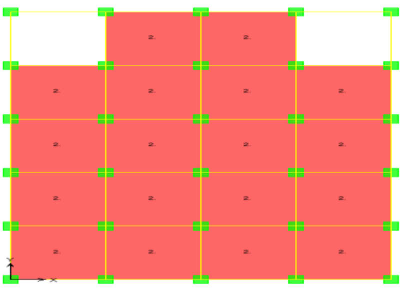

Figure 4: Floor load 2kN/m² under zone II and zone IV

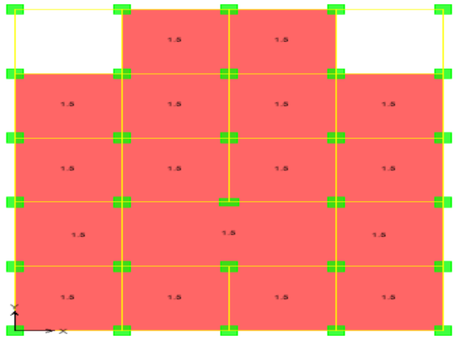

Figure 5: Roof Live load 1.5kN/m² under zone II and zone IV

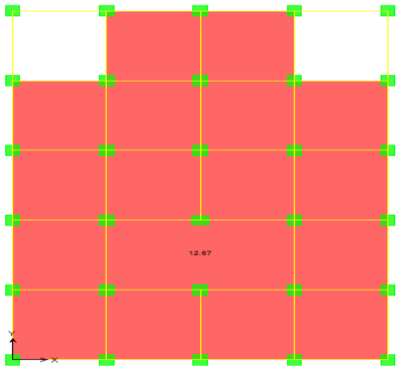

Figure 6: Swimming floor load 12.67kN/m under zone II and zone IV

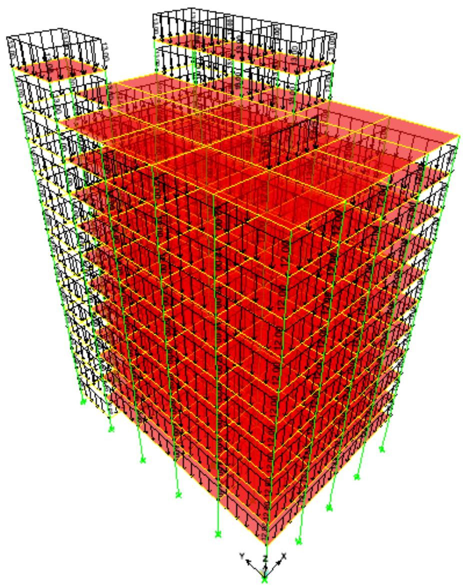

Figure 7: Wall load under zone II and zone IV

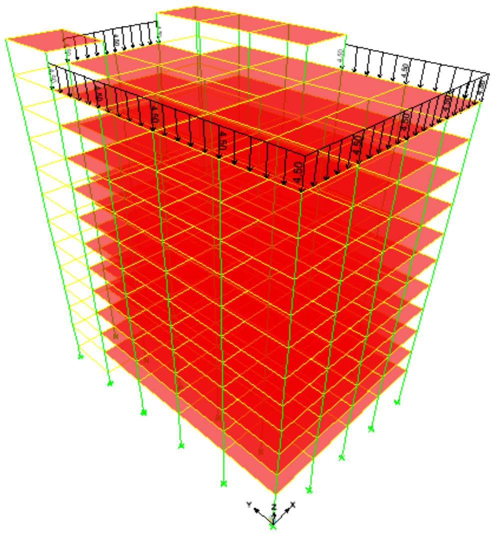

Figure 8: Parapet wall load 4.5kN/m under zone II and zone -IV

4.RESULTS AND DISCUSIONS

4.1 LATERAL DISPLACEMENTS

4.1.1 EXTREME LATERAL DISPLACEMENT ALONG X-DIRECTION

Table 1: Comparison of Extreme lateral displacement(mm) along X-direction for model 1 and Model 2 under zones II and IV respectively

Storey	Linear static method Displacement along X-direction		Variation in %
	Model 1 (zone II) (mm)	Model 2 (zone IV) (mm)	
11	17.2987	41.0835	58
10	16.6251	38.6765	57
9	15.8613	36.8501	57
8	14.8968	34.6696	57
7	13.7035	31.9392	57
6	12.3096	28.726	57
5	10.753	25.1185	57
4	9.0744	21.2136	57
3	7.3121	17.1037	57
2	5.5042	12.8801	57
1	3.6956	8.6503	57

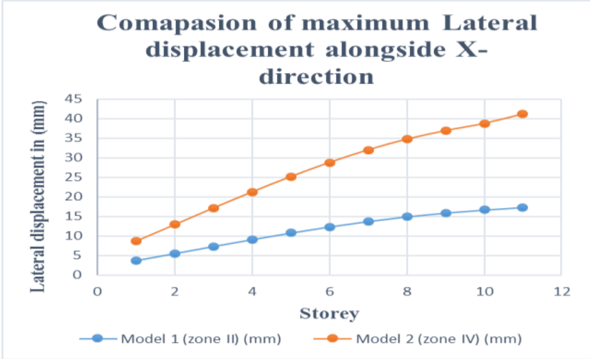

Figure 9: Comparison of Extreme displacement (mm) along X-direction for Model 1 and Model 2 under zones II and IV respectively

4.1.2 EXTREME LATERALDISPLACEMENT ALONG Y-DIRECTION

Table 3: Comparison of Extreme lateral displacement (mm) along Y-direction for Model 1 and 2 under zones II and IV respectively

Storey	Linear Static method Displacement along Y-direction		Variation in %
	Model 1(zone II) (mm)	Model 2 (zone IV) (mm)	
11	17.0933	40.7808	58.1
10	16.5758	39.356	57.9
9	15.8317	37.6108	57.9
8	14.8705	35.3536	57.9
7	13.6596	32.5091	58.0
6	12.2345	29.1467	58.0
5	10.634	25.3578	58.1
4	8.9015	21.2455	58.1
3	7.0821	16.9177	58.1
2	5.226	12.4948	58.2
1	3.3991	8.1352	58.2

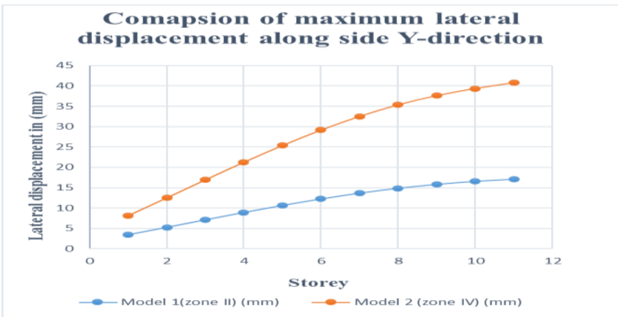

Figure 10: Comparison of Extreme displacement (mm) along Y-direction for Model 1 and Model 2 under zones II and IV respectively

4.2 STOREY DRIFTS

4.2.1 EXTREME STOREY DRIFTS ALONG X-DIRECTION

Table 4: Comparison of Extreme storey drift (mm) along X-direction for model 1 and Model 2 under zones II and IV respectively.

Storey	Linear Static method	
	Extreme Storey drift along X-direction	
	Model 1 (Zone II) (mm)	Model 2 (Zone IV) (mm)
11	0.369	0.692
10	0.273	0.642
9	0.342	0.642
8	0.419	1.002
7	0.487	1.166
6	0.541	1.002
5	0.582	1.395
4	0.61	1.162
3	0.324	1.498
2	0.324	1.497
1	0.324	1.447

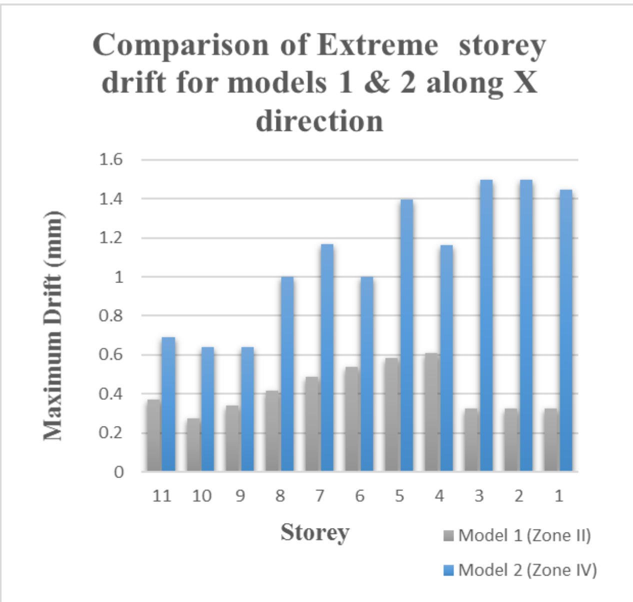

Figure 11: Comparison of Extreme storey drift (mm) along X-direction for Model 1 and Model 2 under zones II and IV respectively.

4.2.2 EXTREME STOREY DRIFTS ALONG Y-DIRECTION

Table 5: Comparison of Extreme storey drift (mm)along Y-direction for model 1 and Model 2 under zones II and IV respectively.

Storey	Linear Static method	
	Extreme Storey drift along Y-direction	
	Model 1 (Zone II) (mm)	Model 2 (Zone IV) (mm)
11	0.328	0.595
10	0.285	0.625
9	0.328	0.799
8	0.426	0.984
7	0.496	1.155
6	0.553	1.296
5	0.596	1.402
4	0.623	1.472
3	0.634	1.501
2	0.622	1.478
1	0.582	1.377

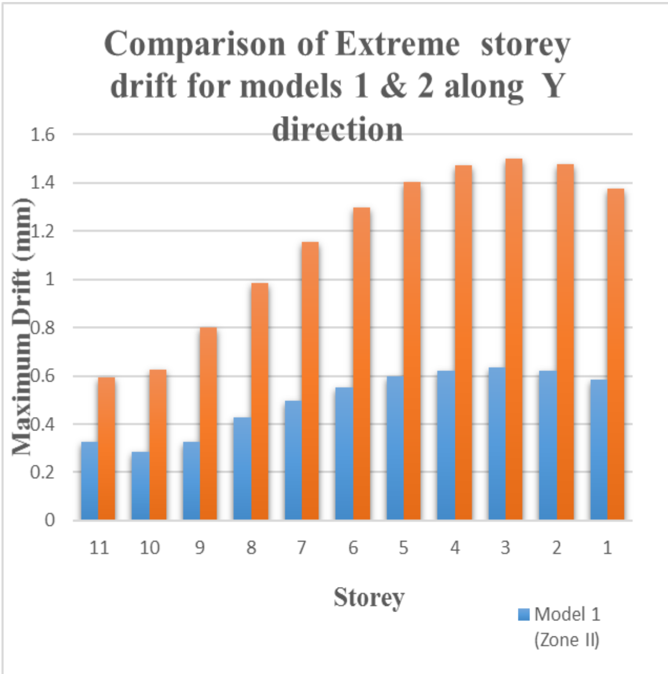

Figure 12: Comparison of Extreme storey drift (mm) along Y-direction for Model 1 and Model 2 under zones II and IV respectively.

4.3 STORY SHEAR

4.3.1 EXTREME STORY SHEAR ALONG X-DIRECTION

Table 6: Comparison of Extreme storey shear(kN) along X-direction for model 1 and Model 2 under zones II and IV respectively

Storey	Linear static method (Extreme story shears along X-direction)	
	Model 1 (zone II) (kN)	Model 2 (zone IV) (kN)
11	124.58	299
10	429.65	1031.17
9	745.26	1788.63
8	1004.66	2411.19
7	1213.17	2911.61
6	1376.34	3303.21
5	1499.72	3599.32
4	1588.86	3813.25
3	1649.31	3958.35
2	1686.63	4047.92
1	1706.37	4095.29

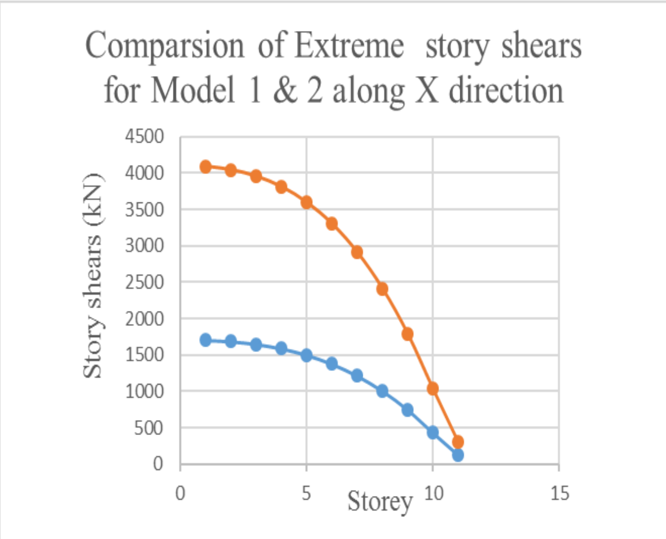

Figure 13: Comparison of Extreme storey shear(kN) along X-direction for Model1 and Model2 under zones II and IV respectively.

4.3.2 EXTREME STORY SHEAR ALONG Y-DIRECTION

Table 7: Comparison of Extreme storey shear(kN) along Y-direction for Model 1 and Model 2 under zones II and IV respectively

Storey	Linear static method (Extreme story shear along Y-direction)	
	Model 1 (zone II) (kN)	Model 2 (zone IV) (kN)
11	124.58	299
10	429.65	1031.17
9	745.26	1788.63
8	1004.66	2411.19
7	1213.17	2911.61
6	1376.34	3303.21
5	1499.72	3599.32
4	1588.86	3813.25
3	1649.31	3958.35
2	1686.63	4047.92
1	1706.37	4095.29

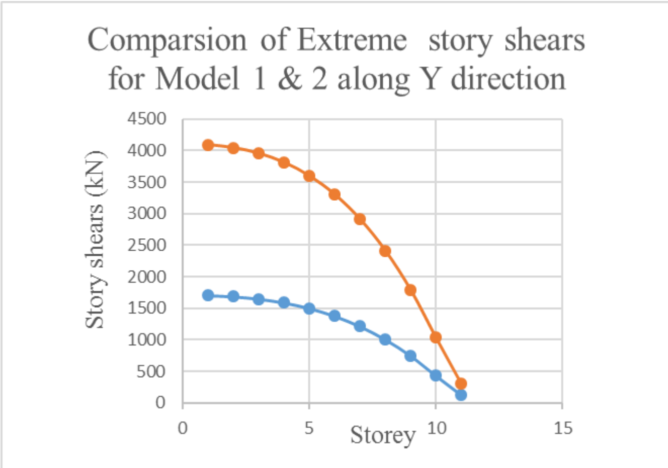

Figure 14: Comparison of Extreme storey shear(kN) along X-direction for Model1 and Model2 under zones II and IV respectively.

4. CONCLUSIONS

1. **Lateral displacements:** it was found out that model 2 was nearly 60% more than model 1 in lateral displacements, as number of floors increases in structural building will lead to larger displacement. Maximum lateral displacement can be obtained in vertical irregular building; it is observed that there is increase in percentage of steel for this two structures with mass irregularity

2. **Story Drift:** It was witnessed extreme story drift at 4^{th} floor was about 0.61mm in model 1 as well as 2^{th}

floor was about 1.497mm in model 2 as higher story drift in X-direction, it was found out 3rd floor was about 0.634mm in model 1 and 3rd floor was about 1.501mm in model 2 as higher story drift in Y-direction, to avoid the damage of building under seismic forces the perilous inter storey drift would be limited to 0.004 times of floor height.

3. **Story shears:** Maximum storey shear takes place at 1st floor in model 1 and model 2 in both X-direction as well as Y-direction respectively. So we conclude the outcome of maximum story shear it was found out that both model 1 as well as model 2 will be having same story shear. it has been noted that quantity of irregularity is extreme, then critical shear force will be extreme.

4.1 POSSIBILITY OF FUTURE EFFORT

The Scope for upcoming are prolonged further down

1. Other approaches of seismic analysis can be done for on this type of RC structures.
2. These buildings are achieved on several zones factors as well as several soil conditions.
3. Mass irregularity on structures can accomplished for different floors in this type of RC structures.
4. Outcome of Base shear parameter can be implemented for this type of buildings.
5. Wind analysis can be performed for these types of structures.

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