

Seismic Response for Dynamic Analysis of High Rise Building with different Seismic Zones

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ABSTRACT: The main objective of Seismic Engineering is design and build a framed structure with minimizing the cost and the damage to the structure and its structural member during seismic is minimized. The dynamic analysis was carried out for the framed structure with different seismic zones (II & V) in terms of response spectrum method according to IS 1893:2002(part1) code by using finite element software package ETABS version 16.2.1 used to perform the modeling and analysis of G+30 building. In the present paper, Seismic response for the dynamic analysis of High Rise building with different seismic zones are studied and results of these analyses are compared in terms of the base shear, seismic weight, storey drift, storey shear

KEYWORDS: Response spectrum analysis, Base shear, Seismic weight, Storey drifts, Storey shear.

I. INTRODUCTION

It is the responsibility of design engineers to ensure the built environment can withstand dynamic actions due to earthquake. Structural engineers must know how the built environment will respond to that dynamic actions. An immediate effect of earthquakes is numerous fatalities due to structural collapse and falling debris, while in the long-term thousands of individuals are left homeless due to collapsed or unsafe buildings and the resulting slow process of rebuilding. The structural engineering community has the ability to influence the direct consequences of these events by better understanding the seismic response of building structures and aiming to constantly improve their seismic design. A structure has to be designed to resist the lateral actions applied to it by the earthquake ground motion. In order to achieve this, a lateral load resisting system is needed to resist the lateral forces.

To perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, and adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniform distribution of mass and stiffness in plan as well as in elevation, suffer much less damage than buildings with irregular configurations

1.1 SCOPE OF STUDY

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 OBJECTIVES OF STUDY

- To study the effect of base shear of the framed structure at different seismic locations.
- To study the effect of seismic weight of the framed structure at different seismic locations.
- To study the effect of storey drift of the framed structure at different seismic locations.
- To study the effect of storey shear of the framed structure at different seismic locations

II. STRUCTURAL MODELLING

The plan layout, elevation and 3D view of the moment resisting frame of thirty storey building (G+30) with different seismic zones (II & V). In this study, the plan layout is kept similar for two buildings for investigation. The each storey height is kept 4.0 m and intended for office use. In the seismic weight calculations only 50% of the floor live load is considered. All columns are considered as fixed at ground and linear dynamic analysis has been performed under seismic zone-II and zone-V.

2.1 BUILDING DESCRIPTIONS

A. MATERIAL

Grade of Concrete	M50
Grade of Steel	Fe500
Young's modulus of concrete	25 x 1000 kN/m ²
Young's modulus of Steel	2 x 10 ⁵ kN/m ²
Density of reinforced concrete	25 kN/m ³
Poisson's ratio of concrete	0.2
Poisson's ratio of steel	0.3
Compressive strength of concrete at 28th days	50 N/mm ²

B. BUILDING DETAILS

Plan area of building	60 x 33 m
No of floors	G+30
Type of Building	Commercial
Typical floor height	3m
Height of the building	92m
Span in X direction	7.5m
Span in Y direction	7.5m

C. MEMBER PROPERTIES

Thickness of Slab	200mm
Column size upto 18 th floor	1250 mm
Column size upto 18F to terrace	1000 mm
Beam Size B1	600x900
Beam Size B2	450 x 750
Beam Size B3	350 x 750
Span in Y direction	7.5m
Wall thickness upto 18 th floor	500 mm
Wall thickness from 18F to top	350 mm



D. LOADING

Typical live load	4.0 kN/m ²
Roof live load	1.5 kN/m ²
Floor finish	1.8 kN/m ²
Roof finish	3.0 kN/m ²
Lift Roof live load	5.0 kN/m ²
Lift Mechanical roof load	10.0 kN/m ²
Staircase dead load	10.0 kN/m ²
Staircase live load	5.0 kN/m ²
200 mm Wall load	20.0 kN/m
100 mm Wall load	10.0 kN/m
Parapet Wall load	6.0 kN/m

E. SEISMIC PARAMETERS

Importance factor, I	1.0
Type of Structure	SMRF
Response reduction factor, R	5.0
Seismic zones	II & V
Seismic zones factor	0.1 & 0.24
Type of soil	Medium

Earthquake Live load on Slab as per clause 7.3.1 and 7.3.2 of IS 1893 (Part-I) - 2002 is calculated as:

Roof (clause 7.3.2) = 0

Floor (clause 7.3.1) = 0.5x4=2 kN/m²

Fundamental Natural period for MRF without brick infill,

$$T_a = 0.075 * h^{0.75},$$

(h=Height of the building in meters)

In x-direction = 2.227 Sec

In y-direction = 2.227 Sec

Fundamental Natural period for infill frame

$$T_a = \frac{0.09 * h}{\sqrt{d}},$$

(h=Height of the building in m and d= Base dimension of the building at the plinth level, in m, along the considered direction of the lateral force)

In x-direction = 1.068 Sec

In y-direction = 1.441 Sec

Seismic Base Shear: The seismic base shear VB in a given direction shall be determined in accordance with the following equation:

$$VB = Ah \times W$$

Where

A_h = the seismic response coefficient

W = the total dead load and applicable portions of other load

Calculation of Seismic Response Coefficient:

The seismic response coefficient A_h shall be determined in accordance with the following equation:

$$A_h = \frac{S_a Z I}{2 R g}$$

Where:

Z = Zone factor given in

S_a/g = average response acceleration coefficient

R = the response reduction factor

I = the importance factor depending upon the functional use of structure

2.2 BUILDING DESCRIPTIONS

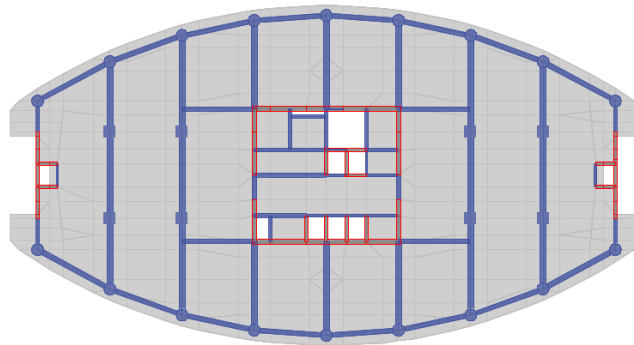


Fig 1: Typical floor plan View (Zone II & V)

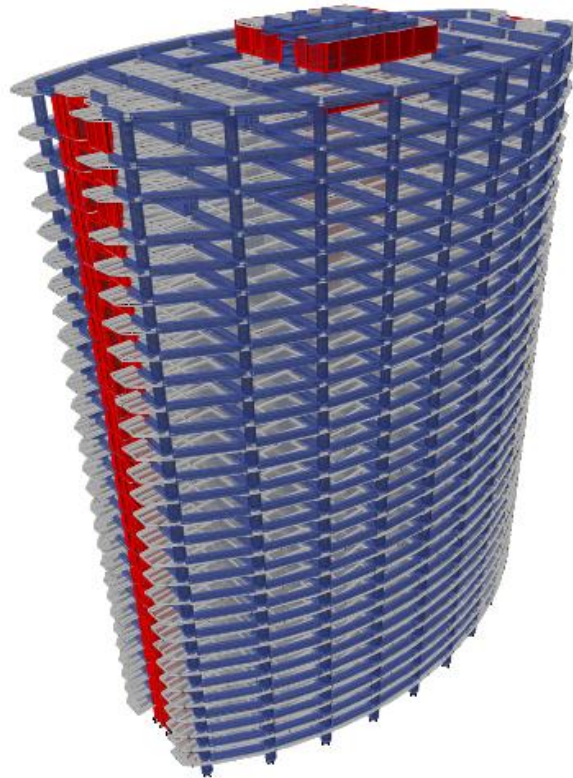


Fig 2: 3D View (Zone II & V)

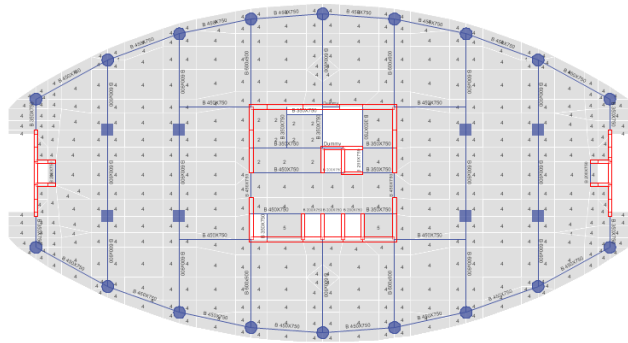


Fig 3: Live load 4.0 kN/m² (Zone II & V)

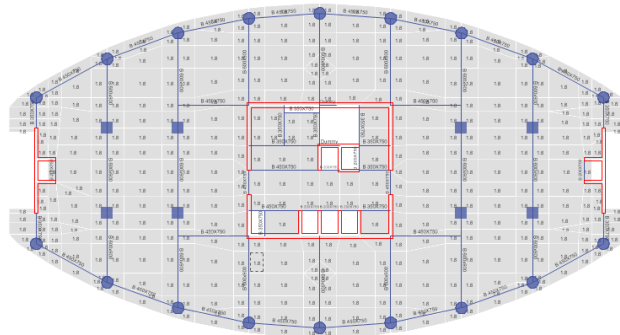


Fig 4: Finish load 1.8kN/m² (Zone II & V)



Fig 5: Wall load in 3D (Zone II & V)

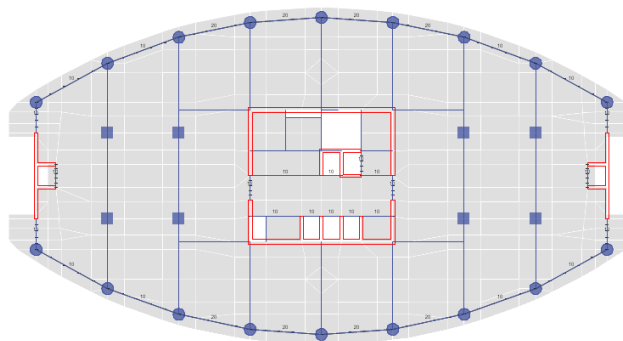


Fig 3: Wall load in plan (Zone II & V)

III.RESULTS AND DISCUSIONS

3.1 LATERAL DISPLACEMENT

3.1.1LATERAL DISPLACEMENT ALONG XDir

Table 1: Comparison of lateral displacement(mm) along X-direction for EQx under zones II and V respectively

Story	Dynamic Analysis		Variation in %
	Lateral Displacement along X dir		
	EQx (Zone II)	EQx (Zone V)	
30	54.89	197.651	27.78
29	51.611	185.798	27.78
28	48.769	175.567	27.78
27	46.607	167.785	27.78
26	43.679	157.245	27.78
25	41.466	149.277	27.78
24	39.234	141.241	27.78
23	36.987	133.154	27.78
22	34.733	125.039	27.78
21	32.478	116.92	27.78
20	30.23	108.828	27.78
19	27.999	100.796	27.78
18	25.798	92.873	27.78
17	23.673	85.224	27.78
16	21.584	77.704	27.78
15	19.537	70.332	27.78
14	17.537	63.135	27.78
13	15.596	56.144	27.78
12	13.72	49.391	27.78
11	11.919	42.909	27.78
10	10.203	36.732	27.78
9	8.582	30.895	27.78
8	7.065	25.433	27.78
7	5.662	20.382	27.78
6	4.383	15.78	27.78
5	3.24	11.663	27.78
4	2.242	8.072	27.78
3	1.401	5.044	27.78
2	0.73	2.628	27.78
1	0.243	0.874	27.80
BASE	0	0	0.00



3.1.1 LATERAL DISPLACEMENT ALONG Y Dir

Table 2: Comparison of lateral displacement(mm) along Y-direction for EQy under zones II and V respectively

Story	Dynamic Analysis		Variation in %
	Lateral Displacement along Y dir		
	EQy (Zone II)	EQy (Zone V)	
30	53.95	194.10	27.78
29	51.431	185.152	27.78
28	49.42	177.911	27.78
27	47.859	172.294	27.78
26	45.678	164.442	27.78
25	43.98	158.329	27.78
24	42.217	151.981	27.78
23	40.386	145.39	27.78
22	38.489	138.559	27.78
21	36.528	131.501	27.78
20	34.509	124.233	27.78
19	32.44	116.784	27.78
18	30.325	109.171	27.78
17	28.2	101.519	27.78
16	26.053	93.79	27.78
15	23.895	86.021	27.78
14	21.735	78.247	27.78
13	19.585	70.505	27.78
12	17.455	62.838	27.78
11	15.359	55.293	27.78
10	13.311	47.92	27.78
9	11.326	40.775	27.78
8	9.422	33.92	27.78
7	7.617	27.422	27.78
6	5.932	21.356	27.78
5	4.391	15.807	27.78
4	3.019	10.87	27.77
3	1.85	6.658	27.79
2	0.919	3.308	27.78
1	0.275	0.99	27.78
BASE	0	0	0.00



3.2 STOREY DRIFTS

3.2.1 STOREY DRIFTS ALONG X-Dir

Table 3: Comparison of Storey drift along X-direction for EQx under zones II and IV respectively.

Story	Dynamic Analysis	
	Storey Drift along X dir	
	EQx (Zone II)	EQx (Zone V)
30	0.0724	0.2606
29	0.0735	0.2648
28	0.0746	0.2684
27	0.0758	0.2727
26	0.0763	0.2749
25	0.077	0.2772
24	0.0775	0.2791
23	0.0779	0.2803
22	0.0779	0.2806
21	0.0778	0.2799
20	0.0773	0.2782
19	0.0764	0.2749
18	0.074	0.2663
17	0.0728	0.2622
16	0.0715	0.2573
15	0.0698	0.2514
14	0.0679	0.2444
13	0.0656	0.2363
12	0.063	0.2269
11	0.0601	0.2164
10	0.0568	0.2046
9	0.0532	0.1915
8	0.0492	0.1771
7	0.0448	0.1613
6	0.04	0.1441
5	0.0349	0.1255
4	0.0293	0.1054
3	0.0232	0.0836
2	0.0167	0.06
1	0.0082	0.0294
BASE	0	0



3.2.2 STOREY DRIFTS ALONG Y-Dir

Table 4: Comparison of Storey drift along Y-direction for EQy under zones II and IV respectively.

Story	Dynamic Analysis	
	Storey Drift along Y dir	
	EQy (Zone II)	EQy (Zone V)
30	0.0505	0.1819
29	0.0522	0.188
28	0.054	0.1943
27	0.0565	0.2033
26	0.0585	0.2106
25	0.0606	0.2183
24	0.0629	0.2264
23	0.0651	0.2343
22	0.0672	0.2418
21	0.0691	0.2487
20	0.0708	0.2548
19	0.0723	0.2603
18	0.0727	0.2616
17	0.0734	0.2642
16	0.0737	0.2654
15	0.0737	0.2654
14	0.0734	0.2642
13	0.0726	0.2614
12	0.0714	0.2571
11	0.0697	0.251
10	0.0675	0.243
9	0.0647	0.2329
8	0.0612	0.2204
7	0.0571	0.2055
6	0.0521	0.1876
5	0.0463	0.1666
4	0.0394	0.1418
3	0.0312	0.1125
2	0.0216	0.0777
1	0.0092	0.0332
BASE	0	0



3.3 STORY SHEAR

3.3.1 STORY SHEAR ALONG X-Dir

Table 5: Comparison of Storey shear(kN) along X-direction for EQx under zones II and IV respectively.

Story	Dynamic Analysis	
	Storey Shear along X dir	
	EQx (Zone II)	EQx (Zone V)
30	319	870
29	669	1822
28	994	2709
27	1289	3511
26	1554	4233
25	1798	4899
24	2023	5510
23	2228	6069
22	2415	6579
21	2585	7041
20	2738	7458
19	2879	7842
18	3008	8195
17	3123	8507
16	3223	8781
15	3311	9020
14	3387	9226
13	3451	9402
12	3505	9549
11	3550	9671
10	3586	9770
9	3615	9848
8	3637	9908
7	3653	9951
6	3664	9982
5	3671	10001
4	3676	10012
3	3677	10017
2	3678	10018
1	3679	10019
BASE	3679	10019

3.3.2 STORY SHEAR ALONG Y-Dir

Table 6: Comparison of Storey shear(kN) alongY-direction for EQy under zones II and IV respectively.

Story	Dynamic Analysis	
	Storey Shear along Y dir	
	EQy (Zone II)	EQy (Zone V)
30	237	645
29	496	1351
28	737	2008
27	955	2602
26	1152	3137
25	1333	3631
24	1499	4084
23	1651	4498
22	1790	4876
21	1916	5219
20	2029	5528
19	2134	5812
18	2230	6073
17	2314	6305
16	2389	6508
15	2454	6685
14	2510	6838
13	2558	6968
12	2598	7077
11	2631	7168
10	2658	7241
9	2679	7299
8	2696	7343
7	2708	7375
6	2716	7398
5	2721	7413
4	2724	7421
3	2725	7424
2	2726	7425
1	2727	7426
BASE	2728	7427



3.4 BASE SHEAR

3.4.1 STORY SHEAR

Load Case	Base Shear kN (Zone II)	Base Shear kN (Zone V)
EQx	3679	10019
EQy	2728	7427

IV. CONCLUSION

In the present study, It is made to compare the results obtained from dynamic analysis of reinforced concrete structure in IS 1893:2002 using ETABS.

- **Lateral displacements:** it was found out that lateral displacement in zone (V) nearly 28% more than zone (II).
- **Story Drift:**It is observed that higher story drift in zone V compared to seismic zone II
- **Story shears:** Maximum storey shear in zone V is almost three times higher than the storey shear zone II.
- **Seismic Weight:** It remains constant, since the structure does not change

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