Seismic Behavior of High Rise R C Building in Different Zones

Engineering

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ABSTRACT

When a structure is subjected to earthquake, it responds by vibrating. An earthquake force can be resolved into three mutually perpendicular directions-the two horizontal directions (x and y) and the vertical direction (z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. It is very essential to consider the effects of lateral loads induced from wind and earthquakes in the analysis of RCC structures, especially for high-rise buildings. The present study is limited to RC multi-storied commercial building in different zones I, II, III & IV .The analysis is carried out the help of FEM software's ETABS. The building model in the study has 21 storeys with constant storey height of 3m. Four models are used to analyze with equal bay lengths and the number of Bays and the bay-width along two horizontal directions are kept constant in each model for convenience. Different values of ZONE FACTOR are taken and their corresponding effects are interpreted in the results.

INTRODUCTION

Dynamic actions are caused on buildings by both earthquakes and wind. But, design for earthquake forces and for wind effects are distinctly different. The spontaneous philosophy of structural design uses force as the basis, which is regular in wind design, where the building is subjected to a pressure on its surface area; this is called force-type loading. But, in earthquake design, the building is subjected to random ground motion at its base, which induces inertia forces in the building that in turn cause stresses; this is called displacement-type loading.

BASIC ASPECTS OF SEISMIC DESIGN

The mass of the building being designed controls seismic design in addition to the building stiffness, because earthquake induces inertia forces that are proportional to the building mass. Designing buildings to behave elastically during earthquakes.

Without damage may render the project economically unfeasible. As a consequence, it may be necessary for the structure to undergo damage and thereby dissipate the energy input to it during the earthquake. Therefore, the conventional earthquake-resistant design philosophy requires that normal buildings should be able to resist:

(a) Low and frequent shaking with no damage to non-structural and structural elements;

(b) Medium shaking with some damage to non-structural elements and minor damage to structural elements

(c) High and infrequent shaking with damage to structural elements, but with NO collapse (to save life and property inside/adjoining the building).

Therefore, buildings are designed only for a fraction 8-14% of the force that they would sustain, if they were designed to remain elastic during the anticipated strong earthquake shaking and thereby tolerating damage. But, sufficient initial stiffness is required to be ensured to avoid structural damage under minor shaking. Therefore, seismic design balances reduced cost and acceptable damage, to make the project feasible. This careful balance is arrived based on extensive research and detailed post-earthquake damage assessment studies. A wealth of this information is translated into precise seismic design provisions. In contrast, structural damage is not acceptable under design wind forces. For this purpose, design against earthquake effects is

called as earthquake-resistant design and not earthquake-proof design.

Dr. K. R. C. Reddy, Sandip A. Tupat(2014) had reported that The wind loads and earthquake loads are estimated for a twelve storied RC framed structure. Based on the results obtained the following conclusions are made. The earthquake and wind loads increases with height of structure. Wind loads are more critical for tall structures than the earthquake loads. Structures should be designed for loads obtained in both directions independently for critical forces of wind or earthquake.

Deepak Suthar, H.S.CHORE, P.A. DODE. (2014) studied that the behavior of high rise structure for both the scheme. In this paper they got the results from mathematical model for model I and model II. The graph clearly shows the story drift, lateral displacement and time period is more in model I as compared to model II. It is also observed that the results are more conservative in Static analysis as compared to the dynamic method resulting uneconomical structure. From all the results it is found that model II is very effective in resisting the lateral forces induced by Earthquake. Because of the Box effect of modular type scheme, it is increasing overall stiffness of the building thus, reducing the sway problem in the structure. As building is in irregular "L-shape" the behavior in both directions is not similar. Further, the comparison between regular and modular type indicates the overall feasibility of the scheme without affecting its stability in gravity as well as lateral loads.

TABLE 4.1 Building Configuration Data.

PARAMETERS	ZONE II	ZONE III	ZONE IV	ZONE V
zone factor	0.10	0.16	0.24	0.36
Basic wind speed	44 m/s	39 m/s	47 m/s	50 m/s
Response reduction factor	5	5	5	5
Importance factor	1	1	1	1
Soil condition	Medium	Medium	Medium	Medium

Slab thickness	0.150 m	0.150 m	0.150 m	0.150 m
Beam size	0.45x0.25 m	0.45x0.25 m	0.45x0.25 m	0.45x0.25 m
Column size	0.75x0.75 m	0.75x0.75 m	0.75x0.75 m	0.75x0.75 m
Live load	2 kN/m²	2 kN/m²	2 kN/m²	2 kN/m²
Dead load	4.5 kN/m²	4.5 kN/m²	4.5 kN/m²	4.5 kN/m²
Floor finish	1.1Kn/m²	1.1Kn/m²	1.1Kn/m²	1.1Kn/m²
Material properties	M_{30}	M_{30}	M_{30}	M_{30}

BASE SHEAR

Base shear is an estimate of the maximum expected lateral force that will occur due to seismic ground motion at the base of a structure. In this paper the base shear for different seismic zones will be calculated and compare the results by tabular form as well as graphical representation due to this we know clear difference b/w the building models in different seismic zones like ZONE II, III ,IV &V.

TABLE 5.1: Base shear Values for Different Zones.

ZONES	BASE SHEAR (Kn)
ZONE II	802.6
ZONE III	1284
ZONE IV	1926
ZONE V	2889

FIG 5.1: Base shear Values for Different Zones.

The base shear of structure increases as we go to higher seismic zones. For a similar building the base shear value of ZONE II is 802.6 KN and ZONE V is 2889 KN. This means base shear increases by more than 350% if seismic ZONE changes from II to V.

POINT DISPLACEMENT

A storey displacement was considered the points at which the maximum storey displacement occurred. Lateral displacements of G+20 RC building models subjected earth quake loads in X directions for the entire different zones.

DISPLACEMENT FOR LOAD COMBO 1D.L+0.8L.L+0.8EQ.L

TABLE 5.2: Displacement values for 1D.L+0.8(L.L+EQ.L).

STORY	ZONE II	ZONE III	ZONE IV	ZONE V
BASE	0	0	0	0
1	0.0014	0.0023	0.0034	0.0051

| 2	0.0051	0.0082	0.0123	0.0184
3	0.0104	0.0166	0.0249	0.0374
4	0.0167	0.0268	0.0401	0.0602
5	0.0237	0.0379	0.0569	0.0853
6	0.031	0.0496	0.0744	0.1116
7	0.0384	0.0614	0.0921	0.1382
8	0.0457	0.0731	0.1097	0.1645
9	0.0528	0.0845	0.1267	0.19
10	0.0596	0.0953	0.1429	0.2144
11	0.066	0.1055	0.1583	0.2374
12	0.0719	0.1151	0.1726	0.2589
13	0.0774	0.1238	0.1858	0.2787
14	0.0824	0.1318	0.1977	0.2966
15	0.0869	0.139	0.2085	0.3127
16	0.0908	0.1453	0.218	0.327
17	0.0942	0.1508	0.2262	0.3393
18	0.0972	0.1555	0.2332	0.3498
19	0.0996	0.1594	0.239	0.3586
20	0.1016	0.1626	0.2439	0.3658
21	0.1033	0.1653	0.248	0.372
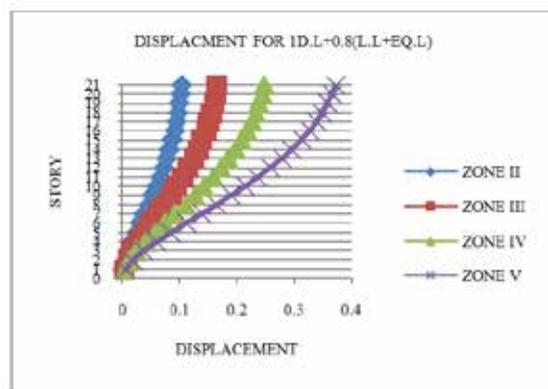
FIG 5.2: Displacement values for 1D.L+0.8(L.L+EQ.L).

STORY DRIFT
STORY DRIFT FOR 1.5 (D.L+EQ).
TABLE 5.6: Story drift for 1.5(D.L+EQ.L).

Story	ZONE II	ZONE III	ZONE IV	ZONE V
1	0.000886	0.001418	0.002127	0.003191
2	0.002306	0.00369	0.005535	0.008302
3	0.003299	0.005279	0.007918	0.011877
4	0.003958	0.006333	0.009499	0.014249
5	0.004359	0.006974	0.010461	0.015692
6	0.004563	0.007301	0.010952	0.016428
7	0.00462	0.007392	0.011087	0.016631
8	0.004566	0.007306	0.010959	0.016438
9	0.004431	0.007089	0.010634	0.015951
10	0.004236	0.006777	0.010166	0.015249
11	0.003997	0.006395	0.009592	0.014388
12	0.003725	0.005961	0.008941	0.013412
13	0.003431	0.005489	0.008234	0.012351
14	0.00312	0.004991	0.007487	0.011231

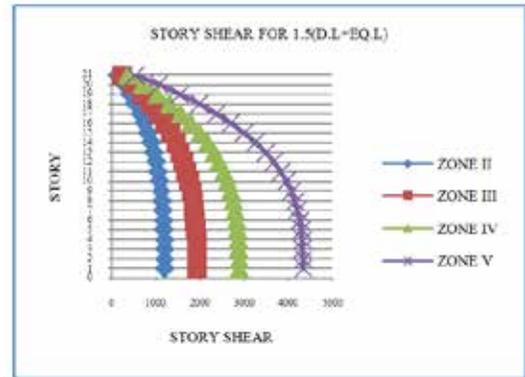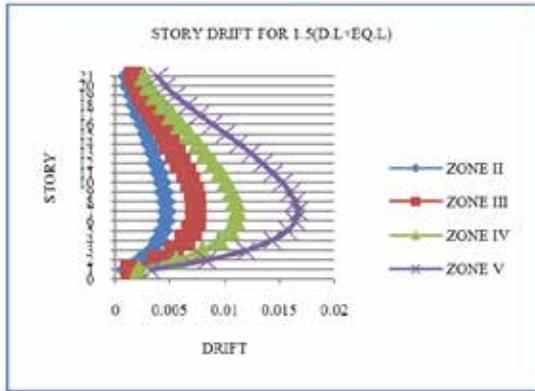| 15 | 0.002797 | 0.004476 | 0.006713 | 0.01007 |
16	0.002469	0.003951	0.005926	0.008889
17	0.002141	0.003426	0.005139	0.007709
18	0.001822	0.002916	0.004373	0.00656
19	0.001524	0.002438	0.003657	0.005486
20	0.001265	0.002024	0.003036	0.004553
21	0.001074	0.001719	0.002578	0.003867

| 21 | 151.29 | 242.06 | 363.1 | 544.65 |

FIG 5.12: Story shear for 1.5(D.L+EQ.L).

CASE STUDY

The building model in the study has Twenty One storeys with constant storey height of 3m. Four models are used to analyze with equal bay lengths and the number of Bays and the bay-width along two horizontal directions are kept constant in each model for convenience. Different values of ZONE FACTOR are taken and their corresponding effects are interpreted in the results.

CONCLUSIONS

The base shear of structure increases as we go to higher seismic zones. For a similar building the base shear value of ZONE II is 802.6 KN and ZONE V is 2889 KN. This means base shear increases by more than 27% if seismic ZONE changes from II to V.

The displacement of building models increases with the increasing of seismic Zones. The displacement is very high at roof and very low at the base. The displacement occur at the ZONE II is 0.1033 and ZONE IV is 0.372. This means base shear increases by more than 27% if seismic ZONE changes from II to V.

The story drift is mainly occurred at the middle of the building structure. The story drift increases with the increasing of seismic zone factor. And the maximum story drift is available at ZONE V for the max. Load combo for 7th floor. The story drift for ZONE II is 0.00887 and story drift for ZONE V is 0.016631m at 7 th floor. This means the story drift is increases by more than 50% when compare to ZONE II to ZONE V.

The Storey Shear is decreased as height of the building increased and reduced at top floor in all the building models subjected to seismic loads considered. The story shear is maximum at the base. And the story shear value for the model in ZONE II is151.29 and ZONE V is 544.65.This means the story shear is increases by more than 27% when compare to ZONE II to ZONE V.

FIG 5.6: Story drift for 1.5(D.L+EQ.L).

STORY SHEAR

STORY SHEAR FOR 1.5(D.L+EQ.L)

TABLE 5.12: Story shear for 1.5(D.L+EQ.L).

Story	ZONE II	ZONE III	ZONE IV	ZONE V
1	1203.93	1926.3	2889.44	4334.16
2	1203.57	1925.71	2888.56	4332.84
3	1202.1	1923.36	2885.04	4327.56
4	1198.8	1918.08	2877.12	4315.68
5	1192.93	1908.69	2863.04	4294.55
6	1183.76	1894.02	2841.03	4261.54
7	1170.56	1872.89	2809.34	4214.01
8	1152.59	1844.14	2766.21	4149.31
9	1129.11	1806.58	2709.87	4064.81
10	1099.4	1759.05	2638.57	3957.85
11	1062.73	1700.36	2550.54	3825.81
12	1018.35	1629.35	2444.03	3666.05
13	965.53	1544.85	2317.27	3475.91
14	903.55	1445.67	2168.51	3252.77
15	831.66	1330.65	1995.98	2993.97
16	749.13	1198.61	1797.92	2696.88
17	655.24	1048.38	1572.57	2358.86
18	549.24	878.79	1318.18	1977.27
19	430.41	688.65	1032.98	1549.46
20	298	476.8	715.2	1072.8

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