Journal of Civil Engineering and Environmental Technology
p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 7, Issue 2; April-June 2020, pp. 205-209

http://www.krishisanskriti.org/Publication.html

Study of Lateral Loads in Low Seismic Zone on a Tall RC Frame Building

Durgesh Nandan Yadav[1] and Anjali Rai[2]

[1]*PG Student (M. Tech Structural Engineering), Civil Engineering Department, Institute of Engineering and Technology, Lucknow*
[2]*Assistant Professor, Civil Engineering Department, Institute of Engineering and Technology, Lucknow*
E-mail: [1]durgeshnanda8@gmail.com, [2]anjali3725@gmail.com

Abstract—*Due to the rapid growth of India's population and the availability of a more industrial-friendly environment, people tend to migrate to major coastal cities, i.e. Mumbai, Chennai, Kolkata, Vishakhapatnam, Puducherry, etc., and to meet the needs of housing in that region, it is necessary to build vertically growing structures like tall buildings, high-rise buildings, etc. to protect the people living in those buildings it is required to design safe structures under various loads when lateral loads are predominant in the form of seismic and wind loads. Thus, in this study, we investigated the effect of lateral loads on Tall RC Frame Building using ETABS 2017 software. Seismic analysis according to Indian code IS 1893: (part-1) 2016 was performed using the response spectrum method. IS 875: 2015 Part III is used for wind analysis by simple diaphragm analysis method. We chose a reinforced concrete (RC) frame building with a plan dimension of 20 m x 20 m, height G + 31, which is in seismic zone II and is exposed to ground wind speeds up to 50 m / s. Finally, after analysis, the results show that the frame is safe under seismic forces but fails under wind loads. To protect the structure from the effects of wind force, shear walls are installed.*

Keywords: *RC Frame structure, Lateral Loads, Wind Load, Seismic Load, Simple Diaphragm Method, ETABS 2017.*

1. INTRODUCTION

Typically, in the case of high-rise structures, Tall RC Structure and skyscrapers, wind and earthquake loads predominate. Thus, for high-rise structures, it is necessary to know about the different loads and their effects on the structure. There are many factors affecting structure and the causes of failure.

Every wind load (Force) is determine by a probabilistic statistical method (as per IS 875: Part 3 2015) based on the concept of "equivalent static wind load", assuming that the structural frames and components / coatings are elastic under strong winds. Typically, a building is subject to an average wind force based on an average wind speed and an oscillating wind force based on an oscillating flow field. It is very important to take into account the effects of lateral loads such as earthquakes and wind loads. In some cases, the wind load is higher than the earthquake load, which depends on a location and area factor that differs by codes.

A Shear wall system is used for counter seismic and wind forces. In structural engineering, a shear wall is a vertical element of a wind or seismic resistance system designed to withstand lateral forces in a plane, usually wind and seismic loads. In various jurisdictions, the design of shear walls is regulated by the International Building Code and the International Residential Code.

2. OBJECTIVE OF WORK

The aims of this research work are to analyze the study of multi-story tall building (G+31) subjected to lateral loads (wind and earthquake load) with gravity load.

1. To study lateral loads behaviour on the RC frame building structural system with wind and seismic forces.
2. To study the parameters i. e. natural time period, story displacement and story drift on the performance of the structure due to lateral loads.
3. To study the parameter under wind and seismic loads and find out which is more prominent in considered low seismic region.
4. Study the effect of corner shear wall on considered parameters.

3. STRUCTURAL BUILDING DETAIL

The length and width of the building are 20 m and 20 m. The height of each story is 3m. The shape of the building is symmetrical to the X and Y axis and it is a square plan. The columns are consider as rigidly fixed at ground level. In this study, a G + 31 high reinforced concrete structure having 6 bays in both X and Y-direction building was investigated by considering different types of support systems. The table below provides details of the building used for structural analysis.

Table 1: Description of the Building

S. No.	Structural Part	Dimensions
1.	Location of site	Puducherry
2.	Type of the Building	RC Tall Building (G+31)
3.	Plan of structure	20m * 20m
4.	Type of structure	RC Frame structure
5.	No. of spacings in X-directions	5 No.@4m
6.	No. of spacings in Y-directions	5 No.@4m
7.	Floor to floor elevations	03.0m
8.	Total elevations of building	93.60m
9.	Slab's thickness	140mm
10.	Column dimensions	600mm*600mm
11.	Beam	300mm*600mm
12.	Glass Panel	6.5mm thick
13.	Lintel	300mm*150mm

Table 2: Material Property (IS 456:2000 & IS 800:2007)

S. No.	Materials	Property
1.	Concrete	M30
2.	Steel	Fe250
3.	Rebar	HYSD500
4.	Steel Density	7850 kg/m^3
5.	Young's Modulus E	2.1 x 10^5 N/mm^2
6.	Shear Modulus	80000 N/mm2
7.	Poisson Ratio	0.3

Table 3: Wind load data: As per IS 875:2015 (part 3)

1.	Basic wind speed	50m/sec
2.	Risk Co-efficient(k_1)	1 (clause 6.3.1)
3.	Terrain category (k_2)	Category 2 (clause 6.3.2)
4.	Topography factor (k_3)	1 (clause 6.3.3)
5.	Class of building	Class-B
6.	Windward Co-efficient (cp)	0.8
7.	Leeward Co-efficient (cv)	0.5

Loadings:

According to the loading standards of the Indian Standard, it consists of IS 875: 1987 Part 1, IS 875: 1987 Part (II) and IS 875: 2015 Part (III) and IS 1893: 2016 Part (I) for Dead Load, Live Load, Wind and earthquake load respectively. According to Indian standards of calculation and according to the structural load on the studied model, a live load of 4 KN / m^2 and a dead load of 4.5 KN / m^2 is taken and applied to the frame of the structure.

For seismic loading, it has several parameters which are taken from the Criteria for the design of earthquake resistant structures IS 1893: 2016 Part (I) General provisions and buildings i. e. seismic zone 2, zone factor (Z) is .10, damping ration is 2%, IF 1.2, medium soil and response reduction factor is considered 5 for frames resistant to simple moments.

4. PROBLEM FORMULATION

This study is aimed at the lateral load response of a multi-storey tall RC frame structure (G + 31) building under seismic and wind force. The structures under consideration are located in seismic zone II and in the main wind speed zone of 50 m / sec, as specified in the IS code guidelines, using the ETAB'S-2017 software.

(a) Model 1- RC Tall Building (G+31) without shear wall (Wind load analysis)

(b) Model 2- RC Tall Building (G+31) without shear wall (Seismic load analysis)

(c) Model 3- RC Tall Building (G+31) with corner shear wall

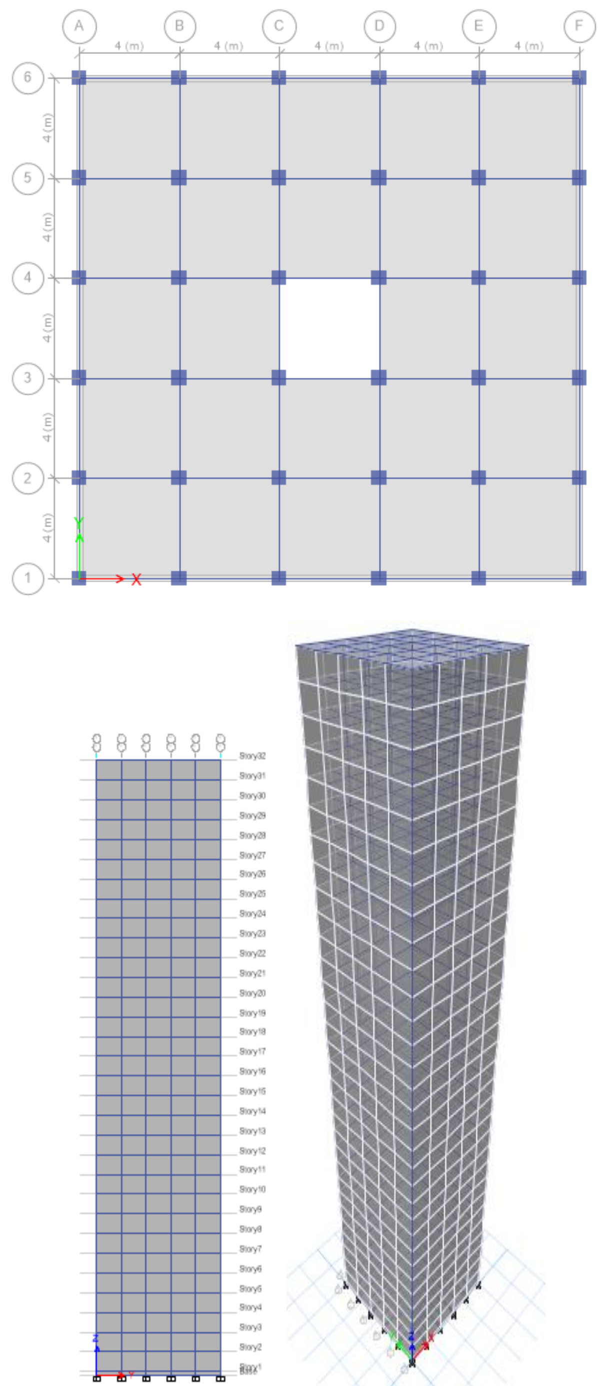

Figure 1: Plan, Elevation and 3D view of Model 1 and Model 2

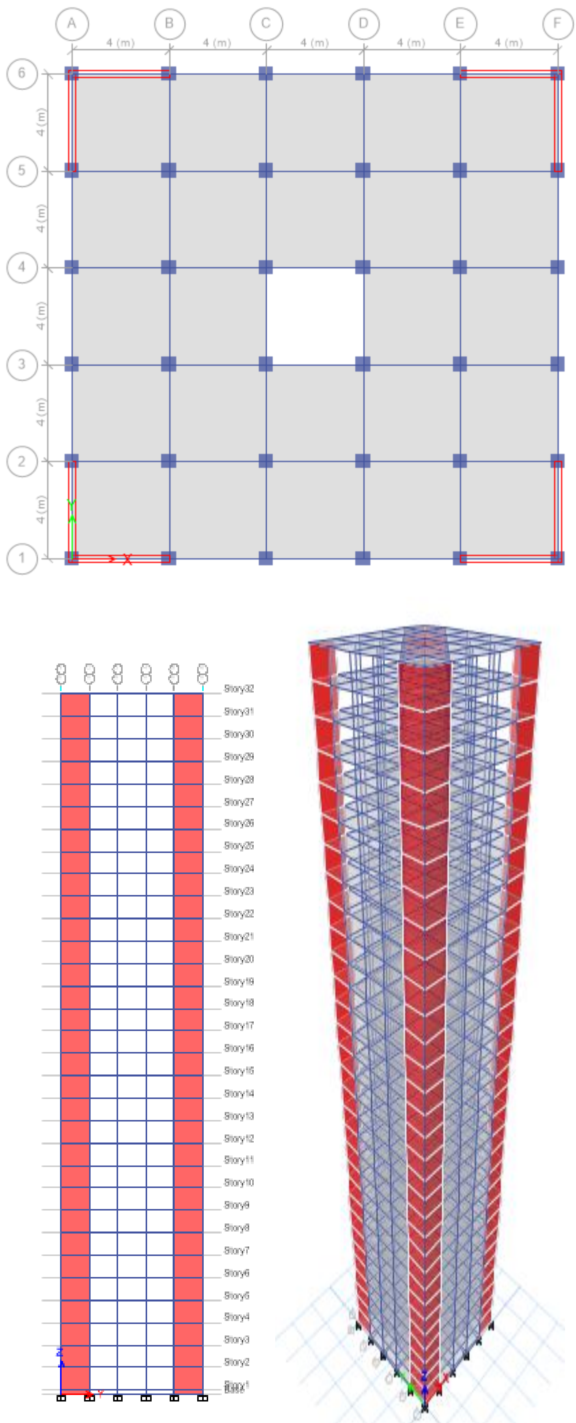

Figure 2: Plan, Elevation and 3D view of Model 3

5. RESULT & DISCUSSION

This study analyzes various parameters such as natural period, story drift, and story displacement or shift. This is analyzed as follows:

a. Natural Time Period

The natural period of a building is T_n, which is the period during which it performs a full cycle of oscillation. It is an innate property of building, controlled by its mass m and stiffness k.

Its equation is as follows and its unit is sec.

$$T_n = 2\pi\sqrt{(m/k)}$$

The natural period response of a building ($1 / T_n$) is known as the natural frequency f_n; Its unit is called as Hertz (Hz).

Table 4: Natural Time Period

Mode	Wind Load	Seismic Load	Corner Shear Wall
1	2.521	2.521	2.088
2	2.521	2.521	2.088
3	2.007	2.007	1.474
4	0.801	0.801	0.592
5	0.801	0.801	0.592
6	0.665	0.665	0.405
7	0.44	0.44	0.286
8	0.44	0.44	0.286
9	0.395	0.395	0.187
10	0.307	0.307	0.172
11	0.307	0.307	0.172
12	0.279	0.279	0.117

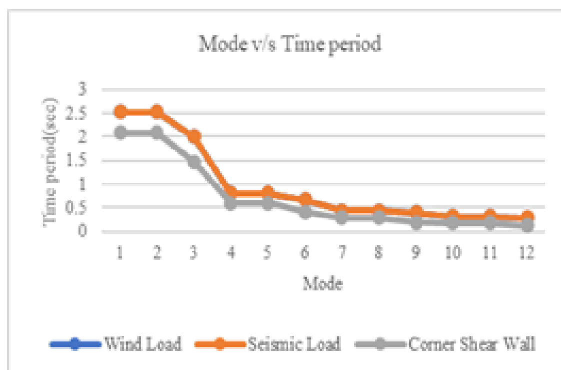

Figure 3: Fundamental natural time period

b. Story Drift

Story drift is the relative displacement between floors above or below the previewed story. According to IS 1893 (Part I): 2016 (clause 7.11.1.1), the story drift in any case should not exceed 0.004 of each floor height due to the shear of the design base, thus the permissible drift value for a floor height of 3 m is 0.004 * 3 = 12 mm.

Table 5: Story Drift

Story	Wind Load	Seismic Load	Corner Shear Wall
1	8.859	0.567	1.149
2	11.994	1.015	2.032
3	12.601	1.097	2.723
4	12.74	1.142	3.264
5	12.761	1.177	3.684
6	12.727	1.209	4.005

7	12.654	1.237	4.244
8	12.547	1.261	4.413
9	12.408	1.282	4.525
10	12.236	1.3	4.588
11	12.036	1.313	4.609
12	11.809	1.323	4.595
13	11.559	1.328	4.551
14	11.287	1.33	4.482
15	10.993	1.327	4.392
16	10.678	1.319	4.284
17	10.345	1.307	4.162
18	9.994	1.29	4.026
19	9.629	1.268	3.882
20	9.249	1.241	3.729
21	8.856	1.209	3.571
22	8.452	1.172	3.41
23	8.036	1.13	3.248
24	7.611	1.082	3.087
25	7.177	1.028	2.93
26	6.736	0.97	2.779
27	6.287	0.905	2.637
28	5.834	0.835	2.508
29	5.378	0.76	2.396
30	4.93	0.681	2.307
31	4.548	0.605	2.231

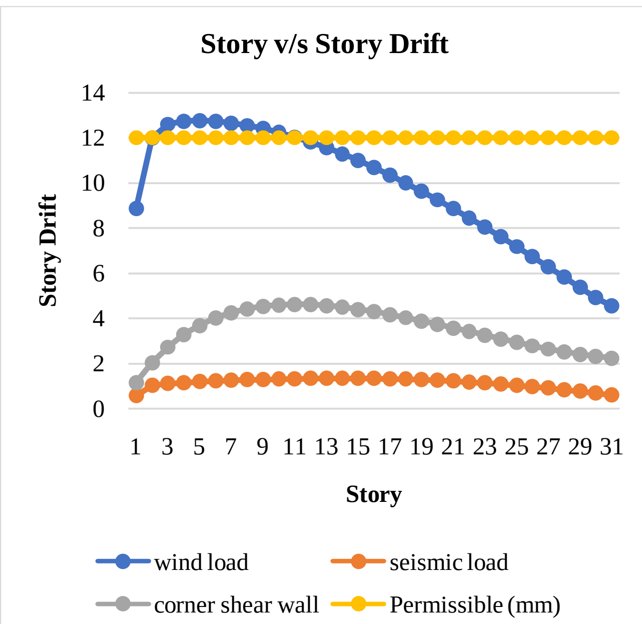

Figure 4: Comparison of Story Drift

Story drift due to wind load is exceeds permissible limit and it is safe in seismic load case.

c. Story Displacement

Lateral shift of the building or structure means a total or complete displacement of the floor relative to the floor due to lateral forces acting on the building. Displacement of the story is a shift of a particular story in relation to the ground. The displacement according to IS 1893 (Part I): 2016 is limited to H / 250.

Table 5: Story Displacement

Story	Wind Load	Seismic Load	Corner Shear Wall
1	9.248	0.763	1.215
2	21.242	1.778	3.247
3	33.843	2.875	5.969
4	46.583	4.017	9.233
5	59.344	5.194	12.917
6	72.071	6.403	16.922
7	84.725	7.64	21.165
8	97.273	8.901	25.579
9	109.68	10.184	30.104
10	121.916	11.484	34.691
11	133.952	12.797	39.3
12	145.761	14.12	43.894
13	157.32	15.448	48.445
14	168.607	16.778	52.928
15	179.6	18.104	57.32
16	190.278	19.423	61.923
17	200.622	20.73	65.766
18	210.617	22.02	69.792
19	220.245	23.288	73.674
20	229.494	24.529	77.403
21	238.35	25.738	80.975
22	246.802	26.91	84.385
23	254.838	28.04	57.633
24	262.449	29.122	90.72
25	269.626	30.15	93.65
26	276.362	31.561	96.429
27	282.649	32.025	99.066
28	288.483	32.861	101.574
29	293.862	33.621	103.97
30	298.791	34.302	106.277
31	303.339	34.907	108.508

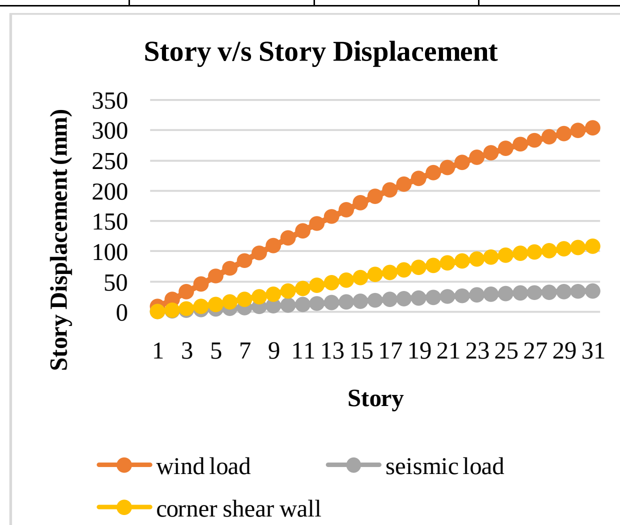

Figure 5: Comparison of Story Displacement

6. CONCLUSIONS

From the above study the following conclusion are given below:

i. Among wind load, seismic load and corner shear wall model due to high wind gust wind model exceeds permissible drift limit.
ii. In low seismic zone seismic model is safe in all the parameters.
iii. Wind load is counterbalanced by corner shear wall efficiently.
iv. Natural Time period (sec) of the model is decreased in case of corner shear wall due to increased stiffness although its mass increases.
v. In case of corner shear wall .433 sec (17.17%) natural time period is decreases.
vi. Displacement is minimum in the model that is not exposed to wind load is 34.07 mm.
vii. Max Drift is minimum in seismic model that is not subjected to extreme wind is 1.33 mm.
viii. For model that is not exposed in wind in that region have no need to any extra provision to make safe structure.

REFERENCES

[1] Chen, X. and Kareem, A., 2005. Coupled dynamic analysis and equivalent static wind loads on buildings with three-dimensional modes. *Journal of structural Engineering*, *131*(7), pp.1071-1082.

[2] Hajra, B. and Godbole, P.N., 2006. Along Wind Load on Tall Buildings Indian Codal Provisions. *3NCWE06 Kolkata, pp285-292*.

[3] Mendis, P., Ngo, T., Haritos, N., Hira, A., Samali, B. and Cheung, J., 2007. Wind loading on tall buildings. *Electronic Journal of Structural Engineering*.

[4] Adnan, A. and Suradi, S., 2008, October. Comparison on the effect of earthquake and wind loads on the performance of reinforced concrete buildings. In *14th World Conference on Earthquake Engineering* (pp. 1-3).

[5] Esmaili, O., Epackachi, S., Samadzad, M. and Mirghaderi, S.R., 2008, October. Study of structural RC shear wall system in a 56-story RC tall building. In *The 14th world conference earthquake engineering*.

[6] Willford, M.R. and Smith, R.J., 2008. Performance based seismic and wind engineering for 60 story twin towers in Manila. *Director*, *2*(1).

[7] Simiu, E., Letchford, C., Isyumov, N. and Chowdhury, A.G., An Assessment of Methods for Determining Wind Loads.

[8] Lam, K.M., Wong, S.S.Y., To, A.P. and Fong, Y.F., 2013. Shielding effects on a tall building from various configurations of surrounding medium-rise buildings. In *the Eighth Asia-Pacific Conference on Wind Engineering*.

[9] IS: 800:2007 General Construction of Steel- Code of Practice.

[10] IS: 456:2000 Plain and Reinforced Concrete- Code of Practice.

[11] IS 875 (Part 3)- 2015 Wind Loads on Buildings and Structures

[12] IS: 1893(Part-1):2016 Criteria for Earthquake Resistant Design of Structures.

[13] IS: 875 (Part 2) - 1987, Code of Practice Design Loads (Other Than for Earthquake) For Buildings and Structures.

[14] IS: 13920:2016 Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- Code of Practice.

[15] Eurocode 8: Design of structures for earthquake resistance, 2004.

[16] Kalpana, P., Prasad, R.D. and Kumar, B.K., Analysis of Building with and without Shear Wall at Various Heights and Variation of Zone III and Zone V.

[17] Kevadkar, M.D. and Kodag, P.B., 2013. Lateral load analysis of RCC building. *International Journal of Modern Engineering Research (IJMER)*, *3*(3), pp.1428-1434.