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Influence of Wind Loads on Tall Reinforced Concrete Structures in Different Terrains and Zones

[1]Nasrin Abu, [2]Shefeena N
[1] Post Graduate Student, Department of Civil Engineering, TKM College of Engineering, Kollam, Kerala, India
[2] Assistant Professor, Department of Civil Engineering, TKM College of Engineering, Kollam, Kerala, India

Abstract
High-rise structure construction has become a feasible solution to the issues related to society. It is very essential to consider the effects of lateral loads induced by wind and earthquakes in the analysis of reinforced concrete structures, especially high-rise buildings. The effect of wind is predominant on tall structures depending on the location of the structure, height of the structure and wind speed. Wind loads as specified in IS: 875 (Part 3)-2015 are considered in this analysis. In this, a multi-storey (G+19) structure with different shapes is modelled in the ETABS 2016 software. The severity of wind load on different structures in various wind zones and in different terrain categories was studied. The effect of variation in terrain category is the major factor in this work because as the height increases the wind speed increases and thus the displacement increases but as the terrain category varies the obstruction for the wind flow increases so the effect of wind force decreases on the particular high rise structures when the wind load is applied. Storey drift, storey displacement and base shear are analysed for various wind load cases and the main aim of this study is to obtain the best suitable structural shape for stability in wind prone area.
Keywords: *Wind loads, Zone Factor, Terrain Category Design Loads, High Rise Buildings, ETABS, IS: 875 (Part 3)-2015, Storey drift, Storey displacement, Base shear*

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I. INTRODUCTION

Buildings are subjected to horizontal loads due to wind pressure acting on the buildings. Wind load is calculated as per IS 875 (Part III)-2015. The horizontal wind pressures act on vertical external walls and exposed area of the buildings. Some of the pressure acting on exposed surfaces of structural walls and columns is directly resisted by bending of these members. The infill walls act as vertical plate supported at top and bottom by floor beams, thus transferring the loads at slab level. The parapet wall is at terrace transfers the wind loads to the surface slab by cantilever action. For simplicity, the wind loads acting on exposed surfaces of a given story are idealized to be supported by upper and lower floors.

Movement of air with respect to the earth surface is known as wind. Earth's rotation and terrestrial radiation differences are the major causes of wind. The effects of the radiation are mainly accountable for either upward or downward convection. Generally at high wind speeds, the wind blows to the ground horizontally. Vertical components of atmospheric motion are comparatively small. Thus the term wind almost exclusively means the horizontal wind. The capability of a structure to withstand enormous pressure of the wind depends on geography, nearness of other hindrances to the flow of air and also depends on the characteristics of the structure. The combined action of internal and external pressure acting on the structure as whole determines the effect of wind on it. The tall building can be described as a multi-storey building generally provided with high speed elevators, constructed using a structural frame, and combining extraordinary height with ordinary room spaces such as could be found in low-buildings.

1.1 WIND EFFECTS ON TALL BUILDINGS

The wind is the most powerful and unpredictable force affecting tall buildings. Tall building can be defined as a mast anchored in the ground, bending and swaying in the wind. This movement, known as wind drift, should be kept within acceptable limits. Moreover, for a well-designed tall building, the wind drift should not surpass the height of the building divided by 500. The wind load is the most important factor that determines the design of all buildings over 10 storeys. Buildings taller than 10 storeys would generally require additional steel for lateral system. An important problem associated with wind induced motion of buildings is concerned with human response to vibration and perception of motion. The complexities of wind loading should be kept in mind when applying a design document. Because of the many uncertainties involved, the maximum wind loads experienced by a structure during its lifetime, may vary widely from those assumed in design. The structural forms used today have greater flexibility combined with less mass and damping than those used for traditional structures of the past. These factors have increased the importance of wind in design consideration. For estimations of the overall stability of a structure and of the local pressure distribution on the building, knowledge of the maximum steady or time averaged wind loads is usually sufficient.

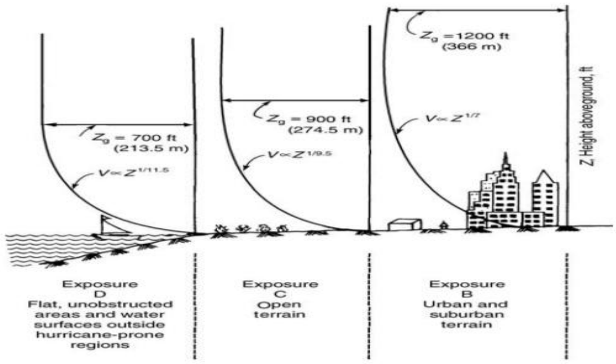


Figure 1: Influence of exposure terrain on variation of wind velocity with height

1.2 WIND ANALYSIS AS PER IS 875 (PART 3)-2015

Wind forces acting on a given surface is equal to the wind pressures multiplied by the affected area. The design wind speed (V_Z in m/s) at any height z is given by the equation:

$V_Z = V_b \times k_1 \times k_2 \times k_3 \times k_4$, where

V_b= Basic wind speed (m/s)

k_1 = probability factor (risk coefficient)

k_2 = terrain roughness and height factor

k_3 = topography factor

k_4 = importance factor for the cyclonic region

The wind speed may be taken as constant upto a height of 10 m. However, pressures for buildings less than 10m high may be reduced by 20% for stability and design of the framing. Basic wind speed V_b, depends on the location of the building. For this purpose, the country is divided into six zones with specified wind speeds ranging from 33m/s to 55 m/s. Basic wind speed is based on gust velocity averaged over a short time interval of 3 seconds at 10m height from mean ground level in an open terrain and for 50 years return period. The risk coefficient k_1 takes into account the degree of reliability required and the expected life of structure. k_2 depends on terrain category and building class/size of structure.

Four terrain categories are specified by the code depending on the availability of obstruction to the flow of wind.

Category 1: Refers to no obstructions available to the building (e.g.) sea coasts and flat treeless plains where other structures if any have heights less than 1.5m.

Category 2: Refers to open terrain with scattered obstructions of 1.5m to 10m height. (e.g.) industrial area.

Category 3: Refers to areas of closed spaced buildings of height up to 10m (e.g.) buildings at outskirts of city

Category 4: Refers to area with highly closed buildings of large heights (e.g.) dense city area.

k_2 factor also depends on the dimensions of the building under considerations. Based on dimension of building, the structures are classified as Class A, Class B and Class C.

Class A: Maximum of l, b, h <20m.

Class B: Maximum of l, b, h → 20m to 50m.

Class C: Maximum of l, b, h > 50m.

k_3 depends on the topography i.e. hill region, cliffs and ridges. If the upward ground slope $0 \leq 3^o$, value of k_3 shall be taken as 1.0. For $0 > 3^o$, the value of k_3 lies between 1.0 to 1.36.

Design Wind Pressure (P_z) = $0.6\ V_z^2$, where

P_z = Design Wind speed in N/m^2 at height z

V_z = Design wind speed in m/s.

Wind load on a building is calculated for the "Building as a whole". Force coefficients are given for the building as a whole in the code for clad or unclad buildings.

The wind force acting normal to the building surface is given by:

$F = C_f\ A_e\ P_d$, where

Cf= force coefficient

Ae=effective frontal area

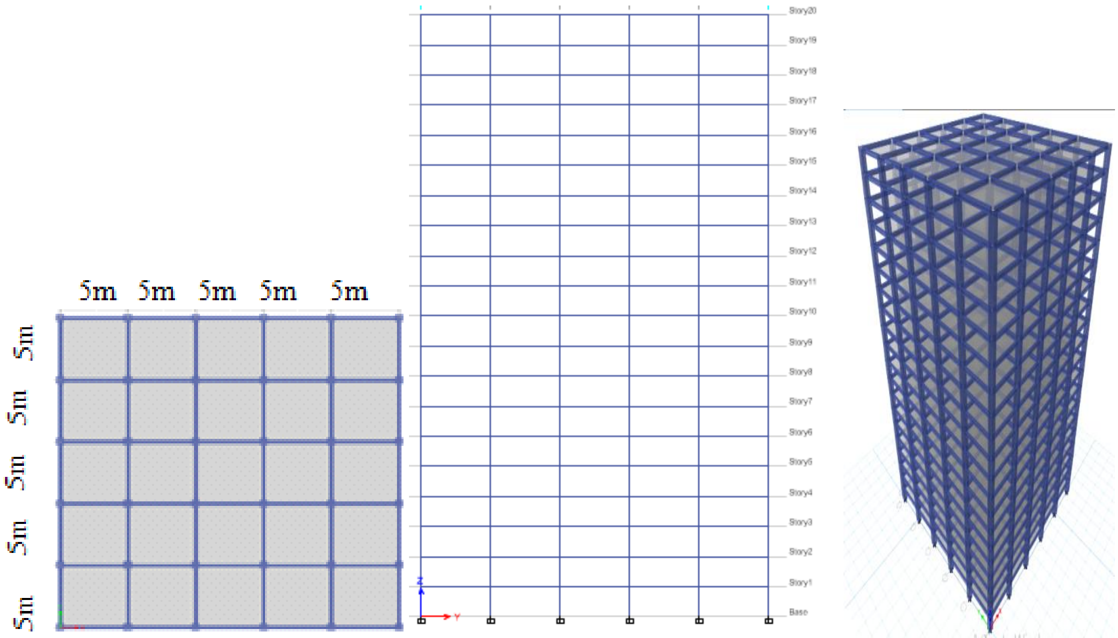
Pd =design wind pressure

II. PROBLEM DEFINITION

A G+19 storey building with different shapes is modeled and analysis is carried out under different wind load conditions. The ETABS 2016 software is used to develop 3D model and to carry out the analysis. The lateral loads to be applied on the buildings are based on IS 875-(Part 3): 2015. The building consists of reinforced concrete elements. Symmetrical general building, having floors of height 3m is selected as a model for the study. Three shaped buildings are modeled namely rectangular, square and octagonal. The width of all buildings in X direction is same. The wind speed corresponding to wind zones I, III, VI is 33m/s, 44m/s and 55m/s respectively. The properties of the building selected for the study is given in table 1. The typical plan, elevation and 3D view of the models are shown in figure 2, figure 3 and figure 4 respectively.

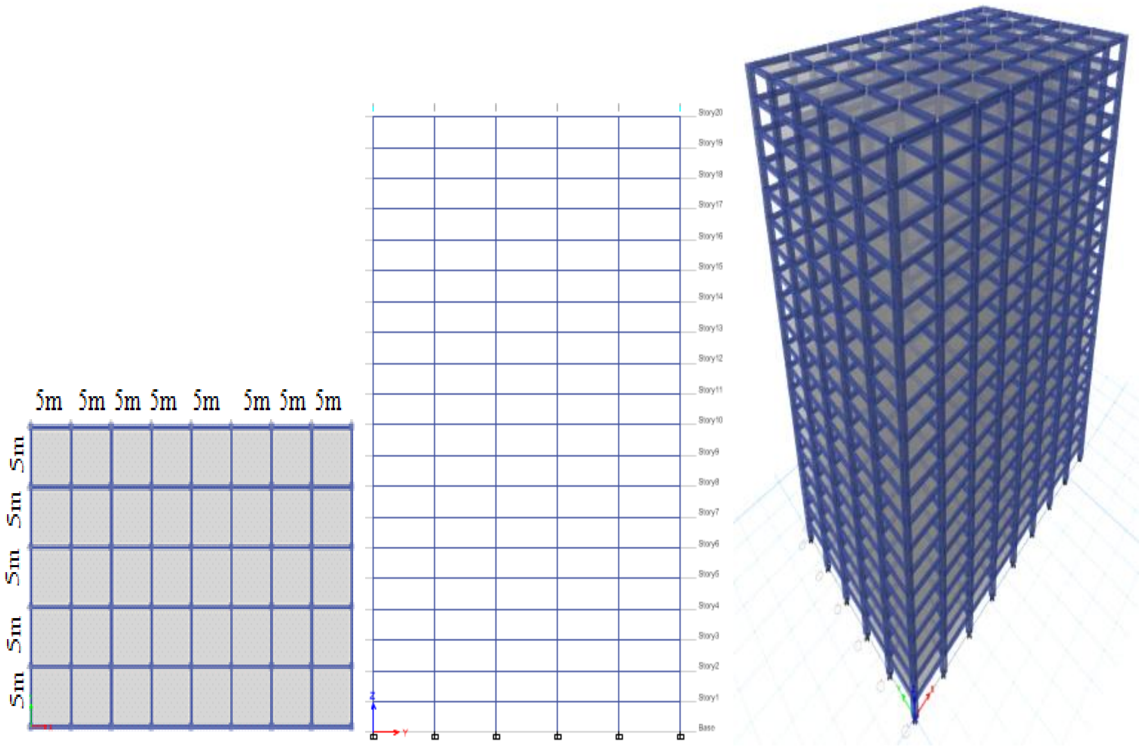
Table 1: General specification of building model

PARAMETERS	VALUES
Number of storeys	G+19
Bottom storey height	3m
Storey height	3m
Structural class	B
Wind zone	I,III,VI
Terrain Category	I, II, III , IV
Thickness of wall	0.23 m
Beam size	0.3 m x 0.5 m
Column size	0.85 m x 0.85 m
Thickness of slab	0.150 m
Grade of concrete	M30
Young's modulus of concrete	25×10^6 kN / m^2
Grade of steel	Fe 415
Density of reinforced concrete	25 kN / m^3
Density of brick	21 kN / m^3
Floor finish	1.5 kN / m^2
Live load	4 kN / m^2
Wall load	13.8 kN / m^2
Risk coefficient (k_1)	1
Topography factor (k_3)	1
Importance factor for the cyclonic region (k_4)	1



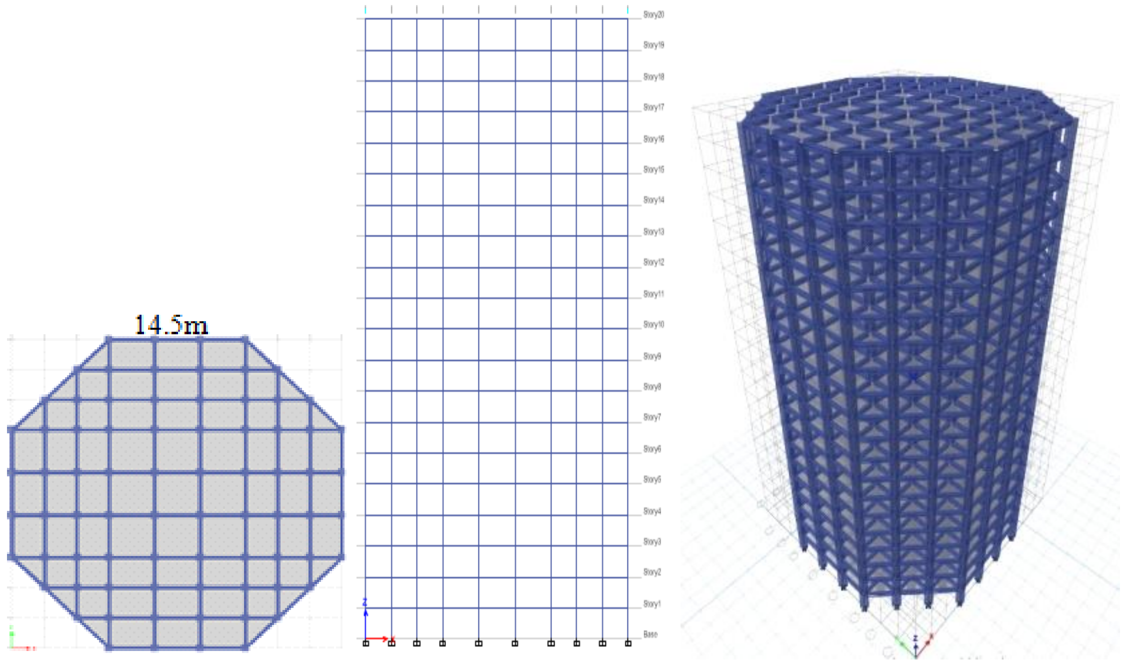
Plan Elevation 3D view

Figure 2: Plan, elevation and 3D model of square building



Plan Elevation 3D view

Figure 3: Plan, elevation and 3D model of rectangular building



Plan Elevation 3D view

Figure 4: Plan, elevation and 3D model of octagonal building

III. RESULT AND DISCUSSION

In structures of ordinary height, dead and live loads are predominant. The wind loading effects are covered by the increase of permissible stresses as recommended by the IS code 875 -Part 3 2015. Hence, for the design of buildings of low to medium height the wind effects are usually ignored. As the height of the building increases, the wind effects become gradually considerable. In the case of very tall slender frames they even become predominant compared to dead and live load effects. Very tall slender building frames are flexible in nature and as a result they interact with the wind dynamically and the safety and the stability of structure may become critical. Hence, for design of very tall frames, a thorough study of wind effects and investigation of criticality are very much necessary. This is particularly considered in regions where wind is more critical than earthquakes

1.3.1 Storey displacement

Displacement is an important criterion to describe the dynamic behavior of building. Storey displacement is the movement of each floor due to lateral forces of wind in either X or Y direction. The analysis results have been tabulated and represented in chart. From the tabulated values it can be observed that the lateral displacement is more at terrace level for buildings situated in different zones and terrains. The lateral displacement is minimum at base level thus as the storey level increases lateral displacement also increases.

- **Square**

Table 2, table 3 and table 4 shows storey displacements of square shaped G+19 reinforced concrete building situated in different terrain categories I, II, III and IV in Zone I , zone III and zone VI respectively.

Table 2: Storey displacements for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	40.563	37.356	31.877	25.606
18	39.495	36.362	31.02	24.867
16	37.73	34.718	29.604	23.648
14	35.083	32.258	27.488	21.839
12	31.516	28.948	24.644	19.439
10	27.042	24.809	21.093	16.491
8	21.717	19.896	16.888	13.072
6	15.665	14.331	12.138	9.305
4	9.199	8.404	7.1	5.402
2	3.17	2.893	2.438	1.844

Table 3: Storey displacements for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	72.112	66.411	56.67	45.521
18	70.214	64.643	55.147	44.208
16	67.075	61.721	52.63	42.041
14	62.37	57.347	48.867	38.825
12	56.028	51.463	43.812	34.558
10	48.075	44.105	37.499	29.318
8	38.608	35.371	30.023	23.238
6	27.848	25.477	21.579	16.543
4	16.353	14.94	12.623	9.603
2	5.636	5.143	4.334	3.279

Table 4: Storey Displacements for zone VI

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	112.675	103.767	88.546	71.127
18	109.709	101.005	86.166	69.074
16	104.804	96.439	82.234	65.689
14	97.453	89.605	76.355	60.664
12	87.543	80.412	68.456	53.998

10	75.117	68.914	58.593	45.809
8	60.325	55.267	46.91	36.31
6	43.513	39.807	33.716	25.848
4	25.552	23.343	19.723	15.005
2	8.807	8.035	6.772	5.123

(ii) Rectangle

Table 5: Storey displacements for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	21.475	19.777	16.874	13.549
18	20.943	19.28	16.447	13.18
16	20.034	18.434	15.718	12.551
14	18.654	17.151	14.614	11.606
12	16.782	15.414	13.122	10.346
10	14.427	13.234	11.251	8.792
8	11.614	10.639	9.029	6.985
6	8.405	7.688	6.511	4.989
4	4.959	4.53	3.827	2.91
2	1.722	1.571	1.323	1.001

Table 5, table 6 and table 7 shows storey displacements of rectangular shaped G+19 reinforced concrete building situated in different terrain categories I, II, III and IV in Zone I , zone III and zone VI respectively.

Table 6: Storey displacements for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	38.179	35.158	29.999	24.088
18	37.232	34.276	29.239	23.43
16	35.617	32.772	27.943	22.313
14	33.163	30.49	25.98	20.634
12	29.835	27.403	23.327	18.393
10	25.647	23.528	20.002	15.631
8	20.646	18.914	16.052	12.418
6	14.942	13.668	11.576	8.869
4	8.817	8.054	6.804	5.173
2	3.061	2.792	2.353	1.779

Table 7: Storey displacements for zone VI

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	59.654	54.935	46.873	37.637
18	58.175	53.557	45.685	36.61
16	55.651	51.206	43.661	34.864
14	51.817	47.641	40.594	32.24
12	46.617	42.817	36.449	28.739
10	40.074	36.762	31.254	24.423
8	32.26	29.553	25.082	19.404
6	23.347	21.357	18.087	13.858
4	13.776	12.584	10.631	8.084
2	4.782	4.363	3.676	2.78

(iii) Octagonal

Table 8 ,table 9 and table 10 shows storey displacements of rectangular shaped G+19 reinforced concrete building situated in different terrain categories I, II, III and IV in Zone I , zone III and zone VI respectively.

Table 8: Storey displacements for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	9.618	8.857	7.556	6.064
18	9.342	8.6	7.335	5.876
16	8.899	8.188	6.981	5.573
14	8.26	7.594	6.469	5.136
12	7.423	6.817	5.802	4.573
10	6.394	5.865	4.985	3.893
8	5.185	4.749	4.029	3.113
6	3.812	3.486	2.951	2.257
4	2.319	2.117	1.787	1.357
2	0.851	0.776	0.654	0.493

Table 9: Storey displacements for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	17.099	15.745	13.432	10.781
18	16.608	15.289	13.04	10.447
16	15.821	14.557	12.41	9.907
14	14.684	13.5	11.501	9.131
12	13.196	12.119	10.315	8.129
10	11.368	10.427	8.862	6.92
8	9.217	8.442	7.163	5.535
6	6.776	6.197	5.246	4.013
4	4.122	3.764	3.178	2.412
2	1.514	1.38	1.162	0.877

Table 10: Storey displacements for zone VI

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	26.717	24.602	20.988	16.845
18	25.951	23.889	20.375	16.323
16	24.721	22.745	19.39	15.48
14	22.944	21.094	17.971	14.268
12	20.619	18.936	16.117	12.702
10	17.762	16.292	13.847	10.813
8	14.402	13.191	11.192	8.648
6	10.588	9.683	8.197	6.27
4	6.441	5.881	4.965	3.769
2	2.365	2.157	1.816	1.371

The max storey displacement of all building in different zones and terrains are compared and shown in figure 5. The top storey displacements of square shaped building, rectangular shaped building and octagonal shaped building in different zones and terrains are compared and corresponding graph is shown in figure 5. Similar to square building, rectangle building have maximum storey displacement in terrain category I and zone VI. The octagonal shaped building has maximum storey displacement in zone VI and terrain I. Comparing all shaped buildings octagonal shaped building has less storey displacement.

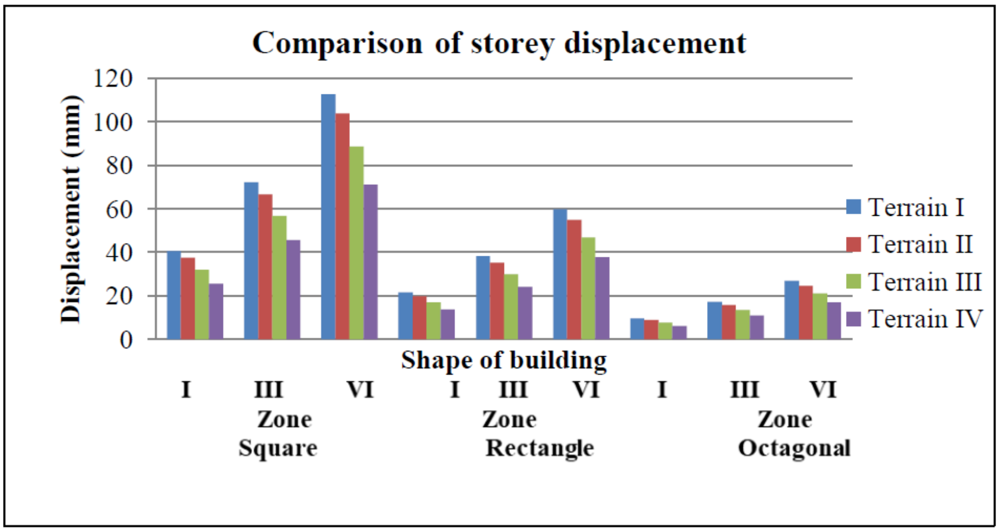


Figure 5: Maximum storey displacement

1.3.2 Storey drift

Storey drift is the drift of one level of multistory building relative to the level below. It is defined as ratio of displacement of two consecutive floors to height of that floor. Storey drift is minimum at base level.

- **Square**

Table 11, table 12 and table 13 shows storey drifts of square shaped G+19 RC building situated in different terrain categories I, II, III and IV in zone I, zone III and zone VI respectively.

Table 11: Storey drifts for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000156	0.000145	0.000125	0.000108
18	0.00026	0.000242	0.000208	0.00018
16	0.000403	0.000375	0.000322	0.000276
14	0.000556	0.000516	0.000444	0.000376
12	0.000709	0.000656	0.000563	0.00047
10	0.000854	0.000788	0.000675	0.000552
8	0.000983	0.000904	0.000773	0.000617
6	0.001072	0.000983	0.000837	0.000651
4	0.001054	0.000964	0.000817	0.000625
2	0.000738	0.000674	0.000568	0.00043

Table 12: Storey drifts for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000278	0.000259	0.000223	0.000192
18	0.000462	0.00043	0.00037	0.000319
16	0.000716	0.000666	0.000573	0.000491
14	0.000989	0.000918	0.000789	0.000668
12	0.00126	0.001166	0.001001	0.000835
10	0.001518	0.001402	0.001201	0.000982
8	0.001747	0.001608	0.001373	0.001096
6	0.001905	0.001748	0.001487	0.001158
4	0.001874	0.001714	0.001452	0.001111
2	0.001312	0.001198	0.00101	0.000765

Table 14: Storey drifts for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000077	0.000072	0.000062	0.000053

18	0.000133	0.000124	0.000107	0.000092
16	0.00021	0.000195	0.000168	0.000144
14	0.000292	0.000271	0.000233	0.000197
12	0.000373	0.000345	0.000296	0.000247
10	0.000451	0.000416	0.000356	0.000292
8	0.00052	0.000479	0.000409	0.000327
6	0.00057	0.000523	0.000445	0.000346
4	0.000565	0.000517	0.000438	0.000335
2	0.0004	0.000365	0.000308	0.000233

(ii) Rectangle

Table 14, table 15 and table 16 shows storey drifts of rectangular shaped G+19 RC building situated in different terrain categories I, II, III and IV in zone I, zone III and zone VI respectively

Table 15: Storey drifts for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000137	0.000128	0.00011	0.000095
18	0.000236	0.00022	0.00019	0.000164
16	0.000373	0.000347	0.000298	0.000256
14	0.000518	0.000481	0.000414	0.000351
12	0.000663	0.000614	0.000527	0.00044
10	0.000801	0.00074	0.000634	0.000519
8	0.000925	0.000851	0.000727	0.000581
6	0.001014	0.00093	0.000791	0.000616
4	0.001004	0.000918	0.000778	0.000595
2	0.000711	0.000649	0.000547	0.000414

Table 16: Storey drifts for zone VI

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000214	0.000199	0.000172	0.000148
18	0.000369	0.000344	0.000296	0.000256
16	0.000582	0.000542	0.000466	0.0004
14	0.00081	0.000752	0.000646	0.000548
12	0.001036	0.000959	0.000823	0.000687
10	0.001252	0.001156	0.00099	0.00081
8	0.001446	0.00133	0.001137	0.000907
6	0.001584	0.001453	0.001236	0.000962
4	0.001569	0.001435	0.001215	0.000929
2	0.001111	0.001014	0.000855	0.000647

(iii) Octagonal

Table 17, table 18 and table 19 shows storey drifts of octagonal shaped G+19 RC building situated in different terrain categories I, II, III and IV in zone I, zone III and zone VI respectively.

Table 17: Storey drifts for zone I

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000041	0.000038	0.000032	0.000028
18	0.000066	0.000061	0.000053	0.000045
16	0.000098	0.000091	0.000079	0.000067
14	0.000131	0.000122	0.000105	0.000089
12	0.000164	0.000152	0.00013	0.000109
10	0.000194	0.000179	0.000154	0.000126
8	0.000223	0.000205	0.000175	0.00014
6	0.000245	0.000225	0.000192	0.000149
4	0.000252	0.00023	0.000195	0.000149
2	0.000194	0.000177	0.000149	0.000113

Table 18: Storey drifts for zone III

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000072	0.000067	0.000058	0.000049
18	0.000117	0.000109	0.000094	0.00008
16	0.000175	0.000162	0.00014	0.000119
14	0.000234	0.000217	0.000186	0.000158
12	0.000291	0.000269	0.000231	0.000193
10	0.000345	0.000319	0.000273	0.000224
8	0.000396	0.000364	0.000311	0.000249
6	0.000436	0.0004	0.000341	0.000265
4	0.000448	0.000409	0.000347	0.000265
2	0.000345	0.000314	0.000265	0.0002

Table 19: Storey drifts for zone VI

Storey	Terrain category I	Terrain category II	Terrain category III	Terrain category IV
20	0.000113	0.000105	0.00009	0.000076
18	0.000183	0.00017	0.000146	0.000125
16	0.000273	0.000254	0.000218	0.000187
14	0.000365	0.000339	0.000291	0.000247
12	0.000455	0.000421	0.000361	0.000302
10	0.00054	0.000499	0.000427	0.000351
8	0.000618	0.000569	0.000486	0.000389
6	0.000682	0.000626	0.000532	0.000414
4	0.000699	0.00064	0.000542	0.000414
2	0.000538	0.000491	0.000414	0.000313

The maximum storey drift of different shaped buildings in different zones and terrains are compared and shown in figure 6. The maximum impact of the drift for square building is found when it is situated in terrain category I and zone VI. Similar to square building, rectangle building have maximum storey drifts in terrain category I and zone VI. The octagonal shaped building have less storey drift compared to other shapes and have maximum storey drift in zone VI and terrain I.

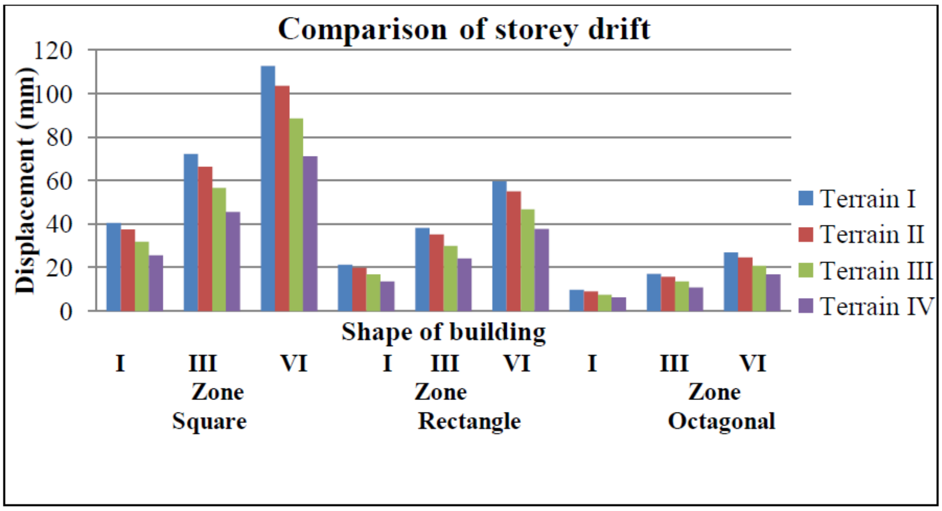


Figure 6: Maximum storey drift

1.3.3 Base shear

Base shear is the total design lateral force expected at the base of the structure. Figure 7 shows maximum base shear for zone VI. Storey shear is the total design lateral force expected at each floor levels of the structure. The storey shear value of all type buildings is more at the base level. Storey shear acting at floors of square ,rectangle and octagonal shaped G+19 RC building situated in different terrains categories I, II, III and IV in zone I is shown in table 20 and . Square building shows maximum base shear in terrain I.

Table 20: Base shear values for zone VI

TERRAIN	SQUARE	RECTANGLE	OCTAGON
I	5696.376	4826.7003	4702.35
II	5182.826	4391.5547	4278.415
III	4341.313	3678.5167	3583.747
IV	3248.263	2752.3448	2681.436

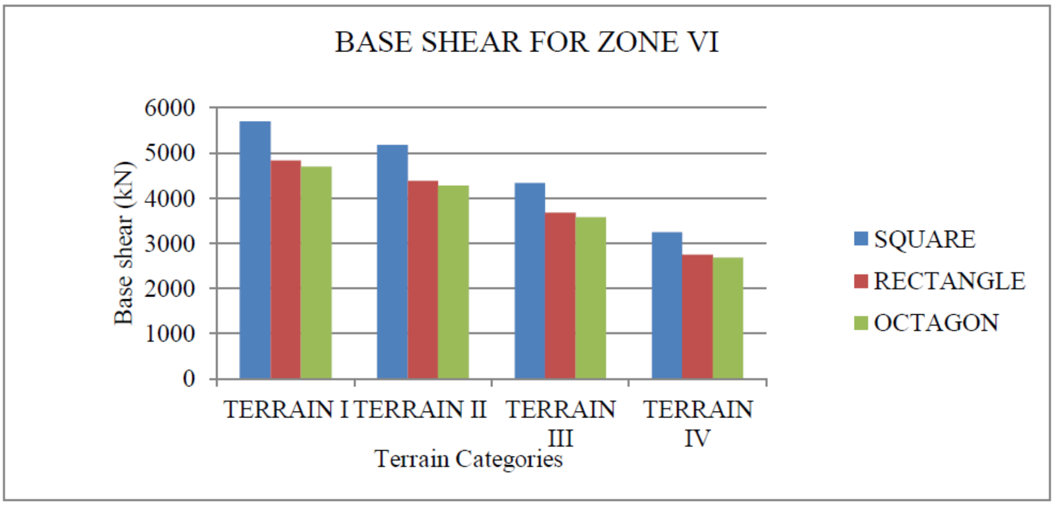


Figure 7: Base shear for different buildings

IV. CONCLUSION

The G+19 storey building with square, rectangular and octagonal plan without shear under wind load analysis have been done using ETABS. The buildings are studied for different parameters such as storey displacement, storey drift and base shear. Wind analysis of square, rectangular and octagonal plan buildings at Zone I to Zone VI with terrain categories I, II, III and IV were analyzed. From this it is understood that the zone, terrain category, shape, height and slenderness ratio have great influence on the strength and stability of a building.

The following conclusions are deduced from this study:

While comparing all these buildings, it is understood that the buildings at Zone I have less displacement. Terrain category IV is best suited for the building and as in the case of octagonal shape has less displacement. Maximum storey displacement value is 112.68 for the building with square plan at Zone VI and terrain category I. Minimum storey displacement value is 6.064 for the building with octagonal plan at Zone I and terrain category IV.

The effective shape to resist wind lateral load is octagonal shape structure for G+19 consideration. The storey displacement increases with increase in height and is maximum at top storey and zero at the base. Both the storey displacement and story drift increases from Zone-I to Zone-VI as the wind force increases for all the shapes and more for terrain category I. The storey drift decreases from terrain category I to IV for all the wind zones and for all the shapes. Generally symmetrical structure is preferred for high rise structure but in this case square shape found to be less stiff compare to rectangular structure in wind load consideration. Base shear is less for octagonal building in terrain I for zone III. Slenderness ratio is the ratio of height to width of building and have great effect in the strength and stability of the building. Octagonal building have less slenderness ratio and hence stable. It is more for square plan building.

The lateral loading due to wind is the major factor that causes the design of high-rise buildings to differ from those of low-to medium rise buildings. For buildings of up to about 10 stories and of typical proportions, the design is rarely affected by wind loads. Above this height, however, the increase in size of the structural members, and the possible rearrangement of the structure to account for wind loading, incurs a cost premium that increases progressively with height.

With innovations in architectural treatment, increases in the strengths of materials, and advances in method of analysis, tall building structures have become more efficient and lighter, consequently more prone to deflect and even to sway under wind loading. Several wind engineering techniques were employed into the design of high rise buildings to control the dynamic response under wind loading by disorganizing the vortex shedding formation (frequency and direction) along the building height and tuning the dynamic characteristics of the building to improve its dynamic behavior and to prevent lock-in vibration.

Wind load analysis is critical to ensure that the following criteria are honored:

- Serviceability of the building, despite expected wind deflections.
- Stability to counter toppling, uplift or sliding of the building.
- Strong structural components to withstand excess loads during the buildings life cycle.

REFERENCES

[1]. B. Dean Kumar and B.L.P. Swami, Wind effects on tall building frames-influence of dynamic parameters, Indian Journal of Science and Technology, Vol. 3, No. 5.May 2010, 583-587.

[2]. Md Ahesan Md Hameed and Amit Yennawar "Comparative study on wind load analysis using different standards" IJIRSET-2018

[3]. B. Shobha, Dr. H. Sudarshan Rao, Dr.Vaishali G. Ghorpade " Effect of wind load on low, medium, High rise buildings in different terrain category" IJTIMES-2018

[4]. Aiswaria and Dr. Jisha S.V "Along and across wind loads acting on tall buildings" Second international conference on Architectural materials and construction engineering ©AMCE-2018

[5]. Md Asim Ahmed, Moid Amir, SavitaKomur , VaijainathHalhalli " Effect of wind load on tall buildings in different terrain category". IJRET-2015

[6]. Indian Standard Code of Practice for Design loads (Other than Earthquake) for Buildings and Structures – wind loads IS 875 (Part 3): 2015 Bureau of Indian Standards New Delhi

[7]. Aly Mousaad Aly and Srinivasa Abburu(2011), "Dynamics and Control of High-Rise Buildings under Multidirectional Wind Loads", Smart Material Research

[8]. Anupam Rajmani (2015), "Analysis of wind & earthquake load for different shapes of high rise building", International journal of civil engineering and technology, vol 4

[9]. Chandradhara G. P, Vikram.M.B, "Effect of wind load on the aspect ratio of the building", International Conference on Innovations in Civil Engineering

[10]. D. K. Mokashi, U. S Patil, Vashistha Kamble and Akshay Mandel(2017), "Wind pressure distribution on triangular shape of building model ", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Volume 5, Issue VI

[11]. F. Cluni , M. Gioffrè, V. Gusella (2013), " Dynamic response of tall buildings to wind loads by reduced order equivalent shear-beam models", Journal of Wind Engineering and Industrial Aerodynamics.

[12]. Guoqing Huang, Xinzhong Chen(2007), "Wind load effects and equivalent static wind loads of tall buildings", Engineering Structure.