Effect of wind and earthquake on buildings height

Khalid Masood[1], Md. Tasleem[2]

PG Student[1], Assistant Professor[2]

M.TECH (Structural Engineering), Department Of Civil Engineering, Integral University, Lucknow, Uttar Pradesh, India

ABSTRACT

This paper presented study of severity of wind and earthquake loads on height of buildings. When we design a RC framed buildings whether it is tall or short building it is important to design with lateral loads. And lateral loads are comprises of wind loads and earthquake loads. The design loadings will be of basic wind speed 55m/s and earthquake zone V.The IS codes used for wind loads is 875(part3):2015 and the IS code used for earthquake is 1893:2002. This is a detailed study for the building height at which wind loads outweighs earthquake loads. As we know that for buildings with short height earthquake load is more dominant and buildings for tall height wind load is more dominant.

1. INTRODUCTION

Due to the scarcity of land there has been increased demand for land. So there has been a considerable increase in the number of tall buildings, both residential and commercial and the modern trend is towards the taller structures. Considering the increasing population as well as lack of horizontal expansion is not a reasonable solution. Then the only solution for the growing demand is the construction of the multi-story structures in the available land. The development of high strength concrete, higher grade steel , new construction techniques and advanced computational technique has resulted in the emergence of a new generation of tall structures that are flexible, low in damping, slender and light in weight.

High rise construction has become a necessity for the urban development. As the demand for multi-story structures has increased tremendously as a solution for the growing population and increased demand for the requirement of dwelling for the increased population.

As the height of the structure increases the forces acting on the structure also increases along with the height of the building increases like wind and earthquake forces. The collection of gravity loading over a large number of stories in a tall building can produce column loading of an order higher than those in low rise building. Loading of a tall building differs from loading on low rise buildings in its accumulation in to much larger structural forces. As the height increases the rigidity and stability of structure gets affected and it becomes necessary to design the structure preferably for lateral forces, moments, story drift and total horizontal deflection at top most story level.

Earthquakes and cyclones are unexpected events which cannot be predicted earlier. The only way to survive through this disaster is by taking careful considerations while planning and designing buildings in urban areas. A structure because of its height is affected by lateral forces due to wind or earthquake actions to an extent that they play an important role in the structural design. High rise buildings has to resist to overturning moment and lateral deflection caused by lateral forces like earthquake and wind forces in addition to the gravity loads acting on the building.

lateral loads can develop high stresses, produce sway movement or cause vibration therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach. Therefore it is necessary to know which force is the major influencing on the building

Wind load is one of the important design loads for civil engineering , it controls the structural design of the high-rise structures. Therefore knowledge of the dynamic characteristics of a high - rise structure under wind loading becomes a requirement in engineering design and in academic study. In high risk seismic zone the seismic performance of structures are considered as the primary importance on the other hand which influence seismic performance , may be the effect of impact forces resulting from earth movement greater than the forces caused by wind loads and consequently, Seismic loading determines form and final design of the structure.

The aim of the project is to study the comparisons of the effects of the influence of the wind and seismic forces on the low rise and high rise buildings.

According to IS 456: 2000 , specifies either the use of wind or earthquake load. With this assumption in respect to the all international codes and standards, wind and earthquake loads never simultaneously apply on the structure. The wind and earthquake forces are never applied on a building at a single time. As an extension to that the analysis is carried out in two different phases.

1.1 Effect of Earthquake on Multi-Storied Buildings-

Earthquake causes shaking of the ground. So a building resting on it will experience motion at its base. From Newton's First Law of Motion, even though the base of the building moves with the ground, the roof has a tendency to stay in its original position.

1.2 Effect of Wind on Multi-Storied Buildings-

High wind pressures can collapse doors and windows, rip off roofing and roof decking and destroy gable end walls. Roof overhangs and other features that tend to trap air beneath them, resulting in high uplift forces, are particularly susceptible to damage.

2. METHODOLOGY

Structure Model Data	
No. Of stories	G+22
	G+23
Story Height	3.00 m
Building plan	35mX35m
Material property	
Grade of concrete	M30
Grade of Steel	HYSD bars for reinforcement Fe 500
Member Properties	
Thickness of slab	0.150m
Beam Size	0.23 x 0.45 m
Column Size	0.40 x 0.40.m
Seismic zone Intensities	
Seismic Zone	V
Wind intensities	
Wind speed	55 m/s
Masonry Material unit weight Load intensities	
Exterior wall	12 kN/m3
Interior wall	6 kN/m3
Parapet wall	4 kN/m3
Load intensities on Slab	
Live load on slab	2 KN/m^3
Dead load on slab	1 KN/m^3
Live load on roof slab	1 KN/m^3

S.N	*Seismic Data*	*As per IS 1893 (Part-1):2016*
1	Zone	V
2	Zone factor	0.36
3	Importance Factor (I)	1.2
4	Soil type	Type II (Medium stiff)
5	Response Reduction Factor ®	5 (SMRF)
6	Damping Ratio	5%
7	Earthquake Load	As per IS 1893 (part-1):2016

S.N	*Wind Data*	*AS Per IS 875 : 2016*
1	Wind Speed	55 m/s
2	Terrain Category	2
3	Structure Class	B
4	Risk Coefficient (k1)	1
5	Terrain, height, and structure size (k2)	1.18
6	Topography Factor (k3)	1.40
7	Wind Load	As per IS 875: Part 3

A symmetric building plan is considered for the study. For a low - rise building G+4 is considered and for high – rise multistory structure G+11 is considered. Response spectrum analysis is carried out for earthquake analysis using the software Etabs. Wind response for a building is considered based on the wind forces generating from different wind speeds. The applied roof load should be 50 % of live load.

3. RESULTS

Storey Displacement for 66m & 69m –

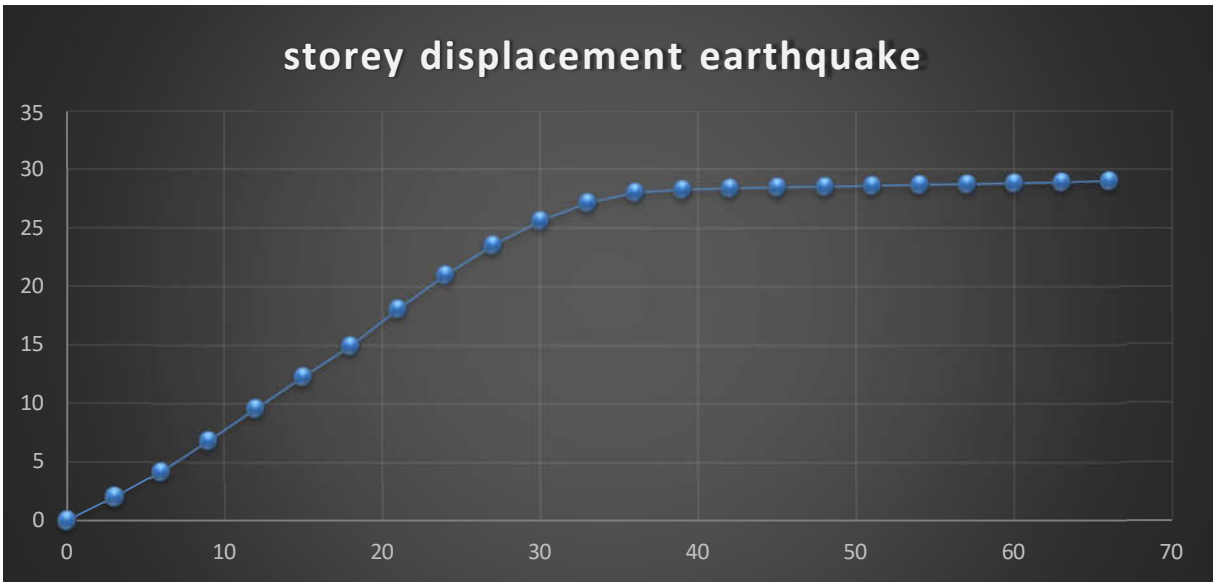

TABLE: Story Response

Story	Elevation	Location	X-Dir
	m		mm
Story22	66	Top	29.049
Story21	63	Top	28.938
Story20	60	Top	28.855
Story19	57	Top	28.784
Story18	54	Top	28.712
Story17	51	Top	28.639
Story16	48	Top	28.566
Story15	45	Top	28.492
Story14	42	Top	28.414
Story13	39	Top	28.315
Story12	36	Top	28.068
Story11	33	Top	27.193

Story10	30	Top	25.661
Story9	27	Top	23.57
Story8	24	Top	21.027
Story7	21	Top	18.125
Story6	18	Top	14.954
Story5	15	Top	12.324
Story4	12	Top	9.614
Story3	9	Top	6.871
Story2	6	Top	4.216
Story1	3	Top	1.998
Base	0	Top	0

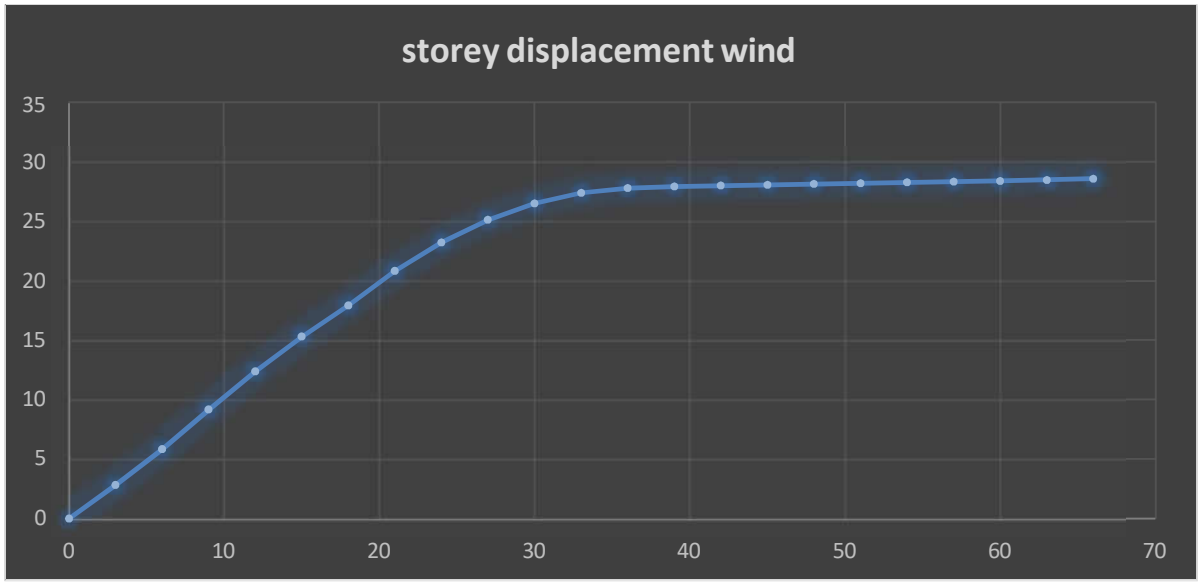

TABLE: Story Response

Story	Elevation	Location	X-Dir
	m		mm
Story22	66	Top	28.64
Story21	63	Top	28.536
Story20	60	Top	28.46
Story19	57	Top	28.396
Story18	54	Top	28.331
Story17	51	Top	28.266
Story16	48	Top	28.2
Story15	45	Top	28.134
Story14	42	Top	28.066
Story13	39	Top	27.989
Story12	36	Top	27.854
Story11	33	Top	27.45
Story10	30	Top	26.572
Story9	27	Top	25.177
Story8	24	Top	23.272
Story7	21	Top	20.869
Story6	18	Top	17.965
Story5	15	Top	15.326
Story4	12	Top	12.389
Story3	9	Top	9.179
Story2	6	Top	5.832
Story1	3	Top	2.828
Base	0	Top	0

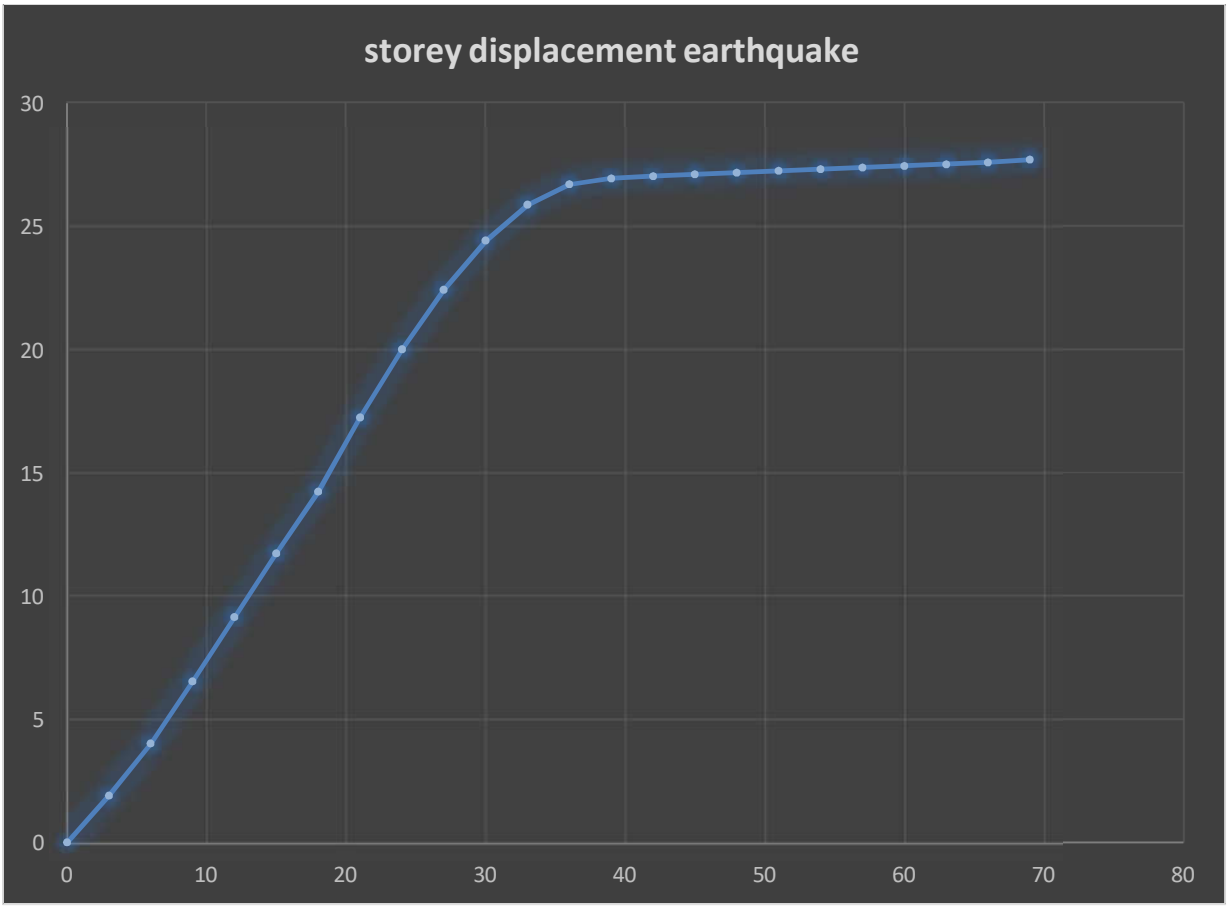
storey displacement earthquake
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80

TABLE: Story Response

Story	Elevation	Location	X-Dir
	m		mm
Story23	69	Top	27.712
Story22	66	Top	27.604
Story21	63	Top	27.526
Story20	60	Top	27.458
Story19	57	Top	27.391
Story18	54	Top	27.324
Story17	51	Top	27.256
Story16	48	Top	27.187
Story15	45	Top	27.117
Story14	42	Top	27.043
Story13	39	Top	26.95
Story12	36	Top	26.714
Story11	33	Top	25.882
Story10	30	Top	24.424
Story9	27	Top	22.435
Story8	24	Top	20.014
Story7	21	Top	17.252
Story6	18	Top	14.233
Story5	15	Top	11.731
Story4	12	Top	9.151
Story3	9	Top	6.54
Story2	6	Top	4.013
Story1	3	Top	1.901
Base	0	Top	0

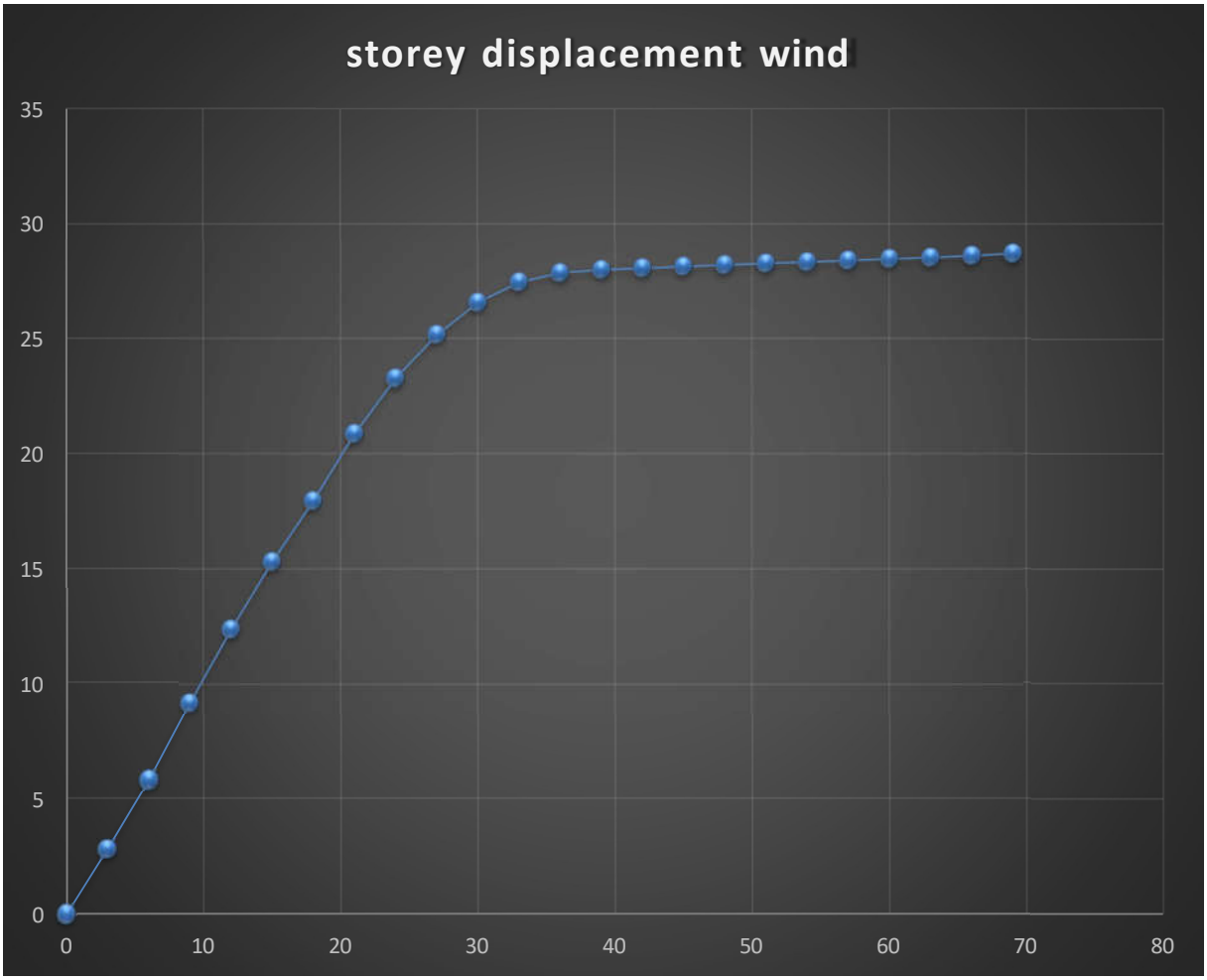
storey displacement wind
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80

TABLE: Story Response

Story	Elevation	Location	X-Dir
	m		mm
Story23	69	Top	28.696
Story22	66	Top	28.591
Story21	63	Top	28.517
Story20	60	Top	28.453
Story19	57	Top	28.39
Story18	54	Top	28.326
Story17	51	Top	28.261
Story16	48	Top	28.196
Story15	45	Top	28.131
Story14	42	Top	28.063
Story13	39	Top	27.986
Story12	36	Top	27.852
Story11	33	Top	27.449
Story10	30	Top	26.57
Story9	27	Top	25.176
Story8	24	Top	23.272
Story7	21	Top	20.868
Story6	18	Top	17.965
Story5	15	Top	15.325
Story4	12	Top	12.389
Story3	9	Top	9.179
Story2	6	Top	5.832
Story1	3	Top	2.828
Base	0	Top	0

4. CONCLUSION & DISCUSSIONS -

In this study, the multistoried building excited to earthquake forces and wind forces for different seismic zones and wind forces are studied. From the modeling and analysis of these building, the following conclusions are drawn out.

- The wind forces are found to be equally dominating for the high rise story. Low rise multistory structures are three times more effected due to earthquake than wind forces. The low rise stories are unaffected by wind forces.
- At the height of the building increases wind load becomes more dominant than earthquake load.
- At 66 m height of the building earthquake load is dominant.
- At 69 m height of the building wind load is dominant.

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