Response Study of a Building with Different Elevations Under Earthquake and Wind Loads

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Abstract **In this day to day life due to increase in the population growth the requirement of shelter is increasing rapidly, as a result the area of construction land is decreasing. Hence multi storey buildings are constructed hugely. The analysis and design of these high rise buildings is necessary. In the design various lateral loads are to be considered such as Wind load & Seismic load. In this paper we have decided to study the response of multi storey buildings with different elevations under earthquake loads in different zones & Wind loads. Reinforced frames of G+5,G+11,G+23, & G+29 of regular configuration are selected and the loads are assumed to act simultaneously. In this analysis we have used Staad Pro V8i for obtaining storey drifts & storey displacements of the above mentioned reinforced buildings.**

Keywords: Structure, Staad, displacement, analysis, Wind load, Earthquake load.

INTRODUCTION

In general different types of loads are considered in analysis of Civil Engineering structures mainly dead and live loads, in addition to these different types of abnormal loads are also acting. It means dynamic loads i.e., direction of load changes with respect to the time. This paper is mainly focused on two types of loads one is Wind load and the other is Seismic load. Effects of Wind load are considering at floor levels in the structure and seismic loads are acted at foundation level. As per our BIS different typical techniques and codes are developed.

Seismic load analysis:

This is one of the part in structural design and analysis. Small structures have low response to these loads, but huge tall buildings have high response of mode shapes so we have to implement this load in design of structures. For high response of the structure damage is more and the mode shapes are shown in below figure. 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 as in IS 1893 part1-2002. In contrast, structural damage is not acceptable under design wind forces. For this reason, design against earthquake effects is called as *Earthquake-Resistant Design* but not *Earthquake-Proof Design*.

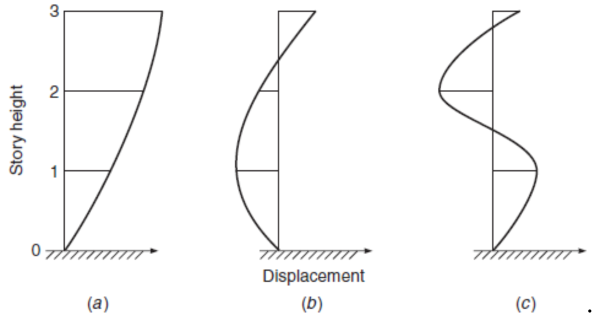

Fig.1 deformed Shapes of Building Due to Seismic Vibrations.

Wind loads analysis:

The analysis of building frames due to wind loads are considered as per ASCE-7: 2002. Basic wind speed as described in section 6.5.4 of the ASCE-7: 02 code. The wind speed considered as 85 mph. Building classification categories as obtained from table 1.1 in ASCE-7:02. Category can be I, II, III and IV. Exposure category as described in section 6.5.6.3 of the ASCE-7 code. In this case it is proposed to take as building structure with coefficient of exposure 1. Selected the type of the structure that best fits the model from the available choices i.e. Building structures, Chimney's, Tanks and similar structures, Solid Signs, Open Signs, Latticed Framework, Trussed Tower.

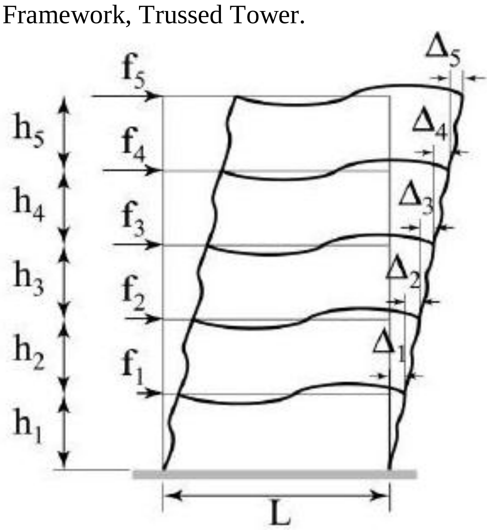

Fig.2 lateral forces due to wind

Physical properties considered for the analysis using STAAD are given in the Table 1-5

Table 1. Physical properties of the columns and beams for 6 floors

Member	Size	Grade
Columns	500mmx500mm	M50
Beams	300mmx300mm	M25

Table 2. Physical properties of the columns and beams for 12 floors

Member	Size	Grade
Columns up to G+5	800mmx800mm	M50
Columns from G+5 to G+11	500mmx500mm	M40
Beams	300mmx300mm	M25

Table 3.Physical properties of the columns and beams for 18 floors

Member	Size	Grade
Columns up to G+5	750mmx750mm	M50
Columns from G+5 to G+11	600mmx600mm	M40
Columns from G+11 to G+17	500mmx500mm	M30
Beams	300mmx300mm	M25

Table 4. Physical properties of the columns and beams for 24 floors

Member	Size	Grade
Columns up to G+5	900mmx900mm	M50
Columns from G+5 to G+11	800mmx800mm	M40
Columns from G+11 to G+17	700mmx700mm	M30
Columns from G+17 to G+23	600mmx600mm	M25
Beams	300mmx300mm	M25

Table 5.Physical properties of the columns and beams for 30 floors

Member	Size	Grade
Columns up to G+5	900mmx900mm	M50
Columns from G+5 to G+11	800mmx800mm	M40
Columns from G+11 to G+17	700mmx700mm	M30
Columns from G+17 to G+23	600mmx600mm	M25
Columns from G+23 to G+29	500mmx500mm	M20
Beams	300mmx300mm	M25

Load Consideration

Table 6. Dead Load and Live Loads considered for the analysis

Type of load	Load value
Dead load	
On floors slabs	
Self-weight	3.00kN/m^2
Partition wall (assumed)	2.00kN/m^2
Floor finish (assumed)	1.00kN/m^2
Total dead load on floors	6.00kN/m^2
On roof slab	
Self-weight	3.00 KN/m^2
Weathering course (assumed)	1.00 KN/m^2
Total dead load on roof	4.00 KN/m^2
Live load	
On floor slabs	
Live load on floors	3.00 KN/m^2
On roof slab	
Live load on floors	1.50 KN/m^2

Earthquake loads: Earthquake loads considered for the calculation of seismic weights are as per the IS 1893(Part 1): 2002 and are given below:

Loads on the floors

Full dead load acting on the floor plus 25 percent of live load(since, as per clause 7.3.1 Table 8 of is1892(Part 1):2002, for imposed uniformly distributed floor loads of 3 kN/m^2 or below, the percentage of imposed load is 25 percent) = 6.00+((25/100)x3)=6.75 kN/m^2

Loads on the roof slab

Full dead load acting on the roof (since, as per clause 7.3.2, for calculating the design seismic forces of the structure, the imposed load on roof need not be considered.) hence take the load as 5.75 kN/m^2

Load Envelops:

Table 7

Envelope-1	Envelope-2
1.0DL+1.0LL	1.0DL+1.0LL
1.5DL+1.5LL	1.5DL+1.5LL
DL±EL	0.9(DL+LL+WL
1.5(DL±EL)	1.5(DL+LL)+WL
0.9DL±1.5EL	1.2(DL+LL+WL)
1.2(DL+LL±EL)	1.5(DL+WL)
DL+0.8(LL+EL)	DL+0.8(LL+WL)

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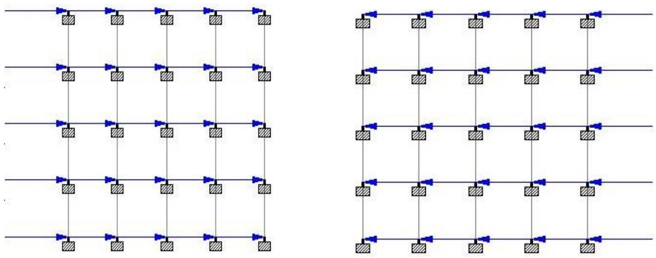
Analysis Details:

Brief overview

In this study, it is proposed to analyze all the frames. Material modeling, type of loads, load values, load cases, load combinations and load envelopes which are taken and considered for analysis are discussed in the study. A symmetrical configuration of square shape for different elevations is considered for the analysis. In this study, the responses i.e. nodal displacements are to be determined for all the frames and for all the load combinations. It is proposed to study the behavior of all the above mentioned frames under the lateral loads. It is proposed to calculate the lateral loads and storey shears of all the five frames due to earthquake loads using ESA method, according to IS 1893(Part1):2002. Lateral loads of all the five frames due to wind loads are determined as per ASCE-7:2002 in the analysis of building frames using STAAD.

Load distribution:

Floor wise lateral load distribution for earthquake and wind loads for five selected frames and for load combinations 1.5(DL±EL) and 1.5(DL+LL) +WL are shown in the Fig.3 and Fig.4



Load Comb: 1.5(Dl+Elx) Load Comb: 1.5dl+1.5(-Elx)

Fig.3 Nodal locations of lateral loads due to earthquake

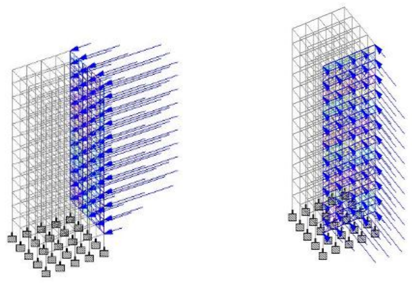
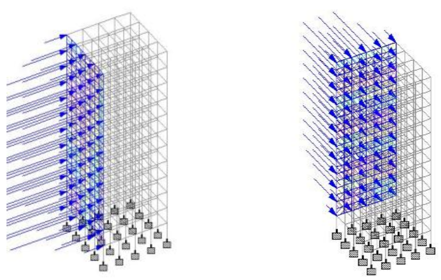
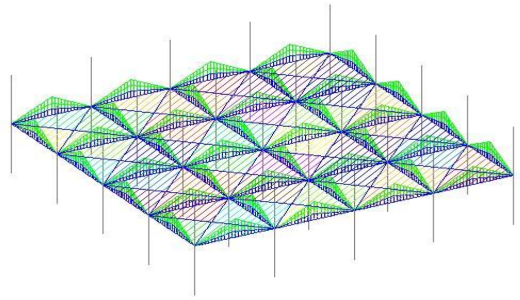


Fig.4 Nodal locations of lateral loads due to wind load



Gravity loads:

Both the Dead load and Live loads are considered as per the Table 6. Load distribution over the beams due to dead and live load from the floor slabs is determined using STAAD and are shown in the Fig.5



Dead load distribution on roof and floor slabs

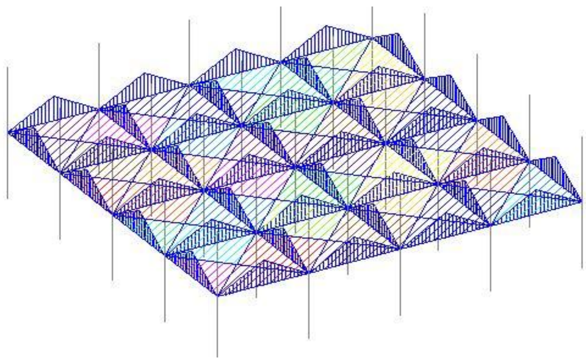


Fig.6. Live load on floor slabs

Results:

In this work it is proposed to compare the responses of three dimensional regular building frames. It is proposed to observe the nodal displacements and storey drifts for the structure at different elevations (i.e.6, 12, 18, 24 and 30 each storey being 4m height). These results are represented in the form of bar charts and curves. The dominated load combinations for which the structure responds more are 1.5(DL±EL), 1.5(DL+LL) +WL as obtained from the analysis.

In case of six storey building, the horizontal roof displacement is more than the wind load represented in the Fig.7 Horizontal displacements for all floors due to DL+LL combination is very less and hence may be ignored for design purposes.

There is a drastic change in the storey drift between the 1st and 2nd floors (i.e. 23mm) which is very less between the other floors (i.e.>10mm) due to earthquake load in zone5 and the same change is observed for the other load combination and are represented in Fig.9 The deformed shape of corner column for the dominated load combinations of a six storey building are as shown in Fig.10

Since the structure is symmetrical by all ways, the horizontal displacements of all the three diagonal columns are approximately same hence only outermost diagonal column is taken into consideration.

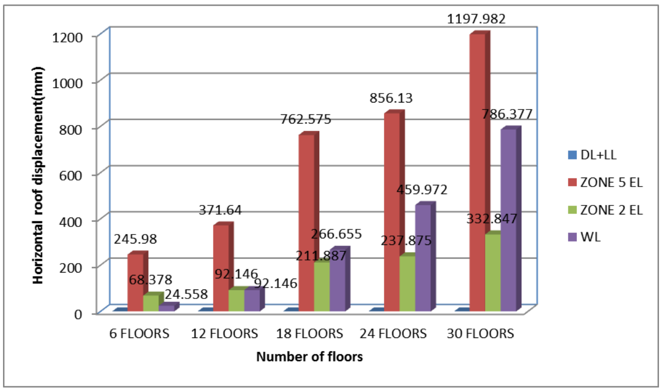


Fig.7 Horizontal Roof Displacement vs. Number of Floors

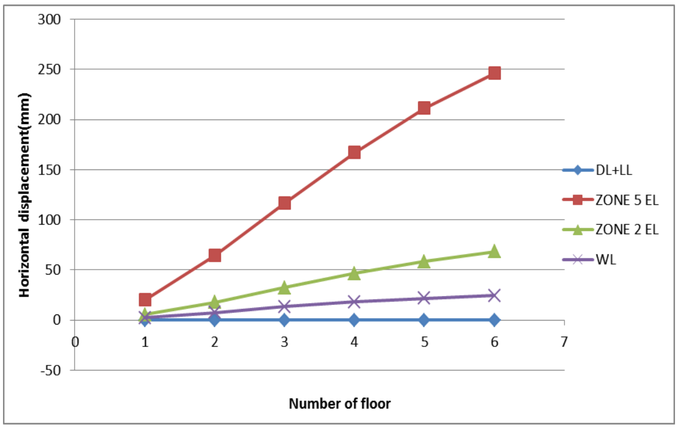


Fig.8 Horizontal Displacement vs. Number of Floors

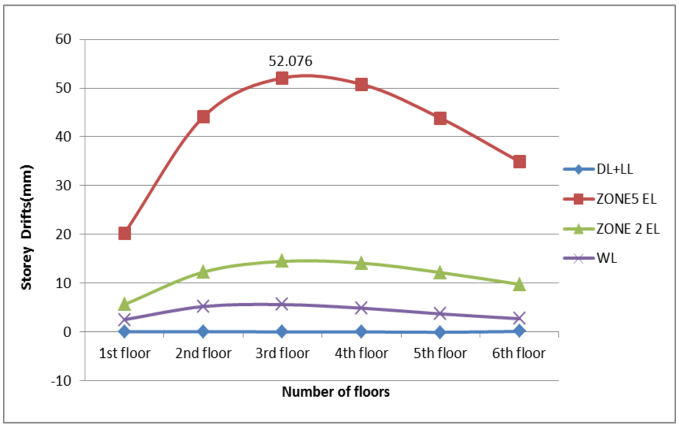


Fig.9 Storey Drifts vs. Number of Floors (6 storey building)

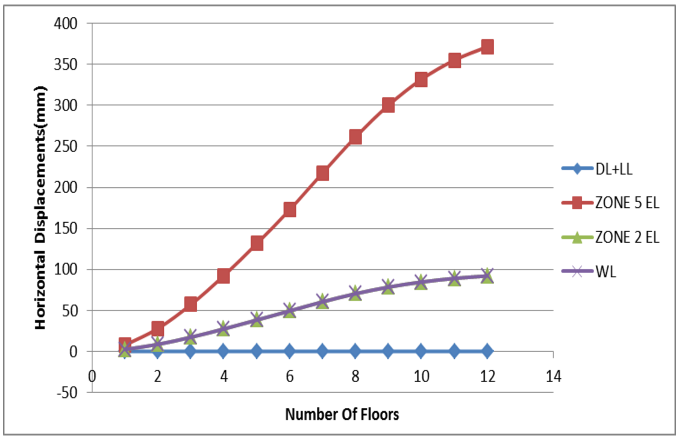


Fig.10 Horizontal Displacement vs. Number OF Floors (12 Storey Building)

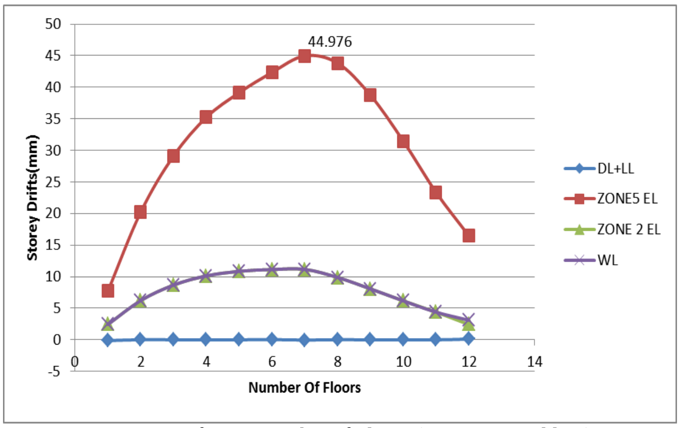


Fig.11 Storey Drifts Vs. Number of Floors (12 Storey Building)

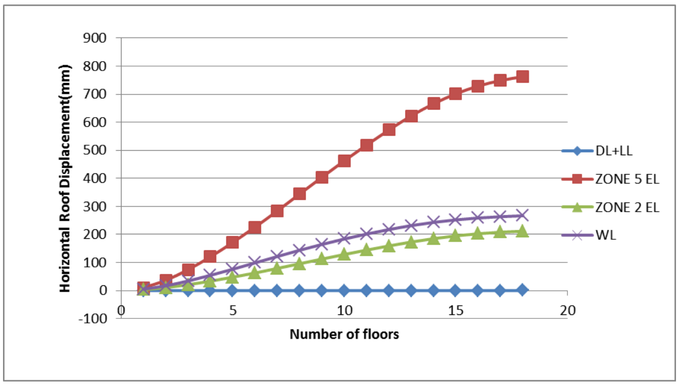


Fig.12 Horizontal Displacement vs. Number of Floors (18 Storey Building)

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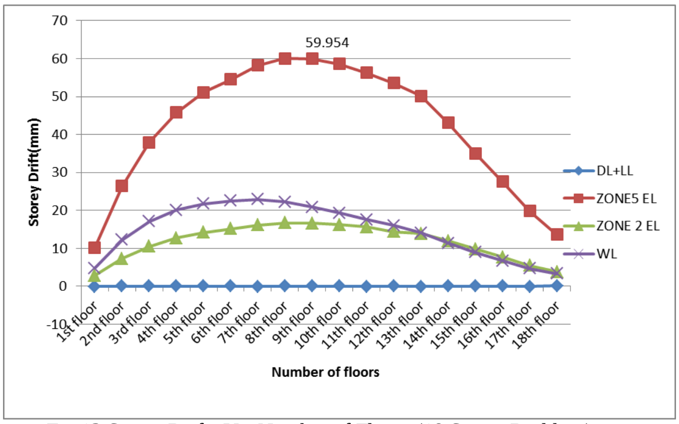

Fig.13 Storey Drifts Vs. Number of Floors (18 Storey Building)

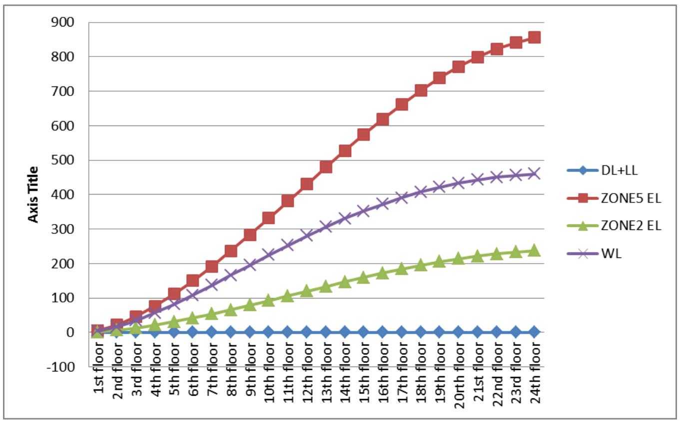

Fig.14 Horizontal Displacement vs. Number OF Floors (24 Storey Building)

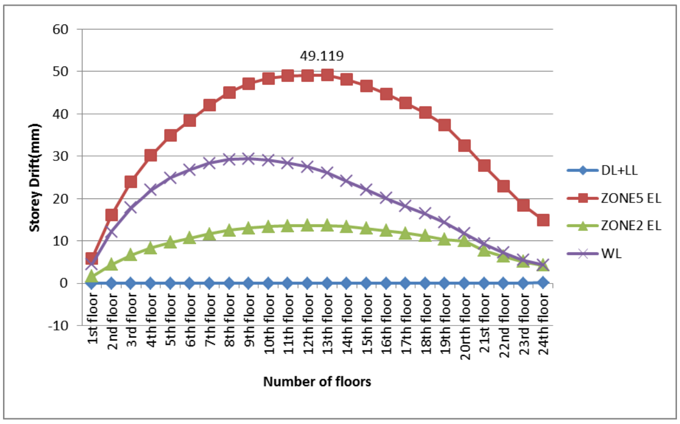

Fig.15 Storey Drifts Vs. Number of Floors (24 Storey Building)

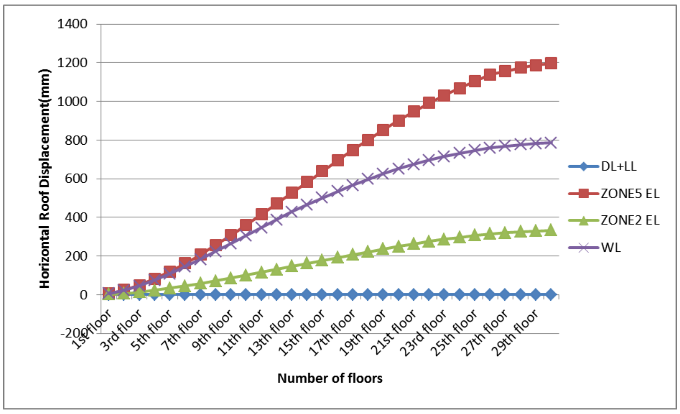

Fig.16 Horizontal Displacement vs. Number OF Floors (30 Storey Building)

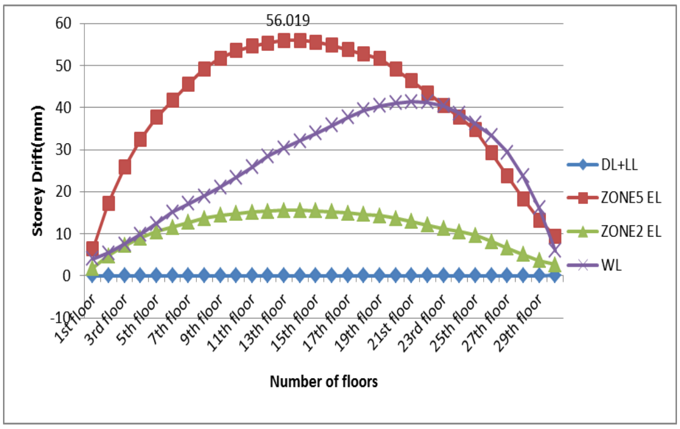

Fig.17 Storey Drifts Vs. Number of Floors (30 Storey Building)

CONCLUSION

The behavior of the structure depends upon the intensities of the earthquake, basic wind pressure and other different factors when the structure is subjected to earthquake and wind loads. In this project, the responses of the building frames with different elevations are determined. The tendency of the results shows that response depends on the intensity of the earthquake and basic wind pressure. It is concluded that most of the times, for the buildings of lower elevation and for all the zones the earthquake load is predominant. For high rise building frames, for lower zones, the wind load is predominant and for higher zones, the earthquake load is predominant. In the above project, the chosen model is a regular frame and for irregular and complicated structure this conclusion may vary.

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