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Research Article

Comparative Study of Wind And Earthquake Analysis On Multi-Storeyed Rc Framed Building By Etabs

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ABSTRACT

Analysis on building for seismic and wind forces is very important because earthquake and wind have damaged many structures from decades. It is very important to analyze any structure because it will be subjected to many forces during its life span which may affect the building. The affect on the performance of the building when subjected to seismic and wind forces hugely depend on the zone, where structure is actually located. In India we have four zones, zone Ⅱ, zone Ⅲ, zone Ⅳ and zone Ⅴ. Out of these four zones zone Ⅴ is very much prone to earthquake. This study reports the comparative study of wind and earthquake analysis on multi-storeyed RC Framed building using ETABS. This study explores the potential of G+11 RC Framed building against seismic and wind forces. This analysis reveals that the base shear due to earthquake is same in both X and Y direction as 2366.1757 KN and study also displayed same base shear due to wind in both X and Y direction as 2026.9818 KN. Present analysis also explored the same mode periods for three different mode shapes due to earthquake and wind as 2.004s, 2.044s, 1.773s and respectively. This study also revealed the higher storey displacement for G+11 in both seismic and wind analysis as 75.738mm and 43.787mm respectively. It also concluded the higher storey shear of G+11 in both seismic and wind analysis as 501.0178KN and 97.5433KN respectively. This analysis displayed earthquake forces are more dominant than wind forces as the height of building increases.

Keywords: Seismic analysis, wind analysis, Base shear, Mode period, Storey shear

1. Introduction

Earthquakes are unpredictable in nature even though we have been studying it from decades [1].In order to construct any structure utmost importance is given to design and construction so that it should withstand seismic forces and wind forces [2][11].Seismic zones which are highly prone to earthquake are analyzed properly because if they are not analyzed properly the structure built there may be affected by these forces which acts on building during its life span. All these loads are taken into account because if any of these forces are not considered during its design and construction, later on these forces may damage the structure when these structures are exposed to such loads. So, prior to construction, these loads have to be studied in order to enhance the performance of structure [3][13]. Earthquake and wind loads are most important in tall buildings. If structures are constructed properly and have irregularities, these structures are not able to bear the loads to which they are subjected which ultimately leads to failure of structure [4][12][14].
In this study different parameters like Base shear, storey displacement, storey shear and mode period have been calculated with the help of ETABS. In addition to these Weak and soft storey mechanisms are also given dure care to increase the performance of building. So, the performance of buildings subjected to wind and earthquake loads are analyzed and dominant force between them is checked [5][16].

1.1 **Objectives:** The main objectives of this study are to Compare the severity of forces acting on the structure, study the structural response of forces that are acting on the structure as the height of the building increases and to get the response of various parameters like: Storey displacement, Storey shear, Mode Periods [6] .

1.2 Data

For seismic and wind analysis using ETABS, the data taken into consideration is seismic zone, size of beams, Size of Columns, Column length, Thickness of slab, Grade of steel, Grade of concrete, Live load on all floors, Number of bays in X and Y direction, Seismic Weight. The data taken is in line with A. Surendra et al. [7][15].

2. Methodology

In this project, we have considered a G+11 storeyed RC Framed building located in zone V (Kashmir). The proposed building is subjected to both wind and earthquake loads. Separate modelling has been done for seismic and wind analysis. The dimensions of the beam, columns and slab thickness have been selected as per the specifications given in IS 456 : 2000 [8][17][18].The various parameters involved in wind analysis like risk coefficient, topography, basic wind speed and terrain factor have been determined using IS 875 (Part 3) : 2015 [9]. The various parameters involved in earthquake analysis like importance factor, seismic zone factor, response reduction factor, design acceleration coefficient, type of soil and natural period have been determined using IS 1893 (Part 1) : 2016 [10][19].For earthquake analysis, manual method has also been done using Equivalent Static Load Method (ESLM). The formulas used in ESLM have been taken from IS 1893 (Part 1): 2016[20].

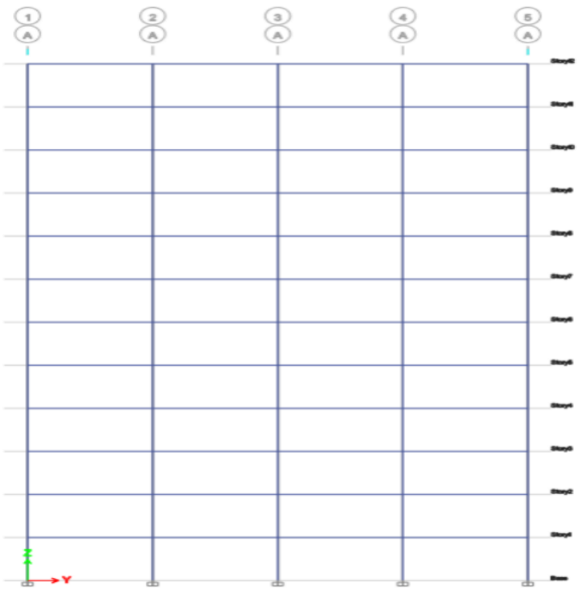


Figure 1: Elevation view of 12 storeyed building

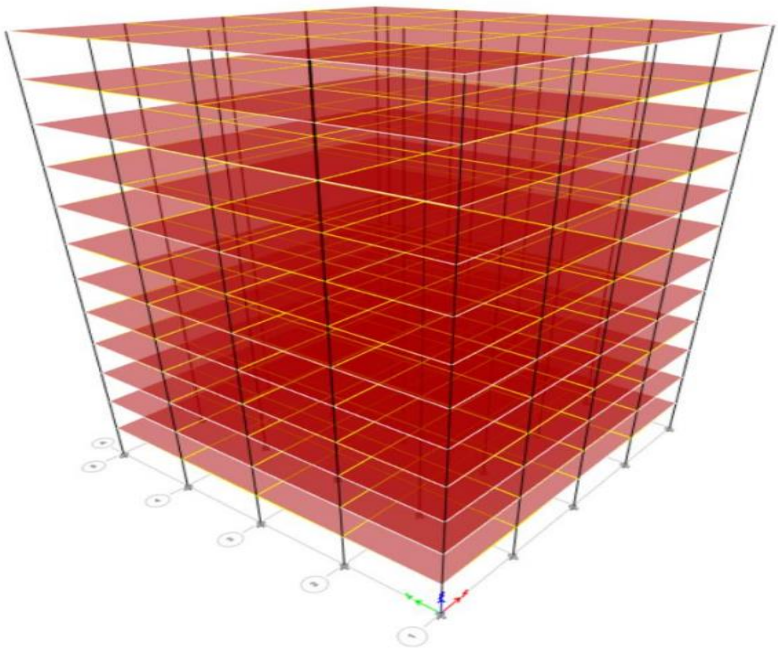


Figure 2: 3D view of 12 storeyed building

3. Results and discussions

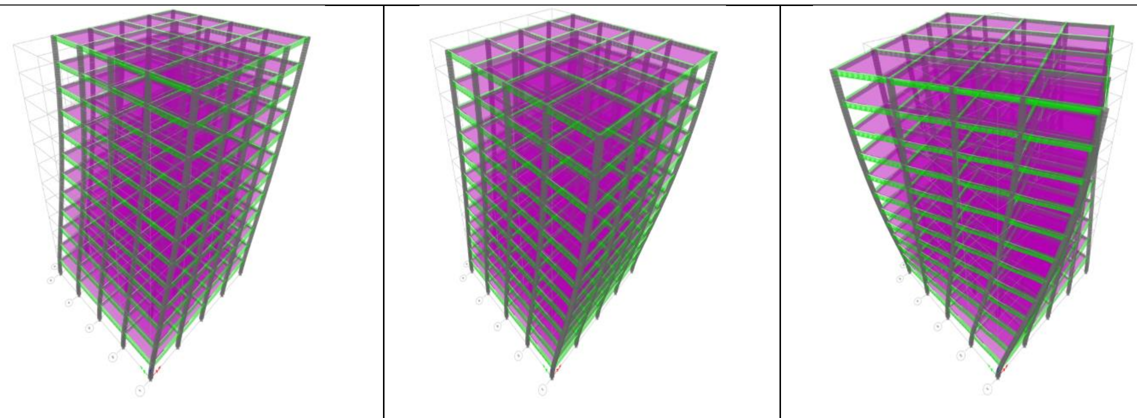
3.1 Mode Period

The mode of oscillation of a building is defined by associated natural period and deformed shape in which it oscillates. Three different mode periods have been determined along with their mode shapes. Since the mode periods determined from equivalent static load method and wind analysis are equal therefore mode shapes due to mode 1, mode 2 and mode 3 will be same. Out of three modes, the mode period of X and Y shape are same from both analysis as 2.044s but under torsion that is Mode 3 has shown same value with decrease in mode period value as 1.773s from both seismic as well as wind analysis. The results are in line with Mohamed et al. [21].

Table 1: Mode periods in X, Y direction and under torsion

Mode No.	Mode period in second(s)	
	ESLM	WIND
Mode 1	2.044	2.044
Mode 2	2.044	2.044
Mode 3	1.773	1.773

Footnote: Mode 1, Mode 2 and Mode 3 represents mode shapes in X direction, Y direction and Mode shape under torsion respectively



Mode shape in X direction	**Mode shape in X direction**	**Mode shape under torsion**

Figure 2: Mode shapes of G+11 building

3.2 Base Shear

Base shear is an estimate of the maximum expected lateral force on the base of the structure due to lateral loads which include seismic loads and wind loads. From table 2, we can observe that the base shear due to earthquake load and wind load is same in X and Y direction as 2366.1757 KN and 2026.9818KN respectively. Table 2 also displays that base shear due to seismic loads is greater than the base shear due to wind load in both X and Y direction acting on the structure that gives clear indication of dominance of earthquake forces over wind forces. The results are in line with Phil Benson Bong[22].

Table 2: Base Shear of G+11 building from seismic and wind analysis

Model	**Base Shear in KN**	
	X-Direction	**Y-Direction**
ESLM	2366.1757	2366.1757
WIND	2026.9818	2026.9818

Footnote: ESLM represents equivalent static load method which is used for seismic analysis.

3.3 Storey Displacement

Storey displacement is total displacement of i^{th} storey with respect to ground and there is maximum permissible limit prescribed in IS codes for buildings. In other words, we can also say that story displacement is the deflection of a single story relative to the base or ground level of the structure. From table 3, we can observe that in both X and Y direction the storey displacement for storey-1 is 4.405 mm and for storey-12 is 75.738 mm under the influence of earthquake load. Similarly in X and Y direction the storey displacement for storey-1 is 3.316 mm and for storey-12 is 43.787 mm under the influence of wind load. Thus, we can observe that storey displacement increases as number of storey increases in the structure. Table 2 also displays that storey displacement caused by earthquake loads is more than the storey displacement caused by wind loads both in X and Y direction, thus giving clear indication that earthquake load is more dominant than wind load. The results are in line with Phil Benson Bong and Ika Bali[22]

Table 3: Storey displacement of G+11building from seismic and wind analysis

Storey No.	**Storey displacement in mm**			
	ESLM		**WIND**	
	X-Direction	**Y-Direction**	**X-Direction**	**Y-Direction**
Storey-12	75.738	75.738	43.787	43.787
Storey-11	73.383	73.383	43.083	43.083
Storey-10	69.708	69.708	41.833	41.833
Storey-9	64.781	64.781	39.934	39.934
Storey-8	58.775	58.775	37.368	37.368
Storey-7	51.925	51.925	34.140	34.140
Storey-6	44.419	44.419	30.265	30.265
Storey-5	36.446	36.446	25.764	25.764
Storey-4	28.169	28.169	20.671	20.671
Storey-3	19.755	19.755	15.050	15.050
Storey-2	11.175	11.175	9.070	9.070
Storey-1	4.045	4.045	3.316	3.316

Footnote: ESLM represents equivalent static load method which is used for seismic analysis.

3.4 Storey Shear

It is the lateral force acting on a storey due to the forces such as seismic and wind force. It is calculated for each storey separately. From table 4, we can observe that in both X and Y direction the storey shear for storey-1 is 2366.1757 mm and for storey-12 is 501.0178 mm under the influence of earthquake load. Similarly in X and Y direction the storey displacement for storey-1 is 2026.9818 mm and for storey-12 is 97.5433 mm under the influence of wind load. Table 4 displays that storey shear decreases as number of storeys increase in the structure and is maximum at the bottom and minimum at top. This study also displayed that storey shear caused due to earthquake loads is more than the storey shear caused by wind loads both in X and Y direction and giving clear idea about the dominance of earthquake load over wind loads. The results are in line with Benson Bong and Ika Bali [22]

Table 4: Storey shear of G+11building from seismic and wind analysis

Storey No.	**Storey Shear in KN**			
	ESLM		**WIND**	
	X-Direction	**Y-Direction**	**X-Direction**	**Y-Direction**
Storey-12	501.0178	501.0178	97.5433	97.5433

Storey-11	947.0338	947.0338	209.9574	209.9574
Storey-10	1315.6421	1315.6421	481.7904	481.7904
Storey-9	1614.2148	1614.2148	669.7302	669.7302
Storey-8	1815.1241	1815.1241	854.7169	854.7169
Storey-7	2030.7422	2030.7422	1036.6305	1036.6305
Storey-6	2163.4412	2163.4412	1213.8442	1213.8442
Storey-5	2255.5932	2255.5932	1385.0526	1385.0526
Storey-4	2314.5706	2314.5706	1549.1544	1549.1544
Storey-3	2347.7453	2347.7453	1708.6708	1708.6708
Storey-2	2362.4896	2362.4896	1867.8263	1867.8263
Storey-1	2366.1757	2366.1757	2026.9818	2026.9818

Footnote: ESLM represents equivalent static load method which is used for seismic analysis.

4.Conclusions

Using software like ETABS to analyze the structure for design purposes is beneficial to acquire the knowledge about the performance of building under different loadings such as seismic and wind loads. This study reveals that the mode shapes due to mode 1, mode 2 and mode 3 are same because the mode periods determined from equivalent static load method and wind analysis are equal. This study also concludes that base shear due to earthquake load is greater than the base shear due to wind load. It also reveals that storey displacement increases as number of storeys increase in a building. Storey displacement caused by earthquake loads is more than the storey displacement caused by wind loads both in X and Y direction acting on the structure. This analysis also displays that storey shear decreases as number of storeys increases in a building and is maximum at the bottom and minimum at top. Storey shear caused by earthquake loads is more than the storey shear caused by wind loads both in X and Y direction acting on the structure. From the above considerations, this study concludes that the earthquake load is more dominant than wind load for G+11 RC framed building.

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