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EFFECT OF WIND LOADS ON HIGH RISE BUILDING IN DIFFERENT SEISMIC ZONES

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ABSTRACT

Earthquake and wind are both juggernaut as they cannot be stopped in any way, though the solutions are provided only to safeguard the buildings. It is therefore necessary to analyze and modify the building elements satisfactorily to withstand earthquake and wind effects. The Indian code for wind load resisting structure is prepared for analysis of the building and to design the structure for resisting wind loading effects.

Keywords: High Rise Building, Wind Loads, Seismic Zone.

I. INTRODUCTION

India has major calamities like earthquake and cyclones majorly. Land available is less to construct any building thus building size is increased in vertical direction only. Thus tall structures are constructed for residential, commercial, official purposes. So according to IS code 16700-2017, super tall-structures whose height are above 250 m; and for tall structures whose height is above 50 m but less than 250 m are to be considered when RCC building is taken into account. Usually building height is taken according to IS code and all criteria are satisfied. Buildings are increasing with height they are more susceptible to failures which are due to wind and earthquake. Both earthquake and wind forces are unpredictable and uncontrollable. Accordingly the building structure is built to resist wind and earthquake lateral forces. Building criteria are developed in IS codes according to the zones in which cities are considered to be built. In general, for design of tall buildings both wind as well as earthquake loads need to be considered. Governing criteria for carrying out dynamic analyses for earthquake loads are different from wind loads. According to the provisions of Bureau of Indian Standards for earthquake load, IS 1893(Part 1):2016 Criteria for Earthquake Resistant Design of Structures, height of the structure, seismic zone, vertical and horizontal irregularities, soft and weak storey necessitates dynamic analysis for earthquake load. The contribution of the higher mode effects are included in arriving at the distribution of lateral forces along the height of the building. As per IS 875(Part 3):2015Design Loads Other than Earthquake for Buildings and structures, when wind interacts with a building, both positive and negative pressures occur simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind induced building failure. In order to design a structure to resist wind and earthquake loads, the forces on the structure must be specified. The exact forces that will occur during the life of the structure cannot be anticipated. Most National Building Codes identify some factors according to the boundary conditions of each building considered in the analysis to provide for life safety. A realistic estimate for these factors is important; however the cost of construction and therefore the economic viability of the project is essential. The code introduces simplified methods for the design which depend on different factors for wind and earthquake that govern the design and influence the results.

II. METHODOLOGY AND ANALYSIS

A. Codal Analysis for Structural Analysis

During the analysis of various models, following IS Codes were used:

1) IS: 875 (Part I):1987 - Indian Standard Code of Practice for design loads (other than earthquake) for buildings and structures (Dead Load).

2) IS: 875 (Part II): 1987 - Indian Standard Code of Practice for design loads (other than earthquake) for

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buildings and structures (Live Load).

3) IS 875 (Part 3): 2015 - Indian Standard Criteria for Design Loads (other than Earthquake) for buildings and structures (Third Revision).

4) IS 1893 (Part 1): 2016 - Indian Standard Criteria for Earthquake Design of Structures (Sixth Revision).

a) Load Combinations: When earthquake forces are considered on a structure, these shall be combined where the terms DL, IL and EL stand for the response quantities due to dead load, imposed load and designated earthquake load respectively. When responses from three earthquake components are considered the response due to each component may be combined using assumption that when maximum response from one component occurs, the responses from other two components are 30 percent each of their maximum

b) Partial safety factors for limit state design of reinforced concrete and pre stressed concrete structures. In the limit state design of reinforced and pre stressed concrete structures, the following load combinations shall be accounted for:

i) 1.5 (DL+IL)

ii) 1.2 (DL + IL ± EL)

iii) 1.5 (DL ± EL)

iv) 0.9 DL ± 1.5 EL

Earthquake loadings taken into account are as follows:

1) EQ(+X) (seismic load in +X direction)
2) EQ(-X) (seismic load in -X direction)
3) EQ(+Z) (seismic load in +Z direction)
4) EQ(-Z) (seismic load in -Z direction)
5) EQ(+Y) (seismic load in +Y direction)
6) EQ(-Y) (seismic load in -Y direction)

B. Calculation Of Loads

1) Dead Load

Wall Load = Unit weight of brick x wall thickness x height = 20 x 0.23 x 3 = 13.8 kN/m3

Internal wall load = Unit weight of brick x wall thickness x height = 20 x 0.115 x 3 = 6.9 kN/m3

2) Live Load

Live Load is defined as the load on the structure due to moving weight. Live load is assumed 2 kN/m3 on floors and 1.5 kN/m3 on roofs.

C. Load Combination Details for Earthquake

1) DL
2) LL
3) EQ(+X)
4) EQ(-X)
5) EQ(+Z)
6) EQ(-Z)
7) 1.5 (DL+LL)
8) 1.5 DL+EQ(+X)
9) 1.5 DL+EQ(-X)
10) 1.5 DL+EQ(+Z)
11) 1.5 DL+EQ(-Z)
12) 0.9DL+1.5EQ(+X)
13) 0.9DL+1.5EQ(-X)
14) 0.9DL+1.5EQ(+Z)

15) 0.9DL+1.5EQ(-Z)
16) 1.2DL+1.2LL+1.2EQ(+X)
17) 1.2DL+1.2LL+1.2EQ(-X)
18) 1.2DL+1.2LL+1.2(EQ+Z)
19) 1.2DL+1.2LL+1.2(EQ-Z)

D. Load Combination Details for Wind Loading

1) DL
2) LL
3) WL(+X) WINDWARD
4) EQ(-X) LEEWARD
5) EQ(+Z) WINDWARD
6) EQ(-Z) LEEWARD
7) 1.5 (DL+LL)
8) 1.5 DL+WL(+X)
9) 1.5 DL+WL(-X)
10) 1.5 DL+WL(+Z)
11) 1.5 DL+WL(-Z)
12) 0.9DL+1.5WL(+X)
13) 0.9DL+1.5WL(-X)
14) 0.9DL+1.5WL(+Z)
15) 0.9DL+1.5WL(-Z)
16) 1.2DL+1.2LL+1.2WL(+X)
17) 1.2DL+1.2LL+1.2WL(-X)
18) 1.2DL+1.2LL+1.2(WL+Z)
19) 1.2DL+1.2LL+1.2(WL-Z)

E. RCC Detail of Building

Model	G+11
Floor to Floor Height	3.0 m
Depth of Foundation	2.5 m
Total Building Height	36 m
Plan Size	50 mx40 m
Plan Area	2000 m2
Soil Type	Medium
Slab thickness	115 mm
Inner Wall Thickness	115 mm
Outer wall Thickness	230 mm
Density of Brick	20 kN/m3
Grade of Concrete	M25
Grade of Steel	Fe 415
Density of Concrete	25 kN/m3
Seismic Zone	Zone II, III, IV, V
Importance Factor	1.0
Zone Factor	0.10,0.16,0.24,0.36 (corresponding to seismic zone)
Size of Beam - First Floor to fourth floor	0.5 x 0.3 m

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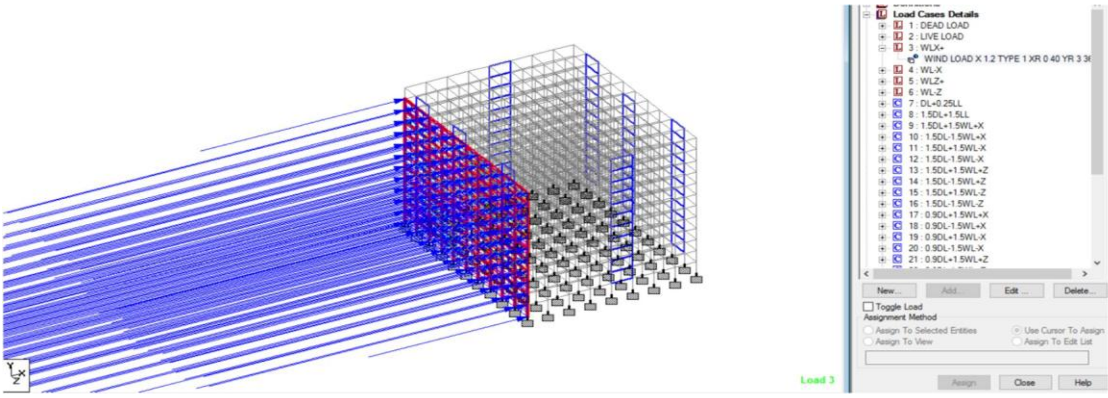
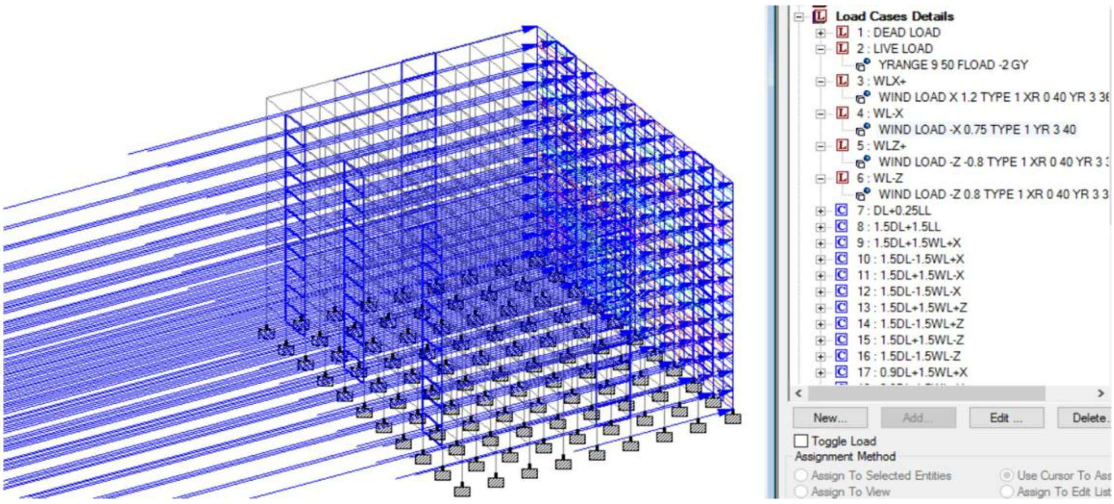
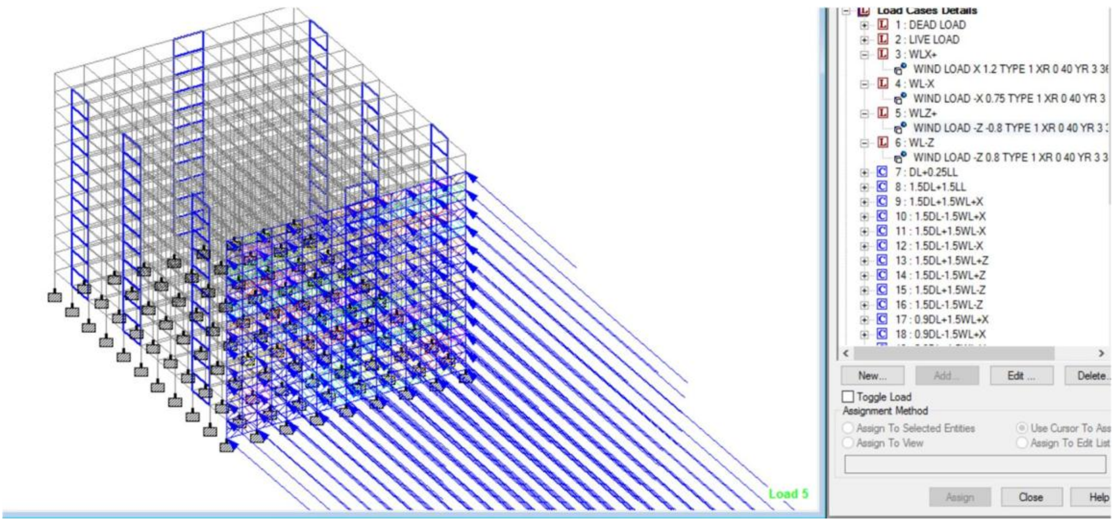
Size of Beam - Fourth Floor to eighth floor	0.45 x 0.3 m
Size of Beam - Eighth floor to twelfth floor	0.3 x 0.3m
Size of Column -First Floor to fourth floor	0.6 x 0.6 m
Size of Column - Fourth Floor to eighth floor	0.6 x 0.45 m
Size of Column - Eighth floor to twelfth floor	0.6 x 0.3m
Size of thickness of shear wall	0.2 m



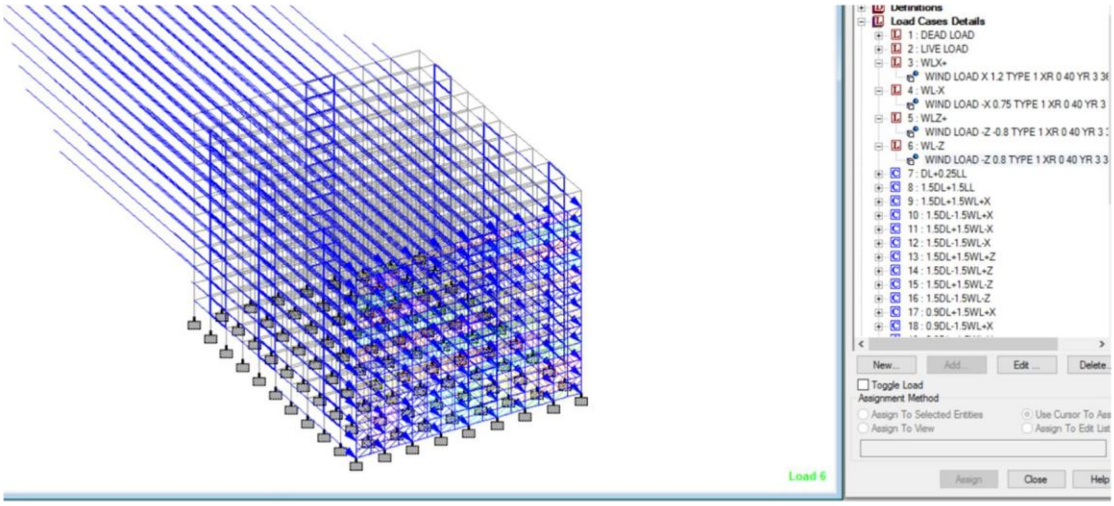
Wind in windward x direction



Wind in leeward x direction



Wind in windward z direction



Wind in leeward z direction

III. CONCLUSION

A. Comparison of wind loading effect on building structure is done with seismic effect on building effect on building in seismic zone II, III, IV simultaneously.

B. It shows that when the seismic zone is increased there is change in shear force, moment, torsion, and axial force.

C. Axial force is in same proportion as in seismic zone III, IV for beams.

D. Moment increases about 1.8 times in local Z direction when compared wind to seismic zone III and seismic zone IV for beams.

E. When torsion is assumed as parameter then there is an increase of 1.5 times in torsion in beams when comparison is done withwind to seismic zone III and seismic zone IV.

F. When moment parameter is compared there is increase of 3.5 times in local Y direction when a comparison is done of wind loading to seismic zone III, seismic zone IV simultaneously.

G. Since effects of wind loading on elements is less than seismic loading effects in zone II. There is a factor that building would besafer in seismic zone two without any seismic dampers, or without any special earthquake resistant system.

H. When seismic zone are considered there is factor that building would collapse if structural strength is not provided to the building with help of elements like seismic dampers, bracings, etc.

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