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Comparative Analysis of a Reinforced Concrete Multistory Building under Wind and Gravity Loadings in Different Seismic Zone's

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Abstract
Influence of wind load as a wonder on structures, especially tall structures can't be unnoticed. It's fundamental to consider the aftereffect of wind in style and examination of structures. The structure is investigated for the gravity loads and furthermore for the parallel burdens for example wind load in zone-ii (Bhopal), zone-iii (Nagpur), zone iv (Delhi), zone-v (Calcutta), zone-vi (Darbhanga).The structure is made on the product known as staad.pro v8i. This examination is the investigation of the Reinforced concrete cement multi-story building (G+10). The codes utilized for the estimations of Dead burden are IS:875(Part 1)- 1987 ,for live burden the code IS :875(Part 2)- 1987 and for the counts of wind power in various breeze zones are IS :875 (section 3) - 1987.The aftereffect of these examination shows the adjustment in powers, removals responses and weight of steel the amount of auxiliary material expected to oppose parallel burdens will increment definitely.quantity of structural material needed to resist lateral loads will increase drastically.

Key Words: -Wind Load Analysis & Design, Comparison of wind intensity, wind zones. Gravity Load Analysis and Design.

Introduction

The wind has two aspects. The first a beneficial one that is its energy can be utilized to generate power, sail boats and cool down temperature on a hot day. The other a parasitic one is that it loads any and every object that comes in the way. The latter is the aspect an engineer is concerned with, since the load caused has to be sustained by a structure with the specific safety. All civil and industrial structure above ground have thus to be designed to resist wind loads. This introductory notes is concerning the aspect of wind engineering dealing with civil engineering structure.

The first floor opens in almost all multi-storey buildings in India because the first-floor parking or reception is adjusted for the lobby. The second floor was used to construct brick walls. According to the Indian seismic code, there is nothing but a soft structure, but the lateral hardness of the building is less than 50% [IS: 1893, 1997]. Generally, the construction of the total seismic base shear experienced during earthquake from its natural time. Earthquake force distributed the base on the wax and mass at the height. In the soft-storied building, the upper storey is getting stiff, the small inter-storey passes through the drift. However, the interstate flow in soft first floor is big. The strength of the column is also large in the first floor for third buildings, because the first floor shear is maximum. For upper states, however, due to the presence of buildings, the strength of the pillar effectively decreases, which occurs with sudden hardness in uneven side force distribution, which can cause stress concentration locally. It has adverse effects on the performance of buildings during land shaking. Such buildings should be analyzed with dynamic analysis and carefully designed. Many earthquakes in the past, for example, Sun Fernando 1971, Northbridge 1994, Kobe 1995, have demonstrated the potential dangers associated with such buildings. In the walls of the filler, there was only minor damage in the upper stove cracks.

Figure 1: Apartment collapse in bhuj (2001).

Raghu et al. (2018), a grid is a planar structural system composed of continuous members that either intersect or cross each other. Grid slab is a very popular structural configuration deployed for the construction of hotel porticos, airport terminal buildings, large banquet hall, convention centres and car parks. A load set on a cable or a beam is channelled to the support along the cable line or the beam axis, an arch, a frame, and continuous beam produce the same type of one– directional load dispersal type. A G+9 Storey Grid slab structure is considered for this study and the models are analysed with seismic zone IV, this models are modelled in ETABS 2016 Software, and the analysis is carried out using a response spectrum method. The comparison is made on the two models for base shear, storey drift, storey displacement and storey stiffness. It was concluded that the Box effect of modular type scheme, it is increasing overall stiffness of the building thus, reducing the sway problem in the structure and As spacing of grid beams decreases higher will be load carrying capacity of the building.

Ramakrishna et al. (2018), for the design engineers, selection of the type of the structure for a particular purpose is very important of late. Under circumstances, slab structures and grid structures proves to be more beneficial compared to the conventional RC Framed Structures. Architectural aspects and the flexibility of the space utilization inside the structures, easy form work etc. The modes are done using E-Tabs 2015 IS Code 456-2000. G+14 storey buildings are taken and designed and analysis is done for both Gravity (D.L and L.L) and lateral (earth quake and wind) loads. The equivalent static method is used to design and analyze the structures, as categorized by Indian Standard Code for earthquake resistant structures. Study provides good information about storey drift, storey displacement, base shear, storey shear, and time period. It is observed that the seismic performance of grid slab structure was better as compared to that of flat slab structure. It is found that the Storey drift of conventional slab is 10% higher than flat slab and grid slab. The Base shear of conventional slab is 44% higher than flat slab and 37% higher compared to grid slab.

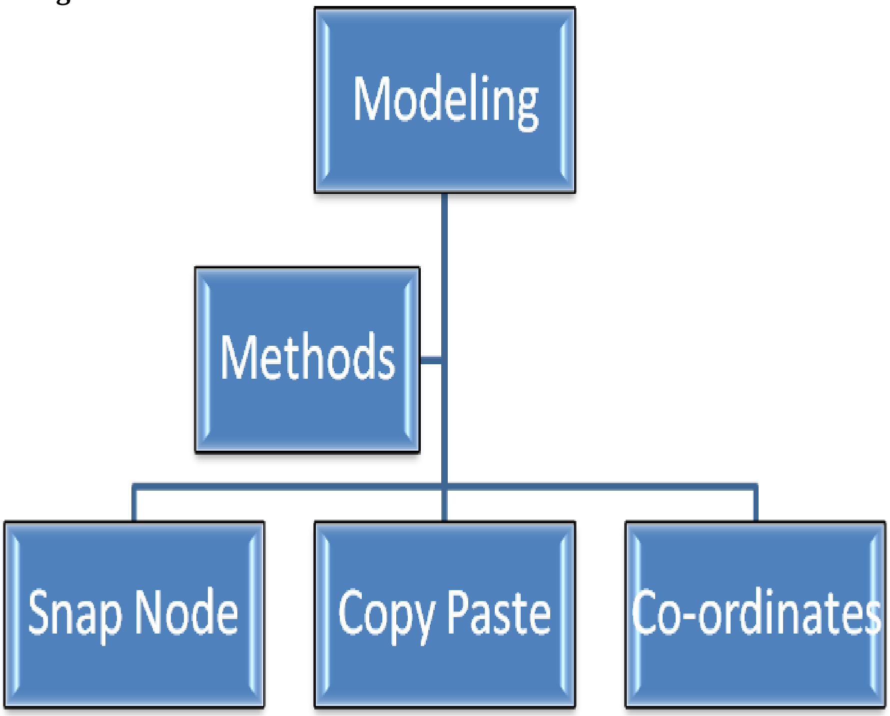
Tushar Golait et al. (2019), recent advancements in the field of Structural Design are related to Flat Slabs and Grid Floors. This research is focused on studying the behavior of conventional slabs, flat slabs and grid slabs. Comparative study was done in terms of nodal deflection, beam shear and beam moments. The modelling and analysis was done using STAAD pro V8i, considering square, hexagonal and octagonal geometries for the structures. The models were developed for 10, 20 and 30 storeys. Seismic loadings were considered for Zone II according to IS: 1893 (Part 1) - 2002, to evaluate the performance of all the 27 models and it was concluded on the basis of analysis that.

II. Methodology

This thesis deals with comparative study of wind behaviour of high rise structures building frames with 3 geometrical (3 D) configurations and completely different wind zones, below the wind impact as per 875 (part-iii):1987 static analysis. A comparison of study ends up in terms of max displacements, wind forces, max bending moments, most axial force, most shear force and reaction This study is tried in following steps: -

1. Modelling of building.
2. Designing of structure in all five wind zones (39, 44, 47, 50 and 55 m/s) as per is- 875 (part-iii):1987.
3. Modelling of building frames is done on staad-pro v8i package.
4. Comparative study of results as wind forces, bending moments, most axial force, displacements, most shear force and reaction**.**
5. Analysis of the structure for the gravity load.

Methods of Modelling of Structure in Staad. Pro:-



Applications of Loading on Structure in Staad.Pro:-

III. Details of Structure Modeling

Table 1: Details of the structure.

S. No.	Particulars	Values
1	Size of Beam	0.6mx0.4m
2	Size Of Column	0.7mx0.5m
3	Plan Size	34.72mx26.83m
4	Height Of Structure	35.5m
5	Height Of Individual Story	3m
6	Density Of Brick Masonry	$20KN/M^3$
7	Density Of Concrete	$25KN/M^3$
8	Grade Of Concrete	M-25
9	Grade Of Steel	Fe-415
10	Soil Condition	Medium Soil
11	Thickness Of Outer Wall	0.2m
12	Thickness Of Inner Wall	0.1m
13	Wind Zones	II, III, IV, V, VI
14	Thickness Of Slab	0.15m
15	Importance Factor	**1**
16	Terrain Category	**2**
17	Class Of Structure	**B**

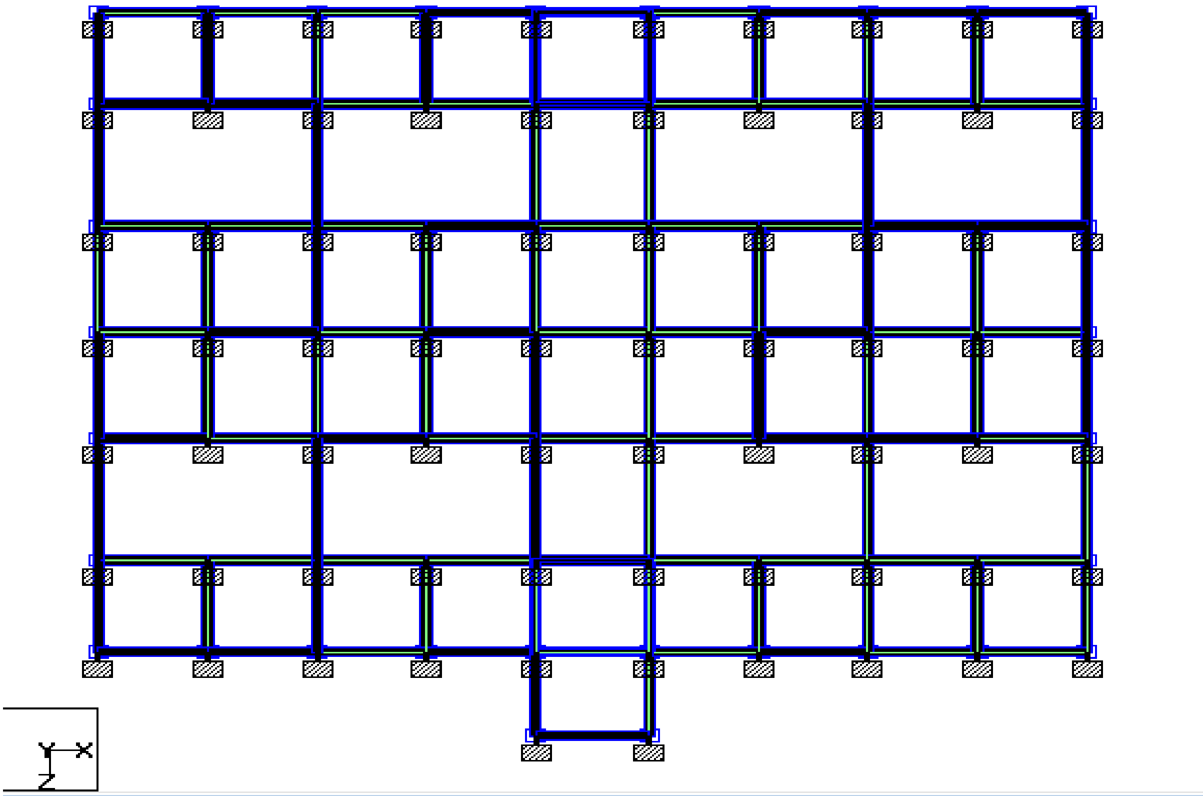


Figure 2: Reinforced Multi-Storey Building Plan.

IV. Load Calculation

Dead load consist of the permanent constructions material load compressing the beam, column, roof ,floor ,wall and foundations including claddings finish and fixed equipment .Dead load is a total load of all of the components of the building that generally do not change over time.

As per IS: 875 (part -I)

Outer wall load = .2*20*2.4= **9.6kn/m^2**

Inner wall load = .1*20*2.4= **4.8kn/m^2**

Parapet wall load = .1*20*1= **2kn/m^2**

Floor load (SLAB) + floor finishing load**= 4.75kn**/m^2

Live Load:-

This loads are not permanent or moving loads. the following loads includes in this type of loadings imposed load, fixed machinery , partitions wall these loads through fixed in positions cannot be re-lived upon to act permanently through-out the life of the structure.

As per IS: 875 (part –II)

Live load = **3KN/m^2**

Wind Load:-

Wind is the motion of air in the atmosphere. Response of structure to wind depends on the characteristic of the structure .Wind may be a mass of air that moves during a principally horizontal direction from a vicinity of air mass to a vicinity with air mass. High winds are often terribly damaging as a result of they generate pressure against the surface of a structure. The intensity of this pressure is that the wind load.

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Design Wind Speed:-

Thebasic wind speed (V_b) for any site shall be obtained the following effects to obtain design wind velocity at any height (V_z) for the decide on structure.

Risk Factor (K_1):-

Risk Coefficient(K_1 Factor) gives basic wind speeds for terrain Category 2 as applicable at 10 m above ground level based on 50 years mean return period. In the design of all buildings and structures, a regional basic wind speed having a mean return period of 50 years shall be used.

V. Load Combinations:-

We have analyses the building for gravity load, wind load for different load combination as per **IS 875 (Part 3): 1987** and STAAD has analyses the building for the worst combination for each member of the building. Following are the load combinations which are taken as per **IS 875 (Part 3):1987 (for gravity loading and wind load) is:-**

1. 1.5(DD+LL)
2. 1.2(DD+LL+WL IN POSITIVE X DIRECTION)
3. 1.2(DD+LL+WL IN NEGATIVE X DIRECTION)
4. 1.2(DD+LL+WL IN POSITIVE Z DIRECTION)
5. 1.2(DD+LL+WL IN NEGATIVE Z DIRECTION)
6. 1.5(DD+ WL IN POSITIVE X DIRECTION)
7. 1.5(DD+ WL IN NEGATIVE X DIRECTION)
8. 1.5(DD+ WL IN POSITIVE Z DIRECTION)
9. 1.5(DD+ WL IN NEGATIVE Z DIRECTION)
10. . 9DD+1.5WL IN POSITIVE X DIRECTION
11. . 9DD+1.5WL IN NEGATIVE X DIRECTION
12. . 9DD+1.5WL IN POSITIVE Z DIRECTION
13. 9DD+1.5WL IN NEGATIVE Z DIRECTION
14.

VI. Structural Analysis And Results

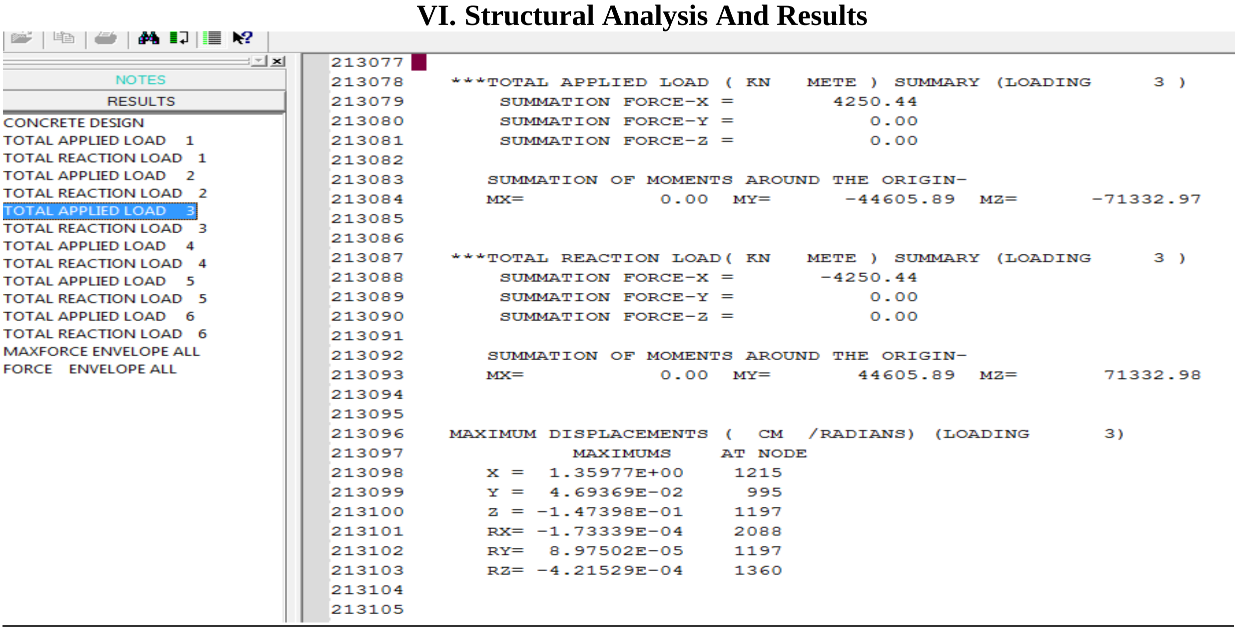
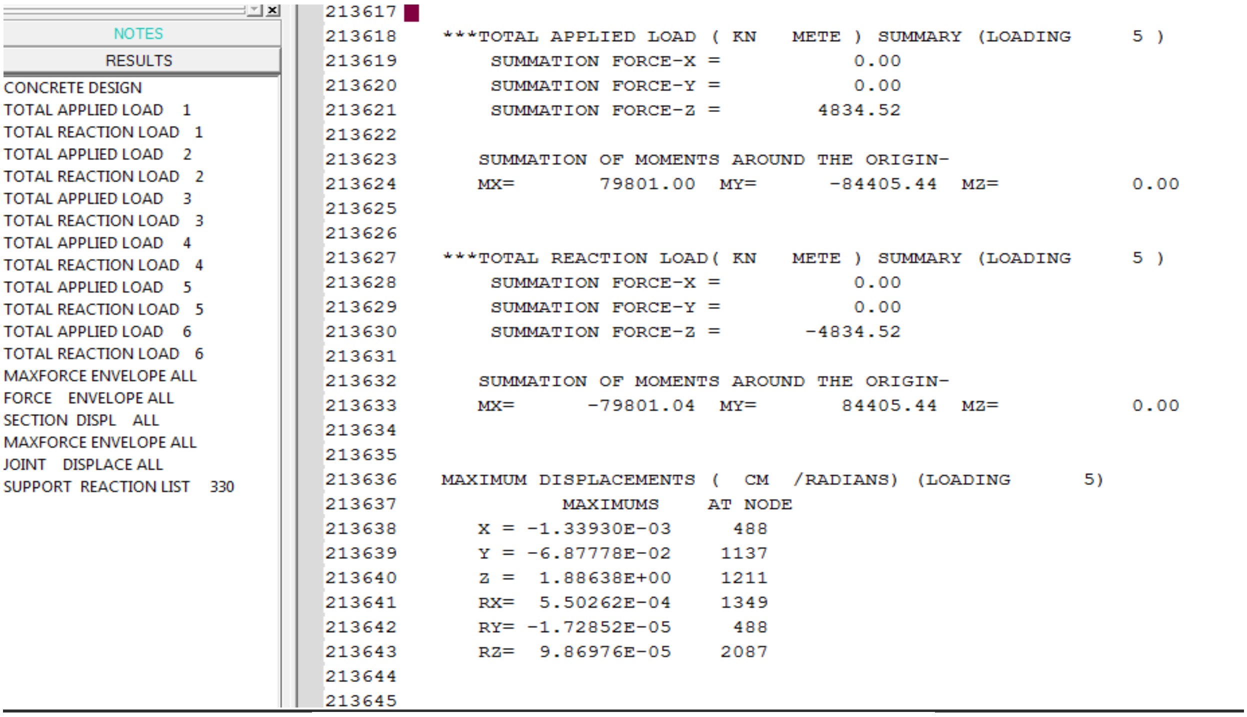


Figure 3: Horizontal Displacement In + X Directions.



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NOTES
RESULTS
CONCRETE DESIGN
TOTAL APPLIED LOAD 1
TOTAL REACTION LOAD 1
TOTAL APPLIED LOAD 2
TOTAL REACTION LOAD 2
TOTAL APPLIED LOAD 3
TOTAL REACTION LOAD 3
TOTAL APPLIED LOAD 4
TOTAL REACTION LOAD 4
TOTAL APPLIED LOAD 5
TOTAL REACTION LOAD 5
TOTAL APPLIED LOAD 6
TOTAL REACTION LOAD 6
MAXFORCE ENVELOPE ALL
FORCE ENVELOPE ALL
SECTION DISPL ALL
MAXFORCE ENVELOPE ALL
JOINT DISPLACE ALL
SUPPORT REACTION LIST 330

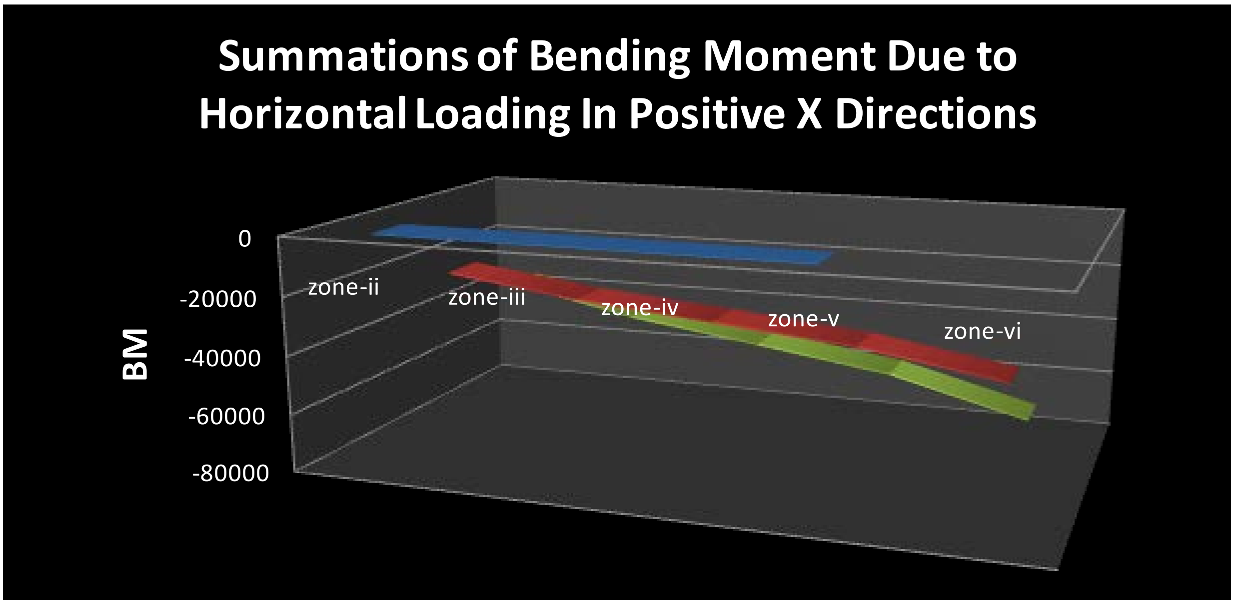
213617
213618   ***TOTAL APPLIED LOAD ( KN   METE ) SUMMARY (LOADING    5 )
213619      SUMMATION FORCE-X =          0.00
213620      SUMMATION FORCE-Y =          0.00
213621      SUMMATION FORCE-Z =       4834.52
213622
213623     SUMMATION OF MOMENTS AROUND THE ORIGIN-
213624     MX=       79801.00  MY=      -84405.44  MZ=           0.00
213625
213626
213627   ***TOTAL REACTION LOAD( KN   METE ) SUMMARY (LOADING    5 )
213628      SUMMATION FORCE-X =          0.00
213629      SUMMATION FORCE-Y =          0.00
213630      SUMMATION FORCE-Z =      -4834.52
213631
213632     SUMMATION OF MOMENTS AROUND THE ORIGIN-
213633     MX=      -79801.04  MY=       84405.44  MZ=           0.00
213634
213635
213636   MAXIMUM DISPLACEMENTS (  CM  /RADIANS) (LOADING      5)
213637             MAXIMUMS    AT NODE
213638     X = -1.33930E-03     488
213639     Y = -6.87778E-02    1137
213640     Z =  1.88638E+00    1211
213641     RX=  5.50262E-04    1349
213642     RY= -1.72852E-05     488
213643     RZ=  9.86976E-05    2087
213644
213645
```

Figure 4: Horizontal Displacement In + Z Direction.

Total Bending Moment:-

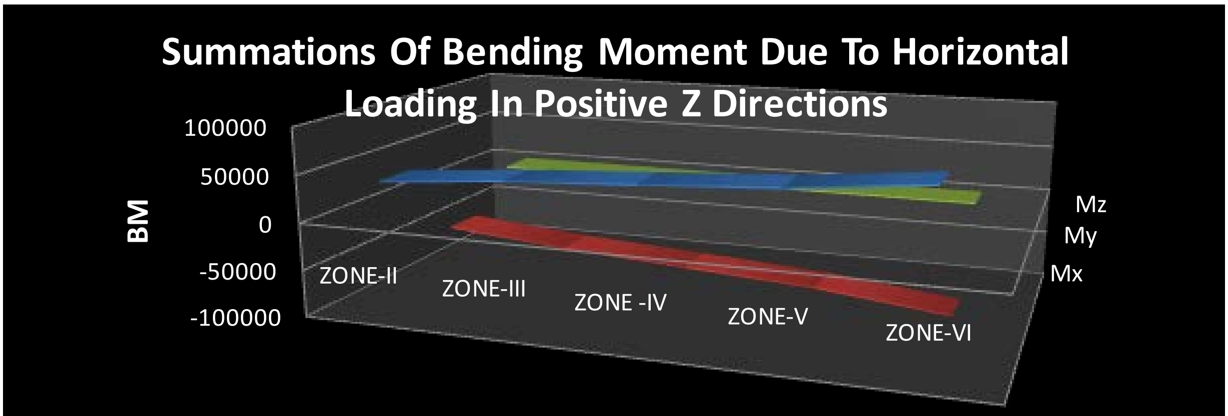
Table 2: Bending Moment Due to Horizontal Loading in Positive X Directions.

S. NO.	LOADING	BM (KN-M)	ZONE -II	ZONE -III	ZONE -IV	ZONE -V	ZONE –VI
1	X Direction	Mx	0	0	0	0	0
		MY	-22454.7	-28516.95	-32633.6	-36923.7	-44605.9
		MZ	-35887.18	-45606	-52131.92	-58995	-71334
2	Z Direction	Mx	40148.95	51018.77	58324	65999	79801
		MY	-42492.75	-53961.03	-61757	-69874.54	-84405.44
		MZ	0	0	0	0	0



	zone-ii	zone-iii	zone-iv	zone-v	zone-vi
Mx (KN-M)	0	0	0	0	
My (KN-M)	-22454.7	-28516.95	-32633.6	-36929.7	-44605.9

Figure 5: Bending Moment Due to Horizontal Loading in Positive X Directions.



	ZONE-II	ZONE-III	ZONE -IV	ZONE-V	ZONE-VI
Mx	40148.95	51018.77	58324	65999	79801
My	-42492.75	-53961.03	-61757	-69874.54	-84405.44
Mz	0	0	0	0	0

Figure 6: Bending Moment Due To Horizontal Loading In Positive Z Directions.

Area of Steel in Beam:-

Table 3: Area of Steel in Beam.

Zones	Bottom Required	Bottom Provided	Top Required	Top Provided
GRAVITY LOAD	0	157	491	549
WIND ZONE II (BHOPAL)	466	471	491	549
WIND ZONE III (NAGPUR)	466	471	559	567
WIND ZONE IV (DELHI)	466	471	609	679
WIND ZONE V (CALCUTTA)	466	471	653	679
WIND ZONE VI (DARBHANGA)	466	471	738	785.39

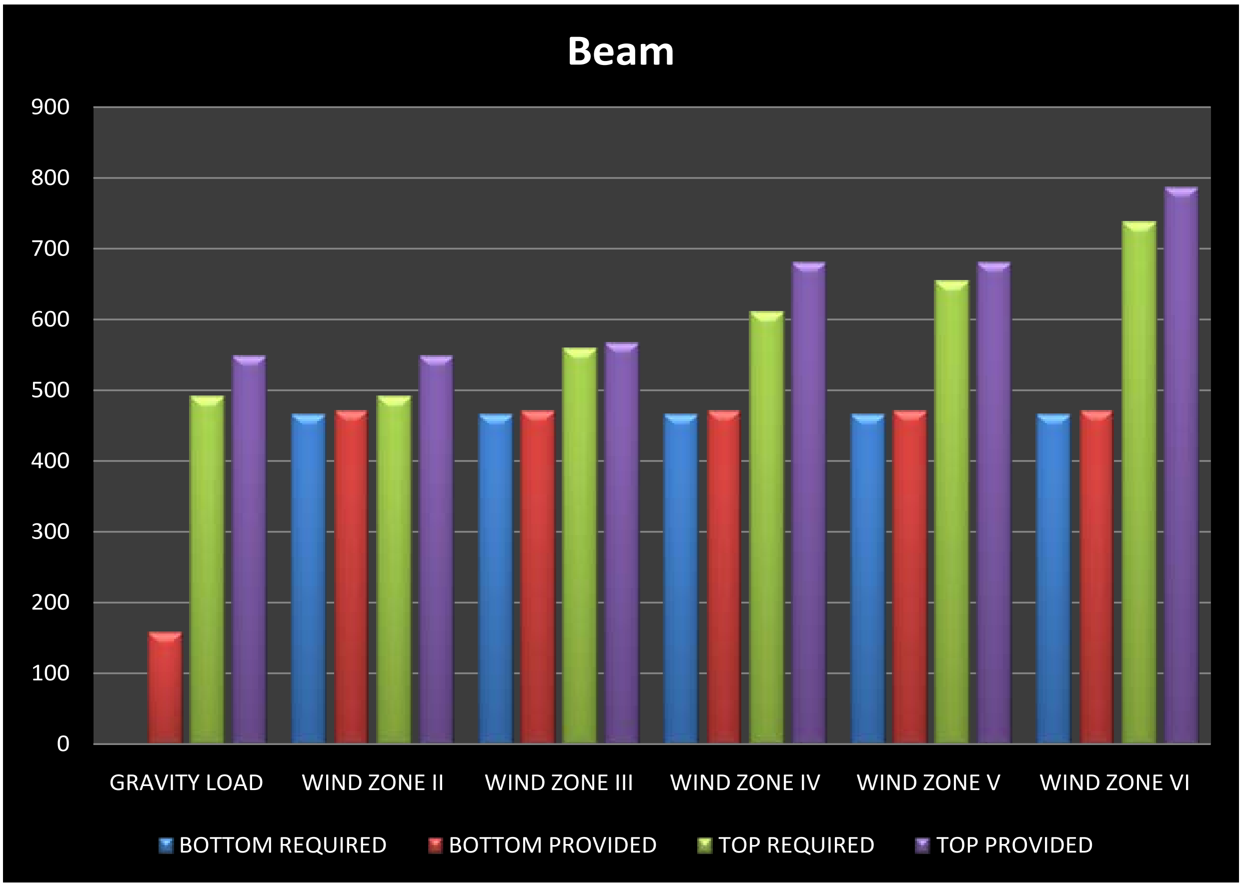


Figure 7: Area of Steel in Beam.

VII. CONCLUSION

This comparative study helps us to understand the response of the building under the various winds loading.

1. From this study we can say that wind force are dominates above the 10m from the ground level.
2. Generally an additional structure is provided to resist the wind load but in my study there is no need to provide any type of additional structure. The whole Rc frame is designed to resist the wind load.
3. Percentage variation of total concrete quantity for the whole structure, between gravity load design and wind load design for wind zone II to VI is found to very respectively .
4. Percentage variation of total reinforcement quantity for whole structure, between gravity load design and wind load design are also increases.

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