



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**

A futuristic digital interface with a glowing globe in the center. The interface includes various data visualizations such as bar charts, line graphs, and pie charts. Text elements like 'BUSINESS', 'NETWORK SEARCH', and 'LORLD' are visible. A person's hand is shown interacting with the interface, with light reflecting off the fingers. The background is dark with blue and purple hues.

# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 1, January 2021

**ISSN** INTERNATIONAL  
STANDARD  
SERIAL  
NUMBER  
INDIA

**Impact Factor: 7.512**

 9940 572 462

 6381 907 438

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# Gust Analysis of (G+50) Storey Tall Building by IS:875 Part III & by ETABS

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**ABSTRACT:** Structures are called as the functions, where the inputs are various types of loads like live loads, wind loads, seismic loads etc. and the outputs are the displacement and deformations like horizontal displacement, overturning moment., settlements etc Evaluating of wind loads can be done by the GUST FACTOR METHOD with a greater accuracy and the interstoreys drift can be suitably controlled by the optimum arrangement of different structural system. The present analysis deals with the evaluation of wind loads by statics approach and gust factor approach for the G+50 storied tall structures and the results are compared with drift. Analysis os structure is perform in etabs as well as manual of the gust factor method by the IS 875 part 3.Different combinations of RCC bracing , steel bracings in X and Y axes and the different arrangement of shear wall and core wall in centre and corner expanding from bottom to top

**KEYWORDS:** Gust factor method, high rise structures, wind analysis ,lateral loads, overturning moments, lateral deformations

## I. INTRODUCTION

A set of model parameters: 1) Model shape, 2) Model mass, 3) Model stiffness and 4)Model damping. Using these quantities as a frequency response function can be defined that gives the dynamic characteristics of the structure. Gust Factor method is a more realistic and rational method to deal with wind loads on high rise structures.

## ANALYTICAL MODEL:

In this study slender tall building is analyzed and sculptured for wind forces. The assorted parameters are thought-about to form it wind resistance. Totally different form the various location of shear wall at completely different location and combination of bracing and shear wall system. Ten models are thought- about to know. The detail examination has been carried out using ETABS, the small print of multi storey building are given in the table.

Type of building	Residential cum commercial Building
Plan area	20.11mX54.54m
Storey height	3.35m
Total height of building	171.71m
Type of soil	Type II( Medium soil)
Terrain category	2
Location of building	Vishakhapatnam

Table1: Details of multi storied structure

Grade of concrete Column Beam	M60, M40
Density of concrete	25 kN/m3
Grade of steel reinforcement	Fe500
Grade of steel bracings	Fe250
Live load	3 kN/m2
Floors finish	1.5kN/m2
Live load reduction factor	25%
Importance factor	1

Table 2: Material properties and loads

Slab thickness	150mm
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**Table 3: Structural members details**

All storey	1m x 1m
All storey	1.3m x 1.3m

**Table 4: Column Size**

## II. OBJECTIVES

1. To perform analysis on G+50 storey slender building & determine the behaviour of RC framed multi-storey building using E-Tabs and GUST factor method.
2. Adopting different locations of Shear Wall and studying the structural behaviour.
3. Performing analysis by providing Core Wall at centre on different storey to identify the behaviour.
4. Performing analysis by providing RCC diagonal bracings in X and Y directions.
5. Performing analysis by providing Steel bracings in X and Y directions.
6. Identifying the Time period , Base Shear , Storey Drift, Overturning moment & Displacement of the structure.

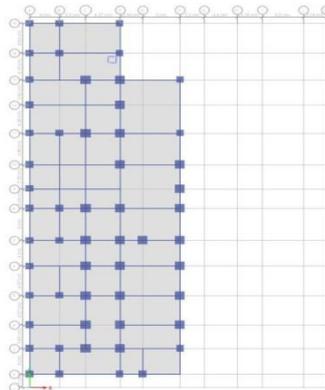
## III. METHODOLOGY

### 3.1 EVALUATION OF WIND LOAD

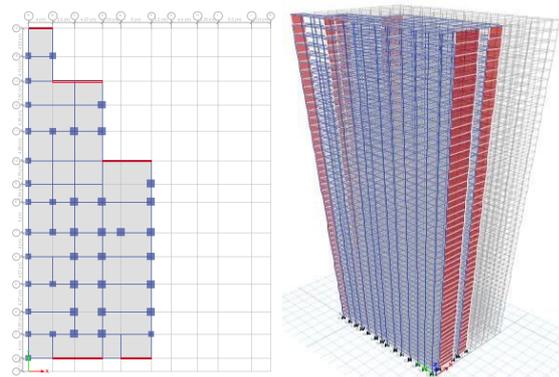
Wind load is calculated based on two different methods: a) Static method and b) Gust factor method.

### GENERAL DESCRIPTION OF MODELS:

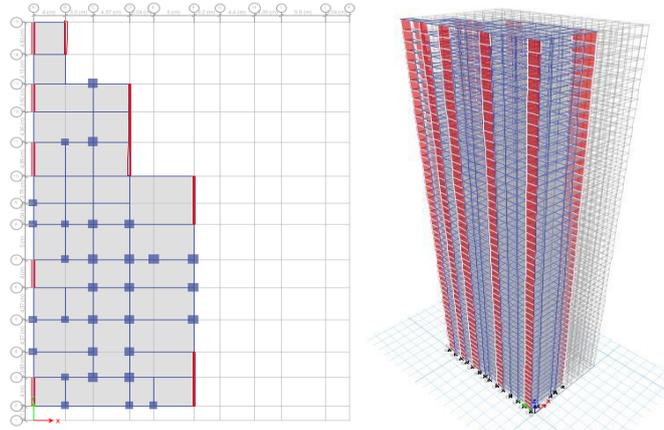
- 1) Model 1: Regular model of G+50 Storey, in this model plane model analysis has been performed by Etabs (wind analysis).



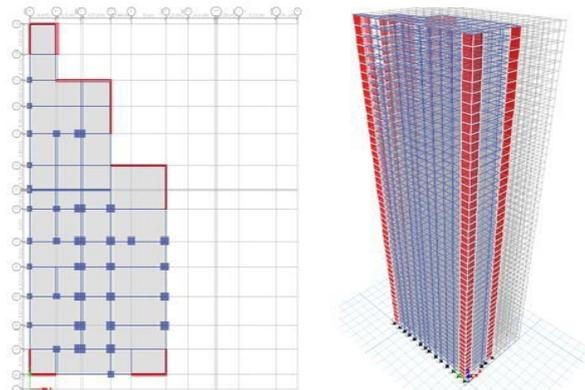
- 2) Model 2 : Regular Model of G+50 Storey , in this model shear wall is provided in X direction & analysis has been performed by Etabs ( wind analysis).



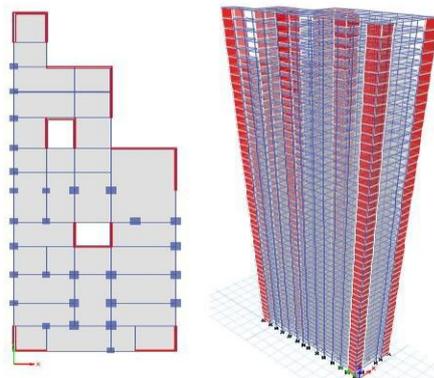
- 3) Model 3 :Regular Model of G+50 , in this model shear wall is provided in Y-direction & analysis performed by Etabs (wind analysis).



- 4) Model 4 : Regular Model of G+50 , in this model shear wall is provided in corner & analysis performed by Etabs (wind analysis) .

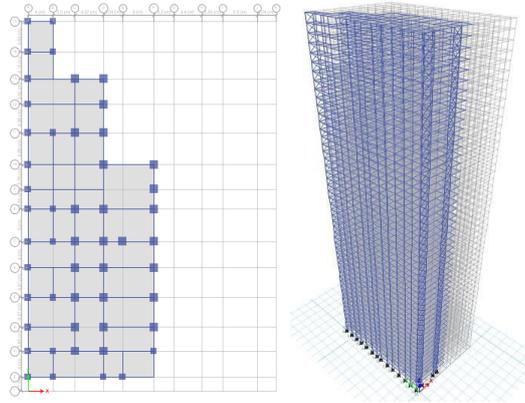


- 5) Model 5 : Regular Model of G+50 , in this model shear wall is provided in corners & core-wall at centre have been performed by Etabs (wind analysis).

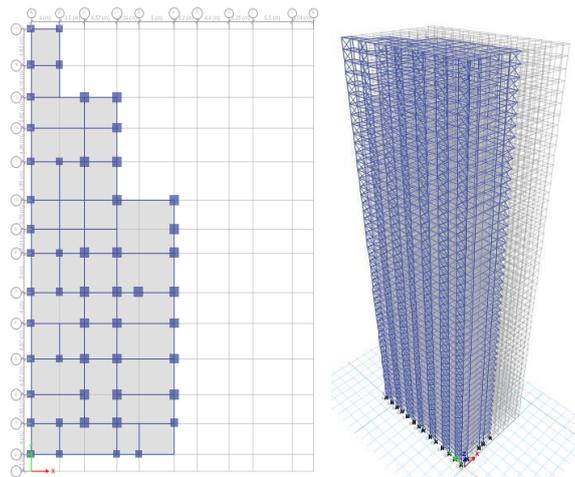




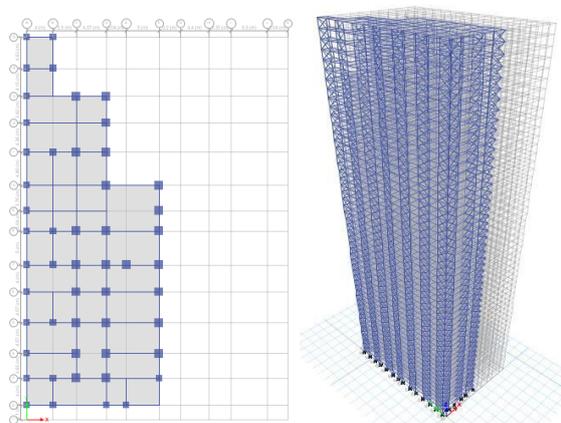
6) Model 6: Regular model of G+50 , in this model RCC diagonal bracing is provided in X direction and analysis has been performed by Etabs (wind analysis).



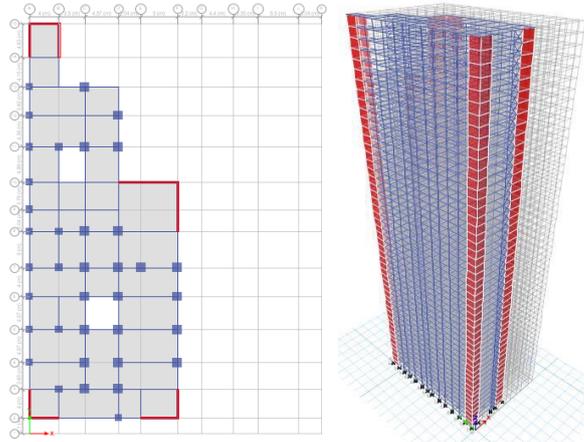
7) Model 7: Regular model of G+50 , in this model RCC diagonal bracing is provided in Y direction and analysis have been performed by Etabs (wind analysis).



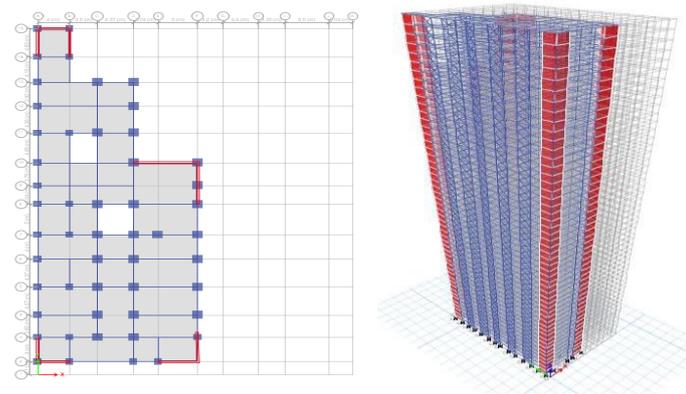
8) Model 8: Regular model of G+50 , in this model RCC diagonal bracing is provided in both X and Y direction & analysis have been performed by Etabs (wind analysis).



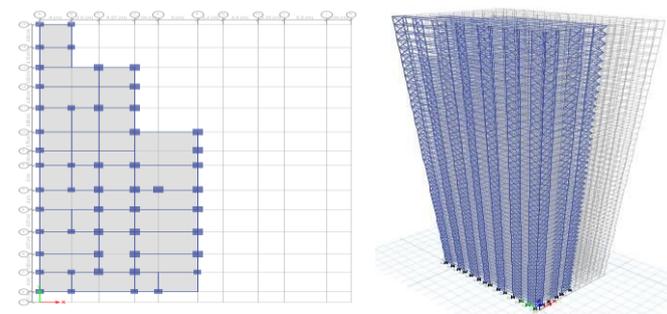
9) Model 9 : Regular model of G+50 , in this model RCC bracing in X direction with shear wall in corner is provided and analysis have been performed by Etabs (wind analysis).



10) Model 10: Regular model of G+50 , in this model RCC bracing in Y direction and shear wall in corner is provided and analysis have been performed using Etabs.



11) Model 11: Regular model of G+50, in this model steel bracing in both X and Y direction is provided and analysis have been performed using Etabs.



#### IV. RESULTS AND DISCUSSION

##### 4.1 STOREY DISPLACEMENT

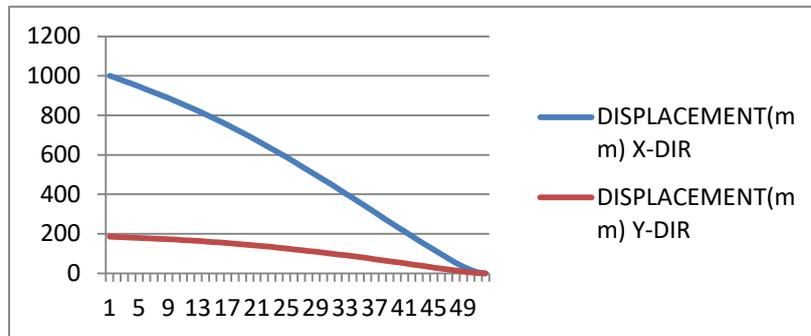
- 1) The different displacement values for the different models have been plotted and noted below. This Story displacement is obtained by performing analysis using ETABS .
- 2) It is observed that the displacements value decreases with the provision of shear wall as compared to



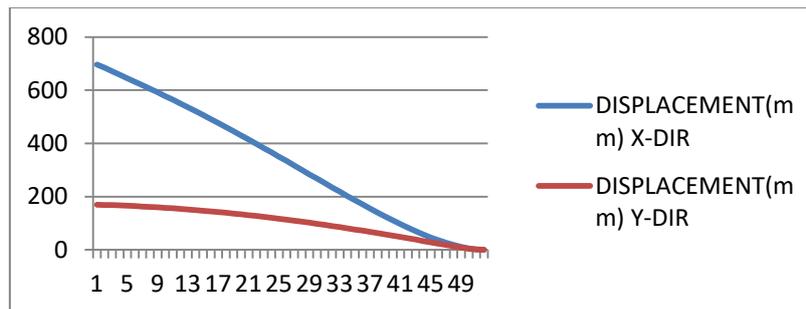
provision of bracings & core wall.

Graph is plotted such that on X-axis-Number of Storeys, Y-axis-Displacement in mm

For Model 1 Regular model of G+50 Storey, in this model plane model analysis has been performed by Etabs (wind analysis).



For Model 2 : Regular Model of G+50 Storey , in this model shear wall is provided in X direction & analysis has been performed by Etabs ( wind analysis).



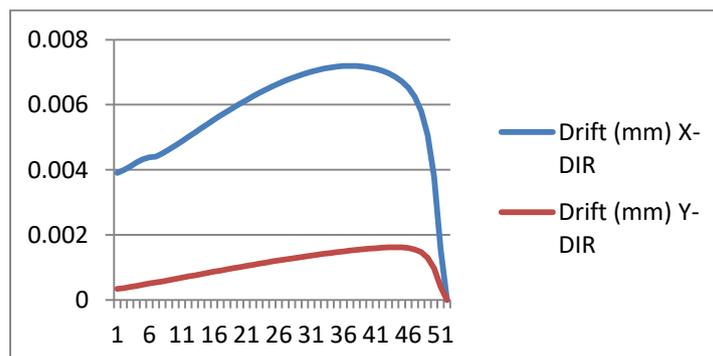
So like this the Graphs for the remaining models from Model 3 to Model 11 is evaluated.

**4.2 STOREY DRIFT:**

- 1) The drift values are plotted and noted below , these values are obtained by performing analysis by equivalent static method using Etabs.
- 2) It is seen that the drift values differ as the structure model is changed by adding or positioning of SW & CW .

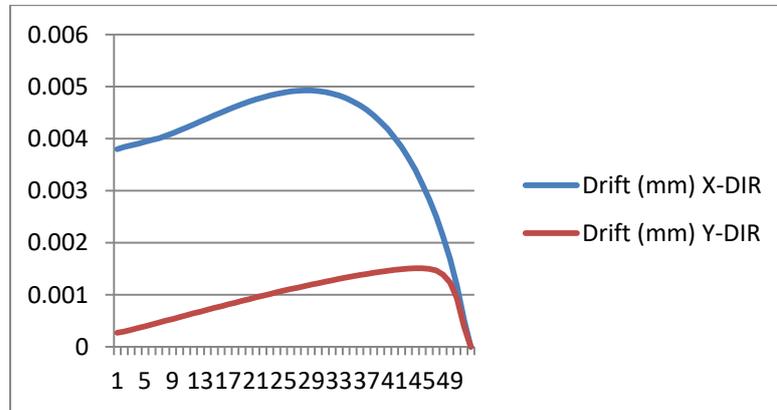
Graph is plotted such that on X-axis-Number of Storeys, Y-axis-Drift in mm.

For Model 1 Regular model of G+50 Storey, in this model plane model analysis has been performed by Etabs (wind analysis).





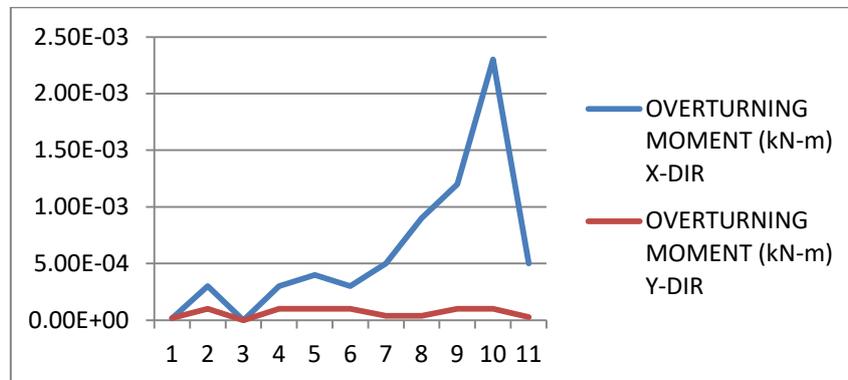
For Model 2 : Regular Model of G+50 Storey , in this model shear wall is provided in X direction & analysis has been performed by Etabs ( wind analysis).



So like this the Graphs for the remaining models from Model 3 to Model 11 is evaluated.

**4.3 OVERTURNING MOMENT:**

Overturning of the structure is caused due to the lateral forces. The different types of horizontal forces acting are as follows, 1) wind loads 2) seismic loads etc. . When structures are subjected to horizontal forces like as wind force and seismic forces, they undergo deflection in the lateral direction and lateral sway is also observed in one direction of the structure. This results in structure to experience overturning.

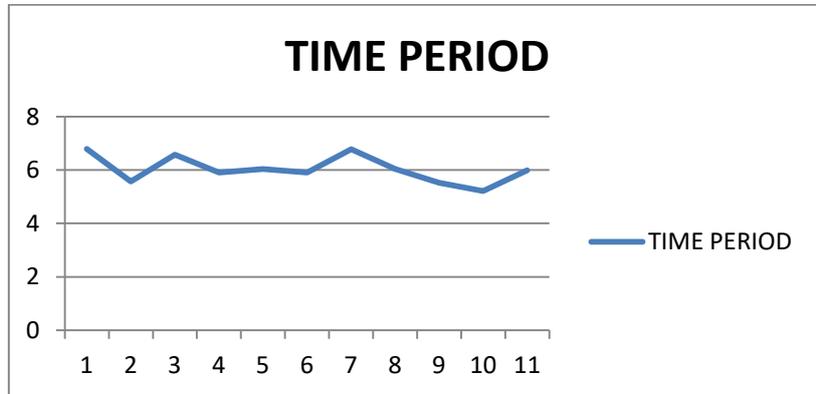


**4.4 TIME PERIOD :**

It is nothing but the undamped free vibration of the structure. The table below represents the values of time period obtained by the analysis using Etabs. The table Shows that time period is different for the different models in both regular and irregular building . As the structure is not similar and hence time period varies.

The variation in time period is considerably less with respect to configuration governing in X-direction as compared to y-direction.

Graph is plotted such that on X-axis-Number of Models, Y-axis-Time Period in Sec.



**4.5 GUST FACTOR APPROACH BUILDING PAREMETERS:**

h = 171.71 m

w = 20.11 m

L = 54.54 m

Terrain category = 2

Basic wind speed ,Vb= 50 m/s Importance factor = 1.3

Risk co-efficient (k1) = 1 Topography factor (k3) = 1 the ratio of height to least lateral dimension is more than 5 i.e. h/w = (171.71 / 20.11) = 8.538.

Hence, Dynamic analysis is necessary (As per IS 875: Part III, Section 9.1 A)

This building shares special location characteristics, on one face i.e. sea face it is exposed to Terrain category 1, transiting into terrain category 3.

Therefore, we need to calculate combined wind profile as per appendix B.

Fetch length (Distance from sea) = X3 = 300m, h4 = 80m

Therefore upto height 80 m, k2 factor shall be as per terrain category – 4, and above that it will be as per terrain category –2.

**DESIGN WIND PRESSURE:**

$$V_z = V_b * k_1 * k_2 * k_3 * k_4$$

$$V_z = 50 k_2$$

Sl.No.	Elevation	k2	Vz(m/s)	Pz (KN/m)
1	170.5	1.29	64.5	2.5
2	167.5	1.27	63.5	2.42

Where, Pz = 0.6 \* Vz<sup>2</sup>

[Upto storey 24, consider k2 value from terrain category – 2. After that consider category – 4]

Wind Induced Lateral forces on Structure:

$$F = C_f * A_e * P_d * G$$

I. Force co-efficient calculation along longer side,

$$a = l/w = 54.54 / 20.11 = 2.712$$

$$b = h/w = 171.71 / 20.11 = 8.538$$

Value of cf = 1.43

II. Force co-efficient calculation along shorter side,

$$a/b = 20.11 / 54.54 = 0.37$$

$$h/w = 171.71 / 54.54 = 3.15$$

Value of cf = 1.25

III. Effective Area Calculations:

$$h = 3.35 * (\text{Floor Height}) = 3.35 * 4.1 h = 13.74 \text{ m}^2$$

$$b = 3.35 * 4$$

$$b = 13.4 \text{ m}^2$$

IV. Gust Factor Calculation: When wind is on sea side,

$$h = 171.71 \text{ m}$$



$$b = 20.11 \text{ m}$$

$$d = 54.54 \text{ m}$$

**FUNDAMENTAL TIME PERIOD:**

$$T = 0.09h / d0.5$$

$$T = (0.09 * 171.71) / (54.54)0.5 = 2.09 \text{ s}$$

$$f = 1/T = 1/2.09 = 0.48 \text{ Hz}$$

$$G = (1 + gf) * r * \sqrt{B(1 + \phi)^2 + \left(\frac{SE}{\beta}\right)}$$

$$\lambda = (C_y * b) / (C_z * h) = (10 * 20.11) / (20.11 * 171.71)$$

$$\lambda = 0.06$$

Therefore  $F_0 = (C_z * f * h) / V_z$

$$F_0 = 25.70$$

$$L_h = 100 * (h/10)0.25$$

$$L_h = 203.56 \text{ m}$$

From page no: 37,

$$g_r = \sqrt{2 \log(3600 F_0)}$$

$$g_r = 2.54$$

$$(C_z * h) / L_h = (20.11 * 171.71) / 203.56 = 16.96$$

$$(F_0 * L_h) / V_b = (0.48 * 203.56) / 64.5 = 1.51$$

$$\beta = \frac{1}{1 + \sqrt{\frac{0.26(h-s)^2 + 0.46 * b^2 * s * h}{L_h}}}$$

$$S = \frac{1}{\left[1 + \frac{35 F_0 * h}{V_b}\right] * \left[1 + \frac{4 F_0 * b}{V_b}\right]}$$

$$= \frac{1}{\left[1 + \frac{35 * 0.48 * 171.71}{64.5}\right] * \left[1 + \frac{4 * 1.48 * 20.11}{64.5}\right]}$$

$$S = 0.01$$

$$\beta = 1.93$$

$$L_h = 85 * (h/10)^{0.25}$$

$$= 85 * (171.71/10)^{0.25}$$

$$L_h = 173.03$$

$$r = 0.34$$

$$\phi = (g_v * I_h * \sqrt{B_s}) / 2$$

$$= (3 * 0.34 * \sqrt{1.93}) / 2$$

$$\phi = 0.71$$

Calculation for  $I_h$

$$I = I_{z_1} + \frac{1}{7} [I_{z_4} - I_{z_1}]$$

$$I_{z_1} = 0.33$$

Therefore,  $I_{z_2} = I_{z_1} + \frac{1}{7} [I_{z_4} - I_{z_1}]$

$$I_{z_2} = 0.34 = r$$

$$E = \frac{\pi N}{(1 + 70.8 N^2)^{\frac{5}{6}}}$$

$$N = (F_0 L_h) / V_b$$

$$N = 1.29 \text{ Hz}$$

$$E = \frac{\pi * 1.29}{(1 + 70.8 * 1.29^2)^{\frac{5}{6}}}$$

$$E = 0.08$$

From Table 36,  $\beta = 0.020$

Therefore,

$$G = (1 + gf) * r * \sqrt{B(1 + \phi)^2 + \left(\frac{SE}{\beta}\right)}$$



$G = 3.05$

Similarly, for calculating storeywise wind forces using Gust Factor;

$G_f = C_f \cdot A_e \cdot P_d \cdot G$

For Example, let us consider storey no. 50,

$G_{50} = 126.73 \text{ KN}$

Similarly, for each floor these factors can be used to determine the respective floor loads as per IS 875-PART III.

## V. CONCLUSION

1. It is observed that the displacements value decreases with the provision of shear wall as compared to provision of bracings & core wall
2. It is seen that the drift values differ as the structure model is changed by adding or positioning of SW & CW.
3. The values of base shear is constant in X axis and Y axis respectively.
4. It is seen that the overturning moment is constant in Y-dir and varies in X-dir with different configurations.
5. The variation in time period is considerably less with respect to configuration governing in X-direction as compared to Y-direction.
6. The Gust Factor approach is an extremely time consuming procedure as compared for manual calculation of floor loads respectively as it involves too many equations and needs to be solved very carefully.

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