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Study The Behaviour Of Multistorey Building With Different Aspect Ratio And Using Non Structuctural Element Against Earthquake

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Abstract:

There are different types of analyses to treat the seismic forces on a structure. Most codes specify both static and dynamic analyses, with the choice based on a number of considerations such as the importance factor of the structure, its height, the effect of soil and the seismic hazard at the location based on past events. Dynamic analysis shall be performed to obtain the design seismic force, and its distribution to different levels along the height of the building and to the various lateral load resisting elements, for the regular and irregular building. To study the different parameters of the buildings such as base shear, displacement, time period and aspect ratio of the building by using finite element method and manually.To check the behavior of the building for considering non-structural elements such as [sign board, ceiling, Architectural elements, Mechanical and Electrical equipment's and compare the results .

***Key Words*:** *. IS-1893, Steel structure, Non-structural element, Staad-pro.*

I. INTRODUCTION

To perform well in an earthquake, a building should possess four main attributes, namely simple and regular configuration, and adequate lateral strength, stiffness and ductility. Buildings having simple regular geometry and uniformly distributed mass and stiffness in plan as well as in elevation, suffer much less damage than buildings with irregular configurations. Building configuration refers to the indicators of shape and dimensions of a building as a unity, resulting from the project solution and related to the geometric proportion of the building contours. In a wider sense, the configuration includes the type, dimensions and position of structural elements, also emphasizing the significance of structural properties of a building. Dynamic analysis shall be performed to obtain the design seismic force, and its distribution to different levels along the height of the building and to the various lateral load are not considered to be part of either the primary or secondary structural systems. It is not a part of a structure not relating to, affecting, or contributing to the structure of something free-standing panels. Examples of non-structural elements include components such as mechanical and electrical plant, ducting, pipework, cable trays, suspended ceilings, light non-load bearing partitions, and cladding systems such as brick veneer.

II. PRELIMINARY DATA CONSIDERED FOR THE ANALYSIS:

a) Material Properties:

Concrete Properties: Grade: M30
Site location: Delhi in Seismic Zone – Iv
Plan Dimension = 30.36X17.15 m

No. of Story = G+18, 30
Height of Each Story = 3.0m
Inner and outer Wall thickness = 0.15 m
Slab Thickness= 125 mm
Frame Type = OMRF
Soil Type =2
Grade of steel: fy500
Columns Details

	G+18	G+30
300x750	Foundation to 6th floor	Foundation to 10th floor
300x600	7th floor to 14th floor	11th floor to 20th floor
300x530	15th floor to 30th floor	21th floor to 30th floor

Beams Details

	G+18	G+30
300x750	Foundation to 6th floor	Foundation to 10th floor
300x600	7th floor to 14th floor	11th floor to 20th floor
300x530	15th floor to 30th floor	21th floor to 30th floor

b) The basic parameters considered for the Analysis and design

Live load in floor area	:4 kN/sq m
Dead	: 10.5 kn/m2-
Floor finish load	: 1.5 kN/sq
Stair case loading	:3 kN/sq m

c) Earthquake parameters considered
Z: IV (DELHI)
Soil typ : Medium soil
Zone factor : 0.36
Static Time : Based on IS 1893
Importance factor : 1.5

Following fig shows the non-structural element resting on the roof of the building as[4 sign board] by using point load in the Staad pro model .

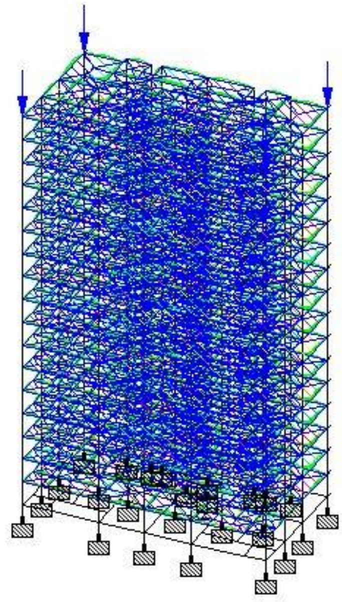


Fig.01 G+18 storey structure

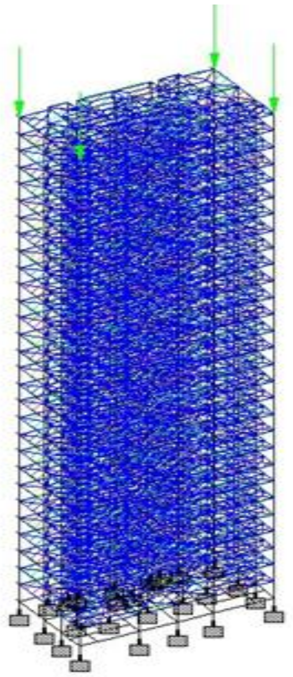


Fig.02 G+30storey structure

Following fig shows the plan shows the Loading plan view of nonstructural element resting on the different floor of the building as [mechanical or electrical equipment] by using area load in the Staad pro model .

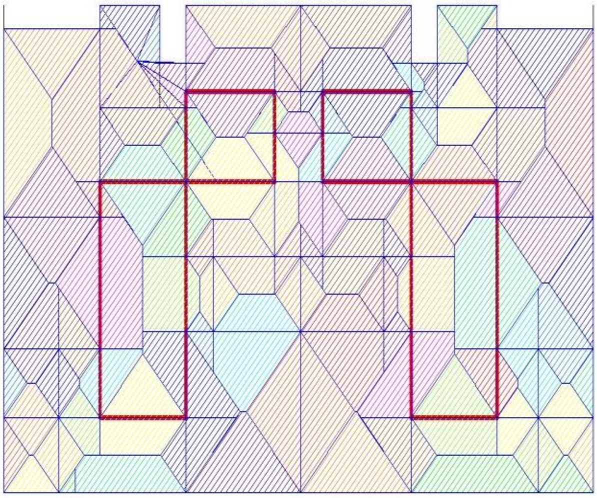
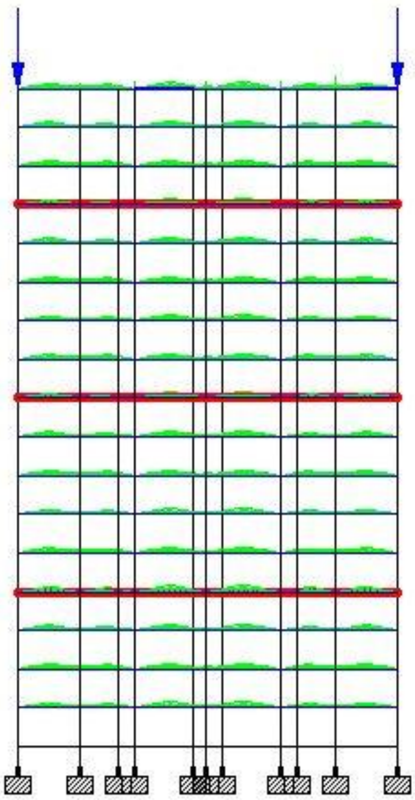


Fig.03 Floor plan of nonstructural element resting



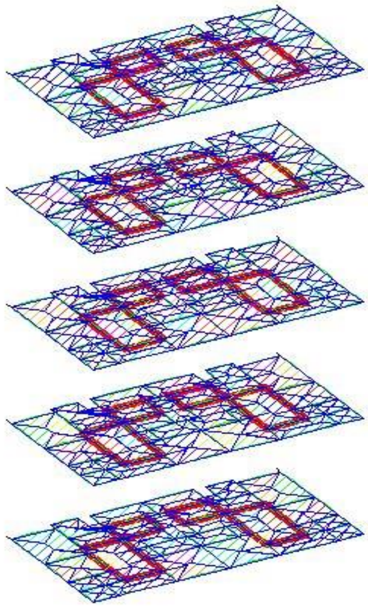


Fig.03 Nonstructural element resting on different floors

Problem Formulation

a) **Details of the pole.**

Size of hoarding	3mx6m
Height of Unipole	6m
Type of structure	Steel Structure

Hoarding board

Size of board: 3mx6m

- Section used : 0.05m x0.05m pipe (for bracing)
- Signage: Signage is hanged on 0.038m x 0.05m pipe covered with ACP panels.
- Connection: Welded Connection is used in frame.
- Column: Steel Column of diameter 0.35m is provided to support the frame of hoarding.
- Base Plate: Size of base plate is 0.60m x 0.60 m Thickness of base plate is 12mm and 32mm diameter bolt are used for connection of column and base plate.

b) Wind calculation

- Preliminary data:

Wind Load: As per IS 875 Part 3 (2015)
Risk Coefficient (k1): 1
Terrain or Height Factor (k2): 0.91

Topography Factor (k3): 1
Basic wind Speed (Vb): 47m/s (Delhi)
Design Wind Speed (Vz): Vb x k1 x k2 x k3
Vz = 35.49 m/s (IS: 875 PT-3, Sec 5.3)

After considering the above wind load data the structure is analyzed using staad pro software.
Area of Hoarding: 3x6m
(Design wind pressure) X (Area of hoarding)
= 0.755 x (3x6) =13.59Kn
Dividing this load and applying on node points
= 13.59/32= 0.424 Kn
Applying UDL at the plate (Width of plate=0.1m)
= 0.755x0.1=0.0755 Kn/m
Applying this load in Staad-pro Software.

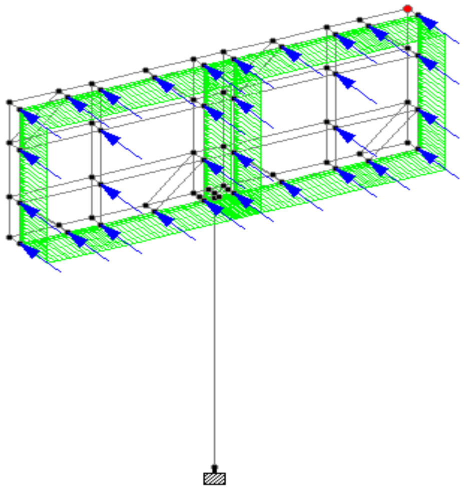


Fig:04 Staad Pro Model of Unipole after applying point load of 0.424Kn

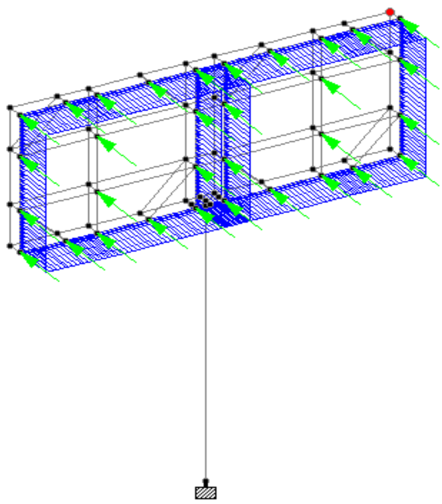


Fig:05 Staad Pro Model of Unipole after applying point load of 0.0755 Kn/m

RESULTS AND DISCUSSION

The analysis of high rise with consideration of non-structural elements for different aspect ratio under earthquake with the help of IS-1893, codal provisions in the terms of model time period ,mass participation, base shear, node displacement, beam displacement and Peak story shear as shown in the graphical representation of the results is shown below.

a) Modal Time Period-

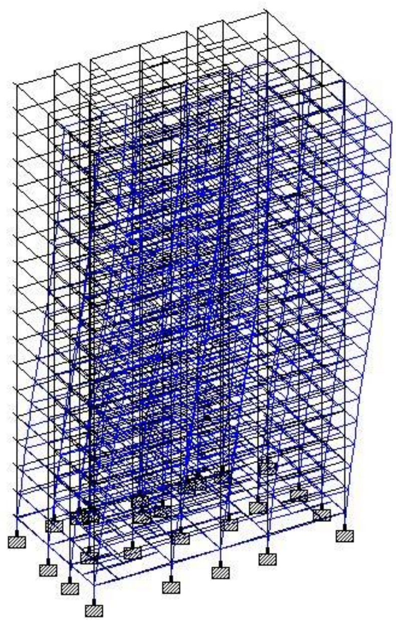


Fig. 06 Modal Time Period in 3-D view

Table 01 - Modal Time Period for Different Mode

Mode	Without structural elements		With structural elements	
	G+18 AR<5	G+30 AR>5	G+18 AR<5	G+30 AR>5
1	3.27837	6.2	3.27794	6.2
2	2.60440	4.943	2.60402	4.943
3	2.26793	4.329	2.26742	4.329
4	1.16513	2.097	1.16419	2.097
5	0.9509	1.697	0.9500	1.697
6	0.8054	1.471	0.80452	1.471

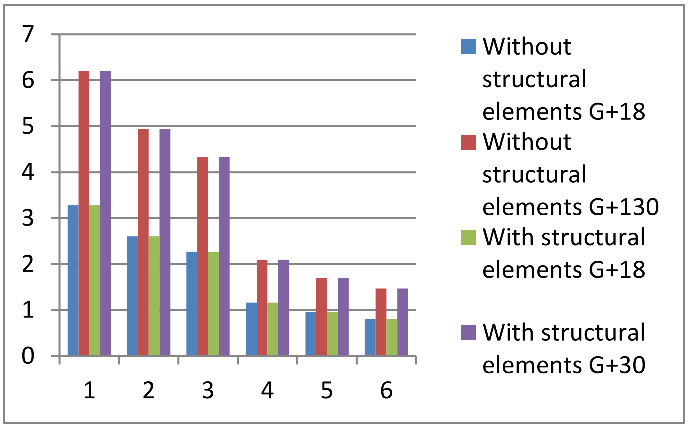


Fig. 07 Modal Time Period For Varying Aspect Ratio

b) Mass Participation in Z

Table 02 - Mass Participation in Z for Different Mode

Mode	Without structural elements		With structural elements	
	G+18 AR<5	G+30 AR>5	G+18 AR<5	G+30 AR>5
1	72.594	70.688	72.594	70.688
2	0.026	0.008	0.0262	0.0089
3	0.015	0.019	0.015	0.019
4	12.61	13.828	12.615	13.829
5	0.011	0.005	0.0115	0.055
6	0.002	0.003	0.0025	0.0035

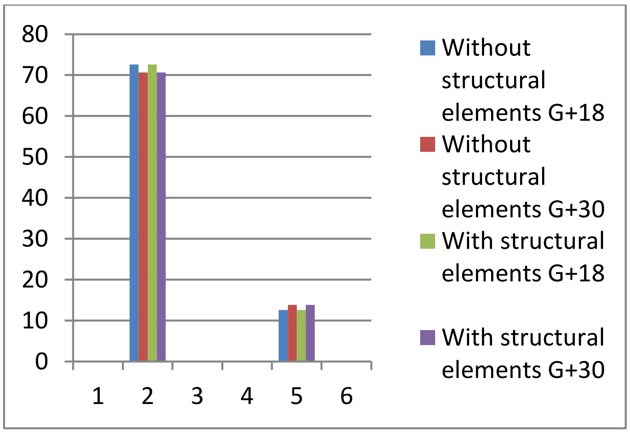
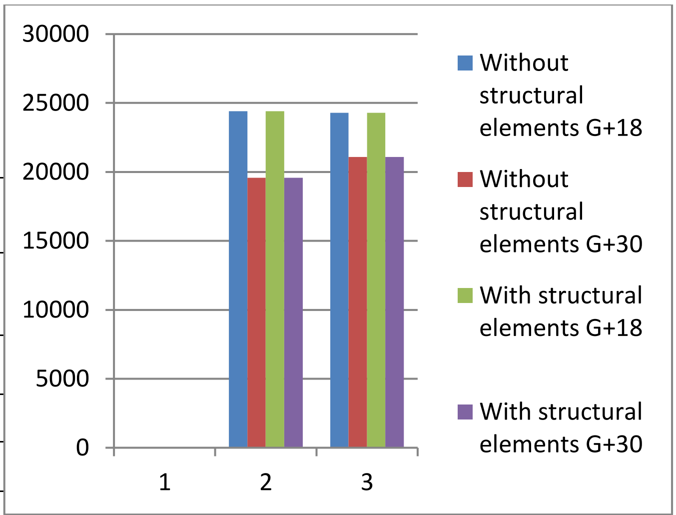


Fig. 08 Modal Time Period For Varying Aspect Ratio

c) Base Shear

Table 03 - Base Shear in X and Y

Mode	Without structural elements		With structural elements	
	G+18 AR<5	G+30 AR>5	G+18 AR<5	G+30 AR>5
1	24412	19586	24412.90	19586.83
2	24300	21092	24300.25	21092.22



d) Peak story Shear

Table 04(a)- Peak story shear for G+18 AR<5

Mode	Without structural elements		With structural elements	
	G+18 AR<5	G+30 AR>5	G+18 AR<5	G+30 AR>5
18	3641.67	3145.75	3641.67	3145.75
17	7028.39	6183.83	7028.39	6183.83
16	9838.95	8851.76	9838.95	8851.76
15	11960.6	11049.19	11960.6	11049.19
14	13391.7	12741.79	13391.7	12741.79
13	14332.1	14058.07	14332.1	14058.07
12	15008.2	15083.40	15008.2	15083.40
11	15622.9	15936.82	15622.9	15936.82
10	16357.4	16750.61	16357.4	16750.61
9	17309.7	17629.79	17309.7	17629.79
8	18461.3	18618.85	18461.3	18618.85
7	19699.5	19689.90	19699.5	19689.90
6	21018.0	20886.27	21018.0	20886.27

5	22250.3	22057.96	22250.3	22057.96
4	23269.1	23073.77	23269.1	23073.77
3	23985.9	23827.37	23985.9	23827.37
2	24335.0	24242.44	24335.0	24242.44
1	24412.9	24300.99	24412.9	24300.99

Table 04(a)- Peak story shear for G+18 AR<5

	Without structural elements		With structural elements	
	G+18 AR<5	G+30 AR>5	G+18 AR<5	G+30 AR>5
30	1704.99	1720.04	1704.99	1720.04
29	3391.96	3438.31	3391.96	3438.31
28	4968.15	5061.69	4968.15	5061.69
27	6408.90	6565.92	6408.90	6565.92
26	7695.41	7931.36	7695.41	7931.36
25	8815.21	9143.99	8815.21	9143.99
24	9763.77	10196.30	9763.77	10196.30
23	10545.1	11088.02	10545.1	11088.02
22	11172.3	11826.52	11172.3	11826.52
21	11667.2	12426.93	11667.2	12426.93
20	12059.5	12911.77	12059.5	12911.77
19	12385.0	13309.83	12385.0	13309.83
18	12682.0	13654.22	12682.0	13654.22
17	12988.6	13797.53	12988.6	13797.53
16	13334.4	14695.80	13334.4	14695.80
15	13739.3	15129.18	13739.3	15129.18
14	14209.8	15650.62	14209.8	15650.62
13	14676.7	16243.41	14676.7	16243.41
12	15385.0	16886.17	15385.0	16886.17
11	16032.3	17552.46	16032.3	17552.46
10	16678.4	18212.02	16678.4	18212.02
9	17291.6	18832.84	17291.6	18832.84
8	17842.9	19389.21	17842.9	19389.21
7	18309.4	19909.46	18309.4	19909.46
6	18722.8	19806.45	18722.8	19806.45
5	19062.7	20354.13	19062.7	20354.13
4	19319.6	20703.69	19319.6	20703.69
3	19489.6	20946.44	19489.6	20946.44
2	19573.9	21075.01	19573.9	21075.01
1	19586.9	21092.88	19586.9	21092.88
BASE	19586.9	21092.88	19586.9	21092.88

3. CONCLUSIONS

Following are the conclusion we have obtained from above analysis results are: -

1. Time period
   When comparing aspect ratio less than 5 building with the aspect ratio greater than 5 building the model time period is less in ratio less than 5 building and more in aspect ratio greater than 5 building.

2. Mass Participation in Z
   Mass Participation in Z direction is more in building having aspect ratio less than 5 and less in building having aspect ratio greater than 5.

3. Base shear
   In case of comparing aspect ratio less than 5 with aspect ratio greater than 5 building base shear the base shear values for X, Z are more in case of aspect ratio less than 5 building and less in case of aspect ratio greater than 5 building .

4. Node Displacement
   In case of comparing aspect ratio less than 5 building with aspect ratio greater than 5 building Node Displacement values for X, Y and Z direction are less in case of aspect ratio less than 5 building and more in case of aspect ratio greater than 5 building.

5. Beam Displacement
   In case of comparing aspect ratio less than 5 building with aspect ratio greater than 5 building Beam Displacement values for X, Y and Z direction are more in case of aspect ratio less than 5 building and less in case of aspect ratio greater than 5 building.

6. Effect of nonstructural Elements
   It also necessary to analyses the structure with consideration of nonstructural Elements due to that the additional load is acting on structure and we can get better behavior of the building.

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