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Lateral load comparison of G+12 storied steel structure in ETABS-2016

Rajai Jayesh[1], Dr. Sanghvi Chaitanya[2]

[1]Post graduate student, applied mechanics department, L.D. College of engineering, Ahmedabad, 380015, India
[2]Professor, applied mechanics department, L.D. College of engineering, Ahmedabad 380015, India

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Abstract - *In India use of steel structure is very rare specially for residential and commercial purpose which covers most of construction work. For fast construction work initiative for use of steel structure on large scale is very much essential. Also it reduces the construction time, and time is money now a days, ultimately steel structure proves time saving and economic. By keep in mind that steel structure is future of construction in India, publishing this paper and shows the comparison of lateral load of G+12 storied steel structure building with different slab dimension of 3mX3m, 4mX4m and 6mX6m in ETABS-2016. Seismic loads and wind loads are applied on building as a lateral loads.*

Key Words: Steel structure, Seismic load, Wind load, ETABS-2016.

1. INTRODUCTION

Steel structure is very fast construction type compare to RCC construction type. Also steel structure saves the construction time compare to RCC structure. To understand the behaviour of steel structure, analyzed the G+12 storied steel structure building in ETABS-2016 and understand the effect of lateral loading. For comparison of lateral loading 3 building with different slab dimensions are taken for analysis i.e. 3mX3m, 4mX4m and 6mX6m with 7 grids in X-direction and 5 grids in Y-direction, so final plan dimension of building will 18mX12m, 24mX16m and 36mX24m respectively. Seismic load applied as per IS 1893-part(1)-2001 and wind load is applied as per IS 875-part(3)- 1987.

Geometry and analysis data of building.

Location	: Ahmedabad
SBC	: 240 kN/m^2
Grade of steel	: 250 MPa
Grade of concrete	: 20 MPa
Grade of reinforcement	: 415 MPa
Importance factor (I)	: 1
Response reduction factor (R)	: 5
Zone factor	: Zone 3 (0.16)
Soil type	: Medium
Wind speed	: 39 m/sec
Category of building	: 3
Class of building	: Class B
Live load	: 2 kN/m^2
Floor finish	: 1 kN/m^2
Wall thickness	: 115 mm
Pre cast slab thickness	: 100 mm

Slab panel size	3mX3m	4mX4m	6mX6m
Dimension of building	18mX12m	24mX16m	36mX24m
Size of precast panel	1mX3m	1.33mX4m	2mX6m

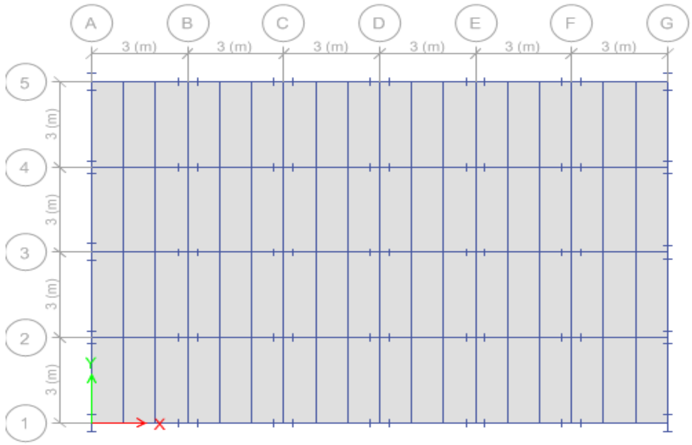

Fig 1- Typical Plan of G+12 storied building

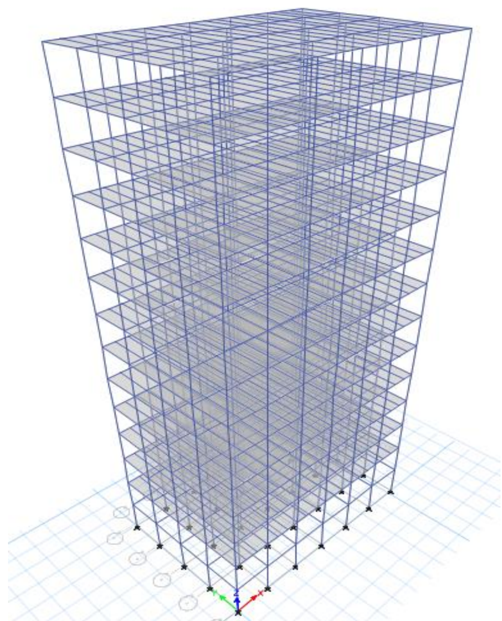

Fig 2- 3D view of G+12 storied building in ETABS-2016

2. Analysis G+12 storied building in ETABS-2016

Analysis the building based on data given above and assigning of member property done by auto select mode, in this mode of auto select in ETABS-2016 automatic member property is assigned to the member. After then run the program gives the actual moment and shear force on the member according to its property, if we design the building in ETABS-2016, we get final size of member and that sizes are obtained as below. Response spectrum analysis is considered for seismic loading.

Load combinations are applied to the structure are as follows.

DL = Dead Load
LL = Live Load
EQX = Earthquake Load in X-direction
EQY = Earthquake Load in Y-direction
WX = Wind Load in X-direction
WY = Wind Load in Y-direction

1) 1.5(D.L+L.L)
2) 1.2(D.L+L.L+EQX)
3) 1.2(D.L+L.L-EQX)
4) 1.5(D.L+EQX)
5) 1.5(D.L-EQX)
6) 1.2(D.L+L.L+EQY)
7) 1.2(D.L+L.L-EQY)
8) 1.5(D.L+EQY)
9) 1.5(D.L-EQY)
10) 0.9D.L. + 1.5EQX
11) 0.9D.L. – 1.5EQX
12) 0.9DL + 1.5EQY
13) 0.9DL – 1.5EQY
14) (D.L+L.L)
15) (D.L+L.L+EQX)
16) (D.L+L.L - EQX)
17) (D.L+L.L+EQY)
18) (D.L+L.L - EQY)
19) (D.L+EQX)
20) (D.L-EQX)
21) (D.L+EQY)
22) (D.L-EQY)
23) 1.2(D.L+L.L+WX)
24) 1.2(D.L+L.L-WX)
25) 1.5(D.L+WX)
26) 1.5(D.L-WX)
27) 1.2(D.L+L.L+WY)
28) 1.2(D.L+L.L-WY)
29) 1.5(D.L+WY)
30) 1.5(D.L-WY)
31) 0.9D.L. + 1.5WX
32) 0.9D.L. – 1.5WX
33) 0.9DL + 1.5WY
34) 0.9DL – 1.5WY
35) (D.L+L.L+WX)
36) (D.L+L.L - WX)
37) (D.L+L.L+WY)
38) (D.L+L.L - WY)
39) (D.L+WX)
40) (D.L-WX)
41) (D.L+WY)
42) (D.L-WY)

Mass source is applied as DL+0.25LL to the building.

Slab panel size	3mX3m	4mX4m	6mX6m
Main beam size	ISLB 225	ISLB 300	ISMB 350
Secondary beam size	ISLB 125	ISLB 225	ISMB 350
Column size	ISWB 500	ISWB 550	ISWB 600

3. Lateral load calculation

1) Seismic load calculation

Horizontal seismic coefficient A_h= (Z/2) * (I/R) * (Sa/g)

Values of Z, I and R are already given above, now for value of (Sa/G), So from IS 1893-part(1)-2001 time period of building and (Sa/g) in X and Y direction given below.

Now base shear V_b= A_h* W, where W= total weight of building (kN).

<table>
<tr><td colspan="2">Dimension of building</td><td colspan="2">18mX12m</td><td colspan="2">24mX16m</td><td colspan="2">36mX24m</td></tr>
<tr><td rowspan="2">Time period (sec.)</td><td>X-dir.</td><td colspan="2">0.827</td><td colspan="2">0.716</td><td colspan="2">0.585</td></tr>
<tr><td>Y-dir</td><td colspan="2">1.013</td><td colspan="2">0.878</td><td colspan="2">0.716</td></tr>
<tr><td rowspan="2">Sa/g</td><td>X-dir.</td><td colspan="2">1.644</td><td colspan="2">1.898</td><td colspan="2">2.325</td></tr>
<tr><td>Y-dir</td><td colspan="2">1.342</td><td colspan="2">1.644</td><td colspan="2">1.898</td></tr>
<tr><td rowspan="2">A_h</td><td>X-dir.</td><td colspan="2">0.026</td><td colspan="2">0.03</td><td colspan="2">0.37</td></tr>
<tr><td>Y-dir</td><td colspan="2">0.021</td><td colspan="2">0.025</td><td colspan="2">0.03</td></tr>
<tr><td colspan="2">W (kN)</td><td colspan="2">8206</td><td colspan="2">12168</td><td colspan="2">20569</td></tr>
<tr><td rowspan="3">V_b (kN)</td><td>Mode</td><td>ET ABS</td><td>Manu al</td><td>ET ABS</td><td>Manu al</td><td>ET ABS</td><td>Manu al</td></tr>
<tr><td>X-dir.</td><td>208 .9</td><td>215.8</td><td>322 .75</td><td>344.5</td><td>696 .1</td><td>735.8</td></tr>
<tr><td>Y-dir</td><td>161 .6</td><td>176.2</td><td>303 .62</td><td>315.7</td><td>564 .2</td><td>594.3</td></tr>
</table>

2) Wind load calculation.

Design Wind Speed V_z= V_b* k_1*k_2*k_3, (IS 875-part (3)-1987)

Where
V_b= Basic wind speed=39 m/sec for Ahmedabad
k_1= Risk coefficient factor=1

k_2= Terrine, height and size factor =1.057
k_3= Topography factor = 1

Consider 5-20% permeability so internal pressure coefficient cpi = +0.5 and -0.5 (cl 6.2.3.2,IS 875-part-(3))
External pressure coefficient cpe = 0.8 (table 4, 875-part (3)-1987)

So
V_b= 39*1*1.057*1= 41.223 m/sec
And wind pressure P_z =0.6*V_b^2
=0.6*41.223^2 =1019.6 N/m^2

Wind force P = (cpe + cpi) * A * P_z

Where A = surface area of structural element. Hence below given table shows the manual and ETABS Wind force comparison.

Dimension of building		18mX12m		24mX16m		36mX24m	
P (kN)	Mode	ETABS	Manual	ETABS	Manual	ETABS	Manual
	X-dir.	617.4	620.3	823.6	827.1	1234.8	1240.6
	Y-dir	926.1	930.5	1234.1	1240.6	1852.2	1860.9

4. CONCLUSIONS

In multi-storey RCC structure governing loads are generally Seismic, but here in case of steel structure wind load is governing factor. In most of case 1.5(DL+WY) is a governing load combination. As building dimension increases member property assigned to the building by auto select mode is going to higher. Lateral load values of seismic and wind loads are increase with increase the building dimensions. Time period reduces with increase the building dimensions. In both lateral load cases seismic and wind manual calculations and ETABS-2016 results are almost near to each other with maximum variation of 5%.

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