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ANALYSIS OF LATERAL LOAD ON DIFFERENT ORIENTATION OF SHEAR WALL

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ABSTRACT:

This study describes mathematical study and relation between wind and earthquake and its effects on building as a whole with respect of Lateral force and Storey shear for different orientation of shear wall. The Effect of Storey drift and storey displacement is also estimated in study. Earthquake Lateral force, Storey Shear, Storey Drift and Storey Displacement are analyzed for Seismic zone factor II.

KEYWORDS: Shearwall; E-TAB; Siesmic; Wind load; lateral loading, equivalent static load, gust Factor.

INTRODUCTION:

In present study, analysis of multi storey building in moderate zones II for earthquake and wind forces is carried out. The building is Residential Building having typical plan dimension is 19m×23.6m and number of floors are considered is from G+15 to G+31. The floor height is 3m for all storeys. The structure is subjected to self-weight, dead load, live load, wind load and seismic loads under the load case details of E-tab. The wind load values are generated by E-tab considering the given wind intensities at different heights and strictly abiding by the specifications of IS 875. Seismic load calculations were done following IS 1893-2002.

SCOPE OF WORK:

The scope of the present work includes the study of the Wind load and Earthquake load estimation on Tall buildings for the structural design purpose with the analytical approach as per IS 875: part 3-1987 and IS1893-2002 respectively. Maximum forces are determine for five different orientation shear wall model as analyzed and obtained the maximum values for lateral loads, story displacement, story drift and story shear. Analysis is carried out with different four zones of earthquake defined by code for lateral loads, shear, drift and displacement. Present work also includes analysis of G+15 storey building with normal beam, slab & column structure.

OBJECTIVES:

Following are the main objectives of the work..

1. To calculate seismic shear
2. To work out storey displacement and storey drift produces by lateral seismic load.
3. To carry out Story shear produces by wind load.
4. To find out gust factor for G+31 building.
5. To work out storey displacement and storey drift produces by wind load.
6. Comparison of the results obtained from wind load and earthquake load analysis.

LITERATURE REVIEW:

- **M R Suresh & Ananth Shayana Yadav S (2015)** They Developed a computer program to analyse the optimum location of shear wall in high rise R.C buildings under lateral loading. They also explain briefly the effect of to find the effective, efficient, and optimum location of shear walls in high rise irregular R.C building. They studied effect of wind and earthquake using the IS 1893(PART-1)-2002 and 875 [PART-I]-1987 on G+20 storey building.
- **Anjali Kulkarni and Vaishnavi Dabir (2016)** They presented comparative study of out to check the dynamic stability of a tall residential structure by applying variations symmetric arrangement of the shear wall. They have analyzed a multi storied building for earthquake in various zones based on IS 1893 and for wind IS 875 is used. The wind loads so obtained on the building have been compared with that of earthquake. Finally they found the shear wall located at the center of building is more effective as compared to other location of shear.
- **Dr. Suchita Hirde and Vinay Magadum (2016)** They have made an attempt to analyses multi storey building situated in wind zone VI compared their performance to the buildings situated in seismic zone V of India so as to study the severity

of wind forces against seismic forces. And they compared effect of earthquake forces with effect of wind forces on performance of multi-storey building situated in Seismic zone V and wind zone VI. According to them,

i. Base shear, story drift and storey displacement is more in case of earthquake analysis for G+5 and G+10 buildings where as for G+15 and G+20 buildings it is more in case of wind analysis.

ii. Earthquake is less effective than wind effect for tall buildings since tall buildings are more flexible and for short buildings earthquake is found to be more.

METHODOLOGY:

The present study deals with analysis of lateral forces and its comparison for G+15, G+31 building. Application example for building with different heights, floor weights for both winds & Earthquakes such as intensity of wind pressure, gust factor (G), seismic zone coefficient (Z), the importance factor (I), Response reduction factor (R) and Structural response factor (Sa/g) are analyzed and discussed for the purpose of comparison by using IS 456:2000, IS 1893:2002 & IS 875:1987 (part3).

BUILDING PARAMETERS:

Table 1 – Structural Arrangement for G+15

Sr. No.	Structural Element	
	Type of element	Size
1	Building Size	19m×23.6m
2	Beam size	0.23x0.5m
3	Column size	0.3x0.6m
4	Slab thickness	0.15m
5	Wall thickness	0.23m
6	Building height	45m
7	Shearwall thickness	0.25m

Table 2 – Structural Arrangement for G+31

Sr. No.	Structural Element	
	Type of element	Size
1	Building Size	19m×23.6m
2	Beam size	0.23x0.5m
3	Column size	0.3x1.2m
4	Slab thickness	0.15m
5	Wall thickness	0.23m
6	Building height	93m
7	Shearwall thickness	0.4m

FLOOR PLAN OF BUILDING:

Fig1. Floor Plan of Bare Frame Building

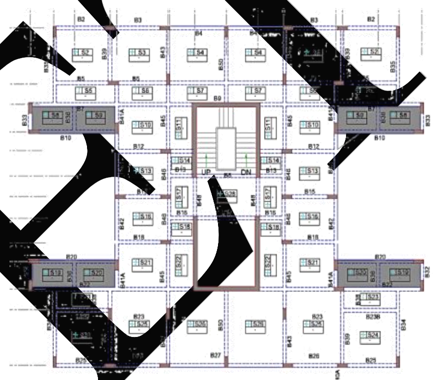

Fig2. Floor Plan of Inner Core Shearwall Building

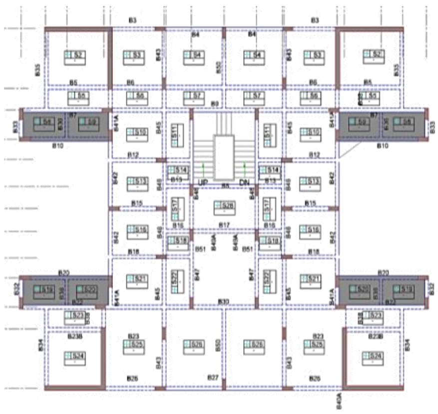

Fig3. Floor Plan of L-Shape Shearwall Building

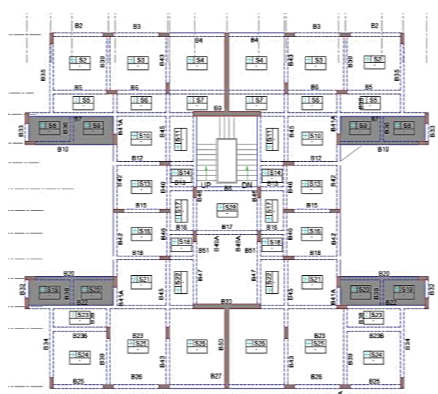

Fig4. Floor Plan of T-Shape Shearwall Building

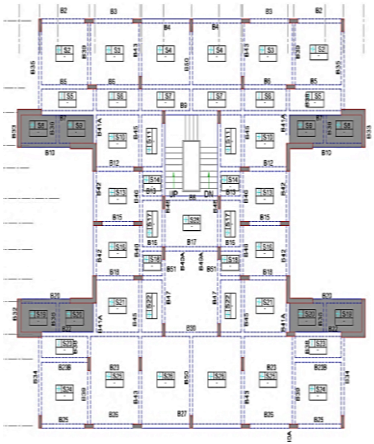

Fig5. Floor Plan of L-Shape outside Shearwall Building

Calculation of lumped masses to various floors:

Roof Weight = 3383.305 KN

Typical floor weight =6931.06 KN

Total Seismic Weight of Structure

$W= \sum wi = 3383.305 + 6931.06x14= 100418.15$ KN

Fundamental Period

T = 0.09h / d

= 0.09(45) / 23.6

= 0.8336 sec

Z=0.1

The building is located on Type II Sa/g =1.63

Ah = (Z/2)(I/R)(Sa/g) = 0.0272

(Clause 6.4.2 of IS: 1893 Part 1)

Design base shear

VB= Ah x W

= 0.0272x 149392

= 2731.38 KN

Tab 3- EQ Lateral Force for G+15

Story	W_i	H_i	$W_i H_i^2 x10^5$	$W_i H_i^2 x10^5 / \sum W_i H_i^2$	Force	Story Shear
T	3383.305	45	68.51193	0.098	266.7	266.7
14	6931.06	42	122.2639	0.174	475.94	742.63
13	6931.06	39	105.4214	0.150	410.38	1153.01
12	6931.06	36	89.82654	0.128	349.67	1502.68
11	6931.06	33	75.47924	0.108	293.82	1796.5
10	6931.06	30	62.37954	0.089	242.83	2039.32
9	6931.06	27	50.52	0.072	196.69	2236.01
7	6931.06	24	39.92291	0.057	155.41	2391.424
8	6931.06	21	30.56597	0.044	118.98	2510.408
6	6931.06	18	22.45663	0.032	87.417	2597.826
5	6931.06	15	15.59489	0.022	60.706	2658.532
4	6931.06	12	9.980726	0.014	38.852	2697.384
3	6931.06	9	5.614159	0.008	21.854	2719.239
2	6931.06	6	2.495182	0.004	9.713	2728.952
1	6931.06		0.623795	0.001	2.4283	2731.38

WIND DESIGN PARAMETERS:

Wind Data:

Basic Wind Speed Vb = 39 m/s

Terrain Category: Category 2

Design Factors

K1 = 1

k2 = varies with height

k3 = 1

Design Wind Speed (Vz) = Vb x k1 x k2 x k3

Design Wind Pressure Pz = 0.6 Vz^2

Wind Load Calculation

F = Ae x Pz x Cf

Effective Area Ae:

In X direction: 23.6 x 3 = 70.8 sq.m

In Y direction: 19 x 3 = 57 sq.m

Along X direction,

a/b = 23.6/19 = 1.24

h/b = 45/19 = 2.37

Along Y direction,

a/b = 19/23.6 = 0.805

h/b = 45/23.6 = 1.906

Cf for these values from fig 4 = 1.3

H	K_2	Vz (m/s)	Pz (KN/m²)	CFx	Cfy	Ae.x (m²)	Ae.y (m²)	Fx (KN)	Fy (KN)
3	0.98	38.22	0.876	1.15	1.15	70.8	57	71.361	57.452
6	0.98	38.22	0.876	1.15	1.15	70.8	57	71.361	57.452
9	0.98	38.22	0.876	1.15	1.15	70.8	57	71.361	57.452
12	0.996	38.84	0.905	1.15	1.15	70.8	57	73.711	59.343
15	1.02	39.78	0.949	1.15	1.15	70.8	57	77.306	62.238
18	1.038	40.48	0.983	1.18	1.18	70.8	57	82.147	66.135
21	1.055	41.15	1.016	1.2	1.2	70.8	57	86.298	69.477
24	1.07	41.73	1.045	1.22	1.22	70.8	57	90.249	72.658
27	1.085	42.32	1.074	1.23	1.23	70.8	57	93.557	75.322
30	1.1	42.9	1.104	1.23	1.23	70.8	57	96.162	77.419
33	1.108	43.212	1.120	1.24	1.24	70.8	57	98.359	79.187
36	1.115	43.485	1.135	1.26	1.26	70.8	57	101.212	81.485
39	1.123	43.797	1.151	1.28	1.28	70.8	57	104.300	83.970
42	1.13	44.07	1.165	1.3	1.3	70.8	57	107.254	86.349
45	1.138	44.382	1.182	1.3	1.3	70.8	57	108.778	87.576

For G +31 Storey:

H=93 m, L=23.6 m, b = 19m

Ratio of height to least dimension = 92/37= 4.89

T = 0.09x93/√23.6 = 1.72 seconds

F = 1/1.72 = 0.58 Hz <1 Hz...........Dynamic Analysis is required.

Vb = 39 m/s

K1 = 1, k3 = 1

Vz = 39 x 1x 0.91x1 = 35.49 m/s

Computational of Gust Factor G =

$$G=1+g_f \cdot r\sqrt{B(1+\emptyset)^2+\frac{SE}{\beta}}$$

From fig 8: For ht 93 m

gf.r = 0.95; L (h) = 950 m

Cy = 10; Cz = 12

λ = Cyb/Cz.h = 10x19/12x93 = 0.17

Also, Cz.h/L(h) = 12x93/950 = 0.978

Background Turbulence Factor B = 0.65

Calculation of Reduced Frequency

F = Cz.F0.h / Vz

= 12x 0.58 x 93/ 35.49 = 18.24

Size reduction factor (s) from fig. is 0.03

The parameter,

$$\frac{f_o L(h)}{\bar{V}_h}$$

= 0.58x 950/ 35.49 = 35.5

The gust energy factor E from Fig 11 is 0.08

Computational of Gust Factor:

φ= 0 and β= 0.016

G= 2.27

Fz = Cf. Ac. Pz. G

RESULTS:

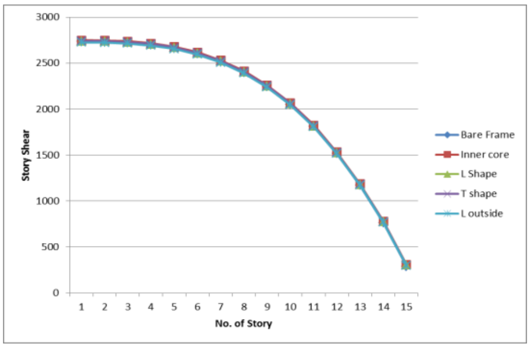

Fig.6 Story Shear due to EQfor G+15

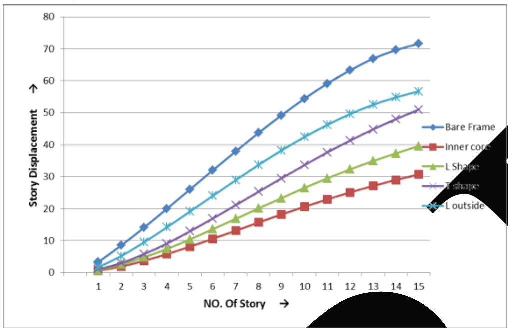

Fig.7 Displacement to EQ in direction X for G+15

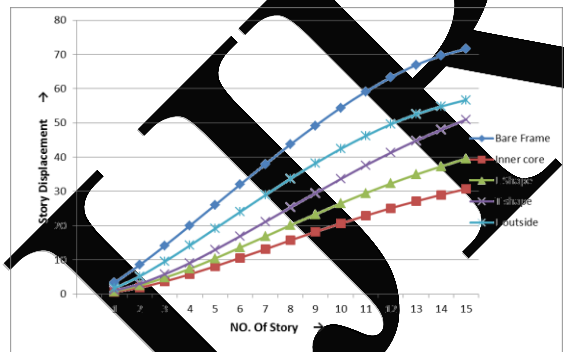

Fig.8 Displacement due to EQ in direction Y for G+15

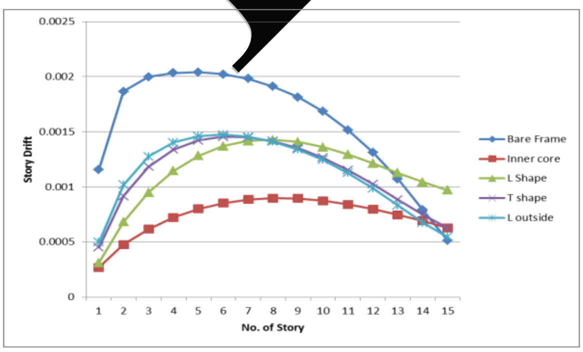

Fig.9 Drift due to EQ in direction X for G+15

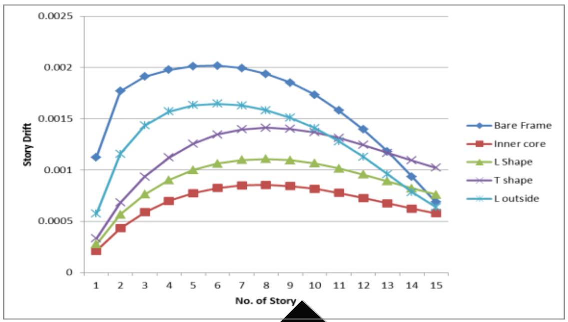

Fig.10 Drift due to EQ in direction Y for G+15

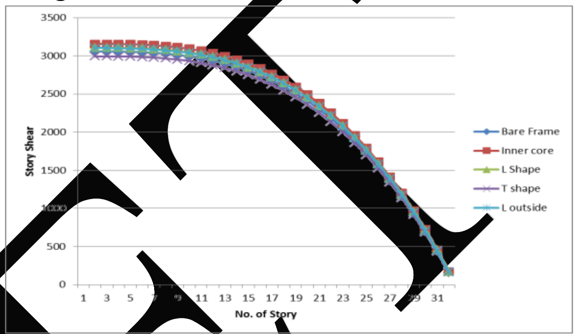

Fig.11 Story Shear due to EQfor G+31

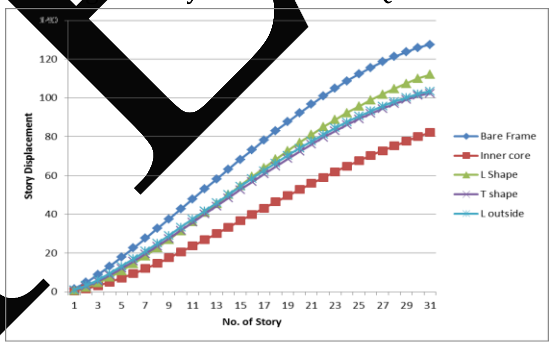

Fig.12 Displacement due to EQ in direction X for G+31

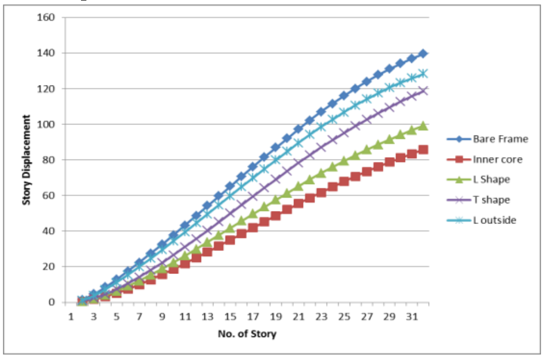

Fig.13 Displacement due to EQ in direction Y for G+31

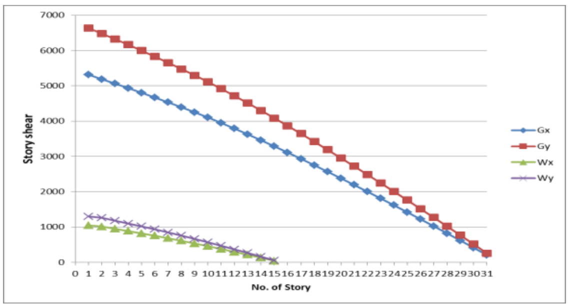

Fig.14 Story Shear due to Wind for G+15 & G+31

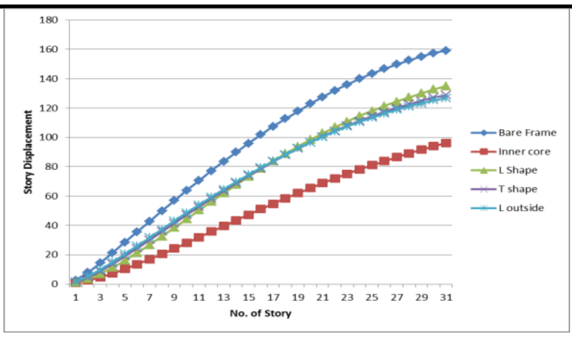

Fig.15 Displacement due to Wind in direction X for G+31

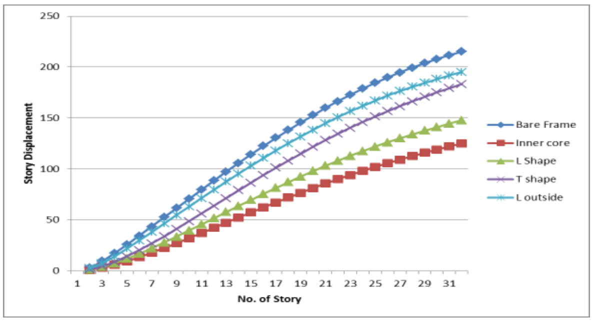

Fig.16 Displacement due to Wind in direction Y for G+31

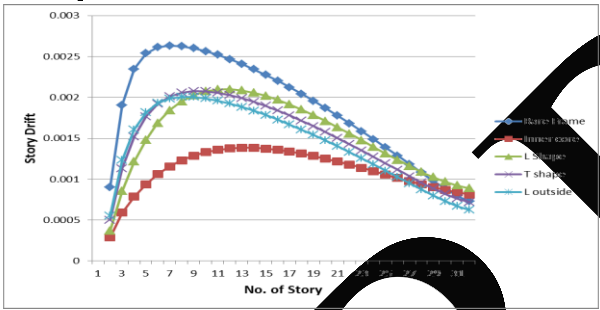

Fig.17 Drift due to Wind in direction X for G+31

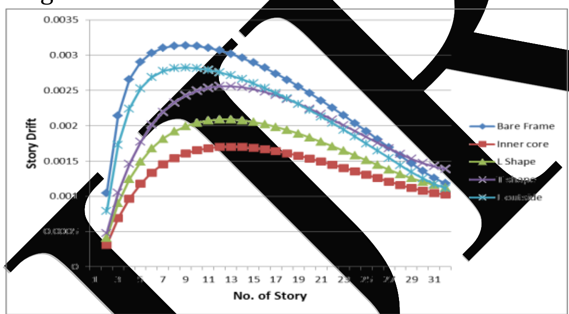

Fig.18 Drift due to Wind in direction Y for G+31

CONCLUSION:

1. From Fig.6 Story shear obtain in Inner core shear wall as compare to other structure is much higher. Story shear of Inner is 1.005, 1.004, 1.003, 1.010 times greater than Bare frame, L-shape, T-shape and L-outer side respectively.

2. From Fig 7 and 8 Displacement produce due to seismic load in x and y direction for bare frame is much greater than other structure which is 69.7mm and 71.6mm respectively in x and y direction. Displacement produces in inner core comparatively much less than any other structure which is 31.7mm and 30.7mm.

3. From Fig 9 and 10 Drift produce due to seismic load in x and y direction for bare frame is much greater than other structure at story4 and story6 which is 0.002035 & 0.002017 respectively in x and y direction. Drift produces in inner core comparatively much less than any other structure which is 31.7mm and 30.7mm.

4. In G+31 story building Story shear obtain in inner core shear wall are 1.033, 1.016, 1.055 and 1.018 times greater than Bare frame, L-shape, T-Shape and L-outside respectively

5. Displacement in G+31 due to seismic load obtain by bare frame is greater than other 1.55, 1.14, 1.25, 1.23 times greater than Inner core, L-shape, T- Shape, L-outside.

6. Story Shear produced by Seismic load in G+ 15 structures as compared to Wind load is 2.92 and 2.35 times greater so we can say that Governing lateral load will be seismic load.

7. In G+31 Wind load obtain due to gust factor is 5315.04 KN and 6636.82KN in X & Y Direction while seismic load obtain is 3056.92KN & 3056.90 KN IN X & Y Direction which is less than Wind load.

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