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Effect of Static and Dynamic Wind Forces on RC Tall Structures at different Height, in different Zones and in different Terrain Category using Gust Factor Method As Per Is: 875 (Part 3) 1987

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ABSTRACT:- The high-rise Structure construction has become a feasible solution to the issues related with the urban society. Very tall buildings are being built due to the recent advancements in construction technology and material science. However, the comfort of occupants and safety of built structures under the action of lateral forces such as earthquake and wind is of major concern in engineering. Due to the introduction of new development methods and improvement of modern and new materials, new type of structures which are regular and irregular in shape with high flexibility and light weight properties has emerged. These kinds of structures are highly susceptible to wind. Therefore it is necessary to develop tools to enable the designer to estimate the effects of wind with a high degree of confidence. In this project, irregular shape of RC structures are analyzed for static and dynamic wind load cases and the severity of wind load on the structure in various wind zones (like 33m/s, 55m/s) at different heights and in different terrain category are studied. ETABS 15 is being used for the modeling of RC bare frames and to analyze the structure.
This project focuses on the study of effect of wind response on different irregular shapes with gust response factor and without gust response factor method and also the variation of wind response factor for the irregular shaped RC structures in various wind zones and for different terrain category. In this present analysis, the variation of wind forces on particular RC bare frames at different wind zones, at different heights and also at different terrain category are shown. The effect of variation in terrain category is the major factor in this work because as the height increases the wind speed increases so the displacement increase as the storey height increases but as the terrain category varies from 1-4 the obstruction for the wind flow increases so the effect of wind force decreases on the particular High Rise Structure, when the wind load is applied in both X & Y-direction. The analysis has been done by considering Static and Dynamic wind load cases.

Keywords:- *Storey drift, Storey displacement, Static linear, Dynamic, Gust Response Factor, Wind load.*

I. INTRODUCTION

Movement of air with respect to the earth surface is known as wind. Earths' rotation and terrestrial radiation differences are the major causes of wind. The effects of the radiation are mainly accountable for either upward or downward convection. Generally at high wind speeds, the wind blows to the ground horizontally. Vertical components of atmospheric motion are comparatively small. Thus the term 'wind' almost exclusively means the horizontal wind. The capability of a structure to withstand enormous pressure of the wind depends on geography, nearness of other hindrances to the flow of air and also depends on the characteristics of the structure. The combined action of internal and external pressure acting on the structure as whole determines the effect of wind on it. In all cases, the computed wind load acts normally to the surface to which they apply. Combined and separate effects of wind loads and imposed loads on vertical Mean plus a fluctuating component constitutes Wind velocity. Gust will be created if the momentary deviation of the fluctuating component occurs from the mean value. Both of these components of wind velocity depends upon the approach terrain and varies with the height. The irregular shapes (U-SHAPE and L-SHAPE) RC 3-D bare frame structures are studied for static linear and dynamic wind load cases. Wind analysis has been conducted as per IS: 875(part 3)-1987. The FEM software package ETABS 15 has been used for the modeling and analysis of the RC bare frames. Storey drift, Storey displacement and their variations are analyzed for static linear and dynamic wind load cases.

II. DESIGN PROCEDURE

Design Wind Speed

Speed of the wind in the atmospheric boundary layer increases with increase in height from ground level to top level at a height called as the gradient height. The variation with height depends mainly on the terrain conditions. However, the speed of the wind at any height never remains constant. It has also been found easier to determine its instantaneous magnitude to an average value and a fluctuating component near this average value. Peak gust velocity remains constant over a short period of time, of about 3 seconds for basic wind speed and corresponds to mean heights in an open terrain above ground level. As mentioned in the code, our country is divided into six different regions. As far as the basic wind speed is concerned, the basic wind speeds in six regions are 33, 39, 44, 47, 50 and 55 m/s respectively. The basic wind speed shall be modified to include risk level, terrain roughness, height of the structure and local topography to get the design wind velocity, V_z given as:

$$\mathbf{V_z = V_b . K_1 . K_2 . K_3} \text{ (P.No 8 of IS: 875 (Part 3) - 1987)}$$

Where,
V_Z = Design wind speed at any height 'z' in m/s
V_b = Basic wind speed for different zones
K_1 = Probability factor (risk coefficient)
K_2 = Terrain roughness and height factor
K_3 = Topography factor

1) Risk coefficient (K_1):

The suggested life period to be assumed and the corresponding K_1 factor for different class of structures as per IS: 875 (Part 3)

2) Terrain and height factor (K_2):

Terrain categories shall be selected with due regard given to the effect of obstruction, which constitute the ground surface. The terrain category used in the design of structure varies depending on the direction of wind under consideration. Terrain in which a specific structure stands shall be considered as being one of the following terrain categories.

a) Category 1

Exposed open terrain with few or no obstructions in which the mean height of any object that surrounds the structure is less than 1.5 m. Open sea-coasts and flat treeless plains are included in this category.

b) Category 2

Open terrain having well scattered obstructions with heights usually between 1.5 to 10m. This is the criterion for measuring regional basic wind speeds and includes open parklands, airfields and undeveloped sparsely built outskirts of suburbs and towns. Open land adjacent to sea coast also comes under Category 2, because of the roughness of large sea waves at high wind speeds.

c) Category 3

Terrain with many closely spaced obstructions having the size of building structures this category includes well wooded areas and shrubs, towns and industrial areas full or partially developed.

d) Category 4

Terrain with plenty of large high closely spaced obstructions. This category includes large city centers, generally with obstructions above 25m and well developed industrial complexes.

3) Topography Factor (K_3):

The basic wind speed Vb, considers general level of site above the sea level. This does not allow for local topographic features such as valleys, hills, cliffs, ridges or escarpments, which can significantly affect wind speed in their vicinity. The effect of topography is to accelerate wind near the summits of hills or crests of cliffs, escarpments or ridges and decelerate the wind in valleys or near the foot of cliffs, steep escarpments or ridges.

The effect of topography is of significant importance at a site when the required slope is greater than about 3°, and below that, the value of K_3 may be taken as equal to 1.0. The value of K_3 is confined in the range of 1.0 to 1.36 for slopes greater than 3°.

Design Wind Pressure

The design wind pressure at any height above mean level can be obtained by the following relationship between wind pressure and wind velocity:

$$P_Z=0.6\ V_z^2$$

Where,
P_Z = Design wind pressure in N/m^2 at height 'z' m
V_Z = design wind velocity in m/s at height 'z' m

***Wind Load on Individual Members*: (IS: 875 (Part 3)**

$$F = (Cpe - Cpi)\ AP_Z$$

Where, Cpe = external pressure coefficient,
Cpi = internal pressure- coefficient,
A = surface area of structural or cladding unit and
P_Z = design wind pressure.

Table: 1 Parameters considered for the study

Number of Storey	20,30
Bottom Storey height	3m
Storey height	3m
Type of building use	Public buildings
Foundation type	Isolated footing
Soil type	Medium
Wind zone	I, VI
Shape of buildings	U-shape, L-shape
Material Properties	
Grade of concrete	M30
Young's modulus of concrete, Ec	$25.0*10^6$kN/m^2
Grade of steel	Fe 415
Density of reinforced concrete	25 kN/m^3
Poisson's Ratio of reinforced concrete	0.25
Member Properties	
Thickness of slab	0.125m
Beam size	0.45*0.75m
Column size	0.85*0.85m
Dead load (DL) intensities	
Floor finish on floors	1.5 kN/m^2
Floor finish on roof	2 kN/m^2
Live load (LL) intensities	
Live load on floors	3 kN/m^2
Live load on roof	2 kN/m^2

Linear Analysis
Bottom Storey height= 3m,
Each Storey height= 3m
The maximum dimension of the building is above 50m, hence it is classified in to "Class C", and Terrain Category 1-4 has been considered for the bare frame models, $k_{1=}1$ Slope below 3^0, k_3=1, Where k_2 value depends on the height of the building (Table 2 IS: 875(part 3)- 1987)).

III. GUST FACTOR

A gust factor is defined as the ratio between a peak gust and mean speed over a period of time. It can be used to examine the structure of the wind along with other statistics. The magnitude of fluctuating component of the wind speed, called gust, depends on the averaging time. Gust factors are heavily dependent on upstream terrain conditions (roughness), and are also affected by transitional flow regimes (specifically, changes in terrain and the distance from the upstream terrain change to the measuring device), Anemometer height, stability of the boundary layer, and potentially, the presence of deep convection.

Wind load calculation as per IS: 875 (part – 3) – 1987 with gust factor method for 20 floors in zone-1 (33 m/s)

Time Period Calculation:

h = 60m (height of structure)
dx = 40m (dx = plan dimension in X- direction)
dy = 40m (dy = plan dimension in Y-direction)
Tx = 0.09h / $\sqrt{d}$ …… **(From page – 48)**
Tx = 0.853 sec Ty = 0.853 sec

Constants and Parameters:

(1) Force coefficient for Clad Building

Along X- axis:
h/b = 60/40 = 1.5 > 1, a/b = 40/40 = 1, .’. C_f = 1.25 **(Fig – 4, page – 39)**
Along Y- axis:
h/a = 60/40 = 1.5 > 1, b/a = 40/40 = 1, .’. C_f = 1.25 **(Fig – 4, page – 39)**

(2) Peak Factor and Roughness Factor

G_f = peak factor defined as the ratio of the expected peak value to the root mean value of a fluctuating load.
r = roughness factor which depends on the size of the structure in relation to the ground roughness.
G_f r = 1.21 **(Fig – 8, page – 50)** for Category – 2 and building height – 60m

(3) Background Factor (B)

B = background factor indicating a measure of slowly varying component of fluctuating wind load **(From Fig 9, page – 50)**
λ = (C_y b) / (C_z h)

Along X Axis:
λ = 0.555 where, C_y = lateral correlation constant = 10 **(page 52)**
C_z = longitudinal correlation constant = 12 **(page 52)**
b = breadth of the structure normal to the wind stream
h = height of the structure
Along Y Axis: λ =0.555
L(h) = 1500, A measure of turbulence length scale **(Fig 8)** for height of 60 m
C_z h /L (h) = 0.48
Along X Axis: **Along Y Axis:**
B = 0.69 **(From Fig 9)** B= 0.69 **(From Fig 9)**

(4) Size Reduction Factor (S)

Reduced Frequency, F0= ($C_Z f_0$ h) / V_Z
F_{0X} = 843.84 / V_Z, f_0 = natural frequency of the structure in Hz = 1 / T = 1.172
Tx = 0.853; Ty = 0.853
Foy = 843.84 / V_Z , h = height of the structure
V_Z = hourly mean speed at height z

(5) Constant ϕ

Φ is accounted only for the buildings less than 75 m high in terrain category 4 and for the buildings less than 25 m high in terrain category 3 and is to be taken as zero in all other cases, Φ=0

(6) Gust energy factor (E)

From Fig 11 and depending on [f_0 L (h)] / V_Z
F_0 = natural frequency of the structure = 1 / T
Ex = 1758 / V_Z,
h = height of the structure
Ey = 1758/ V_Z, V_Z= hourly mean speed at height z

(7) – Damping coefficient

Damping coefficient (as a fraction of critical damping) of the structure – **Table 34** For R.C.C. β = 0.016 **page 52**

(8) Gust Factor – G

Gust factor = (peak load) / (mean load), and is given by
G = 1 + [G_f r [SQRT (B (1 + ϕ)^2 + (S E) / β)]] **(from page – 49)**

(9) Force along wind Load

Along wind load on the structure on a strip area Ae at any height z

$F_x = C_f A_e P_z G$ **(from page – 49)**

C_f = force coefficient for the building

A_e = effective frontal area considered for the structure at height z

P_z = design pressure at height z due to hourly mean wind obtained as 0.6 Vz^2 (N / m^2)

Table: 2 Wind load calculation with gust factor for 20 floors in Zone-I as per IS: 875 (part-3) - 1987

FLOOR	h (m)	hi (m)	h/2 (m)	k2	Vz (m/s)	Pz (kN/m²)	Fo	S	[fo L(h) / Vz]	E	G	Storey force (kN)
1	3	3	1.5	0.670	22.110	0.293	38.166	0.0100	79.512	0.0280	2.0178	88.775
2	3	6	1.5	0.670	22.110	0.293	38.166	0.0100	79.512	0.0280	2.0178	88.775
3	3	9	1.5	0.670	22.110	0.293	38.166	0.0100	79.512	0.0280	2.0178	88.775
4	3	12	1.5	0.690	22.770	0.311	37.059	0.0128	77.207	0.0289	2.0218	94.342
5	3	15	1.5	0.720	23.760	0.339	35.515	0.0135	73.990	0.0298	2.0233	102.798
6	3	18	1.5	0.739	24.387	0.357	34.602	0.0146	72.088	0.0306	2.0252	108.401
7	3	21	1.5	0.754	24.882	0.371	33.914	0.0154	70.653	0.0308	2.0265	112.919
8	3	24	1.5	0.766	25.278	0.383	33.382	0.0165	69.547	0.0314	2.0284	116.647
9	3	27	1.5	0.778	25.674	0.395	32.867	0.0175	68.474	0.0319	2.0302	120.441
10	3	30	1.5	0.790	26.070	0.408	32.368	0.0186	67.434	0.0325	2.0322	124.303
11	3	33	1.5	0.796	26.268	0.414	32.124	0.0196	66.926	0.0330	2.0341	126.321
12	3	36	1.5	0.806	26.598	0.424	31.726	0.0206	66.095	0.0336	2.0361	129.643
13	3	39	1.5	0.816	26.928	0.435	31.337	0.0217	65.285	0.0341	2.0382	133.014
14	3	42	1.5	0.825	27.225	0.445	30.995	0.0227	64.573	0.0347	2.0403	136.105
15	3	45	1.5	0.835	27.555	0.456	30.624	0.0237	63.800	0.0352	2.0425	139.572
16	3	48	1.5	0.844	27.852	0.465	30.297	0.0248	63.119	0.0358	2.0447	142.750
17	3	51	1.5	0.851	28.083	0.473	30.048	0.0258	62.600	0.0363	2.0469	145.287
18	3	54	1.5	0.876	28.908	0.501	29.191	0.0269	60.814	0.0369	2.0492	154.121
19	3	57	1.5	0.889	29.337	0.516	28.764	0.0279	59.924	0.0374	2.0515	158.910
20	1.5	58.5	0.75	0.901	29.733	0.530	28.381	0.0289	59.126	0.0380	2.0539	81.709

Table: 3 Wind load calculation with gust factor for 20 floors in Zone-VI as per IS: 875 (part-3) - 1987

FLOOR	h (m)	hi (m)	h/2 (m)	k2	Vz (m/s)	Pz (kN/m²)	Fo	S	[fo L(h) / Vz]	E	G	Storey force (kN)
1	3	3	1.5	0.670	36.850	0.815	22.899	0.0378	47.707	0.0405	2.0725	253.290
2	3	6	1.5	0.670	36.850	0.815	22.899	0.0378	47.707	0.0405	2.0725	253.290
3	3	9	1.5	0.670	36.850	0.815	22.899	0.0378	47.707	0.0405	2.0725	253.290
4	3	12	1.5	0.690	37.950	0.864	22.236	0.0381	46.324	0.0412	2.0742	268.852
5	3	15	1.5	0.720	39.600	0.941	21.309	0.0391	44.394	0.0415	2.0764	293.056
6	3	18	1.5	0.739	40.645	0.991	20.761	0.0399	43.253	0.0423	2.0792	309.138
7	3	21	1.5	0.754	41.470	1.032	20.348	0.0404	42.392	0.0426	2.0806	322.033
8	3	24	1.5	0.766	42.130	1.065	20.029	0.0409	41.728	0.0429	2.0820	332.592
9	3	27	1.5	0.778	42.790	1.099	19.720	0.0415	41.084	0.0435	2.0842	343.447
10	3	30	1.5	0.790	43.450	1.133	19.421	0.0417	40.460	0.0445	2.0863	354.485
11	3	33	1.5	0.796	43.780	1.150	19.275	0.0421	40.155	0.0445	2.0870	360.009
12	3	36	1.5	0.806	44.330	1.179	19.035	0.0425	39.657	0.0449	2.0885	369.385
13	3	39	1.5	0.816	44.880	1.209	18.802	0.0428	39.171	0.0454	2.0899	378.857
14	3	42	1.5	0.825	45.375	1.235	18.597	0.0433	38.744	0.0458	2.0917	387.587
15	3	45	1.5	0.835	45.925	1.265	18.374	0.0436	38.280	0.0463	2.0931	397.305
16	3	48	1.5	0.844	46.420	1.293	18.178	0.0439	37.872	0.0467	2.0945	406.188
17	3	51	1.5	0.851	46.805	1.314	18.029	0.0443	37.560	0.0472	2.0961	413.271
18	3	54	1.5	0.876	48.180	1.393	17.514	0.0447	36.488	0.0476	2.0976	438.232
19	3	57	1.5	0.889	48.895	1.434	17.258	0.0450	35.955	0.0481	2.0992	451.670
20	1.5	58.5	0.75	0.901	49.555	1.473	17.028	0.0454	35.476	0.0485	2.1007	232.146

Table: 4 Wind load calculation with gust factor for 30 floors in Zone-I as per IS: 875 (part-3) - 1987

FLOOR	h (m)	hi (m)	h/2 (m)	k2	Vz (m/s)	Pz (kN/m²)	Fo	S	[fo L(h) / Vz]	E	G	Storey force (kN)
1	3	3	1.5	0.670	22.110	0.293	38.100	0.0115	61.737	0.034	1.8810	86.068
2	3	6	1.5	0.670	22.110	0.293	38.100	0.0115	61.737	0.034	1.8810	86.068
3	3	9	1.5	0.670	22.110	0.293	38.100	0.0115	61.737	0.034	1.8810	86.068
4	3	12	1.5	0.690	22.770	0.311	36.996	0.0129	59.947	0.035	1.8835	91.405
5	3	15	1.5	0.720	23.760	0.339	35.455	0.0149	57.449	0.036	1.8871	99.718
6	3	18	1.5	0.739	24.387	0.357	34.543	0.0161	55.972	0.036	1.8894	105.174
7	3	21	1.5	0.754	24.882	0.371	33.856	0.0170	54.859	0.037	1.8911	109.586
8	3	24	1.5	0.766	25.278	0.383	33.325	0.0177	54.000	0.037	1.8924	113.183
9	3	27	1.5	0.778	25.674	0.395	32.811	0.0183	53.167	0.038	1.8937	116.838
10	3	30	1.5	0.790	26.070	0.408	32.313	0.0190	52.359	0.038	1.8950	120.553
11	3	33	1.5	0.796	26.268	0.414	32.069	0.0193	51.964	0.038	1.8957	122.432
12	3	36	1.5	0.806	26.598	0.424	31.672	0.0198	51.320	0.038	1.8967	125.598
13	3	39	1.5	0.816	26.928	0.435	31.283	0.0203	50.691	0.039	1.8978	128.804
14	3	42	1.5	0.825	27.225	0.445	30.942	0.0208	50.138	0.039	1.8987	131.725
15	3	45	1.5	0.831	27.423	0.451	30.719	0.0211	49.776	0.039	1.8993	133.691
16	3	48	1.5	0.834	27.522	0.454	30.608	0.0212	49.597	0.039	1.8996	134.679
17	3	51	1.5	0.839	27.687	0.460	30.426	0.0214	49.301	0.039	1.9001	136.335
18	3	54	1.5	0.849	28.017	0.471	30.067	0.0219	48.720	0.039	1.9011	139.676
19	3	57	1.5	0.856	28.248	0.479	29.822	0.0222	48.322	0.040	1.9018	142.040
20	3	60	1.5	0.859	28.347	0.482	29.717	0.0224	48.153	0.040	1.9021	143.059
21	3	63	1.5	0.862	28.446	0.486	29.614	0.0225	47.986	0.040	1.9024	144.082
22	3	66	1.5	0.872	28.776	0.497	29.274	0.0229	47.435	0.040	1.9033	147.518
23	3	69	1.5	0.881	29.073	0.507	28.975	0.0233	46.951	0.040	1.9042	150.646
24	3	72	1.5	0.883	29.139	0.509	28.910	0.0234	46.844	0.040	1.9043	151.346
25	3	75	1.5	0.886	29.238	0.513	28.812	0.0235	46.686	0.040	1.9046	152.398
26	3	78	1.5	0.891	29.403	0.519	28.650	0.0238	46.424	0.040	1.9051	154.160
27	3	81	1.5	0.893	29.469	0.521	28.586	0.0238	46.320	0.040	1.9053	154.868
28	3	84	1.5	0.899	29.667	0.528	28.395	0.0241	46.011	0.041	1.9058	157.001
29	3	87	1.5	0.902	29.766	0.532	28.301	0.0242	45.858	0.041	1.9061	158.073
30	1.5	88.5	0.75	0.906	29.898	0.536	28.176	0.0244	45.655	0.041	1.9064	79.754

Table: 5 Wind load calculation with gust factor for 30 floors in Zone-VI as per IS: 875 (part-3) – 1987

FLOOR	h (m)	hi (m)	h/2 (m)	k2	Vz (m/s)	Pz (kN/m^2)	Fo	S	[fo L(h) / Vz]	E	G	Storey force (kN)
1	3	3	1.5	0.670	36.850	0.815	22.860	0.0322	37.042	0.049	1.9312	245.454
2	3	6	1.5	0.670	36.850	0.815	22.860	0.0322	37.042	0.049	1.9312	245.454
3	3	9	1.5	0.670	36.850	0.815	22.860	0.0322	37.042	0.049	1.9312	245.454
4	3	12	1.5	0.690	37.950	0.864	22.198	0.0336	35.968	0.051	1.9362	261.004
5	3	15	1.5	0.720	39.600	0.941	21.273	0.0356	34.470	0.053	1.9435	285.261
6	3	18	1.5	0.739	40.645	0.991	20.726	0.0368	33.583	0.055	1.9479	301.202
7	3	21	1.5	0.754	41.470	1.032	20.313	0.0377	32.915	0.056	1.9513	314.104
8	3	24	1.5	0.766	42.130	1.065	19.995	0.0383	32.400	0.056	1.9540	324.626
9	3	27	1.5	0.778	42.790	1.099	19.687	0.0390	31.900	0.057	1.9566	335.327
10	3	30	1.5	0.790	43.450	1.133	19.388	0.0396	31.415	0.058	1.9592	346.206
11	3	33	1.5	0.796	43.780	1.150	19.242	0.0400	31.179	0.058	1.9605	351.713
12	3	36	1.5	0.806	44.330	1.179	19.003	0.0405	30.792	0.059	1.9626	360.990
13	3	39	1.5	0.816	44.880	1.209	18.770	0.0410	30.414	0.059	1.9646	370.390
14	3	42	1.5	0.825	45.375	1.235	18.565	0.0414	30.083	0.060	1.9664	378.957
15	3	45	1.5	0.831	45.705	1.253	18.431	0.0417	29.865	0.060	1.9676	384.724
16	3	48	1.5	0.834	45.870	1.262	18.365	0.0418	29.758	0.060	1.9682	387.624
17	3	51	1.5	0.839	46.145	1.278	18.255	0.0421	29.581	0.061	1.9692	392.482
18	3	54	1.5	0.849	46.695	1.308	18.040	0.0425	29.232	0.061	1.9712	402.292
19	3	57	1.5	0.856	47.080	1.330	17.893	0.0428	28.993	0.062	1.9725	409.233
20	3	60	1.5	0.859	47.245	1.339	17.830	0.0430	28.892	0.062	1.9731	412.226
21	3	63	1.5	0.862	47.410	1.349	17.768	0.0431	28.791	0.062	1.9737	415.230
22	3	66	1.5	0.872	47.960	1.380	17.565	0.0435	28.461	0.062	1.9755	425.324
23	3	69	1.5	0.881	48.455	1.409	17.385	0.0439	28.170	0.063	1.9772	434.515
24	3	72	1.5	0.883	48.565	1.415	17.346	0.0440	28.107	0.063	1.9776	436.571
25	3	75	1.5	0.886	48.730	1.425	17.287	0.0441	28.011	0.063	1.9781	439.665
26	3	78	1.5	0.891	49.005	1.441	17.190	0.0443	27.854	0.063	1.9790	444.845
27	3	81	1.5	0.893	49.115	1.447	17.152	0.0444	27.792	0.063	1.9794	446.926
28	3	84	1.5	0.899	49.445	1.467	17.037	0.0447	27.606	0.064	1.9805	453.198
29	3	87	1.5	0.902	49.610	1.477	16.980	0.0448	27.515	0.064	1.9810	456.351
30	1.5	88.5	0.75	0.906	49.830	1.490	16.905	0.0449	27.393	0.064	1.9817	230.286

Modeling in ETABS 15

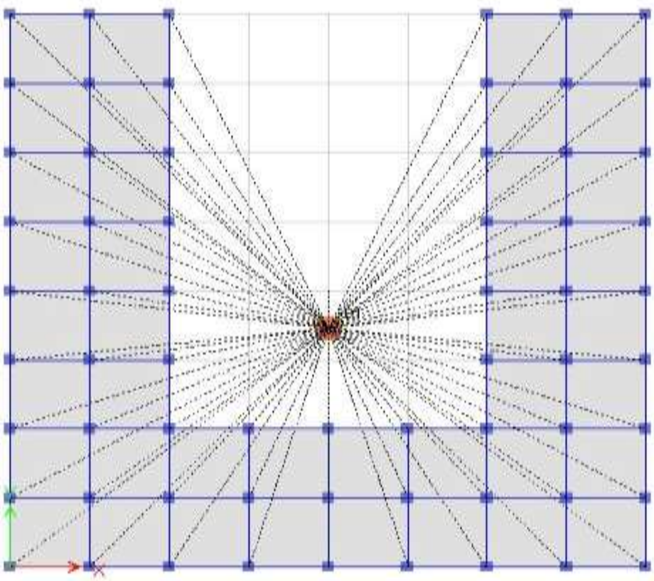

Fig 1: Diaphragm extent for U-Shape

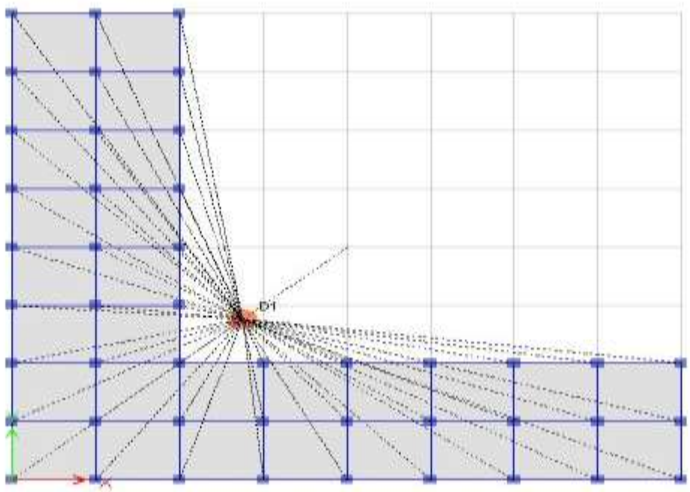

Fig 2: Diaphragm extent for L-Shape

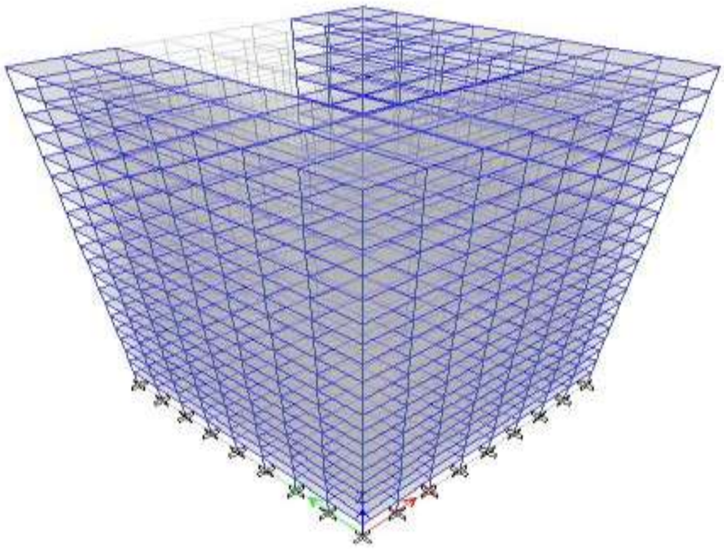

Fig 3: ETABS 3D model for U-shape

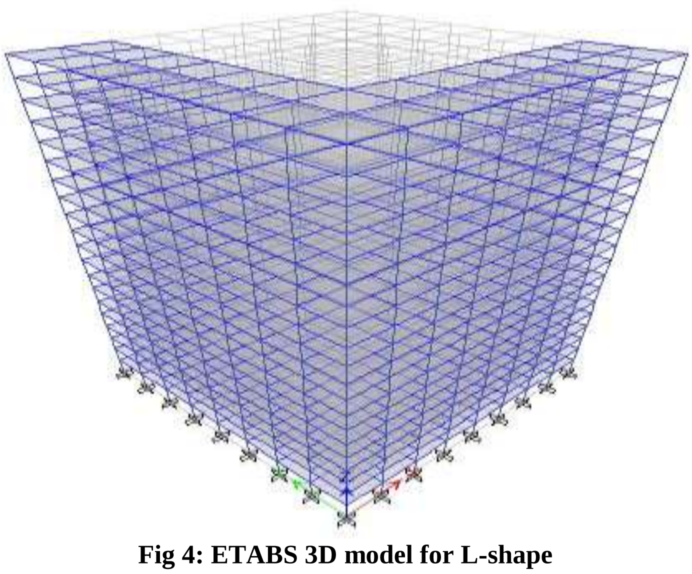

Fig 4: ETABS 3D model for L-shape

Response of 20 Storey Building In Zone-I and Zone-Vi With and Without Gust Factor.

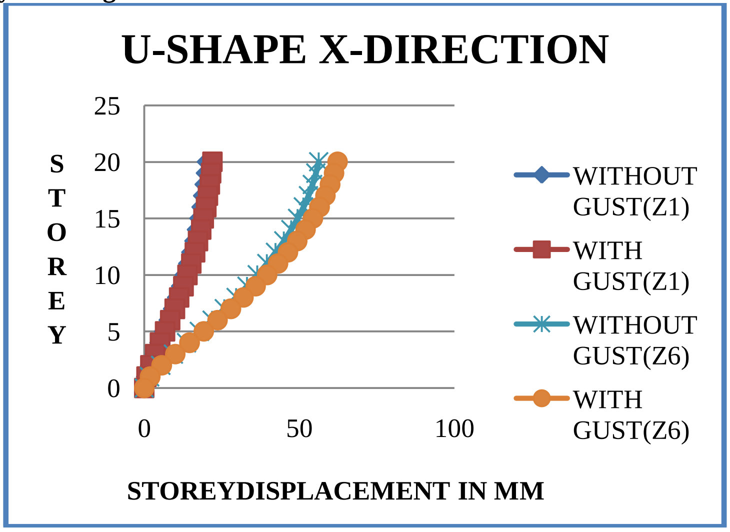

Fig 5: Storey Displacement in X-direction

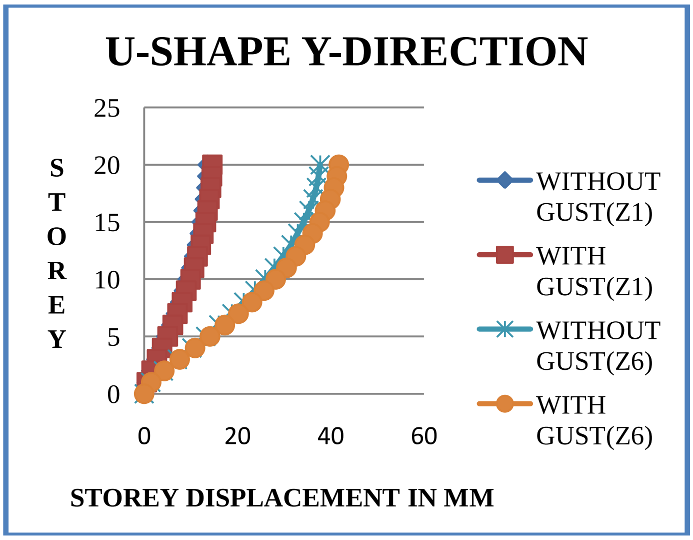

Fig 6: Storey Displacement in Y-direction

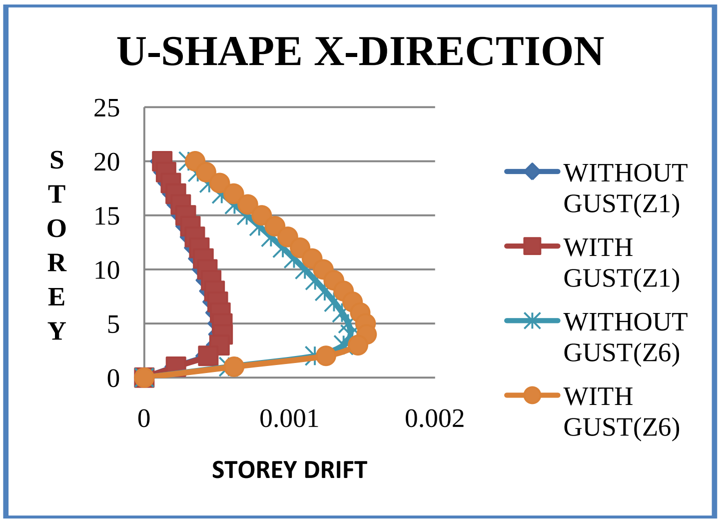

Fig 7: Storey Drift in X-direction

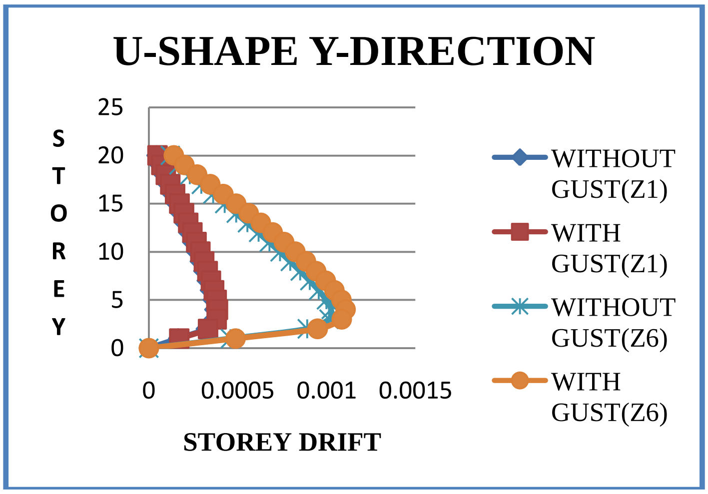

Fig 8: Storey Drift in Y-direction

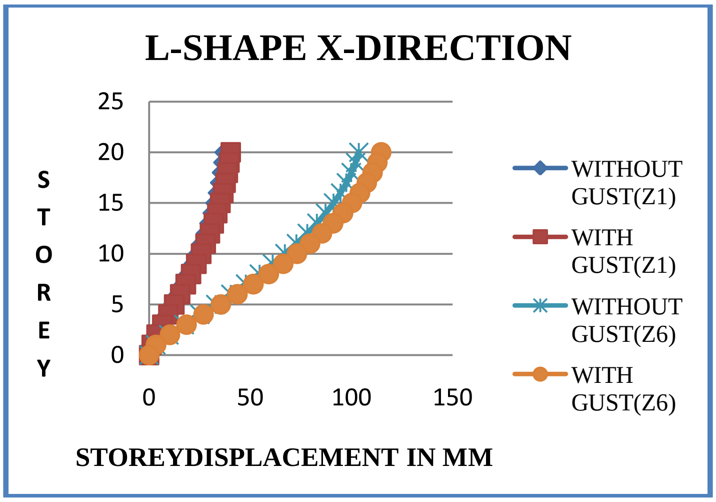

Fig 9: Storey Displacement in X-direction

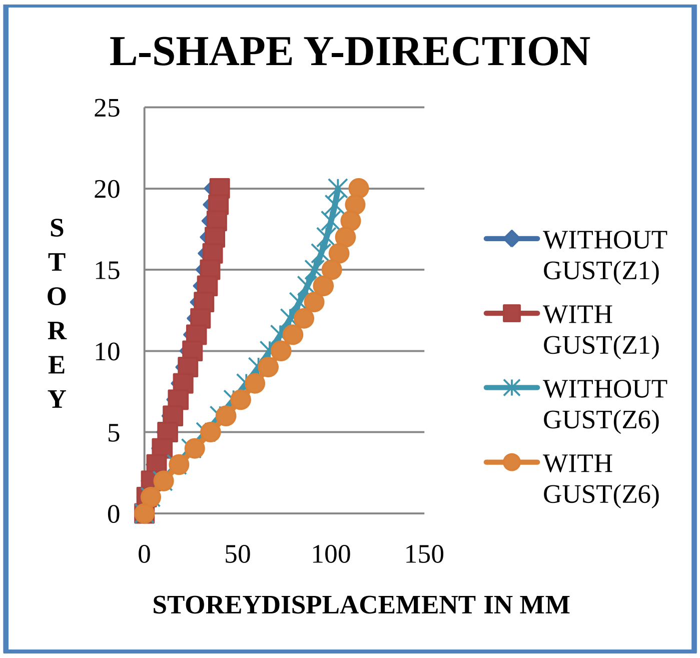

Fig 10: Storey Displacement in Y-direction

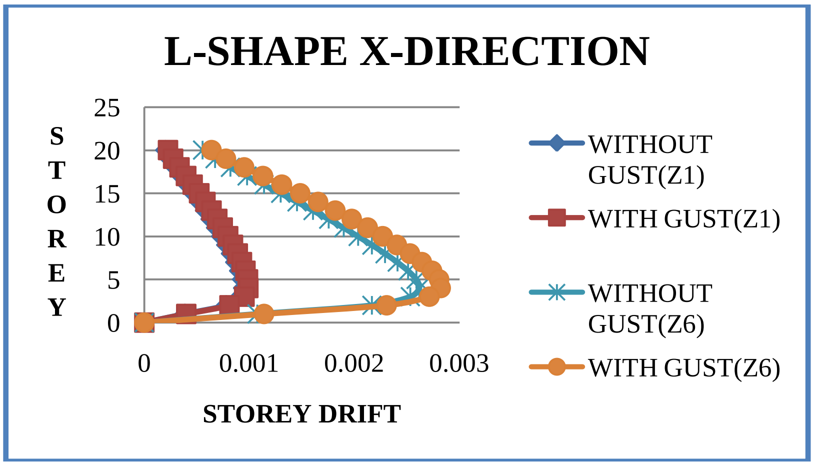

Fig 11: Storey Drift in X-direction

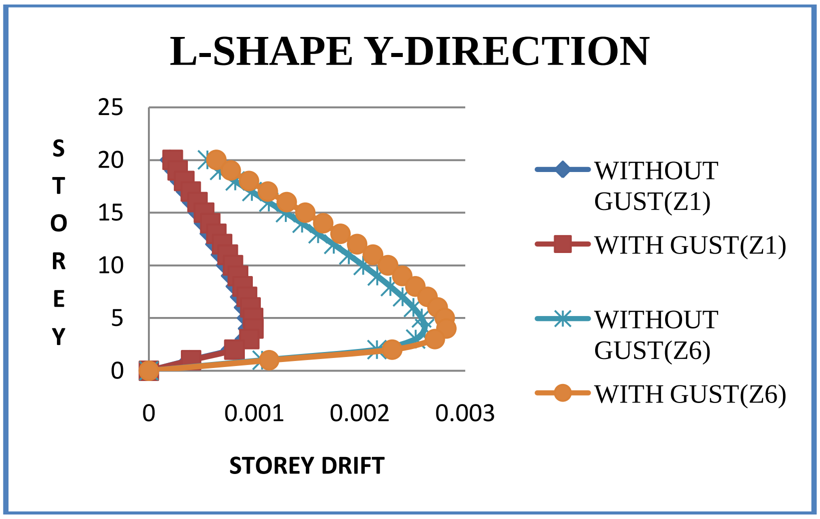

Fig 12: Storey Drift in Y-direction

Response Of 30 Storey Building In Zone-I And Zone-Vi With And Without Gust Factor.

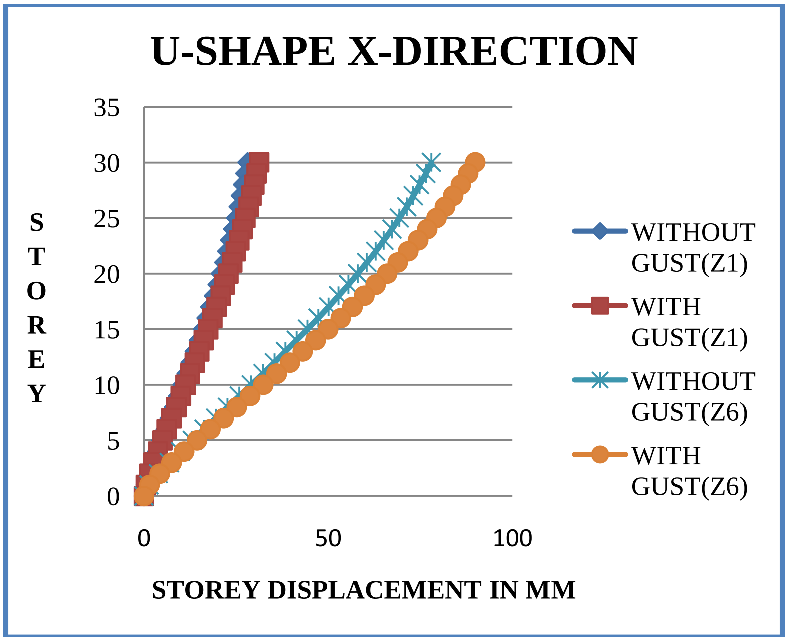

Fig 13: Storey Displacement in X-direction

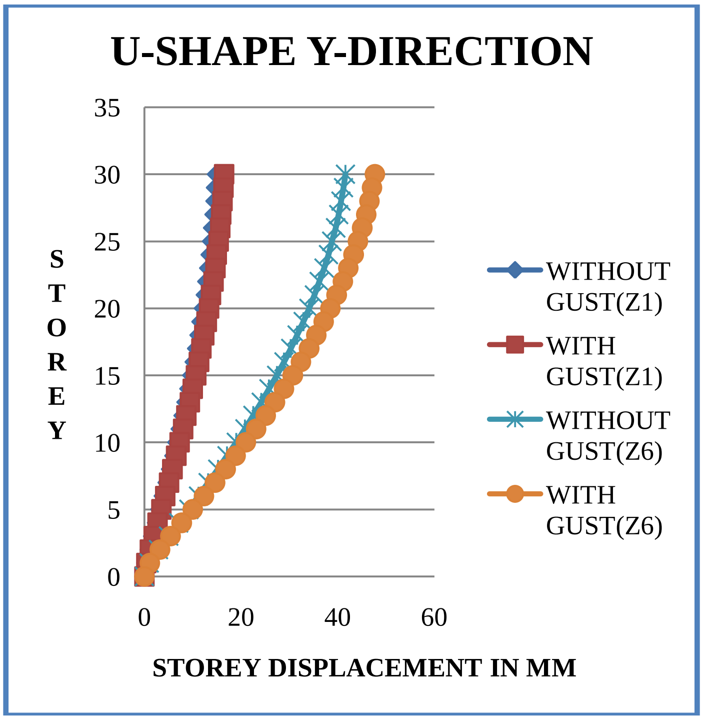

Fig 14: Storey Displacement in Y-direction

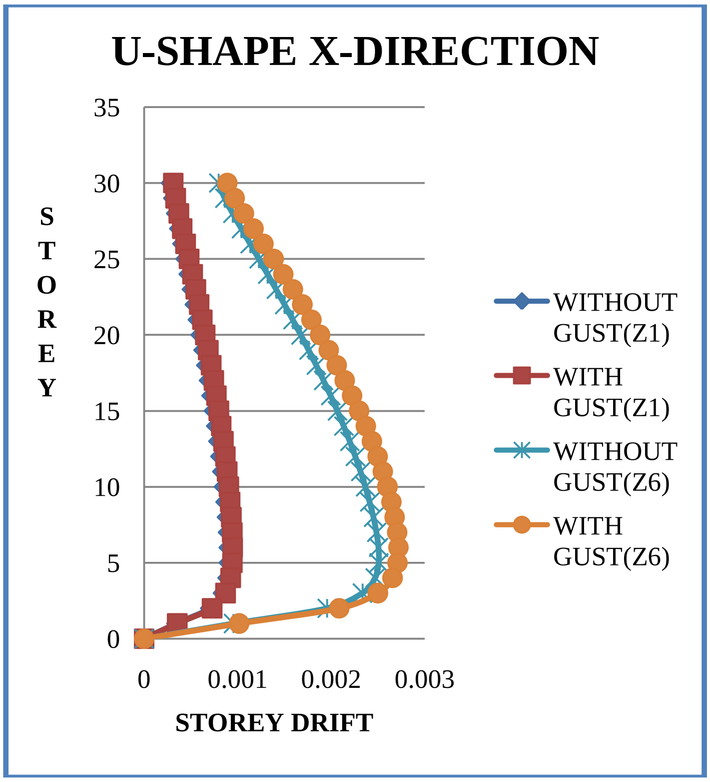

Fig 15: Storey Drift in X-direction

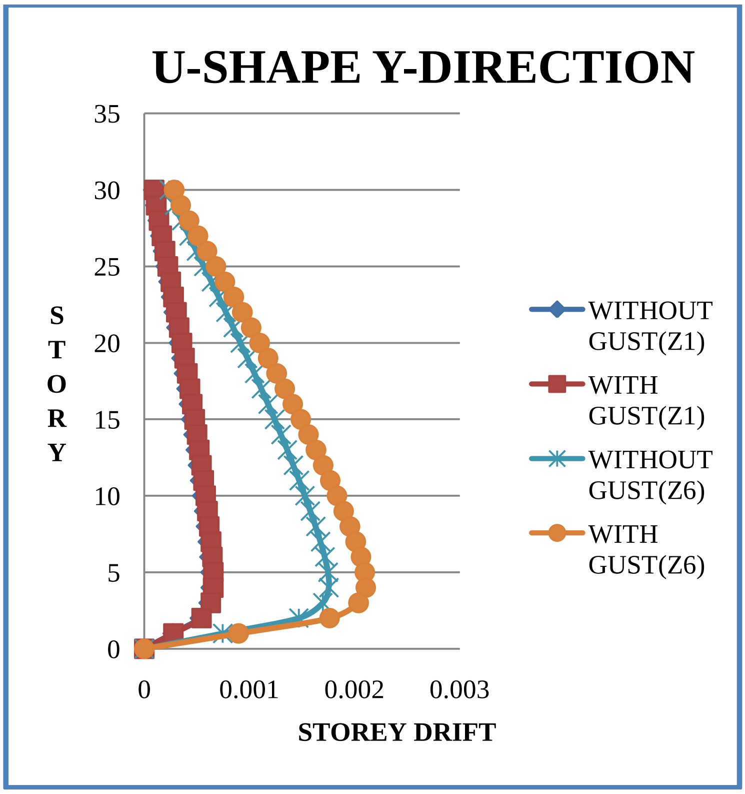

Fig 16: Storey Drift in Y-direction

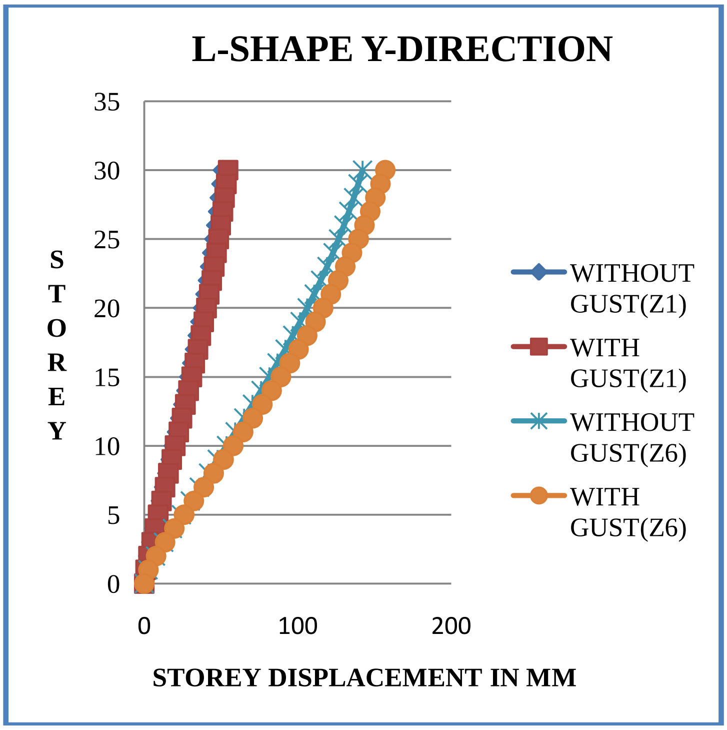

Fig 18: Storey Displacement in Y-direction

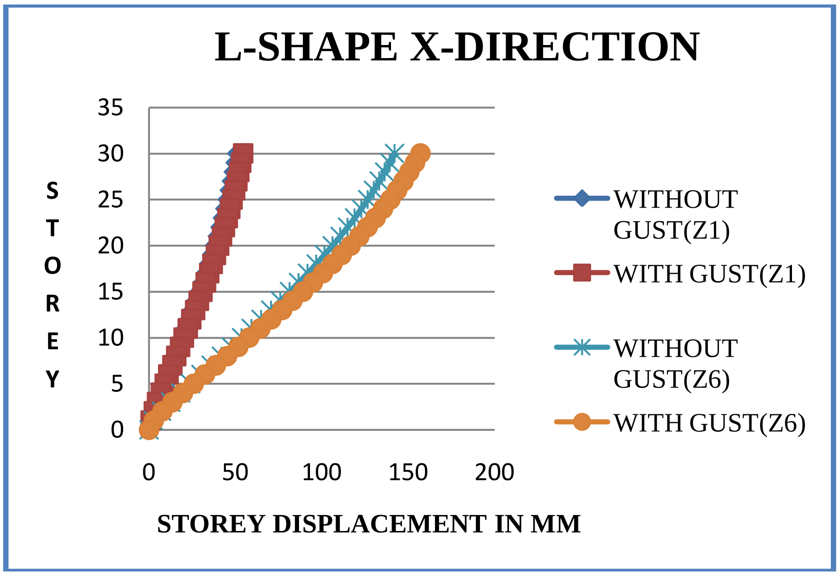

Fig 17: Storey Displacement in X-direction

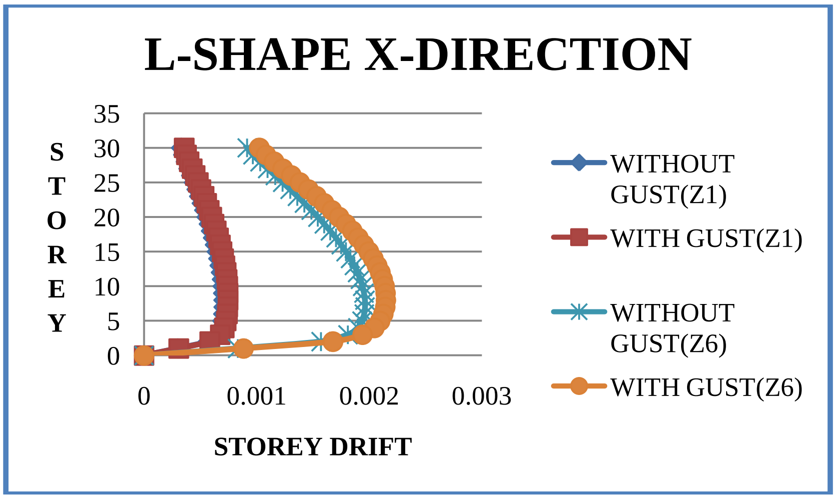

Fig 19: Storey Drift in X-direction

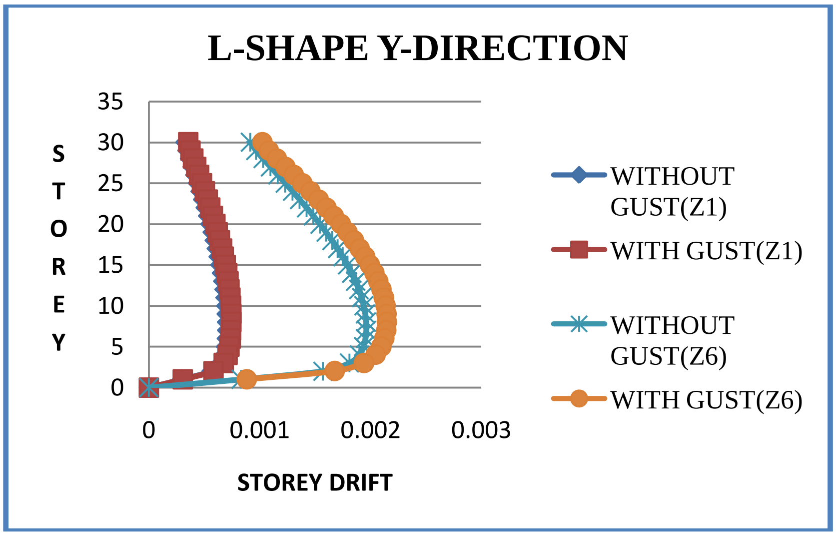

Fig 20: Storey Drift in Y-direction

IV. CONCLUSION AND FUTURE WORK

Following conclusions can be drawn from the present study

- The Storey displacement increases with increase in height. It is maximum at top Storey and goes on decreasing and becomes zero at the base of the structure for both with and without Gust factor and for all shapes.
- The Storey displacement increases from Zone-I to Zone-VI as the wind force increases for both with and without Gust Factor and for all different shapes.
- For every wind zone the Storey displacement goes on decreasing for Terrain Category 1-4 for both with and without Gust factor and for all the shapes and at different heights also.
- The Storey displacement of the U-shape building is lesser compared to other irregular shaped building for with and without Gust factor.
- drift increases from 3rd to 4th storey and it is maximum at 4th storey and 5th storey in both X and Y directions and then it gradually decreases from 5th storey to top storey for all the shapes in Zone-I and Zone-VI at different height with and without Gust factor.
- The storey drift is more in Zone-VI compared to Zone I as the wind speed increase, the storey drift also increases for all the shapes.
- The storey drift is minimum in U-shaped buildings for both with and without Gust factor in Zone-I and Zone-VI compared to other irregular shaped buildings.
- The storey drift decreases from terrain Category 1-4 for all the wind zones and for all the shapes for both with and without Gust factor.

V. SCOPE FOR THE FUTURE STUDY

For better comprehension and conclusion, following additional works may be carried out.

- ❖ Shear walls may be considered and the effect of which can be observed.
- ❖ Infill walls may be considered and the effect of which can be observed.
- ❖ Analysis can be carried out for different heights and remaining wind zones.
- ❖ For the practical observation of dynamic effect the wind tunnel experiment can be carried out.

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