Research Paper on Analysis of multistorey building using IS 875 and comparison of forces developed in slender column for class B building in different terrain categories for same basic wind speed.

Onkar uplanchiwar[1], Prof. Ganesh mahalle[2]

[1]PG Student, Structural and Construction Engineering Department & Ballarpur Institute of Technology, Ballarpur, Chandrapur, Maharashtra, India
[2]Assistant Professor, Structural and Construction Engineering Department & Ballarpur Institute of Technology, Ballarpur, Chandrapur, Maharashtra, India

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Abstract - This paper analyzed the impact of wind loadings on high-rise building for different terrain category. The wind speed , design wind pressure for the different terrain categories taken up for this study were calculated from logarithmic wind profile equation .

The nodal displacement of a 3d highRise building model with reference to the calculated design wind load were performed using finite element analysis software(STADDPROV8I). From the result got,

It was shown that Terrain category IV when compared to other terrain categories recorded undersized wind speed and pressure from the ground to a height of about 39.6m.

***Key Words*:** Staad pro v8i, high-rise building, wind effect, slenderness ratio, etc.

1. INTRODUCTION

Terrain categories are used for determining a structure'sexposure to wind as a result of terrain that surrounds it .

Different types of terrain will produce different roughness effect.

The rougher the terrain is, the more retards the wind within the atmospheric boundary layer At the lower layer of the atmosphere, wind speeds are dominance by the friction against the surface of the earth .

Thus, wind speed changes with height and this variation is related to the drag on the wind as it blows over upstream areas. The more apparent the roughness of the earth surface; the more the wind will be slowed down.

The wind industry and wind conditions in a landscape are referred through roughness classes or roughness length. The term roughness length is the milage above ground level where the wind speed theoretically should be zero.

1.1 IMPORTANCE OF RESEARCH PAPER

The outcomes of this project will help structural engineers better understand wind load design on tall buildings using the various codes investigated in this study. Furthermore, the project's execution would be improved. emphasise the need of considering wind load during the design of tall structures Tall buildings can be designed with wind load considerations in mind.When the safety of towering buildings is guaranteed by the law, society benefits.

Wind-related calamities have put the area in a vulnerable state. In addition, there is the issue of occupancy.

When vibration and deflection are kept within serviceability limits, comfort can be assured.Tall buildings are mitigated or minimised in their current state.

1.2 PROBLEM STATEMENT

Using IS 875 part 3, analyse the G+10 storey class B building in Nagpur. Vary the terrain category of the building to compare the results. Make use of m 25 concrete and fe500 steel.

1.3 OBJECTIVES OF THE STUDY

1.To examine G+10 class B structures in terrain categories 1, 2, 3, and 4.

2.Comparison of the structure's maximum deflection

3.Factors developed in a slim column are compared.

4.Results comparison

1.4 METHODOLOGY

1-Determination of the project's theme

2- Conducting a literature review

3- drafting a G+10 building plan

4-Part 3 of IS 875 study

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5-To examine the G+10 class B building in terrain category 1 at a basic wind speed of 44 m/s.

6-To investigate the G+10 class B building in terrain category 2 for a basic wind speed of 44 m/s.

7-To investigate the G+10 class B building in the terrain category for a baseline wind speed of 44 m/s. 3

8-To investigate the G+10 class B building on terrain Category for a basic wind speed of 44 m/s.

9-Results comparison

10-Conclusion

1.6 APPROACH

(1) With the help of the staad pro v8i programme, a multistory structure is analysed using IS code 875 (part 3).

(2) Is code 875 uses staad pro v8i to compare forces developed in slender columns for class B buildings in various terrain categories.

(3) Is 875 by staad pro programme V8i is used to design parameters

2. WORK CARRIED OUT

2.1 Planning of building

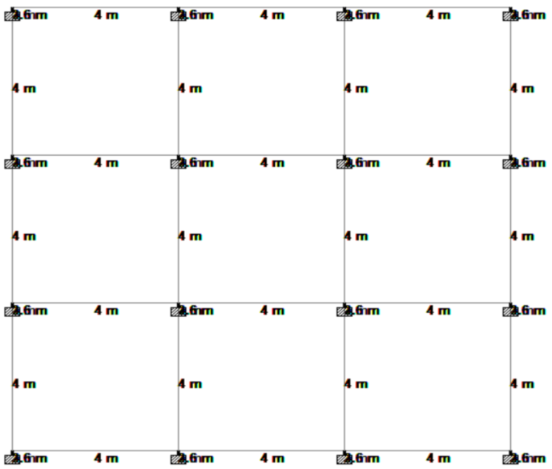

Fig 2.1 :- (Top View) 2-D Line Plan of building

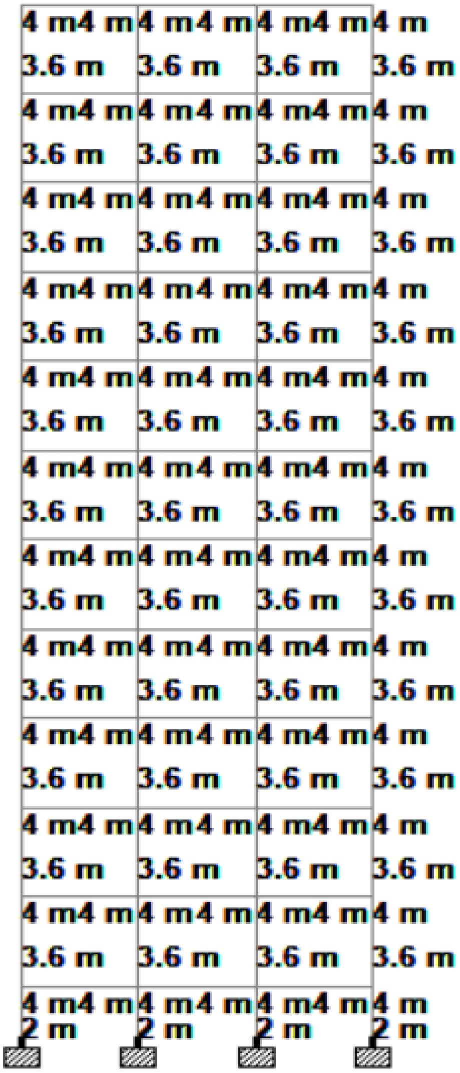

Fig. 2.1 :- Elevation Plan of high rise building

2.2 Calculation of Forces on building

<u>**CALCULATION OF WIND FORCE**</u>

VZ=VB X K1XK2XK3

PZ=0.6VZ^2

VB=BASIC WIND SPEED (44 M/S) …….IS CODE 875 PART 3 ..PJ 53

K3=1

K1=1.07(PROBALITY FACTOR)………..PJ 11 IS CODE 875 PART3 PJ 11

VZ=44X1.07X1XK2

=47.08K2

PZ=0.6 X (47.08K2)^2

=0.6X 2216.5 K2^2

PZ =1329.9 K2^2

K2=1.03 FOR HEIGHT 10 M ………FROM IS CODE 875 PART 3 PJ 12

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$PZ=1329.9X\ 1.03^2=1410.8$

FROM ABOVE FORMULA WE HAVE CALCULATED THE WIND PRESSURE AS BELOW:-

SR NO	HEIGHT	PZ For terrain category 1	PZ For terrain category 2	PZ For terrain category 3	PZ For terrain category 4
1	10.8	1.42792	1.286	1.04	0.781
2	14.4	1.4505	1.329	1.089	0.844
3	18	1.491	1.373	1.139	0.907
4	21.6	1.531	1.416	1.188	0.970
5	25.2	1.572	1.459	1.238	1.033
6	28.8	1.612	1.503	1.287	1.096
7	32.4	1.653	1.546	1.337	1.158
8	36	1.693	1.589	1.387	1.221
9	39.6	1.734	1.632	1.436	1.284

3. LOAD COMBINATION

1)1.5(DL+LL)

2)1.2(DL+LL+WX)

3)1.2(DL+LL-WX)

4)1.2(DL+LL+WZ)

5)1.2(DL+LL-WZ)

6)1.5(DL+WX)

7)1.5(DL-WX)

8)1.5(DL+WX)

9)1.5(DL-WZ)

4. ANALYSIS AND DESIGN OF G+10 BUILDING USING IS 875

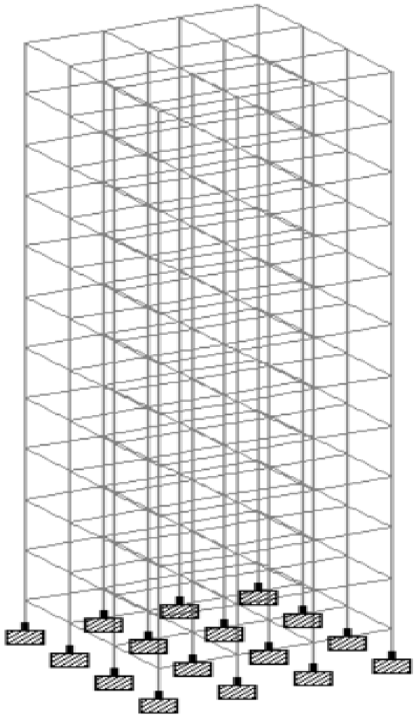


Fig. 4.1 :- STAAD MODEL OF BUILDING

Fig. 4.2 :- BUILDING VIEW

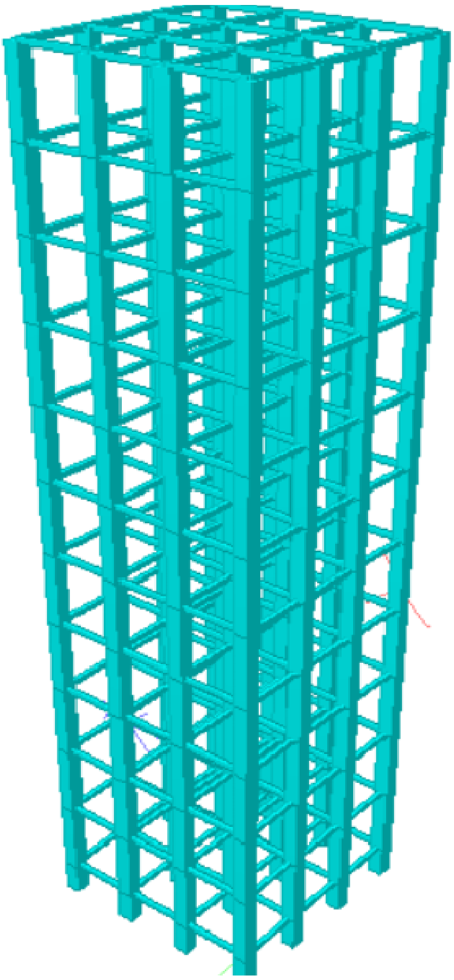


Fig. 4.3 :- 3-D Rendering View

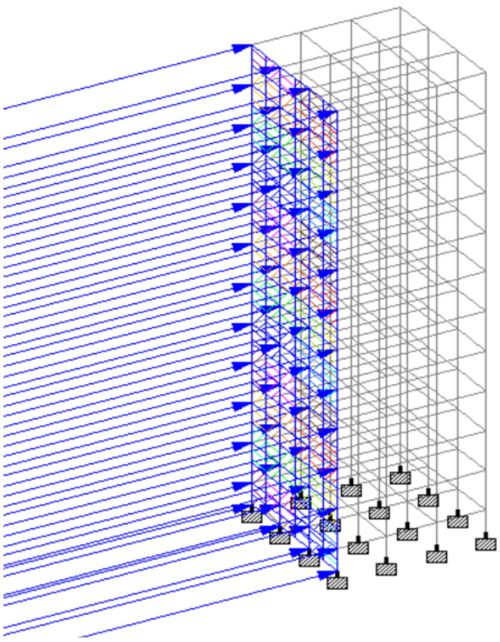


Fig. 4.4 :- WIND LOAD IN X -DIRECTION

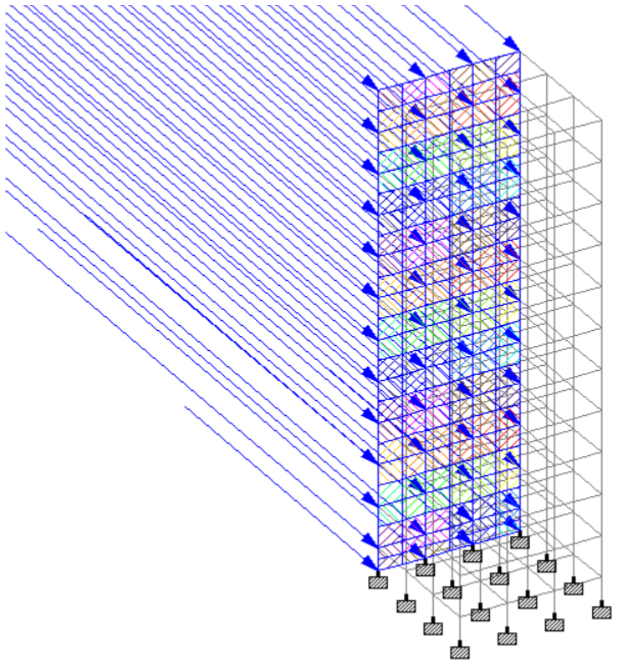
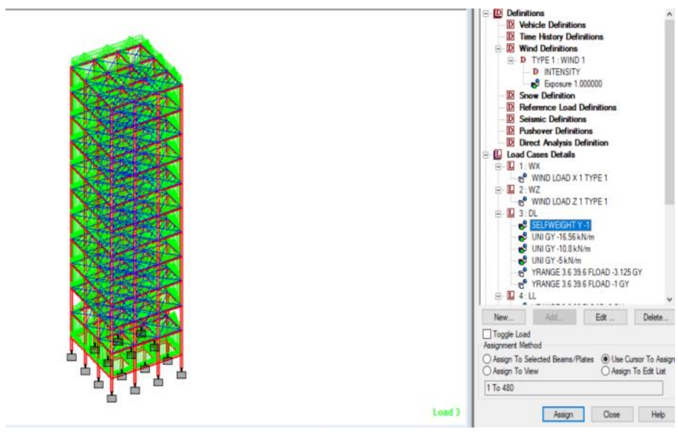


Fig. 4.5 :- WIND LOAD IN Z- DIRECTION



4.1 LOAD CONSIDERATION

Dead Load:- Selfweight factor=-1

Live Load :- -3 kN/m^2

Full brick wall load=20x0.23x3.6=-16.56 KN/m

Density of brick=20 kN/m^3

Thickness of brick wall=0.23 m

Height column=3.6 m

Half brick load=20x0.15x3.6=-10.8 KN/m

Density of brick =20 KN/m^3

Thickness of brick wall=0.15

Height of column =3.6 m

Parapet load=(20 x0.23x1)=-5 KN/m

Floor load=(25x0.125)=-3.125

Density of concrete =25 KN/m^3

Thickness of slab =0.125 m

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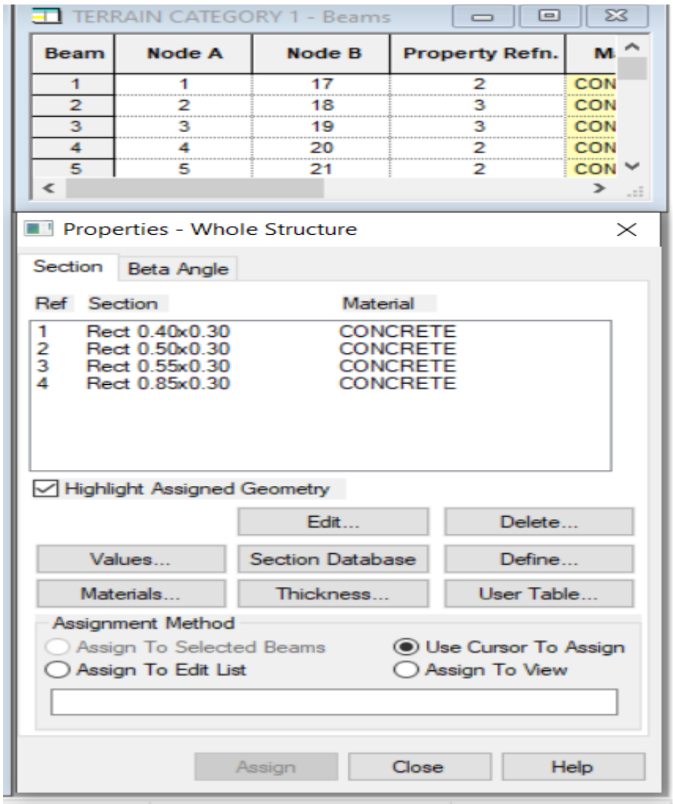


Fig 4.6 .- Properties of structure for terrain category 1

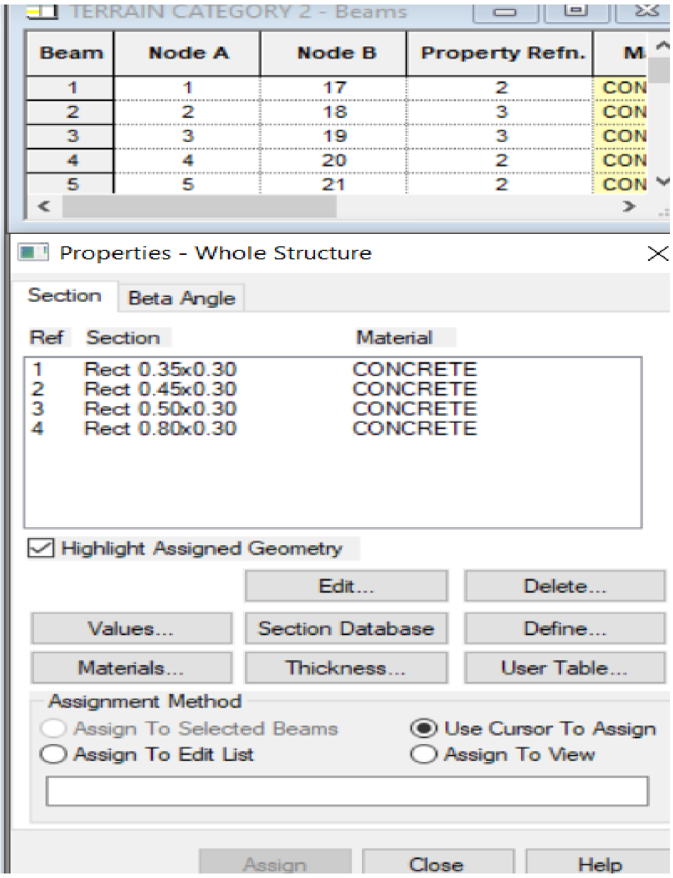


Fig 4.7.- Properties of structure for terrain category 2

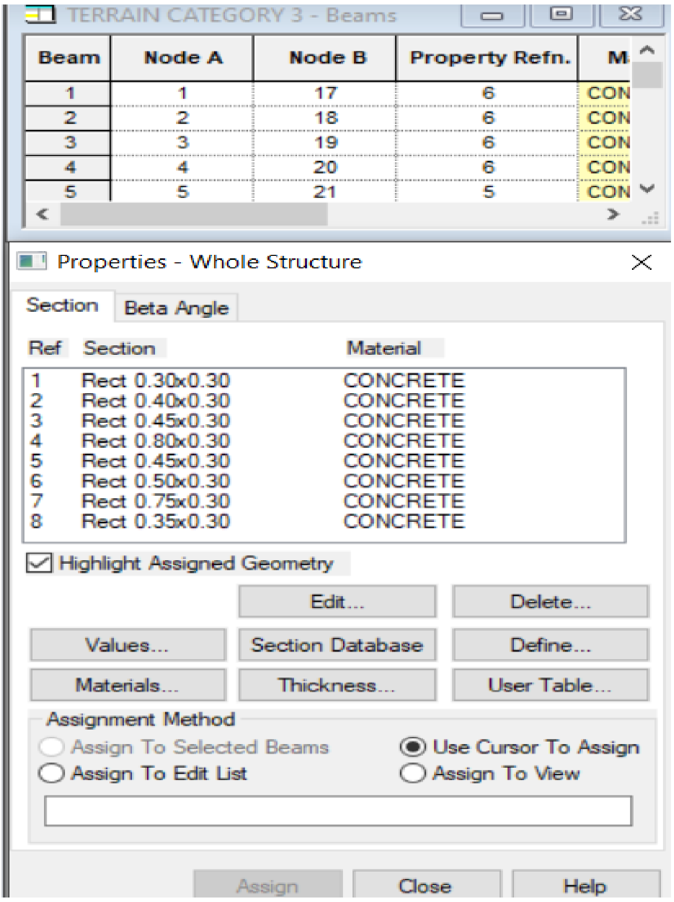


Fig.4.8- Properties of structure for terrain category 3

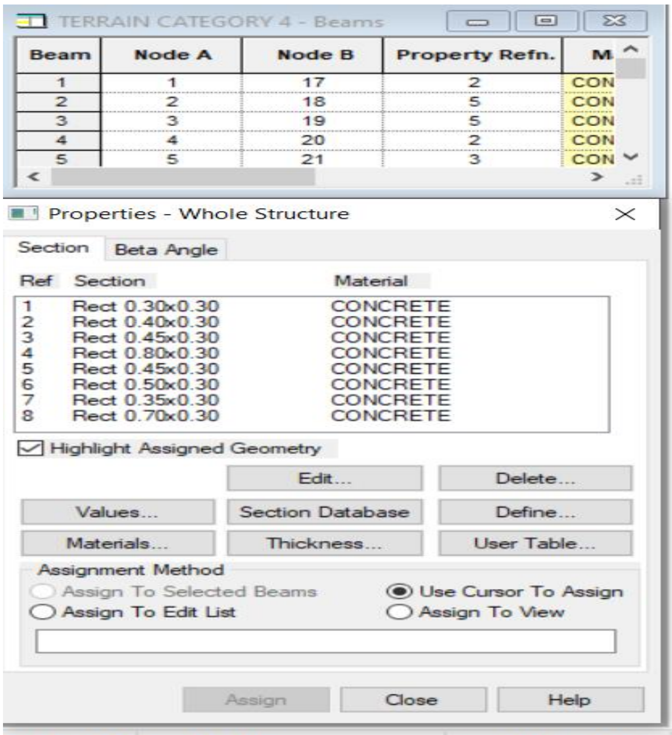
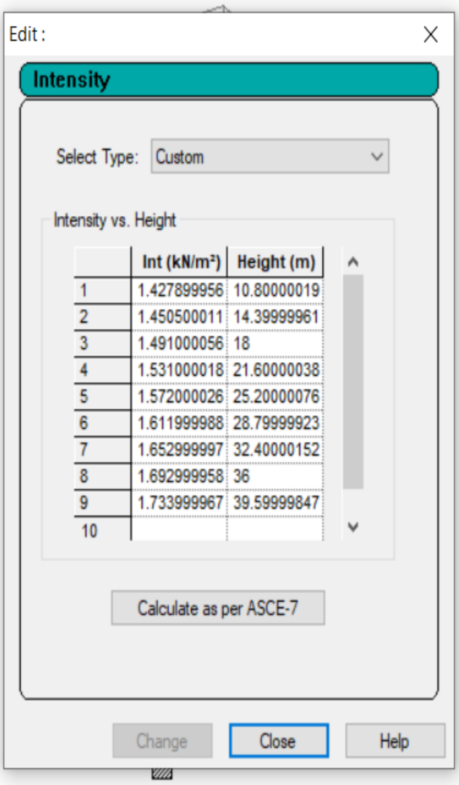


Fig.4.9- Properties of structure for terrain category 4



Wind Parameter

Terrain category –terrain category 1
Class of building- class B
Basic wind speed-44 m/s

	TERRAIN CATEGORY			
	1	2	3	4
Node	x mm	X mm	X mm	X mm
193	89.285	116.302	129.235	143.986
194	89.243	116.257	129.193	143.938
195	89.201	116.214	129.152	143.892
196	89.175	116.186	129.124	143.861
197	90.034	117.159	130.056	145.298
198	90.002	117.126	130.025	145.263
199	89.994	117.118	130.02	145.252
200	89.982	117.104	130.004	145.233
201	90.034	117.159	130.121	145.644
202	90.002	117.126	130.091	145.614
203	89.994	117.118	130.086	145.611
204	89.982	117.104	130.071	145.596
205	89.285	116.302	129.427	144.966
206	89.243	116.257	129.386	144.92
207	89.201	116.214	129.347	144.875
208	89.175	116.186	129.32	144.845

TABLE 1:-SHOWING MAXIMUM NODAL DISPLACEMENT IN X - DIRECTION

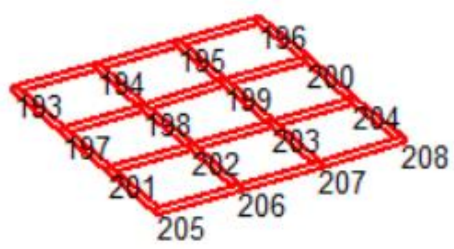


Fig. 5 :- NODAL DISPLACEMENT IN X -DIRECTION

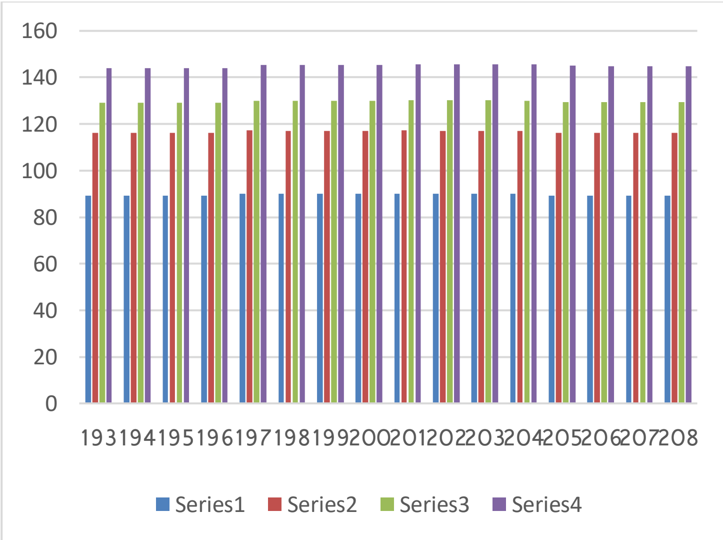


FIG:- MAXIMUM NODAL DISPLACEMENT IN X-DIRECTION GRAPH FOR EACH TERRAIN CATEGORY AS PER LOGARITHMIC WIND PROFILE LAW

SERIES 1 - TERRAIN CATEGORY 1
SERIES 2 - TERRAIN CATEGORY 2
SERIES 3 - TERRAIN CATEGORY 3
SERIES 4 - TERRAIN CATEGORY 4

	TERRAIN CATEGORY			
	1	2	3	4
Node	y mm	Y mm	Y mm	Y mm
193	9.698	10.417	10.892	12.422
194	11.51	12.55	13.63	15.141
195	11.51	12.55	13.63	15.141
196	9.698	10.417	10.892	12.422
197	12.501	13.677	14.803	16.228
198	12.901	13.547	13.982	14.824
199	12.902	13.548	13.982	14.824
200	12.5	13.676	14.802	16.227
201	12.501	13.677	15.806	16.275
202	12.901	13.547	13.978	14.822
203	12.902	13.548	13.978	14.823
204	12.5	13.676	15.805	16.274
205	9.697	10.417	11.14	12.74
206	11.51	12.55	13.673	15.122
207	11.51	12.55	13.673	15.122
208	9.697	10.417	11.14	12.74

TABLE 2:-SHOWING MAXIMUM NODAL DISPLACEMENT IN Y - DIRECTION

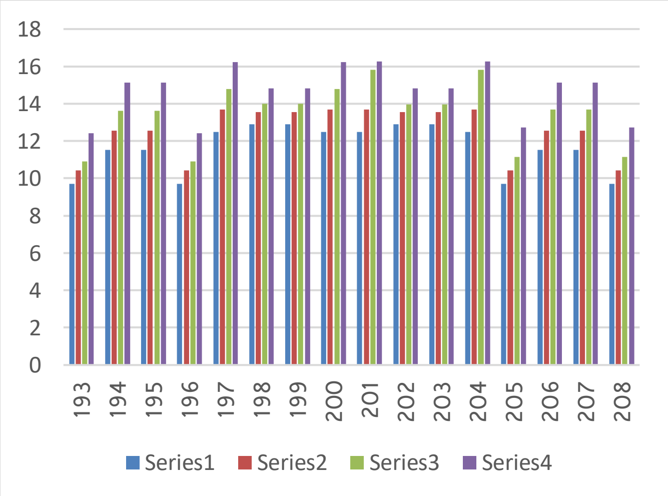


FIG:- MAXIMUM NODAL DISPLACEMENT IN Y-DIRECTION GRAPH FOR EACH TERRAIN CATEGORY AS PER LOGARITHMIC WIND PROFILE LAW

SERIES 1 - TERRAIN CATEGORY 1
SERIES 2 - TERRAIN CATEGORY 2
SERIES 3 - TERRAIN CATEGORY 3
SERIES 4 - TERRAIN CATEGORY 4

TERRAIN CATEGORY				
	1	2	3	4
Node	z mm	Z mm	Z mm	Z mm
193	135.961	162.474	165.556	189.037
194	136.479	163.043	166.003	189.612
195	136.479	163.043	166.003	189.612
196	135.961	162.474	165.556	189.037
197	135.922	162.431	165.513	188.99
198	136.441	163.002	165.964	189.568
199	136.441	163.002	165.964	189.568
200	135.922	162.431	165.513	188.99
201	135.884	162.389	165.471	188.941
202	136.42	162.98	165.947	189.545
203	136.42	162.98	165.947	189.545
204	135.884	162.389	165.471	188.941
205	135.86	162.362	165.442	188.906
206	136.406	162.965	165.931	189.526
207	136.406	162.965	165.931	189.526
208	135.86	162.362	165.442	188.906

TABLE 3:-SHOWING MAXIMUM NODAL DISPLACEMENT IN Z- DIRECTION

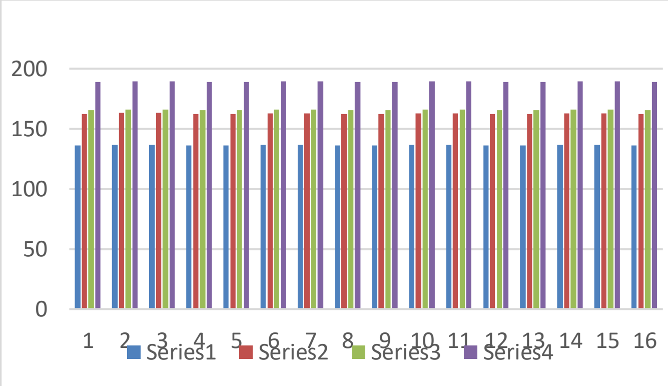
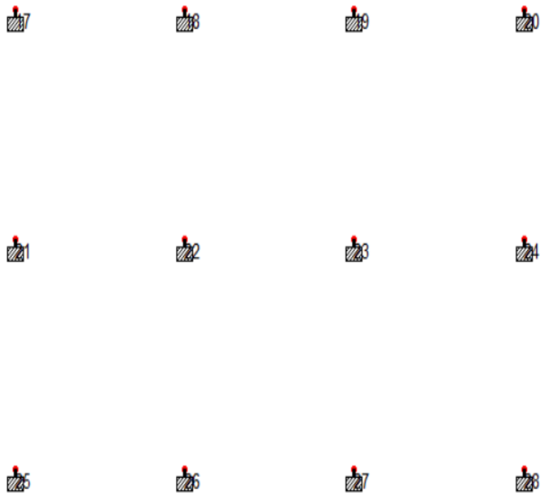


FIG:- MAXIMUM NODAL DISPLACEMENT IN Z-DIRECTION GRAPH FOR EACH TERRAIN CATEGORY AS PER LOGARITHMIC WIND PROFILE LAW

SERIES 1 - TERRAIN CATEGORY 1
SERIES 2 - TERRAIN CATEGORY 2
SERIES 3 - TERRAIN CATEGORY 3
SERIES 4 - TERRAIN CATEGORY 4

	Vertical	Vertical	Vertical	Vertical
Node	Fy KN	Fy kN	Fy kN	Fy kN
17	2259.074	2160.696	2049.911	1941.617
18	2824.85	2740.62	2621.862	2570.023
19	2824.85	2740.62	2621.862	2570.023
20	2259.074	2160.696	2049.911	1941.617
21	2723.464	2636.971	2584.662	2534.901
22	4087.374	4019.315	3923.999	3937.157
23	4087.374	4019.315	3923.999	3937.157
24	2723.223	2636.804	2584.662	2534.901
25	2723.464	2636.971	2453.68	2543.446
26	4087.374	4019.315	3962.299	3936.045
27	4087.374	4019.315	3962.299	3936.045
28	2723.223	2636.804	2453.68	2543.446
29	2258.978	2160.624	2055.161	1913.897
30	2824.641	2740.464	2627.674	2590.637
31	2824.641	2740.464	2627.674	2590.637
32	2258.978	2160.624	2055.161	1913.897

TABLE 4:-SHOWING MAXIMUM AXIAL FORCES IN EACH TERRAIN CATEGORY



	Moment	Moment	Moment	Moment
Node	Mx KNm	Mx kNm	Mx kNm	Mx kNm
17	87.645	88.265	97.207	68.925
18	96.358	96.785	95.88	74.101
19	96.358	96.785	95.88	74.101
20	87.645	88.265	97.207	68.925
21	95.608	94.967	91.798	76.671
22	149.382	152.842	149.424	123.061
23	149.382	152.842	149.424	123.061
24	95.608	94.967	91.798	76.671
25	96.873	96.231	85.236	78.088
26	150.614	154.012	150.624	124.14
27	150.614	154.012	150.624	124.14
28	96.873	96.231	85.236	78.088
29	71.077	71.006	69.634	52.347
30	84.656	84.832	83.444	69.35
31	84.656	84.832	83.444	69.35
32	71.077	71.006	69.634	52.347

TABLE 5:-SHOWING MAXIMUM BENDING MOMENT X IN COLUMN IN EACH TERRAIN CATEGORY

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Node	MZ KNm	Mz kNm	Mz kNm	Mz kNm
17	112.05	92.431	84.426	52.743
18	123.261	141.358	133.997	91.79
19	121.18	139.09	131.811	89.815
20	128.075	106.975	99.89	69.426
21	82.736	92.418	82.974	69.857
22	436.338	406.412	421.484	372.61
23	431.025	400.258	415.702	367.885
24	90.961	99.128	90.715	78.862
25	60.418	92.418	82.974	69.586
26	443.123	406.412	421.484	371.007
27	437.446	400.258	415.702	366.255
28	69.098	99.128	90.715	78.608
29	86.914	92.431	84.426	46.981
30	134.876	141.358	133.997	108.136
31	132.65	139.09	131.811	105.199
32	102.701	106.975	99.89	64.972

TABLE 6:-SHOWING MAXIMUM BENDING MOMENT Z IN COLUMN IN EACH TERRAIN CATEGORY

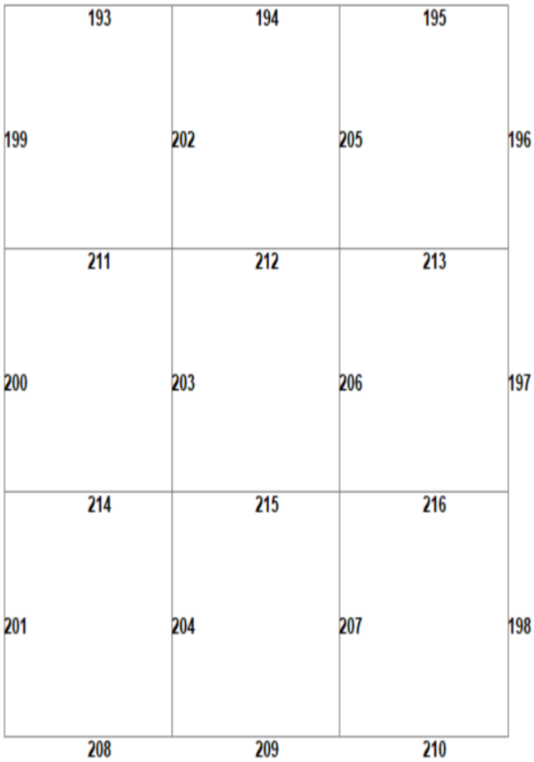

FIG:-FIG SHOW PLINTH LEVEL BEAM FORCES

Beam	Fy kN	Mz kNm	Fy kN	Mz kNm	Fy kN	Mz kNm	Fy kN	Mz kNm
193	97.87	113.644	92.491	103.909	80.343	84.136	78.616	77.339
194	96.069	114.69	90.835	105.626	80.403	86.095	77.29	79.932
195	97.697	115.034	92.366	106.28	80.26	84.981	78.557	80.704
196	112.949	140.918	105.409	128.019	93.699	108.689	88.067	93.223
197	102.329	127.609	97.571	119.359	88.901	103.768	84.047	93.601
198	112.809	137.895	105.301	127.048	92.923	106.234	87.695	97.1
199	112.949	140.918	105.409	128.019	93.699	108.689	88.067	93.223
200	102.329	127.609	97.571	119.359	88.901	103.768	84.047	93.601
201	112.809	137.895	105.301	127.048	92.923	106.234	87.695	97.1
202	103.929	141.838	94.741	126.131	80.504	101.915	73.806	86.191
203	98.725	143.394	91.061	129.325	78.123	104.75	71.651	91.774
204	103.643	148.245	94.52	132.958	80.232	107.009	73.305	93.59
205	103.929	148.699	94.741	133.313	80.504	107.551	73.806	94.489
206	98.725	143.394	91.061	129.325	78.123	104.75	71.651	91.774
207	103.643	148.245	94.52	132.958	80.232	107.009	73.305	93.59
208	97.87	113.644	92.491	103.909	82.274	86.176	77.217	71.949
209	96.069	114.69	90.835	105.626	81.471	88.264	76.032	77.416
210	97.697	115.034	92.366	106.28	82.194	88.412	77.154	78.233
211	83.13	100.212	76.803	89.867	65.138	71.446	61.385	64.175
212	82.982	111.565	76.494	99.971	64.533	77.421	60.76	69.873
213	82.79	111.112	76.558	100.069	64.985	78.145	61.27	70.685
214	83.13	100.212	76.803	89.867	65.555	69.901	61.34	64.005
215	82.982	111.565	76.494	99.971	64.862	78.087	60.716	69.784
216	82.79	111.112	76.558	100.069	65.403	79.071	61.225	70.604

TABLE 7:-PLINTH LEVEL BEAM FORCES

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Beam	Fy kN	Mz kNm	Fy kN	Mz kNm	Fy kN	Mz kNm	Fy kN	Mz kNm
361	105.054	117.538	100.922	110.588	95.978	101.981	90.903	91.205
362	104.044	115.342	100.484	109.89	94.971	100.426	90.911	92.285
363	105.046	91.439	100.916	91.311	95.973	86.535	90.899	80.903
364	104.783	118.417	101.599	113.111	96.428	103.951	92.112	94.706
365	101.475	108.411	98.386	104.512	95.386	100.954	89.991	89.624
366	104.778	86.152	101.595	86.19	98.092	77.603	91.469	79.067
367	104.783	118.417	101.599	113.111	96.428	103.951	92.112	94.706
368	101.475	108.411	98.386	104.512	95.386	100.954	89.991	89.624
369	104.778	86.152	101.595	86.19	98.092	77.603	91.469	79.067
370	106.616	98.452	103.473	93.555	97.782	86.491	95.811	76.26
371	104.701	127.241	100.49	120.008	94.147	108.086	90.625	101.113
372	106.606	123.855	103.465	120.822	97.716	112.217	95.493	107.789
373	106.616	123.872	103.473	120.836	97.782	112.363	95.811	108.422
374	104.701	127.241	100.49	120.008	94.147	108.086	90.625	101.113
375	106.606	123.855	103.465	120.822	97.716	112.217	95.493	107.789
376	105.054	117.538	100.922	110.588	95.535	101.093	89.762	88.957
377	104.044	115.342	100.484	109.89	95.082	100.692	90.89	92.368
378	105.046	91.439	100.916	91.311	95.531	87.637	89.758	82.759
379	108.276	86.21	105.109	82.669	98.618	78.982	96.99	68.65
380	105.795	128.609	101.516	121.381	94.89	109.434	91.831	103.39
381	108.261	133.154	105.098	128.363	98.61	116.743	96.981	113.57
382	108.276	86.21	105.109	82.669	100.501	70.162	97.097	68.385
383	105.795	128.609	101.516	121.381	94.816	109.347	91.827	103.386
384	108.261	133.154	105.098	128.363	100.494	120.969	97.089	113.795

TABLE 8:-FLOOR LEVEL BEAM FORCES

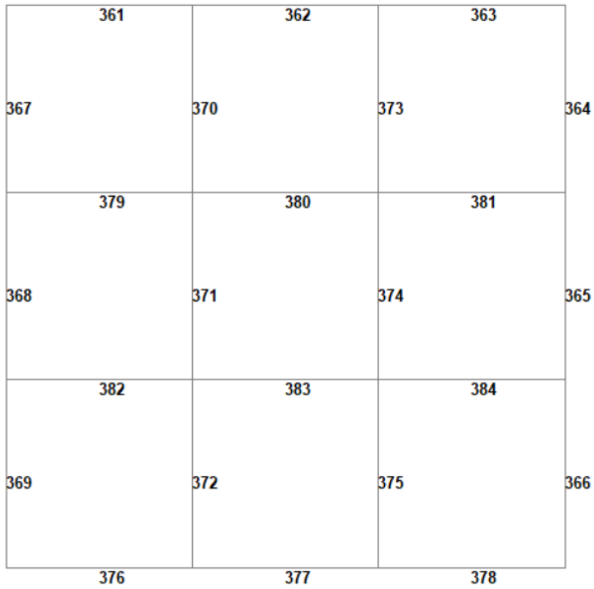

FIG:-FIG SHOW FLOOR LEVEL BEAM FORCES

sr no	quantity of concrete	% decreasing from terrain categor
1	250.1	13.27% (from category 1-2)
2	220.8	11.17% (from category 2-3)
3	198.6	1.6897 (from category 3-4)
4	195.3	-----

TABLE 9:-PERCENTAGE DECREASING IN QUANTITY OF CONCRETE

The types of terrain and a brief description

Category I (TC1):-Lakes or flat, horizontal areas with little vegetation and no impediments (roughness) are classified as Category I (TC1).

Category II (TC2): Low-vegetation areas, such as grass, as well as solitary barriers (trees, buildings)
at least 20 obstacle height separations (roughness height)

Category III (TC3): Vegetation-covered area with a regular pattern.
or structures, or isolated with a maximum separation of 20 feet heights of obstacles (such as villages, suburban terrain, and mountains)
Forest (permanent)

Category IV (TC4):-
At least 15% of the population lives in Category IV (TC4). Buildings cover the surface, and their average height is

reaches 15 metres

4. COMPARISON OF RESULTS

As terrain category increases ,quantity of concrete required for construction decreases nearly by 10 % in each category but quantity of steel almost remains equal.

5. CONCLUSION

The pressure intensity of the wind diminishes as the terrain category increases.

Node displacement in the x, y, and z directions increases as terrain category increases.

The axial force in a narrow column diminishes as the terrain category increases.

The bending moment in the column is almost equal or decreases as the terrain category increases.

Shear force and bending moment in the beam diminish as the terrain category increases.

As the terrain category increases, the amount of concrete required for building drops by almost 10% in each category, but the amount of steel required essentially stays the same.

Although all components and member are designed with a safety factor, it is always suggested that to use that components under their design limit.

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7. BIOGRAPHIES AUTHORS

Onkar uplanchiwar[1], (M-Tech 2nd Year Student), Structural and Construction Engineering Department, Ballarpur Institute of Technology, Ballarpur, Chandrapur, Maharashtra, India.

Prof. Ganesh mahalle[2], (Assistant Professor), Structural and Construction Engineering Department, Ballarpur institute of Technology, Ballarpur, Chandrapur, Maharashtra, India.