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Analysis of High-Rise Building under Seismic and Wind Load using ETABS

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Abstract: These days in Mumbai there not much land left for new development so there is a quick expansion in development field in edge district like Navi-Mumbai, Panvel, Vasai-Virar locale. Thus, there is a need of multi-story building. In seismic and wind examination of working by involving ETABS in this undertaking we for the most part manage investigation, taking into account stacks that is, seismic burden and wind load. Vasai-Virar goes under seismic zone 3. We have taken g+30 story building. The construction higher than G+5 is viewed as under the seismic stacking. In this task we examination and plan of building involving rectangular section for financial construction. We figure out the boundaries like Twisting moments, shear force, Story shear and firmness, upsetting second, story float and so on of building Talk about the outcomes coming from the Straight Powerful Examination (Response Spectrum Analysis) Technique.

Keywords: Multi-Storied Building, Seismic and Wind Analysis, Response Spectrum Analysis.

1. INTRODUCTION

The increase in population by which land deficit occurs and to overcome that, high-rise buildings are opted. The structure is located in Mumbai region. The structure is a residential project. The structure consists of ground floor with 30 upper floors in which 12th floor and 24th floor are refuge floors. Mumbai is the first largest city in the Indian state of Maharashtra and the 1st most populous city in India. It has been known as the "city of dreams" as they call. It has gained this epithet over the years not just because it offers limitless opportunities for the Indian citizens across the states, but also for people across the borders. Nowadays in Mumbai there not much land left for new construction so there is a rapid increase in construction field in outskirt region such as Navi-Mumbai, Panvel, Vasai-Virar region. These types of high-rise buildings are affected by the natural calamities. Calamities like earthquakes are the most dangerous by means of the damage and chaos caused to the structural components and they cannot be controlled. These natural calamities caused property damage and interruptions in development of the normal lifecycle. Since it's aglobal concern, most of the analysis should be carried out and provided with the results to prepare the structure in order to attain time period. With the technological advancement, man tried combating with these natural calamities through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters. Hazard maps indicating seismic zones in seismic codes (IS 1893:2002) are revised from time to time which leads to additional base shear demand on existing buildings. The structure mentioned above is analyzed and checks for serviceability are carried on within limits.

Many researches and studies have been done in order to mitigate excitations and improve the performance of tall building against wind loads & earthquake loads. An extremely important and effective design approach among these methods is aerodynamic modifications, including, modifications of buildings corner geometry and its cross-sectional shape. Tall buildings are gigantic projects demanding incredible logistics and management, and require enormous financial investment. A careful coordination of the structural elements and the shape of a building which minimize the lateral displacement, may offer considerable savings. Nowadays, the challenge of designing an efficient tall building has considerable changed. The conventional approach to tall building design in the past was to limit the forms of the building to a rectangular shape mostly, but today, much more complicated building geometries could be utilized.

A building should possess four main attributes, mainly having simple and regular configuration, adequate lateral strength,

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stiffness and ductility. Buildings having simple regular geometry in plan as well as in elevation, suffer much less damage than the irregular configuration. A building shall be considered as irregular as per is 1893-2002, if it lacks symmetry and has discontinuity in geometry, mass or load resisting elements. These irregularities may cause problem in continuity of force flow and stress concentrations.

Fig. 1: Inertia Forces in Structures

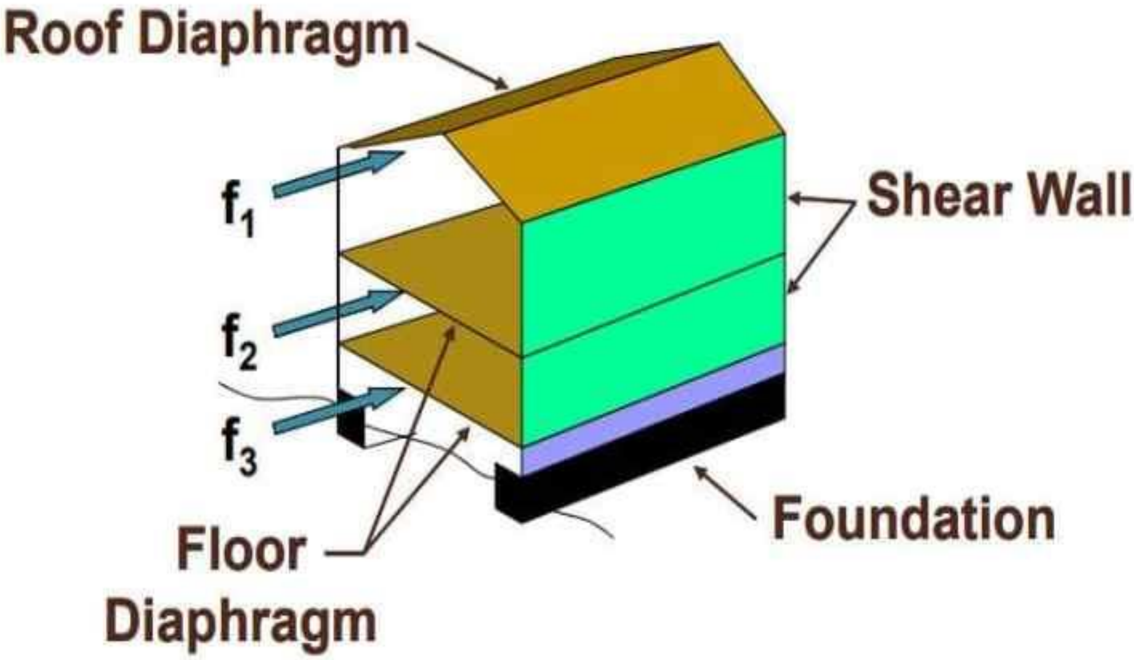

Fig. 2: Effects of Earthquake in Structures

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2. LITERATURE REVIEW

As the peak of the building increases the effect of lateral hundreds (seismic and wind hundreds) emerge as very predominant. This chapter will speak about the previous work carried out on this discipline. Many researchers have studied the efficiency of RC frame with exceptional style of bracings, shear walls and so forth. One of the papers is mentioned beneath.

Ali Kadhim Sallal (2018): The main purpose of this software is to design and analysis multi-Storeyed building in a systematic process. This paper presents a building where designed and analyzed under effect of earthquake and wind pressure by using ETABS software. In this case, (18m x 18m) and eight stories structure are modeled using ETABS software. Ten storey is taken as (3m) height and making the total height of the structure (31m). [1]

Pushkar Rathod and Rahul Chandrashekar (2017): With the help of seismic analysis, the structure can be designed and constructed to withstand the high lateral movement of earth's crust during an earthquake. Any type of basic or a highly advanced structure which maybe under static or dynamic conditions can be evaluated by using ETABS. ETABS is a coordinated and productive tool for analysis and designs, which range from a simple 2D frames to modern high-rises which makes it one of the best structural software for building systems. [2]

Pardeshi Sameer and Prof. N. G. Gore (2016): This paper is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of regular and irregular RC building frames and Time History Analysis (THA) of regular RC building frames and carry out the ductility based design using IS 13920 corresponding to response spectrum analysis. Comparison of the results of analysis of irregular structures with regular structure is done. [3]

Vijaya Bhaskar reddy. Set. al. (2015): This paper presents illustration of a comparative study of static loads for 5 and 10 storey multi storeyed structures. The significance of this work is to estimate the design loads of a structure. They conclude that deflection of the members is high with an increase in no. of floors. It can be observed that axial force is high in 10-storey compared to 5-storey building. [4]

Abhay Guleria (2014): The case study in this paper mainly emphasizes on structural behavior of multi-storey building for different plan configurations like rectangular, C, L and I-shape. Modeling of 15- storey R.C.C. framed building is done on the ETABS software for analysis. Post analysis of the structure, maximum shear forces, bending moments, and maximum storey displacement are computed and then compared for all the analyzed cases. The analysis of the multistoried building reflected that the storey overturning moment varies inversely with storey height. From dynamic analysis, mode shapes are generated and it can be concluded that asymmetrical plans undergo more deformation than symmetrical plans. [5]

Objective:

- To study irregularities in structural analysis of G+30 storey structure as per Code (IS 1893:2002).
- To study the behavior of structure when seismic and wind load is applied.
- Determination of displacements, story drift and modal mass participation ratio and torsion irregularity subjected to earthquake loading zone.
- To analyze the behavior of structure using response spectrum method.

3. METHODOLOGY

In the present study, analysis of G+30 multi-story building in all seismic zones for wind and earthquake forces is carried out.3D model is prepared for G+30 multi-story building using ETABS.

Response Spectrum:

Response spectrum is a plot of peak of steady-state response (displacement, velocity or acceleration) of a series of oscillators of varying natural frequency that are forced into motion by same base vibration or shocks. Response spectrum analysis is typically used to perform seismic analysis. Response spectrum analysis calculates the max response values in each mode of the structure from the spectrum curve and then combines this response using modal super position. A RS analysis seeks to determine the likely max response of structure when subjected to pseudo acceleration of a response spectrum curve.

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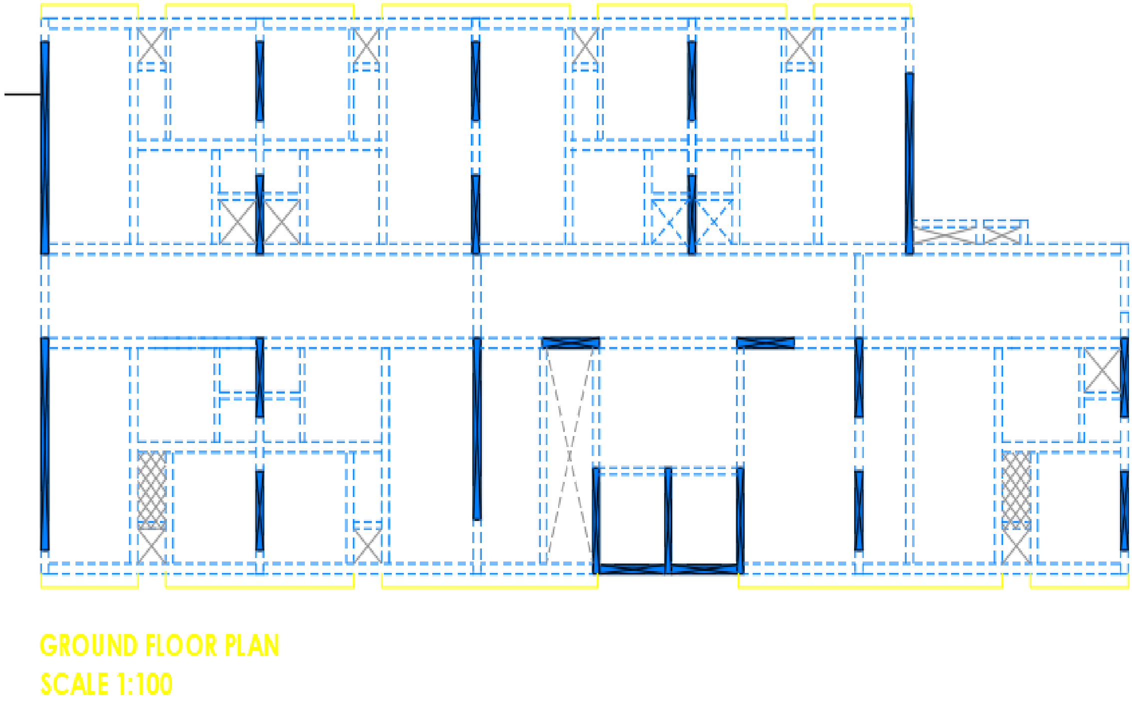

Fig. 3: Structural ground floor plan

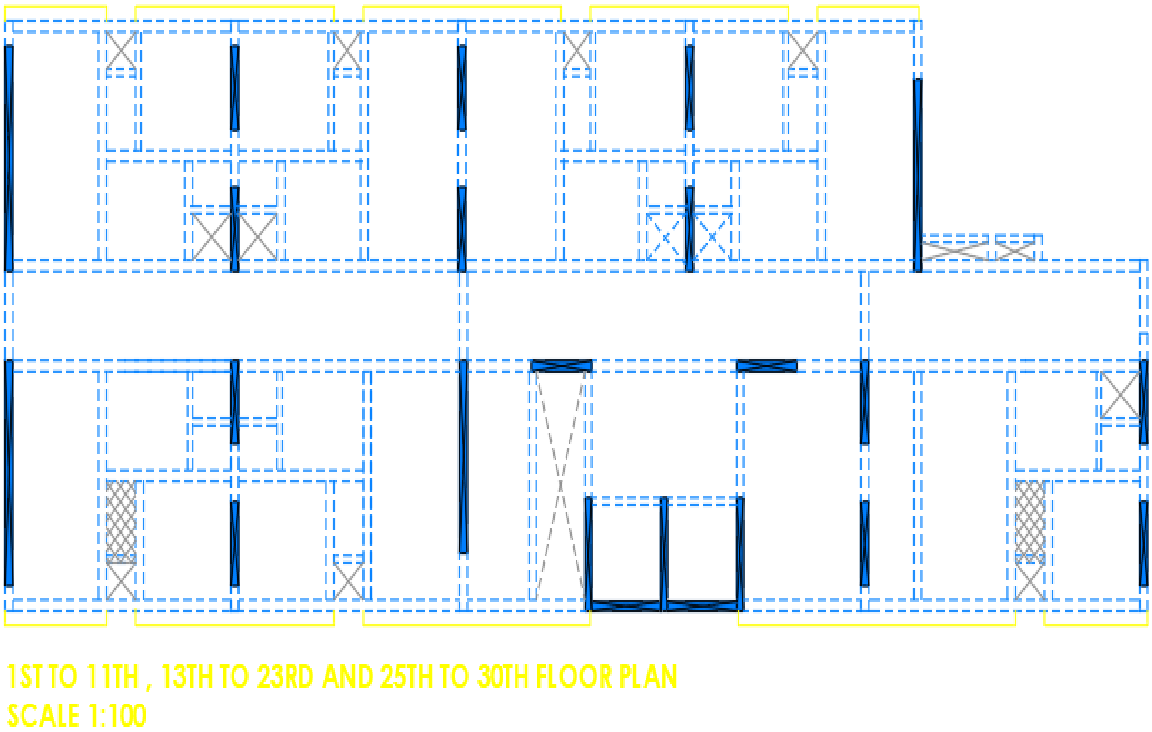

Fig. 4: Structural plan for 1st to 11th, 13th to 23rd and 25th to 30th Floor plan

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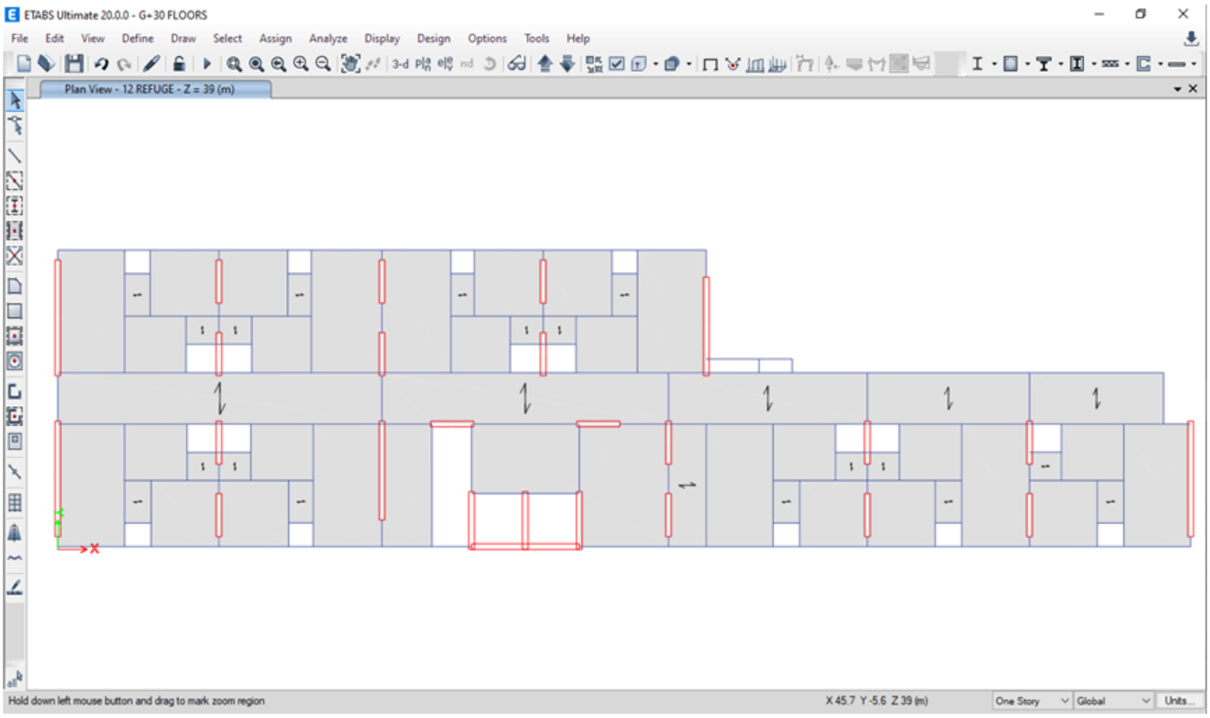

Fig. 5: Typical floor plan

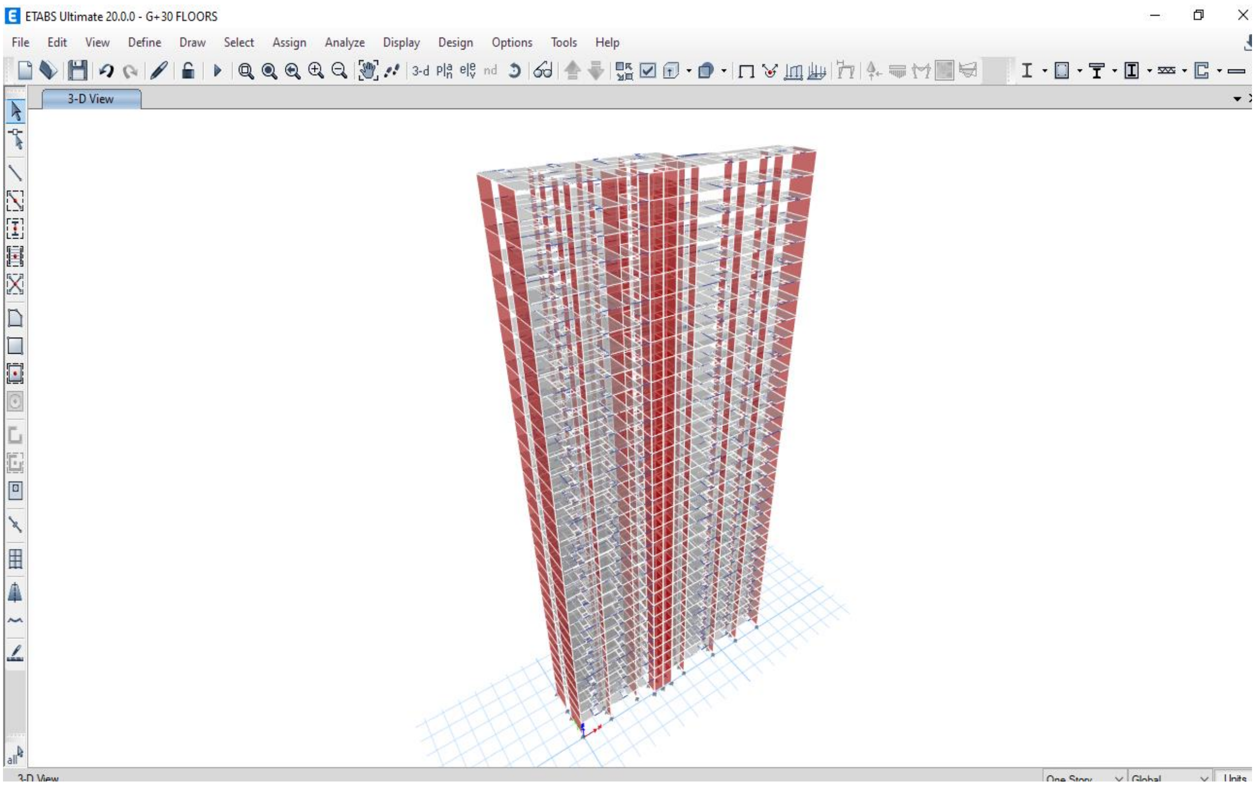

Fig. 6: Elevation View

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4. ANALYSIS:

Torsional irregularity:

Table 4: Torsional irregularity for EQX

FAIL		PASS		LESS THAN1.4			
					0		
EQX 1	UX						
Story	Corner Jt Label 209	Corner Jt Label 211	avg	max/avg	Corner Jt Label 309	Corner Jt Label 312	avg
TERRACE	64.375	58.607	61.49	1.05	61.012	58.608	59.81
30th Floor	63.427	57.868	60.65	1.05	60.185	57.86	59.02
29th Floor	62.356	57.015	59.69	1.04	59.241	57.008	58.12
28th Floor	61.155	56.035	58.60	1.04	58.17	56.03	57.10
27th Floor	59.821	54.925	57.37	1.04	56.967	54.921	55.94
26th Floor	58.358	53.689	56.02	1.04	55.636	53.684	54.66
25Th Floor	56.774	52.332	54.55	1.04	54.184	52.327	53.26
24th Floor	55.076	50.862	52.97	1.04	52.62	50.858	51.74
23th Floor	53.274	49.288	51.28	1.04	50.95	49.283	50.12
22th Floor	51.374	47.618	49.50	1.04	49.184	47.613	48.40
21th Floor	49.387	45.858	47.62	1.04	47.33	45.853	46.59
20th Floor	47.32	44.018	45.67	1.04	45.396	44.013	44.70
19th Floor	45.182	42.106	43.64	1.04	43.389	42.101	42.75
18th Floor	42.981	40.129	41.56	1.03	41.319	40.124	40.72
17th Floor	40.726	38.094	39.41	1.03	39.192	38.089	38.64
16th Floor	38.424	36.01	37.22	1.03	37.017	36.005	36.51
15th Floor	36.084	33.883	34.98	1.03	34.802	33.879	34.34
14th Floor	33.713	31.721	32.72	1.03	32.553	31.717	32.14
13th Floor	31.32	29.531	30.43	1.03	30.278	29.527	29.90
12th Floor	28.911	27.319	28.12	1.03	27.984	27.315	27.65
11th Floor	26.495	25.093	25.79	1.03	25.679	25.089	25.38
10th Floor	24.079	22.859	23.47	1.03	23.369	22.855	23.11
9th Floor	21.67	20.623	21.15	1.02	21.061	20.62	20.84
8th Floor	19.275	18.392	18.83	1.02	18.762	18.389	18.58
7th Floor	16.902	16.172	16.54	1.02	16.478	16.169	16.32
6th Floor	14.557	13.969	14.26	1.02	14.216	13.967	14.09
5th Floor	12.249	11.791	12.02	1.02	11.984	11.79	11.89
4th Floor	9.985	9.644	9.81	1.02	9.788	9.643	9.72
3rd Floor	7.776	7.536	7.66	1.02	7.638	7.536	7.59
2nd Floor	5.633	5.481	5.56	1.01	5.547	5.483	5.52
1st Floor	3.565	3.484	3.52	1.01	3.53	3.495	3.51
GF	1.707	1.68	1.69	1.01	1.662	1.649	1.66

Table 4: Torsional irregularity for EQY

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FAIL		PASS						
EQY 1	UY							
Story	Corner Jt Label	Corner Jt Label			Corner Jt Label	Corner Jt Label		
	209	309	avg	max/avg	211	312	avg	max/avg
TERRACE	28.994	60.265	44.63	1.35	28.994	60.266	44.63	1.35
30th Floor	27.863	58.164	43.01	1.35	27.863	58.164	43.01	1.35
29th Floor	26.728	56.057	41.39	1.35	26.728	56.057	41.39	1.35
28th Floor	25.587	53.933	39.76	1.36	25.587	53.933	39.76	1.36
27th Floor	24.441	51.785	38.11	1.36	24.441	51.785	38.11	1.36
26th Floor	23.289	49.609	36.45	1.36	23.289	49.609	36.45	1.36
25Th Floor	22.134	47.405	34.77	1.36	22.134	47.406	34.77	1.36
24th Floor	20.976	45.174	33.08	1.37	20.976	45.175	33.08	1.37
23th Floor	19.818	42.92	31.37	1.37	19.818	42.921	31.37	1.37
22th Floor	18.662	40.645	29.65	1.37	18.662	40.646	29.65	1.37
21th Floor	17.51	38.354	27.93	1.37	17.51	38.355	27.93	1.37
20th Floor	16.366	36.052	26.21	1.38	16.366	36.054	26.21	1.38
19th Floor	15.231	33.745	24.49	1.38	15.232	33.747	24.49	1.38
18th Floor	14.11	31.439	22.77	1.38	14.11	31.441	22.78	1.38
17th Floor	13.005	29.141	21.07	1.38	13.005	29.143	21.07	1.38
16th Floor	11.92	26.859	19.39	1.39	11.92	26.861	19.39	1.39
15th Floor	10.857	24.599	17.73	1.39	10.857	24.601	17.73	1.39
14th Floor	9.82	22.371	16.10	1.39	9.82	22.373	16.10	1.39
13th Floor	8.812	20.182	14.50	1.39	8.813	20.185	14.50	1.39
12th Floor	7.838	18.043	12.94	1.39	7.838	18.046	12.94	1.39
11th Floor	6.9	15.8	11.35	1.39	6.9	15.866	11.38	1.39
10th Floor	6.002	13.8	9.90	1.39	6.003	13.755	9.88	1.39
9th Floor	5.148	11.8	8.47	1.39	5.149	11.8	8.47	1.39
8th Floor	4.342	10	7.17	1.39	4.342	10	7.17	1.39
7th Floor	3.587	8.2	5.89	1.39	3.588	8.243	5.92	1.39
6th Floor	2.889	6.57	4.73	1.39	2.889	6.619	4.75	1.39
5th Floor	2.25	5.12	3.69	1.39	2.25	5.123	3.69	1.39
4th Floor	1.676	3.776	2.73	1.39	1.677	3.77	2.72	1.38
3rd Floor	1.174	2.674	1.92	1.39	1.174	2.677	1.93	1.39
2nd Floor	0.748	1.66	1.20	1.38	0.748	1.663	1.21	1.38
1st Floor	0.407	0.845	0.63	1.35	0.408	0.939	0.67	1.39
GF	0.166	0.358	0.26	1.37	0.167	0.362	0.26	1.37

Storey Displacement:

Sr. No.	Case	Deflection	Height	Limit	Limit value	Checks
1.	EqX	64.60mm	89900mm	h/250	376.4mm	Ok
2.	EqY	60.26mm	89900mm	h/250	376.4mm	Ok
3.	Spec X	51.26mm	89900mm	h/250	376.4mm	Ok
4.	Spec Y	49.12mm	89900mm	h/250	376.4mm	Ok

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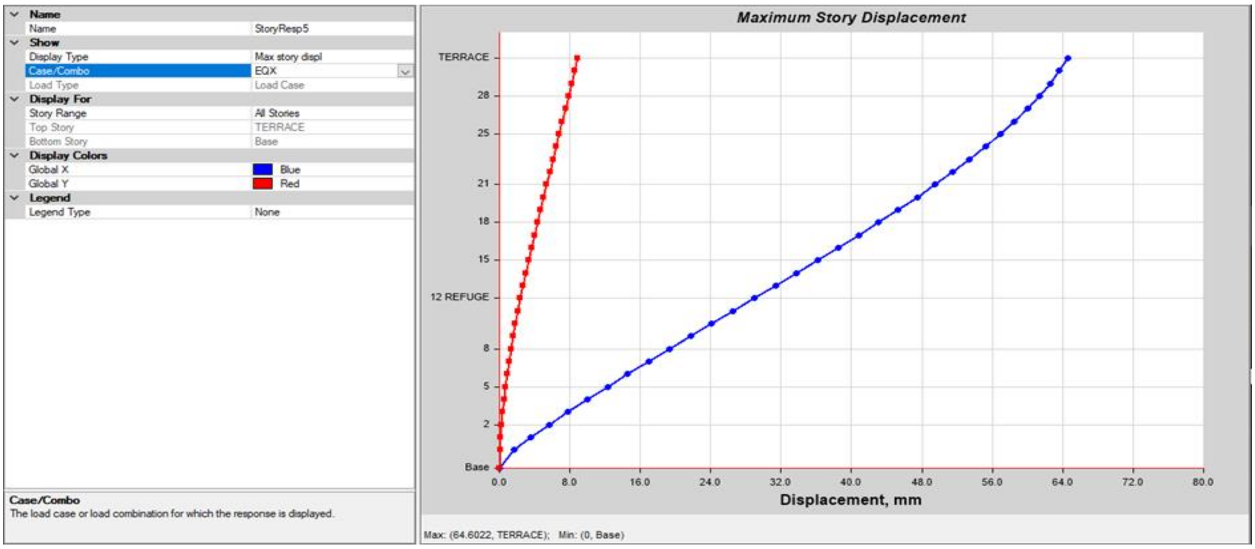
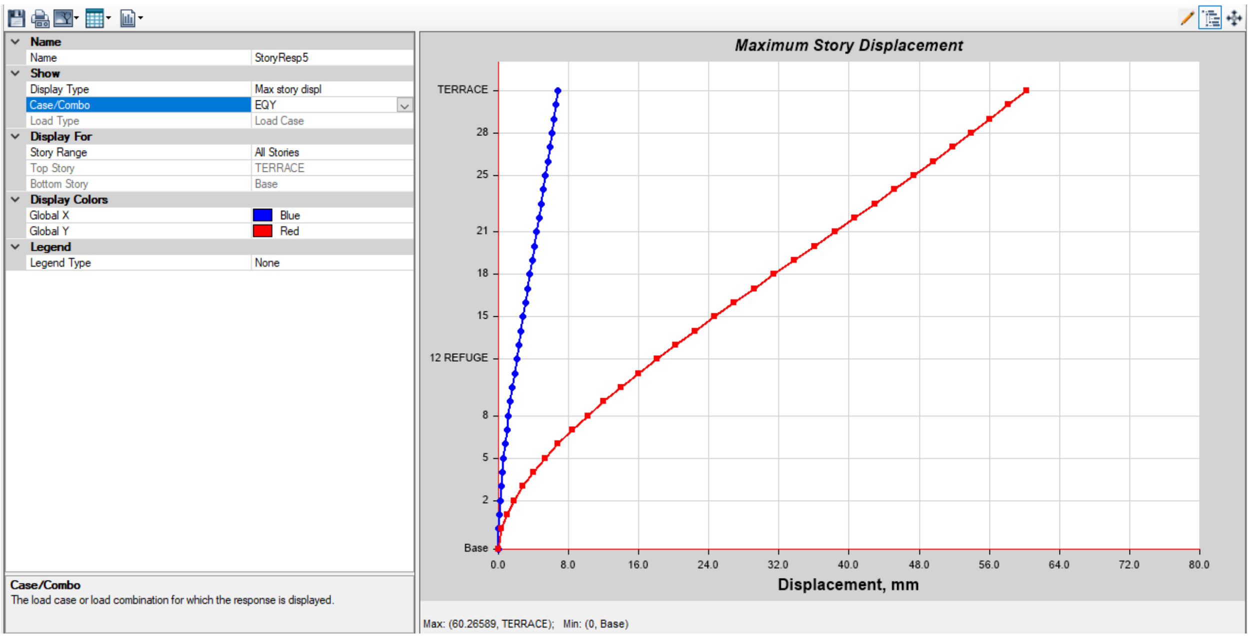
5.	Wind X	36.48mm	89900mm	h/500	188.2mm	Ok
6.	Wind Y	109.11mm	89900mm	h/500	188.2mm	Ok



Graph 1: EQX Displacement graph



Graph 2: EQY Displacement graph

Storey Drift:

Sr. No.	Case	Drift	Floor	Limit	Checks
1.	EqX	0.000835	12 Refugee	<0.004	Ok
2.	Spec X	0.000705	Between 5&8	<0.004	Ok
3.	EqY	0.0007	Between 8&21	<0.004	Ok
4.	Spec Y	0.000673	Between 21&25	<0.004	Ok

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5. CONCLUSION

1. A high-rise building of 30 floors subjected to seismic, wind and live loads wereanalyzed using ETABS software.
2. Behavior of the high-rise building was shown clearly using the graphs and lateraldisplacements.
3. The dynamic analysis must be carried out for high rise structure with vertical regularities having height more than 40m.
4. Response spectrum analysis was performed on the building, from the analysis it was concluded that the structure for serviceability is checked and are within limits.

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