A Comparative Study on Analysis of G+8 Commercial Steel Building Using STAAD. PRO And ETABS

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Abstract - *In this term paper analysis and design of a G+8 commercial building is carried out on STAAD.Pro and ETABS software and a comparison is presented. There are several software packages available in the market to aid civil engineers with designing and analysing large projects in a shorter period. Many of these design/analysis programmes even have functions like checking for geometrical mistakes, simulating the structure of different materials, and analysing the diverse profile of structural parts. Staad. Pro and Etabs are the two most popular design software programs available and are widely used by many design firms. The main focus of this paper is present the findings acquired when designing a steel building using both the softwares. Calculating the load and examining the entire structure is part of the design process. The design techniques utilised using both the software are Limit State Designs that follow the Indian Standard Code of Practice. A structural engineer's primary goal is to use technology to create a structure that is both safe and cost-effective so that they can then dare to design increasingly larger and more complex structures. The modern user interface, visualisation tools, and other features are available in STAAD.pro and Etabs softwares.*

Key Words: Comparative Study, Etabs, STAAD.Pro, Commercial Building, Complex Structures, etc.

1.0 INTRODUCTION

Civil engineering is a professional engineering subject that deals with the planning, development, and maintenance of the built environment, including public works like roads, bridges, canals, dams, airports, sewage systems, pipelines, building structural elements, and trains with the use of mathematical calculations, physics laws, and mechanics theories. Predicting how a structure will respond to external stress is the practice of structure analysis. During the preliminary design phases, the loads being applied to the structure are evaluated using the anticipated external loads. The size and reinforcement to be employed for the various members are computed. The link between these external loads placed on the members and the internal forces and displacements produced within the members to balance out these external loads during use is developed through structural analysis.

Now a days structural engineering software's are used to analyse and design a wide range of different types of structures. Because of their adaptable modelling environment, cutting-edge features, and flexible data collaboration, it enables structural engineers to analyse and design practically any sort of structures, including buildings, bridges, towers, structures for transportation, industry, and utilities, can be easily analysed and designed using various design softwares like STAAD.Pro and Etabs. Thus, eliminating the rigorous human efforts and errors.

1.1 OBJECTIVES OF STUDY

- Analysis and designing of a G+8 commercial steel building by STAAD and ETABS.
- Compare the horizontal displacements, support reactions, axial forces in columns, shear forces and bending moment in beams obtained from both software's.

2.0 LITERATURE REVIEW

Mohammed Arham Siddiqui, Dr. Khalid Moin (2021) carried out analytical study of a G+2 building using STAAD.Pro and Etabs. They found that the vertical reactions obtained using both the software's were almost the same but a considerable deviation was found in shear forces and bending moment values.

Sayeed Ur Rahman, Dr. Sabih Ahmad (2019) did dynamic analysis of a multi-storeyed building using STAAD. Pro and Etabs respectively. They found that the effect of forces obtained from both the softwares were almost similar. However, while analysis and designing Etabs was found more suitable and user-friendly software.

Shubham Srivastava, Mohd. Zain, Vineet Pathak (2018) carried out comparative analytical study of a G+7 building using STAAD.Pro and Etabs. They found that the bending moment and horizontal displacement for the building frame was higher as compare to the Etabs results.

Mohammad Kalim, Abdul Rehman, B S Tyagi (2018) carried out a comparative analytical study using STAAD. Pro and Etabs for a G+14 building. They found that the axial forces obtained were same from both the softwares. However, Etabs was found more suitable while designing a RCC framed building.

K Venu Manikanta, Dr. Dumpa Venkateswarlu (2016) carried out analytical study of a multi-storeyed unsymmetrical building using STAAD. Pro and Etabs. They found that the Support reactions obtained from the two softwares were almost identical, however Etabs gives the lesser values of support reactions.

3.0 MODELLING OF G+8 COMMERCIAL BUILDING

3.1 PLAN AND 3-D VIEW OF THE BUILDING

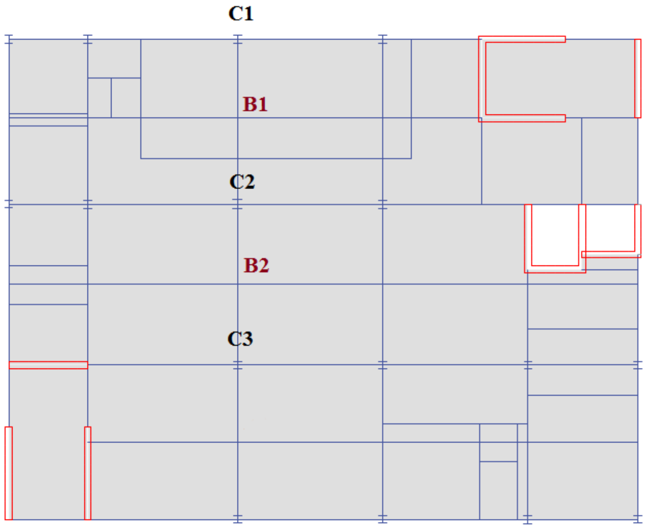

Fig. -3.1: A Typical Structural Plan of the G+8 Building Showing Various Beams, Columns and Shear Walls in ETABS

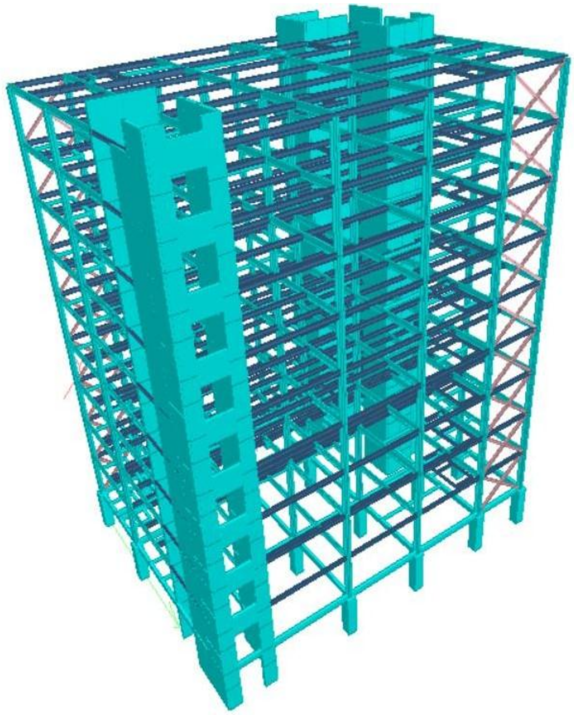

Fig. -3.2: 3-D Rendered View in STAAD. PRO

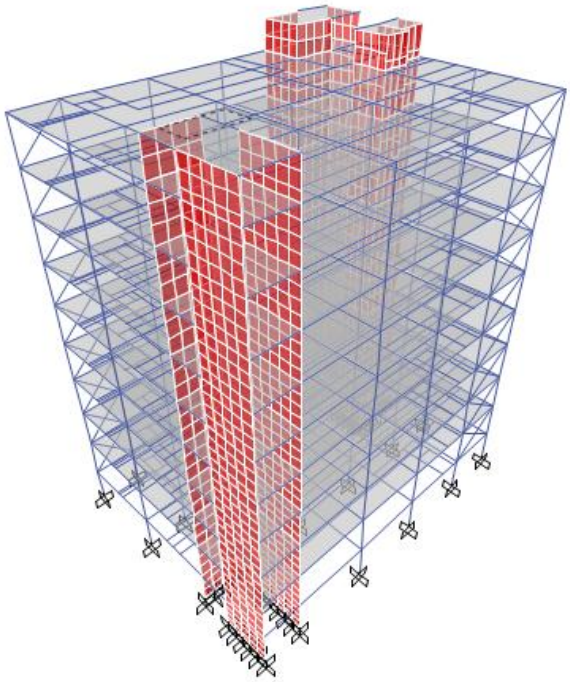

Fig. -3.3: 3-D Rendered View in ETABS

3.2 ARCHITECTURAL PLANNING

A technical representation of a structure that meets the concept of architecture is an architectural drawing. The architectural details, such as rooms, lobbies, staircases, kitchens, wall thicknesses, balconies, and restrooms, are identified by the engineers using these drawings.

The building is designed in such a way that the column grid should remain uniform for the ease of analysis and design. The normal floor to floor height and plinth height for the building is taken as 3.75 m and 3.0 m respectively.

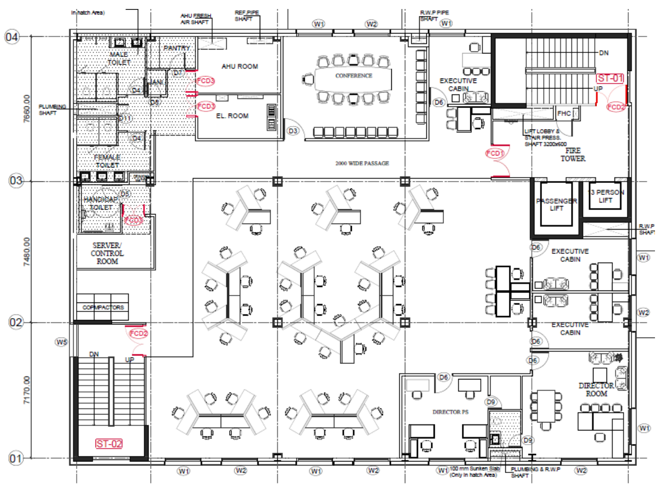

Fig. -3.4: Typical Architectural Plan of the Building Showing various rooms, staircases and lifts

4.0 PRILIMINARY DATA CONSIDERED

4.1 Dead Loads

Concrete grade used	M30
Steel grade used	Fe 550D
Density of concrete	25 kN/m²
Density of floor finish	22 kN/m²
Floor load	2.95 kN/m²
Staircase load	9 kN/m²
Terrace load	6.5 kN/m²
Wall load (100mm thick)	2 kN/m
Wall load (122mm thick)	2.45 kN/m
Wall load (145mm thick)	2.91 kN/m
Wall load (150mm thick)	3.015 kN/m

4.2 Live Loads

Live load on the structure are taken from IS:875 (part 2) are as follows:-

Live load on floors	4 kN/m²
Live load on staircase	4 kN/m²
Live load on terrace level	5 kN/m²
Live load on lift	10 kN/m²

4.3 Seismic Loads

Seismic load on structure IS taken from IS:1893 (part 1) are as follows:

Seismic zone:	IV
Z:	0.24
I:	1.2
R:	3
Sa/g:	As per spectrum curve
Time period:	$0.085*H^{0.75}$
Damping of structure:	5%
Ah:	ZI Sa/(2gR)

4.4 Various Load Combinations

1. 1.0(DL+LL)
2. 1.0(DL+EQX)
3. 1.0(DL-EQX)
4. 1.0(DL+EQZ)
5. 1.0(DL-EQZ)
6. 1.0(DL+0.8LL+0.8EQX)
7. 1.0(DL+0.8LL+0.8EQX)
8. 1.0(DL+0.8LL+0.8EQZ)
9. 1.0(DL+0.8LL+0.8EQZ)
10. 1.0(DL+WLX)
11. 1.0(DL-WLX)
12. 1.0(DL+WLZ)
13. 1.0(DL-WLZ)
14. 1.0(DL+0.8LL+0.8WLX)
15. 1.0(DL+0.8LL-0.8WLX)
16. 1.0(DL+0.8LL+0.8WLZ)
17. 1.0(DL+0.8LL-0.8WLZ)
18. 1.5(DL+WLZ)
19. 1.5(DL-WLZ)
20. 1.5(DL+WLX)
21. 1.5(DL-WLX)
22. 1.2(DL+LL+WLX)
23. 1.2(DL+LL-WLX)
24. 1.2(DL+LL+EQZ)
25. 1.2(DL+LL-EQZ)
26. 1(0.9DL+1.5WLX)
27. 1(0.9DL-1.5WLX)
28. 1.5(DL+LL)
29. 1.5(DL+EQZ)
30. 1.5(DL-EQZ)
31. 1.5(DL+EQX)
32. 1.5(DL-EQX)
33. 1.2(DL+LL+EQX)
34. 1.2(DL+LL-EQX)
35. 1.2(DL+LL+EQZ)
36. 1.2(DL+LL-EQZ)
37. 1(0.9DL+1.5EQX)
38. 1(0.9DL-1.5EQX)
39. 1(0.9DL+1.5EQZ)
40. 1(0.9DL-1.5EQZ)
41. 1(0.9DL+1.5EQZ)
42. 1(0.9DL-1.5EQZ)

DL- Dead Load LL- Live load
ELX- Earthquake load in X direction ELZ- Earthquake load in Z direction WLX- Wind load in X direction WLZ- Wind load in Z direction.

5. RESULTS AND DISCUSSIONS

The G+8 steel structure is modeled and analysed for the various load combinations using STAAD. Pro and ETABS simultaneously for the identical conditions. The parameters chosen for the comparative study of the structure were horizontal displacements, support reactions, axial forces in columns, shear forces and bending moment in beams. The results are presented in table 5.1, 5.2, 5.3, 5.4 and 5.5 respectively. Similarly axial forces in columns, shear force and bending moment diagrams are presented in Fig. 5.1 to 5.6 respectively.

The comparison of various data from both the softwares is presented below:

Table -5.1: Comparison of Horizontal Displacement of the building is presented below:

Displacement direction	Displacement (mm) using	
	Staad.Pro	Etabs
Displacement in X-direction	46.45	42.23
Displacement in Z-direction	31.76	30.96

Table -5.2: Comparison of Support Reactions using Staad.Pro and Etabs:

Support Number	Support Reactions (kN)	
	STAAD.Pro	Etabs
53	2036.2	2071.7
54	2976.7	2853.5
57	3911.8	3792.7
61	3043.1	3035.1
51	2483.7	2268.3
52	5154.8	5002.6
56	6666.7	6791.1
60	5923.5	6229.1
55	5915.6	5928.4
59	5959.9	6018.2
63	4082.5	4228.2
67	2195.1	2276.6
48	3204.6	3331.1
58	3340.3	3500.1
62	2624.1	3000.4
66	1782.3	2123.7

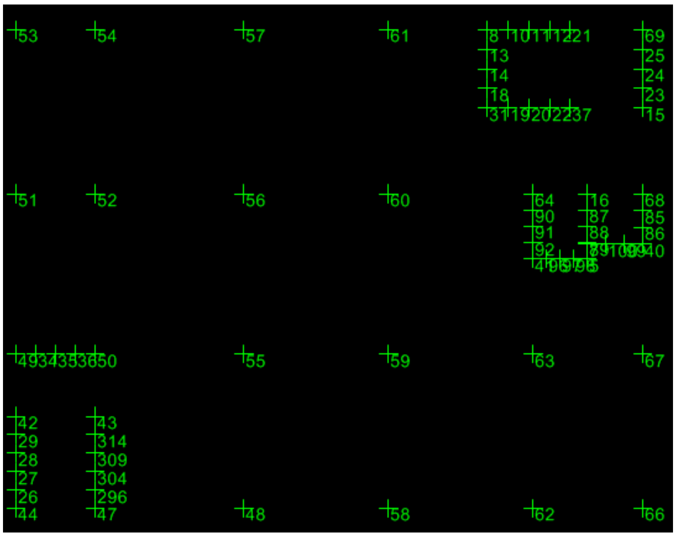

Fig -5.1: Label Showing Support Numbering

Table -5.3: Comparison of Axial Force for Columns 1, 2 and 3 are given below:

Floor Levels	Axial Force (kN)	
	Staad.Pro	Etabs
For Column no. 1		
BASE	3905.3	3792.7
PLINTH	3730.5	3627.1
1ST	3300.5	3230.1
2ND	2900.3	2829
3RD	2500.4	2426.6
4TH	2100.3	2022.5
5TH	1700.7	1617.4
6TH	1200.3	1211.1
7TH	830.5	804.9
8TH	409.8	394.7
For Column no. 2		
BASE	6700.3	6791
PLINTH	6500.4	6623
1ST	5800.8	5882.4
2ND	5100.3	5146
3RD	4300.3	4410.9
4TH	3600.7	3676.7
5TH	2900.3	2943.8
6TH	2200.3	2211.5
7TH	1500.5	1478.7
8TH	732.8	750.1
For Column no. 3		
BASE	5900.3	5928.4
PLINTH	5800.3	5792.2
1ST	5100.5	5134.8
2ND	4500.8	4480.5
3RD	3800.4	3830.8
4TH	3200.3	3184
5TH	2500.3	2540.2
6TH	1900.3	1898.5
7TH	1300.3	1258.1
8TH	640.7	621.2

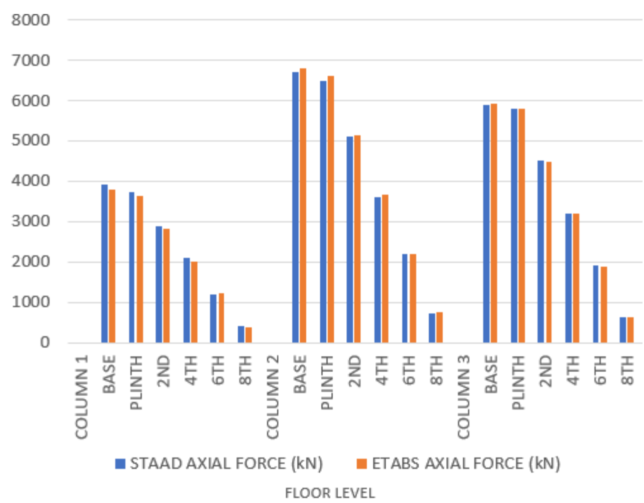

Fig.-5.2: Comparison of Floor-wise Vertical Load on Various Selected Columns

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Table -5.4: Comparison of Maximum Shear Force for Beams 1 and 2 at different levels are given below:

Beams	Maximum Span Shear Forces (kN) using	
	Staad.Pro	Etabs
For B1		
PLINTH	45.8	55
1ST	294	320
2ND	291.5	315
3RD	289.1	314
For B2		
PLINTH	37.1	27
1ST	210	211
2ND	210	211
3RD	211.1	212

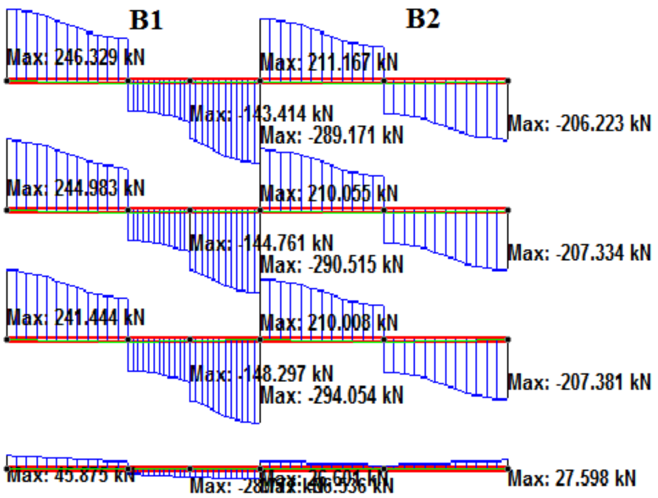

Fig. -5.3: Shear Force Diagrams for beams on different floors obtained using STAAD

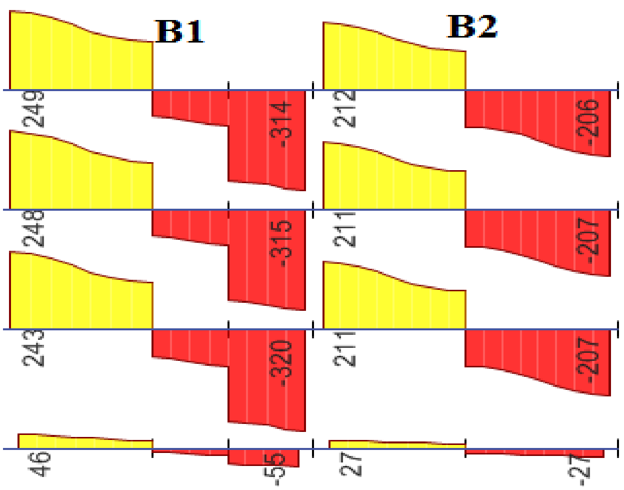

Fig. -5.4: Shear Force Diagrams for beams obtained using ETABS

Table -5.5: Comparison of Maximum Span Bending Moment for Beams 1 and 2 are given below:

Beams	Maximum Bending Moments (kN-m) using	
	Staad.Pro	Etabs
For B1		
PLINTH	71	63
1ST	449	419
2ND	438	408
3RD	432	400
For B2		
PLINTH	60	35
1ST	347	306
2ND	346	305
3RD	350	309

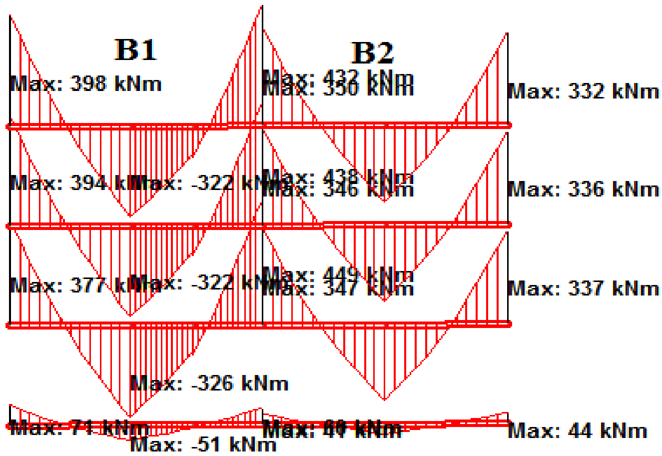

Fig. -5.5: Bending Moment Diagrams for beams on different floors obtained using STAAD

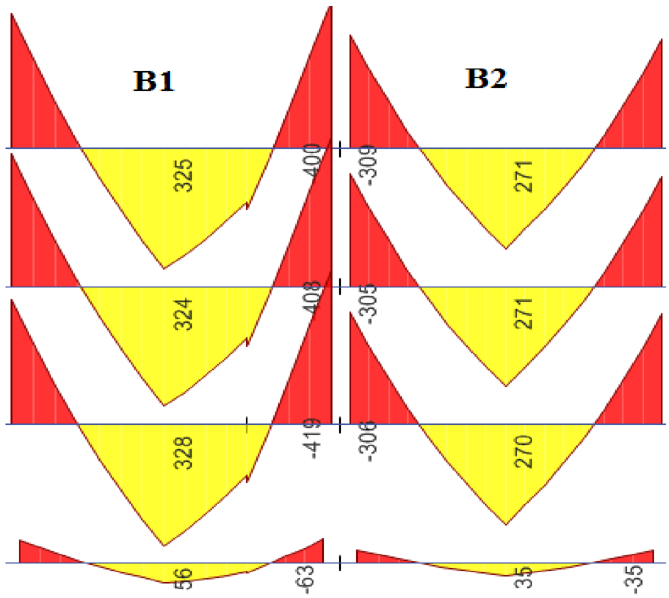

Fig. -5.6: Bending Moment Diagrams for beams on different floors obtained using ETABS

6. CONCLUSIONS

The following conclusions have been drawn from the analysis and design of the G+8 Commercial steel building using STAAD Pro. and ETABS software:

- Displacement of the building due to response spectrum in X direction and Z direction comes out to be higher with STAAD With ETABS the displacement in X direction is slightly lesser and for the Z direction it is nearly same.
- Comparing the values for Axial force, STAAD gives higher value for column 1 on each level than the results obtained from Etabs, while for columns 2 & 3 it was found vice-versa.
- Comparing the highest values for shear force and bending moment at each floor level, it was found that they were roughly equal, with ETABS software displaying higher values for maximum shear force and STAAD showing higher values for maximum span bending moments.
- The vertical loads on most of the supports for both pieces of software were assessed and determined to be roughly equivalent.
- The ETABS programme minimises effort and provides a more user-friendly interface.
- In ETABS, modeling and designing the structure as well as assigning the loads are considerably simpler and take much less time.
- Overall, both programmes are highly useful for structural analysis and design.

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REFERENCES

[1] Siddiqui M. A. and Moin K.: " Comparative Study on Analysis of G+2 Residential Building by STAAD. Pro V8i(SELECT series 5) and ETABS 2018 Software's", 8[8], 1521-1527, August-2021.

[2] Gurudath C., Sah A. K., Sah, M. K., Sharma R. B., Sah R.: "Analysis and design of commercial building using Etabs"5[12], 678-683, IJIRT, May-2019.

[3] Rahman S. U., Ahmad S.: "A comparative study on dynamic analysis of tall buildings using Staad Pro and Etabs", 6[4], 350-358, JETIR, April- 2019.

[4] Srivastava S., Zain M., Pathak V.: "Analysis of multi-storey building (G+7) due to seismic loading using Etabs and compare its results with Staad Pro", 5[7], 642-648, JETIR, July-2018.

[5] Kalim M., Rehman A., TyagI B. S.: "Comparative study on analysis and design of regular configuration of building by Staad Pro and Etabs" 5[3], 1793-1797, IRJET, March-2018.

[6] Manikanta K. V., Venkateswarlu D.: "Comparative study on design results of a multi-storied building using Staad Pro and Etabs for regular and irregular plan configuration", 2[15], 204-215, IJRSAE, September-2016.

[7] STAAD.Pro, Bentley Systems.

[8] Etabs Software, Integrated Building Design Software, University Avenue Berkeley California.

[9] IS:456-2000, "Code of Practice Plain And Reinforced Concrete", Bureau of Indian Standards, New Delhi.

[10] IS:875 (part 1)-2015, "Code of Practice for Design loads (other than earthquake) for buildings and structures", Bureau of Indian Standards, New Delhi.

[11] IS:875 (part 2)-2015, "Code of Practice for Design loads (other than earthquake) for buildings and structures", Bureau of Indian Standards, New Delhi.

[12] IS:875 (part 5)-2015, "Code of Practice for Design loads (other than earthquake) for buildings and structures", Indian Standard Institution, New Delhi.

[13] IS:1893 (Part 1): "Indian Standard code of practice for criteria for earthquake resistant design of structures", Bureau of Indian Standards, New Delhi.