Comparative Study on Analysis of G+10 Regular Residential Building subjected to Wind Load by STAAD.Pro V8i and ETABS 2020 Software's

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Abstract – *In this paper, STAAD.Pro and ETABS software is used to analyse and design a G+10, regular residential building. Famous software programmes like STAAD.Pro and ETABS are widely used in the field of structural engineering for analysing basic and complex structures under a variety of loading conditions. For the analysis purpose, Limit State method is used and the individual members are designed in accordance to IS:456-2000 and for the loading conditions IS:875 (Part-3) were used.*

Key Words: **STAAD.Pro, ETABS**

1. INTRODUCTION

With the aid of physics principles, mathematical equations, and mechanics theories, the field of civil engineering deals with the design, construction, and maintenance of structures such as buildings, bridges, tunnels, highways, and so forth. A structure's weight is eventually transferred to the earth. As a result, the structure's various parts experience internal tensions. For instance, in a building, a slab that is under load will transfer that load to the ground via beams, columns, and footings. Structural analysis is the process of determining these internal stresses in a structure's components, while structural design is the process of determining the ideal size of a structural component. In comparison to former periods, when it took weeks or even months to perform the task, employing STAAD and ETABS software has made modelling and designing very time-efficient, allowing the entire structure to be modelled and developed using various methods of analysis in a matter of hours.

2. OBJECTIVES

1. Analysing and designing of G+10 residential building subjected to wind load by STAAD.Pro and ETABS.

2. Comparing the so obtained results of bending moment, shear force, axial force, and deflection from both the software's.

3. LITERATURE REVIEW

Prof. Neeraj Singh Bais, Sayali Jilhewar (2021)

They did a comparative study of multi-storied building by STAAD.Pro and ETABS and verified it by doing manual calculations. They concluded that the values of shear force, bending moment and storey displacement in STAAD.Pro are slightly higher than that obtained from ETABS while the roof displacement increases with increase in number of storeys and it has a higher value in ETABS as compared to STAAD.Pro.

K Venu Manikanta, Dr. Dumpa Venkateswarlu (2016)

They did a comparative study on the design results of a multi storied building using STAAD.Pro and ETABS for a regular and irregular plan configuration and concluded that the vertical reactions obtained after the analysis were that the value was slightly higher on STAAD.Pro as compared to ETABS.

Mohammed Arham Siddiqui, Dr. Khalid Moin (2021)

They did a comparative study on analysis of G+2 residential building by STAAD.Pro and ETABS and concluded that the displacements that were obtained after analysis from both the software's were approximately same, however STAAD.Pro shows a higher value for shear force and bending moment and ETABS was found to be more user friendly compared to STAAD.Pro.

S Mahesh, Dr. B Panduranga Rao (2014)

They did a comparison of analysis and design of a regular and irregular configuration of a multi storied building in various seismic zones and various types of soils using ETABS and STAAD.Pro. They concluded that the base shear value and story drift value is more in the regular configuration as the structure has symmetrical dimensions. When the results were compared from both the software's, STAAD.Pro gave a higher value.

Ayesha Siddiqui, Dr. Madhuri Kumari (2022)

They did a comparative study on analysis of G+8 Commercial Steel Building using STAAD.Pro and ETABS. They concluded that ETABS showed a higher value for maximum shear force and STAAD.Pro showed a higher value for bending moments.

4. MODELLING OF STRUCTURE

The modelling of the structure has three major components;

- Plan
- Elevation
- 3-Dimensional View

Plan

A plan is a drawing that shows the view from the top of a building. It is commonly used to represent the location of rooms, windows, walls etc in a building. The pan area for this structure is

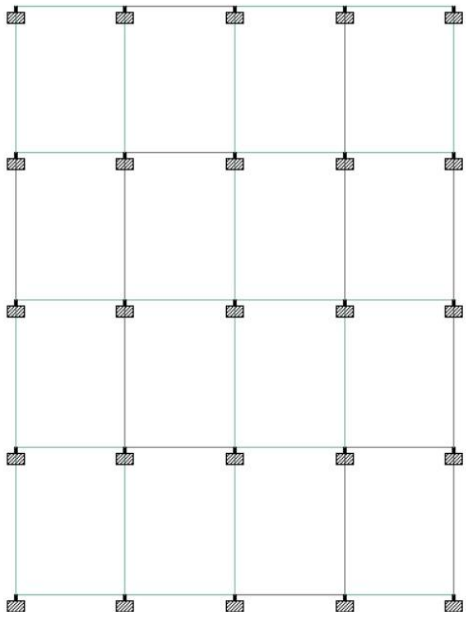

Fig:1 Plan of structure in STAAD.Pro

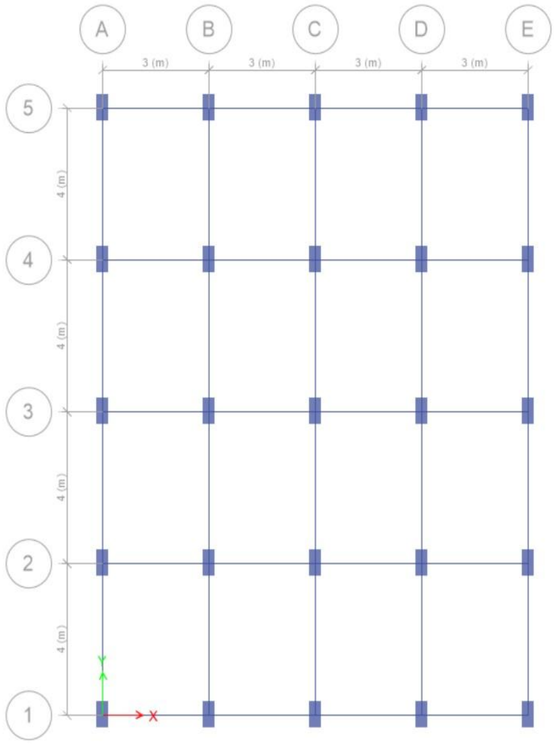

Fig:2 Plan of structure in ETABS

Elevation

Elevation drawings are a particular kind of drawing used to depict a building or a specific area of a building.

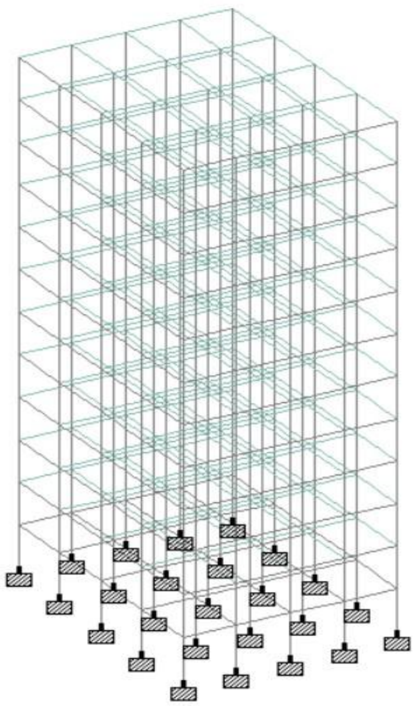

Fig:3 Elevation of structure in STAAD.Pro

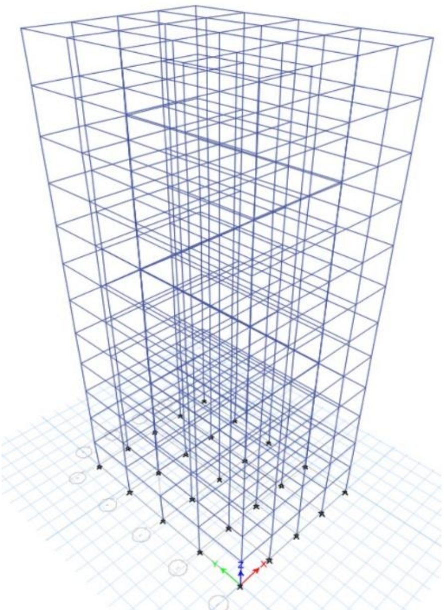

Fig:4 Elevation of structure in ETABS

A building facade or inner surface is depicted from a vertical plane in an elevation. This is comparable to standing in front of a structure and looking straight at it. Elevations are a popular design drawing and a technical architectural or engineering standard used to describe building graphically. Elevation drawings are projections in orthographic space. For this structure, the height of each floor is 3m and the plinth height is 2m.

3-Dimensional View

A 3D projection (also known as a graphical projection) is a design method that displays a 3D object on a 2D surface. In order to project a complex object into a simpler plane for viewing, these projections rely on visual perspective and aspect analysis.

For both engineers and clients, 3D view in civil engineering is a crucial tool. Instead of sifting through various drawings and patterns to determine the overall project's design, it provides both parties with an accurate picture of the project that is constructed to scale.

While 3D models can give depth information to the concept, 2D models can only show length and height on a plan. Engineers employ 3D modelling later in the design process to precisely plan the site, assisting in obtaining the optimum development with the fewest negative effects and minimising construction-related unknowns.

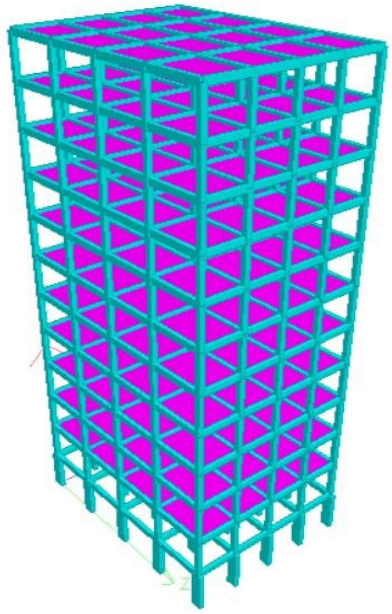

Fig:5 3-D view in STAAD.Pro

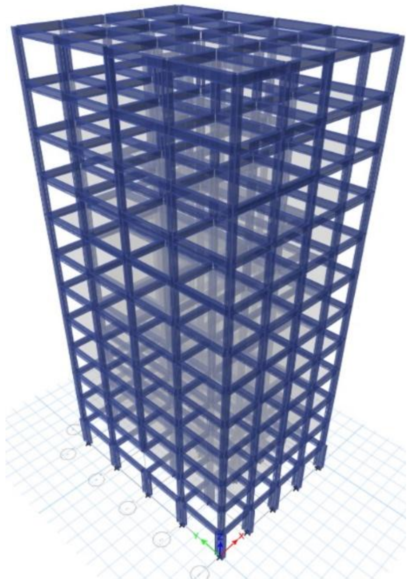

Fig:6 3-D view in ETABS

4.1. PROPERTIES OF MEMBERS

- **Beams**

B1: 0.45mm X 0.23mm

- **Columns**

C1: 0.32mm X 0.71mm

C2: 0.32mm X 0.32mm

- **Slab**

S1: 125mm thick

4.2 PRELIMINARY DATA

- **Dead Loads and Live Loads**

Grade of Concrete used: M25

Grade of Steel used: Fe500 HYSD

Density of Concrete: 25kN/m^2

Floor Load: 4kN/m^2

Staircase Load: 3kN/m^2

Sunk Load: 2kN/m^2

Parapet Load: 5.4kN/m

Partition Wall Load: 6.9kN/m

Main Wall Load: 13.5kN/m

Unit Weight of Brick Masonry: 20kN/m^3

Thickness of Partition Wall:115mm

Self-Weight of slab: 125mm

Height of each Floor: 3m

- **Wind Load**

V_B: 47m/s

Risk Coefficient Factor (K_1): 1

Terrain Coefficient Factor (K_2): 1.036

Topography Coefficient Factor (K_3): 1

Importance Factor (K_4): 1

4.3 LOAD COMBINATIONS

1. 1.5(DL+LL)
2. 1.2(DL+LL+WL)
3. 1.2(DL+LL-WL)
4. 1.2(DL+LL)
5. 1.5(DL+WL)
6. 1.5(DL-WL)
7. 1.5DL
8. 0.9DL

DL: Dead Load

LL: Live Load

WL: Wind Load

5.0 RESULTS AND DISCUSSIONS

The comparison of results given by both softwares are tabulated below.

- **Comparison of maximum and minimum axial force, shear force and bending moment on both softwares**

Axial Force (F_x)	STAAD.Pro	ETABS
Maximum	3090.031 kN	3095.121 kN
Minimum	-17.756 kN	-13.356 kN

Table:1 Maximum and Minimum Axial Force on both softwares.

Shear Force (F_y)	STAAD.Pro	ETABS
Maximum	77.559 kN	74.224 kN
Minimum	-77.396 kN	-82.973 kN

Table:2 Maximum and Minimum Shear Force on both softwares.

Shear Force (F_z)	STAAD.Pro	ETABS
Maximum	27.950 kN	33.190 kN
Minimum	-27.140 kN	-22.344 kN

Table:3 Maximum and Minimum Shear Force (in Z direction) on both softwares.

Bending Moment (M_x)	STAAD.Pro	ETABS
Maximum	0.538 kNm	0.412 kNm
Minimum	-0.510 kNm	-0.677 kNm

Table:4 Maximum and Minimum Bending Moment (in X direction) on both softwares.

Bending Moment (M_y)	STAAD.Pro	ETABS
Maximum	44.000 kNm	42.112 kNm
Minimum	-42.089 kNm	-47.132 kNm

Table:5 Maximum and Minimum Bending Moment (in Y direction) on both softwares.

Bending Moment (M_z)	STAAD.Pro	ETABS
Maximum	66.695 kNm	61.454 kNm
Minimum	-30.187 kNm	-34.309 kNm

Table:6 Maximum and Minimum Bending Moment (in Z direction) on both softwares.

Displacement	STAAD.Pro	ETABS
Maximum	9.634 mm	9.121 mm
Minimum	5.632 mm	4.934 mm

Table:7 Maximum and Minimum Displacements on both the softwares.

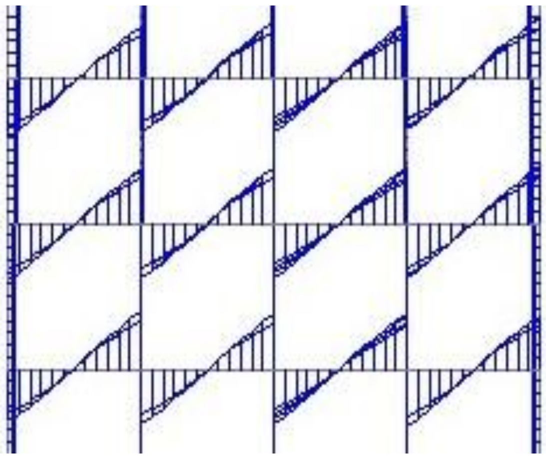

Fig:7 Shear Force Diagram as shown in STAAD.Pro

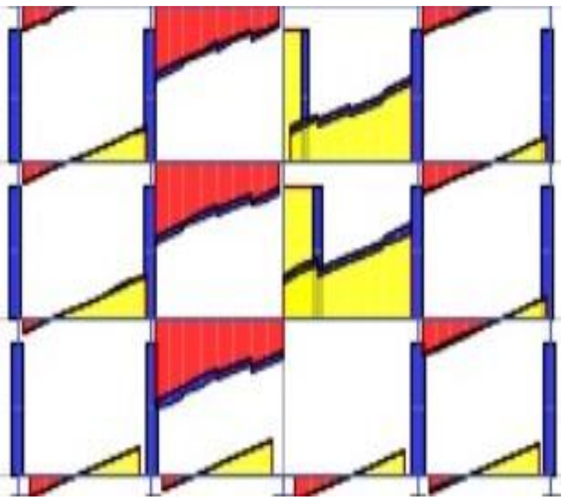

Fig:8 Shear Force Diagram as shown in ETABS

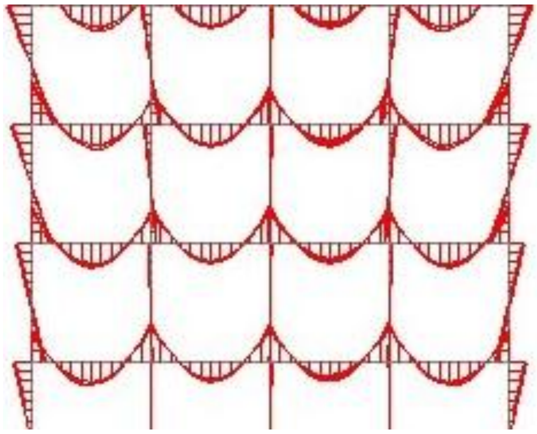

Fig:9 Bending Moment Diagram as shown in STAAD.Pro

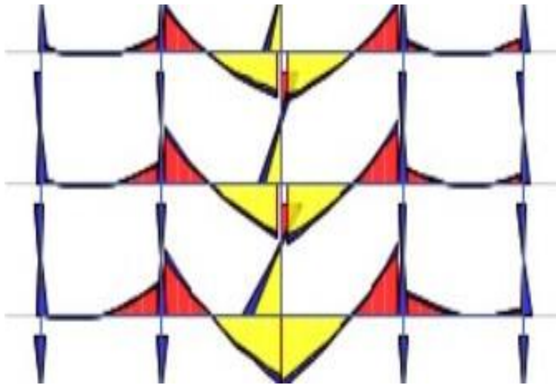

Fig:10 Bending Moment as shown in ETABS

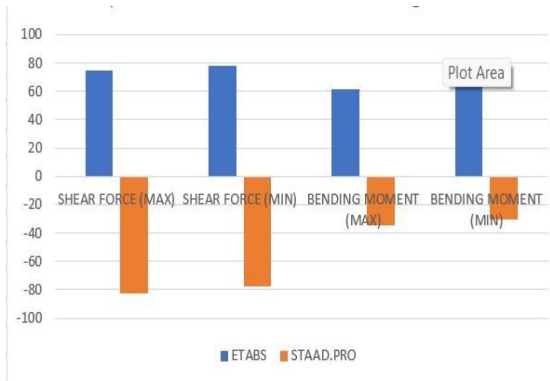

Fig:11 Comparison of Shaer Force (F_Y) and Bending Moment (M_Z)

6. CONCLUSION

From the analysis of the G+10 Residential Building in STAAD.Pro and ETABS, following conclusions are drawn:

- Upon comparing the axial force and the shear force (in Z direction) from both the softwares, it was found that ETABS gave a slightly higher value when compared to STAAD.Pro.

- Upon comparing the shear forces in in X and Y directions, the bending moments in all the directions and the displacement, it was found that STAAD.Pro gave a slightly higher value as compared to ETABS.
- ETABS has a better interface and is more user friendly as compared to STAAD.Pro.
- ETABS software is found more easier to use for analysis and modelling of structure than STAAD.Pro.
- Overall, both the softwares are widely used for analysing and designing a structure.

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