Wind Analysis and Design of G+5 Building using STAAD.Pro

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Abstract: Prior to construction, the structural integrity of any building must be assessed. Since high-rise buildings constructed today have more critical combination force than conventional buildings, this analysis is more crucial for them. In order to establish the design loads for a G+5 building, this study compares wind loads. Determine the design loads for a structure that is exposed to wind loads in a given location using this analysis. That is common knowledge for a certain zone factor can be used to determine the wind loads in that zone. Then, using the fundamental wind speed and other elements specific to that area, it is also possible to determine the wind load in such area. A fast wind, however, is time-dependent and erratic. In this study, IS 875 (Part 3) rules are used to analyses and design a multi-story building for wind loads. In order to provide a clear understanding for the wind analysis of high-rise buildings, the G+5 story building is taken into consideration in this study along with numerous loads, including dead, live, and wind loads. Construction must be structural.

***Keywords*: STAAD.Pro, AutoCAD, Wind Load, High-rise Buildings.**

INTRODUCTION

This project entails using STAAD to design and analyze each structural component of a G+5 multistory building in Ghaziabad. Software for the Pro V8i and hand computation. Indian Standard Codes were followed throughout the design process. The Limit state method has been applied to manual designs. STAAD is used to analyze a portion of the building's structural structure. This analysis is necessary to safeguard our building from wind-related damage.

Slabs, a staircase, and the foundation are designed manually during the design phase, whereas RC Designers are used to design the beams and columns. The building's foundation is made to withstand the maximum axial load that STAAD's analysis of the structure yielded.

Typically, wind load governs structures taller than 10 meters. The IS-875 (Part 3)-1987 provides guidelines for wind analysis of tall buildings. Which primarily includes the impact of the degree of roughness, the type of terrain, the nearby buildings, the basic wind speed, the type of soil, and the significance of the wind direction alone.

Prior cyclone and wind statistics demonstrate that when wind blows, structures are impacted from all angles. For this reason, even though numerous structures have been damaged despite being properly wind-tested in accordance with IS-875 (Part 3), 1987. In this study, tall buildings in ZONE 3 are subjected to wind analysis. A five-story structure in Ghaziabad is chosen and its wind load is calculated for analytical purposes.

LITRATURE REVIEW

"Aman, Manjunath Nalwadgi, Vishal T, Gajendra" Analysis and design of Multi-storey Building by using STAAD.Pro, 2016.

Based on the requirements of the IS standards, a G+5 residential/commercial building was analyzed and designed using STAAD.Pro software. Only dead and live loads were applied, so the combined load was 1.5*(D.L. + L.L.). The bending moments and shear forces that emerged from this analysis of the building's frame were then looked at. All building's components, including the slab, beam, column, footing, and staircase, were depicted in detail. From which it was deduced that the structure was secure and cost-effective because the horizontal deflections were within 20mm. Additionally, the outcomes of Kani's technique and STAAD.Pro were remarkably comparable.

"Riddhima Singh, Manoj Kumar, Siddhant Singh, Shorya Rathi, Zohaib Ahmed Khan" Seismic analysis of multistoried building using STAAD.Pro software, 2022.

This essay used the STAAD.Pro programme to examine the seismic analysis of multistory buildings. According to this study, the failure factors for multistory structures include a lack of structural integrity, poor building techniques, large loads, weak mortar, etc. So, in order to avoid failure of multistory buildings, it is necessary to adhere to the correct instructions given by Indian Standard Code. Because of inadequate resistance in the design and structure, these earthquakes have primarily caused destruction. The four steps of this paper's technique are as follows: creating a plan on STAAD.Pro, assigning member properties, and allocating member supports. After this generating, run the static analysis and a load case.

"Vinay K V, Kavya N, Praveen Yadav B, Gowtham M, Raghavendra N" Wind analysis and design of G + 5 residential building using STAAD.Pro software, 2020.

STAAD.Pro software was used to study the wind analysis of residential buildings. In this study, we discovered that the software is capable of figuring out how much reinforcement is required for any concrete segment. The methodology stages utilized on this project are broken down into the following sections: first, using AutoCAD, plan and model the structure. The next step is to research all potential load scenarios or load cases on structures. STAAD.Pro software study of the building comes last. With the use of building analysis, all of the failing frame sections may be located, allowing for simple data changes for better sections throughout design. After analyzing the building, we were able to see the details of each member's reinforcement, which helped us when designing our own structure.

OBJECTIVE

STAAD-Pro will be used to analyze and design a G+5-story residential structure that complies with IS code.

- Analysis of a five-story Reinforced Concrete Cement Framed building with wind pressure.
- Wind load calculation for a five-story.

- To compare the advantages of building analysis and design that take wind effect into account.

METHODOLOGY

Salient feature of building:

Utility of building: Hostel

Building plan size: 48.34m*12.69m = 626.484m^2

Floor area: 560m^2

Floor to floor height: 4.5m

Number of floors: G+5

Size of beam: 230mm*400mm

Size of column:

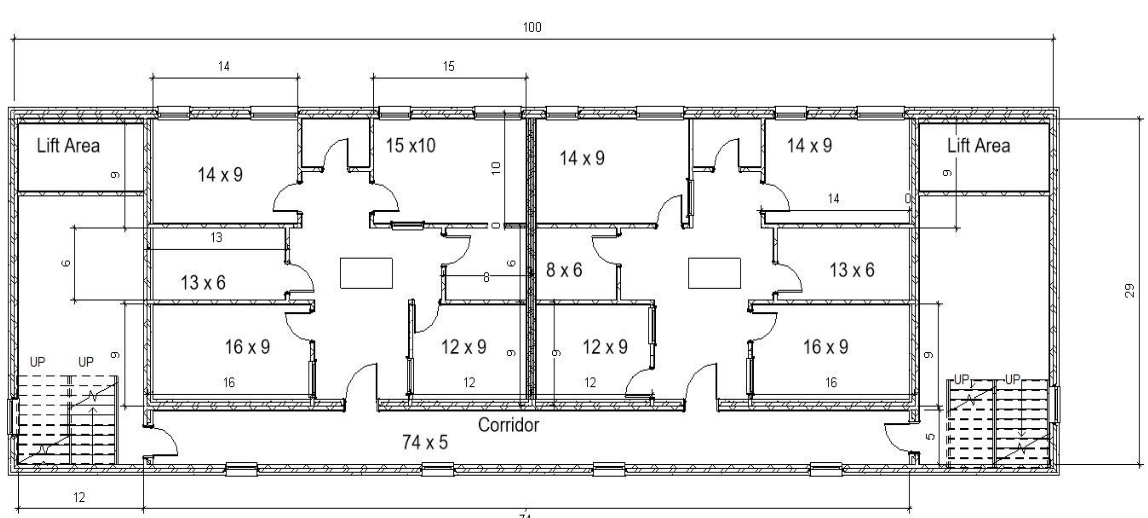
(Group 1) = 230mm*600mm

(Group 2) = 230mm*300mm

The general breakdown of a procedure is as follows:

- Planning
- Modelling
- Loads & Load Combination
- Analysis
- Designing & Detailing

STEP 1: PLANNING & MODELLING



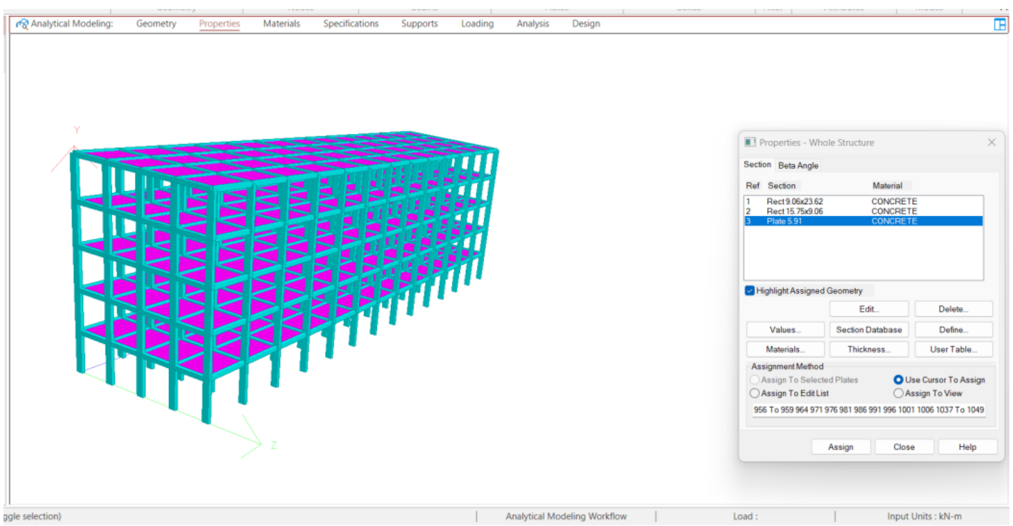
FLOOR PLAN

STEP 2: MODELING & STRUCTURE ANALYSIS

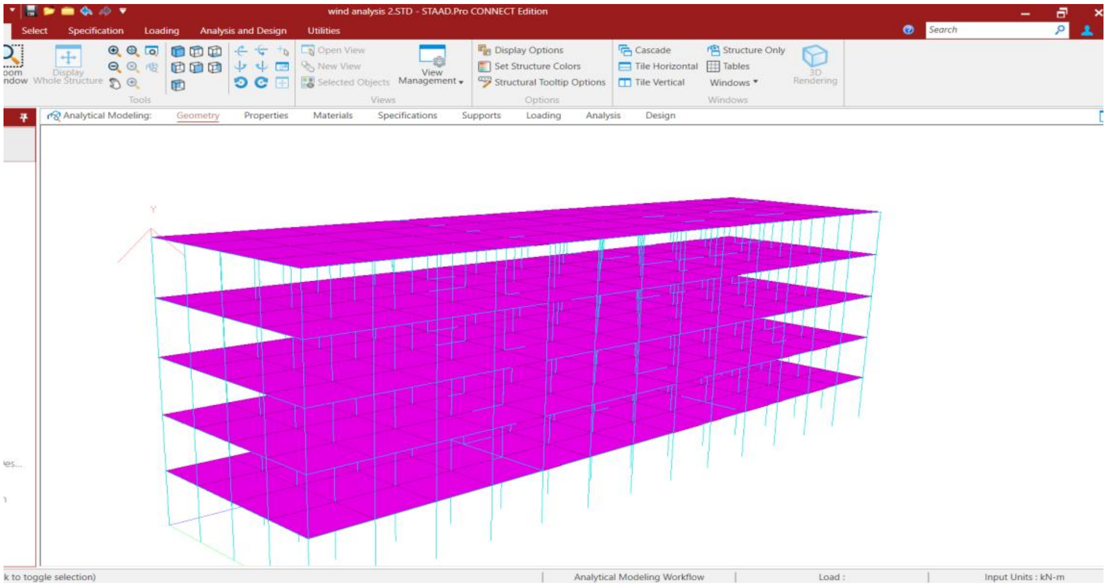
Structural analysis is the technique of estimating how a particular structure will perform under specific loading conditions. It is a crucial component of any engineering project. In structural design, the following performance characteristics are frequently significant:

- Stress
- Deflection
- Support reaction
- Bending moment
- Shear force

Model Geometry Generation



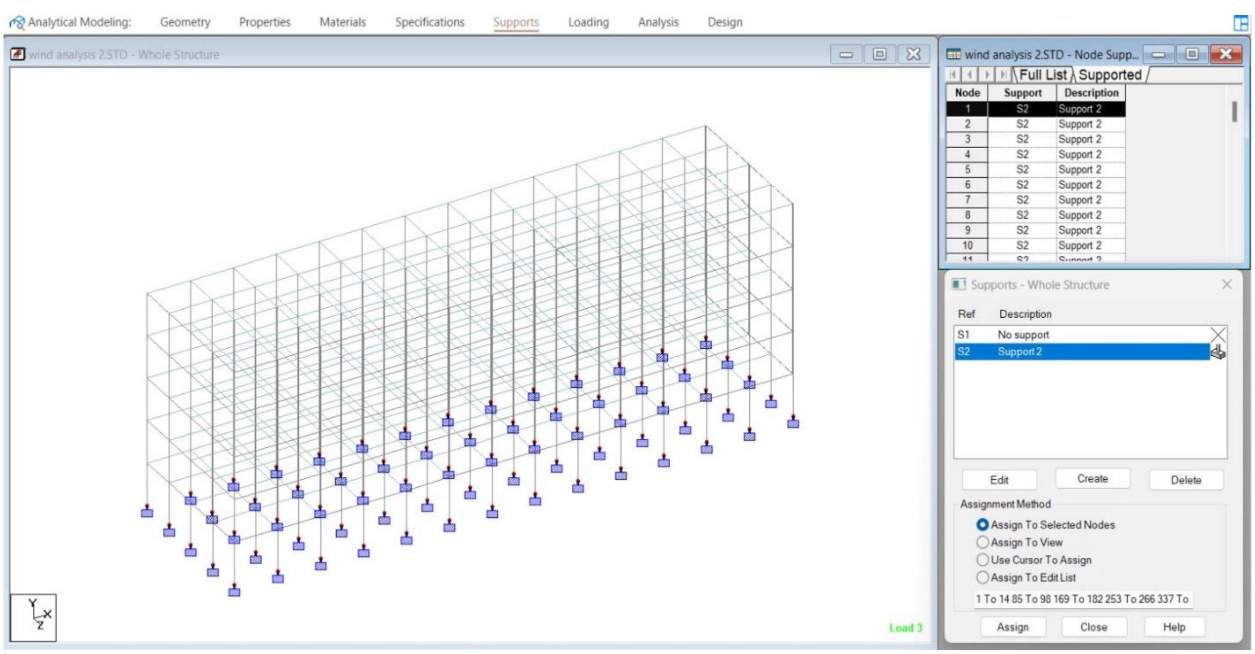
3 Dimensional Rendered View



3 Dimensional Rendered Plane View

Specifying Supports

All column bases have restrictions on translation and rotation along each of the three global axes. In other words, fixed supports are offered at these nodes.



Assigned Support

STEP 3: LOADS & LOADS COMBINATION

Dead Load

As per the IS 875:1987 (Part I)

Floor finish = -1 kN/m^2

Self-weight = 0.15*25 = 3.75 kN/m^2

External Wall

Taking a 230mm brick wall,

Weight of wall for first floor = (4.5-0.3)*0.23*20 = 19.32kN/m

Weight of wall for rest of floor = 0.23*20*(3-0.3) = 12.42kN/m

Internal Wall

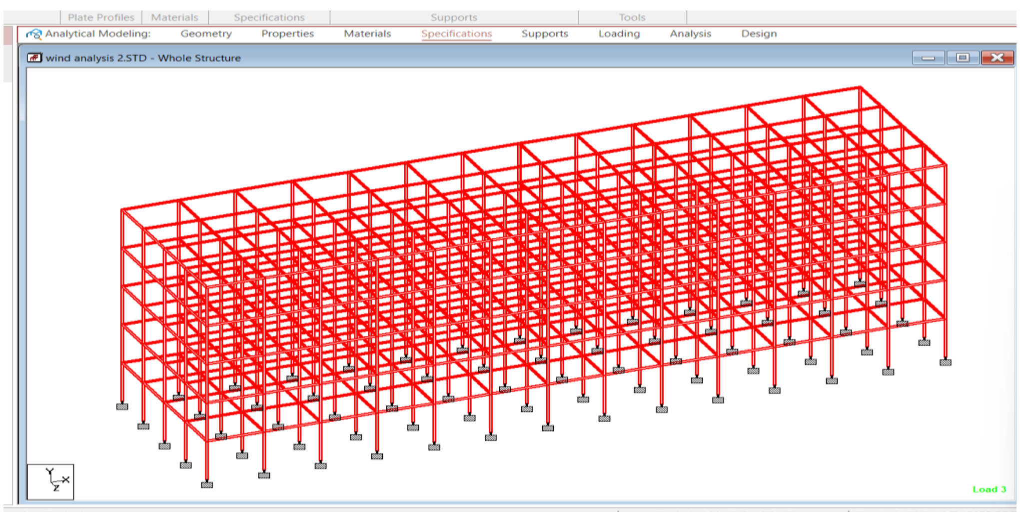
Taking a 115mm brick wall,

Weight of wall for first floor = 19.32/2 = 9.66kN/m

Weight of wall for rest of floor = 12.42/2 = 6.21kN/m

Self-weight of Beam

Weight = 0.23*0.4*25 = 2.3kN/m



Dead Load

Live Load

As per the IS 875:1987 (Part II)

Unit weight of concrete = 25kN/m^2 (IS 456, Cl 19.2.1)

Self-weight = 0.15*25

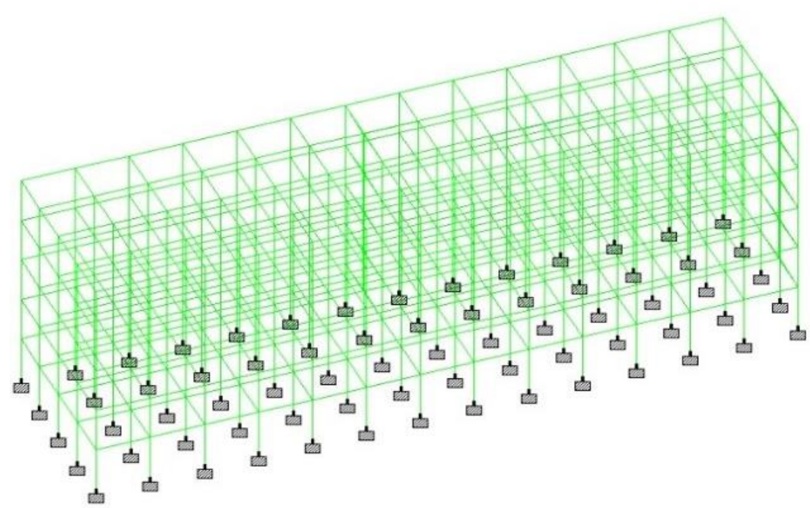
= 3.75kN/m^3

Live load on rooms, bath, and toilets = 2kN/m^2

Live load on corridors, stair case, balconies, and kitchens = 3kN/m^2

Live load on roofs = 2kN/m^2

Floor finish = 1kN/m^2



Live Load

Wind Load

As per the IS Code 875:1987 (Part III) and Revised version at 2015

Design wind flow (Vz) = Vb * k1 * k2 * k3 * k4 [Clause 5.3 of IS 875:1987 (Part-III)]

Vb = Basic wind speed

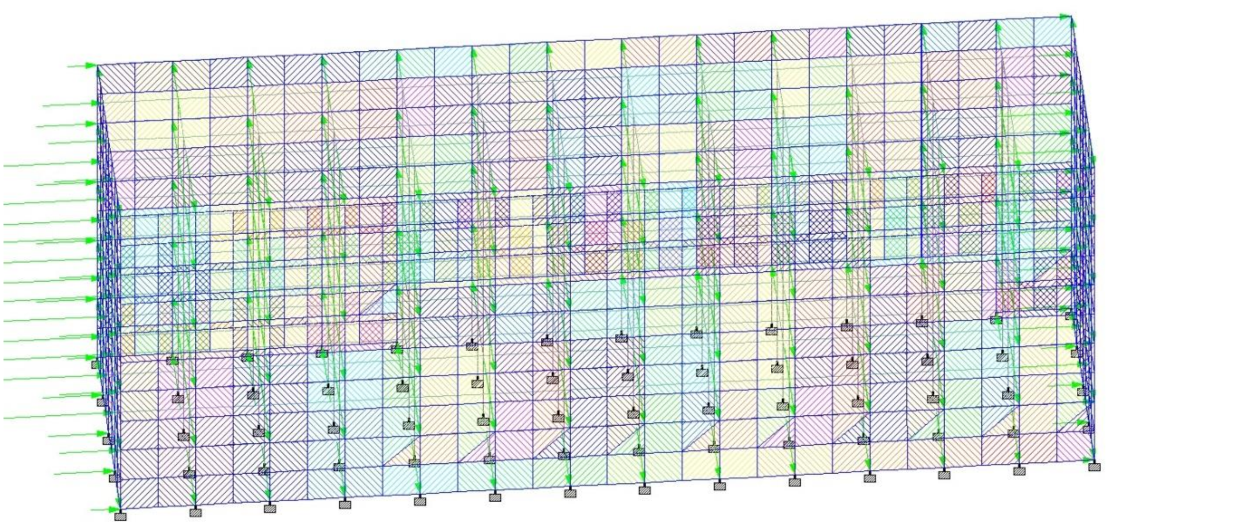
k1= Probability factor = 1 (Clause 5.3.1)

k2= Terrain, height, and structure size factor = 0.894 (As per clause 5.3.2)

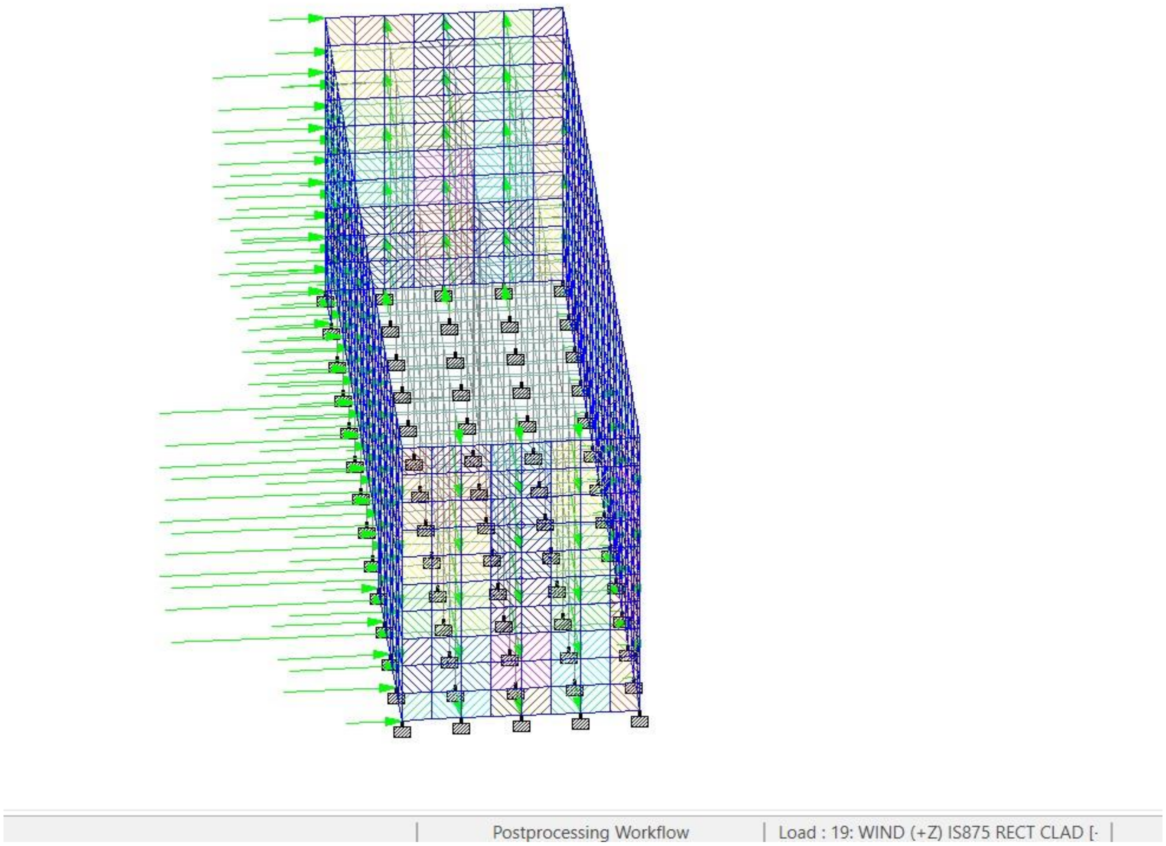
k3 = Topography factor = 1 (As per Clause 5.3.3)

k4 = Importance factor on cyclonic region

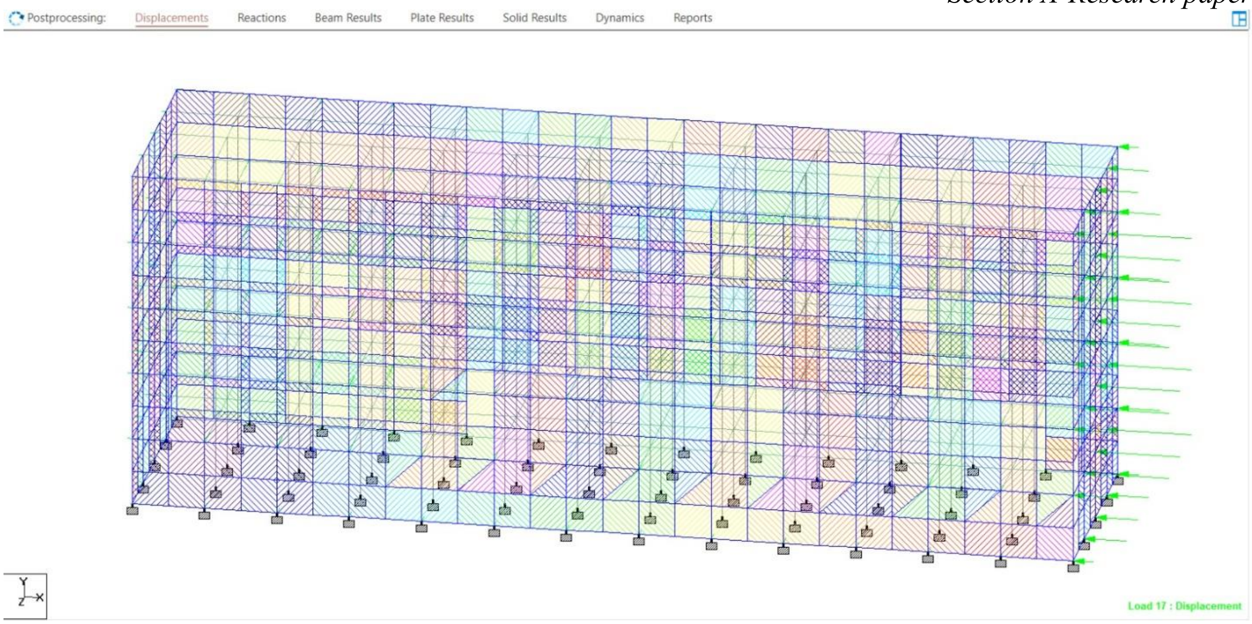
Wind pressure (Pz) = 0.6 * (Vz)^2 (Clause 5.4)



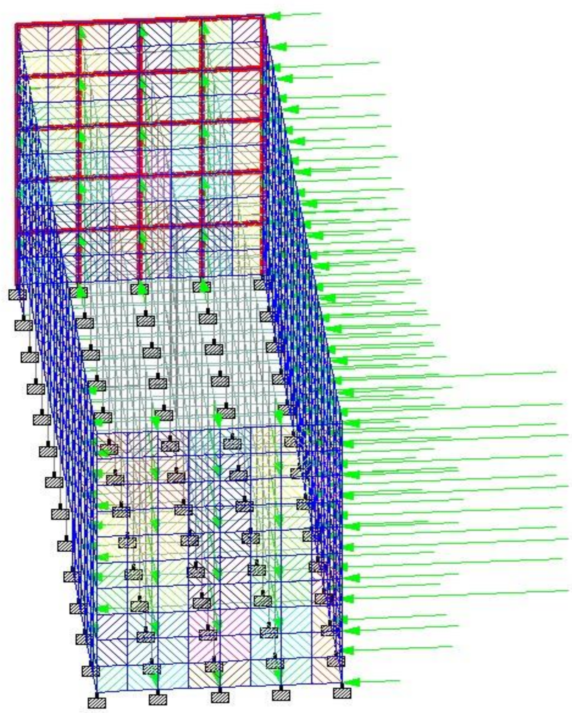
X Direction



Z Direction



–X Direction

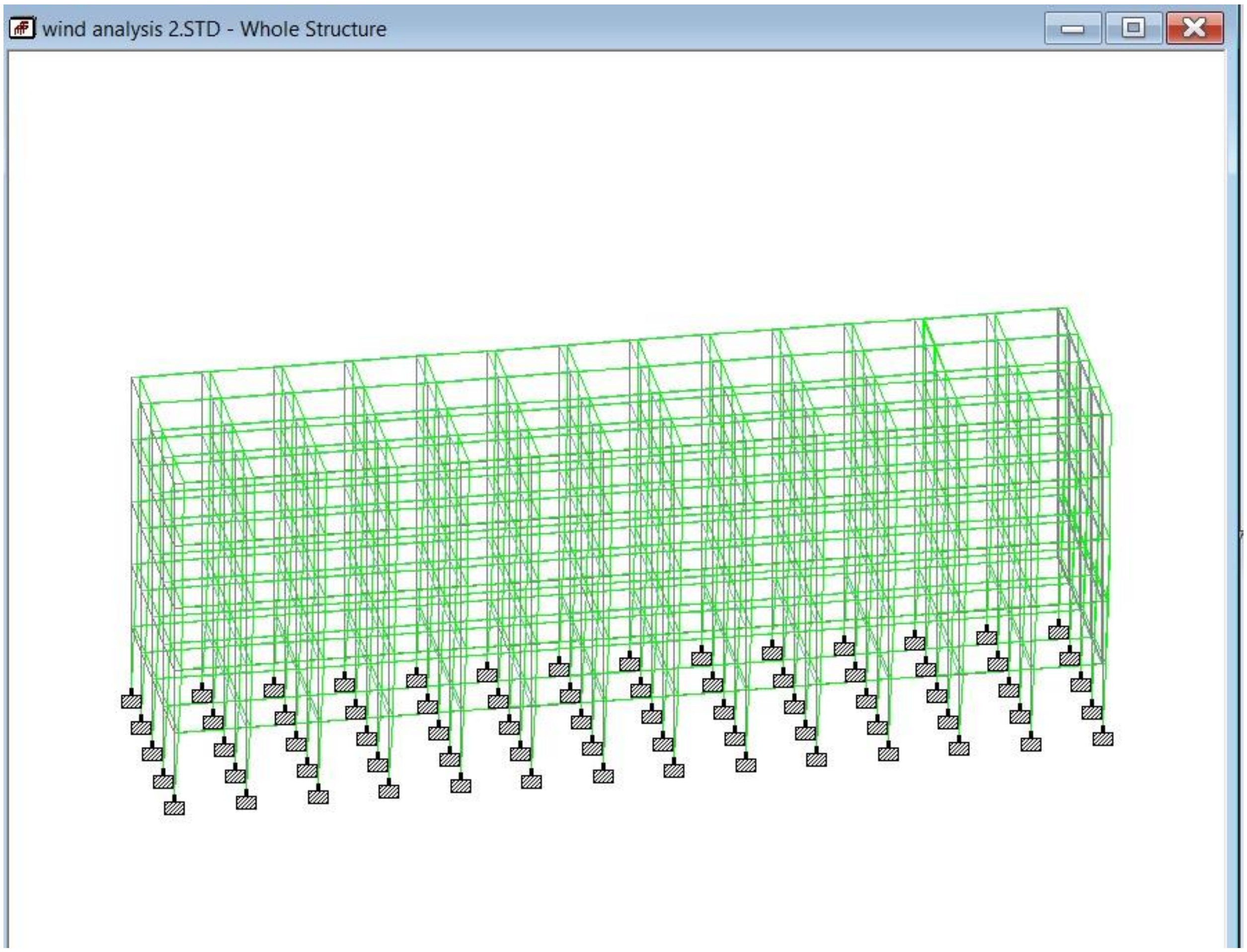


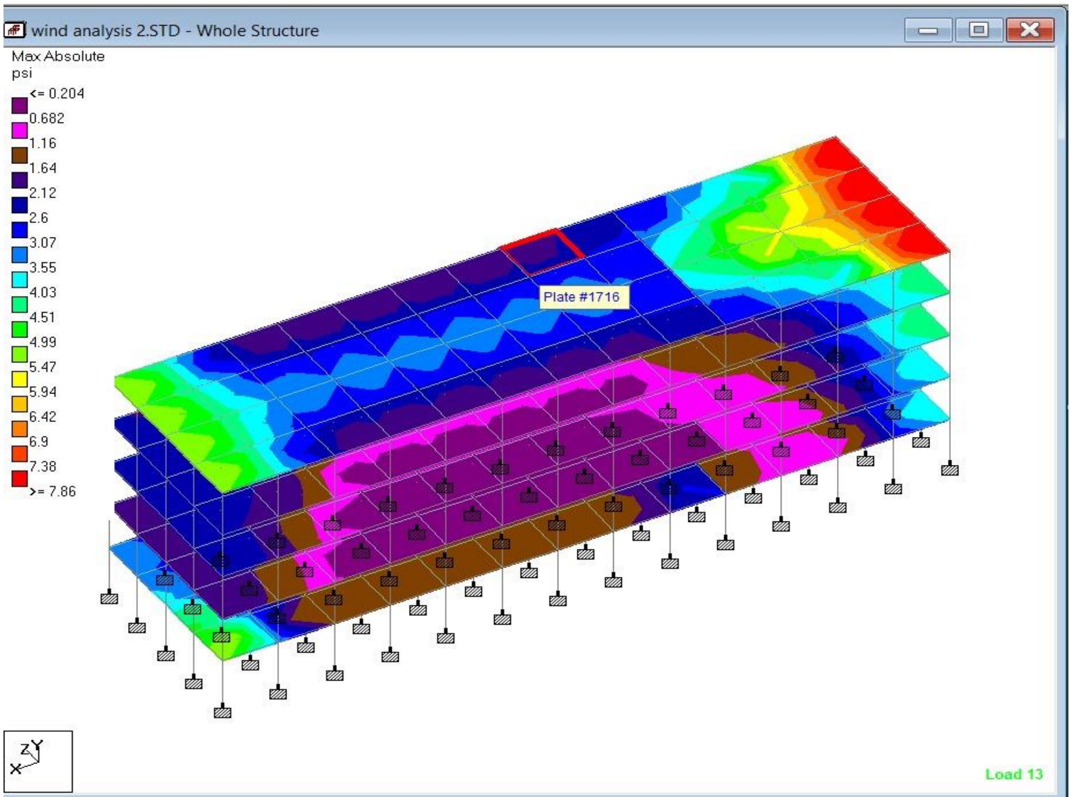
–Z Direction

STEP 4: ANALYSIS

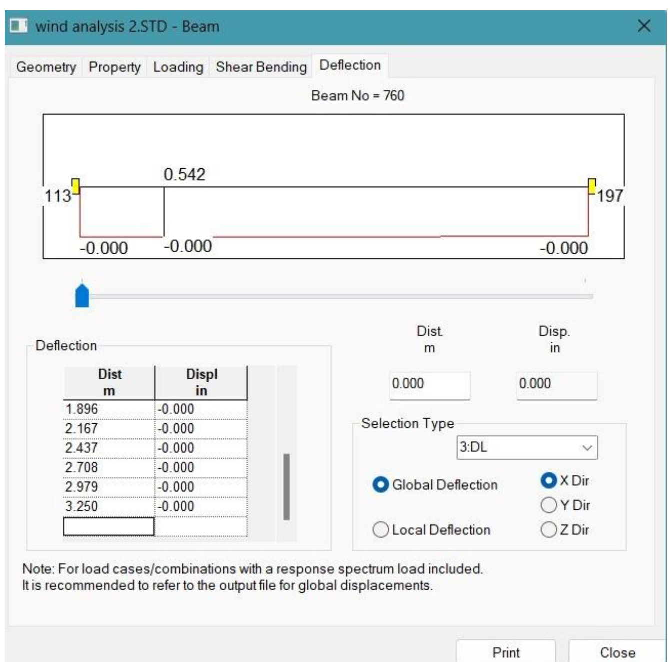
It is possible to study the bending moment and the shear force using the graphs created by post processing after the analysis in STAAD. The image below shows the schematics for the whole building.

Frame Analysis

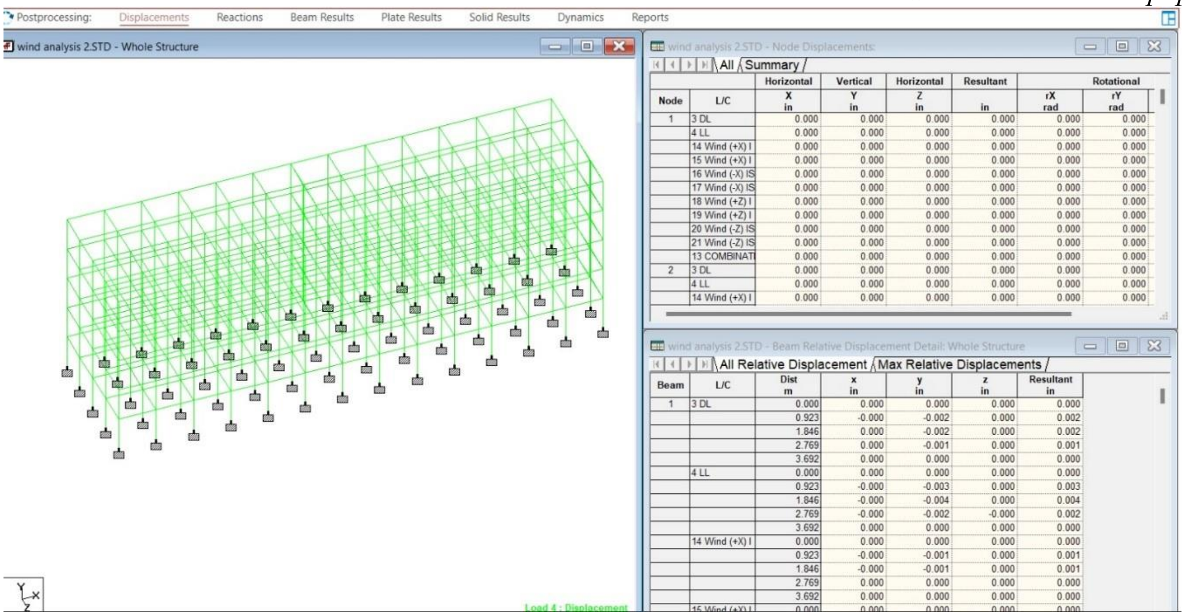


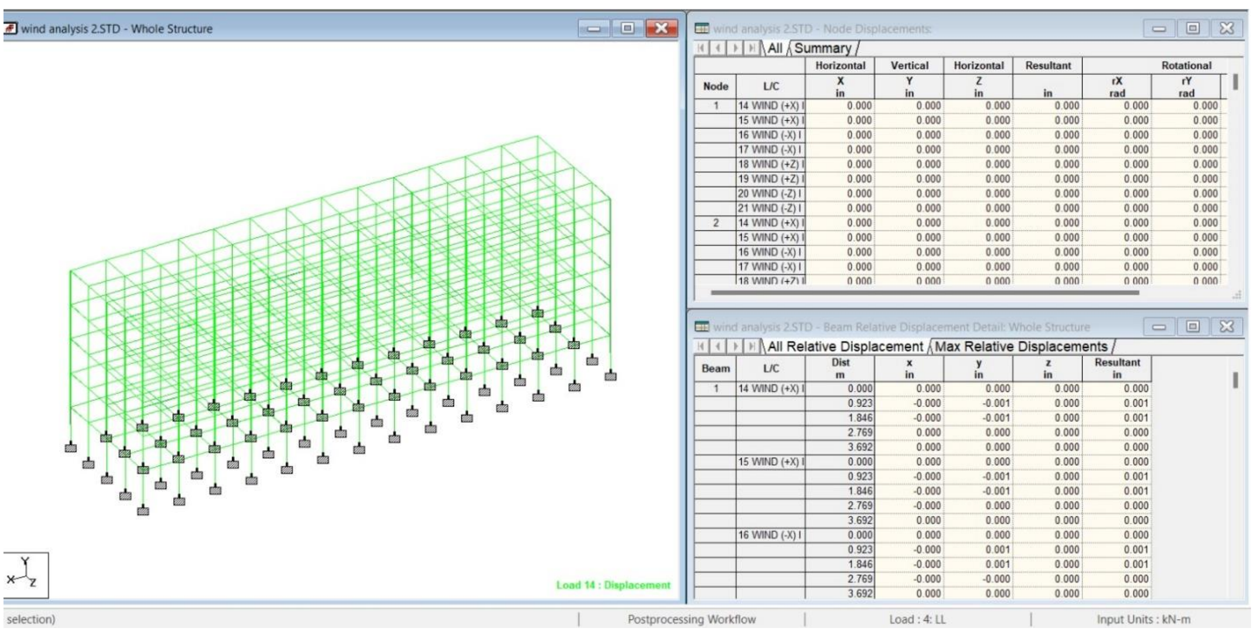


Deflection

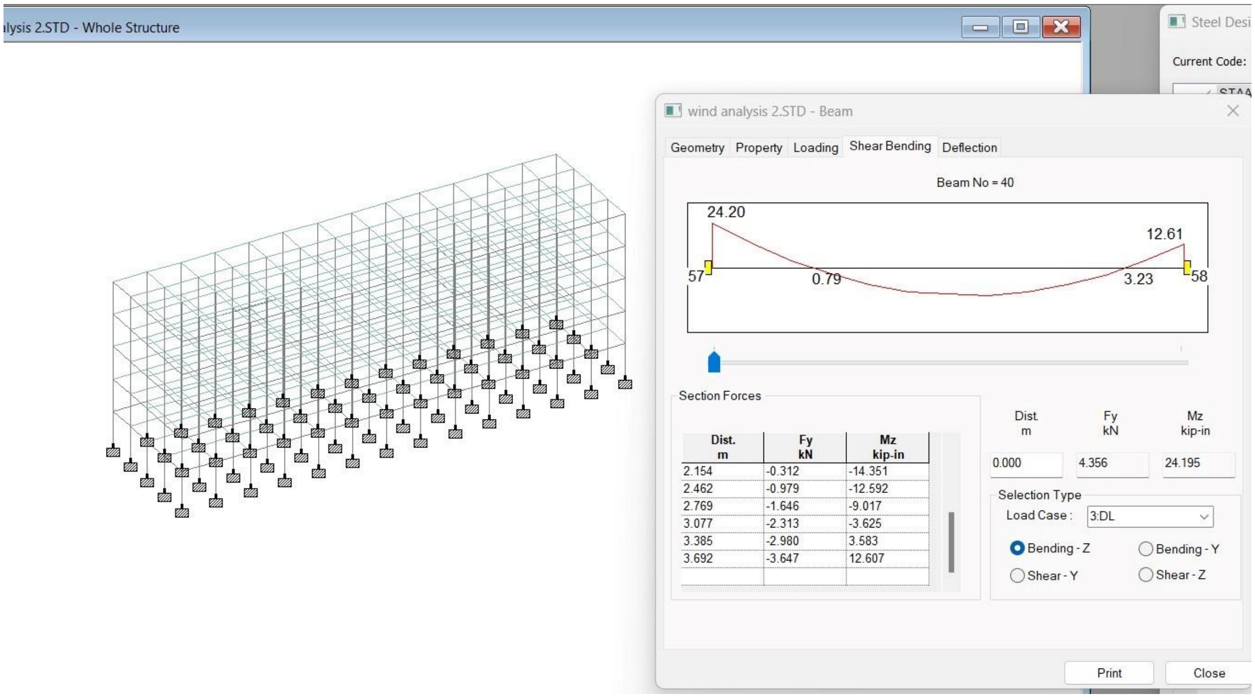


Beam Deflection

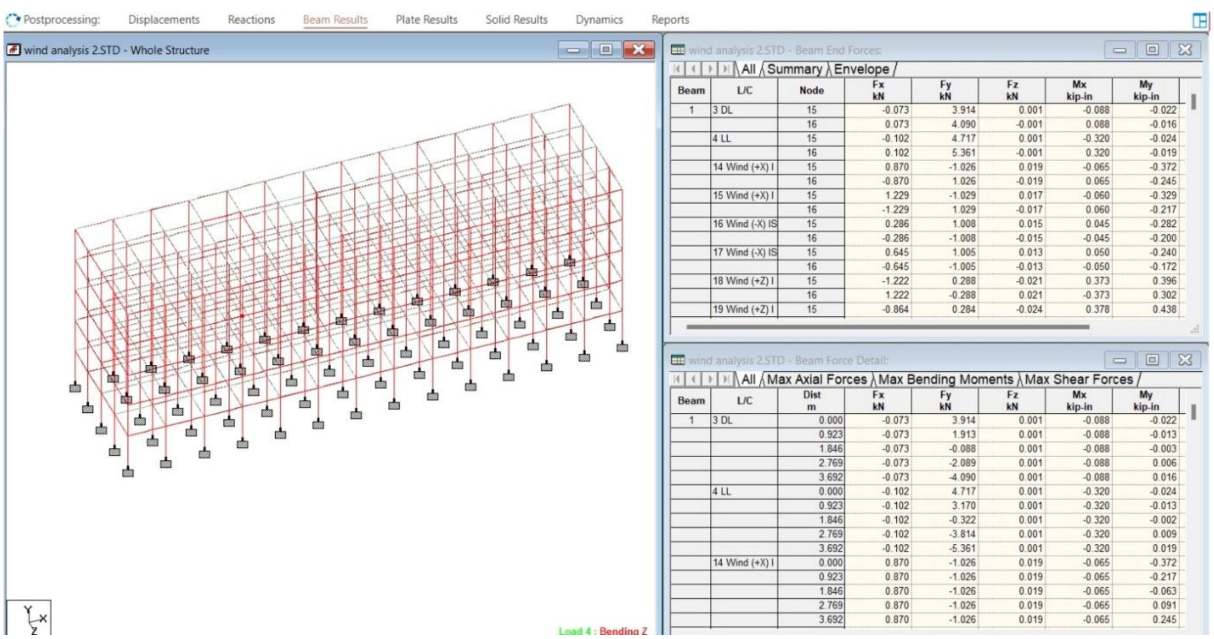




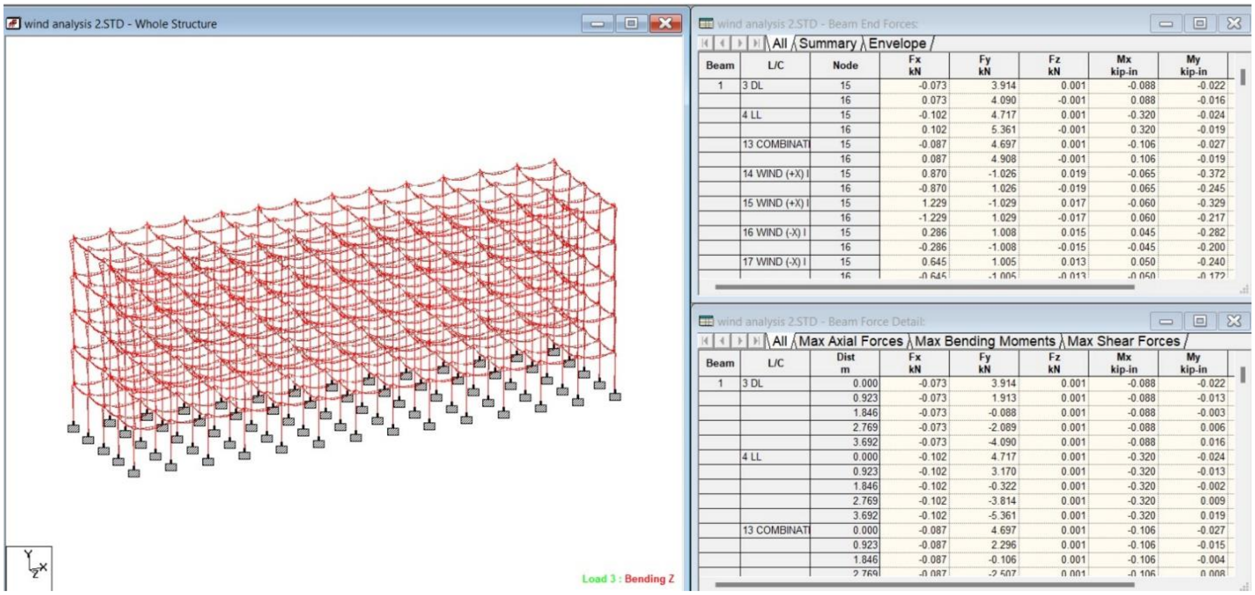
Displacement



Shear Bending

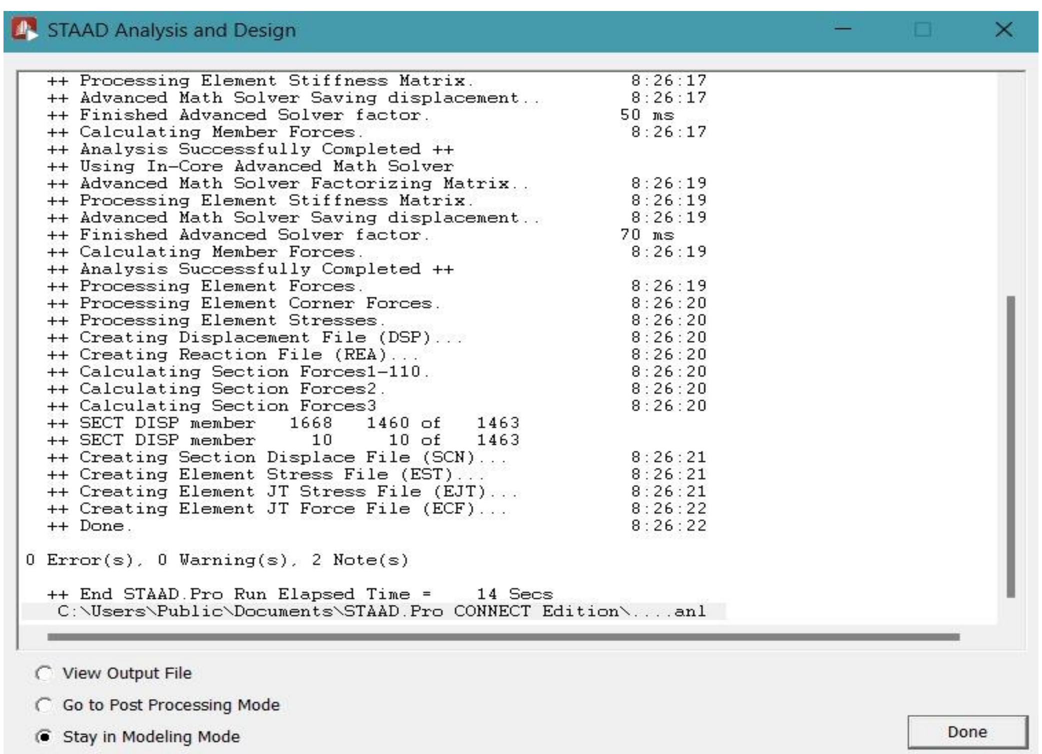


Axial Force

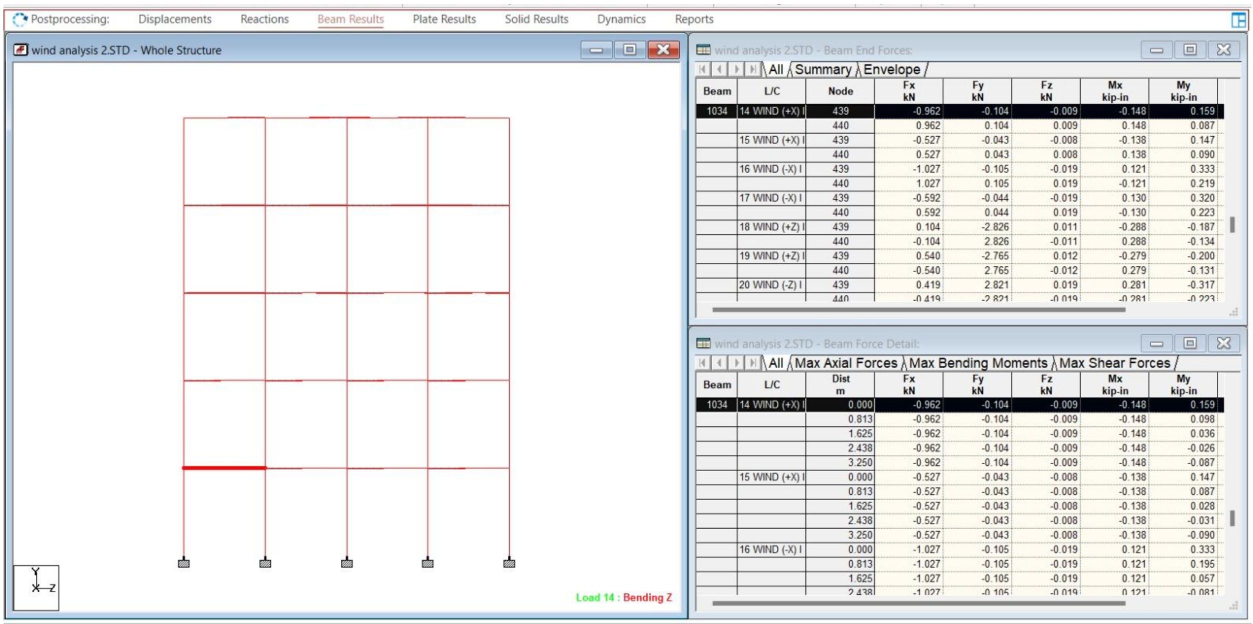


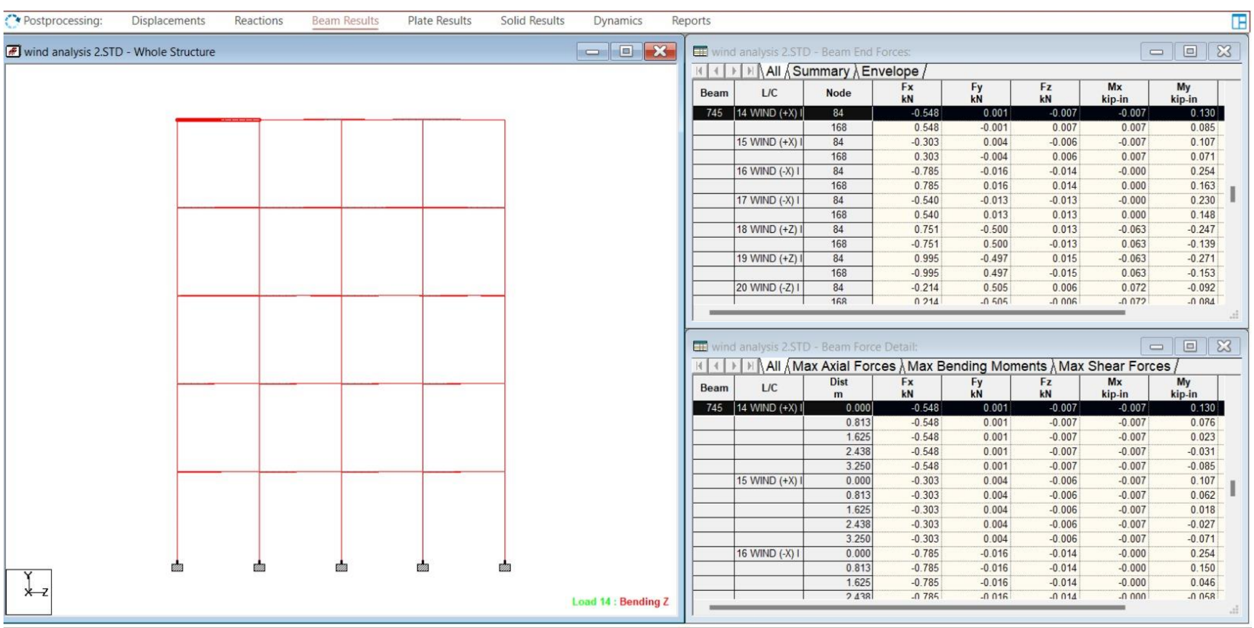
Bending Moment

DESIGN RESULT



SUMMARY





CONCLUSION

The analysis and design of a multi-story dormitory utilizing STAAD is the subject of our project. The structure is represented by a three-dimensional space frame in the model. The loads were estimated in accordance with codal requirements and divided into three categories: dead, live, and earthquake loads. In order to apply the maximum load for the worst condition, the relevant load combinations were also applied.

STAAD is used when compared to manual analysis, analysis of multistory buildings was completed much more quickly. In contrast to manual calculations, it is seen that the reinforcement % in the sections is higher in software design cases. On the building, a specific section's shear fluctuation and moment variation may be seen clearly. Utilizing software increases accuracy.

We develop the residential building's plan using AutoCAD, and then we design the residential building using STAAD. The bending moment and all weights contribute to the building, according to a pro and structural study. For certain constructions, we specifically calculate the wind load and analyze the wind conditions. Obtaining the right conditioning of loads was the primary goal of manual computation. Following are some of the primary reasons why reinforced buildings sustain damage from wind load:

i. The construction materials were of poor quality.

ii. The absence of design in the planning process and the mobility of the frame.

iii. Insufficient beam details during reinforcing.

iv. The reaction of the earth and foundation.

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