Design and Analysis of G+3 Building by STAAD PRO

Priyanka Parekh

Assistant Professor, Department of Civil Engineering, ITM Vocational University

Abstract: *This project's primary goal is to use STAAD Pro to analyze and design a multi-story skyscraper. The primary goal of any structural engineer is to create a structure that is safe in the computing environment; nevertheless, the structural engineer may be willing to take on more risks in order to manage various types of loading circumstances using safer technologies. The subject of civil engineering now has a wider variety of software available. One of them, STAAD Pro, is based on the Limit State Design methodology and complies with the IS Code of Practice. For modelling, analysis, and design as well as visualization in various views and result verification, professionals choose this software. It provides reliable outcomes and is also user-friendly.In order to verify the accuracy, we previously examined a 2D structure and contrasted the results manually. We used all fundamentally feasible loads as well as a combination of loads in accordance with the IS Code of Practise, and the results for G+3 buildings proved to be accurate. It avoids a time-consuming and laborious procedure of load analysis. Along with an evaluated design of a structure, a 3D view is obtained. It is the method of choice for multi-story building study.*

Keywords: STAAD PRO, design and analysis, limit state design method, 3d view, multistoreyed building, structural design

1. Introduction

At every instant of human-civilization we need structures to be lived in or to get according to our requirements. But it is not only to construct a building but building efficient and safe structure so as to fulfill the main objective of the building for which was made. And here comes the role of civil engineering and especially the role of analysis of structure. There are many classical methods for solving any design problem and with time many new software application are also coming into play. Some standard problems also have been solved to show how STAAD Pro can be used in different cases. These typical problems have been solved using basic concept of loading, design, analysis, support conditions as per IS Code of Practice. These basic techniques may be found useful for further analysis of problems.

The paper covers some important projects in this project such as study of multi-storeyed building theoretically in our current semester. Also study of design of various elements of building, planning of various components of a building with column positioning. Introduction to STAAD Pro was new for us; we learnt modeling of the building in the software giving all the boundary conditions such as supporting, loadings, material property, member property, etc. We also carried out analysis and design of various structural beams, columns, with section proportioning and reinforcement.

Analysis: Analysis of the structure means to determination of the internal forces like axial compression bending moment, shear force etc. in the component member are to be designed under the action of given external load.

Design: The design is process of section percussion from the analysis results by using suitable analysis method. The aim of design is to achievement of an acceptable probability that structures being designed will perform satisfactory during their intended life.

Introduction to STAAD PRO: STAAD PRO: It is one of the effective software which is used for the purpose of analysis and design of structure by the structural engineers. The prior aim of our project is to use STAAD Pro software and obtain accurate and precise results than the manual techniques. STAAD Pro features a state-of the-art user interface, powerful analysis, visualization tools, and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verifications. STAAD Pro is preferred for concrete, timber, steel, aluminum and cold-formed steel design of high-rise buildings, petrochemical plants, culverts, tunnels, piles, bridges and much more.

Features of STAAD PRO: Analysis and design tool, GUI (Graphical User Interface) based modeling, Input file/ Output file, Results as per Indian & other standards, 3D rendering view, Report generation

The examples of beam and plane frame using STAAD Pro was solved firstly andthe accuracy of the results by comparing it with the manual calculations were checked. The results were accurate and up to satisfaction.

Structural analysis comprises of the set of laws of physics and mathematics required to study and the behavior of the structure is predicted. Structural analysis can be viewed more appropriately as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.

2. Objectives

Test for safe bearing capacity of soil,
- Creating model in STAAD Pro,
- Generating structural framing plan,
- Application of loads on the member,
- Analysis of the structure,
- Design of the structure.

Application of STAAD pro

It is used by some companies for analyzing the structure and sometimes for design also.

In Staad pro we will design RCC, Steel as well, it is not meant for only buildings, so we can analyze and design separately water tanks and staircases, retaining walls, steel towers, etc.

It supports over 90 international steel, concrete and timber design codes.

It is a structural design oriented program with a user interactive interface which allows for the user working on it extremely easy.

It can be used for modeling, designing and analyzing various structures and structural configurations.

It is extremely useful for buildings and other such structures insignificant to their use varying from residential to commercial to hospitals to offices.

This software can be used for all kinds of buildings of various architectural drawings under a plethora of loads.

Other than buildings, it is also useful for bridges to some extent and also foundation design and analysis.

Shear wall is another feature incorporated into it for design facilitation.

Steel buildings and connections can also be designed and successfully rendered to view the real-life resembling images for detailed clarity.

A great command and knowledge of Staad pro along with the design and structural analysis knowledge is a boon for any civil aspirant ensuring a high probability of successful placements in good companies with good pay-scale.

Designs in Staad pro includes building structures incorporating culverts, petrochemical plants, bridges, tunnels, piles; and construction materials such as timber, steel, concrete, aluminum and cold-formed steel.

Staad Pro software enables structural engineers o automate their undertakings by evacuating the repetitive and lengthy procedures of the manual methods.

It happens to be a structural analysis software that accompanies an adaptable modeling environment, advanced features, an smooth data collaboration. It is the world's number one structural analysis and design software that backs Indian and ever single global code.

It gives options to structural engineers to dissect and design for all intents and any sort of structures. Departments in construction companies, proprietor/ administrators, structural engineering firms and government offices etc and offshore platform designers make use of this software broadly.

Advantages of STAAD pro

One will come to know how to have isometric and point of view perspective and 3D shapes.

One will be aware how to design concrete structures like columns/beams/slabs/footings according to the international codes.

One will get to learn how to generate text/graphics input.

One will come to know how to execute flexible zoom and numerous views.

One will have the knowledge on how to perform code check, member selection and optimized part selection comprising of design/analysis cycles.

One will know how to utilize built-in command file editor and straight forward command language.

One will learn how to finish complete object-oriented instinctive 3D/2D graphic model creation.

One can learn how to do effective algorithm that limits disk space prerequisites.

One will have the knowledge to perform exact and numerically productive plate/shell component consolidating out-of-plane shear and in-plane rotation, program element mesh creation, complete component stress yield incorporating in-plane stresses, out-of-plane shear, bending and main stresses at nodal and also user indicated focuses.

One will come to know how to utilize pull down menus, drifting toolbars, tool tip help.

One get to know how to take presentation quality printer plots related to geometry and results as a major aspect of running yield.

One will figure out how to accomplish user determined design parameters to alter the design.

Extremely Flexible Modeling Environment.
- Broad Spectra of Design Codes.
- International Best Seller.
- Interoperability and Open Architecture.
- Covering All Aspects of Structural Engineering.
- Quality Assurance.
- Extremely Scalable.
- Easy Reports and Documentation.

3. Analysis and design by STAAD PRO

a) Data of the experiment

A Multi-storeyed building has following data:

Table 1: Given data

Building	- GF + 5 upper floors (6 storey)
Plan dimension of typical floor	- 20m × 30m
Column grid	- 5m × 3m
Typical floor height	- 5m
Ground floor height	- 5m
Ground level	- ±0.0 m
Ground beam top	- 0.5 m
All beams including ground beams	- 250mm × 500mm
Location	- outskirts of Vadodara
Floor beams	- 200mm ×500mm
Live load	- -4 KN/m²
Dead loads:	
External wall load	- -15 KN/m
Self weight	- -1 (factor)
Parapet wall load	- -3 KN/m

Calculate the dead load, live load and also determine the wind pressure acting on the building. Design the structure as per IS code.

1) **Steps for solution**
a) Defining nodes
b) Defining supports
c) Defining property
d) **Dead Loads :** Dead loads consist of the permanent construction material loads compressing the roof, floor, wall and foundation systems, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the building that generally d not change over time, such as the steel columns, concrete floors, bricks, roofing material etc.
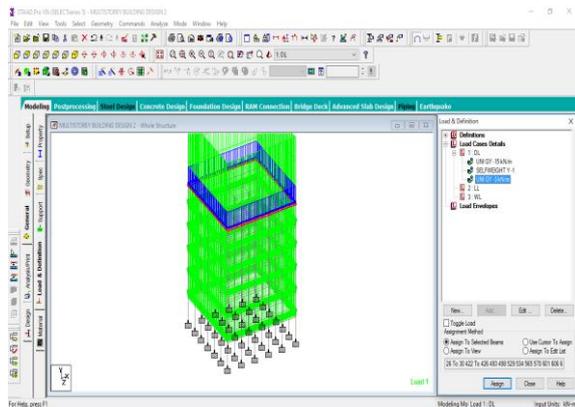

Fig. 1 dead load view

In staad pro assignment of dead load is automatically done by giving the property of the member.

Below is the figure of the external wall load applied to the periphery with the intensity of -15 KN/m except the top most floor using cut section feature.

The blue shows the load condition of the walls assigned and the negative sign shows that the load is acting downward.

In the same load case i.e. dead load case, we also added self-weight and the load by parapet wall on the terrace periphery along with wall load.

For assigning the self-weight first add the self-weight factor as -1 and then assign to the whole view.

As the material, density and section are already assigned, the software automatically calculates and assign the self-weight of the structure.

After assignment of dead load the skeletal structure looks red on color as shown in the figure 2
Dead load is calculated as per **IS 875 PART 1**

After self-weight we assigned a load on the periphery as the load due to parapet wall with intensity of -3 KN/m

This YRANGE load is uniform on the periphery of the top most floor of the structure and the negative sign shows that the load is acting downwards.

The blue color shows the uniform load acting per m on the periphery of the structure.

Live Loads: Live loads are produced by the use and occupancy of a building. Loads include those for human occupants, furnishings, no fixed equipment, storage and construction and maintenance activities.

As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously in a structural evaluation.

In staad we assign live load in terms of U.D.L we have to create a load for live load and select all the beams to carry such load.

Here the floor load of -4 KN/m from 5m to 30m of the structure is assigned. After the assignment of the live load the structure appears as shown below in fig 2.
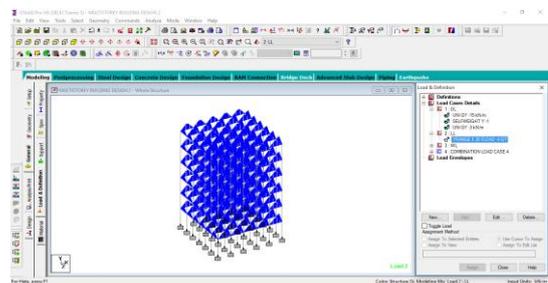

Figure 2: live load view

Wind Load: In the list of loads we can see wind load is present both in vertical and horizontal loads. This is because wind load causes uplift of the roof by creating a negative (suction) pressure on the top of the roof wind produces non static loads on a structure at highly variable magnitudes, the variation in pressures at different locations on a building is complex to the point that pressures may become too analytically intensive for precise consideration in design.
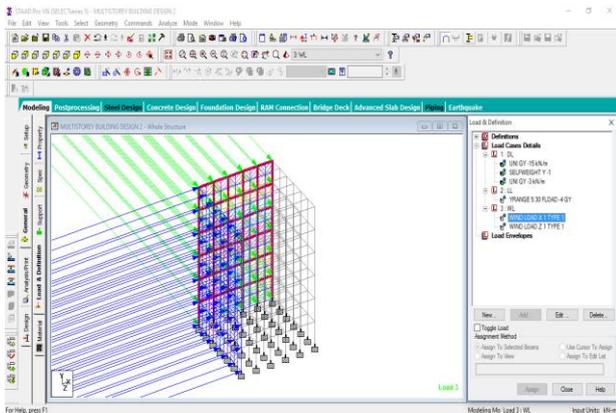
Figure 3: wind load view

Therefore, wind load specifications attempt to amplify the design problem by considering basic static pressure zones on a building representative of peak loads that are likely to be experienced.

After designing wind load can be assigned in two ways:
1) Collecting the standard values of load intensities for a particular heights and assigning of the loads for respective height.
2) Calculation of wind load as per IS 875 PART 3

We designed our structure using second method which involves the calculation of wind load using wind speed.

In Vadodara we have a wind speed of 39 m/s and this value is used in calculation.

After assignment of wind load the structure looks as shown in figure 3.

2) Load Combination

All the load cases are tested by taking load factors and analyzing the building in different load combination as per IS 456 and analyzed the building for all the load combination and results are taken and maximum load combination is selected for the design.
Load factors as per IS 456-2000
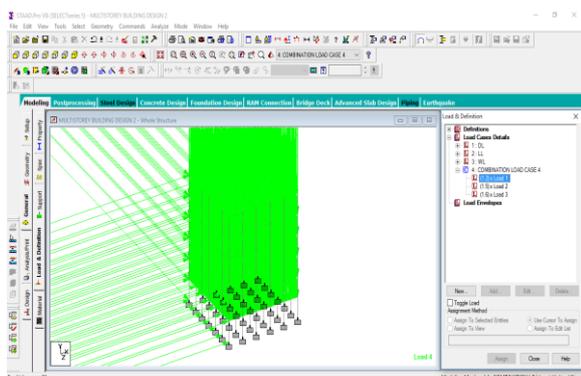Live load - 1.5
Dead load - 1.2
Wind load - 1.6

Figure 4: load combination view

When the building is designed for both wind and seismic loads maximum of both is taken. Because wind and seismic do not come at same time as per code.

Structure is analyzed by taking all the above combinations.

3) Load Distribution

Below figure shows the load distribution on slab surface as two way slab i.e. trapezoidal distribution of uniform load on slabs.
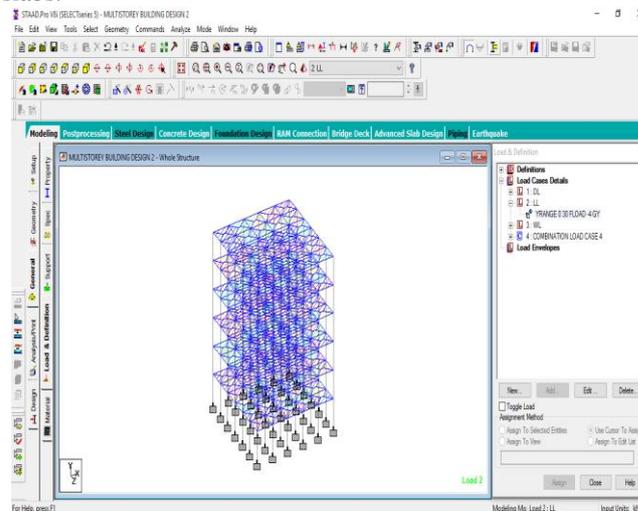

Figure 5: Load distribution view

4. Analysis

The result of the analysis here obtained is with zero errors and zero suggestions. Thus analysis is accurate

Design
We have designed the structure as concrete design by assigning the properties of concrete structure. Below is the figure of design detail of one of the beams designed.
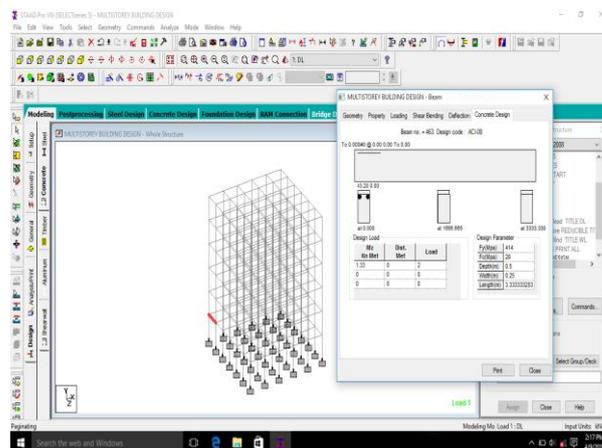

Figure 6: Design view

5. Conclusion

STAAD. Pro graphical input generation facility allows generation of structural models graphically. A powerful geometry generation algorithm facilitates generation and viewing of structural models both 2D and 3D situations. All other specifications like section properties, support loads, material constants, analysis and design requirements, plotting, printing facilities are available. A versatile facility of query allows generation of customized reports. A power

icon based graphic tools provide extremely user-friendly navigation and manipulation capabilities.

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