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Analysis and Design of the Main Building of Five Star Hotel

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Abstract – This study focuses on the comprehensive planning and structural design of the main building of five-star hotel using STAAD.Pro software. The project aims to integrate luxury architecture with structural safety, optimizing both functionality and aesthetics. The hotel is planned as a multi-storey reinforced concrete (RCC) structure, featuring various high-end facilities such as lobbies, restaurants, suites, and conference halls. Structural design was carried out in accordance with relevant IS codes, considering various loads including dead, live, wind, and seismic forces. STAAD.Pro enabled efficient modeling and precise analysis of the structural framework, ensuring stability and cost- effectiveness. Member sizing was optimized based on strength, serviceability, and material economy. The final layout also supports future expansion and accommodates service integration such as HVAC and plumbing. This project demonstrates the importance of structural software in delivering reliable, compliant, and performance-based designs for complex commercial buildings in the hospitality sector.

***Key Words*:** Staad.Pro, Rcc design, hotel planning, seismic load, IS code, compliances.

1. INTRODUCTION

Designing the main building of a five-star hotel means making sure it looks great, works well, and is safe for everyone inside. These hotels usually have big open spaces like lobbies, restaurants, and event halls, which need strong support and smart planning. To do this, engineers use a computer program called STAAD.Pro. It helps them build a virtual model of the building and test how it will handle things like weight, wind, and even earthquakes. First, the team plans how the space will be used and picks the right materials. Then, they design the structure like the beams, columns, and foundations—using the software to make sure everything is strong and follow building rules. STAAD.Pro makes the job faster, more accurate, and helps build a hotel that is safe, cost- effective, and ready to meet the high standards expected in a five-star experience.

Doing all the design work by hand takes a lot of time and can cause mistakes. To make this easier, engineers use software called STAAD.Pro. This software helps create a model of the building, apply loads, and check if the design is safe by following rules like IS 456:2000. In this journal, a Single Column RC Building is designed using STAAD.Pro. It includes making the model, applying the loads, analyzing the structure, and designing the reinforcement. The goal is to make sure the building is safe, affordable, and follows the right design standards

2. LITERATURE SURVEY

1. Venkatapuram Anil Kumar& K. Rajeshwaran (2023): Designing five-star hotels needs careful planning and strong structures. Many engineers now use software like STAAD. Pro to help design buildings that are safe and strong. Below are some recent studies that show how STAAD. Pro is used in designing hotel buildings.
2. Design of Park Hyatt Hotel, Banjara Hills: This project looked at planning and designing the Park Hyatt Hotel in Hyderabad. The team used STAAD. Pro to check the strength of the structure. They also made sure that the rooms, halls, and other spaces were placed well. The project followed all safety rules and showed how software can help in designing large hotels.
3. Hotel Design Project on SlideShare: This project explained how to design a five-star hotel using STAAD. Pro. They used common materials like M20 concrete and Fe415 steel bars. The team checked the strength of all parts of the building like beams, columns, and slabs. It showed that good design needs both nice looks and strong structure
4. Resort Design Using Staad.pro (IJNRD): Even though this was a resort, the design ideas are useful for five-star hotels too. The team used AutoCAD to draw the building and STAAD. Pro to test the structure. They also did some manual calculations to double-check their results. The goal was to make a safe and beautiful building that would attract visitors.
5. G+6 Hotel Building Design (RGMCET College report): This student project designed a hotel with 7 floors (ground + 6 floors). They used AutoCAD, STAAD. Pro, and Revit software to plan, test, and visualize the building. STAAD. Pro helped make sure all the parts of the building were safe under different loads. It also helped reduce mistakes and save money.
6. Five-Star Hotel Planning project (Scribd): This project talked about how to plan and design the main parts of a hotel. It included rooms, kitchens, lobbies, and service areas. STAAD. Pro was used to test the strength of the building under different conditions.

3. OBJECTIVES

To model the main building of five Star Hotel.
To analyze the structure using STAAD.Pro.
To design the building for different load conditions.
To prepare reinforcement drawings using AutoCAD.
To ensure the design meets IS code standards.

4. METHODOLOGY

This project involves two major aspects-architectural planning and structural design.

4.1 Architectural Planning

- Site Area Assumed: ~5000sq. m.
- Zoning: Separate zones of public area (lobby, restaurant, private area, guestroom, service zones, laundry, kitchen).
- Features Considered.
  - Circulation space.
  - Fire exits and staircases.

- Energy-efficient orientation (solar gain, wind direction).

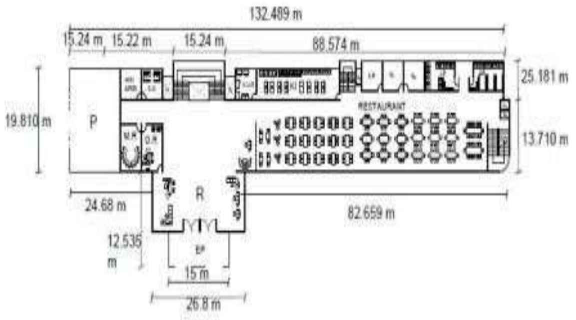


FIG 1: Plan of the building

- Accessibility compliance (ramps, elevators).

4.2 Structural Design using STAAD.Pro

- Structural System: RCC frame structure (beams, slab, columns, footings).

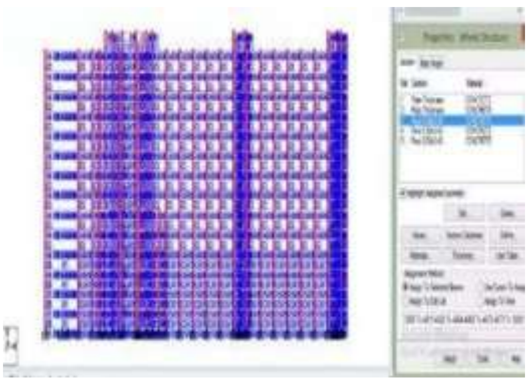


FIG 2: Load distribution in STAAD.Pro

- Loads of considerations:
  - Dead loads (self-weight, walls, etc.).
  - Live loads (as per IS 875).
  - Wind loads (as per IS 875 part 3).
  - Seismic loads (as per IS 1893).
  - Material Grades:
- Material grade:
  - Concrete: M30.
  - Steel: Fe 500.
- Structural Components and modeled:
  - Beam and column frames.
  - Slabs as plate elements.
  - Foundation-Isolated/combined footings depending on the column spacing.
- Load combinations:
  - DL+LL.
  - DL+WL.
  - DL+EQ+LL (Seismic zone III or IV).
- Software output used:
  - Shear force and bending moment diagram.
  - Displacment results.
  - Utilization ratios.
  - Reinforcement detailing.

4.3 MODELING IN STAAD Pro

1. Creating Nodes:
   - A node was created at the base (0,0,0) to represent the foundation level.
   - Another node was placed at the top level of the column (e.g., at 0,3,0 for 3-meter height).
2. Defining Geometry:
   - A vertical member (beam/column) was created by connecting the base and top nodes.
   - This member represents the reinforced concrete column of the structure.
3. Assigning Supports:
   - The bottom node was assigned a fixed support to simulate the foundation, which restrains all translations and rotations.
4. Defining Material Properties:
   - The material was set to Concrete M30 (fck = 30 MPa).
   - Steel used was Fe500 for reinforcement (fy = 500 MPa).
5. Load Assignments:
   - Self-weight of the structure was included automatically.
   - Additional dead loads and live loads were applied at the top of the column.
   - In some cases, wind load was also applied according to IS 875 (Part 3).

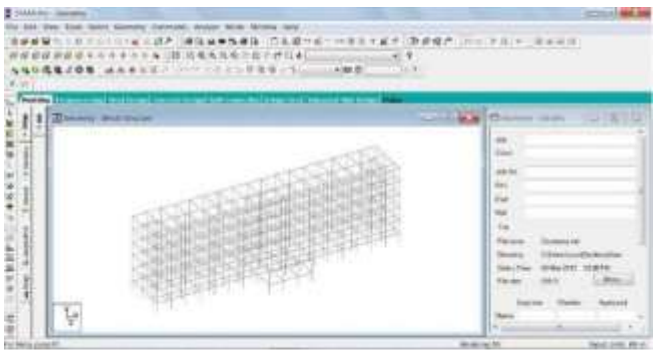


FIG 2: The Model of Structure with All Beams and Nodes

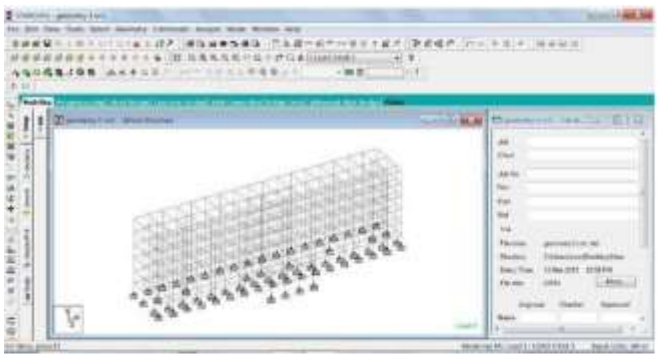


FIG 3: The model with the fixed supports

6. Creating load combinations:
   - Load combinations such as (DL + LL), (DL + WL), etc., were defined as per IS code.

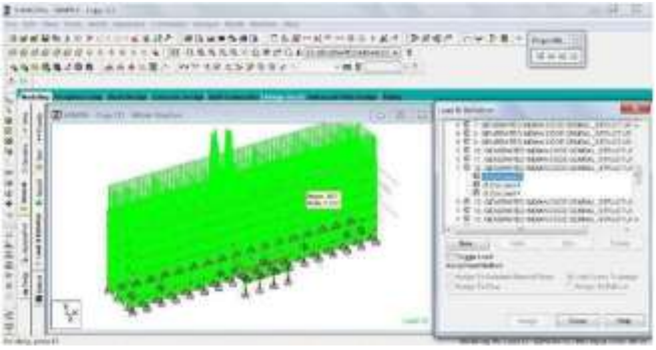


FIG 3: Application of loads

7. Saving and Analyzing the Model:

- The model was saved and the **analysis was run** to check for axial force, bending moment, shear force, and displacement.

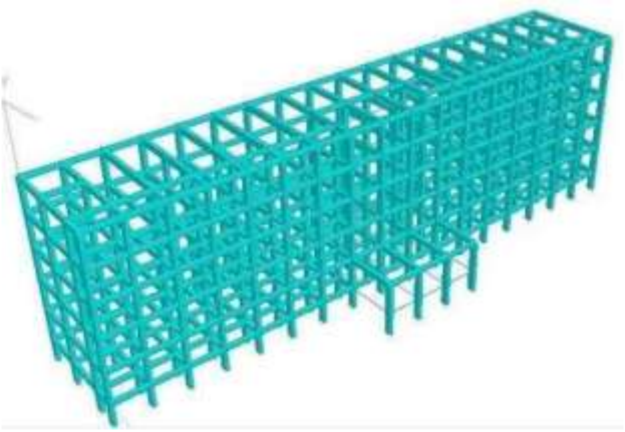
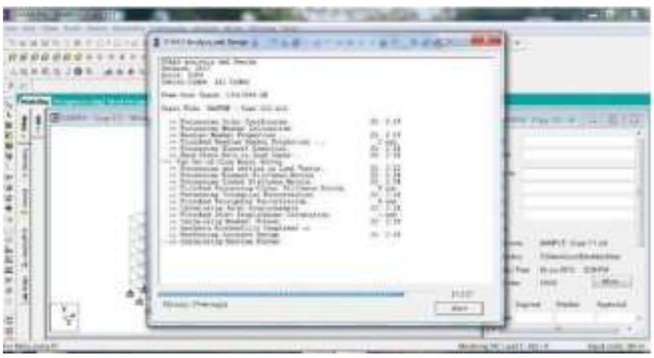


FIG 4: 3d Rendered model in Staad.Pro.

8. Checking Errors and Viewing Results:
   - The structure was checked for modeling or support errors.
   - All outputs were viewed in the post-processing mode for structural behavior and design forces.



5. DEAD LOAD

In structural engineering, a dead load (also known as a static or permanent load) refers to the constant load acting on a structure due to the self-weight of structural elements and all permanently attached components. This includes:

- The self-weight of primary structural elements such as beams, columns, slabs, and walls.
- The weight of non-structural elements like flooring materials, false ceilings, partitions, and cladding.
- The load from permanent fixtures and equipment, such as plumbing systems, HVAC units, and built-in machinery that are fixed in position.

Dead loads are considered invariable over time and are typically calculated based on the unit weight (density) of materials used in construction. They form a fundamental part of the load combinations used in structural analysis and design, ensuring the structure's safety and serviceability under all expected conditions.

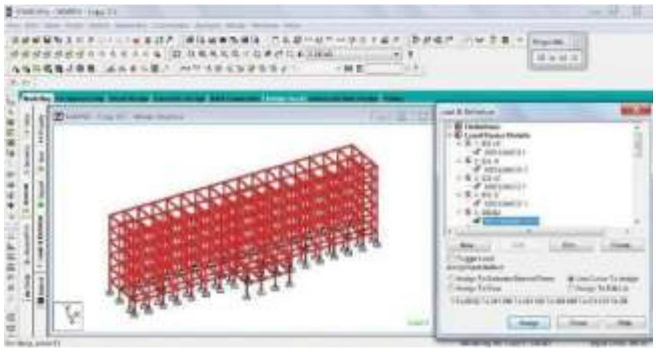


FIG 5: Application of Dead load on the structure.

6. LIVE LOAD

The second vertical load that is considered in plan of a structure is forced loads or live loads. Live loads are either portable or moving burdens with no quickening or effect. These heaps are thought to be delivered by the planned utilize or inhabitance of the building including weights of versatile parcels or furniture and so forth.

Live load continues changing now and again. These heaps are to be reasonably expected by the planner. It is one of the significant loads in the plan. The base estimations of live loads to be expected are given in IS 875 (section 2) – 1987. It relies on the expected utilization of the building.

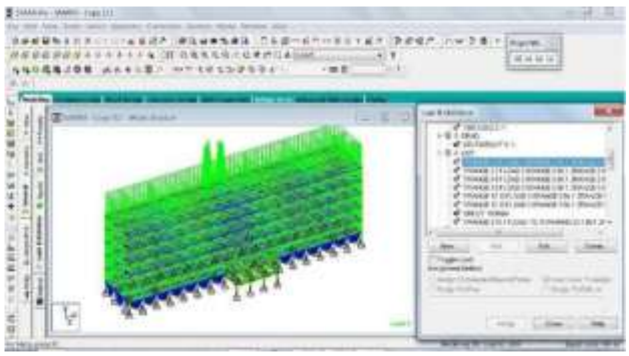


FIG 6: Application of Live load on the structure.

7. SESIMIC LOAD

Seismic loading is one of the basic concepts of earthquake engineering which means application of an earthquake generated agitation to a structure. It happens at contact surfaces of a structure either with the ground or with adjacent structures or with gravity waves from tsunami.

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FIG 7: Application of Seismic load in X direction.

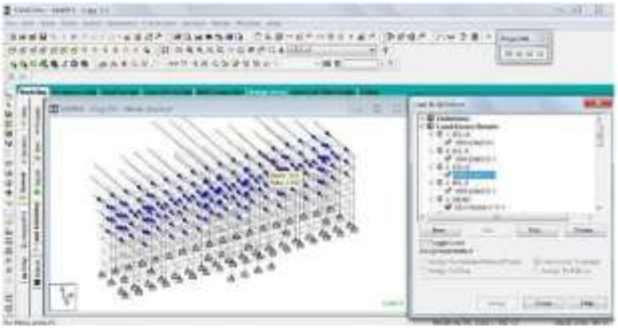

FIG 7.1: Application of Seismic load in Z direction.

8. WIND LOAD

Wind is a mass of air that moves in a mostly horizontal direction from an area of high pressure to an area with low pressure. The wind load is defined as the load on a structure due to the action of wind. High winds can be very destructive because they generate pressure against the surface of a structure. The effect of the wind is dependent upon the size and shape of the structure.

Calculating wind load is necessary for the design and construction of safer, more wind-resistant buildings and placement of objects such as antennas on top of buildings.

9. COLUMN DESIGN

Column design is a pivotal part of structural engineering, as columns are responsible for carrying heavy vertical loads in buildings, bridges, and other structures. The design process must ensure that these columns can safely resist forces like axial loads, bending, shear, and other stresses, while also maintaining the structure's stability and performance. STAAD. Pro, a renowned structural analysis and design software, offers engineers the tools to model, analyze, and optimize column designs to meet safety, stability, and serviceability requirements.

10. BEAM DESIGN

Beam design in STAAD. Pro involves analyzing and designing beams to ensure they can withstand the loads applied to them while meeting safety, stability, and serviceability requirements. Here's an overview of how beam design works in STAAD. Pro

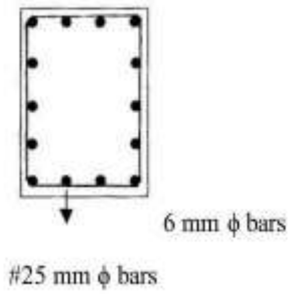

FIG 8: BEAM Design.

11. CONCLUSION

This project effectively showcased the use of STAAD.Pro in the planning and structural design elements, the building is not only aesthetically pleasing but also safe and functional under different load scenarios. The applications of IS codes, along with sophisticated modeling and simulation methods, supported the validation of design choices, ensuring the structures overall reliability.

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