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Design And Analysis Of RCC & Steel Structures For A Multi-Speciality Hospital Building Using STAAD.PRO

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ABSTRACT

Multi-specialty hospital buildings play a vital role in providing medical services to the community. It is crucial to examine emerging issues, analyze challenges, study trends, and evaluate strategic options for planning, designing, and constructing hospitals. The primary aim of this project is to conduct a comparative study of the design and analysis of RCC and steel-framed structures for a hospital building (G+9 with 2 basements) using STAAD.Pro software. STAAD.Pro is one of the leading tools for structural design. In this project, both RCC and steel-framed structures are analyzed to determine shear forces, bending moments, deflections, and reinforcement details for structural components such as beams and columns to achieve an economical design. The analysis results are used to verify the structural fitness for use. Finally, this study aims to determine the most cost-effective structural system for the hospital building using STAAD.Pro.

1. INTRODUCTION

The complex design of hospital buildings necessitates robust structural solutions. RCC structures are widely used due to their durability, while steel structures excel in flexibility and load-carrying capacity. This paper compares these two systems for a G+9 hospital building using STAAD.pro. Develop architectural and structural models. Analyse RCC and steel structures under various load conditions. Compare key metrics and costs to recommend the optimal solution.

2. LITERATURE

Dr.Ashokkumar.Net.al(2017)
The study aims at identifying an optimum structural shape of building which could withstand the forces under consideration. This study shows that STAAD Pro is more flexible when compared to ETABS software in terms of analysis of structure. The shear force and bending moment over each component of the building was calculated for different combinations of loads. Beams and columns were modelled as frame elements. It represents the strength and deformation capacity of members and the properties to be assigned are cross sectional dimensions, reinforcement details and the type of materials used are determined.

MVK Satish et.al (2017) examined and designed a G+3 hospital building & its facility arrangement reaction to seismic load were studied using Staad-pro and after were investigated through a 3D- nonlinear reaction history examination and corrected with non-linear static working methodology (NSP), this study recommends utilization of modular NSP rather than first node NSP as it gives better result while comparing building structures.
Safwan Ahmad et.al (2017) designed a G+2 hospital building using Staad pro by applying suitable loads and sectional details to components within the main aim of this factor was to study the extent of credibility using Staad.pro.
Sankar. J et.al (2016) This chapter deals with the modelling RC plane frames of G+3storey building and analysed by using STAAD.PRO. all loads acting on buildings such as dead load and live load were considered except the wind load. It was assumed that wind load would not govern the demands on the members and storey level. The unit weight of some material is taken from Table 1, IS 875(part1):1987. To represent the structural aspects of a typical frame in a building and exhibit its behaviour under external loading.
Adiyanto et.al (2008) analysed a 3-storey hospital building using Staad.pro. Seismic loads were applied to the building. The dead loads and live loads were taken from BS6399:1997 and seismic loads intensity is based on equivalent static force

procedure in UBC 1994. Results showed that the building can withstand any intensity of earthquake. It means that the buildings were suitable to be built in any area located near the epicentre of the earthquake.

3. METHODOLOGY

3.1 Project Description

- **Building Type**: Multispecialty Hospital
- **Structure Type**: RCC and Steel
- **Storeys**: G+9 with 2 cellars
- **Total Built-up Area**: 504 m²

3.2 Analytical Approach

Step 1: Planning
Architectural layouts were developed in AutoCAD, ensuring compliance with IS codes and healthcare-specific requirements.

Figure 1. Ground floor plan of hospital building.

Step 2: Load Calculations
Loads were determined as per IS 875 standards:

Dead Load:
Dead load refers to the permanent weight of a structure and its fixed components, such as walls, floors, roofs, and foundations. It is constant and does not change over time. Engineers calculate dead load based on the materials used in construction and ensure that the structure can support it for stability and safety. Dead load differs from live load, which is temporary and variable. Proper consideration of dead load is essential for designing durable and safe buildings.

Wall Load = 19.2 kN/m
Parapet Wall Load = 5.4 kN/m
Slab Load = 2 kN/m²
Floor Finishes = 1 kN/m²
Furniture Load = 1.5 kN/m²

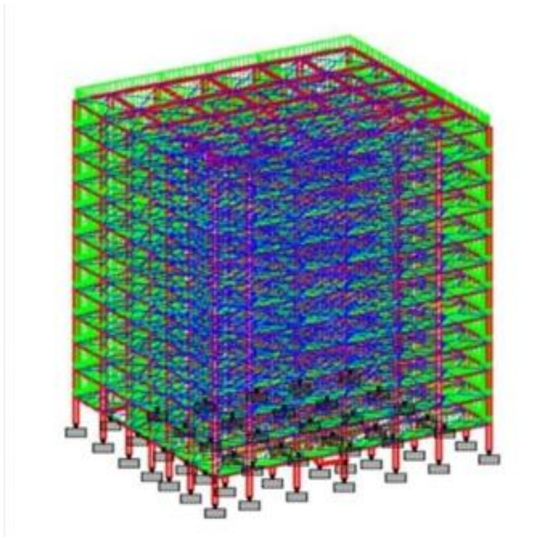

Figure 2. structure under dead load

Live Load:
Live load refers to temporary or movable forces that a structure must support, such as people, furniture, equipment, and vehicles. Unlike dead load, which is constant, live load can change based on the building's usage. Engineers calculate live loads based on local building codes and the specific function of the structure. Proper design ensures that structures can safely support varying loads, preventing failure and ensuring safety during use.

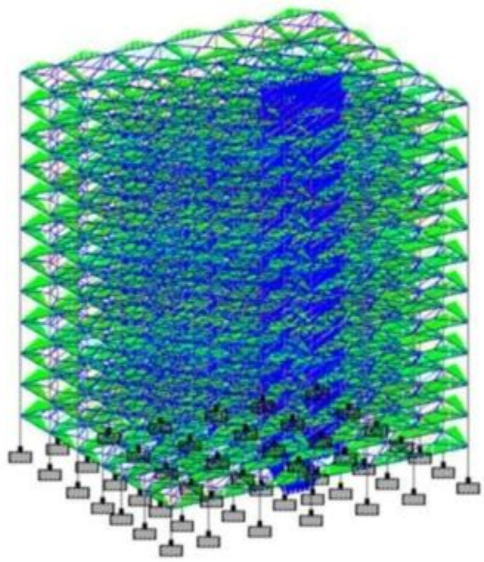

Figure 3. structure under live load

Roof = 1.5 kN/m²
Floor = 3 kN/m²
Stairs = 5 kN/m²

Wind-Load:
Wind load is the force exerted by the wind on buildings and structures. Key factors influencing wind load include wind speed, building height, shape and size, location, and local building codes. Structures are designed to withstand these forces by ensuring they are strong, stable, and flexible. Proper wind load design is essential for the safety and durability of buildings in windy conditions.

3.3 Load Calculation Summary

Table 4.1: Wind Load Calculations.

Height(m)	**Terrain multiplier (K2)**	**Wind pressure (Pz)(N/m^2)**	**Pd (KN/m^2)**
2	1.1275	1690.7	2.282
6	1.1715	1838.2	2.694
10	1.2055	1952.9	2.975

Calculated based on IS 875-Part III using the following parameters:
Basic Wind Speed (Vb) = 44 m/s
Terrain Category = 2
Height Multiplier (K2): Based on Table 4.1

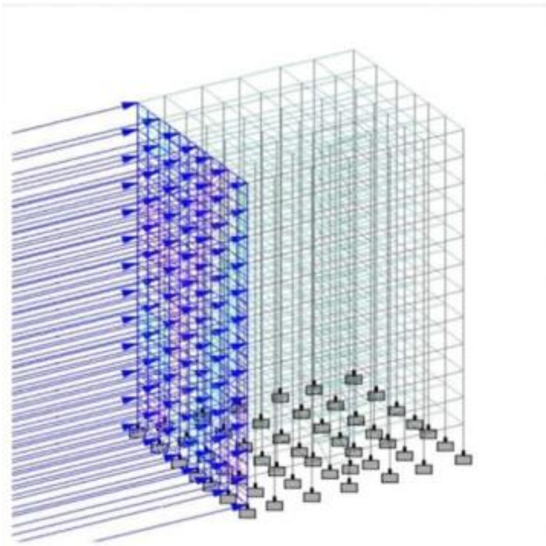

Figure 4. structure under wind load

Table 4.2: Load Combinations for Analysis.

Load Combination	**Expression**
Combination 1	1.5 DL + 1.5 LL
Combination 2	1.5 DL + 1.5 WL (X direction)
Combination 3	1.5 DL + 1.5 WL (Z direction)

3.4 Structural Performance

Table 4.3: Parameters.

Parameter	**RCC Structure**	**Steel Structure**
Max Shear Force (KN).	75.759	136.136
Max Bending Moment (KN-m)	61.613	177.335
Deflection in beam (mm)	-6.417	-7.895

4. RESULTS AND DISCUSSION

Our project involves analysis and design of multi-speciality hospital building (G+9) by using Staad.pro.

- Easy to use interface.
- Conformation with Indian Standard Codes.
- Versatile nature of solving any type of problem.

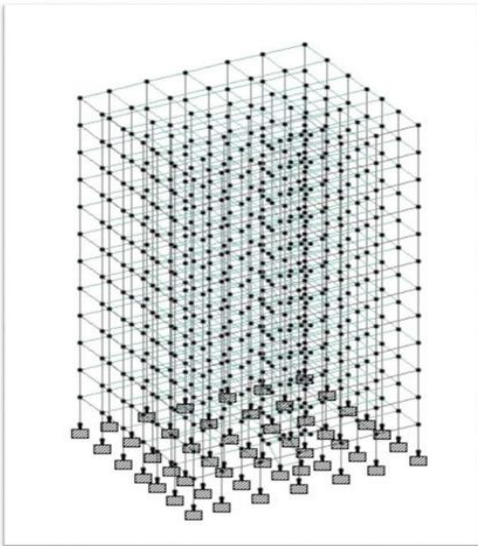

Figure5. model of the structure.

STAAD. pro features are a state-of-the-art user interface. visualization tools, powerful analysis and design engine 2/4 advanced finite element and dynamic analysis capability. From model generation, analysis and design to visualization and result verification, STAAD. pro is the professional's choice for steel, concrete, timber, aluminium and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much. To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties.

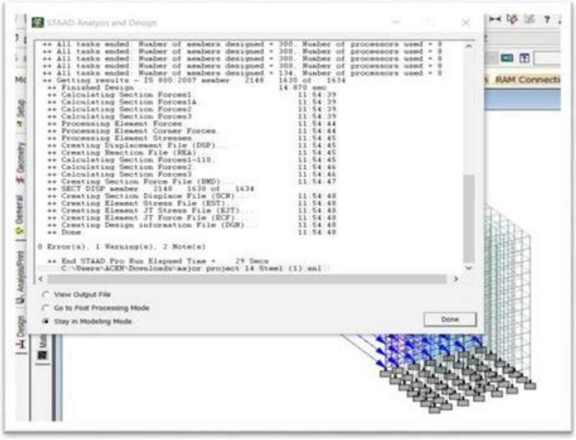

Figure 6. Figure shows zero errors

5. CONCLUSION

RCC structures are cost-effective and durable, making them suitable for projects prioritizing affordability. Steel structures excel in dynamic load scenarios, such as wind and seismic conditions. For this project, RCC is the preferred choice due to its economic benefits and adequate structural performance. Maximum shear force in beam of RCC structure is about 55% of that of steel structure. Maximum bending moment in beam of RCC structure is about 34% of that of steel structure. Maximum deflection in beam of RCC structure is about 81% of that of steel structure. Maximum shear force in column of RCC structure is about 99% of that of steel structure. Maximum bending moment in column of RCC structure is about 89% of that of steel structure.

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