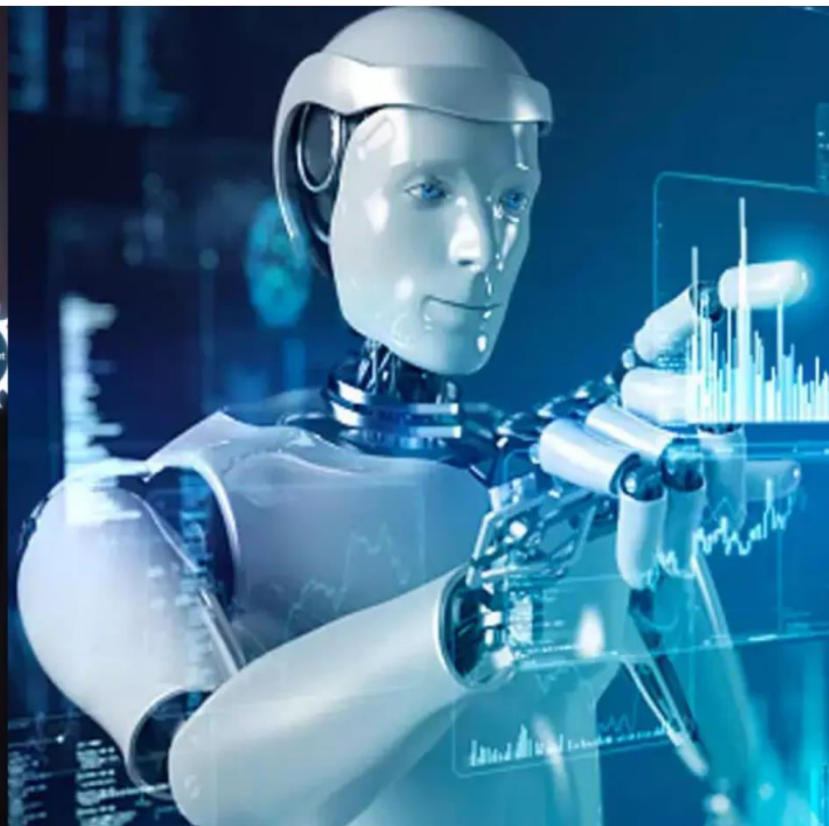




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Planning, Analysis, Modelling, Design, and of a Commercial Complex and Residential Building (Basement+Ground+3floors) Using STAADPro

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ABSTRACT: This project focuses on the comprehensive planning, analysis, and structural design of a multi-storey (Basement + Ground + 3 Floors) building intended for dual commercial and residential use. The architectural layout is developed in AutoCAD, prioritizing functional space for a basement parking facility, ground-floor retail, and upper-level residential units. The structural core is executed using STAAD.Pro, where the building is modelled as a 3D space frame. Detailed load analysis is performed by applying Dead, Live, and lateral loads (Wind and Seismic) in accordance with IS 875 and IS 1893 standards. Using the Limit State Method (IS 456:2000), the software calculates critical bending moments and shear forces to design reinforced concrete elements, including beams, columns, slabs, and footings. This systematic approach ensures a safe, stable, and economical design that optimizes material consumption while strictly adhering to national building codes and safety regulations.

KEYWORDS: Planning, Analysis, Residential building by using STAADPro

I. INTRODUCTION

Human beings need food, clothing, and shelter for survival. Over time, people have improved their living standards. One major goal is to achieve safe and affordable housing. A house provides security and reflects a person's social status. Everyone desires a peaceful and comfortable living environment. This can be achieved by choosing a safe and convenient residential location.

Engineers consider many factors before planning a building. These include municipal rules, building by-laws, environmental conditions, and financial capacity. They also check water supply, sewage systems, ventilation, and future expansion needs. Principles like Vastu are also sometimes considered.

Residential buildings must have proper ventilation. This is ensured through sufficient doors and windows. Structural analysis helps determine the size and shape of a building. It ensures the building can safely resist all loads during its lifetime.

Urban areas are growing rapidly due to population increase. Land is limited and expensive in cities. Therefore, multistorey buildings are becoming common. These buildings help in better land utilization and urban development.

Commercial buildings are used for business purposes. These include offices, shops, and warehouses. Their design depends on economic growth and business needs. They can generate higher income but also involve higher risks. Factors like location, lease terms, and maintenance are important.

This project focuses on a mixed-use building. It includes both commercial and residential spaces. The structure consists of a basement, ground floor, and three upper floors. Such projects are complex and require careful planning and design.

The first stage is planning. It defines the project scope and requirements. It includes deciding the number of shops and apartments. Parking, accessibility, and site conditions are also considered. Site investigation and preliminary designs are important steps.

The next stage is structural analysis. The building is tested for different loads. These include dead load, live load, wind load, and earthquake load. Internal forces like bending and shear are calculated. This ensures safety and efficiency.

Modelling is done using software like STAAD. Pro. The building is created as a 3D model. It includes beams, columns, slabs, and materials. Accurate modelling is very important for correct results.

Design is the next step. Structural elements are sized based on analysis results. Reinforcement is provided as per Indian Standards. Foundations are designed to safely transfer loads.

Finally, estimation is done. It calculates the cost of materials, labour, and equipment. This helps in budgeting and planning. Overall, this process ensures safe, economical, and successful construction.

II. LITERATURE SURVEY

Several studies have been carried out on the analysis and design of multi-storey buildings using STAAD.Pro, which is widely used in structural engineering.

K. Prabin Kumar et al. (2018) conducted a study on the design of multi-storey residential buildings. In their work, STAAD.Pro was used to analyze and design all structural members. The study considered different structural actions such as axial force, bending (flexure), shear, and tension. The researchers also calculated the quantity of reinforcement required for concrete sections. Their work highlights the importance of software-based analysis in improving accuracy and efficiency in structural design.

Deevi Krishna Chaitanya et al. (2017) focused on the analysis and design of a G+2 multi-storey building. They applied methods of static indeterminacy to determine unknown forces in the structure. Moment distribution techniques were used to achieve compatibility of forces. Specifically, Kani's method was applied to distribute moments at joints in continuous beams and frames. This approach ensured the stability and proper load distribution in the structure, demonstrating the importance of classical analysis methods along with modern tools.

Lakshmi Anuj et al. (2019) worked on the planning, analysis, and design of a G+2 residential building using STAAD.Pro. The structural frame analysis was carried out using the software, while the design of slabs, beams, footings, and staircases was performed based on IS 456:2000 using the Limit State Method (LSM). Important design aspects such as shear, torsion, and development length were considered according to code provisions. Columns and footings were designed using IS 456:2000 along with SP-16 design charts. Safety checks like one-way and two-way shear were also verified as per code requirements.

III. METHODOLOGY

The methodology for the analysis and design of a multi-storey building involves several important stages, including planning, modeling, analysis, design, optimization, and documentation using STAAD.Pro and relevant Indian Standard codes.

1. Preliminary Planning

The process begins with studying architectural drawings to understand the building layout and requirements. Site data such as soil condition, seismic zone, and wind parameters are collected. Based on these details, a suitable structural system like RCC is selected.

A Load identification is then carried out. Dead loads include self-weight, walls, and finishes. Live loads are considered as per IS 875 Part 2. Wind loads are calculated using IS 875 Part 3, and seismic loads are determined as per IS 1893.

2. Modeling in STAAD.Pro

The structure is modeled in STAAD.Pro by creating nodes, beams, columns, and slabs. Material properties such as concrete and steel are assigned. Slabs and shear walls are meshed for better accuracy.

Supports are defined at the base, and all loads (dead, live, wind, and seismic) are applied. Load combinations are created as per IS codes, including directional cases like ±X and ±Z.

3. Structural Analysis

Static analysis is performed to study the behavior of the structure under different loads. Key parameters such as deflection and storey drift are checked. Internal forces like bending moment, shear force, and axial force are obtained for all members.

4. Design of Elements

Structural elements are designed based on analysis results using IS 456:2000. Beams are designed for flexure and shear, columns for axial and biaxial loads, and slabs as per code provisions. Foundations are designed based on support reactions and soil conditions.

5. Optimization and Documentation

Member sizes are revised if required to ensure safety and economy. The analysis is repeated until satisfactory results are achieved.

IV. EXPERIMENTAL RESULTS

Design Calculations

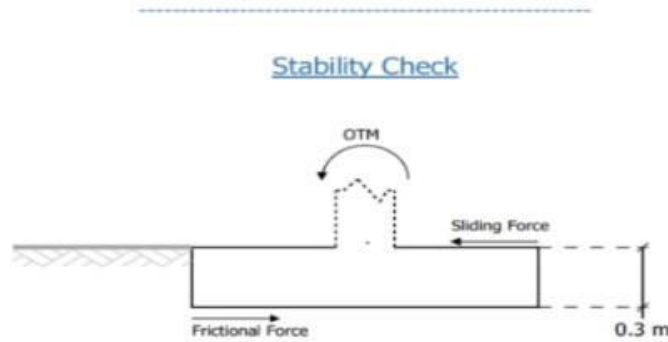
Load Combinations

Load Combination/s- Service Stress Level	
Load Combination Number	Load Combination Title
1	DL
2	LL
101	SL:1.000 x DL
103	SL:1.000 x DL+1.000 x LL
121	SL:0.800 x DL+0.800 x LL
Load Combination/s- Strength Level	
Load Combination Number	Load Combination Title
1	DL
2	LL
201	UL:1.500 x DL
202	UL:1.500 x DL+1.500 x LL
203	UL:0.960 x DL+0.960 x LL
211	UL:1.200 x DL
219	UL:0.900 x DL

Applied Loads

Before consideration of self weight and load safety factor table

Applied Loads - Service Stress Level					
LC	Axial (kN)	Shear X (kN)	Shear Z (kN)	Moment X (kNm)	Moment Z (kNm)
1	420.286	-0.001	0.727	0.572	-0.011
2	165.234	-0.121	2.883	1.514	0.073
101	420.286	-0.001	0.727	0.572	-0.011
103	585.520	-0.122	3.610	2.086	0.062
121	468.416	-0.098	2.888	1.669	0.049



Load Case No.	Factor of safety against sliding				Factor of safety against overturning		
	Along X-Direction	Along Z-Direction	Resultant	Required FOS	W.R.T. X-Direction	W.R.T. Z-Direction	Required FOS
1	189.362	250.972	151.161	1.500	519.190	279.418	1.500
2	30.912	34.779	23.105	1.500	72.257	47.530	1.500
101	189.362	250.972	151.161	1.500	519.190	279.418	1.500
103	76.315	90.077	58.227	1.500	186.923	115.836	1.500
121	77.227	91.153	58.923	1.500	189.156	117.220	1.500

V. CONCLUSION

This study presents a detailed approach to the planning, analysis, and design of a combined residential and commercial building, providing valuable insights into modern structural engineering practices. The project successfully integrates theoretical concepts with practical applications, demonstrating the complete workflow involved in building design

- 1.The project provides a comprehensive understanding of the complete process involved in planning, analysis, and design of mixed-use buildings consisting of residential and commercial spaces. It highlights the integration of architectural requirements with structural considerations.
2. The application of STAAD.Pro proved to be highly effective in analyzing the structure under various loading conditions such as dead load, live load, wind load, and seismic load. It ensured accurate assessment of structural behavior and safety.
- 3.The analytical results obtained from the software were cross-verified using conventional methods like the substitute frame method. This validation process improved the reliability and accuracy of the design, ensuring confidence in the final outcomes.
- 4.The design of structural elements such as beams, columns, slabs, and foundations was carried out systematically. All designs were performed in accordance with codal provisions like IS 456:2000, ensuring safety, serviceability, and durability of the structure.
- 5.The study emphasized the importance of considering different load combinations and real-time conditions during analysis and design. This approach helps in achieving a structurally stable and efficient building system.
- 6.The estimation process provided detailed knowledge about the economic aspects of construction. It included calculation of material quantities, labor requirements, and overall project cost, which are essential for budgeting and project planning.

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