Design and Analysis G+3 Residential and Commercial Building Using Staad Pro Software.

Saisarthak Tadakhe, Aniket Nikam, Saurav Bhagat , Sarthak Khalekar , Sanket Gore

Department of Civil Engineering, Sanjivani K. B. P. Polytechnic, Kopargaon
Maharashtra, India

ABSTRACT

The structural design and analysis of multi-story buildings play a crucial role in ensuring safety, durability, and cost-effectiveness. This project focuses on the design and analysis of a G+3 (Ground plus three floors) residential and commercial building using ETABS and RCDC software. The aim is to develop an efficient, structurally sound, and economically viable design that adheres to the provisions of the Indian Standard Codes, including IS 456:2000 for reinforced concrete structures and IS 1893:2016 for seismic design

In this project, ETABS is employed for 3D modeling, load analysis, and dynamic structural analysis, providing insights into the behavior of the building under various loading conditions. The software facilitates the creation of a detailed structural model, accounting for dead loads, live loads, wind loads, and seismic forces. By considering these factors, the software calculates moments, shear forces, and displacements in critical structural elements, helping to identify potential areas of concern in terms of stress and deflection. This process ensures that the building design is capable of withstanding static and dynamic forces that may occur during its lifetime.

INTRODUCTION

In today's rapidly urbanizing world, the demand for multi-story buildings that serve both residential and commercial purposes has risen significantly. The combination of residential and commercial spaces in the same building maximizes land use, especially in densely populated urban areas where space is limited. However, designing these structures requires careful consideration of a variety of factors, including structural stability, cost-effectiveness, and adherence to regulatory standards. This project focuses on the design and analysis of a G+3 (Ground plus three floors) residential and commercial building using advanced software tools such as ETABS and RCDC. These tools aid in ensuring that the structure is both safe and efficient under different loading conditions while meeting the requirements of Indian Standard (IS) codes.

The G+3 building, with its combination of residential and commercial spaces, presents a unique challenge. It must accommodate the different loading patterns and functional needs of both types of occupants. Residential floors typically experience live loads that result from human occupancy and furniture, while commercial floors may face greater loads due to equipment, storage, or increased foot traffic. Hence, a robust design must consider these varying requirements and ensure that all structural components can support the building's intended use throughout its lifespan. One of the key aspects of this project is ensuring structural safety under different loads such as dead loads, live loads, wind loads, and seismic forces. Dead loads include the weight of permanent elements like walls, floors, and roofs, while live loads are temporary or movable loads, such as people, furniture, and vehicles. Wind loads are especially critical in taller buildings, as they can exert lateral forces that could compromise structural integrity.

Additionally, in regions prone to seismic activity, designing buildings that can withstand earthquake forces is crucial. This is where the use of advanced software like ETABS comes into play. ETABS is widely regarded as one of the most powerful tools for analyzing and designing building structures.

OBJECTIVE

1.Structural Modeling:
Create a 3D model of the G+3 residential and commercial building using STAAD Pro.

2.Load Assessment:
Analyze loads (dead, live, wind, and seismic) following IS code standards.

3.Stability Analysis:
Evaluate the structure for stress, deflection, and stability under various load conditions.

4.Design Optimization:
Develop an economical and safe design for structural components, ensuring compliance with codes.

METHODOLOGY

1.Problem Definition
Specify structural details (G+3 structure, material types, and geographical location within seismic zones).

2. Preliminary Design
Architectural Layout: Prepare the floor plans, elevation, and layout.
Calculate dead, live, wind, and seismic loads as per IS codes

3.Structural Modeling
Use STAAD. Pro to create the structural framework.
Define elements, materials, and apply loads.

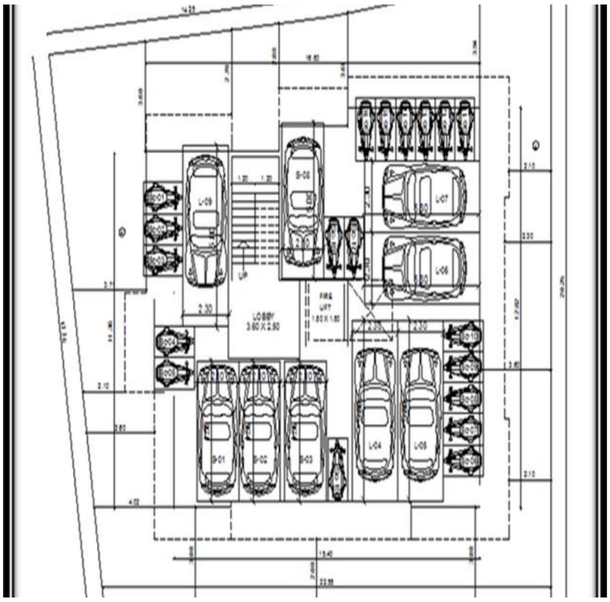
4.Design of Structural Components
Beams, Columns, and Slabs:
Perform reinforcement design using STAAD.Pro.

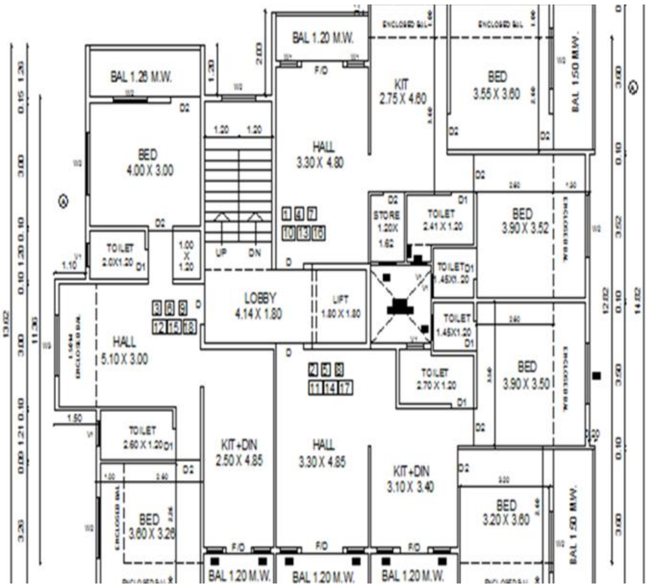
5.Validation and Cross-Verification
Manual Calculation: Check key components with hand calculations.
Comparison: Compare with similar projects.
Peer Review: Review design and calculations.

6.Final Design Report

Prepare a detailed design report that includes calculations, design drawings, and analysis results.

Preliminary Design





1.used : (M30)
2.Steel grade used : (Fe500)
3.Support: Fix supportHeight = 3m

4.Beam dimension : (230mmX400mm)
5.Column dimension : (230mm*800mm)
6.Slab thickness: (150mm)
7.Concrete grade

1.Depth of Beam (d): The depth of the beam should generally be taken as between 1/10 to 1/12 of the span for simple beams and 1/12 to 1/15 of the span for cantilever beams.

2.Width of Beam (b): The width of the beam should be between 1/2 to 1/3 of the depth of the beam.

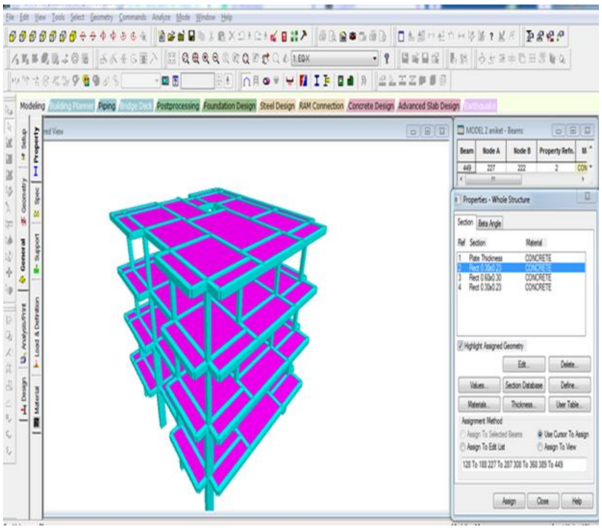
3.The column size is cover from IS 456:2000 Clause 26.

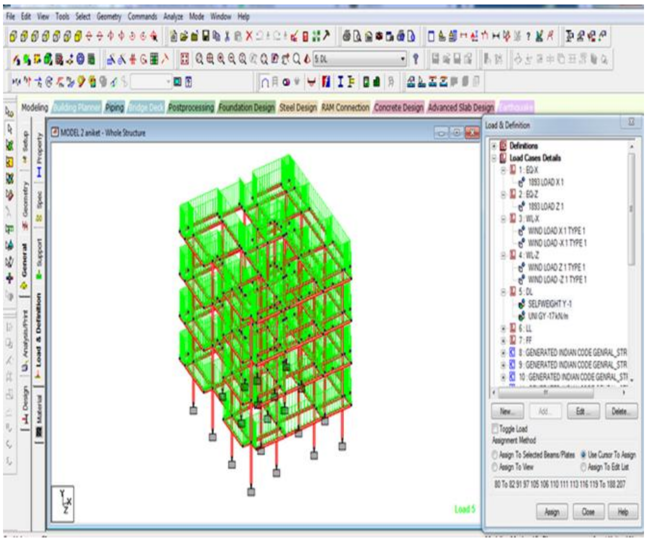
MATERIAL PROPERTIES

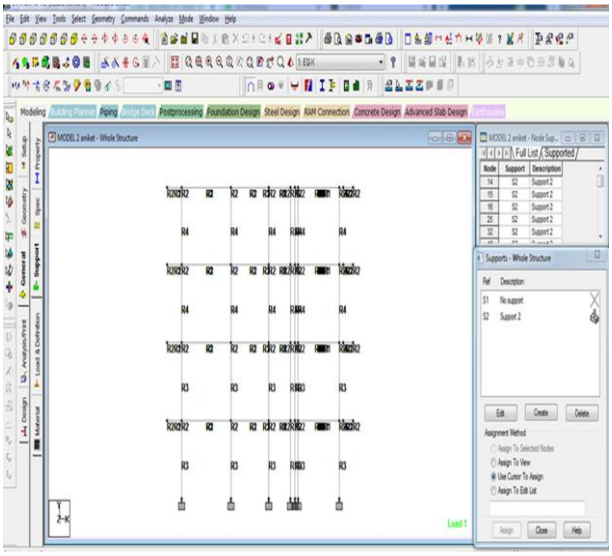
IS 875 (Part 1): 1987 - Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures, refer to
IS 875 (Part 1): 1987, Clause 3.1 - Dead Load, Clause 3.2 - Unit Weights of Materials, Clause 4.2 - Calculation of Dead Load

Calculation of Dead Load

Dead load for any structural member can be calculated as:
Dead load for beam=0.23x0.30x25=1.8 kN/m
for column= 0.30x0.60x25=4.5 KN/m
For slab= 0.15x1x25= 3.75 KN/SQ.m
Brick wall= 0.23x2.60x20= 11.96 KN/SQ.m







LIVE LOAD STAAD PRO

live load for a building using IS 875. (Part 2): 1987 - Code of Practice for Design Loads (Other Than Earthquake) for Buildings and Structures.
Refer to IS 875 (Part 2): 1987
Residential buildings: 2.0 kN/m²
Offices: 2.5 to 4.0 kN/m² (depending on usage)
Assembly areas: 3.0 to 5.0 kN/m²
Corridors and staircases: 3.0 kN/m²
Roof loads: 1.5 kN/m² (if accessible for maintenance).

LOAD APPLICATION [DEAD LOAD]

WIND APPLICATION

To determine wind load for a building as per IS 875 (Part 3): 2015, refer to Clause 5.3, Clause 6.3, Clause 7.2.2

Basic Wind Speed

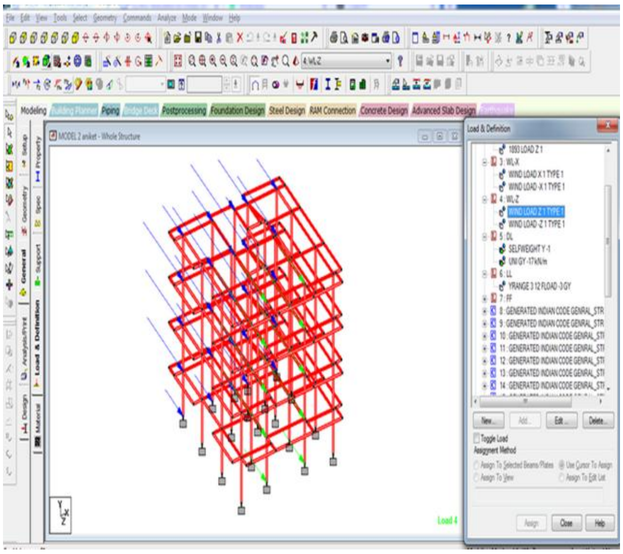
Obtain the basic wind speed (Vb) from Table 1 or the wind zone map provided in the code. This value depends on the geographical location of the structure.

Design Wind Speed (Vz)

Vz= Vb x K1 x K2 x K3 x K4

Design Wind Pressure

Pz= 0.6 x Vz 2



SEISMIC APPLICATION [dead load]

To determine seismic loads for buildings as per the Indian Standard, you must refer to IS 1893 (Part 1): 2016, which specifically deals with seismic load considerations for structures.

IS 1893 (Part 1): 2016 provides the seismic zoning map of India. Locate your city or region on the map to determine its seismic zone.

Use Zone Factor from Table 2: Once you identify the seismic zone, use the corresponding Zone Factor (Z) from Table 2 of

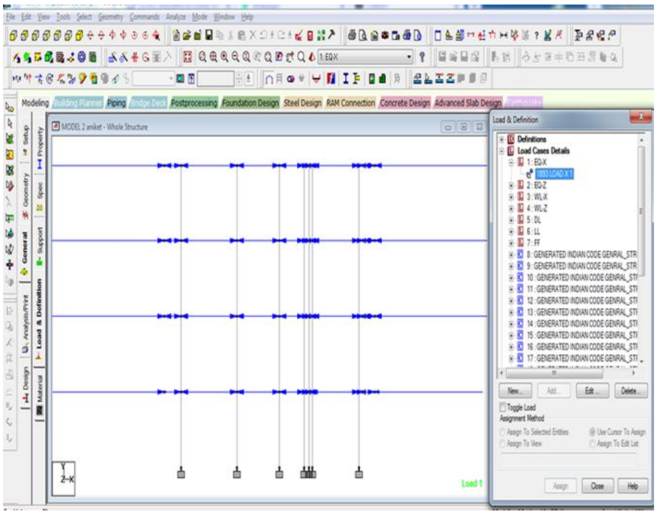
IS 1893 (Part 1): 2016.

Seismic Zone	Zone Factor
Zone II	0.10
Zone III	0.16
Zone IV	0.24
Zone V	0.36

Design Wind Pressure

Tx= (0.09 x H) / D ^0.5

=0.664 sec



RESULT

Objective Achievement:

The analysis effectively demonstrated how modern tools like STAAD.Pro aid in designing earthquake-resistant buildings by ensuring adequate detailing of structural components, achieving the desired performance against lateral and vertical loads, and meeting code requirements such as IS 456 and IS 1893.

Structural Design Comparison:

At 1st Floor (Beam Design):

STAAD.Pro: 3-T10 (top), 3-T12 (bottom), Stirrups: 12-T8 @ 100 mm c/c.

At 2nd Floor (Beam Design):

STAAD.Pro: 3-T10 (top), 3-T16 (bottom), Stirrups: 12-T8 @ 100 mm c/c.

Column Design Comparison:

At ground Floor:

STAAD.Pro: 12-T20.

At 1st Floor:

STAAD.Pro: 12-T16.

1.Structural Analysis: Building stability under all load conditions (dead, live, wind, seismic) is being verified.

2.Load Distribution: Dead and live loads have been applied. Preliminary calculations for self-weight and occupant loads are ongoing.
3.Structural Component Design: Initial designs for beams, columns, and footings are in progress using the Limit State Design method.

4.Deflection & Safety: Deflection checks and seismic load verification are underway, with preliminary results within limits.

5.Software Integration: 3D visualization and preliminary drawings are being generated using STAAD Pro and AutoCAD.

6.Manual Comparison: Manual calculations for beams and columns are being compared with STAAD Pro results for accuracy.

CONCLUSION

1.The design and analysis of the G+3 residential and commercial building using STAAD Pro have demonstrated that the software provides an efficient, accurate, and time-saving approach to structural design.

2.Preliminary results show that the building complies with all load conditions (dead, live, wind, seismic) and remains stable.

3.The Limit State Design method, applied as per IS: 456-2000, ensures that the structural components (beams, columns, footings) are safe and economical.

4.Integration with AutoCAD for 3D visualization and drawing generation improves design accuracy and presentation.

5.Comparison with manual calculations validates the reliability and precision of STAAD Pro.

6.STAAD Pro proves to be a powerful tool for the design of multi-story buildings, offering both time efficiency and structural safety.

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