"Comparative Structural Analysis of Multi-Storied Buildings Using Revit–Robot Integration, ETABS, and Manual Design as per IS 456"

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Abstract - *The integration of Building Information Modelling (BIM) with structural analysis software has improved the accuracy and efficiency of modern building design. This study focuses on a G+4 multi-storied reinforced concrete (RCC) building, modeled in Autodesk Revit and analyzed using Robot Structural Analysis and ETABS. The primary objective is to compare the results obtained from these software platforms with manual calculations performed as per IS 456:2000. The structural model was first developed in Revit, providing coordinated architectural and structural details, and then exported to Robot for analysis. A parallel model was analyzed in ETABS to verify consistency. Key parameters including bending moments, shear forces and axial loads were compared across all three approaches. The findings indicate close agreement between software results and IS 456 manual design, with minor variations due to algorithmic differences. This study demonstrates the effectiveness of BIM-integrated workflows while emphasizing the continued importance of manual IS code validation for ensuring structural safety and compliance.*

***Key Words*: Building Information Modelling (BIM), Revit, Robot Structural Analysis, ETABS, Multi-storied RCC Building, IS 456 Manual Design**

1.INTRODUCTION

Building Information Modelling (BIM) has emerged as a transformative approach in the architecture, engineering, and construction (AEC) industry by integrating design, visualization, and analysis into a single framework. Among the available BIM platforms, Autodesk Revit plays a key role in developing coordinated architectural and structural models of multi-storied buildings. Its interoperability allows direct export of structural models to analysis software, enabling accurate assessment of structural behaviour under various loading conditions.

In this study, a G+4 reinforced concrete (RCC) building is modelled in Revit to establish a BIM-based framework for design and analysis. The structural model is analysed using Robot Structural Analysis, which is well-suited for integration with Revit, and also using ETABS, a widely adopted software for multi-storied building analysis and design. By evaluating the same structure across both platforms, differences in results due to variations in computational approaches and assumptions can be identified.

To ensure reliability, the results of bending moments, shear forces, axial loads, and deflections from both software are validated against manual design calculations performed as per IS 456:2000. Manual design not only serves as a benchmark but also ensures compliance with codal provisions, which remain essential for structural safety.

This comparative study highlights the effectiveness of BIM-enabled workflows while demonstrating the continued significance of manual code-based validation in structural engineering practice.

2. LITERATURE SURVEY

Building Information Modelling (BIM) is increasingly used for structural design due to its integration of architectural and analytical models. Ahmed et al. (2024) demonstrated BIM application through Revit and Robot Structural Analysis for a G+5 RCC building, improving accuracy and sustainability. Sampaio et al. (2019) highlighted BIM's capability in generating analytical models and reinforcement details but noted interoperability limitations between Revit and Robot. Jebur (2020) modelled and analysed a G+5 building with Revit–Robot integration, emphasizing efficiency and validating results with IS 456:2000.

Other studies compared software like ETABS, STAAD.Pro, and Robot, showing variations in bending moments, shear forces, and deflections due to computational differences. However, all confirmed close agreement with IS code-based manual design, reinforcing the necessity of manual checks. Research on seismic behaviour of multi-storied RCC structures further demonstrated ETABS as a reliable tool for dynamic analysis. Overall, literature indicates that BIM-integrated workflows enhance accuracy and productivity, while manual validation remains critical for safety and compliance.

3. OBJECTIVES

- To model a G+4 multi-storied RCC building in Revit using BIM.
- To analyze the structure using Robot Structural Analysis and ETABS.

- To validate and compare the results with manual calculations as per IS 456:2000.

4. METHODOLOGY

The study focuses on a G+4 multi-storied RCC building, modeled in Autodesk Revit to integrate architectural and structural elements in a coordinated 3D framework. The Revit model serves as the base for structural analysis in Robot Structural Analysis and ETABS, where bending moments, shear forces, axial loads, and deflections are evaluated under standard load conditions.

The Robot analysis leverages Revit's BIM data for precise evaluation, while ETABS provides a parallel verification of the structural behavior. To ensure accuracy and compliance, manual calculations are performed following IS 456:2000, serving as a benchmark for validating software outputs.

Results from the three approaches are compared to assess consistency, reliability, and discrepancies, highlighting the efficiency of BIM-integrated workflows while emphasizing the continued importance of manual code-based validation for structural safety and adherence to standards.

1. PLAN AND ITS SPECIFICATIONS

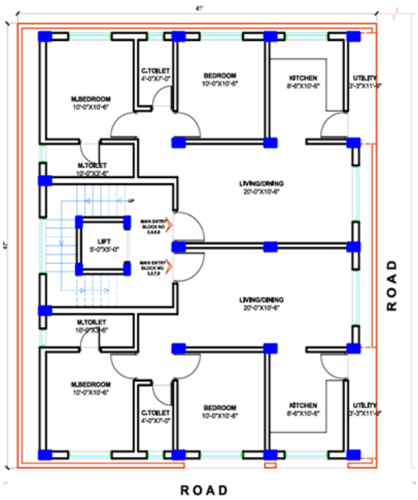

Fig -1: Plan of the building

The G+4 multi-storied RCC building is having a plot area of 179.02 m^2 with a built-up area of 152.59 m^2. Each floor has a height of 3.0 m, foundation depth is 1.50 m, and parapet height is 1.20 m. The main wall thickness is 0.230 m, partition walls are 0.150 m, and slab thickness is 0.125 m. Columns are 230×380 mm for regular frames and 150×300 mm for the lift core, while beams are 230×380 mm. The structure uses M25 concrete and Fe 500 steel.

5. RESULTS AND OBSERVATIONS

5.1. Structural modelling in Revit

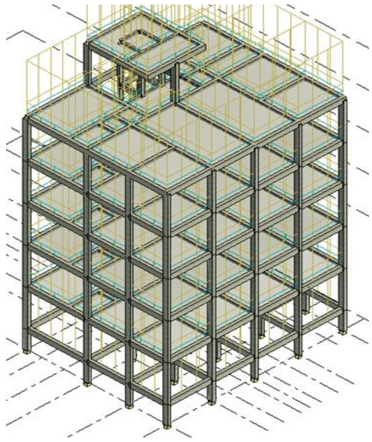

Fig -2: 3D modeling Revit

5.2. Structural analysis in Robot

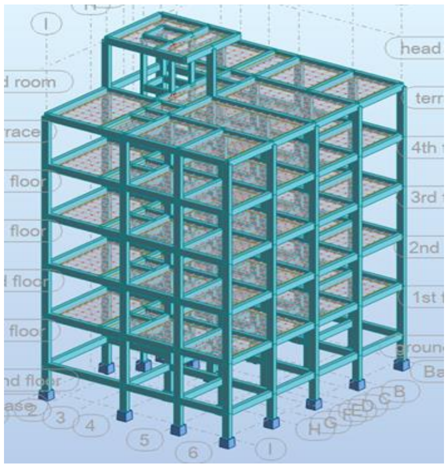

Fig -3: 3D model in Robot

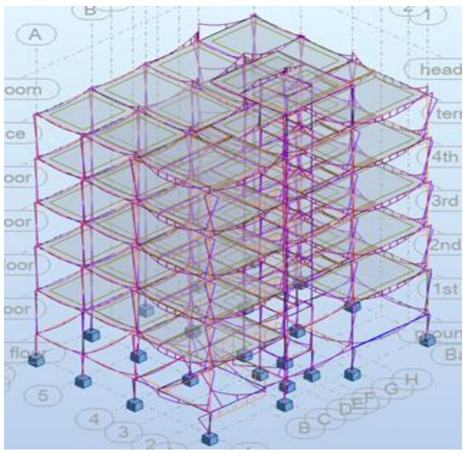

Fig -4: Bending moment of whole structure

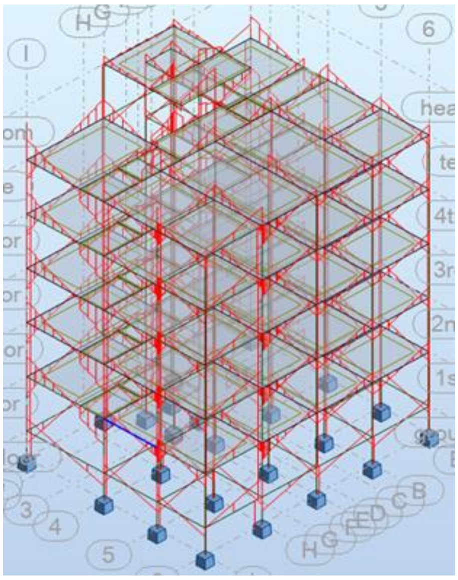

Fig -5: Shear force of whole structure

The maximum axial force and bending moment for the column is 1700 kN and 25 kNm respectively and 9 bars of 16mm diameter is provided as reinforcement for this column.

The bending moment and shear force of beam is 32 kNm and 64 kN respectively and 2 bars of 16mm diameter is provided as bottom reinforcement.

5.3. Structural analysis ETABS

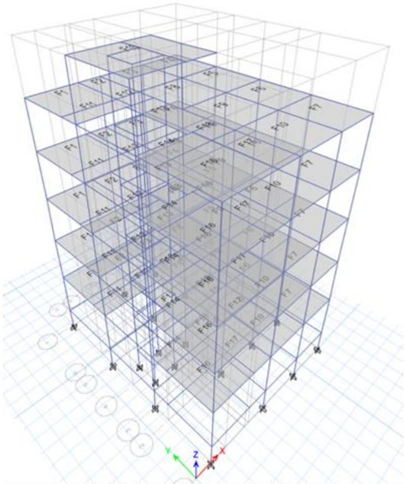

Fig -6: 3D model in ETABS

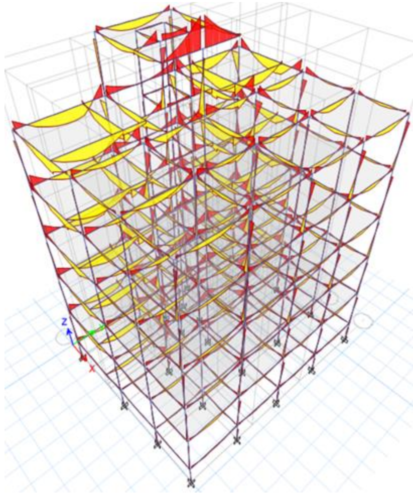

Fig -7: Bending moment of whole structure

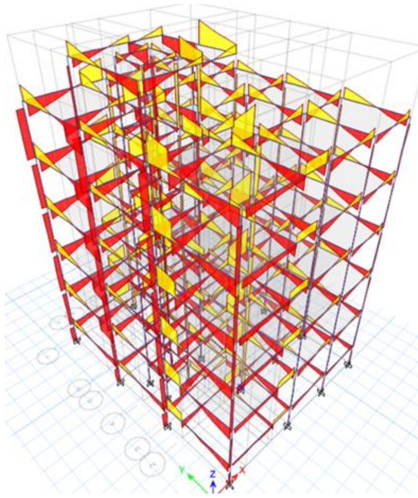

Fig -8: Shear force of whole structure

The maximum axial force and bending moment for the column is 1740 kN and 31 kNm respectively and 4460mm^2 provided as reinforcement for this column.

The bending moment and shear force of beam is 37 kNm and 55 kN respectively and 382mm^2 is provided as bottom reinforcement.

Table -1: Comparison results of beam

Values for beam			
	SF	BM	AST
Manual calculations	56	65	480
RSA	64	32	200
ETABS	55	37	382

Table -2: Comparison results of column

Values for column			
	Axial force	BM	AST
Manual calculations	1670	35	2190
RSA	1700	25	1660
ETABS	1740	31	4460

7. CONCLUSIONS

A G+4 multi-storied RCC building was modelled in Revit and analysed using Robot Structural Analysis and ETABS, with results compared to manual calculations as per IS 456:2000. Beam analysis showed ETABS results were closer to manual values, while Robot gave lower bending moment and reinforcement requirements. For columns, axial forces matched closely across all methods, though reinforcement demand varied, with ETABS predicting higher values.

The comparison confirms that BIM-integrated workflows enhance efficiency and accuracy in structural analysis, but manual design remains essential for validation and code compliance. Combining software-based analysis with IS 456 checks ensures reliability and safety in the design of multi-storied buildings.

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REFERENCES

[1] Faizan Ahmed et al (2024): "Analysis and Design of G+5 Residential Building Using BIM" International Journal of Research and Analytical Reviews.

[2] Alcinia Z. Sampaio (2019): "Analysis of BIM Implementation Structural Projects"

[3] Mr. Hamzah Sabah Jebur (2020): "Modelling, Analysis and Design of a Multi-Story Building by Using Building Information Modelling (BIM) Approach." International Research Journal of Engineering and Technology (IRJET)

[4] Bedilu Habte (2021): "Application of BIM For Structural Engineering: A Case Study Using Revit and Customary Structural Analysis and Design Software" Journal of Information Technology in Construction

[5] IS 456:2000, Indian Standard Code for practice of plain and reinforced concrete (Fourth revision), Bureau of Indian standards, New Delhi, July 2000.

[6] IS 875(Part 2), Indian Standard Code for practice for design loads (other than earthquake) for buildings and structures, Imposed load (Second revision), Bureau of Indian standards, New Delhi,1989.