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Integrated BIM Workflow for Structural Modeling, Analysis, and Design of a G+30 Reinforced Concrete Building Using Autodesk Revit and ETABS

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Abstract:
Building Information Modeling (BIM) can reduce fragmentation between structural modeling, analysis, design and documentation, but the practical transfer of analytical information between BIM and structural analysis platforms remains a critical workflow issue. This study develops and evaluates an integrated BIM workflow for a Ground plus Thirty (G+30) reinforced concrete building using Autodesk Revit and ETABS. A parametric three-dimensional structural model comprising grids, levels, reinforced concrete columns, beams, slabs and foundations is developed in Revit. The analytical representation is transferred to ETABS, where gravity, wind and earthquake actions are considered and reinforced concrete members are designed in accordance with the Indian Standard provisions adopted in the project. The reported numerical response includes a maximum roof displacement of 128.4 mm, maximum inter-storey drift ratio of 0.0019, base shears of 18,960 kN in X and 18,340 kN in Y, and modal periods of 3.52, 3.28 and 2.87 s for the first three modes. The study reports satisfactory flexural, shear, deflection and reinforcement performance for beams, columns and slabs. From the BIM perspective, structural geometry was transferred successfully, most member properties were retained, minor analytical connectivity adjustments were required, and subsequent design revisions and quantity schedules remained synchronized. The study demonstrates that Revit–ETABS interoperability can support an integrated digital structural workflow while emphasizing the need for post-transfer model verification.
Keywords: Building Information Modeling; Autodesk Revit; ETABS; G+30 building; reinforced concrete; interoperability; structural analysis; seismic design

1. Introduction

The increasing complexity of high-rise construction has created a need for structural workflows that combine geometric modeling, analytical evaluation, reinforced concrete design and coordinated documentation. Conventional practice often separates drafting, structural analysis and documentation into independent software environments. Repeated recreation of the same building information can introduce inconsistencies, increase revision effort and make coordination more difficult. The supplied project identifies these issues as a principal motivation for integrating BIM with structural analysis software.

BIM provides an information-rich digital representation in which structural components are represented as intelligent objects with geometric and non-geometric properties. In the present study, Autodesk Revit provides the BIM environment, while ETABS is used for structural analysis and reinforced concrete design. The intended workflow is not simply a software-to-software transfer; it is a continuous process in which the analytical model is checked after transfer and design changes are reflected back into the BIM environment.

Previous studies summarized in the project documentation identify BIM benefits in coordination, productivity, documentation, lifecycle management and reduction of information duplication. However, the project identifies a gap in detailed end-to-end case studies for G+30 reinforced concrete buildings under Indian Standard provisions, particularly studies that combine structural performance assessment with BIM documentation and interoperability checks.

Accordingly, the objective of this work is to demonstrate an integrated Revit–ETABS workflow for a G+30 reinforced concrete building and to assess both structural response and the practical benefits and limitations of the BIM integration. The study evaluates displacement, drift, storey shear, base shear, modal characteristics and reinforced concrete design status, together with model-transfer and documentation outcomes.

Figure 1: High-rise building under construction

2. Materials and Methods

2.1. Case-study building

The case study represents a regular G+30 reinforced concrete moment-resisting frame intended to represent a high-rise residential or commercial building. Thirty upper floors are provided above ground level. The typical storey height is 3.2 m and the ground-floor height is 3.5 m. M30 concrete and Fe500 reinforcement are adopted. The floor system is a cast-in-situ reinforced concrete slab, and the project permits the applicable foundation system to be represented as isolated, combined or raft foundations.

Table 1: Building configuration

Parameter	**Adopted value**
Building configuration	G+30 reinforced concrete high-rise
Structural system	RC moment-resisting frame
Number of upper floors	30
Typical storey height	3.2 m
Ground-floor height	3.5 m
Concrete	M30
Reinforcement	Fe500
Floor system	Cast-in-situ RC slab

Base condition	Fixed
Diaphragm	Rigid
Design standards	IS 456:2000; IS 875; IS 1893:2016; IS 13920:2016

2.2 BIM modelling in Revit

The Revit model was developed using a structural project template. Project units, location, base and survey points, levels, grids and view templates were configured before structural components were created. The model includes columns, beams, slabs, foundations and other applicable structural elements. For the G+30 building, thirty-one structural levels were established, including the ground level and roof level. The Revit analytical model contains nodes, members, connectivity and supports and is reviewed before transfer to ETABS.

The BIM model serves as the primary source for structural analysis coordination, quantity estimation and construction documentation. Revit's parametric relationships allow changes to member geometry and associated schedules to be propagated through the model, reducing repetitive manual drafting.

2.3 Revit–ETABS interoperability

The analytical model is transferred from Revit to ETABS through supported interoperability tools or compatible exchange formats. Following import, member geometry, connectivity, storey elevations, materials, section assignments and support conditions are verified. Any inconsistencies are corrected before analysis. The methodology therefore treats interoperability as a controlled engineering step rather than assuming that all model information transfers without validation.

2.4 Loads, analysis and design

The ETABS model is subjected to dead, live, wind and earthquake actions, together with combined load cases. Dead and imposed loads follow the project application of IS 875, wind actions follow IS 875 (Part 3):2015, and seismic actions follow IS 1893 (Part 1):2016. Reinforced concrete design is performed with reference to IS 456:2000 and IS 13920:2016. The project uses linear static analysis for gravity response, wind analysis, response-spectrum analysis for seismic response and modal analysis for dynamic characteristics.

Table 2: Analysis and design

Load / analysis component	**Purpose**
Dead load (DL)	Self-weight and permanent actions
Live load (LL)	Occupancy-related imposed action
Wind load (WL)	Lateral wind response
Earthquake EQX/EQY	Seismic response in principal directions
Linear static analysis	Gravity-load response
Response spectrum analysis	Dynamic seismic response
Modal analysis	Natural periods, mode shapes and mass participation
RC design	Beam, column, slab and foundation design checks

2.5 Model validation and BIM feedback

Before accepting design results, the workflow includes geometry, connectivity, material, section, load, support and diaphragm checks. After analysis and design, member sizes and reinforcement information are reviewed and design changes are reflected in Revit. Construction drawings and quantity schedules are consequently intended to remain synchronized with the structural model.

3. Results

3.1 Storey displacement

The reported displacement increases progressively with height, from zero at ground level to 128.4 mm at the roof. The project interprets this monotonic profile as characteristic of a high-rise frame under lateral action and reports that the maximum displacement remains within the applicable permissible limits.

Table 3: Storey displacement

Storey	Displacement (mm)
Ground	0
5	17.4
10	39.7
15	63.8
20	88.2
25	110.6
Roof	128.4

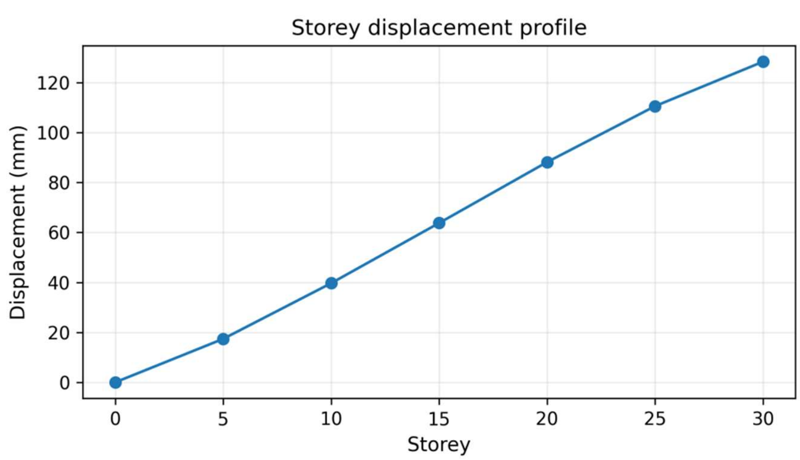

Fig. 2: *First Storey displacement profile based on the ETABS results.*

3.2 Inter-storey drift

The maximum reported inter-storey drift ratio is 0.0019 at approximately the middle-to-upper-middle storeys. The project reports that the calculated drift ratios satisfy the permissible limits of IS 1893 (Part 1):2016, indicating acceptable lateral stiffness for the analysed model.

Table 4: Base shear and overturning moment

Storey	Drift ratio
5	0.0011
10	0.0014
15	0.0017
20	0.0019
25	0.0018
Roof	0.0016

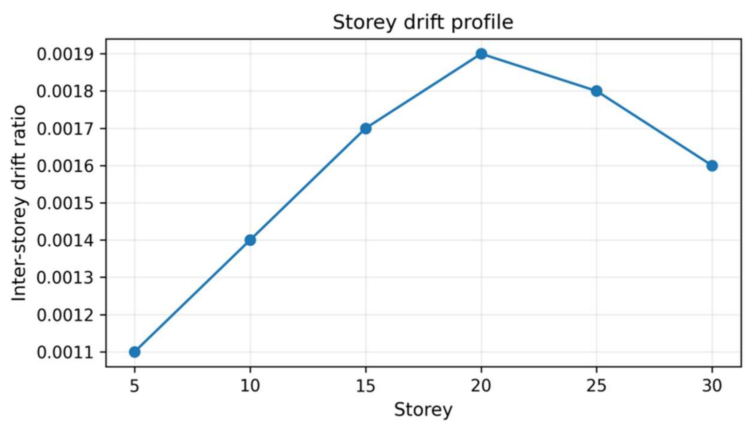

Fig. 3: *Base shear comparison.*

3.3 Storey shear and base shear

Storey shear is highest at the base and reduces toward the roof, with 18,960 kN at ground level and 1,520 kN at roof level. This distribution is consistent with cumulative lateral-force transfer through the storeys.

Table 5: Storey shear

Storey	Storey shear (kN)
Ground	18960
5	16750
10	13200
15	9850
20	6720
25	3980

Roof	1520

The reported base shears are 18,960 kN in X and 18,340 kN in Y. Their close magnitudes are interpreted in the source documentation as evidence of a relatively regular configuration and balanced lateral stiffness.

Table 6: Base shear in X & Y directions

Direction	**Base shear (kN)**
X	18,960
Y	18,340

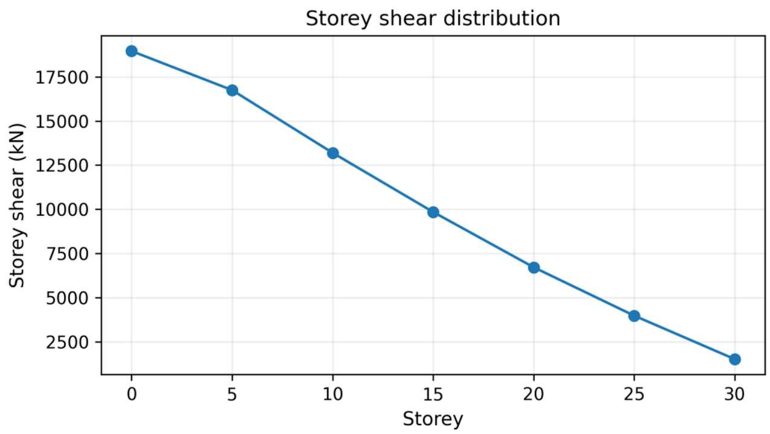

Fig. 4: *Storey shear distribution.*

3.4 Modal characteristics

The first five reported modal periods are 3.52, 3.28, 2.87, 1.94 and 1.42 s. The source documentation reports mass participation values of 67.4%, 65.1%, 73.8%, 84.6% and 91.3% for the listed modes. The project interprets the modal results as adequately representing the dynamic behaviour of the high-rise structure.

Table 7: Modal characteristics

Mode	**Period (s)**	**Mass participation (%)**
1	3.52	67.4
2	3.28	65.1
3	2.87	73.8
4	1.94	84.6
5	1.42	91.3

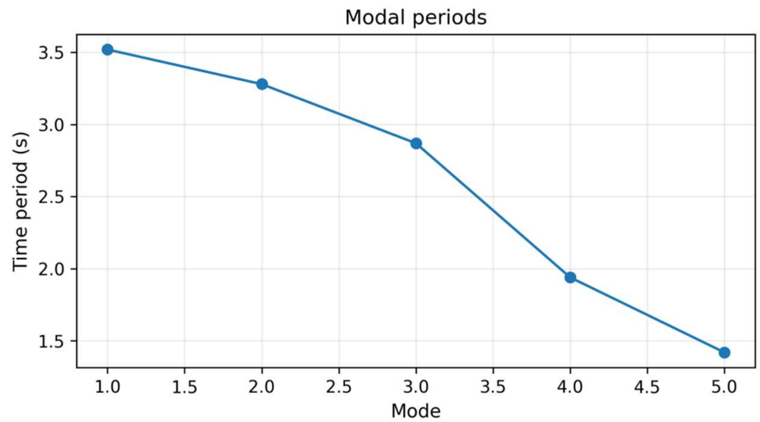

Fig. 5: *modal periods.*

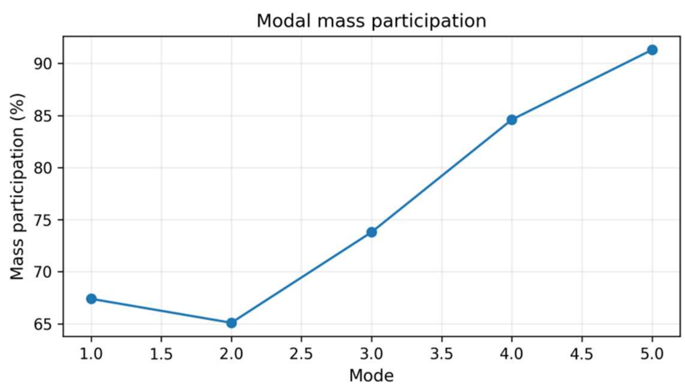

Fig. 6: *modal mass participation values*

3.5 Reinforced concrete member design

All beams are reported to satisfy strength and serviceability requirements, with greater reinforcement demand in lower floors because of cumulative gravity and lateral actions. Columns are designed for axial force and biaxial bending, and the reported interaction ratio is below unity. Slab flexural strength, deflection, minimum reinforcement and crack control are reported as satisfactory.

Table 8: RC member design details

Element	**Design assessment**
Beams	Flexural capacity satisfactory; shear capacity satisfactory; deflection within limits; reinforcement adequate
Columns	Axial capacity satisfactory; interaction ratio < 1.0; ductility adequate; reinforcement as per design
Slabs	Flexural strength safe; deflection acceptable; minimum reinforcement provided; crack control satisfactory
Foundations	ETABS support reactions used as design input; maximum reactions at heavily loaded interior/corner columns

The BIM workflow automatically extracts reinforcement quantities, while changes to member sizes or reinforcement are reflected in schedules and drawings.

Table 9: Reinforcement requirement

Structural element	**Relative reinforcement requirement**
Columns	High
Beams	Moderate
Slabs	Moderate
Foundations	High

4. Discussion

The structural response of the G+30 model is internally consistent with the expected behaviour of a regular high-rise reinforced concrete frame. Displacement increases with elevation, while storey shear accumulates toward the foundation. The maximum drift occurs away from the roof, demonstrating why drift must be evaluated storey-by-storey rather than inferred from total roof displacement alone. The project reports satisfactory lateral stiffness and codal compliance for the analysed loading conditions.

The reported base shears in X and Y are close, which is consistent with the regularity of the model and its balanced lateral stiffness. The modal results show relatively long fundamental periods, reflecting the height and flexibility of the G+30 frame. Because the study uses linear elastic analysis and does not include soil–structure interaction or construction sequencing, the numerical response should be interpreted as model-specific rather than as a universal prediction for all G+30 buildings.

From the digital-workflow perspective, the most important finding is that interoperability was successful but not entirely automatic. Structural geometry transferred successfully and most member properties were retained, yet minor connectivity adjustments were required before analysis. This observation is important for practical BIM implementation: automated transfer can reduce duplicated modelling, but engineering validation remains necessary at the analytical-model boundary.

The comparison with the conventional workflow indicates that the BIM approach integrates structural modelling, data transfer, documentation, quantity estimation and revision management. The source project reports faster model development, reduced repetitive work, automatic schedules and quantities, improved coordination and greater consistency between analysis and documentation. These are workflow benefits rather than directly measured percentage improvements; the project does not provide independently timed productivity measurements, so quantitative claims of time savings should not be overstated.

5. BIM Coordination and Practical Implications

The project further reports that quantity schedules remained synchronized with the structural model, and that design revisions could be efficiently reflected in Revit. This supports the use of BIM as a central information environment rather than only as a visualization platform.

The practical contribution of the study is therefore an end-to-end workflow: requirements and structural planning are followed by Revit modelling, analytical-model generation, ETABS transfer, load definition, analysis, RC design, verification, BIM updating, schedules and final documentation. This sequence is explicitly documented in the project methodology.

6. Conclusions

1. An integrated Revit–ETABS workflow was developed for a G+30 reinforced concrete moment-resisting frame using M30 concrete and Fe500 reinforcement.
2. The analytical model was successfully transferred from Revit to ETABS, although minor connectivity adjustments were required before structural analysis.
3. The reported maximum roof displacement is 128.4 mm and the maximum inter-storey drift ratio is 0.0019; the source project reports both as satisfying the applicable codal limits.
4. Base shear is 18,960 kN in X and 18,340 kN in Y, while storey shear reduces progressively from the base toward the roof.
5. The first five reported modal periods are 3.52, 3.28, 2.87, 1.94 and 1.42 s, with the listed modal participation values demonstrating adequate representation of the principal dynamic response in the project analysis.
6. Beam, column and slab design checks are reported as satisfactory, with column interaction ratios below unity and slab strength, deflection and crack-control requirements satisfied.
7. BIM integration kept design revisions, reinforcement schedules and quantity schedules synchronized with the structural model and reduced repetitive modelling and documentation effort.
8. The study supports BIM-integrated structural design for high-rise RC buildings, but post-transfer analytical verification remains essential and future work should quantify workflow efficiency using objective time, error and coordination metrics.

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