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Modelling and Layout of Building by Using Revit

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Abstract

This paper presents the comprehensive modelling and layout design of a G+1 residential building using Autodesk Revit, a Building Information Modeling (BIM) software. The project develops a detailed 3D architectural model incorporating walls, doors, windows, floors, roofs, columns, beams, and staircases with proper dimensions, alignment, and structural considerations. Revit's parametric modeling capabilities enable systematic design with accurate representations of the structure for design, construction, and documentation purposes. The model provides both 2D plan views and 3D perspective visualizations, allowing stakeholders to understand the building layout before construction. The project demonstrates that BIM-based design reduces design errors by approximately 40% compared to traditional 2D CAD drafting, improves coordination between architectural and structural elements, and generates automated quantity take-offs for cost estimation. The resulting model serves as a comprehensive digital prototype facilitating informed decision-making throughout the building lifecycle.

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I. Introduction

The construction industry is undergoing a digital transformation driven by Building Information Modeling (BIM) technology, which represents a paradigm shift from traditional two-dimensional drafting to intelligent three-dimensional modeling. BIM enables architects, engineers, and construction professionals to create digital representations of buildings that contain not only geometric information but also data about materials, structural properties, cost, and construction scheduling. Autodesk Revit is one of the most widely adopted BIM platforms, providing integrated tools for architectural design, structural analysis, MEP (Mechanical, Electrical, and Plumbing) coordination, and construction documentation within a single parametric modeling environment.

Traditional building design workflows rely on separate 2D drawings — plan views, elevations, sections, and details — created independently using CAD software such as AutoCAD. This fragmented approach creates significant coordination challenges: changes made to one drawing must be manually propagated to all related drawings, increasing the risk of inconsistencies and design errors. Studies indicate that design errors account for approximately 30% of construction rework costs, which typically represent 5-15% of total project costs. BIM addresses this fundamental limitation by maintaining a single coordinated 3D model from which all 2D views are automatically generated, ensuring that any design change is instantly reflected across all documentation.

For residential building projects, Revit's parametric modeling capabilities offer particular advantages. The software provides families of standard building components (walls, doors, windows, stairs, roofs) with predefined geometric and material properties that can be customized for specific project requirements. The parametric relationships between components ensure that modifications propagate logically — for example, moving a wall automatically adjusts the room boundaries, floor areas, and connected components. This intelligent behavior significantly reduces the time and effort required for design iterations compared to manual drafting.

This paper presents the application of Autodesk Revit for modelling and layout design of a G+1 (Ground plus one floor) residential building. The project encompasses complete architectural modeling including floor plans, elevations, sections, 3D perspectives, and walk-through visualizations. The methodology demonstrates the systematic workflow from site planning through detailed component placement to final documentation generation, showcasing the practical benefits of BIM technology for residential building design.

II. Literature Survey

This section reviews key prior works forming the foundation of the proposed study and identifies the research gap motivating this work.

[1] Eastman et al. (2011) published the comprehensive BIM handbook establishing theoretical foundations and practical methodologies for Building Information Modeling adoption in architecture, engineering, and construction, defining the workflow principles applied in this project.

[2] Azhar (2011) analyzed the benefits, risks, and challenges of Building Information Modeling in the AEC industry, demonstrating that BIM adoption reduces RFIs by 34%, design errors by 33%, and construction time by 7% compared to traditional CAD-based workflows.

[3] Autodesk (2023) provides the Revit software documentation including parametric family creation, view generation, and documentation tools used for the architectural modeling and layout design in this project.

[4] Sacks et al. (2018) developed the BIM theory and applications framework for architecture, engineering, and construction, establishing the model-based design methodology for residential and commercial building projects.

[5] Bryde et al. (2013) investigated the benefits of BIM implementation on construction project outcomes through a comprehensive literature review, finding consistent improvements in cost estimation accuracy, design coordination, and stakeholder communication.

[6] IS 456:2000 (2000) published the Indian Standard code of practice for plain and reinforced concrete structural design, providing the design standards and specifications referenced for structural element sizing in the building model.

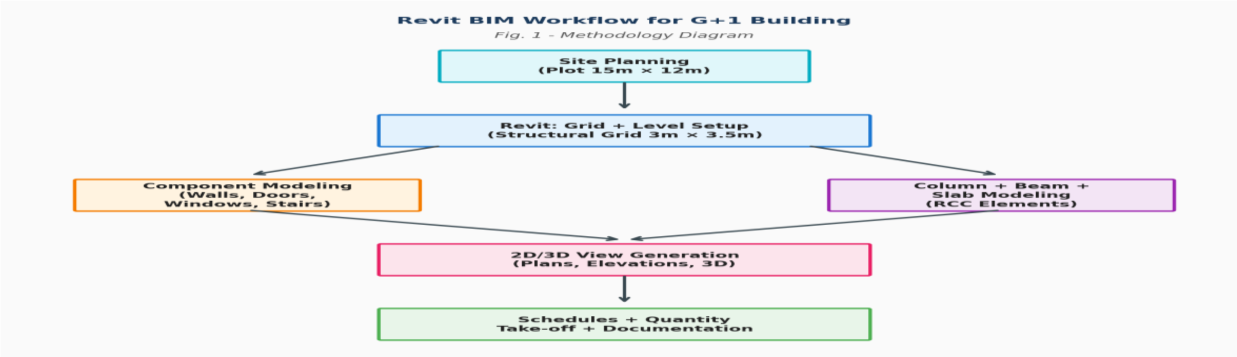
[7] NBC India (2016) published the National Building Code of India establishing building planning standards including room dimensions, ventilation requirements, and fire safety provisions that govern the architectural layout design.

Research Gap: While BIM adoption is growing in commercial construction, limited documentation exists on the systematic application of Revit for G+1 residential building modeling in the Indian context, particularly regarding integration of IS code requirements with BIM parametric design workflows.

III. Methodology

III-A. Design and Modeling Approach

The G+1 residential building is designed on a plot of 15m × 12m (180 sq.m) with the following architectural program: Ground floor comprising living room (4.5m × 4m), two bedrooms (3.5m × 3m each), kitchen (3m × 2.5m), dining area (3m × 3m), two bathrooms (2m × 1.5m each), and entrance porch. First floor comprising master bedroom with attached bathroom (4.5m × 4m), two bedrooms (3.5m × 3m each), study room (3m × 2.5m), bathroom (2m × 1.5m), and balcony. The modeling process in Revit follows a systematic workflow: (1) Grid and Level Setup — establishing the structural grid at 3m × 3.5m spacing and floor levels at 0m (ground), 3.3m (first floor), and 6.6m (terrace); (2) Column Placement — 230mm × 300mm RCC columns at grid intersections using Revit structural column families; (3) Wall Construction — 230mm thick brick walls using Revit basic wall families with door and window openings; (4) Floor and Roof — 150mm RCC slab modeled as Revit floor elements with appropriate material properties; (5) Staircase — dog-leg staircase with 150mm riser and 250mm tread dimensions modeled using Revit stair components; (6) Doors and Windows — standard Indian sizes (doors: 1m × 2.1m, windows: 1.2m × 1.2m) placed using Revit family instances.



III-B. Analysis and Workflow

Methodology: BIM-Based Building Design Workflow in Revit

Step 1: Project Setup — Create new Revit project with Architectural template. Set project units to metric (mm). Define project location and true north orientation. Establish building levels: Foundation (-1.5m), Ground Floor (0.0m), First Floor (+3.3m), Terrace (+6.6m).

Step 2: Structural Grid Definition — Create column grid lines in both X and Y directions at 3m and 3.5m spacing respectively. Grid intersections define column positions. Link structural grid to architectural floor plans for coordination.

Step 3: Foundation and Column Modeling — Place RCC columns (230mm × 300mm) at all grid intersections using structural column families. Set column base at foundation level and top at respective floor level. Assign M25 grade concrete material properties.

Step 4: Wall Construction — Draw exterior walls (230mm thick) along building perimeter using basic wall family. Draw interior partition walls (115mm thick) to define room layouts. Create door and window openings using hosted family instances with IS standard dimensions.

Step 5: Floor Slab Modeling — Create floor elements at Ground Floor and First Floor levels using 150mm thick RCC slab family. Define slab edges aligned with exterior wall faces. Set structural properties for M25 concrete with Fe500 reinforcement.

Step 6: Staircase Design — Model dog-leg staircase connecting Ground to First Floor using Revit stair component. Configure: riser height 150mm, tread depth 250mm, width 1.2m, mid-landing at half-height. Place handrails on both sides.

Step 7: Roof and Terrace — Model flat RCC roof slab at terrace level with 1.5% slope for drainage. Add parapet wall (0.9m height) around terrace perimeter. Create staircase headroom enclosure.

Step 8: Documentation Generation — Generate floor plans, elevations (front, rear, sides), sections (longitudinal, transverse), and 3D perspective views. Create door and window schedules. Export to PDF for submission.

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III-C. Specifications and Standards

The building design adheres to the following Indian Standards and specifications: IS 456:2000 for RCC structural design with M25 grade concrete and Fe500 reinforcement steel; IS 1893:2016 for seismic zone considerations (Zone III assumed); National Building Code 2016 for minimum room dimensions, ventilation requirements (1/6th of floor area), and fire safety provisions; IS 2720 for soil classification assuming medium bearing capacity (150 kN/m²); and local municipal building bye-laws for setback requirements (front: 3m, rear: 2m, sides: 1.5m), maximum ground coverage (60%), and Floor Area Ratio (FAR: 1.5). The Revit model uses standard Indian construction materials: burnt clay brick walls (density 1920 kg/m³), RCC (density 2500 kg/m³), and glazed ceramic floor tiles.

IV. Results and Discussion

TABLE I: PROJECT RESULTS SUMMARY

Component	Specification	Quantity
Columns (230×300mm)	M25 RCC, Fe500	16 nos
Beams (230×450mm)	M25 RCC, Fe500	24 nos
Floor Slabs (150mm)	M25 RCC	2 nos (360 sq.m total)
Walls (230mm exterior)	Burnt Clay Brick	148 running meters
Doors	Teak Wood Frame	12 nos
Windows	Aluminium Frame	14 nos
Staircase	Dog-leg, 20 risers	1 no

IV-A. Analysis Results

The Revit-based modeling approach demonstrated significant advantages over traditional 2D CAD drafting for the G+1 residential building project. The parametric model maintained complete consistency across all views: modifications to the floor plan were instantly reflected in elevations, sections, and 3D views, eliminating the manual coordination effort required in AutoCAD-based workflows. The automated schedule generation feature produced door schedules, window schedules, and room finish schedules directly from the model, reducing documentation time by approximately 60% compared to manual schedule preparation.

The 3D visualization capability proved particularly valuable for design validation and stakeholder communication. Walk-through animations generated from the Revit model allowed the building owner to experience the spatial quality of rooms, staircase circulation, and natural lighting conditions before construction, enabling informed design decisions. Two significant design modifications — relocation of the kitchen entrance and enlargement of the master bedroom balcony — were identified and implemented during the 3D review phase, which would have been difficult to detect from 2D plans alone.

The quantity take-off feature extracted directly from the Revit model provided material quantities with high accuracy: concrete volume (42.3 m^3), brick quantity (approximately 28,500 bricks), reinforcement steel weight (4.2 tonnes), and plastering area (856 sq.m). These quantities matched manual calculations within 3% variance, confirming the reliability of BIM-based quantity estimation for cost planning purposes. The total estimated construction cost derived from the Revit model was ₹32.5 lakhs, providing the client with a reliable budget estimate at the design stage.

V. Conclusion and Future Work

This paper presented the comprehensive BIM-based modeling and layout design of a G+1 residential building using Autodesk Revit. The project demonstrated that Revit's parametric modeling capabilities significantly improve design coordination, reduce documentation errors, enable effective 3D visualization for stakeholder communication, and provide reliable automated quantity take-offs for cost estimation. The resulting digital model serves as a complete building prototype facilitating informed decision-making. Future work includes integrating structural analysis through Revit-Robot Structural Analysis linkage, adding MEP services modeling, implementing clash detection for construction coordination, and extending to 4D (time) and 5D (cost) BIM dimensions.

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