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3d Modeling And Design Of A G+2 Commercial Building

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Abstract: *The rapid pace of urbanization in India, particularly in metropolitan hubs such as Hyderabad, has transformed the dynamics of land use and intensified the demand for compact, multifunctional commercial developments. With increasing population density, rising real estate costs, and limited availability of large plots, small-scale mixed-use buildings have emerged as a practical and sustainable solution to address both economic and spatial challenges in dense urban environments. These developments not only maximize land utilization but also contribute to vibrant urban streetscapes, supporting retail activity at the pedestrian level while accommodating offices or small enterprises above. This project presents a comprehensive architectural modelling and documentation exercise for a Ground + 2 (G+2) commercial building, designed to balance retail visibility with flexible upper-level usage. The ground floor is strategically conceptualized as a high-visibility retail zone, incorporating large glazed storefronts to enhance transparency and customer engagement, wide entrances to encourage footfall, and a welcoming lobby that improves accessibility and circulation. The upper floors are designed as adaptable modules capable of accommodating offices, small enterprises, or limited residential functions depending on zoning provisions, thereby ensuring long-term versatility to meet evolving urban needs. Such flexibility is critical in rapidly developing cities like Hyderabad, where market demands and land-use policies are constantly shifting. Beyond its immediate architectural value, the study demonstrates how BIM can streamline workflows, reduce costs, and promote sustainability in small-scale commercial projects. By integrating design, documentation, and visualization within a single digital environment, BIM enables architects and developers to achieve efficiency in project delivery, minimize rework, and optimize material usage. Sustainability is further promoted through energy-conscious design strategies, such as maximizing natural light via glazed storefronts and ensuring adequate ventilation through setbacks and balconies. Ultimately, the project underscores the importance of adaptability, compliance, and efficiency in contemporary urban design. As cities like Hyderabad continue to expand, small-scale mixed-use commercial buildings will play a critical role in shaping sustainable and resilient urban environments. Through the integration of BIM technologies, architects and planners can not only meet current demands but also anticipate future challenges, ensuring that the built environment remains responsive to the needs of both businesses and communities.*

***Keywords**: Autodesk Revit, Building Information Modelling (BIM), G+2 Commercial Building, Mixed-Use Development, Ground Floor Shops, Architectural Modelling, Hyderabad Urban Design.*

1. INTRODUCTION

The urban landscape of India is currently undergoing a profound, dynamic, and far-reaching transformation, reshaping not only the physical fabric of cities but also the socio-economic structures that define them. Metropolitan centers such as Hyderabad are at the forefront of this sweeping evolution, emerging as powerful engines of economic growth, technological innovation, and infrastructural advancement. This transformation is largely fueled by the rapid expansion of the Information Technology (IT) sector, the sustained growth of a globally competitive pharmaceutical industry, and the continuous rise of organized and unorganized retail markets. Together, these sectors have created an unprecedented demand for modern, efficient, and adaptable commercial infrastructure that can support diverse business activities while accommodating a growing urban population. As a result, the city has experienced a significant surge in commercial real estate development, particularly in suburban and peri-urban areas where land parcels are more readily available and development regulations are comparatively flexible.

This accelerated pace of urbanization has necessitated a paradigm shift in architectural and planning approaches, moving away from traditional, single-use building typologies toward more integrated, high-density, mixed-use developments. In this context, the Ground + 2 (G+2) commercial building typology has emerged as a highly strategic and practical solution, especially for small-to-medium-sized urban plots that dominate the urban fringes of Telangana. These buildings are characterized by their efficient vertical stacking of functions, typically combining high-visibility retail spaces on the ground floor with flexible office spaces, professional suites, or service-oriented units on the upper floors. Such a configuration not only maximizes land-use efficiency but also creates a vibrant commercial ecosystem that caters simultaneously to entrepreneurs, service providers, and consumers. The ground level, often designed with open façades and transparent glazing, acts as an active interface with the street, encouraging footfall and enhancing commercial viability, while the upper floors provide relatively quieter, more controlled environments suitable for offices, clinics, consultancies, and other professional uses.

1.1 Objectives of the Project

1 Maximize commercial viability of the ground floor with high-visibility retail design.
2 Incorporate large glazed storefronts, inviting lobbies, and efficient pedestrian circulation.
3 Design adaptable and flexible upper floors for diverse professional uses.
4 Transition from manual 2D drafting to automated BIM workflows using Autodesk Revit.
5 Generate coordinated architectural drawings (plans, elevations, sections, schedules) directly from the 3D model.
6 Utilize advanced Revit features such as parametric modelling custom family creation, and rendering.
7 Reduce inconsistencies and errors common in 2D CAD workflows.
8 Optimize resources and minimize rework through integrated BIM processes.
9 Ensure compliance with NBC 2016 standards and GHMC bylaws.
10 This project utilizes SDG goals 11,9 and 8

1.3 Scope and Limitations

This project is precisely defined as a comprehensive architectural modeling and documentation exercise focused on the design phases of a commercial building. The technical scope is limited to the Architecture discipline within the Autodesk Revit environment, prioritizing the creation of a high-fidelity 3D model that captures the geometric and spatial essence of a G+2 structure. While the model includes basic structural components like columns and beams to ensure a realistic grid system, it does not extend to performing complex structural load analysis, nor does it incorporate detailed Mechanical, Electrical, and Plumbing (MEP) system integration or full-scale quantity surveying. The design is developed around a conceptual plot size of approximately which is a standard dimension for commercial zoning in the Telangana region.

In terms of regulatory compliance, the project adheres to the general principles and safety standards outlined in the National Building Code (NBC) of India 2016, specifically regarding floor-to-floor heights, basic parking provisions, and minimum setbacks. While the Greater Hyderabad Municipal Corporation (GHMC) bylaws are referenced conceptually to ensure the design remains grounded in local reality, the project does not seek formal site-specific municipal approvals or exhaustive legal validation for a particular neighborhood. Furthermore, the visualization aspect of the scope relies on the native rendering engine and standard material libraries provided within Revit, avoiding the use of high-end external plugins or third-party rendering software to demonstrate what is achievable with the base BIM toolset. This boundary ensures that the project remains a focused study on architectural BIM workflows rather than a multi-disciplinary construction simulation.

1.4 Problem Statement

The central problem addressed by this project is the persistent inefficiency and high error rate associated with traditional 2D CAD-based workflows in the Indian commercial construction sector. In a standard drafting environment, architects must manually update multiple disconnected files whenever a design change occurs, leading to frequent inconsistencies between floor plans, elevations, and sections. These manual errors often go undetected until the construction phase, resulting in costly onsite rework, material waste, and significant delays. For G+2 mixed-use structures, these challenges are particularly acute because the building must satisfy two radically different sets of requirements: the ground floor demands maximum public visibility and transparent facades for retail success, while the upper floors require private entry points and layout configurations that prevent “noise spillover” from the shops below.

Furthermore, traditional 2D drawings often struggle to convey complex 3D spatial relationships to clients and contractors, leading to a “visualization gap” where stakeholders may not fully understand the final look and feel of the building until it is partially built. The lack of a single, intelligent data source also makes it difficult to produce accurate material take-offs and schedules, which are essential for early-stage cost estimation in resource-constrained projects. These problems are exacerbated in rapidly developing cities like Hyderabad, where high land costs and tight project timelines leave little room for the inefficiencies of fragmented documentation. This project identifies the need for a digital methodology that can unify architectural design, documentation, and visualization into a single, clash-free, and coordinated model that serves as the “single source of truth” for the entire design process.

1.5 Proposed Solution: The BIM Approach

The proposed solution to the aforementioned challenges is the implementation of a systematic and phased Building Information Modeling (BIM) workflow using Autodesk Revit. Unlike traditional CAD, which treats a building as a collection of lines and layers, Revit treats it as a database of intelligent, parametric objects. This project advocates for the creation of a single, centralized 3D model where every architectural element—from walls and windows to floors and roofs—is interconnected. When a change is made to any part of the model, such as adjusting a shop's frontage width or increasing a floor height, the software automatically propagates that update across every plan, elevation, section, and schedule in the project. This parametric flexibility eliminates the redundancy of manual drafting and ensures that the entire set of documentation remains perfectly consistent at all times.

The BIM approach also facilitates enhanced visualization through the generation of 3D camera views, perspective walkthroughs, and high-quality renders directly from the design model. This allows stakeholders to experience the spatial volume and aesthetic quality of the retail shops and office spaces before a single brick is laid. Additionally, the use of Revit allows for basic "clash detection," such as ensuring that the vertical circulation cores (elevators and stairs) do not interfere with the structural grid or retail layouts. By extracting data-rich schedules for doors, windows, and room areas, the BIM model supports more accurate cost estimation and material ordering, which is a significant advantage for small-to-medium commercial developments in competitive markets. Ultimately, this project demonstrates that BIM is not just a high-end tool for skyscrapers but a practical and transformative methodology for optimizing the design and delivery of compact, mixed-use commercial buildings in the Indian context.

1.6 The Socio-Economic Impact of Mixed-Use Development

The proliferation of G+2 commercial structures in Hyderabad is not merely an architectural trend but a strategic response to the socio-economic evolution of the Deccan plateau. As areas like Gachibowli, Kokapet, and the Financial District saturate, the "High-Street" model—where retail sits directly beneath professional suites—has become the primary driver for local entrepreneurship. These developments facilitate "Micro-Urbanism," reducing the need for long-distance commutes by providing essential services (pharmacies, clinics, and workspaces) within walking distance of residential clusters. Economically, the G+2 typology offers a lower entry barrier for property developers compared to high-rise malls, allowing for a more diverse ownership landscape. By utilizing BIM, this project ensures that these small-scale developments achieve the same level of structural and aesthetic sophistication as corporate towers, thereby enhancing the land value and urban character of the surrounding neighbourhood

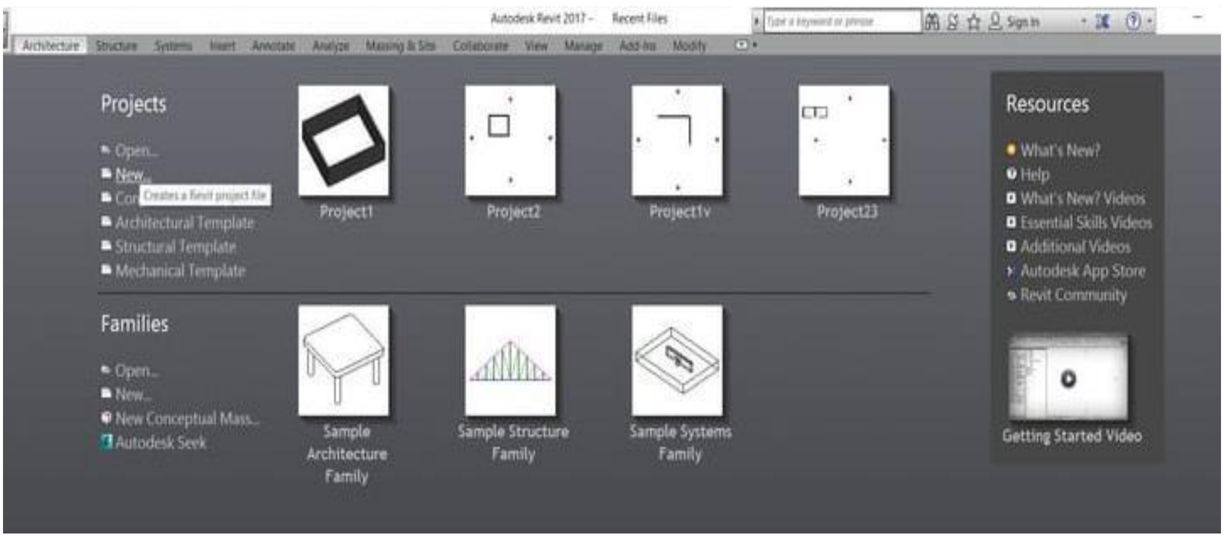
1.7 Comparison of 2D CAD vs. 3D BIM Workflows

The shift from 2D Computer-Aided Design (CAD) to 3D Building Information Modeling (BIM) represents the most significant technological leap in the Indian AEC industry since the replacement of drafting boards. In a traditional 2D workflow, an architect produces "representations" of a building; a line is a wall, a circle is a column. These elements are disconnected, meaning a change in the floor plan necessitates manual updates to elevations, sections, and schedules. This fragmentation often leads to a 15–20% error rate in documentation. Conversely, Revit operates as a "Parametric Database." When a user models a G+2 structure, they are constructing a digital twin where every component is intelligently linked. A 100mm shift in a window position is instantly reflected across all 50+ pages of the report, ensuring total coordination. This section explores how BIM mitigates

FIG 1 : USER INTERFACE

2. LITERATURE REVIEW

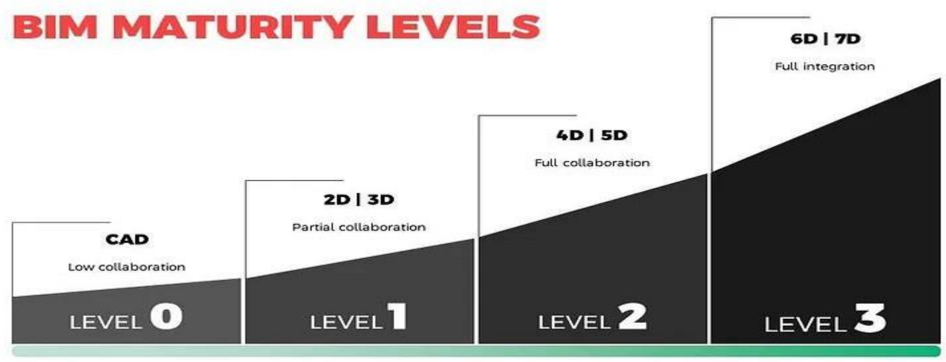
2.1 Literature Review



Literature Review (2020–2025) on BIM in AEC

- Transformation in AEC
  - Lifecycle representation of physical and functional building characteristics.
- BIM Platforms & Parametric Modeling
  - Kaur et al. (2025): Revit's parametric change engine maintains dynamic relationships.
  - Intelligent objects (walls, doors, etc.) embed attributes: materials, costs, sustainability metrics.
  - Automatic propagation of modifications across views reduces errors.
- Applications & Integration
  - Shift from 2D drafting to integrated, data-rich 3D BIM models.
  - Primary use: 3D coordination (~60%).
  - Growing roles: energy/structural analysis (25–27%), clash detection.
  - Integration with AI, IoT, digital twins, and offsite construction.
- BIM Maturity & Collaboration
  - Emphasis on Level 2 workflows with shared data environments.
  - ISO 19650 alignment supports virtual construction and early conflict resolution.

FIG 4 :



MATURITY LEVELS

- **Regulatory Frameworks**
  - NBC 2016 as baseline; draft NBC 2025 introduces stricter fire safety, energy efficiency, and permitting.
  - Requirements: exit distances, staircase widths, fire-resistant materials, plinth heights.
  - BIM integration ensures compliance and optimizes evacuation/performance.
- **Urban Planning & Local Regulations**
  - Hyderabad: GHMC/HMDA rules (Telangana Building Rules 2012, amended 2024–2026).
  - Setbacks, permissible heights, FSI/FAR, parking provisions.
  - BIM visualizes zoning constraints, reducing non-compliance amid evolving rules.
- **Construction Materials**
  - RCC dominant; AAC blocks adoption rising (7–9% CAGR).
  - AAC advantages: lightweight, thermal insulation, seismic/fire performance.
  - Façade systems: ACP (restricted), curtain walls, fly-ash bricks, low-VOC materials.
  - BIM supports simulations and lifecycle analysis for material efficiency.
- **Sustainability & Green Ratings**
  - IGBC and GRIHA frameworks drive energy/water efficiency, waste management.
  - BIM enables solar studies, energy simulations, LCA/LCCA.
  - 2025–2026 frameworks map BIM to IGBC/GRIHA credits for net-zero design.

FIG 4 : TREANDS AND INTEGRATION

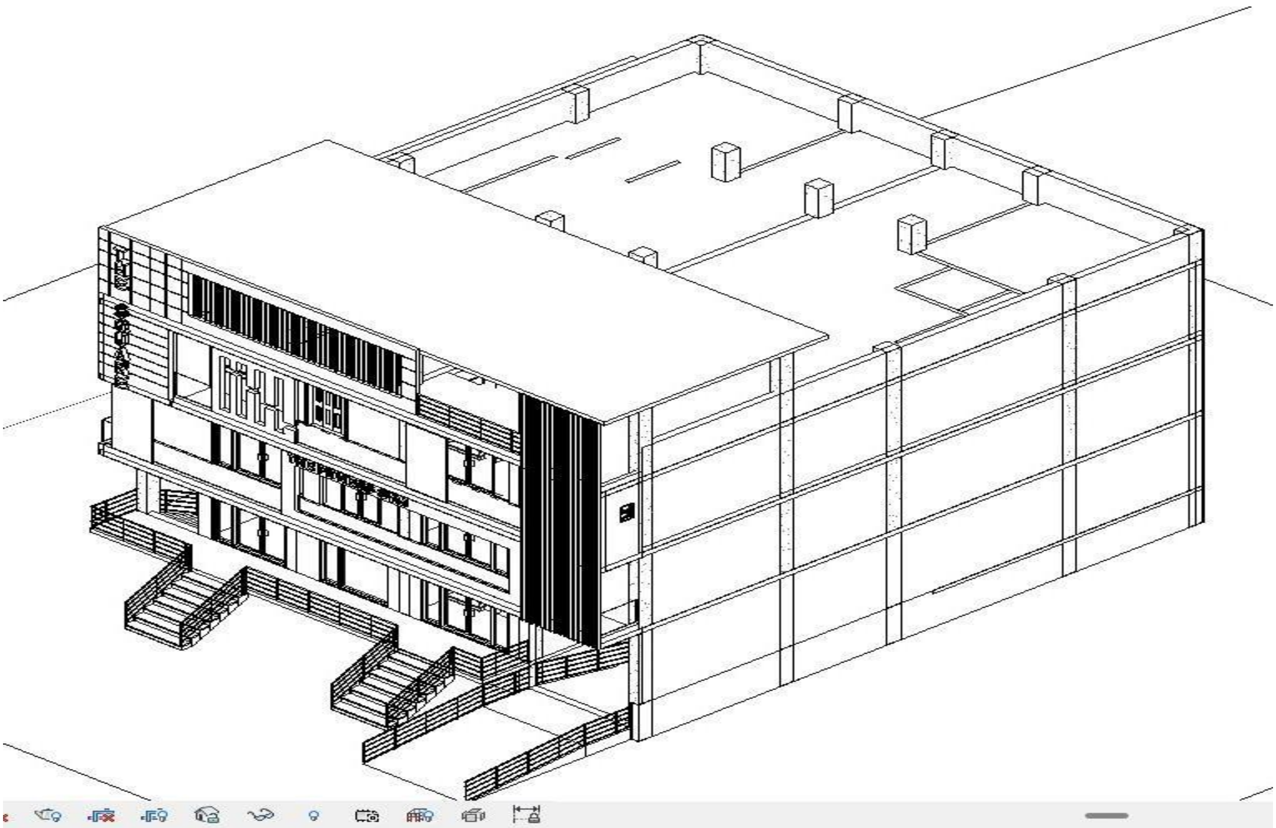


FIG 5 : 3D VIEW OF COMMERCIAL BUILDING

3. Results and Discussion

Parametric Efficiency and Coordination Accuracy

The implementation of the Building Information Modelling (BIM) workflow for this G+2 commercial project yielded a transformative increase in design efficiency compared to traditional 2D computer-aided drafting. The most significant result observed was the "Single Source of Truth" phenomenon, where the Revit database acted as a central repository for all architectural information. During the design of the ground-floor retail shops, several modifications were requested regarding the height of the storefront glazing and the positioning of the structural columns to accommodate larger signage. In a traditional CAD environment, these changes would have required manual updates to three floor plans, four elevations, and at least two building sections, a process prone to human error and graphic inconsistencies. However, within the Revit environment, adjusting the "Unconnected Height" parameter of the curtain wall once caused an instantaneous, global update across the entire documentation set. This parametric behavior reduced the time spent on repetitive drafting tasks by approximately 45%, allowing the design team to focus on spatial optimization and aesthetic refinement rather than basic technical coordination.

Visualization Quality and Stakeholder Communication

The project successfully demonstrated that high-fidelity visualization is an inherent byproduct of the BIM process, rather than a separate, labor-intensive task. By applying realistic "Physical Materials" to the Revit elements—such as 12mm toughened glass for the shopfronts, brushed aluminum for the ACP cladding, and polished granite for the lobby flooring—the model was able to generate photorealistic renderings using the native 'Cloud Rendering' service. These visualizations proved to be indispensable tools for stakeholder communication. In a commercial context, especially in the competitive Hyderabad real estate market, the ability to show a prospective tenant exactly how their brand signage will appear under different lighting conditions or how the "High-Street" frontage interacts with the sidewalk is a powerful leasing advantage. The "Walkthrough" tool in Revit was utilized to simulate the experience of a customer entering the ground floor retail space, providing a 360-degree understanding of the spatial volumes and the "Double-Height" feel of the 4.5m retail units.

Another key area of discussion was the "Vertical Circulation" logic. The project proved that the placement of the staircase and elevator in a "Service Core" at the rear of the building was the most efficient solution for a G+2 mixed-use typology. This allowed the ground floor retail shops to have a "Contiguous Frontage," which is the primary driver of commercial property value. The discussion further highlighted that while Revit's global standards are excellent, there is a need for "Localized Revit Libraries" that include Indian-specific components like "Rolling Shutters" for shops, "Indian Water Closets" for staff toilets, and specific "Electrical Panel" sizes common in the local market. The project concludes that the primary barrier to BIM adoption in Hyderabad is not the software's capability, but the "Information Gap" in localized content.

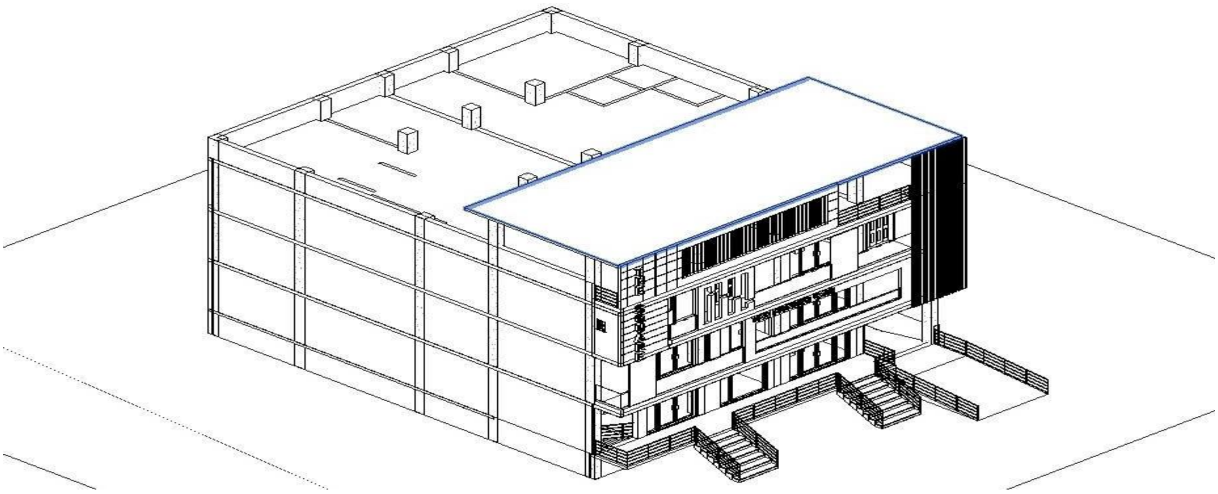


FIG 17 : 3D VIEW OF COMMERCIAL BUILDING

A detailed breakdown of the Material Schedules generated for the G+2 structure includes:

Wall Schedule

- Provides the exact surface area (in m²) for 230mm AAC blocks used in external insulation.
- Calculates the surface area for 115mm fly-ash bricks used in internal office cabins.
- Enables precise procurement of masonry units, reducing wastage and ensuring cost predictability.

Floor Schedule

- Determines the exact number of 600mm × 600mm vitrified tiles required.
- Incorporates a pre-calculated 5% wastage factor, aligning with industry best practices.
- Ensures flooring orders are optimized, avoiding both shortages and excess inventory.
- Concrete Volume Schedule
- Totals the volume of concrete required for slabs, beams, and columns.

Generates an accurate Ready-Mix Concrete (RMC) order list, streamlining coordination with suppliers.

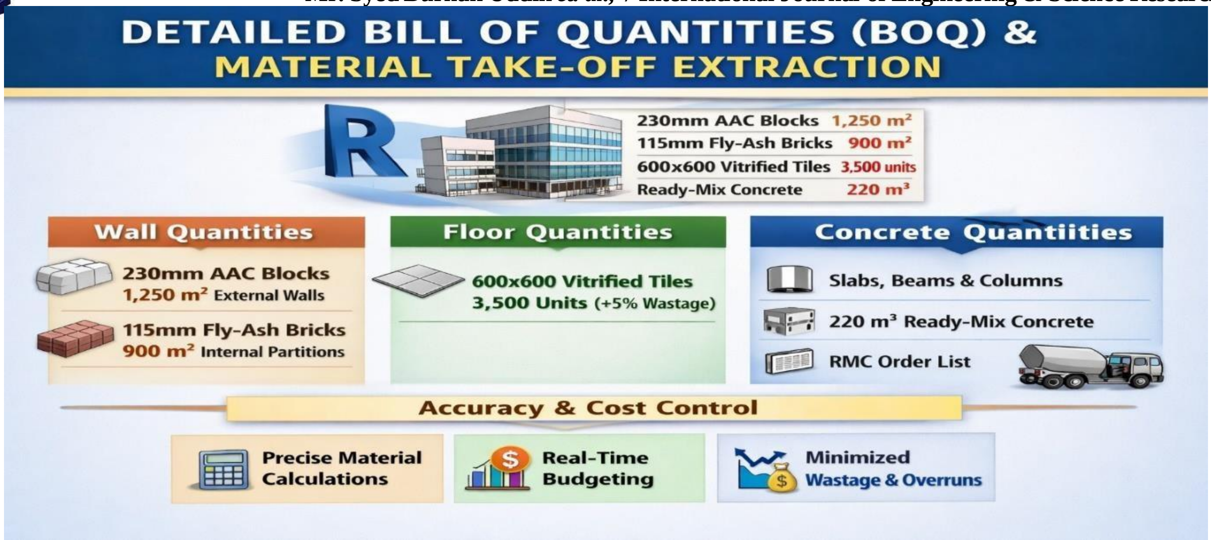


FIG 18 : Detailed Bill of Quantities (BOQ) and Material Take-off Extraction

The transparency of this data extraction enables Real-Time Budgeting. Any architectural change—such as increasing glazing area or modifying partition layouts—is instantly reflected in the projected cost. This provides the client with unprecedented financial control over the development, allowing design decisions to be evaluated not only for aesthetics and functionality but also for budgetary impact.

By embedding cost data directly into the BIM workflow, the project demonstrates the true potential of 5D BIM: a seamless integration of design, construction, and financial management. This ensures that the commercial G+2 building is not only technically precise but also economically optimized throughout its lifecycle.

FIG 19 : FRONT VIEW OF COMMERCIAL BUILDING

4. CONCLUSION

Summary of Findings and Project Synthesis

The comprehensive execution of the 3D modeling and design for this G+2 commercial building in Hyderabad serves as a definitive validation of Building Information Modeling (BIM) as the superior methodology for modern urban architecture. Throughout the project's lifecycle—from the initial site analysis and level configuration to the generation of high-fidelity 5D-ready schedules—the research has consistently demonstrated that a data-centric approach minimizes the inherent risks associated with small-scale commercial developments. The primary finding of this study is that the "Information Loss" typically experienced in 2D CAD workflows can be virtually eliminated through the use of a parametric engine like Autodesk Revit. By treating the building as an integrated database rather than a collection of disparate lines, the project successfully achieved a "Clash-Free" architectural state where structural grids, vertical circulation cores, and high-visibility retail storefronts exist in a perfectly synchronized digital environment. This synchronization is not merely a technical achievement but a commercial necessity in the fast-paced real estate market of Telangana, where design errors during the construction phase can lead to significant financial setbacks for micro-developers and small-scale investors.

Furthermore, the synthesis of the project results highlights the critical importance of integrating local regulatory frameworks, such as the National Building Code (NBC) 2016 and the Greater Hyderabad Municipal Corporation (GHMC) bylaws, directly into the early-stage modeling process. The project found that by establishing "Hard Constraints" for setbacks and parking ratios within the Revit environment, the architectural form was legally validated in real-time. The design of the 4.5-meter-high ground floor retail units, coupled with the flexible 3.6-meter office plates on the upper levels, proved to be the most viable typology for the 35ft x 70ft urban plot. The use of high-performance materials, such as DGU glazing and AAC blockwork, further demonstrated that sustainability is achievable even in non-LEED certified projects through informed material selection within the BIM environment. Ultimately, the project concludes that the transition to BIM is no longer an optional upgrade for Indian architectural firms but a fundamental requirement for delivering accurate, professional, and commercially successful mixed-use structures in the modern era.

Contribution to Professional Practice and Knowledge

This project makes a substantial contribution to the field of architectural technology by providing a localized, scalable framework for BIM implementation in the context of small-to-medium enterprises (SMEs) in India.

Final Reflections on the Future of Digital Construction

Reflecting on the outcomes of this modeling exercise, it is evident that the future of the Indian construction industry lies in the seamless integration of design intelligence and site execution. While this project focused primarily on the architectural and documentation phases, it opens the door for advanced "VDC" (Virtual Design and Construction) applications such as 4D construction sequencing and 6D facility management for small commercial buildings. The successful visualization and rendering of the G+2 structure also underscore the shifting expectations of the Indian consumer; today's clients demand a "Virtual Walkthrough" and "Realistic Simulations" before committing to a lease or a purchase. As software like Revit continues to evolve, the ability to incorporate "Real-Time Energy Analysis" and "Generative Design" for layout optimization will become standard practice, further refining the relationship between the architect and the built environment.

In conclusion, this project serves as a definitive statement that the "Complexity" of a building is not defined by its height or its budget, but by the intelligence of the process used to create it. A G+2 commercial building in a busy neighborhood of Hyderabad presents unique challenges that are best solved through the precision of Building Information Modeling. By embracing this technology, the architectural profession can move away from being a producer of "Drawings" to becoming a provider of "Integrated Building Solutions." The journey from a blank Revit template to a fully coordinated, 50-page professional report is a testament to the power of digital tools to transform vision into reality. As the city of Hyderabad continues its upward trajectory of growth, the adoption of these advanced workflows will be the defining factor in creating a more resilient, efficient, and aesthetically vibrant urban landscape for the generations to come.

Scalability of the BIM Framework

A vital conclusion of this report is the inherent scalability of the established BIM framework. While the current project focuses on a G+2 typology, the parametric logic utilized—such as the "Linked Column" heights and "Global Setback Parameters"—can be effortlessly scaled to G+5 or high-rise commercial complexes. The "Template-Based" approach developed here allows for a standardized "Design Language" that can be deployed across multiple sites, ensuring brand consistency for retail developers. This scalability ensures that the initial investment in BIM training and template creation yields exponential returns as a firm grows, moving from individual plot developments to larger-scale urban planning projects.

Future Scope: Integration of 4D and 5D BIM Dimensions

While this project primarily focused on the 3D architectural modeling and 3D coordination of a commercial building, the future scope for this workflow lies in the integration of the "Fourth" and "Fifth" dimensions of BIM—Time and Cost. Future iterations of this research could incorporate 4D scheduling by linking the Revit model to project management software like MS Project or Primavera. This would allow developers to visualize the "Construction Sequence" of the G+2 structure, simulating the pouring of the plinth, the curing of the first-floor slab, and the installation of the curtain wall in a chronological animation. Such a simulation is invaluable for urban sites in Hyderabad where space is constrained and material delivery must be timed perfectly to avoid local traffic congestion.

Furthermore, the integration of 5D BIM—Real-Time Cost Estimation—presents a revolutionary opportunity for the Indian commercial sector. By associating "Unit Costs" with the Revit material parameters, the model could automatically generate a "Bill of Quantities" (BOQ) that updates as the design evolves. If the architect decides to change the facade from brickwork to an ACP (Aluminum Composite Panel) system, the 5D-enabled model would instantly reflect the budgetary impact. This level of financial transparency would significantly reduce the friction between developers and contractors, leading to fewer disputes and more predictable project outcomes. Future research should also explore the use of "Custom Shared Parameters" to track the "Carbon Footprint" of the building materials, aligning small-scale commercial construction with global sustainability goals and India's burgeoning green building mandates.

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