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Enhancing Construction Project Management through the Implementation of Revit for Effective Panning and Coordination: A Review

Divyesh Solanki [1], Prof. Chintan S. Raichura[2], Prof. (Dr.) J. R. Pitroda[3], Er. Mukesh Macwan[4]

[1]Final Year, M.Tech (Civil) Construction Engineering and Management, BVM Engineering College, Vallabh Vidyanagar – Gujarat – India, Email- sdivyesh283@gmail.com

[2]Assistant Professor, Civil Engineering Department, Darshan Institute of Technology University, Rajkot –Gujarat – India, Email- chintan.raichura@darshan.ac.in

[3] Professor, PG Coordinator Construction Engineering and Management, Civil Engineering Department, BVM Engineering College, Vallabh Vidyanagar– Gujarat – India, Email- jayesh.pitroda@bvmengineering.ac.in

[4] Project Manager, Civil Engineer, Synnove Atmosphere Project, Vadodara – Gujarat – India, Email-atmosphereengineers2022@gmail.com

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Abstract- In the realm of construction management, Building Information Modelling (BIM) has revolutionized the design and planning processes, with Autodesk Revit being at the forefront of this technological transformation. This abstract outline the significance of Revit in 3D design and planning within the construction industry. By integrating architectural, structural, and mechanical design into a single 3D environment, Revit enhances collaboration among multidisciplinary teams and allows for real-time updates and modifications, significantly reducing the likelihood of errors and omissions. The software's parametric capabilities enable users to create intelligent models that foster improved decision-making, resource optimization, and cost estimation, thus streamlining the project lifecycle from conceptual design to construction and maintenance. Additionally, Revit's visualization tools facilitate effective coordination and communication with stakeholders, providing a clearer understanding of project outcomes and enhancing client satisfaction. This paper explores the applications and benefits of Revit in construction management, demonstrating its role as an essential tool for enhancing project efficiency, accuracy, and collaboration in modern building practices.

Key Words: Autodesk Revit, Building Information Modelling (BIM), Construction, planning, 3D design

1. INTRODUCTION

The implementation of Revit in construction project management represents a significant advancement in the way projects are planned, coordinated, and executed. Revit, a powerful Building Information Modeling (BIM) software, facilitates a comprehensive approach to project management by integrating various aspects of design and construction into a unified platform. This introduction outlines the key benefits of utilizing Revit for effective planning and coordination in construction projects.

Revit's ability to create detailed 3D models allows project teams to visualize the entire construction process before it begins. This capability not only aids in understanding spatial relationships and construction sequences but also helps identify potential issues early on, thereby reducing the likelihood of costly rework and delays. The integration of architectural, structural, and MEP (Mechanical, Electrical, and Plumbing) designs into a single model fosters better collaboration among different disciplines, ensuring that all stakeholders are aligned throughout the project lifecycle.

One of the standout features of Revit is its support for real-time collaboration. Multiple stakeholders can work on the same project simultaneously, regardless of their geographical locations. This collaborative environment minimizes data mismatches and enhances communication, ensuring that all team members are informed about changes as they occur. Furthermore, Revit's cloud-based tools facilitate seamless updates and notifications about design alterations, which helps maintain project integrity and reduces misunderstandings among team members.

Revit significantly streamlines workflows by automating various tasks associated with project management. For instance, it simplifies cost estimation and material takeoff processes by providing accurate quantities directly from the model. This automation not only enhances efficiency but also allows project managers to focus on strategic decision-making rather than getting bogged down by manual calculations and estimations. Additionally, the use of advanced modeling tools and plugins within Revit can further optimize performance for large-scale projects.

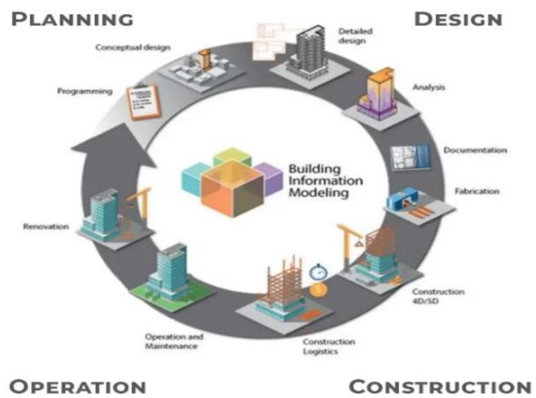

Figure-1: BIM using in Construction Industry

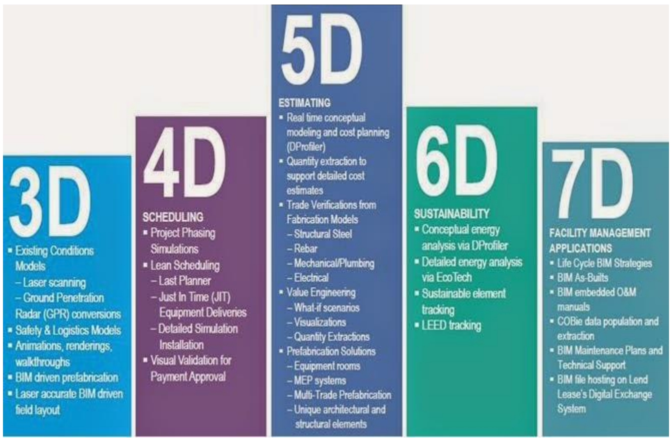

Figure-2: BIM Levels and Dimensions

2. Revit in Construction Project Management

Table-1: Revit using in Construction Man

Intelligent 3D Modeling	Revit enables users to create parametric 3D models that incorporate detailed information about building elements. This parametric modeling allows for automatic updates across the model when changes are made, ensuring consistency and reducing errors throughout the design process.
Centralized Data Management	The software functions as a dynamic database that stores all project-related information in a structured manner. This centralized approach facilitates easy access to critical data, enhances collaboration among team members, and ensures that any modifications are reflected across all documentation and schedules.
Enhanced Collaboration	Revit supports a collaborative environment where multiple disciplines can work on a shared model simultaneously. This real-time collaboration minimizes conflicts and ensures that all stakeholders are aligned with the most current project information.
Efficient Documentation	Revit automates the generation of construction documents from the 3D model, including floor plans, sections, and schedules. This automation not only saves time but also ensures that all documentation is consistent and accurate, which is vital for regulatory compliance.
Cost Estimation and Resource Management	The software provides tools for cost estimation and material takeoff, allowing project managers to track quantities and costs effectively. Changes made to the model automatically update related cost estimates, providing real-time insights into budget management.

2.1 Objectives

1. To analyze the capabilities of Revit 3D design in enhancing project visualization and communication.
2. To evaluate the accuracy of Material and cost estimation and resource allocation using Revit models.
3. To detect clashes and conflicts early allows teams to address potential risks proactively, thereby mitigating delays and budget overruns associated with unforeseen issues during construction.

3. Revit (BIM) in Construction Industry

3.1 Revit significantly enhances collaboration among different project stakeholders in the construction industry[1]

Revit is a powerful Building Information Modeling (BIM) software developed by Autodesk, widely used in construction management for its ability to create detailed 3D models and facilitate collaboration among various stakeholders in the architectural, engineering, and construction (AEC) industries.

Integrated Design and Documentation: Revit allows for the creation of unified models that integrate architectural, structural, and MEP (mechanical, electrical, plumbing) designs. This integration helps ensure consistency across all project documentation and reduces errors that can arise from disjointed workflows.

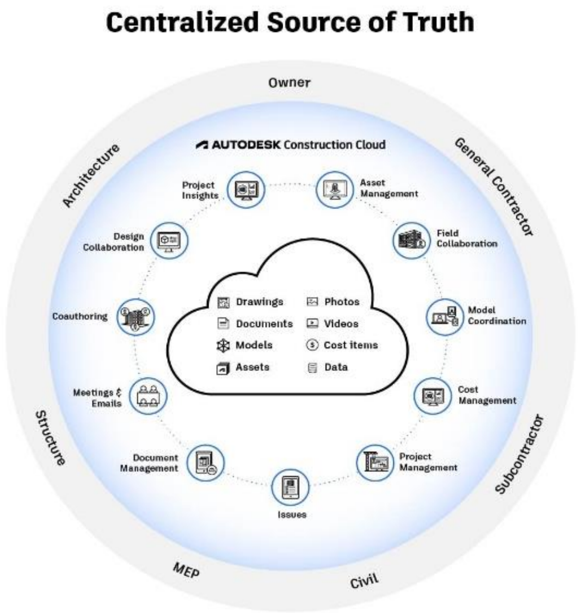

Figure-3: Integration and collaboration of Revit (BIM)[1]

Real-Time Collaboration: The software supports multi-user access through work-sharing capabilities, enabling architects, engineers, and contractors to work simultaneously on a single model. This fosters better communication and coordination, minimizing the risk of data mismatches and errors during construction.

Clash Detection: Revit's advanced modeling capabilities allow users to identify potential conflicts between various building systems early in the design phase. This proactive approach significantly reduces the likelihood of costly rework during construction.

Automated Documentation: Revit automates the generation of construction documents from the model data, ensuring that all drawings are accurate and up-to-date. This feature streamlines the documentation process and saves time for project teams.

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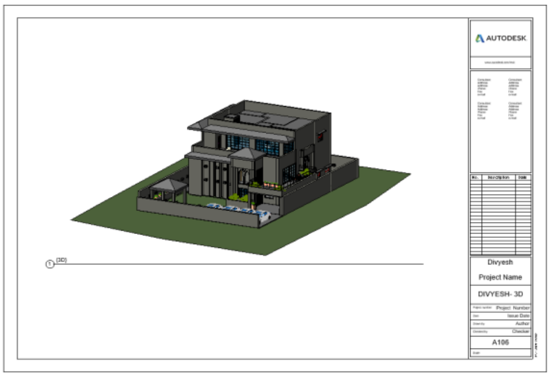


Figure-4: 3D Model Documentation

Cost Estimation and Resource Management: The software facilitates precise material estimations and cost calculations directly from the model. This capability helps contractors develop reliable budgets and manage resources efficiently throughout the project lifecycle.

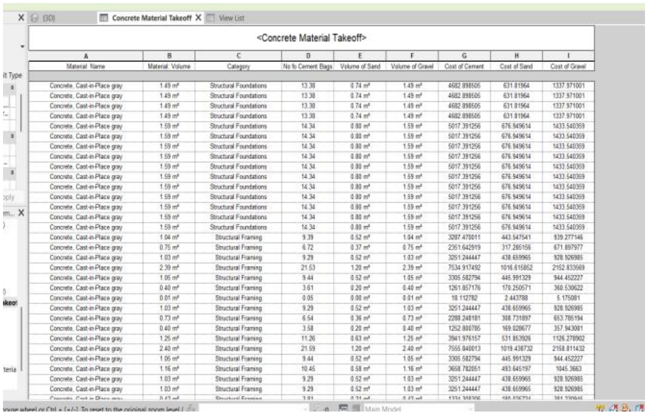


Figure-5: Revit Cost Estimation and Resource Management

3.2 Creating 3D Modeling

Creating 3D designs in Revit involves a systematic approach to modeling architectural and structural elements using Building Information Modeling (BIM). Below is a detailed guide on how to effectively utilize Revit for 3D design.

Overview of Revit 3D Modeling

Revit is a powerful BIM software that allows architects, engineers, and designers to create detailed 3D models of buildings and their components. The software integrates various aspects of design, documentation, and project management, making it essential for modern construction projects.

Steps for 3D Designing in Revit

1. Start with a Template

Launch Revit and select an appropriate template based on your project type (architectural, structural, or MEP).

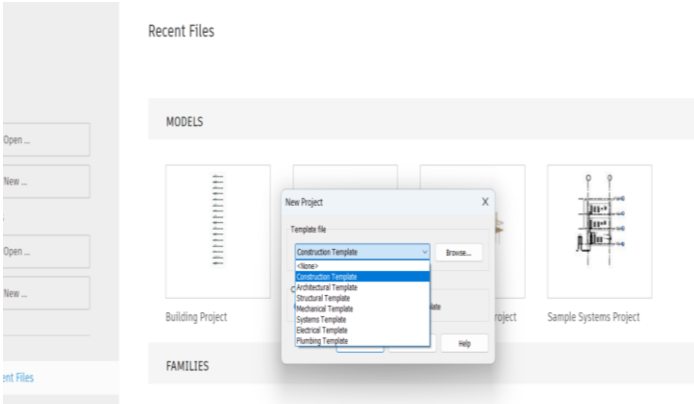


Figure-6: Different Types of Templates using in Revit

2. Build Basic Geometry

Use drawing tools to create fundamental building elements such as walls, floors, and roofs. Precise dimensions can be inputted to ensure accuracy.

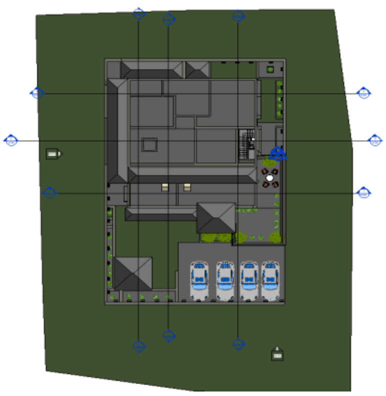


Figure-7: Build Basic Geometry

3. Add Detail [17]

Insert architectural components like doors, windows, and stairs from Revit's library or customize them as needed. This enhances the model's realism and functionality.

Figure-8: Add Details for doors, windows and other Furniture

4. Define Properties

Assign properties and parameters to each element to make them intelligent and parametric. This allows for easy modifications throughout the design process.

5. Refine the Model

Adjust materials, textures, and lighting to improve the visual quality of the model. Advanced tools can be used to manipulate complex forms.

Figure-9: Refine the Model

6. Coordinate with Other Disciplines

Collaborate with structural engineers and MEP designers using Revit's coordination tools to resolve any clashes or conflicts in the design.

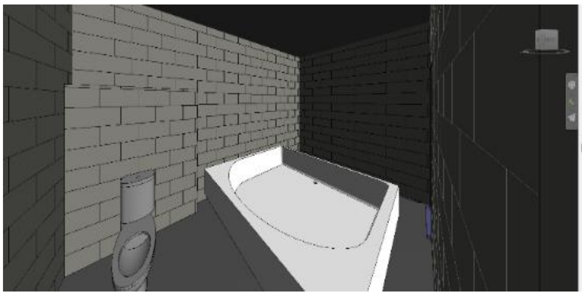


Figure-10: Coordinate With MEP

7. Utilize Revit's documentation features to produce 2D drawings and schedules directly from the 3D model, ensuring consistency across all project documents.

Figure-11: Generate Documentation 2D,3D,4D

3.3 Key Features of Revit for 3D Modeling

Parametric Modeling: Changes made to one element automatically update related components (e.g., adjusting a wall height will automatically resize adjacent doors and windows).

Clash Detection: Tools in Revit help identify potential design conflicts early in the process, reducing costly rework during construction.

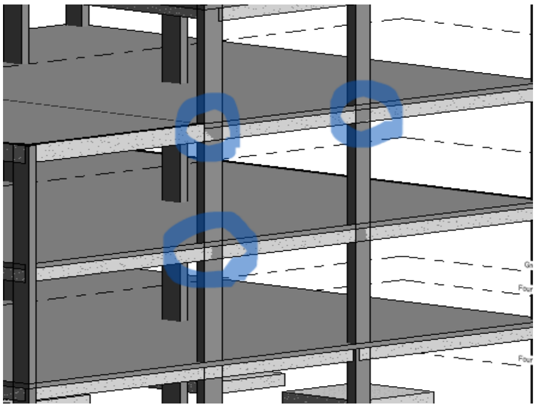


Figure-12: Clash Detection for Slab to Column

Embedded Design Data: Each element in a Revit model contains data that allows for interaction with other components, enhancing overall project efficiency.

Multi-Monitor Support: Users can organize views across multiple monitors for improved workflow.

Tips for Effective Use of Revit

1. Regularly save your work to prevent data loss.
2. Familiarize yourself with keyboard shortcuts to enhance productivity.
3. Use 3D views and walkthroughs to visualize designs from different perspectives.
4. Take advantage of Revit's extensive libraries of pre-built components to save time during the modeling process.

By following these steps and utilizing the features of Revit effectively, users can create detailed and accurate 3D models that facilitate better design decisions and enhance collaboration among project stakeholders.

4. Critical Steps in Revit Structural Modeling

Revit is a powerful Building Information Modeling (BIM) tool widely used for structural design and modeling. It offers a comprehensive set of features that facilitate the creation, analysis, and documentation of structural elements in both residential and commercial projects. The following sections outline the critical steps and best practices for effective structural modeling in Revit.

1. Initial Project Setup:

Define project parameters, units, and location settings to ensure consistency throughout the modeling process. This foundational setup is crucial for accurate modeling and coordination with architectural elements.

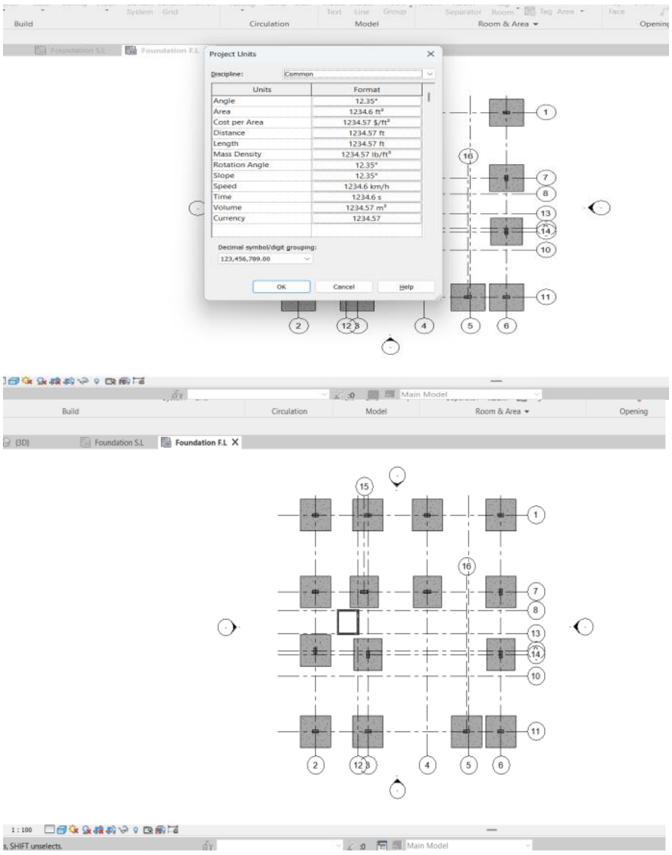


Figure-13: parameters, units and Grid Plan layout

2. Importing Architectural Models:

Import the architectural model into Revit, which serves as a base for integrating structural elements. This step allows for better alignment and coordination between architectural and structural designs.

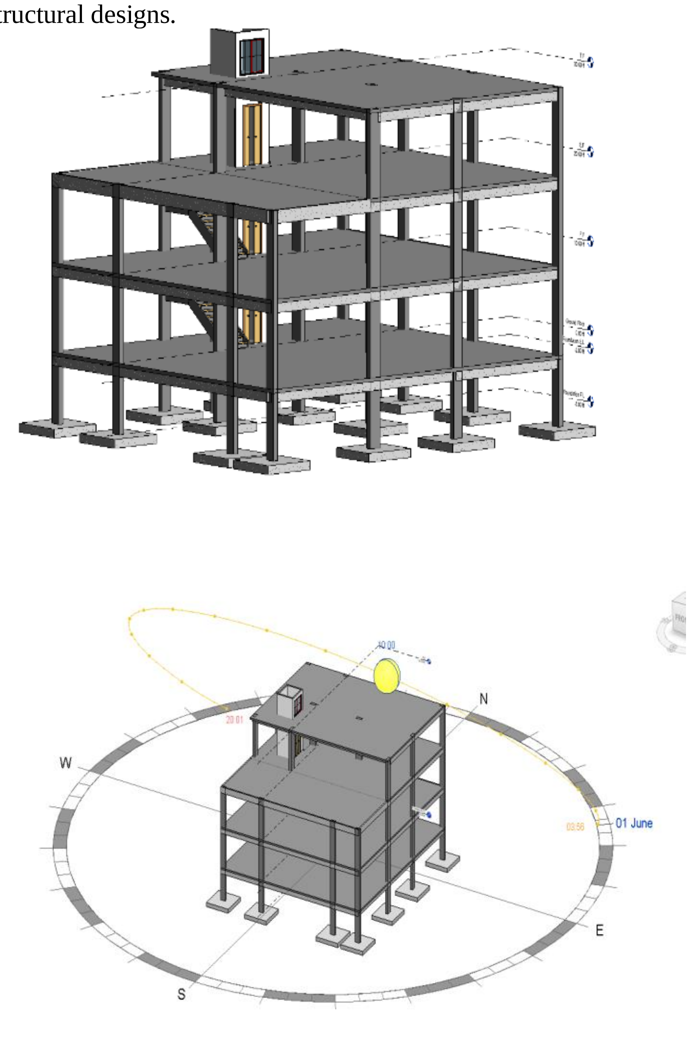
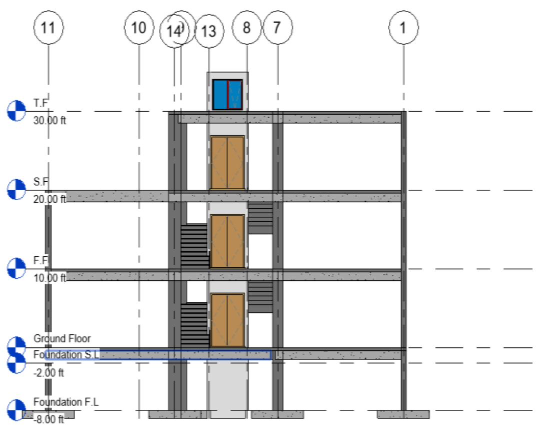


Figure-14: Structural 3D model

3. Creating Structural Elements:

Use Revit's tools to create essential structural components such as columns, beams, slabs, and walls. The software's parametric capabilities enable easy modifications to these elements based on design requirements.



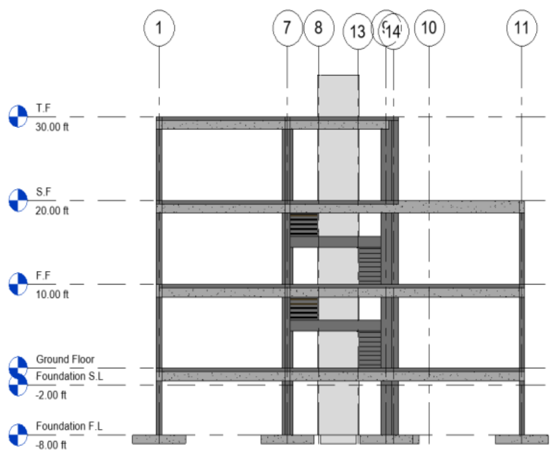


Figure-15: Structural Elevation View and Back side view

4. Connection Design and Analysis:

Define connection types and parameters to ensure structural integrity. Revit allows for detailed connection design, which is vital for load-bearing structures.

5. Structural Detailing and Documentation:

Generate detailed drawings, schedules, and construction documentation directly from the 3D model. This documentation is essential for contractors during the construction phase and ensures compliance with relevant codes.

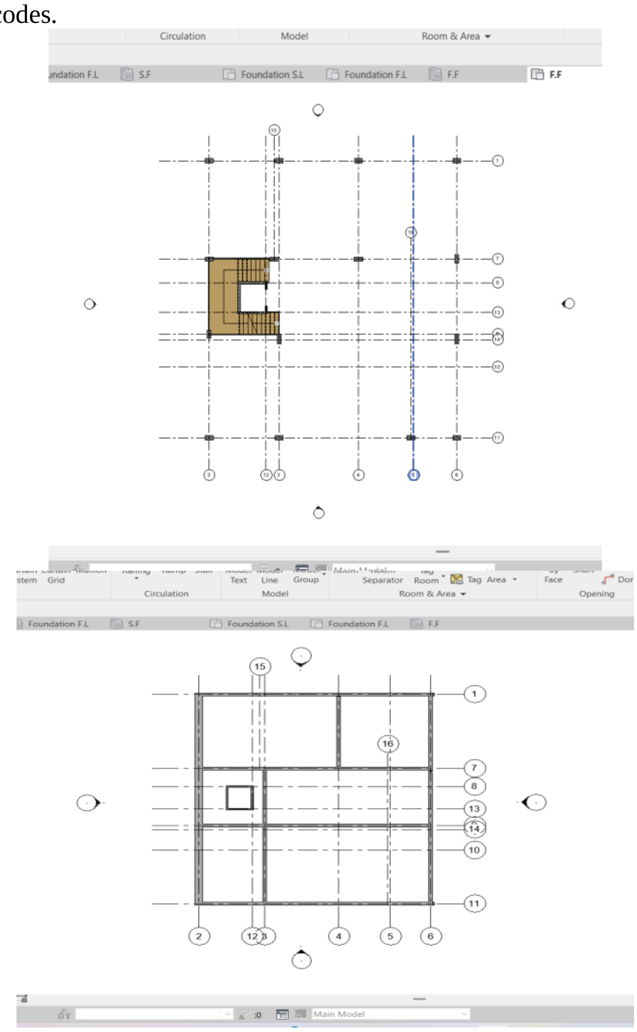


Figure-16: Column and Beam layout plans

6. Structural Analysis and Simulation:

Integrate structural analysis tools to simulate performance under various load conditions, helping identify potential design flaws early in the process.

5. Critical Literature Review

Korman et al. (2008) emphasize the importance of a comprehensive approach to MEP coordination, including design, construction, operations, and maintenance. They suggest using BIM models to resolve physical conflicts but also considering critical design criteria, constructability issues, and operations and maintenance concerns. They suggest a revised work process that integrates these aspects for better coordination. They also emphasize that resolving all physical interference does not guarantee well-coordinated facilities[2].

Saeed Karshenas et al. (2010) created the Visual Scheduling Application (VSA) to improve activity sequencing and project scheduling. The application uses Microsoft DirectX Graphics Library and Revit CAD software to create a virtual building prototype. Users can walk inside the virtual building, visualize project activities, and select tasks. VSA also interfaces with MS Project, allowing for easy digital transfer of activity information to the schedule. The approach aims to increase scheduling efficiency by incorporating cognitive theories that suggest the human brain interacts more effectively with 3D virtual worlds. This reduces manual data entry and memory usage compared to long lists of activities[3].

Saeed Karshenas et al. (2012) developed a game engine for construction planning and scheduling educational games, focusing on performance and flexibility. The engine imports data from Revit models, uses Microsoft Project for scheduling, and offers a feedback module. The game allows instructors to create unique construction scenarios, demonstrating the effectiveness of serious games as educational tools [4].

Yulong LI et al. (2013) developed a Teaching Practice Model combining BIM technology and Sand Table Simulation to improve Construction Project Management teaching quality. The model enhances students' understanding of BIM software and dynamic construction processes. However, it requires strengthening laboratory construction, providing process guidance, using standardized operational processes, and cultivating teamwork[5].

The study by **Hexu et al. (2014)** explores the use of Building Information Modeling (BIM) in panelized construction, specifically with scheduling. The system includes a construction sequence reasoning component and activity duration calculator, which can be exported to Microsoft Project for stakeholder communication and support on-site management. The automated scheduling system can help project managers plan on-site assembly work effectively[6].

Hosein Taghaddos et al. (2014) developed a simulation-based auction protocol (SBAP) framework for efficient resource scheduling in large-scale modular construction projects. The system uses a database to pull data, run a simulation model, and generate graphical reports to aid superintendents and project managers in decision-making. SBAP can schedule fast-track projects with limited data, level resources, and schedule resources based on shifts and calendars. It is demonstrated in a large case study of modular construction with 191 modules, demonstrating its capabilities in time-dependent resource levelling, effective yard space allocation, and visual outputs[7].

The study by **Kasim Alomari et al. (2016)** revealed that despite construction management personnel's knowledge of Building Information Modelling (BIM) and 3D laser scanning technologies, there is a lack of interest in these technologies among owners. The barriers to their diffusion include high costs and low experience. BIM offers cost improvements, ease of communication, and reduced omissions and change orders, while laser scanning is useful for presenting 3D models, comparing facilities, and sharing information. The study suggests the need for industry-focused research on BIM and 3D laser scanning to gain industry perspectives and reduce implementation costs[8].

Fernanda Rodrigues et al. (2016) developed a data management methodology for building construction using Building Information Modelling (BIM) (Revit) and Business Intelligence (BI) tools. This approach improves decision-making reliability, project deliverability, and sustainability by reducing errors and resource consumption. The methodology allows stakeholders to capture, record, process, synthesize, and analyse real-time data, detecting errors before they occur. This leads to remote collaboration, rapid decision-making, better accountability, increased productivity, efficiency, and environmental sustainability[9].

Ralph Tayeh et al. (2020) developed a new visualization technique for building information models and interactive holograms. They created a plugin for transferring models into game engines, software for intuitive interaction, and a display platform for hologram visualization. The plugin was found to be more effective than traditional methods and user-friendly, benefiting construction management education. The technologies enhanced BIM-data, human-building, and human-human interaction levels, making a collaborative visualization tool available for construction project teams[10].

M. Deosarkar et al. (2021) explores the use of Building Information Modelling (BIM) in creating an intelligent 3D smart model for a residential building in Pune, Maharashtra, India. BIM helps manage project complexity and manages diverse demands of designers and contractors. The study presents a detailed 3D smart model, design report, scheduling, estimation, and clash detection. Revit, a popular tool for coordinating design phases and providing consistency in drawings, is used daily in an architecture firm. The research compares Revit to well-known BIM software for interior design and architecture purposes, highlighting its key points and offering valuable value for documentation and systems integration. While Revit may not be suitable for design phases, it offers valuable value for documentation and systems integration[11].

A.S Hadi et al. (2021) examines the use of Building Information Modelling (BIM) as a valuable tool for engineers. The study evaluates the interlinking of Revit with structural analysis software like Robot Structural Analysis and Etabs. A case study is presented, focusing on a multi-story reinforced concrete building. BIM technology saves time and effort, optimizes structural scenarios, and ensures economical design with minimal errors. BIM models store all information, improving consistency across the project. However, the results obtained may differ from traditional methods due to differences in structural analysis methods. The finite element method used in BIM software is more accurate and provides real results, while traditional methods are manual and less accurate[12].

Bedilu Habte et al. (2021) discuss the advantages of Building Information Modelling (BIM) in construction projects, focusing on the structural analysis and design stage. BIM allows for a common model/database for all aspects of a building, from design to asset management. The study examines early adopters' experiences and demonstrates how BIM can integrate structural design activities and cross-discipline collaboration without leaving traditional platforms. The study uses Revit and ETABS and SAFE software packages for interoperability[13].

The study by **Habte et al. (2021)** explores the use of Building Information Modelling (BIM) in the structural analysis and design stages of a building. It demonstrates how BIM can integrate all structural design activities and enable cross-discipline collaboration without leaving one's traditional platform. The study uses Revit and conventional structural software packages ETABS and SAFE to model a sample building. Plugins and applications are developed for these packages to facilitate interoperability and modelling, analysis, design, and clash detection. The study highlights the benefits of BIM in structural design projects, such as the ability to store results in a central model and integrate other disciplines like sanitary engineering and electrical engineering[14].

Ya Hui Teo et al. (2022) discuss the potential of advanced technology in Building Information Modelling (BIM) and management strategies to improve productivity, accuracy, and efficiency in the construction industry. They suggest that visual programming and machine learning hybrid methods could help contractors complete construction works on time and meet client expectations. However, the construction industry may take time to adopt visual programming due to personnel needing to learn coding from scratch. Combining innovative technology with suitable management methods can improve workflow, reduce conflict, and lower labor costs[1].

Keshav et al. (2022) emphasizes the importance of construction management in ensuring timely project completion, focusing on schedule, cost, and quality. Building Information Modelling (BIM) has significantly improved the construction industry by providing accurate data to customers. The integration of BIM with Augmented Reality (AR) enhances transparency in design, costing, and progress visualization. This integration removes time-lapse and on-site data hindrances, enhancing data efficiency. The research highlights the value of both construction management and BIM in removing barriers such as time management, budget constraints, unrealistic expectations, and hazard management, and enhancing resource allocation for efficient project activities[15].

V. Mahendra Kumar et al. (2024) discusses the use of Autodesk Revit architecture for planning and modelling a G+5 residential building. The project transitions from 2D to 3D digital interfaces, integrating BIM technology for easy modelling. Revit Architecture provides a clear, excellent visualization of buildings, making it useful for commercial buildings before construction in the field. The project uses various templates, including construction, structure, and architecture templates, to create realistic models and estimate the building. The ground floor of the selected G+1 building is planned and modelled using families like wall, door, and window floor celling. Revit saves time by reducing manual tasks and paper work, making the project more sustainable and cost-effective. The project also highlights the importance of reputation and the tools available to create sustainable

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structures. Overall, Revit offers a comprehensive solution for creating sustainable structures[16].

6. Case study (Residential Bungalow House)

Project Overview:

Project Details:
Project Construction Types: Residential Bungalow House
Location: Vadodara, Gujarat
Size:2200 square feet
Duration:18 months
Stakeholders- Client, Architectural, General Contractor, Consultants (Structural, MEP, Mechanical, Electrical, Plumbing)

Implementation of Revit:

Phase 1: Design Planning:

The initial phase focused on using Revit for architectural design and collaborating with various stakeholders. Key activities included:
Creating 3D Models: The architectural team developed a detailed 3D model of the building, enhancing visualization for the client and stakeholders.
Collaboration Tools: Stakeholders used Revit's collaboration features, including shared models and cloud-based coordination, allowing for real-time updates and communication.

Phase 2: Construction Planning:

The use of Revit was expanded to construction planning:
4D Scheduling: The team integrated project schedules with the 3D model to create a 4D simulation, enabling visualization of the construction process over time.
Material Takeoffs: Revit's automated quantity take-off features provided accurate material lists, which improved budgeting and procurement planning.
Phase 3: Ongoing Collaboration and Adjustments
Throughout the construction, ongoing collaboration using Revit allowed for:
Real-Time Updates: Changes made to the model in response to field conditions were reflected in real-time, ensuring all stakeholders had access to the latest information.
Client Engagement: Interactive 3D walkthroughs were presented to the client, increasing their engagement and satisfaction.

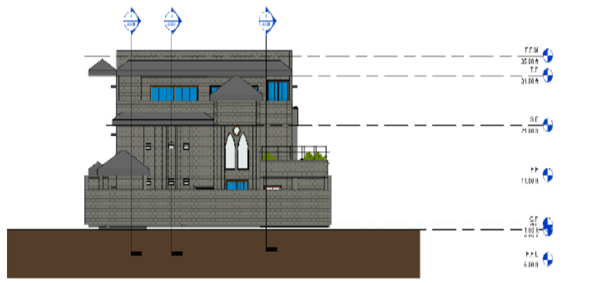
Challenges Faced:

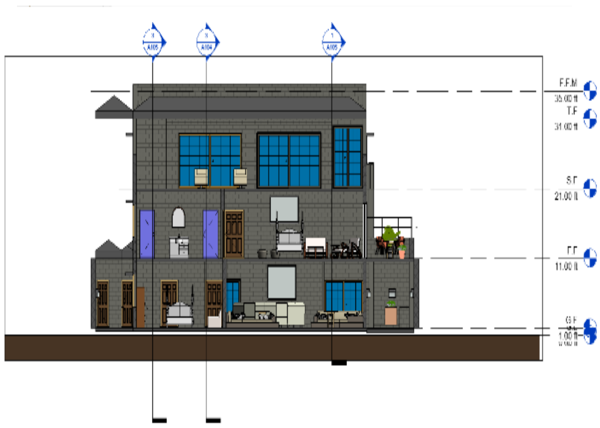
1. Training and Familiarization: Some team members initially struggled with the transition from traditional CAD software to Revit. A structured training program was implemented to address this.
2. Resistance to Change: Certain stakeholders exhibited reluctance to adopt BIM processes. Ongoing education on the benefits of Revit and early success stories helped mitigate these concerns.
3. Software Integration Issues: Integrating Revit with existing project management software posed challenges. Solutions involved customizing workflows to ensure seamless data exchange.

Conclusion:

The implementation of Revit for 3D design and planning in the residential bungalow house project showcased the transformative power of BIM in construction management. While challenges existed, the overall benefits—improved collaboration, reduced errors, cost savings, and enhanced visualization—demonstrate that adopting BIM practices can significantly elevate project outcomes. This case study serves as a model for future projects seeking to leverage technology for improved efficiency in the construction industry.

Figure-17: Graphical 3D model view





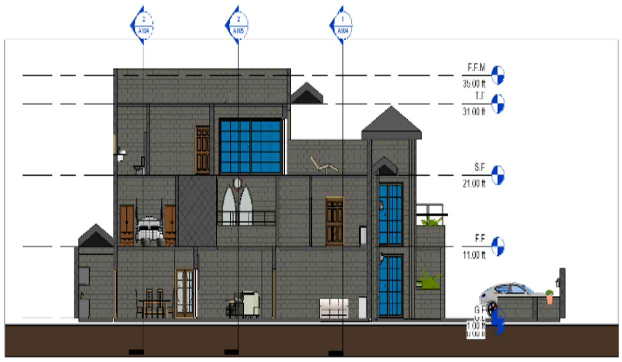


Figure-18: Graphical Sectional View

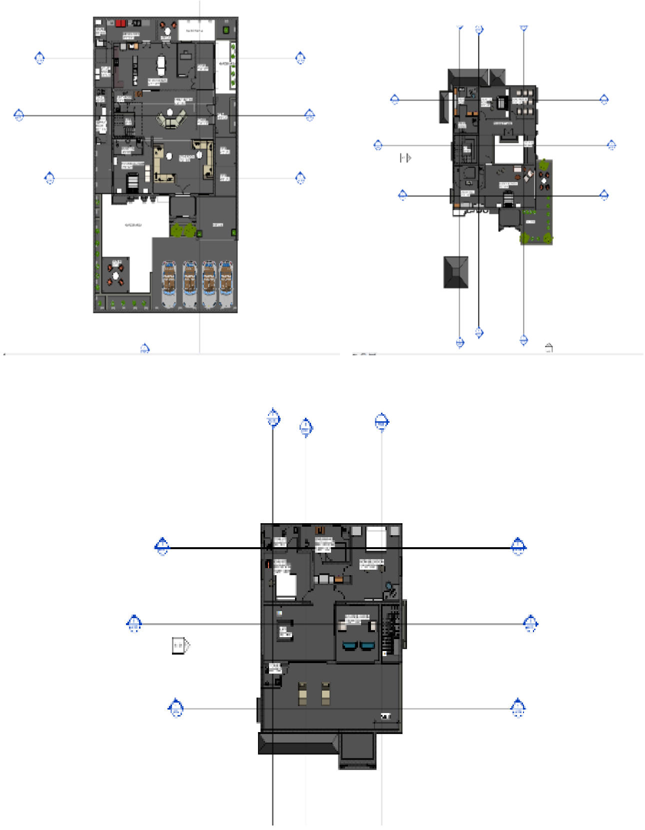


Figure-19: Graphical Plan View

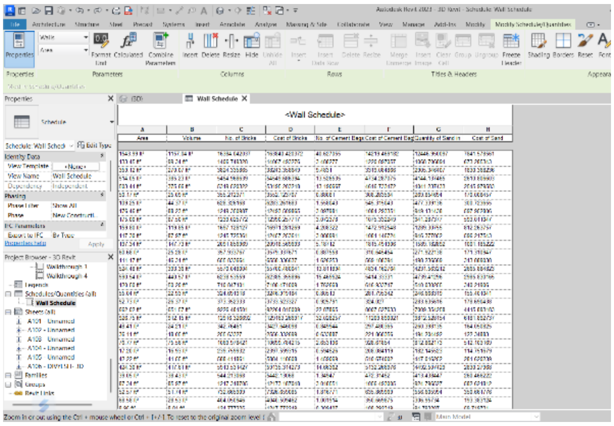


Figure-20: Estimation and Cost Analysis

7. Critical Literature Outcomes

1. The use of Revit enhanced communication among architects, engineers, contractors, and clients. Interactive modelling facilitated discussions and quick decision-making.
2. Early clash detection and coordinated modelling significantly reduced errors and omissions, leading to fewer change orders and a smoother construction process.
3. Accurate quantities and improved scheduling led to better budget management and resource allocation, resulting in savings estimated at 10% of the total project budget.
4. The ability to create realistic 3D models allowed stakeholders, including clients, to visualize the project effectively and provide feedback throughout the design process.

8. CONCLUSIONS

In conclusion, the adoption of Revit in construction project management is a transformative step towards achieving greater efficiency, cost-effectiveness, and quality control. By leveraging its advanced features for collaboration and coordination, construction teams can navigate complex projects more effectively, ultimately leading to successful project delivery and enhanced client satisfaction. The shift from traditional methods to a BIM-centric approach exemplifies how technology can drive innovation and excellence in the architecture, engineering, and construction (AEC) industry.

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AUTHOR PROFILE

Name of Author- Divyesh Solanki
Email Address- sdivyesh283@gmail.com
Final Year, M.Tech (Civil) Construction Engineering and Management, BVM Engineering College, Vallabh Vidyanagar – Gujarat – India,