"QUANTIFYING BUILD: REVIT AUTOMATION VS. EXCEL MANUAL ESTIMATION IN G+2 RSIDENTIAL BUILDING"

Guided By
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Abstract

This project aims to revolutionize construction estimation methodologies by exploring the capabilities of Building Information Modeling (BIM) software, specifically Autodesk Revit, in automating the estimation process for a G+2 building. The study is meticulously designed to comprehensively understand and evaluate the accuracy of Revit-generated estimates by comparing them with traditional manual estimation methods using Excel.

Furthermore, this project addresses the practical implications of implementing automation in construction management. By scrutinizing the accuracy of Revit- generated estimates through comparison with manual Excel methods, the research aims to bridge the gap between technology-driven solutions and traditional industry practices. The investigation into factors contributing to discrepancies between the two methods will offer valuable insights into the limitations and strengths of automated estimation tools. As the construction industry continues to evolve, this study provides a timely examination of the potential challenges and benefits associated with the adoption of advanced technologies, contributing to the ongoing discourse on the integration of BIM tools in construction project workflows.

1. Introduction

1.1 Introduction of the project work

This project aims to explore the integration of Autodesk Revit software in automating construction estimation processes for a G+2 building model. It addresses the limitations of traditional manual methods and the increasing demand for streamlined, tech-driven solutions in the construction industry. The objectives include developing a standardized methodology for automated estimation, fine- tuning the process for accuracy, and validating results through comparative analysis with manual Excel-based estimations. The significance of automated estimation lies in its ability to enhance accuracy, efficiency, and handling of complex project parameters. The project focuses on the transformative potential of Building Information Modeling (BIM), particularly with Revit, in construction estimation. It outlines BIM principles and its specific application in construction estimation, narrowing its scope to materials estimation for a G+2 building while acknowledging inherent limitations and constraints.

1.2 Introduction of Autodesk Revit in project:

Autodesk Revit, a leading Building Information Modeling (BIM) software since its introduction in 2000, has transformed construction and architectural design processes. Unlike traditional CAD software, Revit offers intelligent 3D modeling with parametric capabilities, facilitating dynamic relationships between elements. Its user-friendly interface features a ribbon- style toolbar for easy navigation and a central workspace for realtime visualization. Collaborative tools enable concurrent work by team members, enhancing workflow efficiency. This project focuses on leveraging Revit's advanced features to automate construction estimation processes for a G+2 building. The study aims to compare automated estimations with manual methods,contributing to the discourse on integrating BIM technologies in the construction industry.

1.3 Excel in project: Introduction of MS

This project acknowledges the enduring importance of Microsoft Excel in construction estimation processes alongside advanced technologies like Autodesk Revit. Excel's versatile spreadsheet capabilities and intuitive interface have made it a staple in project management and estimation. It offers a flexible platform for manual estimation, systematically organizing complex data associated with construction material quantities. In this project, Excel serves as the manual benchmark for estimation, facilitating meticulous breakdown and evaluation of material quantities with its tabular layout and formula-driven calculations. Its compatibility with various data formats enhances workflow efficiency and enables comparison with Revit's automated results. Despite Revit's automation, Excel's role remains pivotal in providing a reference point for analysis, highlighting the coexistence of traditional manual methods and emerging technologies in construction estimation

1.4 Aim:

"Quantifying build: Revit automation vs. excel manual estimation in G+2 Residential building"

1.5 Objective:

1. Develop a standardized methodology for automating construction material estimation in Revit for a G+2 building.
2. Implement and fine-tune the automated estimation process to ensure accuracy and reliability.
3. Evaluate the accuracy of Revit estimates by comparing them against manually calculated Excel estimates.
4. Investigate factors contributing to differences between Revit and manual estimates.
5. Explore efficiency and time-saving aspects of the automated estimation process in Revit.

1.6 Area Of Study:

Key components of your study might include

Construction Estimation Methods: Investigate traditional manual estimation using Excel spreadsheets versus automated estimation using Building Information Modelling (BIM) software like
Revit

Comparison of Accuracy: Analyse the accuracy and precision of cost estimation between manual and automated methods. This could involve comparing estimation errors, discrepancies, and deviations.

Efficiency and Time Analysis: Evaluate the time required for estimation using each method.
Determine the efficiency gains or losses associated with automation compared to manual estimation.

Resource Utilization: Assess the human and technological resources required for both manual and automated estimation processes. Consider factors such as labor hours, software costs, and training.

Risk Assessment: Identify potential risks associated with each estimation method, including errors, data inconsistencies, and learning curve challenges.

Case Studies or Real-world Examples: Incorporate real-world case studies or examples of G+2 residential building projects to provide practical insights and validate your findings.

Recommendations and Future Outlook: Based on your analysis, provide recommendations for construction firms or professionals regarding the selection of estimation methods. Also, discuss potential future trends in estimation technology and its impact on the construction industry.

2. Problem statement and methodology

2.1 Problem Statement:

In the realm of construction estimation, the reliance on traditional manual methods, particularly using Microsoft Excel, poses inherent challenges that necessitate scrutiny and refinement. The manual process of estimating construction materials involves intricate calculations and formula-driven data entry in Excel, a widely adopted tool in the construction industry. However, the susceptibility to human errors, the time-intensive nature of calculations, and the complexity of handling diverse project parameters often result in variations and discrepancies in estimations. This calls for a critical examination of the manual estimation process to identify areas of improvement and explore how emerging technologies, such as Building Information Modelling (BIM) software like Revit, can enhance accuracy and efficiency.

The challenge lies in reconciling the reliability of Excel-based estimations with the burgeoning need for streamlined and automated approaches. As construction projects evolve in complexity and scale, the limitations of manual estimation become more pronounced. This problem statement aims to delve

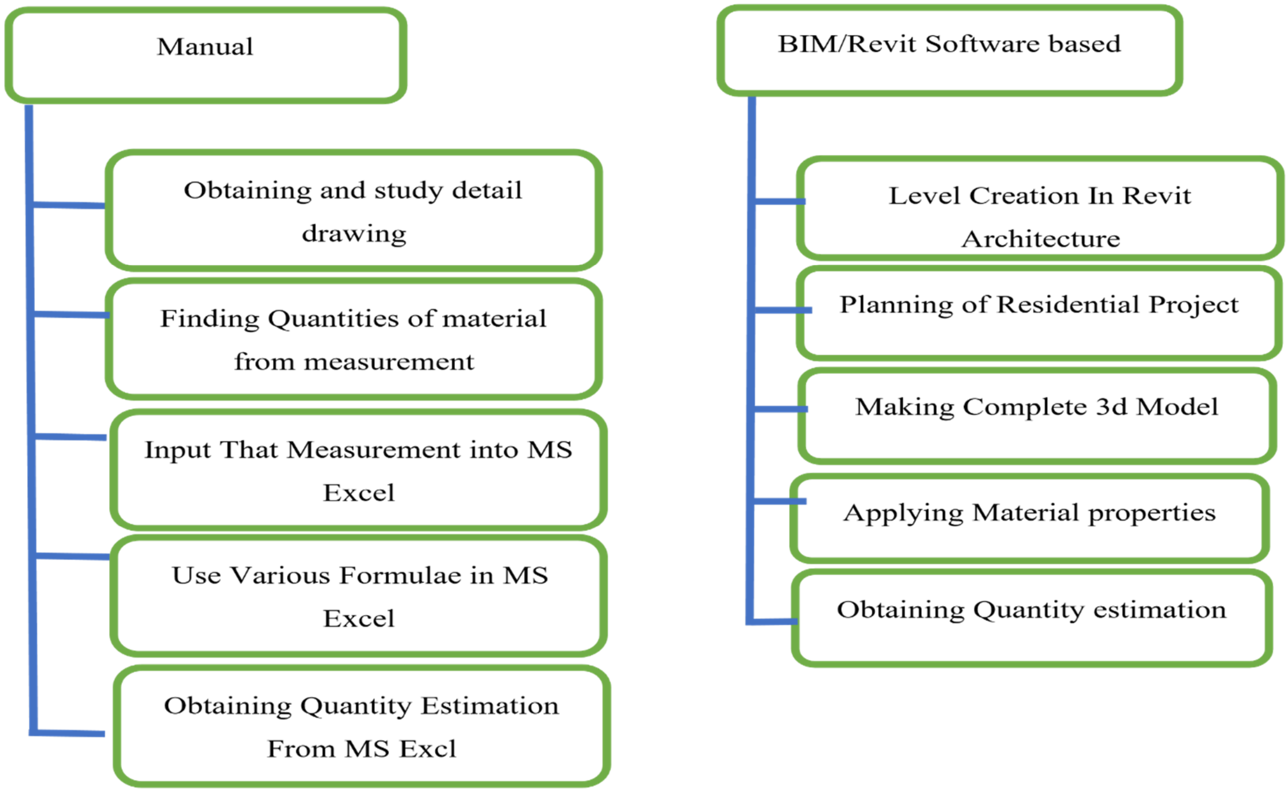


Fig2.1.1 Comparison of Manual and BIM

into the intricacies of the manual estimation process using Excel, identifying key pain points and proposing potential enhancements. Through a thorough examination of Excel's role in construction estimation, we seek to bridge the gap between traditional methods and advanced technologies, ultimately contributing to the evolution of accurate and efficient construction estimation practices.

2.2 Methodology:

In this comprehensive project, our methodology encompasses a meticulous process for achieving automated estimations of various construction materials, including brick, footing, beam, slab, column, and structural rebar, for a G+2 residential building. The methodological framework is designed to leverage the capabilities of Autodesk Revit, a powerful Building Information Modelling (BIM) software, to streamline and enhance the construction estimation process.

The first phase involves developing a standardized methodology for automated estimation within the Revit environment. We will construct a detailed 3D model of the G+2 residential building, incorporating precise parameters related to each construction component. Utilizing Revit's parametric modelling capabilities, we will establish dynamic relationships between elements, enabling the software to calculate and generate accurate quantities of brick, footing, beam, slab, column, and structural rebar based on the defined model. Iterative testing and refinement will be conducted to ensure the accuracy and reliability of the automated estimation process within Revit.

Simultaneously, a manual estimation benchmark will be established using Microsoft Excel. The parameters used in the Revit model will be translated into an Excel spreadsheet, where manual calculations and formulas will be applied to estimate the quantities of construction materials. This step serves as a crucial benchmark for comparison, allowing us to evaluate the accuracy of Revit-generated estimates against traditional manual methods. Excel's familiarity, widespread use, and flexibility make it an ideal tool for the manual estimation process, providing a reference point to assess the reliability of automated results.

The final phase involves a comprehensive comparison and validation of the automated estimates from Revit with the manual estimates derived from Excel. Data on material quantities for brick, cement, sand, footing, beam, slab, column, and structural rebar will be collected and analysed, highlighting any discrepancies or variations between the two methods. Through statistical analysis and visual representations, we aim to assess the accuracy of Revit-generated estimates, identify factors influencing variations, and derive insights into the overall reliability of automated construction estimation for a G+2 residential building. This iterative and systematic approach ensures a robust and thorough evaluation of both automated and manual estimation methods.

2.3 Procedure for creating this Model in Revit: Following Are the three different View of G+2 Residential Building.

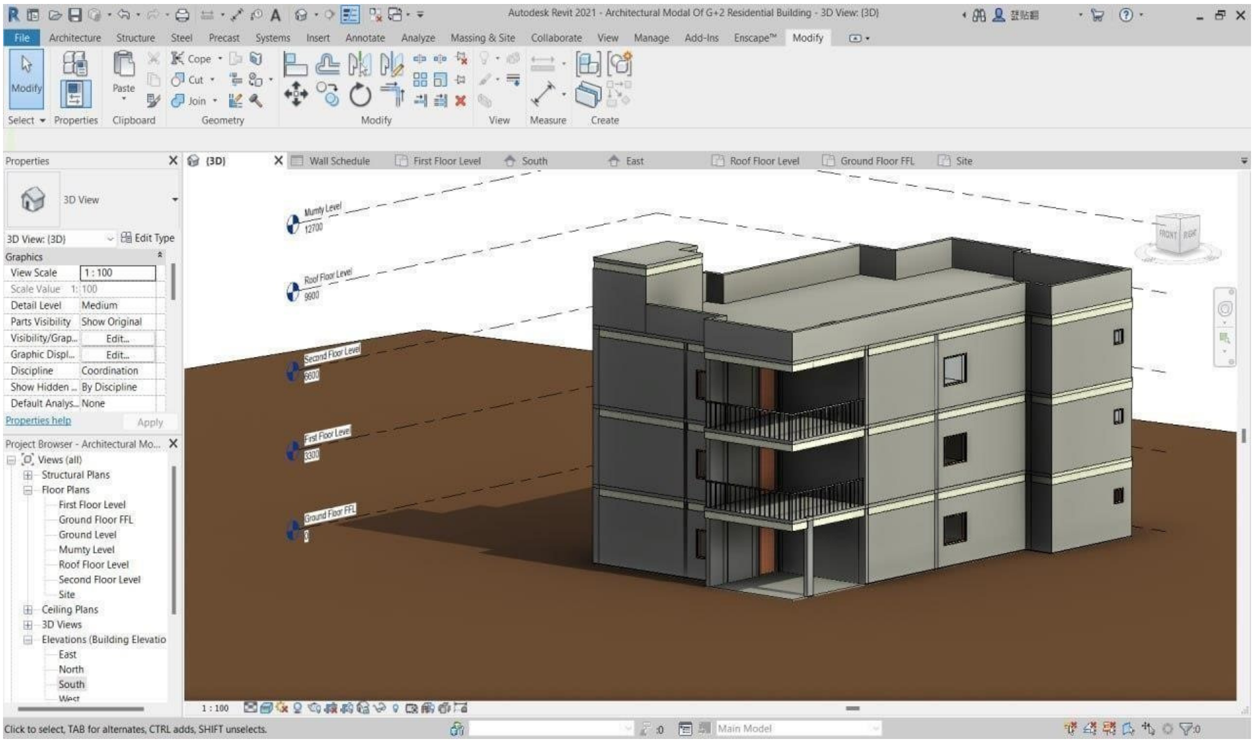


Fig2.1.2 3D Architectural model view-1

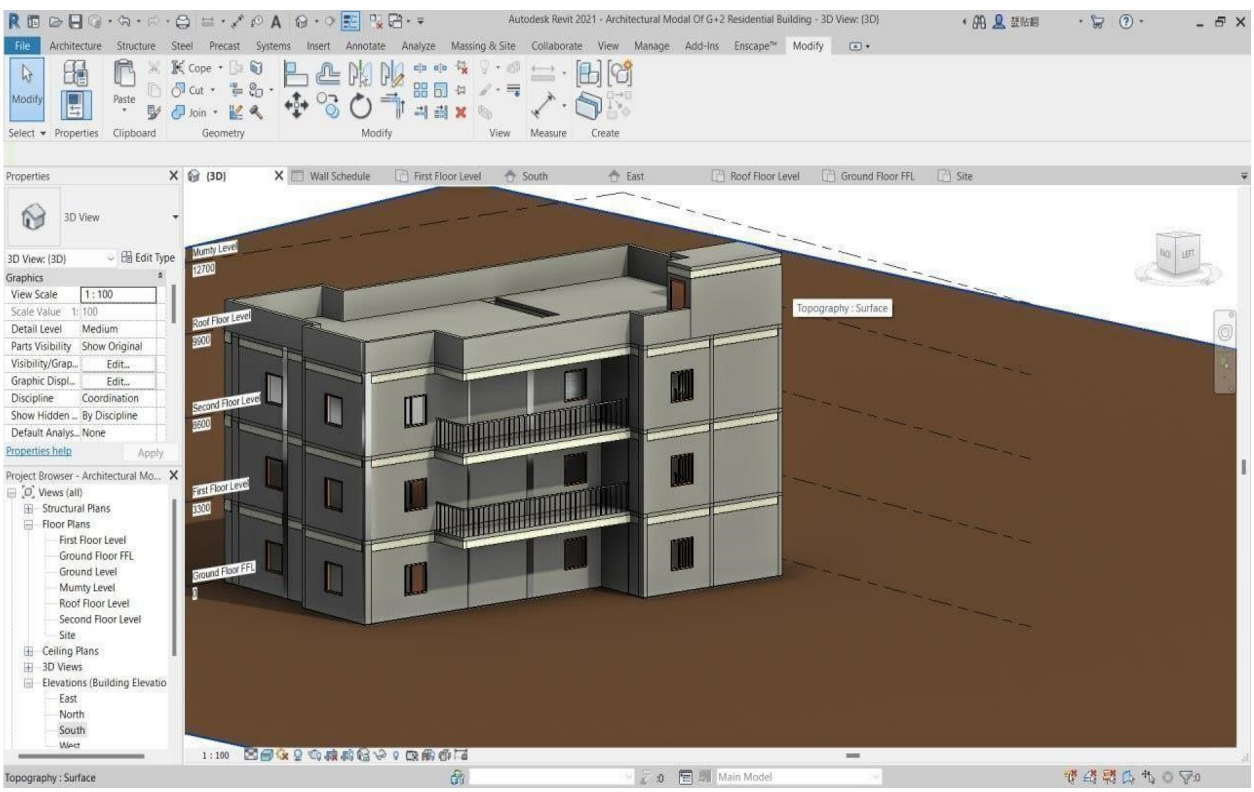


Fig2.1.3 3D architectural model view-2

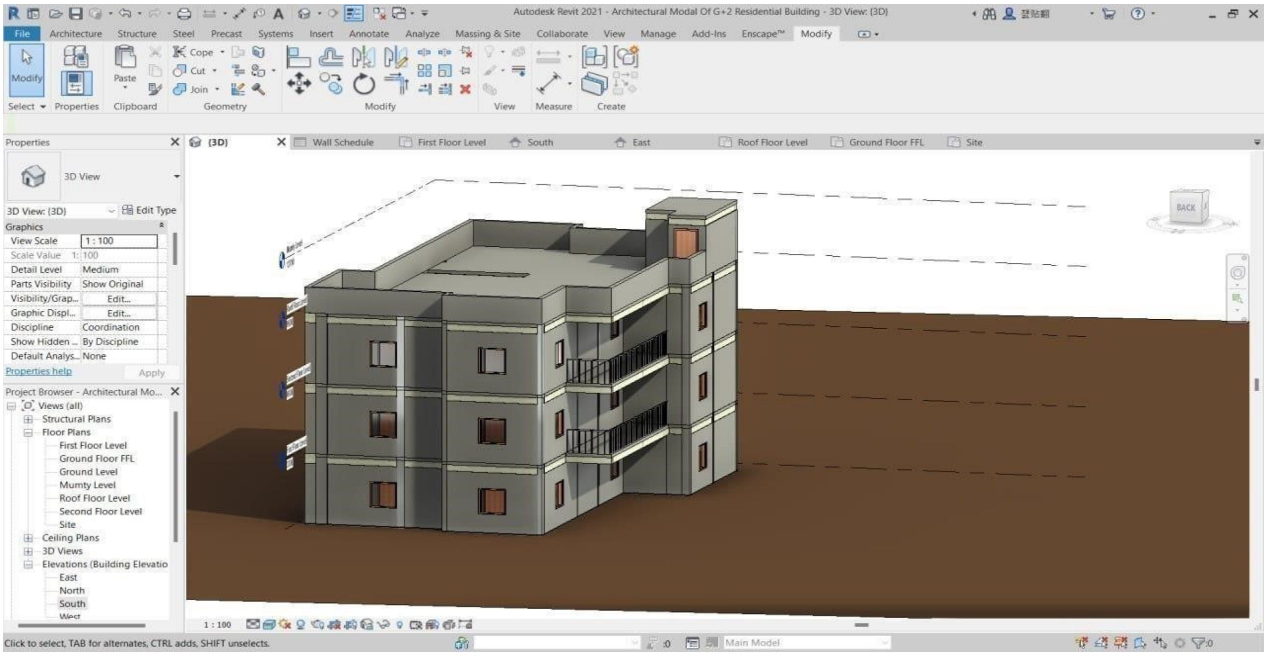


Fig2.1.4 3D architectural model view-3

2.3.1 Level Creation:

Creating levels in Revit Architecture is a fundamental step in establishing the vertical framework of a building. To initiate this process, open your Revit project and navigate to the "Architecture" tab. Select the "Level" tool from the "Datum" panel. Upon activating the tool, a cursor will appear, allowing you to click on the desired location in the drawing area to place the initial level. Enter the appropriate elevation value for the level, ensuring accuracy in vertical positioning.

Subsequently, additional levels can be created by repeating the process. Revit provides options for placing levels at equal or specific distances above or below existing ones, promoting consistency throughout the project. Labels associated with each level can be customized to display information such as floor numbers or other designations, facilitating clear communication within the project team. To refine the visual representation of levels, consider adjusting the display options in the "Properties" palette. Customize the line style, line weight, and color to enhance clarity and distinguish between different levels easily. As the project progresses, the "Rearrange" tool can be employed to reorder levels and maintain an organized hierarchy within the model Moreover, levels can be associated with specific views, ensuring that the information is presented appropriately in floor plans, sections, and elevations. The use of "View Range" settings allows for precise control over the visibility of elements in each view, contributing to a more refined and contextspecific representation of the building's vertical structure

In conclusion, the creation of levels in Revit Architecture involves a straightforward process initiated from the "Architecture" tab, allowing users to establish a hierarchical framework for the project. This foundational step is pivotal for accurate modelling and efficient collaboration, forming the basis for subsequent design and construction activities in the BIM environment.

2.3.2 Planning Of G+2 Residential Project:

Floor planning in Revit Architecture involves a systematic process to create a digital representation of a building's layout, For door and window sizes conforming to the Indian Standard Code, refer to the relevant IS codes, such as IS 1003 for wooden doors and IS 1038 for steel doors. Incorporate these dimensions during the placement of doors and windows to ensure compliance with industry standards. Utilize the "Door" and "Window" schedules in Revit to generate comprehensive lists detailing their sizes, types, and quantities, aiding in project documentation.

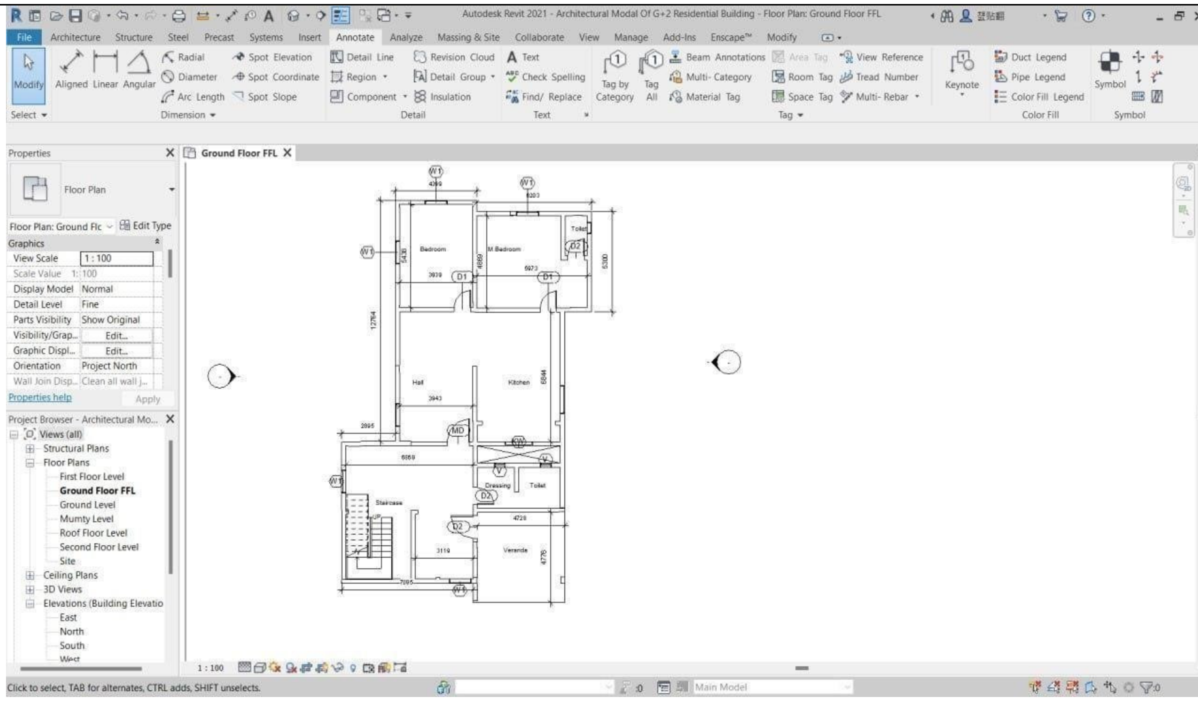


fig.2.1.5 Typical floor plan

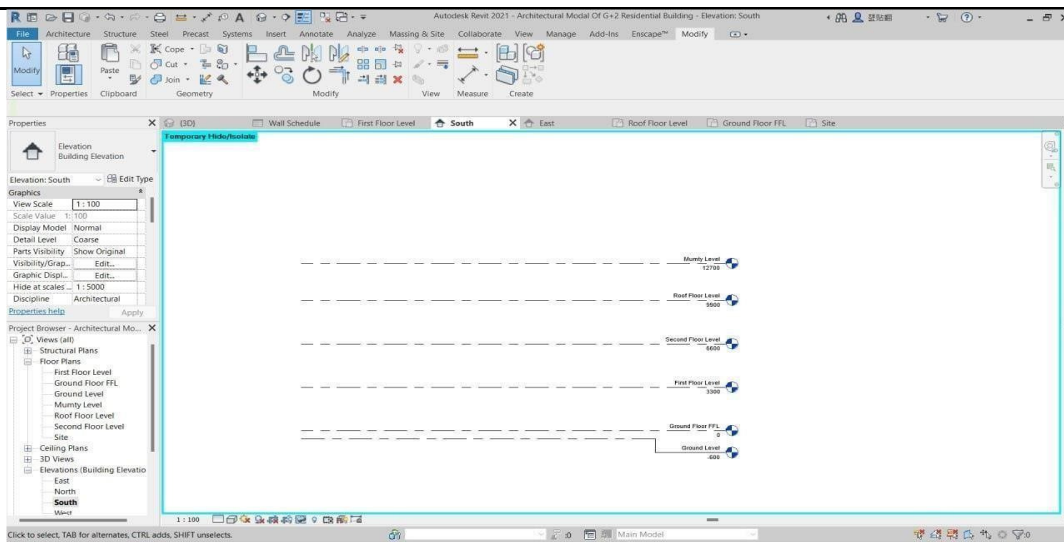


fig.2.1.6 level creation in Revit architecture

To enhance project clarity and communication, employ door and window tags in Revit, which can be customized to display pertinent information. The customization includes door and window numbers, sizes, and any additional specifications required by the Indian Standard Code. Additionally, utilize the "Room" tool to define spaces, allowing for automatic calculation of areas and generating accurate floor plans.

Staircases are integral components of building design, and in Revit, they can be added using the "Stair by Component" tool. Set the desired dimensions, number of risers, and tread depth, ensuring compliance with building codes and standards. Implement staircase tags to label and annotate the stair

integrating various elements such as doors, windows, staircases, and adhering to Indian Standard Code for door and window sizes. Begin by accessing the "Architecture" tab and selecting the "Level" tool to establish the building's horizontal framework.

Subsequently, utilize the "Wall" tool to sketch the external and internal walls, employing dimensions and constraints for accuracy. With the basic structure in place, add doors and windows by selecting the respective tools and placing them in desired locations. components, providing clarity on their specifications.

For a holistic view of the project, leverage the "Floor Plan" views, allowing users to visualize and manipulate the floor layout in 2D. Explore the "Visibility Graphics" settings to control the display of elements, optimizing the visual representation of the floor plan. Integrate dimensions, annotations, and keynotes as required to enhance the clarity of the plan.

Moreover, ensure that your floor plan aligns with the broader BIM framework, allowing for seamless coordination with other disciplines like structural and MEP (Mechanical, Electrical, Plumbing) systems. Regularly update and synchronize the model to reflect any modifications and maintain consistency throughout the project.

In conclusion, floor planning in Revit Architecture entails a methodical approach, incorporating door and window sizes adhering to the Indian Standard Code, door and window tags, staircase tags, and meticulous detailing of each element. This process ensures precision, compliance with standards, and facilitates effective communication in the collaborative BIM environment, contributing to a comprehensive and well- documented architectural project.

2.3.3 Automatic Estimation of Brick Using Revit:

In the context of our project focused on automated construction estimation using Revit for a G+2 residential building, the automatic estimation of brick, cement, and sand involves a systematic process that leverages the capabilities of Building Information Modelling (BIM) software. We initiate this process by first establishing the structural framework of the building using the "Architecture" tab and creating levels to define the project's vertical hierarchy. With the levels in place, the "Wall" tool is employed to sketch the external and internal walls, incorporating accurate dimensions and constraints. This foundational step sets the stage for the subsequent automated estimation of construction materials.

Size Of Brick (Without Mortar):- 19cmx9cmx9cm

Mortar Size:- 1cm

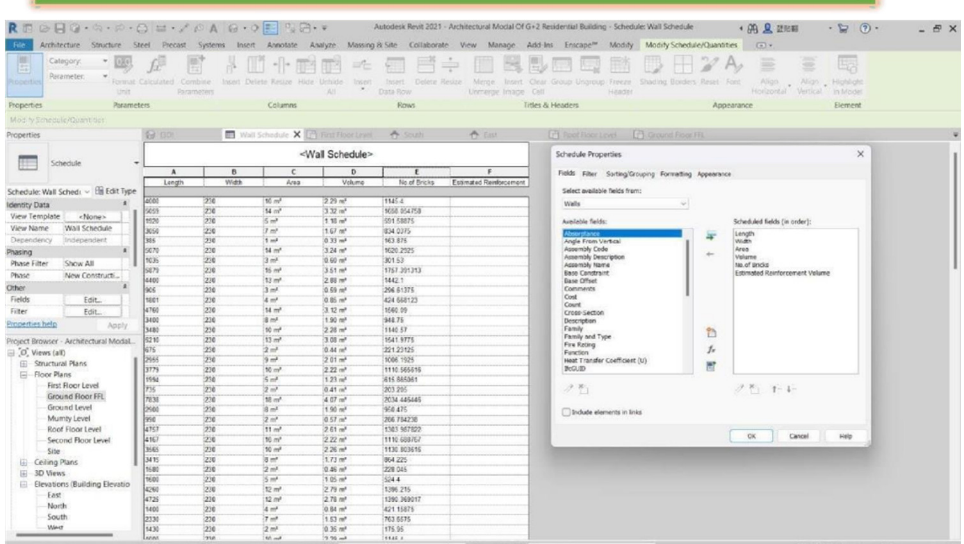
Size Of Brick (With Mortar):- 20cmx10cmx10cm

Volume of one Brick With Mortar:- 20x10x10 = 2000cm^3 (0.002m^3)

Total No of Bricks in 1 m^3 = (Volume of 1 m^3)/(vol. of one Brick with mortar)

=1/0.002

=500 no. of Bricks



For brick estimation, we utilize Revit's parametric modelling capabilities to define the type and thickness of walls. The software calculates the wall area based on the defined parameters, allowing for an automated quantification of the number of bricks required. Incorporating the dimensions and properties of the bricks, such as length, width, and height, ensures precision in the estimation process. Concurrently, the "Wall Schedule" feature in Revit facilitates the extraction of detailed information about the walls, including their areas and specifications, providing a comprehensive overview for project documentation

fig2.1.8 flow diagram for calculating wall schedule in revit

Moving on to cement and sand estimation, we integrate the "Material Takeoff" tool within Revit to automate the calculation of the quantities required. By associating the wall types with specific material properties, the software efficiently computes the volumes of cement and sand needed for construction. This process ensures that the estimations align with the specified parameters and meet industry standards.

To adhere to the Indian Standard Code for door and window sizes, we consider the relevant IS codes during the placement of these elements. Revit's "Door" and "Window" schedules enable the creation of detailed lists specifying their sizes, types, and quantities. Door and window tags are customized to display essential information, including dimensions and specifications, fostering clarity in the project documentation.

The automated estimation process extends to staircases, where the "Stair by Component" tool is employed to define the dimensions and parameters of the stairs. Staircase tags are utilized for annotation, providing a clear representation of their specifications. The project's floor plan views in Revit allow for a comprehensive visual representation of the building's layout, integrating all elements seamlessly.

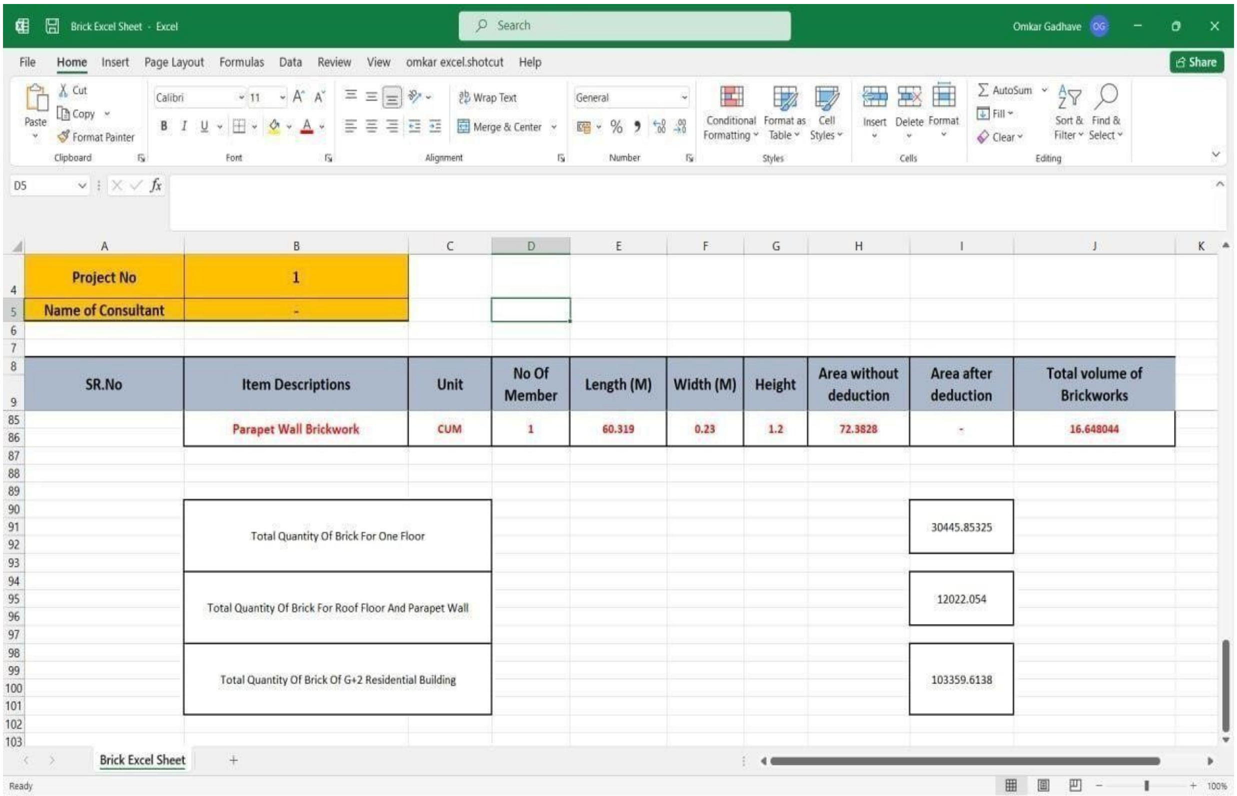
Table No. 1. Final Quantity Of Brick

Sr. No	Item Description	Unit of Quantity	Total Quantity
1	Brick Quantity	No.	105717

Throughout this process, constant reference to the Indian Standard Code ensures that the dimensions and specifications align with industry standards. The integration of manual estimation benchmarks using Microsoft Excel enhances the project's robustness, providing a reliable basis for comparison. This systematic methodology not only streamlines the estimation process but also ensures compliance with standards and enhances the overall efficiency of the construction project. The project's overarching goal is to bridge the gap between traditional manual methods and advanced BIM technologies, contributing to the evolution of accurate and efficient construction estimation practices.

2.3.4 Manual Estimation of Brick:

In the manual estimation process using Microsoft Excel for brick, cement, and sand, we embark on a detailed procedure to ensure accuracy and adherence to industry standards. The process initiates with the entry of relevant parameters, such as the dimensions of walls for brick estimation, and the volume of concrete for cement and sand calculations. The formula for brick estimation involves multiplying the wall area by the number of bricks per square meter, considering the specified brick dimensions. Similarly, for cement and sand estimation, the volume of concrete is multiplied by the ratio of cement and sand, factoring in the required mix proportionsas per industry standards.



SR.No	Item Descriptions	Unit	No Of Member	Length (M)	Width (M)	Height	Area without deduction	Area after deduction	Total volume of Brickworks
	Parapet Wall Brickwork	CUM	1	60.319	0.23	1.2	72.3828	-	16.648044

Total Quantity Of Brick For One Floor	30445.85325
Total Quantity Of Brick For Roof Floor And Parapet Wall	12022.054
Total Quantity Of Brick Of G+2 Residential Building	103359.6138

The Excel spreadsheet serves as a dynamic platform for these calculations, allowing for easy adjustments and updates. Formulas are employed to automate the computations, providing efficiency and reducing the likelihood of manual errors. Additionally, Excel facilitates the creation of itemized lists and schedules, breaking down the quantities of bricks, cement, and sand based on the calculated values. The flexibility of Excel allows for customization of these schedules to include additional information such as costs, suppliers, and other relevant details. Following are the list of types of door and window used in project. ensures a robust and dependable manual estimation process for brick, cement, and sand in construction projects.

Furthermore, the manual estimation process integrates compliance with the Indian Standard Code, ensuring that the dimensions and proportions used in the calculations align with industry norms. Excel's powerful data manipulation capabilities enable the systematic organization and presentation of the estimated quantities, contributing to a clear and comprehensive project documentation. This manual approach in Excel serves not only as a benchmark for validating automated estimates but also as a practical and accessible method for construction estimation, catering to industry practices and standards. The synergy of Excel's versatility and the systematic application of formulas

2.3.5 Procedure for creating Structural Model in Revit:

Creating a structural model in Revit Structure involves a systematic and comprehensive process that establishes the framework for an accurate representation of the building's structural elements. Begin by launching Revit and selecting the "Structural" template to ensure access to specialized tools catered to structural engineering. Start with defining the project levels, indicating the vertical hierarchy of the structure, which forms the basis for subsequent modelling.

Utilize the "Column" tool to add vertical elements that support the building's load. Specify the dimensions, type, and location of the columns based on the structural requirements. The "Beam" tool is then employed to add horizontal structural members connecting the columns, further defining the building's skeletal structure. Parameters such as span, depth, and material are considered to ensure accuracy and compliance with engineering standards.

Table No.3. Types of Door used in project

Sr. No	Types Of Door	Sizes Of Door (mm)
1	MD (main door)	1200 X 2100
2	D1	900 X 2100
3	D2	750 X 2100

Table No.4. Types of Window used in project

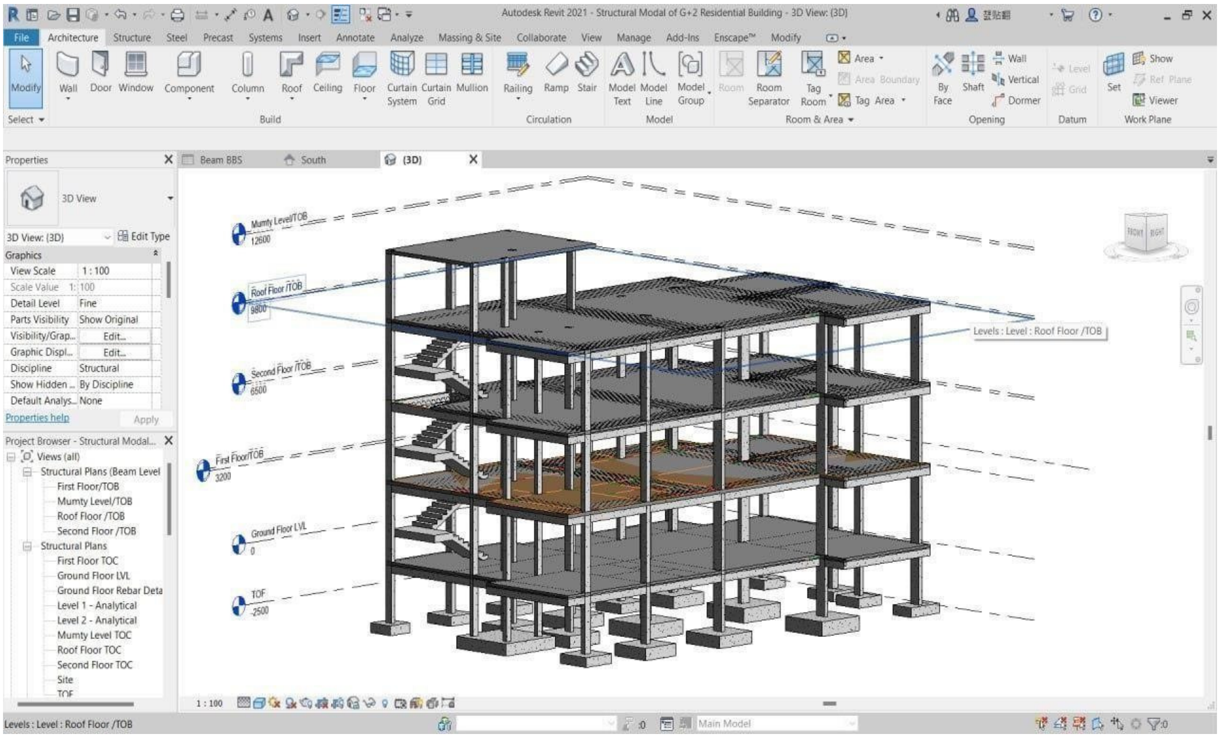
Sr. No	Types Of Window	Sizes Of Window (mm)	Sill Height (mm)
1	V (ventilator)	600 X 600	1500
2	KW (kitchen window)	1500 X 1200	900
3	W1	1200 X 1200	900

Proceed to the creation of floors using the "Floor" tool, specifying the structural slab thickness and type. Revit provides options for defining various floor types, each serving specific structural purposes, ranging from concrete slabs to composite decks. The integration of floor systems contributes to the overall rigidity and load-bearing capacity of the structure.

For the creation of foundations, utilize the "Foundation" tool, accounting for the type of foundation required based on the building's structural needs. Parameters such as foundation type, depth, and dimensions are inputted to accurately represent the building's support structure. Revit offers flexibility in choosing different foundation types, including isolated footings, strip footings, and mat foundations.

To complete the structural model, incorporate lateral load- resisting elements such as shear walls or braces using the appropriate tools within Revit. Ensure proper placement and detailing of these elements to enhance the building's overall stability and resistance to lateral forces. Throughout the modelling process, leverage Revit's tagging structural elements effectively. Labels and tags can be customized to display relevant information such as member sizes, material specifications, and analytical data. Utilize the "Schedule" tool to generate comprehensive lists detailing the quantity and specifications of structural components, aiding in project documentation and collaboration and scheduling features to annotate and document.

As the model evolves, implement structural analysis tools within Revit or export the model to structural analysis software for a more detailed analysis of the building's response to loads. Regularly validate the model against engineering codes and standards, ensuring compliance with industry regulations and best practices.



In conclusion, the creation of a structural model in Revit involves a step-by-step process, encompassing the definition of levels, addition of columns, beams, floors, foundations, and lateral load-resisting elements. The parametric nature of Revit ensures flexibility and accuracy in the representation of structural elements, while tagging and scheduling tools enhance documentation and collaboration. This systematic approach in Revit Structure serves as the foundation for a robust and accurate structural analysis, contributing to the overall success of the construction project.

2.3.6 Level Creation:

Creating structural levels for a G+2 residential project in Revit Structure involves a methodical process to establish the vertical hierarchy of the building. Begin by opening Revit and selecting the "Structural" template to access specialized tools for structural engineering. Navigate to the "Architecture" tab and use the "Level" tool from the "Datum" panel to define the first level, typically the ground floor. Specify the elevation and continue placing levels for each subsequent floor, aligning with the standard floor-to-floor heights. Customize level names in the Level Properties dialog to reflect floor numbers accurately. Utilize the "Elevations" and "Sections" tools to verify alignment and spacing, ensuring a coherent structure

For efficiency, consider copying levels using the "Copy/Monitor" tool for repetitive structures. Adjustments can be made to individual levels as needed, and periodic saving of the project is crucial to preserving changes. Updating project views allows for real-time visualization of the structural hierarchy in both 3D and 2D representations. The established levels serve as the foundation for the addition of columns, beams, and other structural elements, contributing to a comprehensive and accurate representation of the G+2 residential project. Always adhere to relevant building codes and standards to ensure the structural levels align with industry regulations and best practices, laying the groundwork for a robust and compliant structural model in Revit.

2.3.7 Footing, Column, Beam And Slab Placement:

In Revit Structure, the placement of footings, columns, Beam and slabs is a critical step in building the structural framework of a project. Begin by accessing the "Structure" tab and selecting the "Foundation" tool to add footings. Place footings by specifying their dimensions and type, considering the structural requirements. For columns, use the "Column" tool to add vertical elements that support the structure, specifying dimensions and type based on the project's needs.

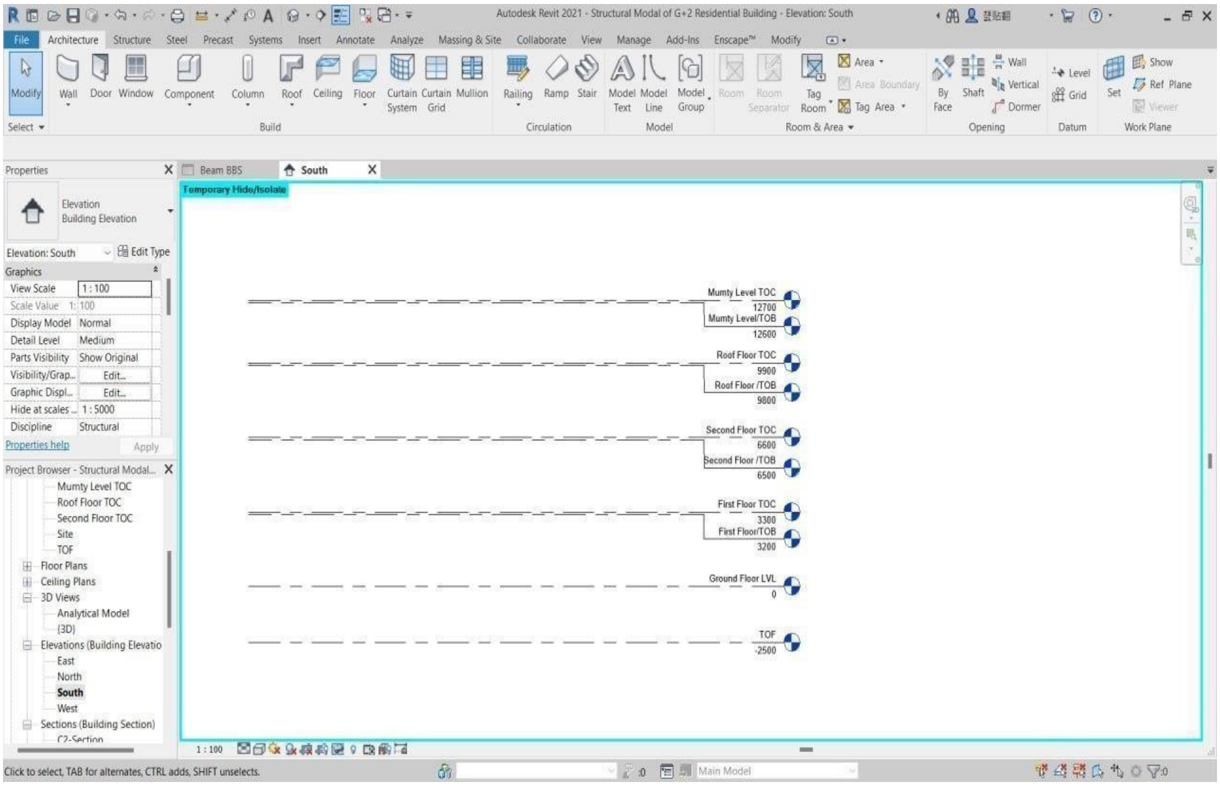


fig2.1.10 level in revit structure

Ensure proper alignment with levels and adjust properties as required.

Once footings and columns are in place, proceed to add slabs using the "Floor" tool. Specify the slab type, thickness, and location to accurately represent the structural floor elements. Consider the use of different slab types for various areas of the project, such as flat slabs or waffle slabs, to meet design and structural requirements.

Leverage the "Structural Plan" view to visualize and verify the placement of these elements in 2D, and utilize the "3D" view for a comprehensive three-dimensional representation. Periodically check and adjust the placement of footings, columns, and slabs to ensure proper alignment and structural integrity throughout the project.

This systematic approach in Revit Structure ensures the accurate representation of foundational elements, contributing to the overall success of the structural model. Always refer to industry standards and codes for precise placement and detailing of structural elements to guarantee compliance and adherence to best practices in structural engineering.

2.6.8 Creating Automatic schedule of beam slab column and footing in revit structure:

Creating an automatic schedule of beam, slab, column, and footing elements in Revit Structure is a systematic process aimed at efficiently managing and organizing the structural components within your project. To embark on this endeavour, one must ensure that the project's structural framework is well-defined and properly modelled, encompassing beams, slabs, columns, and footings.

In the Revit interface, under the "View" tab, select "Schedules" to initiate the scheduling process. Create new schedules for each category—such as "Structural Framing" for beams, "Floors" for slabs, "Structural Columns" for columns, and "Structural Foundations" for footings.

In configuring the schedules, choose relevant parameters like family and type, material, dimensions, and other pertinent information. Customize the schedule appearance, applying sorting and grouping options to organize data based on criteria like structural types or loadbearing capacity. Leverage Revit's formula capabilities to calculate and display additional information, enhancing the schedule's functionality. Implement filters and sorting/grouping features for a comprehensive overview, and utilize shared parameters for project-specific information.

Automation is achieved by enabling the "Automatic Update" option, ensuring real-time reflection of model modifications in the schedule. Create separate schedules for different construction phases or work packages to facilitate project management. Utilize the

"Export" feature to generate schedule reports in various formats for collaboration with stakeholders. Populate all necessary parameters for each structural element, resolving any model warnings or errors. Implement shared parameters for project-specific information and regularly review and validate the schedule data for accuracy

Enhance clarity through formatting options, including text styles, cell shading, and conditional formatting. Cross- reference the schedule with the model to identify discrepancies or missing information. Link data between different schedules to maintain a cohesive representation of the structural system. Explore the "Group and Associate" options for consistent handling of repetitive structural components. Consider using "Scope Boxes" and "View Templates" for focused analysis and consistent visual styles.

Ensure schedules are synchronized with team members using Revit's "Worksharing" features. Apply filters to highlight specific elements based on criteria such as material type or load capacity. Integrate 3D views and annotations within the schedule sheet for visual representation. Collaborate with architects and MEP engineers to coordinate schedules. Regularly update the Revit software to benefit from the latest features. Customize the schedule appearance by adjusting fonts, colors, and line weights. Incorporate user-defined parameters for project-specific information. Document assumptions and constraints directly within the schedule.

Leverage Revit's "Design Options" for exploring alternative structural configurations. Utilize "Model Groups" to organize complex structural assemblies. Implement "Family Types" to accommodate various configurations within the same schedule. Coordinate with the project team to address discrepancies identified during schedule reviews. Utilize "Global Parameters" to control and adjust multiple aspects of the schedule. Implement Revit's "Design Validation" for structural analysis checks within the model. Regularly update the schedule to reflect design changes, scope modifications, or client requirements. In summary, this comprehensive approach ensures the creation of an automated and efficient structural schedule in Revit for your project.

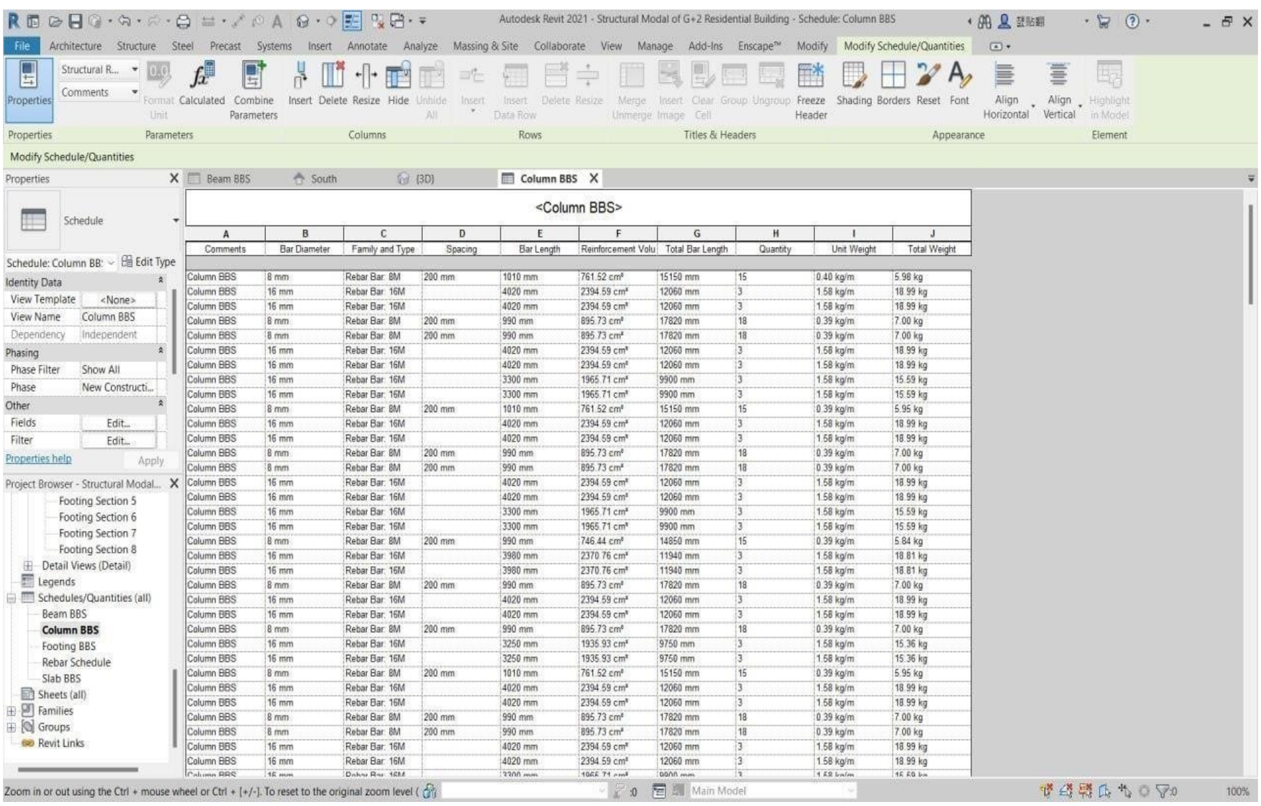


fig2.1.11 structural schedule of column

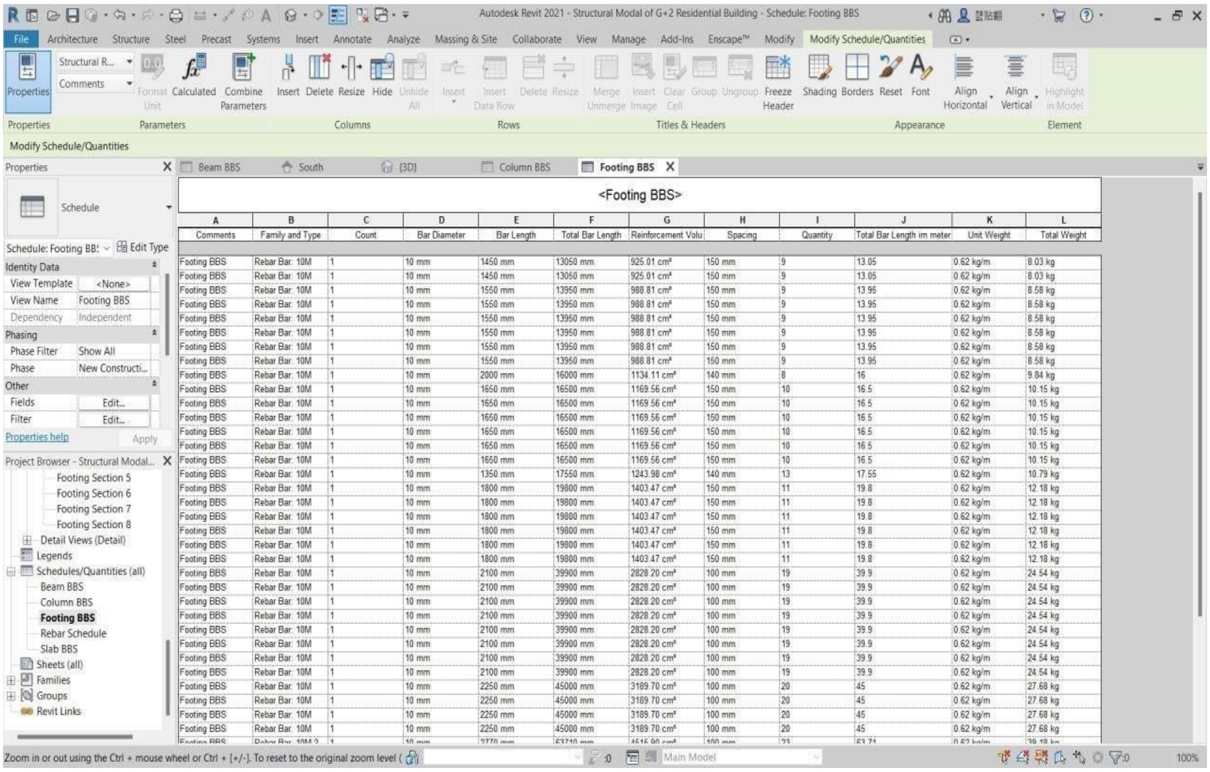


Fig2.1.12 structural schedule of footing

Table no 5. Column Steel Quantity from Revit

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of Column from Revit	Kg	2754.4

Table no 6. Footing Steel Quantity From Revit

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of Footing from Revit	Kg	932.1

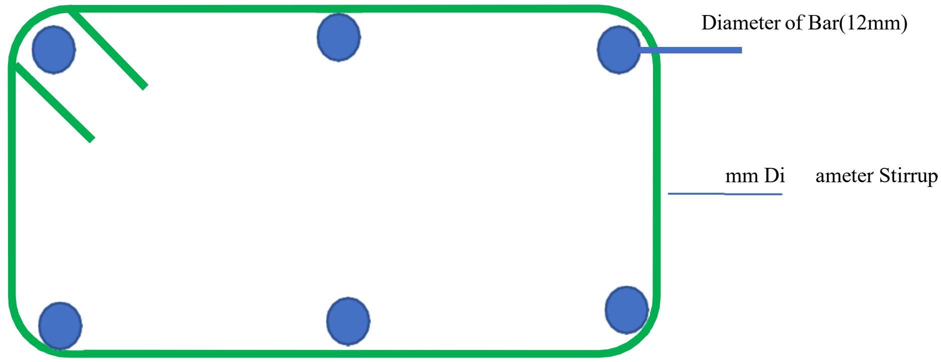
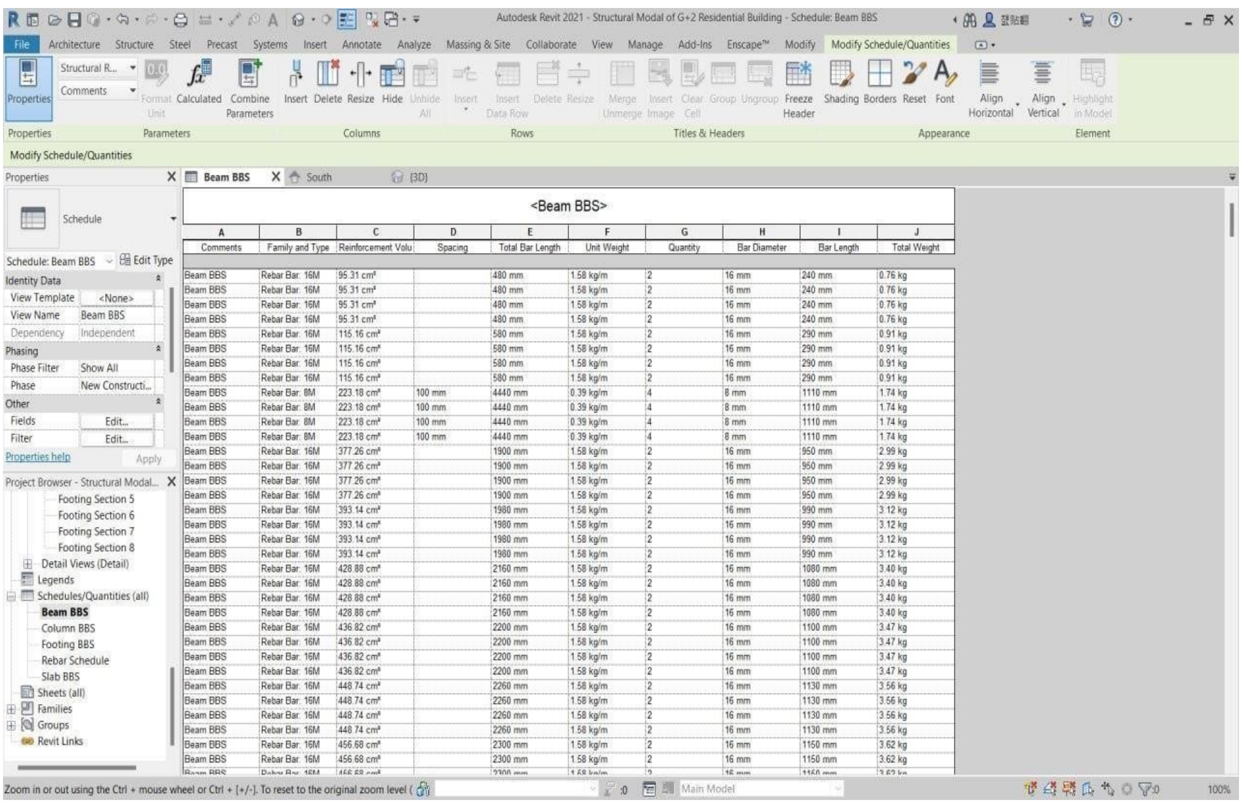


Fig2.1.13structural detail of column



<Beam BBS>

A	B	C	D	E	F	G	H	I	J
Comments	Family and Type	Reinforcement Volu	Spacing	Total Bar Length	Unit Weight	Quantity	Bar Diameter	Bar Length	Total Weight
Beam BBS	Rebar Bar: 16M	95.31 cm³		480 mm	1.58 kg/m	2	16 mm	240 mm	0.76 kg
Beam BBS	Rebar Bar: 16M	95.31 cm³		480 mm	1.58 kg/m	2	16 mm	240 mm	0.76 kg
Beam BBS	Rebar Bar: 16M	95.31 cm³		480 mm	1.58 kg/m	2	16 mm	240 mm	0.76 kg
Beam BBS	Rebar Bar: 16M	95.31 cm³		480 mm	1.58 kg/m	2	16 mm	240 mm	0.76 kg
Beam BBS	Rebar Bar: 16M	115.16 cm³		580 mm	1.58 kg/m	2	16 mm	290 mm	0.91 kg
Beam BBS	Rebar Bar: 16M	115.16 cm³		580 mm	1.58 kg/m	2	16 mm	290 mm	0.91 kg
Beam BBS	Rebar Bar: 16M	115.16 cm³		580 mm	1.58 kg/m	2	16 mm	290 mm	0.91 kg
Beam BBS	Rebar Bar: 16M	115.16 cm³		580 mm	1.58 kg/m	2	16 mm	290 mm	0.91 kg
Beam BBS	Rebar Bar: 8M	223.18 cm³	100 mm	4440 mm	0.39 kg/m	4	8 mm	1110 mm	1.74 kg
Beam BBS	Rebar Bar: 8M	223.18 cm³	100 mm	4440 mm	0.39 kg/m	4	8 mm	1110 mm	1.74 kg
Beam BBS	Rebar Bar: 8M	223.18 cm³	100 mm	4440 mm	0.39 kg/m	4	8 mm	1110 mm	1.74 kg
Beam BBS	Rebar Bar: 8M	223.18 cm³	100 mm	4440 mm	0.39 kg/m	4	8 mm	1110 mm	1.74 kg
Beam BBS	Rebar Bar: 16M	377.26 cm³		1900 mm	1.58 kg/m	2	16 mm	950 mm	2.99 kg
Beam BBS	Rebar Bar: 16M	377.26 cm³		1900 mm	1.58 kg/m	2	16 mm	950 mm	2.99 kg
Beam BBS	Rebar Bar: 16M	377.26 cm³		1900 mm	1.58 kg/m	2	16 mm	950 mm	2.99 kg
Beam BBS	Rebar Bar: 16M	377.26 cm³		1900 mm	1.58 kg/m	2	16 mm	950 mm	2.99 kg
Beam BBS	Rebar Bar: 16M	393.14 cm³		1980 mm	1.58 kg/m	2	16 mm	990 mm	3.12 kg
Beam BBS	Rebar Bar: 16M	393.14 cm³		1980 mm	1.58 kg/m	2	16 mm	990 mm	3.12 kg
Beam BBS	Rebar Bar: 16M	393.14 cm³		1980 mm	1.58 kg/m	2	16 mm	990 mm	3.12 kg
Beam BBS	Rebar Bar: 16M	393.14 cm³		1980 mm	1.58 kg/m	2	16 mm	990 mm	3.12 kg
Beam BBS	Rebar Bar: 16M	428.88 cm³		2160 mm	1.58 kg/m	2	16 mm	1080 mm	3.40 kg
Beam BBS	Rebar Bar: 16M	428.88 cm³		2160 mm	1.58 kg/m	2	16 mm	1080 mm	3.40 kg
Beam BBS	Rebar Bar: 16M	428.88 cm³		2160 mm	1.58 kg/m	2	16 mm	1080 mm	3.40 kg
Beam BBS	Rebar Bar: 16M	428.88 cm³		2160 mm	1.58 kg/m	2	16 mm	1080 mm	3.40 kg
Beam BBS	Rebar Bar: 16M	436.82 cm³		2200 mm	1.58 kg/m	2	16 mm	1100 mm	3.47 kg
Beam BBS	Rebar Bar: 16M	436.82 cm³		2200 mm	1.58 kg/m	2	16 mm	1100 mm	3.47 kg
Beam BBS	Rebar Bar: 16M	436.82 cm³		2200 mm	1.58 kg/m	2	16 mm	1100 mm	3.47 kg
Beam BBS	Rebar Bar: 16M	436.82 cm³		2200 mm	1.58 kg/m	2	16 mm	1100 mm	3.47 kg
Beam BBS	Rebar Bar: 16M	448.74 cm³		2260 mm	1.58 kg/m	2	16 mm	1130 mm	3.56 kg
Beam BBS	Rebar Bar: 16M	448.74 cm³		2260 mm	1.58 kg/m	2	16 mm	1130 mm	3.56 kg
Beam BBS	Rebar Bar: 16M	448.74 cm³		2260 mm	1.58 kg/m	2	16 mm	1130 mm	3.56 kg
Beam BBS	Rebar Bar: 16M	448.74 cm³		2260 mm	1.58 kg/m	2	16 mm	1130 mm	3.56 kg
Beam BBS	Rebar Bar: 16M	456.68 cm³		2300 mm	1.58 kg/m	2	16 mm	1150 mm	3.62 kg
Beam BBS	Rebar Bar: 16M	456.68 cm³		2300 mm	1.58 kg/m	2	16 mm	1150 mm	3.62 kg

Fig2.1.14 structural schedule of beam

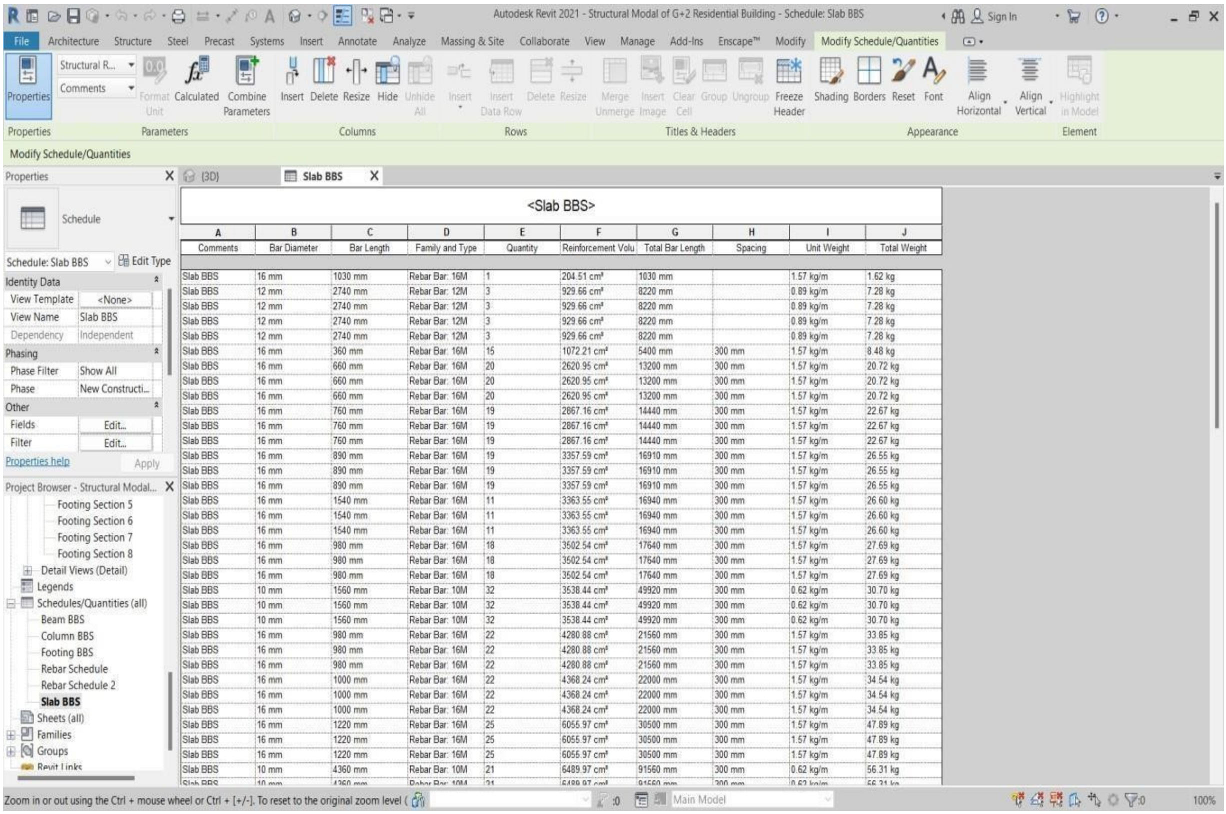


Fig2.1.15 structural schedule of Slab

Table no 7. Beam Steel Quantity From Revit

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of Beam from Revit	Kg	8087.75

Table no 8. Slab Steel Quantity From Revit

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of Slab from Revit	Kg	10752.58

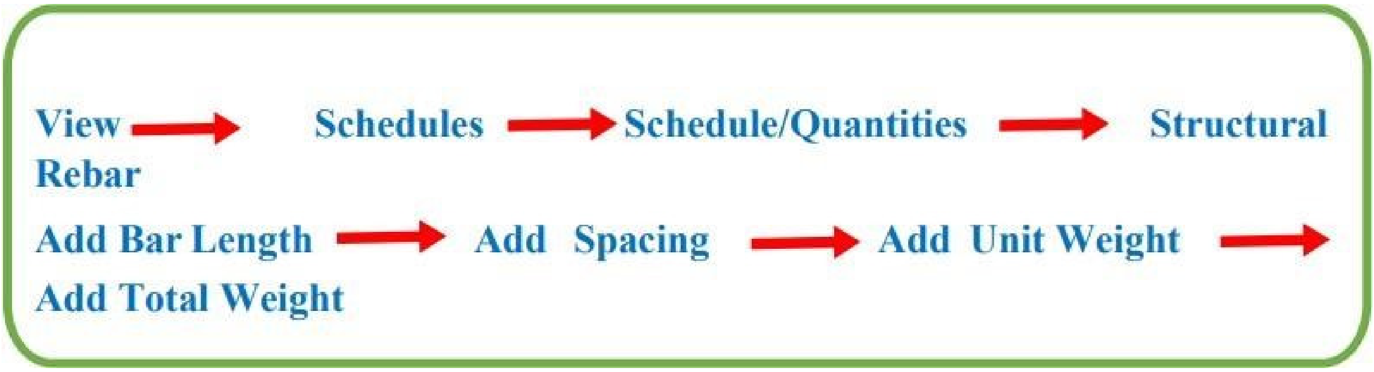


Fig2.1.16 flow diagram for calculating structural rebar schedule in Revit

2.3.9 Rebar Placement and Automatic estimation of rebar in Revit:

In Revit Structure, rebar placement is a crucial aspect of reinforcing concrete elements within a building model. To initiate the process, one must have a well-defined structural framework, including columns, beams, and slabs. Revit provides a dedicated "Rebar" toolset to facilitate the detailing and placement of reinforcement within these elements. Users can select the appropriate rebar shapes, sizes, and spacing configurations based on design requirements. The "Rebar" tool allows for the creation of reinforcement layouts by defining cover, hooks, and constraints. Users can specify reinforcement parameters such as number, distribution, and orientation, ensuring compliance with structural design codes.

Automatic generation of rebar cages or individual bars can be achieved by associating them with the host structural elements. Revit's "Path Reinforcement" feature enables the creation of continuous reinforcement along curved or irregular paths.

Users can also utilize the "Area Reinforcement" tool for detailing reinforcement within slabs, ensuring proper distribution of reinforcing bars in specified regions. The software's 3D modeling capabilities allow for a comprehensive visualization of the rebar placement, aiding in clash detection and coordination with other building components. Through the "Rebar Constraints" functionality, users can enforce specific constraints to maintain the intended structural integrity.

2.4 Rebar Placement:

Revit's parametric capabilities extend to rebar scheduling, allowing users to generate accurate quantity takeoffs and construction documentation. Rebar placement in Revit facilitates an efficient and collaborative approach to reinforcing concrete elements, ensuring accurate detailing and adherence to design specifications. Regular coordination with structural engineers and continuous updates to the rebar model guarantee alignment with evolving project requirements. In essence, Revit provides a robust platform for precise and systematic rebar placement, enhancing the overall efficiency and accuracy of the structural detailing process.

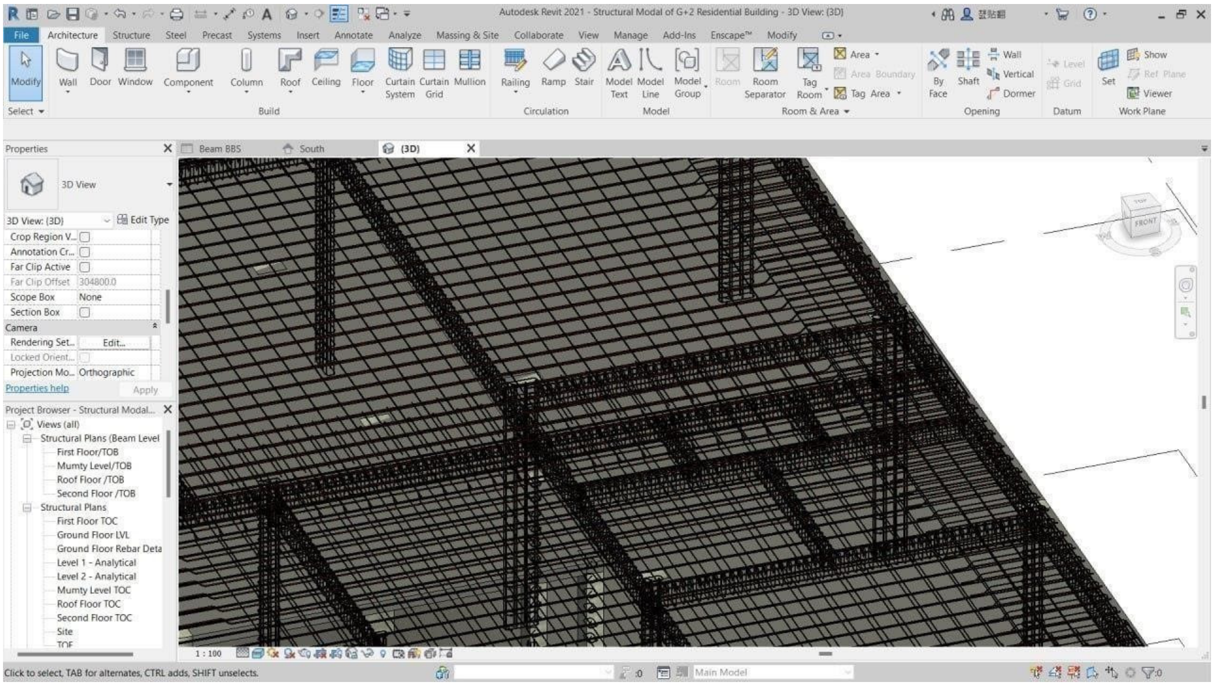


Fig2.4.1 rebar placement-1 (Slab)

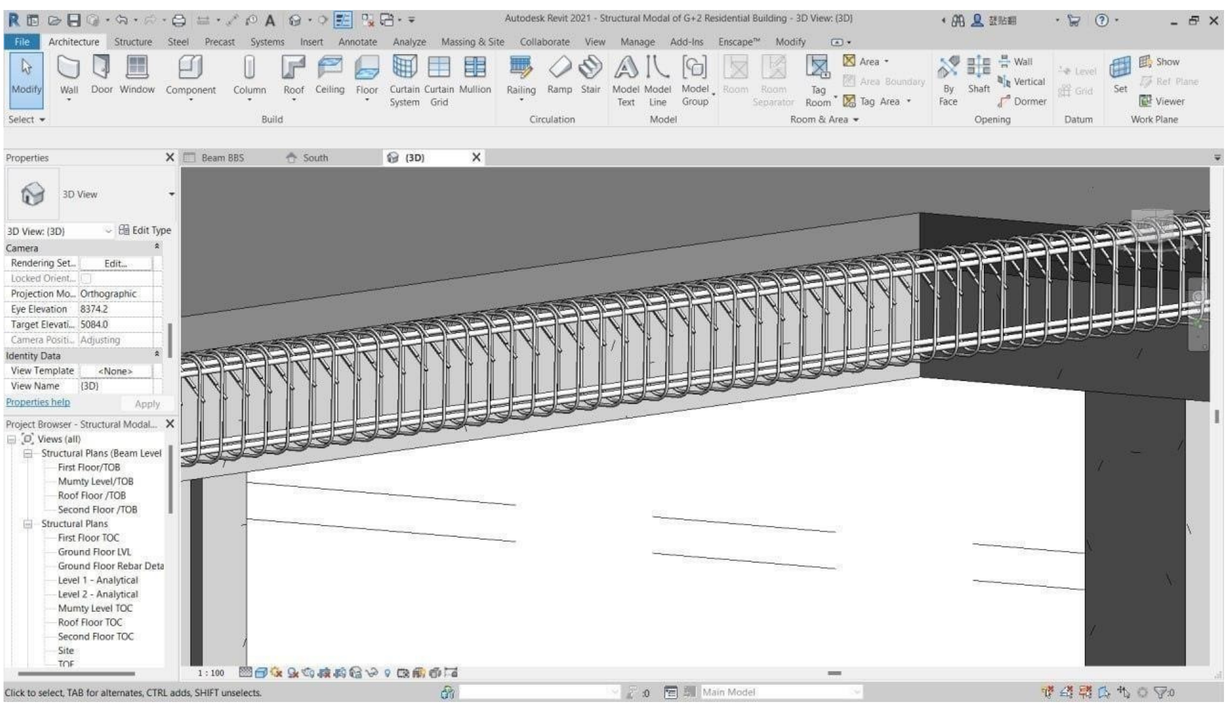


Fig2.4.2 rebar placement-2 (Beam)

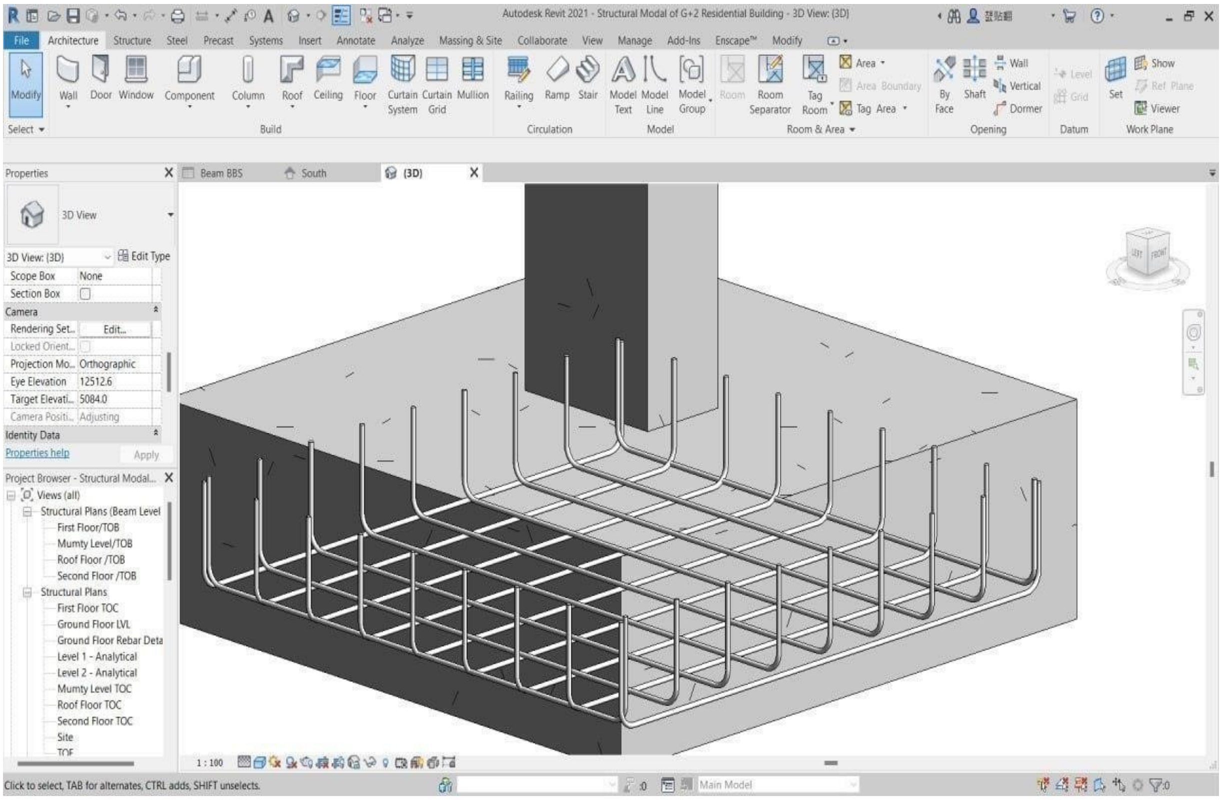


Fig2.4.3 rebar placement-3 (Footing)

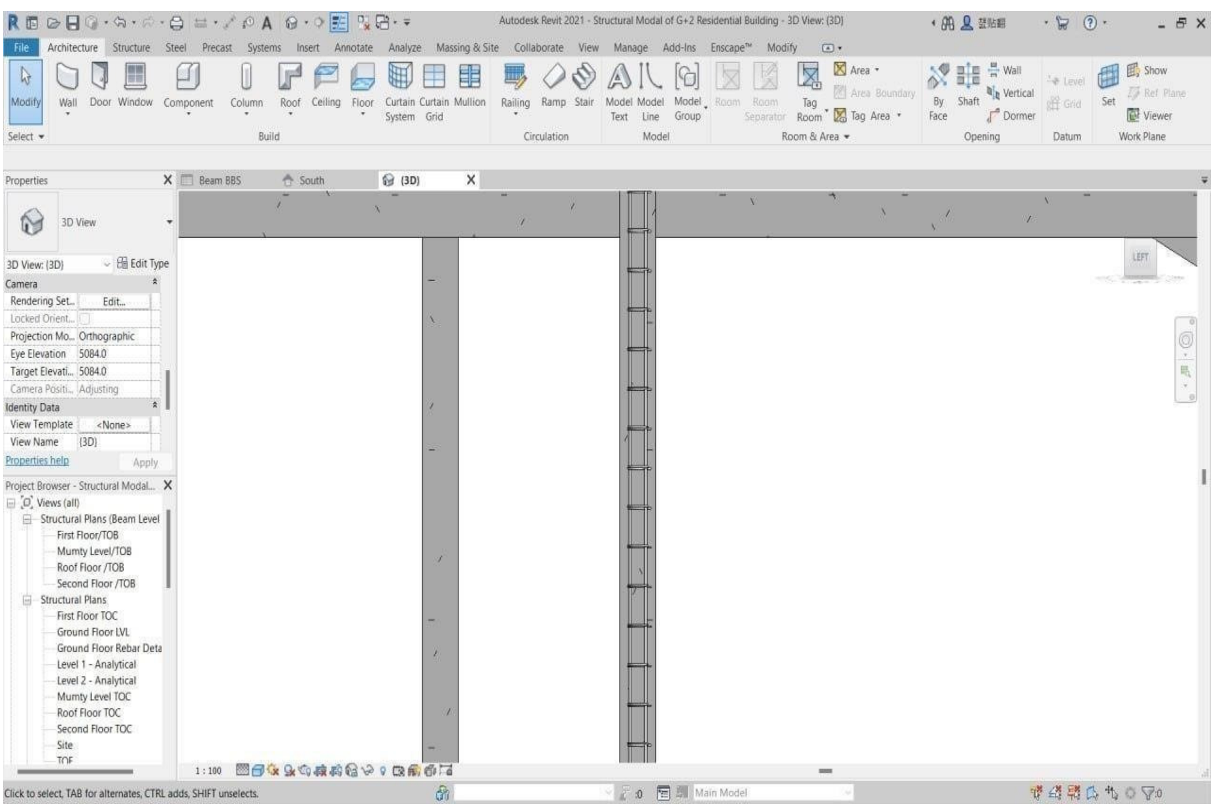


Fig2.4.4 rebar placement-4 (Column)

2.5 Manual Estimation of structural rebar in MS Excel: Manual estimation of structural rebar in MS Excel involves a systematic process within a spreadsheet environment to calculate the quantity, lengths, and dimensions of reinforcing bars required for a construction project. Begin by creating a detailed list of structural elements requiring reinforcement, such as columns, beams, and slabs, specifying dimensions, spacing, and bar types. In Excel, organize this information into columns, representing each element's attributes.

For each structural element, calculate the total length of rebar required based on the element's dimensions and specified spacing. Utilize formulas in Excel to automate these calculations and ensure accuracy. Incorporate factors such as laps, hooks, and overlaps in the formulas to reflect real-world construction practices. Integrate constants or variables representing the type and size of reinforcing bars, considering project-specific requirements and design codes.

Implement additional Excel sheets for different categories of structural elements to maintain a systematic and organized estimation process. Use conditional formatting or color- coding to visually distinguish different types of reinforcing bars, facilitating clarity and ease of interpretation. Employ Excel functions such as SUM to calculate the total quantity of each bar type across all structural elements.

Include contingency factors or waste allowances in your calculations to accommodate unforeseen variations in rebar lengths. Clearly label and document assumptions, formulas, and variables within the Excel spreadsheet to enhance transparency and facilitate collaboration with project stakeholders.

Create a summary sheet that consolidates the estimated quantities for all reinforcing bars, providing an overview of the total rebar requirements for the entire project. Incorporate unit prices or costs for each type of reinforcing bar to calculate the total cost of materials. Regularly review and update the Excel spreadsheet to accommodate design changes, ensuring that the estimation remains accurate throughout the project lifecycle. Utilize Excel's sorting and filtering capabilities to organize and analyze data efficiently. Enhance the aesthetics and professionalism of the Excel estimation by applying formatting options, such as borders, fonts, and cell colors. Consider using headers and footers to include project details, revision numbers, and other relevant information.

Implement data validation in Excel to ensure that input values conform to specified criteria, reducing the risk of errors in the estimation process. Include cell comments or annotations to provide additional context or explanations for specific calculations. Incorporate Excel's data linking features to establish connections between different sheets or external data sources, facilitating seamless updates and consistency across the estimation model. Implement version control practices to track changes and revisions in the Excel spreadsheet.

Collaborate with structural engineers and other project stakeholders to validate assumptions, methodologies, and quantities in the manual estimation. Utilize Excel's collaboration features, such as comments or shared workbooks, to streamline communication and feedback.Ensure that the Excel spreadsheet adheres to industry standards and is aligned with project specifications. Regularly refer to relevant design codes and standards to validate the accuracy of your manual estimation.Validate the manual estimation against benchmarks or historical data from similar projects to enhance its reliability. Perform sensitivity analyses by adjusting variables to assess the impact on the estimated quantities and costs.

Document any challenges, constraints, or uncertainties associated with the manual estimation process in Excel, providing a comprehensive record for future reference. Consider creating a documentation sheet within the Excel file to capture these details. Implement error-checking routines or validation rules in Excel to identify and rectify potential errors in the estimation model. Utilize conditional formatting to highlight discrepancies or outliers in the data.

In conclusion, manual estimation of structural rebar in MS Excel involves a meticulous and organized approach, leveraging Excel's formulas, functions, and formatting features. The spreadsheet should be transparent, adaptable to changes, and subject to continuous validation.

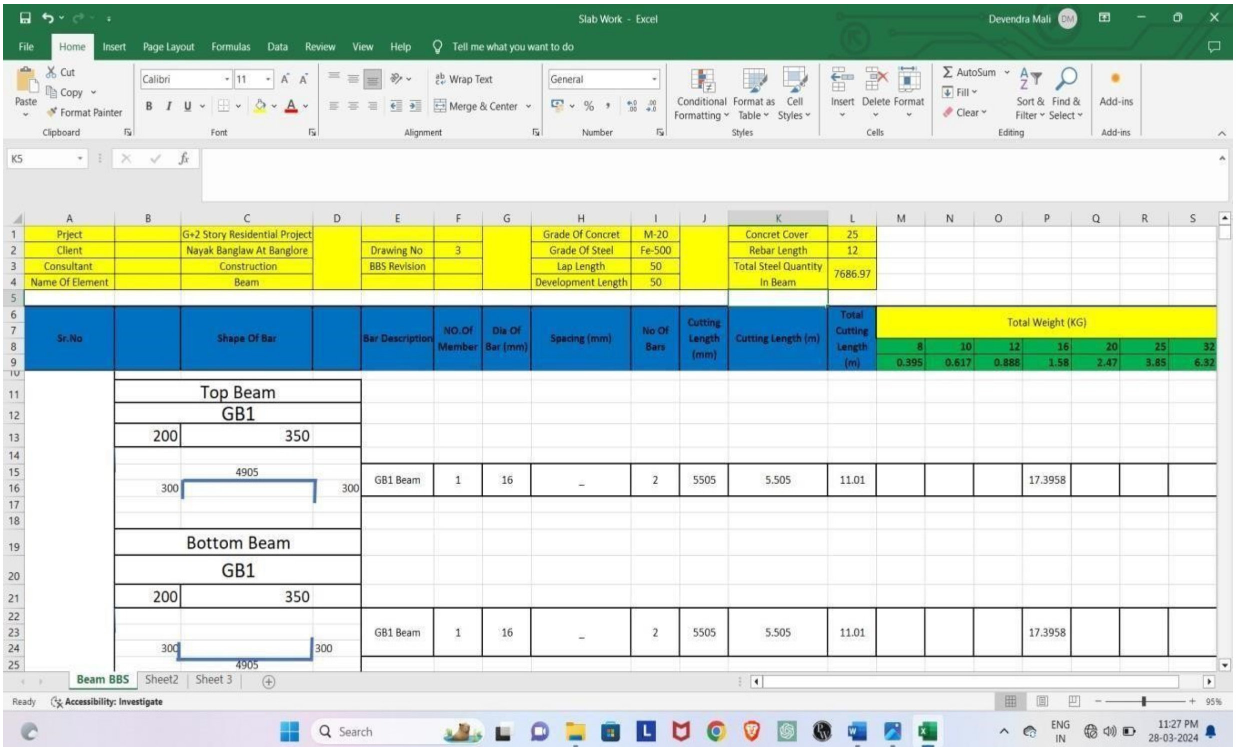


Fig2.5.1 beam estimation

Table no 9. Beam Steel Quantity From MS Excel

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of beam from MS Excel	Kg	7686.96

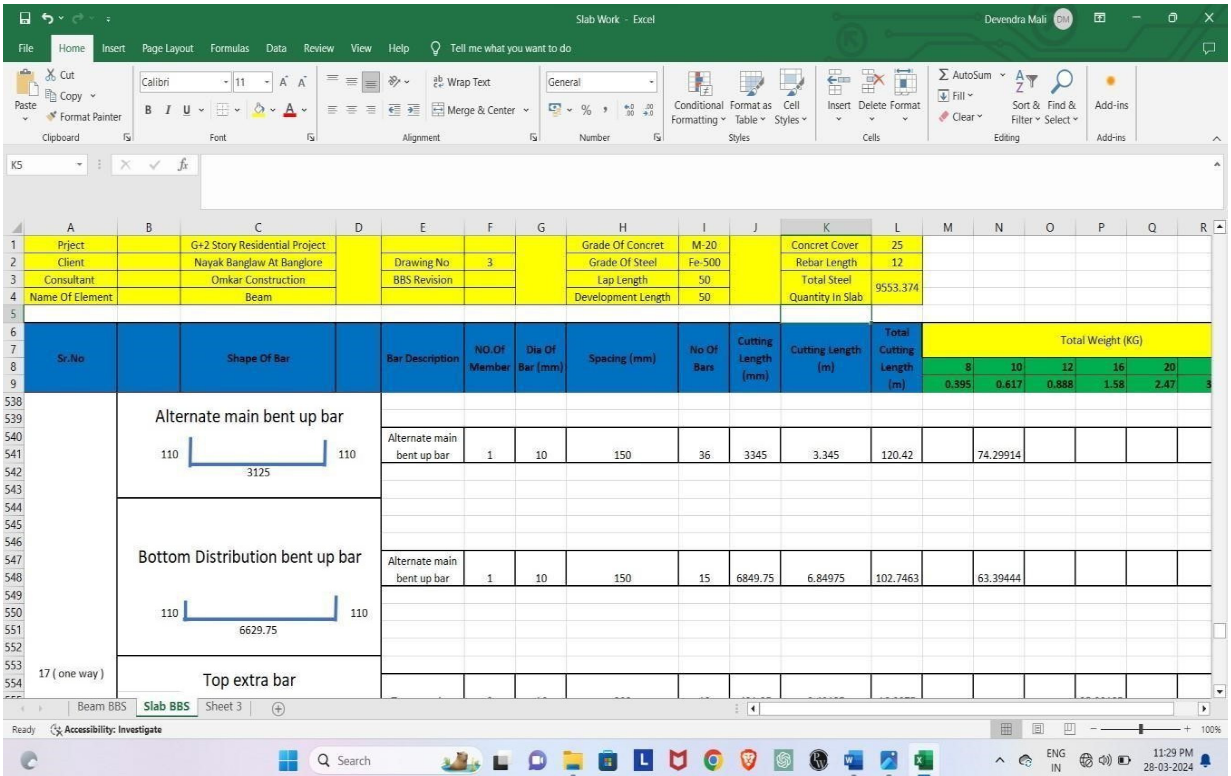


Fig2.5.2 slab estimation

Table no 10. Slab Steel Quantity From MS Excel

Sr. No	Description Of Item	Formula for BBS of Slab	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of Slab from MS Excel	Main bar =L-2cover+18db Distribution bar=L-2 cover+ 18db	Kg	10553.27

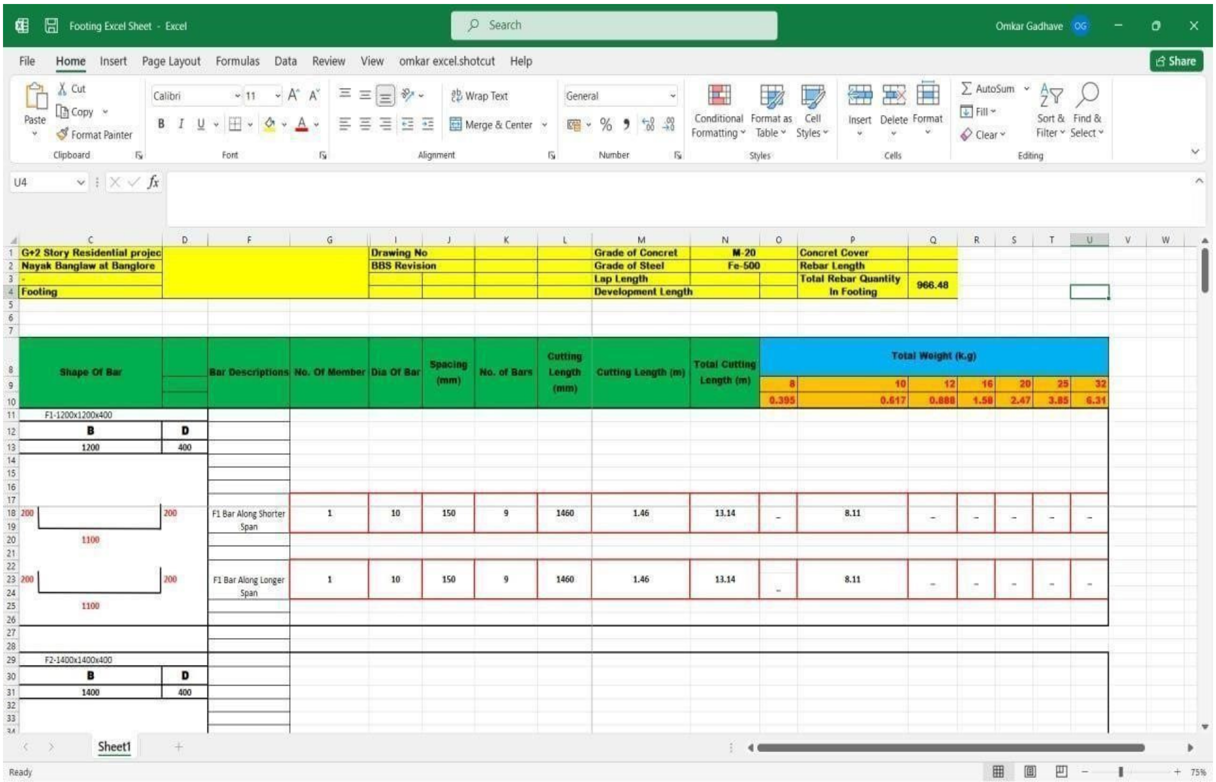


Fig2.5.4 footing estimation

Table no 11. Footing Steel Quantity From MS Excel

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of footing from MS Excel	Kg	966.48

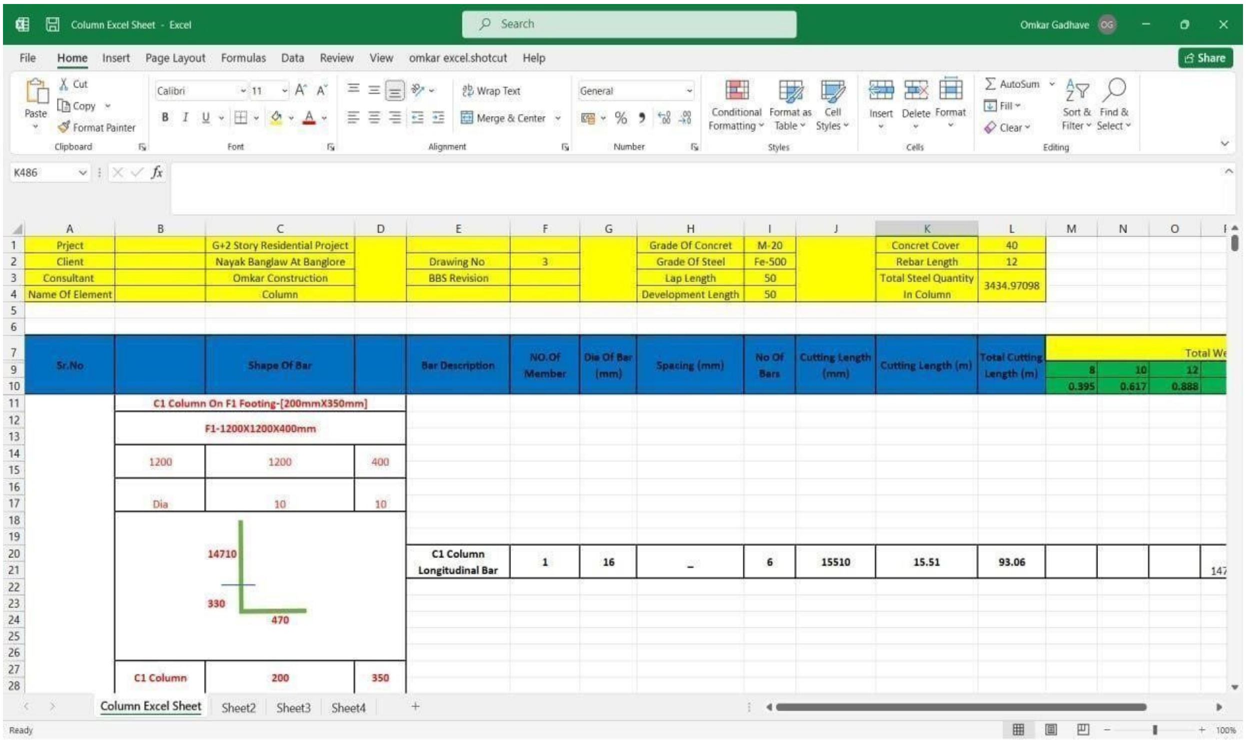


Fig2.5.5 column estimation

Table no 12. Column Steel Quantity From MS Excel

Sr. No	Description Of Item	Unit Of Quantity	Total Quantity Of Steel
1	Steel Quantity Of column from MS Excel	Kg	3434.9

3. RESULTS AND RESULTS DISCUSSSION

3.1 Results

Table 13. Result table

SR. NO	DESCRIPTION OF ITEMS	ESTIMATION FROM REVIT (KG)	ESTIMATION FROM EXCEL (KG)	REMAREK (% VARIATION)
1.	Footing Reinforcement Quantity	932.1 (kg)	966.48 (kg)	3.68%(less)
2.	Column Reinforcement Quantity	2754.4 (kg)	3434.9 (kg)	24.70%(less)
3.	Beam Reinforcement Quantity	8087.75 (kg)	7686.96 (kg)	5.21%(more)
4.	Slab Reinforcement Quantity	10752.58 (kg)	9553.37 (kg)	12.55%(more)
5.	Bricks Quantity	105717 (in no.)	103360 (in no.)	2.28%(more)

3.2 Result Discussion:

Footing: -

Footing Reinforcement from Revit and excel is 932.1 kg and 966.48 kg respectively. Footing Reinforcement from revit is 3.68% less than Excel. we have full control over excel but in some portion of revit we do not have control such as Bend Deduction, hooks, and additional reinforcement for corner and other structural need. The minor or small difference occurs due to this and this minor difference is occurred in each footing hence it results into higher value. That higher value is accepted. It is just few percent higher or lower than excel.

Column: -

Column Reinforcement from Revit and excel is 2754.4kg and 3434.9kg respectively. Column Reinforcement from revit is 24.70% less than Excel. we have full control over excel but in some portion of revit we do not have control such as Bend Deduction, hooks, and additional reinforcement for corner and other structural need. The minor or small difference occurs due to this and this minor difference is occurred in each Column hence it results into higher value. That higher value is accepted. It is just few percent higher or lower than excel.

Beam: -

Beam Reinforcement from Revit and excel is 8087.5 kg and 7686.96 kg respectively. Beam Reinforcement from revit is 5.21% more than Excel. we have full control over excel but in some portion of revit we do not have control such as Bend Deduction, hooks, and additional reinforcement for corner and other structural need. The minor or small difference occurs due to this and this minor difference is occurred in each Beam hence it results into higher value. That higher value is accepted. It is just few percent higher or lower than excel.

Slab: -

Slab Reinforcement from Revit and excel is 10752.58 kg and 9553.37 kg respectively. Slab Reinforcement from Revit is 12.55% more than Excel. we have full control over excel but in some portion of Revit we do not have control such as Bend Deduction, hooks, and additional reinforcement for corner and other structural need. The minor or small difference occurs due to this and this minor difference is occurred in each slab hence it results into higher value. Slab include various corner portion or some alternate bent up bar. In this there is some variation in reinforcement quantity. That higher value is accepted. It is just few percent higher or lower than excel.

Brick: -

Brick Quantity from Revit And Excel is 105717 (no) and 103360 (no) respectively. Brick Quantity From Revit is 2.28 % more than Excel. This is due to following reason :

1) For Calculation of brick quantity in Revit it deducts door and window area automatically
2) For Calculation of brick quantity in Revit it deducts beam area automatically.
3) For Calculation of brick quantity in Revit it deducts column area automatically. Due to this the minor difference is occurred in Revit and our brick estimation is for G+2 Residential Building Hence this results into higher valuable but this higher value is acceptable. It just few % higher or lower than xcel

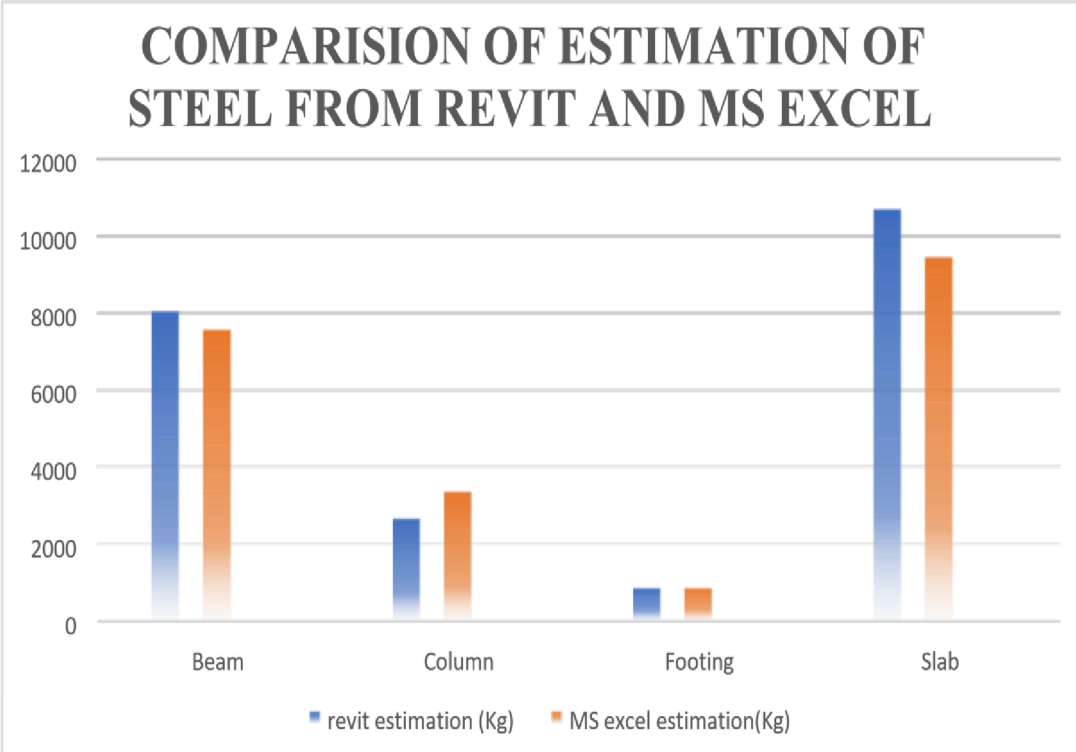


Chart-1

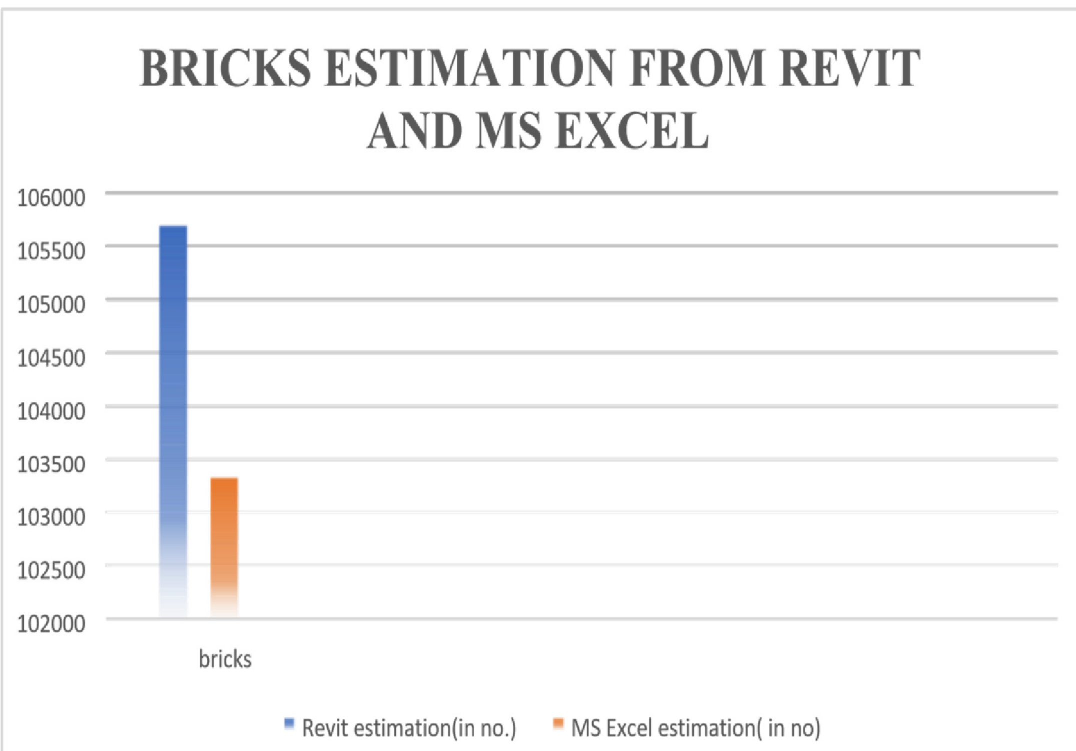


Chart-2

3.3 Reasons for difference in Revit and Excel estimation

1. Model Detailing and Assumptions

Revit: The accuracy of the reinforcement estimation depends on the level of detail in the BIM model. If the Revit model doesn't fully account for all reinforcement details—such as hooks, bends, and additional reinforcement for corners or other structural needs—the estimate might be lower.

Excel: Excel calculations are based on manual inputs that can include or exclude certain assumptions about the reinforcement, such as lap lengths, splice requirements, and wastage, which might not be fully accounted for in the Revit model.

2. Calculation Methodologies

Revit: Uses the physical properties and exact dimensions from the 3D model to calculate the reinforcement quantity. This method tends to be more precise, directly reflecting the modeled elements.

Excel: Relies on formulas that are manually entered and can include additional factors or conservative assumptions for reinforcement estimation, potentially leading to a slightly higher estimate.

3. Human Error and Data Input

Any manual data entry, whether in Revit (during modeling) or Excel (in calculations), is susceptible to human error. Misinterpretation of design drawings or incorrect input values can cause discrepancies.

Excel calculations might include a buffer or rounding up to account for uncertainties, leading to a higher estimate.

4. Material Waste and Handling

Excel: Estimators often include allowances for waste and handling losses in their calculations, which might not be automatically accounted for in Revit estimates.

Revit: Unless explicitly modeled or included in the calculation parameters, waste factors might be underrepresented, leading to a lower quantity estimate.

5. Overlap and Splicing of Rebars

The treatment of overlaps, splices, and anchorage lengths can differ. Revit calculates based on the modeled details, which might not always include additional lengths for overlaps unless specifically accounted for.

Excel spreadsheets can more easily incorporate standard overlap lengths and splicing requirements based on codes, which might explain the higher figure.

6. Design Revisions

If the Revit model isn't updated to reflect the latest design revisions but the Excel sheet is, or vice versa, discrepancies can arise due to differences in the version of the design being estimated.

Resolving Discrepancies

To reconcile these differences, review both the Revit model and the Excel calculations to ensure that: They are based on the same design version. Assumptions and calculation methodologies are aligned.

All necessary details (including waste, splicing, and laps) are appropriately accounted for in both methods.

By closely examining these aspects, you can identify the reasons behind the discrepancy and adjust the estimates accordingly for more accurate and consistent result

3.4 Advantages of Revit over Excel:

1. Integrated Building Information Model (BIM): Revit is a BIM software, which means it allows users to create a 3D model of a building and attach data to the elements within that model. This integrated approach provides a more accurate representation of the project and facilitates better estimations compared to Excel, which typically relies on flat data tables.

2. Parametric Modeling: Revit allows for parametric modeling, where changes to one aspect of the model automatically update related elements. This feature ensures that estimations remain consistent and up-to-date as the design evolves, reducing errors and saving time compared to manually updating Excel spreadsheets.

3. Quantification: Revit provides tools for automatically quantifying materials and components based on the 3D model. This automation streamlines the estimation process and reduces the risk of errors that may occur when manually entering data into Excel.

4. Visualization: Revit offers visualization capabilities that allow users to see the project in 3D, enhancing understanding and communication of the design intent. This can be particularly useful for estimators to visualize quantities and better comprehend how various elements contribute to the overall project.

5. Integration with Cost Estimating Software: Revit can integrate with specialized cost estimating software, allowing for seamless transfer of data between the two platforms. This integration enables estimators to leverage the advanced features of Revit for modeling while still benefiting from the comprehensive estimating capabilities of dedicated software.

Overall, using Revit for estimations offers increased accuracy, efficiency, and integration compared to Excel, particularly for complex construction projects where precise quantification and modelling are essential.

4. Conclusion:

1. Thorough of study of standardized methodology for automatic construction material estimation in Revit for G+2 building was done
2. According to study of project, footing reinforcement from Revit is 3% less than excel. Column reinforcement from Revit is 24.70% less than excel. Minor difference occurs in each beam hence it results into higher value. Slab reinforcement from Revit 12.55% more than excel. Brick quantity from Revit is 2.28% more than excel due the deduction of door window in Revit difference as comparative manual. Revit software is more accurate and it required less time for estimation than excel. Revit is more reliable than excel.
3. Thorough the accuracy of Revit estimation by comparing them against manually calculated excel estimates
4. We conclude various factors contributing to difference between Revit and manual estimation such as bend deduction, hook length, development length, clear cover and reinforcement at corner
5. By using Revit software, we can save time for calculating estimation of brick and bar bending schedule (BBS) footing, column, beam and slab. In Revit we just have to do modelling then we get estimation in very less time as compared to excel

4.1Future Scope:

Quantifying the future scope of Revit automation versus Excel manual estimation in a G+2 residential building project involves considering various factors such as technological advancements, industry trends, efficiency gains, and potential challenges. Here are some future scopes to consider:

1) Advanced Integration with Building Information modelling (BIM) Platforms: As BIM technology evolves, there will likely be deeper integration between Revit and other BIM platforms. This integration could enable seamless data transfer between different phases of construction projects, facilitating more accurate and efficient estimation processes.
2) AI and Machine Learning Applications: Future advancements in AI and machine learning could revolutionize estimation processes. These technologies could be integrated with Revit automation to analyse historical data, identify patterns, and make more accurate predictions regarding material quantities, costs, and project timelines.
3) Cloud-Based Collaboration and Data Sharing: Cloud computing is already transforming the construction industry by enabling real-time collaboration and data sharing among project stakeholders. Future developments in cloud technology could enhance the scalability and accessibility of Revit automation tools, allowing estimators to work collaboratively on largescale residential projects with greater ease.
4) Enhanced Visualization and 3D modelling: As virtual reality (VR) and augmented reality (AR) technologies become more prevalent in the construction industry, estimators may leverage these tools to visualize and interact with building models in real-time. This could lead to more accurate estimations and better communication among project teams.
5) Sustainability and Lifecycle Cost Analysis: With increasing emphasis on sustainability and environmental responsibility, future estimators may need to consider factors such as energy efficiency, carbon footprint, and lifecycle costs when quantifying building materials. Revit automation tools could be enhanced to incorporate sustainability metrics and provide more comprehensive cost analyses.
6) Standardization and Regulatory Compliance: As building codes and regulations continue to evolve, estimators will need to ensure compliance with the latest standards and requirements. Revit automation can help streamline this process by automatically generating reports and documentation that demonstrate compliance with relevant regulations.
7) Training and Skill Development: As Revit automation becomes more widespread, there will be a growing demand for skilled professionals who can effectively utilize these tools. Future scope includes the development of training programs and certifications to equip estimators with the necessary skills to leverage Revit automation effectively.
8) Risk Management and Contingency Planning: Future estimators may rely on Revit automation to conduct risk assessments and develop contingency plans for unforeseen events such as material shortages, labour strikes, or design changes. By simulating different scenarios and analysing potential risks, estimators can mitigate project delays and cost overruns.

In summary, the future scope of quantifying building in Revit automation versus Excel manual estimation in G+2 residential building projects is promising, with potential advancements in technology, collaboration, sustainability, and risk management driving greater efficiency and accuracy in the estimation process. However, it will be essential for industry professionals to stay abreast of these developments and continually adapt their skills and processes to leverage the full potential of Revit automation.

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