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A BIM-BASED PROBLEM-SOLVING ANALYSIS OF CONSTRUCTION-RELATED ISSUES AND CLASH DETECTION

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Abstract: The construction industry is significantly more complicated than it was in the past as a direct result of the high number of people engaged and the amount of documentation required. In the context of the Indian economy, the majority of projects are still being carried out using a conventional manner, which results in a great deal of difficulty during the execution phase. These difficulties include delays in construction, material waste, cost overruns, poor quality of work, and the identification of confrontations. The conventional methods do not consider the spatial aspects of the building process, nor are they immediately linked to a model of the structure being constructed. BIM is a potential tool in the architecture, engineering, and construction (AEC) industry that can minimize such problems and clashes in construction by making recommendations. Within the scope of this project, BIM is being utilized for the purpose of conducting an analysis of a G+1 residential building. Autodesk REVIT 2022 for 3D modeling, scheduling using Autodesk Navisworks, Microsoft Excel for estimation and costing, and Autodesk Navisworks for analysis of the structure. All of these programs were developed by Autodesk. The goal of the analysis is to find design flaws on the collaboration of structural and architectural models, detect clashes based on techniques that detect clashes, evaluate the severity of the clashes, and manage residential building conflicts. The project's goal is to resolve the problems and conflicts that have arisen during the construction process and to put the findings of the study into practise on an active project.

Keywords: **AEC, BIM, Clashes, Autodesk Navisworks, Autodesk REVIT**

1. INTRODUCTION

BIM (Building Information Modeling) is a digital representation of the physical and functional characteristics of a building or infrastructure asset. It involves the creation and management of a virtual model of a building or infrastructure project, which contains all the relevant information required for the design, construction, and operation of the project.

BIM is not just a software tool, but a collaborative process that involves all stakeholders in the construction industry, including architects, engineers, contractors, owners, and facility managers. BIM provides a platform for these stakeholders to share information, coordinate their activities, and make informed decisions throughout the lifecycle of a project (Kumar and Mukherjee 2009).

2. BIM

BIM enables stakeholders to create a digital model of a building or infrastructure project that is accurate, reliable, and easily accessible. This digital model contains information about the physical properties of the project, such as the size, shape, and location of building elements, as well as information about the functional and operational aspects of the project, such as heating, ventilation, and air conditioning (HVAC) systems, electrical systems, and plumbing systems (Rokooei.2015; Shaikh et al., 2016).

BIM is widely used in the construction industry, as it helps to improve collaboration, reduce errors and rework, increase efficiency, and lower costs. It is also becoming increasingly important in the operation and maintenance of buildings and infrastructure assets, as it provides a platform for the management of building data and the optimization of building performance (Srimathi and Uma,2017; Patil and Khandare,2017).

2.1 Clash Detection

Clash detection is one of the most important features of BIM, as it enables the identification of conflicts or clashes between building elements before construction begins. Clash detection is the process of identifying and resolving clashes or collisions between different building elements in a BIM model. In BIM, each building element is modeled as a 3D object with its own dimensions, properties, and attributes. When two or more building elements occupy the same space or intersect with each other, a clash occurs (Langar, 2017). Clash detection software compares the geometry and spatial relationships of different building elements in the BIM model to identify potential clashes or collisions.

Once clashes are identified, they can be resolved by adjusting the design of the affected elements. The design team can work collaboratively to review the clashes, assess the impact of any necessary changes, and make adjustments to the design accordingly. This process helps to avoid costly errors and rework that would otherwise arise during construction. Clash detection can also help to identify other issues, such as accessibility, constructability, and maintainability issues, which can be addressed before construction begins (Quan et al., 2020). By resolving clashes and other issues early in the design process, BIM helps to improve the quality of construction, reduce costs, and ensure that projects are delivered on time and within budget (Jose and Jacobe, 2018, Gor et al., 2018).

2.2 Clash Detection in a Non-BIM and BIM Based Environments

In a non-BIM environment, clash detection is typically done manually by reviewing 2D drawings and specifications to identify potential conflicts. This process can be time-consuming and prone to errors, as it relies on the human ability to interpret and visualize 3D space from 2D drawings (Shah, and Varghese, 2019).

In a BIM environment, clash detection is automated using specialized software that compares the 3D models of different building elements to identify potential clashes. The BIM model contains all the necessary information about the building elements, including their dimensions, location, and properties, making it easier to identify and resolve conflicts before construction begins (Rui, 2019; Patil et al.,2020; Koshti et al., 2021).

In summary, using BIM for clash detection provides many benefits over a non-BIM environment, including greater accuracy, faster detection, collaboration, and cost savings (Hasan and Rasheed, 2019). The study aims to identify the clashes and issues of the building construction which affects the time, cost, energy consumption, operational management and quality of the project by using Building Information Modeling.

To identify the practical constraints and to suggest proper solution for the execution of construction project. To enhance the project performance and to produce better outcomes using BIM while executing the construction project.

3. METHODOLOGY FRAMEWORK

The methodological framework of this study describes that the step by step procedure of the tasks to be done in this project. Sufficient details are gathered from various literatures regarding Building Information Modeling, application of clash detection, scheduling, modelling and tracking. Autodesk AutoCAD 2022 produce the various design detail drawings of the 2D plan with the base of the initial sketch plan. These 2D plans are imported into Autodesk Revit 2022 software to develop 3D models of design drawings.

In this study software used for clash detection process is Autodesk Navisworks Manage 2022. After the creation of 3D models by Autodesk Revit 2022, it is necessary to import the 3D model into Autodesk Navisworks Manage 2022 in order to perform clash detection. A proper Work-Breakdown Structure is prepared for the entire project according to the chainages marked.

The schedule of the project is made in Autodesk Navisworks Manage 2022 software. The schedule can be imported into Autodesk Navisworks Manage 2022 and viewed under Selection Tree Palette and all activities are linked to the model. It incorporates time sensitive data into 3D models and controls the schedule at various stages throughout the project. Quantification and estimation of the project is done using Autodesk Navisworks Manage 2022 software. Energy analysis of the building and facility management process are done using Autodesk Revit 2022. After the analysis the results are discussed and compared. The framing of the methodological process as shown in Figure 1.

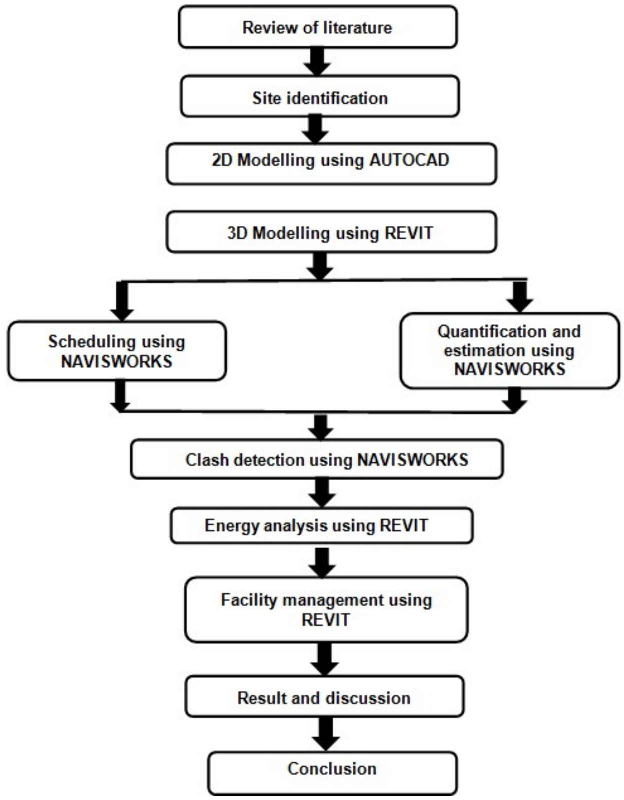

Figure 1. METHODOLOGY

4. MODELLING PROCESS

4.1 CREATING 2D CAD DETAILS

The plan of a G+1 residential building, which is a proposed project in Kerala is taken for study. The area of this building is about 1526 sq. ft. The house consists of two floors with the ground floor containing entrance hall, bedroom, bathroom, kitchen and the first floor contains bedroom, bathroom, balcony as shown in Figure 2.

Figure 2. 2D CAD DETAILS

4.2 BIM-BASED 3D MODELING

The result of 3D modeling using the BIM software Revit 2022, which was done in accordance with the manual for Autodesk Revit. This project's model creation process aims to create three-dimensional models from simple two-dimensional sketches. In Autodesk Revit, Revit MEP (Mechanical, Electrical & Plumbing Design) and Revit Architecture are built independently and then coordinated with one another. Each subject has its own set of model-making templates.

4.2.1 Generating the architectural BIM models

Throughout the design, documentation, and construction phases, Architecture Revit in Autodesk enables architects and building professionals to record, evaluate, and sustain vision. The build environment is the focus of the modeling and detailing tool for architecture called Revit. To closely reflect the actual situation, all displayed features, including footings, roofs, columns, doors, floors, windows and walls were produced by altering the 3D parametric models already accessible in the library of Revit which is shown in Figure 3.

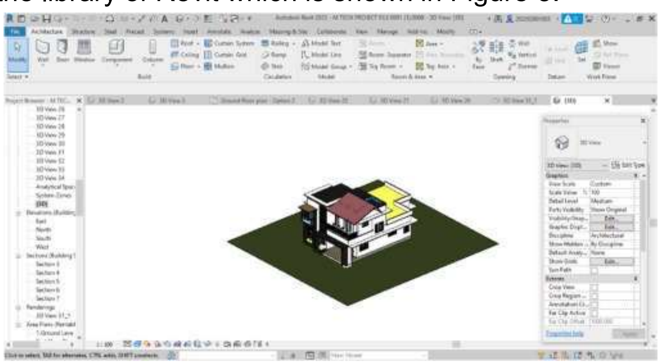

Figure 3. REVIT ARCHITECTURE RENDERING IMAGE

4.2.2 Making the model using Revit MEP

Professionals that work in MEP engineering should use Revit MEP. Mechanical, Electrical, and Plumbing are the three engineering specialties that Revit MEP supports. Tools particular to Revit MEP may be found under the "Systems" menu. The systems involved in mechanical systems, electrical distribution systems, and plumbing systems are covered by its tools. Without any visible direction from the structural component of the home, the modeling is first carried out exclusively primarily on the architectural component. The plumbing fittings were then added to the architectural model. Since it was chosen to utilize the established nominal sizes from Revit, the plumbing diameters used in this work are approximations of those found in the actual design. Since this component is unrelated to the conflict analysis conducted in this work, the mechanical characteristics of the model elements were not adjusted. Only lighting and electrical plug data were collected for the electrical model using a 2D sketch. The plumbing model combines sanitary pipe, pipefitting, and a plumbing fixture shown in Figure 4.

Figure 4. REVIT MEP 3D VIEW

4.2.3 Revit coordination

Any building's construction requires cooperation between the architectural, structural, and MEP disciplines. Lack of cooperation would result in mistakes brought on by misunderstanding, which would have major time, resource, and financial ramifications. Rendered architecture model.

4.3 DEVELOPMENT OF 4D BIM

Aiming to eliminate delays and sequencing issues, the 4D BIM tool simulates and tracks construction schedules using BIM to graphically communicate and evaluate project operations. Giving a project team a tool to use in order to keep track of project activity becomes very vital. Linking the elements in the building model with the tasks and associating individual elements or groups of elements to each of the activities in the timeline are crucial steps in generating a 4D BIM of the construction process, which is shown in Figure 5.

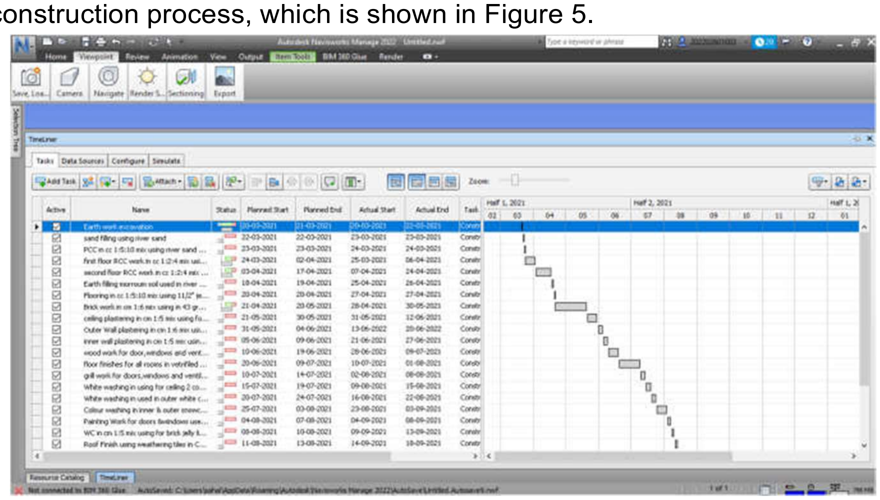

Figure 5. SCHEDULE OF PROJECT

4.3.1 Integration of 3D model with schedule

This includes three steps; developing selection sets, linking project activities with the selection sets as shown in Figure 6, linking the 3D models with its time associations.

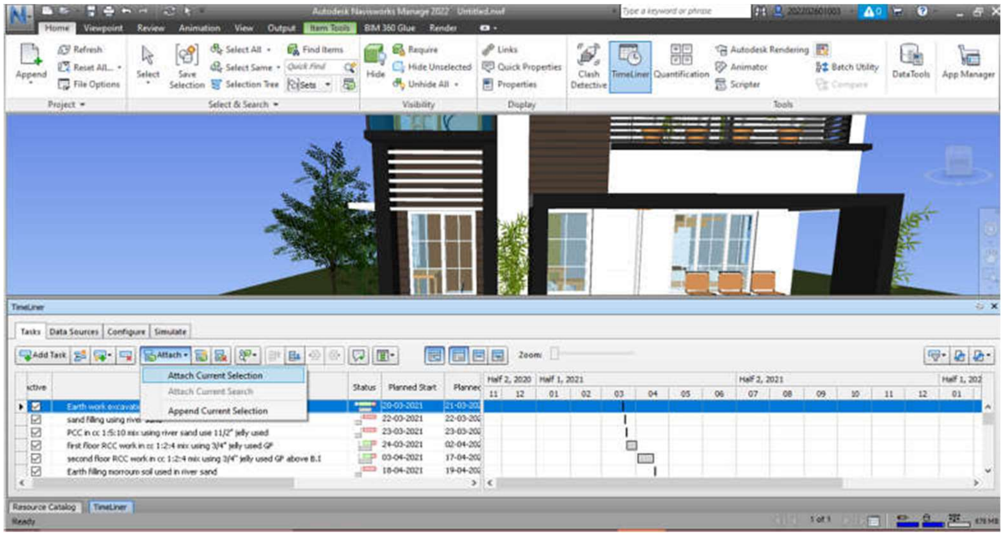

Figure 6. LINKING TASKS WITH 3D MODEL

To fit the timetable, Navisworks configuration and linking parameters (such as start dates, finish dates, interval size, and playback length) need be changed. This produces the first 4D model.

The benefits of 4D modeling were recognized after the scheduling activities and model components were connected. The timetable is automatically adjusted if there are any changes to the plan. The projected development of the virtual project construction was displayed right away in the model as soon as the "time liner" was chosen for a certain day. Through a visual medium, the simulation aids in comprehending the flow of building activity.

4.3.2 Conflict Detection Analysis For Bim Based Designs

Every significant design incompatibility must be addressed and evaluated again during the conflict analysis process, altering and updating solutions as necessary to reach the required degree of coordination. The three selected components were made into 3D models and evaluated in Navisworks for any conflicts that could exist between them. Typically, the conflicts that were discovered through detection were removed. Because this software can identify collisions in real time during the design phase, it provides BIM stakeholders with a very effective way to enhance coordination between various building systems and ultimately prevent the need for expensive fixes after drawing completion and during the construction phase (Savitri et al., 2020).

Collision detection may be done once each discipline has contributed to the BIM model. This procedure entails looking for things from other disciplines that compete with one another, that is, elements that share a place physically or that have conflicting specifications. The "select" option is used to select various model components that can clash with one another.

The Clash Detective tool continuously updates the state of the clashes when they are found and shown inside the "Results" page of Navisworks Manage since Navisworks manage dynamically assigns a status to each clash for usage in the future, which is shown in Figure7.

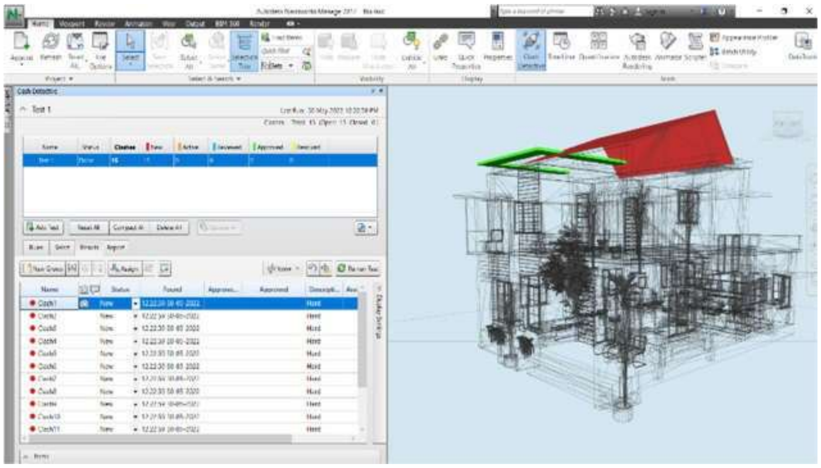

Figure 7. CLASH DETECTIVE SHOWING THE RESULT TAB

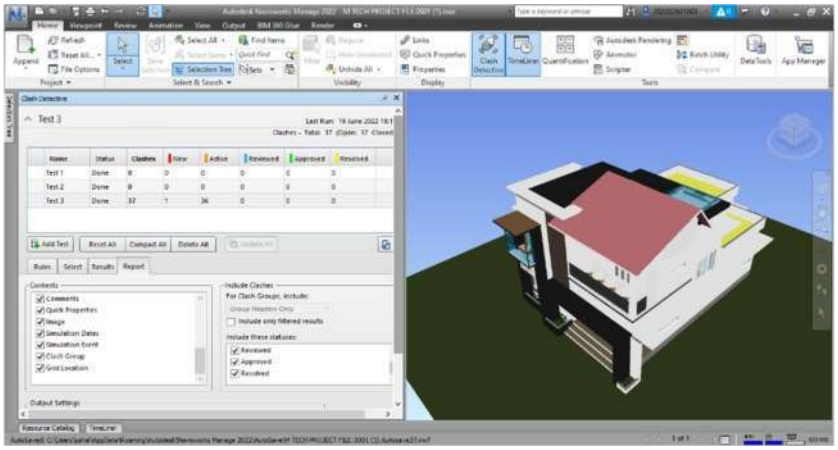

Figure 8. CLASH DETECTIVE SHOWING THE 'REPORT' TAB

In this project, total of 12 clashes are detected in this clash test. Each of the clashes are reviewed and resolved by using element ID exported into clash report. The clash assigned are visible on once open it and paste the element ID in 'Select by ID' tab in Revit. To locate each conflict, you may choose it, and you can also name each one separately. The corrected file is produced in 'nwf' format from Revit Architecture. After making the adjustments, Navisworks is opened once more to look for conflicts. Both a text file and an HTML file may be exported from the conflict report.

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4.4 Development of 5D BIM

5D BIM is used to create a virtual model of a building or infrastructure project that includes information about the time and cost of construction. The development of 5D BIM was a natural progression from the earlier versions of BIM. As the use of BIM became more widespread, stakeholders in the construction industry began to recognize the potential for adding time and cost information to the model. This led to the development of 5D BIM, which allows stakeholders to simulate the construction process and estimate the cost of the project before construction begins (Hamledari et al., 2018).

To develop a 5D BIM model, the construction schedule and cost estimate are integrated into the 3D BIM model. The model is then used to simulate the construction process, allowing stakeholders to identify potential issues and conflicts before construction begins. This helps to reduce delays, change orders, and cost overruns during construction (Bakhshi et al., 2018).. The use of 5D BIM has many benefits for stakeholders in the construction industry. It helps to improve communication and collaboration between different stakeholders, reduces errors and rework during construction, and helps to ensure that projects are delivered on time and within budget. It also helps to improve the quality of construction, as stakeholders can identify and resolve issues before construction begins (Bakhshi et al., 2018, Kulkarni & Kamdi,2021).

In summary, the development of 5D BIM has been an important step in the evolution of BIM, as it has added the element of time and cost to the model. 5D BIM is a powerful tool that can help stakeholders in the construction industry to plan and manage construction projects more effectively, resulting in cost savings, improved quality, and better project outcomes.

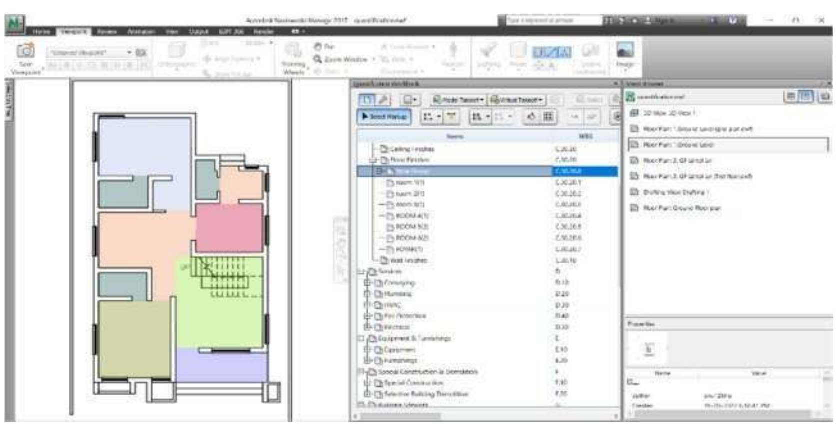


Figure 9. QUANTIFICATION USING NAVISWORKS

4.5 Development of 6D BIM

6D BIM is an extension of 5D BIM that adds the element of sustainability and lifecycle management to the model. It is also known as "BIM with Sustainability" or "BIM for Facility Management". The development of 6D BIM was driven by the need for a more sustainable approach to building design and construction. The goal of 6D BIM is to provide a comprehensive view of the building's lifecycle, from design and construction to operation and maintenance, and ultimately, decommissioning.

To develop a 6D BIM model, the 5D BIM model is further enhanced with data on the building's energy consumption, water usage, and other environmental factors. This information is used to assess the building's sustainability and to identify opportunities for energy and resource savings. The use of 6D BIM has many benefits for building owners and operators. It helps to optimize building performance and reduce operating costs by identifying areas for energy and resource savings (Wang et al., 2022; Shin & Park, 2023) . It also helps to improve the building's overall sustainability and environmental impact, which is becoming increasingly important as the construction industry strives to reduce its carbon footprint.

In addition, 6D BIM can be used to improve the maintenance and operation of the building by providing accurate and up-to-date information about the building's systems and components (Chen et al., 2023). This information can be used to schedule maintenance tasks, order replacement parts, and plan for future upgrades.

In summary, the development of 6D BIM has been an important step in the evolution of BIM, as it has added the element of sustainability and lifecycle management to the model. 6D BIM is a powerful tool that can help building owners and operators to optimize building performance, reduce operating costs, and improve the building's overall sustainability and environmental impact.

4.6 7D BIM

7D BIM is an extension of 6D BIM that adds the element of operational and facility management to the model. It is also known as "BIM with Operations and Maintenance" or "BIM for Asset Management". The development of 7D BIM was driven by the need to improve the management and maintenance of building assets over their entire lifecycle. The goal of 7D BIM is to provide a comprehensive view of the building's lifecycle, from design and construction to operation, maintenance, and ultimately, decommissioning. To develop a 7D BIM model, the 6D BIM model is further enhanced with data on the building's operational and maintenance activities. This includes information on asset condition, equipment maintenance schedules, and repair history. This information is used to develop a comprehensive asset management plan that supports the building's long-term operation and maintenance.

The use of 7D BIM has many benefits for building owners and operators. It helps to optimize building performance and reduce operating costs by providing a complete view of asset condition and maintenance needs. It also helps to extend the useful life of building assets, reducing the need for costly replacements. In addition, 7D BIM can be used to improve the planning and execution of maintenance activities by providing accurate and up-to-date information about the building's systems and components. This information can be used to schedule maintenance tasks, order replacement parts, and plan for future upgrades(Salvi et al., 2022).

In summary, the development of 7D BIM has been an important step in the evolution of BIM, as it has added the element of operational and facility management to the model. 7D BIM is a powerful tool that can help building owners and operators to optimize building performance, reduce operating costs, and extend the useful life of building assets.

5. RESULT AND DISCUSSION

5.1 DESIGN CONFLICT DETECTION RESULTS

In this study there are 12 clashes are detected by conducting the clash detection test. Each clash was grouped by category and resolved by using element ID of that clashing member. These element ID was copied from the clash report and that ID was pasted in the Revit to locate the member where the clash was occurred, finally it is resolved by changing the elements, which is shown in Figure 10, clash points and displacements are given in Table 1.

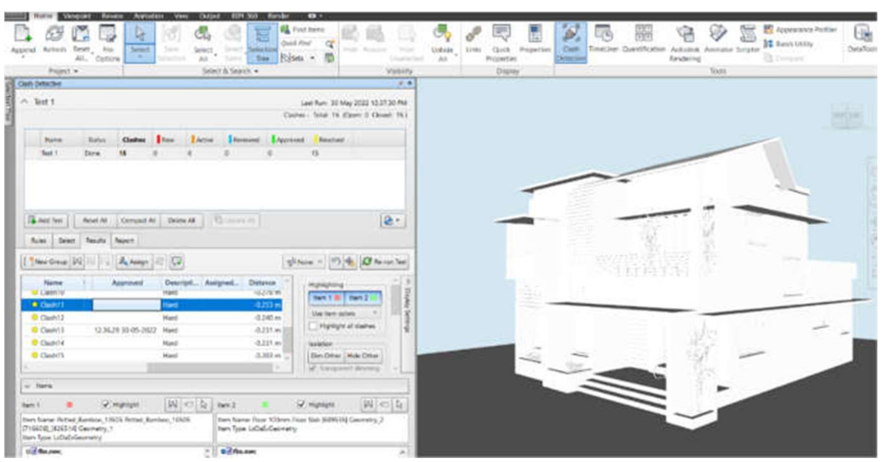


Figure10. RESOLVED CLASH DETECTION RESULT

Table 1 CLASH POINTS AND DISPLACEMENTS

No	Clashes	Displacement in meter
1	Wall vs Sunshade	0.469
2	Column vs Sunshade	0.300
3	Wall vs Roof	0.278

4	Floor vs Step	0.160
5	Roof vs Wall	0.210
6	Floor vs Column	0.150
7	Wall vs Rail	0.180
8	Roof vs Wall	0.320
9	Rail vs Wall	0.230
10	Stair vs Rail	0.364
11	Wall vs Floor	0.180
12	Floor vs Door	0.120

The Quantity take off details for structural elements and construction materials like bricks, cement, and sand has been calculated and the quantity units were compared in materials wise are shown in Figure11. As a result it helps to reduce the material consumption and wastages.

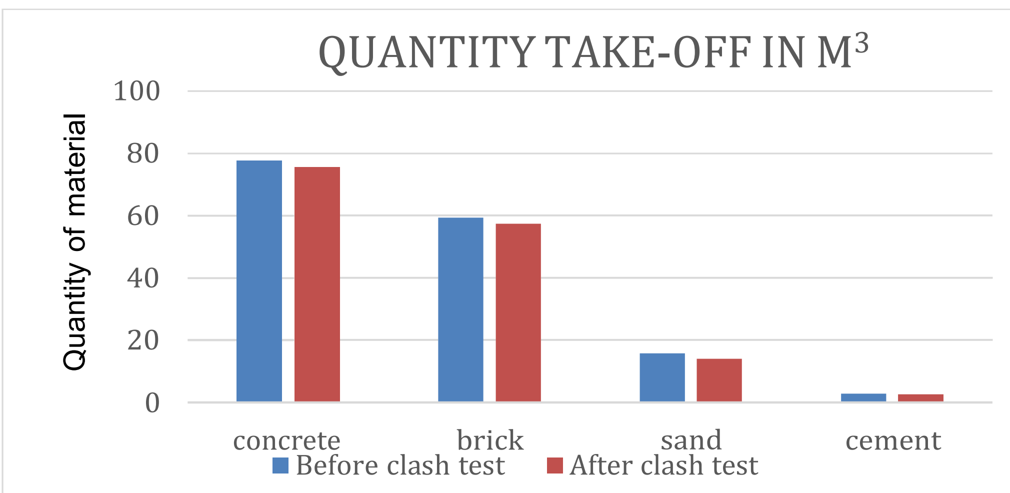
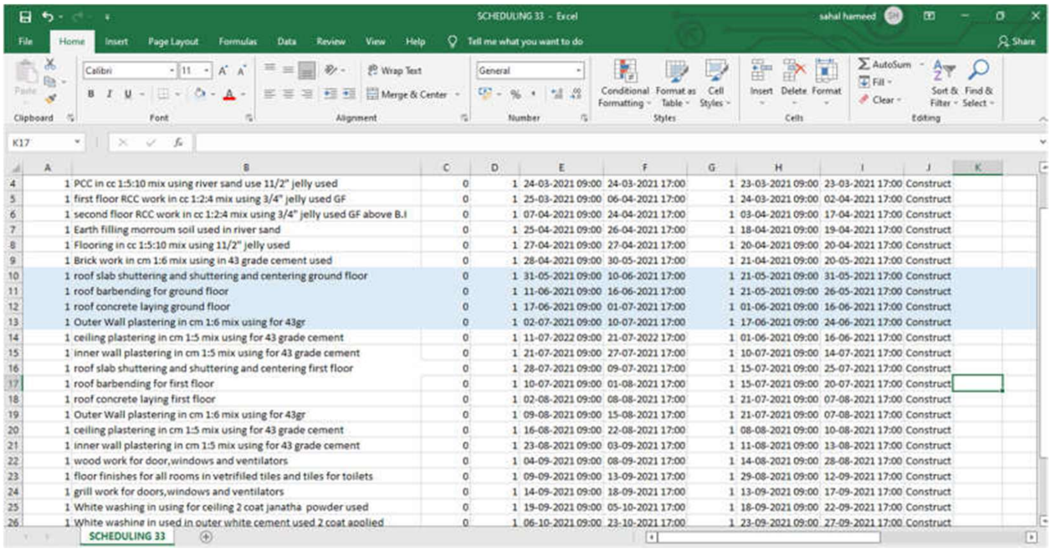


Figure11. COMPARISON CHART OF QUANTITY TAKE OFF OF MATERIALS

5.2 SCHEDULING USING BIM

By proper scheduling using BIM it is found that there is saving of duration of the project by 40 days which was about 20 percentage of the actual duration of the project. Scheduling is given in Figure12. Activities using start to start relationship is shown in Table 2.



	A	B	C	D	E	F	G	H	I	J
4	1	PCC in cc 1:5:10 mix using river sand use 11/2" jelly used	0	1	24-03-2021 09:00	24-03-2021 17:00	1	23-03-2021 09:00	23-03-2021 17:00	Construct
5	1	first floor RCC work in cc 1:2:4 mix using 3/4" jelly used GF	0	1	25-03-2021 09:00	06-04-2021 17:00	1	24-03-2021 09:00	02-04-2021 17:00	Construct
6	1	second floor RCC work in cc 1:2:4 mix using 3/4" jelly used GF above B.I	0	1	07-04-2021 09:00	24-04-2021 17:00	1	03-04-2021 09:00	17-04-2021 17:00	Construct
7	1	Earth filling morroum soil used in river sand	0	1	25-04-2021 09:00	26-04-2021 17:00	1	18-04-2021 09:00	19-04-2021 17:00	Construct
8	1	Flooring in cc 1:5:10 mix using 11/2" jelly used	0	1	27-04-2021 09:00	27-04-2021 17:00	1	20-04-2021 09:00	20-04-2021 17:00	Construct
9	1	Brick work in cm 1:6 mix using in 43 grade cement used	0	1	28-04-2021 09:00	30-05-2021 17:00	1	21-04-2021 09:00	20-05-2021 17:00	Construct
10	1	roof slab shuttering and shuttering and centering ground floor	0	1	31-05-2021 09:00	10-06-2021 17:00	1	21-05-2021 09:00	31-05-2021 17:00	Construct
11	1	roof barbending for ground floor	0	1	11-06-2021 09:00	16-06-2021 17:00	1	21-05-2021 09:00	26-05-2021 17:00	Construct
12	1	roof concrete laying ground floor	0	1	17-06-2021 09:00	01-07-2021 17:00	1	01-06-2021 09:00	16-06-2021 17:00	Construct
13	1	Outer Wall plastering in cm 1:6 mix using for 43gr	0	1	02-07-2021 09:00	10-07-2021 17:00	1	17-06-2021 09:00	24-06-2021 17:00	Construct
14	1	ceiling plastering in cm 1:5 mix using for 43 grade cement	0	1	11-07-2022 09:00	21-07-2022 17:00	1	01-06-2021 09:00	16-06-2021 17:00	Construct
15	1	inner wall plastering in cm 1:5 mix using for 43 grade cement	0	1	21-07-2021 09:00	27-07-2021 17:00	1	10-07-2021 09:00	14-07-2021 17:00	Construct
16	1	roof slab shuttering and shuttering and centering first floor	0	1	28-07-2021 09:00	09-07-2021 17:00	1	15-07-2021 09:00	25-07-2021 17:00	Construct
17	1	roof barbending for first floor	0	1	10-07-2021 09:00	01-08-2021 17:00	1	15-07-2021 09:00	20-07-2021 17:00	Construct
18	1	roof concrete laying first floor	0	1	02-08-2021 09:00	08-08-2021 17:00	1	21-07-2021 09:00	07-08-2021 17:00	Construct
19	1	Outer Wall plastering in cm 1:6 mix using for 43gr	0	1	09-08-2021 09:00	15-08-2021 17:00	1	21-07-2021 09:00	07-08-2021 17:00	Construct
20	1	ceiling plastering in cm 1:5 mix using for 43 grade cement	0	1	16-08-2021 09:00	22-08-2021 17:00	1	08-08-2021 09:00	10-08-2021 17:00	Construct
21	1	inner wall plastering in cm 1:5 mix using for 43 grade cement	0	1	23-08-2021 09:00	03-09-2021 17:00	1	11-08-2021 09:00	13-08-2021 17:00	Construct
22	1	wood work for door,windows and ventilators	0	1	04-09-2021 09:00	08-09-2021 17:00	1	14-08-2021 09:00	28-08-2021 17:00	Construct
23	1	floor finishes for all rooms in vetrifiled tiles and tiles for toilets	0	1	09-09-2021 09:00	13-09-2021 17:00	1	29-08-2021 09:00	12-09-2021 17:00	Construct
24	1	grill work for doors,windows and ventilators	0	1	14-09-2021 09:00	18-09-2021 17:00	1	13-09-2021 09:00	17-09-2021 17:00	Construct
25	1	White washing in using for ceiling 2 coat janatha powder used	0	1	19-09-2021 09:00	05-10-2021 17:00	1	18-09-2021 09:00	22-09-2021 17:00	Construct
26	1	White washing in used in outer white cement used 2 coat applied	0	1	06-10-2021 09:00	23-10-2021 17:00	1	23-09-2021 09:00	27-09-2021 17:00	Construct

Figure 12. SCHEDULING EXPORTED TO EXCEL

Table 2 ACTIVITIES USING START TO START RELATIONSHIP

Activity code	Activity name	Actual duration of construction (Days)	Activities using start to start relationship (Days)	Time saved (Days)
(a)	Roof slab shuttering and centering of ground floor	10	(a)➔(b)	10
(b)	Bar bending of roof slab ground floor	10		
(c)	Roof slab concrete laying ground floor	15	(c)➔(d)	10
(d)	Outer wall plastering Ground floor	10		
(e)	Roof slab shuttering and centering of first floor	10	(e)➔(f)	10
(f)	Bar bending of roof slab first floor	10		
(g)	Roof slab concrete laying of first floor	15	(g)➔(h)	10
(h)	Outer wall plastering First floor	10		
Total				40

5.3 QUANTIFICATION AND ESTIMATION RESULTS

In this project the actual cost of construction was about 3250000 rupees, while by estimating the cost using BIM it is found that the total cost of construction was about 3000000 rupees, by reducing the duration of the project by 40 days here the labour charge of 40 days work was saved which is 320000 rupees, which is shown in table 5.3, these labour charges are major reason for the cost overrun. By estimating using BIM it was comes to know that there is a saving of 320000 rupees which is about 10 percentage of the actual cost of construction (Ziyu et al., 2019).

5.4 ENERGY EVALUATION RESULTS

For the analysis we need divide the whole building into different zones by using spacers. By giving materials which are less heat absorbing for construction will reduce the overall energy consumption. The major type materials which are used in construction of walls in buildings, their heat transfer coefficient and thermal resistance are given below in Table 3.

Table 3. HEAT PROPERTIES OF WALL MATERIALS

Material	Heat Transfer Coefficient (HTC) in ($W/m^2.K$)	Thermal Resistancein ($m^2.K/W$)
Concrete masonry	0.3815	2.6212
Common brick	2.5116	0,3981
Metal sheeting rails	0.1895	5.2757
Concrete cast in-situ	3.4867	0.2868
Infiltration barriers	0.7698	1.2990

By analyzing this residential building it is found that total annual energy consumption is about 48,024 Kw-h, from this 40,194 kw-h is used for cooling, 3,361 kw-h is used for interior lighting and 4,369 kw-h is used inter equipment and the monthly energy consumption.

5.5 OPERATION OF FACILITY MANAGEMENT

It is the 7th dimensional analysis of the project, facility management is completely data based approach, here we can give the complete data of all the electrical items, the bathroom accessories, electrical equipment and other installations by giving these details it will get saved on the that model data base. By doing facility management here the complete quantity takeoff and estimate of pipes and scheduling of the plumbing fixture are done. Details of the accessories are given in the Figure13.

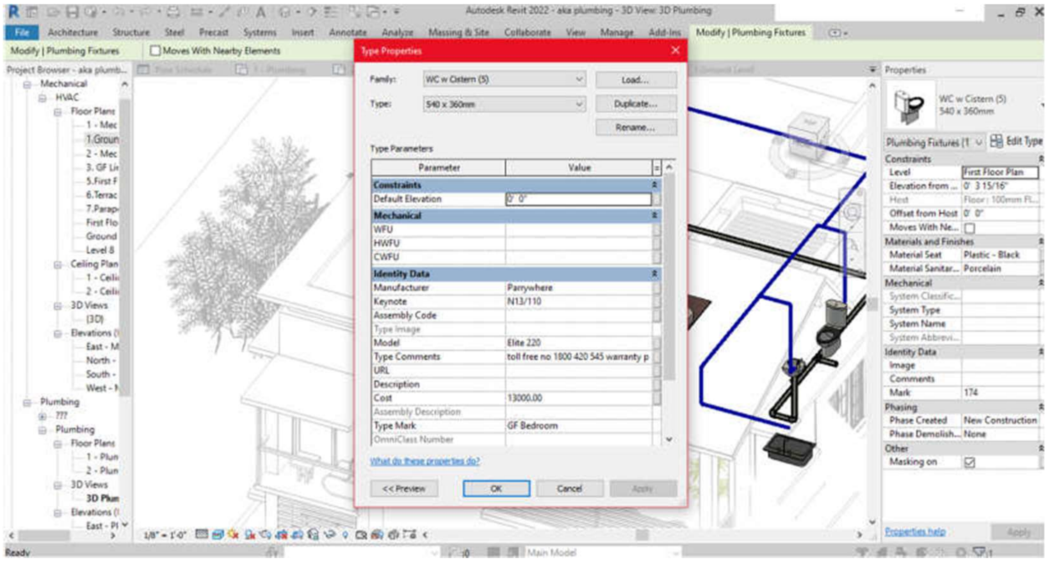


Figure13. DETAILS OF PLUMBING ACCESSORIES

6. CONCLUSION

4D BIM improves the ability to monitor and control the construction and to thereby identify and resolve clashes more quickly, thereby reducing claims. 20 % of the duration of the project is saved in scheduling using BIM.10 % of the cost of construction is also saved by using BIM for scheduling and cost estimation. All the clashes in the building are detected and it helped for saving the materials and time for construction, it made the design error free. Total energy consumption is calculated and recommendation for reducing the energy consumption are given. Points for minimum lighting and maximum lighting are identified. Solar study of the building is done, interior lighting and sun orientation are analyzed. Position of ventilations are suggested. Facility management for toilet and kitchen accessories are given. Operational and maintenance time is saved using facility management. Plumbing schedule and plumbing fixture are done using facility management.

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