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ijirset@gmail.com



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Implementation of Clash detection in construction using Building Information Modeling: Case study of a Hostel Building

Aishwarya Chothave¹, Mrugdha Bhadange¹, Pratiksha Shinde¹, Urmila Shinde¹, Mrs. Kaveri Sonawane²

U.G. Students, Department of Civil Engineering, MVP Samaj's KBTCOE, Nashik, Maharashtra, India¹

Assistant Professor, Department of Civil Engineering, MVP Samaj's KBTCOE, Nashik, Maharashtra, India²

ABSTRACT: Construction now-a-days has become extremely intricate, and with emerging technological and infrastructure needs, complexities have risen. With complexities comes an increasing need for efficient planning, precision and effective management. Planning has become one of the most crucial factors that determine the success of any construction project. A plethora of planning methodologies have been researched but most of them are not qualified enough to improve the construction performance. Because of the enormous discrepancy between execution and planning, a planning method, perhaps, a management tool is needed to augment the project performance and minimize the risks associated with finances and delays.

Building Information Modeling (BIM) has recently evolved and has proved to be a highly efficient technology for information management in Architecture, Engineering and Construction (AEC) industry. 2D CAD drawing for execution is now rusty and timeworn for executing large and time-critical projects. An important application of the BIM technology is the Clash detection tool which is used for the coordination of building systems within 3D building models and which further enables us to optimize time and cost accurately. This project gives a brief introduction about Clash detection in BIM and the basic premise of this research being the identification of clashes, cost optimization and time optimization for the construction of residential building using BIM Coordination.

This research is a case study of a residential building construction that focuses on simplifying and standardizing the process of BIM Coordination using AutoCAD, Autodesk Revit, Autodesk Navisworks Manage for modelling, analysing and testing because of its superior software designs. The study reports that the total cost of the project has been minimised significantly and due to on-time completion over-runs have been avoided.

KEYWORDS: Building Information Modeling, Clash Detection, Planning methodologies, Construction

I. INTRODUCTION

Building Information Modeling (BIM):

With BIM, we can digitally construct a virtual model of a building. The computer-generated model consists of pertinent data and accurate geometry required to assist the construction activities. The construction industry has not realized BIM's entire potential yet. BIM is interlinked with technology with both, hardware and software. BIM will continue to evolve with technology. Due to the failure in providing the necessary spatial and aspects and data, traditional scheduling and progress monitoring techniques like Bar charts, CPM, PERT, etc., although still being used by the project managers for planning, have a disadvantage in the decision-making. There is an increasing need for project managers to shorten the delivery time and decrease the costs involved in the process, without altering the quality of the building. Omissions and errors in paper documentation, drawings often cause unanticipated field costs and delays during the project delivery. Furthermore, cross-disciplinary communication between the various professionals of the construction sector is very problematic and can be seen to be a significant contributing factor in poor performance of project productivity. Limited tools are available for planners to amalgamate the visual representation of site with the time progress, which makes them rely on imagination to decide the right sequence of construction plan. BIM model was built to enable planners to visualise construction with time at the planning stage itself even before starting the work on site, which will remove any flaws that were left out during project planning. AEC professionals as well as researchers, have a number of views on what BIM is:

"A modelling technology and associated set of processes to produce, communicate and analyse building models."

Clash Detection:

In any multidisciplinary project, clash detection is extremely crucial for the inspection of clashes. A 'clash' occurs when multiple elements in your design interfere with one another taking up the same space. In BIM, we combine Structural, Civil, and Architectural & MEP (Mechanical, Electrical and Plumbing) models to prepare one BIM model, which can have many clashes in the constituent elements.

There are three types of clash:

1. **Hard clash** – When two elements occupy the same space, such as a pipe running through a column.
2. **Soft clash** – When no tolerances are provided for maintenance and safety.
3. **Workflow or 4D clash** – when there are time conflicts such as scheduling of contractors, delivery of material etc.

Need for Clash Detection:

A range of services have to come together in order for the end building to appear. The Architect produces a model, consequently, the structural engineer, mechanical and electrical engineer and the environmental engineer will produce their own models based on that. Each of these models might contain documents, structured data files and other files which could contain non-geometric data about what is being built. These models are then brought together into a digital model which will show what has been designed. With so many different models coming together, clashes are unavoidable. Clash detection can mitigate the incongruity during the planning phase itself, eliminating chances of delays and cost overruns.

Scope of Work:

In this project, BIM model of the building's architecture have been created by Revit Architecture software. Structural details of the building have been created in the Revit Structure software. And the clash detection has been performed in the Navisworks software. The Architectural, structural and service models were imported into Navisworks software to identify the hard clashes.

II. CASE STUDY

This study data consists of different sections. Relevant data is collected for the analysis of the details of construction. This data includes architectural, structural, electrical, mechanical 2D drawing plans. The case study is built upon BIM to determine clash in the design phase. In the study we have selected a Hostel building located in Nashik. We utilized Autodesk softwares such as AutoCAD, Autodesk Revit, Autodesk Navisworks Manage for modeling, analysing, and testing.

III. METHODOLOGY

1.1 Drafting AutoCAD plan of Hostel Building

2D drafting creates technical drawings, as well as editing and annotating designs. Drafters use CAD software to develop the floor plans, building permit drawings, building inspection plans and landscaping layouts.

1. New drawing. In Start Drawing templates, select the New button in the toolbar.
2. After opening of new drawing then set unit and dimension style.
3. Then start to draw the plan in 2D
4. Offset are used to take offset from one distance to required distance.
5. Specify an inside point to create the other side of the wall.
6. By using all tools and command we can prepare 2D drawing which is given below.



Figure 1: Autocad Drawing of Hostel Building

1.2 Drafting 3D drawing of Hostel using Revit

1. Click View tab Create panel Plan Views drop-down, and then click. (Floor Plan)
2. In the New Plan dialog: For Type, select a view type from the list, or click Edit Type to modify an existing view type or create a new view type.
3. Click OK.
4. Open a plan, section, or elevation view.
5. Click View tab Create panel 3D View drop-down Camera.
6. Click in the drawing area to place the camera.
7. Drag the cursor to the desired target and click to place it.

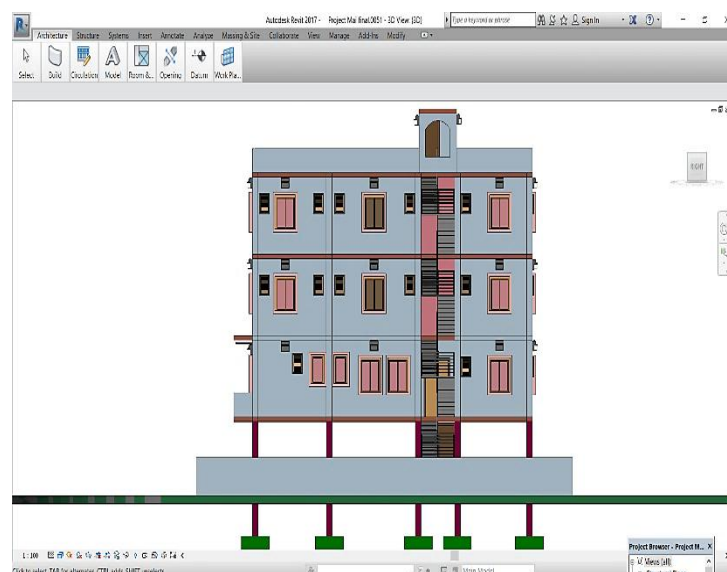


Figure 2: 3D Drawing of Hostel using Revit

1.3 Adding Structural Elements

Structural Model Elements are, literally, elements that support a structure such as columns, rebar, trusses, and so on.

1.4 Importing File to Navisworks Software

Navisworks manage's greatest strength is Clash Detection. In this case study software used for clash detection process is Navisworks Manage. Detecting collisions and interferences at the time of design phase enables to very efficiently augment collaboration and eventually avoid cost during the execution phase. Following are the steps for clash detection process.

1. The first step in this case study is to import all the Revit files i.e. structural and architectural files into Navisworks which is use in clash detection process. For clash detection process in Navisworks, it is required to import 3D Revit files into Navisworks or export files from Revit to Navisworks.
2. In the next step in clash detection process converts all the recently imported rvt files into Navisworks file format that is .nwf file format which is shown in fig. 1.4

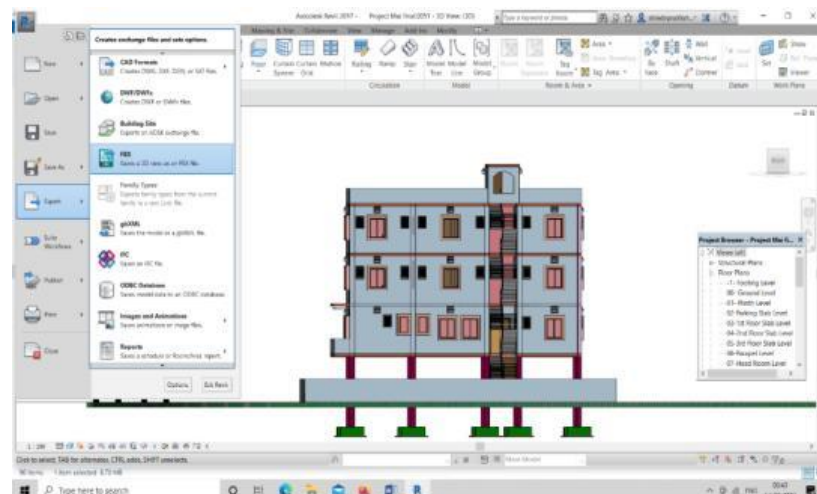
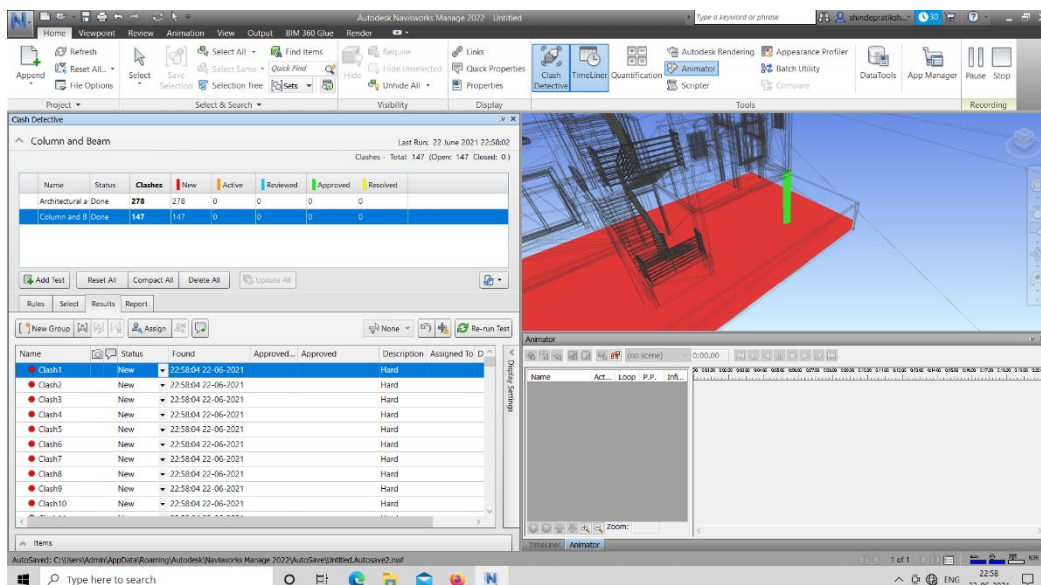


Figure 3: Converting Revit into NWC format

3. Once all rvt files are transformed into .nwf file format we can be simply opened in Navisworks software and then clash tests carry out by using .rvt files.
4. For performing clash test in Navisworks software press the 'Clash Detective' tool
5. After that we can simply click on to 'Select' tab that is located within clash detective tool in Navisworks software.
6. Next step is click on 'Select' tab then two different columns will appear on computer screen so select different model elements which have the chance of conflicting with each other which is shown in fig. 1.5 For example structural element can interfere with architectural element, so in one column we should select 'structural element' and in another column we should chose 'architectural element' and then simply click on 'OK' to run clash test.

8. Autodesk Navisworks automatically gives a status to each clash for future use. So after the clash detective tool that keeps on updating the status of clashes after they are identified and are identified and are listed within results tab which is shown in figure below.



9. Further, for creating report of clash test click on report tab and creating report on .XML file format which is shown in fig. 1.7

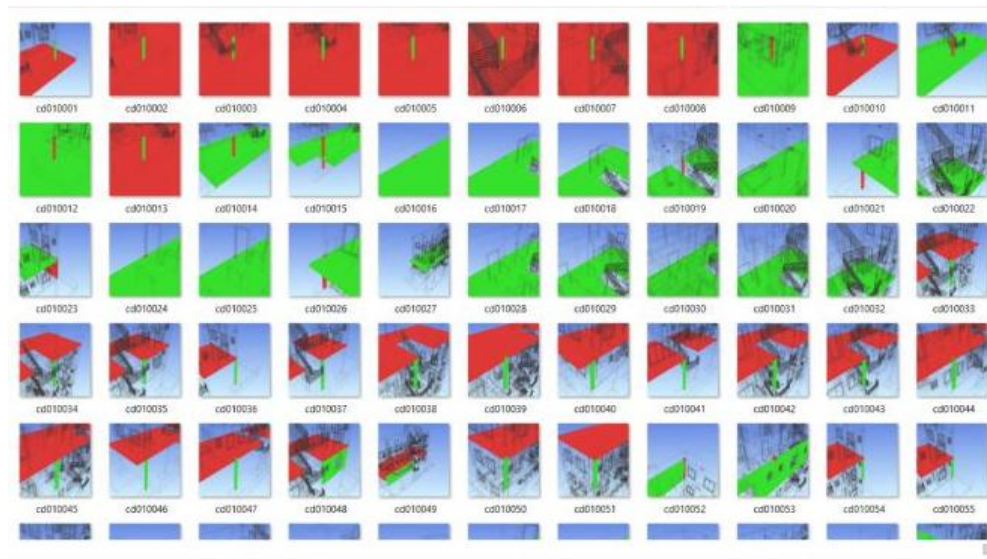


Figure 6: Clash report generated by Navisworks

10. Clashes can be resolved by changing position of particular elements.

In our project totally around 278 clashes detected in clash test. And all the clashes are resolved using elements ID exported in clash report. The clash we assigned is visible in Autodesk Revit, once we open it and paste the element ID in 'Select by ID' tab in Revit. Each clash can be selected to know the location of it and separate labelling can be done too. From Revit Architecture the rectified file is exported in.nwf format. Once the changes are done the file Navisworks is opened again to check for clashes. The clash report can be exported as text file or HTML format.

IV. RESULTS

While conducting clash detection test, the final clash test reports for Architectural versus Structural are 198 clashes where clashes for Column versus Wall are 107 and clashes for Beam versus Column are 89.

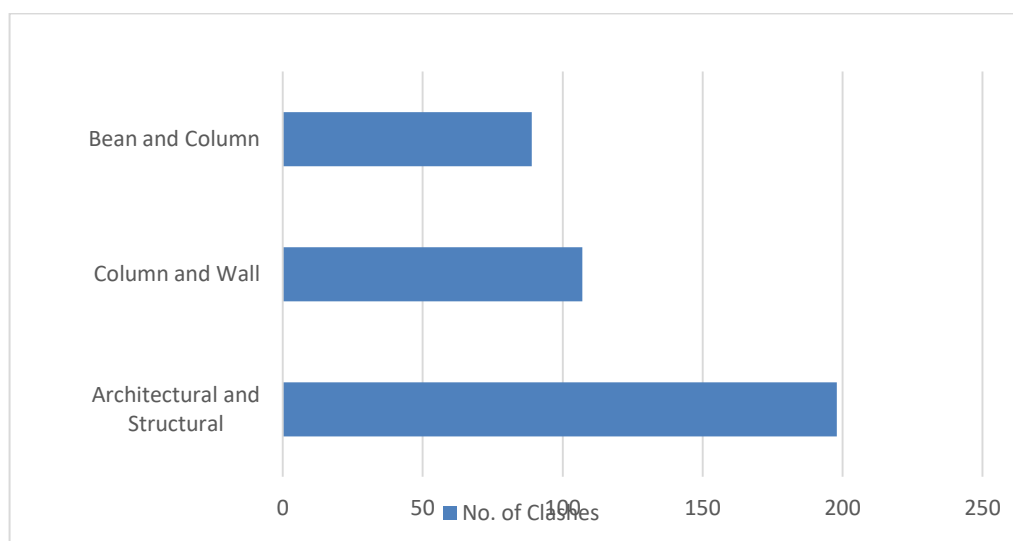


Figure 7: Clash Test Report

1. Hard Clash Result at Tolerance of 50 mm:

Table 1 illustrates a hard clash between Architecture and structure with tolerance 50 mm.

Architectural and Structural	Tolerance	Clashes	New	Active	Resolved	Type	Status
	0.050 m	107	0	107	0	Hard	OK

Figure no. 2.2 shows the percentage of hard clashes between Architectural and Structure in different levels of the building. A total of 107 hard clashes are detected in this analysis. All 198 clashes are divided between the footing level (18.7%), plinth level (4.7%), ground floor level (16.82%), first floor level (23.35%), second floor level (23.35%), third floor level (4.7%).

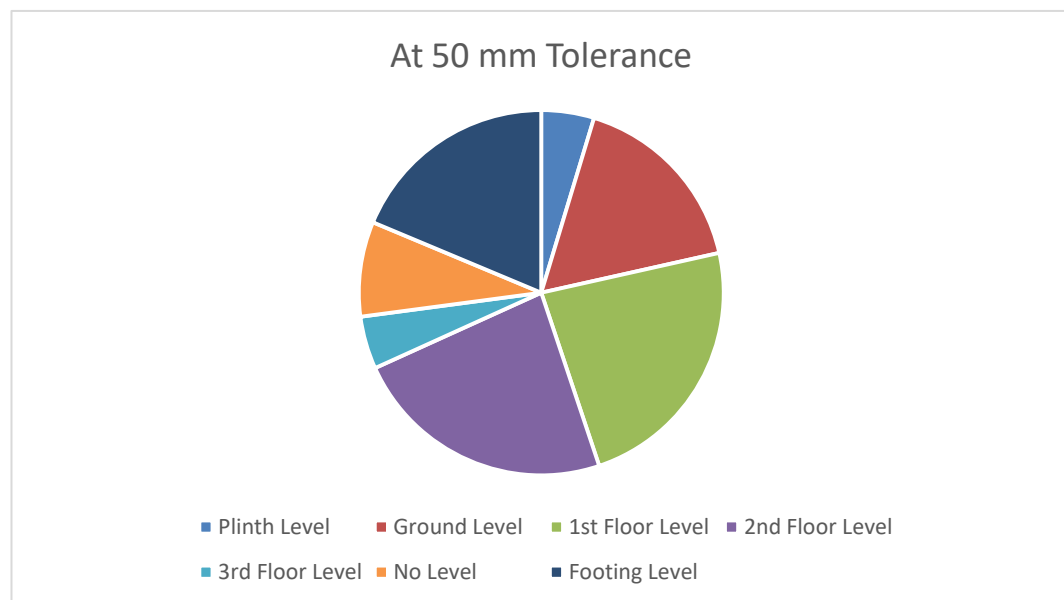


Figure 8: Distribution of Hard Clash (T=50 mm)

2. Hard Clash Result at Tolerance of 10 mm

Table 2 illustrates a hard clash between Architecture and structure with tolerance 10 mm.

Architectural and Structural	Tolerance	Clashes	New	Active	Resolved	Type	Status
	0.010 m	198	0	0	0	Hard	OK

Figure no. 2.3 shows the percentage of hard clashes between Architectural and Structure in different levels of the building. A total of 198 hard clashes are detected in this analysis. All 198 clashes are divided between the footing level (10.10%), plinth level (4.05%), ground floor level (22.25%), first floor level (28.30%), second floor level (26.76%), third floor level (4.05%).

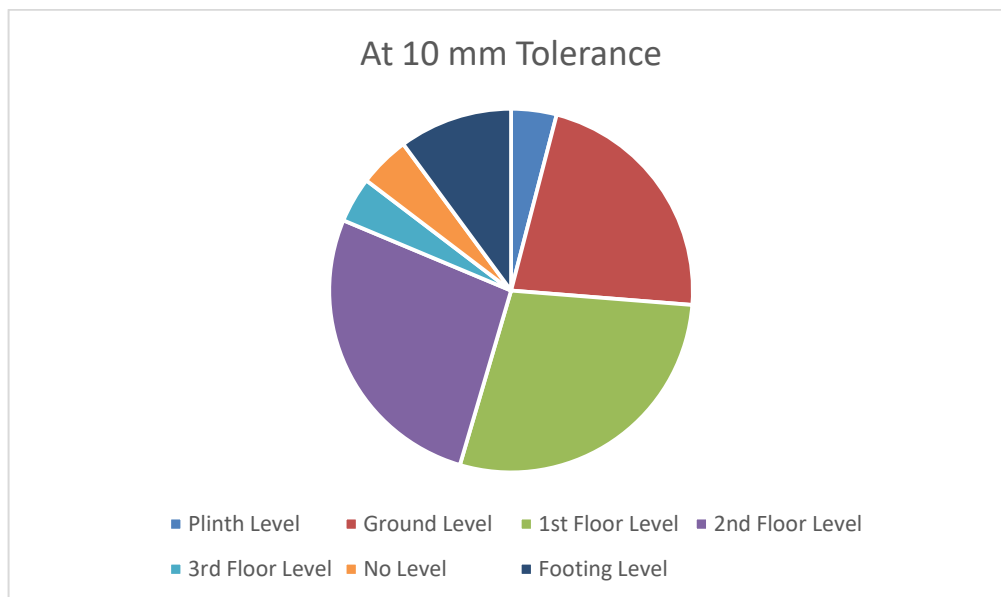


Figure 8 : Distribution of Hard Clashes (T= 10mm)

The uncertainty in the design phase leads to the vast number of clashes, furthermore, the lack of specificity, the lack of agreement, the lack of time for project delivery might lead to hard clashes and sometimes, design error.

V. CONCLUSION

As the 4D model has been more effective, its proper generation and implementation on construction planning can be more promising.

1. The problem faced on the site because of poor visualization can be mitigated and with BIM, planning can be efficiently done.
2. It can also help in finding issues like detecting design clashes.
3. Time, cost-effectiveness, and higher quality projects are possible by using BIM. In order to determine existent clashes in construction, Autodesk Revit and Autodesk Navisworks manage were chosen.
4. Clash detection results revealed that it is a faster as well as simple process and errors due to humans are reduced greatly.
5. Navisworks recognizes design clashes so they can be dealt with in time. design error removal, cost, and time optimization is possible after the detection of these clashes.

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