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Impact of 4D BIM On Construction Project

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Abstract : A major share of construction projects fall short of their projected completion dates. The usage of 4D BIM for project planning resulted from this supporter of solutions that might address the underlying causes of time-impacting issues. The effects of 4D BIM on construction projects are examined in this study. G+10 Residential Building is used as a case study. After creating a 2D plan, Microsoft Project and Revit are utilised to create a 3D model and plan the activities. Navisworks was then used for 4D simulation. Conflict reports are discovered by 4D simulation, and 4D simulation with various time intervals can be shown. The findings highlighted the most important ways the 4D BIM assistance had an impact on the objectives related to the effects of 4D BIM on project reliability, monitoring, and diagnostics.

IndexTerms – Four Dimensional, Building Information Modelling, Planning, Scheduling, Construction Project, Visulization, Case Study

I. INTRODUCTION

A substantial percentage of building projects struggle to meet their completion dates due to different issues. This advocated for remedies that might address the fundamental causes of time-sensitive consequences, which led to using "4D building information modeling (BIM)" for program management. A construction business, which has a reputation for being ineffective and conflicting, continues to struggle with on-time delivering. Because of the production of construction project overruns, several methodologies have been introduced to reduce potential delay impacts of these factors, some are recognized as lean production to ensure the greatest performance of the construction project through the attempts of a completely partnered development team. Sustainable building principles inhibit project delays by utilizing methods such as modeling work and visual interface making plans, preassembly, and associated documentation, as well as comprehensive communication. The emergence of "Building information modeling (BIM)", which the construction industry has gradually embraced in recent years, has resulted in a much more contemporary byproduct of the continuous improvement. Time-related knowledge is connected with different elements of the service model using "4D BIM". Information on a particular component or working area's scheduled date, design and assembly period, hardening and curing tolerances, scheduling, or interrelatedness with some other sections might all be provided. The incorporation of scheduled time based characteristic data also allows for the creation of 3D representations of a program's evolution, demonstrating how it would be built so that both the superstructure and adjacent site would seem at every step. This is quite useful for arranging tasks in a professional and rational manner that maximizes productivity on the job site. Working groups may successfully develop materials in a simulated space first there after offering immediate feedback on style or approach using construction projects as well as visual data.

II. OBJECTIVES

- To investigates the effects of 4d BIM on construction projects & identify clash.
- To study and visualize the different phase of the construction with planning.

III. SCOPE OF WORK

This portion introduces the basic understanding of the “4D BIM” in the construction industry along with basic knowledge about the effectiveness of the modeling process to reduce the time consumption of a system. The "4D BIM" allows a project participant to perform all the duties including such planning, budgeting, and scheduling inside a digital world where mistakes are significantly less serious and there is more room for changes.

IV. RESEARCH METHODOLOGY

1) LITERATURE REVIEW:

Building information modeling (BIM) is quickly becoming a tool for building production scheduling but also 4D simulations. Although literature review of construction phase modeling focuses on scheduling structural components and designing and visualizing associated labor activities. Despite some practical experience with "BIM"-based layout design or clear conceptual, site activities such as safety as well as logistics are almost disregarded.

2) DATA COLLECTION:

For data collection of all 2d drawing is created, then a 3d model is created, and finally 3d model is divided in to levels and zones to match the scheduled activities. Microsoft Project is used for scheduled activities. In the next step, develop selection sets in navisworks and link project tasks with selection sets. And last, stimulate the 3d model with its time associations.

3) DATA ANALYSIS:

For data analysis construction stimulation is studied with different time interval and clashes are solved.

V. LITERATURE REVIEW

According to Wang et al 2018, this study explores the potential application of 4d BIM or four dimensional building information modelling, as a key tool for the planning of activities related to construction site safety. This work is based on the BIM safety research project, which is still active as of the time of writing. A demonstration of how four dimensional project layout and safety related planning procedures carried out with the help of BIM software that is currently available has been offered as part of the research development's intermediate results.

According to Raul et al 2020,The development of "BIM"-based technologies for construction quality development and preparation as part of "4D-construction" management is the primary objective of the research study. The safety improvement methods, in particular those carried out by the builders, have been analyzed in order to determine the design tasks that could benefit from the use of BIM.

According to Brevis 4d BIM offers improved chances to produce alternate preliminary designs of different building phases and activities. Strategic planning method is used that takes safety considerations in to account has the potential to result in increases safety.

According to Raul, The implications of using 4D BIM on building projects are investigated in this research. Many infrastructure projects are not completed within their scheduled timeline. These goals centered on the implications of 4D BIM on project dependability, surveillance, and diagnostics. The results revealed eight main ways in which 4D BIM supports project outcomes.

VI. DATA COLLECTION

6.1 INTRODUCTION

Here for the data collection case study of residential project is taken, which is having G+10 story building. The proposed guideline is thoroughly explained in this section. In the first step 2d plan is prepared after that 3d model is covered in to step 2. In next step Microsoft project is used for the creating a schedule of project. In third step discuss about the 3d model is integrated with schedule in Navisworks. Last step covers about the development of the 4d model.

6.2 CREATE A 2D PLAN

A 2d plan is gives information about layout of the building. The residential project is a typical building, which means all the layout are same. Here the image shows the layout of the building.

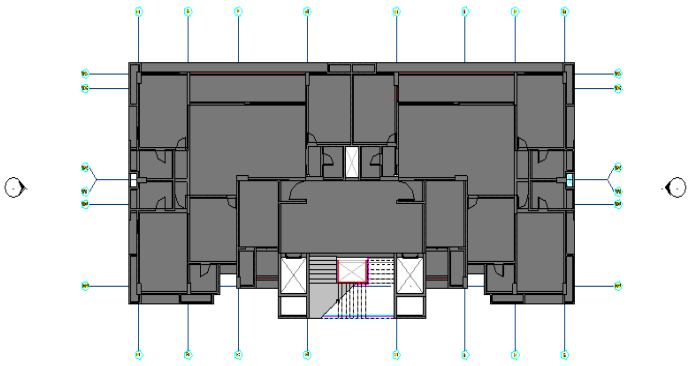


Figure 1-2D Plan

6.3 CREATE A 3D MODEL

After creating 2d model, Revit or other software can be used to transform them in to 3d model. Here Revit is used for creating 3d model. When there are no 2d or 3d models available so 3d laser scanning can be used to gather the spatial locations of different points and extract coordinates to create a 3d model.

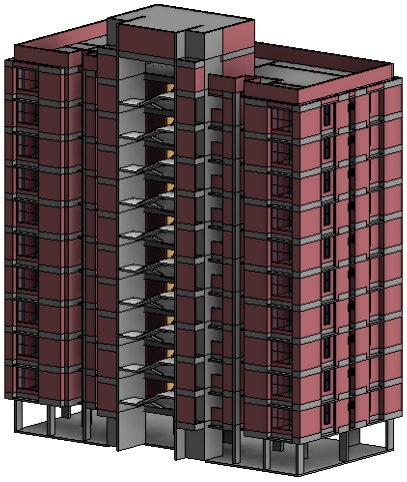


Figure 2-3D Model

Figure 3-3D Model Front View

6.4 CREATE A SCHEDULE(TIMELINE) OF PROJECT

Any construction project must have an accurate schedule of all activities involved in order to move forward with further planning.For creating a schedule Microsoft project or Primavera P6 are used. For this project Microsoft project is used, which is a straightforward process that involves feeding the software the schedule dates of the activities involved in construction project and using that information to create an activity profile and Gant chart. For scheduling, the project plan start date and plan end date are taken for each activity. Here two images shows the planning of the activity and through this planning is done till 10th floor.

GANTT CHART

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
0		**Residential Project Case Study**	**175 days**	**Mon 5/2/22**	**Fri 12/30/22**	
1		**L0**	**6 days**	**Mon 5/2/22**	**Mon 5/9/22**	
2		L0-Floor	1 day	Mon 5/2/22	Mon 5/2/22	
3		L0-Column	3 days	Tue 5/3/22	Thu 5/5/22	2
4		L0-Framing	2 days	Fri 5/6/22	Mon 5/9/22	3
5		**L1**	**15 days**	**Tue 5/10/22**	**Mon 5/30/22**	
6		L1-Floor D	1 day	Tue 5/10/22	Tue 5/10/22	4
7		L1-Floor	1 day	Wed 5/11/22	Wed 5/11/22	6
8		L1-Stair	1 day	Thu 5/12/22	Thu 5/12/22	7
9		L1-Column	3 days	Fri 5/13/22	Tue 5/17/22	8
10		L1-Wall	3 days	Wed 5/18/22	Fri 5/20/22	9
11		L1-Door	2 days	Mon 5/23/22	Tue 5/24/22	10
12		L1-Window	2 days	Wed 5/25/22	Thu 5/26/22	11
13		L1-Framing	2 days	Fri 5/27/22	Mon 5/30/22	12
14		**L2**	**15 days**	**Tue 5/31/22**	**Mon 6/20/22**	
15		L2-Floor D	1 day	Tue 5/31/22	Tue 5/31/22	13
16		L2-Floor	1 day	Wed 6/1/22	Wed 6/1/22	15

Figure 4-Msp-1

GANTT CHART

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
17		L2-Stair	1 day	Thu 6/2/22	Thu 6/2/22	16
18		L2-Column	3 days	Fri 6/3/22	Tue 6/7/22	17
19		L2-Wall	3 days	Wed 6/8/22	Fri 6/10/22	18
20		L2-Door	2 days	Mon 6/13/22	Tue 6/14/22	19
21		L2-Window	2 days	Wed 6/15/22	Thu 6/16/22	20
22		L2-Framing	2 days	Fri 6/17/22	Mon 6/20/22	21
23		**L3**	**15 days**	**Tue 6/21/22**	**Mon 7/11/22**	
24		L3-Floor D	1 day	Tue 6/21/22	Tue 6/21/22	22
25		L3-Floor	1 day	Wed 6/22/22	Wed 6/22/22	24
26		L3-Stair	1 day	Thu 6/23/22	Thu 6/23/22	25
27		L3-Column	3 days	Fri 6/24/22	Tue 6/28/22	26
28		L3-Wall	3 days	Wed 6/29/22	Fri 7/1/22	27
29		L3-Door	2 days	Mon 7/4/22	Tue 7/5/22	28
30		L3-Window	2 days	Wed 7/6/22	Thu 7/7/22	29
31		L3-Framing	2 days	Fri 7/8/22	Mon 7/11/22	30
32		**L4**	**15 days**	**Tue 7/12/22**	**Mon 8/1/22**	
33		L4-Floor D	1 day	Tue 7/12/22	Tue 7/12/22	31
34		L4-Floor	1 day	Wed 7/13/22	Wed 7/13/22	33

Figure 5-Msp-2

6.5 DIVIDE 3D MODEL IN TO LEVELS

The industry foundation classes(IFC) format can be used in this module to export the 3d Revit file, after that it can be separated in to levels. Revit's IFC file functionality offers the additional benefit of level division for 4d simulation. When a dialogue box with the option to split by levels occurs while exporting a Revit file, this can be done. The 3d model could instead be partitioned through module one. The industry foundation classes(IFC) format can be used in this module to export the 3d Revit file, after that it can be separated in to levels. Revit's IFC file functionality offers the additional benefit of level division for 4d simulation. When a dialogue box with the option to split by levels occurs while exporting a Revit file, this can be done. The 3d model could instead be partitioned through module one.

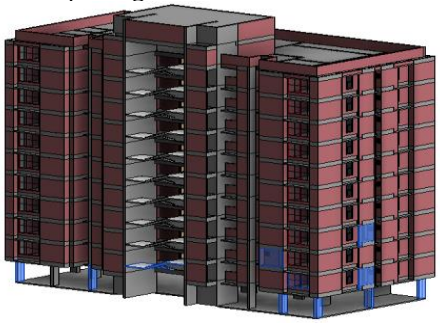


Figure 6-3D Model Levels

6.6 DEVELOP SELECTION SETS

The MSP schedule now imported in to navisworks and seen in the selection, which displays various model components. The schedule will depend on the number of the items and their repetition, and it can be linked using either a selection set or a search set.

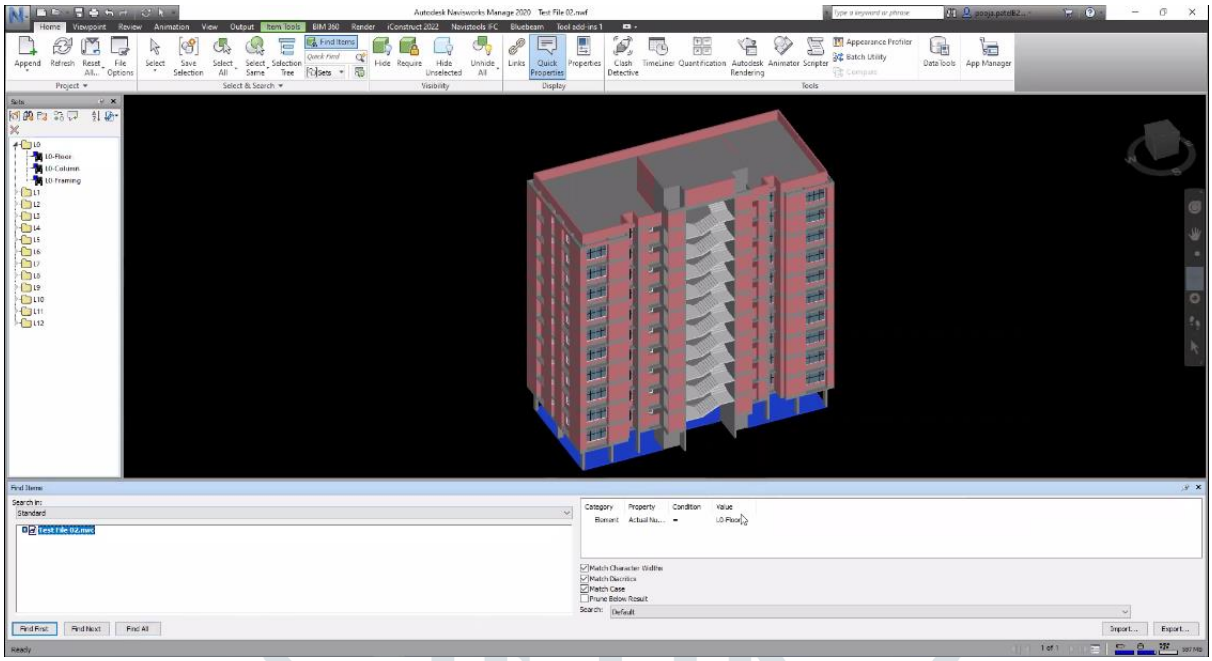


Figure 7-3D Model Set-1

6.7 LINK SELECTION OF SETS WITH PROJECT TASKS

All the activities should be linked with the 3d model so the 3d model can identify the each components. Based to the requirements different task type can be given, after that according to activity name attach set.

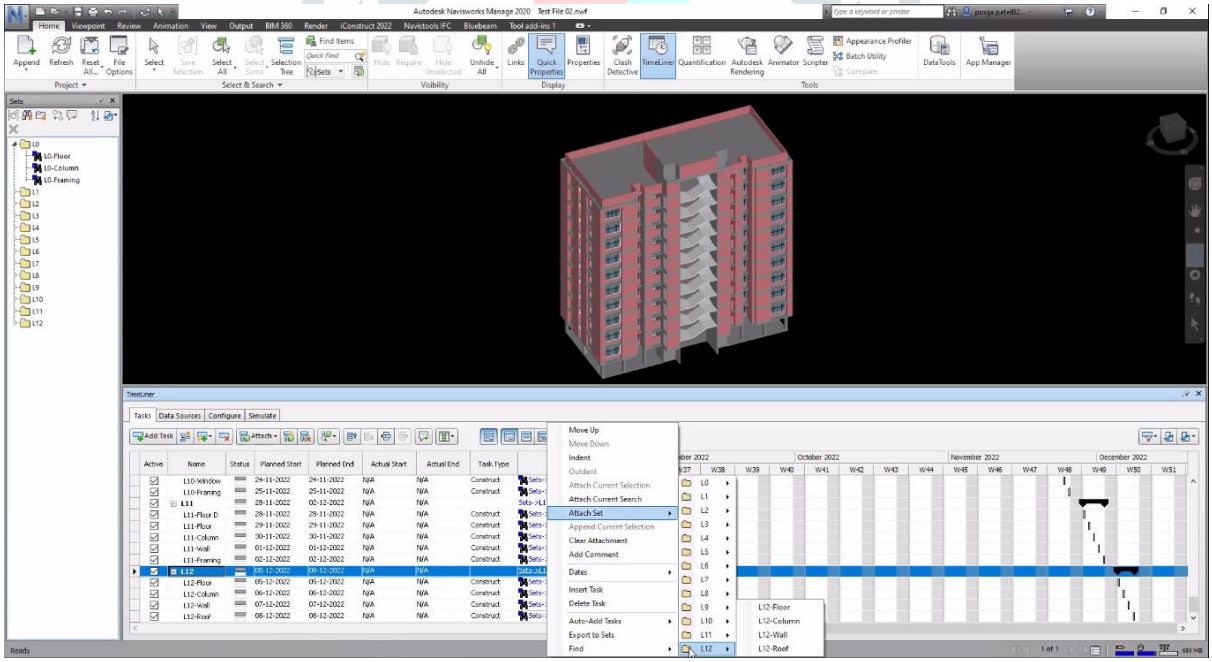


Figure 8-3d Model With Timeline

VII. DATA ANALYSIS

7.1 CLASH DETECTION

A crucial step in the integrated BIM modelling process is clash detection. BIM modelling entails building a through master model that contains design models from several engineering disciplines. The best BIM software for clash detection and clash report generation is navisworks. By detecting conflicts between various models early in the design process, clash detection through building information modelling aids in project acceleration by assisting architects and contractors in removing the possibility of multi-level design changes that could lead to budget overruns and delays in project completion. The clash detection procedure, which makes use of navisworks, locate areas where independent models conflict with one another by examining the areas where model elements from different architectural and engineering design disciplines overlap. Conflict detection makes sure everything meshes together and nothing is incompatible. In this project architecture model is taken for cash study, so for understanding clash is found. Here the clash is found having tolerance of 0.020 m. There are total four clashed found, but due to tolerance value this clashes are avoided.

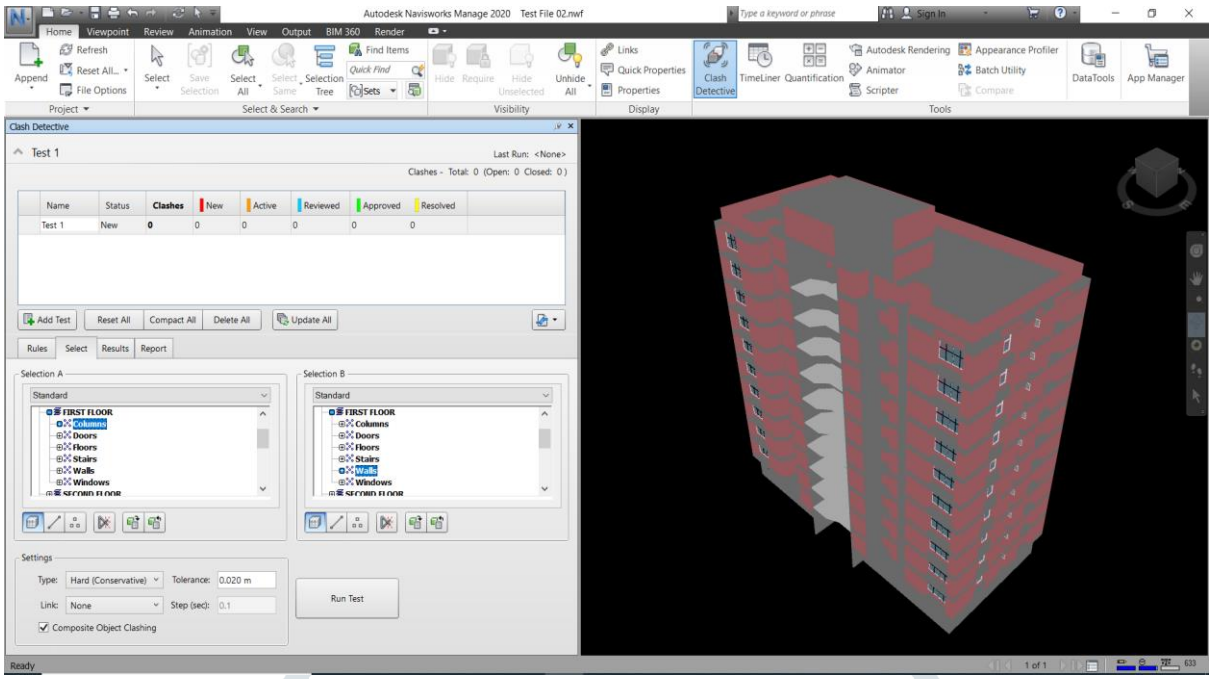


Figure 9-3D Model Identify Clash

In this project architecture model is taken for cash study, so for understanding clash is found. Here the clash is found having tolerance of 0.020 m. There are total four clashed found, but due to tolerance value this clashes are avoided.

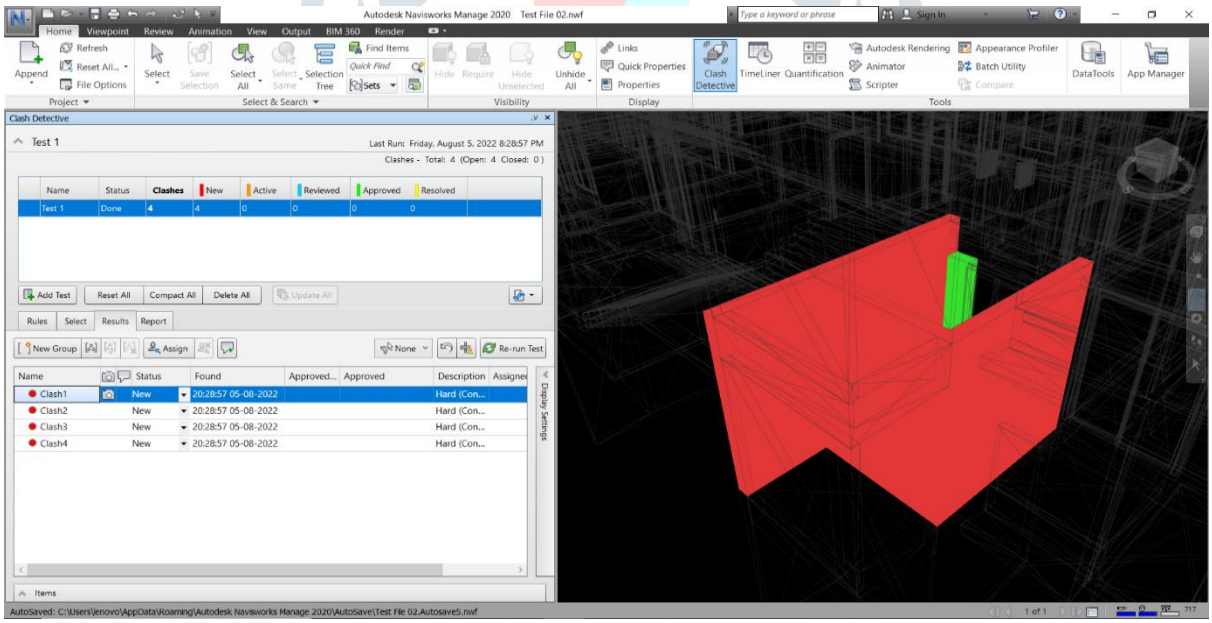


Figure 10-3D Model Clash 2

AUTODESK® NAVISWORKS®

Clash Report

Test 1	Tolerance	Clashes	New	Active	Reviewed	Approved	Resolved	Type	Status
	0.020m	4	4	0	0	0	0	Hard (Conservative)	OK

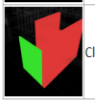
							Item 1					Item 2				
Image	Clash Name	Status	Distance	Description	Date Found	Clash Point	Item ID	Layer	Path	Item Name	Item Type	Item ID	Layer	Path	Item Name	Item Type
	Clash1	New	-0.230	Hard (Conservative)	2022/8/6 03:28	x:3.960, y:-4.233, z:4.875	*Element ID:* 574396	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Columns > Family3 > LIFT WALL > Family3 > Concrete, Cast-in-Place, Gray	Concrete, Cast-in-Place, Gray	Solid	*Element ID:* 532485	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Walls > Basic Wall > 230 MM BRICK WAL > Basic Wall > Brick, Common	Brick, Common	Solid
	Clash2	New	-0.230	Hard (Conservative)	2022/8/6 03:28	x:-4.896, y:-4.463, z:4.875	*Element ID:* 574395	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Columns > Family3 > LIFT WALL > Family3 > Concrete, Cast-in-Place, Gray	Concrete, Cast-in-Place, Gray	Solid	*Element ID:* 532486	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Walls > Basic Wall > 230 MM BRICK WAL > Basic Wall > Brick, Common	Brick, Common	Solid
	Clash3	New	-0.115	Hard (Conservative)	2022/8/6 03:28	x:3.960, y:-8.446, z:4.875	*Element ID:* 574396	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Columns > Family3 > LIFT WALL > Family3 > Concrete, Cast-in-Place, Gray	Concrete, Cast-in-Place, Gray	Solid	*Element ID:* 532382	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Walls > Basic Wall > 115 MM BRICK WALL > Basic Wall > Brick, Common	Brick, Common	Solid
	Clash4	New	-0.115	Hard (Conservative)	2022/8/6 03:28	x:-2.919, y:-8.331, z:7.300	*Element ID:* 574395	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Columns > Family3 > LIFT WALL > Family3 > Concrete, Cast-in-Place, Gray	Concrete, Cast-in-Place, Gray	Solid	*Element ID:* 532381	FIRST FLOOR	File > Test File 02.nwc > FIRST FLOOR > Walls > Basic Wall > 115 MM BRICK WALL > Basic Wall > Brick, Common	Brick, Common	Solid

Figure 11-Clash Report

7.2 4D SIMULATION

Here first simulation is taken at level three. It can be easily seen that till the 22nd June 2022 total work is completed 21.11%. and stair case of level three is pending. Hence like that any time interval project progress can be seen with visualization.

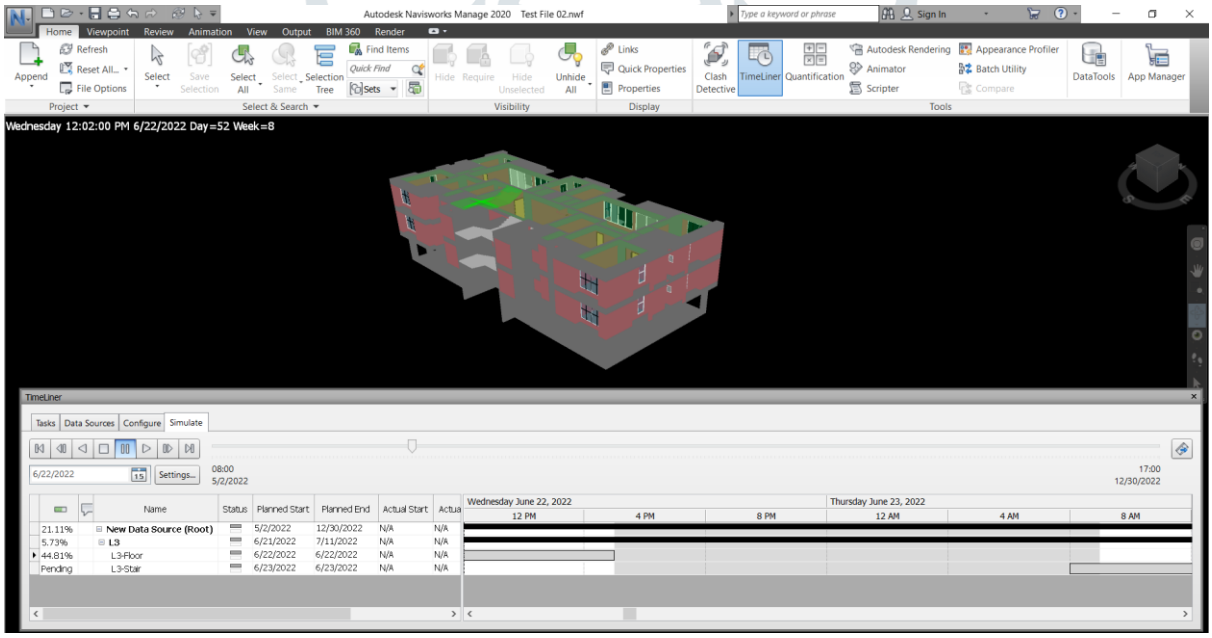


Figure 12-3D Model 4D Simulation-1

VIII. CONCLUSION

So for the cash study it can easy to find out clashes, apart from that we can also find out 4d simulation with different time interval so it gives idea about project progress and also generates report and also complete project within timeline or before the timeline. Through 4D BIM project is completed within timeline so additional cost also decrease. In addition it also improve coordination among participating entities, increases work efficiency and productivity.

IX. FUTURE SCOPE

In this case study 4D BIM is taken but in MSP file the researcher can also add the cost each activity wise. After attaching navisworks client and contractor can know about the budget of the project with different time interval with simulation. In this case study only architecture model is used but research can create structural design model, MEPF(mechanical, electrical, plumbing, firefighting) model, independent from each other. Clash detection enters the scene once all the models have been incorporated in to the BIM modelling process.

X. ACKNOWLEDGMENT

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