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BUILDING INFORMATION MODELLING OF A TWO STOREY BUILDING USING AUTODESK REVIT AND AUTODESK NAVISWORK MANAGE

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ABSTRACT

Building Information Modelling is a widely used technology in the construction industry. BIM gives different dimension to a project and helps to view all possible aspects of building from designing and a model can be generated. The final model gets analyzed by BIM software to eliminate the maximum error during execution. This paper discusses about two BIM software (Autodesk Revit and Autodesk Naviswork manage) implementation in a two storey building.

KEYWORDS: Building Information Modelling (BIM), Dimension, Construction, Implementation

INTRODUCTION

BIM, gives three dimensional features resembles realistic, serves as a construction productivity tool to increase productivity in the design and execution phases. Most of the large construction companies are experimenting with BIM to produce cost and schedule savings. . BIM data help to demonstrate the entire building life cycle. Quantities and properties of materials in a project are extracted without any difficulties and work can be defined effortlessly. BIM helps in visualizing the building which result in considerable cost savings, from design and construction to maintenance. BIM helps in eliminating a lot of risks and issues easier and earlier before actual construction took place. As a result the construction process gets shortened and construction takes place more efficiently. This BIM helps to save cost and maintenance can be done for reducing additional cost. The BIM extends to 5Dimension (cost). BIM includes many software for performing a different dimensional properties. 3D BIM software like Autodesk Revit possess modeling of a building. 4D BIM software like Autodesk Revit and Naviswork manage to give duration of a project. 5D BIM software (Autodesk Revit and Autodesk Naviswork manage) deals with the cost of a project. The dimensional properties are increasing in BIM. But they are yet to be developed a lot.

The paper shows the Autodesk Revit and Autodesk Naviswork manage implementation in a two storey building. The construction stage and life cycle of a building can be studied using both the software which helps in execution.

AUTODESK REVIT

Autodesk Revit is a building information modeling software which helps for structural engineers, architects, MEP engineers, designers and contractors. It allows users to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Revit is capable to plan and track the various stages in the building's lifecycle, from designing stage to construction and later demolition.

***Features of Revit*:** Parametric components, work sharing, design options , set schedules, documentation, phasing of project, interoperability, linked file performance, work in perspective views, improved integration between Revit and structural analysis software.

RESULTS OBTAINED THROUGH AUTODESK REVIT

2D Plan

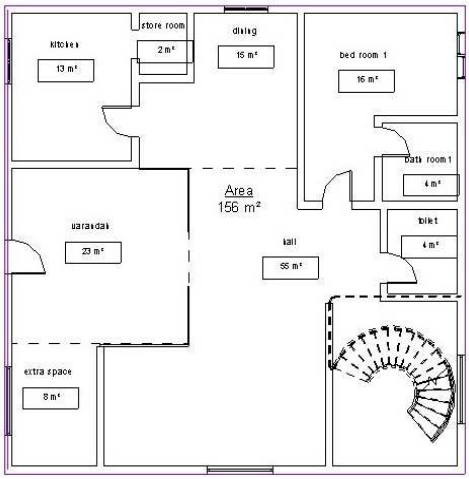

Figure 1: Ground Floor Plan of Building

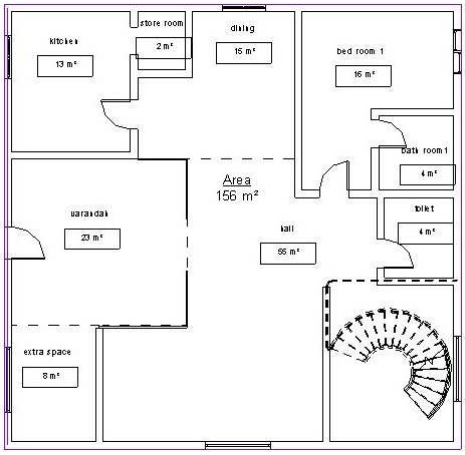

Figure 2: First Floor Plan of Building

3D Sectional View

Figure 3: Sectional View of Ground Floor

Through the sectional view we can change the elements in ground floor. it helps in the work flow of the building.

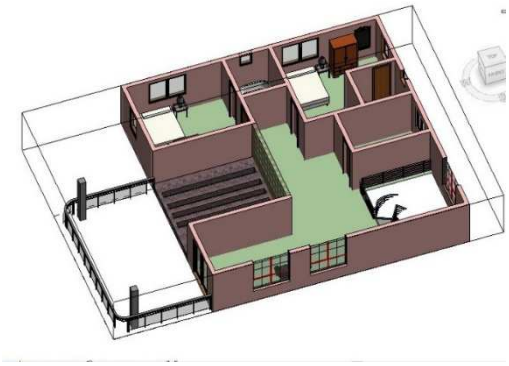

Figure 4: 3D View of the First Floor

Through the sectional view we can change the elements in ground floor. it helps in the work flow of the building.

Schedules

It helps to create schedules, quantities, and material takeoffs to quantify and analyze the components and materials used in a project.

Table 1: The Wall Schedule of Ground Floor

<Wall Schedule 1>

A	B	C	D	E	F	G	H
Area	Volume	Width	bricks	cost of bricks	Length	Count	Mark
ground floor							
ground floor							
342 SF	6.36 m³	0' - 8"	3180.62838	25445.04	41' - 0"	1	ground floor
302 SF	5.60 m³	0' - 8"	2801.387995	22411.10	40' - 0"	1	ground floor
346 SF	6.44 m³	0' - 8"	3218.175112	25745.40	41' - 0"	1	ground floor
100 SF	1.86 m³	0' - 8"	928.194212	7425.55	11' - 8"	1	ground floor
270 SF	5.02 m³	0' - 8"	2510.479623	20083.84	40' - 0"	1	ground floor
76 SF	1.42 m³	0' - 8"	708.325708	5666.61	13' - 6"	1	ground floor
43 SF	0.81 m³	0' - 8"	403.562701	3228.50	5' - 8"	1	ground floor
46 SF	0.86 m³	0' - 8"	431.314257	3450.51	6' - 0"	1	ground floor
148 SF	2.74 m³	0' - 8"	1372.113183	10976.91	17' - 0"	1	ground floor
102 SF	1.89 m³	0' - 8"	943.076648	7551.01	14' - 8"	1	ground floor
61 SF	1.13 m³	0' - 8"	564.987781	4519.90	7' - 8"	1	ground floor
123 SF	2.29 m³	0' - 8"	1143.851341	9150.81	14' - 6"	1	ground floor
45 SF	0.84 m³	0' - 8"	417.815191	3342.52	8' - 8"	1	ground floor
65 SF	1.21 m³	0' - 8"	605.344051	4842.75	7' - 8"	1	ground floor
43 SF	0.80 m³	0' - 8"	397.544687	3180.36	7' - 6"	1	ground floor
91 SF	1.69 m³	0' - 8"	842.185574	6737.48	10' - 9"	1	ground floor
360 SF	6.69 m³	0' - 8"	3344.50944	26756.08	72' - 0"	1	ground floor
280 SF	5.20 m³	0' - 8"	2601.28512	20810.28	56' - 0"	1	ground floor
360 SF	6.69 m³	0' - 8"	3344.50944	26756.08	72' - 0"	1	ground floor
226 SF	4.19 m³	0' - 8"	2096.022447	16768.18	56' - 0"	1	ground floor
				254848.91			

It gives the brick count and cost of bricks using formula.

Table 2: The Wall Schedule of First Floor

<Wall Schedule 2>

A	B	C	D	E	F	G
Area	Volume	Width	Length	no of bricks	cost of bricks	Mark
first floor						
27 m²	5.33 m³	0' - 8"	40' - 0"	2662.822592	21302.58	first floor
28 m²	5.65 m³	0' - 8"	41' - 0"	2825.630548	22605.04	first floor
27 m²	5.32 m³	0' - 8"	41' - 0"	2657.614148	21260.91	first floor
13 m²	2.70 m³	0' - 8"	16' - 0 1/2"	1349.234038	10793.87	first floor
9 m²	1.84 m³	0' - 8"	13' - 5 1/2"	920.049976	7360.40	first floor
5 m²	0.93 m³	0' - 8"	10' - 8"	465.571672	3724.57	first floor
11 m²	2.13 m³	0' - 8"	16' - 0"	1064.945459	8519.56	first floor
6 m²	1.12 m³	0' - 8"	7' - 7 1/2"	560.962747	4487.70	first floor
14 m²	2.80 m³	0' - 8"	17' - 4"	1399.017363	11192.14	first floor
5 m²	0.97 m³	0' - 8"	8' - 0"	483.089522	3864.72	first floor
5 m²	1.06 m³	0' - 8"	7' - 2 1/2"	528.126936	4225.02	first floor
5 m²	0.98 m³	0' - 8"	8' - 2 1/2"	488.306261	3906.45	first floor
10 m²	1.93 m³	0' - 8"	12' - 7 1/2"	966.114277	7728.91	first floor
13 m²	2.59 m³	0' - 8"	16' - 0 1/2"	1296.273054	10370.18	first floor
7 m²	1.39 m³	0' - 8"	13' - 5 1/2"	695.574976	5564.60	first floor
				146996.67		

It gives the brick count and cost of bricks using formula. The number of bricks is calculated by the formula volume/0.002.

Table 3: The Floor Schedule Exist in Building

Floor Schedule

A	B	C	D	E
Area	Volume	Perimeter	Level	Family and Type
Level 1				
23 m²	9.01 m³	62' - 3 1/2"	Level 1	Floor: grass flo0or
382 m²	152.95 m³	258' - 7 1/2"	Level 1	Floor: floor1
149 m²	59.42 m³	416' - 0"	Level 1	Floor: grass flo0or
7 m²	2.67 m³	46' - 11"	Level 1	Floor: floor1
Level 2				
141 m²	56.33 m³	164' - 7 1/2"	Level 2	Floor: Generic Floor - 400mm
Level 3				
134 m²	53.54 m³	197' - 5"	Level 3	Floor: Generic Floor - 400mm 2

It gives the area and the type of floor exist in building at different heights.

<Room Schedule>

A	B	C	D	E	F
Name	Area	Perimeter	Level	Volume	Number
Level 1					
bath room1	4 m²	27' - 4 1/2"	Level 1	11.33 m³	4
bed room 1	16 m²	60' - 4 1/2"	Level 1	41.09 m³	3
dining	15 m²	55' - 6 1/2"	Level 1	39.33 m³	6
extra space	8 m²	36' - 7 1/2"	Level 1	19.76 m³	7
hall	55 m²	144' - 2 1/2"	Level 1	164.53 m³	8
kitchen	13 m²	47' - 4 1/2"	Level 1	33.64 m³	1
store room	2 m²	19' - 4 1/2"	Level 1	5.61 m³	2
toilet	4 m²	27' - 4"	Level 1	11.23 m³	5
varandah	23 m²	62' - 7"	Level 1	57.20 m³	9
Level 1	140 m²	480' - 10"			
Level 2					
b.r 2	5 m²	28' - 7"	Level 2	12.33 m³	11
b.r 3	4 m²	27' - 9 1/2"	Level 2	11.61 m³	13
balcony	39 m²	85' - 1"	Level 2	117.27 m³	16
bed room 2	18 m²	56' - 4 1/2"	Level 2	47.56 m³	10
bed room 3	18 m²	64' - 0 1/2"	Level 2	47.90 m³	12
hall 2	63 m²	143' - 4 1/2"	Level 2	163.54 m³	15
study room	8 m²	39' - 0 1/2"	Level 2	21.81 m³	14
Level 2	157 m²	444' - 3 1/2"			
totals	297 m²	925' - 1 1/2"			

Figure 4: Room Schedule of the Building

Number of the room's exits in buildings and their usages are mentioned

3D Views

Figure 5: 3D View of The Building

Figure 6: Rendering View of the Building

The 3D view is an animated view of the building.

It shows, reality view of the building.

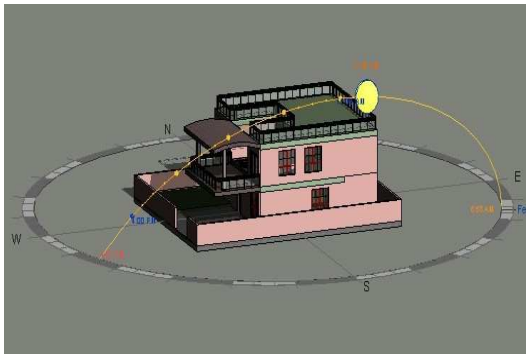

Figure 7: Sun Path of the Building.

Using sun path the face of the building can be designed. the sun path helps the designers to plan a building with natural lightings.

Phasing of Project

Through phasing the demolition and reconstruction of the building can be made through

Phasing the properties of the existing building can be studied and further demolition and renovation can be made.

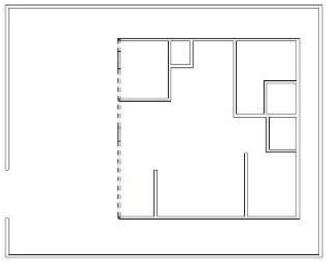

Figure 8: Demolition Stage of the Building

Dashed lines represent the wall going to be demolished. Their properties can be studied. Marked elements as demolished in the current phase using the demolish tool. If you demolish an element in one view, it is marked as demolished in all views that have the same phase.

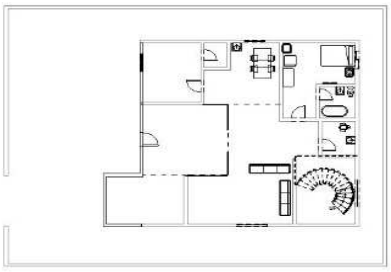

Figure 9: Phase after Reconstruction of the Building

The new wall is reconstructed at front side

Energy Analysis

Energy simulation can help you analyze the movement of energy in, out, and through the rooms and volumes in a building model. This information can help designers make better informed, cost-effective decisions that improve the performance and reduce the environmental impact of buildings.

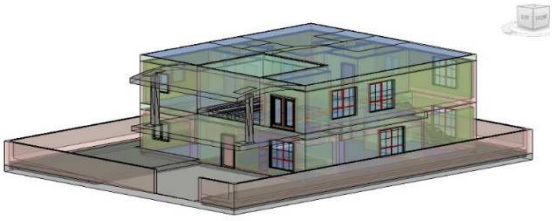

Figure 10: Energy Analysis of the Building.

Building Performance Factors

Location:	Chennai, India
Weather Station:	726146
Outdoor Temperature:	Max: 105°F/Min: 61°F
Floor Area:	2,717 sf
Exterior Wall Area:	1,845 sf
Average Lighting Power:	0.45 W / ft²
People:	1 people
Exterior Window Ratio:	0.33
Electrical Cost:	$0.05 / kWh
Fuel Cost:	$0.14 / Therm

Energy Use Intensity

Electricity EUI:	18 kWh / sf / yr
Fuel EUI:	5 kBtu / sf / yr
Total EUI:	68 kBtu / sf / yr

Life Cycle Energy Use/Cost

Life Cycle Electricity Use:	847,480 kWh
Life Cycle Fuel Use:	2,271 Therms
Life Cycle Energy Cost:	$18,233

*30-year life and 6.1% discount rate for costs

Figure 11: Energy Analysis Report of Two Storey Building and it Shows the Life Period of Building as 30 Years

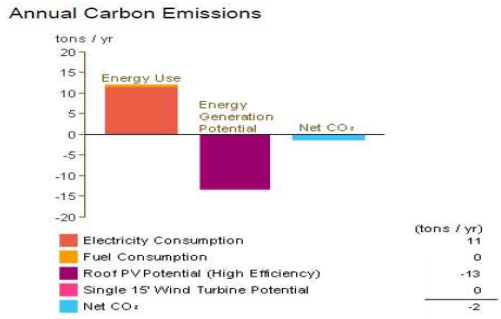

Figure 12: Annual Carbon Emission of Building through Energy Analysis

Work-Sharing

Work-sharing is a design method that allows multiple team members to work on the same project model at the same time. Using LAN connectivity the team members can update and work on the particular job.

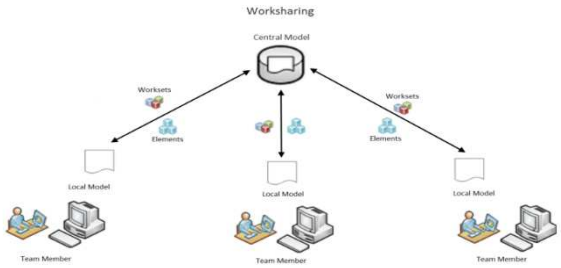

Figure 13: Work-Sharing Performed Through a Central Model

Design Options

A design option is a set of collection with one primary option and one or more secondary option. With design options, a team can develop, evaluate, and redesign building components and rooms within a single project file. In this project roof are taken into design set options for customer choice.

Figure 14: Inclined Roof in Design Option as Primary Option.

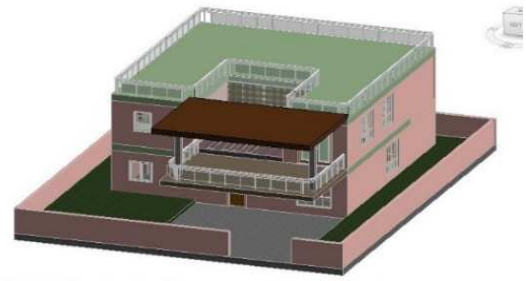

Figure 15: Flat Roof in Design Options (Secondary Option)

Figure 16: Slope Roof Design Option. (Secondary Option)

AUTODESK NAVISWORK MANAGE

Naviswork is a 5D BIM software. It helps to simulate along with them. The main feature of Naviswork is clash detection. The software performs clashes test and they give more quality in animation and rendering than Autodesk Revit.

Clash Detection

Clash detection allows for the effective identification, inspection and reporting of interferences in a 3D project model. It helps to reduce the risk of human error during model inspections. Clash detection helps to rectify the clashes and again the test can be performed. Through this the errors during construction can be eliminated. Before performing clash detection test some of the rules should be selected. So that original clashes can be detected and it saves time.

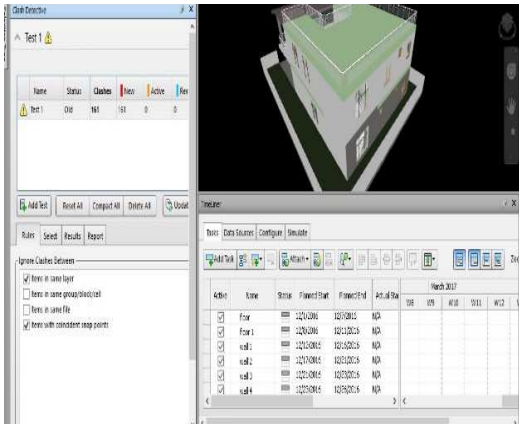

Figure 17: After Clash Detection

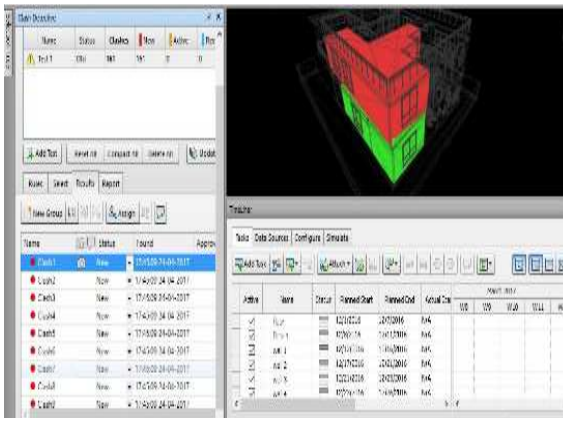

Figure 18: Before Clash Detection

Some of the rules are applied to reject unwanted clash results.

After the rules are applied the levels are selected for detecting the clashes. The building possesses 3 levels and all the levels are selected for clash detection and run results are performed. The results show 160 clashes

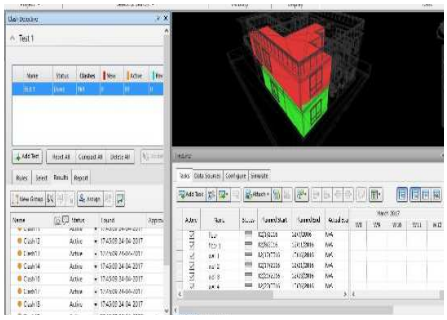

Figure 18(a): After Clash Detection

The obtained clashes are reviewed and the clashes are approved. And they can be redesigned.

Time Liner with Simulation: Time Liner import schedules from a variety of sources or you can assign the task. Then connect tasks in the schedule with objects in the model to create a simulation. This allows you to see the effects of the schedule on the model, and compare planned dates against actual dates. Time Liner also allows the export of images and animations based on the results of the simulation. Time Liner will automatically update the simulation if the model or schedule changes.

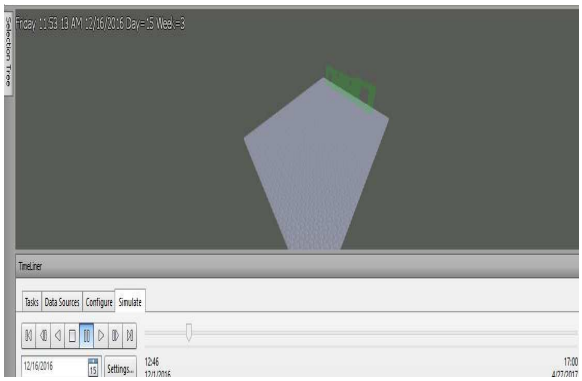

Figure 19: Completed Flooring in the Ground Floor (Duration – 3rd Week)

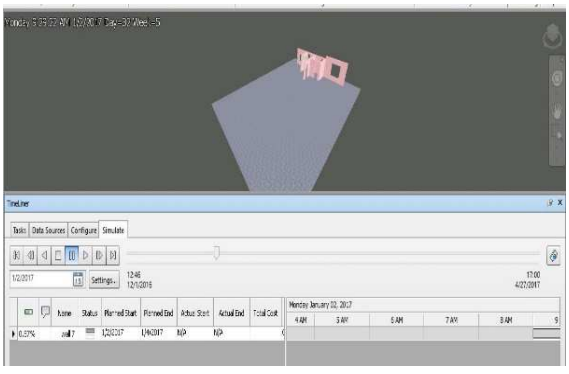

Figure 20: Completed Flooring in the Ground Floor (Duration – 5th Week)

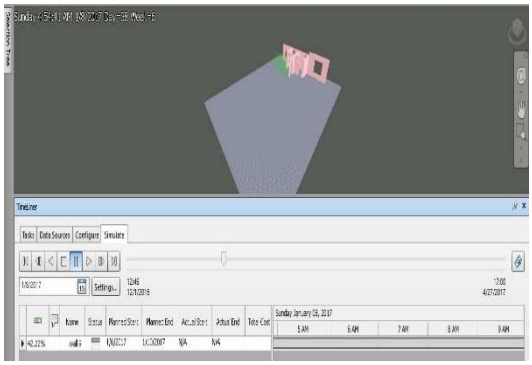

Figure 21: Completed Flooring in the Ground Floor (Duration – 6th Week)

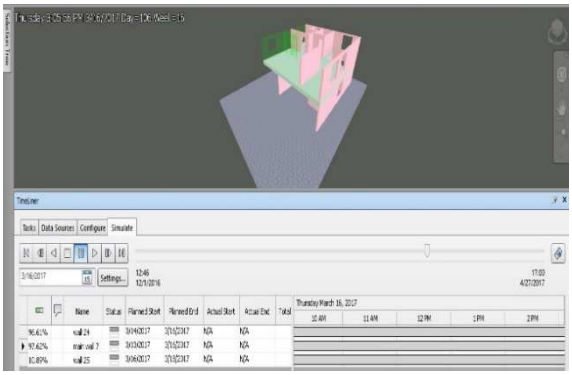

Figure 22: Completed Flooring in the First Floor (Duration – 16th Week)

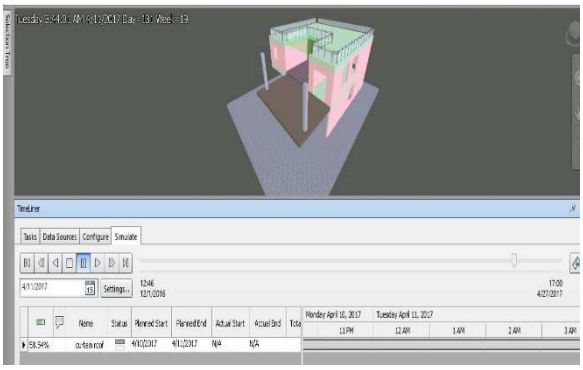

Figure 23: Completed Flooring in the First Floor (Duration – 19st Week)

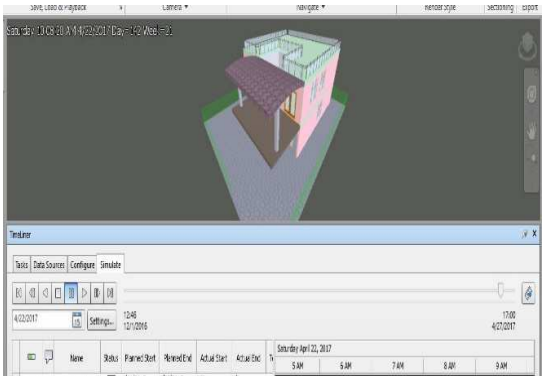

Figure 24: Completed Flooring in the First Floor (Duration – 21st Week)

REVIEW OF AUTODESK REVIT AND AUTODESK NAVISWORK MANAGE

Autodesk Revit helps in 3D modelling of a structure and helps to manage the project in an efficient way. But they lack in the cost estimation of a project. And any estimation files cannot be imported into it, as it stays as 4D BIM.

Autodesk Naviswork manage doesn't model any building and 3D model can be imported into it for performing Naviswork. Any changes to the structure cannot be directly made in Naviswork, but the changes can be updated from Autodesk Revit. Like Revit, Naviswork also lacks in cost estimation of the building, but any estimation files can be imported into it for further changes in estimation. The duration can be seen along with simulation. Clash detection is one of the attractive feature in Naviswork and better animator than Revit.

CONCLUSIONS

In this paper, through BIM software an entire project can be managed. From various literatures, Autodesk Revit and Autodesk Naviswork manage were chosen due to its superior software design. The two storey building was planned, and the 3D modelling of the two storey building their schedules, phasing stage, design options, energy analysis are performed through Autodesk Revit. Clash detection of the building and time liner with simulation of the building is performed through Autodesk Naviswork manage. These details will help to review the properties of the building and helps to make decision for further changes in the structure.

REFERENCES

1. Aladaga H., Demirdögen G. and Isik Z. (2016) "Building Information Modeling (BIM) Use In Turkish Construction Industry", Procedia Engineering 161, PP 174 – 179, World Multidisciplinary Civil Engineering-Architecture-Urban Planning Symposium 2016.
2. Ahn D. and Cha H. (2014)," Integration Of Building Maintenance Data In Application Of Building Information Modeling (BIM)", Journal Of Building Construction And Planning Research, 2, PP 66-172.
3. Arayic Y. and Egbu C. (2012), "Building Information Modelling (BIM) Implementation and Remote Construction Projects: Issues, Challenges, And Critiques". Journal Of Information Technology In Construction – PP 756-772.
4. Aziz N.D., Nawawi A.H., Ariff N. R. M., Asean (2013),"Building Information Modelling (BIM) In Facilities Management: Opportunities To Be Considered By Facility Managers ", Procedia - Social And Behavioral Sciences 234, PP 353 – 362, Turkey Asli (Annual Serial Landmark International) Conferences On Quality Of Life 2016.
5. Blanco F.G.B And Chen H. (2014)," The Implementation Of Building Information Modelling In The United Kingdom By The Transport Industry", The 9th International Conference On Traffic & Transportation Studies (Ictts'2014), Procedia - Social And Behavioral Sciences 138, PP 510 – 520.
6. Bryde D., Broquetas M. And Volm J.M. (2013)," The Project Benefits Of Building Information Modelling (Bim)", International Journal Of Project Management 31, PP 971–980.
7. Bui N., Merschbrock C. And Munkvold B.E. (2016)," A Review Of Building Information Modelling For Construction In Developing Countries", Creative Construction Conference 2016, Ccc 2016, 25-28 June 2016, Procedia Engineering 164 PP 487 – 494.

8. Carbonari G., Stravoravdis S. And Gausden C. (2015)," Building Information Model Implementation Of Existing Buildings For Facilities Management: A Framework And Two Case Studies", Building Information Modelling (BIM) In Design, Construction And Operations 395.

9. Ceranic B., Latham D And Angela Dean (2015)," Sustainable Design And Building Information Modelling: Case Study Of Energy Plus House, Hieron's Wood, Derbyshire UK", Energy Procedia 83, Pp 434 – 443, International Conference On Sustainability In Energy And Buildings 2015.

10. Chougule N. S. and Konnur B. A. (2015)," A Review Of Building Information Modeling (BIM) For Construction Industry", International Journal Of Innovative Research In Advanced Engineering (Ijirae) Issue 4, Volume 2.

11. Elbeltagi E., Hosny O., Dawood M. And Elhakeem A. (2014)",

12. BIM-Based Cost Estimation/ Monitoring For Building Construction", Emad Elbeltagi Int. Journal Of Engineering Research And Applications ISSN: 2248-9622, Vol. 4, Issue 7 (Version 4), PP.56-66.

13. Fai S., Graham K., Duckworth T., Wood N. and Attar R. (2014)," Building Information Modelling and Heritage Documentation", Autodesk Research.

14. Ganah A. And John G. (2015)," Integrating Building Information Modeling And Health And Safety For On-site Construction", Safety And Health At Work 6, PP 39-45.

15. Halttula H., Aapaojab A. and Haapasalo H. (2015), "The Contemporaneous Use Of Building Information Modeling Andrelational Project Delivery Arrangements", 8th Nordic Conference On Construction Economics And Organization, Procedia Economicsandfinance21,PP 532 – 539.

16. Kacprzyk Z. and Tomasz K (2014), "Building Information Modelling – 4d Modelling Technology On The Example Of The Reconstruction Stairwell", Procedia Engineering 91, PP 226 – 231.

17. Khaddaj M. And Srour I. (2014),"Using BIM to Retrofit Existing Buildings", International Conference On Sustainable Design, Engineering And Construction.

18. Khodeir L., Daliaaly and Shaimaatarek (2015), " Integrating HBIM (Heritage Building Information Modeling) Tools In The Application Of Sustainable Retrofitting Of Heritage Buildings In Egypt", Improving Sustainability Concept In Developing Countries, Procedia Environmental Sciences 34, PP258 – 270.

19. Kumar J. and Mukherjee M. (2009), "Scope Of Building Information Modeling (BIM) In India", Journal Of Engineering Science And Technology Review 2 (1), PP 165-169.

20. Maia L., Mêda P.and Freitas J.G. (2016),"BIM Methodology, A New Approach - Case Study Of Structural Elements Creation", 1st International Conference On Structural Integrity, Procedia Engineering 114, PP 816 – 823.

21. Manning R. and Messner J.I. (2008),"Case Studies In Bim Implementation For Programming Of Healthcare Facilities", Itcon Vol. 13 (2008), Manning & Messner, pp. 446.

22. Mojtabavalinejadshoubi, Bagchi A and Borough A.S. (2015),"Reducing The Operational Energy Demand In Buildings Using Building Information Modeling Tools And Sustainability Approaches", Ain Shams Engineering Journal 6, PP 41–55.

23. Nowak P., Ksi M., Drap M. And Zawistowski J. (2016)," Decision Making With Use Of Building Information Modeling", Procedia Engineering 153 (2016), PP 519 – 526.

24. Ramesh M., Helen Santhi M., (2014) "Constructability Assessment Of Climbing Formwork Systems Using Building Information Modeling," Procedia Engineering 64 (2013), PP 1129 – 1138, International Conference On Design And Manufacturing, Icondm.

25. Rokooei S. (2015),"Building Information Modeling In Project Management: Necessities, Challenges And Outcomes", Procedia - Social And Behavioral Sciences 210, PP 87 – 95, 4th International Conference On Leadership, Technology, Innovation And Business Management.

26. Silva M.J.F., Salvado F., Couto P. And Valeazevedo A. (2013), "Roadmap Proposal For Implementing Building Information Modeling (BIM) In Portugal", Open Journal Of Civil Engineering, 6, PP 475-481.