BUILDING INFORMATION MODELING IN AEC INDUSTRY WITH ITS IMPLEMENTATION AND EXECUTION ON A PILOT PROJECT

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Abstract - *The following case study shows how BIM enhances the conventional and traditional design, scheduling and cost estimating methods with a more reliable and self-operating technology. Based on the information obtained, evolution of BIM in AEC industry and the case study, the work finds out that these are the areas of potential development and enhancement in the near future: i) The process of BIM will be more automated and simplified with virtual reality, software algorithms, artificial intelligence and robotic construction coming into existence ii) linking sustainability and energy analysis parameters to BIM delivered projects in the construction and design of building model to deliver an energy efficient structure , and iii) with the development and allocation of resources for 7D BIM technology one can expect simplified and quick parts replacement, optimised compliance and to derestrict BIM as an initial design stage process to a extensive exercise through an entire facility life cycle.*

Keywords - BIM, modelling, designing, analysis, construction scheduling, cost and time estimation.

1 – INTRODUCTION

BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. Due to numerous steps of construction industry and its complicated and extensive structure, errors and reworks often might happen in this section. As such, BIM (Building Information Modeling) is regarded as a beneficial tool in minimizing the waste and improving the efficiency of building construction. In other words , BIM can be used by engineers ,architects, project managers etc. in order to achieve these goals :To decrease design errors, To reduce clash detection, To boost the integration of cost and time, To improve the integration of design and construction phase, To increase the collaboration between different construction sections and finally to improve recycling.

Building Information Modeling has been part of the construction industry for some time now. It is the process of designing a building collaboratively using one coherent system of computer models rather than as separate sets of drawings. BIM is now getting applied to all types of construction, be it buildings, roads, railways, bridges, tunnels etc. Today, we can even apply it to different stages of construction such as planning, design, construction and maintenance. BIM does not solely refer to buildings, but to all sectors that have to do with construction including: roads, railways, utilities, bridges, tunnels, structures, architecture, topography etc.

Information is the heart of Building Information Modeling. BIM changes the way information regarding the entire life cycle of a project and its parts is managed and exchanged. Making available both visual and non-visual information related to every aspect of construction, BIM enables designers, engineers, builders, manufacturers and owners gain a thorough understanding of a project much before its actual construction, thus enabling timely refinement, avoiding errors and generating efficiency .We can easily say that the M in Building Information Modeling stands for Model and Management. Using Building Information Modeling, not only a simplified version of an object, structure, building or construction is modelled, but also the process of construction is organized and controlled more effectively.

Be it project management, land surveying, road design, structure design or construction- the role of Building Information Modeling has almost become indispensable for beyond the ordinary results. Using BIM, owners can improve building quality, significantly reduce building lifecycle costs, better understand design projects from beginning to end, optimize operational efficiencies and increase occupancy and use rates.

In construction, Building Information Modeling could be used to monitor the productivity of a construction process. BIM brings the opportunity to try out solutions in advance before building the structure on site: with a constructible model, the structure can be prototyped virtually. Project parties can understand and review the design more easily, which helps guarantee its accuracy and completeness, and visualize and evaluate alternatives in terms of cost and other project parameters. BIM leads to better communication between project parties and better quality. Building Information Modeling refers to a collaborative method of working which is based on the generation and exchange of data and information between the various project parties. For

effective functioning, BIM requires integration of the following five elements: Processes, Policies, People, Information and Technologies Processes refer to the specific order of work activities with a beginning, an end, and a clear identification of the inputs and outputs of each stage. Policies refer to the principles and rules to guide the decision-making process. Policies are framed to develop standards and best practices to minimize disputes between the parties involved. People make the difference and therefore are the most important. Effective management by people can only lead to successful BIM. Important people in Building Information Modeling usually include: BIM director, BIM manager, BIM consultant, BIM technologist.

2 – LITERATURE REVIEW

A number of studies have been done by researchers in the past to study the impact of BIM on the construction industry. Piyush Sharma, Sakshi Gupta [1], at American journal of engineering studied how Building Information Modeling (BIM) has evolved over the years and how it has impacted the Indian construction industry also its future in the Indian built environment sector.

Saeed Raza Mohandas and Hossein omranny [3] studied how BIM is beneficial for minimising waste and increasing efficiency of building construction. Also it enlightens upon the importance of BIM for architecture, engineers and construction professionals and how it can be used by architects, project managers, modelers etc.
Jenifer Whyte [4] previously looked upon the international research and how the work relates to and inform changes in policy. The paper looked upon the status of BIM in UK and how to implement BIM in public procurement. The research also included research challenges, contribution to practice and future research opportunities.

Debases Sarkar and Raj Modi [5] research the use of BIM in the real estate industry of Ahmedabad and its use in process involving MEP (mechanical, electrical and plumbing) professionals along with possible conflicts between building systems. The 3D models developed with Revit 2015 software would reduce co-ordination problems amongst the architects, structural engineers, contractors etc.

Frida Krantz [6] studied BIM in production phase of civil works since people are reluctant in using BIM in the production phase of construction projects. The purpose of the study is therefore to investigate driving forces behind the use of BIM and the resistors against it and to investigate in what ways BIM could be used in the production phase.

The main objective of this project is to understand the concept and methodology of Building Information modeling (BIM) and then determine its impact and influence on the architecture, engineering and construction industry in the present scenario.

3 - METHODOLOGY

3.1. PILOT PROJECT CAD FILE

The initial step of the project in the beginning was to get a site plan of project made in the conventional CAD format.

The following plan in Fig 1 is a CAD file of the project on which the implementation, execution of BIM was to be done. It was treated as a pilot project for further design, Analysis and planning.
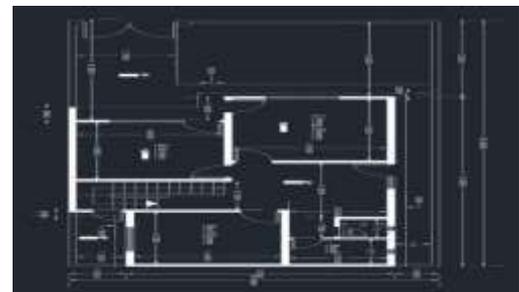

Fig 1: CAD plan of pilot project

3.2. LEVEL 1 FLOOR PLAN

The above plan was then drafted upon the Revit software and the following plan was made at level 1. The below plan in the Fig 2 is of the ground level or base level of the pilot project modified on Revit 2018. It is the level 1 floor plan of the construction site.
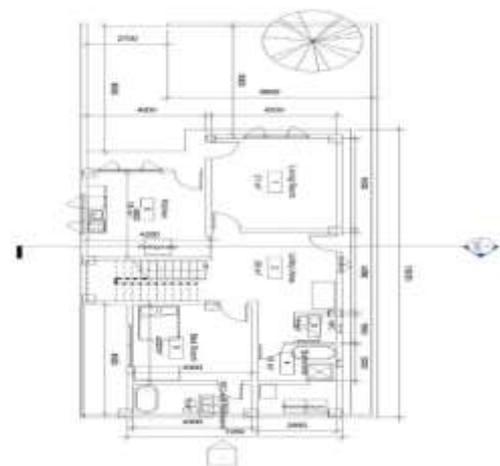

Fig 2: Level 1 floor plan

3.3. LEVEL 2 FLOOR PLAN

Roof of the ground floor was made at level 2 and the beams, walls, doors and windows were constructed along with the mumty on the roof .The below plan in the Fig 3 shows the floor plan of the level 2 of the construction site.
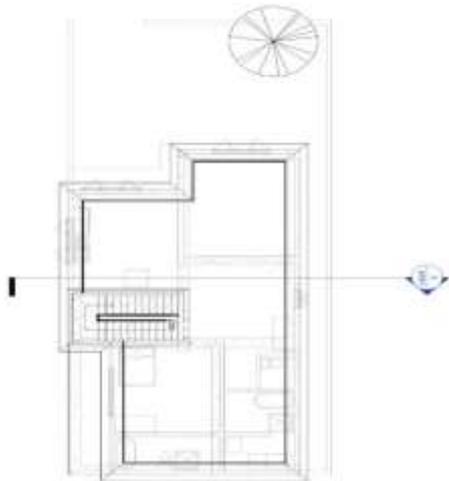

Fig 3: level 2 floor plan

3.4. LEVEL 3 FLOOR PLAN

The roof of the mumty was placed at level 3 of the site and the roof of the house was further enhanced by adding railing to it .The following plan in the Fig 4 shows the level 3 floor plan of the construction site from the top view of the same.
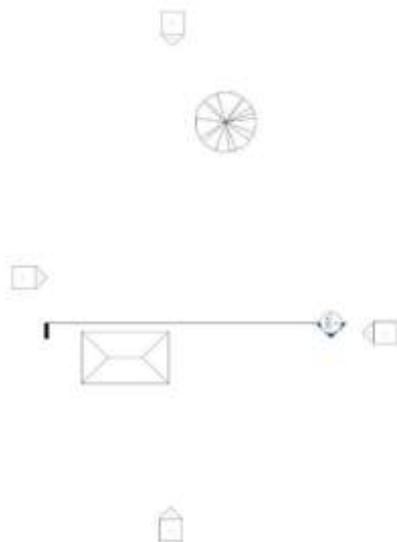

Fig 4: Level 3 floor plan

3.5. SITE PLAN

The top view of the site was checked and further objects such as trees, grass and boundary of the site was place and was checked for placing errors from the top view .The following Fig 5 shows the top view of the whole construction site.
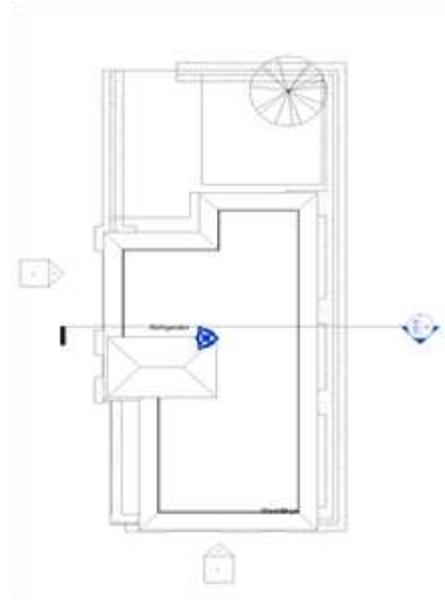

Fig 5: Site plan

3.6. ELEVATION PLAN

The elevation of all the levels were checked from the ground floor to its roof and mumty roof level .The below Fig 6 shows the elevation plan consisting of the elevation of the site namely level 1, level 2, level 3 from the side view.

Fig 6: Elevation of Site

3.7. REALISTIC 3D VIEW OF SITE

The realistic view of the site was take into account and Checked for any errors .The following Fig 7 shows the realistic view of the site in 3 dimensions.

Fig 7: Realistic 3D view of site

4 – MODEL RESULTS AND ANALYSIS

The project is a frame structure consisting of a residential house of one floor. The building consist of a ground floor having space for living room, lobby area, Bathroom, Bedroom, Terrace Floor and Mumty on terrace just above the staircase level. In front of the building there is lawn area and there is ramp which connected with the parking area for parking purpose. Staircase is provided from lobby area up to the terrace level through the mumty. Revit works exactly opposite to AutoCAD. In AutoCAD, first to draw 2D drawing and then move towards 3D (Not BIM). In Revit first to create direct 3D model and then get directly 2D drawing with material quantity and many more which is essential to manage construction of building. In the present work it is created 3D model and able to get 2D drawing as shown below and material quantity as per the requirements. The schedule of door, window, room, wall material and beam is tabulated. The solar study and shadow analysis of site is done from sunrise to sunset. A Gantt chart was produce in navisworks representing the various works to be carried out along with the timeline of each process. Once the timeline of the project was completed along with the Gantt chart a video representing all the task and processes to be carried out was developed. This process of construction along with the timeline of the project is called as stimulation and the video comprises of this process.

4.1. SPACE PLANNING OF GROUND FLOOR

The planning of various rooms in the house was done according to the standards and the bathrooms, WC, space was also highlighted. The following Fig 8 is the pictorial representation of the ground floor of the house with various sections of the house clearly mentioned and highlighted.

Fig 8: Space planning

4.2. TOP SECTION VIEW

The realistic section view of the site was made and all the interiors walls, staircase were checked. The below Fig 9 shows the realistic section view of the site from the top.

Fig 9: Realistic Section view of site

4.3. SCHEDULING OF VARIOUS MEMBER OF SITE

4.3.1. DOOR SCHEDULE

The following Table 1 shows the schedule of doors to be inserted in the project along with their dimensions and count.

Table 1: Door schedule

DOOR SCHEDULE				
Name	Count	Level	Height	Width
M_Single-Flush: 0915 x 2134mm	1	Level 1	2134	915
M_Single-Flush: 0915 x 2134mm	1	Level 1	2134	915
M_Single-Flush: 0915 x 2134mm	1	Level 1	2134	915
M_Single-Flush: 0915 x 2134mm	1	Level 1	2134	915
M_Single-Flush: 0915 x 2134mm	1	Level 1	2134	915
M_Door-Opening: 0915 x 2134mm	1	Level 2	0	0
M_Single-Flush: 0762 x 2032mm	1	Level 1	2032	762
M_Single-Flush: 0813 x 2134mm	1	Level 1	2134	813
M_Single-Flush: 0813 x 2134mm	1	Level 1	2134	813

4.3.2. WINDOW SCHEDULE

The following Table 2 shows the schedule of windows along with their level and dimensions.

Table 2: Window schedule

Window Schedule				
Family and Type	Level	Width	Height	Sill Height
M_Window-Casement-Triple-Awning-Triple: 2150 x 1500mm	Level 1	2150	1500	900
M_Window-Casement-Double: 850 x 1500mm	Level 1	850	1500	900
M_Window-Casement-Triple-Awning-Triple: 2150 x 1500mm	Level 1	2150	1500	900
M_Fixed: 0406 x 1220mm	Level 1	406	1220	915
M_Fixed: 0406 x 1220mm	Level 1	406	1220	915
M_Window-Casement-Triple-Awning-Triple: 2150 x 1500mm	Level 1	2150	1500	900

4.3.3. ROOM SCHEDULE

The following Table 3 shows the schedule of the rooms with their level and dimensions.

Table 3: Room schedule

Room Schedule		
Name	Level	Area
Living Room	Level 1	21 m²
Bed Room	Level 1	17 m²
Bathroom	Level 1	10 m²
WC	Level 1	2 m²
Kitchen	Level 1	18 m²
Lobby Area	Level 1	29 m²
WC and Bathroom	Level 1	6 m²

4.3.4. BEAM SCHEDULE

The following Table 4 shows the schedule of the structural frame or beams along with their volume, length and count.

Table 4: Schedule of Beams

Structural Framing Schedule			
Family and Type	Volume	Length	Count
M_Concrete-Rectangular Beam: 450 x 600mm 2	3.75 m³	15200	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	2.02 m³	8555	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	1.08 m³	4324	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	2.39 m³	9264	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	1.01 m³	4199	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	1.00 m³	4117	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	3.23 m³	13255	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	1.99 m³	8471	1
M_Concrete-Rectangular Beam: 450 x 600mm 2	1.53 m³	6326	1

4.3.5. WALL MATERIAL SCHEDULE

The below Table 5 shows the schedule of the wall with its volume, breadth, area and height.

Table 5: Wall material Schedule

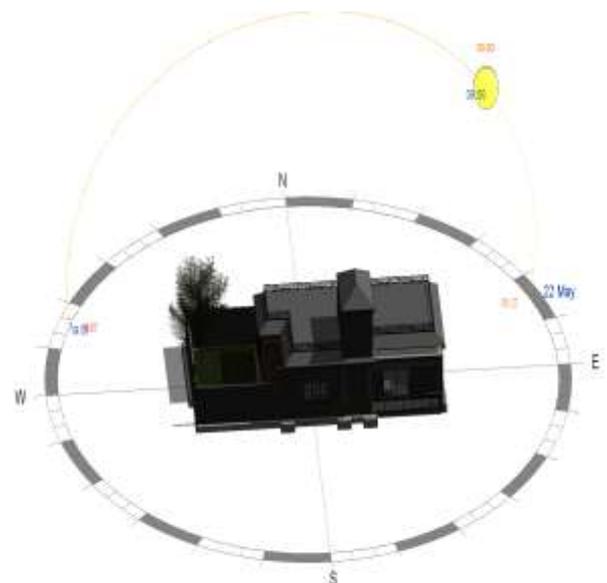| Wall Material Takeoff				
Family and Type	Material: Area	Volume	Width	Area
Basic Wall: Generic - 120mm 2				
Basic Wall: Generic - 120mm 2	3 m²	0.35 m³	120	3 m²
Basic Wall: Generic - 120mm 2	6 m²	0.72 m³	120	6 m²
Basic Wall: Generic - 200mm				
Basic Wall: Generic - 200mm	43 m²	8.54 m³	200	43 m²
Basic Wall: Generic - 200mm	10 m²	1.99 m³	200	10 m²
Basic Wall: Generic - 200mm	11 m²	2.13 m³	200	11 m²
Basic Wall: Generic - 200mm	14 m²	2.85 m³	200	14 m²
Basic Wall: Generic - 200mm	21 m²	4.16 m³	200	21 m²
Basic Wall: Generic - 200mm	7 m²	1.36 m³	200	7 m²
Basic Wall: Generic - 200mm	13 m²	2.52 m³	200	13 m²
Basic Wall: Generic - 200mm	15 m²	2.94 m³	200	15 m²
Basic Wall: Generic - 200mm	21 m²	4.23 m³	200	21 m²
Basic Wall: Generic - 200mm	19 m²	3.74 m³	200	19 m²
Basic Wall: Generic - 200mm	13 m²	2.69 m³	200	13 m²
Basic Wall: Generic - 200mm	4 m²	0.83 m³	200	4 m²
Basic Wall: Generic - 200mm	14 m²	2.84 m³	200	14 m²
Basic Wall: Generic - 200mm	43 m²	8.65 m³	200	43 m²
Basic Wall: Generic - 200mm	4 m²	0.82 m³	200	4 m²
Basic Wall: Generic - 200mm	14 m²	2.84 m³	200	14 m²
Basic Wall: Generic - 200mm	2 m²	0.40 m³	200	2 m²
Basic Wall: Generic - 200mm	12 m²	2.48 m³	200	12 m²
Basic Wall: Generic - 200mm	7 m²	1.35 m³	200	7 m²
Basic Wall: Generic - 200mm	12 m²	2.38 m³	200	12 m²
Basic Wall: Generic - 200mm	4 m²	0.85 m³	200	4 m²
Basic Wall: Generic - 200mm	16 m²	3.10 m³	200	16 m²
Grand total: 24				

4.4. SOLAR STUDY AND SHADOW ANALYSIS

The solar study and shadow analysis of the project was done and the following results were obtained .The Fig 10 below is a drop box that shows the various values to be entered for the analysis like the date, Location of the project, time of the project , no. of frames etc. The various results of the shadow analysis at various intervals of time are illustrated in the below mentioned figures. The Fig 11 Fig 12, Fig 13, Fig 14 and Fig 15 exhibits the shadow on the site during sunrise, at 09:00 IST , 14:00 IST , 17:00 IST and at sunset respectively.
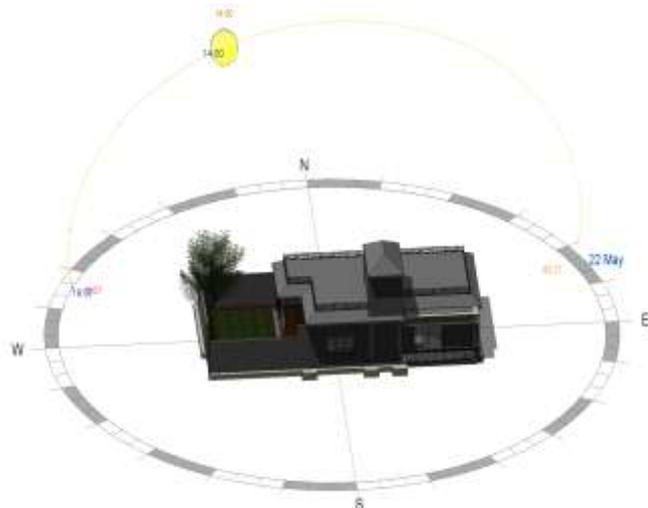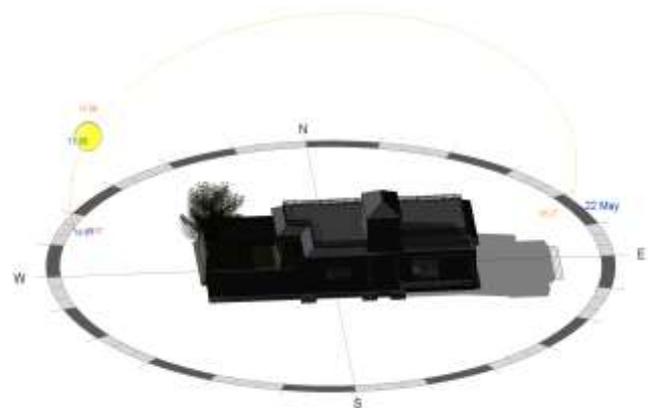

Fig 10: Sun settings drop box
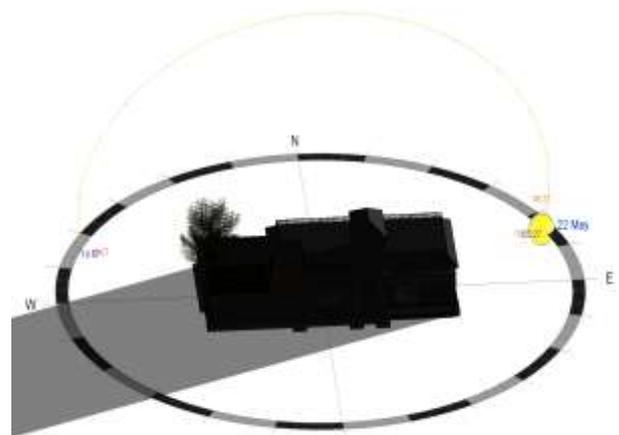
Fig 11: Shadow at 05:27(sunrise)

Fig 12: Shadow at 09:00

Fig 13: Shadow at 14:00

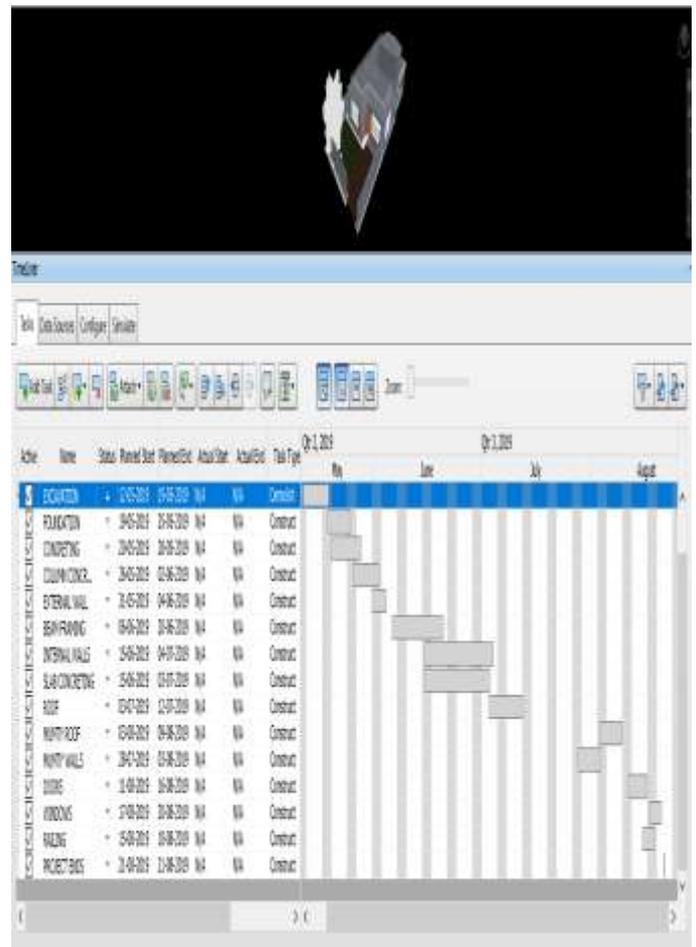**Fig 14:** Shadow at 17:00
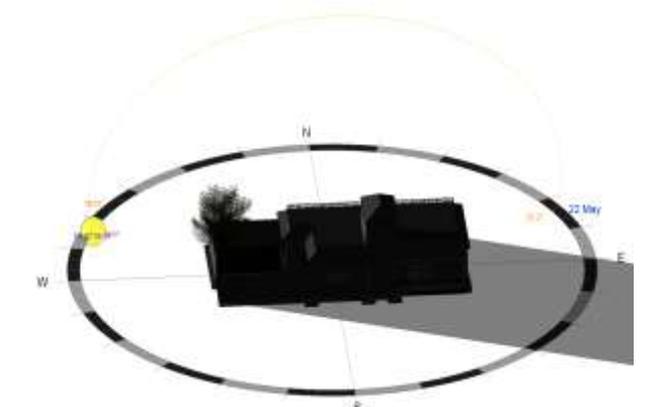
Fig 15: Shadow at 19:07(sunset)

4.5. PROJECT TIMELINE IN NAVISWORKS

The navisworks software was used to create a timeline of various works of the project. The following Fig 16 shows the layout of the project timeline. The Fig 17 shows the project timeline and Fig 18 shows Gantt chart of the same.
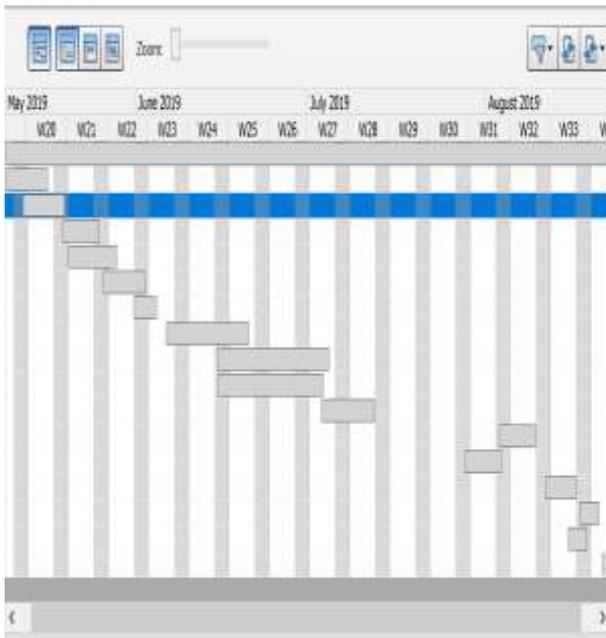

Fig 16: Layout of project timeline

Active	Name	Planned Start	Planned End	Task Type	Attached
	1 PROJECT STARTS	09-05-2019 09:00	21-08-2019 17:00 Construct	Explicit Selection
	1 SITE WORK	09-05-2019 09:00	16-05-2019 17:00 Temporary	Explicit Selection
	1 EXCAVATION	12-05-2019 09:00	19-05-2019 17:00 Demolish	Explicit Selection
	1 FOUNDATION	19-05-2019 09:00	25-05-2019 17:00 Construct	Explicit Selection
	1 CONCRETING	20-05-2019 09:00	28-05-2019 17:00 Construct	Explicit Selection
	1 COLUMN CONCRETING	26-05-2019 09:00	02-06-2019 17:00 Construct	Explicit Selection
	1 EXTERNAL WALL	31-05-2019 17:00	04-06-2019 17:00 Construct	Explicit Selection
	1 BEAM FRAMING	06-06-2019 09:00	20-06-2019 17:00 Construct	Explicit Selection
	1 INTERNAL WALLS	15-06-2019 09:00	04-07-2019 17:00 Construct	Explicit Selection
	1 SLAB CONCRETING	15-06-2019 09:00	03-07-2019 17:00 Construct	Explicit Selection
	1 ROOF	03-07-2019 09:00	12-07-2019 17:00 Construct	Explicit Selection
	1 MUMTY ROOF	03-08-2019 09:00	09-08-2019 17:00 Construct	Explicit Selection
	1 MUMTY WALLS	28-07-2019 09:00	03-08-2019 17:00 Construct	Explicit Selection
	1 DOORS	11-08-2019 09:00	16-08-2019 17:00 Construct	Explicit Selection
	1 WINDOWS	17-08-2019 09:00	20-08-2019 17:00 Construct	Explicit Selection
	1 RAILING	15-08-2019 09:00	18-08-2019 17:00 Construct	Explicit Selection
	1 PROJECT ENDS	21-08-2019 09:00	21-08-2019 17:00 Construct	Explicit Selection

Fig 17: Project timeline

Fig 18: Gantt chart of Project timeline

5 - CONCLUSION

The main objective of this project was to understand the concept and methodology of Building Information modeling (BIM) and then determine its impact and influence on the architecture, engineering and construction industry in the present scenario. The BIM implementation and its use in designing, analysis and planning in design and construction firm was taken into consideration and was studied upon. The aspects of Development of BIM and its Future in Indian Construction Industry over the times was looked upon and the aspects due to which BIM is unable to grow in India were taken into considerations and various ideas and techniques were thought of to eradicate these barriers in letting full implementation of BIM in India. A successful case study was done by Designing, Analysis and Planning on a Pilot Project and then observing the various aspects of BIM implementation. The scheduling done in 4D building information modeling and applied in the pilot project helps in better understanding of the components of the project along with their specifications which in turn will reduce the time of construction along with the probability of error and hence will help in reducing the cost to a large extent. Also the timeline formation as per the desired time standards of construction in the project within navisworks software of building information modelling will help in completing the project on time with the required standards which will have a reducing impact on cost to a large extent. The simulation helps in having a perfect idea of the construction works to be carried out along with the timetable of the same and the video of the simulation give a perfect visual representation of the project construction.

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