

Application of Building Information Modelling Software's for Planning and Scheduling of Multi-Storeyed Building

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Abstract – Basically conventional type of building construction process was a backward to proper task scheduling and planning of the on-going construction project work at site, which was resulting in poor monitoring of complete process. The current study on concept of building information model (BIM) derives a platform where all the key information of every sole element of the process of construction can be integrated virtually. It assists the Architects, Engineers and Constructors to foresee what is to be built in simulated environment and to recognise potential design, construction or operational problems. The BIM expands this methodology into 3 dimensional (3D) drawings in the three primary dimensional width (b), height (h) and depth (d) with time as 4th dimension (4D) and cost as 5th dimension (5D). BIM in terms of 5D modelling saves a lot of time and money over traditional scheduling process. The paper presents the implementation of project management functions with use of BIM concept in residential or multi-storeyed buildings. The BIM tool is to assist especially for design, defining the building form and spaces, visualization to analysing costs, time and performance of energy. It is a tool of construction management which is most useful for the real simulation process of any kind on-going building projects.

Key Words: 5D, BIM, Microsoft project, Modeling, Navisworks manage, REVIT, Scheduling, Visualization.

1. INTRODUCTION

Project management has become an important field of study since early 80's and it is gaining attention ever since. Management helps to plan, schedule, track work and report; hence it has found applications in various business sectors. The field of civil engineering is involved with different types of projects which are massive and complex in nature. Project planning and scheduling are crucial factors that influence the execution process and act as integral part of management. The path from designing to scheduling involves various steps of human interpretation and data manipulation. Manual methods of planning process have proved to be tedious and time consuming compared to application of software's and modern techniques that have been employed for managing purpose. [12]

Construction project planning currently involves several techniques and methodologies that have model dependences and sequencing of activities involved in the project. Bar charts, Critical path method (CPM), network diagrams and time-change diagrams are some of the techniques. These techniques do not have the capacity of modeling and usual zing in terms of both sequencing and execution pattern of activities. The stake holders uses AutoCAD 2D drawing tool for planning and designing the building. This tool does not give perfect information and clarification about the planning to the clients. Hence it is difficult in understanding for the clients. Using Building information model concept has overcome the drawback of AutoCAD 2D drawing and gained popularity in the field of construction. [2]

Building information model (BIM) tool is used by the professionals which helps them to provide efficient information about the project concept in planning, designing, scheduling, construction estimation and documentation etc. Managing the process of construction according to schedule and within the estimated cost is proving major advantages by using this BIM tool. This BIM tool works step wise, where the levels from foundations to finishing of the building can be seen. The levels are shown part by part individually from footings, columns, beams, slab, walls, doors and windows etc. The BIM is designed in such a way that we are able to see 3D visualization, monitoring and rendering of the desired plan. BIM methodology manages and secures the data throughout the life cycle of the construction. Hence the BIM conveys concept to clients in a very easy convincing way. The tool professional uses this model to create project into 3D view for rendering and visualization. Hence the project manager uses the 4D BIM tool for real simulation of actual project. BIM has changed significantly in the way of project delivery; it introduces new design, construction and has digital representation of the process. By using this tool many innovative projects has completed successfully and there is benefit to the increased in quality design, improves quality and also reduces time delay as well as it reduces cost. [2]

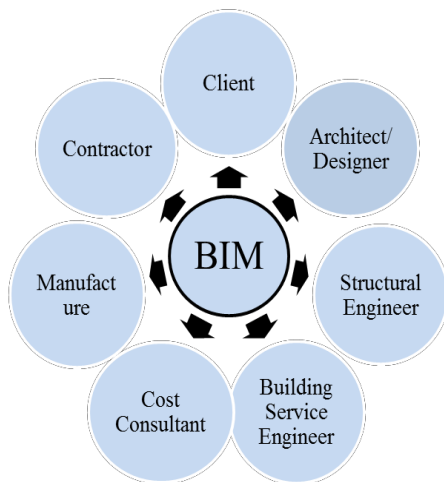


Fig -1: Stakeholders in Building Information Model

2. What is Building Information Model?

BIM is a tool which is planned in sequential order that allows sharing data about project between various applications which later be represented in forms 3D, Time as a 4D and cost as a 5D up to nD. This all the information use the owner/ professional maintain the throughout lifecycle. After so many years of research and developments in the construction industry, it has being adopted. BIM models are used by different professionals in the construction industry across the world.

The team member adjusts this work portions according to construction requirements and changes in design to succeed this model toward accuracy much as possible. While the model has been created, this could be achieved before physical start of the construction project.

2.1 Dimensions of Building Information Model (BIM)

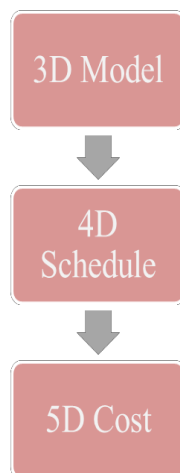


Fig -2: Dimensions of Building Information Model

3D Models:

3D model is defined as a three dimensional space which is (width (b), height (h), length (l)), relationship, geographic information of building and geometry. By using 3D model designing the error due to in consistent 2D drawings are identified and eliminated.

a) Design model: Architectural, MEP (mechanical, electrical and plumbing), structural, site models.

b) Construction model: Breaking the design models down into the construction sequences.

4D Model:

4D model is defined as the which is 3D model construction project is attached time schedule by using suitable software program, which provide users to virtual simulation of construction project in the form of 4D environment and also which the visualized that the various building activities at particular time duration can be seen in 3D model.

The time scheduling involves the construction project for scheduling daily and monthly activities, so that the lot of client attract towards a 4D BIM. The data of 4D BIM model can be stored such that it can be used for the entire project planning.

5D Model:

5D model defined as the one in which the 3D model is linked with time-schedule and cost by using suitable software. This helps in getting budget as well as increases performance during construction stages.

In the 5D model, the cost of the project can be calculated to rate the financial performance of the project during the actual construction process.

2.2 Need of 4D/5D modelling

1. Difficulty has been observed using the traditional scheduling and monitoring methods like Critical path method (CPM). This method is not easy and fast running, since it is effectible on the construction management parameters such as time, cost and quality by the reduction of productivity of the construction industry.
2. Construction project repeatedly originates from an inappropriate design, improper construction planning and lack of communication. Which performs unsatisfactory work which results is long project duration and cost will be high.
3. The Critical path method (CPM) contains schedule which is considers as time and precedence constraints. So that these traditional methods are using in construction planning and it is found to be effective.

- The site engineer while executing construction order, he must link the scheduled information with the three-dimensional modelling. It is a difficult when there is any changes in the process therefore it will be affecting overall construction project.

2.3 4D / 5D BIM Simulation process

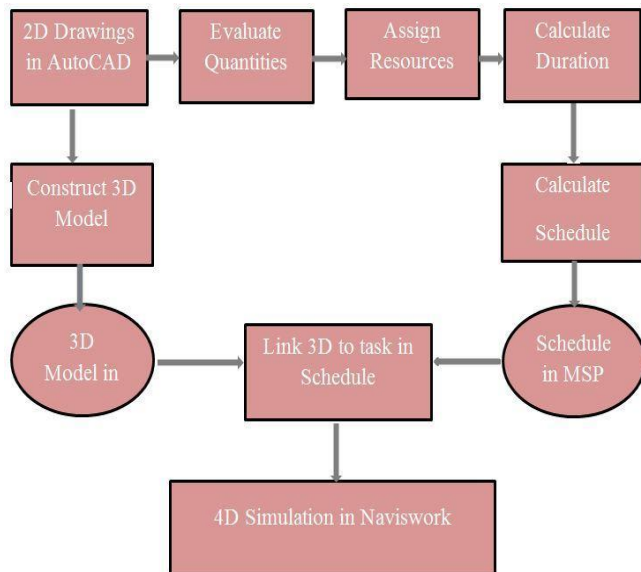


Fig-3: 4D/5D Simulation process

- The Naviswork Manage software is established by linking AutoCAD Revit 3D model files attach with Micro-Soft Project. This creates the 4D of the building information modelling analysis time.
- In the Naviswork Manage Software there is one timelier bar options, in this options adding scheduling activity file which is imported from Micro-Soft Project. Each activity is updated with 3D model set up file. Using simulation video options which can see the various building activity's in 3D Model.
- Timelier will automatically update the simulation if model or schedule change.

3. LITERATURE REVIEW

Mudasir Amin Chowdary et al. (2016) explain that the various modeling and project planning of structures by implementing 5D model BIM technique. Akash A. Patel et al. (2016) explains about the implementation of project management functions with use of Building Information Modelling concept in Residential Building. Raiyan Mansoori et al. (2016) explain the Application of Building Information Modelling and Methodology. Prakash Chandar (2015) discussed about the integration of construction schedule activity with 3D model result, and it is in the form of 4D planning. Sagar M. Malsane et al. (2015) explains the Simulate construction scheduling using BIM 4D allocation to

track progress. Nisarg M. Mistry et al. (2014) discusses about the Building Information Modelling (BIM) and the different software used for construction project management and monitoring in the construction industry. Vijay Kumar et al. (2013) explain the Building Information Model based project scheduling and progress monitoring in Architects, Engineer and Construction Industry.

4. METHODOLOGY

4.1 Steps for creating a 4D/5D model

Step 1: Creating Architectural design:

The designs of the construction project are created by using AutoCAD 2D drawing software.

Step 2: Creating 3D model:

The construction of building is viewed by 3D model which is created by using Autodesk Revit Architecture. The AutoCAD 2D drawing is imported into Autodesk Revit Architecture by using link CAD option.

Step 3: Creating various drawings:

If the drawing is made separately in AutoCAD, they are imported into Autodesk Revit software using insert option. It helps Revit Architecture software to play important role in detecting clashes between various components of the project. Turn to help in managing, planning and get the forecast of project at planning stage.

Step 4: Creation of 3D view:

In the Revit Architecture software pressing a home shape button in view tabs, the different 3D view can be viewed by rotating the cube. It has shown various components are attached with the project. This will help users to view the project in real virtual.

Step 5: Export 3D model into Autodesk Naviswork Manage:

For a preparation of 4D model, created 3D model is exported to Autodesk Naviswork Manage Software.

Step 6: Initiating scheduling process:

Micro-Soft Project Software is used as scheduling tool. It schedules the various activities as identified work break down structure. It is used as schedule for construction project, shows the start and finishes dates, locating critical paths and floats times of the activities and also shows the sequence, interrelationship between the various activities. And also shows the cost of each activates.

Step 7: Creation of 4D model:

When 3D model file is imported into Naviswork Manage software, the program automatically align rotation and rescale the units in which each file is attached to display the units. 3D model and Micro- Soft Project schedule is

imported in Autodesk Naviswork Mange to making 4D model.

Step 8: Linking the activities with 3D model:

The project schedule is imported to Naviswork Manage Software data source in time liner tab for creation of 4D models, activities from the Micro-Soft Project schedules are linked with 3D model elements.

Step 9: Simulation of the project:

The 4D model is visualized by the project through starting the simulation. In the simulation process the amount of work done on the various work activities and can be seen in the 3D view. It helps in visualization of project, planning and managing etc. Also cost of the various activities can be seen in Micro-Soft Project. This gives the total project cost of the building.

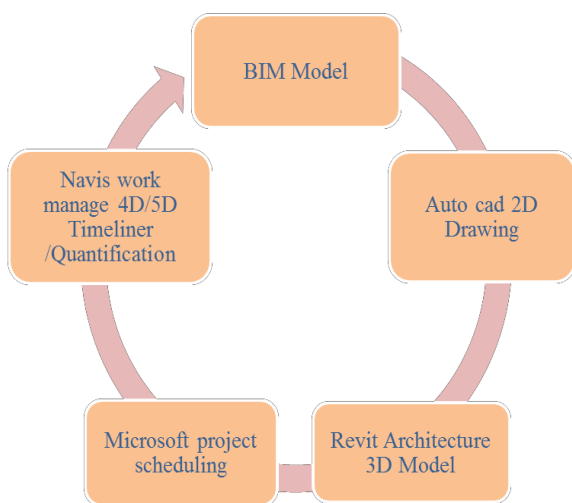


Fig-4: Process of developing BIM Model

4.2 Setting up and running 4D schedule requires following steps:

1. Imports the Micro-Soft Project into Naviswork Manage software. In time liner bar defines some default task types such as construction, demolish, temporary.
2. Link activity ID with related 3D element in the model.
3. Making sure that all the activity ID's are linked with appropriate 3D element in the model.
4. Building information 3D model is created in Autodesk Revit is to be integrated with Micro-Soft Project plan for visual simulation.
5. The 4D model can be created in various numbers of levels in details, from upward horizontal level of the longitude area of structure during the design phase

to the detailed work as part of large project coordination during the construction phase.

6. The procedure is continued to the model are updated and maintain that updated which is link between the schedule and 3D model. The simulation changes can be seen in 3D model.
7. The 5D model is an integration of 3D model with construction cost and schedule of project duration.
8. 5D model explains about the visualization, planning, scheduling, monitoring and clash detection at all stages of pre-construction and post- construction process of the building.

5. Results and Discussions

5.1 Methods for conducting 4D /5D planning simulation process results

A) Residential building construction process. Project details

- Name of the Project: Nitayachaitanya Apartment (B-Wing) - Residential project.
- Location: Subhashchandra Nagar, (R.C Nagar) Belagavi.
- No. of Storey's: Basement + 5 stories.
- Site Area is 796.74 sq. mtrs.
- Built up Area: 1407.56 sq. mtrs.
- Planned Estimated Cost in R.s : 4,53,30,932/-
- Planned Start : In the year 2016
- Planned Finish : December 2017
- Planned project Duration: 585 Days

B) 2D drawing in AutoCAD

Figure shows typical Basement floor plan of the building, location at Subhashchandra Nagar, (R.C Nagar) Belagavi. Built up Area is 1407.56 sq. mtrs. The conventional 2D drawing is prepared in AutoCAD 2014. The 2D drawing (AutoCAD 2014) can be inserted into desired 3D modelling software which support drawing format.

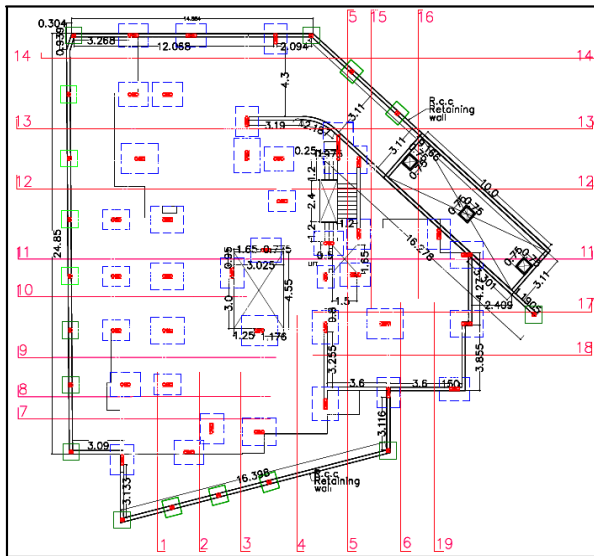


Fig -5: Basement floor plan

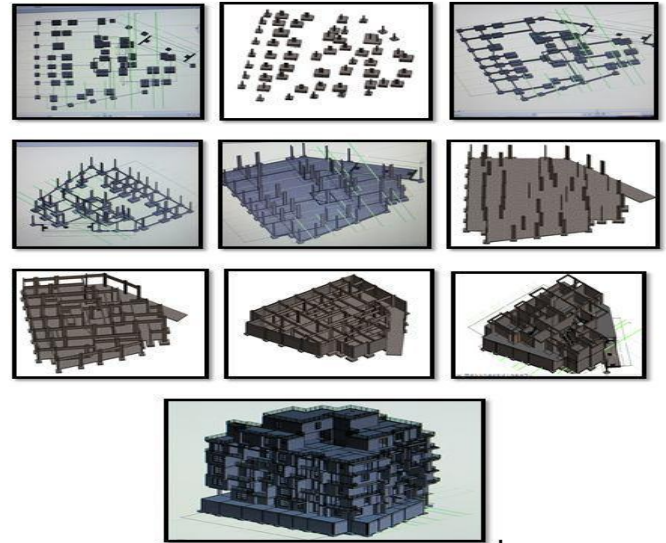


Fig-7 3D model is created in Revit Software

C) Creation of 3D Model by importing 2D Drawings in Autodesk Revit Architecture 2016

The modeling process of Autodesk Revit Architecture involves sequence of stages, in which each are linked to individual task in the Microsoft Scheduling by Naviswork Manage 2015.

D) Scheduling in Micro-Soft Project office

Building duration and cost of different activity task is created in Micro-Soft Project software 2013. It's having the features of giving relationship such as start to start, start to finish, finish to start and finish to finish etc.

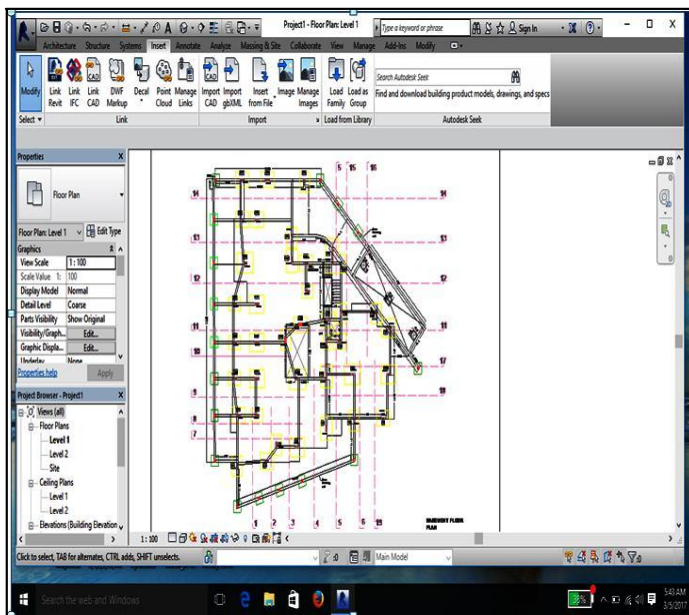


Fig-6: 2D drawing is imported in Revit Architecture 2016

1. In this work Planning and Scheduling of Residential project (Basement+5 stories) using Microsoft Project software.
2. Calendar-Using Standard calendar, working day is Monday to Saturday from 8 am to 6 pm; with one hour break (1pm to 2pm).

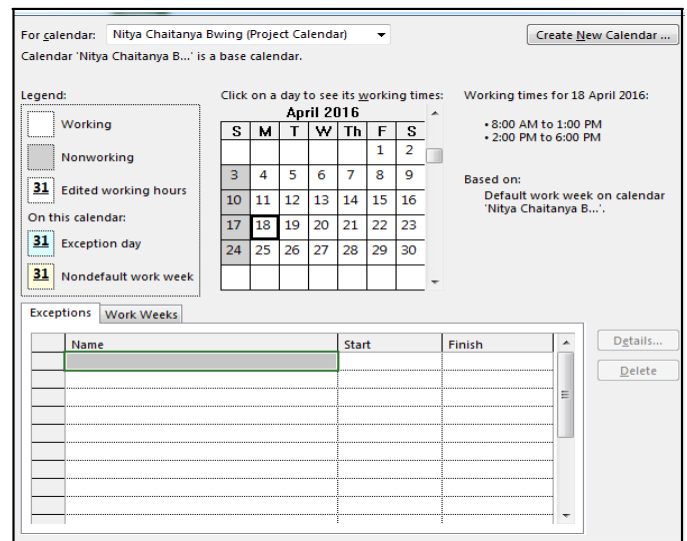


Fig-8 Project Calendar

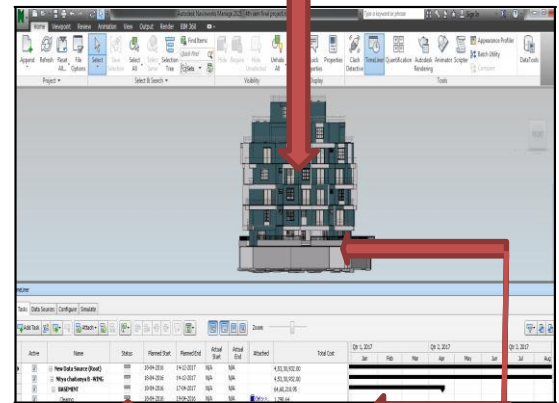
Table-1 MSP details

| | |
|--------------------|---|
| Project | Nitayachaitanya Apartment Residential project(B-wing) |
| Project started | April 18-2016 |
| Project completion | December 14-2017 |
| Duration | 585 Days |
| Estimated cost | Rs. 4,53,30,932/- |



Step 1

| Task Mode | Task Name | Duration | Start | Finish | Precedence | Cost | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
|-----------|--|----------|--------------|--------------|------------|-------------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
| 0 | Whya chaitanya B-WING | 585 days | Mon 18-04-16 | Thu 14-12-17 | | Rs. 45,330,932.00 | | | | | | | | |
| 2 | BASEMENT | 96 days | Mon 18-04-16 | Tue 26-07-16 | | Rs. 6,400,210.95 | | | | | | | | |
| 3 | Clearing | 2 days | Mon 18-04-16 | Tue 19-04-16 | | Rs. 1,200.64 | | | | | | | | |
| 4 | Excavation | 25 days | Tue 19-04-16 | Sat 14-05-16 | 3 | Rs. 614,036.20 | | | | | | | | |
| 5 | a) in soil | 2 days | Tue 19-04-16 | Thu 21-04-16 | 3 | Rs. 52,857.60 | | | | | | | | |
| 6 | b) in soft rock & boulders | 5 days | Wed 20-04-16 | Tue 26-04-16 | 3 | Rs. 70,476.80 | | | | | | | | |
| 7 | c) in hard rock | 10 days | Fri 21-04-16 | Tue 03-05-16 | 3 | Rs. 144,925.00 | | | | | | | | |
| 8 | Excavation with breaker | 20 days | Mon 25-04-16 | Sat 14-05-16 | 3 | Rs. 345,776.80 | | | | | | | | |
| 9 | Transporting excavated Material | 24 days | Thu 21-04-16 | Mon 16-05-16 | 3 | Rs. 45,260.00 | | | | | | | | |
| 10 | Anti Termite Treatment | 1 day | Mon 16-05-16 | Tue 17-05-16 | 9 | Rs. 121,901.22 | | | | | | | | |
| 11 | Plinth filling | 2 days | Wed 22-06-16 | Thu 23-06-16 | 33FF+2 day | Rs. 424,509.00 | | | | | | | | |
| 12 | PCC 1:3:6 in foundation | 5 days | Tue 17-05-16 | Mon 23-05-16 | 10 | Rs. 1,124,784.00 | | | | | | | | |
| 13 | CENTERING | 44 days | Mon 23-05-16 | Thu 07-07-16 | | Rs. 372,806.16 | | | | | | | | |
| 14 | Retaining wall & water tank& staircase | 15 days | Mon 23-05-16 | Tue 07-06-16 | 12 | Rs. 102,141.72 | | | | | | | | |
| 15 | Column | 8 days | Sat 11-06-16 | Mon 20-06-16 | 33FF+1 day | Rs. 48,376.38 | | | | | | | | |
| 16 | Footing | 8 days | Tue 07-06-16 | Wed 15-06-16 | 14FF+0 day | Rs. 31,817.10 | | | | | | | | |
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| 18 | Beams | 15 days | Wed 22-06-16 | Thu 07-07-16 | 33 | Rs. 71,180.42 | | | | | | | | |
| 19 | pocket slab | 15 days | Thu 09-06-16 | Fri 24-06-16 | 33FF+3 day | Rs. 34,027.62 | | | | | | | | |
| 20 | Main Slab | 15 days | Fri 10-06-16 | Sat 25-06-16 | 33FF+4 day | Rs. 60,231.22 | | | | | | | | |
| 21 | REINFORCEMENT | 37 days | Tue 14-05-16 | Fri 08-07-16 | | Rs. 1,528,815.73 | | | | | | | | |
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| 24 | Column | 8 days | Mon 13-06-16 | Tue 21-06-16 | 15FF+1 day | Rs. 117,961.16 | | | | | | | | |



Step 3 & step 4

Fig-8 Task schedule in Microsoft project

E) The creation of 4D/ 5D model by importing and attaching 3D model and MSP schedule (time and cost) in Naviswork Manage software 2015.

1. Export 3D model Revit Architecture to DWF file into Naviswork Mange software.
2. Export Micro-Soft project schedule to Naviswork Manage software.
3. Linking the 3D model with activities in the duration schedule.
4. Updated between 3D model and Micro-Soft schedule relationship in set up files.

| Task Mode | Task Name | Duration | Start | Finish | Precedence | Cost | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter | 1st Quarter | 2nd Quarter | 3rd Quarter | 4th Quarter |
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Step 2

Fig-10 Steps for establishing 4D model

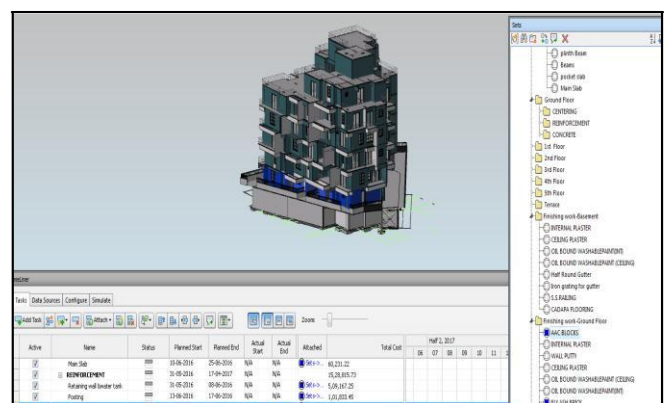


Fig-11 Attaching MSP schedule with 3D model in Naviswork sotware

F) The simulation and Visualization of 4D and 5D model in Naviswork Manage software

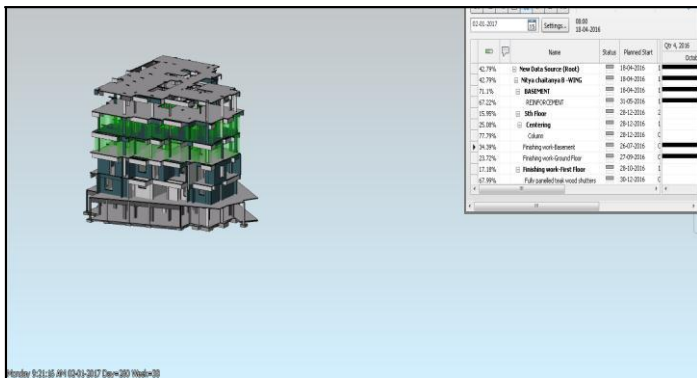


Fig-12 Ongoing 5D simulation process in Naviswork

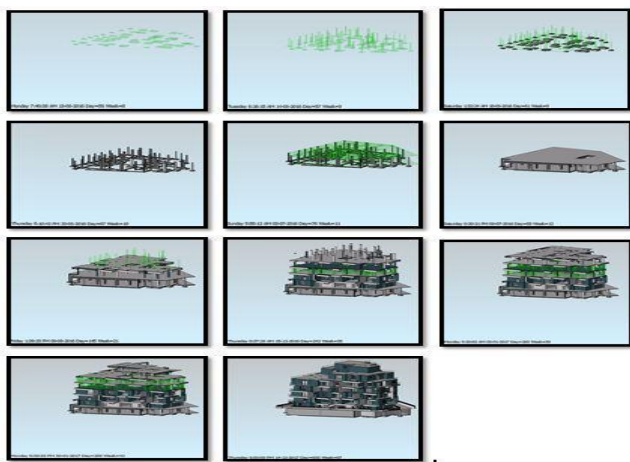


Fig-13 Sequential simulation of 4D BIM model in Naviswork

1. 4D simulation involves the step by step construction of building. Hence task activity from Micro-Soft Project office linked to its corresponding building component.
2. This integration work schedule and 3D model is carried out in Naviswork Manage 2015 software.
3. Once all the activity tasks from the Micro-Soft schedule are linked or attached to corresponding 3D element model, the 4D simulation is viewed.
4. In the 4D simulation shows the progress of tasks taking place day to day basis.
5. The “Nitayachaitanya Residential Building” element planned and executed activity shows in green colour and also dates shown below the activity which is differentiate from rest of the other building.
6. A video of the simulation from the start to finish date can be exported to give client to demo of the project.

7. Using simulation video options the various building activity task at a particular time point which can see in the 3D Model. And also the cumulative estimated cost can be seen in Micro-Soft project file which is attached in timelier bar.

6. CONCLUSIONS

- 1) Micro-Soft Project is the useful software for preparing scheduling and baseline.
 - Creates budgets based on task duration and resource rates. A calendar can be prepared and assigned to each resource and the resource can be assigned to multiple tasks based on its availability.
 - The software is unable to solve problems and manage complex facilities. The application helps to create different path schedules and levels the resources automatically if needed. It provides information and displays results in form of bar and Gantt charts, graphs and pie charts, etc.
- 2) The BIM tool provides the users to real time representation of project which improve speed up the construction planning.
- 3) The 4D/5D BIM technique is easily adopted by construction manager, site engineer etc.
- 4) 4D BIM model is use full tool to visualize the work progress day by day in computer monitor and also increased efficiency.
- 5) 5D BIM model is appropriate tool to use for construction cost and resources management.

7. SCOPE FOR FUTURE WORK:

The 4D/5D BIM model application can be further added to various data bases from other fields like Plumbing, Electrical and Mechanical etc. In 5D BIM technology –“4th D” is a time schedule and “5th D” is a cost, further which can be described by other dimensions like such as an operation, sustainability, safety, resources, material etc. and it can be taken up to nD.

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