

APPLICATION OF BIM AND CONSTRUCTION PROCESS SIMULATION USING 5D BIM FOR RESIDENTIAL BUILDING PROJECT

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Abstract - In today's growing construction field quality of work, time and cost these are the very important elements. Building information which comes timely and correctly in multiple dimensions will facilitate a advanced decision building process which can develop these three things. 5D Building Information Modelling is raising development in the construction industry that integrates all the key information from the initial design to the finishing stage. The habitual construction industry's production effectiveness is moderately low and the waste of resources is serious, which has actually hindered the construction field green sustainable development. With applying BIM 5D in construction field, the intensity of careful management in the construction stage being developed successfully. The intention of this paper to study the effect of BIM execution on the conventional building design procedures. The BIM is holdout this methodology into 3D drawings in the three main dimensional width, height and depth with the time as the 4th and cost as the 5th. 4D model based scheduling simulation can be used to check or the progress at site without being a truly present there. It can also help in monitoring delays in relation to a planned schedule. The estimating based on 5-D model produces accurate quantities for the competent estimation of architectural, structural and services components

Key Words: BIM, 3-D, 4-D, 5-D Models

1. INTRODUCTION

BIM is instrumental in shifting the construction industry's paradigm from two dimensional (2D) based drawing information systems to a three dimensional (3D) object information systems. This transformation changes the documentation method used in building design and construction, from manual conducts which are human readable, and integrates digital descriptions of building elements with other information including time as 4D and can be used to track the growth of the project during construction from beginning to completion. and cost as 5D This beneficial to the owner or project head recognize how the money is being spent over the project and know how to allocate the finances throughout different stages of project.

which are computer readable. This process is recognised as n-dimensional (n-D) modelling, where different "dimensions" of information are integrated into a digital building model. The construction field is constantly shifting in an effort to recognize the construction process, minimize material waste, decrease overall cost, accelerate project achievement, and developed coordination among people involved. The performance of Building Information Modeling (BIM) related software, such as Autodesk's Revit and Nemetschek, into construction projects contributes to making this growth in the industry feasible. There many more are applications/software used to prepare 5D BIM models, such as Autodesk Navisworks, Vico Office, CostX, etc. Current 5D models are largely usefull for cost analysis of a project and allow various disciplines to visualize the development of construction tasks and related estimation of schedule and time.

1.1. Aim of the project

Building Information Modeling (BIM) to defined as a consistent, digital, 3D, virtual representation of the project to be built for use in design decision-managerial, construction scheduling and planning, cost estimates and maintenance of construction projects.

1.2 Objectives

1. Studying traditional site working methods.
2. Studying Building Information Modeling and its framework.
3. Preparing 3D model in Revit Autodesk for practical problem.
4. Preparing scheduling and cost estimation in Microsoft project
5. To prepare a 5D model in Autodesk Nevisworks for a practical problem by using time as 4th cost as a 5th dimension.

2. LITERATURE REVIEW

Hyunjoo Kim¹ and Francois Grobler(2013) This paper suggests improved cost analysis can be developed using data extraction in Building Information Modeling (BIM). BIM models contain a wealth of information and tools have been developed to automate a series of process such as quantity takeoff, scheduling, and estimating. This paper discuss a sample tool to support BIM-based, automated cash flow analysis

Dr. Peter Smith (2007) The paper is related to quantity surveying firms in Australia in which discuss about procedure and issues with BIM performance and interviews with BIM demand 3D/ 3 Dimensional model and is also usually defined in additional dimensions such as 4D (time), 5D (cost) and even 6D (as-built operation). 4D links information and records in the 3D model with project encoding and scheduling data and provide the simulation analysis of construction activities. 5D involves all of this with cost data such as quantities, schedules and prices.

RokooeiSaeed shows the connection of Building Information Model and role of project managers on construction projects. It focus attention on the consequence of having better BIM knowledge and experience for project managers to accomplish. This paper also discusses the requirement of BIM knowledge and experience enhancement of project managers

P. Nowaka, Mariola k, M.Drapsb, Jacek Z.Gives what are the possibilities of BIM(Building Information Modeling) techniques and regarding software for optimizing construction decision making. Authors presents chosen tools for decision making -point of orientation method. Paper consist also practical example of suggested methodology use-choice of the best location of the building

Hyunjoo Kim, Kyle Anderson b,SangHyun Lee b,², John Hildreth (2013) The objective of this paper is to developed a structure for automating the creation of construction schedules by using data saved in BIM. Using the draw out information, this research proposed system that creates construction tasks, calculate activity durations.

P. Vladimir, J. Virgauda, Darius M, U. Leonas, Saulius. Uses theoretical ethics and practical pioneering applicability of BIM and construction process simulation technique, used to calculate the most effective substitute of the project by applying the suitable multiple criteria valuation techniques, are considered in the article

Juan F, FaizaM , Hussein A. Identify the key obstacle in BIM/Building Information Model for a project's scheduling and estimating. The main focus of paper is on how sub contractors are now a day's using BIM for cost estimating and scheduling. The study provides suggestion on using BIM for estimating. The investigation give result that less than 7% of contractors use BIM in their projects and less than 3% use it for estimating.

3. PROBLEM STATEMENT

1. Construction projects are becoming complicated in nature due to error in certification and co-ordination. BIM can be a solution to the problem
2. Calculating constructability and recognizing design conflicts before construction starts.
3. Over budget, delays, rework, poor communication, cost overrun, time overrun are typical problems faced by construction industry. These problems can be minimising by increasing the building information exchange effectiveness.

4. METHODOLOGY

The objectives of the research will be achieved by implementing the following steps:

1. Study on the previous research that is related to the building information modeling applications.
2. Studying Building Information Modeling and its framework in order to apply it in the current study.
3. Studying Autodesk Revit.Preparing 3D model for practical problem.
4. Preparing scheduling and cost estimation in Microsoft project.
5. Navisworks used to confirm the model and the progress of theconstruction on the iPad using the apps BIM360Glue, Buzzsaw, Autodesk 360

5. BIM MODEL

"A BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward." "A BIM is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward."

5.1 4D modeling

4D BIM is to add time to the project 3D model. It is useful to simulate the construction process of the project in order to identify issues such as critical path activities, logistical delivery and refining the construction process. It can also be used to examine ways to make up time. The contract administrator can also use the programme to assess delays and applications for Extension of Time (EOT) raised by the contractor. A 4D enhanced model enables a diverse team of project participants to evaluate and comment on the project scope and corresponding schedules in a very proactive and timely manner

5.2 5D modeling

The two main elements of a cost estimate are quantity take-off and pricing. Quantities from a Building Information Model can be extracted to a cost database or an excel file. However, pricing cannot be attained from the model. Cost estimating requires the expertise of the cost estimator to analyze the components of a material and how they get installed. If the pricing for a certain activity is not available in the database, cost estimator may need a further breakdown of the element for more accurate pricing. For instance, if a concrete pour activity is taking place, the model may account for the level of detail for the rebar, wire mesh, pour stop, formwork, concrete etc., but not include it as part of the quantity take-off extraction.

6. ADOPTED SOFTWARE FOR PROJECT

6.1 Autodesk Revit

6.2 Microsoft Project

6.3 Autodesk Navisworks

6.1. Autodesk Revit

After introducing the most popular Building Information Modeling software and Autodesk as company that develops Revit, the spotlight will move now to Revit itself. In 1997 ReonidRaiz and Irwin Jungreis founded the company Charles River Software, which started building Revit. Their main goal was to include parametric modelling to existing idea of CAD, and to allow the user to determine the parametric components graphically, instead of having to use a programming language. This idea of bidirectional associativity is the concept that distinguished Revit from other Building Information Modeling software platforms for a certain period of time, until the competition caught up. Bidirectional associativity means that when u change a certain component of your model (for example wall) all components in relation with the modified one will automatically adjust themselves to applied changes. This concept of bi-directional associativity makes the software more intuitive and therefore easier to work with for the user. It also saves enormous amount of time when applying changes to an existing model.

6.2. Microsoft project

Using this software we can get the actual cash flow, planned cash flow and achieved cash flow. Microsoft Project is a project management software program, developed and sold by Microsoft, which is designed to assist a project manager in developing a plan, assigning resources to tasks, tracking progress, managing the budget, and analyzing workloads. Project creates budgets based on assignment work and resource rates. As resources are assigned to tasks and assignment work estimated, the program calculates the cost,

equal to the work times the rate, which rolls up to the task level and then to any summary tasks and finally to the project level. Resource includes people, equipment and materials can be shared between projects using a shared resource pool. Each resource can have its own calendar, which defines what days and shifts a resource is available. Resource rates are used to calculate resource assignment costs which are rolled up and summarized at the resource level. Each resource can be assigned to multiple tasks in multiple plans and each task can be assigned multiple resources, and the application schedules task work based on the resource availability as defined in the resource calendars.

6.3. Autodesk Neviswork

Autodesk Navisworks Manage is a software application providing a comprehensive project review solution which supports coordination, analysis, and communication of design intent and constructability. It allows integration of multidisciplinary design data created in different BIM design applications to a single project model. It also provides the interference management and clash detection functions to anticipate and avoid potential problems in the project which can eventually minimize delays and reworks. In addition, it supports 4D and 5D simulation and analysis by combining parametric models with the project schedule and costs (Autodesk, 2012).

7. PROCESS OF 5D SIMULATIONS

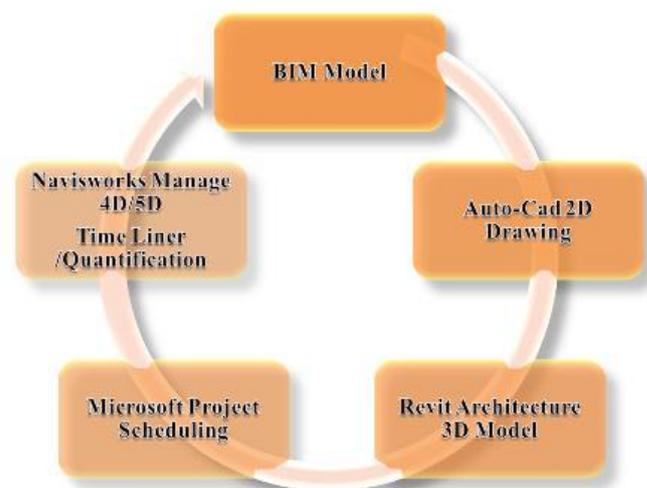


Fig1: Process for developing BIM model

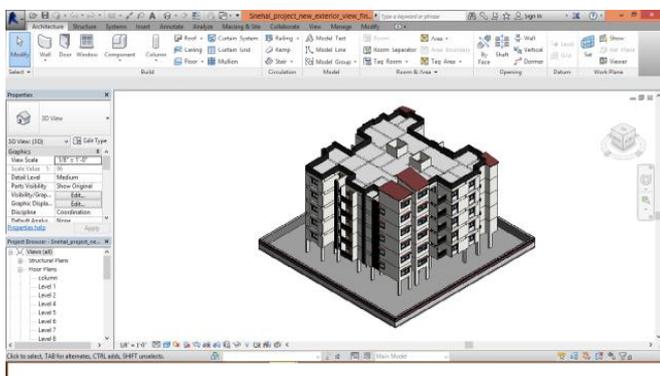
There are many kinds of BIM software, such as BIM technology, ArchiCAD, Bentley Architecture, Digital Project, BIM software, PKPM, BIM 5D software, Luban and so on, which are widely used in BIM modelling software products that achieve part of the function of BIM. The Revit + Navisworks combination is popular in civil buildings among them. Revit has the functions of modeling, modeling and testing for buildings, hydropower, HVAC and structures

while Navisworks supports 3D model integration, simulation, data collaboration and calibration. Commonly used deep engineering design software are Architecture, Navisworks and so on. The simulation software of construction collision detection and construction process includes Navisworks, Bentley and so on.

8. CASE STUDY

A proposed G+5 residential building (Parag Construction) situated at Off PaudPhata Road, Near Dr. KalmadiShamarao High School, Pune has been selected for project study. Designing is done in 2D AutoCAD drawings, 3D model in revit Autodesk and scheduling and cost estimation is in Microsoft project software.

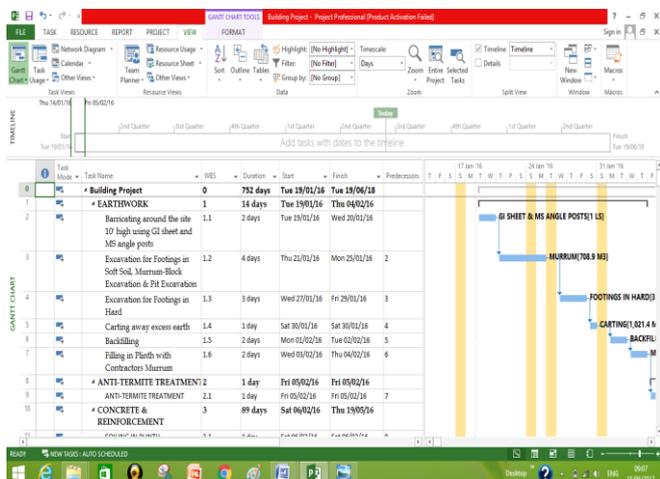
8.1 3D Model



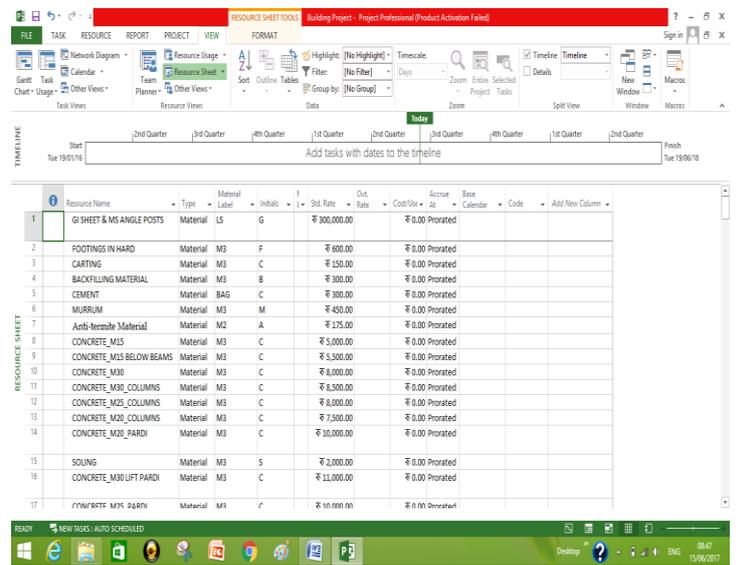
3D model of the case study building created by Revit Autodesk

For construction of Architectural Building Information Model detailed AutoCAD drawings are referred. With the help of Revit Architecture 2014 software, and other available details such as, material used and cost of respective materials etc. the model is completed

8.2 Activities,duration,linking shown in MSP



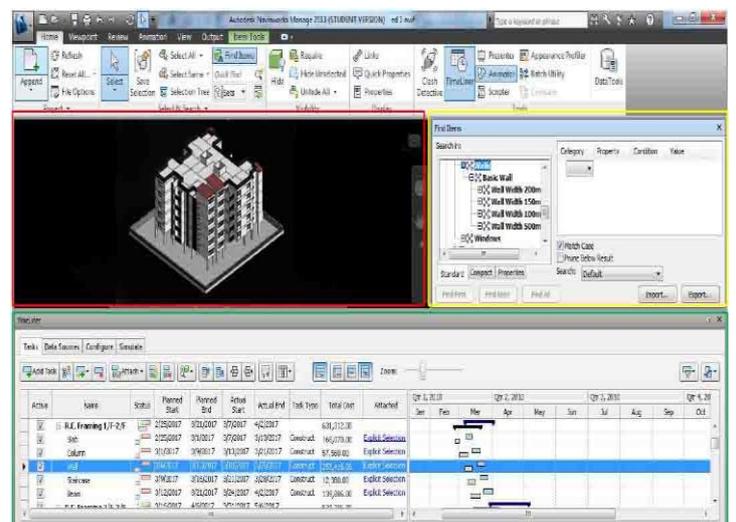
8.3 Resources sheet in MSP shown below-



Resource Name	Type	Material Label	Initials	Std. Rate	Ovt. Rate	Cost/Unit	Accrue At	Base Calendar	Code
GI SHEET & MS ANGLE POSTS	Material	LS	G	₹ 300,000.00		₹ 0.00	Prorated		
FOOTINGS IN HARD	Material	M3	F	₹ 600.00		₹ 0.00	Prorated		
CARTING	Material	M3	C	₹ 550.00		₹ 0.00	Prorated		
BACKFILLING MATERIAL	Material	M3	B	₹ 300.00		₹ 0.00	Prorated		
CEMENT	Material	BAG	C	₹ 300.00		₹ 0.00	Prorated		
MURRUM	Material	M3	M	₹ 450.00		₹ 0.00	Prorated		
Anti-Termite Material	Material	M2	A	₹ 175.00		₹ 0.00	Prorated		
CONCRETE_MIS	Material	M3	C	₹ 5,000.00		₹ 0.00	Prorated		
CONCRETE_MIS BELOW BEAMS	Material	M3	C	₹ 5,500.00		₹ 0.00	Prorated		
CONCRETE_M3D	Material	M3	C	₹ 8,000.00		₹ 0.00	Prorated		
CONCRETE_M3D COLUMNS	Material	M3	C	₹ 8,500.00		₹ 0.00	Prorated		
CONCRETE_M3D COLUMNS	Material	M3	C	₹ 8,000.00		₹ 0.00	Prorated		
CONCRETE_M3D COLUMNS	Material	M3	C	₹ 7,500.00		₹ 0.00	Prorated		
CONCRETE_M3D PARDI	Material	M3	C	₹ 10,000.00		₹ 0.00	Prorated		
SOLING	Material	M3	S	₹ 2,000.00		₹ 0.00	Prorated		
CONCRETE_M3D LIFT PARDI	Material	M3	C	₹ 11,000.00		₹ 0.00	Prorated		
FORMWORK M3K PARDI	Material	M3	F	₹ 10,000.00		₹ 0.00	Prorated		

8.4 5D BIM Model in Autodesk Neviswork

3D model from Autodesk Revit and time schedule and cost from Microsoft Project software is imported to Nevisworks for simulation and better visualization purpose



3. CONCLUSIONS

The 5D Model is integrated with all useful information including 3D model, schedule and cost which is prepared in Microsoft project, it is very easy and convenient to obtain information from the single integrated model by using Navisworks manage without referring to other information. By inputting the schedule and duration of tasks into the model, the 5D BIM software is able to allow users to easily define the forecast interval and can generate cash flow forecast monthly, weekly, daily or even hourly in the simulation, which is very difficult to achieve in the traditional approach.

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