"Planning & Scheduling of Multi Storey Building Using BIM"

Submitted in partial fulfilment of the requirements
for the degree of

Bachelor of Engineering

By

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Under guidance of

Prof.Umesh V. Jadhav

Department of Civil Engineering

School of Engineering and Technology

Anjuman-I-Islam's Kalsekar Technical Campus

New Panvel, Navi Mumbai. 41026

2018-19

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CERTIFICATE

This is to certify that the project entitled **"Planning & Scheduling of Multi Storey Building Using BIM"** is a bonafide work of **Shaikh Farheen Rizwan Ahmed, Shaikh Md Shafique Md Hanif, Shaikh Mohd Irshad Nizamuddin, Shaikh Riyaz Ahmad Shakeel Ahmad** submitted to the University of Mumbai in partial fulfilment of the requirement for the award of the degree of "Undergraduate" in "Civil Engineering"

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APPROVAL SHEET

This dissertation report entitled **"Planning & Scheduling of Multi Storey Building Using BIM"** by **Shaikh Farheen Rizwan Ahmed, Shaikh Md Shafique Md Hanif, Shaikh Mohd Irshad Nizamuddin, Shaikh Riyaz Ahmad Shakeel Ahmad** is approved for the degree of "Civil Engineering"

Examiners

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Supervisors:

1. …………………………

2. …………………………

Date: 04-05-2019

Place: Panvel

DECLARATION

We declare that this written submission represents my ideas in our own words and where others ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that, we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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Date: 04-05-2019

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ABSTRACT

The following project deals with the planning, modelling, quantity estimation and scheduling of a multi storey residential building using advance civil engineering application as BIM which includes software like AutoCAD, Autodesk REVIT, Primavera and Microsoft Excel Spreadsheets. Project starts with planning of the building using AutoCAD, the modelling and quantity estimation will be carried out with the help of Autodesk REVIT and finally the scheduling will be done by using Primavera.

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CHAPTER 1

INTRODUCTION

1.1 General

The different phases of the project life cycle include planning, design, construction, maintenance and decommissioning. The construction phase can be divided into pre and post construction stages. The traditional media of communication among various phases of life cycle is two dimensional (2D) drawings. The introduction of object oriented computer aided design (CAD) software facilitated three-dimensional (3D) models as media of communication between the planning and design phases and introduced the concept of Building Information Modelling (BIM). Some of the applications of these 3D models in the preconstruction stage include resolving constructability problems, space conflict problems, and site utilization. During construction, post construction and maintenance still 2D drawings are most widely used. Thus the usage of a 3D model developed through BIM during different early stages of the lifecycle is not in use after the preconstruction stage.

Building Information Modelling

BIM is a process which provides a framework to develop data rich product models and facilitates the realization of integrated benefits. In this process the real world elements of a facility such as walls, doors, windows and beams are represented as objects in a three dimensional digital model. In addition to modelling, facility information from conception to demolition is integrated into the model. Thus the model serves as a gateway to provide any time access to insert, extract, update, or modify digital data by all the project participants involved in the facility life cycle.

Advantages

BIM has the ability to create an accurate model, which is useful throughout the entire lifecycle of the project, It enables the application of parametric modelling, which means that the objects and components within the model can be related to each other parametrically, It allows identifying collisions and clashes, which reduces the cost and time wasted to solve problems, It links cost estimation and schedule to elements of the model, BIM assists in the creation of accurate shop drawings, BIM allows for the process of checking design using software, BIM is time saving, and cost reduction technique and Finally, it eases the process of sharing model information between all participants of the project.

Disadvantages

BIM has no Standard Contract Documents available in most of developing countries, BIM requires reliable input data because any incorrect input data will cause incorrect output data, in BIM, engineers and architects are reluctant to providing digital data to suppliers and contractors because the data can be modified without their consent and Finally, BIM applications may not interface with other programs easily. Unlikely, there is no adequate research that addresses Building Information Modelling in most developing countries.

1.2 Objectives

- To exchange data process more effectively.
- To make effective data of the building.
- Learning of software like AutoCAD, REVIT, Primavera, etc.
- To execute the project on site simultaneously.
- To plan and schedule the respective project more efficiently and effectively.
- To analyse and get a progress report of a project through software.

1.3 Scope

1. BIM is very viable career option as implementation of software is done for better development.
2. With BIM an accurate virtual model of a building can be created.
3. To project constructability and price.
4. A BIM is building the actual project digitally in its complete form before engaging in the construction process in real-world environment.
5. BIM increase the stakeholder co-ordination.
6. It helps in building a reliable workflow.

CHAPTER 2

LITERATURE REVIEW

2.1 General

Different authors have tackled the issue of Building Information Modelling. Porwal and Hewage (2013) developed Building Information Modelling (BIM) framework for public construction projects. Hannele et.al (2012) proposed a framework for expanding uses of building information modelling in life-cycle construction projects. Bragadin (2012) developed a framework for the safety and innovation in building construction rehabilitation projects using Building Information Modelling. Benedict and David (2012) developed Building Information Modelling and Integrated Project Delivery framework in commercial construction industry. Per Anker and Elvar (2013) developed a framework for Building Information Modelling (BIM) in Denmark and Iceland. Abdul-Lateef et al. (2009) developed a model for building maintenance management in Malaysian University Campuses. Al-Hussein et al. (2005) developed a model for optimization Algorithms for the selection and on-site location for mobile cranes. Azhar et al. (2008) proposed a visual interactive building information modelling framework for construction projects. Miner and Thomson (2006) developed a building information modelling framework to analyse contractual risks. Osman et al. (2003) proposed a framework for hybrid CAD-based construction site layout planning system using genetic algorithms. All the above researchers did not develop a framework that deals with Building Information Modelling in construction projects in Egypt. Therefore, the Overview of Building Information Modelling analysis was developed in this paper to overcome this limitation and provide recommendations to all developing countries.

2.2 AutoCAD

Azidah Abu Ziden (2012), studied the effectiveness of AutoCAD software in learning of Engineering Drawing to enhance students understanding. It concludes that AutoCAD increase the performance of high and medium level students group gave a positive impact on the study. Effective use of this software proved to be helpful based on the data obtained.

Asmaa G. Salihet.al. (2014), presents the significant revolution with computers usage in civil engineering business and construction process has been presented. AutoCAD software is an extremely powerful tool and can be adapted to specific needs in order to serve the intended purpose of any project. Civil engineering professionals use this software for variety of infrastructure projects, like: land development, transportation, water projects and road design. Amol A. Metkariet.al. (2015), proposed Ladies Hostel building for Rajarambapu Institute of Technology College Rajaramnagar. In that case study, building project, included real life examples of BIM and AutoCAD uses and benefits. Also in the case study, a prototype building project, examined the 2D,3D, 4D and 5D model by using AutoCAD & BIM tools Prakash Chandaret.al. (2015), research on Integrating Building Information Modelling (BIM) and Construction Project Scheduling to Result in 4D Planning for a Construction Project, the conventional 2D drawings are prepared in AutoCAD 2010. The 2D drawings are converted into 3D model in Revit Architecture 2014 and the Time Scheduling is done in Microsoft Office project2007.Raiyan Mansoori et. al. (2016), studies the planning and design of Residential building (G+16) By Using AutoCAD & REVIT Software taking 4th dimension as time. In this paper study is restricted to civil engineering construction planning& scheduling by creating a 4D model, further other dimensions like cost, resources, materials etc. can be taken as nth dimensions.

2.3 Autodesk REVIT

Ajla Aksamija et.al.(2011), Parametric design offers some advantages over traditional modelling methods, since it allows adaptation of an object by rules and constraints or "Parameters" to influence the object's properties. These processes as well as parametric Computational tools, are relatively new in architectural design. They enable the adaptation of model geometry based on rules or data values, eliminating the need to recreate the model for every design change. Cesar Augusto Hunt (2013), the benefits of using building information modelling are evident, especially when analysing the way that this methodology enhances the structural design workflow. Engineers are realizing the power of BIM for more efficient and intelligent design, and most firms using BIM are reporting strong favour for this technology. Using the building information model not only enables the production of construction documents, but it also serves as a base to present the results from the structural analysis and design in an easy sharable way, keeping all the information regarding the analysis, design and documentation of a structural project in one place. NisargM. Mistry et.al (2014) worked on Software for Building Information Modelling (BIM) for Project Management and Controlling. It can be concluded that REVIT helps to provide immediate competitive advantage, better coordination and quality, and can contribute to higher profitability for architects and the rest of the building team. It can also be concluded that BIM is an efficient and reliable tool of project management. Project management can be done more effectively by using this type of tool. Wei Peng (2014), the art of architecture refers to the law of beauty, and uses the unique architectural art language, so the building image has cultural value and aesthetic value, with symbolic and formal beauty, reflecting the national character and sense of the times. This paper takes the BIM building information modelling as integrated platform, through the REVIT data interface, and uses 3Ds max software to design the art shape of building structure. Shashank R. Chandak (2016), presents the cost of optimization of construction projects using BIM Software REVIT. The projects conclude that by using BIM method 80% reduction in time to generate estimates 10% saving on construction cost through clash detection. 20% saving through construction cost simulation. Based on the afore-mentioned literature review it is observed that REVIT are user friendly software. Hence, we have decided to do modelling and quantity estimation of a residential structure by Autodesk REVIT.

2.4 Primavera

As of 2008 Primavera Systems supported long-established products - P3 and Sure-Trak - and the newer P6 version. The long-standing P3 product in its various forms was used by 25% of the heavy construction industry, its predominant customer base; the next most popular software was used by 11%. Nearly 40% of general contractors with an annual revenue of 5M dollar to 10M dollar used Primavera P3. In comparison, the P6 version did not register in a CFMA 2008 survey of the United States construction industry. The P3 version to P6 version change is based in a move from DOS-type shortcut keys to mouse-based icons. Thus a software application that was once very fast to use but grounded in shortcut functions (which some users found difficult to master) moved to a mouse-based application that is quicker to learn, but once mastered never achieves the same speed of use. The Primavera Project Planner DOS core launched in 1983 and the P3 Windows interface launched in 1994. After a 27-year version life, Oracle ceased sales of the P3 and Sure Trak versions on December 31, 2010. In 2012, Primavera P6 EPPM Upgrade Release 8.2 added capabilities for governance, project-team participation, and project visibility. Mobile PPM was introduced through Primavera P6 Team Member for I Phone and Team Member Web Interface, to streamline communications between project team members in the field and in the office. In addition, Primavera P6 Analytics Release 2.0 gained new enterprise-reporting tools and dashboard for monitoring and analysing performance data, including geospatial analysis. Organizations could also investigate comparative trends and cause-and-effect in multiple projects with Primavera Contract Management Release 14 as it included the report-writing capabilities of Oracle Business Intelligence Publisher.

Primavera Systems, Inc. was a private company providing Project Portfolio Management (PPM) software to help project-intensive organizations identify, prioritize, and select project investments and plan, manage, and control projects and project portfolios of all sizes. On January 1, 2009 Oracle Corporation took legal ownership of Primavera. Primavera Systems, Inc. was founded on May 1, 1983 by Joel Koppe man and Dick Faris. It traded as a private company based in Pennsylvania (USA), developing software for the Project Portfolio Management market. To help expand its product capabilities, Primavera acquired Eagle Ray Software Systems in 1999, Evolve Technologies (a professional services automation vendor) in 2003, Pro Sight (an IT portfolio management software vendor) in 2006, and, in the same year, Pert master (a project risk management software vendor).

In 2008, Oracle announced it was acquiring Primavera, turning it into the Primavera Global Business Unit (PGBU) Oracle Corporation announced the release of version 8.3 of Primavera P6 Enterprise Project Portfolio Management. This version was stated to enhance and extend previous work, improved reporting, and user experience and application integrations. This version incorporated material from Oracle acquisitions of Skire and Instantis in 2012. In 2012 Primavera P6 EPPM, upgrade Release 8.2, added capabilities for governance, project-team participation, and project visibility. In addition, Primavera P6 Analytics Release 2.0 gained new enterprise-reporting tools and dashboards for monitoring and analysing performance data, including geospatial analysis. Organizations could also investigate comparative trends and cause-and effect in multiple projects with Primavera Contract Management Release 14 as it now includes the report-writing capabilities of Oracle Business Intelligence Publisher.

2.5 Planning and Controlling

Before implementing Primavera to schedule projects, team members and other project participants should understand the processes involved in project management and the associated recommendations that help smooth the Primavera implementation that supports your corporate mission. If you were driving to a place you had never seen, would you get in the car without directions or a map? Probably not. More than likely you would take the time to plan your trip, consider alternate routes, and estimate your time of arrival. Planning the drive before you even left would help your trip be more successful. And, along the way, should you encounter road blocks or traffic delays, you would have already identified alternate ways to reach your destination.

Project management follows the same methodology and purpose—to achieve each project goals, you need to plan them in advance. Good project management is no longer an option in today’s corporate world. It is a critical tool to help your company stay on target and accomplish its goals. Simply stated, project management is the process of achieving set goals within the constraints of time, budget, and staffing restrictions. It allows you to get the most out of your available resources. Resources include

- Man power
- Material
- Money
- Machinery
- Information
- Facilities
- Role

Project portfolio management factors in all of these variables across multiple projects, enabling project managers and company executives to see an accurate picture of how each projects resource use affects other projects. The process of project management is guided by three key principles:

- Planning
- Controlling
- Managing

2.6 Managing a Project

The process of guiding a project from start to finish is the responsibility of a project manager. A good project manager wears many hats, acting at various times as a motivator, communicator, coordinator, and advisor. As you control the project's progress, it is your job to keep your team aware of changes to the schedule and possible consequences. In many ways, you are the project ambassador, ensuring that your project organization is carrying out its responsibilities for the best possible outcome. To be an effective project manager also requires consistency when you update your projects. Select a day each week, or biweekly, when you will regularly update projects.

This regular update will include progress on values such as

- ❖ Dates on which activities started or finished.
- ❖ Dates when resources are consumed.
- ❖ Changes to resource rates.

The Project Management module provides many tools to assist you in reporting progress to both team members and senior management. Use the Project Web Site option to create a central location where team members can view project progress.

Consider the many system reports as a means for communicating change. In addition, senior management can use Primavera Web Portfolio Management module to summarize project data and easily capture a snapshot of how a project or group of projects is progressing.

Application of Primavera

- ❖ Balance resource capacity.
- ❖ Monitor and visualize project performance versus plan.
- ❖ Plan, schedule and control complex projects.
- ❖ Conduct what-if analysis and analyse alternative project plan.
- ❖ Allocate best resource and track progress.

Advantages of Primavera

- ❖ Primavera P6 Reduces Risk
- ❖ Easy to Use Software
- ❖ Optimized Resources
- ❖ Enhanced Visibility
- ❖ Forecasting of Project Activities

2.7 Gap and Findings

1. ZHANG and ZHILI (2013)

BIM is transforming the AEC industry to a high-tech and high-productivity industry. The application of BIM can spread all through the project life cycle, from planning stage to construction and installation, and even rebuilding or dismantle. The Study investigated if BIM can help reduce project time and save money through a case study project. The study introduced a BIM centred project delivery process and compared it with the traditional process and found the benefits of applying BIM to project exist. These benefits include (i) fast real-time design, (ii) accurate 3D visualization with multiple design views, (iii) automatic document management, (iv)enhanced collaboration and communication, (v) fast and accurate model-based estimating, and (vi) optimized 4D scheduling. Although the benefits of using BIM for project time and cost control are varying, the learning curve required and initial cost for BIM setup could be the main barrier for the spreading of this advanced technology. A long-sighted company should be confident that the rewards of bringing in BIM will be more significant.

2. MUSTAFA SELCUK, DAVID BOYD (2017)

The key to establishing and driving the innovative capability of BIM is an understanding of innovation as practice, which involves working with a variety of evolving perspectives that need to be articulated and reconciled on an ongoing basis. The conceptual continuum based on technology and human centred perspectives on BIM enables an explanation of the complex practice of innovating as a process of negotiation rather than as implementation of generalized solutions. This implies that practitioners must be ready to face and work with tensions that arise when contrasting implicit assumptions coincide in practice. They should not reject certain perspectives.

3. PAVAN MEADATI, AMIN AKHNOUKH (2011)

BIM provides the means to facilitate an integrated and coherent information management strategy. BIM eliminates fragmentation and provides seamless flow of facility information among the planning/design, construction, and operation and maintenance phases. Ceasing the implementation of BIM after the preconstruction stage of the project lifecycle, project participants are not able to realize the benefits offered by BIM. The FADAA, ODDAA and O&M information integration techniques facilitate the extension of BIM implementation into the O&M phase.

4. SCOTT ROOT and JAE-JAN (2012)

The process of how sustainable and BIM goals were conceived, integrated and measured could be more adequately applied through a single focus as opposed to a comparative effort trying to link the two. The creativity of the OAC (Owner/ Architect/ Contractor) teams will be a key driving force in finding innovative ways of integrating the two approaches. 350 ICSDC 2011.

5. SUNGKON MOON and JAE-JAN (2018)

In this study, design error costs were quantified and their economic impacts on a project were analysed. Additionally, the efficacy of BIM-assisted design validation was analysed by examining the ratio of BIM's benefit to the investment cost of its adoption. The following are the results of testing the hypotheses formulated.

• Hypothesis 1: BIM-assisted design validation—that is, the effect of avoiding design error costs, was accepted when BIM impact was not reflected, making up 0.736% of the total construction amount, and rejected when BIM impact was reflected, making up 0.454% of the total construction amount;

• Hypothesis 2: This hypothesis was accepted because, among classified errors, the costs due to design errors leading to schedule delays were analysed to be 211.86% (7.0 billion won) and194.69% (4.2 billion won) higher when BIM impact was and was not reflected, respectively, than design errors requiring direct cost input; and

• Hypothesis 3: This hypothesis was accepted because BIM's investment-to-benefit ratio, or ROI, was analysed to be at least 194.41% even when the total BIM investment cost (3.27 billion won) was not input, with the BIM benefit assumed to be equivalent to the design error cost (6,357,278,419 won); this ratio would likely increase as the project progressed. Although the effectiveness of BIM-assisted design error validation was clearly demonstrated in this study, more effort is needed in applying working-level BIM to prevent indirect economic losses that affect projects more than direct economic losses. In this regard, there is also a need to analyse the economic effects of BIM-based construction planning, operation, and construction site safety management. In future research, the economic effects of rework and construction schedule delays associated with MEP and finishing work need to be analysed to achieve a balanced BIM effect analysis with all major elements considered.

6. MOHAMMAD K and FARZAD S (2012)

The concept of sustainable design and construction should include a program to protect workers from construction accidents, which would have positive impacts on the environment and humans. If the potential for hazards are identified during the design phase, elimination of hazards would be easier and more economical. Involving the contractor early in the design process creates a collaborative environment in which the design experts and the constructors' team can collaborate to significantly improve the safety conditions on the jobsite. BIM should not only be viewed as just a simulation tool, but also as a centralized database to be used for multiple disciplines in order to integrate and communicate. BIM is becoming the new standard and will result in comprehensive change in the construction industry. For the broader utilization of this technology in the construction industry for safety and health, we have to become more pragmatic in our use of BIM. More research is needed to address the barriers and the limitations of BIM application for safety management and the factors impacting implementation with respect to construction safety.

Chapter 3

Case study

3.1 General

Project taken for the case study is currently going on in New Panvel and it is completely built except finishing. In this project work the model created is up to G + 7 floors to show the building progress. The actual software's used by various stakeholders for the construction of this project are:

Architect: AutoCAD 2017

Client: Nil

Contractor: AutoCAD 2017, Microsoft Excel 2007

3.2 Case Study Details

Name of Project: Proposed Residential Buildings On Land Bearing Sr. No 8/10

Structure details: G+7th Floor Residential Building

Location: Atgaon, Shahapur, Thane

Name of Client (builder): Mr. Sanjay Borgaonkar

Name of Architect: Upasni Design Cell

Name of Structural Consultant: John Mathew

Name of Contractor: Ganesh Patil

The Case study taken for this project is because the Software used to execute the ongoing project is Conventional software's, where implementation of Modern Techniques is not done. The Project duration of 17 months shown is given by contractor is on the basis of experience.

Therefore, whether the project is on time, before time, delay, completion etc. could not be known. Hence to overcome this situation BIM tool and Primavera for actual Project duration to be known has been used in this study

BIM is Autodesk's strategy for the application of information technology to the building industry. BIM solutions have three characteristics:

- They create and operate on digital databases for collaboration.
- They manage change throughout those databases so that a change to any part of the database is coordinated in all other parts.
- They capture and preserve information for reuse by additional industry-specific Applications.

The application of BIM solutions results in higher quality work, greater speed and productivity, and lower costs for building industry professionals in the design, construction, and operation of buildings.

3.3 The Road to BIM

Over the past few decades, consistent effort has been made to provide traditional three-dimensional BIM with "fourth" (4D), "fifth" (5D) and even "sixth" (6D) dimensions, developing on its base Product Lifecycle Management (PLM) analogue for construction industry (Darius et al., 2013). The accompanying chart shows the tendencies in CAD usage. During the past 50 years. As we can see, from the mid-60s onwards, more and more of the Industry has adopted some form of CAD and Figure 3.1 shows the most common methods like

Hand Drafting, 2D CAD, 3D CAD and BIM

In the early 1980s architects began to use PC-based CAD. The familiar layer metaphor that originated with pin-bar drafting was easily adapted to the layer-based CAD systems of the day and within a few years a large percentage of construction documents and shop drawings were plotted from computers rather than being manually drafted on drawing boards. Slowly technology began to affect the process. DWG files were exchanged with consultants instead of physical underlay drawings. Beyond simple graphics these files communicated information about a building through their layer structure; a rectangle on one layer represented a concrete column, but on another layer a tile pattern on the floor. Electronic file formats originally designed to store only graphics and drive plotters now directly conveyed information about the building that would not appear in the plotted version of the file. The use of CAD files was evolving towards communicating information about a building in ways that a plotted drawing could not.

This evolution continued with the introduction of object-oriented CAD in the early 1990s. Data “objects” in these systems—doors, walls, windows, roofs—stored non graphical data about a building in a logical structure together with the building graphics. These systems often supported geometrical modelling of the building in three dimensions, thereby automating many of the laborious drafting tasks like laying out building section drawings and generating schedules. Forward-thinking design firms adopted these tools, realizing that the data in the object-oriented CAD files, if carefully structured and managed it could be used to automate certain documentation tasks like schedules and room numbering. A parallel development in the 1990s was the increasing use of the Internet for sharing data digitally, information could not be effectively communicated unless it was represented digitally. CAD files that had been exchanged on floppy disks within the design team appeared instead on Internet File Transfer Protocol (FTP) sites, on web pages, and attached to emails.

The same forward-thinking design firms who were adopting object-oriented CAD into their practices began sharing and delivering their documents to clients digitally and began investigating web-based project management and collaboration services. But object-oriented CAD systems remain rooted to building graphics, built on graphics based CAD foundations and as a result are not fully optimized for creating and managing information about a building. Other industries such as Manufacturing, have realized great benefit from non-graphical, parametric information technology tools. Another generation of software solutions, designed with current technology and purpose-built, is required to fully realize the benefits information technology can bring to the building industry. The next generation of information-centric software provides building information modelling in place of building graphic modelling. By storing and managing building information as databases, building information modelling solutions can capture, manage, and present data in ways that are appropriate for the building team member using that data. Because the information is stored as a database, changes in that data so frequently occur during design which can be logically propagated and managed by the software throughout the project life cycle.

BIM solutions add the management of relationships between building components beyond the object-level information in object-oriented CAD solutions. This allows information about design intent to be captured in the design process. The BIM contains not only a list of building components and locations but also the relationships that are intended between those objects. For example, that a door should be Three feet from a window or the eaves of the roof should overhang the exterior wall by 550 mm, or that three beams should be spaced equally across a structural bay or that the slope of an excavation should be maintained at a certain angle. These relationships, implicitly understood by the designer, become explicit when the building is described in a building information modeller.

Further, these relationships can be inferred by the building information modeller as the user works or explicitly entered as work progresses. These relationships then allow for changes to the building information model to be managed by the software consistent with the design principles and intent for the project. The richness of the relationships embedded within building components themselves, as well as those embedded in the overall model, makes reuse of the data in other applications even more powerful and the design process significantly more efficient.

3.4 Building Information Modelling (BIM)

BIM is a building design and documentation process. It enables us to create and manage information about a building project, using the information about the building project which is stored in a 3D model. More importantly, the intelligent data inherent in the building model allows us to experience our design before it is real, simulate and visualize design alternatives, analyse performance, and make better informed design decisions earlier in the process. Figure 1 shows how various stakeholders are associated with each other. (Autodesk Official Training Guide, 201

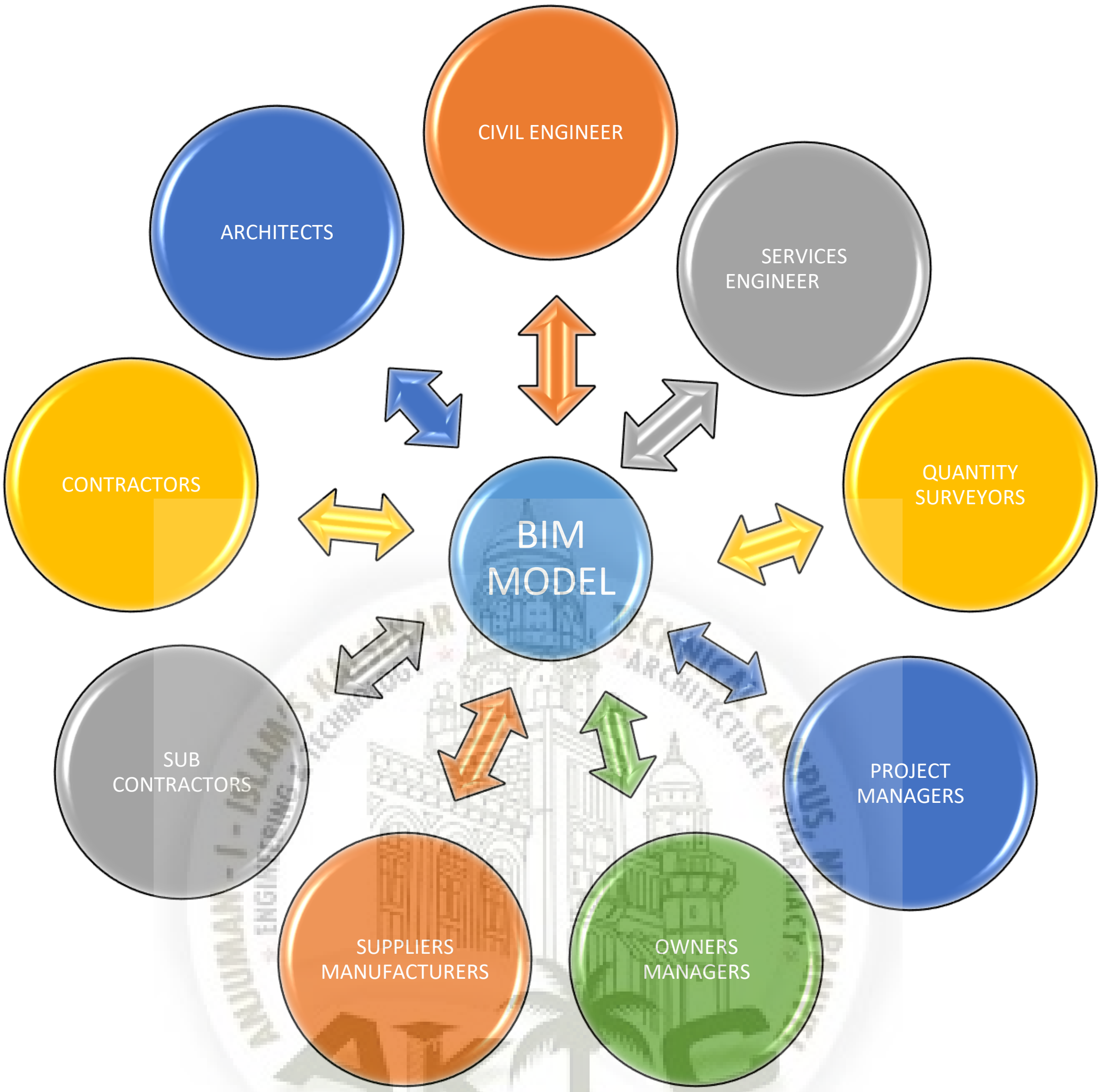


Fig. 1: BIM correlation chart for various stakeholders

The building industry has traditionally illustrated building projects with manually created drawings. Information was added to these drawings by using notes and specifications. With the advent of CAD technology, this process was made faster and easier; however, the output of manual drafting, graphics CAD systems, and object-oriented CAD systems remained the same: a graphic abstraction of an intended building design. (Autodesk Official Training Guide, 2010).

The development of the BIM methodology has turned this relationship around. BIM software captures information about a building and then presents that information as 2D and 3D views, schedules or in other required formats. Architects and engineers can use digital design information to analyse and understand that how their projects will perform before they are built. Developing and evaluating multiple alternatives simultaneously enables easy comparison and informs better sustainable design decisions. BIM is core to Autodesk's sustainable design approach for building performance analysis and simulation. (Autodesk Official Training Guide, 2010)

3.5 Definition of BIM

BIM is an emerging technological and procedural shift within the Architecture, Engineering and Construction and Operations (AECO) industry. Researchers have been investigating the components and repercussions of building product models for many years before the emergence of BIM as a new term. While the mere presence of a label or an acronym is viewed by some researchers as a sign of poor lexical literacy, others refer to names as "vital for communication and useful for understanding a situation". Many industry writers and analysts have contested the many terms available while others have argued for the acceptance of BIM as is because of its adoption by industry's major CAD developers. Whether the term itself is useful, agreed upon or contested, BIM is continuing its proliferation in both industrial and academic circles as the 'new CAD paradigm'. (Succar, 2009) Eastman et al. defined BIM as a "modelling technology and associated set of processes to produce, communicate and analyse building models. He also identified that "BIM is one of the most promising developments in the AEC industries". The major difference between BIM tools and conventional ones is that the BIM tools focus on the data of the model rather than the drawings and 3D images. In other words, the BIM tool provides more information on what it can support than what it contains. Eastman et al. summarized that BIM technology can be used to support the design and analysis of building system. In the early design process, it includes experimental analysis of structure, environmental controls, construction method, use of new materials or systems, detailed analysis of user processes; and In the field of building system analysis, it involves many functional aspects of the building system, such as structural integrity, temperature control, ventilation, lighting, circulation, acoustics, energy distribution and consumption (Weilin et al., 2012). Figure describes how information flows during the life cycle of a project (Darius et al., 2013). BIM is an integrated process for exploring a project's key physical and functional characteristics digitally before it is built. Autodesk provides a comprehensive portfolio of BIM solutions, which assist customers in delivering projects faster and more economically, while minimizing environmental impact. (Autodesk Official Training Guide, 2010). Coordinated, consistent information is used throughout the BIM process to:

• Design innovative projects and conduct analysis from the earliest stages.

• Better visualize and simulate real-world appearance, performance, and cost.

• Document more accurately.

3.6 The Characteristics of BIM

BIM solutions create and operate on digital databases for collaboration, manage change throughout those databases so that a change to any part of the database is coordinated in all other parts, and capture and preserve information for reuse by additional industry-specific applications.

3.6.1 Digital Databases

BIM solutions create and operate on digital databases for collaboration. The building industry has traditionally illustrated building projects through drawings and added information over those illustrations via notes and specifications. CAD technology automated that process, and object-oriented CAD extended the idea of adding information to illustrations and graphics into software. The result of earlier manual drafting, graphics CAD systems, and object-oriented CAD systems were identical: the creation of graphic abstractions of the intended building design. The principles of BIM turn this relationship around. BIM applications start with the idea of capturing and managing information about the building, and then present that information back as conventional illustrations or in any other appropriate way. A BIM captures building information at the moment of creation, stores and manages it in a building information database, and makes it available for use and reuse at every other point in the project. Drawings become a view into the database that describes the building itself. In a building information modeller, the building information is stored in a database instead of in a format (such as a drawing file or spreadsheet) predicated on a presentation format. The building information modeller then presents information from the database for editing and reviews in presentation formats that are appropriate and customary for the particular user.

Architects, for example, work on the information using the conventions of the highly stylized symbolic graphic language of building design (such as plan, section and elevation), entering and reviewing information in a format that looks just like the architectural drawings they have worked with for years. They work on the building information through a drawing rather than working directly on a drawing in the computer. Similarly, structural engineers work with the data presented graphically in familiar framing and bracing diagrams, quite different from the architects' interface to the data. Builders work with some of these same presentations and also isometric views of the building geometry to study phasing and coordination issues and databases or spreadsheets of quantity data provided from the BIM. Although each professional working on the building project views the building information in the way he or she expect to see it, these presentations of the information—drawings, schedules, cost estimates, other conventional presentations of the building information—are all views into the same information model. While each discipline interacts with familiar and customary views of the information, the building information modeller assures that changes made in any of these view sis reflected in all other presentations. BIM organize collaboration by the building team through digital databases. The BIM can be distributed to individual team members working on a network or sharing files through project collaboration tools such as the Autodesk® Buzz-saw™ service. Team member's work independently on local data sets while the BIM solution manages changes to the model from each of these local databases in a central shared location. Team members can compare their work to concurrent work by other team members and dynamically reserve and release portions of the database for use over the network. A record of these interactions—who changed what, and when—is available for review, and a history of all changes made by all team members can be preserved in the BIM for as long as this information is useful. Changes can be selectively rolled back to support investigations of options or changes in design direction.

3.6.2 Change Management

BIM solutions manage iterative change through a building's design, construction, and operation. A change to any part of the database is coordinated in all other parts. The process of building design and documentation is iterative. The understanding of a design problem develops during the design process. In addition to the refinements typical to any design process, a new insight into the design problem may lead the design team to discover that the solution could be quite different, and possibly better. At that point another iteration occurs that may reconsider earlier assumptions. Managing this iterative change is an inherent part of the design process. Maintaining an internally consistent representation of the building as a database improves drawing coordination and reduces errors in the documents to the benefit of all building team members. Time that would otherwise be spent in manual document checking and coordination can be invested instead in the real work of making the building project better. The resulting documents are of higher quality, and thus the costs of changes and coordination are reduced. BIM tools enable the design, construction, and occupancy of the building to proceed with less friction and fewer difficulties than conventional tools. Estimating, procurement, and construction are also iterative processes of definition and elaboration. Specific materials and products are selected from among the range of possibilities that meet the project specification. Selection, refinements, and substitutions may result in changes to some aspects of the design. Ambiguities in the design documents are resolved between the design and construction teams before construction. The construction and design teams consider changes to improve constructability and value for the client. Each of these decisions requires evaluation and that new information be captured to support later evaluations as well as operation and management of the building. BIM solutions capture and manage this information and make it available to support the collaborative process. The operation of buildings after completion is also an iterative process that is well supported by BIM solutions. The first occupancy of a building—the end of the conventional design and construction cycle—is just the beginning of the life and use of the structure. The evolving occupancy of the building together with the maintenance requirements of the building materials, assemblies, and systems result in changes throughout the life of the building. BIM supports the building life cycle with solutions for the design and documentation of the continuing maintenance, renovation and renewal of the building itself within the BIM.

3.6.3 Reuse of Information

BIM solutions capture and preserve information for reuse by additional industry-specific applications. Successful information technology solutions outside the building industry are based on one primary principle: Data is captured once, as close to its point of origin as possible, and stored in a way that it is always easily available and can be presented in context whenever required. A simple example is, a personal financial management package that captures information from our check book register as we write checks and make deposits, stores and manages that information for a variety of purposes, and presents it back as our income tax return in one case and a statement of net worth in another. BIM accomplishes the same thing for the building industry.

The moment that an architect sketches the outline of a building on a site survey, data is created. The general size of the building foot print is now known. General program requirements and planning ratios can be applied to deduce the overall building configuration. Similarly, when an architect is working out the building plan, data is being created that can be re-presented in interior elevations, sections, and schedules. Conventional tools require all this data to be re-derived at the point in the project where the information about building size or sections and schedules is required. BIM tools capture this data at the moment it is created, store it, and make it available for re-presentation as information in other documents and artefacts as needed.

A construction cost estimator traces over a drawing on a digitizing tablet to derive quantities for a cost estimate or bid or to measure that drawing manually. The construction project manager in the same company traces over these same drawings to develop plans for construction sequencing and phasing. Using BIM, instead of tracing over the plans for the quantities, the estimator and the design team can interact with the BIM. Or, if the project team is not ready for that level of collaboration, the estimator can trace over digital plans in software, constructing a BIM in about the same amount of time required for the manual tracing. Now this data is captured in the BIM itself and can be re-presented as a phasing and sequencing plan.

A third example is the use of schedule data in a building information model for inventory management in a retail operation. As the display unit layout is planned for a store in BIM, the possible configurations and capacity for each unit are captured and reported back later in a schedule for inventory calculations, and the inventory schedule information can be linked to a procurement system to coordinate the management of inventory with the capacity of the store. The BIM data extends to the support of the store operations.

Reuse of building information leads to connections from Autodesk's current solutions to other applications for energy analysis, structural analysis, cost reporting, FM and many others. The persistence of the BIM through the building design, procurement, construction and operation supports the management of workflow and process around this information.

3.7 Need of BIM in Project Scheduling and Progress Monitoring

Effective planning is one of the most important aspects of a construction project and influences the success of a project (Chevalier and Russell, 1998). Fischer (2002) argued that there are fundamental differences between a construction plan and a construction schedule. Whilst a plan shows activities and their logic relationships, activities do not show specific start and end dates. A schedule shows temporal information, which enables project duration to be defined. (David and Lamine, 2004)

Construction projects are becoming much more complex and difficult to manage. One complexity is the reciprocal interdependencies between different stakeholders such as financing bodies, authorities, architects, engineers, lawyers, contractors, suppliers and trades. As a response to the increasing complexity of projects, Information and Communication Technology (ICT) has been developing at a very fast pace. During the last decade, a major shift in ICT for the construction industry has been the proliferation of BIM in industrial and academic circles as the new CAD paradigm. BIM is currently the most common denomination for a new way of approaching the design, construction and maintenance of buildings. (David et al., 2013)

The rising interest in BIM can be seen in conjunction with new PM frameworks, such as Integrated Project Delivery (IPD), which increases the need for closer collaboration and more effective communication. When people collaborate on a project and communicating specific characteristics of the project amongst the different parties involved, requires documentation of these characteristics. Traditionally, this documentation was done on a paper or document basis. BIM takes the traditional paper-based tools of construction projects, puts them on a virtual environment and allows a level of efficiency, communication and collaboration that exceeds those of traditional construction processes. Hence the coordination of complex project systems is perhaps the most popular application of BIM at this time. It is an ideal process to develop collaboration techniques and a commitment protocol among the team members. BIM has also been linked to the development of lean approaches to the management of projects, as the enhanced collaboration and information sharing can contribute to the lean management's goal of reducing non value adding waste. (David et al., 2013) BIM has a potential use at all stages of the project life-cycle: it can be used by the owner to understand project needs, by the design team to analyse, design and develop the project, by the contractor to manage the construction of the project and by the facility manager during operation and decommissioning phases. Looking to the future leads to speculation that BIM will eventually lead to a virtual project design and construction approach, with a project being completely simulated before being undertaken for real. As such BIM will provide potential beneficial project outcomes by enabling the rapid analysis of different scenarios related to the performance of a building through its life cycle. (David et al., 2013)

The several main reasons to use BIM as per (Ghang et al., 2006):

- A building is composed of geometric components and the geometric information is substantial for BIM.
- Parametric modelling provides mechanisms to translate and embed domain expertise as explicit geometric expressions that can automate generation of the building information especially geometric information and that can facilitate the generation of a rich building model.
- Maintenance of the validity of information generated is crucial for revision and reuse of building information. The semantic integrity of building model can be maintained based on the imposed geometric constraints and rules, as building model is being revised

3.8 Benefits of BIM based Project Scheduling and Monitoring

We-nfa-et al., (2011) describes the several advantages of BIM technique:

(1) Visualization of the construction project

The key benefit of BIM is its accurate geometrical representation of the parts of a building in an integrated data environment.

(2) Improvement of coordination efficiency

BIM makes information sharing and exchange become smooth, timely and accurate and free from time and place restrictions.

(3) Simulation characteristics

BIM can not only simulate 3D building models, 4D schedule and 5D cost estimate but also simulate operation that isn't able to be operated in the real world, such as emergency evacuation simulation, simulated sunlight, heat transfer simulation, etc.

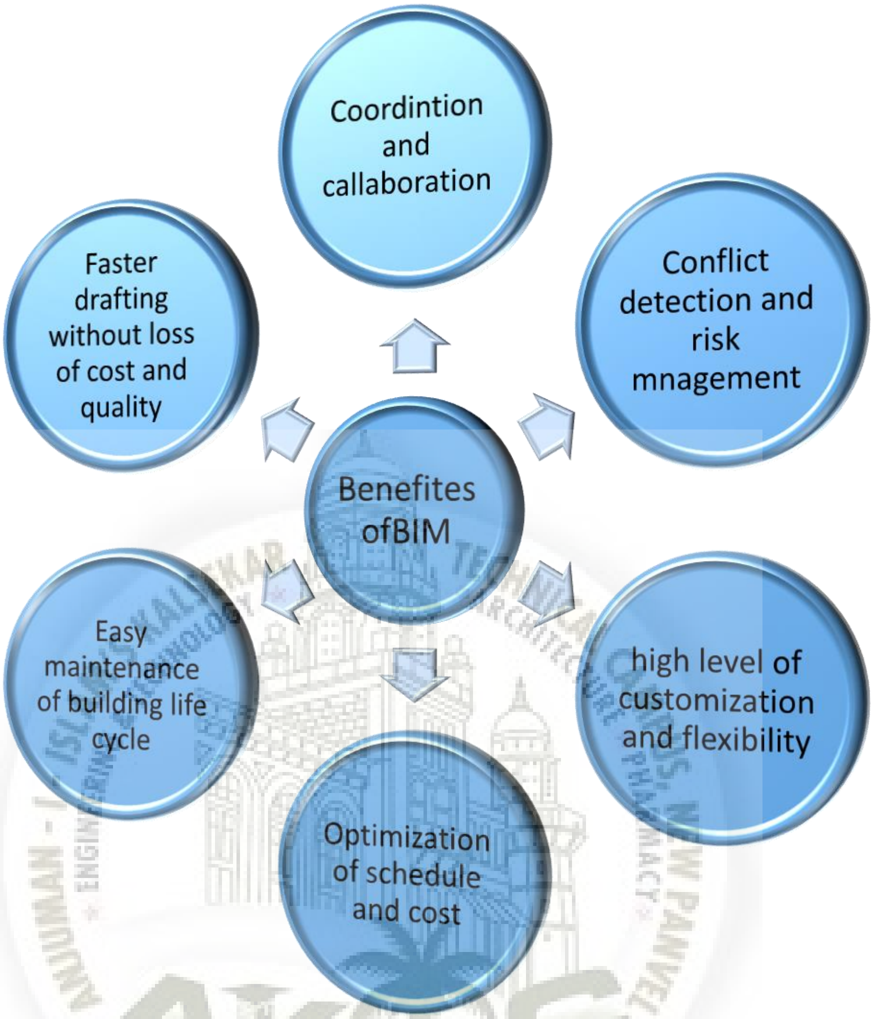


Fig.2: Benefits of BIM process

(4) Integrated management

BIM can integrate objective design, feasibility studies, decision-making, design and planning, supply, implementation of the control and operation management into an integrated management process.

(5) Full life-cycle management

BIM provides a platform for the parties involved in the construction to consider the process of project life-cycle, based on which, the participants manage to achieve the win-win situation and make the overall goal optimal.

3.9 Applications of BIM

A BIM can be used for the following purposes (Azhar, 2011): Figure 3.6 shows the application of BIM within the AEC industry and various stakeholders that are associated with

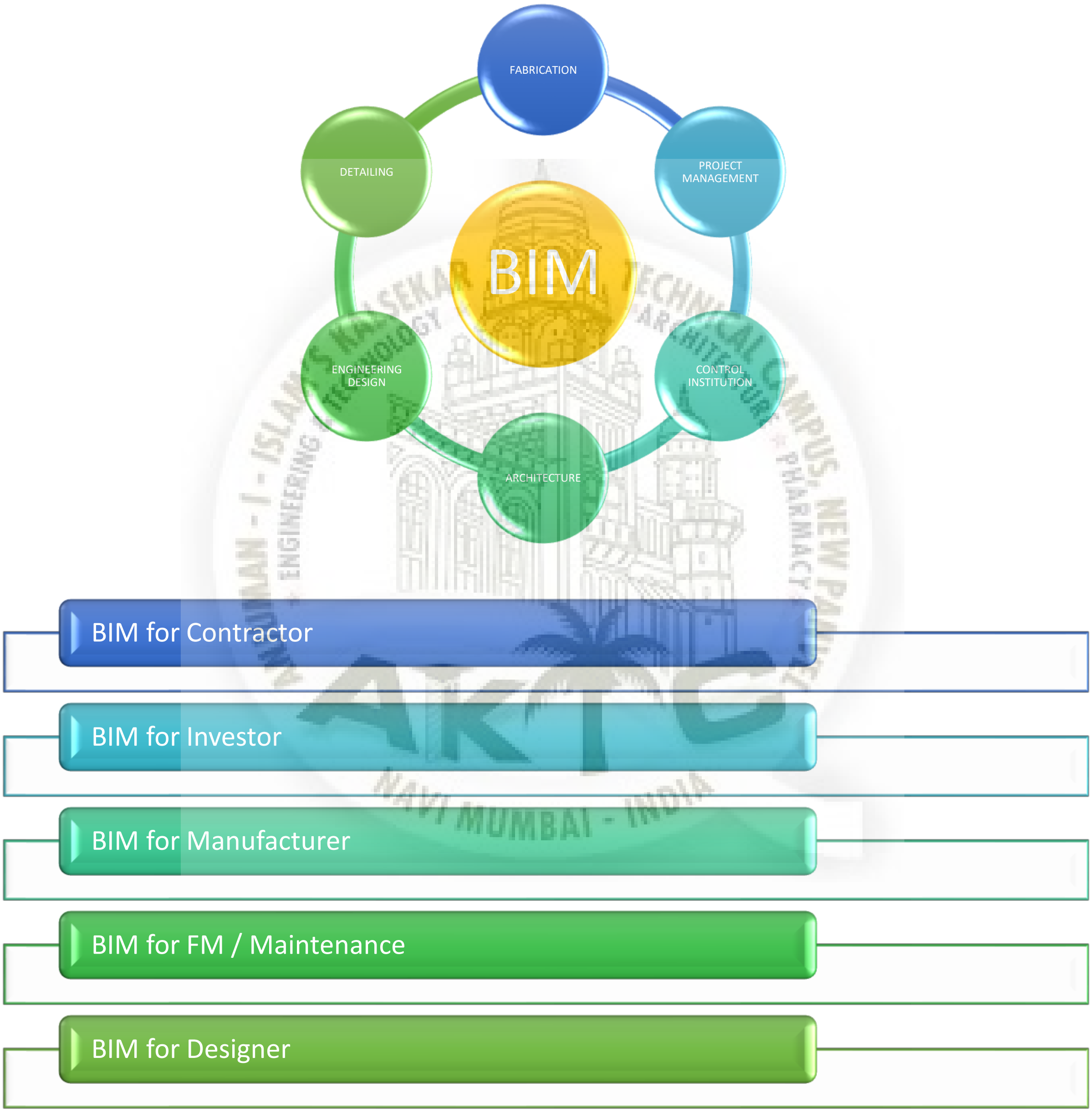


Fig.3: BIM used in different phases of construction

(1) Visualization: 3D renderings can be easily generated in house with little additional effort.

(2) Fabrication/shop drawings: It is easy to generate shop drawings for various building systems. For example, the sheet metal ductwork shop drawings can be quickly produced once the model is complete.

(3) Code reviews: Fire departments and other officials may use these models for their review of building projects.

(4) Cost estimating: BIM software has built-in cost estimating features. Material quantities are automatically extracted and updated when any changes are made in the model.

(5) Construction sequencing: A BIM can be effectively used to coordinate material ordering, fabrication, and delivery schedules for all building components.

(6) Conflict, interference, and collision detection: Because BIM are created to scale in 3D space all major systems can be instantly and automatically checked for interferences.

(7) Forensic analysis: A building information model can be easily adapted to graphically illustrate potential failures, leaks, evacuation plans, and so forth.

(8) Facilities management: Facilities management departments can use it for renovations, space planning, and maintenance operations.

(9) Faster and more effective processes: Information is more easily shared and can be value-added and reused.

(10) Better design: Building proposals can be rigorously analysed, simulations performed quickly, and performance benchmarked, enabling improved and innovative solutions.

(11) Controlled whole-life costs and environmental data: Environmental performance is more predictable, and lifecycle costs are better understood.

(12) Better production quality: Documentation output is flexible and exploits automation.

(13) Automated assembly: Digital product data can be exploited in downstream processes

and used for manufacturing and assembly of structural systems.

(14) Better customer service: Proposals are better understood through accurate visualization.

(15) Lifecycle data: Requirements, design, construction, and operational information can be used in facilities management.

Chapter 4

Methodology

4.1 General

The project is software based. Planning, modelling and scheduling will be done by using AutoCAD, Autodesk REVIT and Primavera. This project consist of three main parts as follows:

4.1.1 Planning

Planning of a residential building has been done as per Bye-Laws and IS Code requirement, keeping in mind the accommodation. For planning AutoCAD software is used. This residential building consists of 7 floors. Ground floor consist of four flats whereas from 1st floor to 7thfloor there are six flats on each floor. Others floors are the replica of 1st floor. Each flat consists of two flats with bedroom, kitchen, children bedroom, water closet(WC) and four flats with hall, kitchen and WC along with balcony.

4.1.1.1 Ground floor plan

- Ground floor consist of four flats with hall, kitchen and WC along with a passage for easy go and also an area which is open to sky.
- In order to avoid unnecessary chaos and disturbance enough entrance space and passage is provided.
- Server and Maintenance is provided for systematic monitoring of electricity and computer servers.

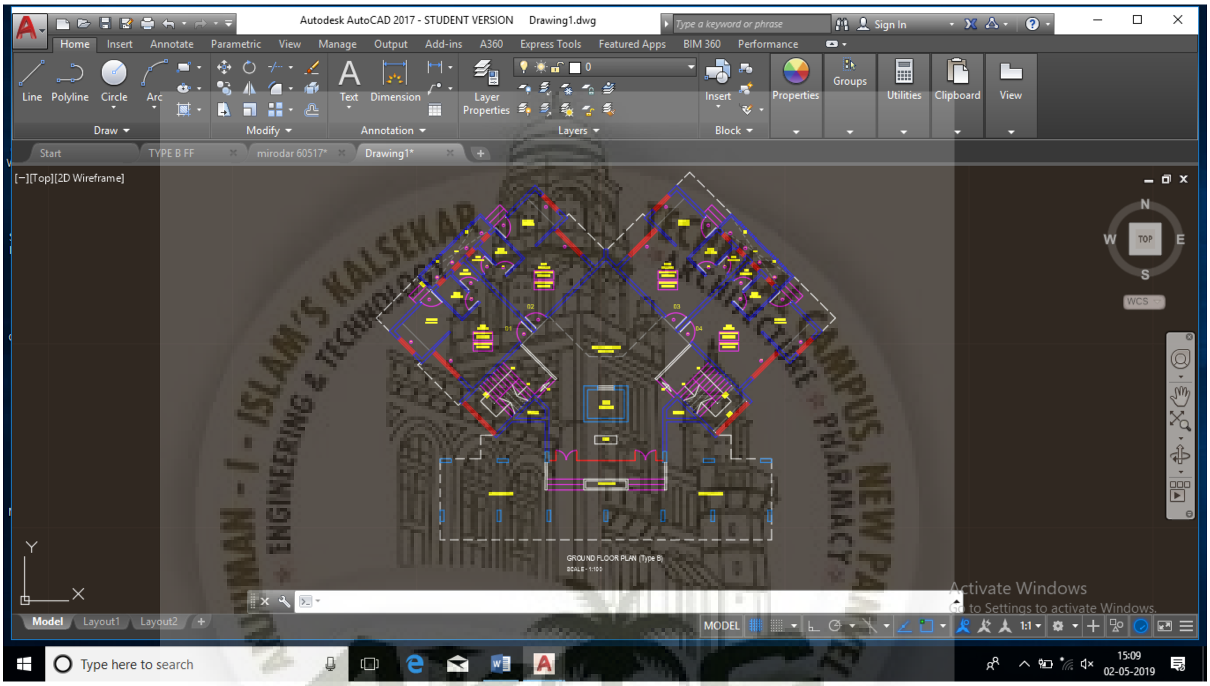


Fig. 4: Ground floor plan

4.1.1.2 First Floor Plan

- 1^{st} floor plan is a floor of total 6 flats in which two flats with bedroom, kitchen, child bedroom, WC and balcony.
- Remaining four flats with hall, kitchen, WC and balcony.
- Passage in front of two flats each is about 1.5m and provided passage in front of an elevator is 2m for easy movement
- Open well staircase is provided throughout the building with Elevators on opposite sides.

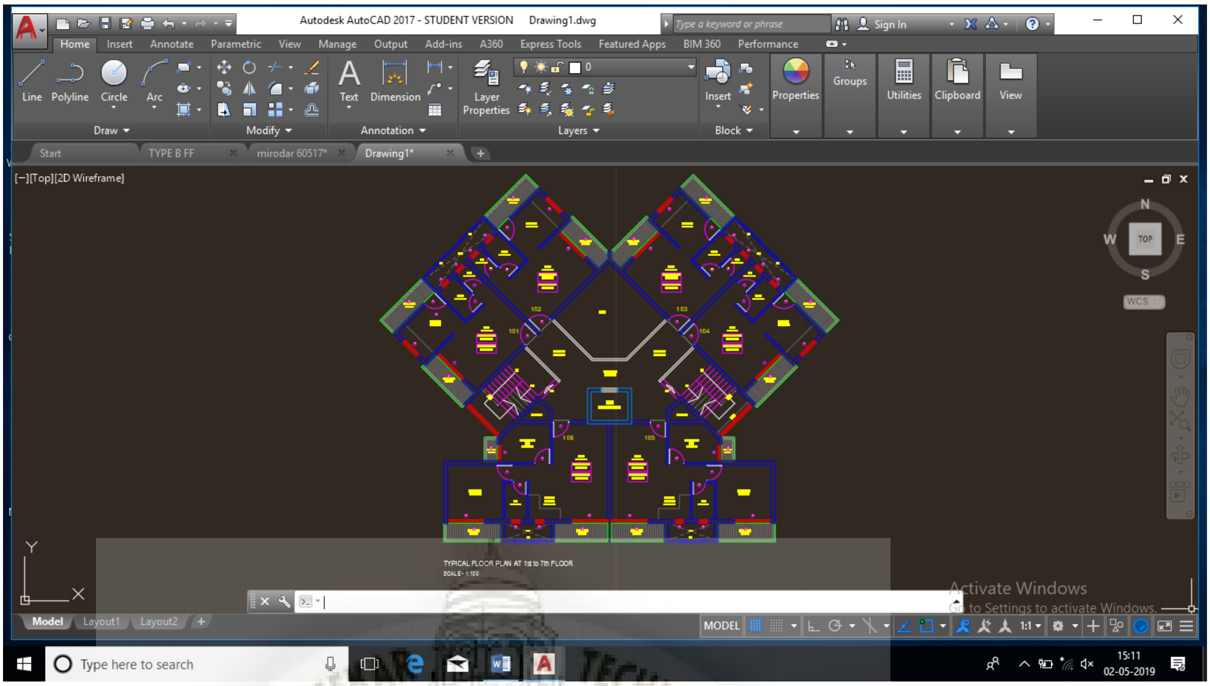


Fig. 5: First floor plan

4.1.2 Modelling

This project demonstrates how to create and manage more complex projects and draw model using Autodesk Revit software as the base layer. The group focuses on the modelling of civil and building engineering structures, both linear and non-linear. In modelling the quantity of material will be estimated and the 3-Dimensional view will be displayed. Revit is a single software application that supports a BIM (Building Information Modelling) work flow from concept to construction. Use Revit to model designs with precision, optimize performance and collaborate more effectively

The step by step procedure for modelling in Autodesk Revit is mentioned below:

1. Importing the AutoCAD plans for ground floor.
2. Defining levels: Levels are defined from plinth level to 7th floor including the water tank Including the terrace level

3. Editing walls beams and columns: dimensions for different walls beams and columns

4. Modelling of ground floor: Beams, columns and walls which are required on ground floor as per the AutoCAD drawing is placed.

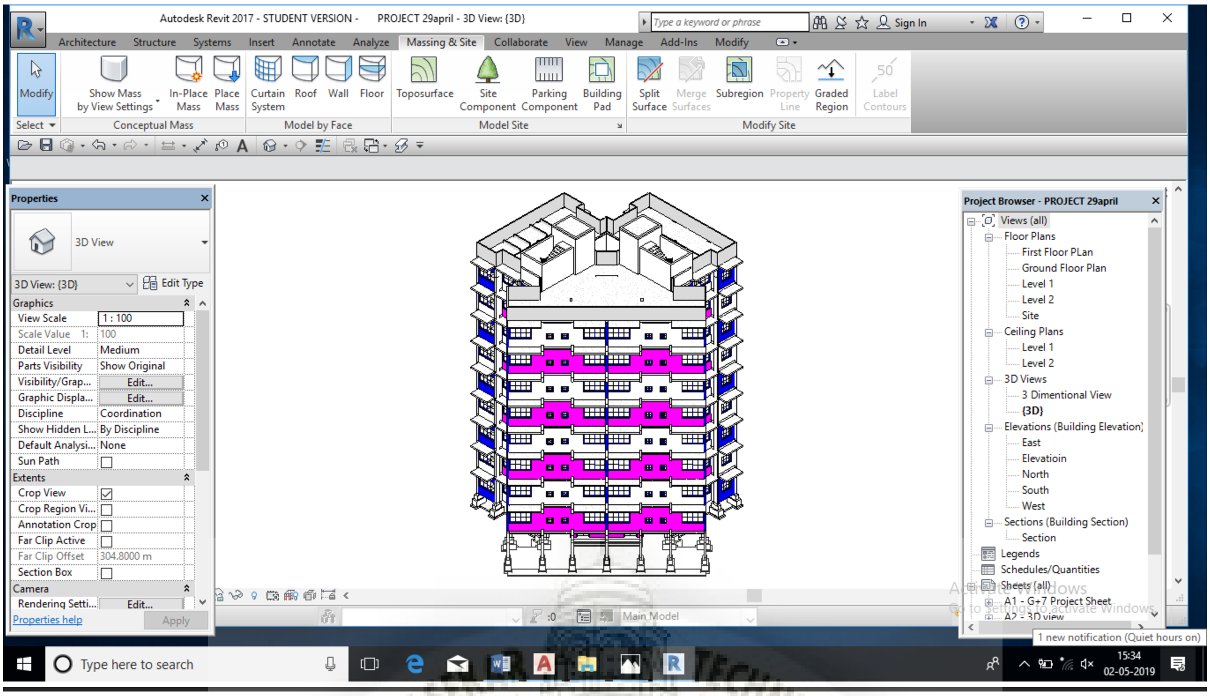


Fig.6: 3D Model

4.1.2.1 Modelling of Ground floor:

- Ground floor consist of four flats with hall, kitchen and WC along with a passage for easy go.
- An area is provided which is open to sky.
- Elevator is provided at the centre for comfort.

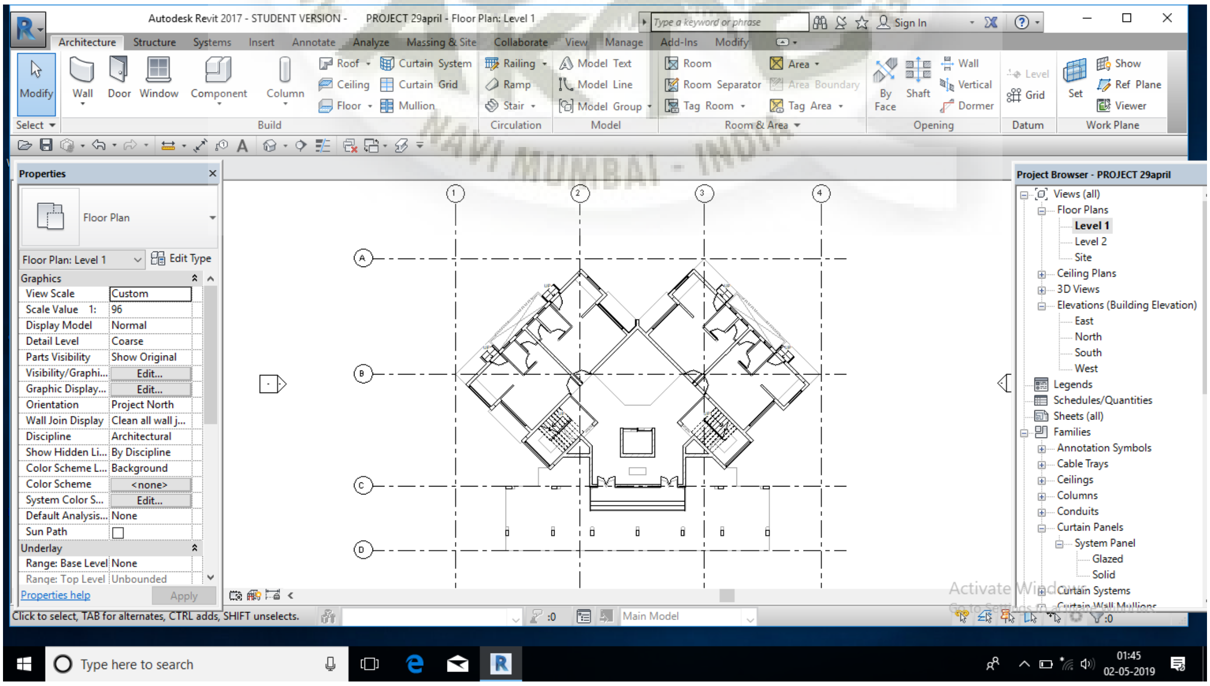


Fig.7: Ground floor model plan

4.1.2.2 Modelling of first floor:

This floor I being modelled as per the comfort of the people residing there. Floor from 2nd are replica of 1st floor.

- 1st floor plan is a floor of total 6 flats in which two flats with bedroom, kitchen, child bedroom, WC and balcony.
- Remaining four flats with hall, kitchen, WC and balcony.
- Book shelves and study table is provided in the child bedroom.

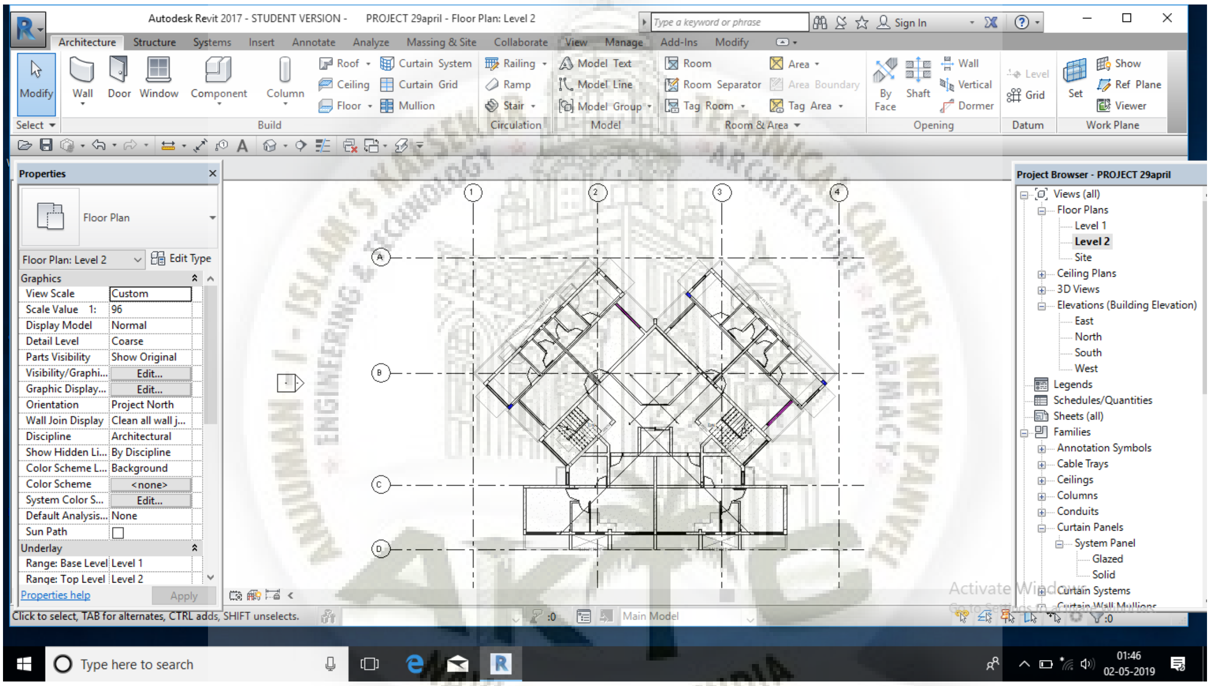


Fig. 8: First floor model plan

4.1.2.3 Site Plan Detail

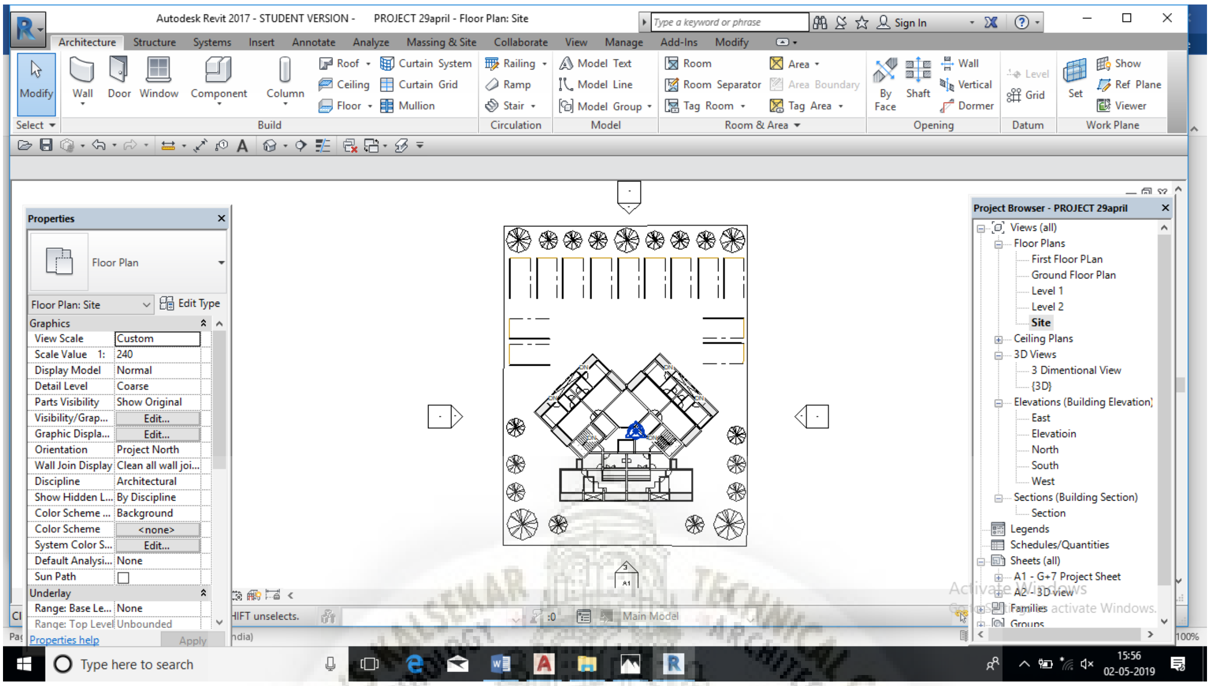
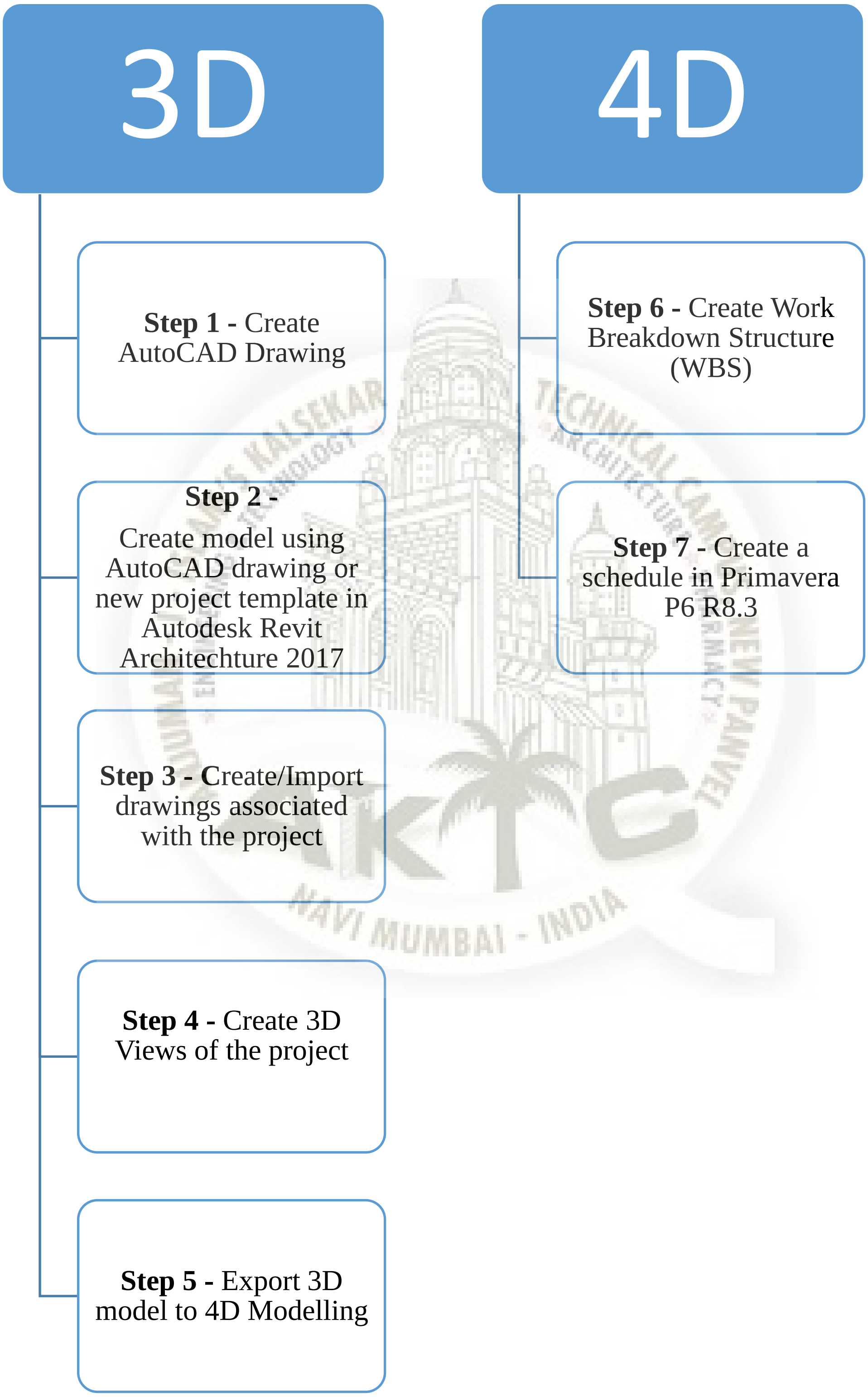


Fig. 9: Site plan model

4.1.3 Procedure for Project Scheduling and monitoring using BIM

The information flow among various applications in the system and also the procedure that needs to be followed in using the system



The procedure for creating 3D and 4D modelling from the given flow chart is explained in detail step by step below:

Step 1: Creating Architectural Design

The design of the construction project is created using AutoCAD 2017, a widely used Software package in Architectural design practice.

Step 2: Creating 3D model

Project model can be directly designed in the Autodesk Revit Architecture 2017. However, if the architect is using AutoCAD for designing the architectural drawing than 2D CAD drawing can be imported to the Revit using link cad option and later model is created.

Step 3: Creating or merging various drawings

Autodesk Revit Architecture 2016 facilitates merging of various components like Heat, Ventilation and Air Conditioning (HVAC), Mechanical, plumbing and piping, electrical etc. under one platform. If drawings are made separately than they are imported in the Revit using insert option. Revit plays a vital role in detecting clashes between various components of the project, which in turn helps in managing, planning and getting forecast of project at planning stage.

Step 4: Creation of 3D view

An orthographic 3D view is created by pressing a home shape button in the view tab, different 3D views can be viewed by rotating the cube. 3D view shows the various components attached with the project. This enables the user to view the project in real virtually.

Step 5: Export 3D model for 4D Modelling

After creating the 3D model in the Autodesk Revit Architecture 2017 it is exported for the preparation of 4D model. Model is exported while 3D view is open in Revit.

Step 6: Creating Work Breakdown Structure

This is done to make project control effective and manageable. It defines and groups a project's discrete work elements in a way that helps organize and define the total work scope of the project.

Step7: Initiating Scheduling Process

Primavera project planner P6 is used as the scheduling tool. The project is scheduled based on the activities. P6 is used for schedule the project showing the start and completion dates, and also showing the sequence and interrelationship between the different activities.

Step 8: Stimulation of the project

The amount of work done on the various work packages could be seen in the 3D views. The project is updated as progress information becomes available from corresponding Primavera P6 Schedule.

4.1.4 Creation of Three Dimensional Model (3D)

4.1.4.1 The view Window

To put it simply "the big white area where the objects go" is the view window. As a result of our actions, this area will become populated with our model. Notice that the background is white. Revit are driven by the object not by the layer.

The user interference page shows the ribbon which is in top most side along with properties palette and project browser which is shown in the left side of the screen which is elaborated in further sections. The white screen shows the four views i.e. North, South, East and West which helps in viewing the model elevation from each aspect

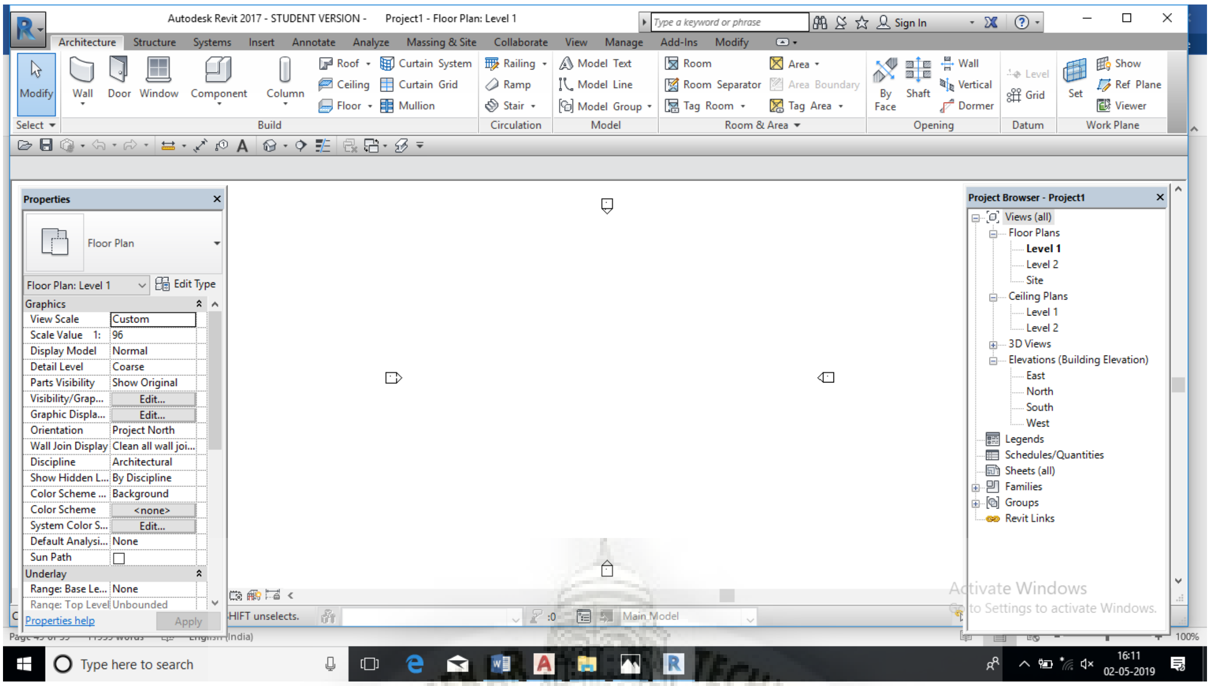


Fig. 10: User interference page of Autodesk Revit 2017

4.1.4.2 The REVIT Workflow

As the top of the Revit window is the ribbon a series of tabs is built into the Ribbon. Each tab contains the panel. This Ribbon will be our Revit launch pads, click the Wall button on the Architecture tab as shown in the figure

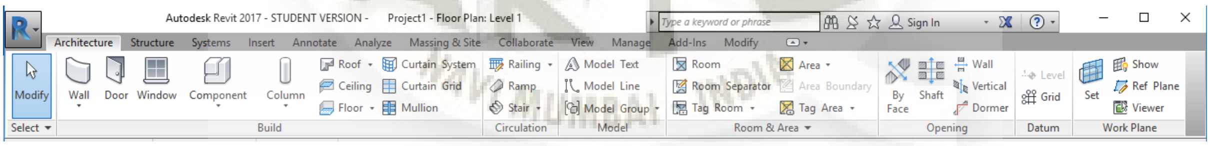


Fig. 11: Ribbon

4.1.4.3 Properties Palette

The properties palette contains the instance parameters of whatever we are currently working on. In this palette we will find the Type Selector, Edit Type and a selection filter as shown in the figure

The properties palette initially shows the graphic options for the floor plan along with the level number. Identify data which is suitable located at the left side of the white screen.

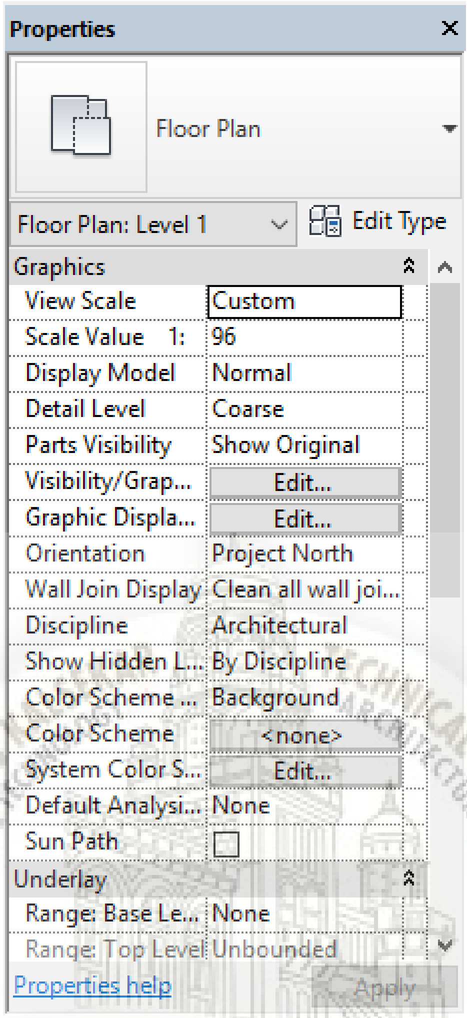


Fig. 12: Property palette

4.1.4.4 Project browser

The project browser is the hierarchical listing of all the views legends, schedule, sheets, families, groups and links in our project. Expansion and collapsing of the project can be done by selecting the "+" and "-" icons.

The project browser helps in viewing various floor plans, ceiling plans, building elevations, building sections etc.

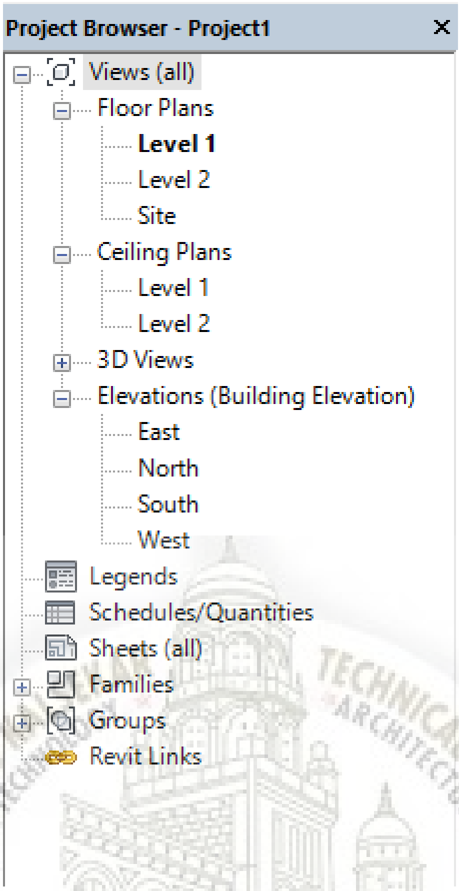


Fig. 13: Project Browser

4.1.4.5 View control bar

The view control bar is at the top the bottom of every view and changes slightly depending on the type of view as shown in figure. For example, sheet views have only four buttons and perspective views don't have a scale option.

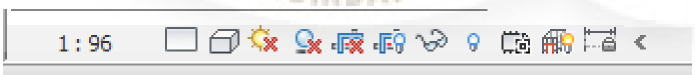


Fig. 14: View control bar

It contains the function outlined in the following list:

- SCALE: - The first item on the view control bar is the scale. In REVIT we can change the scale of a view by selecting this menu. Change the scale here and Revit will scale annotation and symbols accordingly see in figure, the unit of scale is in various forms, further it can be changed whenever required for better convenient. In this the standard scale is taken i.e. 1:100

- DETAIL LEVEL: - It allows us to view the model at different qualities. There are three levels to choose from Coarse, Medium and Fine. The line and borders of the building while zooming depends upon the details level selected, here in this model for best quality, Fine level is selected.

4.1.4.6 Three Dimensional View (3D View)

The 3D view icon brings us to a new conversation. Complete the complete steps, which will move us into the discussion of how a Revit model comes together:

- Click the 3D view icon, as shown in figure
- Again on the View Control Bar, select the Shadows On Icon and turn on shadows as shown in figure

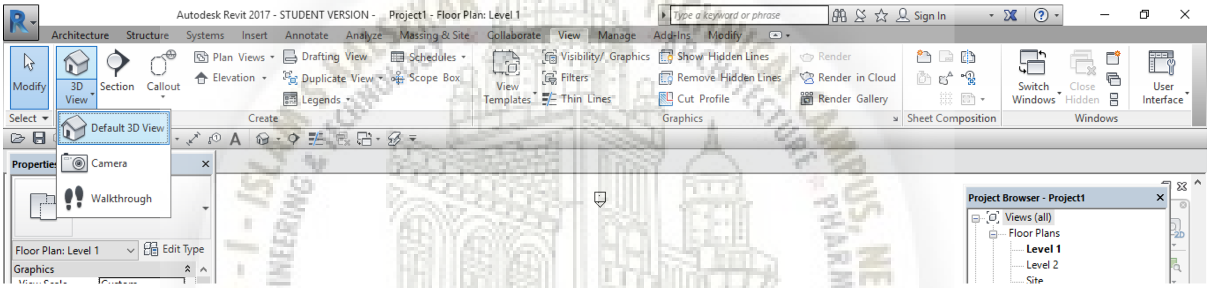


Fig. 15: The 3D view icon

Warning – If we turn on shadows, do so with care. This could be the single worst item in REVIT in terms of performance degradation. Our model will slow down with shadows on.

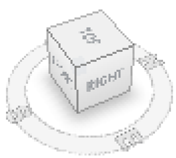


Fig. 16: The view cube

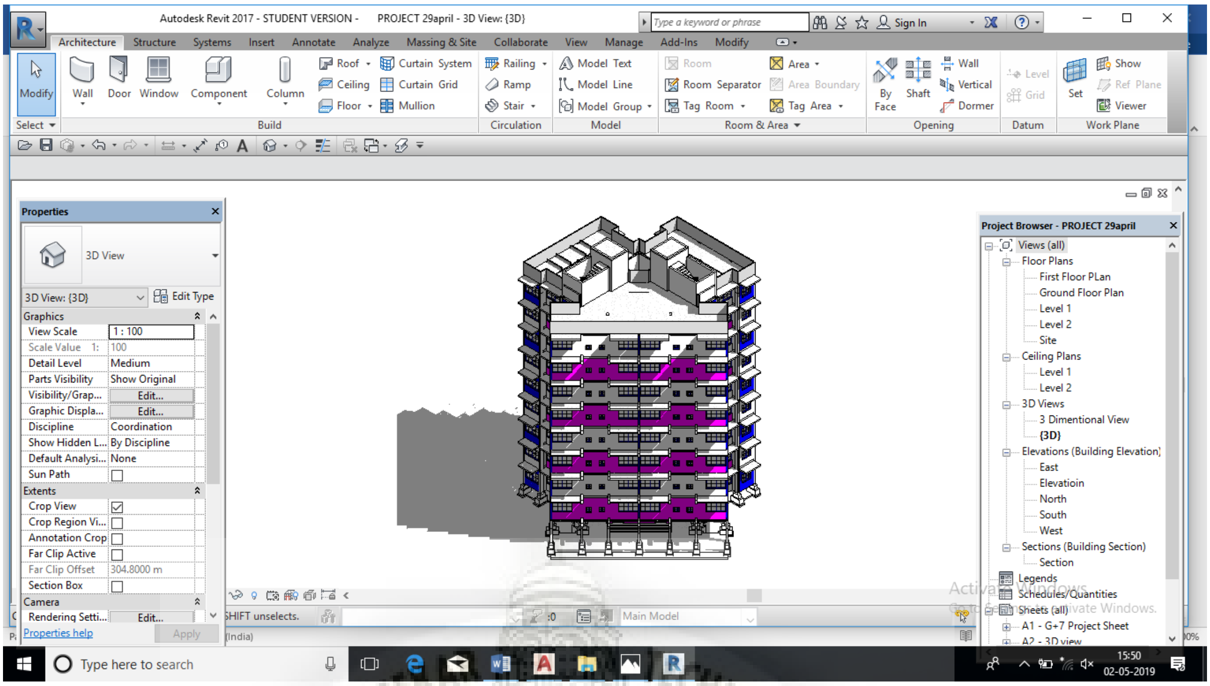


Fig.17: The shaded realistic 3D view

4.1.4.7 Creating an Elevation

Elevations are essential for any project so essential in fact that Revit provides four of them before we place a single wall into the model. The four shapes that represent houses that were in the model at the beginning of the project model are elevation markers as shown in the figure.

To elaborate the view from each side the four markers i.e. North, South, East and West of the 3D model is shown below

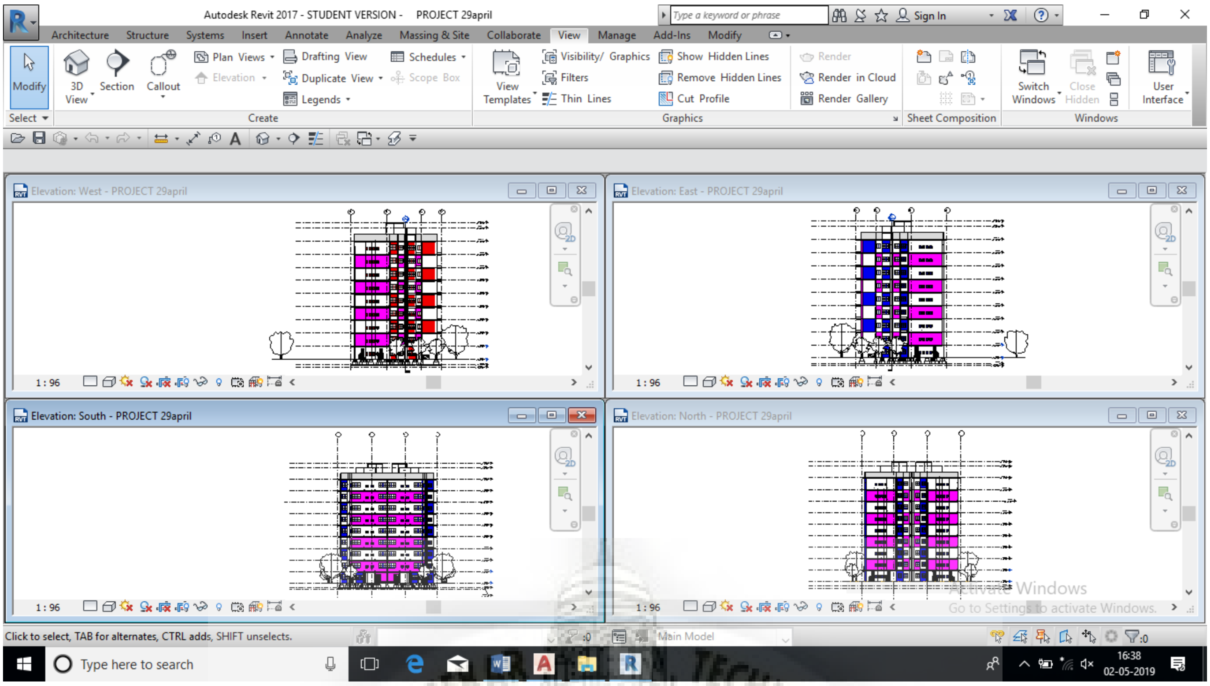


Fig. 18: All Four Elevation view

4.1.4.8 Creating Building Sections

As our model starts to develop we will begin to see areas that need further attention. This brings a good point. Sections in Revit Architecture, when placed into the model not only helps in setting construction documents but also helps in physically work on the model.

To add a section and some important wall modify commands follow along:

- Go to level 1 floor plan and zoom in on the respective areas.
- On the create panel of the view tab select sections as shown in figure 19

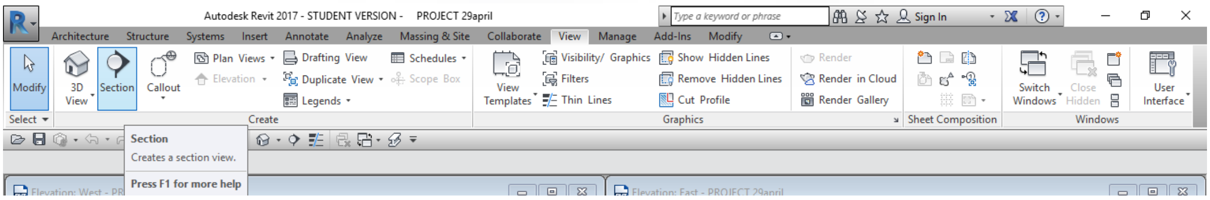


Fig. 19: Section command on Create Panel

- A section takes two picks to place into the model we must pick the point for the head then we pick a point for the tail. To place the section first pick a point right to the vertical wall as shown in figure 20

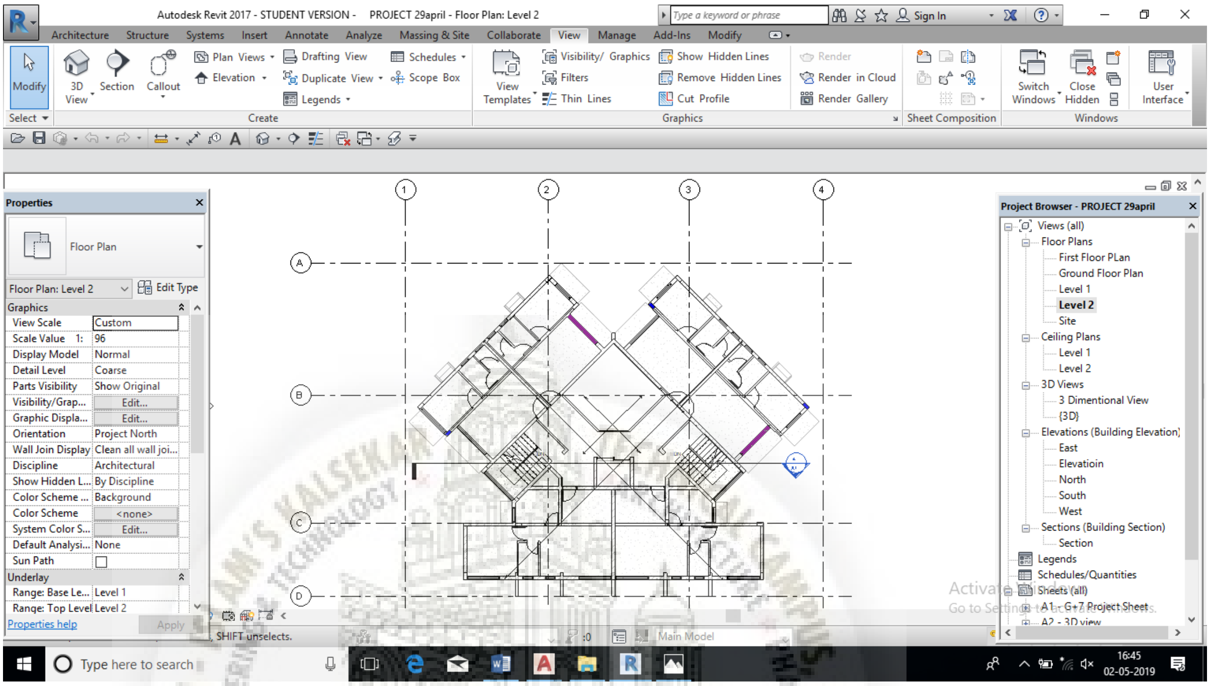


Fig. 20: Placing the section into plan

- After we pick the first point. Move the cursor straight down the view. When we are positioned directly below the bottom wall pick the second point.
- With the section placed it looks like we need to flip it to face the wall we intended to modify. A few blue icons appear. We are interested in the icon that looks like two arrows. This is a flip grip. It's the same things we saw in the doors and windows as shown in figure 21

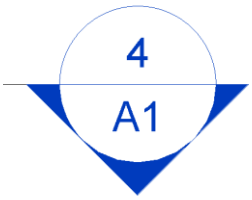


Fig. 21: Flip grip

- When we see the flip grip, pick it. It flips the section into the correct direction. With the section cut, it's time to open the view we've created. In the project browser, we now see a new category called sections (building section). In this category is a view called section1.when we cut the section, we added a view to the project. This view carries its own properties and can be drafted over as shown in figure 22

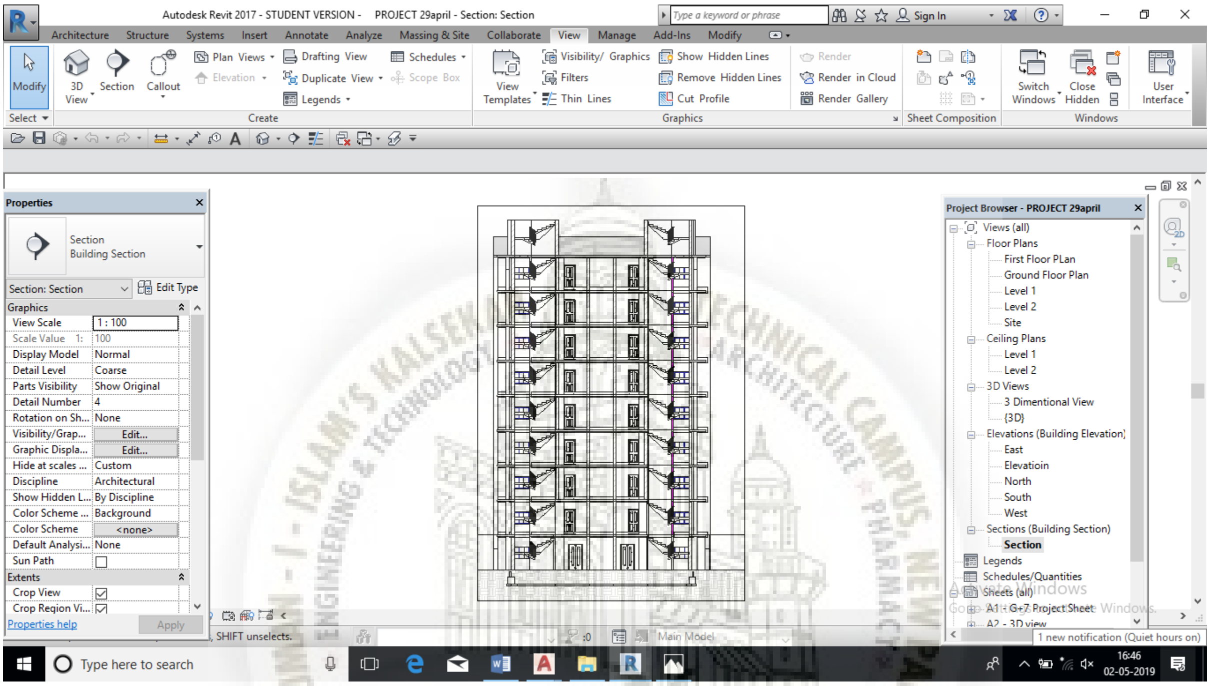


Fig. 22: Section of a plan

4.1.4.9 Laying Out Sheets

Creating sheets is easy as we have already seen we can create sheets through a sheet list schedule. We can also create sheet by right clicking the sheet node in the in the project browser and selecting new sheet from the context menu. Regardless of which methods we used to create them in the following section.

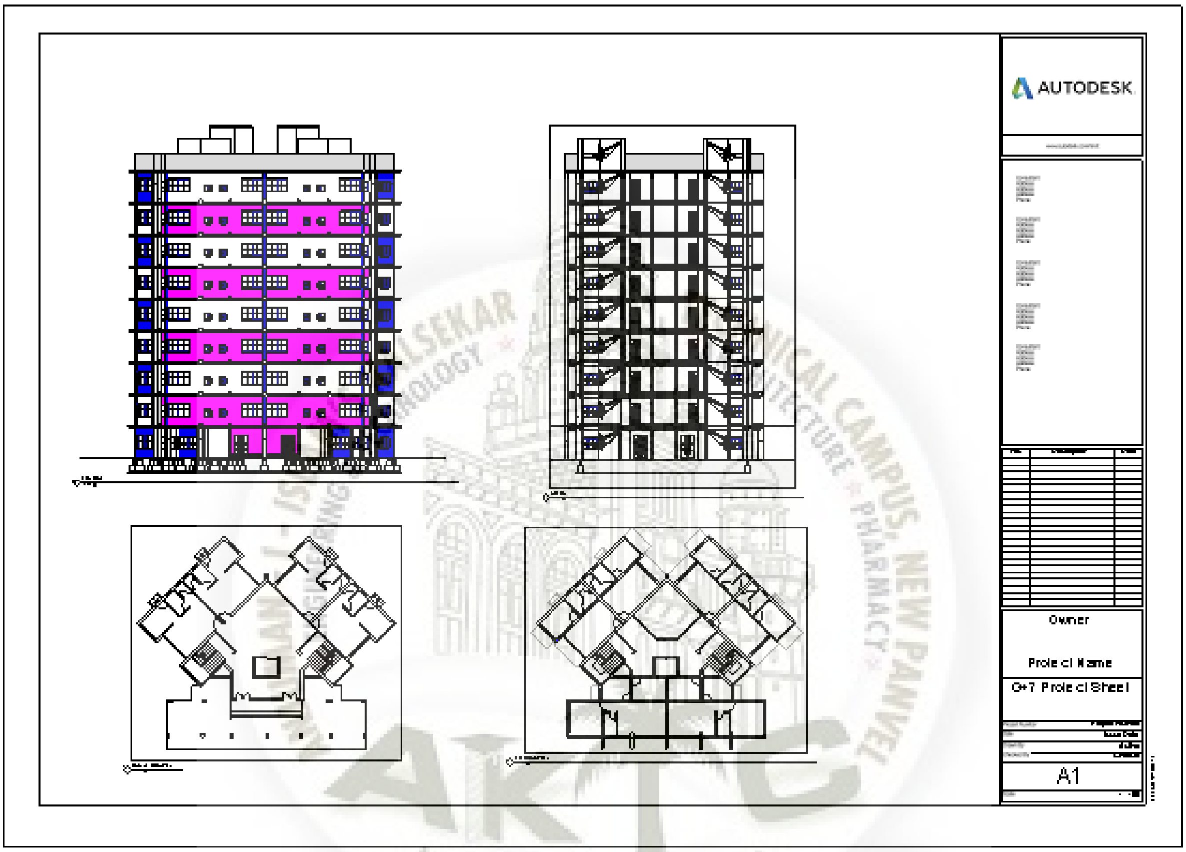


Fig. 23: Sheet layout of GF and 1st floor plan

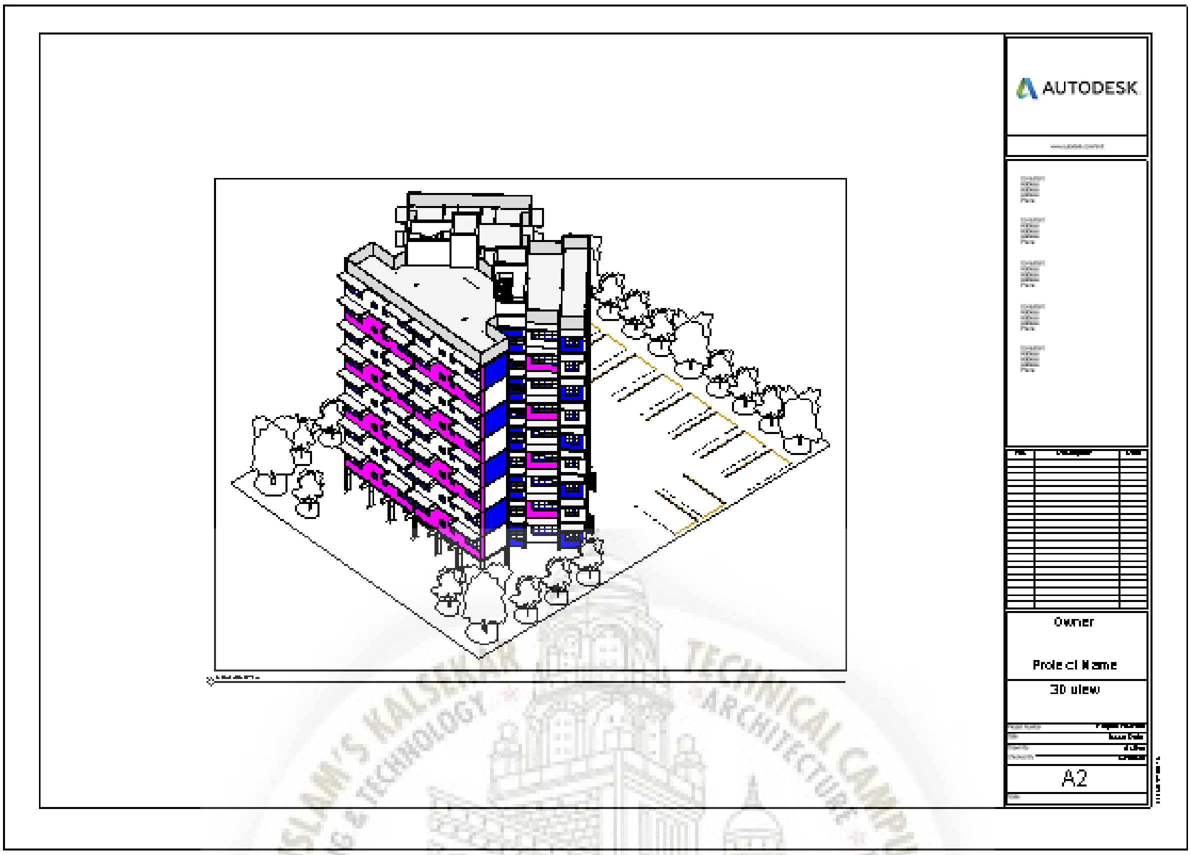


Fig. 24: Sheet layout of 3D model

4.2 Exporting Three Dimensional View (3D)

For Fourth Dimensional Modelling with respect to time we need to export the 3D view of Autodesk Revit Architecture 2017, for exporting the 3D view, open the 3D view on the screen, then click Export and click NWC (It saves the scene as a Navisworks NWC file) The snapshot shows us how the 3D model is being exported in NWC (Navisworks Cache) format so that the following model can be opened easily in the Navisworks 2017 software easily. While exporting the 3D Revit file, the following file is exported as cache file, further after 4D modelling the file is saved as NWF (Navisworks File) format.

4.3 Creating a WBS and Primavera P6 R8.3 Schedule

Till date industry is relying on Microsoft Project Management and Primavera for Scheduling purpose. For this study, Construction schedule is prepared in Primavera P6 R8.3. Activities are identified from the Autodesk Revit Architecture 2017 view and accordingly Work Break down Structure (WBS) is prepared to make a Construction schedule.

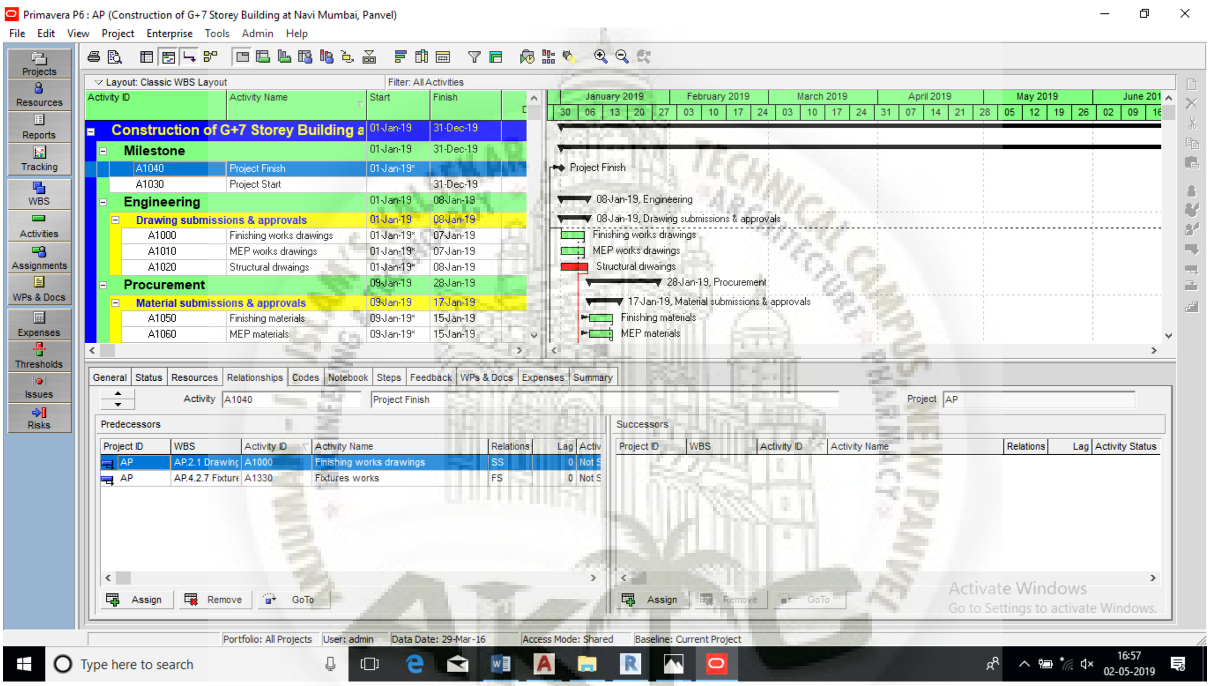


Fig.25: Schedule of Gr. G+7 Floor Residential Building in Primavera P6 R8.3

The construction schedule done in the above software of the complete structure gives us the result of 365 days, i.e. 12 months from the date of actual start of the project (1st January 2019). The image shows us the activity list on the left hand side and a Gantt chart at the right hand side. Complete scheduling of activities and Gantt chart is shown in fig. Therefore, proper tool like Primavera should be used in order to overcome these barriers.

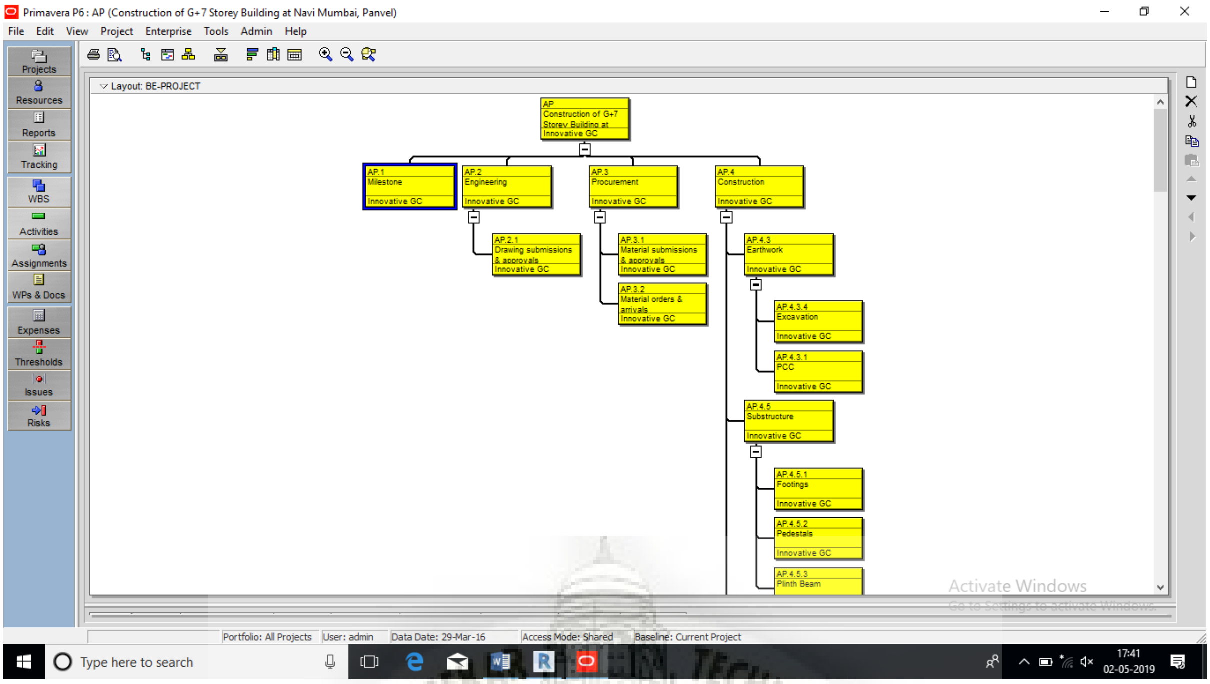


Fig. 26: WBS of project

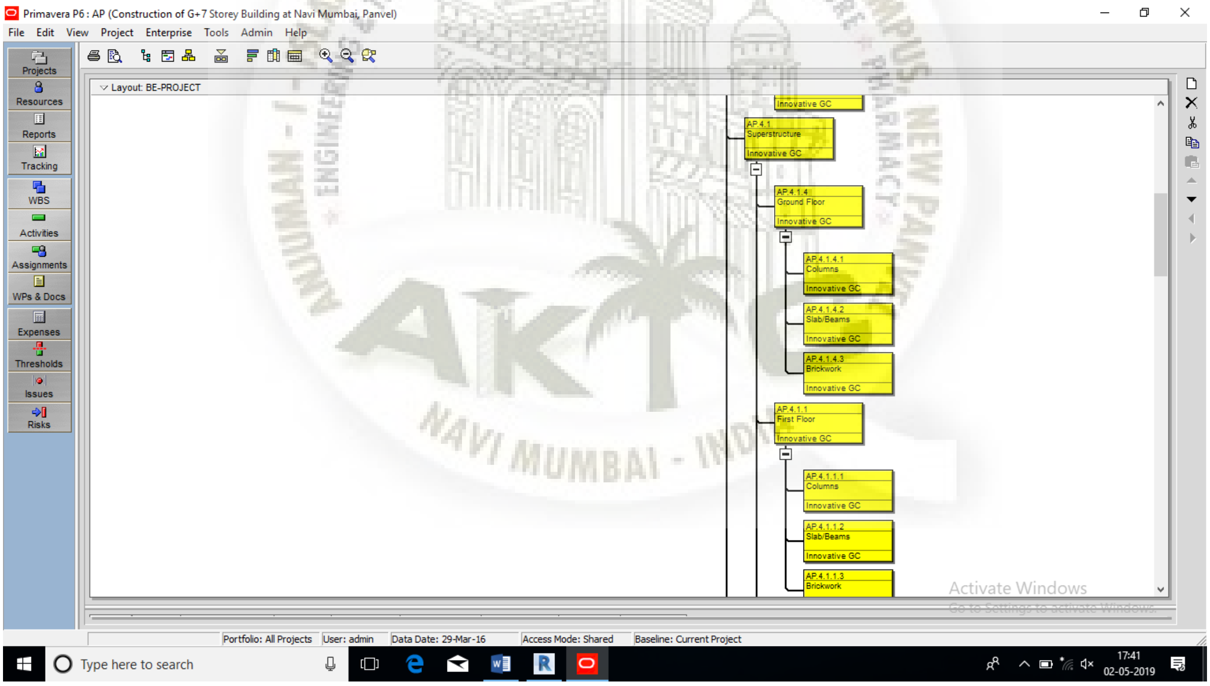


Fig. 27: WBS of project

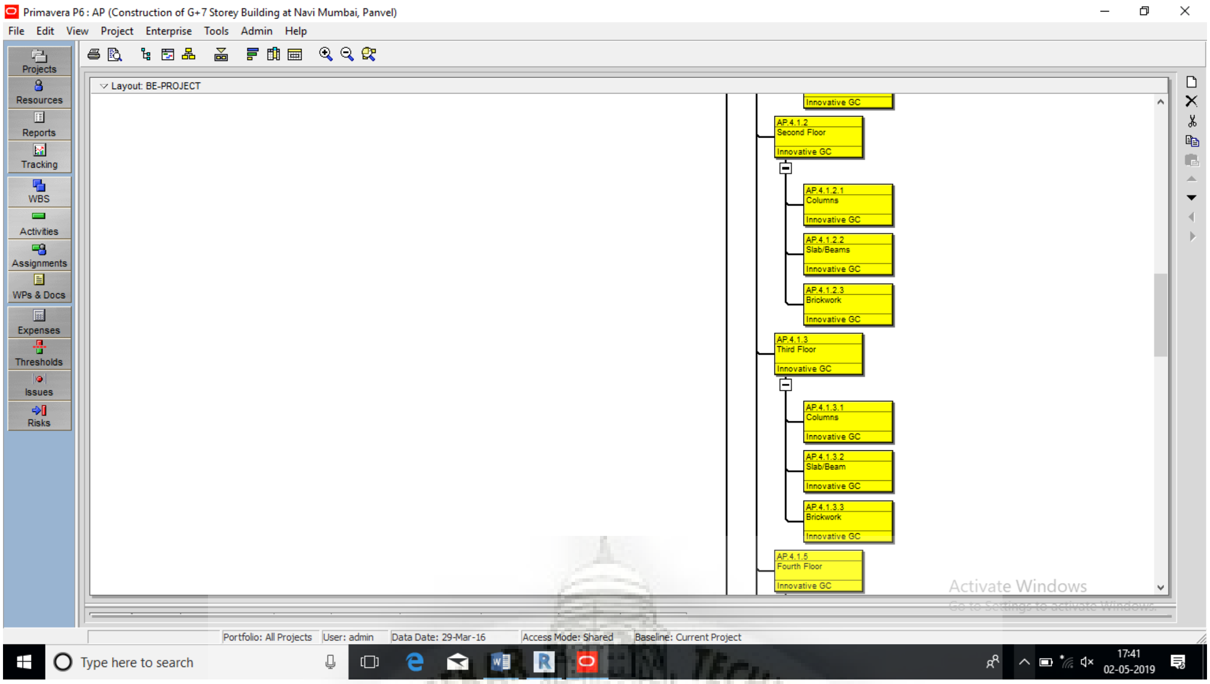


Fig. 28: WBS of project

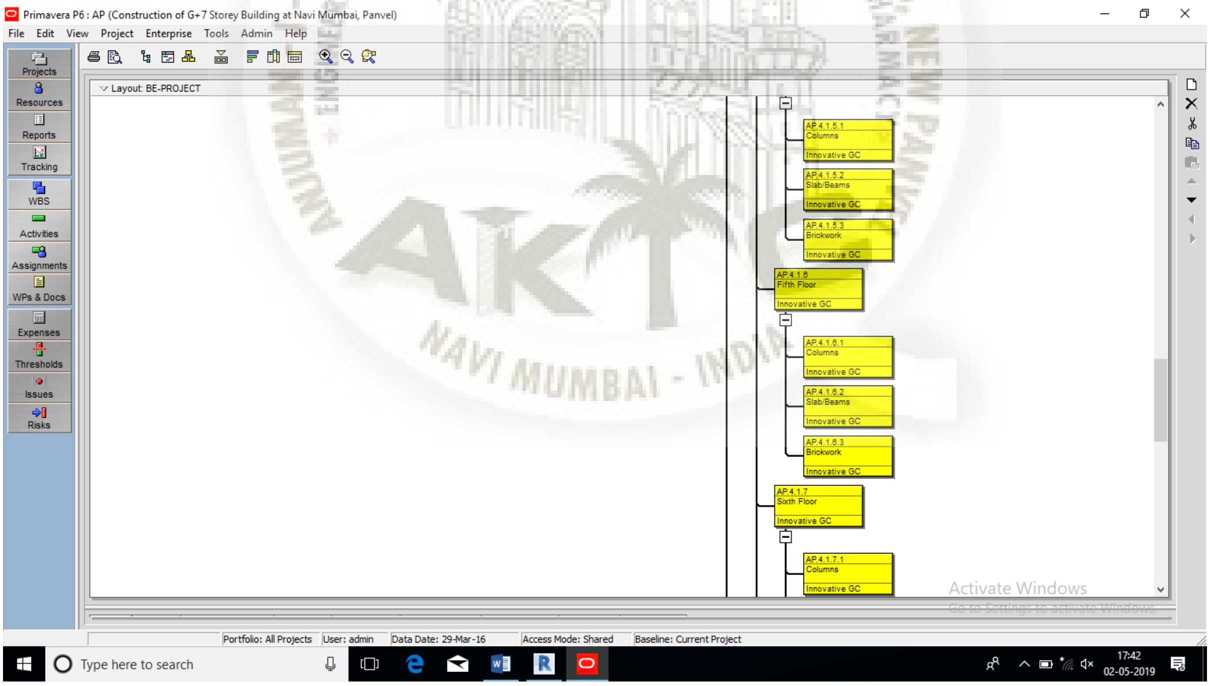


Fig. 29: WBS of project

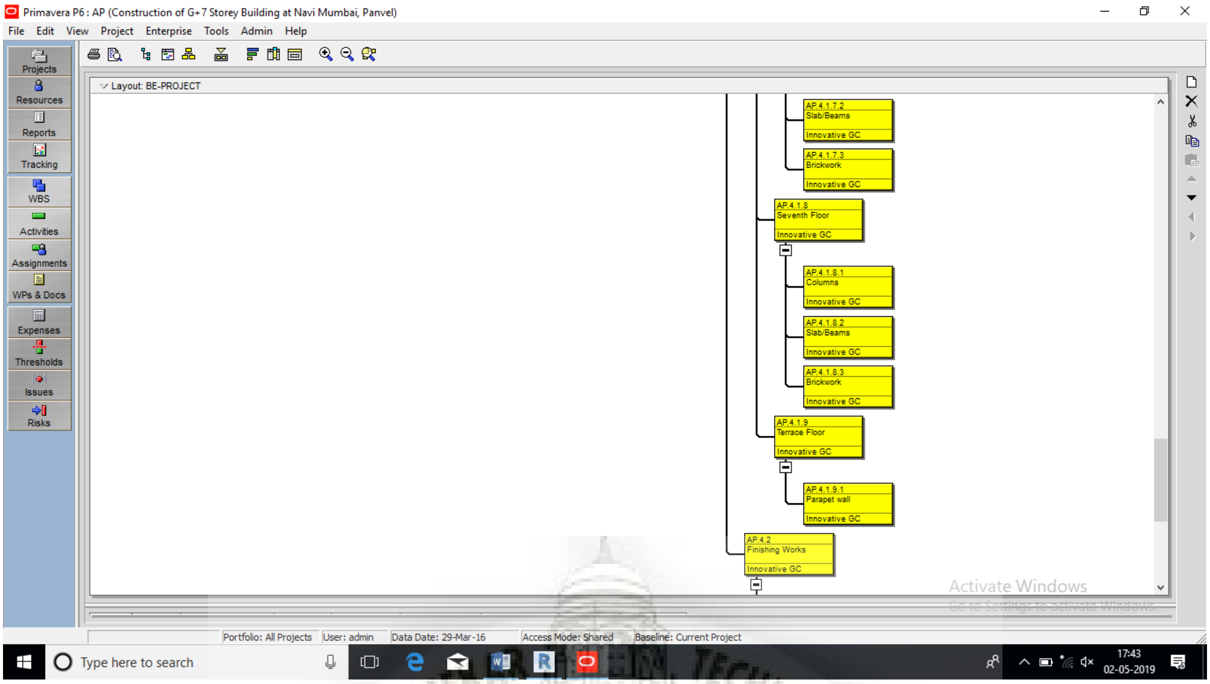


Fig. 30: WBS of project

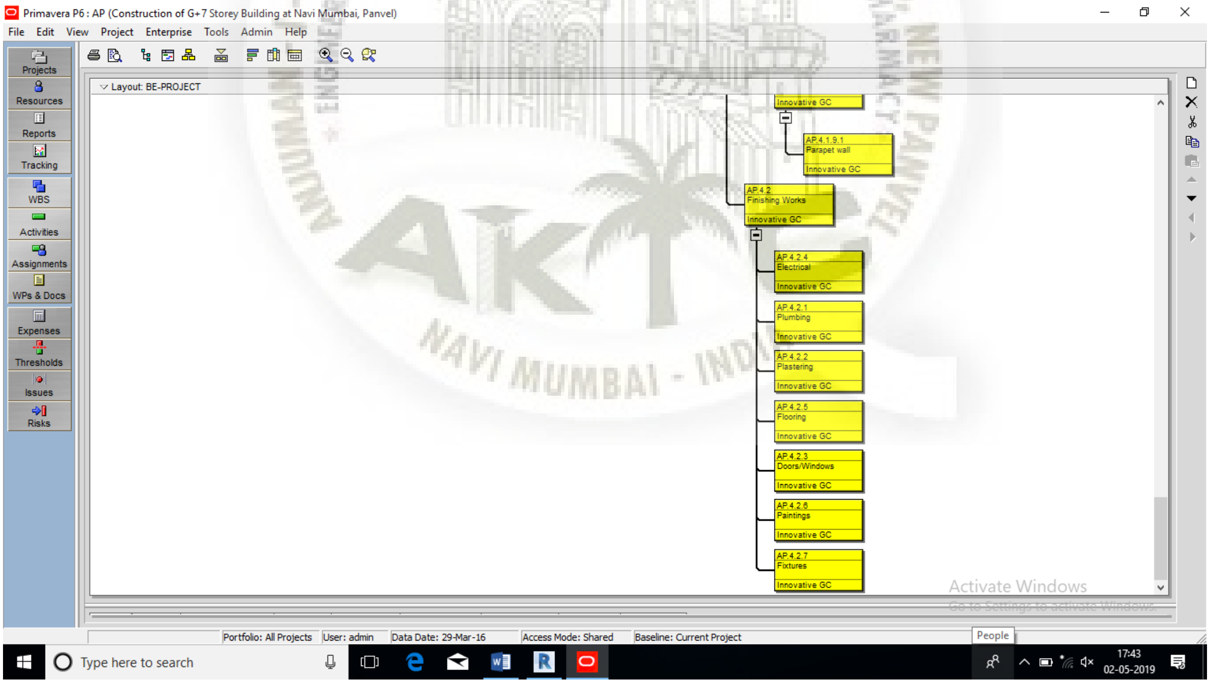


Fig. 31: WBS of project

Chapter 5

Result and Discussion

In this project we have successfully planned and scheduled a project so that there is a mutual understanding maintain between the employees on site and as well as in office. The project started from 1st of January 2019 and its estimated scheduled time of completion is 31st December 2019. The project has been planned and scheduled as per conventional method.

In this project we have generated logic report of our project. It shows some of the reports generated in Primavera P6 including the start and finish dates of activities.

5.1 Activity Logic Report

5.2 Activity Status Report

Chapter 6

Conclusion

1. Application of BIM with the currently used tools like Primavera P6 R8.3 helps in linking of the activities with the corresponding elements of a Three Dimensional (3D) Model thus making the project sequence easier to understand.

2. The proposed methodology utilizes the dynamic linkage between the activities in the schedule and corresponding 3D components, and help to detect the incompleteness and logical errors in the schedule sequence. This is because, BIM provides the user with a real time representation of the project which may improve and speed up the construction planning as well as ensure data integrity and accuracy.

3. BIM, thus is not only a visualization tool but can be utilized as a project scheduling and monitoring tool at any stage of the project in which the schedule and the 3D components can be manipulated in a single BIM environment.

4. The schedule in BIM allows easier understanding of the project as well as helps to detect possible problems in it. Therefore, by integrating and displaying specification or recommendation and construction resource information, the schedule in BIM promotes interaction and collaboration among the project team members from different fields.

By reading some of the journals we have come to know that BIM is the most function able application which makes the work easier and by application of BIM completion of the project take place smoothly. We also found that the BIM has a positive impact on environment and human as BIM give sustainable design and construction which include a program to protect workers from construction accident.

With the help of BIM, we can develop three-dimensional (3D) model mentally by visualising the different component of the project. With the help of practical experience and visualisation capabilities we can spend less time in developing 3D visual models.

Chapter 7

Scope of Future Study

- Current model can be further enhanced by adding Mechanical, Electrical and Plumbing features
- The Quantity Estimation and Costing (5D) can also be done in Autodesk Naviswork.
- The 3D model was linked with time as 4th dimension so as to create 4D modelling projects, the same can be further worked on other dimension like cost, resources, materials and labours. Thus making a 5D model
- The project Tracking and Updating can also be done in Primavera P6
- Resource Allocation can be done to optimise the resources to achieve a quality product for economic construction

Chapter 8

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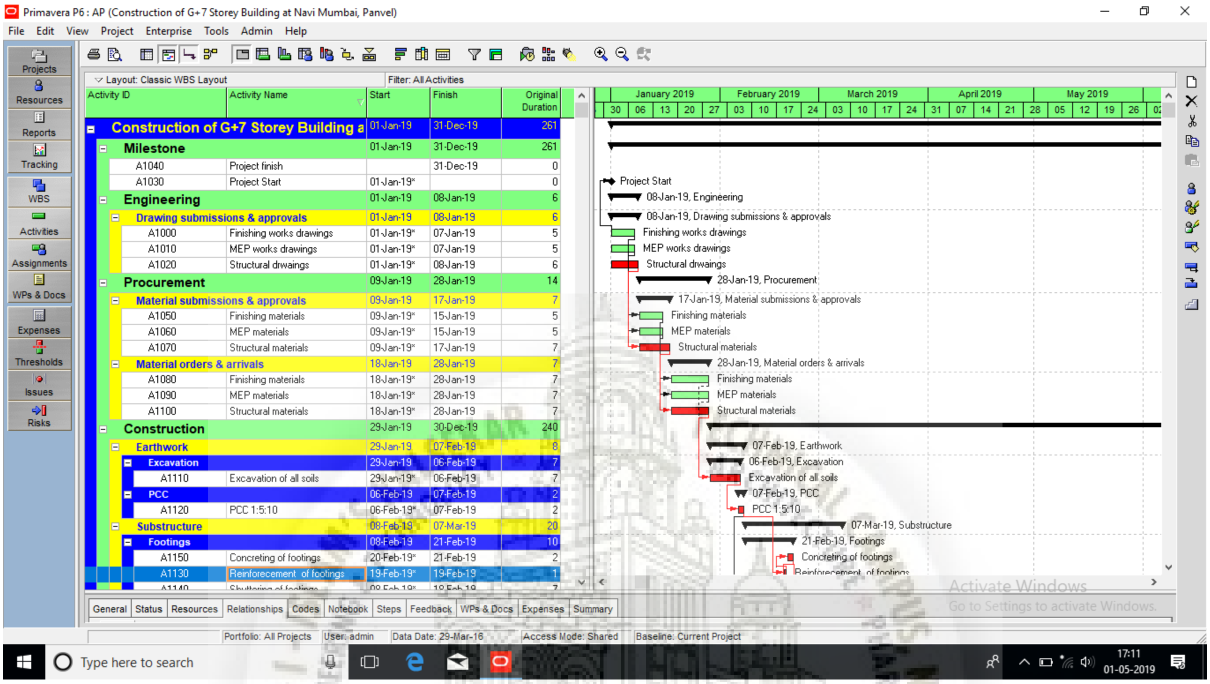
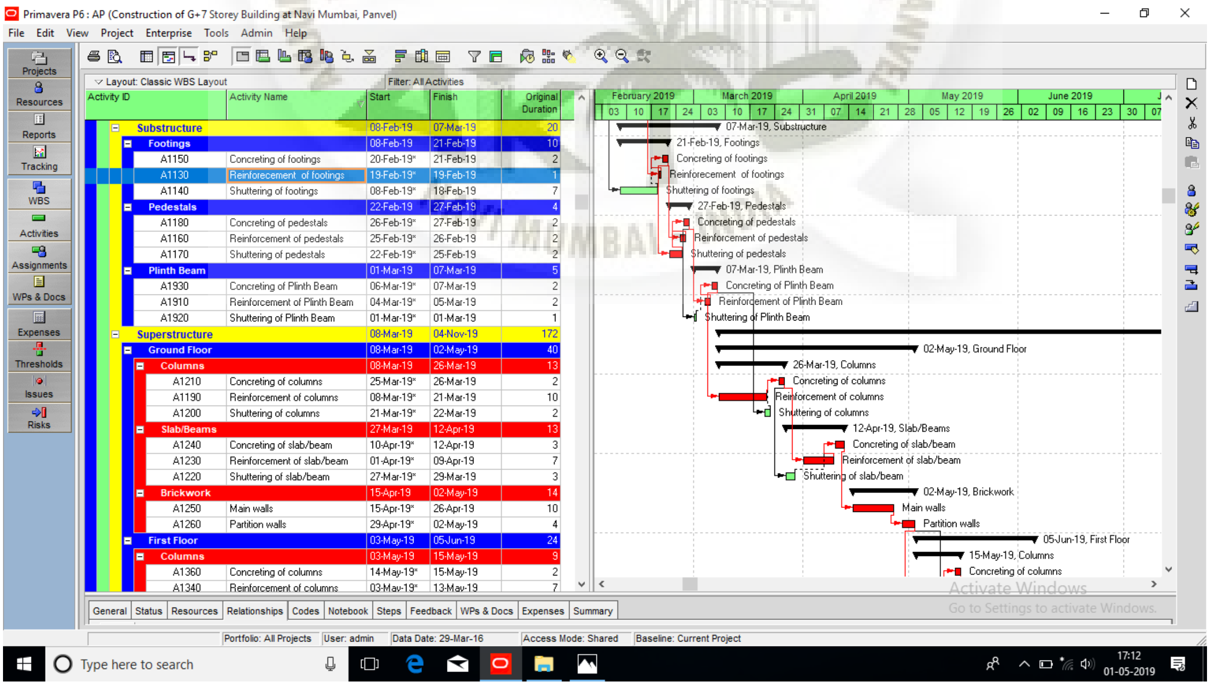
Appendix I

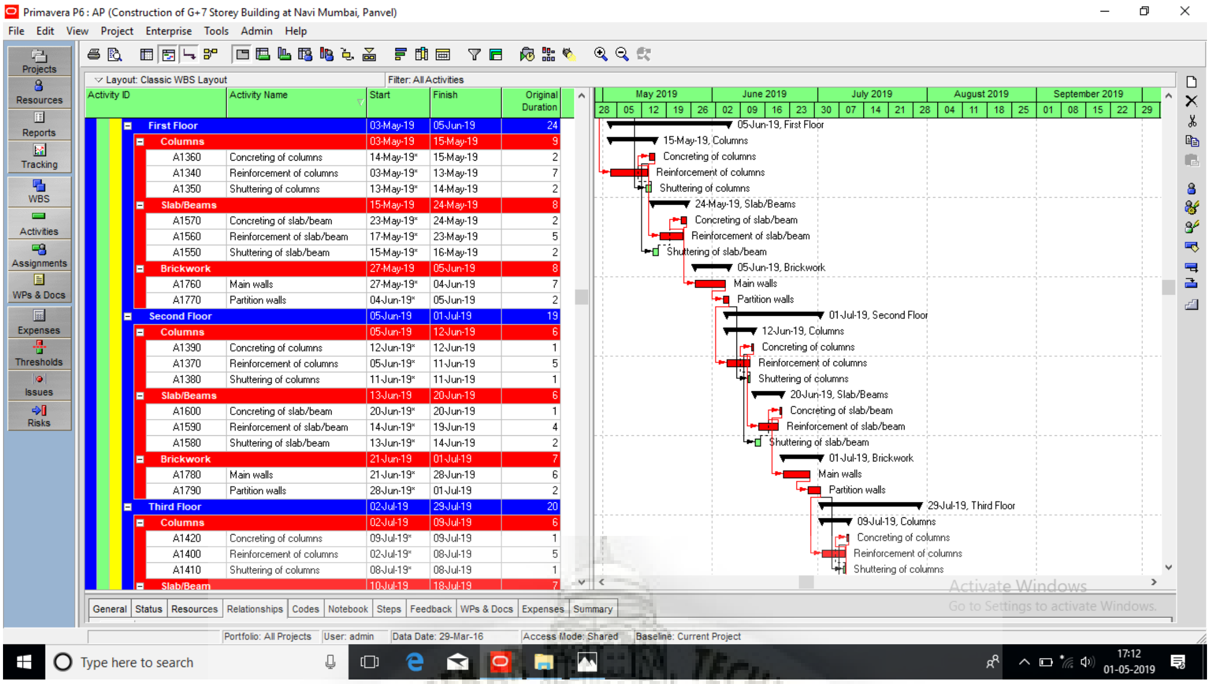
Autodesk Revit Sheet Layout

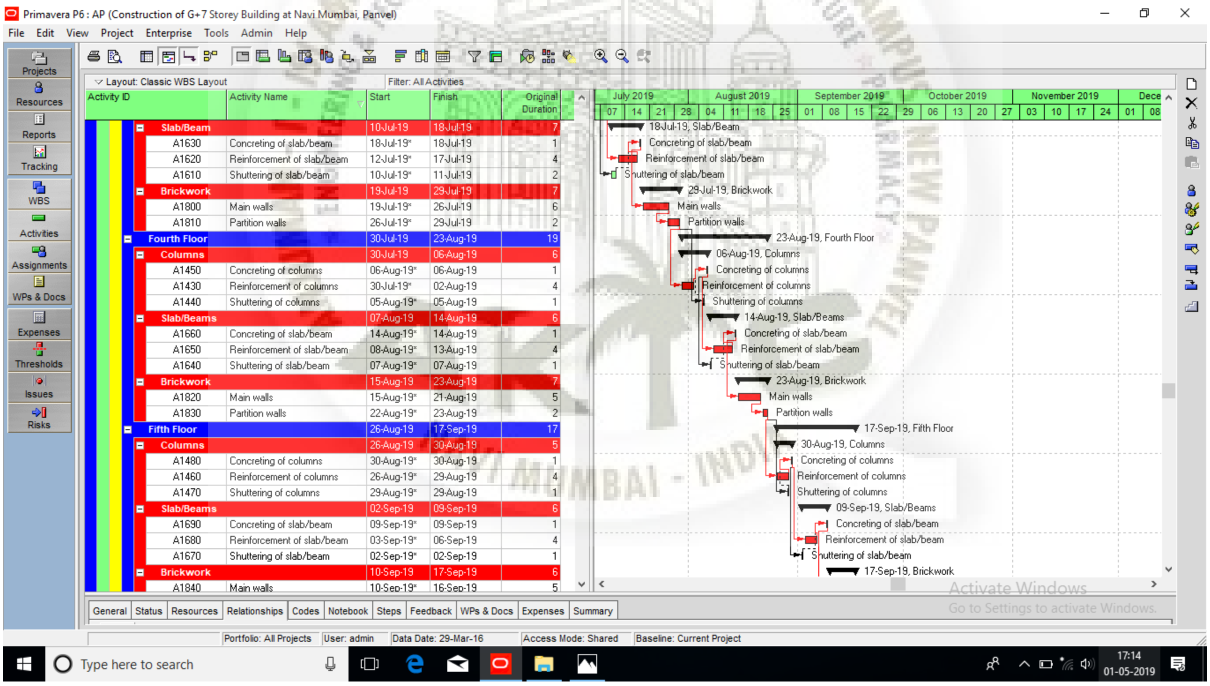
Appendix II

Primavera P6 Activities and Gantt Chart






Primavera P6 : AP (Construction of G+7 Storey Building at Navi Mumbai, Panvel)
Layout: Classic WBS Layout
Filter: All Activities
Activity ID | Activity Name | Start | Finish | Original Duration
First Floor | 03-May-19 | 05-Jun-19 | 24
Columns | 03-May-19 | 15-May-19 | 9
A1360 | Concreting of columns | 14-May-19* | 15-May-19 | 2
A1340 | Reinforcement of columns | 03-May-19* | 13-May-19 | 7
A1350 | Shuttering of columns | 13-May-19* | 14-May-19 | 2
Slab/Beams | 15-May-19 | 24-May-19 | 8
A1570 | Concreting of slab/beam | 23-May-19* | 24-May-19 | 2
A1560 | Reinforcement of slab/beam | 17-May-19* | 23-May-19 | 5
A1550 | Shuttering of slab/beam | 15-May-19* | 16-May-19 | 2
Brickwork | 27-May-19 | 05-Jun-19 | 8
A1760 | Main walls | 27-May-19* | 04-Jun-19 | 7
A1770 | Partition walls | 04-Jun-19* | 05-Jun-19 | 2
Second Floor | 05-Jun-19 | 01-Jul-19 | 19
Columns | 05-Jun-19 | 12-Jun-19 | 6
A1390 | Concreting of columns | 12-Jun-19* | 12-Jun-19 | 1
A1370 | Reinforcement of columns | 05-Jun-19* | 11-Jun-19 | 5
A1380 | Shuttering of columns | 11-Jun-19* | 11-Jun-19 | 1
Slab/Beams | 13-Jun-19 | 20-Jun-19 | 6
A1600 | Concreting of slab/beam | 20-Jun-19* | 20-Jun-19 | 1
A1590 | Reinforcement of slab/beam | 14-Jun-19* | 19-Jun-19 | 4
A1580 | Shuttering of slab/beam | 13-Jun-19* | 14-Jun-19 | 2
Brickwork | 21-Jun-19 | 01-Jul-19 | 7
A1780 | Main walls | 21-Jun-19* | 28-Jun-19 | 6
A1790 | Partition walls | 28-Jun-19* | 01-Jul-19 | 2
Third Floor | 02-Jul-19 | 29-Jul-19 | 20
Columns | 02-Jul-19 | 09-Jul-19 | 6
A1420 | Concreting of columns | 09-Jul-19* | 09-Jul-19 | 1
A1400 | Reinforcement of columns | 02-Jul-19* | 08-Jul-19 | 5
A1410 | Shuttering of columns | 08-Jul-19* | 08-Jul-19 | 1
Slab/Beam | 10-Jul-19 | 18-Jul-19 | 7
Portfolio: All Projects | User: admin | Data Date: 29-Mar-16 | Access Mode: Shared | Baseline: Current Project
Type here to search
17:12
01-05-2019


Primavera P6 : AP (Construction of G+7 Storey Building at Navi Mumbai, Panvel)
Layout: Classic WBS Layout
Filter: All Activities
Activity ID | Activity Name | Start | Finish | Original Duration
Slab/Beam | 10-Jul-19 | 18-Jul-19 | 7
A1630 | Concreting of slab/beam | 18-Jul-19* | 18-Jul-19 | 1
A1620 | Reinforcement of slab/beam | 12-Jul-19* | 17-Jul-19 | 4
A1610 | Shuttering of slab/beam | 10-Jul-19* | 11-Jul-19 | 2
Brickwork | 19-Jul-19 | 29-Jul-19 | 7
A1800 | Main walls | 19-Jul-19* | 26-Jul-19 | 6
A1810 | Partition walls | 26-Jul-19* | 29-Jul-19 | 2
Fourth Floor | 30-Jul-19 | 23-Aug-19 | 19
Columns | 30-Jul-19 | 06-Aug-19 | 6
A1450 | Concreting of columns | 06-Aug-19* | 06-Aug-19 | 1
A1430 | Reinforcement of columns | 30-Jul-19* | 02-Aug-19 | 4
A1440 | Shuttering of columns | 05-Aug-19* | 05-Aug-19 | 1
Slab/Beams | 07-Aug-19 | 14-Aug-19 | 6
A1660 | Concreting of slab/beam | 14-Aug-19* | 14-Aug-19 | 1
A1650 | Reinforcement of slab/beam | 08-Aug-19* | 13-Aug-19 | 4
A1640 | Shuttering of slab/beam | 07-Aug-19* | 07-Aug-19 | 1
Brickwork | 15-Aug-19 | 23-Aug-19 | 7
A1820 | Main walls | 15-Aug-19* | 21-Aug-19 | 5
A1830 | Partition walls | 22-Aug-19* | 23-Aug-19 | 2
Fifth Floor | 26-Aug-19 | 17-Sep-19 | 17
Columns | 26-Aug-19 | 30-Aug-19 | 5
A1480 | Concreting of columns | 30-Aug-19* | 30-Aug-19 | 1
A1460 | Reinforcement of columns | 26-Aug-19* | 29-Aug-19 | 4
A1470 | Shuttering of columns | 29-Aug-19* | 29-Aug-19 | 1
Slab/Beams | 02-Sep-19 | 09-Sep-19 | 6
A1690 | Concreting of slab/beam | 09-Sep-19* | 09-Sep-19 | 1
A1680 | Reinforcement of slab/beam | 03-Sep-19* | 06-Sep-19 | 4
A1670 | Shuttering of slab/beam | 02-Sep-19* | 02-Sep-19 | 1
Brickwork | 10-Sep-19 | 17-Sep-19 | 6
A1840 | Main walls | 10-Sep-19* | 16-Sep-19 | 5
Portfolio: All Projects | User: admin | Data Date: 29-Mar-16 | Access Mode: Shared | Baseline: Current Project
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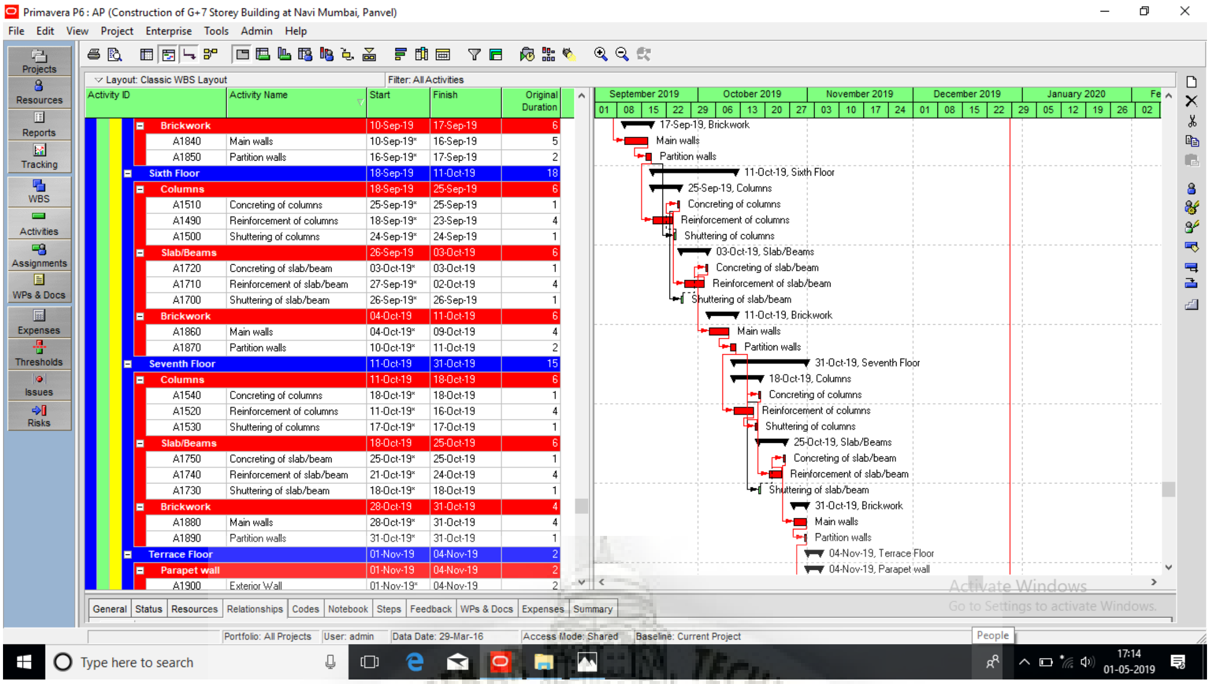
01-05-2019


Primavera P6 : AP (Construction of G+7 Storey Building at Navi Mumbai, Panvel)
Layout: Classic WBS Layout
Filter: All Activities
Activity ID | Activity Name | Start | Finish | Original Duration
Brickwork | 10-Sep-19 | 17-Sep-19 | 6
A1840 | Main walls | 10-Sep-19* | 16-Sep-19 | 5
A1850 | Partition walls | 16-Sep-19* | 17-Sep-19 | 2
Sixth Floor | 18-Sep-19 | 11-Oct-19 | 18
Columns | 18-Sep-19 | 25-Sep-19 | 6
A1510 | Concreting of columns | 25-Sep-19* | 25-Sep-19 | 1
A1490 | Reinforcement of columns | 18-Sep-19* | 23-Sep-19 | 4
A1500 | Shuttering of columns | 24-Sep-19* | 24-Sep-19 | 1
Slab/Beams | 26-Sep-19 | 03-Oct-19 | 6
A1720 | Concreting of slab/beam | 03-Oct-19* | 03-Oct-19 | 1
A1710 | Reinforcement of slab/beam | 27-Sep-19* | 02-Oct-19 | 4
A1700 | Shuttering of slab/beam | 26-Sep-19* | 26-Sep-19 | 1
Brickwork | 04-Oct-19 | 11-Oct-19 | 6
A1860 | Main walls | 04-Oct-19* | 09-Oct-19 | 4
A1870 | Partition walls | 10-Oct-19* | 11-Oct-19 | 2
Seventh Floor | 11-Oct-19 | 31-Oct-19 | 15
Columns | 11-Oct-19 | 18-Oct-19 | 6
A1540 | Concreting of columns | 18-Oct-19* | 18-Oct-19 | 1
A1520 | Reinforcement of columns | 11-Oct-19* | 16-Oct-19 | 4
A1530 | Shuttering of columns | 17-Oct-19* | 17-Oct-19 | 1
Slab/Beams | 18-Oct-19 | 25-Oct-19 | 6
A1750 | Concreting of slab/beam | 25-Oct-19* | 25-Oct-19 | 1
A1740 | Reinforcement of slab/beam | 21-Oct-19* | 24-Oct-19 | 4
A1730 | Shuttering of slab/beam | 18-Oct-19* | 18-Oct-19 | 1
Brickwork | 28-Oct-19 | 31-Oct-19 | 4
A1880 | Main walls | 28-Oct-19* | 31-Oct-19 | 4
A1890 | Partition walls | 31-Oct-19* | 31-Oct-19 | 1
Terrace Floor | 01-Nov-19 | 04-Nov-19 | 2
Parapet wall | 01-Nov-19 | 04-Nov-19 | 2
A1900 | Exterior Wall | 01-Nov-19* | 04-Nov-19 | 2
Portfolio: All Projects
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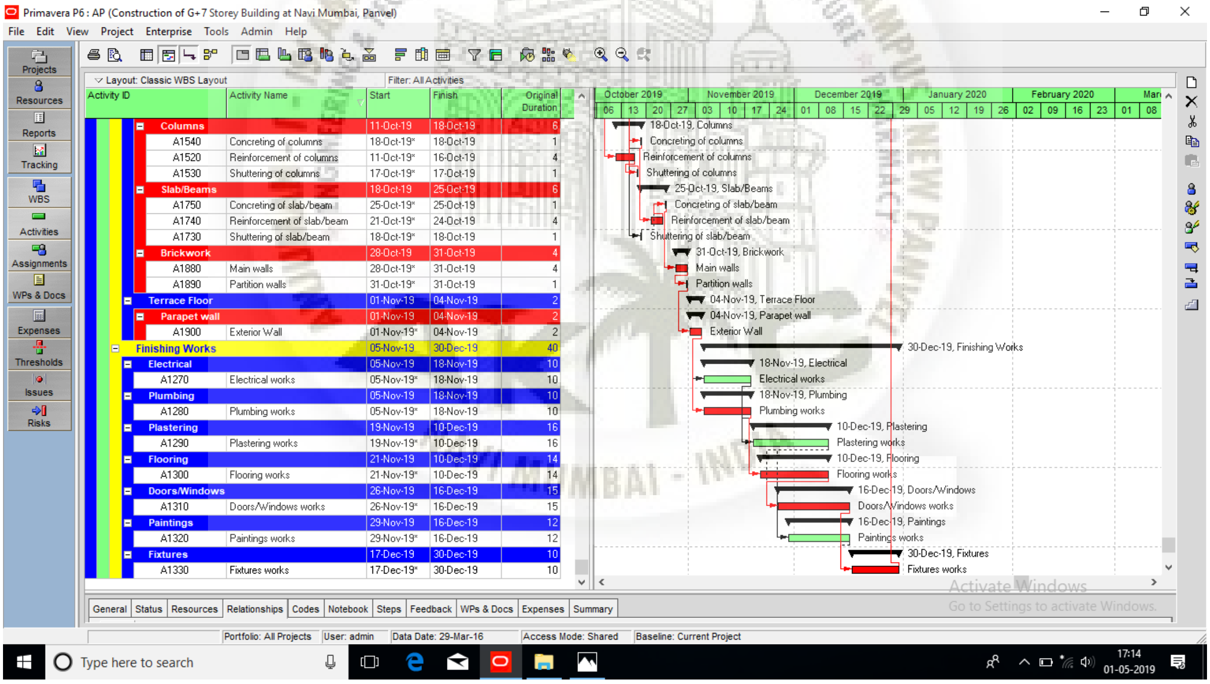
Data Date: 29-Mar-16
Access Mode: Shared
Baseline: Current Project


Primavera P6 : AP (Construction of G+7 Storey Building at Navi Mumbai, Panvel)
Layout: Classic WBS Layout
Filter: All Activities
Activity ID | Activity Name | Start | Finish | Original Duration
Columns | 11-Oct-19 | 18-Oct-19 | 6
A1540 | Concreting of columns | 18-Oct-19* | 18-Oct-19 | 1
A1520 | Reinforcement of columns | 11-Oct-19* | 16-Oct-19 | 4
A1530 | Shuttering of columns | 17-Oct-19* | 17-Oct-19 | 1
Slab/Beams | 18-Oct-19 | 25-Oct-19 | 6
A1750 | Concreting of slab/beam | 25-Oct-19* | 25-Oct-19 | 1
A1740 | Reinforcement of slab/beam | 21-Oct-19* | 24-Oct-19 | 4
A1730 | Shuttering of slab/beam | 18-Oct-19* | 18-Oct-19 | 1
Brickwork | 28-Oct-19 | 31-Oct-19 | 4
A1880 | Main walls | 28-Oct-19* | 31-Oct-19 | 4
A1890 | Partition walls | 31-Oct-19* | 31-Oct-19 | 1
Terrace Floor | 01-Nov-19 | 04-Nov-19 | 2
Parapet wall | 01-Nov-19 | 04-Nov-19 | 2
A1900 | Exterior Wall | 01-Nov-19* | 04-Nov-19 | 2
Finishing Works | 05-Nov-19 | 30-Dec-19 | 40
Electrical | 05-Nov-19 | 18-Nov-19 | 10
A1270 | Electrical works | 05-Nov-19* | 18-Nov-19 | 10
Plumbing | 05-Nov-19 | 18-Nov-19 | 10
A1280 | Plumbing works | 05-Nov-19* | 18-Nov-19 | 10
Plastering | 19-Nov-19 | 10-Dec-19 | 16
A1290 | Plastering works | 19-Nov-19* | 10-Dec-19 | 16
Flooring | 21-Nov-19 | 10-Dec-19 | 14
A1300 | Flooring works | 21-Nov-19* | 10-Dec-19 | 14
Doors/Windows | 26-Nov-19 | 16-Dec-19 | 15
A1310 | Doors/Windows works | 26-Nov-19* | 16-Dec-19 | 15
Paintings | 29-Nov-19 | 16-Dec-19 | 12
A1320 | Paintings works | 29-Nov-19* | 16-Dec-19 | 12
Fixtures | 17-Dec-19 | 30-Dec-19 | 10
A1330 | Fixtures works | 17-Dec-19* | 30-Dec-19 | 10
Portfolio: All Projects
User: admin
Data Date: 29-Mar-16
Access Mode: Shared
Baseline: Current Project