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6-D Analysis of G+6 Residential Building

Boraste Samrudhi[1], Badgujar Shubhangi[2], Mhaisdhune Pranav[3], Jadhav Shriyog[4], S.M. Waysal[5], A.M. Bhoi[6]

UG Students, Department of Civil Engineering, NDMVP College of Engineering, Nashik, India[1,2,3,4]

Professor, Department of Civil Engineering, NDMVP College of Engineering, Nashik, India[5,6]

ABSTRACT: Revit is equipped with design options, which allows users to manage multi-design options in same model. These design options may vary among spatial arrangements, material selections etc. Designers and clients can facilitate alternative design plans by comparing and managing quantities and cost estimations of multi-design plans, such information and data are accessible in BIM models. In this work we proposed effective analysis of a structure to analyze 6 dimensions of the building which includes Visualization of model, Time model, Cost model and Energy model. It also helps us to know the phasing of work, time required for completion of construction, cost and material management.

KEYWORDS:BIM, 3D, 4D, 6D, Autodesk Revit, residential buildings

I.INTRODUCTION

Building Information Modelling (BIM) is a process that transforms construction process from fragmental traditional practices to an integrated digital manner process. It is supported by various tools, technologies and contracts to gather, generate, analyze and manage the digital representation of the produced project model. BIM is well known as n-D Modelling platform for effective communication and collaboration and its application has extended from 3D geometric model to include scheduling, costing, and facility management. BIM implementation added valuable advantages to construction industry throughout the project life cycle. In the design stage, BIM has proved its capability to enhance productivity and efficiency. This study analyzes the current situation of the development of the construction industry and the construction phase of the project management problems. It also analyzes the application principle of BIM technology and the modeling flow of BIM 6D. Then, it focuses on the discussion of the integrated application of BIM 6D in the construction stage including the visualization of the end, the paper review and collision detection, 6D construction simulation and so on. 6D building information modeling helps to analyze the energy consumption of a building and come out with energy estimates at initial design stages. Accounting for various life stages of a structure, 6D BIM ensures accurate prediction of energy consumption requirements.

- The rapid development of information technologies leads to new approaches to the design of buildings and building structures.
- Nowadays more attention is given to building information modeling (BIM) rather than CAD design method. Building information modeling (BIM) is the process of creating, collecting and using information about a building throughout its life cycle.
- Unlike CAD design, information modeling is not only a graphical representation, but also information about the building stored in the database.
- The main advantage of BIM over other modeling methods is the availability of information about the building or structure, which can be used at different stages: architectural design, engineering calculations, construction, maintenance, reconstruction.
- The opportunities of software systems that implement the technology of BIM, such as Autodesk Revit, Archicad, Allplan, AECOsim, are expanding every year.

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| Volume 4, Issue 6, June 2021 |

II.LITERATURE REVIEW

Effective analysis of a structure to analyze 6 dimensions of the building which includes Visualization of model, Time model, Cost model and Energy model. It also helps us to know the phasing of work, time required for completion of construction, cost and material management.This project involves 6D information modeling which helps to analyze the energy consumption of a building and come out with the energy estimation at initial stages of requires design. Detailing the features of BIM in existing buildings, once having reconstrued the digital model, many BIM facets may provide significant opportunities for competitive renovation enterprises.

The use of technological tools like BIM for construction processes and sustainability evaluation of project have gained the immense attention of policy makers, researchers, government agencies and key stakeholders in the construction industry in recent years.Various applications of BIM and sustainability includes lifecycle cost assessment, simulation of building design performances, sustainable design, and indoor environment quality. BIM integrates different disciplines by effective communication, analyses the project systems.BIM estimates the cost and time of the project at any time using quantity takeoffs, draws a big picture of project using visualization and builds collaborative teams.

Lastly if we see BIM as the complete source of project knowledge, then it is within this arena that we exchange intelligence. And that can be done most effectively when we speak the same language, through a consistent data structure. When design data becomes totally transparent, we make better decisions

III.MATERIAL AND METHODS

6D BIM stands for 3D, 4D, 5D and 6D Building Information Modeling. It is a phrase extensively used in the AEC industry and refers to the intellectual linking of all the individual 3D CAD components or assemblies with all aspects of project life-cycle management information. The 6D model is typically delivered to the owner when a construction project is finished so as to have the complete understanding of the project at hand.

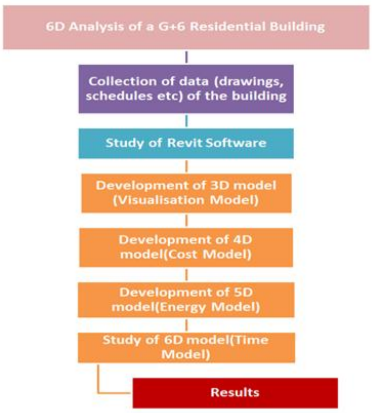

Figure 1 : Proposed methodology

Autodesk Revit is a building information modelling software for architects, landscape architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers and contractors. The original software was developed by Charles River Software, founded in 1997, renamed Revit Technology Corporation in 2000, and acquired by Autodesk in 2002. The software allows users to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Revit is 4D building information modeling capable with tools to plan and track various stages in the building's lifecycle, from concept to construction and later maintenance and/or demolition.

From the outset, Revit was intended to allow architects and other building professionals to design and document a building by creating a parametric three-dimensional model that included both the geometry and non-geometric design and construction information, which is also known as Building Information Modeling or BIM (1975 Eastman C.).

3D Model (Visualization Model)

Visualizing an entire project can be difficult, especially if you are planning your first development project and are not familiarized with construction practices yet. The rise of virtual building design has made this simpler, allowing simulations of how a fully constructed building will look like, on the inside and from the outside.

Virtual building design consists of the digital representation of physical, mechanical and functional aspects of a building once it is completed. Virtual design has evolved to a point where multiple designs can be integrated into a single 3D model, which can also simulate construction, operation and maintenance. This concept is called Building Information Modeling, or BIM, and it gives developers and contractors a better understanding of concepts compared with conventional 2D drawings.

Revit allows for entire buildings or parts of buildings to be modeled and worked on, which is very useful for all parties involved in construction projects. Using Revit modeling as part of the BIM process eases the creation of 3D renders, 3D perspectives, detailed drawings and walkthroughs. All these features were not available in traditional 2D CAD software.

Revit families are understood as groups of variables with certain values, which can be clearly identified and modified to create new families or family types. These elements facilitate the creation of detailed 3D models. These not only serve as a visual representation of building components, since they also provide valuable information for scheduling, material takeoff and product orders.

4D Model (Time Model)

- 4D simulation is a process that combines a 3D models with the project schedule allowing all stakeholders to visualise the construction phase in a virtual environment.
- 4D also, and perhaps more importantly, allows you to enhance construction sequencing by simulating the placement of resources – effectively mapping the model and the delivery timeline together.
- Using preliminary 3D models and summary schedules developed during front-end design, 4D simulation enables the project team to visually review construction activity across the entire project, in planning and real-time stages.
- Utilising 4D simulations enhances the work processes during the proposal, early project planning, detailed engineering and construction phases of the project, optimising the construction schedule.
- Basically, an Energy Analysis Model (EAM) is an abstraction of a building's overall form and layout into a 'computational network' that can capture all of the key paths and processes of heat transfer throughout the building effectively.
- SrinSoft's BIM services offers entirely new way to create an EAM automatically from Revit building elements and two programs like Autodesk Revit and Autodesk Insight 360 can be used to create superior energy and environmental performance inside the building.
- Working in Revit makes it simple to find data about the building being modelled, such as its life cycle energy use or its renewable energy potential.

Instead of drawing lines to design buildings as in older CAD programs, actual walls and building elements are being drawn in Revit. Because of this, as the model is drawn, the program is noting the materials and insulation values as well as other properties of those materials. Once the model is created, Revit has the information it needs to come up with an energy model for the building.

5D Model (Cost Model)

Drawing on the components of the information model being able to extract accurate cost information is what's at the heart of 5D BIM. Considerations might include capital costs (the costs of purchasing and installing a component), its associated running costs and the cost of renewal/replacement down the line. These calculations can be made on the basis of the data and associated information linked to particular components within the graphical model. This information allows cost managers to easily extrapolate the quantities of a given component on a project, applying rates to those quantities, thereby reaching an overall cost for the development.

The benefits of a costing approach linked to a model include the ability to easily see costs in 3D form, get notifications when changes are made, and the automatic counting of components/systems attached to a project. However, it's not just cost managers who stand to benefit from considering cost as part of your BIM process. Assuming the presence of 4D programme data and a clear understanding of the value of a contract, you can easily track predicted and actual spend over the course of a project. This allows for regular cost reporting and budgeting to ensure efficiencies are realised and the project itself stays within budget tolerances.

The accuracy of any cost calculations is, of course, reliant on the data produced by multiple teams and shared within the Common Data Environment. If that information is inaccurate, so too will be any calculations that rely upon it. In this respect using BIM to consider cost is no different to more traditional ways of working. It is for this reason that quantity surveyors and estimators still have an important role to play, not only in checking the accuracy of information but also in helping to interpret and fill information 'gaps'. Many elements of a project will still be modelled in 2D or not at all. There's also likely to be differences between models in how things are classified and the cost manager will need to clarify and understand the commonality between what at first feel like disparate things.

An information model is likely to contain three types of quantity. Quantities based on actual model components (with visible details) which you can explore through the model are the most obvious. Quantities may also be derived from model components (such as mouldings around windows) that aren't always visible. The third kind of quantity is non-modelled quantities (these include temporary works, construction joints etc.). Unless the construction phase is modelled then the design model will show, graphically, design quantities but not the construction quantities. A cost manager is likely to be skilled in picking up the quantities that aren't solely based on model components. One of the advantages of extrapolating cost from the information model is the fact that the data can be queried at any time during a project and the information that feeds cost reports is regularly updated. This 'living' cost plan helps teams design to budget and because cost managers are engaged from the start of a project this allows for faster, more accurate reporting of costs at the early stages of a project. Compare this to a traditional approach where a cost manager's report may be updated a few times during the early stages of a project with completed designs only fully costed at the end of the project team's design process.

6D Model (Energy Model)

6D BIM is used to make a structure self-sustainable & energy efficient. This method includes information that allows stakeholders to analyse the energy consumption of a structure and create estimates of energy usage during the initial design phase. Using a 6D BIM model will help reduce energy consumption in the long run and improve operational management after construction is completed.

Basically, an Energy Analysis Model (EAM) is an abstraction of a building's overall form and layout into a 'computational network' that can capture all of the key paths and processes of heat transfer throughout the building effectively.

SrinSoft's BIM services offers entirely new way to create an EAM automatically from Revit building elements and two programs like Autodesk Revit and Autodesk Insight 360 can be used to create superior energy and environmental performance inside the building.

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| Volume 4, Issue 6, June 2021 |

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Development of Building Model

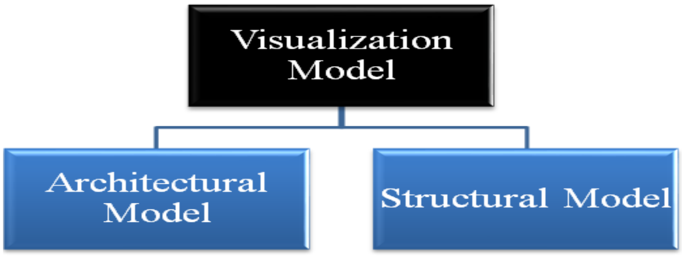

Figure 2 :Development of Visualization Model

As shown above in this project Architectural and Structural Models are developed of a G+6 Residential building using Revit Software. Now let's see how it was done.

First data related the structure was collected and then with the help of data we created an Architectural model.

- Foundation plan creation:

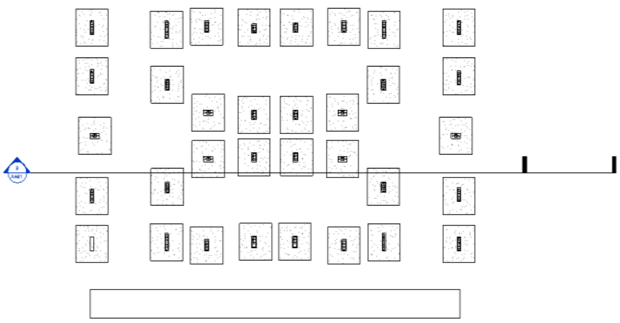

Figure 3: Foundation Bottom

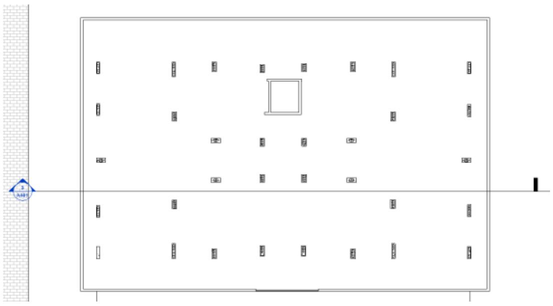

Figure Ошибка! Текст указанного стиля в документе отсутствует.**4: Foundation Top**

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| Volume 4, Issue 6, June 2021 |

- Floor plan creation:

Figure 5: First Floor plan

Typically, same floor plan was developed for each of the six levels to get the Architectural model.

- Terrace Level:

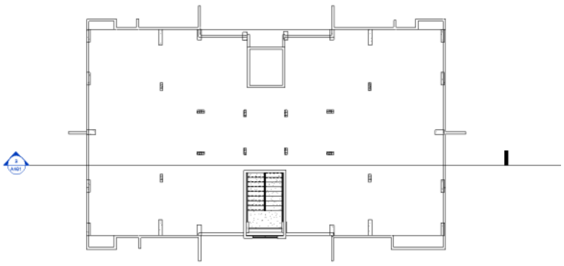

Figure 6: Terrace Level

➢ Headroom Level:

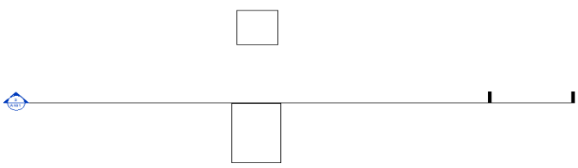

Figure 7: Headroom Level

IV.RESULTS AND DISCUSSION

This model was developed by selecting the location option in Revit which was then sent through mail to Autodesk and through the Autodesk Insight Software it was optimized and the results which were received are displayed below.

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| Volume 4, Issue 6, June 2021 |

Architectural Model:

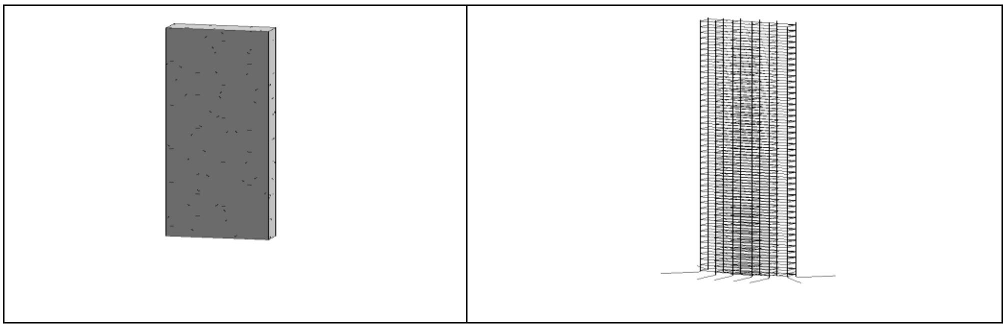
Figure 8 : Different Architectural Views

Structural Model Development

- Development of foundation:

Figure 1Foundation& its Reinforcement

- Development of Columns:



Figur2 : Column & its reinforcement

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Development of Beams:

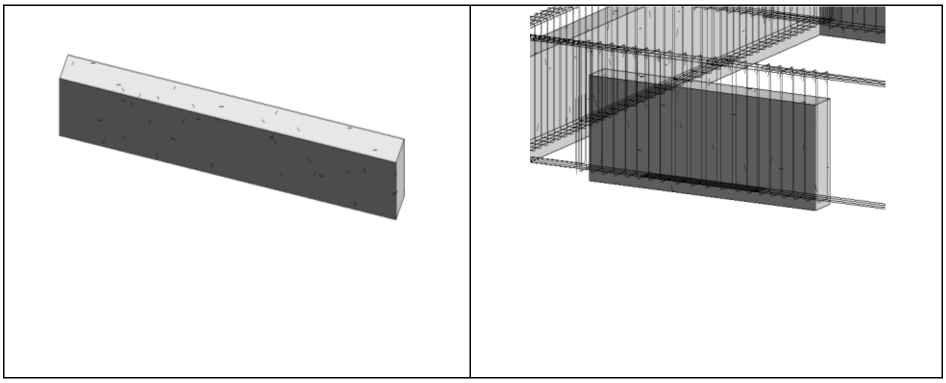

Figure 3Beam and its reinforcement

- Development of Slab:

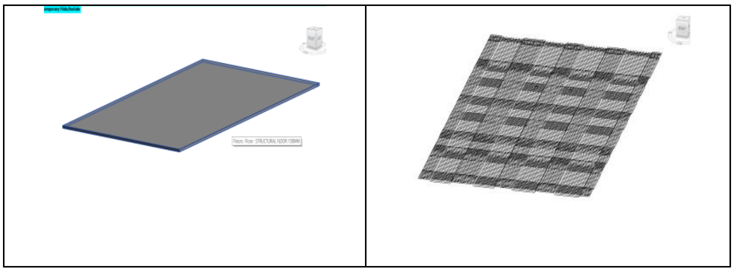

Figure.4Slab & its reinforcement

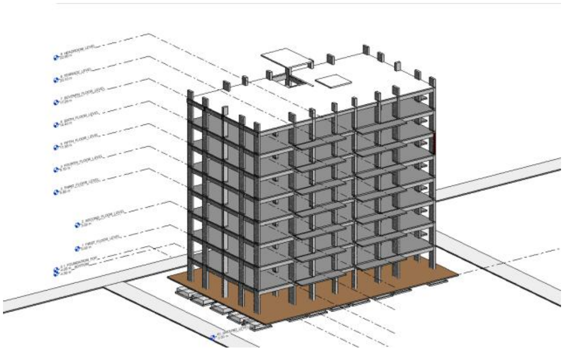

Figure.5 Structural Model

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| Volume 4, Issue 6, June 2021 |

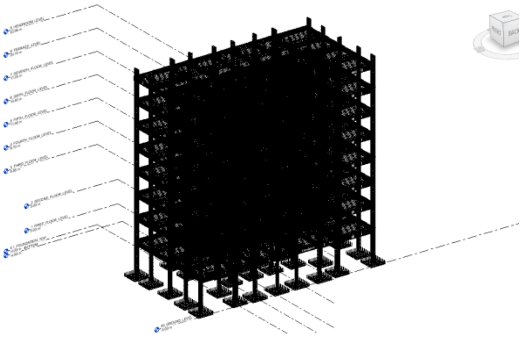


Figure 6 Structural Model

Cost Model

Table 1 Column Concrete

COLUMN CONCRETE			
BASE LEVEL	TOP LEVEL	TOTAL VOLUME (CUBIC METRE)	COST
Foundation top	GL1	26.508	100758.2
GL	Floor 1	18.091	68762.23
Floor 1	Floor 2	18.064	68656.71
Floor 2	Floor 3	18.064	68656.71
Floor 3	Floor 4	18.064	66544.8
Floor 4	Floor 5	18.064	68656.71
Floor 5	Floor 6	18.064	68656.71
Floor 6	Floor 7	21.375	81229.15
	TOTAL	156.304	594033

Table 2 Beam Concrete

Total Volume (cubic meter)	Total Cost
144.43	548847.7

Table 3 Slab Concrete

Total Volume (cubic meter)	Total Cost
563.02	2139482

Table 4 Summary of material and its cost

TOTAL VOLUME	968.814	m^3
TOTAL COST	3681590.68	RUPEES
FOR 1m^3 OF M20 CONCRETE		
CEMENT BAGS =	8.22	
SAND=	0.472 m^3	
AGGREGATE=	0.856m^3	

REQUIRED CEMENT BAGS =	**7964**	
SAND=	**457.28 m³**	
AGGREGATE=	**829.30 m³**	

Table 5 : Wall Schedule

Total									
Length	Width	Area	Volume	No of Bricks	Cost of Bricks	No of Cement Bags	Cost of Cement Bags	Quantity of sand in Kg	Cost of Sand
703.11 m	**40.20 m**	**4761.1 m^2**	**714.17 m^3**	**357083.25**	**2142499.49**	**885.6**	**309948**	**271348**	**170949**

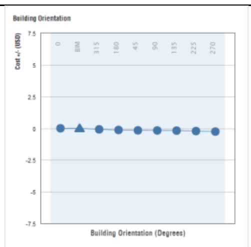
Table 6: Door And Window cost

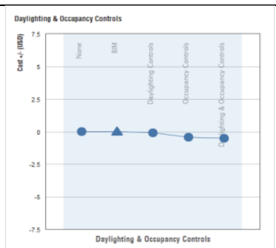
Total Door Cost	840000
Total Window Cost	406000

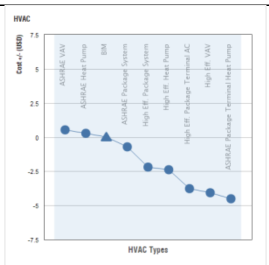
Table 7 Steel Quantity and cost

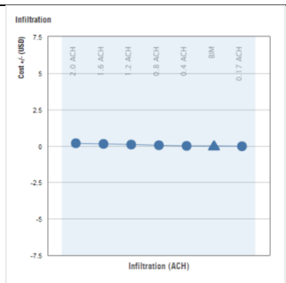
BAR DIAMETER USED	8mm,10mm,12mm and 16 mm
TOTAL LENGTH OF STEEL	34448.33 m
TOTAL WEIGHT OF STEEL	73859.88 KG
TOTAL VOLUME	9.409 CUBIC METER
TOTAL COST	3692993.18 RS.

Table 8 Energy Analysis Graphs









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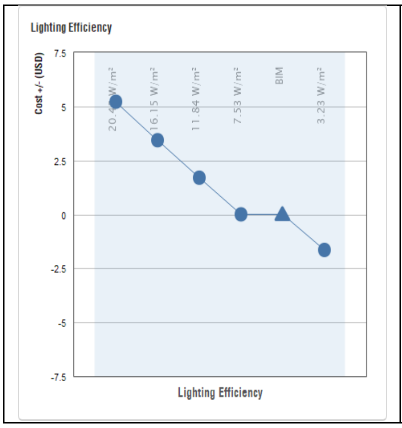

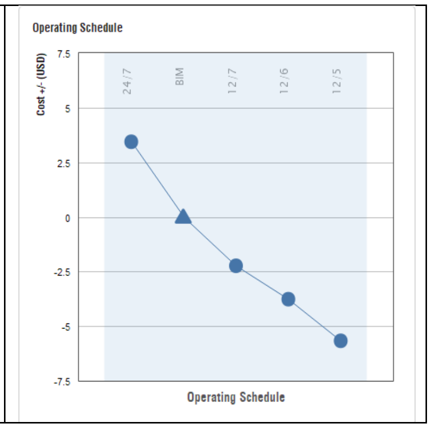

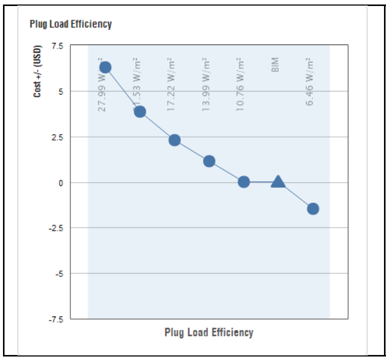

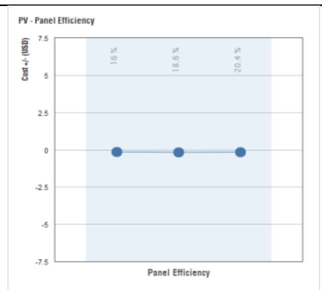

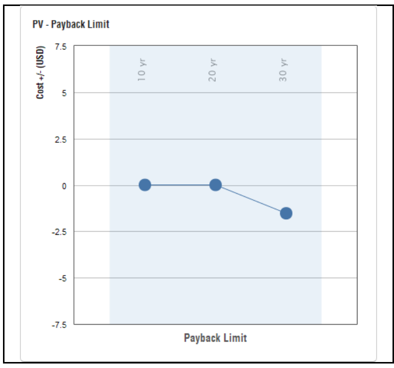

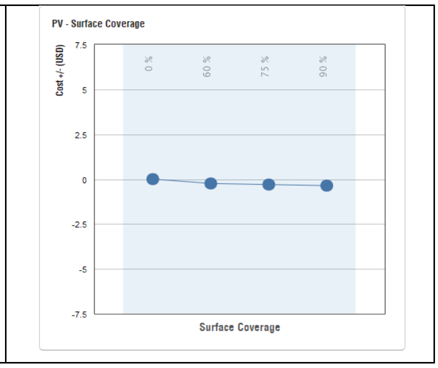

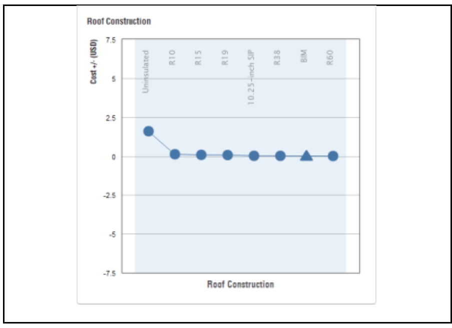

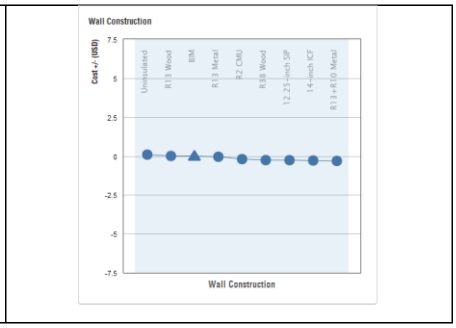

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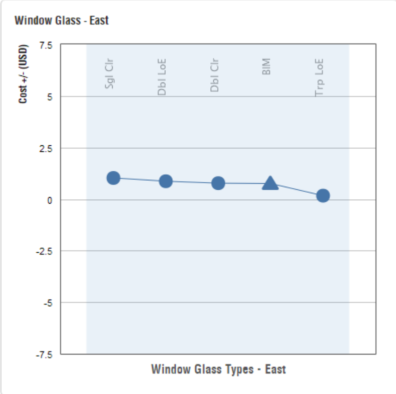

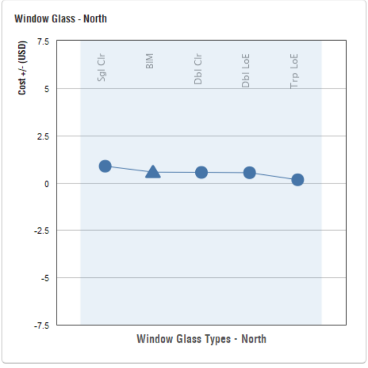

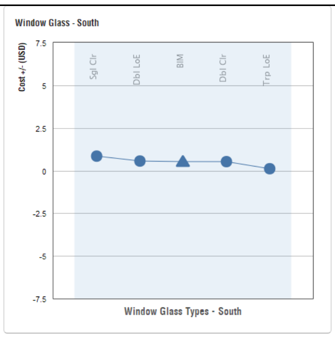

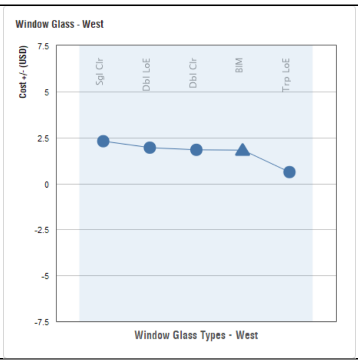

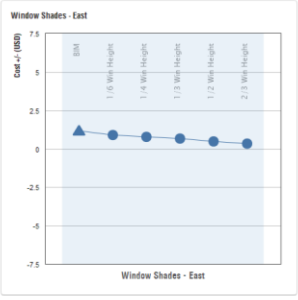

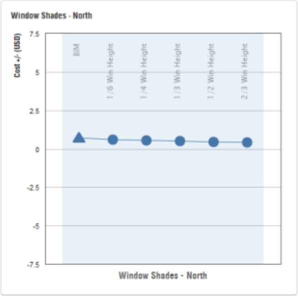

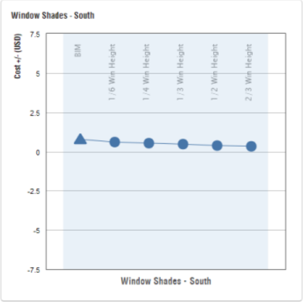

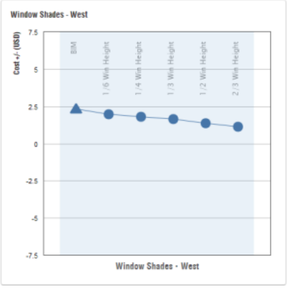

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| Volume 4, Issue 6, June 2021 |

V.CONCLUSION

- Benefits of 3D BIM
- Enhanced 3D visualization of the entire project
- Streamlined communication and sharing of design expectations
- Easy collaboration between multiple teams irrespective of their area of expertise
- Reduced instances of rework and revisions due to complete transparency from the beginning

Benefits of 4D BIM

- Improved site planning and scheduling optimization
- Seamless coordination among architects, contractors, and on-site teams
- Better preparedness in terms of next steps during every construction stage
- Enhanced information sharing related to timeline expectations helping to avoid costly delays
- Enhanced safety and efficiency due to documentation of an entire plan with specific timelines

Benefits of 5D BIM

- Real-time cost visualization with notification on changes in costs
- Automatic count for components/system/equipment associated with a project
- Simplified cost analysis and budgetary analysis with predicted and actual spends over time
- Minimization of budgetary offshoot due to regular cost reporting and budgeting

Benefits of 6D BIM

- Reduced energy consumption in the long run
- Faster and more accurate decision making related to component installation during the design process
- Detailed analysis and impact of a decision on economic and operational aspects over the entire lifecycle
- Better operational management of the building or structure after handover.

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