BIM Model for Efficient Design

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Abstract : One of major objective is to understand the processes, tools and techniques required for implementing Building Information Modelling on projects and also experience the working methodology & processes which is experienced by working in a BIM based project environment. Enhance the understanding of using of BIM model and design the project in a way that meets the all the requirement and also have efficient in terms of building life cycle. In current scenario of construction many building design models do not comprise with sufficient information for building performance, evaluation and analysis. Using BIM will analyze the design optimization and various methods of making a project efficient and how it can increase the building performance through design. In order to find out energy consumption and environmental impact certain parametric calculation has to be carried out. Basing on the calculation spreadsheets are derived from building codes. This process is mainly carried out once end of the design process to satisfy code compliance. This whole process is very tedious which does not give the area for consideration to design team to think about the alternative measures. There is demand to estimate or forecast the building performance and define alternative measure in order to maximize the building performance. BIM can made this possible. So the overall objective of this project is to examine the uses and benefits of BIM for construction projects and analyze BIM based model to make the design sustainable and more efficient.

Keywords —BIM, Design, Building performance, Compliance, Optimization, Design.

I. INTRODUCTION

With the growth of construction industry in terms of designing the building and technology over the years many building information modeling and simulation process has merged to and used by the construction industry throughout the building life cycle. Because of various diversity and fragmented nature of the disciplines, events and tasks while project management in construction and design stage the pressure arises of lower costing and better productivity which have been the major forces to drive the building information modeling, simulation and cloud based analysis in construction industry. The varieties of application cover virtually in each phase of the construction form initiation to the completion of project and even after that for managing the facility.

II. METHODOLOGY

To evaluate the capabilities of building with various tools (Revit, GBS) a hypothetical project was used. The project involved real life design methodology. Building model is created in Revit for analysis with in Revit and for building performance analysis export to GBS.

Project Description: Commercial Building G+5

No. of floors – 5 (Area – 722 sqm)

1. Architectural Revit Workflow and data input

The designer of the project designed the Revit model and model itself contained parametric data and information of the building elements. Firstly, model was not intended for simulation a few modifications were changed to the same model to improve the final result. Revit model contained all the information in a cluster form and for the analysis building had to be isolated. The reason for these are: -

1. Revit calculates analytical surface based on elements in the model and their status of construction (old or new construction)

2. Values for energy modelling are size dependent different value for bigger and different value for small building

3. Type of building also have different values such as commercial, school, theaters, Residential, malls etc.

Material property	Base Run	Alternative Run
Walls		
Density	1,550.00 kg/m³	1850 kg/m³
Thermal conductivity	1.35 W/m2 ℃	1.05 W/m2 ℃
Specific Heat	0.8400 J/(g·°C)	0.8400 J/(g·°C)
Electrical resistivity	2,000,000.0000 Ω·m	2,000,000.0000 Ω·m
Glass		
Density	2,480.00 kg/m³	2,240.00 kg/m³
Thermal conductivity	1.0500 W/(m·K)	1.1000 W/(m·K)

Specific Heat	0.8400 J/(g·°C)	0.8400 J/(g·°C)
Electrical resistivity	1.0000E+10 Ω·m	1.0000E+10 Ω·m
Reflectivity	0.00	N/A
Floors		
Density	2,300.00 kg/m³	2,300.00 kg/m³
Thermal conductivity	1.0460 W/(m·K)	1.0460 W/(m·K)
Specific Heat	0.6570 J/(g·°C)	0.6570 J/(g·°C)
Orientation		
Specific Heat	Standard	+165

2. Model validation

When we initiate to run the energy simulation, Revit will show an error message if there is any inconsistencies in the energy model that needs to be adjusted. Then the model validation comes into picture. It is very important aspect in Revit to complete in energy analysis process. This is required because of certain characteristics in the software and the modeling engine based on which it works.

3. Energy Simulation Modelling

When the model is built to an acceptable level after that energy simulation can be started and is connected to Green Building Studio so a registration is required. After completing the energy setting next is to run energy simulation. The software will ask you whether you want to run with the existing model or want to create new analytical model. If any changes has been made then it is better to create new model. It should be noted that certain parameter can only be added by the cloud or Green Building Studio information like energy price and currency. Best option is to create new project in GBS and then add the project from Revit through energy analysis**.**

4. Energy setting used for this project

Parameters	value	Note
Building type	Office	Affects EPD (Equipment power density) and LPD (Lighting per day)
Location	Noida, 201301	find location on map
Ground plane	Level 1	Building has no basement only has stilt parking
Export category	Room	enclosed spaces
Export complexity	Simple	This has to do with openings. Simple is faster. Effect on simulation is minimal
Include thermal properties	not checked	when checked returned an error message
Project phase	New construction	All elements to be analyzed should be in the same phase
Silver Space Tolerance (mm)	304.8	Default value. minimum gap be-tween spaces that will not be as-signed as a room
Building Envelope	Use function parameters	Differentiates between interior and exterior elements. An automatic option is also available
Analysis model	Use building elements	
Analytical space resolution (mm)	457.2	Default value. Minimum gap between elements that will be ignored when identifying energy model spaces
Analytical surface Resolution (mm)	304.8	the smallest dimension of any surface to be included in the energy model
Building operation schedule	Year-round	Has significant effect. This is the times in which the facility is in use
HVAC System	12 SEER/0.9 AFUE. Split/Pack-aged Gas, 5-11 Ton	

5. Exporting to gbXML

To analyze the energy model for design alternatives, cost and other parameters model needs to be exported to GBS in gbXML format. The export process is simple and it will export as per the settings made by the user in energy setting dialogue box.

6. Autodesk Green building studio workflow

a. Base run

After creating the energy model and done with all the energy settings next step is to run the simulation and create base run for the project. It can be done by Revit or by the cloud. It will take certain time to complete the simulation. After the successfully completion it will show the result in documented form in Revit.

GBS automatically also create the 154 design alternatives along with the base run. This automatically created alternatives shows the effect of changing in building elements and application of energy conservation measure to simulation model. This project base run defaults are taken by the information collected from the model imported from Revit.

b. Design Alternatives

Design alternative feature in Green building studio contain the capability to modify the base assumptions of the Base model and then run a simulation that emulates the impact of the modification on energy efficiency.

While creating the design alternative certain properties of the has been changed and along with this GBS also has some modification which were made to the following.

- HVAC equipment
- Wall construction
- These had the maximum impact on energy efficiency
- Other possible modifications are;
- Lighting efficiency
- Occupancy control
- Day lighting sensors and control
- Glazing type
- Roof construction

III.   STEPS TO MASTERING THE DESIGN EFFICIENT

Step 1- Model Your Project
Step 2- Define Model Location
Step 3- Define Energy Settings
Step 4- Create energy model and Run simulation
Step 5- Analyze Results

IV.   DATA ANALYSIS & RESULTS

The results contained here is obtained after several of running in Revit and GBS. Different settings were changed in the base model to check or get the best possible result. The spatial data and weather data were given by the software itself. Other parameters like external and internal elements such as materials, energy demand, equipment's etc. were changed and reduce as per the energy demand. Other changes applied to the model to make the design more sustainable and efficient and result is presented in following section.

The results will be studied based on values obtained for:-

- Fuel charges
- Water demand and cost

- Energy use

- CO2 emission

V.   CONCLUSION

Using BIM on projects helps team members of the project and discover useful ways to improve the building performance, make the design sustainable and efficient and get the more realistic view of project. It also gives the sufficient time to think and change the design in early stage so that project can be completed within the cost and also have the minimum lifecycle cost after completion. It enables the project team to make the smart decision according to usage. But it also requires a complete knowledge of software which will adversely affect the project because this learning curve has more of practical and theoretical knowledge. There is a lot of learning resources, Books, Journal which help the team or Architect to understand the software. Building performance reflects the actuals performance of building which accurately relates the real life situation. The aim of this project was to perform energy simulation using BIM tools and make the design more sustainable and efficient which is successfully achieved. This project can act as guide for future Architect designers, Civil engineers in their journey to perform and learn this activity in better manner using BIM.

This above result obtained for the simulation shows that GBS and Revit can be used for the building performance

analysis. To get the more accurate results it's important to apply this following recommendations:-

1. Simplified and basic models are more suitable for the analysis because it has certain limitation that can show errors so it's better that after the conceptual design stage analysis should be done.

2. Validation of model is also very important at the early stage so it's better if we can create a separate model for analysis because complex model are less likely to get the best result.

3. Knowledge of HVAC will help to create better design alternatives it is important to understand the different terminologies used in the software.

4. Autodesk software is particularly based on the American standards default value are also based on that. So this is one of the problems that can be arises when someone is selecting the design alternatives. User should use the default values as much as possible. There are various options that are close to preferred specification of the most countries.

Building information modeling is gradually becoming the standard among tools used for designing in the AEC industry. It also affected the members of AEC industry by the development of BIM and its competences. BIM has developed with the times and is gradually becoming the need in almost all sector of AEC industry. This whole project was intended to explore the potential of Autodesk Revit and Green Building Studio for making the design more efficient and sustainable so that building would have minimum impact. The result has been generated based on code developed by *USDOE-2 (United States department of Energy).* To complete this whole process energy modeling and simulation has been done and software interface was evaluated. The suitability of the project location was also evaluated and based on that material had selected.

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