APPLICATION OF BIM METHODOLOGY FOR ENERGY SIMULATION OF BUILDINGS

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ABSTRACT

The Building Information Modeling (BIM) methodology has impacted the architecture, engineering and construction industry in a positive way, since it has revolutionized the management, control and development of the life cycle of projects, by means of software and tools. The research topic focuses on Building energy simulation, as it can provide design information in the early stages of a project and is effective for decision making. In addition, issues related to occupational comfort and a safe environment for users are taken into account.

Simulations will be carried out using the Design Builder tool, which is a tool for energy and performance analysis throughout the life cycle of a building.
Using this tool, it is possible to perform analysis per year or per month of the building and show the critical points for a given time, in which certain parameters such as the location of the building, the zoning of each of the areas, among other elements, must be defined.

The purpose of this research is to use the previously developed apartment building to integrate the benefits of Building energy simulation.

The main objective is to provide data on energy simulation using the Design Builder software, this tool provides consumption data, allowing to improve the understanding of the factors in the construction phases. It also allows to identify areas of opportunity that offer potential energy savings and improve energy utilization.

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Keywords: *BIM, Softwares, IFC, Deliverables.*

1. INTRODUCTION

The purpose of this work is to use the BIM Methodology, but focused on the simulation of energy in a building. We know that BIM methodology facilitates the collaboration of the different parties involved in a project and improves project development practices. However, Building energy simulation is a methodology that assists architects, designers and operators to provide an analysis of the shape, size and orientation of a building during the early stages of the building life cycle. It can generate design solutions and improve building energy performance.

The research and development process consists of providing information on the use of Design Builder for the development of the building energy simulation. In addition, it aims to demonstrate the benefits of integrating energy simulation into the building planning stage and the potential of using 3D models.

In this way, the research can serve as a source of information for future generations and Guatemalan companies that want to execute and plan projects related to the energy simulation of a building.

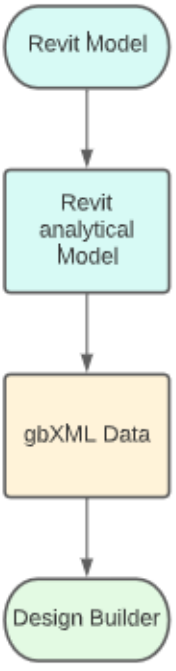
2. METHODOLOGY

The purpose of the research work is to analyze the use of the BIM methodology applied in the analysis of energy simulation. The building to be analyzed is an apartment complex with 3 levels of family housing, located in Guatemala City.

Figure No. 1

First, the Building Project Execution Plan will be developed, which contains the information, execution phases, use cases and deliverables, goals and the project coordination plan.

The exchange of information between Revit and Design Builder software, both will allow the development of information between the different parties involved in the project. The exchange of files will be generated by means of an energy analytical model so that the information between the two softwares will be compatible.The information exchange process should be viewed as follows.



It is important to understand that Design Builder is a software specialized in the environmental and energy simulation of buildings, it allows to analyze the aspects of comfort, energy consumption and CO2 emissions, among many other factors.

The structure of the program consists of 8 modules, which are the ones on the figure No. 2.

Figure No. 2

For the purposes of this research will focus on simulation, this module integrates the calculation of Energy Plus, in this it is possible to perform dynamic simulations in real time, using information from climate data, location, among other data.

To begin with the development process, first the location parameters of the project are configured, the following image shows what was defined in the project.

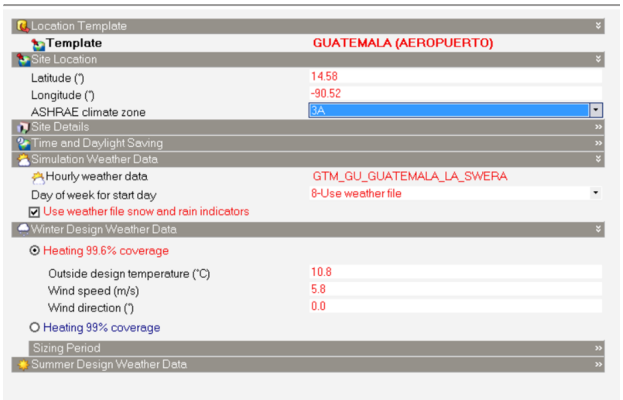


Figure No. 3

In the editing screen, the analytical energy model generated in Revit was imported. Once the model is loaded, each of the activities that take place in the building must be defined by zones. For this case of residential use, the areas of bedrooms, bathrooms, laundry rooms, living rooms, kitchens, corridors and lobby were defined. The following image shows an example of the defined activities.

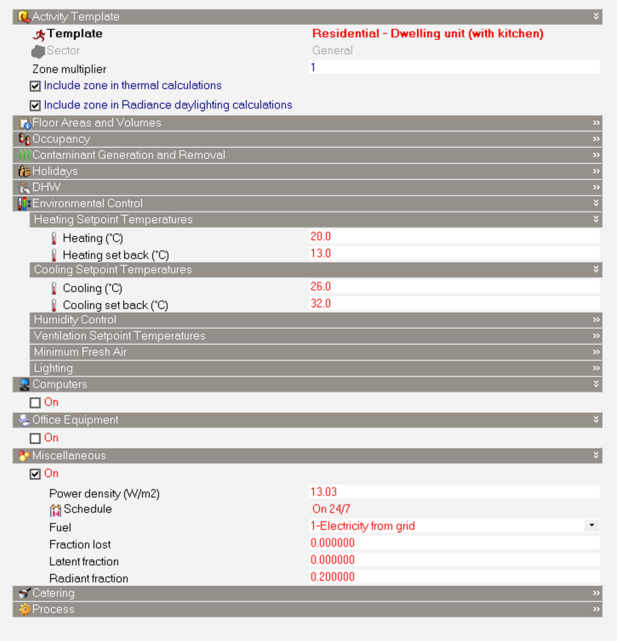


Figure No.4

Then the building construction, openings, lighting and HVAC parameters were modified. Once these parameters were modified, the program was run to see the results generated in the simulation.

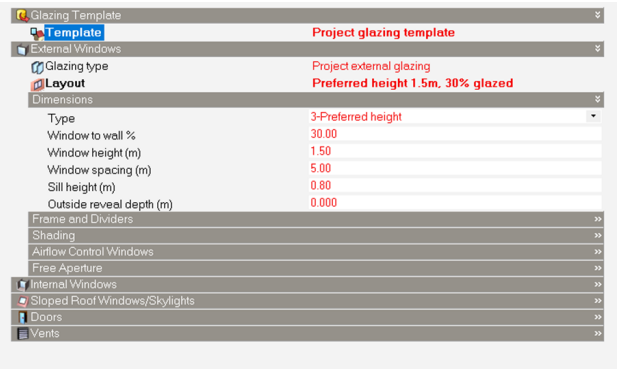


Figure No.5

3. RESULTS AND DISCUSSION

Building Execution Plan:

1. Building Information

The basic information of the project is shown below. The building is a 3-level complex of family apartments of 138 square meters.

Information	Description
Project owner	Universidad Del Valle de Guatemala
Project Title	Apartment building
Type of proyect	Family apartments
Type of contract	Energy design
Location	Guatemala City
Project category	G4

2. Section B - Phases of execution.

The following shows the contractor's data responsible for each of the planning phases.

Contractor	Description
Excavation	The type of contract is to perform the excavation of basement 1.
Civil work	Responsible for the construction of walls, salbs and columns of the building.
Windows and doors	Installation of doors and windows in the assigned areas.
Plasterboard	Installation of plasterboard partition walls for the interior area of the apartments.
Facade installation	Installation of decorative elements of the building.

3. Section C: Use Cases and Project Deliverables

The project uses focus on the design and planning stage of the building. For application purposes the uses of building system design, sustainability assessment (LEED) and design reviews will be used.

4. Section D: Project Goals

Priority Goal Description
Evaluate design efficiency Scheduling
Determine location to analyze site requirements.

This process is reviewed for design compliance Design Review
Efficient construction planning

5. Section E: Coordination Plan

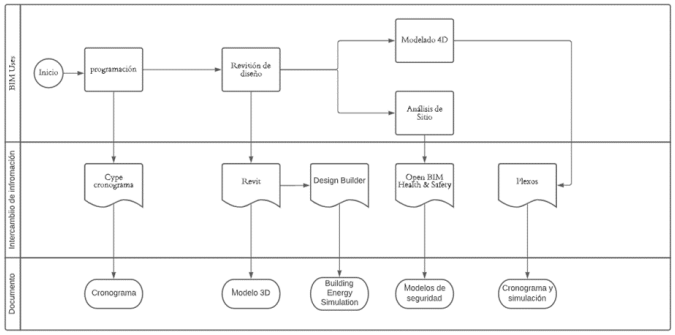


Figure No. 6

The coordination plan shown above integrates the development to be done in Design Builder, and shows what information will be generated from the use of the software.

Once the modeling and editing of the building is finished, we proceed to the thermal loads performed with Design Builder, with the "simulation" tab we generate the operating temperature and air temperature data, in this case we will focus on the operating temperature.

The simulation of temperature and heat loss was performed for each of the levels of the building, it should be taken into consideration that the level of accuracy of the data depends on several factors such as time, time of the year, etc. In this case, a simulation of a full year of the apartment building will be performed.

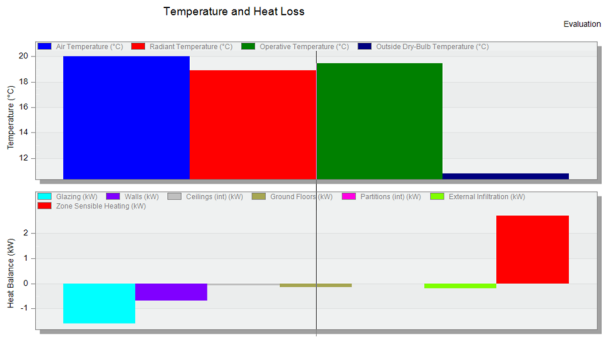


Figure No.7: Level 0

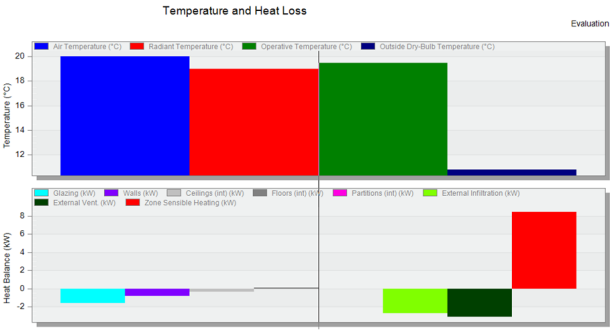


Figure No.8: Upper levels

The graph shows the results generated from the location and the defined parameters. In the results we can see the internal and external conditions of each of the levels. In the graph for levels 1, 2 and 3, the heat balance is shown, which means that the building has a steady state heating of 10.46kW. In addition, we can see that the upper levels have higher ventilation losses than the lower level.

Within the operating temperature, the temperature is 18°C, if we compare it with the air temperature, which is 20°C, it can be said that it is not a comfortable environment. In addition, it is observed that the upper levels have external infiltrations, this means that improvements should be made in the glazing of the building, this should be considered in the process of improving the design.

We proceed to the analysis of the Cooling Design of the building and we can see how each of the temperatures oscillate, we can see the behavior of the operating temperature, the most important thing would be to take into account that the ventilation system is deficient.

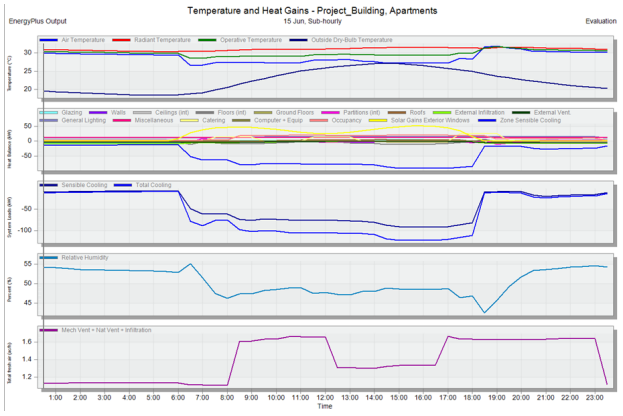


Figure No.9

The following figure shows a more general diagram of the entire apartment project.

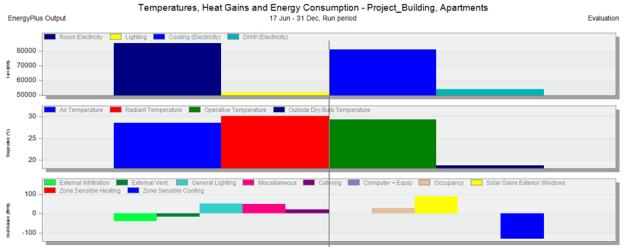


Figure No.10

Thanks to this analysis, improvements can be made to the design before it is built, with the results presented, modifications can be made in order to have a model as close to reality as possible. In addition, changes can be made in the direction of the windows so that the building can handle natural ventilation most of the time and cross ventilation can be used for the summer season.

4. Conclusions and recommendations

- Thanks to energy simulations, it is possible to see improvements for the design in both comfort and performance of the building throughout its life cycle.

- The advantages of performing these types of simulations is that changes can be made prior to implementation, which helps to save time and money.

- It is recommended to include these energy simulation processes in the buildings to analyze the spaces in more depth and design a comfortable environment for the users.

- It is recommended to perform a model using the IES VE software, which helps to perform virtual environment simulations in buildings.

5. BIBLIOGRAPHY

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