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## **Concept, Application and Implementation of Building Information Model (BIM) Technology**

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### **ABSTRACT**

Management of construction project process is critical matter that needs thoughtful collaboration during dealing with information, data and workflow. That is because it involves large number of stakeholders such as owners, consultants for every specialization, general contractors, huge number of subcontractors, traders, etc. Furthermore, the operation and maintenance of the buildings during its life cycle depends on the data collected after the end of construction phase. Collecting these data through the construction phase and managing the workflow with the traditional ways are very cumbersome and susceptible to various types of errors. Recently, Building Information Modeling (BIM) technology has been implemented in some projects to solve the problems of the workflow, the loss of data and coordination among the stakeholders of a project. Accordingly, the current paper presents the concept and application of Building Information Modeling (BIM) technology to easily manage the workflow through the design and construction phases. BIM technology has been applied on a graduation project that consists of preparing: architectural design, structural design, bill of quantities, time scheduling, modeling, and shop drawings of residential villa. The study showed that the workflow of the construction processes did not have many errors as in traditional ways of working. Sharing data among the project stakeholders represented in the students working on the project was much easier as BIM depends on working internet clouds. All data were represented in one source which was the model created in Revit software. The final design and shop drawings were well coordinated with each other and predicted zero conflicts during construction stages.

**Keywords:** BIM, Virtual building, Sustainable, Facility Information Management, Energy consumption analysis, Green building design, RC building design; Revit software.

## Introduction

Building Information Modeling (BIM) has been expanded rapidly in Egypt during the last few years. In Thus, the construction education as well as the construction management profession should be kept up with the ongoing technology. Accordingly, the graduation project for Bachelor students in the construction Engineering and Management Department of Pharos University in Alexandria was prepared to make use of such development through the implementation of the BIM technology on their graduation project. A residential villa was the case study for the application of what they have been taught through all project phases using BIM technology. First, the architectural design phase took place. Afterward, a structural system was proposed, modeled, and analyzed. Then, a physical model was finished with extracting all documentations including: construction sheets with all details and quantity takeoffs. Finally, time scheduling and energy analysis was performed.

## The Concept of Building Information Modeling (BIM)

Building Information Modeling (BIM) has many definitions according to various standards from different countries and organizations. The construction information model in China is more compatible with the full name of the English definition of BIM. While, the National BIM norm of the United States for BIM is described as follow:

- (1) BIM is a facility (construction) of the physical and functional characteristics of digital expression;
- (2) BIM is a shared knowledge resources, is a sharing of information about this facility, to provide reliable basis for the establishment of the facility from the construction to the demolition of the whole life cycle of the process;
- (3) In the different stages of the project, the stakeholders through the BIM to insert, extract, update and modify information in order to support and reflect the respective responsibilities of the collaborative work.

The inner function of BIM has a narrow and generalized interpretation as illustrated below:

Narrow definition: three dimensions of the Information Modeling Building can be viewed from the static construction information model:

- (1) Building is representative of the BIM industry attributes. BIM service object is the construction industry rather than other industries [1].
- (2) Information is the soul of BIM. BIM is the characteristics of different organizations at different stages of the project to provide a variety of information related to the construction of products.
- (3) Model is the form of BIM information creation and storage, information of construction facilities can be expressed as a diversified form of expression.

Generalized definition: BIM is a database-based cloud computing and data technology and simulation technology, combining and handling geometry and non-geometry knowledge related to the building project life cycle, offering information and assistance for project preparation, design, construction, operation, and maintenance as illustrated in Fig. 1.

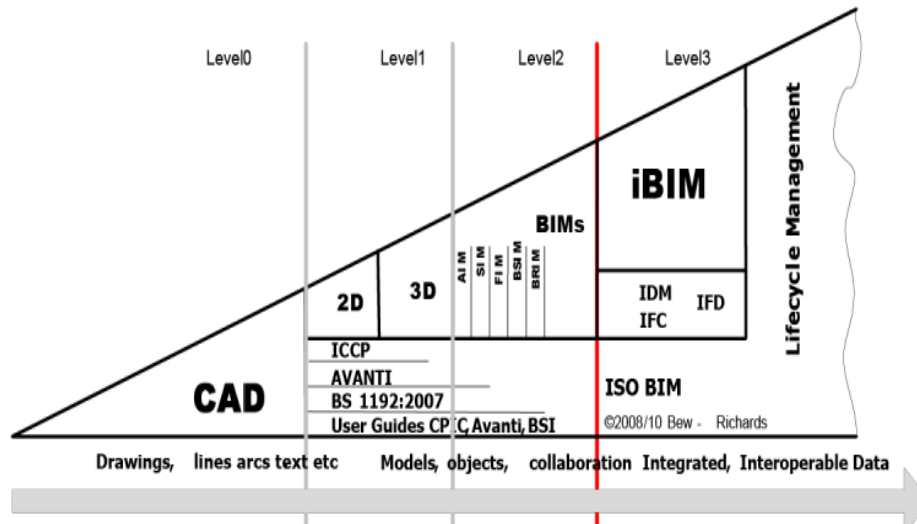


Fig.1 Building Information Modeling Levels. [1]

## BIM technical features

### Visualization

BIM visualization is a type of income of what you see is what you see, such that people form a three-dimensional and even n-dimensional separate stereo picture to display in front of people to be the shape of the previous line of part form. It is an isomorphism between interaction formation and visual input. For a high degree of virtualization of the modeling, project architecture, development and execution of the entire process in the visual world, the project is a comprehensive expression of the related details.

### Coordination

In the development of the early construction stage, clash detection tests can be made. The BIM building knowledge model can be used to organize, produce and provide coordination data to avoid any conflicts during the construction process.

### Simulation

In the planning process, energy modeling, emergency escape simulation, simulation of the sunshine and heat conduction can be implemented. In the bidding phase and construction phase, the 3D models including n-dimensions can be used to produce time model, construction organization design, cost management, evaluate the reasonable construction schedule to guide construction; in the project activity phase, simulation of traditional regular emergency care, such as earthquake light simulation and simulation of fire evacuation is performed [2].

## BIM technology and other technology integration development to achieve the line

### BIM and cloud computing technology integration

Cloud computing infrastructure is given a fresh extension of information technology, centralized control of many physical resources and virtualization of these resources, creating a large pool of virtual resources. Virtualization technologies, dynamic scalability, on-demand deployment, high versatility, high reliability and high cost are the key characteristics of cloud computing technology. BIM will use cloud-computing technologies to meet the tremendous demand for computational resources making full use of the powerful processing capacity of cloud computing technology, three-dimensional and even n-dimensional architectural modeling in different results of correlation analysis, enabling architects to thoroughly understand the project design process concepts, and the complex surface treatment on the final result. Also, switches work style in cooperative architecture, to achieve inter temporal type of collective work, through the cloud

computing help architectural design and collaboration, the architect, structural engineer and so on different aspects to be able to use the most simple, the most economical way achieve synergy. Ensuring a high-performance engine, participants can access the cloud anywhere, allow high-performance graphics workstations, upload the BIM model to the cloud server in real time, participants can provide multiple mobile terminals and desktop terminals for synchronous access, review and adjustment anywhere, and can be used to direct design and management, procurement management, construction management operation and production delivery management [4].

### BIM and Internet of things technology integration

BIM property management framework for intelligent visualization, integration to provide simple assistance that can help building operations and maintenance. The integration of Building Information Modeling (BIM) with real-time data from the Internet of Things (IOT) devices presents a powerful paradigm for applications to improve construction and operational efficiencies. Connecting real-time data streams from the rapidly expanding set of (IOT) sensor networks to the high-fidelity BIM models provides numerous applications [5].

### Application of BIM technology on a case study

Fig. 2 shows the progress of the project during the implementation phases of the BIM technology on the case study. Herein below, each phase is explained.

#### 1- Work Sharing

Revit Cloud Work-sharing allows you to collaborate on Revit models in the cloud as shown in Fig. 3 [5]. You can co-author cloud models, centralize all project design data, and improve communication and collaboration across the entire team. Access the Revit Cloud Work-sharing section of the Revit help to learn more.

#### 2- Modeling Phase

Structural and architectural models are modeled in Revit software by creating many families using Revit. Also, adding a special tool in creating like Dynamo and creating levels and adding finishes material as shown in Fig. 4.

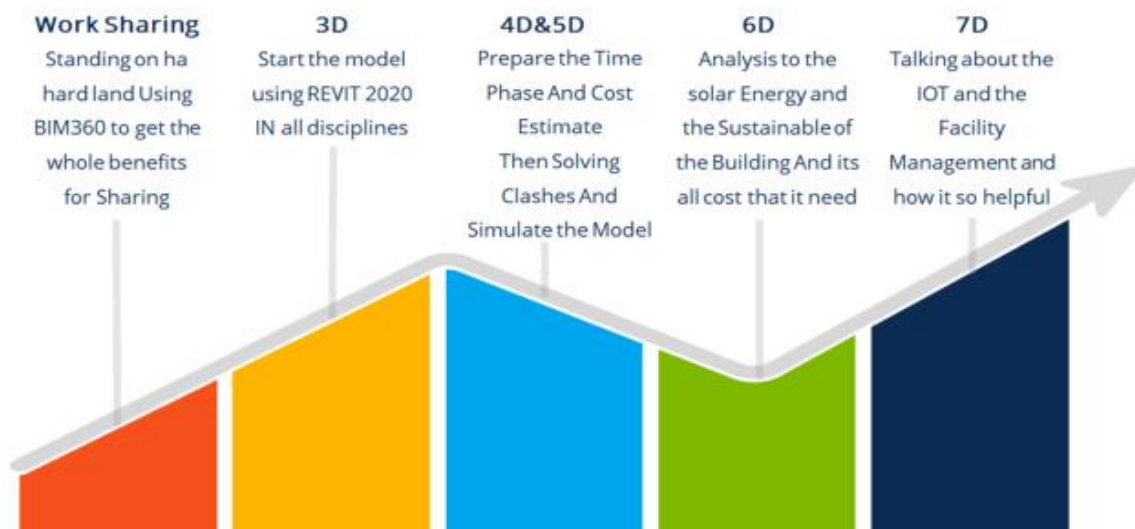


Fig.2 Progress of the project. [5]

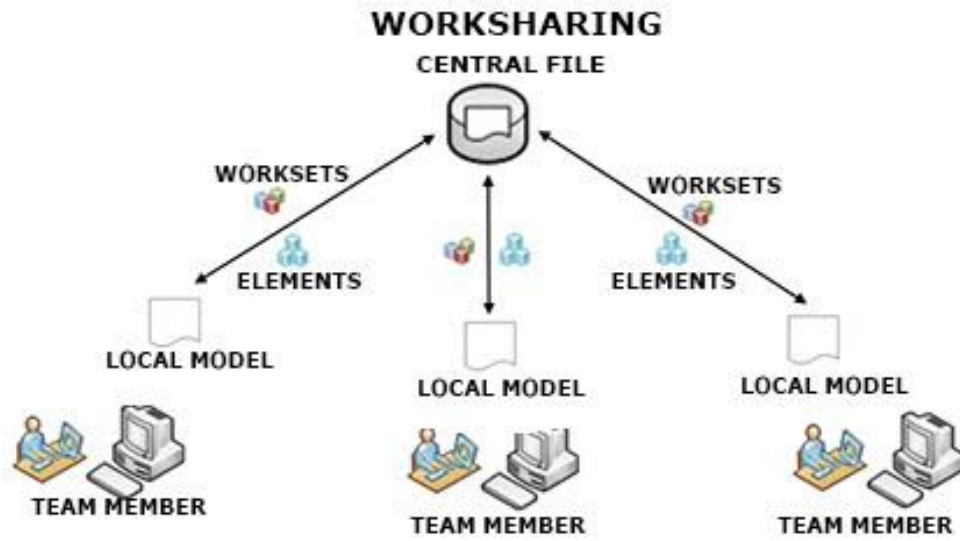


Fig.3 Working shearing between the project team. [5]

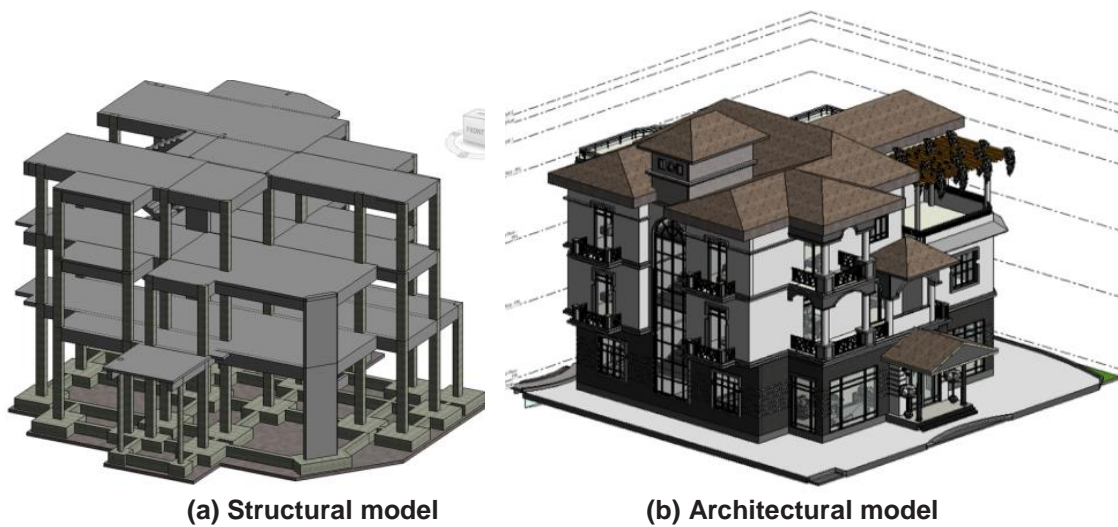
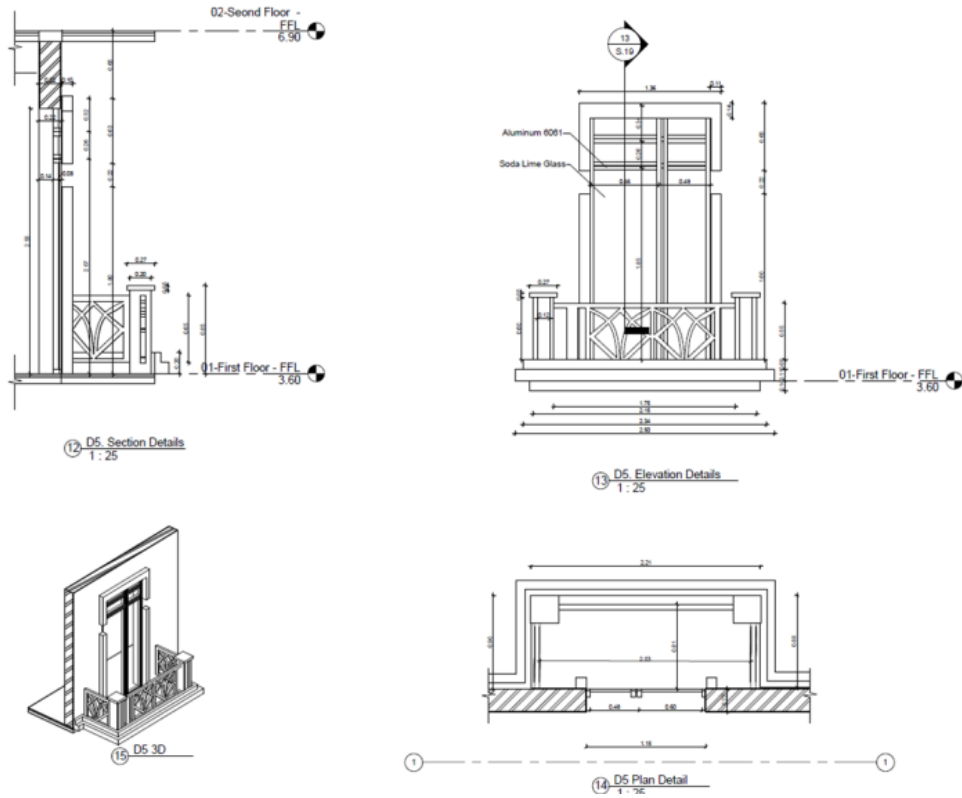


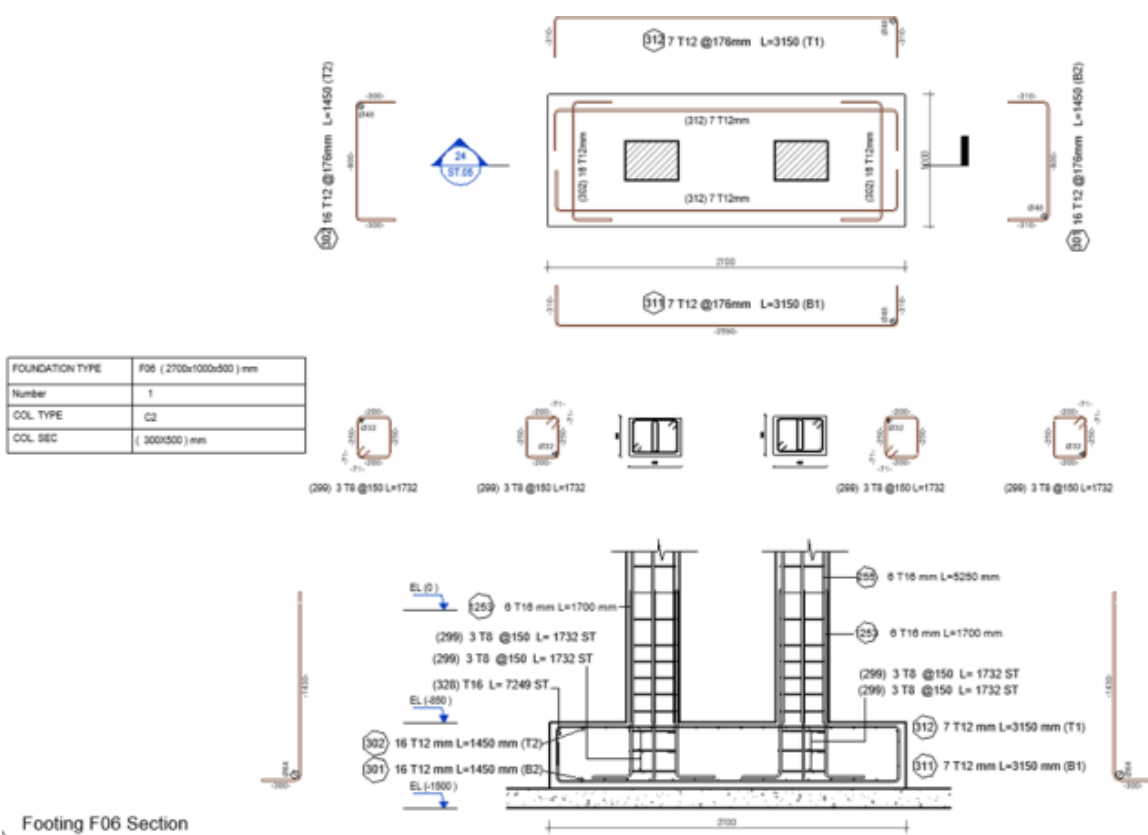
Fig.4 3D structural and architectural models.

### 3- Applying dynamo technology in the model to create many families

After finishing structural and Architectural models with (LOD300), we had to upgrade the model to (LOD400) and extract all shop drawings files for each single details of the architectural and structural model including: windows, doors, wall finishes, curtain walls, and concrete rebar as shown in Fig. 5.



(a) Detailing of architecture model.



(b) Detailing of structure model.

Fig.5 Detailing of structural and architectural models (LOD400).



#### 4- Design

**First way:** is to share the structural model from Revit to Robot software to perform structural analysis and get all the data required to start our design and get all the reinforcement data as shown in Fig. 6.

**Second way:** we exported the model to CSI software programs, Etabs and Safe, to get analysis and data and to compare between different software as shown in Fig. 7.

After finishing the structural design of all elements, we started to model the rebar of all these elements in Revit and extract Shop drawing files as showed before as example in Fig. 5.

#### 5- Time Schedule (4D Phase)

After finishing the model and extracting all the drawings and details, we started to make a time schedule for all activities in the project. Then, connecting this schedule with the model to make a progressing simulation video in Navisworks software.

#### 6- Clash detection

Clash tests were performed on certain elements to detect the conflicts between the architectural model and the structural model. Several clashes were discovered then solved in the models. A final test was done to make sure that all clashed have been solved.

#### 7- Analysis to solar energy (6D)

After finishing the architectural model we can make an energy model to start calculate how the building will deal with the out-source energy that will affect on its surface of our building as shown in Fig. 8.

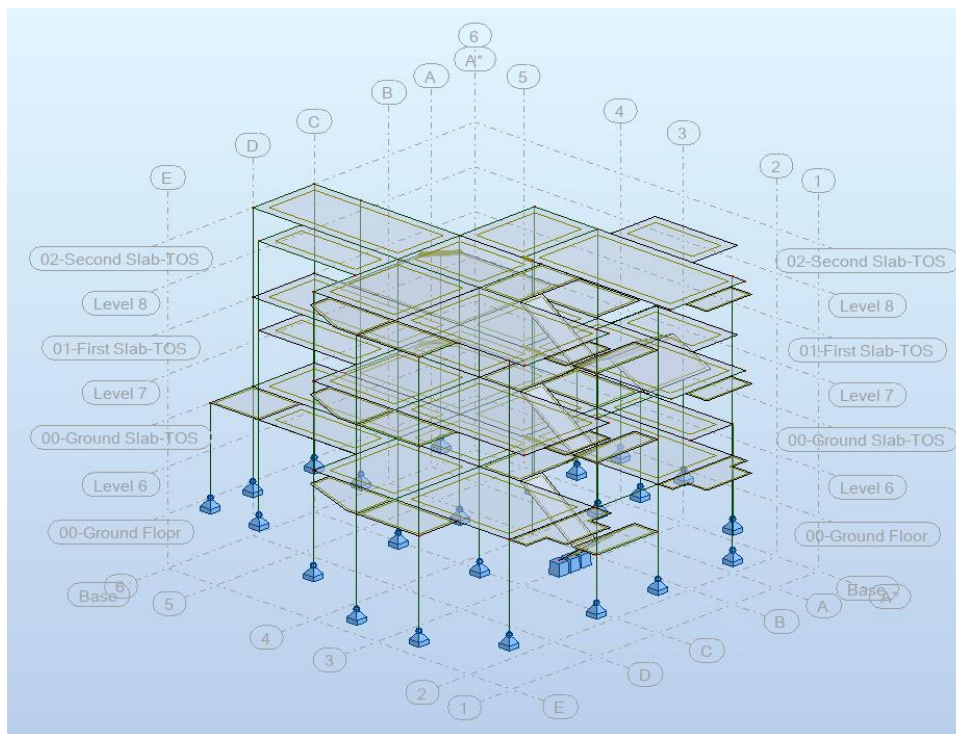


Fig.6 3D modeling using Robt Structure program.



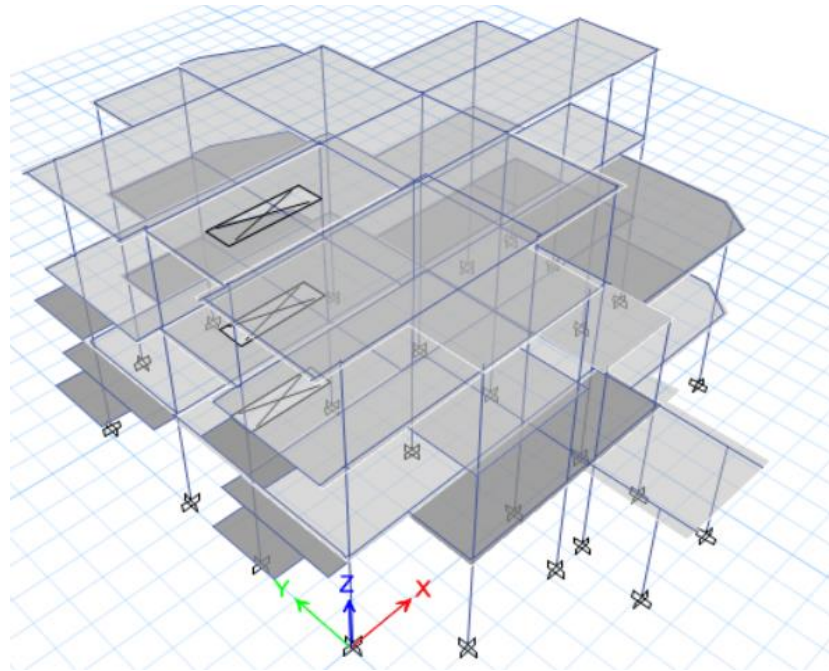


Fig.7 3D modeling using Etabs program.

### Building Orientation

Rotates a building clockwise from 0 degrees, e.g. 90 degrees rotates the North side of the building to face East.

Current Setting:  
315 - 180



### Lighting Efficiency

Represents the average internal heat gain and power consumption of electric lighting per unit floor area.

Current Setting:  
20.45 W/m<sup>2</sup> - 3.23 W/m<sup>2</sup>

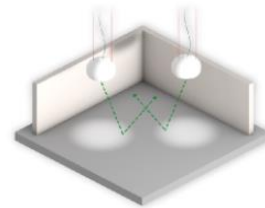


Fig.8 Analysis of solar energy.

### CONCLUSION

Using BIM as a tool to update the flow of information during a project is just as critical as doing it the first time. BIM tools will continue to develop in their ability to be streamlined, but current processes allow a BIM-enabled construction manager to complete tasks with relatively good efficiency.

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