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Limitations of Autodesk Robot Structural Analysis Professional for Structural Design Output: A Review of Frame Building

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Keywords

BIM, Reinforced Cement Concrete, ARSAP, Frame building, Structural Design, AEC Industry.

Abstract

Building information modeling (BIM) is an emerging approach to building design, construction, and operation through modeling technology to increase the integrity and stability of a structure. Different features and tools used to produce, to communicate and to analyses the building information models. The aim of this paper is to conduct an in-depth study of the major features and BIM tools which are generally used to provide better structural design coordination in different construction phases of building. BIM has its own features, analysis option, design and output options, limitations and advantages. Different BIM tools and various features of BIM software with coordination of different professions are mentioned in this paper which are being used by Architecture, Engineering and Construction (AEC) industry. Outcome of this paper is to discuss the features and tools of BIM with the emphasis on applicability and their limitations to have better structure design coordination and successful management at different phase of building construction. This study can provide help to the construction industry that by using BIM tools and features can results in efficient, cost-effective and sustainable building construction in present as well as near future by using BIM tools and features.

1. Introduction

Building Information Modelling (BIM) is an approach to building design, construction, and operation through modeling technology. Different processes and tools used to produce, to communicate and to analyses the building information models. BIM tools are used in early design stages for exchanging building information and sustainable design in construction industry. Basic models created by using suitable BIM software and then export to BIM integrated software for various analysis. It contains large amount of information on these models which allows to get efficient, cost effective and feasible design of building.

There are many features of BIM are being used in construction industry for ensuring the sustainability construction projects. Automated construction systems (BIM feature) are widely being used in Architecture, Engineering and Construction (AEC) and facilities management (FM) to get peak potential of building information model for sustainable and efficient building design. Quantity Take-Off (QTO) system, Green building (GB) system, Modular coordination (MC), Computer-integrated construction (CIC) and ARSAP are modern BIM featured products to work on project of any level complexity with efficient, cost-effective and sustainable construction project output.

BIM can provide better structural design coordination between various disciplines (Architecture, Structural Analysis, Energy Efficiency, Measurements and Budget, Facilities, Planning Execution and Coordination) and can provide advantage to the construction industry by providing a computable BIM. It can also provide unique collaboration between MEP and HVAC through BIM cloud feature and enabling all project participants to extract any information required for decision making at design phase as well as construction phase which give efficient, effective and quick design of a building.

Building information modeling (BIM) can lead to solve various coordination and technical issue between different disciplines and various building construction phases. Using variety of BIM tools and its various features to have better structure design coordination and successful management at different phase of building construction which can results in efficient, cost-effective and sustainable building construction.

2. Bım tools

Building information modeling (BIM) technology has been used in the construction industry for many years. Many programs, software, applications and systems specifically developed to integrate BIM technology in the building industry is an effort to facilitate data exchange and establish an interactive information sharing platform for different technologies (virtual construction, 3D AutoCAD, BIM management, information systems, computer information construction and information technology) [1]. BIM tools are used in the early stages of designing sustainable buildings and for exchanging information during energy simulation and daylighting analysis to improve design efficiency and effectiveness. BIM Tools help clients to better visualize the progress of building projects during most of the different stages of construction BIM Tools are useful for sustainability purposes, it is being used by various other tools in the construction market [2]. BIM tools are useful for sustainability purposes and categized in two types; one which creates basic models by using suitable BIM software and other which exports the models to BIM for analysis [3]. Many LEED (Leadership in Energy and Environment design) credits can be obtained by appropriately using BIM-based analysis tools. BIM requires the use of software, such as Autodesk Revit and ARSAP for different tasks. It includes determining building orientation, daylight and shadow analysis, site analysis, massing and structure analysis (BIM-integrated tools). BIM based analysis tools that are based on BIM tools are used for sustainability and

performance analyses, for instance Integrated Environmental Solutions [4].

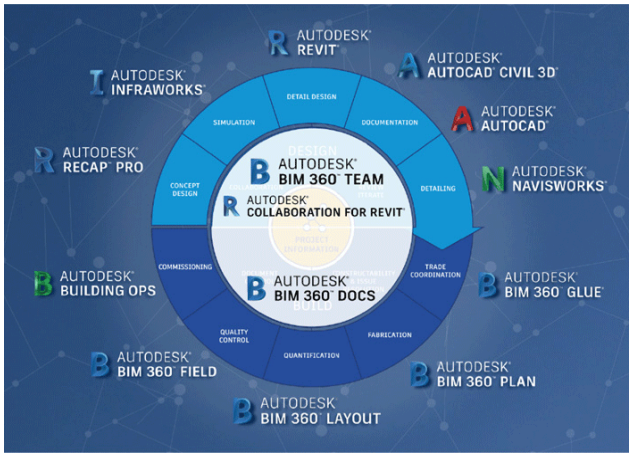

Figure 1. BIM tools.

Building Information Modelling (BIM) allows for an effective and efficient analysis to be carried out. BIM contains a large amount of information on the 3d models and has capability in comparison to the information available when along traditional analysis methods. Stability Oriented Domain Engineering and Aspect Oriented Design are new concepts which promote to the identification, modelling, design, and implementation of reusable-building blocks and opportunities to apply the concepts in the Robotics domain and the extend to approach to the architectural design phase [5]. BIM processes are established for new buildings to maintain, refurbish or deconstruct. BIM implementation carries high modeling effort from captured building data into semantic BIM objects, information updating in BIM and handling of complex data, objects and relations in BIM but yet not used in existing buildings [6]. Autodesk Architectural Revit and Bentley Systems which are largely used in Architecture, Engineering and Construction (AEC) industry. AEC industry has reached numerous technological advancements in Building Information Modelling (BIM). Such as, generation of construction schedules by automatic data extraction from BIM models [7]. Different types of BIM tools can be seen in figure 1.

Table 1. Following table illustrate different BIM tools.

Levels	BIM Tools				
Fundamental level	Revit architecture	Revit structure	Revit Topo surface	Navisworks timeliner	Robot structural professional
Application level	Revit Recap 360	Navisworks Animations	Navisworks Animator		
Advanced level	Revit live	3DS Max	Stingray		

3. Bım features

The features of BIM offer to companies with opportunity to experiment with new tools for project life cycle and these companies encourage the use of their products by promoting the benefits of BIM in ensuring sustainability in construction projects [8]. Computer-integrated construction (CIC) and BIM variables for theory and implementation improving construction effectiveness by better utilization of construction information systems in an BIM-integrated way [9]. Using BIM for operational activities and various other cases that are presenting the benefits of using BIM for different stages of a construction project. Building information modeling (BIM) has been widely used in Architecture, Engineering, Construction, and facilities management (AEC/FM) industry. Developing automated construction systems is certainly dependent upon the advanced construction technologies such as BIM. Autodesk Architectural Revit is considered as the reference 3D modeling software. Automated construction systems are dependent upon the advanced construction technologies to get peak potential of building information modeling, BIM models should be expanded by inserting new data and parameters into models because of existing parameters in BIM platforms such as Revit are designed for conventional construction practice and do not utilize many features of automated construction. Specifically, a customized BIM system for automated building construction could be realized by providing new information related to various stages of construction process to the BIM model [10]. Features of BIM software are as shown in figure 2.

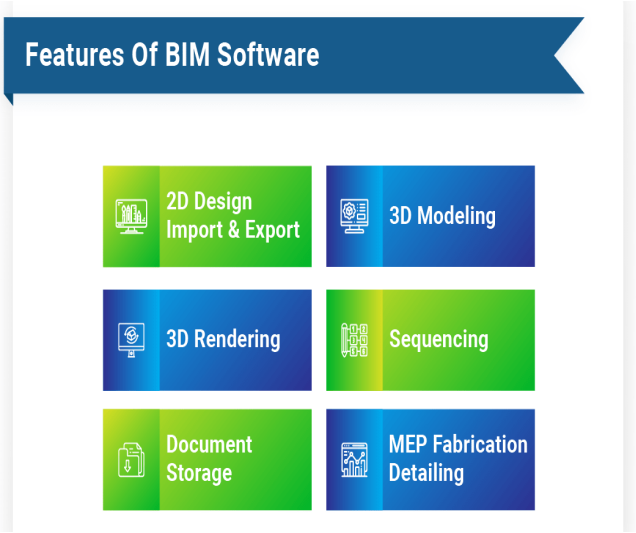

Figure 2. BIM features.

In construction projects, Cost estimation is very important factor for making decision in the initial phase and the detailed design phase. Construction phase based on QTO can function for procurement and predicting construction costs. Construction phase based on Quantity Take-Off (QTO) a BIM feature for procurement and predicting construction costs. QTO system is useful for improving the reliability of schematic estimation by decreasing risk factors and shortening time required [11]. Measuring the feasibility of using of BIM application to facilitate Green building index (GBI) assessment process. Green building assessment tools can bring long-term advantage to the owners and occupants of a building. The use of GBI system in design process can generate major advantage that are not possible when using standard practices. Green building assessment feature (GBI system) in design process can generate major long-term advantages to the owners and occupants of a building [12]. Building Information Modelling (BIM) has potential of waste minimization for construction phase. Use of graph-based representation, analysis, and visualization BIM-enabled building waste analysis (BWA) can be used for advancing the state of the art in BIM technology for construction waste minimization [13]. Modular coordination (MC) and parametric design both have great potentials in reducing waste at the design stage. Large volumes of waste can be decreased through integration of parametric design into MC. Real-life projects give rigorous insights into the logistical challenges of implementing such workflows in construction projects and validate these algorithms when applied in large-scale with a wider range of design variables, covering more parameters, and being exposed to a wider variety of design constraints [14].

Table 2. Features of BIM.

BIM Features			
Architectural design	Conceptual Design Tools Smart modeling tools Curtain walls Custom windows Create rooms	Component library Compositions & materials library Parametric Components Building and story manager Propagate (copy detail) Sections	3D Grid Clash detection External references Point cloud tool
HVAC modeling	HVAC profile library Bends	T-connections	Flow terminals
Structural engineering and fabrication	Structural toolset	Profile library	
Building data	IFC import and export Automatic classification (BIMIFY)	Custom Properties Model explorer	Project browser
Construction Documents	Generate construction documents Tags Reflected ceiling plans	Annotation tools Detail sections	Interior elevations Schedules
Cloud connection	Built in cloud connection BISYS 24/7 Common data environment	Interactive 3D viewer Unlimited users and roles	Automate repetitive tasks

(Source : https://help.bricsys.com/hc/en_EU/articles/360007744834)

4. Bım as better structural design coordination

Successful management in the process of building design coordination results to deliver efficient, cost-effective and quality of projects. BIM had vital impact on design coordination, supporting the identification of causes of coordination issues and the factors which effect their resolution and management clashed between various building systems [15]. Architects design building aesthetically and structural engineers do the structural design of building. BIM can provide these two professions to chance to combine at one BIM platform to reduced design coordination issues and give efficient, effective and quick design of a building [16]. BIM-integrated tool has been incorporated into a computer model called MCMPro, which was developed using Visual Basic for Applications (VBA) as an add-on to a CAD model. MCMPro can incorporates BIM technology based on CAD parametric modelling and manufacturing requirements in a 3D-model, in order to generate sets of shop and fabrication drawings [17].

Table 3. Bım Multidisciplinary coordination.

Steps	Multidisciplinary coordination
1	proper Models placement in relation
2	Selection of coordination tools
3	Proper export of models (IFC formats)
4	Combining models into one multidisciplinary model
5	Specifying the scope of model checking
6	Determining the rules for the model checking
7	Carrying out a model checking
8	Assigning the results of the check to the relevant persons
9	Sending coordination reports
10	Results analysis

The use of BIM-integrated software in a number of disciplines (Architecture, Structural Analysis, Energy Efficiency, Measurements and Budget, Facilities, Planning Execution and Coordination) and the most common file exchange format The evolution of teams in software use throughout the different contest editions as well as the information flow among the Architecture and the Structural Analysis disciplines Worldwide governments are putting Building Information Modeling (BIM) methodology as a requirement in their projects due to effective and efficient structural design output. It also provides well and better coordination between different disciplines in various phases of building constructions [8]. BIM can provide advantage to the construction industry by providing a computable BIM and enabling all project participants to extract any information required for decision making at design phase as well as construction phase. It can provide unique collaboration between MEP and HVAC through BIM cloud feature [18]. A framework based on BIM and facility management systems (FMSs) can provide automatic scheduling of maintenance work orders (MWOs) to enhance good decision making in FM [19]. BIM used to extract geometry information and parametric data of steel structures efficiently and accurately [20]. Construction products can be pre-designed using BIM software with efficient design output by successful coordination and better collaboration in between various disciplines [21]. Building Information Modeling (BIM) coordination process is shown in fig.3.

Figure 3. BIM Coordination process.

5. Conclusion

Building information modeling (BIM) can give better structure design coordination and successful management by using variety of BIM tools and its various features at different phase of building construction which can results in efficient, cost-effective and sustainable building construction. Following are conclusions:

- Two type of BIM tools are used one which creates 3D model by suitable BIM software and other which exports the model to integrated BIM software.
- Various BIM features are being used in construction industry (Quantity Take-Off (QTO) system, Green building (GB) system, Modular coordination (MC), Computer-integrated construction (CIC) and ARSAP etc.).
- BIM can solve different structure design phase coordination issues as well as provide better information exchange for construction phase.

Different types of BIM tools and various BIM features are used to give better structural design coordination between various disciplines and different phases of building construction to ensure the sustainable, efficient and effective design of a building.

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Declaration of Conflict of Interests

The authors declare that there is no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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