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Application of BIM Based Interoperability-A Case Study

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Abstract. Interoperability is the ability of different software or tools that helps to exchange the data among all of these tools without changing of its characteristics and value. It helps to operate the BIM tools and converting any data format to other format without changing the data. The objective of this research is to practice the various BIM tools and interoperability in the construction industries. Also, to show the various application of these tools in different stages and how they are important. In this research, Interoperability of various BIM tools are explored in a building, studied as a case study using different formats used in BIM tools. The different tools used in different stages in BIM collaboration, REVIT during plan and Autodesk Navisworks Manage during 4D simulation. The challenges that faces in doing the interoperability of different BIM tools and success that achieved are presented in this paper. This paper addressed the total process, benefits and application of BIM based Interoperability.

Keywords: Building Information Modeling (BIM), Virtual, 3D Modeling, Parametric, Interoperability.

1. Introduction

BIM (Building Information Modeling) is an intelligent 3D model-based process that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure. To simulate the planning, design, construction and maintenance phases of a project it requires the development and use of a computer-generated model (Azhar, 2011). The main difference between BIM and conventional 3D CAD is usually that the latter describes a building by separate 3D views such as plans,

sections and elevations.

Data in these 3D drawings are graphical entities only, such as lines, arcs and circles, in compare to the intelligent contextual semantic of BIM models, where objects are described in terms of building elements such as spaces, walls, beams and columns. A building information model contains all information connected to the building. For example, an air conditioning unit within a BIM would also take on information about its supplier, operation and maintenance procedures, flow rates and clearance requirements (Innovation, 2007). Through BIM execution, risks are decreased, plan expectation is kept up, and the construction is streamlined (Azhar, 2011; Goedert & Meadati, 2008; Nath, Attarzadeh, Tiong, Chidambaram, & Yu, 2015; Qian, 2012; Tse, Wong, & Wong, 2005).

Interactions are important in virtual building simulations, and various types of links may be found during the development of composed BIM models.Whenever the interaction involves the components of the 3D model, a common link in BIM needs to exist, i.e. the interoperability of various models that may have been made by different software tools is required.

Interoperability can be described as "The ability of two or more systems or components to exchange information and to use the information that has been exchanged (Geraci et al., 1991). In Interoperability, by using various types of software and combining them, we can complete a project easily. It additionally ought to enable duplex update of building data, the changes in one program ought to be able to flow between the programs (Kumar, 2008).

An observation of building performance tools by (Attia, 2010) narrates the principle difference between the needs and priorities of architects and engineers thinking the interoperability of the building model. Architects exchange models with 3D drawing packages and the exchange of models with CAD programs. As opposed to, engineers described the ability to exchange models with MEP drawing packages and the ability to exchange models for multiple simulation domains.

In whole process different Autodesk tools was used. REVIT used for 2D and 3D visualization- Robot for structural – Navisworks Manage for simulation- Autodesk Design Review tools for reviewing the design. Industrial Alliance for Interoperability (IAI) established the Industry Foundation Classes (IFC) as an open standard model to allow software vendors to create interoperable applications via the IFC file format. Using IFC, DWF, NWD in BIM we can collaborate different stage of our project includes internal collaboration and external collaboration. Interoperability eliminates the costly process of integrating every application with other applications.

2. Application of BIM in building construction

Interoperability requires different BIM software available in the market. The

implementation of each software makes the interoperability program complete. Various BIM software applications are available in the market. The top five software's that's are needed for building constructions are as follows:

- Revit
- Robot Structural Analysis
- Navisworks Manage
- Autodesk Design Review

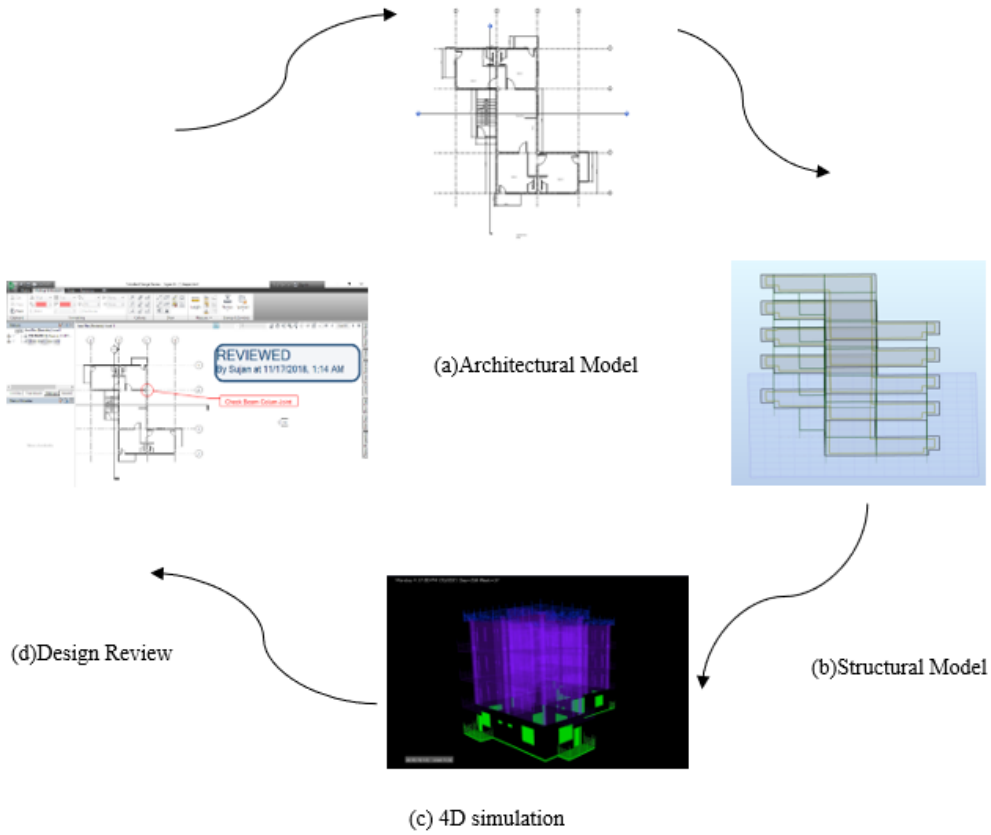
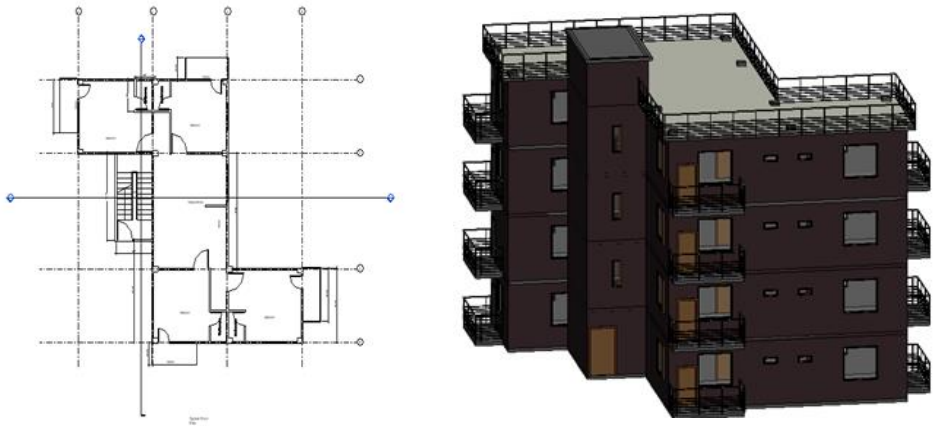


Fig. 1: Flow chart of interoperability in this project

2.1. Methods for development of base model

The architectural model was developed with the Autodesk Revit to describe the requirements of the project. The model was developed in the preliminary design phase to study the interaction of shapes, different viewpoints including inside or outside the building, or concepts.

In this model, we found both floor plan and 3D model together shown in figure 2(a) & 2(b).

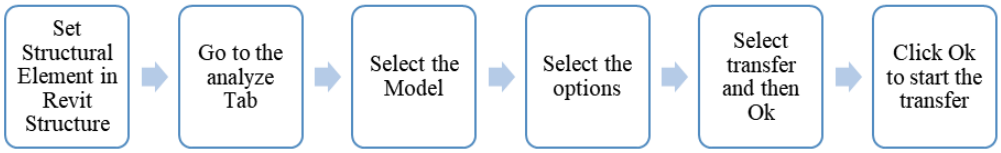


(a)Floor Plan (b) 3D model

Fig. 2: Architectural Model

2.2. Methods for tranbsfering base model into revit structure

A Revit Architecture file was imported to a Revit Structure model enabling structural engineers to start their design based on the architectural model. Architectural view was completely shown in the corresponding structural views (2D and 3D). For transferring the file from Autodesk Revit to Autodesk Robot Structural Analysis clicked the Robot Structural Analysis tool under the analyze tab in Autodesk Revit. Assigning wind loads, seismic loads and load combination in Autodesk Robot, we found reactions, detailing of beam, column and slab.



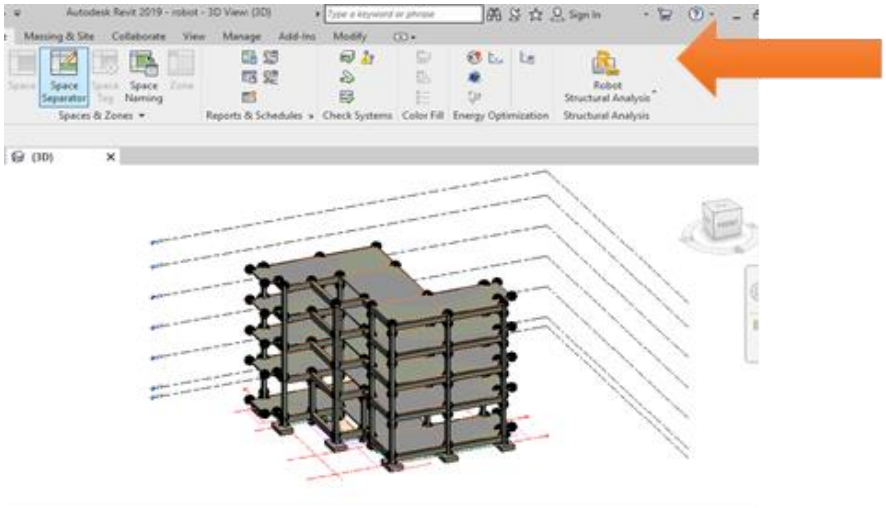


Fig. 3: Converting from Autodesk Revit to Autodesk Robot Structural Analysis

For the analysis for the Structural model the following sequence was used:

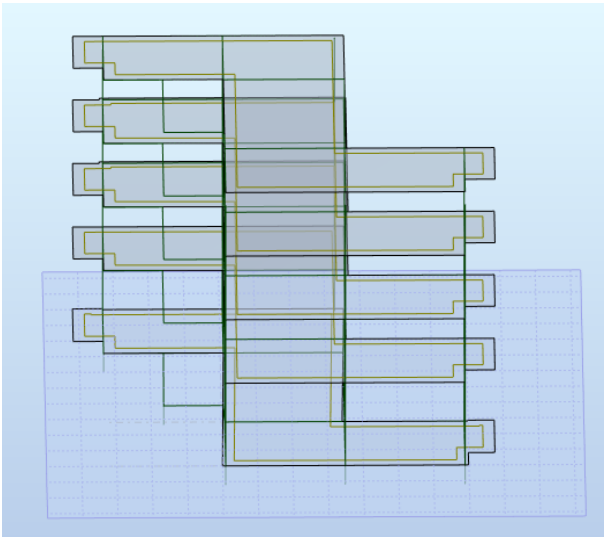


Fig. 4: Structural model

2.3. Methods for 4d simulation

4D simulations for construction planning and scheduling helps architects, contractors, engineers and designers visualize construction sequences & assess

onsite and offsite progress across project lifetime. The model was imported from Revit to Navisworks as a NWD file format. The scheduling of this project which was done in Microsoft Project was linked with Navisworks for simulation shown in the figure 5.The use of 4D simulation on this project. A virtual construction of this project was visualized. From the virtual construction, the schedule which was done in the Microsoft project, was implemented virtually.

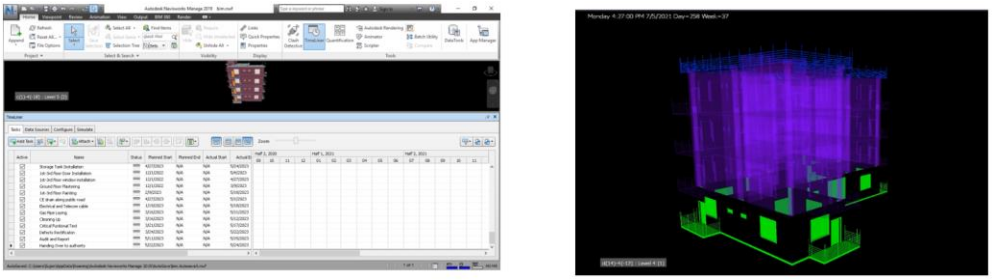


Fig. 5: 4D simulation

2.4. Methods for clash detection

Clash detection is a vital and basic part of the BIM modeling process. In BIM modeling, clash detection takes place during the design phase to solve identified problems or errors before construction begins. A clash detection was done using the Navisworks Manage. The model was imported an NWD file format for using in Navisworks Manage. It involves overlaying of drawing to see if there are any conflicts. Total 2600 clashes were found in this study. In figure 6, a clash detection was shown. By detecting the clashes in the Navisworks Manage, the clash report are automatically made with individual clashes indicating their measurements.

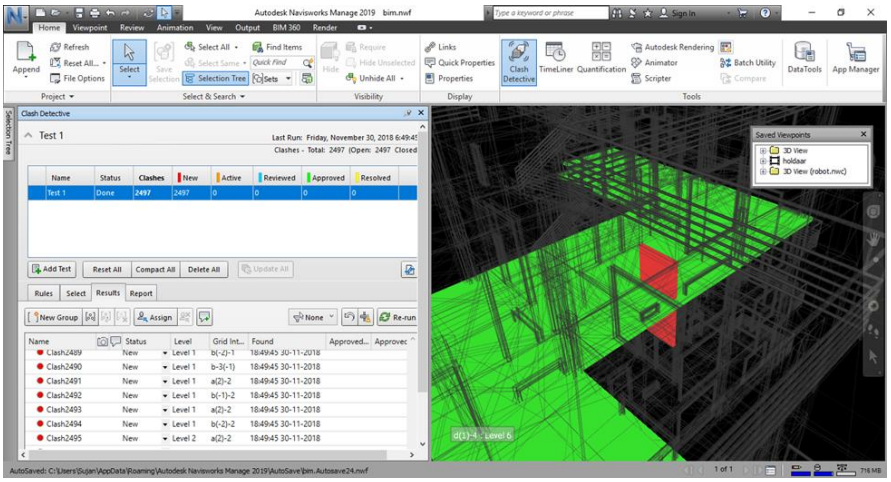


Fig. 6: Clash detection

A clash report is shown below:

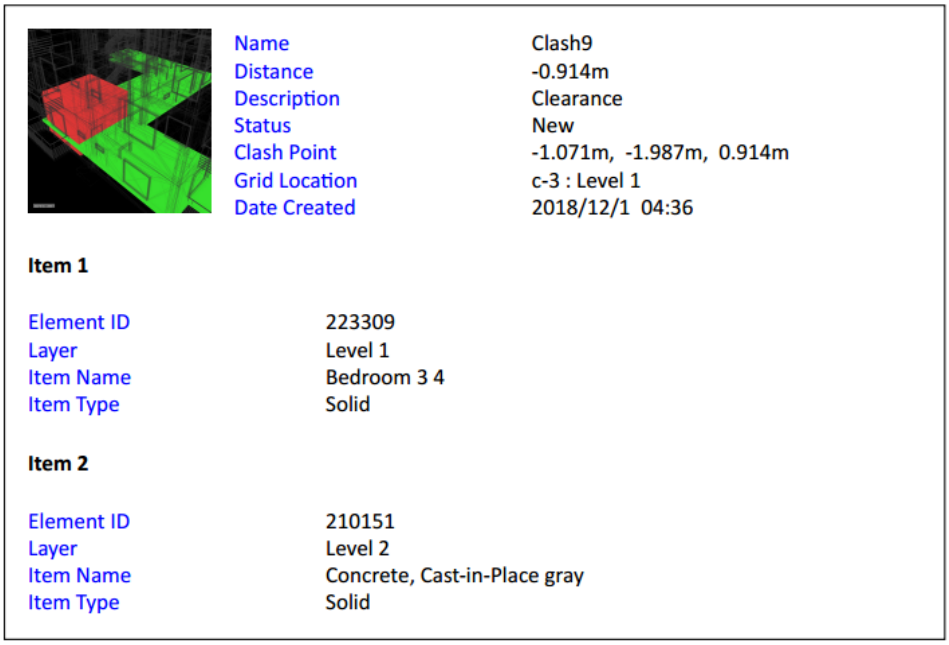
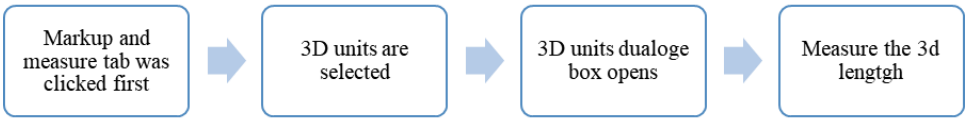


Fig. 7: Clash detection report

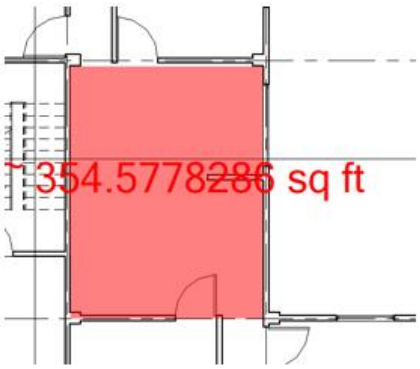
2.5. Methods for design review

A design review is a milestone within a product development process whereby a design is evaluated against its requirements in order to verify the outcomes of previous activities and identify issues before committing to - and if need to be re-priorities - further work. For reviewing the model, in Autodesk Design Review (ADR) the file was imported from Revit to DWF. By using Autodesk Design Review software we reviewed our project including both 2D plan and 3D models. We added comment after reviewing the project by a stamp. There are some review are done by ADR such as: 2D & 3D measurements, Aparting 3D components, Stamp and Comments.

Example of 3D measuring, following steps are:

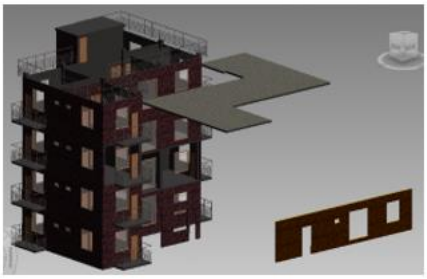


Typical reviewing works are shown in figure 8.

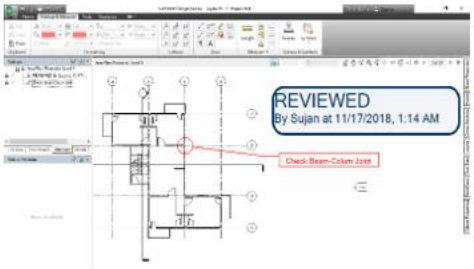


2D area measurement

(b) 3D measurement



(c)Apart from 3D model



(d) Stamp and Comment

Fig. 8: Some Reviewing procedure in ADR

3. Evaluation and discussion

From this study we can say that Using BIM based Interoperability on can change anything of the design or correct the others document associated with the other change of the design in one click. BIM gives us the Interoperability platform to for solving design related issue that comes different stages in construction - occurs time consuming and difficulty. Interoperability help up to reduce time and difficultness during solving those issues.

4. Risks associated with BIM interoperability

The key risk of BIM is taking responsibility for updating BIM data and ensuring its accuracy. It needs more time for imputing and reviewing BIM data. For these reasons, costs will be increased in the design and project administration process. Thus, before BIM technology is totally utilized, the risks of its use should not solely be known and allotted, however the price of its implementation should be paid for as well. The benefits for using BIM in any project are more rather than risks.

5. Conclusion

In this research, the various types of BIM tools are used for Interoperability of a projects. The various software is collaborated for a project studied as a case study.

Here, Architectural and Structural models are interlinked to each other by interoperability of Revit and Robot Structural Analysis. Using of BIM technology accelerates, collaboration at intervals project group sought to increase, which can result in improved profitableness, reduced prices, higher time management and improved customer satisfaction. Interoperability reduces the time needed to develop a building and increases the collaboration between team members. The clashes between the architectural and structural models or the clashes of different components of similar models are detected. Virtual construction is also shown by the software Navisworks Manage. The 4D timeliner that are made in Microsoft project or Primavera p6 are attached to the Navisworks manage. This research highlights the advantages of interoperability and a practical uses of various BIM tools by Interoperability characteristics with proper measurements.

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