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# Based BIM techniques to clash detection for construction projects

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**ABSTRACT**

Building Information Modeling (BIM) has brought about a qualitative change in the design and management of construction projects because it represents a digital simulation of the physical characteristics of the building, and this increases its efficiency before the actual construction begins. In Iraq, most construction projects still use CAD two-dimensional drawing for the purpose of the implementation process, especially government projects, and this causes many problems due to the difficulty of communication between the various disciplines involved in the design and misunderstanding during implementation. This type of problem is reduced by combining BIM drawings prepared by designers and making them into a single model. In this process of merging conflicts are found using BIM tools such as Autodesk Navisworks. There are three main types of detection. This article includes how a clash detector can help improve clashes in the design phase before starting to construct a specific building using BIM applications and focuses on hard detection type (overlap of a particular element with the others). The methodology involved in this research is to study an educational building (24-classroom model school) consisting of structural and architectural BIM models only, clash detection analysis is done using Autodesk Revit and Autodesk Navisworks Manage software.

**Keywords**: BIM; Clash detection; Construction project; Revit; Navisworks

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## 1. Introduction

The building and construction sector is one of the sectors that relies heavily on information as well as on traditional paper communication methods. Therefore, errors and omissions in the exchange of drawings and documents between stakeholders often affect project productivity [1] [1]. Moreover, cross-disciplinary communication between various construction professionals is problematic and can be seen as an important contributory factor in poor project productivity performance [2]. There is a need for more efficient systems that can coordinate and communicate better between project team members while expressing the same project idea to all parties involved in the project and at all its period [3].

In the digital age, BIM is an integrative technology that uses 'parametric intelligence' to enhance and increase productivity in the construction industry [4]. BIM technology provides customers with accurate and trustworthy building information, supports building modeling functionality, and provides an excellent hypothetical view of

the model before construction begins [5]. BIM technology facilitates and expedites the construction process. It also improves coordination and reduces errors, lowering costs and increasing productivity with higher work quality [6] [7] [8].
Clash detection is an important aspect of the 3D BIM model development process, which is concerned with detecting conflicts and interferences, especially for multidisciplinary projects model [9] .This study aims to evaluate the effect of BIM on the construction projects during the design phase as well as how this technique can detect all existing clashes in the drawings of all disciplines before proceeding with the implementation process. The structural elements were created using Revit structural software. Architectural elements and details were created using Architectural Revit software. The model has been exported and the architectural and structural models have been integrated into Navisworks to identify conflicts and clashes between elements.

Building Information Modeling (BIM) is a digital representation of a building or infrastructure project that is used to facilitate the design, construction, and maintenance of the project. It is a virtual approach in which construction project data and information related to their degree of execution are modelled and tracked through computer software packages for enabling design and planning teams, including construction stakeholders such as civil engineers, architects, owners, designers, suppliers, consultants, contractors, and subcontractors to more effectively and easily manage their project [10]. Using on the BIM methodology is useful in increasing cooperation between different design groups and helps reduce errors if each group works alone without sharing information with other groups The examination process is carried out for the different designs after they are collected in one model, and this will give a fantastic visualization, excellent 3D view as well as reveal the clashes before starting construction work. Clash detection is the process of identifying and resolving conflicts between different building components in a BIM model. This is a crucial step in the construction process as it helps to identify potential problems before they occur on the construction site through reduce human error, prevent costly redesign in the later stages, prevent scheduling clashes, plan an efficient build process, and reduce cost and change orders, etc. The use of BIM techniques for clash detection can save time and money by identifying and resolving conflicts before they become an issue on the construction site. One of the most popular BIM techniques for clash detection is the use of Navisworks software. Navisworks is a 3D design review software that allows users to view and analyze multiple BIM models in a single environment. Navisworks is widely used in the construction industry for clash detection, and it provides a powerful tool for identifying and resolving conflicts between different building components, such as MEP systems, structural elements, and architectural components.

Another BIM technique for clash detection is the use of Revit software. Revit is a BIM software that is widely used in the construction industry for building design and construction coordination. Revit allows users to create detailed 3D models of building components and detect conflicts between different systems in the model. They also stated that the use of Revit for clash detection improves the efficiency and accuracy of the construction process. In addition to Navisworks and Revit, there are several other BIM software programs that can be used for clash detection. These include Solibri Model Checker, Autodesk BIM 360, and BIMcollab. Each of these software programs has its own unique features and capabilities, and they can be used to detect and resolve conflicts in BIM models. They also stated that these software programs are widely used in the construction industry for clash detection and they provide a powerful tool for identifying and resolving conflicts before they become an issue on the construction site.

## 2. Materials and methods

The case study was selected for the project of building a secondary school with a capacity of 24 classrooms within the school buildings project that is currently being implemented in most cities of Iraq. The work methodology is shown in Figure 1.

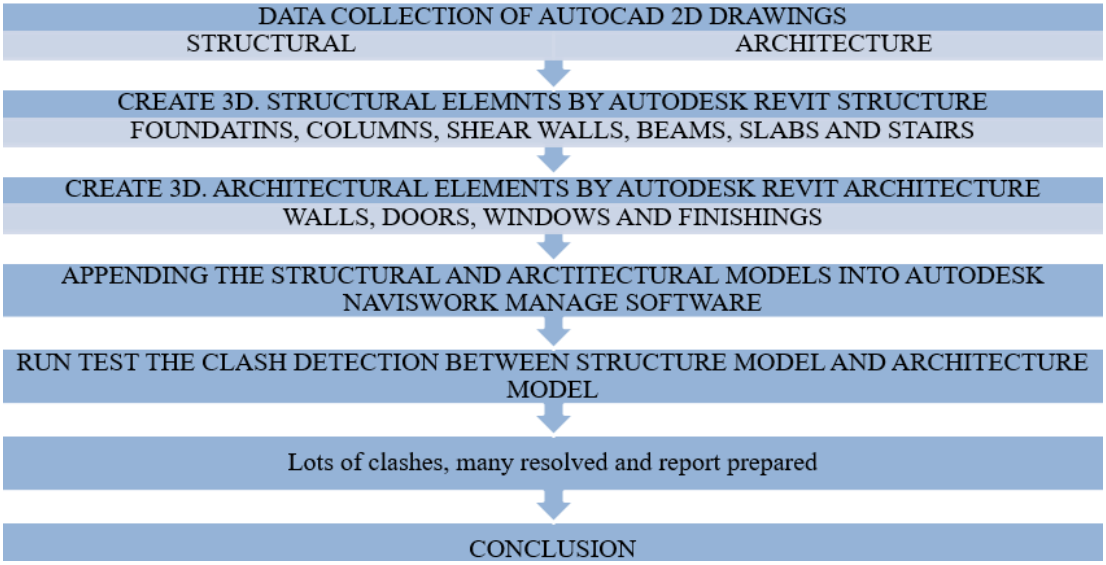


Figure 1. Workflow chart

### 2.1. Modeling process

The AutoCAD 2D architectural and structural plans were chosen only for the purpose of identifying the clash between them as shown in Figures 2 and 3.

Figure 2. Structural Layout

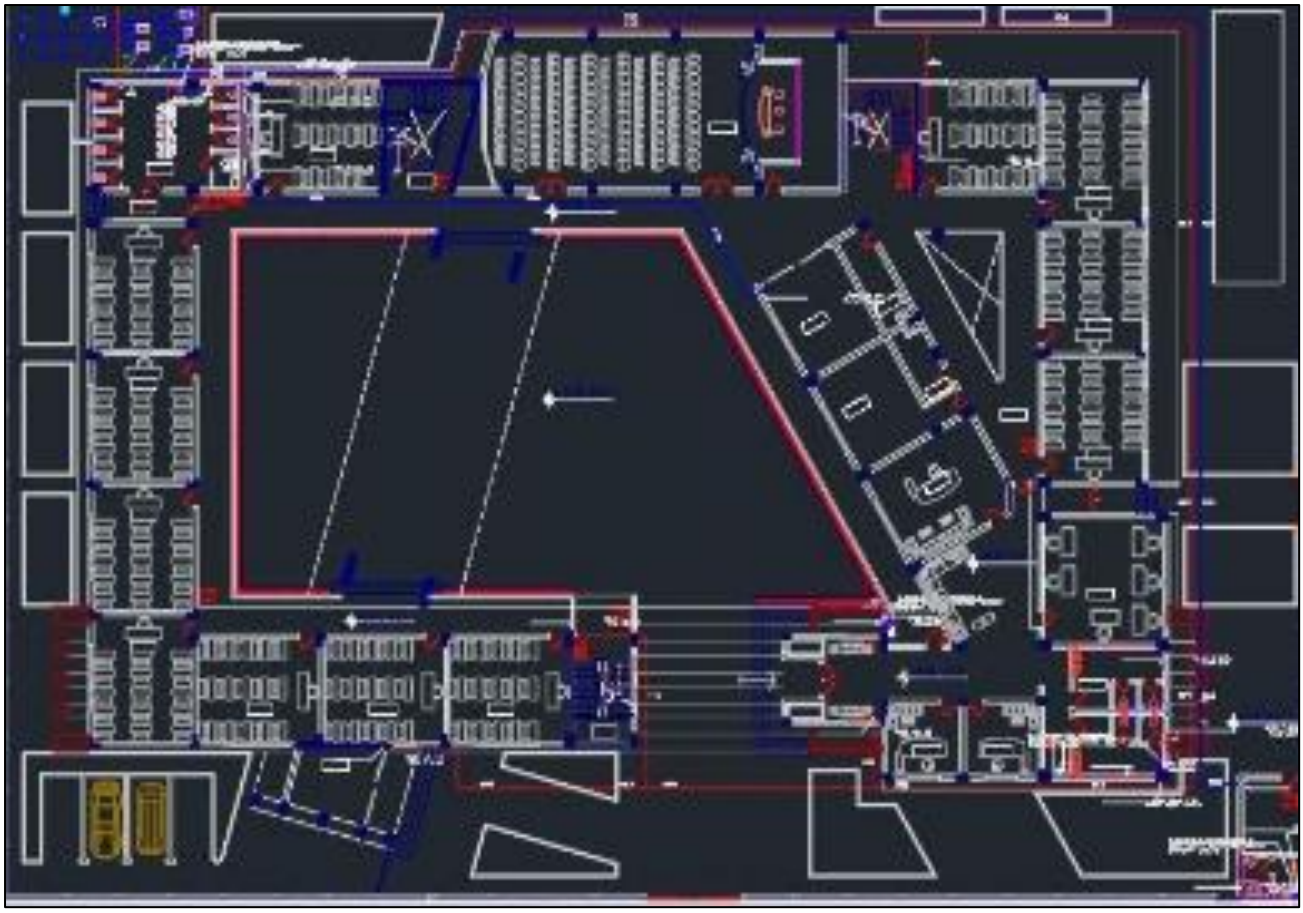

Figure 3. Architectural Layout

There are many programs that create 3D models, but Autodesk Revit is one of the best, as it was used to create the Revit structural and Revit architectural models for this project by linking each level of the Revit to the AutoCAD 2D file that we took from the company, where the structural and architectural files are imported with all their details, dimensions and levels. From AutoCAD 2D to Revit to represent the 3D model as shown in Figures 4 and 5.

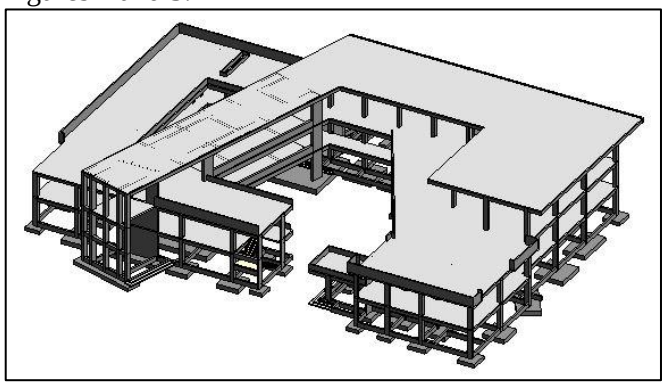

Figure 4. 3D Structural Model

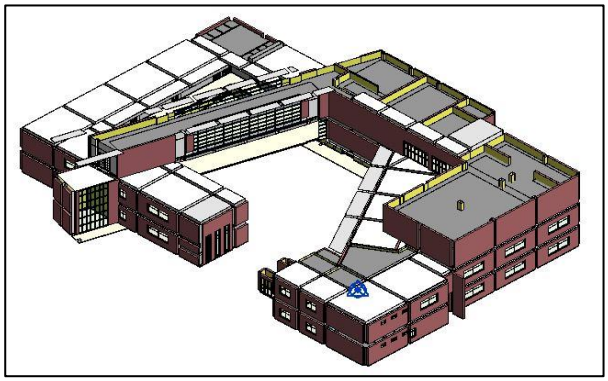

Figure 5. 3D Architectural Model

BIM technology depends on the exchange of data between the different departments within the project and during all its phases. Therefore, it has become important to verify the accuracy of the data in order to ensure the outputs and benefit from them in the following stages such as analysis, operation and maintenance. There are many BIM tools and programs that are useful in enhancing the efficiency of the project, including Navisworks, which is one of its most important features in detecting clashes and overlaps between project elements and identifying duplicate elements during design. The 3D models (structural and architectural) that were created by Autodesk Revit are imported into Navisworks Manage for clash detection. The clash detective icon in the control bar is selected and the elements to be tested are selected in the form of two groups, selection A and selection B,

and the type of overlaps (surfaces, lines and points between the elements) is selected for the clash test. There are three types of conflicts that clash detection searches for:

1) hard clashes: Refers to a building element that physically penetrates another building element.
2) duplicate Clashes Refers to checking a pattern against itself to detect any element that is repeated more than once on the drawing.
3) clearance Clashes: Refers to items that are closer together than a certain distance.

Only the hard clash type is chosen in this study because it is considered the most important type of collision, as well as determining the tolerance distance of 50 mm and doing the test by clicking on the Run Test as shown in Figure 6.

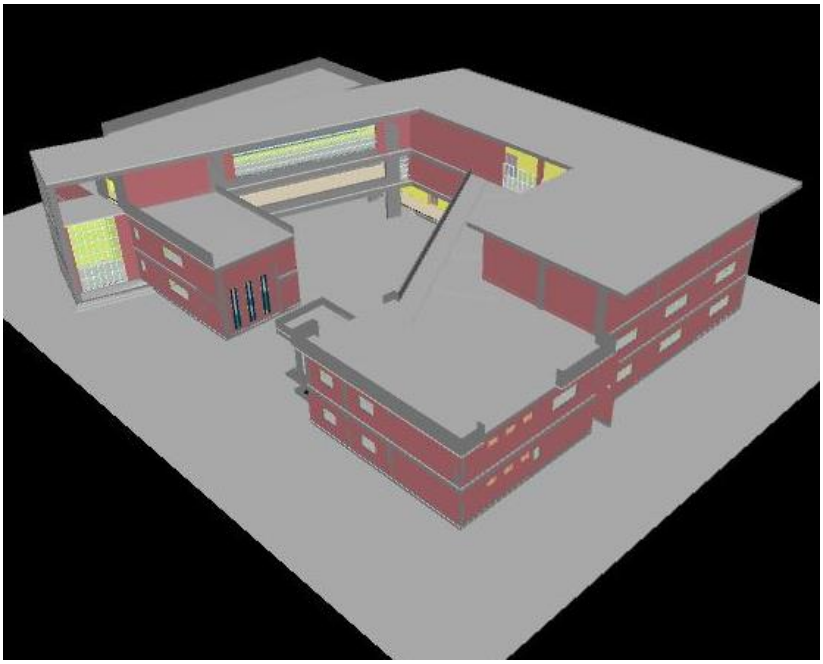

Figure 6. Defining rules for clash test in Navisworks

After clicking on the test check button, the test result appears. The program displays information about the conflict between the elements, as well as the level, network, and date, as shown in Figure 7.

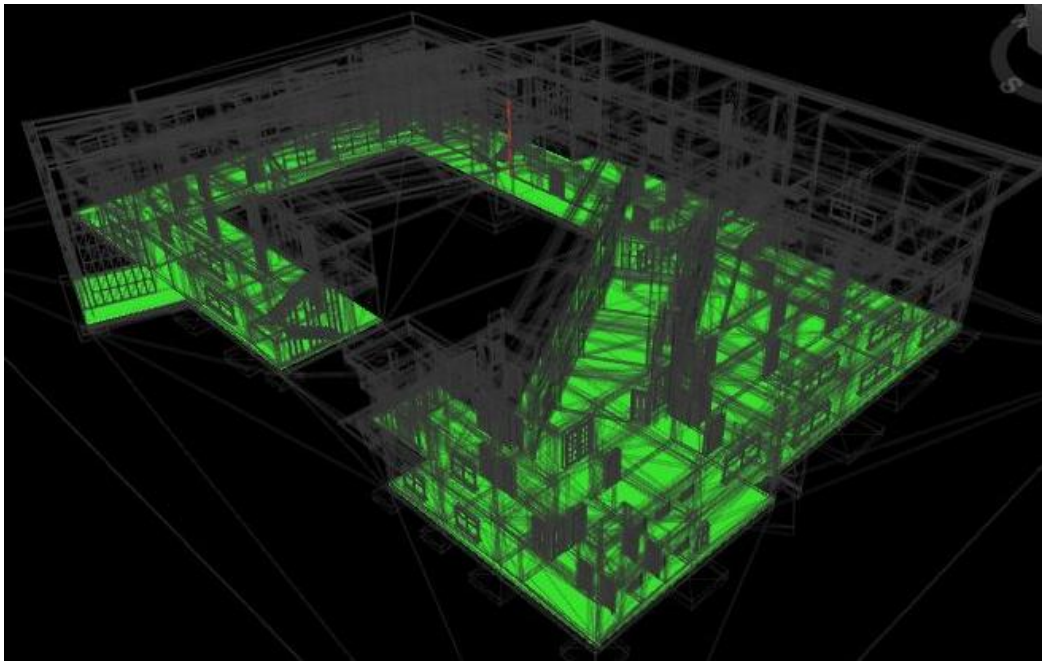

Figure 7. Hard clashes test result

886 clashes between structural and architectural models were detected, and this includes a large number of insignificant clashes that do not require any changes or have a solution. Clashes have been liquidated and many of them have been resolved. Finally, the clash test report is prepared in the form of a file with different formats such as XML, HTML, TEXT and other formats. It is also possible to solve problems and overlaps, and re-test and update results.46 clashes remained. The conflicting elements are colored red and green to make it easier to visualize the engagement as in the two Figures 8 and 9.

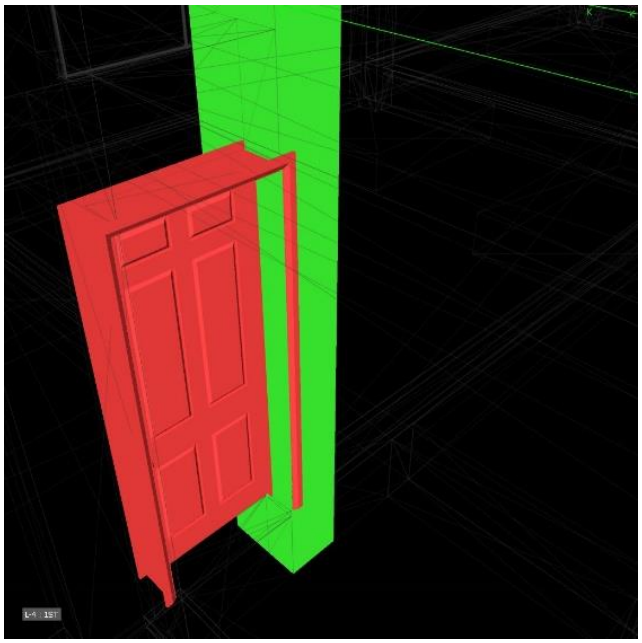

Figure 8. Clash between structural column C1 (Green) and door D2 (Red)

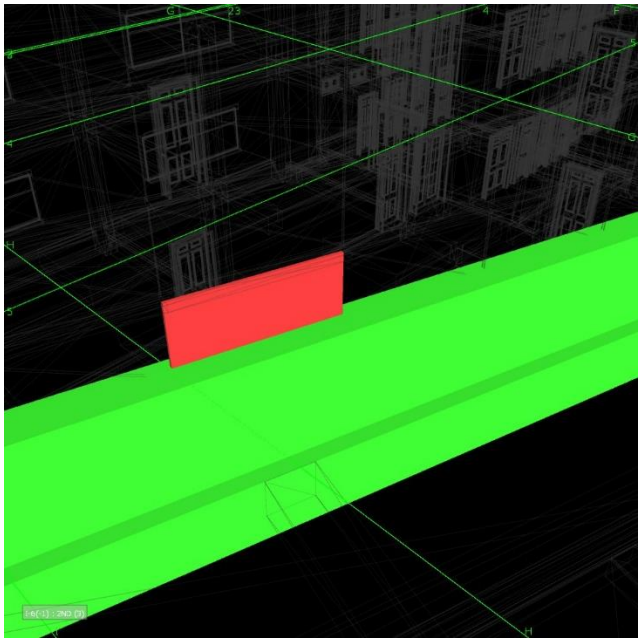

Figure 9. Clash between structural beam G1 (Green) and curtain wall C4 (Red)

BIM helps find potential problems and discrepancies after linking files for common sections in designs (structural, architectural and mechanical) before construction begins, and this will reduce time and cost and increase project quality. Autodesk Revit and Autodesk Navisworks programs were chosen to detect clashes for a school construction project, where the structural and architectural three-dimensional models were prepared by Revit, and a test was conducted to detect conflicts between the models in the Navisworks program, This tool helps in identifying and discovering collisions and overlaps between the components of the building, if they are found in the designs, and exporting a report about them and solving them, and this reduces the need to review and modify designs during construction, and for this it will control both the time and cost of the project.

**Declaration of competing interest**

The authors declare that they have no recognized non-financial or financial competing interests in any materials conversed in the current work.

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