

The Development of IBS Structure Panel Using Revit Software

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Abstract

Autodesk's Revit is a sophisticated Building Information Modelling (BIM) software that transforms the way architects, engineers, and construction professionals create, collaborate, and visualize their projects. Revit has become the industry standard for producing and maintaining complex building models due to its rich set of tools and capabilities. Revit, at its heart, allows users to generate sophisticated 3D models that span the whole building's lifespan. These models function as a digital representation of the actual structure and include precise information about its components, materials, and systems. Building Information Modelling (BIM) software is made by Autodesk and is called Revit. By using Revit, it can create a conventional column family, IBS column family, conventional beam family, and IBS beam family. This project also showed extrusion for conventional column family, IBS column family, conventional beam family, and IBS beam family. Revit's parametric modeling capabilities are a game changer in the field of architecture. Families, as parametric objects, allow dynamic modifications and real-time updates throughout the project. By establishing relationships between different family parameters, such as dimensions, materials, and geometry, designers can easily adjust the model and see the effect reflected across the entire project. This parametric flexibility reduces errors, streamlines design iterations, and ultimately leads to more efficient and accurate construction documentation. The result of this project highlighted conventional column model design, IBS column model design, conventional beam model design, and IBS beam model design. The objective of this project is to create a library of IBS panels that are commonly used in construction and compare the advantages between IBS panels and conventional panels for the component structure.

1. Introduction

Building Information Modelling (BIM) software is made by Autodesk and is called Revit. Its capacity to create a virtual three-dimensional model of a building makes it comparable to programs like AutoCAD or SketchUp. However, Revit enables elements inside a building model to be parametrically linked [1]. Before the actual production began, designing and then drawing the thing was the key task for engineers. Given that there may be a problem, it is essential that the task be done exactly. Until recently, architects primarily depended on hand drawing; the first application specifically designed for them to use on a computer was only launched in 1960 [2]. In a game-changing development, computer-aided design became an indispensable tool for architects in 1974. Engineering software has evolved significantly during the past 20 years as processing power has risen tremendously. Because CAD could not provide all the capabilities required by architects, a new type of software known as CAAD was established [3]. Revit is one of the most recent applications which had its initial release on 5 April 2000 and its most recent stable edition in April 2018 [4].

Most of the wealthy nations that have used BIM in the building sector have found it to be successful. There are several benefits of BIM in construction, including lowering costs, times, carbon footprints, and capital expenses. Revit or Autodesk Revit is a building information modeling program. It has robust Building Information Modelling capabilities that may be used for planning, designing, building, and managing infrastructure (BIM) [5]. The construction sector is always changing. Therefore, to ensure a successful and efficient construction process, the industry is looking for novel techniques employed by AEC (Architecture, Engineering, and Construction) specialists [6]. Revit training may assist in designing and taking the drawing to the next level to get more knowledgeable about the Revit software. The construction sector is currently being negatively impacted by a lack of skilled workers, increased demand, expanding sustainability concerns, and others. There are lots of benefits to studying Revit Structure. As a result, the sector must employ cutting-edge techniques, equipment, and individuals with Revit certification to help businesses solve these issues [7].

2. Materials And Methods

Revit can generate construction documentation such as cutaways, 3D views, and stereo panoramas using several rendering techniques [8]. The building model may also be viewed in virtual reality by using Revit Interoperability and Autodesk's 3ds Max program. By using Revit, it can create a conventional column family, IBS column family, conventional beam family, and IBS beam family [9].

2.1 Autodesk Revit

Autodesk's Revit is a commercial building information modeling (BIM) program. Architects, structural engineers, mechanical, electrical, and plumbing (MEP) engineers, designers, and contractors are common users. Users using Autodesk Revit may build, modify, and examine 3D models in detail. BIM technologies have completely transformed architecture as we know it. As a result, it's no surprise that most Revit users work in this industry [10].

2.2 Conventional Column Family

First, open the Revit software. Then, select "New Family" from the "Families" section. Select the "Metric Column.rft" template and "Open" as shown in Fig. 1 (a). Set the Column Parameters. Click on "Family Types" to discover the column's parameters. After that, modify family types and adjust the parameters to meet the needs of the project. Create a Geometry by selecting the column shape and using the modify tools in the Ribbon menu to change the geometry. Add Parameters by selecting the relevant parameter type from the "Create" tab. Adding parameters for material, dimensions, visibility, and so on. Then, apply Materials by selecting the "Manage" tab and then clicking on "Materials" to assign the necessary materials to the geometry of the column in Fig. 1 (b).

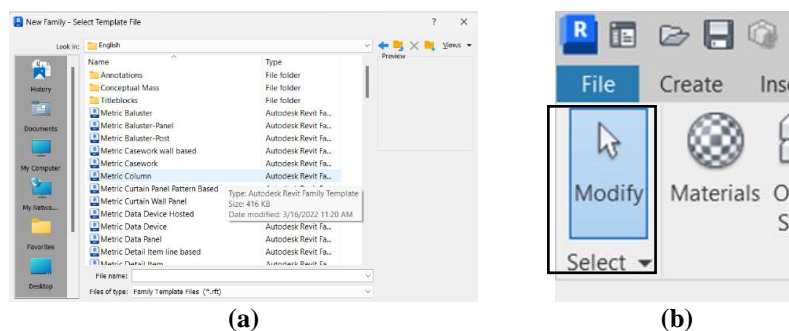


Fig. 1 (a) Metric Column.rft, (b) template and Materials

Place the column instances, adjust the parameters, and confirm that it operates as intended. Save the family by clicking on the "Save" or "Save As" button if satisfied. Go to the "Insert" tab in the project, then select "Load Family". Lastly, click on the location of the column family file, select it, and click "Open". The column family will be ready for use in the project.

2.3 IBS Column Family

First, open Revit. Click on "New Family" under the "Families" section to start a new family. Then, select the family template. Select the "Metric Column.rft" template for work in metric units or "Imperial Column.rft" for work in imperial units. Set the column parameters. Click on the "Family Type" button that can be found in the Properties palette to discover the column's parameters and modify family types. Create a Geometry. Select the column shape and use the modify tools in the Ribbon menu to change the geometry. Include parameters. Click the "Create" tab and select the relevant parameter type. After that, apply Materials by going to the "Manage" tab and selecting "Materials" to assign the proper materials to the geometry of the column. Choose from the provided materials collection to meet the requirements of the IBS system. Test and save the family by clicking the "Save" or "Save As" option. Insert the Family into the Project. Load the IBS column family into the project file to utilize it in a Revit project. Open the project, navigate to the "Insert" menu, and then select "Load Family". Lastly, click to the location of the IBS column family file, select it, and then click "Open". In the project, the IBS column family will be available for use.

2.4 Conventional Beam Family

First, open Revit. Click on "New Family" under the "Families" section to start a new family and select Family Template. In the New Family dialog box, select "Metric Structural Framing.rft" for work in metric units or "Imperial Structural Framing.rft" for work in imperial units. Click "Open" to proceed. Locate the "Family Types" button in the Properties palette. Click on it to access the beam's parameters and modify Family Types. In the Family Types dialogue box, changes to various parameters can be made to determine the size, material, and other attributes of the beam.

Adjust characteristics (beam length, width, depth, reinforcement, and so on) to meet project specifications. Then, construct the geometry. To adjust the geometry of the beam, choose the beam shape and use the adjust tool from the Ribbon menu. Adjust the shape by adding fillets, chamfers, or any other desired geometric changes. Add a parameter by clicking the "Create" tab and selecting the relevant parameter type. For materials, select the "Manage" tab and then "Materials" to assign the proper material to the beam shape. Choose from a library of available materials or design a new one to meet the needs of the project. Test and save the family by clicking the "Save" or "Save As" option. Insert the Family into the project. Load a beam family into the project file to use in a Revit project. Navigate to the "Insert" tab after opening the project. Select "Load Family." Click on the location where the beam family file was saved, select it, and then click "Open." Beam families will be available for project placement.

2.5 IBS Beam Family

First, open Revit. Then, click on "New Family" under the "Families" section to start a new family. This will launch a new family template to work on. Select Family Template. In the New Family dialog box, select "Metric Structural Framing.rft" for work in metric units or "Imperial Structural Framing.rft" for work in imperial units. Click "Open" to proceed.

Configure the Beam Parameters. The Family Editor will launch with a standard beam form. Locate the "Family Types" button in the Properties palette. Click on it to access the beam's parameters. In the Family Types dialogue box, changes to various parameters can be made to determine the size, material, and other attributes of the beam. Adjust characteristics such as beam length, width, depth, reinforcement, and so on to meet project specifications. Then, construct the geometry. To adjust the geometry of the beam, choose the beam shape and use the adjust tool from the Ribbon menu. Adjust the shape by adding fillets, chamfers, or any other desired geometric changes. Add a parameter by clicking the "Create" tab and selecting the relevant parameter type. For materials, select the "Manage" tab and then "Materials" to assign the proper material to the beam shape.

Choose from a library of available materials or design a new one to meet the needs of the project. Test and save the family by clicking the "Save" or "Save As" option. Insert the Family into the project. Load a beam family into the project file to use in a Revit project. Navigate to the "Insert" tab after opening the project. Select "Load Family". Finally, click on the location where the beam family file was saved, select it, and then click "Open." Beam families will be available for project placement.

2.6 Extrusion for Conventional Column Family

First, launch the Revit software and open a new project or an existing project where you want to create a column family. In the project browser, find the "Families" category and right-click on it. Select "New" -> "Family" to start creating a new family. In the "New Family - Select Template" dialog box, choose the "Metric Generic Model.rft" template and click "Open" to start the family creation process in Fig. 2(a). In the "Create" tab, click on the "Extrusion" button in the "Forms" panel to activate the extrusion tool. In the drawing area, click and drag to create a rectangular sketch representing the base shape of the column as shown in Fig. 2(b).

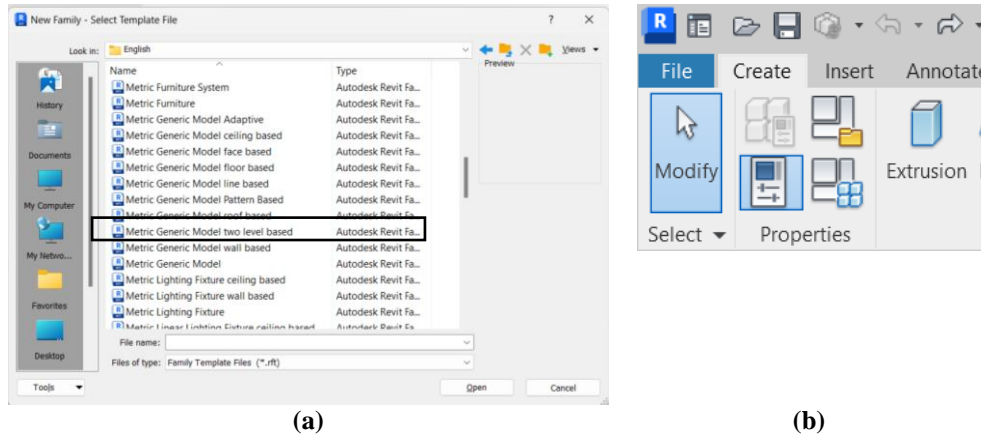


Fig. 2 (a) Metric generic model.rft template and (b) the extrusion button

Specify the desired dimensions by entering values in the options bar. In the "Properties" panel, adjust additional parameters of the extrusion (height, width, depth, and position). Specify the desired values for the extrusion's parameters. Use the "Add Parameters" button in the "Properties" panel to add any necessary parameters for the column family (material, dimensions, or other specific properties). Customize the appearance of the column by assigning appropriate materials, adding additional details, or applying any desired 3D modeling operations available in the Revit environment. Review the created column family in 3D and 2D views to ensure it meets your requirements. It can be switched between views using the "View Cube" or the view tabs at the bottom of the window. Then, save it by clicking on the "Save" button in the "Quick Access Toolbar" or by pressing "Ctrl + S". Give the family a name and specify a location to save it. Close the family editor environment by clicking on the "Close" button in the upper-right corner of the Revit window. Lastly, load it into the project by selecting the appropriate category, such as "Columns," in the project browser and clicking on the "Load Family" button.

2.7 Extrusion for IBS Column Family

Launch Autodesk Revit and open a new project or an existing one. In the project browser, locate the "Family Types" folder, right-click on it, and select "New". In the "Family Template" dialog, choose the "Metric Generic Model" template if you are working in the metric system or the "Imperial Generic Model" template for the imperial system. Then, click "OK" to create the new family. In the "Family Editor" environment, the default reference planes (Front/Back, Left/Right, Top/Bottom) will be shown and select the "Front/Back" reference plane and click on the "Create" tab. In the "Form" panel, choose "Extrusion" to create a 3D extrusion.

Then, draw a 2D sketch of the column profile on the "Front" plane using one of the many sketching tools that are accessible (lines, rectangles, circles, or arcs). As a closed loop, make sure the sketch is closed. Once the sketch has been drawn, select the sketch geometry and click the "Finish Edit Mode" button in the "Modify" panel to exit the sketching mode. In the "Properties" palette, adjust the properties of the extrusion. Specify the desired extrusion height, material, and any other relevant parameters based on the IBS column requirements. Add additional details or features to the column (use the available modeling tools: creating voids, adding openings, or applying parametric dimensions). By moving to a 3D view or by using the "Family Types" dialogue, preview the column family and adjust different parameters while seeing the results in real-time. Click the "Save" button to store the family file. Choose a suitable location and give it a relevant name. By returning to the main project window, using the "Load Family" option from the "Insert" tab, and browsing for the saved family file, load the IBS column family into the project. Lastly, by choosing the appropriate tool ("Column" or "Structural Column") and clicking on the desired location within the project, insert instances of the IBS column family into the project once it has loaded.

2.8 Extrusion for Conventional Beam Family

Launch Revit software and open a new project. In the project browser, click on the "Families" category and right-click to select "New Family". In the New Family - Select Template dialog box, choose the appropriate template based on the unit system and the type of beam. For example, select "Metric Generic Model.rft" for a metric system.

In the family template, go to the "Create" tab on the ribbon and select "Extrusion" from the "Forms" panel. Draw the profile of the beam cross-section by sketching a closed loop using lines and arcs and make sure the profile is drawn in the appropriate orientation and on the appropriate work plane (e.g., plan, elevation). Click the "Finish Edit Mode" button on the ribbon. The sketch will then be complete and ready for extrusion. Then, select the profile, then click the ribbon's "Create Extrusion" button. Preview the extrusion in the 3D view to ensure it matches the expectations. Use the navigation tools to rotate and zoom in on the extruded beam to inspect its details. Click the "Save" button on the ribbon to save the family. Give the family file a name, and then decide where to save it. By selecting "Load Family" under the "Insert" tab on the ribbon, you can load the recently established family into your project. Locate the family file that has been saved and load it into the project. Place instances of the traditional beam family in the project by choosing the proper tool from the "Structure" tab of the ribbon. To insert the beam, click on the chosen spot in the project. Lastly, utilize the newly established conventional beam family as necessary while continuing modeling and documenting the project.

2.9 Extrusion for IBS Beam Family

Launch Revit software and open a new or existing project. In the project browser, locate the Families category, right-click, and select "New Family" to create a new family template. In the New Family - Choose the appropriate template in the Select Template dialogue box based on the unit system. For example, select "Metric Generic Model.rft" for a metric system. Once the family template is loaded, a 3D view will be shown, and several tools on the ribbon. Expand the Views category in the Project Browser, then double-click the 3D view to make it active. Select "Extrusion" from the "Forms" panel on the "Create" tab of the ribbon's "Create" tab. The drawing tools are shown on the ribbon when you are in the Modify | Create Extrusion mode.

Create a 2D profile of the IBS beam using the sketching tools (Line, Rectangle, or Arc). On the XY plane, begin by sketching the cross-section of the beam. Click the green checkmark on the ribbon to complete the sketch after drawing the profile. In the "Properties" palette, enter the extrusion parameters. According to the specifications of the IBS beam, adjust the extrusion's height, material, and other characteristics. To complete the extrusion, click on the green check mark on the ribbon. Then, save the family by clicking on the "Save" button or pressing Ctrl + S. Choose an appropriate name and location for the family file. Load the newly created IBS beam family into the project by returning to the project environment, navigating to the "Structure" tab on the ribbon, and selecting the "Load Family" button. In the Load Family dialog box, browse to the location where the IBS beam family has been saved and select it. Click "Open" to load the family into the project. Once the family is loaded, place the IBS beam instance in the project by selecting it from the "Structure" tab drop-down menu or by using the "Place Components" tool.

3. Results and Discussion

Revit, the powerful building information modeling (BIM) software, has revolutionized the way architectural projects are envisioned, designed, and executed. At the heart of Revit's functionality lies the concept of family. Families are basic building blocks that enable architects, engineers, and designers to create intelligent and parametric models, enable efficient design iterations, and improve collaboration throughout the project lifecycle. This essay will explore the important reasons why creating families in Revit is essential to achieving successful results in architectural projects.

Creating families in Revit allows architects to design and model custom elements tailored to specific project needs. Families empower designers to go beyond predefined generic components, enabling a more accurate representation of their design intent. By creating custom families, architects can exercise greater control over their designs and achieve a greater degree of flexibility in expressing their creative vision.

Revit's parametric modeling capabilities are a game changer in the field of architecture. Families, as parametric objects, allow dynamic modifications and real-time updates throughout the project. By establishing relationships between different family parameters, such as dimensions, materials, and geometry, designers can easily adjust the model and see the effect reflected across the entire project. This parametric flexibility reduces errors, streamlines design iterations, and leads to more efficient and accurate construction documentation.

Fig. 3 is going to be one of the types of model design or the final look for conventional columns. The result for this column is the design that usually exists in this industry. For the result, Fig. 4 shows the model design for the Industrialized Building System (IBS) column. This column design is something different from the column conventional because the corbel was added. The result in Fig. 5 shows the shape of the conventional beam model design. This design is usually called an I-shape or H-shape and it has been used a lot in construction. Lastly, **Fig.**

6 shows the final look of the Industrialized Building System beam model design. For this IBS beam, a curve design has been chosen as the result.

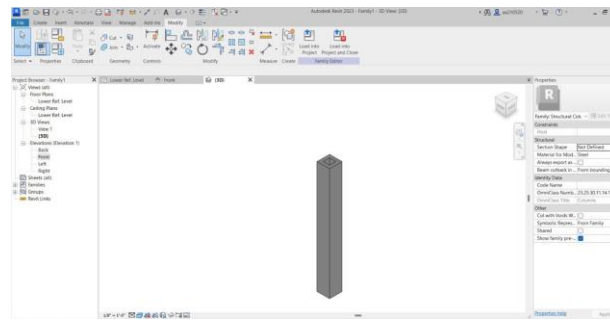


Fig. 3 The flood barrier prototype undergoing water testing

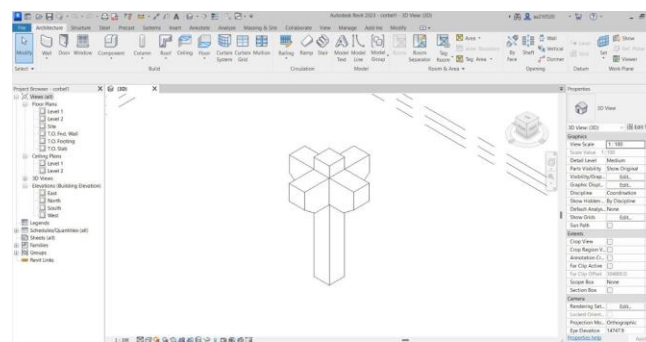


Fig. 4 The flood barrier prototype undergoing water testing

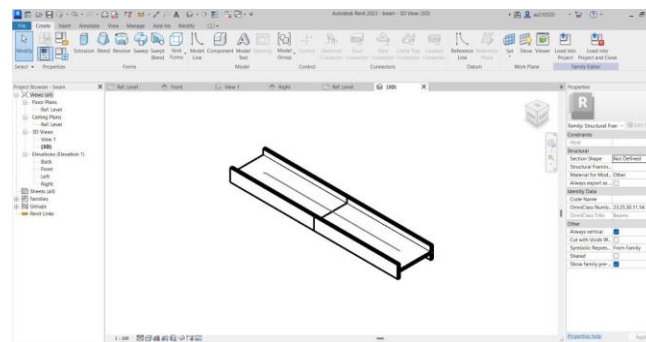


Fig. 5 The flood barrier prototype undergoing water testing

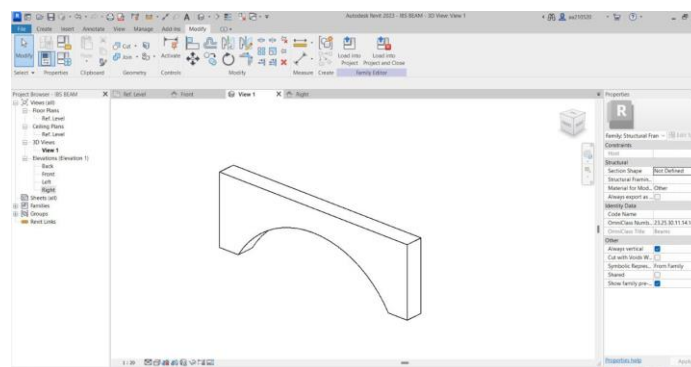


Fig. 6 The flood barrier prototype undergoing water testing

Revit can generate and manage 3D models of buildings and structures that include a variety of elements. It enables users to collaborate and work productively throughout the design and construction processes. Revit's parametric modeling capacity is one of its most important features. This means that the parameters of the

elements in the product, like size, materials, and connections to other elements, define them. When one element is changed, all connected items are updated immediately, saving time, and reducing mistakes. It also includes tools for producing precise construction paperwork, and realistic 3D drawings, including schedules and material takeoffs. This improves overall project coordination by streamlining communication between project stakeholders. Something new may be created with Revit.

4. Conclusion

As a conclusion, In the context of the widespread IBS structural panel approach in the field of construction, this research aims to focus on the use of Revit software to form some building structures such as columns, beams, and floors directly in Revit. In addition, the aim of this study is to create a library of IBS panels and to determine the easiest way to make corbel components. Additionally, the designer must be able to define relationships between building elements to create a parametric building model in Revit. It is also true that a successful Revit user needs to have a thorough understanding of construction technology in addition to software functionality to define these relationships in a sensible manner. To evaluate whether Revit can be an acceptable software to achieve the main goal of this study, the following study has been done to ensure that Revit is suitable for use in the construction field and this case study found that it is very suitable for workers such as architects, engineers and so on because it makes work in this field of construction easier.

In addition, when conducting a survey with the surrounding community, the study found that not too many people know about the existence and use of this Revit software among students because for them this is an application that is still less used among students. However, that does not mean it is unknown. This is because nowadays a lot of revitalization has been made among the Malaysian community because of the encouraging impact of BIM, which has attracted the interest of many countries around the world to take full advantage of BIM technology, including Malaysia. As a recommendation from this study, the government can further expand the knowledge about Revit software to the younger generation such as female students by including the use of Revit software in learning methods such as AutoCAD and STAADpro applications that are used by students now, with this initial exposure can be obtained by the younger generation today. In addition, it can encourage the creators of building materials such as corbels, beams, and columns to use this Revit software because it can make the work easier and can also give designers new ideas in terms of shape or other things. In the revolutionary industry 4.0, various important skills need to be mastered in the field of 3D Modeling. It doesn't matter if you are an architect, engineer, draftsman, student, or anyone else can now learn a skill that is very important in today's market. Because of that, it needs to be expanded further in the community.

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Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation.

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