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# The Adaptation of Building Information Modelling (BIM) on Existing IPD Pasir Mas As-Built Plan for Future Engineering References. Case Study: Blok Dewan Serbaguna

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**Abstract**: Building Information Modelling (BIM) is the new technology used in construction industry. It is increasingly known as the best alternative in the construction firm that would replacing the conventional method. BIM is tools of information management that has been used by Architecture, Engineering and Construction (AEC) industries in Malaysia. BIM are commonly implemented in a new building project because the process is easy rather than to the existing building. Therefore, most of existing buildings have not been implemented with BIM yet, make it difficult for engineers to refer to most existing buildings in the future. In recent years, the implementation of BIM on existing buildings has received growing attention. The aim of this study is to provide the information on existing building through BIM implementation for future engineering references. Therefore, the case study was conducted on existing building of '*Blok Dewan Serbaguna, IPD Pasir Mas'*. This study also carried out to compare the analysis results of the building with existing as-built drawing. A literature review was done to explore the information regarding the implementation of BIM on existing building, definitions of BIM,uses of BIM, BIM tools in construction projects as well as benefits of BIM. This study conducted using tools of BIM software which are Tekla Structural Designer for analysis and design structure, and Autodesk REVIT for modelling the building. Therefore, this software will produce accurate detailed documentation of steel and concrete designs, as well as provide detailed information of the existing building for future engineering references.

**Keywords**: Building Information Modelling, Engineering Reference, Existing Building, Autodesk REVIT.

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## 1. **Introduction**

Industry and business transformation become more effective through the application of innovation processes and technologies. Building Information Modelling is a process of developing, using, and transferring project information through a 3D model using digital technology to improve the delivery system throughout the project life cycle. In Malaysia, the opportunity is not being missed, although BIM is not yet widely used in Malaysia. The government has recognised the capabilities and benefits of BIM in reducing construction costs and eliminating design errors in the planning phase. Moreover, BIM is a software-based collaborative tool used in the AEC sector [1]. Nowadays, most BIM processes focus on new buildings rather than retrofitting old structures. As a result, the engineer will find it difficult to refer to the majority of current structures in the future [2]. The purpose of this study is to adapt BIM to an existing building *'Blok Dewan Serbaguna'* plan for future engineering references. The plan of the existing building will be obtained using Tekla Structural Designer (TSD) software for integrated modelling, design, analysis, and detailing of reinforced concrete structures based on Eurocode 2. TSD is intended exclusively for structural engineers and provides a comprehensive solution for the design of reinforced concrete structures. After that, Autodesk REVIT was then used to create a 3D model of the structure which is one of the products from BIM that is recommended by the government for use in construction projects.

### 1.1 Application BIM for Existing Buildings

BIM is commonly described as the process of designing a new building. Designing a new building is simple: you create a new file and organise all the necessary information. The existing building needs to be enlarged, renovated, or listed. An engineer's knowledge is probably hidden under an existing facade or surface. But the building sector is still unaware of the benefits of existing structures. Many studies are now being conducted to address the condition of existing buildings and the lack of documentation. Built-in point clouds can help capture point clouds and improve the results. Geometric building models are created during these surveys. There is no doubt that this type of survey provides accurate geometry data. Much less time is spent on site [3]. An existing model can provide valuable information about the performance, demand, and life cycle of windows, walls, doors, and other building components. As a result, the scanner cannot properly capture the data. Due to the rapid advances in research from BIM, stakeholders would like to see this technology deployed and studied in existing buildings [3].

### 1.2 Level of Development (LOD)

A BIM metric specifies and articulates the content and reliability of a model throughout the design and building process. LOD is a BIM industry standard used to describe the various stages of construction project development. The Level of Detail (LOd) scale includes an element's geometry and associated information (LOi). The shape of an element and its associated information have evolved over time so that all team members can rely on this information. Table 1 lists the levels of LOD. It is LOD 100 to LOD 500. In this study, LOD 300 was achieved by using Autodesk REVIT. Autodesk REVIT modellers can quickly evaluate construction blueprints, calculate quantities, and communicate with subcontractors, manufacturers, and others.

**Table 1: Level of Development (LOD)**

| LOD | Design Stage | Description |
|---|---|---|
| LOD 100 | Pre-Design | The model consists of 2D symbols and masses representing the individual components. |
| LOD 200 | Schematic Design | The elements are characterised by their estimated number, size, shape, and position. |
| LOD 300 | Design Development | The elements are defined with precise dimensions and their relative position is reinforced. |
| LOD 350 | Construction Documentation | How an element is connected to other elements is indicated. |

**Table 1: Continued**

| LOD | Design Stage | Description |
|---|---|---|
| LOD 400 | Construction Stage | The linkages and connections of a component with other components are clearly indicated. |
| LOD 500 | As-Built | The model starts with a simulation of the real-world functioning of the architecture. Here are all the development phases and their definitions. |

## 2. Materials and Methods

### 2.1 Planning

This study concentrated on the pre-existing '*Blok Dewan Serbaguna'*. Figures 1 and 2 depict the Architectural plan of '*Blok Dewan Serbaguna'* for the purpose of conducting this study. The existing structure has two floors: the ground floor (stage, badminton court, office, guest room, store room, catering room, switch room, and restroom) and the first floor (gymnasium room, men's and women's locker rooms, and AHU room).

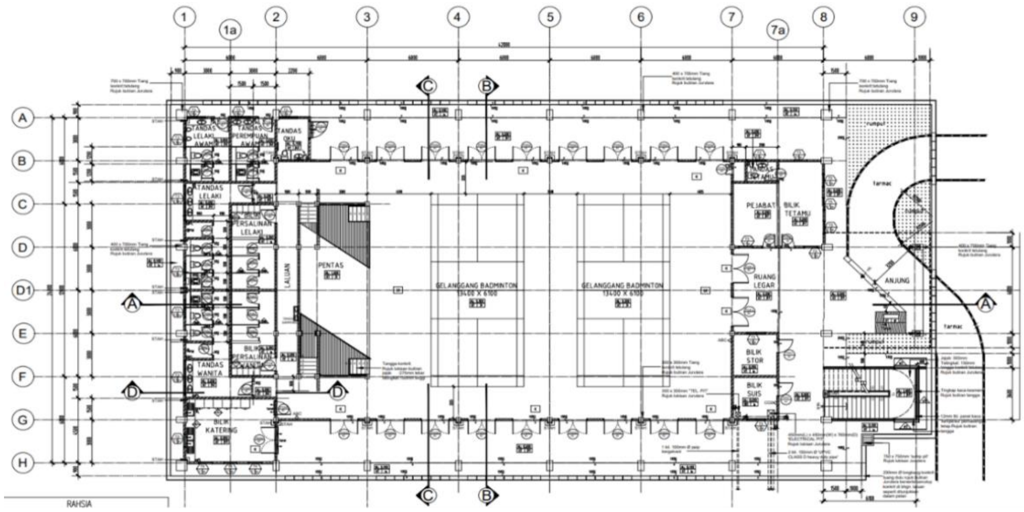


**Figure 1: The ground floor plan**

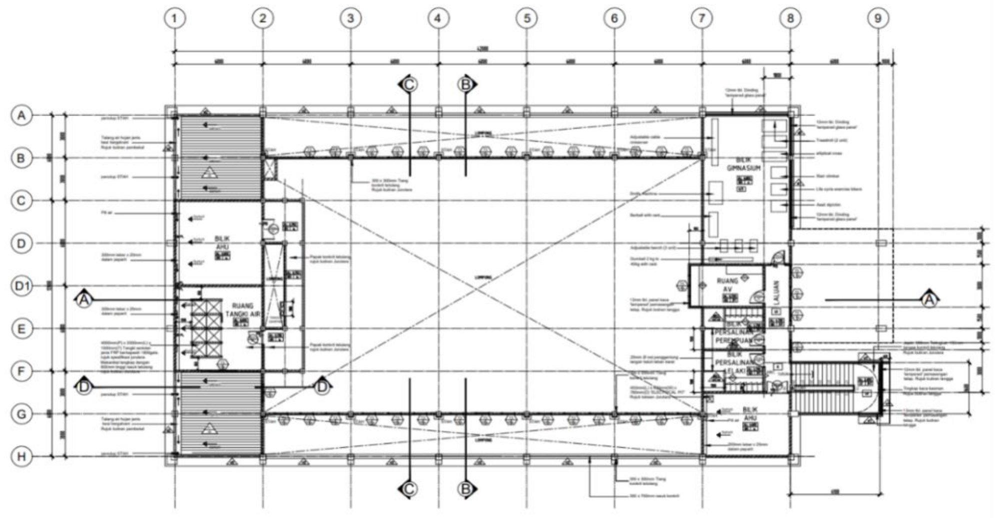


**Figure 2: The first floor plan**

### 2.2 Material Properties

For the characteristic strength of concrete, fck is equal to the 28-day cylindrical strength. The appropriate type of concrete grade was determined based on factors such as strength, durability, concrete grade, and concrete unit weight. In this study, C30/37 concrete with a unit weight of 25 $kN/m^3$ was used. The reinforcement is designed to reduce deflection and control cracking while maintaining the desired characteristic strength. The high-strength steel had a strength of 500 $N/mm^2$.

### 2.3 Tekla Structural Designer (TSD)

The flow of the TSD software used to analyse and design '*Blok Dewan Serbaguna'* is shown in Figure 3.

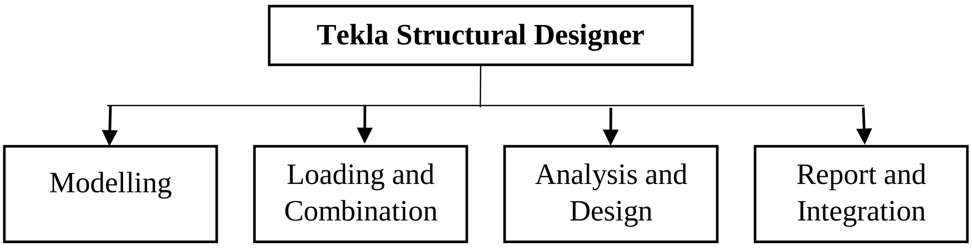


**Figure 3: TSD software flowchart for analysis and design of TSD software**

The construction level of the existing building was created using the plan for the modelling process. The grid line of the building, on the other hand, was constructed so that the supporting columns, beams, and slabs were marked. The load that was entered for the building is shown in Table 2.

**Table 2: Imposed loads on each part of the building**

| Categories of Loaded Areas | Qk ($kN/m^2$) |
|---|---|
| Imposed 1 (Toilet) | 2.0 $kN/m^2$ |
| Imposed 2 (Office, Catering room, Store, AHU room, Guest room) | 3.0 $kN/m^2$ |
| Imposed 3 (Stairs) | 3.0 $kN/m^2$ |
| Imposed 3 (Gymnastic rooms) | 5.0 $kN/m^2$ |
| Imposed 4 (Badminton court, Stage) | 5.0 $kN/m^2$ |
| Selfweight of partition | 1.2 $kN/m^2$ |

After inputting all the loads, run the analysis and design to calculate the load-bearing capacity of the building and reinforce the components. Finally, they used Tekla Integration to generate a report detailing the study and design of the building and export the modelling to Autodesk REVIT.

### 2.3 Autodesk Revit

In this study, the "JKR template" was used in Autodesk REVIT software, so the format is standardised as Malaysia format. The process for modelling an existing building at '*Blok Dewan Serbaguna*' using Autodesk REVIT is shown in Figure 3.

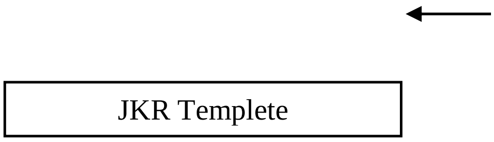


**Figure 4: A flowchart for modelling an existing structure in Revit**

First, the model was integrated into TSD, and the type of structural column, frame structure, and materials used were input into Autodesk REVIT. The material was selected using "JKR Templete". After that, the modelling was shown in 3D view. This software automatically updates the elevation plan, structural plan, and floor plan. Next, the reinforcement for beams and columns was input using the design results from TSD software. The reinforcement bars for columns and beams were displayed in the 3D view. Finally, other model-based elements such as foundations, staircases, and roofs were also created in this software.

## 3. Result and Discussion

The result of the analysis of the existing building of 'Blok Dewan Serbaguna' was determined by the performance in the TSD software. From the analysis result, the maximum values of shear force diagram (SFD) and bending moment diagram (BMD) of beams and columns were obtained. The design result was prepared using TSD software to determine the arrangement of reinforcement. In addition, Autodesk REVIT was used to create the modelling of the building in the 3D view, the elevation plan, the floor plan, the structural plan, and the arrangement of reinforcement in the 3D view, as well as other model-based elements such as the foundation, the staircase, and the roof.

### 3.1 Maximum Shear Force Diagram (SFD) and Bending Moment Diagram (BMD)

The maximum SFD and BMD values of beam 2B167, located on the ground floor, are shown in Figure 5. The value of the maximum shear force on the beam was 258.6 kN, while the maximum value for the bending moment diagram was 356.8 kNm. In this case, the critical shear forces and bending moments occurred due to the excessive loading caused by the load combination. The maximum SFD and BMD values for column C53 are shown in Figure 6. The maximum shear force of the column was 128.4 kN and the maximum bending moment of the column was 154 kNm. This is due to the fact that the load was transferred from the roof, the beam, and the slab to the column.

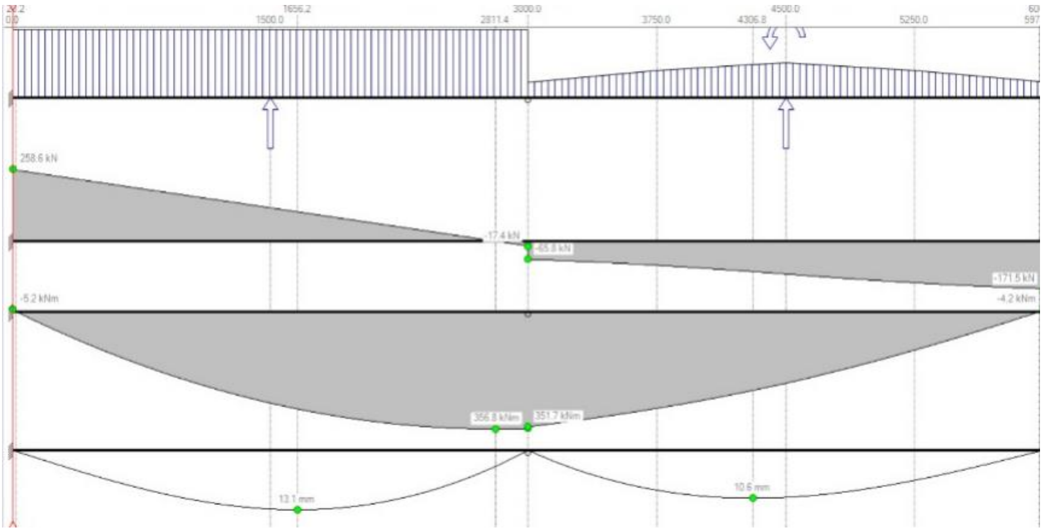


**Figure 5: Max SFD and BMD on Beam**

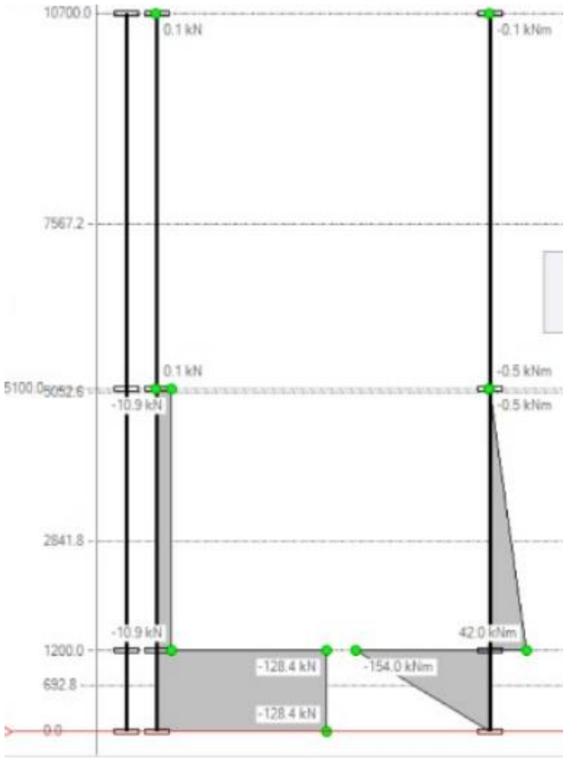


**Figure 6: Max SFD and BMD on Column**

3.2 The Results of Beam, Column, and Slab Design

The maximum size of reinforcement on the beam was shown in Table 3, namely 4H12 for a beam size of 250x500 mm. The maximum reinforcement of the column, shown in Table 4, is 4H25+3H16 with a column size of 700x400 mm. For the slab, the maximum reinforcement was used with a slab thickness of 150 mm. The reinforcement size was H8 at the bottom X and bottom Y, while H10 at the top X and top Y (see Table 5).

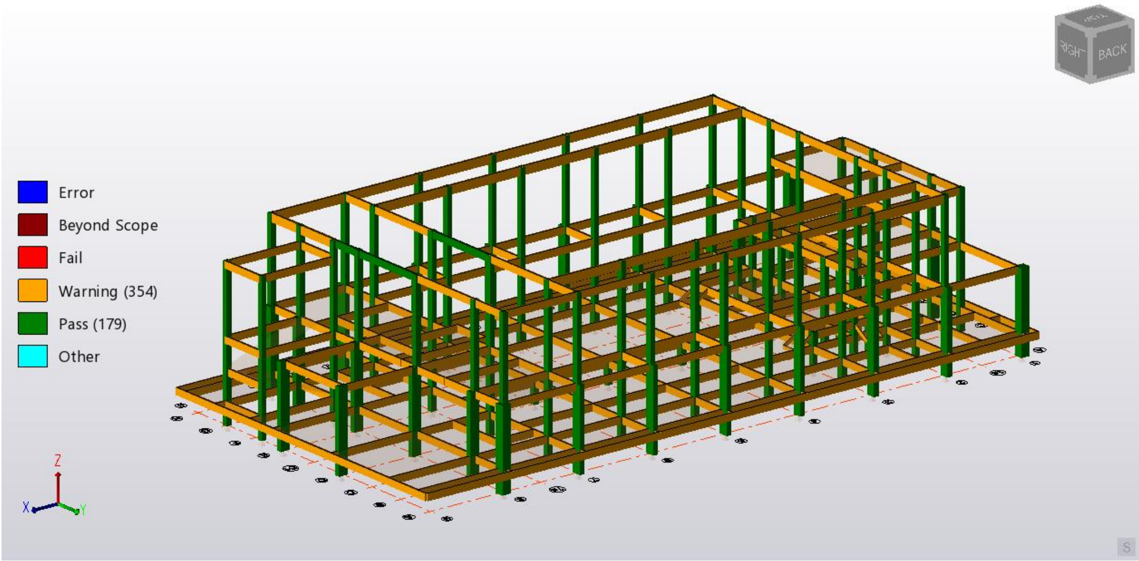


**Figure 7: Design status from Tekla Structural Designer**

**Table 3: Maximum size of reinforcement on beam**

| **Beam size (mm)** | **Reinforcement size** |
|---|---|
| 250x500 | 4H12 |

**Table 4: Maximum size of reinforcement on column**

| **Column size (mm)** | **Reinforcement size** |
|---|---|
| 700x400 | 4H25 + 3H16 |

**Table 5: Maximum size of reinforcement on slab**

| **Slab thickness (mm)** | **Reinforcement size** | |
|---|---|---|
| 150 | H8 | H8 |
| | H10 | H10 |

2.4 Modelling an existing building

The modelling of an existing 'Blok Dewan Serbaguna' using Autodesk REVIT is shown in Figure 8 to 10. This modelling was imported from Tekla Structural Designer. After creating the reinforcement bars on all beams and columns and generating other elements such as foundations, staircases, walls, and roofs, all information and data for the element structure and rebars were displayed in the 3D concept.

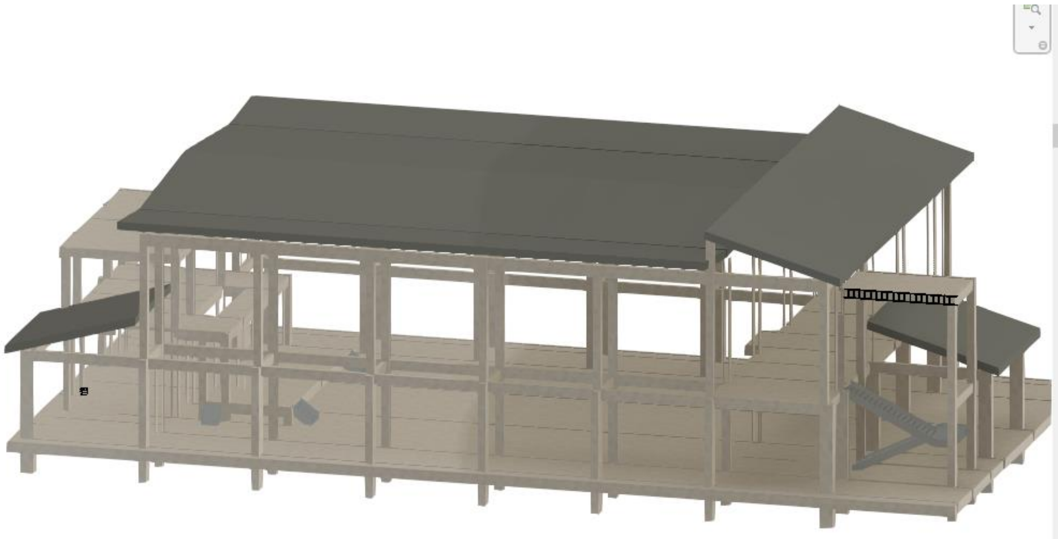

**Figure 8: Modelling of '*Blok Dewan Serbaguna at IPD Pasir Mas'***

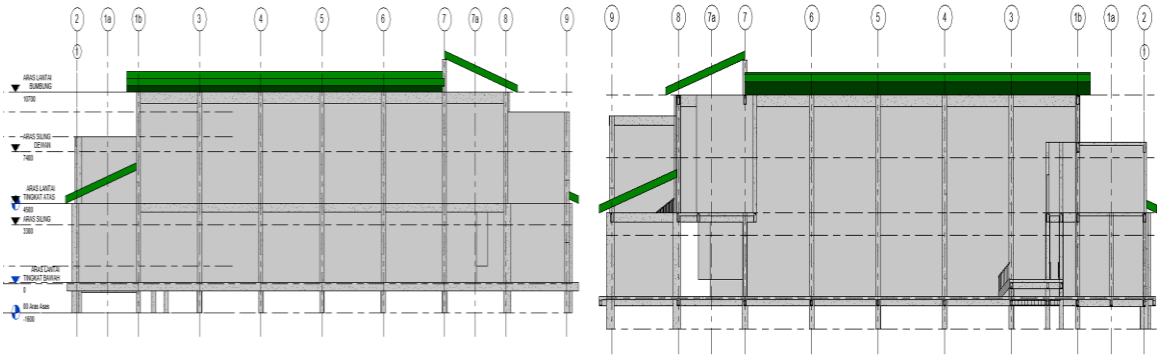

**Figure 9: Rear and front elevation**

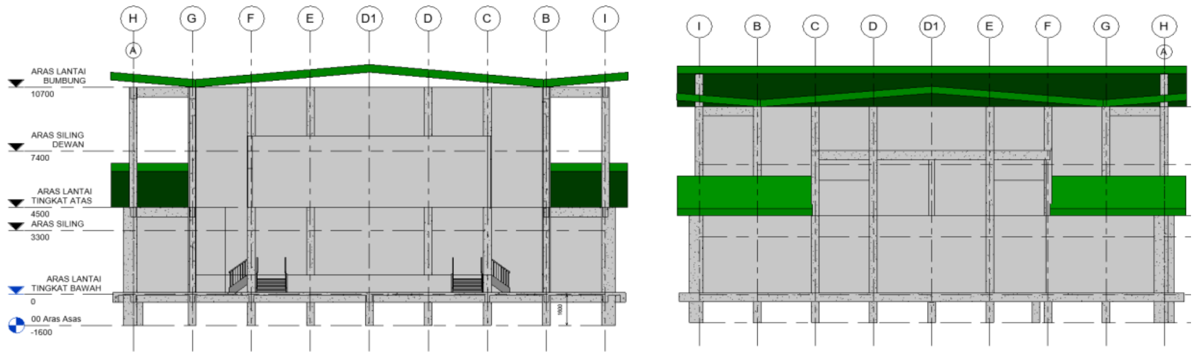


**Figure 10: Right and left elevation**

As a BIM component, it is also possible structural detail of reinforcement, namely in corners of a designed structures. The level of detail made possible by 2D and 3D visualization of reinforcement in the model allows careful consideration of the reinforcement solutions to be adopted. Model the reinforcement directly on the structural elements. This reinforcement modeling mode is possible at any concrete structural element. This modeling method is time consuming and somewhat automated, although not specifically versatile and complex. Currently, this was the way used to model the reinforcement of the concrete stairs on the analyzed building.

Model using the extension 'Reinforcement' in Revit Structure to the reinforcement. With this extension it is possible to model the various structural reinforcement in concrete elements: distributed in foundations, walls, beams, columns. Figures 11 show the reinforcement of a beam, column and foundation in 3D. The reinforcement modeling process is not practical enough to easily convert traditional CAD methods to BIM [6]. The brickwall and roof for the building 'Blok Dewan Serbaguna' were sketched in Autodesk REVIT software (refer Figure 12).

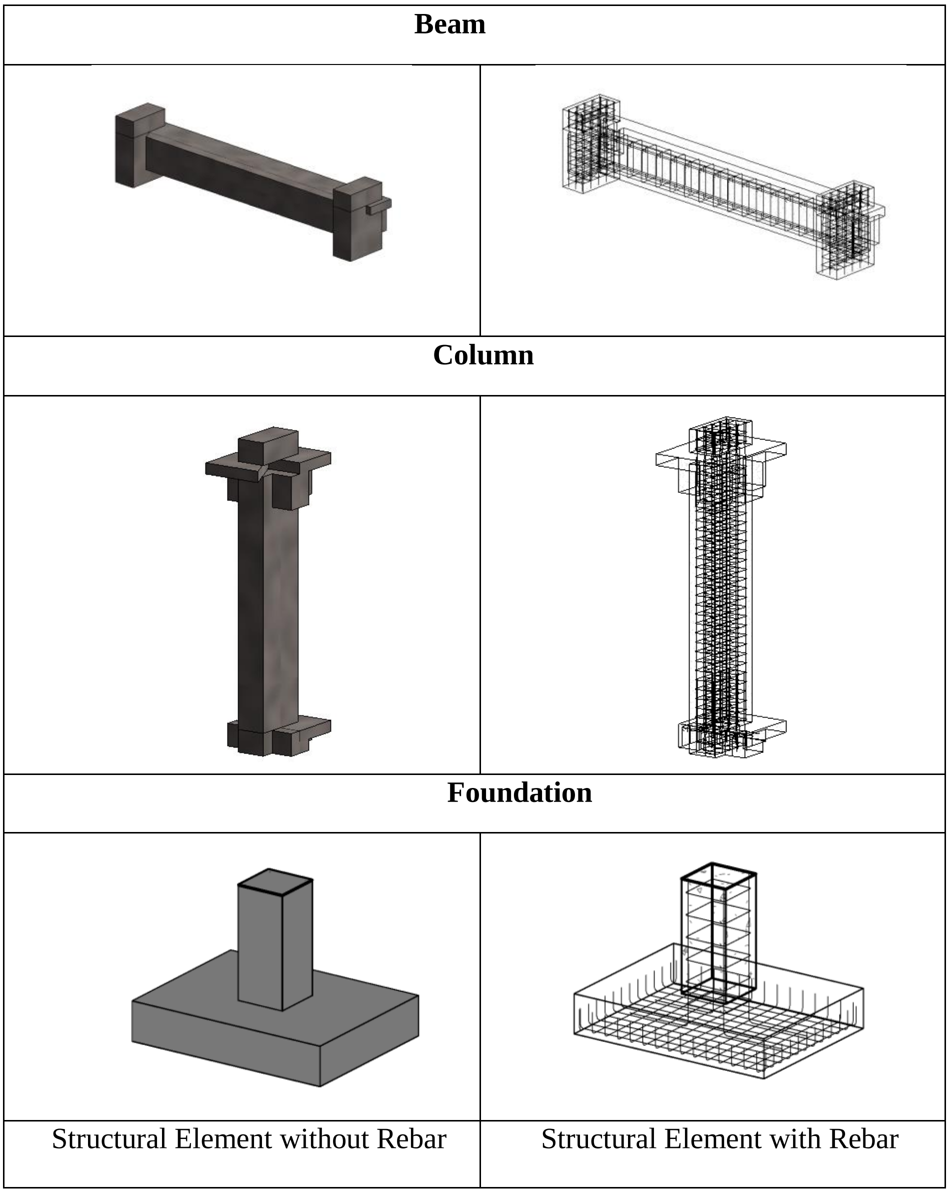


**Figure 11: Reinforcement on beam, column and foundation in Autodesk REVIT**

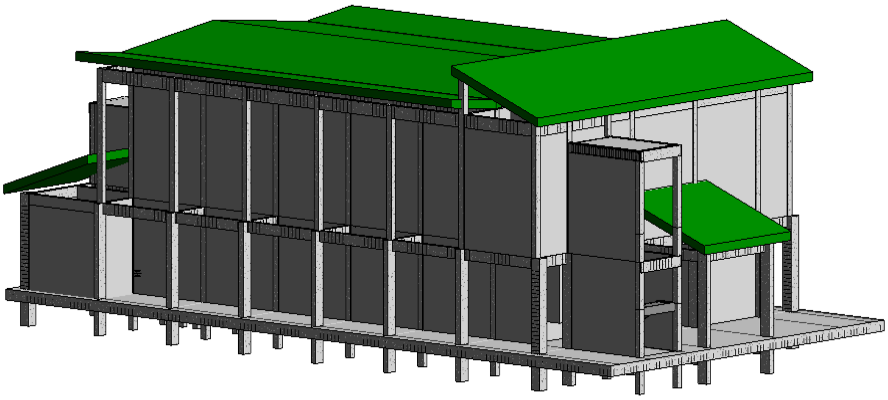

**Figure 12: Element brickwall and roof in Autodesk REVIT**

## 4. Conclusion

The structural analysis and design of an existing *'Blok Dewan Serbaguna'* using Tekla Structural Designer was completed as a result of the findings of this study, and the first objective was attained as a result. With the help of the software Tekla Structural Designer (TSD), it was possible to successfully analyse and design the element structures of the building. According to the manufacturer's specifications, the maximum values of the shear force and bending moment diagrams of the beam 2B167 at grid D1/1-2 are 258.6 kN and 356.8 kNm, respectively. The values were 128.4 kN and 356.8 kNm for the column C53. This occurred as a result of the high load imposed by the load combination that was applied to it. The second objective was to create a building model using Autodesk REVIT. TSD design result was critical in order to do the 3D version of reinforcement in Autodesk REVIT. Additionally, the floor plan, elevations, sections, and 3D view were automatically changed. The Level of Development (LOD) for this investigation was 300.

In conclusion, the primary purpose of serving as a future reference for engineers was accomplished successfully. Engineers will have simple access to all the information and data on the element structure, such as the element structure's size, the size and quantity of reinforcement bars employed. This is because the structure was designed in 3D, including the reinforcement bars. As a result, it's convenient for engineers to refer to it in the future. In summary, BIM technology was successfully implemented on the existing structure of the '*Blok Dewan Serbaguna'.* TSD and Autodesk REVIT, the software utilised in this study, are both beneficial for creating BIM. Additionally, this software is extremely beneficial in UTHM's adoption of BIM for existing buildings, as it enables engineers to access information instantly regardless of their location. As a result, this study can serve as a reference for future engineers and will aid in the development of the '*Blok Dewan Serbaguna in IPD Pasir Mas*'.

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