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Evaluation Of Calculation Work Volume of Fgd and Esp Pltu Suralaya Development Projects Using the Autodesk Revit Application

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ABSTRACT

In construction work, problems such as volume estimation, construction methods, and work interfaces often occur. Problems like this can be minimized with the Building Information Modeling (BIM) method. BIM changes conventional methods from being inefficient to integrated and collaborative processes. The various benefits and advantages of using BIM include the integration between design and construction. The application of BIM can minimize errors between design and construction. In BIM, we can define some modeling information, like coordinate, model view, clash detection, rebar schedule & detail fabrication, concrete volume, and others that are useful in the construction process. This study applies Autodesk Revit software for volume estimation and analyzes the differences in the BIM-based volume estimation results with conventional methods. The Revit software volume output is then compared to the existing or contracted Bill of Quantity (BOQ). The results of the evaluation show that the volume contains from the BIM calculation on the volume of concrete is 3056.31 m3 and the weight of the reinforcement bar is 540.18 tons, these results are different from the BOQ of the contract, each of which is 2765.11 m3 for concrete volume and 490.05 tons for reinforcement bar weight, which each has a shortage of 291.20 m3 and 52.64 tons.

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1. INTRODUCTION

Construction is one of the efforts in realizing the national goal of developing a more advanced Indonesia, especially in the sector of building construction(Raftery et al., 1998). In the process of construction work, there are 2 main phases, namely pre-construction and construction(Abdul-Rahman et al., 2007). The pre-construction phase includes the planning stage until before implementation begins(Lines et al., 2015). Therefore, construction service actors must work efficiently and effectively from planning to implementation(Smith & Tardif, 2009). In the construction process problems often occur, such as design changes to logistics planning(Vrijhoef & Koskela, 2000). Problems that arise can increase costs and take quite a long time, resources are used

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inefficiently so that they can interfere with subsequent construction process activities(Kaplan & Anderson, 2007).

Improvements to designs and models using information technology-based software today have been provided in software and other tools that allow for analysis, simulation, and digital manufacturing where construction actors can understand how the ideas contained in the technological dimension can be understood and understood in the management process. Building Information Modeling (BIM) is a necessary process and can be implemented from the start of a project as a design tool, thereby helping to analyze development feasibility, identify clashes, and evaluate costs(Azhar, 2011).

The advantage of this BIM software is its ability to model and provide clear and detailed information in material specifications and can be used as a reference for the volume calculation process and planning estimates, and when there is a problem or design change it can be easily changed. The existence of BIM is expected to be able to change the conventional construction process where clashes or misunderstandings often occur between divisions, due to unclear flow of information and information that is not properly recorded which results in time delays, which has an impact on increasing construction costs.

Per the actual situation in construction projects, there is a lot of building/structural project work that has implemented building modeling which has information data in the model or commonly called BIM(Whang & Park, 2016). In this industrial era 4.0, construction players are expected to be able to make buildings that are accurate, fast, and can be understood by all divisional aspects such as electrical, mechanical, and others(Sepasgozar et al., 2020). Information on the building is simulated into a 3-dimensional (3D) view using software from Autodesk Revit, such as calculating the volume of the building and calculating the quantity take off(Tejaswini et al., 2020). This study aims to evaluate building volume against the manual design calculation of the project (RAB) and determine the effectiveness of using BIM in the FGD and ESP PLTU Suralaya control building projects.

2. RESEARCH METHOD

The object of this research building is located in Suralaya, Pulo Merak District, Cilegon City, Banten Province which is at the coordinates of 5°53'45.44" South Latitude (LS) and 106° 1'20.68" East Longitude as shown in Figure 1. The building is part of the expansion project of PLTU Suralaya units 9 & 10 with a capacity of 2x1000 MegaWatt (MW) each.

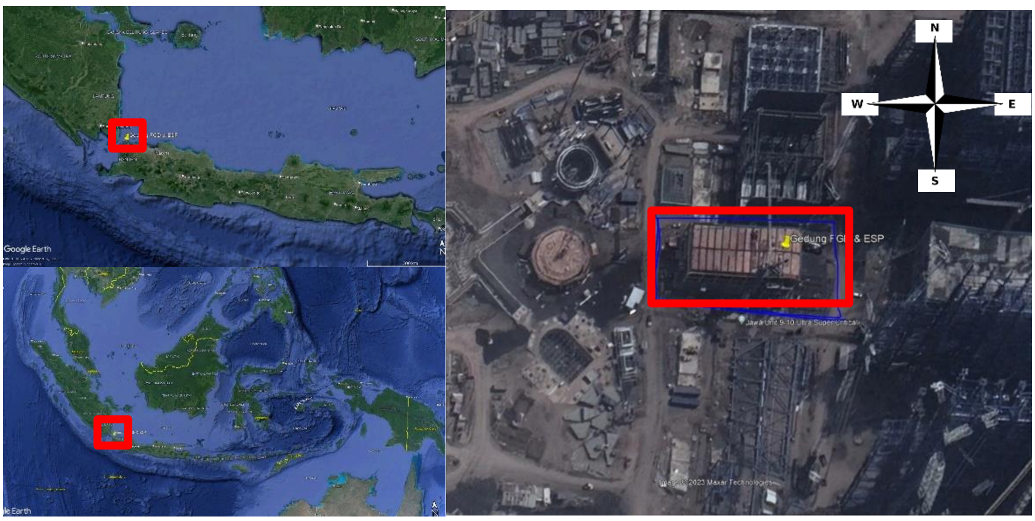

Figure 1. FGD & ESP control building project location.

In this study, the data collected was in the form of secondary data for data processing at the next stage, namely in the form of Detail Engineering Design (DED) and Bill of Quantity (BOQ)(Husin et al., 2020). The DED is used as a basis for carrying out the BIM modeling process with work elements referring to the BOQ document(Jalaei & Jrade, 2014).

In this study, there are stages carried out in the work process(Corbin & Strauss, 1990). The stages carried out in this research were collecting various types of reference books, articles, BIM information and workmanship systems, making/reviewing structure modeling from DED drawings, exporting concrete volumes from building models, and comparing these volumes with contract volumes. More details are shown in Figure 2.

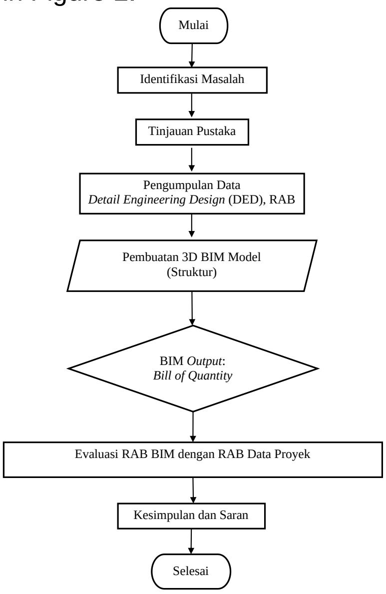

Figure 2. Research flow chart

3. RESULTS AND DISCUSSIONS

BIM modeling is carried out by structural modeling using Autodesk Revit 2022 software. The Autodesk Revit 2022 using account license. For modeling results from building structures, it is achieved up to the detail level of LOD 400, namely up to the assembly of steel. For reinforcement assembly, distribution of reinforcement, lap splice, hook bars, hops, and shrinkage reinforcement is regulated in ACI 318-18 standard. For modeling, several ways are carried out, starting from making grids to making section drawings. After all structural and steel elements have been modeled, a 3D view can be seen in the Autodesk Revit window at the BIM LOD 400 level as shown in Figure 3. and Figure 4.

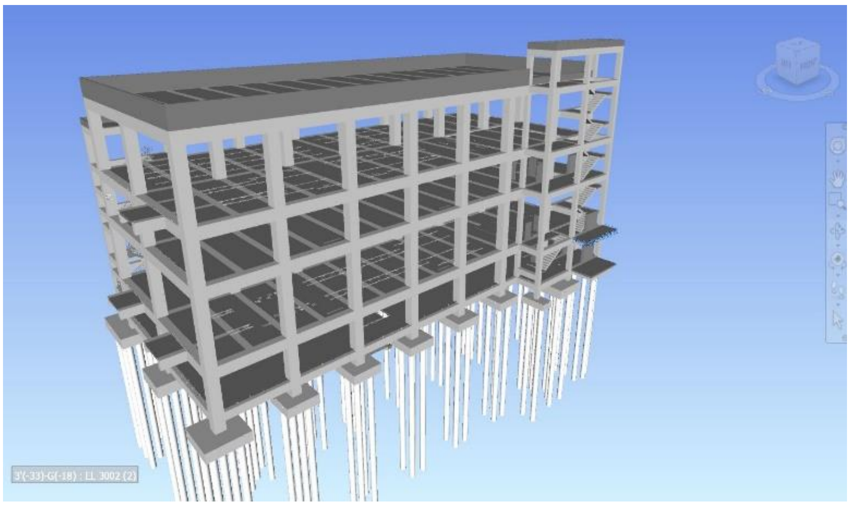

Figure 3. Structure Model

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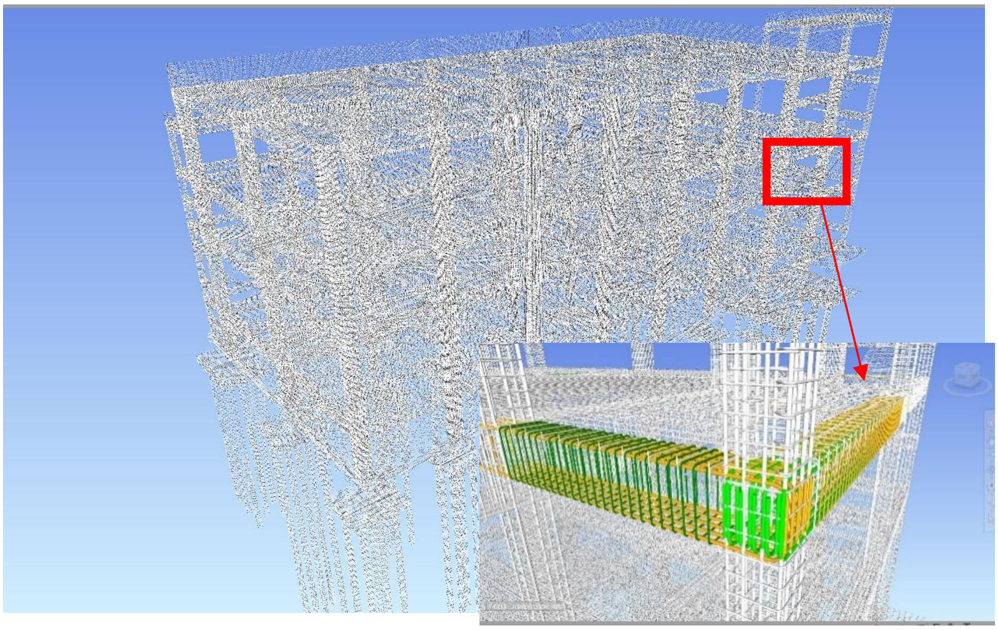

Figure 4. *Assembly Rebar.*

3.1. Clash Analisis

When the structural elements have been modeled, the next stage is clash detection using Autodesk Naviswork Manage tools, where the processed data from the BIM model is composited into one complete building with a detailed level of LOD 400 on the structure. This method needs to be used to check whether any structural elements collide with other elements which causes miscommunication between work divisions. Based on the results of running Autodesk Navisworks, clash identification was obtained, for example, the UNP plate that collided with the floor plate Figure 5.

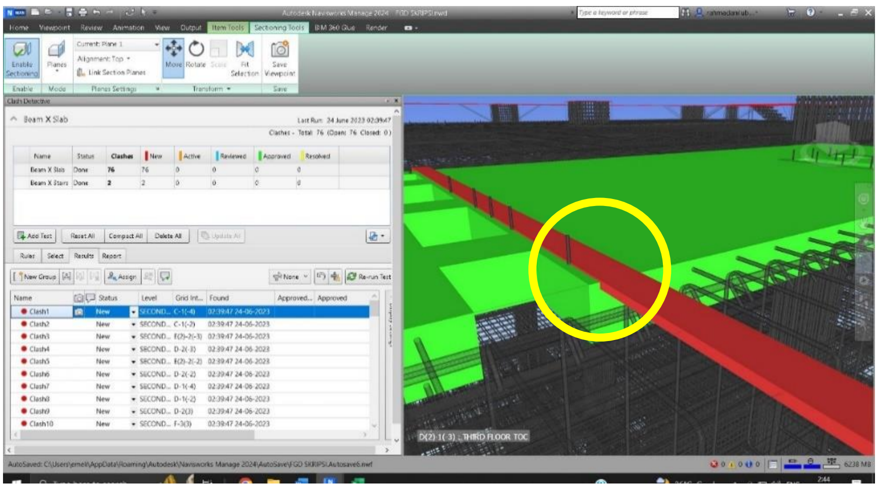

Figure 5. Clash Detection.

After the analysis of the building model has been identified, then the model is repaired to overcome the problem, so that no more clashes.

3.2. Material Take Off

After making sure that the model is valid, that is according to the DED image and no clash detection occurs again. So next we do Material Take Off (MTO) to make a report regarding the material requirements needed for the construction process.

3.3. Comparison of BIM and RAB Work Volumes

The results of the concrete volume comparison between the BOQ contract and the BOQ of the BIM report of the structural components (Columns, Beams, Floor Plates) are presented in tabular form. Based on Table 1, the results obtained for the quantity calculation of the volume of concrete for structural work using the BIM method in the Suralaya FGD & ESP building were 3056.31 m3, while in the contract BOQ it was 2765.11 m3 with a minus difference of 291.20 m3 or if it was percentage at 10 .74%. Then the results obtained for the weight quantity of steel reinforcement for structural work using the BIM method in the Suralaya FGD & ESP building were 540.18 m3, while in the BOQ contract, it was 490.05 m3 with a minus difference of 52.64 m3 or if it was a percentage of 10.74% These results have a big difference in the volume of concrete and in terms of the weight of the iron reinforcement. So it needs a further review of BOQ on work contracts. The results of the comparison of the concrete volume of the structural work components are shown in Table 1.

Table 1. Quantity Design & Quantity BIM

Work Item	*Unit*	*Quantity Design*	*Quantity* BIM	Deviasi
Ground Slab & Underground Structure	m^3	735.65	1077.5	-323.85
Above Ground StructureType I				
1st *Floor*	m^3	374.61	398.67	-24.06
2nd *Floor*	m^3	365.56	376.44	-10.88
3rd *Floor*	m^3	369.49	379.90	-10.41
Roof Floor	m^3	394.22	376.96	17.26
Staircase-1	m^3	77.61	18.92	58.68
Staircase-2	m^3	32.65	14.24	18.40
Column	m^3	395.04	411.33	-16.29
Canopy	m^3	2.28	2.33	-0.05
		2,765.11	**3,056.31**	**-291.20**
Rebar Ground Slab & Underground Structure	m^3	54.11	137.825	-83.72
Rebar 1st *Floor* (D≤25mm)	m^3	63.09	62.391	0.70
Rebar 2nd *Floor* (D≤25mm)	m^3	57.10	57.615	-0.52
Rebar 3rd *Floor* (D≤25mm)	m^3	58.62	58.889	-0.27
Rebar Roof Floor(D≤25mm)	m^3	55.48	52.824	2.66
Rebar Staircase-1 (D≤25mm)	m^3	18.83	11.581	7.25
Rebar Staircase-2 (D≤25mm)	m^3	9.66	5.485	4.18
Rebar Column (D≤25mm)	m^3	170.34	153.124	17.22
Rebar Canopy (D≤25mm)	m^3	0.21	0.335	-0.13
Dowel Bar 13 @1200 L=400mm	m^3	0.10	0.112	-0.01
		490.05	**540.180**	**-52.64**

If we look at the size of the difference, the largest volume is found in the item ground Slab & Underground Structure with a concrete volume of minus 323.85 m3 and Rebar Ground Slab & Underground Structure with the weight of iron reinforcement, which is minus 83.72 tons. If we break down the quantity of these items, it can be seen that the largest volume element is found in the foundation/bore pile sub-item as shown in Table 2. So further research is needed on the bore pile volume. whether the bore pile item has been included in the design or entered into another contract item.

4. CONCLUSION

The use of BIM is very helpful in the construction process, especially in engineering design. When the DED design collides with other structures, BIM can easily detect it and can be repaired immediately without having to start over from scratch. In addition, BIM can provide comments on models, see buildings from all sides, and can also report well. Based on the results of the analysis and discussion of quantity, several conclusions can be drawn as follows: The use of Autodesk Revit software is very heavy, therefore it requires quite high specifications such as Intel® i-Series, Xeon®, AMD® Ryzen, and Ryzen Threadripper PRO. 2.5GHz or higher and has at least 12GB of RAM. The results of the average volume calculation produce a balanced value except for the calculation of the below-ground level and it is necessary to review whether the quantity design has taken into account the lower structure such as bore pile and pile cap. The total concrete requirement is 2675 m3 and the total concrete rebar requirement is 487.54 tons. In general, the design volume of the project (BOQ) is above the BIM volume. If the actual field volume is greater than the design volume, there will be a shortage of funds for project financing. This will result in the need for an addendum to the contract so that it is following the actual calculation.

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