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THE COMPARISON BETWEEN THE BOQ OF CONVENTIONAL AND BIM METHOD ON BPJS BUILDING IN CENTRAL JAKARTA

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Abstract. In the construction planning process, the calculation of the quantity of each project work was packaged in a Bill of Quantity (BoQ) to complete the project and greatly affected the continuity of the entire construction construction process. With advances in technology in the world of construction, it could simplify planning in built a building and could increased the accuracy of calculations without using assumptions that could increased the volume of work. One of the results of current technological advances was the creation of the Building Information Modeling (BIM) method, a method that was able to simulate all information in a development project into a 3-dimensional model. Currently the use of the BIM method in Indonesia was still limited so that in this research, the aim was to determine the effectiveness of the use of BIM on the accuracy calculation of the volume of the BoQ and to know the percentage comparison. The building project that was used as a comparison was a building with the middle rise building category, namely the Central Jakarta BPJS Building. Based on the research conducted, it was found that the difference between conventional and BIM results on pilecap components was 5%, column 6%, beam 35%, floor slabs 2%, stairs 22%, ceiling 2.26% floor coverings 14% lower than conventional calculations but for the wall component the BIM calculation is 0.78% greater than the conventional calculation. So that the total percentage ratio is 10%, thus this proves that the use of the BIM method in calculating quantity was effective in terms of calculation accuracy.

Keywords : Bill of Quantity; BIM; Construction

1. INTRODUCTION

With the development of the construction industry requires planners and construction service implementers to improve the quality and effectiveness of the construction process. The construction industry requires construction service actors to complete projects in a short time but still with good quality in the most cost efficient manner possible. However, in reality, current construction projects often experience problems, both in collaboration between design modeling and construction analysis [1]. Design modeling which often changes according to field conditions, can increase construction costs and tends to take a long time, and the resources used also become inefficient [2]. Design modeling also affects the volume of preparatory, structural, architectural and mechanical work that is packaged in the BoQ [3]. The conventional method of BoQ, the calculation still uses manual calculations, namely by reference to CAD drawings and Ms. Excel calculations which can be wrong due to human error [4]. This problem can be minimized by utilizing the latest technology, namely BIM at the construction concept stage [5, 6].

The method or sequence of work on a project that is applied is based on related information from all aspects of building work that are managed and then projected into a 3-dimensional model based on technology

[7, 8]. This technology-based concept, namely Building Information Modeling (BIM) [9], where its use can produce buildings with a fast execution process and all the detailed information is contained in one Big Data, it can minimize errors at the construction stage in the Architecture Engineer Construction industry (AEC) of Indonesia [10].

One of the BIM method based software is Autodesk Revit [11,12]. Autodesk Revit can be used for project drawing, project management, project control, and work volume calculation [13,14].

The performance efficiency between conventional methods and the BIM concept in terms of time, human resource and cost requirements for project planning that use applications with the BIM concept can expedite the project planning time twice times faster than the original plan, reduces human resource requirements by 26.66%, and saves employee costs by 52.25% compared to using conventional applications [15].

2. METHODS

The data obtained is processed and analyzed according to the problems that have been identified. Data analysis was performed with the help of several software including; Autodesk Revit, Autodesk CAD, and Microsoft Excel. The research location is the Central Jakarta BPJS Building Project which is on Jl. Central Salemba-Central Jakarta

Research in this study includes several stages. The flow chart in this final project research is presented in Figure 1.

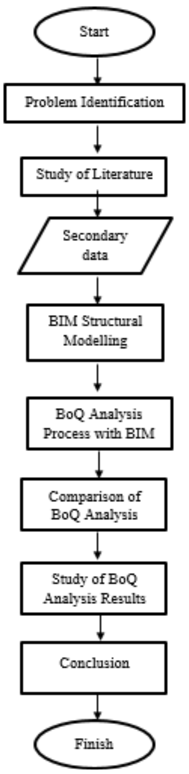

Figure 1. Research Stages Flowchart

3D modeling

This stage uses software in the form of Autodesk Revit with a research period ranging from May 2020 to June 2020.

The 3D modeling steps in Autodesk Revit begin by reading the DED image that has been obtained through the project contractor, then the modeling is divided into structural and architectural modeling which will be explained as follows:

1. Create the main structure starts from the bottom structure, namely the foundation by selecting open families, and selecting the structural foundations template
2. Set the size of the foundation according to the project's drawing based on the DED image by creating a Reference Plane reference line then creating a 3D material with Create Extrusion and changing the default foundation material to concrete
3. After finishing to make the family foundation, then proceed by opening a new project fil for placing the overall building as shown in Figure 2.

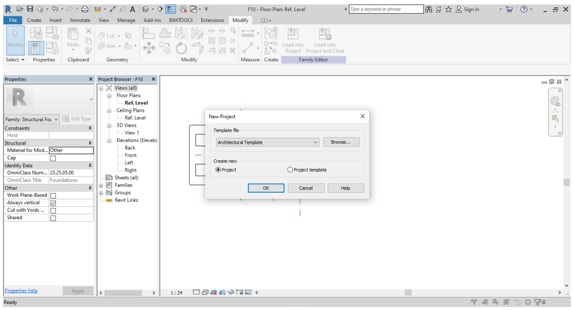

Figure 2. New Project View

4. Adjust the height of the building per floor by creating a level on the Elevations tab as shown in Figure 3.

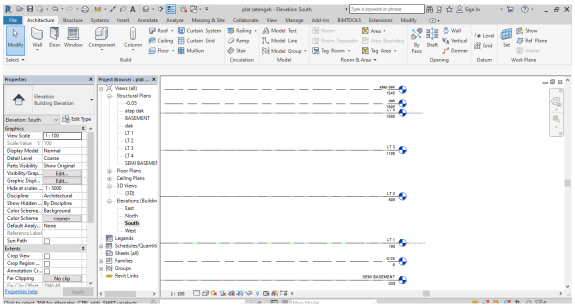

Figure 3. Elevation Tab View

5. Insert AutoCAD drawings as drawing references in Autodesk Revit with the Insert – Link CAD command as shown in Figure 4.

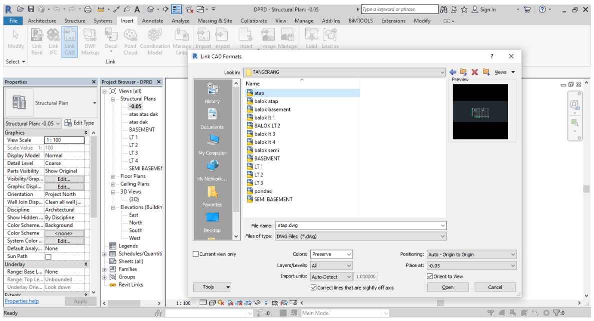

Figure 4. Insert Tab View

6. Building axles created using the grid in the Ribbon Architecture on the Structural Plans tab as shown in Figure 5.

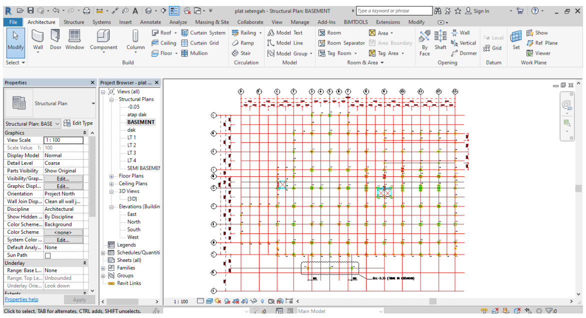

Figure 5. Structural Plans Tab

7. Place the foundation according to the foundation plan into the grid using the Ribbon Structure then selecting Isolated, then there will be a foundation that has been made in the project family as shown in Figure 6.

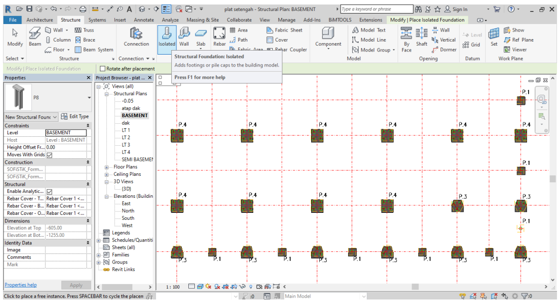

Figure 6. Foundation View in Structural Plan

8. Make the dimensions of the upper structure, namely columns, beams, and floor plates which will be used by entering the existing family and then placing the columns and beams according to the plan as shown in Figure 7.

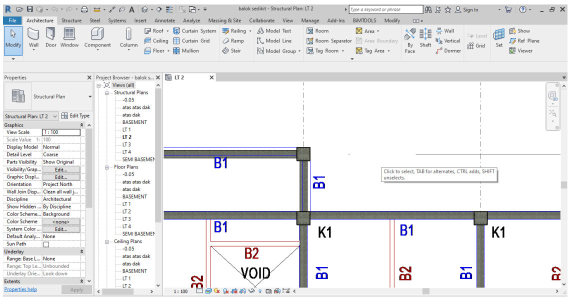

Figure 7. Upper Structure View in Structural Plan

9. Adjust the floor plate placement and empty the voids according to the DED plan by using the Ribbon Structure then selecting Floor as shown in Figure 8.

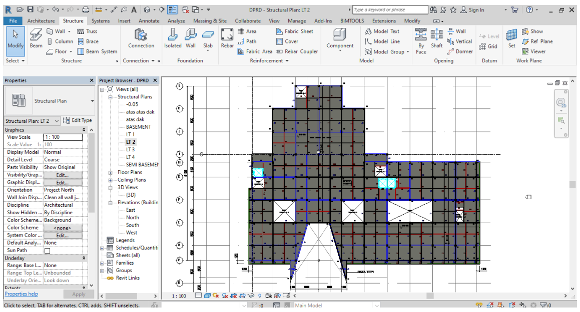

Figure 8. Floor Plate View in Structural Plan

10. Create architectural components starts from the ladder that matches the DED image by changing the initial settings in the Ribbon Architecture then selecting Stair as shown in Figure 9.

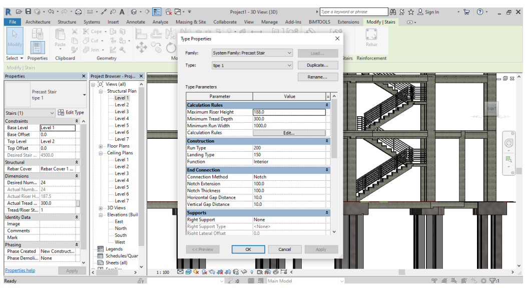

Figure 9. Stair View

11. Create walls, doors, and windows by selecting Wall, Door, and Window in the Ribbon Architecture and changing their Properties to match those used in the project as shown in Figure 10.

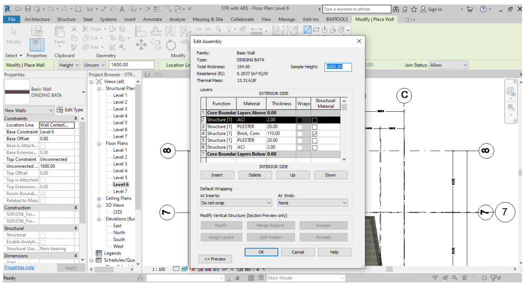

Figure 10. Edit Assembly Tab View

12. Create a ceiling on the Views Floor Plans and select Ceiling in the Ribbon Architecture as shown in Figure 11.

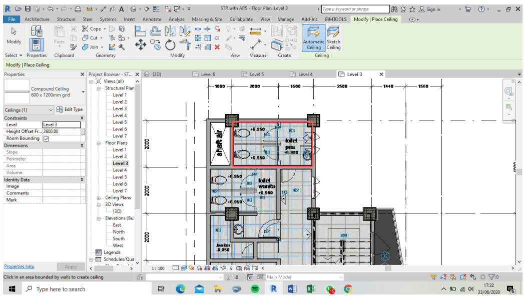

Figure 11. How to Create a Ceiling

13. Make floor coverings according to the type, size and placement as shown in Figure 12.

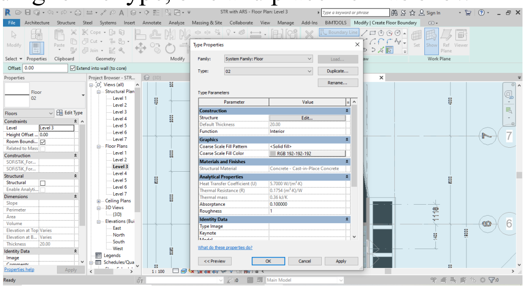

Figure 12. Type Properties to Make Floor Coverings

3. RESULTS AND DISCUSSION

The calculation result of the effectiveness using BIM on the accuracy of the BoQ:

Pile Cap Validation

Figure 13 is the results of the pile cap volume output:

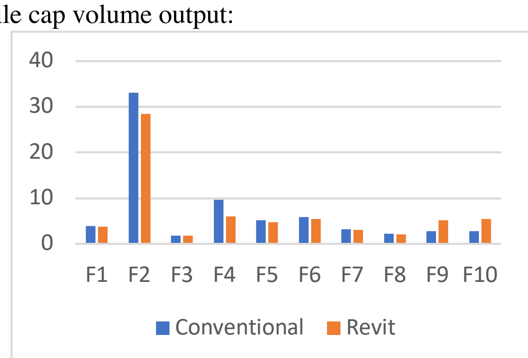

Figure 13. Pile Cap Comparison Graph

The output volume of Revit is 5.93% lower than conventional calculations because Revit calculations are more accurate in calculating irregular pile cap shapes such as the F2 type pile cap.

Column Validation

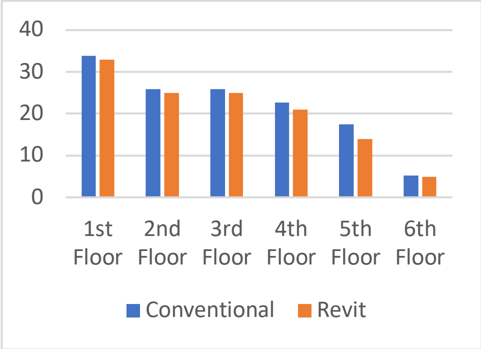

Figure 14. Column Comparison Graph

Figure 14 shows the comparison graph between the calculation of conventional and Revit. Revit result column volume 6.19% slightly smaller than the volume stated in the BoQ because the conventional calculation assumptions and Revit are the same, but a significant difference on the 5th floor occurs because of an error in the estimator in calculating the number of columns.

Beam Validation

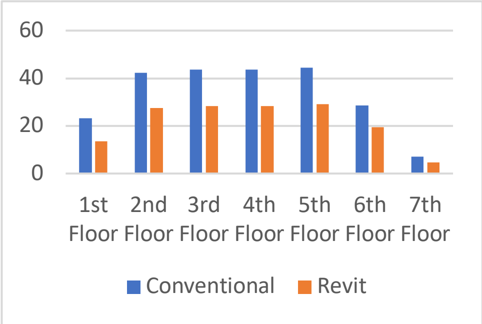

Figure 15. Beam Comparison Graph

The calculation of the beam in Revit uses the net span of the outer side of the column and for the beam sloof uses the net span of the outer side of the pile cap, while the conventional calculation uses the span of the axle to the axle of the beam without reducing the volume of the column side and the side of the pile cap. The differences can be showed in Figure 15. The meeting of the plate and beam also affects the volume of the beam, this causes a significant difference 35.27% between the Revit calculation and manual calculation.

Floor Plate Validation

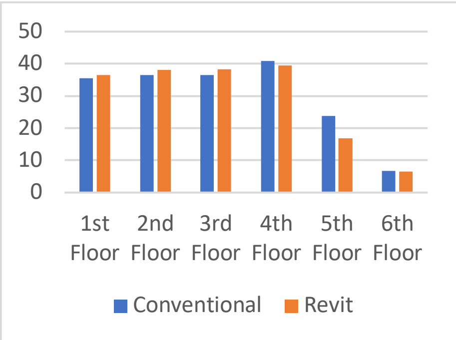

Figure 16. Floor Plate Comparison Chart

Furthermore, for the plate volume from Revit, which is to directly calculate the entire slab area multiplied by the thickness of each floor, without reducing the area of the columns and beams, so that the results do not have a significant difference with conventional calculations as shown in the Figure 16 which is only 2%. If there is a significant change, it can be caused by the incompatibility of the plan drawing with the calculation of the BoQ.

Stairs Validation

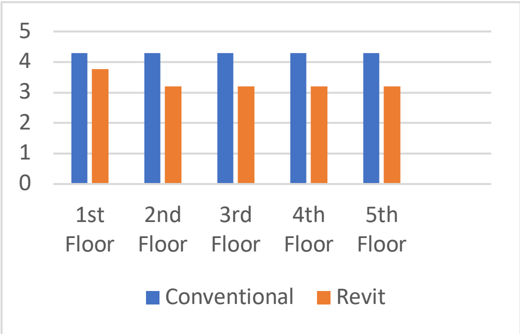

Figure 17. Stairs Comparison Graph

The volume of stairs produced by Revit with conventional calculations differs by almost 20% as shown in Figure 17, this is because Revit calculates the suitability of the height of the stairs and the width of the steps widths with the floor height of the building. So that if its not ideal, Revit will automatically resize it.

Wall Validation

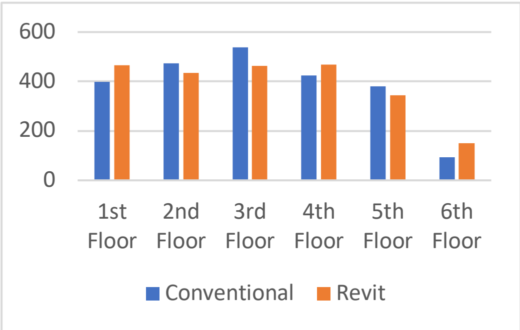

Figure 18. Wall Comparison Graph

The wall calculation by Revit does not have a significant difference with conventional calculations as shows in Figure 18, which is only 0.78% different, however, for the wall drawing must be careful because Revit does not reduce the wall area when drawing on the axle of the column, so the wall drawing must start on the outer side of the column. The calculation can also be more accurate because the wall area can be automatically reduced when entering door and window materials.

Validation of Floor Coverings and Ceiling

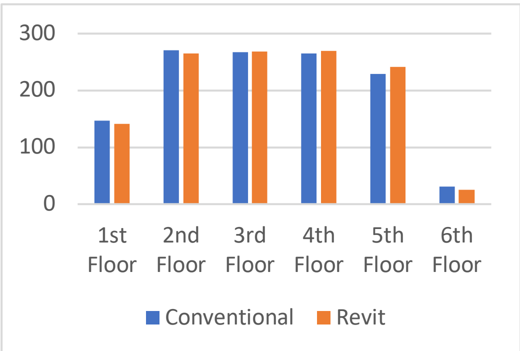

Figure 19. Floor Coverings Comparison Graph

Figure 19 and Figure 20 shows the comparison graph between the calculation of conventional and Revit. The area of floor coverings and ceilings is not automatically reduced when there are walls or columns around them, so the drawing must be done carefully to achieve accurate results.

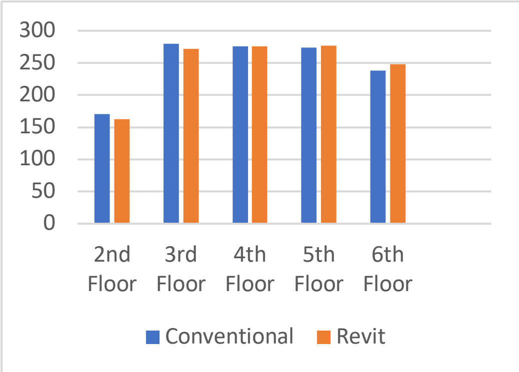

Figure 20. Ceilings Comparison Graph

All comparison data for each component are summed and the average difference is obtained as in the Table 1.

Table 1. Average differences in calculations

Component	Difference in calculation (%)
Pile Cap	5
Column	6
Beam	35
Platform	2
Stairs	22
Ceiling	2.26
Floor Covering	14
Wall	-0.78
Total	85.48
Average	10.68

4. CONCLUSION

The difference between conventional BoQ calculations and Revit calculations is around 10%, therefore this proves that the BIM method can help calculate quantity more quickly and accurately.

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