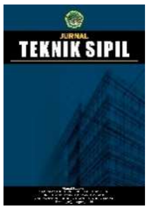
Jurnal Teknik Sipil,
Vol. 17, No.1, 2024, Hal 13-22
p-ISSN: 2963-7287 e-ISSN: 2963-6701

JURNAL TEKNIK SIPIL
Universitas 17 Agustus 1945 Semarang
Jurnal Home Page: https://jurnal2.untagsmg.ac.id/index.php/JTS



The Implementation of BIM Tekla Structure on Quantity Take Off for Structural Works of X Building Project

Eka Aprillia[1*], I Nyoman Dita Pahang Putra[1]
[1]Departement of Civil Engineering, University of Pembangunan Nasional Veteran Jawa Timur
Email: ekaapr23@gmail.com*

Diterima Mei 2024; Disetujui Mei 2024; Dipublikasi Juni 2024

Abstract. BIM technology in the construction world is growing. However, the application of BIM in Indonesia has not been carried out thoroughly. BIM technology can help quantity take off work that affects the success or failure of a project. BIM can reduce the error rate of quantity take off planning calculations compared to manual calculations. Tekla Structure is one of the software developments of BIM that can produce quantity take off building output along with 3D visualisation. This research conducts 3D modelling and discusses the comparison of quantity take off using BIM-based software Tekla Structures with a recap of the manual calculation contained in the initial Bill of Quantity for the X Building Project planning. This difference can be used as a consideration for the application of BIM in the initial calculation of project planning. The percentage difference obtained for the pile cap resulted in concrete volume deviation of 0.69% and -19.1% for reinforcement volume. The spun piles work resulted in a concrete volume deviation of -0.8% and reinforcement volume of 8.45%. In the calculation of column work, the deviation value for concrete volume is 3.14%, while the volume of reinforcement is -12.2%. The results of the BIM quantity take-off are deemed more reliable due to the 3D visualization of BIM objects and the ability to adjust the detail of work elements.

Keywords: BIM, Tekla Structure, Quantity Take-off

1 Introduction

Building Information Modeling (BIM) is the outcome of technological advancements in the construction industry. BIM enables the conceptual visualization of virtual buildings prior to the actual construction phase, facilitating the analysis of potential errors [1]. BIM can foster effective communication among stakeholders as well [2]. Currently, BIM has developed to 7D BIM.

The utilization of Building Information Modeling (BIM) in Indonesia lags behind of developed nations. This lag in BIM implementation primarily stems from a lack of awareness regarding its pivotal role and the scarcity of proficient experts within Indonesia.

Additionally, the high cost associated with BIM software poses a significant barrier to its widespread adoption [3].

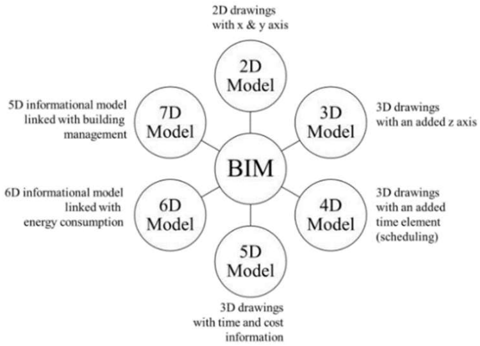


Figure 1 BIM dimensions
(Sari et al.,(2020))

BIM-based software has the capability to automatically and more accurately generate quantity take-off, accountable by the presence of BIM objects in 3D[4]. In contrast, traditional methods of quantity take off necessitate high precision and may involve discrepancies in calculation assumptions. Errors in quantity take off calculations can have adverse effects on multiple stakeholders and impact the projects success. Quantity take-off derived from 2D drawings typically lacks the necessary level of detail, particularly when assessing interactions between structural elements like beam-column, beam-plate, and others[5].

Tekla Structures represents one of the outcomes of the advancement in BIM software, encompassing a comprehensive array of solutions tailored for structural BIM [6]. Tekla Structures has the capability to integrate scheduling, produce detailed drawings, and model complex structures along with their respective materials.

In 2024, Saputro et al. conducted a study comparing BIM-based quantity take-off with the Mutual Check 100 (MC-100) document. The findings revealed that the overall concrete difference percentage was 0.2% smaller than what was stated in the Bill of Quantities (BOQ). The results for the difference in reinforcement are also 12.5% smaller. Saputro et al. concluded that the conventional quantity take-off method is less comprehensive compared to the BIM approach [7].

In this study, the BIM method was applied by modeling the X Building Project in 3D to integrate all data and analyze quantity take-off comparisons. The comparison of quantity take-off based on the planned Bill of Quantity document with quantity take-off based on BIM software Tekla Structures was conducted to determine the percentage of difference.

Jurnal Teknik Sipil,
Vol. 17, No.1, 2024, Hal 13-22
p-ISSN: 2963-7287 e-ISSN: 2963-6701

2 Research Methods

This research utilizes secondary data from the Detail Engineering Design of the DKV ITS Building Project, which is then modeled in Tekla Structures. The modeling process focuses on the structural components such as pile caps, piles, and columns. Following the 3D modeling, volume calculations are performed utilizing the organizer feature. The volume data is subsequently processed using Microsoft Excel, which is integrated with Tekla Structures, and compared the volume of structural work specified in the planned Bill of Quantity. Below is a flowchart delineating the research implementation:

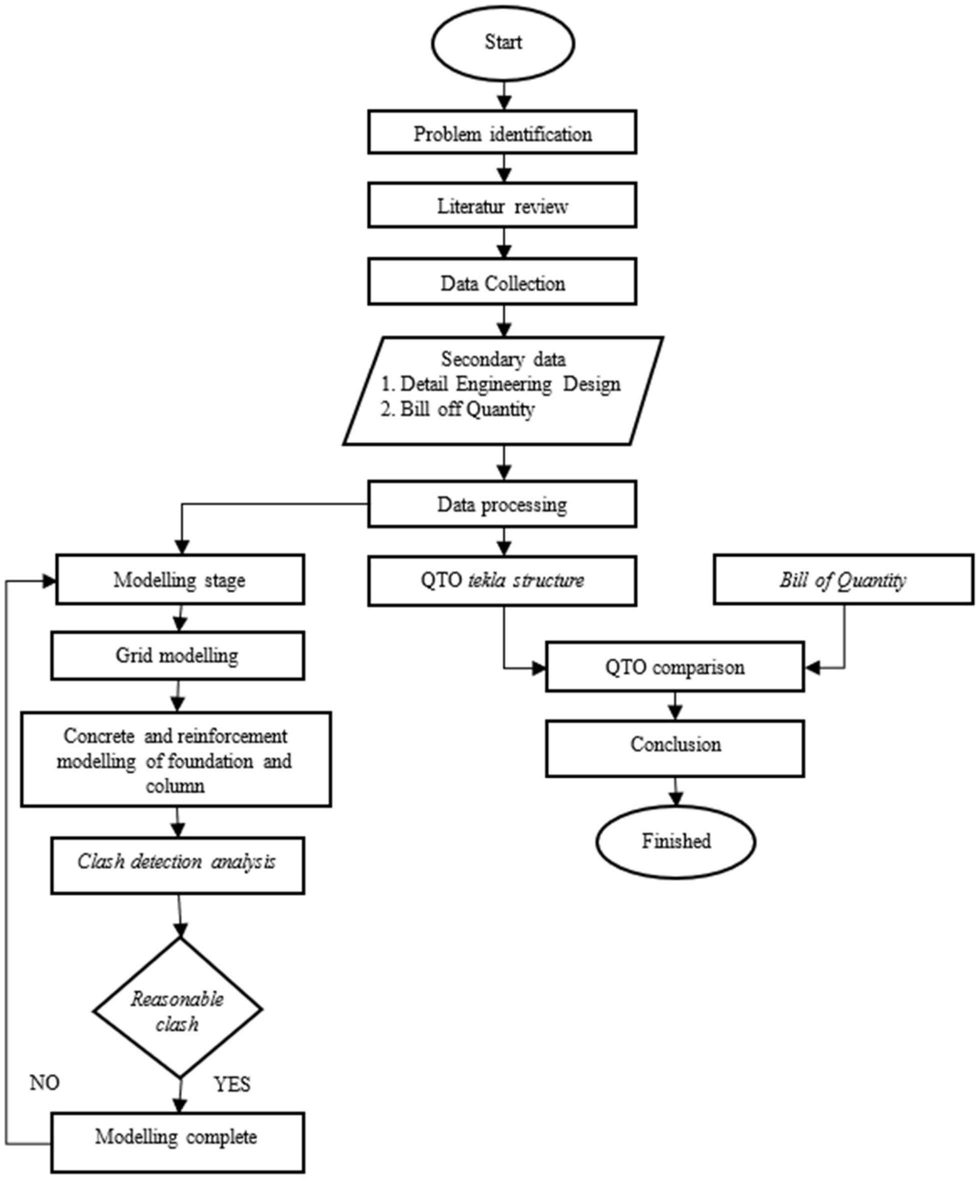


Figure 2 Research flow chart

3 Results and Discussion

3.1 3D Modelling of Tekla Structure

The structural elements designated for modeling encompass the foundation structure, which includes modeling of pile caps and spun piles, succeeded by modeling of the column structure.

A. Tekla Structure file creation

1.) Login to the Trimble Tekla Structures web platform. 2.) Proceed to log in to the Tekla Structures software. Choose the South-East Asia environment to showcase the modeling materials. Then, click OK. 3.) Opt for "new," assign a name to the file, and proceed to click "create."

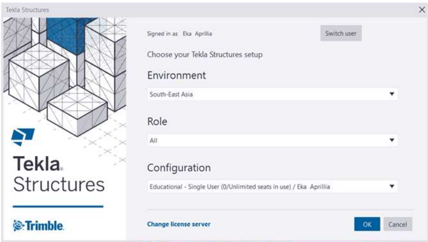


Figure 3 South east asia environtment

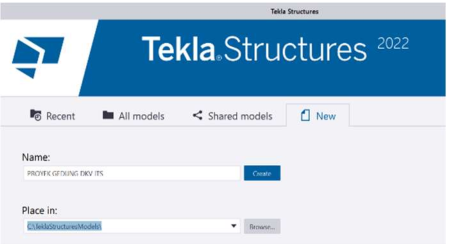


Figure 4 Tekla Structure file

B. Grid modelling

1.) Double-click on the existing grid until the grid properties appear. 2.) Fill the properties according to the planning grid. The X-axis is for a horizontal and the Y-axis represents the vertical direction. For modelling the building elevation on the Z axis. 3.) Import CAD files in DWG form for grid adjustment and help in modeling.

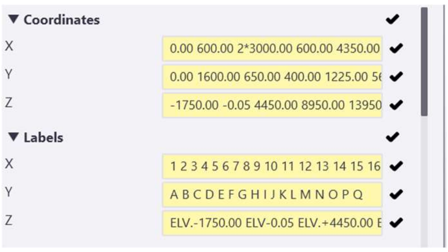


Figure 5 Grid properties

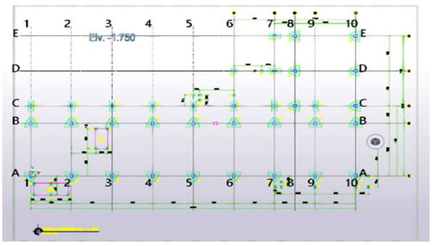


Figure 6 Import CAD

C. Pile cap modelling

The X Building project incorporates four types of pile caps, namely PC1, PC2, PC3, and PC4.

1) Concrete Modelling

Klik concrete footing lalu pilih pad footing. Input the specific details of the pile cap in the properties of the pad footing. Specify the name, profile shape, dimensions, concrete grade, and elevation thickness. For instance, model PC1 as a trapezoidal shape measuring 2280 x 1974 mm with a thickness of 800 mm. For concrete coverings, input the global concrete covers for rebar, which are 75 mm on each side.

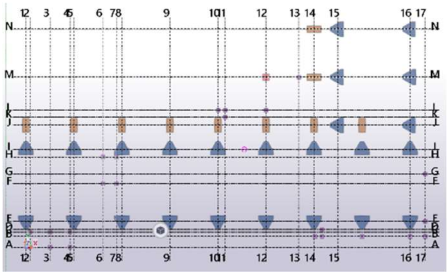


Figure 7 Concrete pile cap

2) Reinforcement modelling

Choose rebar crossing. Input the properties with the diameter and spacing of the rebar. Proceed to select the concrete pile cap and enter. Utilize the splitter tool to model the reinforcement connection. The reinforcement of the pile cap comprises horizontal, vertical, and stirrup reinforcement.

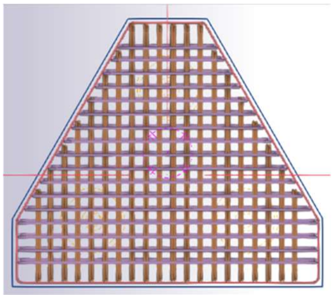


Figure 8 Pile cap reinforcement

D) Modelling of piles

The piles used are spun piles with a depth of 18 meters.

1) Concrete modelling

Click concrete column option and input the properties accordingly. Utilize a circular section profile to model the inner diameter at 290 mm, and for the outer diameter at 450 mm, employ a circular hollow section profile to prevent concrete collision. Divide the modeling of the 18-meter piles into three segments: 2 meters for the pile head and 16 meters for the remaining length of the piles and the pencil shoe.

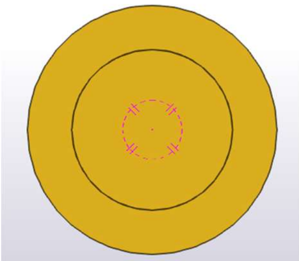


Figure 9 Top view of concrete piles

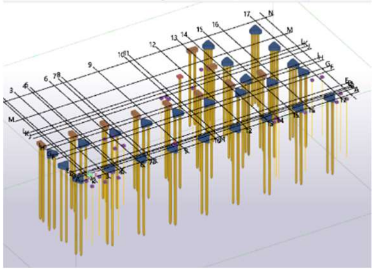


Figure 10 Concrete piles

2) Reinforcement modelling

Open the Applications and components menu, then choose Round Column Reinforcement. Input the main bars with 10D-16 and an reinforcement anchorage length of 50D. Stirrups and stirrups attribute for modeling D13-150 stirrups.

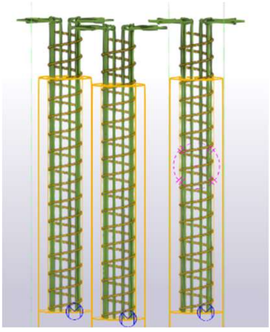


Figure 11 Reinforcement piles

E) Column modelling

There are three types of column sizes used, namely K1, K2 and K3.

1) Column modelling

Select concrete column. Fill in the properties. Place the concrete column on top of the pile cap according to the planning drawing.

2) Reinforcement modelling

Open the Applications and components menu, choose rectangular column reinforcement. Input the main bars and side bars for modeling the main reinforcement. Bar ends are utilized for modeling reinforcement extensions such as anchorage and crossing connections, adapted to building standards. Stirrups are employed for modeling stirrup reinforcement. Utilize bar group tools to generate detailed hook stirrup modeling.

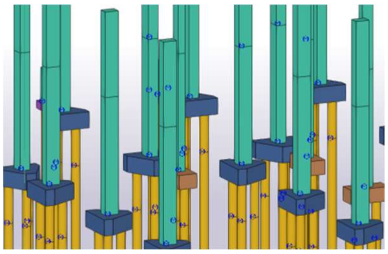


Figure 12 concrete column

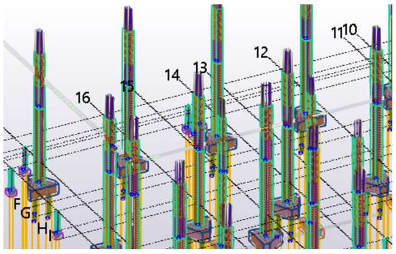


Figure 13 Column reinforcement

3.2 Clash Detection Analysis

Clash detection is employed to identify structural collisions. Click on "manage," then select "clash check" until the clash check manager appears. Select the structure modelling that will be clash checked. Click run in the clash check manager.

The clash check results will appear along with the clash sign.

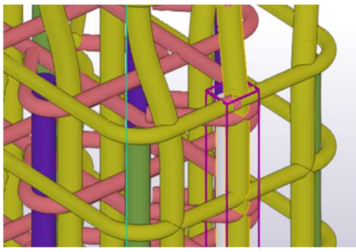


Figure 14 Column clash

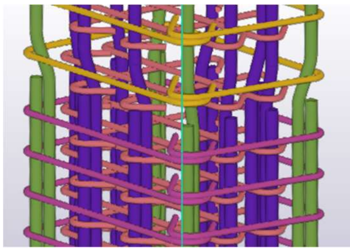


Figure 15 Clash fix result

A clash was detected in the column section. Remedial action was taken by adjusting the upper main reinforcement to align with the lower main reinforcement.

3.3 Quantity take off

Enable the selection of objects in components. Block all modeling by pressing CTRL+A. Click on "manage" and then access the "organizer." The Tekla Structures quantity take-off feature will appear automatically.

Table 1 Recapitulation of Tekla Structure QTO results

No.	Name of Work	Tekla Structure BIM Volume	Unit
1	**Pile cap**		
	Concrete	85.87	m3
	Reinforcement	114333.84	kg
2	**Pile head**		
	Concrete	12.18	m3
	Reinforcement	5362.5	kg
3	**Column elv -0.05 to elv +4450**		
	Concrete	134.54	m3

Reinforcement	35159.50	kg

3.4 Comparison of *Tekla Structure* Quantity Take Off with BOQ

Based on the recapitulation of the results of modelling using tekla structure that has been carried out, a comparison of the quantity take off of foundation and column work based on BIM and BOQ planning X Building Project is obtained.

Table 2 Comparasion of quantity take-off

No.	Name of Work	Unit	Volume		DEV. (%)	Desc.
			BIM	BOQ		
1	**Pile cap**					
	Concrete	m3	85.87	85.28	0.69%	BIM > BOQ
	Reinforcement	kg	11433.84	14141.96	-19.1%	BIM < BOQ
2	**Pile head**					
	Concrete	m3	12.18	12.28	-0.8%	BIM < BOQ
	Reinforcement	kg	5362.50	4940.38	8.54%	BIM > BOQ
3	**Column elv -0.05 to elv +4450**					
	Concrete	m3	134.54	130.45	3.14%	BIM > BOQ
	Reinforcement	kg	35159.50	40039.56	-12.2%	BIM < BOQ

A negative deviation indicates that the BIM volume result is smaller than the volume specified in the Bill of Quantities (BOQ) of the planning document, while a positive deviation indicates a larger BIM volume.

The deviation in pile cap concrete work is relatively insignificant at 0.69%. The author concludes that the planner may have been less meticulous in calculating the volume of pile cap concrete, especially failure to calculate the volume of PC4 as indicated in the Detail Engineering Design (DED) drawing of 23 pile caps. For pile cap reinforcement, the deviation value is -19.1%, signifying a considerable disparity. This deviation is substantial due to the planner's oversight in calculating the pile cap concrete blanket, consequently affecting the iron requirement.

The analysis of the deviation in pile head concrete work indicates that the BIM volume is -0.8% less than what is specified in the Bill of Quantities (BOQ). The author concludes that there are differences in calculation assumptions and accuracy in calculating the volume of pile head concreting. Conversely, for reinforment work, the BIM results exhibit a 8.54% increase. This discrepancy arises from differences in calculating the anchorage of the pile head entering the pile cap.

Regarding column concrete work, the author concludes that the planner calculated the column concrete volume not from the top elevation of the pile cap, but as indicated in the BOQ, from elevation -0.05. This discrepancy in calculation methodology results in a 3.14% larger volume of column concrete in BIM compared to the planning BOQ. The column reinforcement work has a deviation value of -12.2%. This variance stems from differing assumptions regarding iron anchorage into the pile cap, the connection between columns, and the detailing of column stirrups and hook stirrups, ultimately leading to smaller BIM volume results.

4 Conclusion

From the research titled "The Implementation of BIM Tekla Structure on Quantity Take Off for Structural Works of X Building Project" the authors derive the following conclusions.

Structural modeling has been conducted, beginning with the pile cap and spun piles foundations to columns. The results of the quantity take-off in Tekla Structures are generated using the organizer feature and subsequently processed with the assistance of Microsoft Excel.

The comparison of the quantity take-off for structural work on the X Building Project is outlined as follows. A negative sign (-) indicates that the volume derived from the BIM method is smaller than the planned BOQ volume, and vice versa. The foundation work is divided into two parts: pile cap and spun piles. The percentage difference obtained for the pile cap resulted in concrete volume deviation of 0.69% and -19.2% for reinforcement volume. The spun piles work resulted in a concrete volume deviation of -0.8% and reinforcement volume of 2.02%. In the calculation of column work, the deviation value for concrete volume is 2.73%, while the volume of reinforcement is -12.2%. The results of the BIM quantity take-off are deemed more reliable due to the 3D visualization of BIM objects and the ability to adjust the detail of work elements.

References

[1] D. Laorent, P. Nugraha, and J. Budiman, “Analisa Quantity Take-Off Dengan Menggunakan Autodesk Revit,” *Dimensi Utama Teknik Sipil*, vol. 6, no. 1, pp. 1–8, 2019, doi: 10.9744/duts.6.1.1-8.

[2] Y. C. Sari, C. A. Wahyuningrum, and N. C. Kresnanto, “Building Information

Modeling (BIM) for Dams-Literature Review and Future Needs," *J. Civ. Eng. Forum*, vol. 6, no. 1, p. 61, 2020, doi: 10.22146/jcef.51519.

[3] H. Fitriani, A. Budiarto, A. Rachmadi, and A. Muhtarom, "Analisis Persepsi Perusahaan Architecture, Engineering, Construction (AEC) terhadap Adopsi Building Information Modeling (BIM)," *Media Tek. Sipil*, vol. 19, no. 1, pp. 25–32, 2021, [Online]. doi: 10.22219/jmts.v19i1.14281

[4] S. Arrafi, W. Alamsyah, and M. Purwandito, "Penerapan Building Information Modeling (BIM) Pada Gedung Kuliah Pascasarjana IAIN Langsa Menggunakan Software Tekla Structures," *Prince J. Plan. Res. Civ. Eng.*, vol. 2, no. 1, pp. 146–159, 2023,[Online].Available:https://ejournal.unidaaceh.ac.id/index.php/prince/article/view/449

[5] S. Alshabab, A. . Vysotskiy, and T. Khalil, "BIM-based quantity take-off," *Build. Inf. Model. Technol. Found. Ind. Pract.*, vol. 4, no. 55, pp. 383–391, 2018, doi: 10.1007/978-3-319-92862-3_23.

[6] S. Firoz and S. K. Rao, "Modelling Concept of Sustainable Steel Building by Tekla Software," *Int. J. Eng. Res. Dev.*, vol. 1, no. 5, pp. 18–24, 2012, [Online]. Available: https://www.semanticscholar.org/paper/Modelling-Concept-of-Sustainable-Steel-Building-by-Firoz/4628d64c6c275b9f43f246186b754ba10fcd4ba0

[7] D. N. Saputro, S. J. Dilaga, N. Intang, S. Hermanto, H. Susanto, and U. J. Soedirman, "Implementasi Metode Building Information Modeling (BIM) Pada Tahap Mutual Check-100 (MC-100) Pada Pekerjaan Struktur," vol. 7, no. 1, pp. 13–22, 2024, doi: 10.24815/jarsp.v7i1.33075.