P-ISSN : 2598-1277
E-ISSN : 2621-3966

JOURNAL OF GREEN SCIENCE AND TECHNOLOGY

VOLUME REQUIREMENT ANALYSIS OF BEAM STRUCTURE WORK

'Ilma Alfianarrochmah[1*], Muhammad Nazhif Irsyal Fikri[1]

[1]) D3 Civil Engineering Study Program, Universitas Sebelas Maret, Surakarta.*
Corresponding Author's Email: ilmaalfianarrochmah@staff.uns.ac.id
No.HP Corresponding Author: 082138640390

ABSTRACT

Beams serve as the main structural elements that transmit loads from floor slabs to columns and ensure the overall stability of the building. Calculation of beam volume requirements is essential to determine the amount of materials required, such as concrete and reinforcing steel. The conventional method of calculating the volume of a beam structure involves the use of basic mathematical formulas to calculate the dimensions and volume of materials required. This method is often used in the learning process of civil engineering to teach basic concepts of volume calculation. The method of implementing beam structure work affects the technical aspects. Therefore, it is necessary to conduct research related to the calculation of beam structure requirements in the Joglo Elementary School building construction project. The purpose of this research is to analyze the needs of bracing, formwork, and concreting on floors 1, 2, and 3 of the Joglo Elementary School Building Project. This type of research is quantitative research. The calculation uses conventional methods (mathematical formulas). The data collection method used is the field observation method and data processing is assisted using Microsoft Excel 2021 software. The need for beam formwork for the 1st floor is 12,492.12 kg, the 2nd floor is 28,222.35 kg, and the 3rd floor is 28,222.35 kg. The formwork requirements for the 1st floor beams amounted to 627.220 m^2, the 2nd floor amounted to 873.91 m^2, and the 3rd floor amounted to 873.91 m^2. The need for concreting the 1st floor beam or tiebeam is 68,424 m^3, the 2nd floor is 97,084 m^3, and the 3rd floor is 97,084 m^3.

Keyword: *Beam Execution Method, Concreting, Formwork.*

1. INTRODUCTION

The calculation of the volume of beam structures using conventional methods involves the use of basic mathematical formulas to calculate the dimensions and volume of materials required. Conventional methods use basic formulas the are easy to understand so that they can be accessed by various groups. The use of conventional methods does not require expensive software or advanced technology, making it more economical, especially for small or medium projects. Conventional methods allow flexibility in the process of adjusting calculations based on field conditions that may change, such as design modifications or technical difficulties that arise during construction. By not relying of software, the risk of errors that may occur due to bugs or technical problems can be minimized. This method is often used in the learning process of civil engineering to teach the basic concepts of volume calculation, thus helping students understand the basic principle before moving on to more complex methods [1].

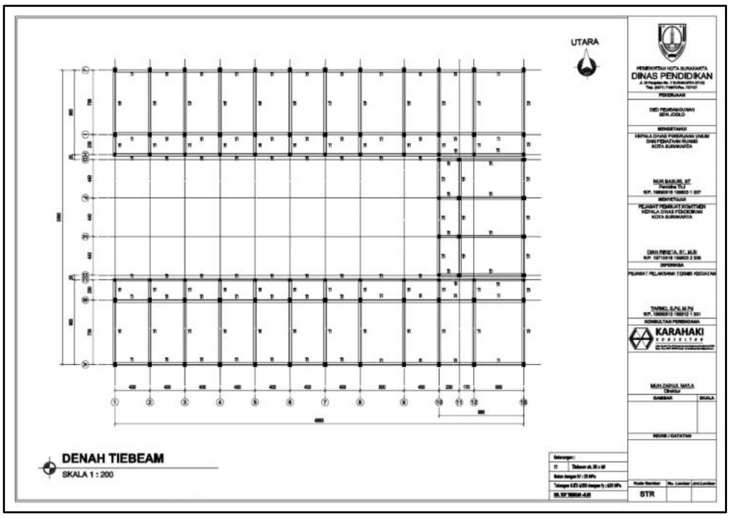
In the construction of the SDN building, planning is needed, especially in structural word [2]. One of them planning in terms of methods and materials for structural work. The beam structure serves as one of the main structural elements that ensure the overall stability of the building [3][4]. The method of implementing beam structure work in construction projects is important to note [5] to ensure the success and efficiency of development. The implementation method of beam structure works not only affect the technical aspects of the construction project but also the overall success of the project in terms of time, cost, and quality [6]. The calculation of beam structure requirements is very important in the context of building construction planning [7]. The calculation of beam volume requirements is very important to

P-ISSN : 2598-1277
E-ISSN : 2621-3966

determine the amount of material required, such as bracing, formwork, and concreting [3] [8]. The availability of sufficient materials will affect the sustainability of the project and avoid waste or material shortages. Therefore, research will be conducted related to the calculation of beam structure requirements in the Joglo Elementary School building construction project. The purpose of this research is to analyze and identify the need for bracing, formwork, and concreting on floors 1, 2, and 3 of the Joglo Elementary School Building Project.

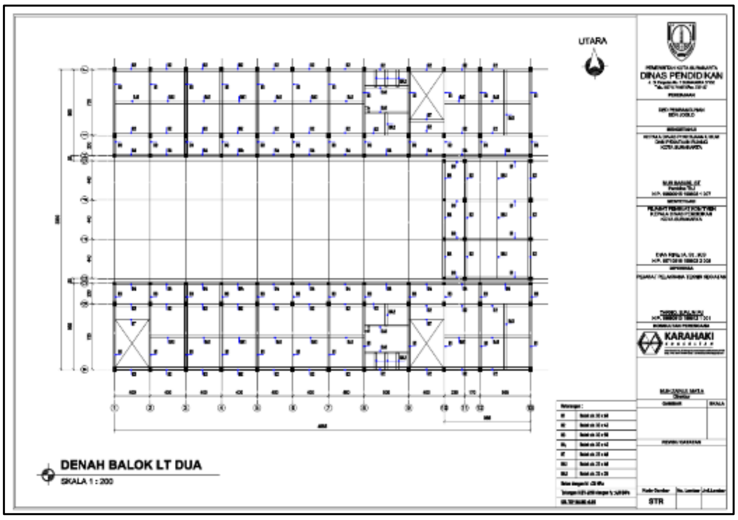
2. RESEARCH METHODOLOGY

This type of research is quantitative research. The calculation uses conventional method (mathematical formulas) [9]. The data collection method is used is the field observation method and data processing is assisted using *Microsoft Excel* software [8][10]. The data sources in this study are primary data and secondary data. The primary data is question is observation data and volume calculation analysis, while the secondary data in question is Detail Engineering Drawing data. This research will calculate the needs of bracing, formwork, and concreting in the construction project of the Joglo Elementary School Building which consists of 3 floors. Analysis of the calculation of the volume of beam work on the SDN Joglo Building Construction Project based on the Detail Engineering Drawing of the project. The working drawings used can be seen in Figure 1 until Figure 3.



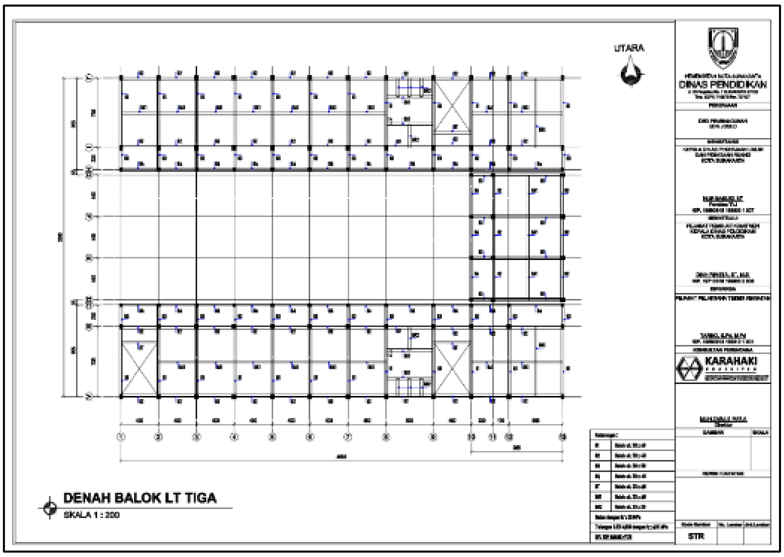
Source : DED Development of SDN Joglo

Figure 1. Plan of the 1st Floor Beam Work (*tiebeam*)



Source : DED Development of SDN Joglo

Figure 2. Plan 2nd Floor Beam Work



Source : DED Development of SDN Joglo

Figure 3. Plan of the 3rd Floor Beam Work

The construction project for the SDN Joglo Kota Surakarta workplace building involves the use of 8 types of beams with varying dimensions. For reinforcement, BJTS 420 B with a yield strength (fy) of 410 MPa is used. The concrete quality of the beams is set at K-300 or equivalent to 25 MPa, with a target slump value of 10 ± 2 cm. In analyzing the calculation of beam reinforcement requirements, the author uses the following formula:

Total wight = (Support + Field + Stir) x number of points .... (1)
Reinforcement weight= amount of reinforcement x length x coef. iron.................. (2)
Coef. iron weight= $\frac{1}{4} \times \frac{22}{7} \times D^2 \times 7850$.. (3)
Weight of stirrups= number of reinforcement x (circumference + overlap) x coef.iron(4)
Overlap = (10 cm assumption for bending)

Where
7850 = spesific gravity of steel (kg/m^3)

In analyzing the calculation of beam formwork requirements, the author uses the following formula [1]:

Volume = ((2 x length x height) + (length x width)) x QTY .... (5)

In the analyzing of the calculation of the volume of beam concreting, you can uses the following formula [1]:

Volume = length x width x height x QTY.. (6)

3. ANALYSIS RESULTS AND DISCUSSION

Identification of implementation methods is carried out during field observations or observations. Analysis of the need or volume of material for beam structure work on the Joglo Elementary School Building Construction Project consists of the need for concreting, formwork installation, and concreting.

3.1. Beam Work Implementation Method

The following is the method of implementing beam work on the SDN Joglo Workplace Building Construction Project.

1. Beam Fixing Work
   The stages of beam concreting work include :
   a. Ensuring tools and materials (reinforcing steel, cutting tools, binders, and meansuring tools) are available.

 P-ISSN : 2598-1277
E-ISSN : 2621-3966

b. Cutting reinforcing steel according to the length and spesifications specified in the working drawings.

Figure 4. Cutting Reinforcing Steel

c. Bend reinforcing steel according to the shape and size specified in the working drawings using a reinforcement bending tool.
d. Assembling reinforcing steel. Ensure all reinforcement connections using binding wire are strong and neat.
e. Install the main reinforcement (longitudinal bars) and make sure the distance between the reinforcement is in accordance with the spesifications.

Figure 5. Installation of Main Reinforcement

f. Install stirrups around the main reinforcement. Ensure the spacing between stirrups is in accordance with the specifications in the working drawings.
g. Double check that all reinforcement have been installed correctly and in accordance with the working drawings.
h. Take measurement to ensure the distance between reinforcement, the length of the reinforcement, and the position of the reinforcement are in accordance with the spesification.

P-ISSN : 2598-1277
E-ISSN : 2621-3966

Figure 6. Measurement of Distance between Rebar

i. Tie all reinforcement connections firmly with binding wire. Ensure strong ties so as not to shift during the casting process.

Figure 7. Tying Reinforcement Connections with Wire Hooks

2. Beam Formwork Work
   Stages of beam formwork work include :
   a. Ensuring all formwork material; wood plywood, nails, and tools; saws, hammes, and meters are available.
   b. Checking the condition of the formwork material so that nothing is damaged or detective.
   c. Measuring beam dimensions according to technical specifications.
   d. Install scaffolding on the formwork to prevent shifting or deformation during casting.Stiffeners and supports must be strong and stable to withstand the load of wet concrete.

Figure 8. Installation of scaffolding on formwork

 P-ISSN : 2598-1277
E-ISSN : 2621-3966

e. Install the beam formwork on top of the scaffolding as a support and arrange the reinforcement according to the predetermined dimensions. Use nails or bolts to tighten the formwork so that it is sturdy and does not leak.

Figure 9. Installing formwork on *scaffolding*

f. Perform a final check on the formwork to ensure there are no leaks or unevenness.

3. Making Cyclindrical Concrete Test Object

The stages of making cylindrical concrete include:

a. Prepare concrete materials such as cement, coarse aggregate, fine aggregate, and water according to the specified mixture proportions.
b. Also prepare tools such as slump cones (*Abrams cones*), compactor rods (16 mm diameter and 600 mm long), flatbeds (iron or glass plates), and concrete cyclinder molds (15 cm diameter and 30 cm hight).
c. Mixing the concrete ingredients in the mixer according to the specified proportions until a homogeneous mixture is archived (the constituent substances are completely mixed).
d. Placing the slump cone on a clean and moist flat base, without standing water.
e. Filling the cone with fresh concrete in three layers, each one-third the height of the cone (approximately 100 mm per layer).
f. Each layer is compacted 25 times with a compaction rod inserted evenly across the surfaces of the layer.
g. Repeating the filling and compacting steps for the second and third layers, ensuring that the last layer is filled to the brim and leveled.
h. Hold the cone with both hands and lift it vertically upwards for 5-10 seconds, avoiding horizontal or wobbling movements.
i. Place the cone next to the collapsed concrete and measure the distance between the height of the cone and the height of the collapsed concrete. This is the slump value.

Figure 10. Measuring the Height of the Concrete Mix

P-ISSN : 2598-1277
E-ISSN : 2621-3966

j. Fill the cyclinder mold with concrete in three layers, each about 10 cm thick.
k. Each layer should be compacted using a tamping rod 25 times for each layer to remove air bubbles and ensure concrete density.
l. After the mold is completely filled, level the concrete surface using a leveling tool (trowel) so that the concrete surface becomes flat and smooth.

Figure 11. Levelling the surface of cylindrical test specimens

m. Leave the concrete in the mold for a period of 24 hours in humid conditions and protected from vibration or other disturbances.
n. After 24 hours, remove the concrete from the mold carefully so as not to damage the shape and surface of the concrete.
o. Place the concrete test specimens in clean water or in a curing chamber with high humidity for 28 days to ensure the concrete reaches maximum strength.
p. After the curing period, the concrete specimens are ready for testing, usually using a compression testing machine to determine the compressive strength of the concrete.

Figure 12. Testing Concrete Cylinder Compressive Strength

4. Beam Concreting Work

Stages of beam casting work include:

a. Ensure that all tools and materials such as concrete, molds (formwork), vibrators, and measuring instruments are available.
b. Check the strentght and straightness of the formwork to avoid deformation during casting. Make sure the formwork has been smeared with formwork oil to facilitate removal.
c. Recheck the position and height of the reinforcement and formwork using measuring instruments.
d. Pour concrete gradually and evenly into the formwork. Use a vibrator to ensure the concrete fills all spaces and no air is trapped.

P-ISSN : 2598-1277
E-ISSN : 2621-3966

Figure 13. Pouring fresh concrete using a pump truck

e. Level the concrete surface using a screed or ruler.
f. Recheck the quality of the casting to ensure there are no cracks or voids in the concrete.
g. Curing to keep the concrete moist so that the hydration process runs well. This can be done by springkling water.
h. Remove the formwork after the concrete has reached a certain strength, usually after 7 days.
i. Conduct final inspection to ensure the quality of concrete and the accuracy of beam dimensions according to specification.

3.2. Calculation of Beam Fixing Requirements

The following is an analysis of the calculation of formwork requirements for beam type T1a beams used in this project. The recapitulation of the calculation of formwork requirements for beam work can be seen in Table 2 below.

V = (pedestal weight + field weight + stirrup weight) x number of points
= ((jumlah tulangan x panjang x koef. Besi) + (jumlah tulangan x panjang x koef. Besi) + (jumlah tulangan x (keliling + overlap) x coef. iron)) x number of points
= (1 x 1.2 m x $\frac{1}{4} \times \frac{22}{7} \times 0.019^2 \times 7850$ x 2) + (6 x 7.35 x $\frac{1}{4} \times \frac{22}{7} \times 0.019^2 \times 7850$) + (84 x (1.2 + 0.1) $\times \frac{1}{4} \times \frac{22}{7} \times 0.01^2 \times 7850$) x 28
= (5.341 kg + 74.498 kg + 67.325 kg) x 28
= 4,120.656 kg

Table 1. Recapitulation of Calculation of Beam Reinforcement Requirements

BEAM TYPE	LENGTH (M)	NUMBER OF POINTS	QUANTITY (Kg)	FIELD (Kg)	SENGKANG (Kg)	REINFORCEMENT WEIGHT (Kg)
1st Floor						
T1a	7.35	28	5.342	74.499	67.326	4,120.656
T1b	4.00	50	5.342	40.544	36.640	4,126.257
T1c	2.30	28	25.596	2.836	21068	2,182.074
T1d	4.00	25	5.342	40.544	36.640	2,063.128
			TOTAL			12,492.12
2nd Floor						
B1	7.35	28	21.367	123.575	309.958	12,737.206
B2	4.00	50	16.025	49.446	42.277	5,387.411
B3	2.30	28	42.733	2.836	130.459	4,928.808
B4	4.00	25	10.683	49.446	42.277	2,560.163
BT	4.00	2	5.342	49.446	39.458	188.493
BA1	4.20	29	-	42.571	31.961	2,161.428
BA2	2.00	8	-	20.272	12.084	258.847

BEAM TYPE	LENGTH (M)	NUMBER OF POINTS	QUANTITY (Kg)	FIELD (Kg)	SENGKANG (Kg)	REINFORCEMENT WEIGHT (Kg)
			TOTAL			28,222.356
3rd Floor						
B1	7.35	28	21.367	123.575	309.958	12,737.206
B2	4.00	50	16.025	49.446	42.277	5,387.411
B3	2.30	28	42.733	2.836	130.459	4,928.808
B4	4.00	25	10.683	49.446	42.277	2,560.163
BT	4.00	2	5.342	49.446	39.458	188.493
BA1	4.20	29	-	42.571	31.961	2,161.428
BA2	2.00	8	-	20.272	12.084	258.847
			TOTAL			28,222.356

Source: Analysis Result, 2025.

3.3. Calculation of Beam Formwork Requirements

The following is an analysis of the calculation of formwork requirements for beam type T1a beams used in this project. The recapitulation of the calculation of formwork requirements for beam work can be seen in Table 2 below.

T1a Formwork = ((2 x length x height) + (length x width)) x QTY
= ((2 x 7.35 x 0.4)+(7.35 x 0.3)) x 28
= 226.380 m^2

Table 2. Recapitulation of Calculation of Beam Formwork Requirements

BEAM TYPE	HEIGHT (m)	WIDTH (m)	LENGTH (m)	NUMBER	BEKISTING (m^2)
Floor 1					
T1a	0.4	0.3	7.35	28	226.380
T1b	0.4	0.3	4.00	50	220.000
T1c	0.4	0.3	2.30	28	70.840
T1d	0.4	0.3	4.00	25	110.000
		TOTAL			627.220
Floor 2					
B1	0.6	0.3	7.35	28	308.700
B2	0.4	0.3	4.00	50	220.000
B3	0.5	0.3	2.30	28	83.720
B4	0.4	0.3	4.00	25	110.000
BT	0.4	0.25	4.00	2	8.400
BA1	0.4	0.25	4.20	29	127.890
BA2	0.35	0.25	2.00	8	15.200
		TOTAL			873.910
Floor 3					
B1	0.6	0.3	7.35	28	308.700
B2	0.4	0.3	4.00	50	220.000
B3	0.5	0.3	2.30	28	83.720
B4	0.4	0.3	4.00	25	110.000
BT	0.4	0.25	4.00	2	8.400
BA1	0.4	0.25	4.20	29	127.890
BA2	0.35	0.25	2.00	8	15.200
		TOTAL			873.910

Source: Analysis Results, 2025.

3.4. Calculation of Beam Requirements

The following is an example of the calculation of concreting requirements for beam type T1a used construction. A recapitulation of the calculation of concreting requirements for beam work can be seen in Table 3 below.

Volume of concreting beam type T1a = length x width x height x number of points
= 7.35 x 0.3 m x 0.4 m x 28
= 24.696 m^3

Table 3. Recapitulation of Calculation of Beam Masonry Requirements

BEAM TYPE	HEIGHT (m)	WIDTH (m)	LENGTH (m)	NUMBER	VOLUME (m^3)
Floor 1					
T1a	0.4	0.3	7.35	28	24.696
T1b	0.4	0.3	4.00	50	24.000
T1c	0.4	0.3	2.30	28	7.728
T1d	0.4	0.3	4.00	25	12.000
		TOTAL			68.424
Floor 2					
B1	0.6	0.3	7.35	28	37.044
B2	0.4	0.3	4.00	50	24.000
B3	0.5	0.3	2.30	28	9.660
B4	0.4	0.3	4.00	25	12.000
BT	0.4	0.25	4.00	2	0.800
BA1	0.4	0.25	4.20	29	12.180
BA2	0.35	0.25	2.00	8	1.400
		TOTAL			97.084
Floor 3					
B1	0.6	0.3	7.35	28	37.044
B2	0.4	0.3	4.00	50	24.000
B3	0.5	0.3	2.30	28	9.660
B4	0.4	0.3	4.00	25	12.000
BT	0.4	0.25	4.00	2	0.800
BA1	0.4	0.25	4.20	29	12.180
BA2	0.35	0.25	2.00	8	1.400
		TOTAL			97.084

Source: Analysis Results, 2025.

4. CONCLUSION

The implementation of beam structure work includes concreting, beam formwork, concreting, demolition of beam formwork, and beam maintenance. The total beam work needs in the construction of the Joglo Elementary School Building are;

a. Floor beam or tiebeam reinforcement requirements amounted to 12,492.12 kg, floor 2 amounted to 28,222.35 kg, and floor 3 amounted to 28,222.35 kg.
b. Formwork requirements for the 1st floor beam or tiebeam amounted to 627.220 m^2, 2nd floor amounted to 873.91 m^2, and 3rd floor beam amounted to 873.91 m^2.
c. The need for concreting the 1st floor beam or tiebeam amounted to 68,424 m^3, the 2nd floor amounted to 97,084 m^3, and the 3rd floor amounted to 97,084 m^3.

REFERENCES

[1] M. A. Rahman, I. Aqiel, and D. A. Safitri, "Perhitungan Waste Material Pekerjaan Penulangan, Pengecoran Serta Pemasangan Bekisting Pada Proyek Pembangunan Menara 17 PWNU Jawa

Timur," *Konstr. Publ. Ilmu Tek. Perenc. Tata Ruang dan Tek. Sipil*, vol. 2, no. 2, pp. 212–221, 2024, [Online]. Available: https://journal.aritekin.or.id/index.php/Konstruksi/article/view/277

[2] R. Apriansyah, "Implementasi Konsep Building Information Modelling (BIM) Dalam Estimasi Quantity Take Off Material Pekerjaan Struktural," 2021.

[3] S. A. Ihsan and S. Wacano, "Analisis Perbandingan Perhitungan Quantity Take Off Menggunakan BIM Revit dengan Metode Konvensional pada Struktur Atas Proyek Pembangunan Gedung RSPON," in *Seminar Nasional Teknik Sipil Politeknik Negeri Jakarta*, 2024.

[4] L. M. P. Kuswinardi, Reskina T. A Sinurat, and Palghe Tobing, "Analisa Struktur Dan Metode Pelaksanaan Kolom Dan Balok Pada Pembangunan Gedung APD PLN Medan," *J. Ilm. Tek. Sipil Agreg.*, vol. 1, no. 1, pp. 6–14, 2021, doi: 10.51510/agregat.v1i1.55.

[5] R. Hidayat and E. Sari, "Metode Pelaksanaan Pekerjaan Struktur Kolom Dan Balok Beton Precast," in *Prosiding SEMSINA*, 2022, pp. 8–16. doi: 10.36040/semsina.v3i1.4904.

[6] J. V. Simanullang, S. Angreni, L. Gaol, and D. T. Septiningtiyas, "Perhitungan Ulang Volume Struktur Atas dan Rencana Anggaran Biaya Proyek Apartemen Princeton Boutique Living, Medan.," in *Konferensi Nasional Social dan Engineering Politeknik Negeri Medan*, 2024, pp. 1278–1287.

[7] D. F. L. Zahra, Sony Pramusand, and Denny Yatmadi, "Pelaksanaan Pekerjaan Pembetonan Struktur Balok dan Pelat Lantai Basement 2 Pembangunan Gedung Eka Hospital," in *Seminar Nasional Teknik Sipil Politeknik Negeri Jakarta*, 2024.

[8] Alfia Magfirona, T. I. K. Amar, and Abdul Aziz Muhammad Habib Failasufa, "Analisis Komparasi Quantity Take Off Pekerjaan Struktur Berdasarkan Metode Konvensional Dan Metode BIM Studi Kasus : Perencanaan Omah DW," *J. TESLINK Tek. Sipil dan Lingkung.*, vol. 5, no. 1, pp. 60–67, 2023, doi: 10.52005/teslink.v5i2.272.

[9] S. R. Fachlevi, R. Maulana, O. H. Ardian, and S. N. Sari, "Analisis Perbandingan Perhitungan Volume Pada Bill of Quantity Menggunakan Software Autodesk Revit 2022 Dengan Perhitungan Manual Berdasarkan Sni 2847 Tahun 2019 Pada Gedung Serbaguna Di Desa Towangsan," *STORAGE J. Ilm. Tek. dan Ilmu Komput.*, vol. 2, no. 3, pp. 150–164, 2023, doi: 10.55123/storage.v2i3.2370.

[10] S. I. Amri, N. Hardyanti, and S. Sumiyati, "Analisis Perbandingan Quantity Take Off (QTO) Beton Menggunakan Metode Building Information Modelling (BIM) dan Metode Konvensional (Studi Kasus : Proyek Kantor PNM Cabang Jember)," *J. Profesi Ins. Indones.*, vol. 1, no. 6, pp. 225–233, 2023, doi: 10.14710/jpii.2023.19025.