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Calculation of Steel Reinforcement Needs for Beams and Prestressed Beams: Case Study on a Residential Project in South Jakarta

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Abstract: This study aims to analyze the need for reinforcement in conventional and prestressed beams in a residential project in South Jakarta. A quantitative descriptive approach is used, allowing for the systematic and measurable presentation of numerical data. Data were collected through direct field surveys, focusing on the analysis of work execution methods and the calculation of steel reinforcement requirements, particularly for ground floor structural elements. The case study was conducted on a conventional beam of type As 4' ; E - I with a span of 22.40 meters, which resulted in an iron demand volume of 991.77 kg for 25 mm diameter and 472.37 kg for 13 mm diameter. Meanwhile, for the prestressed beam As J; 3 - 8 with a cross-sectional size of 400 x 500 mm and a span of 14.30 meters, an iron requirement of 526.96 kg for a diameter of 22 mm and 295.00 kg for a diameter of 13 mm was obtained. The results of this study provide a detailed estimation of the material requirements for reinforcing the residential structure, which can serve as a reference for planning and controlling construction costs.

Keywords: Volume calculation, Prestress, civil engineering internship

INTRODUCTION

In the construction of multi-storey residential buildings, beams represent one of the primary structural elements, serving to transfer loads from slabs to columns and subsequently to the foundation. Accordingly, the planning and execution of beam construction must be conducted with precision to ensure the strength, stability, and safety of the overall structure.

In a residential development project located in South Jakarta, the structural framework comprised both conventional and prestressed beams. The use of prestressed beams was intended to enhance structural efficiency, minimize deflection, and allow for longer spans without increasing cross-sectional dimensions. The growing application of prestressed beams in residential buildings reflects the increasing demand for open interior spaces as well as material and cost optimization.

Despite these advantages, discrepancies are frequently observed between the reinforcement material estimates during the planning phase and the quantities realized in the field. Such inconsistencies can lead to material wastage, project delays, and cost overruns. Therefore, an accurate and systematic analysis of reinforcement requirements—particularly for both conventional and prestressed beams on the ground and first floors—is essential, given their critical role in the structural integrity of the building.

In this study, we analyze the construction and maintenance processes in a residential housing project located in the urban area of South Jakarta. The analysis includes the selection of construction methods, project management, and quality control. This study aims to produce a more accurate estimation of reinforcement needs, thereby contributing to improved material and budget efficiency and enhancing the overall quality of project implementation. Moreover, the findings of this analysis serve as a valuable reference for project planners, contractors, and supervisors in evaluating the alignment between technical specifications, work volumes, budgetary planning, and applicable construction standards.

LITERATURE REVIEW

Beams are structural elements of buildings that bear external loads that cause deflection moments, shear forces, and torsional moments along their spans, which can be reinforced by single reinforcement and double reinforcement. In addition to withstanding external loads, beams must also be able to transfer external loads for further support on columns without structural cracks occurring (Bangash, 2009).

To strengthen the beam structure, it is necessary to use rebar that can withstand the tensile forces on the building structure. Rebar is an important component in construction, playing a significant role in ensuring the strengthening and safety of building structures. There are two types of rebar, namely screw rebar and plain rebar. In the design of concrete iron, SNI 03-2847-2013 guidelines are used as a reference for designing, distributing, and connecting reinforcement in beam structures. An estimator is needed in the process of calculating the volume of concrete iron that will be used in the beam work.

According to Glenn M. Hardie (1987), estimation is a prediction of future costs of various construction activities, based on real data. The estimation process is divided into two parts, namely measurement and pricing. In the estimation process, the measurement of the quantity of concrete iron is carried out by two methods, namely detailed or detailed estimation using a bar bending schedule, while the second method is an approach method by reviewing the span per unit length in measuring the need for concrete iron.

Prestressed concrete, also known as prestressed concrete, is a type of reinforced concrete that has been pre-stressed to reduce potential tensile stresses due to the load received. In this process, the condition of the tensile and compressive fibers in each cross section must be carefully examined. The stresses that occur will vary depending on the condition of the concrete and tendons.

The prestressed concrete loading process is carried out in two stages, namely transfer and service. The transfer stage begins when the concrete has hardened, where the prestressing tendon cables are pulled. At this stage, the working dead load consists of the weight of the structure itself, plus tool loads and worker activities.

RESEARCH METHODS

This research applies a descriptive approach in reviewing and analyzing quantitative data obtained from the field. This approach was chosen because of its ability to systematically process, analyze, and present numerical data. In its implementation, the research used a survey technique by conducting a private houses in South Jakarta to analyze the method of work as well as the need for iron reinforcement by sampling on the ground floor required in construction.

1. The data collection process was carried out through two stages of information gathering. The first stage focused on obtaining primary data consisting of Detail

Engineering Design (DED) and Work Plan and Construction Project Requirements (RKS) documents. The second stage included the collection of secondary data sourced from various scientific literature, such as research journals and technical modules relevant to the research topic.

2. Through direct observation at the project site, the researcher was able to gain a deeper understanding of the actual conditions in the field. This combination of primary and secondary data allows researchers to conduct a comprehensive analysis to produce accurate calculations related to construction material requirements. This approach ensures that the research results obtained can be scientifically and practically justified.

RESULTS AND DISCUSSION

Calculation of Reinforcement Requirements

Volume calculations in beam structures consist of three main components that need to be analyzed in detail. Each component has a different calculation method to produce an accurate volume. The following is an explanation for each calculation:

The Calculation Method of Reinforcing Iron Requirements in Weight Units is a way to determine the amount of reinforcing iron requirements based on the design of reinforced concrete structures. This calculation is carried out to ensure the structure has strength and stability according to applicable standards (for example, SNI, ACI other design standards). The following are general steps for calculating reinforcing iron requirements in units of weight:

1) Determine the dimensions and specifications of reinforcement that already exist in the detailed drawing
2) Calculating the total length of reinforcement
3) Determine the weight of iron per meter according to the diameter of the iron
4) Calculating the total weight of reinforcement
5) Adding loss factor/coefficient
6) Recapitulation of needs

The following table contains the weight of the iron used in the construction of this beam.

Table 1. Weight of Reinforcing Beam Iron

No.	Diameter (D)	Unit	Steel Table		Unit
			Weight / 12 m'	Weight / m'	
1	10	mm	7.40	0.617	kg
2	13	mm	12.50	1.04	kg
3	19	mm	26.71	2.23	kg
4	22	mm	35.81	2.98	kg
5	25	mm	46.29	3.86	kg

Formula for Calculating Iron Requirement

To calculate the need for reinforcing iron in a construction project, several basic formulas are used according to the type and specification of the reinforcement. The following are the steps and formulas used:

Table 2. Formula for Calculating Iron Requirement

No.	Work Items	Formula
1	Top Principal Reinforcement	= (Coefficient (1.1) x total length) x Diameter weight iron x Top reinforcement content
2	Bottom Principal Reinforcement	= (Coefficient (1.1) x total length) x Weight of iron diameter x Bottom reinforcement content
3	Top Extra Reinforcement	= (Coefficient (0.35) x total length) x Weight of iron diameter x Extra top reinforcement content
4	Bottom Extra Reinforcement	= (Coefficient (0.65) x total length) x Weight of iron diameter x Extra bottom reinforcement content
5	Stirrups	= (Coefficient (1,1) x perimeter of beam dimension) x (total length/spacing of stirrups) x weight of iron diameter

Reinforcing Iron Requirements for Ground Floor

In this calculation, a sampling of the calculation of the Base floor beam As 8; A - L" and the Calculated Base floor beam As 4'; E - I are taken.

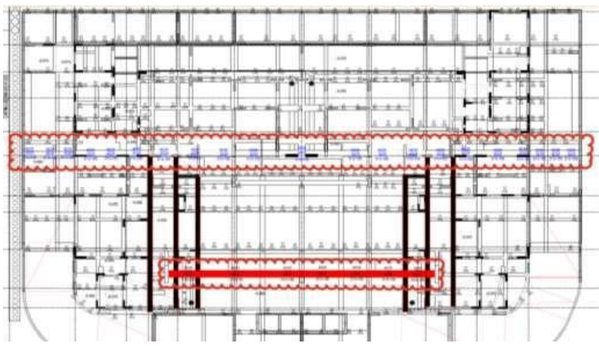

Figure 1. Ground floor plan & Calculated Beam Area

Source: Practical Work Documentation, 2024

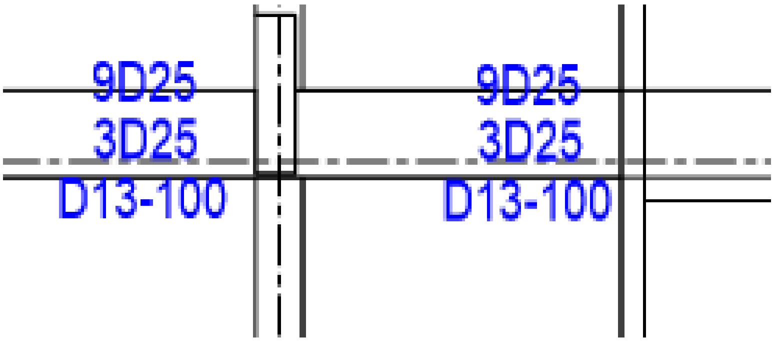

Figure 2. Fixing details of ground floor beam As 8 "A - L" Calculated Beam Area

Source: Practical Work Documentation, 2024

Figure 3. Fixing details of Calculated Ground floor beams As 4'; E - I with a span length of 22.40 meters.

Source: Practical Work Documentation, 2024

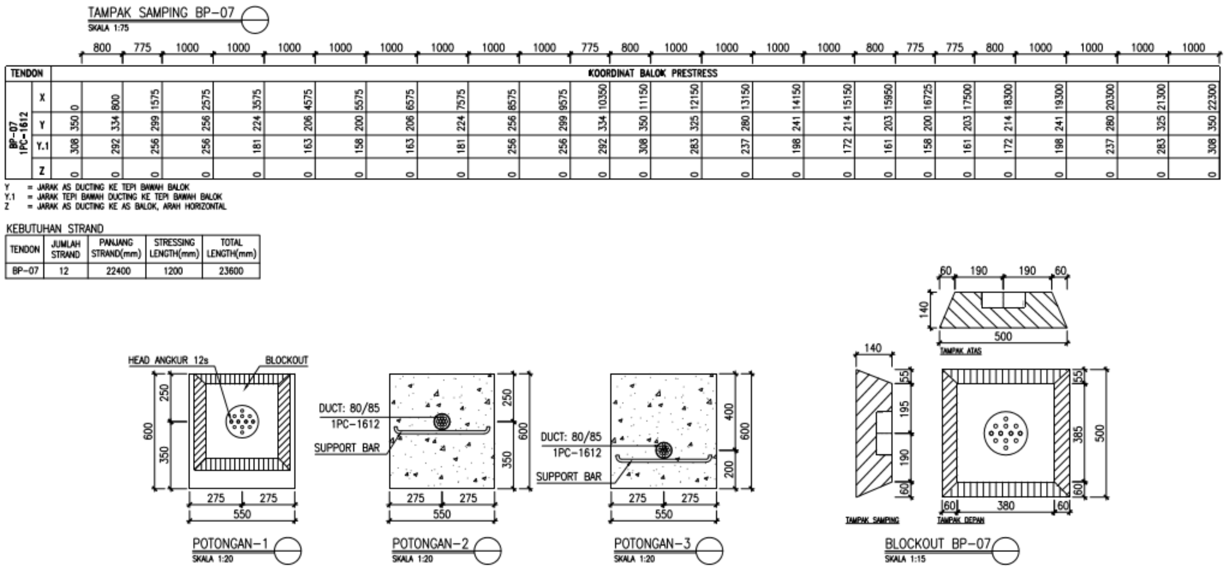

Figure 4. Fixing details of ground floor beams with a prestressed system As 4'; E - I with a span length of 22.40 meters.

Source: Practical Work Documentation, 2024

Based on the table, the need for reinforcing iron beams 550 x 600 Ground Floor As 8

"A - L" with a span length of 46.475 meters is obtained.

Table 3. Reinforcing Iron Requirements for 550 x 600 Beams

No.	Job Description	Him.	Tul content.	Koef	Total Length	Weight Dia per kg	Total weight (kg)	Total weight (btg)
			A	B	C = Length x B	D	E=(AxCxD)	F=E/weight btg
1	Rebar Top Principal	25	6	1.1	51.12	3.85	1180.3	25.56
2	Rebar Bottom Line	25	3	1.1	51.12	3.85	590.46	12.78
3	Rebar Top Extra	25	6	0.35	16.27	3.85	375.75	8.13
4	Rebar Extra Bottom	25	3	0.65	30.21	3.85	348.91	7.55
5	Stirrups	13	8	2.53	117.58	1.04	980.05	78.39

Reinforcing iron requirements for prestressed beams 550 x 600 Ground Floor As 4'; E - I with a span length of 22.40 meters.

Table 4. Reinforcing Iron Requirements for Prestressed Beams 550 x 600

No.	Job Description	Him.	Tul content.	Koef	Total Length	Dia Weight per kg	Total weight (kg)	Total weight (btg)
			A	B	C = Length x B	D	E=(AxCxD)	F=E/weight btg

1	Rebar Top Principal	25	4	1,1	24.64	3.85	379.46	8.21
2	Rebar Botto m Line	25	4	1,1	24.64	3.85	379.46	8.21
3	Rebar Top Extra	25	4	0,35	7.84	3.85	120.74	2.61
4	Rebar Extra Bottom	25	2	0,65	14.56	3.85	112.11	2.43
5	Stirrups	13	8	2,53	56.67	1.04	472.37	37.78

CONCLUSIONS

The implementation of beam and prestressed beam concreting work in the field has generally gone quite well, both in terms of planning, preparation of shop drawings, and implementation in the field. Calculation of iron requirements and accuracy in cutting and installing reinforcement are important aspects in ensuring the quality of work. The use of prestressed beams is proven to provide efficiency in the use of concrete and steel materials, especially in long spans. Although the implementation has been good, some things that need to be considered in the field implementation process include the application of K3 (Occupational Safety and Health) needs to be more disciplined, and coordination between vendors and subcontractors must be improved to avoid project delays. Installation of reinforcement must be in accordance with the working drawings to ensure the strength of the structure. It is important for the workforce to actively pay attention to the implementation in the field and not hesitate to ask questions if something is not understood.

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