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Analysis of Column Requirements in the Puri Indah Mall Parking Building

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ABSTRACT

The construction of a parking building requires meticulous technical planning and implementation in compliance with standards to ensure the quality and safety of the structure. Concrete columns serve as the primary vertical structural elements with a crucial role in distributing loads to the foundation. This study aims to examine the implementation methods for column construction on the 6th floor, Zone 1, of the Puri Indah Mall Parking Building, identify issues encountered and their solutions, and calculate the required volume of concrete and the number of truck mixers needed.The findings indicate that the implementation methods encompass the following stages: determining the column axis, fabricating and installing reinforcements, installing column shoes and concrete decking, quality inspection, casting, formwork dismantling, column curing, and installing corner guards. The total concrete requirement for the columns on the 6th floor, Zone 1, is 8.246 m³, with a total of 2 truck mixers needed.This study provides practical contributions in the form of an efficient and standardized guide for column construction work, as well as material requirement calculations that can be adapted for similar projects. The implications of these findings support the optimization of resources and logistics in the management of sustainable construction projects.

INTRODUCTION

The construction of a parking building as part of a mall project is an integral component of the infrastructure that supports the operation of the main building. The parking facility is designed to accommodate vehicle loads, requiring a structure that is sturdy, safe, and efficient. One of the primary elements in the structure of a parking building is the concrete column, which functions to distribute vertical loads from the floors to the foundation. The construction of concrete columns demands special attention, both in terms of execution and material requirement calculations, to ensure that the resulting structure meets the design specifications and safety standards.

The execution of concrete column work involves several key stages, namely formwork preparation, reinforcement installation, concrete pouring, and curing. Each stage impacts the final quality of the column, necessitating meticulous execution in accordance with established procedures. Additionally, accurate calculation of concrete requirements is crucial to avoid material shortages or excess, which can affect the cost and time efficiency of the project. Inaccuracies in execution or

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calculations can lead to various issues, such as structural cracks, dimensional discrepancies, or material wastage.

The execution of concrete column work often encounters various challenges, such as time constraints, material availability, and variations in workforce quality. Therefore, an in-depth analysis of the work execution and concrete requirement calculations is essential in the construction of parking buildings, particularly in the context of mall developments, which demand high standards of quality and aesthetics.

This study aims to analyze the execution of work and the calculation of concrete column requirements in mall parking buildings. The construction of parking facilities in mall projects is a vital component of the infrastructure supporting the operation of the main building. Parking buildings are designed to withstand vehicle loads, requiring a structure that is robust, safe, and efficient. One of the primary elements in the structure of a parking building is the concrete column, which functions to distribute vertical loads from the floors to the foundation.

The construction of concrete columns requires special attention, both in the execution of work and in the calculation of material requirements, to ensure that the resulting structure complies with design specifications and safety standards. The stages of concrete column construction include:

1. Preparation and installation of formwork.
2. Installation of concrete reinforcement.
3. Concrete pouring.
4. Curing.

Each of these stages significantly impacts the final quality of the column, requiring careful execution in accordance with established procedures. Additionally, the calculation of concrete requirements is a critical factor to avoid material shortages or excess, which could affect the cost and time efficiency of the project. Inaccuracies in execution or calculation can lead to various issues, such as:

1. Cracks in the structure.
2. Dimensional inconsistencies in the columns.
3. Material wastage.

The execution of concrete column work often encounters various challenges, such as:

1. Time constraints in execution.
2. Unstable material availability.
3. Variations in workforce quality.

Therefore, an in-depth analysis of the execution process and concrete requirement calculations is essential for parking building construction projects, particularly in the context of mall developments, which have high demands for quality and aesthetics.

Research Objectives

This study aims to:

1. Analyze the execution of concrete column work in mall parking buildings.
2. Identify problems encountered during the execution of concrete column work.
3. Determine applicable solutions to address these problems.
4. Calculate the concrete requirements and the number of mixer trucks needed for concrete column work in a specific zone.

RESEARCH METHODS

This study was conducted to analyze the execution of concrete column work and calculate concrete requirements in the parking building of a mall construction project. The methodology employed includes several stages, namely data collection, data analysis, and result evaluation. The steps taken in this research are explained as follows:

1. Research Approach

This research employs a descriptive-analytical approach aimed at systematically describing the process of concrete column work execution and analyzing material requirement calculations based on field data. The data used includes primary data obtained directly from the project site and secondary data from the project’s technical documents.

2. Data Collection

Data collection was conducted using several methods:

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a. Field Observation
Directly observing the execution process of concrete column work, including the stages of preparation, reinforcement installation, formwork construction, concrete pouring, and curing. The observation also involves measuring the actual column dimensions to compare them with the design specifications.
b. Interviews
Conducting interviews with relevant parties, such as project managers, contractors, and workers, to gather information on challenges and solutions implemented during the execution of the work.
c. Technical Documentation
Collecting technical documents such as working drawings, technical specifications, daily reports, and material usage records. This data is used to support the analysis of concrete requirement calculations.

This study was conducted to analyze the execution of concrete column work and calculate concrete requirements in the parking building of a mall construction project. The methodology employed includes the stages of data collection, data analysis, and result evaluation. The steps of this research are explained as follows:

1. **Research Approach**
   This study employs a descriptive-analytical approach, aimed at systematically describing the process of concrete column work execution and analyzing material requirements based on field data. The data used includes:
   a. **Primary data:** Obtained directly from the project site.
   b. **Secondary data:** Sourced from the project's technical documents.
2. **Data Collection**
   Data collection was carried out using the following methods:
   a. Field Observation:
   Direct observation of the concrete column work process, including the preparation stages, reinforcement installation, formwork construction, concrete pouring, and curing. Additionally, measurements of the actual column dimensions are carried out to compare them with the design specifications.
   b. Interviews:
   Interviews are conducted with project managers, contractors, and workers to obtain information about the challenges encountered and the solutions implemented during the execution of the work.
   c. Technical Documentation:
   Collecting technical documents, such as working drawings, technical specifications, daily reports, and material usage records. This data is used to support the analysis of concrete requirement calculations.
3. **Data Integration in Analysis**
   Observations, interviews, and technical documentation are integrated through data triangulation to ensure the validity and consistency of the information. Observation data provides an overview of the actual processes in the field, which is then enriched by interviews to gain perspectives from project stakeholders. Technical documentation is used to verify the findings from the other two methods, ensuring that the final analysis accurately reflects field conditions.
4. **Methodological Limitations**
   In this study, several methodological limitations were identified:
   a. **Field Observation:** The potential for researcher bias in observing processes in the field.
   b. **Interviews:** Limitations in the information provided by respondents, such as subjective bias or a lack of detailed data.
   c. **Technical Documentation:** Restricted access to certain documents that are internal or confidential to the project.

RESULTS AND DISCUSSION

The issue addressed in this study is the Execution Method and Concrete Requirement Calculation for Concrete Columns on the 6th Floor, Zone 1 of the Puri Indah Mall 2 Parking Building

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Construction Project. A conventional method is employed for column work in this project, as it was also applied in the B Residence Apartment Building Construction Project in Grogol. The conventional method refers to a construction approach that uses traditional materials such as wood, cement, and bricks. This method is widely used, facilitating field workers in constructing columns for the project.

Below is the workflow diagram for column work in the Puri Indah Mall 2 Parking Building Construction Project. Ensure that there are no vertical lines in the diagram. Tables should be referenced in the text by stating something like: "... (Tables are written with a capital 'T')."

The study examines the conventional method applied to concrete column work and the calculation of concrete requirements for the parking building's 6th floor, Zone 1, in the Puri Indah Mall 2 Construction Project. This approach, also implemented in the B Residence Apartment Building Project in Grogol, involves traditional construction materials such as wood, cement, and bricks. The conventional method is often chosen due to its simplicity and ease of understanding for field workers, accelerating the construction process and improving efficiency in executing concrete column work.

Comparison with previous studies indicates that the use of conventional methods in constructing concrete columns remains a predominant choice in many construction projects. However, there is a growing trend toward adopting modern methods with more innovative materials. For instance, research by Muhammad Sodikin (2020) highlights that the use of modular formwork and precast concrete can significantly reduce construction time and improve column structural quality. Nevertheless, in the context of the Puri Indah Mall 2 Parking Building Construction Project, the conventional method remains the preferred option due to the affordability of materials and the accessibility of local resources.

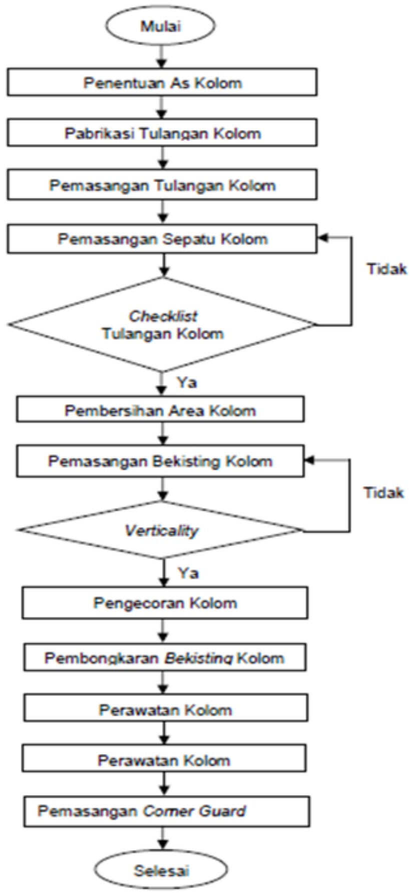

Figure 1. Workflow Diagram for Column Work

Columns are structural components that serve to support vertical and horizontal loads as well as moments acting on the floor slabs and beams they support. The structure of a column is made of steel and concrete. These two materials have excellent combined properties, where steel is a material resistant to tension, while concrete is resistant to compression. Columns are classified into several types based on their shape. The columns used in the Puri Indah Mall 2 Parking Building Construction Project are square columns. The following outlines the method for executing column work on the 6th floor of the Puri Indah Mall 2 Parking Building Construction Project.

1. Determination of Column Axis Position

The determination of the column axis position is carried out through a survey using a theodolite. This is done by marking lines on the floor slab. The marking of these lines is performed using marking tools.

Figure 2. Determination of Column Axis

2. Column Reinforcement Fabrication

The fabrication process involves cutting steel to the required length, bending it into the desired shape, and assembling it into a strong column reinforcement framework.

Figure 3. Column Reinforcement Fabrication

3. Column Reinforcement Installation

The installation of column reinforcement is carried out by placing the assembled and structured column reinforcement steel at the fabrication site in accordance with the specifications.

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Figure 4. Column Reinforcement Installation

4. Column Base Installation

The installation of the column base is a stage carried out to secure the position of the reinforcement and formwork, ensuring they remain in place during the concreting process.

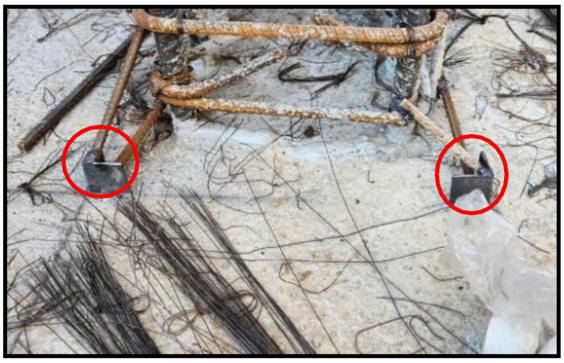

Figure 5. Column Base Installation

5. Concrete Decking Installation

The installation of concrete decking is a stage performed to indicate the thickness of the concrete cover for a specific column. The concrete cover thickness for the columns in the Puri Indah Mall 2 Parking Building Construction Project is 50 mm.

Figure 6. Concrete Decking Installation

6. *Column Reinforcement Checklist*

The column reinforcement checklist includes: inspecting the column dimensions, the number of main reinforcements, the number of stirrups, wire tie connections, column bases, and the installation of concrete decking.

Figure 7. Column Reinforcement Checklist

7. Column Area Cleaning

The column area is cleaned using an air compressor. This is done to ensure that no dust or debris, such as soil, leftover reinforcement tying wire, or other contaminants, remains in the area to be cast. If dirt adheres to the column area and is not cleaned, it can affect the bond strength between the concrete layers, thereby impacting the overall strength of the concrete.

Figure 8. Column Cleaning

8. Column Formwork Installation

The installation of formwork uses materials made from wooden panels and steel as supports. Each part of the formwork is assembled according to the dimensions and shape of the column to be constructed. The installation process is carried out with the assistance of heavy equipment, such as a tower crane. Formwork for columns, which is set to the height and dimensions specified in the design, is treated with form oil. This oil lubricates the formwork surface to prevent the concrete from sticking to it during dismantling. The formwork is then lifted using a tower crane and positioned vertically, reinforced with column formwork supports.

Figure 9. Column Formwork Installation

9. Column Verticality

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The verticality of the column formwork is measured using a simple tool, namely a string tied to a plumb bob and hung on a wooden piece installed perpendicular to the formwork. The measurement is conducted by observing whether the string is perfectly perpendicular. If the string is not perpendicular to the formwork, the formwork needs to be braced or reinforced using push-pull supports to ensure it conforms to the column dimensions.

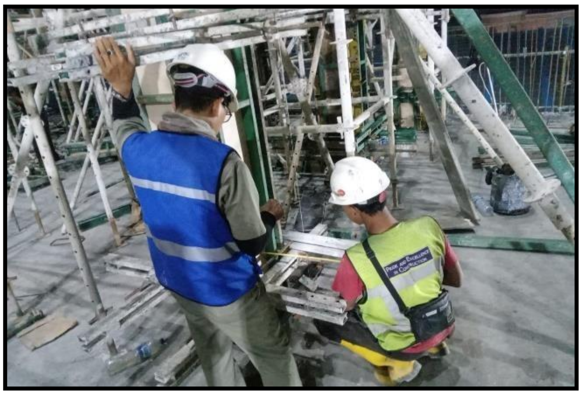

Figure 10. Column Verticality

10. Column Concreting

The concreting process is carried out gradually and continuously, starting from the bottom of the column and moving upward. Concrete is poured into a concrete bucket, which is connected to a tremie pipe. The use of a tremie pipe facilitates the work process. The concrete-filled bucket is lifted using heavy equipment, such as a tower crane.

Figure 11. Column Concreting

11. Column Formwork Removal

The removal of column formwork is carried out with workers wearing complete personal protective equipment. The workers carefully loosen the ties and bolts connecting the formwork to the column, ensuring each step is performed slowly to avoid damaging the concrete surface.

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Figure 12. Column Formwork Removal

12. Column Curing

Column curing is carried out by maintaining the moisture of the concrete through various methods, one of which is the use of a curing compound to ensure optimal concrete strength and durability. The curing compound forms a protective layer on the concrete surface, preventing excessive water evaporation and allowing the hydration process to occur effectively. The curing compound used is Sika Antisol S.

Figure 13. Column Curing

13. Corner Guard Installation

The function of a corner guard is not only to protect corners from impacts or abrasions that could damage the column but also to provide a neat and organized appearance.

Figure 14. Corner Guard Installation

Calculation of Concrete Requirements for Columns on the 6th Floor, Zone 1

The calculation of concrete requirements for the columns on the 6th floor, Zone 1, in the Puri Indah Mall 2 Parking Building Construction Project is as follows.

1. Column Data for the 6th Floor, Type K.1A
   a. Column Length = 0,600 m
   b. Column Width = 0,600 m
   c. Column Height = 3,100 m
   d. Column Cover Thickness = 0,050 m
   e. Number of Columns = 12
2. Concrete Volume for Columns on the 6th Floor, Type K.1A
   a. Column Volume = (Column Area × Column Height)
   = (Length ×Width) × Height
   = (0,600 ×0,600) × 3,100
   = 1,116 m^3
   b. Column Reinforcement Volume = (Column Reinforcement Area × Column Height)

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= (0,500 × 0,500) × 3,100)
= 0,775 m^3

c. Concrete Volume for Columns = Column Volume – Column Reinforcement Volume
= 1,116 – 0,775

d. Total Concrete Volume for Columns = Concrete Volume for Columns × Number of Columns
= 0,341 × 12
= 4,092 m^3

3. Column Data for the 6th Floor, Type K.1B
   a. Column Length = 0,600 m
   b. Column Width = 0,600 m
   c. Column Height = 3,100 m
   d. Column Cover Thickness = 0,050 m
   e. Number of Columns = 4
4. Concrete Volume for Columns on the 6th Floor, Type K.1B
   a. Column Volume = Column Area × Column Height)
   = (Length × Width) × Height
   = (0,600 × 0,600) × 3,100
   = 1,116 m^3
   b. Column Reinforcement Volume = (Reinforcement Area × Column Height)
   = (0,500 × 0,500) × 3,100)
   = 0,775 m^3
   c. Concrete Volume for Columns = Column Volume – Column Reinforcement Volume
   = 1,116 – 0,775
   = 0,341 m^3
   d. Total Concrete Volume for Columns = Concrete Volume for Columns × Number of Columns
   = 0,341 × 4
   = 1,364 m^3
5. Column Data for the 6th Floor, Type K.2
   a. Column Length = 0,500 m
   b. Column Width = 0,600 m
   c. Column Height = 3,100 m
   d. Column Cover Thickness = 0,050 m
   e. Number of Columns = 9
6. Concrete Volume for Columns on the 6th Floor, Type K.2
   a. Column Volume = (Column Area × Column Height)
   = (Length × Width) × Height
   = (0,500 × 0,600) × 3,100
   = 0,930 m^3
   b. Column Reinforcement Volume = (Reinforcement Area × Column Height)
   = (0,400 × 0,500) × 3,100)
   = 0,620 m^3
   c. Concrete Volume for Columns = Column Volume – Column Reinforcement Volume
   = 0,930 – 0,620
   = 0,310 m^3
   d. Total Concrete Volume for Columns = Concrete Volume for Columns × Number of Columns
   = 0,310 × 9

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$= 2{,}790 \text{ m}^3$

7. Concrete Volume for Columns on the 6th Floor, Zone 1

Total $= 4{,}092 + 1{,}364 + 2{,}790$

$= 8{,}246 \text{ m}^3$

8. Truck Mixer Requirement for Column Casting on the 6th Floor, Zone 1

Number of Truck Mixers $= \dfrac{8{,}246 \text{ m}^3}{7 \text{ m}^3} = 1{,}178 = 2$ Units of Truck Mixers

(1 Truck Mixer = 7 m^3)

CONCLUSION

Based on the findings of the Puri Indah Mall 2 Parking Building Construction Project, the following conclusions can be drawn:

1. The column construction process involves systematic steps such as column axis determination, reinforcement fabrication, formwork installation, concrete pouring, and curing. Each stage is designed to ensure that the column structure meets design and quality standards.
2. The total concrete requirement for the 6th-floor columns in Zone 1 is 8.246 m^3. To meet this requirement, two mixer trucks with a capacity of 7 m^3 each are needed.
3. Common challenges include time constraints, material availability, and variations in workforce quality. The approach adopted involves detailed planning, strict field supervision, and adherence to standard procedures.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

Based on the findings of the Puri Indah Mall 2 Parking Building Construction Project, the following conclusions can be drawn:

1. **Column Construction Process**
   The column construction process involves systematic steps, including determining column axis positions, reinforcement fabrication, formwork installation, concrete pouring, and curing. Each stage is designed to ensure that the column structure meets the established standards for design, strength, and quality. Careful execution at every stage is crucial to avoiding structural issues in the future.
2. **Concrete Requirements**
   The total concrete requirement for the columns on the 6th floor, Zone 1, is 8.246 m^3. To fulfill this requirement, two mixer trucks with a capacity of 7 m^3 each are necessary. Accurate calculations of the required concrete volume are critical to avoiding material wastage and ensuring project continuity according to the schedule.
3. **Challenges and Solutions**
   Common challenges in column construction include time constraints, material availability, and variations in workforce quality. The solutions implemented include more detailed planning, strict field supervision, and consistent adherence to standard procedures. This approach is expected to ensure timely completion of the work without compromising quality.

Recommendations for Future Research and Practice

Based on the findings of this study, it is recommended to conduct further research on the utilization of the latest technologies in concrete pouring processes and material management to enhance efficiency and reduce construction time. Additionally, the development of more intensive training programs for the workforce can improve the quality and consistency of the work. In future construction practices, integrating BIM (Building Information Modeling) technology can assist in planning, monitoring, and project management more efficiently while reducing the likelihood of technical errors.

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