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STUDY ON THE USE OF CONCRETE COLUMNS IN INDOOR AND OUTDOOR SPORTS FIELD CONSTRUCTION PROJECTS IN TANGERANG CITY

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Abstract: In every building construction, the components of all structures must have the strength to withstand the loads they bear. Beams and columns are very important structural components in building construction. For this reason, these two structural components must be calculated and analyzed based on the appropriate combination of factored loads and forces. In preparing this research report, the author reviewed the use of concrete columns in the Tangerang City sports field construction project. This review aims to find out how much steel is used and how much concrete volume is needed for each column. From the results of the author's review, the column used in this project is the K1 column type with dimensions of 60x60 cm, with 12D25 reinforcement, with a column height of 13 m, with a volume per column of 4.68 m3, with a concrete volume per column of 4.6286 m3. So the results obtained from 70 column piles require a concrete volume of 324,002 m3, with a large mixer truck capacity of 7.5 m3, it requires 44 trucks to transport the ready-mix concrete.

Keywords: Column Use, Column Volume, And Column Reinforcement.

INTRODUCTION

Research on sports infrastructure development, such as the construction of Indoor and Outdoor sports fields in Tangerang City, aims to explore the technical and construction management aspects that support the success of the project. As one of the metropolitan cities that continues to grow, Tangerang City needs adequate public facilities to improve the quality of life of the community through sports and recreational activities. The development project is designed to meet the need for modern and functional sports facilities. This research focuses on important aspects of construction, in particular the use of concrete columns as the main structural element. K1-type columns with dimensions of 60x60 cm and a height of 13 meters were chosen to ensure the strength of the structure, which can support the dynamic and static loads of the building. The study also evaluated material requirements, including the calculation of concrete volume and reinforcement use efficiency.

In addition to the technical aspects, this study also identifies challenges faced during the implementation of the project, such as obstacles in time, quality, and resource management. With a case study approach, this study examines construction implementation methods, quality control procedures, and project management effectiveness.

The results of this research are expected to contribute to the development of civil engineering science, especially related to the optimization of the design and implementation of concrete structures in similar projects. The findings are also expected to be a reference for practitioners in designing and managing infrastructure projects efficiently and effectively.

In this study, the selection of K1-type concrete columns with dimensions of 60x60 cm and reinforcement of 12D25 using the K-300 concrete quality standard is based on the principles of elasticity and material strength. These principles ensure that the structure is able to distribute the dead load (the load from the elements of the structure itself) and the live load (user load and wind) evenly, so that the stability of the building is guaranteed in the long term.

In addition to structure theory, project management theory is an important foundation for managing project implementation efficiently. Project management includes not only the planning aspect, but also quality, time, and cost control. In the context of this study, a time schedule based on the S-Curve method is used to monitor the progress of the project periodically, ensuring that the work of the lower and upper structures, including the installation of columns and beams, runs according to the target time. Quality control of materials, such as ready-mix concrete, is also carried out through laboratory testing, including slump tests and concrete compressive strength tests, to ensure the quality of the materials used in accordance with the specified standards.

Furthermore, risk control theory plays a role in identifying and managing the various challenges that arise during project implementation. For example, constraints such as material delays, tool damage, or inconsistency of work results with initial planning can be minimized with ongoing risk evaluation. In this study, this theory-based approach was applied to analyze the efficiency of the concrete volume in the columns and determine the material requirements accurately, so as to reduce the potential for resource wastage.

The grand theory in this study integrates structural theory, project management, and risk control as a holistic approach in designing and executing construction projects. This approach focuses not only on technical success but also on the overall sustainability and efficiency of the project. This research contributes to providing new insights on how the basic principles of civil engineering can be applied practically to support the development of quality infrastructure, especially in the context of the needs of urban communities, such as in Tangerang City.

RESEARCH METHODOLOGY

This research uses a case study approach to analyze and develop optimal solutions in the planning and implementation of the construction of Indoor and Outdoor Sports Fields in Tangerang City. The research begins with the field observation stage, where the existing conditions of the project site, such as soil characteristics, structural design needs, and material use efficiency, are analyzed to understand the underlying technical needs of the development.

Research Stages

1. **Observation**
   This observation covers the main stages in the construction of concrete columns, such as the installation of reinforcement according to technical specifications, the installation of formwork, the casting of concrete with K-300 quality, and the removal of the formwork after the concrete reaches adequate initial strength. This observation also includes supervision of heavy equipment such as concrete pump trucks to ensure the efficiency and quality of casting results.

2. **Quantitative**
   Quantitative methods are applied to calculate the material requirements used in the construction of concrete columns. Calculations were made to determine the volume of concrete based on the dimensions of the columns (60x60 cm with a height of 13 m) and the need for reinforcement (12D25) according to the structural design. This quantitative data is used to evaluate the efficiency of material utilization and ensure that material requirements are in accordance with the planned allocation in the project budget. This method is also used to calculate the number of ready-mix trucks required to transport concrete, taking into account a truck capacity of 7.5 m^3.

3. **Data Analysis**
   The data collected during observation and measurements were analyzed to assess the efficiency and durability of the concrete column structure. This analysis includes a comparison between the results of measurements in the field with the technical specifications set out in the project document, such as the strength of the concrete after the slump test and the compressive strength. In addition, the analysis is conducted to evaluate the efficiency of material use as well as the potential risk of structural failure due to technical errors or material management. The data is also analyzed to determine whether the execution method used provides optimal results in terms of structural resilience and time efficiency.

4. **Literature Study**
   This research also involves a literature review to understand more about the latest concrete column technology and construction methods relevant to this project. The literature study includes previous research on the design and implementation of concrete columns, construction standards such as SNI 2847-2019, as well as innovations in the use of concrete materials. This study helps provide a solid

theoretical basis for analyzing field data, evaluating implementation methods, and identifying best practices that can be applied to the project. In addition, the literature review supports efforts to develop more efficient and sustainable construction approaches.

5. **Evaluation and Recommendations**
The evaluation stage is carried out by integrating the results of observation, quantitative calculations, and data analysis. The finished concrete column structure is retested to ensure that the construction results conform to technical specifications and meet long-term safety and durability requirements. Based on the results of the evaluation, recommendations are developed to improve the efficiency and quality of construction in the future. These recommendations include the use of more innovative construction methods, improvements in material management, and the implementation of stricter supervision techniques during the casting and installation process of reinforcement. These recommendations are designed to provide practical solutions that can be applied to similar projects, as well as contribute to the development of better construction methods in the civil engineering industry.

RESULTS AND DISCUSSION

Execution of Construction Work

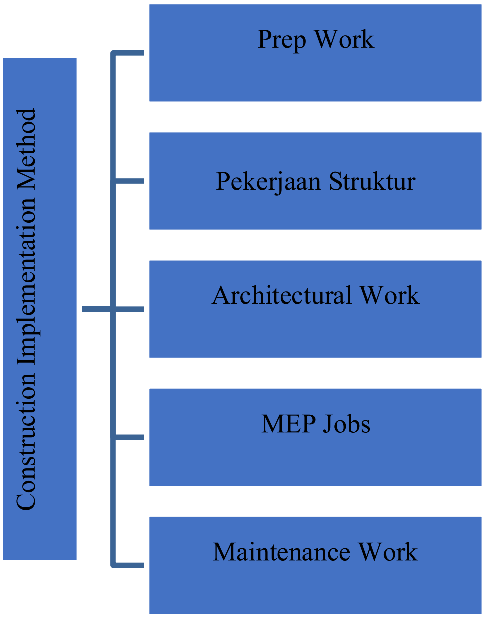


Figure 1. Construction Implementation Methodology Chart

1. **Preparation Work**
Preparatory work is the earliest stage in the implementation of the project. The Tangerang City indoor and outdoor sports field construction project consists of temporary fence construction, land clearing, creation of keet directors, construction of storage warehouses, construction of worker barracks, field measurement, installation of bouwplanks, and making shop drawings.

2. **Structure Work**
Structural work, in essence, is concrete structure work and structural work for building construction projects, including foundation work, sloof, columns, beams, slabs, and roof frames. Structure work is divided into two, namely lower structure work and upper structure work.

3. **Lower Structure Work**
Based on the results of the soil investigation, the lower structure of the indoor and outdoor sports field buildings of Tangerang City is planned to use pile foundations with different depths and diameters. The pile foundation is installed at (± 36) points using K-300 (25 Mpa) concrete quality. In this project, the first work in the implementation of the lower structure work is the diversion of the land according to

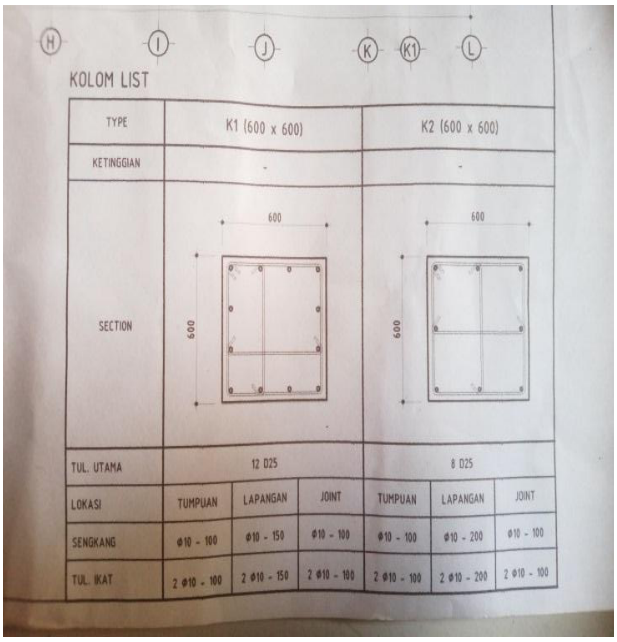
the specified depth of the foundation. Then, continue to lay the pile foundation on the ground at each predetermined point. After the pile is stuck, a pile cap is made to lock the foundation.

1. *Pile Cap*
2. *Tie Beam*

4. **Top Structure Work**

In the upper structure work in the construction of the Tangerang City Indoor and Outdoor Sport Field consists of columns, beams, floor plates, stands, and stairs using K-300 quality ready mix concrete (equivalent to f'c = 25 MPa) with threaded reinforcement of different diameters in each work. Figure 2 and Figure 3 show the column point plan in the upper structure and column list details, respectively.

Figure 2. Column point plan



KOLOM LIST

TYPE	K1 (600 x 600)			K2 (600 x 600)		
KETINGGIAN	-			-		
SECTION						
TUL. UTAMA	12 D25			8 D25		
LOKASI	TUMPUAN	LAPANGAN	JOINT	TUMPUAN	LAPANGAN	JOINT
SENGKANG	Ø10 - 100	Ø10 - 150	Ø10 - 100	Ø10 - 100	Ø10 - 200	Ø10 - 100
TUL. IKAT	2 Ø10 - 100	2 Ø10 - 150	2 Ø10 - 100	2 Ø10 - 100	2 Ø10 - 200	2 Ø10 - 100

Figure 3 Column List Details

Source: Source: Shop Drawing of PT Anugerah Bangun Kencana, 2022

5. **Plate Beams and Stands**

Beams are building structures made of concrete material that are flat as horizontal elements. The stand is a floor located on the ground that serves as spectator seating on a field. In this project, the beam and floor plate work starts from the installation of scaffolding, repetition work, installation of formwork, and ends with the casting of floor plates and stands. The quality of concrete for casting beams, floor plates and stands is K-300 (equivalent to 25 Mpa).

Calculation of Column Concrete Volume Requirements

1. **Column Type K1**

   Column Volume Calculation

   Column Volume : P x L x T
   : 0,6 x 0,6 x 13
   : 4,68 m^3

Reinforcement Volume Calculation

1. **Calculation of the main reinforcement volume**

   Reinforcement Length = Height floor to floor Upper stand
   = 7,700
   Rebar Area = ¼ x π x d^2
   = ¼ x π x 0.025^2
   = 0,0004908 m^2
   Total Reinforcement = 12 buah
   Reinforcement Volume = Panjang x Luas x Jumlah
   = 7,700 x 0,0004908 x 12
   = 0,04534992 m^3

2. **Calculation of the Volume of Focus Reinforcement**

   Reinforcement Length = 2 x (b column – 2decking) + 2 x (h column – 2decking) + (2 x 6D)
   = 2 x (0,6 – (2 x 0,04)) + 2 x (0,6 –(2 x 0,04)) + (2 x 6(0,010))
   = 2,2 m
   Rebar Area = ¼ x π x d^2
   = ¼ x π x $0,010^2$
   = 0,0000785 m^2
   Total Reinforcement $= \frac{Tinggi\ tulangan\ \left(\frac{1}{4}\right)h}{Jarak\ pemasangan\ tulangan\ sengkang}$
   $= \frac{1,155}{0,100}$
   = 11,55 buah, di bulatkan menjadi 12 buah.
   Reinforcement Volume = Panjang x Luas x total
   = 2,2 x 0,0000785 x 12
   = 0,0020724 m^3

3. **Calculation of the Volume of Field Reinforcement**

   Reinforcement Length = 2 x (bkolom – 2decking) + 2 x (hkolom – 2decking) + (2 x 6D)
   = 2 x (0,6 – (2 x 0,04)) + 2 x (0,6 –(2 x 0,04)) + (2 x 6(0,010))
   = 2,2 m
   Rebar Area = ¼ x π x d^2
   = ¼ x π x $0,010^2$
   = 0,0000785 m^2
   Total Reinforcement $= \frac{Tinggi\ tulangan\ \left(\frac{1}{2}\right)h}{Jarak\ pemasangan\ tulangan\ sengkang}$
   $= \frac{2,31}{0,100}$
   = 23,1 buah, di bulatkan menjadi 23 buah.
   Reinforcement Volume = Panjang x Luas x Jumlah
   = 2,2 x 0,0000785 x 23
   = 0,0039721 m^3

4. **Total Reinforcement Volume Calculation**

   Total Reinforcement Volume = Main Reinforcement Volume + Focus Reinforcement Volume + Field Reinforcement Volume
   = 0,04534992 + 0,0020724 + 0,0039721
   = 0,05139442 m^3 (0,0513 m^3)

a) Concrete Volume Calculation

Concrete Volume = Column Volume – Total Reinforcement Volume
= 4,68 – 0,05139442
= 4,6286 m^3 x 70 column rod
= 324,002 m^3

b) Calculation of Mixer Truck Requirements

Large Mixer Truck Capacity = 7,5 m^3

Kebutuhan Pengecoran $= \frac{\text{Volume Beton}}{\text{kapasitas truk mixer}}$
$= \frac{324{,}002}{7{,}5}$
= 43,20026 m^3 = 44 Truk Mixer

2. Column Type K2

Column Volume Calculation

Column Volume : P x L x T
: 0,6 x 0,6 x 1,5
: 0,54 m^3

Reinforcement Volume Calculation

1. Calculation of the main reinforcement volume

Reinforcement Length = 1.500
Rebar Area = ¼ x π x d^2
= ¼ x π x 0.025^2
= 0,0004908 m^2
Total Reinforcement = 8 buah
Reinforcement Volume = Panjang x Luas x Jumlah
= 1,500 x 0,0004908 x 8
= 0,0058896 m^3

2. Calculation of the Volume of Focus Reinforcement

Reinforcement Length = 2 x (bkolom – 2decking) + 2 x (hkolom – 2decking) + (2 x 6D)
= 2 x (0,6 – (2 x 0,03)) + 2 x (0,6 –(2 x 0,03)) + (2 x 6(0,010))
= 2,28 m
Rebar Area = ¼ x π x d^2
= ¼ x π x $0{,}010^2$
= 0,0000785 m^2
Total Reinforcement $= \frac{\text{Tinggi tulangan} \left(\frac{1}{4}\right)\text{h}}{\text{Jarak pemasangan tulangan sengkang}}$
$= \frac{0{,}225}{0{,}100}$
= 2,25 fruit, rounded into 3 pieces.
Reinforcement Volume = Length x Area x Quantity
= 2,28 x 0,0000785 x 3
= 0,00053694 m^3

3. Calculation of the Volume of Field Reinforcement

Reinforcement Length = 2 x (bkolom – 2decking) + 2 x (hkolom – 2decking) + (2 x 6D)
= 2 x (0,6 – (2 x 0,03)) + 2 x (0,6 –(2 x 0,03)) + (2 x 6(0,010))
= 2,28 m
Rebar Area = ¼ x π x d^2
= ¼ x π x $0{,}010^2$
= 0,0000785 m^2
Total Reinforcement $= \frac{\text{Tinggi tulangan} \left(\frac{1}{2}\right)\text{h}}{\text{Jarak pemasangan tulangan sengkang}}$
$= \frac{0{,}45}{0{,}100}$
= 4,5 buah, di bulatkan menjadi 5 buah.

Reinforcement Volume = Panjang x Luas x Jumlah
= 2,28 x 0,0000785 x 5
= 0,0008949 m^3

4. Total Reinforcement Volume Calculation

Total Reinforcement Volume = Main Reinforcement Volume + Focus Reinforcement Volume + Field Reinforcement Volume
= 0,0058896 + 0,00053694 + 0,0008949
= 0,00732144 m^3 (0,0073 m^3)

5. Concrete Volume Calculation

Concrete Volume = Column Volume – Total Reinforcement Volume
= 0,54 – 0,00732144
= 0,53267856 m^3 x 24 column rod
= 12,784 m^3

6. Calculation of Mixer Truck Requirements

Large Mixer Truck Capacity = 7,5 m^3

Casting Needs $= \frac{\text{Volume Beton}}{\text{kapasitas truk mixer}}$

$= \frac{12{,}784}{7{,}5}$

= 1,7045 m^3 = 2 Truk Mixer

From the results of the recapitulation of concrete needs in the K1 and K2 type columns from the construction of the Tangerang City Indoor and Outdoor Sport Fields, they are as follows:

Table 1. Calculation Recapitulation

Column Type	K1-type	K2-type
Column Dimensions	600 x 600	600 x 600
Main reinforcement	12D25	8D25
Column Volume	4,68 m^3	0,54 m^3
Main Reinforcement Volume	0,0453 m^3	0,0058896 m^3
The Volume of Focus	0,0020724 m^3	0,00053694 m^3
Field Swing Volume	0,0039721 m^3	0,0008949 m^3
Concrete Volume	324,002 m^3	12,784 m^3
Mixer Truck Needs	44 Truk Mixer	2 Truk Mixer

CONCLUSION

From the observation of the research carried out on the construction project of the Tangerang City Indoor and Outdoor Sport Field including structural work which can be concluded as follows:

1. Standard Operating Procedure (SOP) in the manufacture of concrete columns is very important to ensure the safety and quality of the concrete produced in accordance with the standards that have been set. By following the SOPs that have been set, it can help in minimizing the risk of work accidents and ensure that the concrete produced has sufficient strength and durability.
2. The implementation of column work in the Tangerang city indoor and outdoor sports field construction project has met the existing SOP standards in the field both technically and in terms of implementation.
3. The implementation of column work technically has gone well where each work has a time schedule and according to what is planned. However, there are some tribune works that exceed the specified elevation limit, so they must be dismantled and re-polished during maintenance work.
4. The columns used in this construction are column types K1 and K2 with dimensions of 600 x 600. K1 13 meters high with 12 D25 main reinforcement and 10 cm spacing with K-300 concrete quality requires a Concrete Volume: 324,002 m3 and a Mixer Truck Requirement of: 44 Mixer Trucks. K2 1.5 meters high with 8D25 main reinforcement and 10 cm spacing with K-300 concrete quality requires a concrete volume: 12,784 m3 and the need for a mixer truck as many as 2 mixer trucks.

From the author's observations during the research on the Tangerang City *Indoor* and *Outdoor Sport* Field construction project , there are several suggestions for the progress and success of the project in the future, including:

1. It is further improved in casting supervision so that no more porous concrete is found, especially for columns, beams, and floor plates.
2. It is necessary to increase the supervision of the dismantling of the column so that there is no visible reinforcement due to the column of gompal or it is not yet time to open.
3. It is further improved in the implementation of the dismantling of both columns, beams and floor plates so that there are no formwork wood left behind, and reinforcement attached to the stand floor plate.

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