FINAL ASSIGNMENT

COMPARISON ANALYSIS OF COST AND TIME BETWEEN ALUMINUM FORMWORK AND SEMI-SYSTEM FORMWORK ON WALL

(Case study: RSS Building MRTJ Station, Central Jakarta)

Submitted to the Islamic University of Indonesia Yogyakarta to fulfil the requirements for obtaining a Bachelor's degree in Civil Engineering

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CIVIL ENGINEERING STUDY BACHELOR PROGRAM
FACULTY OF CIVIL ENGINEERING AND PLANNING
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Prepared by

Muhammad Daffa Huberta 18511162

Accepted as one of the requirements to obtain the degree of Bachelor of Civil Engineering

Examined on August 15, 2025 By

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DECLARATION OF ORIGINALITY

I hereby truthfully declare that this Undergraduate Final Project, which I have prepared as a requirement for the completion of the bachelor's program in the Civil Engineering Study Program, Faculty of Civil Engineering and Planning, Islamic University of Indonesia, is entirely my own work. Any sections of this Final Project that are taken from the works of others have been properly cited and clearly stated in accordance with academic writing norms, rules, and ethics. Should it be found in the future that all or part of this Final Project is not my own work, or that plagiarism is present in certain sections, I am willing to accept any sanctions in accordance with the applicable laws and regulations.

Yogyakarta, August 03, 2025

The Declarant

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FOREWORD

All praise and gratitude are due to Allah SWT, by whose grace I was able to complete this Final Project entitled *"Comparison Analysis of Cost and Time Between Aluminium Formwork and Semi-System Formwork on Wall."* This Final Project is one of the academic requirements for completing undergraduate studies in the Civil Engineering Study Program, Faculty of Civil Engineering and Planning, Islamic University of Indonesia, Yogyakarta.

During the preparation of this Final Project, I encountered many obstacles. However, with the valuable criticism, suggestions, and encouragement from various parties, *alhamdulillah*, I was able to complete it. In this regard, I would like to express my deepest gratitude to:

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2. Adityawan Sigit, S.T., M.T., Ph.D., as my supervisor, for his patience and guidance throughout the completion of this Final Project.
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Finally, I sincerely hope that this Final Project may be beneficial for all who read it.

Yogyakarta, August 27, 2025

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l	= Wall length (mm)
H	= Wall height (mm)
m^2	= Meter square
n	= Number of wall panels
OH	= Man-day (*Orang hari*)
RAP	= Implemented budget plan (*Rencana anggaran pelaksanaan*)
SNI	= Standard Nasional Indonesia

ABSTRACT

Formwork is one of the most resource intensive components in reinforced concrete construction, often contributing significantly to both project cost and duration. The efficiency of a construction project is therefore closely related to the selection of an appropriate formwork system. As formwork plays a critical role in determining the timeline and budget of construction projects, selecting the appropriate method is essential for project optimization. This study aims to compare the cost and time efficiency of aluminium formwork and semi-system formwork in wall construction. The research is based on a case study of the RSS Building at the MRT Jakarta Station, Central Jakarta.

The methodology involves a comparative quantitative approach using both primary data from field observations and interviews, as well as secondary data from project documentation and prior studies. Cost calculations include production, installation, and rental components, while time efficiency is measured through man-day analysis. Labour productivity coefficients, especially for aluminium formwork, were adopted from existing research to ensure accurate and standardized comparison.

The results indicate that aluminium formwork offers greater efficiency, with a total cost of Rp 591,678,031.53 compared to Rp 976,997,040.88 for semi-system formwork. Additionally, aluminium formwork demonstrates better performance in reducing execution time due to its modularity and reusability. Therefore, aluminium formwork is recommended for large-scale projects and should be considered in future construction planning and national standards.

Keywords: Aluminium Formwork, Semi-System Formwork, Cost Comparison, Time Analysis, Construction Efficiency

CHAPTER I
INTRODUCTION

1.1 Background

The development of construction projects, particularly infrastructure, in Indonesia continues progressing alongside the increasing demand for public transportation. Rizki & Co (2019) stated that this necessitates adequate infrastructure construction. As a result of this development, the need for labour continues to grow. In a construction project, labour is one of the most important factors for the successful execution of the project, ensuring that it aligns with the planned budget, quality, and timeline.

One form of public transportation is the urban rapid train, Moda Raya Terpadu Jakarta (MRTJ). Sugiarto & Co. (2021) stated that the MRT Jakarta project was developed to reduce traffic congestion, enhance economic growth, improve quality of life, and support urban regeneration. Additionally, the MRT Jakarta project is an alternative solution to the challenges posed by the increasing limitations on available land and road space.

The MRT Jakarta project comprises three main components: tunnel construction, rail tracks, and stations. The station construction has the most significant components, namely walls and reinforced concrete. During the mixing of reinforced concrete for the station work, equipment is needed to hold the concrete mixture, which is called formwork temporarily. This formwork not only shapes the concrete structure but also supports the load during the curing process until the structure is strong enough to bear its weight.

The choice of formwork type and construction method significantly impacts construction project activities. The types of formworks commonly used in Indonesia include conventional and semi-conventional systems. Conventional formwork generally utilizes materials such as wood, plywood, and various types of boards that can serve as formwork. The semi-conventional formwork is an evolution of conventional systems, where plywood is the primary material, supplemented by additional materials like steel or hollow sections for added strength.

Generally, plywood used as formwork for concrete mixtures is designed for single use only. Using plywood as formwork significantly affects the concrete work, as concrete placement can only proceed once the formwork has been perfectly installed. However, since plywood is generally limited to one-time use, it incurs significant costs due to the increasing material requirements as the project progresses, impacting both the budget and the timeline for structural work.

Innovation in the types and methods of formwork execution continues to evolve, impacting costs, quality, and project timelines. One formwork method recently developed and introduced in Indonesia is precast formwork (Zulin formwork). This precast formwork, made from aluminium, involves several stages in its fabrication process, making it superior to conventional and semi-conventional systems. It generates little to no waste material because it can be reused, requires less labour for installation, and significantly reduces the time needed for execution due to its easy and modular assembly.

1.2 Problem Statement

Based on the background of the issues mentioned above, the problem statement can be formulated as follows:

1. What is the cost comparison between aluminium formwork and semi-system formwork for wall work?
2. What is the time comparison needed for aluminium formwork and semi-system formwork?
3. Which wall formwork method is more efficient in terms of cost and time for use in the MRT Jakarta station construction project?

1.3 Research Objectives

The objectives of this research are as follows:

1. To determine the cost comparison required for wall formwork using comparative methods for full semi-system and full aluminium formwork.
2. To assess the time comparison between semi-system formwork and aluminium formwork on wall.
3. To identify the efficient wall formwork method in terms of cost and time for use in the MRT Jakarta station construction project.

1.4 Research Benefits

This research has the following benefits.

1. To determine the cost comparison required between semi-system formwork and aluminium formwork.
2. To assess the time comparison for semi-system formwork and aluminium formwork.
3. To serve as a reference and consideration for construction practitioners in selecting formwork for large-scale projects.
4. The use of aluminium formwork can be a guideline and should be included in the SNI as it is a new and emerging method in projects in Indonesia.

1.5 Research Limitations

Due to the many factors affecting this research, it is necessary to set limitations to ensure the study is directed and yields results as planned.

1. This research is conducted only on the Design and Build project of the MRT Jakarta RSS Building at Monas Station.
2. The research is carried out directly in the field.
3. This study is limited to the formwork work for basement wall structures.
4. The observed work focuses only on semi-system formwork
5. The analysis for the aluminium formwork is derived using a journal research as a standard

6. Semi-system formwork refers to the primary material of multiplex poly film with added hollow steel for reinforcement, ready to be installed on wall reinforcement.
7. The research is limited to the cost and time comparisons between semi-system formwork and aluminium formwork.
8. The research use the actual budget plan and unit price of the project for calculation and only using officials unit price (AHSP) as a reference

CHAPTER II
LITERATURE REVIEW

2.1 Prior research

The writing of this final assignment refers to several references in the form of scientific journals or final assignments that have been conducted in the last 10 years. Research similar to and discussion of formwork comparison is as follows.

2.1.1 On the methodology of conventional and semi-system formwork project comparison

Lawdy (2024) conducted research to identify the limitations of traditional formwork and explore the use of semi-system formwork in construction projects, as well as to examine and compare both conventional and semi-system formwork approaches. This study uses a qualitative research methodology conducted in the Psychology lecture hall, where it analyses and compares different methods for structural work, drawing insights from previous research.

The result of this is that before the implementation of value engineering, the cost of column formwork was IDR 180,140/m², whereas semi-system formwork would have cost IDR 112,980/m², resulting in a savings of IDR 67,160/m², or 37%. The cost of beam formwork was IDR 220,800/m², but semi-system formwork would have reduced this to IDR 116,940/m². Traditional formwork was priced at IDR 239,950/m² for the floor slab, while semi-system formwork would have increased the cost to IDR 269,260/m², making traditional formwork 15% less expensive. Therefore, semi-system formwork is the most cost-effective solution for columns and beams, while traditional formwork remains the more economical option for the floor slab.

2.1.2 Comparative Analysis of Aluminium Formwork and Conventional Formwork on The Success of the Structural Work Quality

Yehezkiel (2024) researched the innovations in formwork within the construction industry that are continuously advancing, with aluminium formwork being one notable development. Differences were observed in the quality of work between aluminium and conventional formwork structures, necessitating an analysis to explore these variations. The approach involves analyzing data from questionnaires and expert interviews. The analysis aims to assess how aluminium and conventional formwork affect structural work's success and identify the differences using a multiple linear regression model.

The research findings indicate that the impact of aluminium and conventional formwork structures on the success of the quality of structural work in the Kediri Regency Stadium construction project can be determined through the regression equation $Y = 3.946 + 0.564 X1 + 0.392 X2 + 0.155$, with an Adjusted R Square value of 0.949. This suggests that as the use of aluminium formwork increases, the quality and success of the structural work also improve. Furthermore, there is a noticeable difference in the quality of structural work between aluminium and conventional formwork, with an average acceptance difference of 5.08%. Overall, the quality of work using aluminium formwork surpasses that of conventional formwork in this project.

2.1.3 *Studi Analisis Perbandingan Waktu dan Biaya Bekisting Metode Konvensional Dengan Metode Aluminum Formwork Pada Proyek Bess Mansion Surabaya*

Ihsan (2020) analyzed the Bess Mansion Apartment construction project in Surabaya, East Java; formwork work was carried out using the conventional method involving wood-based formwork. However, formwork technology has advanced, with various methods now available that impact cost and time efficiency. One such method is aluminium formwork, an environmentally friendly and cost-effective alternative. As a result, research is needed to compare the time and cost implications of these two formwork methods. The research is conducted using a comparative method between the two formworks.

The results of this research on the Surabaya Bess Mansion Apartment construction project show that the use of conventional formwork for columns, beams, floor slabs, and stairs incurred a cost of IDR 10,593,794,954.14 and took 478 days to complete. In contrast, using aluminium formwork for the same components resulted in a cost of IDR 11,308,383,251.40 and required only 292 days to finish. While aluminium formwork is more expensive than conventional formwork, it offers significant time savings, completing the project in 186 fewer days.

2.1.4 Analisis Perbandingan Biaya dan Waktu Antara Pekerjaan Bekisting Aluminum dan Bekisting Semi Sistem pada kolom

This research by Haris (2023) regarding cost and time comparison of aluminium formwork and semi-system formwork employs a comparative method to analyse the costs of two types of formworks: one using a combination of semi-system formwork and the other using aluminium formwork for the entire floor. The cost and time analysis for the formwork work was based on data collected directly from the project and from relevant references.

The cost analysis results show that the total cost was IDR 1,995,361,259.91 using the formwork combination method. The price for aluminium formwork for the entire floor amounted to IDR 1,592,588,673.58, while the cost for semi-system formwork was IDR 1,455,959,607.91. Regarding time, the semi-system formwork for columns, from the basement level 2 to the 2nd floor, took 36 days, with a daily productivity of 62.81 m^2/day. In comparison, the aluminium column formwork for all floors from the 3rd to the 22nd took 76.5 days, with a daily productivity of 135.785 m^2/day. Using aluminium formwork for the entire floor allows for more effective and efficient column structure work, offering advantages in terms of both cost and time compared to the semi-system formwork method.

2.2 Research Difference

The research to be conducted presents several key differences compared to previous studies. Unlike earlier research, this study utilizes a specific brand of precast aluminium formwork known as Zulin, distinguishing it in terms of material choice and application. Furthermore, the study focuses on different structural elements, specifically walls and retaining walls, rather than the typical structures examined in prior research. These distinctions in both the material used and the structural components being analysed contribute to the uniqueness of this study. A detailed comparison of the technical differences between this research and previous studies is provided in the following Table 2.1:

Table 2.1 The Difference from Previous Research

Aspect	**Prior Research**					**Current Research**
Type	Journal	Journal	Final Assignment	Final Assignment		Final Assignment
Researcher	Muhammad D.V. Lawdy (2024)	Yehezkiel Rivaldo Widjaya (2024)	Raihan Ilyasa Ihsan (2020)	Haris Ahmad Kurniawan (2023)		Muhammad Daffa Huberta (2022)
Title	On the methodology of conventional and semi-system formwork project comparison	Comparative Analysis of Aluminium Formwork and Conventional Formwork on The Success of the Structural Work Quality	*Studi Analisis Perbandingan Waktu dan Biaya Bekisting Metode Konvensional Dengan Metode Aluminum Formwork Pada Proyek Bess Mansion Surabaya*	*Analisis Perbandingan Biaya dan Waktu Antara Pekerjaan Bekisting Aluminum dan Bekisting Semi Sistem pada kolom*		Comparison Analysis of Cost and Time Between Zulin Aluminium Formwork and Semi-System Formwork on the Wall

Continuation of Table 2.1 The Difference from Previous Research

Aspect	Prior Research					Current Research
Location	Malang	Kediri	Surabaya	Jakarta		Jakarta
Purpose	Examine and compare conventional and semi-system formwork project	Determine the result of work on aluminium and conventional formwork structures on the success of structural work	Discussed the comparison of the conventional method of formwork with aluminium formwork as an option for construction company	To determine the cost comparison required for column formwork work using the combination method, full semi-system, and full aluminium formwork		To identify and highlight the Zulin wall formwork method and determine whether it's efficient in terms of cost and time for use in the MRT Jakarta station construction project.
Method	Qualitative research	Multiple linear regression model	Comparative method	Comparative method		Comparative method

Continuation of Table 2.1 The Difference from Previous Research

Aspect	**Prior research**					**Current Research**
Result	Semi-system formwork is the most cost-effective solution for columns and beams, while traditional formwork remains the more economical option for the floor slab.	The quality of work using aluminium formwork surpasses that of conventional formwork in a particular project.	Aluminium formwork is more expensive than conventional formwork. However, it offers significant time savings, completing the project in 186 fewer days.	Using aluminium formwork for the entire floor allows for more effective and efficient column structure work, offering advantages in terms of both cost and time.		

CHAPTER III
THEORETICAL BASIS

3.1 General Definitions

Formwork is a system that supports and shapes concrete components. They remain in place until the structures are capable of supporting themselves. Formwork systems play an essential role in construction and selecting the right formwork system can lead to a more sustainable result. According to several experts, the definitions of formwork are as follows.

Al-ashwal (2017). A formwork system is used to cast structural elements like columns, beams, slabs, shear walls, and smaller building components like stairs. It is imperative to consider cost, time, and quality when selecting formwork for any type of building.

Gambatese, & Co (2003). Formwork is a temporary or permanent structure that supports the weight of freshly poured concrete until it has gained sufficient strength to support itself. Formwork can be made from various materials, including wood, metal, or plastic, and its design must account for factors such as concrete pressure, reinforcement placement, and environmental conditions.

Peurifoy, & Co (2016). Formwork is a temporary or permanent mould used in construction to support and shape freshly poured concrete until it attains sufficient strength to support itself. It consists of various components, including panels, braces, and ties, which must be designed to withstand the weight and pressure of the wet concrete, as well as environmental factors such as wind and temperature fluctuations. The proper design and installation of formwork are crucial for ensuring dimensional accuracy, surface finish, and overall structural integrity of the final concrete product.

Based on the definitions provided by various experts, it can be concluded that formwork serves as a supporting structure that functions as a mould to contain the concrete mixture and impart the desired shape to the cured concrete. This formwork system is designed to be dismantled or removed once the concrete has attained adequate compressive strength to sustain its own weight.

As an integral component of the structural framework, formwork must be engineered with precision and efficiency to adequately support the imposed loads, utilizing appropriate construction methodologies to ensure safety and structural integrity. Different formwork materials have advantages and disadvantages. For instance, plastic and wood are lightweight. Wood formwork can only be used a limited number of times and is prone to swelling, twisting, and cracking. However, wood is cheaper than plastic or steel formwork. Steel formwork is strong and durable, but it can also be expensive.

Formwork reuse contributes to cost savings and material waste reduction. Based on previous research, expenditure on formwork is up to 25 % or more than the cost of a building's structure. Furthermore, the formwork system is also one of the main factors determining the success of construction projects, including the cost, quality, speed, and safety of the project. According to Prajapati & Co (2014) in summary, formwork can significantly impact construction project cost and duration and other activities. In recent years, its potential to be reused has attracted increasing attention.

According to Chowdhury & Co (2019), choosing the appropriate formwork method is crucial for ensuring efficiency, safety, and quality in construction projects. Here are key considerations for selecting a formwork method:

1. Type of Structure or the design and geometry of the concrete structure significantly influence the choice of formwork. Complex shapes may require specialized formwork systems, while simpler forms can utilize standard panels.
2. Material of Formwork, formwork can be made from various materials, including wood, metal, or plastic. The choice depends on cost, reusability, and the required surface finish. Metal formwork, for instance, is durable and reusable but may have higher initial costs compared to timber.

3. Project Size and Scale, some large-scale projects may benefit from modular or system formwork that allows for quick assembly and disassembly. Smaller projects might be more suited to traditional methods.
4. Construction Timeline, the speed of construction is a critical factor. Methods that allow for rapid setup and removal, such as panelized systems or lightweight materials, can help meet tight schedules.
5. Cost Considerations, budget constraints play a significant role. The choice of formwork should balance initial costs with long-term reusability and maintenance expenses.
6. Labour Availability, which is the skill level and availability of labour can affect the choice of formwork. Some systems require specialized training or experience, while others are more straightforward to implement.
7. Environmental Conditions and site conditions, including weather and accessibility, should be considered. For example, materials that resist water damage might be necessary in areas with high moisture.

This framework serves as a guide to selecting the most suitable formwork method based on the specific requirements of a project. Ultimately, this comprehensive evaluation promotes efficiency, safety, and quality in construction.

3.1.1 Requirements and specifications for formwork

Formwork must be designed not only to create moulds that meet the desired dimensions but also to support its weight and any additional loads that may occur. To meet the requirements and specifications, the American Concrete Institute (ACI), in the book Formwork for Concrete, states that formwork must fulfil the following criteria:

1. Material Durability: Formwork should be constructed from durable materials capable of withstanding the weight and pressure of wet concrete, as well as environmental factors like moisture and temperature changes.
2. Load Capacity: The design must ensure that the formwork can support the weight of the concrete and any additional loads, such as construction equipment and personnel.

3. Accuracy: Formwork should be fabricated to precise dimensions to ensure that the finished concrete structure aligns with the design specifications and tolerances.
4. Finish Quality: The inner surfaces of the formwork should provide a smooth finish to the concrete, potentially using release agents to facilitate easy removal without damaging the surface.
5. Ease of Use: Formwork should be designed for quick and easy assembly and disassembly, minimizing labour costs and time on-site.
6. Reusability: It is beneficial for formwork to be reusable to reduce material costs and waste while still maintaining structural integrity over multiple uses.
7. Safety Compliance: All formwork systems must adhere to safety standards to protect workers and ensure stability during the construction process.

3.2 Types and Methods of Formwork Work

1. Conventional Formwork

Conventional formwork is made from wood, plywood, or particleboard materials, with a support structure typically constructed from wooden beams. In many cases, steel reinforcements are added to enhance its strength and stability. One of the key advantages of conventional formwork is its ease of installation and dismantling. Additionally, the components of conventional formwork can often be reused for different projects, provided they remain in good condition and are not significantly damaged. This makes it a cost-effective solution in construction, as it allows for repeated use over time.

The following are the steps in the installation of conventional formwork that must be carried out in sequence:

1. Setting the wall axis position using measuring tools.
2. Use stakes and string lines to outline the area where the formwork will be erected and mark the installation of wall shoes.
3. Installing wall reinforcement, completing the reinforcement, and placing decking concrete on each outer side of the reinforcement.

4. Installing the wall shoes.
5. Installing the formwork that has been coated with oil, the panels is secure using nails or screw ensuring that every corner joint of the formwork is perfectly sealed.
6. Installing braces, such as wooden beams, on each side of the formwork to prevent lateral movement and maintain structural integrity.

2. Semi System Formwork

Semi-system formwork is a versatile construction method that merges the benefits of traditional and modular formwork systems, making it ideal for various reinforced concrete projects. Its design features standardized components that can be easily assembled and disassembled, allowing for quick setup and adaptability to different shapes and sizes of concrete pours, such as walls, slabs, and columns. Typically made from durable yet lightweight materials like steel, aluminum, or plywood, semi-system formwork offers a cost-effective solution by promoting reuse and reducing labor time on site. Additionally, it incorporates safety features that protect workers during construction, making it a practical choice for contractors seeking efficiency and flexibility in their projects.

The following are the steps in the installation of semi system formwork that must be carried out in sequence:

1. Determining the wall axis points and establishing reference lines using measuring tools to ensure accurate placement.
2. Marking the wall base according to the planned wall dimensions by pulling a string dampened with paint from the endpoints of the wall.
3. Installing the prefabricated wall reinforcement, completing the reinforcement, and then placing the concrete decking on the outer side of the reinforcement.
4. Installing the wall base.
5. Installing formwork that has been coated with oil, then installing lock beams for added strength, use tie rods to connect and secure formwork panels, ensuring they can withstand the pressure of the poured concrete.

6. Installing supports consisting of push-pull props and kicker braces on each side of the wall to prevent it from tilting or swaying during the pouring process.

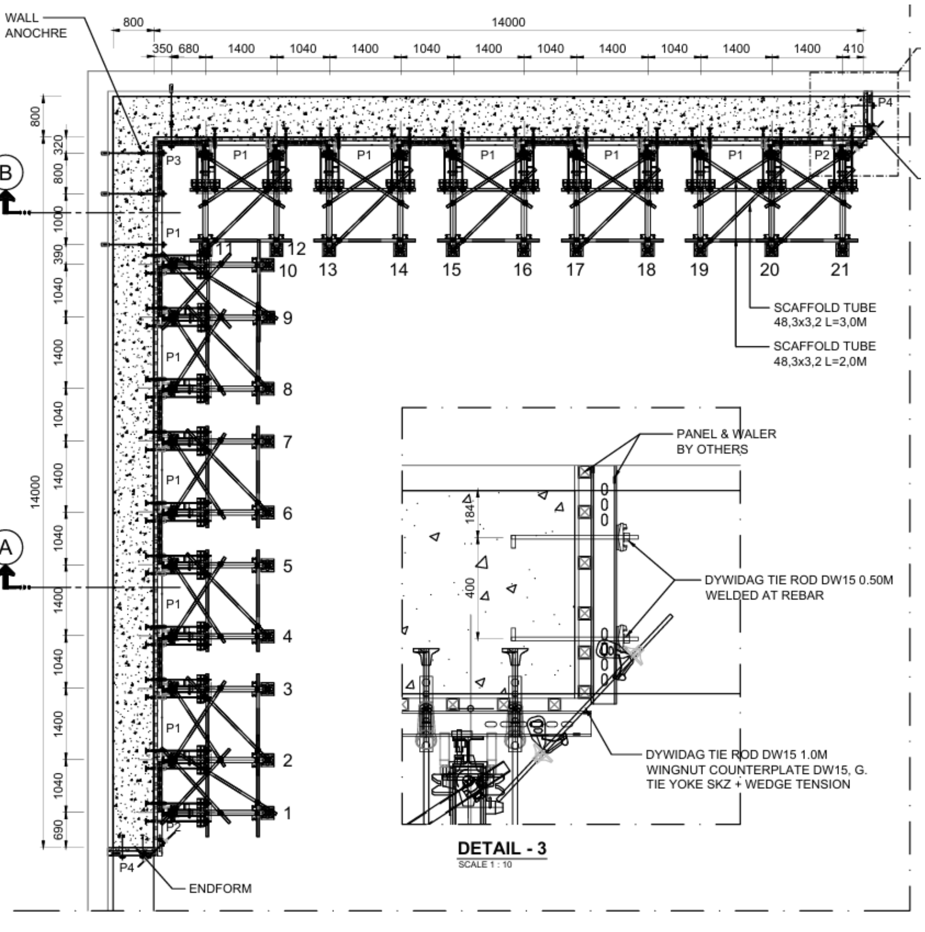

Figure 3.1 Semi-System Formwork placement

(Source: Project data)

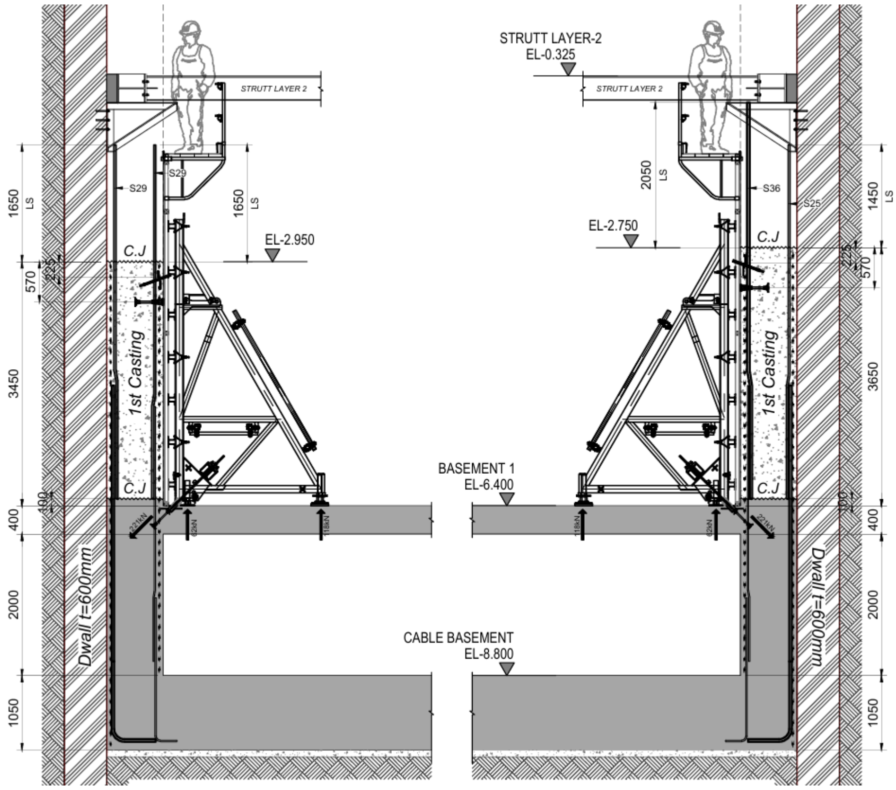

Figure 3.2 Semi-System Formwork platform

(Source: Project data)

Figure 3.3 Semi-System Formwork

(Source: Personal Documentation)

3. Aluminium Formwork

Aluminium formwork is an advanced development of a universal formwork system that can be used in various types of buildings. Aluminium formwork consists of components such as panels, accessories, and other reinforcements made from aluminium. Aluminium formwork has two types of panels: standard panels and custom panels. Standard panels are formwork panels with specific dimensions that are mass-produced by the company, allowing for quick availability and uniformity in construction. In contrast, custom panels are manufactured to specific sizes ordered specifically by contractors to meet unique project requirements.

Key Features of Aluminium Formwork:

1. Modularity: Aluminum formwork consists of standardized components that can be easily combined to create various shapes and sizes, allowing for adaptability in different construction scenarios.
2. Lightweight and Durable: The materials used in Aluminum formwork are designed to be lightweight yet strong, facilitating easier handling and transportation on-site.
3. Quick Assembly: The system is engineered for rapid assembly and disassembly, which helps reduce labour time and speeds up the construction process.
4. Versatility: Aluminum formwork can be used for various concrete applications, including walls, slabs, and columns, making it a versatile choice for contractors.
5. Safety Features: The design incorporates safety measures to protect workers during the construction process, ensuring stability during concrete pouring.
6. Cost-Effective: Aluminum formwork can help lower overall project costs by promoting reuse and reducing construction time.

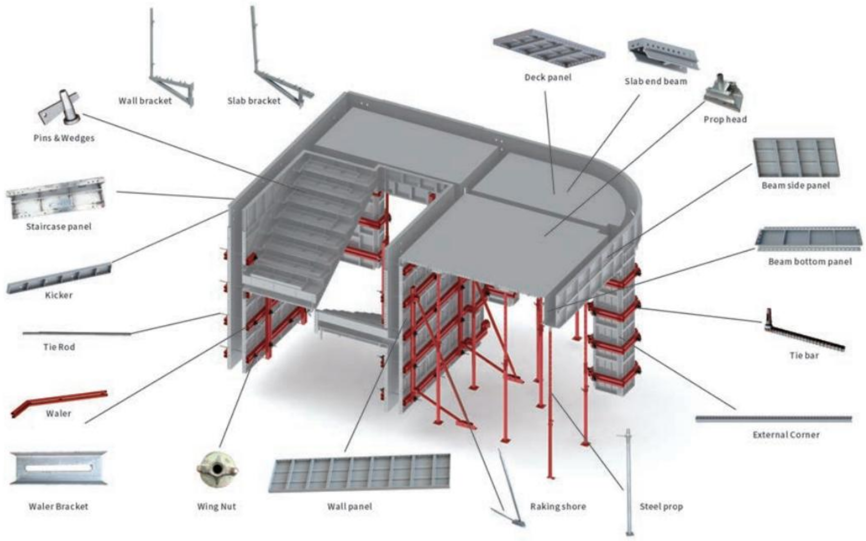

Figure 3.4 Aluminum Formwork

(Source: GETO formwork and scaffolding expert)

Figure 3.5 Aluminum Formwork

(Source: Personal Documentation)

Aluminium formwork is commonly used in high-rise buildings, bridges, tunnels, and various infrastructure projects, thanks to its efficiency and adaptability. It allows for precise concrete placement and achieves high-quality finishes, making it a popular choice among construction professionals.

Aluminium formwork system widely used in construction, particularly for concrete structures. Zulin Group stated that, this system is designed to be flexible, efficient, and easy to assemble, making it suitable for various applications such as residential, commercial, and industrial projects. The manufacturing process for aluminium formwork involves several key steps to ensure quality, durability, and efficiency. Here is an overview of the typical manufacturing process according to (Zulin Group, 2024), namely as follows:

1. High-quality materials, such as aluminium or steel, are chosen for their strength, lightweight properties, and durability.
2. Detailed designs are created using computer-aided design (CAD) software to ensure precision and functionality. This includes creating standard components and custom solutions based on project requirements.
3. The selected materials are cut to size using advanced machinery like CNC machines. This ensures that all components meet the exact specifications needed for assembly.
4. Parts are formed and welded together for metal components to create the desired shapes. This process may involve bending, stamping, and assembly of frames.
5. Components undergo surface treatment processes such as anodizing or galvanizing to enhance corrosion resistance and durability, improving the lifespan of the formwork.
6. Rigorous quality control checks are conducted throughout the manufacturing process. This includes testing material strength, inspecting welds, and ensuring dimensional accuracy.
7. Once individual components are completed, they are assembled into formwork systems. This can involve fitting panels, connectors, and accessories together according to the design specifications.
8. A thorough inspection is conducted to ensure the assembled formwork meets all safety and performance standards. Any defects are addressed before the product is approved for shipping.

9. The finished formwork systems are carefully packaged to prevent damage during transportation. They are then shipped to construction sites or distributors as needed.
10. Manufacturers often then provide support services, including installation guidelines, maintenance tips, and training for construction teams to ensure effective use of the formwork.

Figure 3.6 Aluminum Formwork Assembly

(Source: Personal Documentation)

This comprehensive manufacturing process ensures that formwork is reliable, efficient, and capable of meeting the demands of various construction projects.

3.3 Project Management

Project management is the systematic process of planning, executing, and closing projects to achieve specific goals. A project is a temporary endeavour to create a unique product, service, or result. The primary purpose of project management is to ensure that projects are completed on time, within budget, and to the desired quality standards (Meredith, & Co., 2017).

According to Project Management Institute (PMI) publications, such as the PMBOK® Guide, Project management encompasses several distinct phases, often referred to as the project life cycle:

1. Initiation: This phase involves defining the project's purpose, scope, and objectives. It includes identifying stakeholders and obtaining necessary approvals to move forward.
2. Planning: In this critical phase, project managers develop a detailed project plan that outlines the scope, schedule, budget, resources, and risk management strategies. Effective planning ensures that all team members understand their roles and responsibilities.
3. Execution: This phase involves putting the project plan into action. It includes coordinating people and resources, managing stakeholder expectations, and ensuring quality control. Effective communication is essential during this phase to keep everyone aligned.
4. Monitoring and Controlling: Concurrent with execution, this phase focuses on tracking project progress against the plan. Key performance indicators (KPIs) are used to measure success, and project managers must be prepared to adjust as needed to address any deviations or issues that arise.
5. Closing: The final phase involves completing all project activities, obtaining formal stakeholder acceptance, and closing out any contracts. This phase also includes conducting a post-project evaluation to capture lessons learned and improve future project performance.

3.4 Time Management

Time management in project management refers to the processes involved in planning, estimating, scheduling, and controlling the time required to complete project activities, which is essential for ensuring timely project delivery. Key components include defining and sequencing activities to establish task order and dependencies, accurately estimating the duration of tasks using techniques such as expert judgment and parametric estimating and creating a project schedule with tools like Gantt charts or network diagrams. Resource allocation involves assigning the right resources to tasks while considering their availability, and ongoing monitoring and controlling help assess progress against the schedule, using methods like Earned Value Management (EVM) to identify any deviations.

Effective time management is critical for meeting deadlines, optimizing resource use, mitigating risks, and controlling costs, as delays can lead to increased expenses. Overall, implementing robust time management practices significantly enhances the likelihood of project success by ensuring objectives are met within the designated timeframe (Kerzner., 2017)

In Ministerial Regulation, Number 28/PRT/M/2016, 5.3.4 explains that productivity is defined as the ratio of output (results) to input (production components). Therefore, to calculate the productivity value it can be determined using equation 3.1 as follows:

$$\text{Productivity} = \text{Volume produced} / \text{Working time}$$

The level of productivity is influenced by several factors, such as the volume of work produced, the number of workers, and effective working hours. Generally, workers perform tasks during normal effective working hours of 7-8 hours.

3.5 Cost

Cost management in construction project management involves planning, estimating, budgeting, financing, funding, and controlling costs to ensure that the project is completed within the approved budget. It is a critical aspect of project management, as effective cost control directly impacts the overall success of a construction project (Haas., 2024). Understanding the distinction between direct and indirect costs is crucial for effective budgeting and cost control in construction project management. According to Oberlander (2014), direct and indirect costs are as follows:

3.5.1 Direct cost

Direct costs are expenses that can be directly attributed to a specific project or activity. These costs are incurred specifically for the construction of a project and can be easily traced to a particular cost object, such as a project, a task, or a specific phase of the construction. Common examples of direct costs include:

1. Labour Costs: Labour costs encompass the wages and salaries paid to workers directly involved in construction activities and represent a significant portion of a project's budget. These costs include basic wages for construction workers, overtime pay for hours worked beyond the standard schedule, and employee benefits such as health insurance and retirement contributions. Employers also incur payroll taxes, including Social Security and unemployment insurance, as well as expenses for training and certification needed for compliance and safety. Managing labour costs effectively is crucial for accurate budgeting and resource allocation, enabling project managers to negotiate contracts and ensure the successful completion of projects.
2. Material Costs: Material costs encompass the expenses incurred for purchasing all materials specifically used in a construction project, making them a vital part of the overall budget. This includes essential items such as concrete, steel, and lumber, as well as fixtures and finishes like windows, doors, plumbing supplies, and flooring materials. In addition to the purchase price, material costs involve transportation, handling, and storage expenses, which can significantly impact the total cost. Accurate estimating and managing material costs are crucial for keeping the project within budget and on schedule, as delays or cost overruns can disrupt timelines and affect overall project profitability.
3. Equipment Costs: Equipment costs refer to the expenses associated with machinery and tools directly utilized on a construction job site, representing a significant portion of the overall project budget. This includes the purchase, lease, or rental costs of heavy machinery such as excavators, bulldozers, cranes, concrete mixers, and smaller tools like drills, saws, and scaffolding. Additionally, equipment costs encompass maintenance, repair, and operating expenses, including fuel and insurance.

Proper management of equipment costs is essential for ensuring that the right tools are available when needed, which helps maintain project schedules and productivity.

3.5.2 Indirect cost

Indirect costs, on the other hand, are expenses that cannot be directly attributed to a specific project or activity. These costs are necessary for the overall functioning of the project but are not tied to a specific cost object. Indirect costs are often allocated across multiple projects. Common examples include:

1. Overhead Costs: Overhead costs refer to general administrative expenses that are essential for the overall operation of a construction company but are not directly tied to any specific project. These costs typically include office rent, utilities, and salaries for support staff such as administrative personnel, project managers, and human resources. Overhead costs are crucial in maintaining the infrastructure needed to support project execution, ensuring that the organization can operate efficiently.
2. Insurance: Insurance costs are premiums paid for various types of coverage that protect the construction company against potential risks and liabilities associated with its operations. This includes liability insurance, which safeguards against claims for property damage or personal injury, and workers' compensation insurance, which covers medical expenses and lost wages for employees injured on the job. These insurance premiums often span multiple projects, providing essential protection that mitigates financial risk. Understanding and managing insurance costs is critical for project budgeting, as inadequate coverage can lead to significant financial exposure in the event of accidents or disputes.
3. Utilities and Maintenance: Utilities and maintenance costs encompass the expenses associated with keeping equipment and facilities operational. This includes costs for electricity, water, heating, and cooling, as well as routine maintenance and repairs for machinery, tools, and office facilities. While these costs are not directly linked to a specific project, they are

essential for ensuring that all operational facets of the construction business operate effectively.

CHAPTER IV
RESEARCH METHODOLOGY

4.1 Research Data

According to Mayer-Schönberger, & Co (2013) data consists of raw facts, figures, or observations that can be processed and analysed to provide valuable insights or knowledge. It is crucial in various fields, including scientific research and business, influencing decision-making and driving innovation.

In this research, there are two methods of data collection, namely:

1. Primary data refers to data that is gathered directly by researchers through methods like surveys, interviews, experiments, or direct observation. This data type is original and specific to the research at hand, ensuring it is highly relevant and accurate for addressing the research questions.
2. Secondary data includes data that has already been collected and published by other sources, such as books, academic articles, or databases. Researchers often use secondary data to identify trends, compare results, or complement their primary data.

Saunders & Co (2019) stated that both types of data are important, with primary data providing more direct control over the research process, while secondary data offers a wider context and additional background information.

Table 4.1 Research Data

No	Data Type	Data	Formwork Type	Source
1	primary	1. Method 2. Time 3. Cost 4. Productivity 5. Material	1. Aluminium 2. Semi system	1. Observation 2. Interview 3. MRTJ project

Continuation of Table 4.1 Research Data

2	Secondary	1. Material cost 2. Material	1. Aluminium 2. Semi system	1. AHSP 2. Literature study

4.2 Subject and Object of the Research

4.2.1 Subject Research

Creswell (2014) states In research, the subject refers to the central focus or area of investigation—the specific phenomenon, group, or concept that the researcher aims to explore. It outlines the study's boundaries and influences the choice of data and research methods. The main subject of this research is data on the prices and time related to formwork work, which was obtained from the construction project of the MRTJ station located on Thamrin Street in the National Monument area of Central Jakarta.

4.2.2 Object Research

Creswell (2014) stated that the object refers to the specific elements, factors, or phenomena examined within the study's broader subject. While the subject represents the overall theme or area of focus, the object involves the aspects or variables that the researcher intends to investigate, measure, or analyse. The object of this research is the comparative analysis of costs and time for semi-system formwork and aluminium formwork in the wall structure of the station building.

4.3 Research Stages and Data Analysis

The steps undertaken in this research are as follows.

4.3.1 Research Stages

The Stages of this research were as follows:

1. Problem formulation includes defining the research problem, its significance, and the research objectives.
2. Literature review to gather relevant information related to the research topic from various sources, such as references, journals, books, and reports.

3. Data collection to gather the necessary information for analysing the research problem.
4. Calculating the volume and dimensions for the required materials for existing aluminium formwork and semi-system formwork.
5. Calculating and analysing the comparison of costs and time between aluminium formwork and semi-system formwork.
6. Data analysis and discussion, interpreting the results based on existing theoretical foundations.
7. Conclusions and recommendations based on the findings from calculations and analysis

4.3.2 Data Analysis

The analysis aims to provide an overview of the systematic and accurate comparison between semi-system formwork and aluminium formwork.

1. Cost analysis
   a. Calculate the aluminium and semi-system formwork volume by referencing the dimensions and number of walls from the project's working drawings.
   b. Determine the unit cost of wall formwork using aluminium and semi-system formwork based on the budget plan (RAP) for the MRTJ station construction project and research journal entitled "*Analisis Pengaruh Pemilihan Jenis Bekisting Terhadap Durasi Dan Biaya Pelaksanaan Pekerjaan Struktur Proyek X,*" (Hartono Lim, 2021) as a benchmark for the aluminium formwork analysis.
   c. Calculate the total cost by multiplying the work volume by the unit cost and then multiplying by the number of walls on each floor.
2. Time Analysis
   a. Based on actual field data, calculate the number and duration of labour required for wall work with aluminium and semi-system formwork.
   b. Measure labour productivity through direct observation on site.

c. The duration of wall formwork work includes the time from formwork fabrication to the reinforcement of formwork until it is ready to be filled with concrete.
d. Calculate the duration of wall formwork work for each floor.

4.4 Research Flowchart

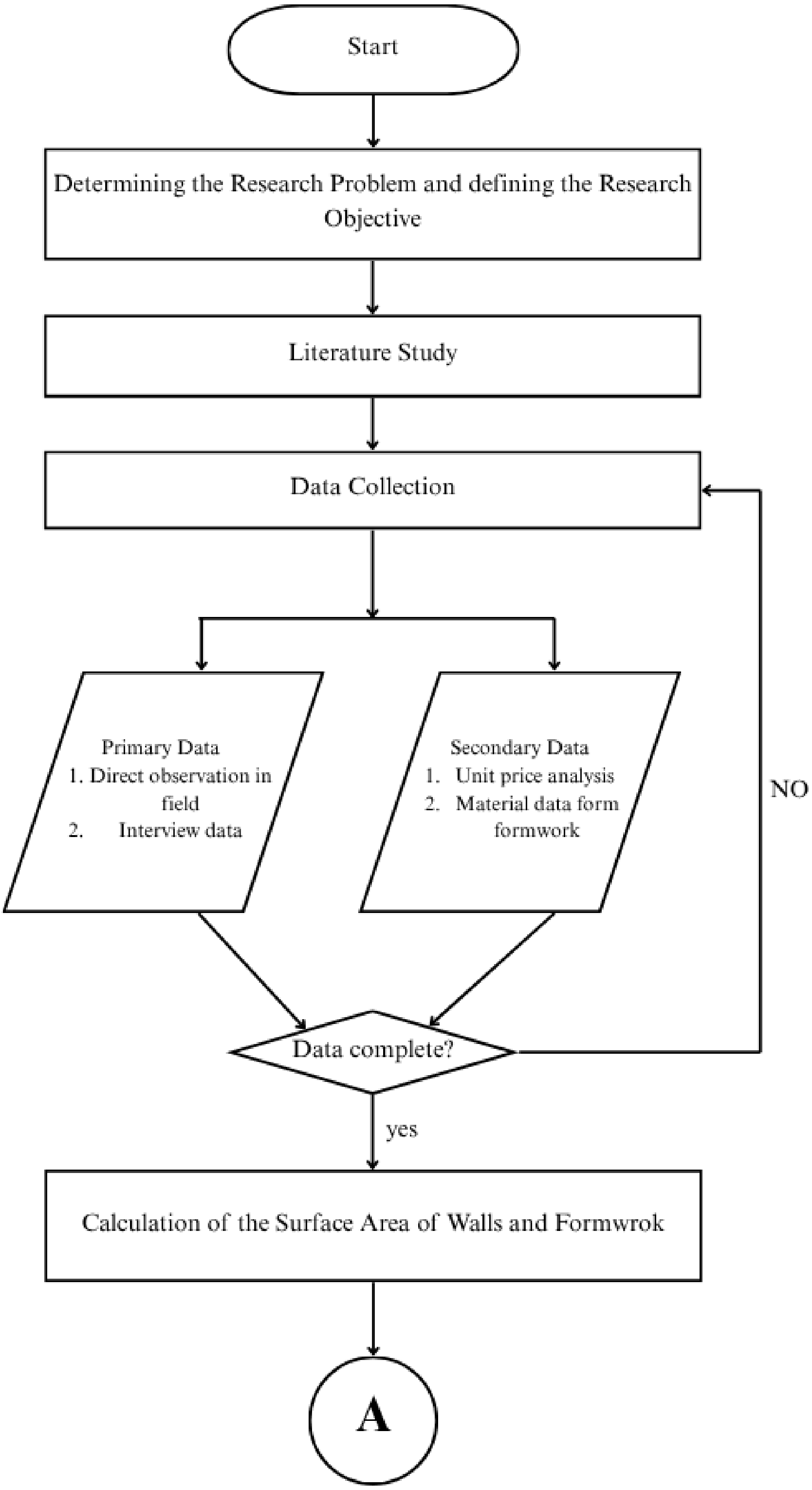

Figure 4.3 *Flowchart* Penelitian

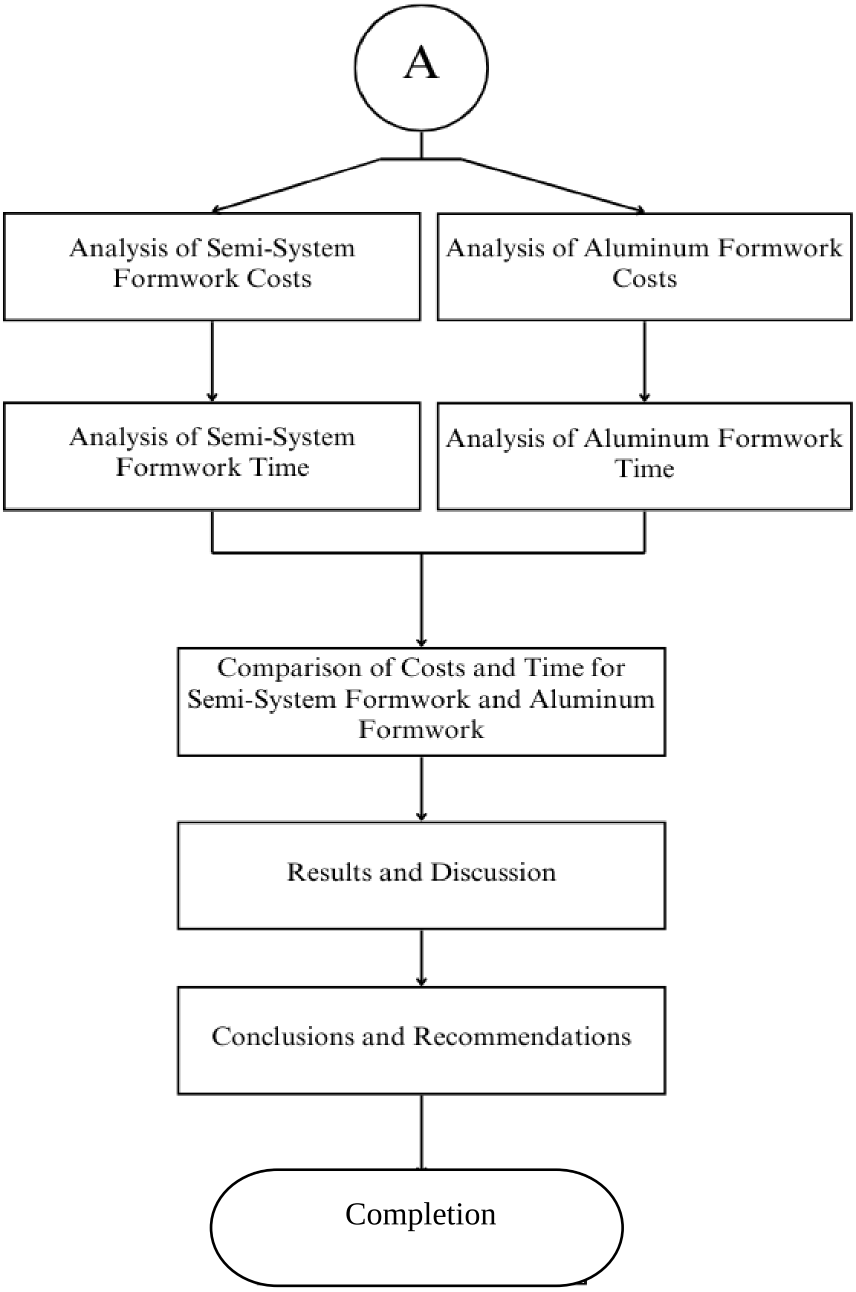

Figure 4.3 *Flowchart* Penelitian

CHAPTER V
ANALYSIS AND DISCUSSION

5.1 General Overview

The value of a task and the methods used significantly impact the planning of a project. A comparison of alternative methods in terms of cost and time can be made to identify the most effective method, followed by an analysis of the budget plan, which is then implemented during the project execution.

In order to select the appropriate method, an analysis of the budget plan and the time required for formwork work is carried out by comparing the semi-system formwork method and the aluminium formwork method. The following are the project data that serve as the subject of this final project:

Project Name	: Mass Rapid Transit Jakarta Project (MRT-J)
Project Location	: Hotel Indonesia Roundabout and Jakarta National Monument, Thamrin, Jakarta Pusat, Indonesia
Contractor	: SHIMIZU ADI KARYA Joint Venture
Consultant	: ORIENTAL CONSULTANT GLOBAL
Number of floors	: Under Ground Construction
Total Budget	: Rp 4,038,472,467,522.00
Construction Period	: December 2019 – December 2025

An analysis of the budget and timeline for formwork Installation, whether employing semi-system or aluminium formwork, is influenced by various factors, including material types and quantities, building structure, and labour requirements. Therefore, it is crucial to evaluate the associated costs and timeframes for each method in order to optimize efficiency and effectiveness during project implementation.

5.2 Wall Detail

In the MRT-J Jakarta Station construction project, several walls are divided into multiple phases for the formwork process. This study specifically examines the formwork for the RSS electrical central building, which is divided into phases 1 through 7, which, when combined, form a rectangular configuration. The floor plan of the station's walls and a summary of the quantity and length of each wall phase in the MRT-J Jakarta Station project are presented in Figure 5.1 and Table 5.1 below.

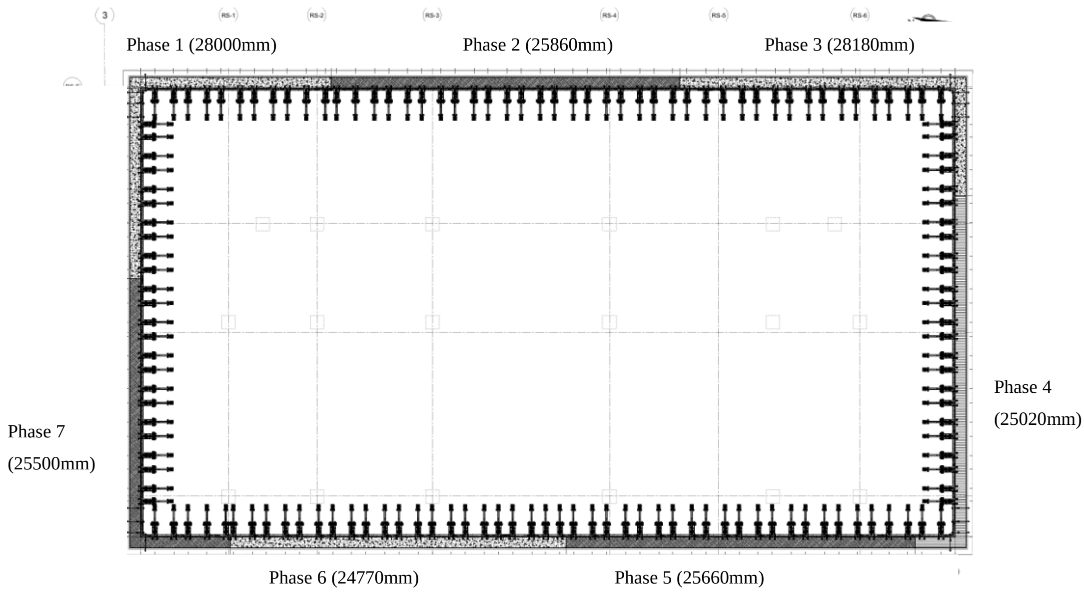

Figure 5.1 Formwork Installation Layout

(Source: Project Data)

Table 5.1 Summary of Formwork Quantities for RSS Building Construction

Phases	**Number of Formwork**				**Total**
	Panel 1	Panel 2	Panel 3	Panel 4	
1	10	2	1	2	15
2	10	1	-	1	12
3	11	1	1	1	14
4	11	-	1	1	13
5	10	1	-	1	12
6	10	1	-	1	12
7	9	2	1	-	12
Total for All Phase					90

(Source: Compiled by the author)

5.3 Calculation of Wall Area

The wall has a total length of 186,040 mm and a uniform height of 4,880 mm, which is divided into seven construction phases. Each phase corresponds to specific wall segments with distinct lengths and dimensions. The surface area calculation for the wall in Phase 1, with a height of 4,880 mm, is presented below:

Phase 1 Area = $l\ x\ H$

= $28{,}000mm\ x\ 4880mm$

= $136640\ mm^2$

= $136.64\ m^2$

The recapitulation of wall surface areas using the same calculations and formulas for phases 1 to 7 of the RSS building was carried out similarly and can be seen in Table 5.2 below.

Table 5.2 Summary of Wall Area for All Phases

Phase	Length	Height	Area
	m	m	m^2
1	28	4.88	136.640
2	25.68	4.88	125.318
3	28.18	4.88	137.518
4	27.96	4.88	136.445
5	25.67	4.88	125.270
6	25.05	4.88	122.244
7	25.5	4.88	124.440
Total Area		m^2	907.875

(Source: Compiled by the author)

5.4 Calculation of Formwork Area

In the construction phase of the RSS MRT-Jakarta building project, semi-system formwork was utilized for all primary structural walls. To facilitate a comprehensive and objective comparison between semi-system and aluminium formwork systems, this study employs the following approach:

1. Applying semi-system and aluminium formwork across all wall components ensures uniform variables and consistent site conditions.

5.4.1 Calculation of Semi-System Formwork

The total area of formwork is calculated by determining the surface area based on the dimensions of the formwork applied to the wall structures. This approach ensures that the estimated formwork area accurately reflects actual field conditions. The dimensional specifications of the semi-system formwork are presented in Figures 5.2 through 5.9.

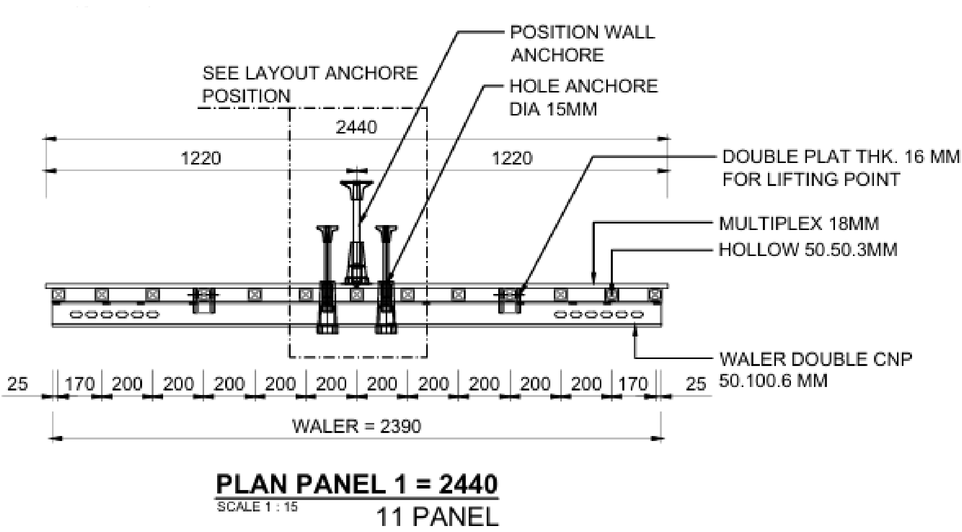

Figure 5.2 Top Detail of Formwork Panel 1 Dimension

(Source: Project Data)

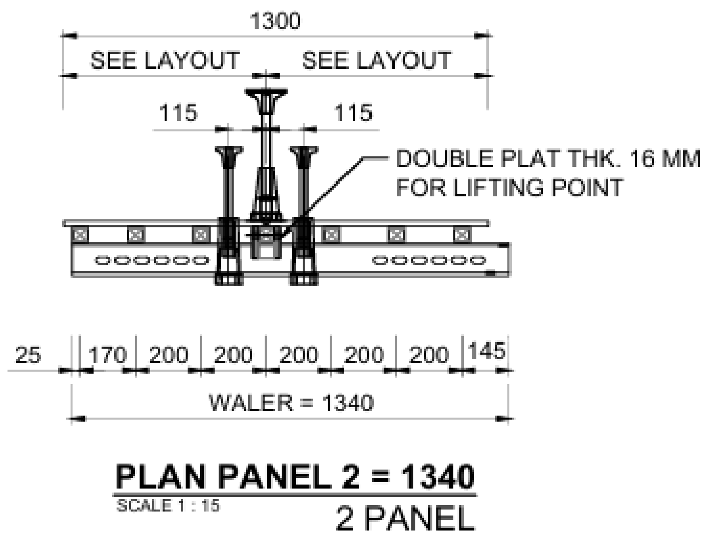

Figure 5.3 Top Detail of Formwork Panel 2 Dimension

(Source: Project Data)

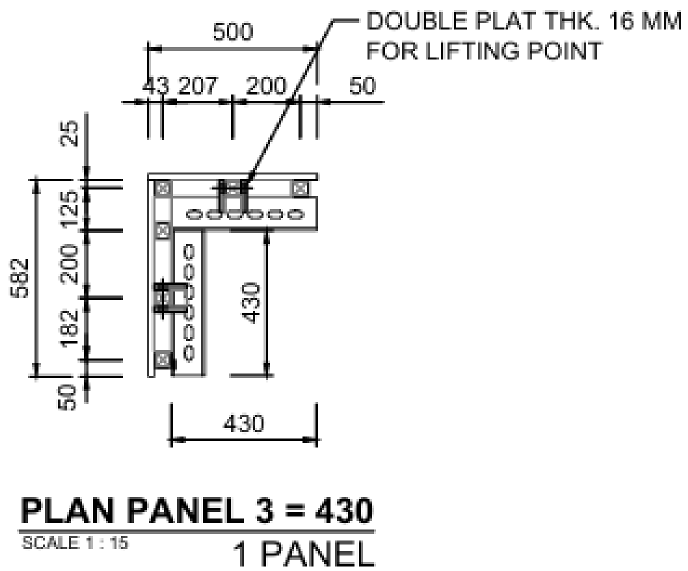

Figure 5.4 Top Detail of Formwork Panel 3 Dimension

(Source: Project Data)

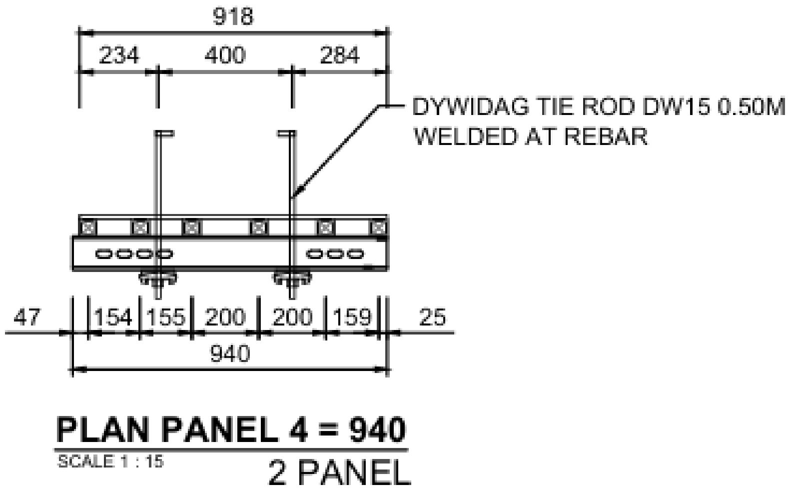

Figure 5.5 Top Detail of Formwork Panel 4 Dimension

(Source: Project Data)

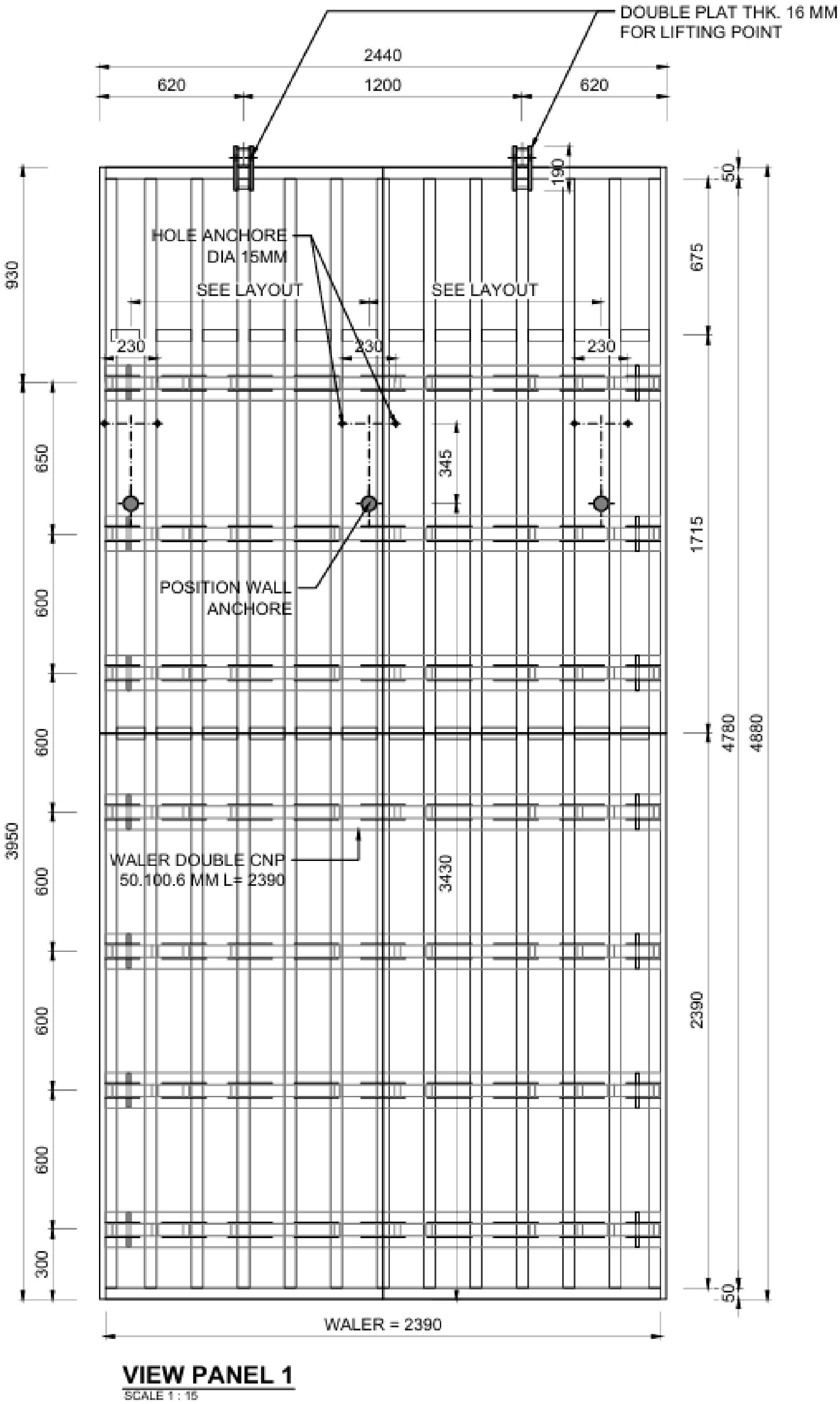

Figure 5.6 Width Dimension of Formwork Panel 1

(Source: Project Data)

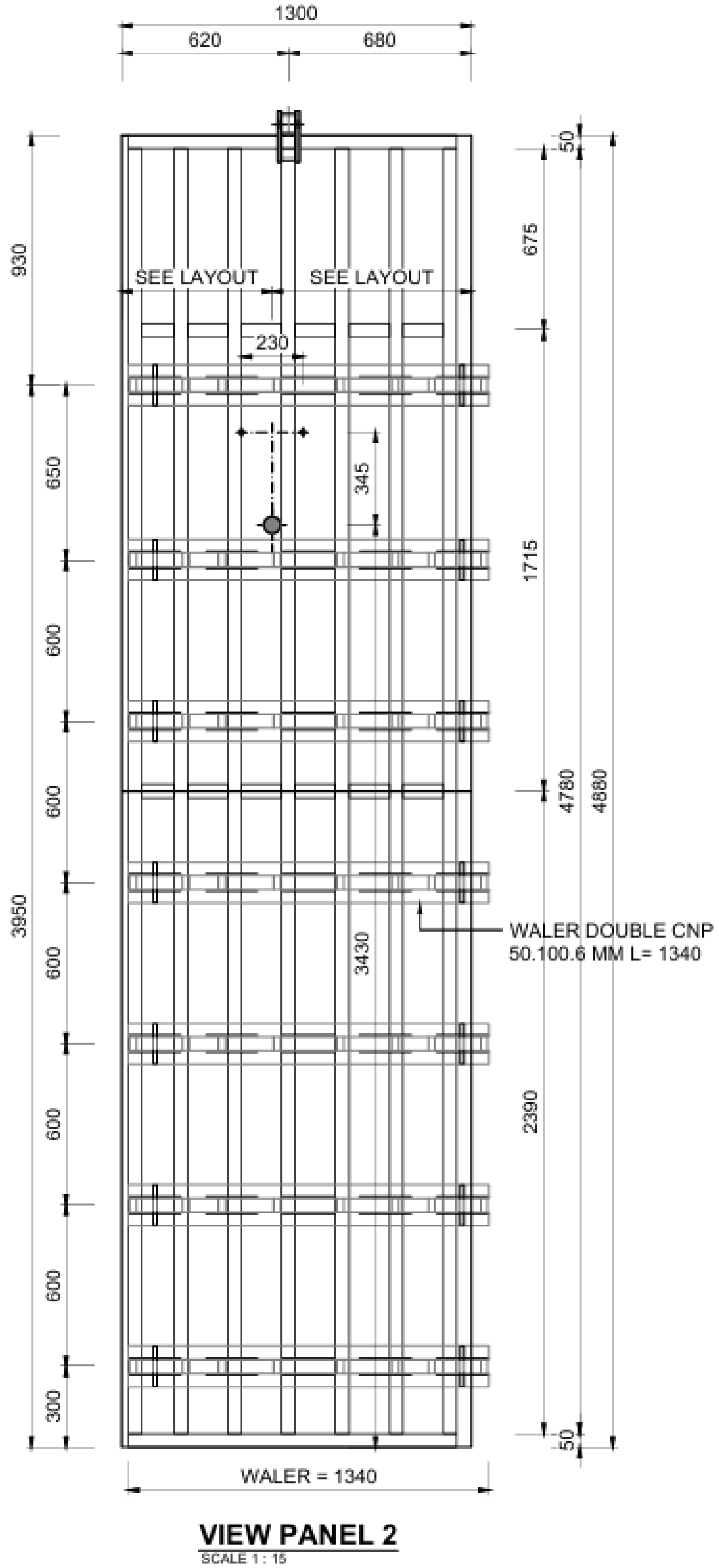

Figure 5.7 Width Dimension of Formwork Panel 2

(Source: Project Data)

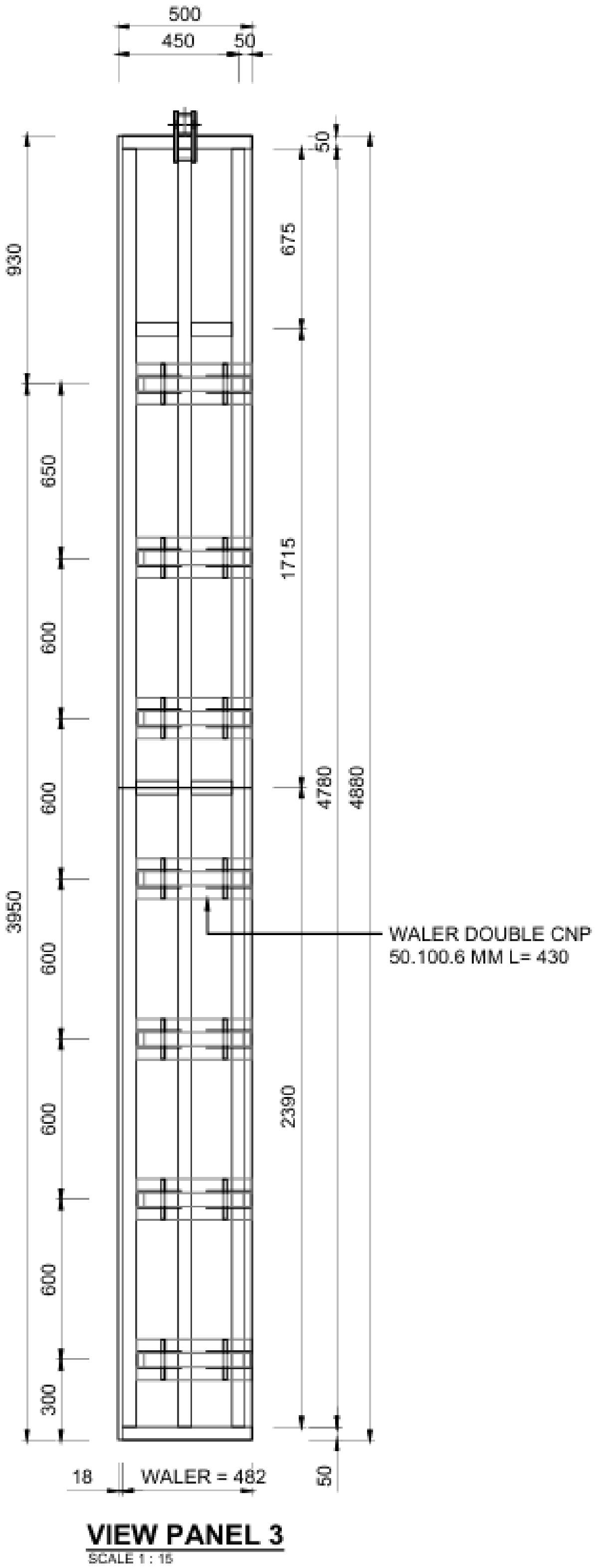

Figure 5.8 Width Dimension of Formwork Panel 3

(Source: Project Data)

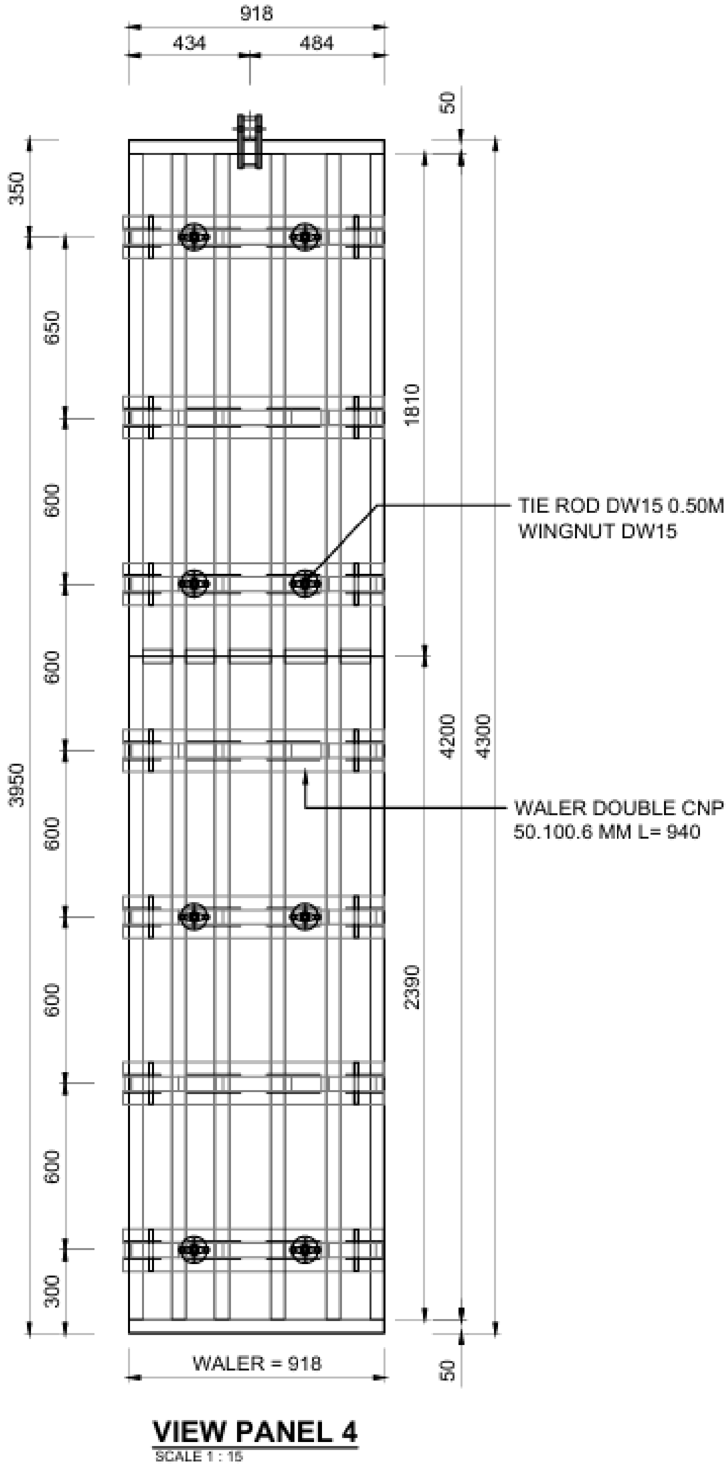

Figure 5.9 Width Dimension of Formwork Panel 4

(Source: Project Data)

Referring to Figures 5.2 through 5.9, the following presents the calculation of the formwork area for Phase 1 that includes Panel P1, P2, P3, and P4, which is measured from the base of the wall to the highest bracket:

P1 Area = $(l\ x\ H)\ x\ n$

= $(2440mm\ x\ 4880mm)\ x\ 10$

= $119072\ mm^2$

= $119.072\ m^2$

P2 Area = $(l\ x\ H)\ x\ n$

= $(1300mm\ x\ 4880mm)\ x\ 2$

= $12688\ mm^2$

= $12.688 m^2$

P3 Area = $(l\ x\ H)\ x\ n$

= $(1082mm\ x\ 4880mm)\ x\ 1$

= $5280\ mm^2$

= $5.28\ m^2$

P4 Area = $(l\ x\ H)\ x\ n$

= $(916mm\ x\ 4300mm)\ x\ 2$

= $7877.6\ mm^2$

= $7.878 m^2$

Notation:

$l\ =$ formwork panel length

$H =$ formwork panel height

$n\ =$ number of panels

Note that the formwork area differs than wall area as it account for the end cover of each side of the formwork. The recapitulation of the required formwork area, utilizing the same calculations and formulas from Phase 2 to Phase 7, has been carried out as outlined and is provided in Table 5.3 below.

Table 5.3 Recapitulation of Formwork Area for Phase 1 through 7

Phases	Formwork Area (m^2)				Total each phase (m^2)
	P1	P2	P3	P4	
1	119.072	12.688	5.28016	7.8776	144.91776
2	119.072	6.344	0	3.9388	129.3548
3	130.9792	6.344	5.28016	3.9388	146.54216
4	130.9792	0	5.28016	3.9388	140.19816
5	119.072	6.344	0	3.9388	129.3548
6	119.072	6.344	0	3.9388	129.3548
7	107.1648	12.688	5.28016	0	125.13296
Total					944.85544

(Source: Compiled by the author)

5.4.2 Calculation of Aluminum Formwork

Calculating the total area of aluminium formwork follows the same method as that of the semi-system formwork, which involves measuring the formwork dimensions for each panel. As indicated in the corresponding drawings, the panel details are identical to those presented in Figures 5.2 through 5.9.

Furthermore, the recapitulation of the required aluminium formwork area, which employs the same calculations and formulas applied in the semi-system formwork from Phase 1 through Phase 7, has been systematically carried out. The results of these calculations are previously provided in Table 5.3.

5.5 Calculation of Semi-System Formwork Cost

The calculation of costs for the semi-system formwork is carried out using AHSP (Analisa Harga Satuan Pekerjaan) from the project as a reference. This approach is intended to enable a fair comparison with the aluminium formwork method, considering the work volume, the number of workers deployed, and the conditions on-site.

5.5.1 Unit Price Analysis of Semi-System Formwork

The coefficient indices and unit prices applied in the semi-system formwork work are derived from actual project data to ensure relevancy and accuracy. Labour wage rates are based on the Governor Regulation of the Special Capital

Region of Jakarta No. 10 of 2020 concerning the Provincial Sectoral Minimum Wage. In accordance with the applied coefficients, this study employs the Implementation Budget Plan (RAP) to calculate the cost of semi-system formwork. The detailed cost estimation for constructing 1 m² of semi-system wall formwork is presented in the subsequent calculation.

Table 5.5 Production Cost for 1 m2 of Semi-System Formwork

No	Description	Unit	Coeff	Unit Price (Rp)	Total Price (Rp)
A	LABOR				
1	Labourer	OH	1.32	180,500.00	238,260.00
2	Skilled Worker	OH	0.66	190,000.00	125,400.00
3	Lead Worker	OH	0.066	206,500.00	13,629.00
4	Foreman	OH	0.011	218,300.00	2,401.30
Total Labor					379,690.30
B	MATERIAL				
1	Bolt (4 Inch)	Kg	0.4	25,000.00	10,000.00
2	Formwork Oil	Litre	0.2	29,700.00	5,940.00
3	Polyform 18mm	Sheat	0.127	140,000.00	17,780.00
Total Material					33,720.00
Total (A+B)					413,410.30
Overhead 10%-15%				10%	41,341.03
Unit Cost of Work					**454,751.33**

(Source: Compiled by the author)

In the RSS centre construction project, the semi-system formwork can be reused three times. This means that during the wall construction phase, the semi-system formwork is fabricated once and utilized for the subsequent three phases. The cost of the first use is based on the unit price per square meter as shown in Table 5.7. For the second and third uses, only labour costs for formwork installation are calculated, along with the rental cost of reinforcement materials. After three uses, the formwork must be refabricated, and production costs will apply again for the 4th and 7th phases accordingly. The rental cost is determined based on the quantity of materials and the planned duration of use. Material rental prices refer to the rental list from PT PERI that is used for the construction period. Therefore, the costs for the second and third uses after each fabrication, as well as reinforcement material rental, are shown in Tables 5.6 and 5.7.

Table 5.6 Installation Cost for 1 m2 of Semi-System Formwork

No	Description	Unit	Coeff	Unit Price (Rp)	Total Price (Rp)
A	LABOR				
1	Labourer	OH	1.32	180,500.00	238,260.00
2	Skilled Worker	OH	0.66	190,000.00	125,400.00
3	Lead Worker	OH	0.066	206,500.00	13,629.00
4	Foreman	OH	0.011	218,300.00	2,401.30
Total Labor + 10%					417,751.33

(Source: Compiled by the author)

Table 5.7 Rental Cost for Formwork

No	Item Description	Quantities	Price (rent/month)
FORMWORK & WALL ANCHOR ACCESSORIES			
1	Anchor Plate Sb-Dw26	42	1,175,000.00
2	Anchor Wale 55/ U160	42	7,380,000.00
3	Push-Pull Prop Rs 210, Galv	42	2,510,000.00
4	Push-Pull Prop Rs 450, Galv	42	5,080,000.00
5	Wing Nut Counterplate Dw15 G	60	190,000.00
6	Threaded Anchor Plate Dw20	290	4,200,000.00
7	Wing Nut D20, Galv	42	140,000.00
8	Hook Strap Hb 24-100/120	84	700,000.00
9	Pin For Push-Pull Prop D16	168	140,000.00
10	Vario Coupling Vkz 99cm	84	2,562,000.00
11	Wedge Tensionproof Kz	352	1,041,600.00
12	Flange Clamp	290	945,000.00
13	Scaff.Tube Steel 48,3x3,2 L=2m	48	2,390,000.00
14	4.8 Bolt M20 X 80	860	1,620,000.00
15	Hex Nut Sw 36/110 Dw20	42	185,000.00
TOTAL			30,258,600.00

Continuation of Table 5.7 Rental Cost for Semi-System Formwork

BRACE FRAME			
1	Lead Anchor Coup Dw20	42	185,000.00
2	Dywidag Tie Rod Dw 15 0.50m	44	1,180,000.00
3	Dywidag Tie Rod Dw 15 0.85m	16	472,000.00
4	Dywidag Tie Rod Dw 15 1m	8	393,333.33
5	Waterstop Centerpiece Dw15	16	195,000.00
6	Brace Frame Sb-B	21	21,717,500.00
7	Brace Frame Sb-C	21	19,080,000.00
TOTAL			43,222,833.33
PLATFORM			
1	Girder Gt 24, 360	42	4,992,000.00
2	Handrail Holder Gt24/Vt20	38	1,581,600.00
3	Base Spindle Tr 38-70/5 Galv	126	6,363,000.00
4	Adj. Crosshead Spi -2 Tr38-70/50	126	5,416,000.00
5	Guardrail Post Hsgp-2	38	3,535,200.00
6	Base Standard Uvb 24	126	12,474,000.00
7	Standard Uvr 200	126	4,192,000.00
8	Top Standard Uvh 100	126	7,098,000.00
9	Ledger Uh 150 Plus	694	5,502,000.00
10	Ledger Brace Ubl 150/150	312	5,712,000.00
TOTAL			56,865,800.00
TOTAL FORMWORK COST		1 month	130,347,233.33
		4 months	**521,388,933.33**

(Source: Compiled by the author)

5.5.2 Analysis of Semi-System Formwork Cost

After obtaining the budget plan for the formwork works, the total cost of semi-system wall formwork required for each phase is calculated. The following is the cost calculation for the semi-system wall formwork works:

1. Production cost of semi system formwork for phase 1 P1 formwork:

Cost = Formwork area x Production cost for $1m^2$ formwork

= $119.072\ x\ 454{,}700.00$

= $IDR. 54{,}142{,}038.40$

2. Production cost of semi system formwork for P2 formwork:

Cost = Formwork area x Production cost for $1m^2$ formwork

= $12.688\ x\ 454{,}700.00$

= $IDR. 5{,}769{,}233.60$

3. Production cost of semi system formwork for phase 1 P3 formwork:

Cost = Formwork area x Production cost for $1m^2$ formwork

= $5.2802\ x\ 454{,}700.00$

= $IDR. 2{,}400{,}888.75$

4. Production cost of semi system formwork for phase 1 P4 formwork:

Cost = Formwork area x Production cost for $1m^2$ formwork

= $7.878\ x\ 454{,}700.00$

= $IDR. 3{,}581{,}944.72$

For phase two and three only labour cost for installation is calculated as it has similar dimension and height. For phase 3 however there is an added material that needs to be calculated along with the installation cost. The calculation is as follows:

1. Installation cost and material add-on cost of semi system formwork for phase 3 P1 formwork:

Cost = (Formwork area x Installation cost for $1m^2$ formwork)

$+$ (Material add-on Area x Production cost for $1m^2$ Formwork)

= $(130.979\ x\ 379{,}690.30) + (2\ x\ 454{,}700.00)$

= $IDR. 50{,}640{,}931.74$

2. Installation cost of semi system formwork for P2 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $6.344\ x\ 379{,}690.30$

= $IDR. 2{,}408{,}755.26$

3. Installation cost of semi system formwork for P3 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $5.28\ x\ 379{,}690.30$

= $IDR.\,2{,}004{,}825.53$

4. Installation cost of semi system formwork for P4 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $3.939\ x\ 379{,}690.30$

= $IDR.\,1{,}495{,}524.15$

The semi-system formwork used in this study allows for up to three usage cycles. As a result, materials from Phase 1 are reused in Phases 2 and 3. In Phase 4, new materials are introduced and subsequently reused in the next two phases. This reuse strategy contributes to cost efficiency across phases. The formwork process from Phase 1 is then repeated to Phase 7. A summary of the cost analysis for the semi-system formwork from Phase 1 to Phase 7 is presented in Table 5.8 below.

Table 5.8 Recapitulation of Budget Plan of Semi-System Wall Formwork for Phase 1 through Phase 7

Phases	**Type**	**Area (m2)**	**Usage and Material cost**		**Total cost**
			Production/Add-on	Installation	
Base Wall					
Phase 1	P1	119.072	54,142,038.40		54,142,038.40
	P2	12.688	5,769,233.60		5,769,233.60
	P3	5.28016	2,400,888.75		2,400,888.75
	P4	7.8776	3,581,944.72		3,581,944.72
Phase 2	P1	119.072		45,210,483.40	45,210,483.40
	P2	6.344		2,408,755.26	2,408,755.26
	P3	0			
	P4	3.9388		1,495,524.15	1,495,524.15
Phase 3	P1	130.9792	909,400.00	49,731,531.74	50,640,931.74
	P2	6.344		2,408,755.26	2,408,755.26
	P3	5.28016		2,004,825.53	2,004,825.53
	P4	3.9388		1,495,524.15	1,495,524.15
Phase 4	P1	130.9792	59,556,242.24		59,556,242.24
	P2	0			
	P3	5.28016	2,400,888.75		2,400,888.75

Continuation of Table 5.8 Recapitulation of Budget Plan of Semi-System Wall Formwork for Phase 1 through Phase 7

	P4	3.9388	1,790,972.36		1,790,972.36
Phase 5	P1	119.072		45,210,483.40	45,210,483.40
	P2	6.344		2,408,755.26	2,408,755.26
	P3	0			
	P4	3.9388		1,495,524.15	1,495,524.15
Phase 6	P1	119.072		45,210,483.40	45,210,483.40
	P2	6.344		2,408,755.26	2,408,755.26
	P3	0			
	P4	3.9388		1,495,524.15	1,495,524.15
Phase 7	P1	107.1648	48,727,834.56		48,727,834.56
	P2	12.688	5,769,233.60		5,769,233.60
	P3	5.28016	2,400,888.75		2,400,888.75
	P4	0			
Rent Price (4,5 months)					586,562,550.00
Total					**976,997,040.88**

(Source: Compiled by the author)

Based on the calculations in Table 5.8, the total planned execution budget using semi-system wall formwork from Phase 1 to Phase 7 is Rp. 976,997,040.88.

5.6 Calculation of Aluminium Formwork Cost

The wall construction using the aluminum formwork method in the RSS building project uses concrete with a strength of fc' 40 MPa. In the cost analysis, the semi-system formwork uses the implemented budget plan (RAP) based on project data. In contrast, for the aluminum formwork, the author independently calculated the RAP with the same approach to obtain a cost estimate, ensuring a fair comparison with the semi-system formwork.

5.6.1 Unit Price Analysis of Aluminium Formwork

The coefficient indices and unit prices used for the aluminum formwork are adapted from actual project data from the field to maintain accuracy and relevance. Labor wages refer to Governor Regulation of the Special Capital Region of Jakarta No. 10 of 2020 on the Provincial Sectoral Minimum Wage. Based on these coefficients, the cost of aluminum formwork is calculated using the Implementation Budget Plan (RAP), with minor and precise adjustments to labor and material components. To find labour coefficient the calculation data was taken from the study entitled "*Analisis Pengaruh Pemilihan Jenis Bekisting Terhadap Durasi Dan Biaya Pelaksanaan Pekerjaan Struktur Proyek X*," (Hartono Lim, 2021) in which the coefficient for aluminum formwork installation on shear walls was derived using a method that monitored working hours and daily worker productivity. wall formwork is presented in the following calculation.

The total labor coefficient required to complete the installation of aluminum wall formwork ready for casting per 1 m² is 0.1634 worker-days. This consists of a skilled worker coefficient of 0.109, and foreman coefficient of 0.055. The cost to construct 1 m² of aluminum wall formwork is shown in Table 5.9 below.

Table 5.9 Production Cost for 1 m2 of Aluminium Formwork

No	Description	Unit	Coeff	Unit Price (Rp)	Total Price (Rp)
A	LABOR				
1	Skilled Worker	OH	0.109	190,000.00	20,691.00
2	Foreman	OH	0.055	218,300.00	11,897.35
Total Labor					32,588.35
B	MATERIAL				
1	Aluminium 6061	M2	1	1,041,666.00	1,041,666.00
2	Formwork Oil	Litre	0.2	29,700.00	5,940.00
Total Material					1,047,606.00
Total (A+B)					1,080,194.35
Overhead 10%-15%				10%	108,019.44
Unit Cost of Work					**1,188,213.79**

(Source: Compiled by the author)

Unimax International (2025) explains that aluminium formwork systems are engineered for long-term use, with a reuse potential of 200–300 cycles under proper maintenance. This implies that for the RSS building project, aluminium formwork can be reused throughout the entire construction. As a result, formwork costs are only incurred at the initial stage, and for subsequent Phases, only labor costs for installation and minor material costs such as formwork oil tare considered. This is similar to the semi-system formwork method in later stages.

The detailed costs for aluminium formwork installation and are presented in Table 5.10.

Table 5.10 Installation Cost for 1 m2 of Aluminium Formwork

No	Description	Unit	Coeff	Unit Price (Rp)	Total Price (Rp)
A	LABOR				
1	Skilled Worker	OH	0.109	190,000.00	20,691.00
2	Foreman	OH	0.055	218,300.00	11,897.35
Total Labor					32,588.35
Overhead 10%-15%				10%	3,258.83
Unit Cost of Work					**35,847.19**

(Source: Compiled by the author)

The calculation of the total rental cost for aluminum formwork reinforcement materials follows the same method as that used for the semi-system formwork previously.

5.6.2 Analysis of Aluminium Formwork Cost

After obtaining the budget plan for the formwork works, the total cost of semi-system wall formwork required for each phase is calculated. The following is the cost calculation for the Aluminium wall formwork works:

1. Production cost of semi system formwork for phase 1 P1 formwork:

   Cost = Formwork area x Production cost for $1m^2$ formwork

   $= 119.072\ x\ 1{,}188{,}213.79$

   $= IDR.\,141{,}481{,}350.40$

2. Production cost of semi system formwork for P2 formwork:

   Cost = Formwork area x Production cost for $1m^2$ formwork

   $= 12.688\ x\ 1{,}188{,}213.79$

   $= IDR.\,15{,}075{,}881.60$

3. Production cost of semi system formwork for phase 1 P3 formwork:

   Cost = Formwork area x Production cost for $1m^2$ formwork

   $= 5.2802\ x\ 1{,}188{,}213.79$

   $= IDR.\,6{,}273{,}886.11$

4. Production cost of semi system formwork for phase 1 P4 formwork:

Cost = Formwork area x Production cost for $1m^2$ formwork

= $7.878\ x\ 1{,}188{,}213.79$

= $IDR. 9{,}360{,}164.32$

For phase two through seven only labour cost for installation is calculated as it has similar dimension and height. For phase 3 however there is an added material that needs to be calculated along with the installation cost. The calculation is as follows:

1. Installation cost and material add-on cost of semi system formwork for phase 3 P1 formwork:

Cost = (Formwork area x Installation cost for $1m^2$ formwork)

$+$ (Material add-on Area x Production cost for $1m^2$ Formwork)

= $(130.979\ x\ 35{,}847.19) + (2\ x\ 1{,}047{,}606.00)$

= $IDR. 6{,}644{,}796.01$

2. Installation cost of semi system formwork for P2 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $6.344\ x\ 35{,}847.19$

= $IDR. 206{,}740.49$

3. Installation cost of semi system formwork for P3 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $5.28\ x\ 35{,}847.19$

= $IDR. 172{,}071.70$

4. Installation cost of semi system formwork for P4 formwork:

Cost = Formwork area x Installation cost for $1m^2$ formwork

= $3.939\ x\ 35{,}847.19$

= $IDR. 128{,}358.99$

The Aluminium formwork used in this study allows for up to 200 usage cycles minimum. As a result, materials from Phase 1 are reused in through phase

7. This reuse strategy contributes to cost efficiency across all phases. The formwork installation process from Phase 2 is then repeated to Phase 7. A summary of the cost analysis for the Aluminium formwork from Phase 1 to Phase 7 is presented in Table 5.11 below.

Table 5.11 Recapitulation of Budget Plan of Aluminium Wall Formwork for Phase 1 through Phase 7

Phases	Type	Area (m2)	Usage and Material cost		Total cost
			Production/Add-on	Installation	
Base Wall					
Phase 1	P1	119.072	141,481,350.40		141,481,350.40
	P2	12.688	15,075,881.60		15,075,881.60
	P3	5.28016	6,273,886.11		6,273,886.11
	P4	7.8776	9,360,164.32		9,360,164.32
Phase 2	P1	119.072		3,880,360.01	3,880,360.01
	P2	6.344		206,740.49	206,740.49
	P3	0		-	-
	P4	3.9388		128,358.99	128,358.99
Phase 3	P1	130.9792	2,371,800.00	4,268,396.01	6,644,796.01
	P2	6.344		206,740.49	206,740.49
	P3	5.28016		172,071.70	172,071.70
	P4	3.9388		128,358.99	128,358.99
Phase 4	P1	130.9792		4,268,396.01	4,268,396.01
	P2	0		-	-
	P3	5.28016		172,071.70	172,071.70
	P4	3.9388		128,358.99	128,358.99
Phase 5	P1	119.072		3,880,360.01	3,880,360.01
	P2	6.344		206,740.49	206,740.49
	P3	0		-	-
	P4	3.9388		128,358.99	128,358.99
Phase 6	P1	119.072		3,880,360.01	3,880,360.01
	P2	6.344		206,740.49	206,740.49
	P3	0		-	-
	P4	3.9388		128,358.99	128,358.99
Phase 7	P1	107.1648		3,492,324.01	3,492,324.01
	P2	12.688		413,480.98	413,480.98
	P3	5.28016		172,071.70	172,071.70
	P4	0		-	-
Rent Price					391,041,700.00
Total					**591,678,031.53**

(Source: Compiled by the author)

Based on the calculations in Table 5.11, the total planned execution budget using semi-system wall formwork from Phase 1 to Phase 7 is Rp 591,678,031.53.

5.7 Cost Comparison Between Semi-System and Aluminium Formwork

Based on the cost analysis presented above, the total expenses required for each type of formwork have been determined. A comparison of the costs between aluminum formwork and semi-system formwork is summarized in Table 5.12 below.

Table 5.12 Recapitulation of Cost Comparison between Semi-System and Aluminium Formwork

Area	Formwork	Cost (Rp)
All Phases	Semi-System	Rp. 976,997,040.88.
	Aluminium	Rp. 591,678,031.53.

(Source: Compiled by the author)

Based on Table 5.12 if aluminum formwork is used for all floors, the total cost amounts to Rp. 591,678,031.53, whereas the use of semi-system formwork results in a total cost of Rp. 976,997,040.88.

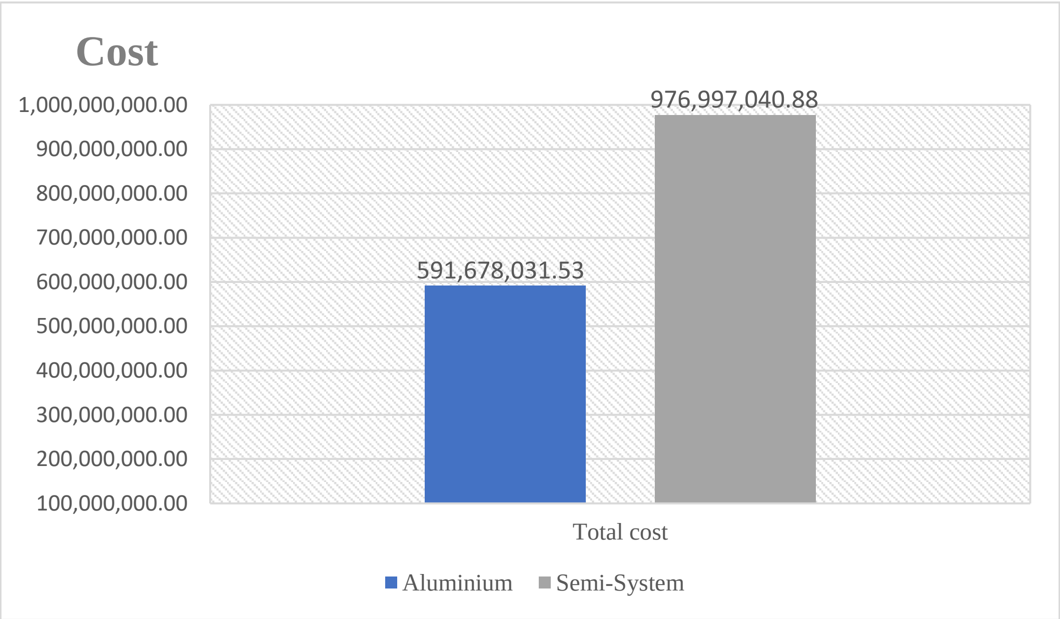

Figure 5.10 Comparison Graphic of Aluminium and Semi-System Formwork Cost

(Source: Compiled by the author)

5.8 Time Analysis of Formwork Work

Work time analysis in a project is conducted to estimate the time required to complete individual tasks and the overall project. Productivity in semi-system and aluminum formwork installation is used to calculate the installation duration, excluding the production time of both formwork types.

5.8.1 Analysis of Semi-System Formwork Duration

The work duration for semi-system formwork is calculated from the production phase to the installation phase. To estimate the daily installation time under effective working hours, labor coefficients and the number of workers are required. The labor coefficient for semi-system formwork per day under effective working hours refers to Table 5.5 in the implementation budget plan.

According to an interview with PT. Shimizu, the Wall formwork panels for the semi-system are Assembled on-site. Within two days of effective working hours, enough panels can be produced for one phase. The RSS building project consists of seven phases, requiring six days to complete the Wall formwork production. Field monitoring shows that 15 workers are involved daily in the semi-system formwork installation. The calculation for the installation time of semi-system wall formwork in the RSS building project is as follows.

Table 5.13 Labor Coefficient for Semi-System Formwork

No	Labor	Coefficient
1	Labour	1.320 OH
2	Skilled Worker	0.660 OH
3	Lead Worker	0.066 OH
4	Foreman	0.011 OH

(Source: Project Data)

1. Phase 1

   Area = $144{,}918\ m^2$

Total Coeff = 2,057

Number of Labor = 15 Labor

Duration $= \frac{Area \times Total\ Coeff}{Number\ of\ Labor}$

$= \frac{144{,}918 \times 2{,}057}{15}$

$= 19{,}87 \approx 20\ days$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$= \frac{144{,}918}{20}$

$= 7{,}246\ m^2/days$

2. Phase 2

Area $= 129{,}355\ m^2$

Total Coeff = 2,057

Number of Labor = 15 Labor

Duration $= \frac{Area \times Total\ Coeff}{Number\ of\ Labor}$

$= \frac{129{,}355 \times 2{,}057}{15}$

$= 17{,}738 \approx 18\ days$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$= \frac{129{,}355}{18}$

$= 7{,}186\ m^2/days$

3. Phase 3

Area $= 146{,}542\ m^2$

Total Coeff = 2,057

Number of Labor = 15 Labor

Duration $= \frac{Area \times Total\ Coeff}{Number\ of\ Labor}$

$= \frac{146{,}542 \times 2{,}057}{15}$

$= 20{,}096 \approx 20\ days$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$= \frac{146{,}542}{20}$

$= 7{,}327\ m^2/days$

Based on the analysis, the average productivity rate for the installation of semi-system wall formwork is determined to be 7.237 m² per day. The corresponding total duration required to complete the formwork installation is detailed in Table 5.14.

Table 5.14 Recapitulation of Calculation of the Duration for Semi-System Wall Formwork

Phases	Area (m^2)	Duration (Days)
Assembly & production		6
Phase 1	144,918	20
Phase 2	129,355	18
Phase 3	146,542	20
Phase 4	140,198	19
Phase 5	129,355	18
Phase 6	129,355	18
Phase 7	125,133	18
Total Duration		**137**

(Source: Compiled by the author)

The total duration of the semi-system wall formwork activities, which spans 136 days, represents the time required to complete the wall formwork process sequentially from fabrication to installation, excluding subsequent activities such as wall casting, beam and slab formwork installation, and other related tasks.

5.8.2 Analysis of Aluminium Formwork Duration

The duration of aluminum wall formwork work is calculated from fabrication to installation. Calculation is conducted by simulating the existing condition on site, with the Installation of Semi-System formwork as a model.

Aluminum formwork is produced by recycling previously used panels, which shortens production time compared to creating new formwork from scratch. During fabrication, adjustments are made to match the project's requirements.

Once the shop drawing is submitted to the subcontractor, the aluminum wall formwork takes approximately a week to produce and arrive at the project site. The aluminum formwork installation is carried out by 15 workers, with each panel installed by a team of three. To calculate the daily installation duration under effective working hours, labor coefficients and the number of workers is required. The labor coefficient data for aluminum formwork installation is based on the calculations provided in Subsection 5.6.1.

Table 5.15 Labor Coefficient for Aluminium Formwork

No	Labor	Coefficient
1	Skilled Worker	0,109 OH
4	Foreman	0.055 OH

(Source: Compiled by the author)

1. Phase 1

Area $= 144{,}918\ m^2$

Total Coeff $= 0.163$

Duration $= \frac{Area \times Total\ Coeff}{2}$

$= \frac{144{,}918 \times 0{,}163}{2}$

$= 11{,}84 \approx 12\ days$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$= \frac{144{,}918}{19}$

$= 12.076\ m^2/days$

2. Phase 2

Area $= 129{,}355\ m^2$

Total Coeff $= 0.163$

Duration $= \frac{Area \times Total\ Coeff}{2}$

$$= \frac{129{,}355 \times 0.163}{2}$$

$$= 10{,}568 \approx 11\ days$$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$$= \frac{129{,}355}{11}$$

$$= 11{,}759\ m^2/days$$

3. Phase 3

Area $= 146{,}542\ m^2$

Total Coeff $= 0.163$

Duration $= \frac{Area \times Total\ Coeff}{2}$

$$= \frac{146{,}542 \times 0.163}{2}$$

$$= 11.972\ \approx 12\ days$$

Productivity $= \frac{Area\ (m^2)}{Duration\ (days)}$

$$= \frac{146{,}542}{12}$$

$$= 12{,}212\ m^2/days$$

Based on the analysis, the average productivity rate for the installation of Aluminium wall formwork is determined to be 11.955 m² per day. The corresponding total duration required to complete the formwork installation is detailed in Table 5.16.

Table 5.16 Recapitulation of Calculation of the Duration for Aluminium Wall Formwork

Phases	Area (m^2)	Duration (Days)
Assembly & production		7
Phase 1	144,918	12
Phase 2	129,355	11
Phase 3	146,542	12
Phase 4	140,198	11

Continuation of Table 5.16 Recapitulation of Calculation of the Duration for Aluminium Wall Formwork

Phase 5	129,355	11
Phase 6	129,355	11
Phase 7	125,133	11
Total Duration		**86**

(Source: Compiled by the author)

The total duration of the Aluminium wall formwork activities. Subsequently from production through installation which spans 130 days, represents the time required to complete the wall formwork process, excluding subsequent activities such as wall casting, beam and slab formwork installation, and other related tasks.

5.9 Time Comparison

Based on the previous analysis the time and productivity of semi-system and aluminium formwork can be compared using the comparison method in table 5.17 below.

Table 5.17 Recapitulation of Time and Productivity Comparison of Semi-System and Aluminium Formwork

Phases	Formwork type	Total Duration (days)	Productivity (m^2/days)
Phases 1-7	Semi-System	137	7,237
Phases 1-7	Aluminium	86	11,955
Difference		**59**	**4,718**

(Source: Compiled by the author)

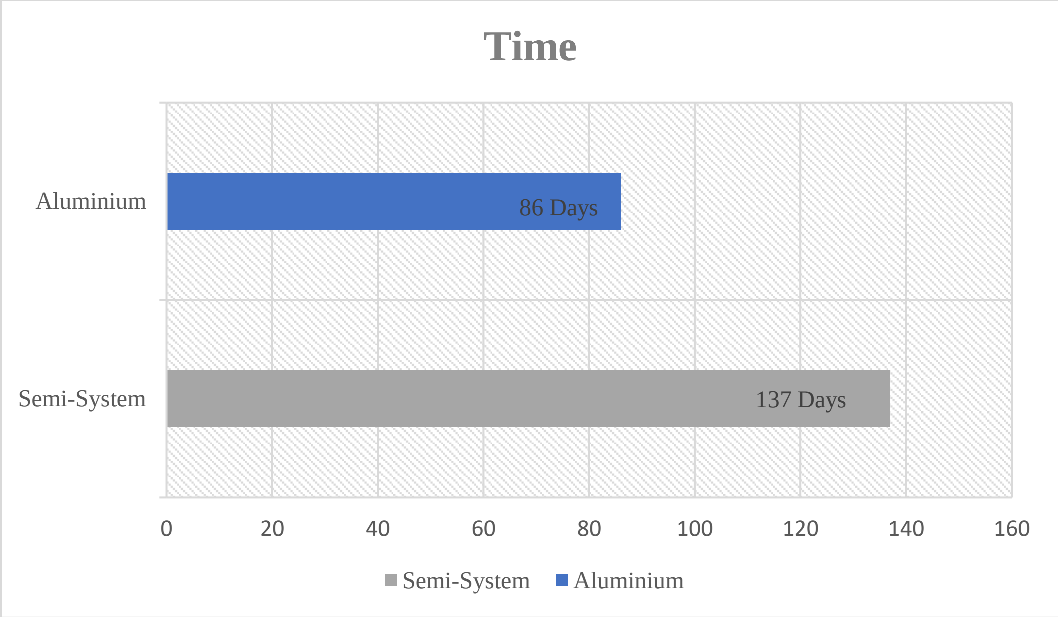

Figure 5.11 Comparison Graphic of Aluminium and Semi-System Formwork Installation Time

(Source: Compiled by the author)

5.10 Discussion

This section discusses the cost and duration analysis of wall formwork construction based on the implementation methods: semi-system formwork and aluminum formwork. The cost data for the semi-system formwork were obtained from the RSS Building project, while the aluminum formwork cost data were derived from the author's own calculations.

Based on the analysis, the total cost for wall formwork using aluminum is Rp 722,025,264.86, while the cost using semi-system formwork is Rp 911,823,424.22. The total cost difference across all phases is Rp 189,798,159.36 with semi-system being more expensive. It can be concluded that polyfilm-based formwork materials are generally more costly than aluminum in terms of labour. Normally, aluminum formwork is more expensive than polyfilm-based semi-system formwork, as shown in the unit price breakdown in Section 5.6.1. This is due to the high cost and complex initial production process of aluminum materials.

However, in this case, the aluminum formwork was cheaper because the RSS Building project had relatively consistent wall dimensions and used only four types of panels, all in identical quantities for each construction phase. As a result, the aluminum formwork was fabricated once and reused throughout the project. In contrast, the semi-system formwork required three fabrication cycles during the construction process, leading to higher overall costs.

For construction time, the semi-system formwork required 137 days with an average daily productivity of 7.237 m^2/day, while aluminum formwork took 86 days with an average productivity of 11.955 m^2/day. The total time difference between the two methods is 59 days. It can be concluded that aluminum formwork installation is faster due to its plug-and-cast system, while the semi-system formwork requires more complex and time-consuming installation.

In the RSS Building project, due to the large size and complexity of the formwork components that needs to be installed, the difference in daily productivity and installation time between the two systems was not highly significant. However, the fabrication duration for semi-system formwork was longer, as it required three fabrication cycles from Phase 1 to Phase 7, assuming no significant formwork damage occurred. In contrast, the aluminum formwork was fabricated only once at the beginning and reused until the project was completed, with no additional fabrication needed. Based on these parameters, it can be concluded that aluminum formwork offers a more efficient timeline compared to the semi-system formwork.

CHAPTER VI
CONCLUSION AND SUGGESTION

6.1 Conclusion

Based on the data analysis and discussion that has been presented in previous chapter, the cost and time comparison between semi-system and aluminium formwork is obtained. Thus, it can be summarized that:

1. The cost estimation for wall formwork work in the RSS Building MRT Station Jakarta project using the semi-system formwork method amounted to Rp 976,9997,040.88, while the aluminium formwork method amounted to Rp 591,678,031.53.
2. The estimated duration for wall formwork using the semi-system method was 137 days, with a daily labor productivity of 7.237 m^2/day. In comparison, the aluminium formwork was completed in 86 days with a daily productivity of 11.955 m^2/day.
3. Based on the cost comparison, it can be concluded that aluminium formwork was less expensive than the semi-system formwork. Likewise, the installation duration for aluminium formwork was relatively faster. Therefore, in the RSS Building MRT Station Jakarta project, the aluminium formwork method is considered the most efficient in terms of both cost and time, as it not only reduced expenses but also shortened the construction duration. As a result, it helped minimize additional costs that could arise from prolonged work durations.

6.2 Suggestion

The results of this study are expected to provide valuable insight for selecting appropriate formwork methods in multi-story building construction. The following recommendations are suggested based on the findings:

1. Future research may consider analysing additional structural elements when using two types of formworks, such as columns, floor slabs, beams, stair slabs, and others.
2. The use of aluminum formwork should be considered for large-scale building projects due to its advantages in terms of method, cost efficiency, and execution time.
3. Time calculations and wages should be further detailed, particularly regarding the exact worker productivity, formwork dismantling and the cycle time required for formwork relocation at each phase.
4. If a project involves wall structures with varying dimensions and shapes in each part, and changes in formwork shape are likely, the semi-system formwork method is recommended.
5. Project with uniformly size dimension may benefit more from aluminium formwork because of its reusability.

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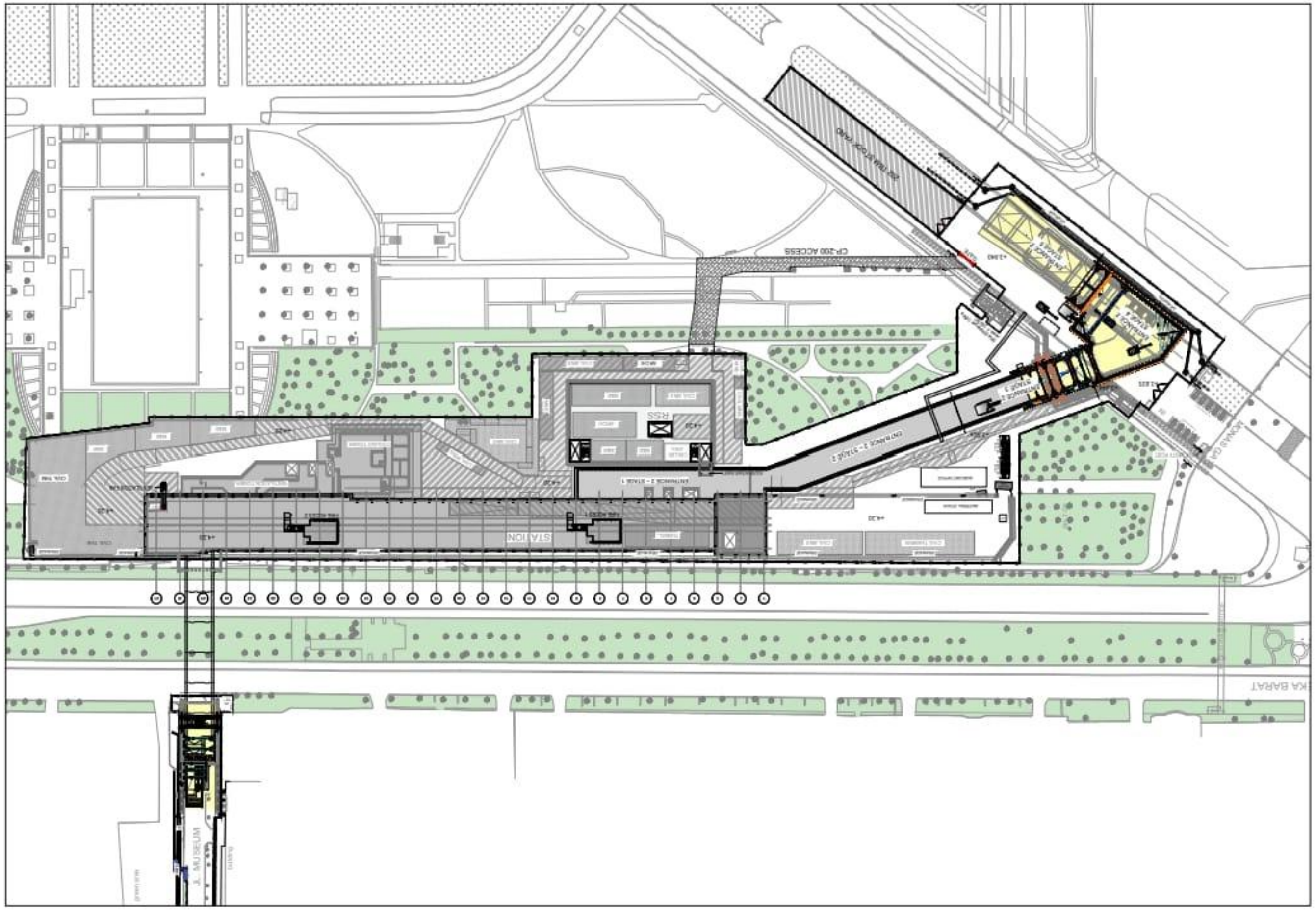
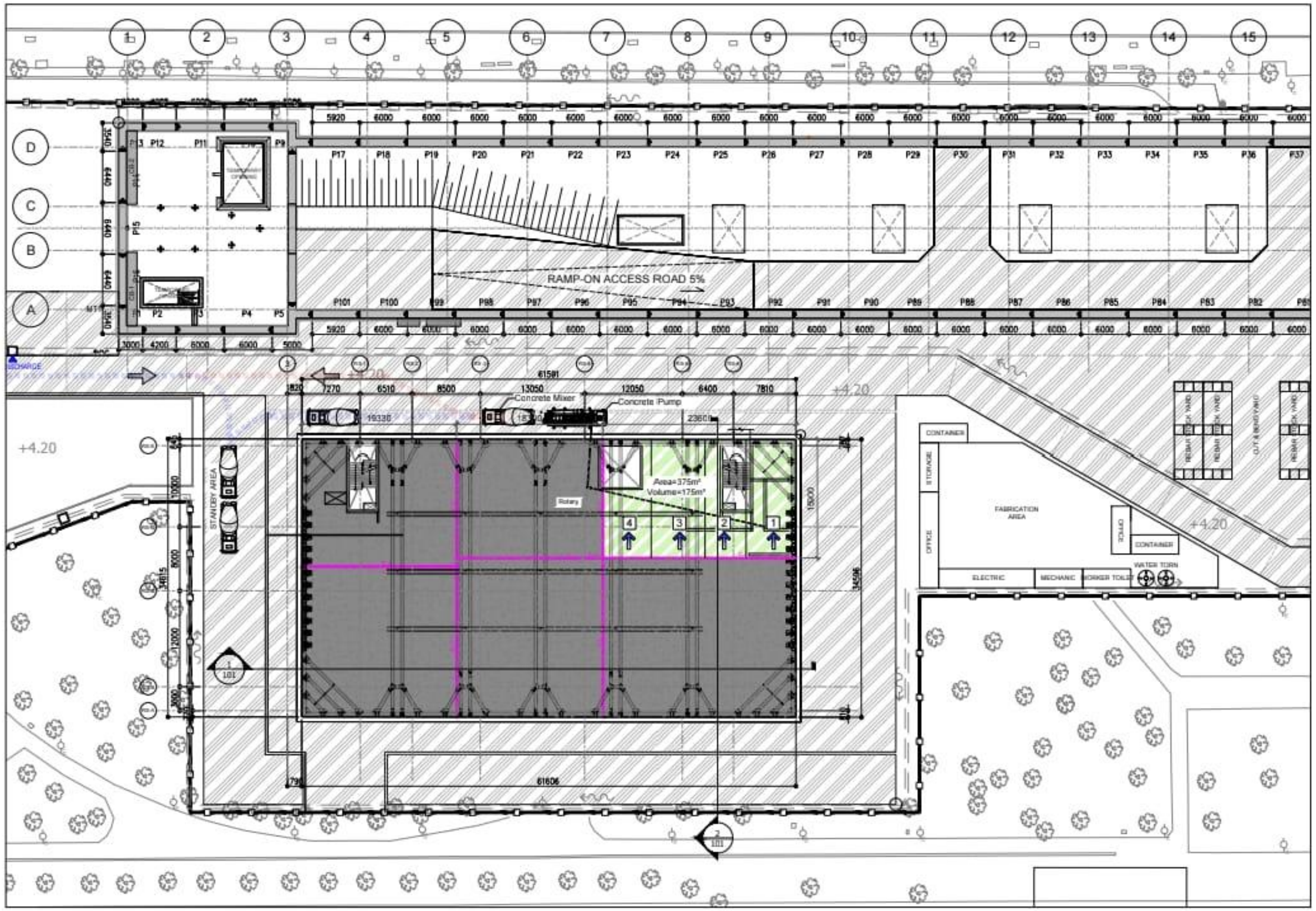
ATTACHMENT

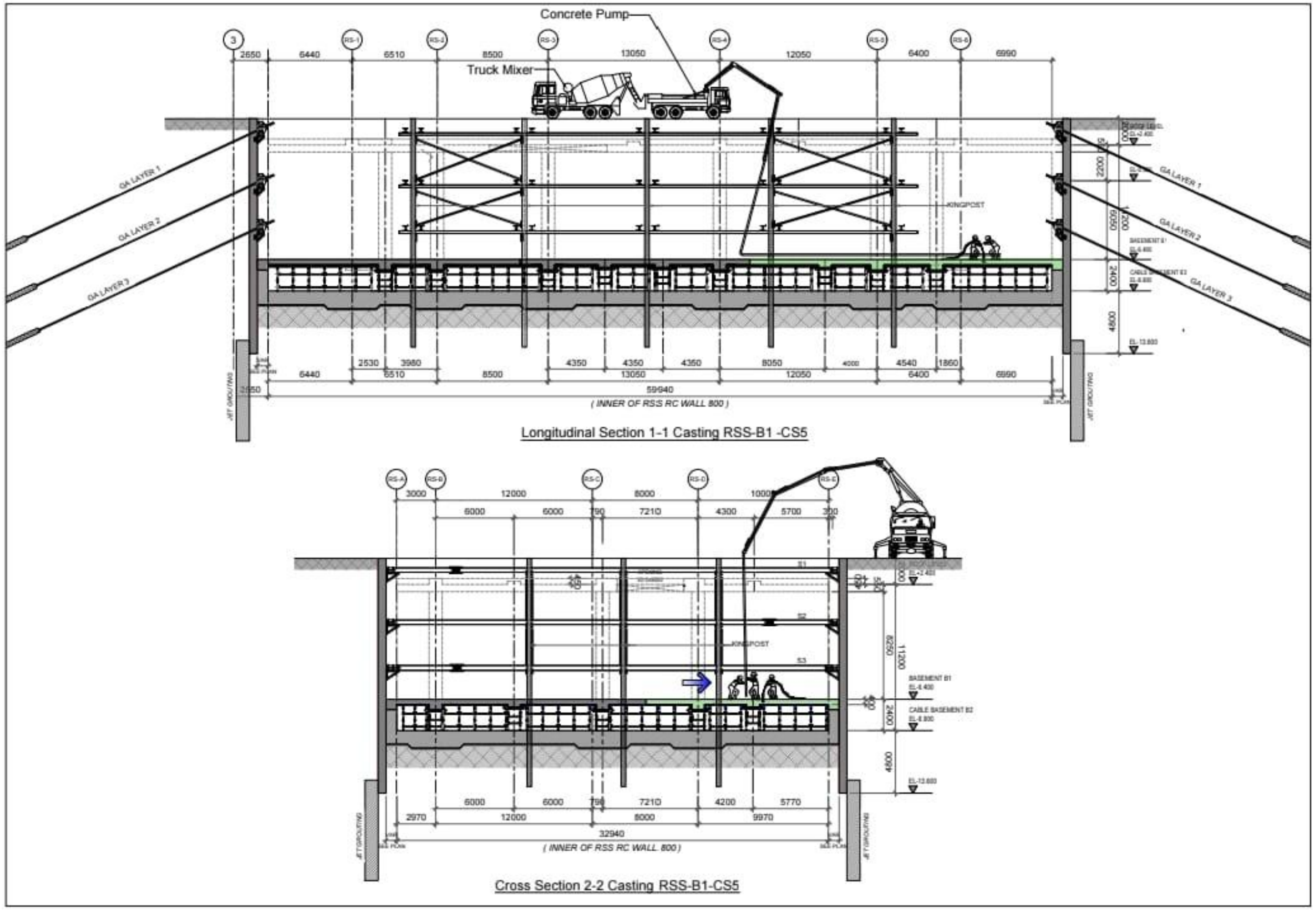
Attachment 1 Construction Layout of the MRTJ Project



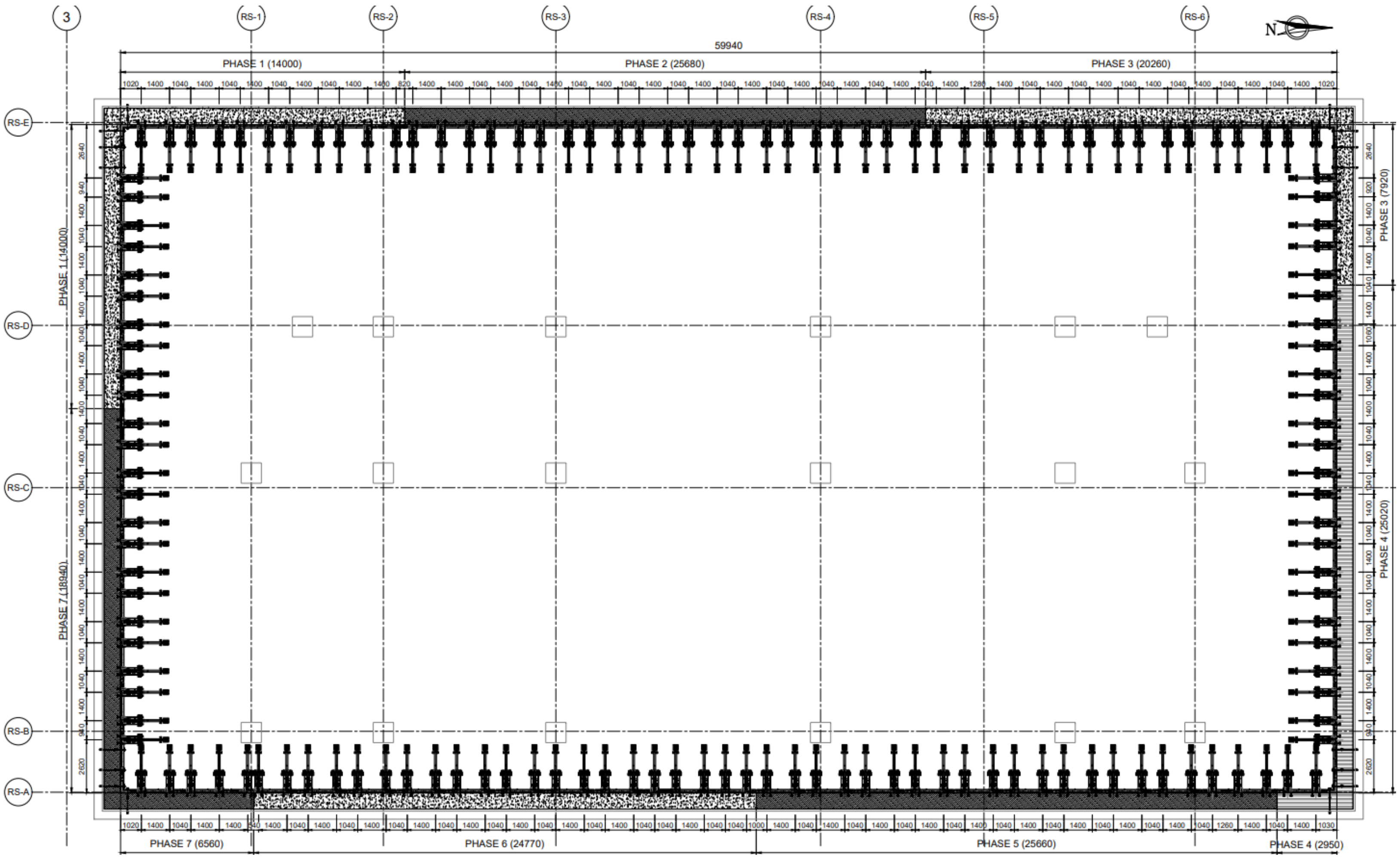
Attachment 2 RSS Building Top Layout



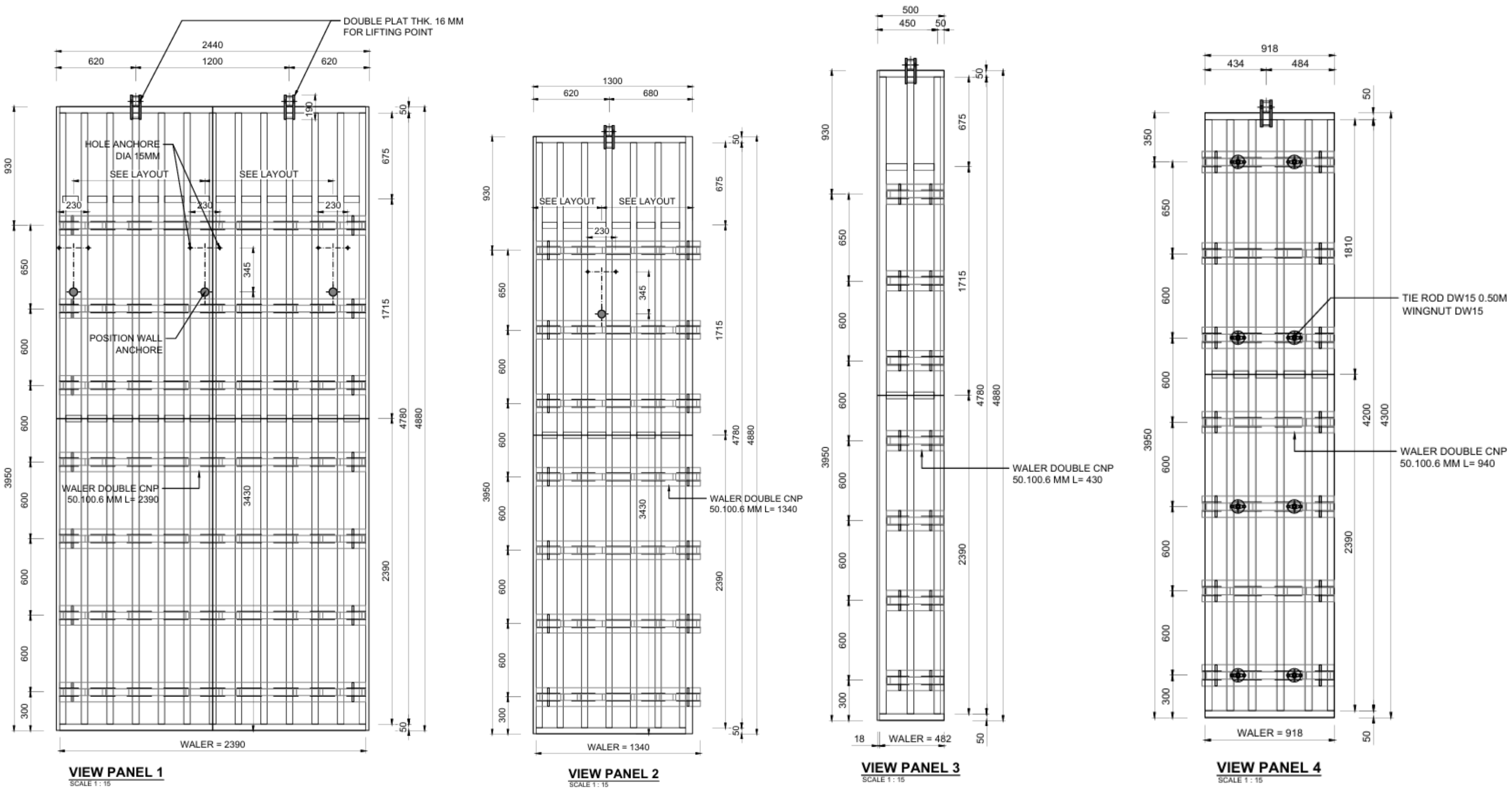
Attachment 3 Cross section of RSS Building Layout



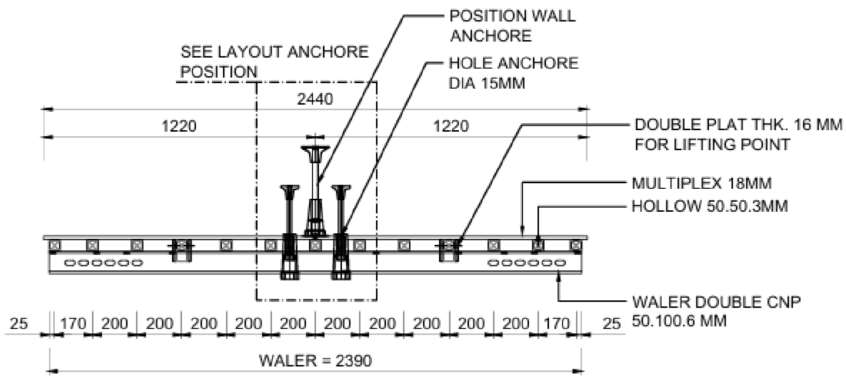
Attachment 4 RSS Building Formwork Layout



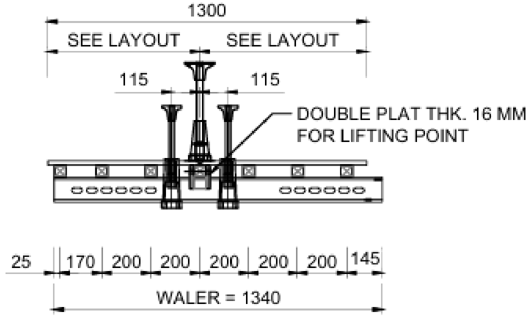
Attachment 5 Formwork Panel Type



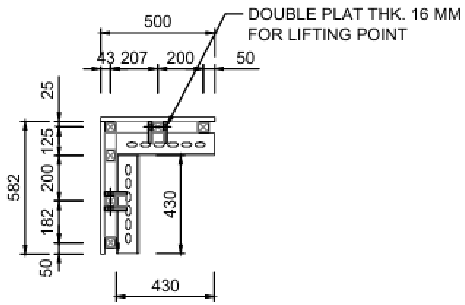
Attachment 6 Formwork Panel Detail



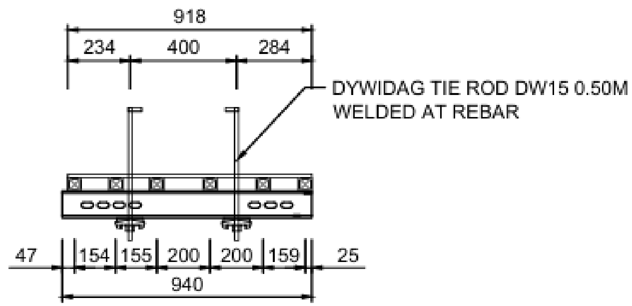
PLAN PANEL 1 = 2440
SCALE 1 : 15
11 PANEL



PLAN PANEL 2 = 1340
SCALE 1 : 15
2 PANEL



PLAN PANEL 3 = 430
SCALE 1 : 15
1 PANEL



PLAN PANEL 4 = 940
SCALE 1 : 15
2 PANEL

Attachment 7 Semi System Formwork on The Site

Figure A.1.2 RSS MainWall Semi System Formwork Phase 3

Figure A.1.3 RSS Main Wall Semi System Formwork Phase 2

Figure A.1.4 RSS Main Wall Semi System Formwork Phase 7

Figure A.1.5 Platform for Semi System Formwork

Figure A.1.6 Exterior Non Modular Semi System Formwork wall 1

Figure A.1.7 Exterior Non Modular Semi System Formwork wall 2

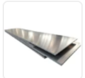
Figure A.1.8 Exterior Non Modular Semi System Formwork wall 3

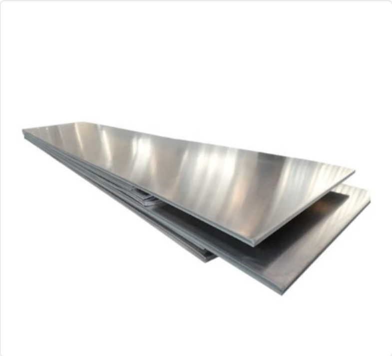
Figure A.1.9 Exterior Non Modular Semi System Formwork wall 4

Attachment 8 Project Semi System Unit Price and Aluminium Material Price

Pemasangan 1 m2 bekisting untuk dinding D-wall (3 kali pakai)

No	Uraian	Sat.	Koefisien	Harga Satuan (Rp)	Jumlah Harga (Rp)
A	TENAGA KERJA				
1	Tenaga	OH	1.320	180,500.00	238,260.00
2	Tukang	OH	0.660	190,000.00	125,400.00
3	Kepala tukang	OH	0.066	206,500.00	13,629.00
4	Mandor	OH	0.011	218,300.00	2,401.30
	JUMLAH HARGA TENAGA KERJA				379,690.30
B	BAHAN				
1	Bolt 4 inch	kg	0.40000	25,000.00	10,000.00
2	Formwork oil	liter	0.20000	29,700.00	5,940.00
4	polyfirm width 18mm	lembar	0.12700	140,000.00	17,780.00
	JUMLAH HARGA BAHAN				33,720.00
C	PERALATAN				
	JUMLAH HARGA ALAT				-
D	Jumlah (A+B+C)				413,410.30
E	Biaya Umum dan Keuntungan 10% - 15% x D			10%	41,341.03
F	Harga Satuan Pekerjaan (D+E)				**454,751.33**





Plat Alumunium 6061 Tebal 20mm x 1.2m x 2.4m

Rp. 15.000.000

Update Terakhir	23 Nov 2024
Negara Asal	Indonesia
Pembelian Min	1 Pieces
Kategori	Plat Aluminium
Subkategori	Plat Aluminium Lembaran

Bagikan

Minta Penawaran

Hubungi dengan WhatsApp

Attachment 9 Rental Price of Formwork Reinforcement Equipment

Customer:	SURYA NUSANTARA KONSTRUKSI
Project:	MRT POWER HOUSE
Offer No.:	SO20-037
Reference:	September 21, 2021

3. PRICING SUMMARY

PROJECT : MRT POWER HOUSE

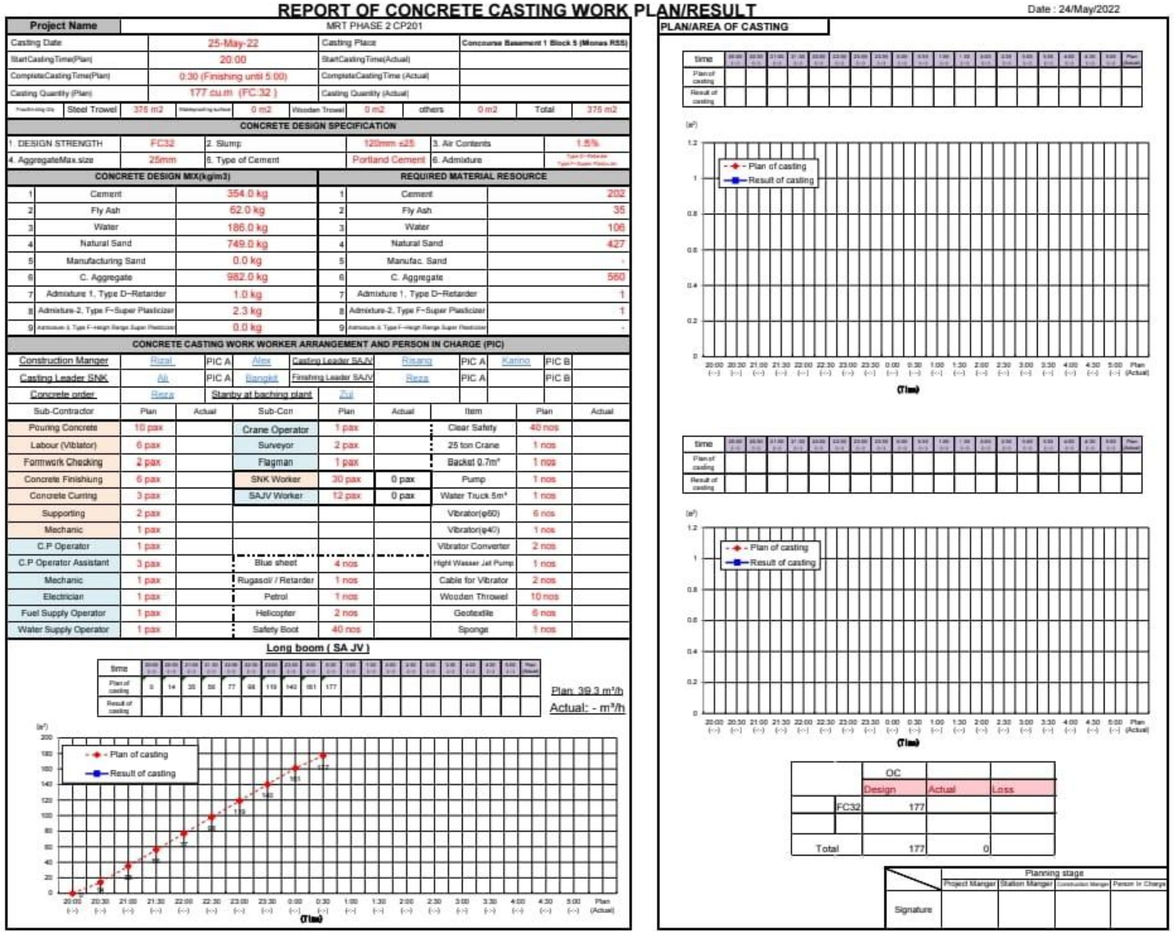
No	Description	PERI System	Qty	Approx. Weight (kg)	Rental Duration (month)	Net Sales Price / set (IDR)	Total Sales Price (IDR)	Net Rental Price / set / Month (IDR)	Total Rental Price (IDR)	Net Price CONS / set / (IDR)	Total Consumable Price (IDR)
1	WALL SINGLE SIDED, L=72.00 M, H=4.00 M	VARIO	1	14,610.09	4	2,138,141,427.00	2,138,141,427.00	81,249,807.00	324,999,228.00		
	CONSUMABLE	VARIO	1	824.53			-		-	94,186,852.00	94,186,852.00
2	PLATFORM	PERI UP	1	9,455.60	4	1,530,072,578.00	1,530,072,578.00	58,143,856.00	232,575,424.00		-
							-		-		-
TOTAL				24,890.22			3,668,214,005.00	139,393,663.00	557,574,652.00	94,186,852.00	94,186,852.00

OPTION 1 : SALES / INVEST:	TOTAL SALES PRICE (Incl consumable)	3,762,400,857.00
OPTION 2 : RENTAL (4 month):	TOTAL RENTAL COST + CONSUMABLES	651,761,504.00

Notes:

1. *Exclude Plywood, Timber, Plank, Pipe PVC*
2. *The material will be delivered 3 – 4 weeks after receiving the purchase order*
3. *Excluding VAT and other applicable local sales taxes*
4. *Prices stated are inclusive of shipment of material to Greater Jakarta*

Attachment 10 Casting Site Report



REPORT OF CONCRETE CASTING WORK PLAN/RESULT

Date : 24/May/2022

Project Name	MRT PHASE 2 CP201		
Casting Date	25-May-22	Casting Place	Concourse Basement 1 Block 5 (Monas RSS)
StartCastingTime(Plan)	20:00	StartCastingTime(Actual)	
CompleteCastingTime(Plan)	0:30 (Finishing until 5:00)	CompleteCastingTime (Actual)	
Casting Quantity (Plan)	177 cu.m (FC 32)	Casting Quantity (Actual)	

Finishing Qty	Steel Trowel	375 m2	Waterproofing surface	0 m2	Wooden Trowel	0 m2	others	0 m2	Total	375 m2

CONCRETE DESIGN SPECIFICATION

1. DESIGN STRENGTH	FC32	2. Slump	120mm ±25	3. Air Contents	1.5%
4. AggregateMax.size	25mm	5. Type of Cement	Portland Cement	6. Admixture	Type D-Retarder, Type F-Super Plasticizer

CONCRETE DESIGN MIX(kg/m3)			REQUIRED MATERIAL RESOURCE		
1	Cement	354.0 kg	1	Cement	202
2	Fly Ash	62.0 kg	2	Fly Ash	35
3	Water	186.0 kg	3	Water	106
4	Natural Sand	749.0 kg	4	Natural Sand	427
5	Manufacturing Sand	0.0 kg	5	Manufac. Sand	-
6	C. Aggregate	982.0 kg	6	C. Aggregate	560
7	Admixture 1, Type D-Retarder	1.0 kg	7	Admixture 1, Type D-Retarder	1
8	Admixture-2, Type F-Super Plasticizer	2.3 kg	8	Admixture-2, Type F-Super Plasticizer	1
9	Admixture-3, Type F-High Range Super Plasticizer	0.0 kg	9	Admixture-3, Type F-High Range Super Plasticizer	-

CONCRETE CASTING WORK WORKER ARRANGEMENT AND PERSON IN CHARGE (PIC)

Construction Manger	Rizal	PIC A	Alex	Casting Leader SAJV	Risang	PIC A	Karino	PIC B
Casting Leader SNK	Ali	PIC A	Bangkit	Finishing Leader SAJV	Reza	PIC A		PIC B
Concrete order	Reza	Stanby at baching plant		Zul				

Sub-Contractor	Plan	Actual	Sub-Con	Plan	Actual	Item	Plan	Actual
Pouring Concrete	10 pax		Crane Operator	1 pax		Clear Safety	40 nos	
Labour (Vibtator)	6 pax		Surveyor	2 pax		25 ton Crane	1 nos	
Formwork Checking	2 pax		Flagman	1 pax		Backet 0.7m³	1 nos	
Concrete Finishiung	6 pax		SNK Worker	30 pax	0 pax	Pump	1 nos	
Concrete Curring	3 pax		SAJV Worker	12 pax	0 pax	Water Truck 5m³	1 nos	
Supporting	2 pax					Vibrator(φ50)	6 nos	
Mechanic	1 pax					Vibrator(φ40)	1 nos	
C.P Operator	1 pax					Vibrator Converter	2 nos	
C.P Operator Assistant	3 pax		Blue sheet	4 nos		Hight Wasser Jet Pump	1 nos	
Mechanic	1 pax		Rugasol / Retarder	1 nos		Cable for Vibrator	2 nos	
Electrician	1 pax		Petrol	1 nos		Wooden Throwel	10 nos	
Fuel Supply Operator	1 pax		Helicopter	2 nos		Geotextile	6 nos	
Water Supply Operator	1 pax		Safety Boot	40 nos		Sponge	1 nos	

Long boom (SA JV)

time	20:00	20:30	21:00	21:30	22:00	22:30	23:00	23:30	0:00	0:30	1:00	1:30	2:00	2:30	3:00	3:30	4:00	4:30	5:00	Plan (Actual)
Plan of casting	0	14	35	56	77	98	119	140	161	177										
Result of casting																				

Plan: 39.3 m³/h

Actual: - m³/h

PLAN/AREA OF CASTING

		OC		
		Design	Actual	Loss
	FC32	177		
Total		177	0	

	Planning stage			
	Project Manger	Station Manger	Construction Manger	Person In Charge
Signature				