

CHAPTER 2

NOVOTEL HOTEL BSD DEVELOPMENT

2.1 General Description

Novotel BSD is a hotel building located at Jl. Edutown CBD 55 Kav Lot I No. 8, BSD, Kab. Tangerang. This project is located at Jl. Edutown CBD 55 Kav Lot I No. 8, BSD, Kab. Tangerang (Figure 2.1). At the west side of this project is Branz BSD Apartments by OkeStay, while Upper West BSD City – Official is at the north side of Novotel BSD. The Land Contour of this project is relatively flat, and the adjacent land alongside of this project is vacant or there is no other project conducted for now.



Figure 2. 1. Visual Location of Novotel BSD

A temporary workplace created on a construction site to support the management, administrative, and coordinating tasks related to the construction project is called a site office, often referred to as a project office or construction site office. During the building phase, the site office acts as the main hub for project management, communication, and documentation. Its main objective is to give the project team a dedicated area in which to organize, coordinate, and oversee the several facets of the building project. The site office area (Figure 2.2) is not only occupied for site office only, it also includes the canteen for office staff and workers. There are also warehouses for safety equipments such as helmets, safety vest, safety shoes, and many other safety equipments. Besides

the safety equipments, there is also warehouse for chemical needs such as concrete integral, paint, and waterproofing.



Figure 2. 2. Site Office of Novotel Hotel Project

Project Boundaries Work for this project are Foundation and Structural Work. A building or structure's stability, safety, and lifespan are dependent on the foundation and structural work done throughout the construction process. The goal of the foundation work is to transmit the loads from the building to the underlying rock or soil, which serves as support for the entire structure. They prevent settling or movement and disperse the structural loads. On the other hand, structural work entails the planning and constructing of the weight-bearing components that guarantee the stability and integrity of the structure. Beams, columns, slabs, walls, and other structural components are included in this.

This project consists of 13 typical floors for tower, 3 floors of podium, and 2 basements (Figure 2.4) with $\pm 5.200 \text{ m}^2$ for the land area and $\pm 33.980 \text{ m}^2$ for the structure area. Basement 2 is located at -7.5 meters, while Basement 1 is located at -3.9 meters from the land surface. The method for the concrete casting for Basement 2 is using Mass Concrete Raft Foundation or Mat Foundation Method while Basement 1 is using Partial Method. Low Structure or Foundation is using lower w/c (water cement ratio) than upper structure due to prevent water from seeping to the concrete. Given this project consists of tower and podium the level of each floor is different for each type (typical and podium). Podium is divided into Ground Floor, Mezzanine, and Upper

Ground. Ground Floor is located at +0.00 meter, while the road is located at -1.50 meters, Swimming Pool area is located at the Ground Floor but has different elevation at -0.55 meters for Structure Level and -0.50 meter for Finishing Floor Level, Mezzanine Floor is located at +5.50 meters, Upper Ground is located at +10.00 meters, and Podium Roof Slab is located at +16.50 meters. Tower consists of typical type from 1st floor until 13th Floor with the same height for each floor at 3.60 meters (+16.90 meters - +60.10 meters). The flow of the concrete casting for upper structure will start from the typical tower and then podium (see Figure 2.3). The casting zone for upper structure is adjusted to the layout of the wall and not to the toilet to avoid leakage.

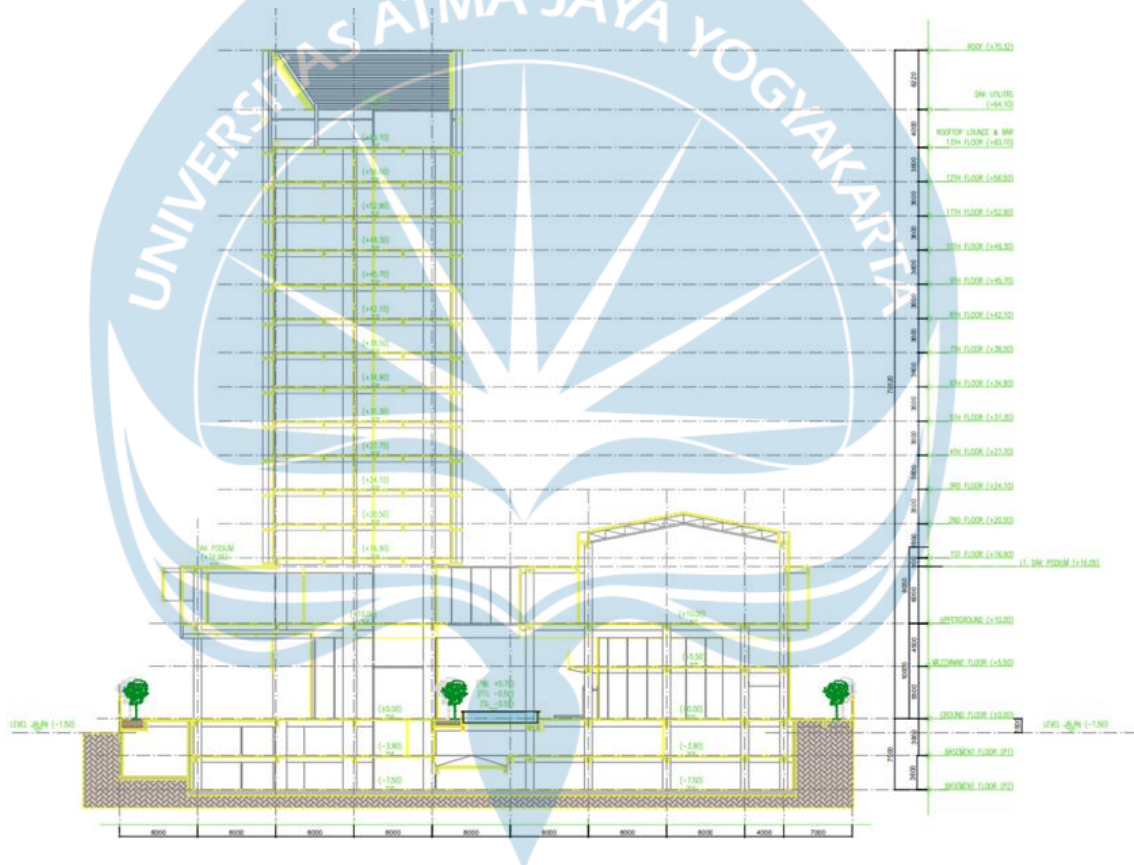


Figure 2. 3. Floor to Floor Level

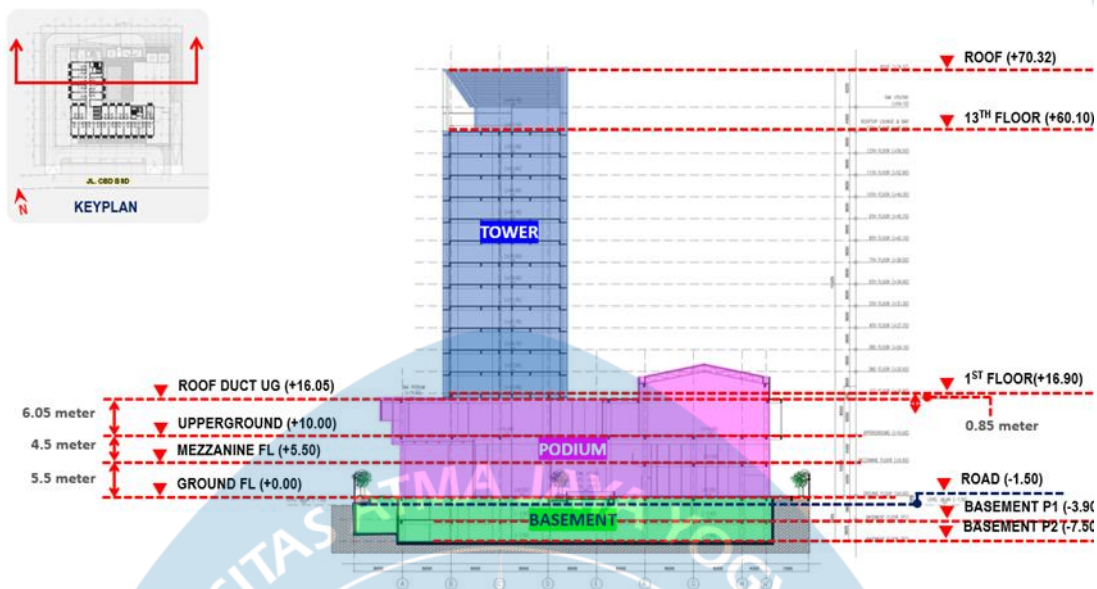


Figure 2. 4. Novotel Hotel Plan

The owner chose Fixed Lump Sum as the type of contract with the scopes of Foundation and Structural Work. A fixed lump sum contract is a kind of construction contract in which the contractor commits to finishing a project for a predefined, fixed quantity of money. It is also referred to as a fixed-price or lump sum contract. Under this type of contract, the agreed-upon price is usually set before the project begins and doesn't change based on the actual expenses the contractor incurs while building the project. The scope of work is precisely defined in the contract, outlining the duties, deliverables, and requirements that the contractor must meet. Modifications to the scope of work might incur extra fees and need discussion.

A fixed lump sum contract offers the customer cost predictability, which is one of its primary benefits. Because the client is aware of the project's whole cost up front, financial planning and budgeting are more predictable. In a fixed lump sum contract, the risk of cost overruns is assumed by the contractor. The contractor has the responsibility of paying any additional costs incurred in case the agreed-upon fixed price is exceeded by the actual cost of construction. The deadline for project completion is outlined in the contract. Generally, the contractor must fulfil the completion deadlines and project milestones mentioned in the contract.

The quality and performance requirements that the contractor must satisfy are specified in the contract. It is the contractor's duty to provide work that meets these requirements. Usually, the payment plan is set up according to the accomplishment of

stages or project milestones. Instead of being based on the contractor's actual expenses, payments are provided in accordance with the timetable that was previously established.

PT. Total Bangun Persada Tbk is using several Sub-Contractor for Novotel Hotel BSD Project as below:

- Bore Pile Work : PT. Catur Bored Indonesia
- Diggings Work : PT. Sun General Contractor
- Dewatering Work : PT. Tahta Bumi Nusantara
- Concrete Casting Work : CV. Handika Jaya Utama
- Reinforcement Work : CV. Maju Perkasa
- *Bobokan* Work : CV. Langgeng Ayom
- Framework Work : PT. Putra Cipta

For Consultants, Novotel BSD is using Ferry Ridwan Arsitek as the Architecture Consultant, PT. Cipta Sukses as the Structure Consultant, and Mepraya as the Mechanical Electrical and Plumbing Consultant. This project starts from May 12th, 2023 until June 12th, 2024 or an estimated 397 days.

The building is divided into several zones for casting with gridline which divides the zone is not on the area of toilet. This is because of the leaking might happen if the gridline of the zone is placed on the toilet area.

This project is using different concrete specifications for Bore Pile, Pile Cap, Tie Beam, Slab, Beam, Column, Shear Wall, Retaining Wall, and Stair for this project are given as below (Table 2.1).

Table 2. 1. Concrete Quality

Type	Fc'	Slump
Column and Shear Wall	40 MPa	12 + 2 cm
Raft, Pile Cap, Tie Beam, and Retaining Wall	35 MPa	14 + 2 cm
Beam, Slab, and Stair	35 MPa	12 + 2 cm
Bore Pile	30 MPa	18 + 2 cm

Compressive strength, or Fc', is a crucial characteristic of concrete that is frequently used to evaluate its effectiveness and appropriateness for uses. The highest compressive stress that concrete can sustain when subjected to axial loading is known as

its compressive strength. Compression tests on cylindrical concrete specimens are used to measure it. The figure that indicates the range of possible test results for a particular percentage is known as the typical compressive strength. For use in structural design calculations, the typical strength of concrete is ascertained by statistical analysis of test results.

The term "slump" describes the consistency or workability of newly mixed concrete. This easy-to-use test evaluates the consistency of concrete mix both before and during preparation. The results of the slump test reveal how much water is in the concrete mix, which affects how easy it is to place, how well it compacts, and whether it can reach the required strength and durability. The main purpose of the slump test is to evaluate how workable fresh concrete is. One important characteristic that affects how simple it is to mix, pour, and finish concrete is workability.

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The amount of water in the mixture may be determined by looking at the slump. While too much water might increase droop, it can also weaken and shorten the concrete's hardened surface. The slump test is a tool used by concrete manufacturers and contractors to regulate the consistency of the mix to satisfy project-specific specifications. Workability is further influenced by aggregate size, gradation, and kind. While poorly graded aggregates may require mix design modifications to reach the required slump, well-graded aggregates with a blend of coarse and fine particles can boost workability. Admixtures can be added to the mix design to increase workability without appreciably raising the water content, such as plasticizers or superplasticizers. The rheological characteristics of the concrete mix can be altered by these substances. The slump test is used to determine if the concrete mix is workable once it has been formulated and manufactured. In this test, the height of a concrete conical form after a certain quantity of consolidation is measured. The workability of the concrete may be

determined by looking at the results of the slump test. It could be essential to modify the mix design if the slump falls outside of the designated range. For instance, altering the amount of water, changing the kind or quantity of admixtures, or changing the proportions of the aggregate.

The foundation of Novotel BSD is using Raft Foundation (Bore Pile and Pile Cap) with the depths of 16 meters, 20 meters, 25 meters, and 32 meters (Figure 2.5). A bore pile is a kind of deep foundation component that is made by excavating a hole in the earth and then packing it full of concrete. Moving structural loads from shallow, less competent soil layers to deeper, more competent soil or rock strata, bored piles are frequently employed. These piles are used in many different construction projects, such as those involving buildings, bridges, and other infrastructure. Structural loads can be effectively transferred by bored piles to deeper, more stable soil or rock layers. The kind of rock or soil encountered, as well as the structural strength of the concrete and reinforcing elements, all affect the load-bearing capability.

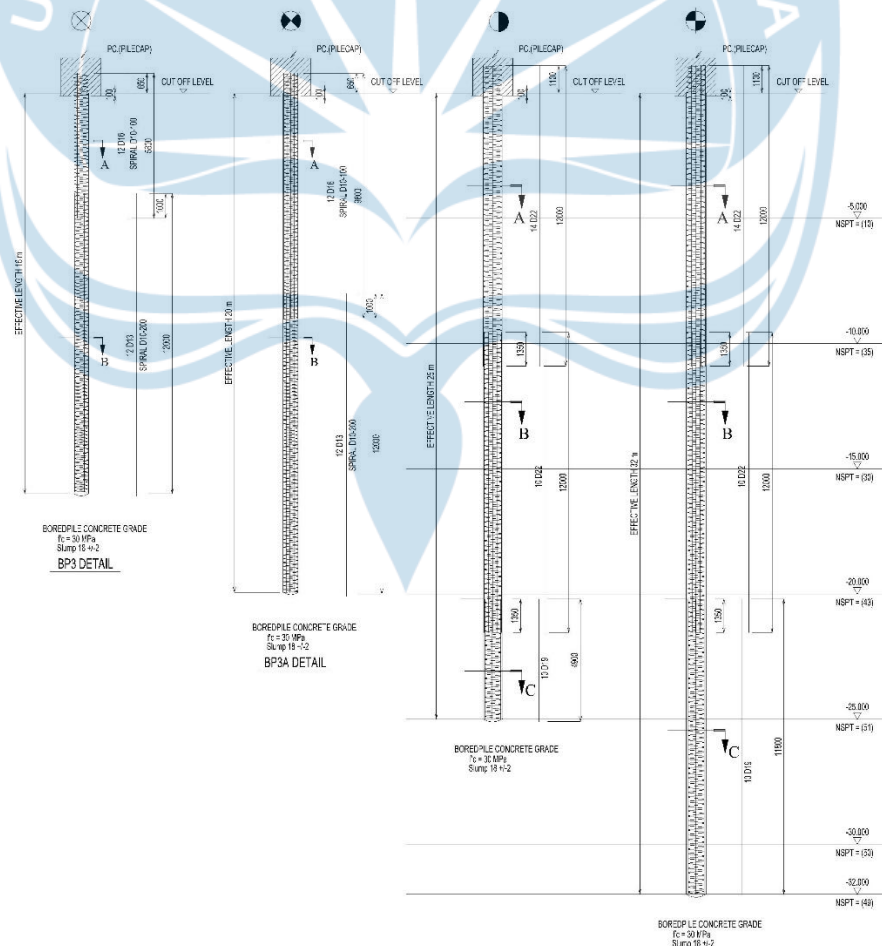


Figure 2. 5. Bore Pile Depth

The process of dewatering involves reducing or eliminating the amount of water present in the soil or building site to establish a stable and dry atmosphere. This is frequently required during building projects to facilitate operations like excavation, foundation building, or other tasks that call for a dry working space. Enabling safe and effective building, dewatering techniques work to lower the groundwater table or decrease the amount of water in the soil. When excavating trenches, foundations, or other below-grade constructions, dewatering is frequently necessary. It keeps the soil from becoming unstable, makes the working environment dry, and makes building easier. Dewatering wells are often constructed deeper than the nearby structures' dewatering wells.

Raft foundations are suitable in areas with poor soil properties, such as expansive clay soils, where the foundation must spread the weight over a larger area to minimize settling. Before adding a layer of concrete to a raft foundation, the entire area needs to be dug. The entire slab is poured at once when the reinforcing steel, or rebar, has been added. Raft foundations are used to provide uniform building settling. The likelihood of differential settling is lower when the loads are dispersed across a wide area. Soil investigation is a process used to assess the physical and chemical properties of the soil at a specific location. Soil research is done to get the essential data so that informed decisions may be made on the design, construction, and maintenance of structures, such as buildings, bridges, roads, dams, and other civil engineering projects. The investigation yields information on the composition, strength, permeability, settling characteristics, and other relevant soil properties. Soil investigation is conducted first to collect general information regarding to condition of soil layer and soil profiles of this project, obtain index properties parameter and engineering properties parameter, identify type of foundation that will be used to support upper structure based on allowable bearing capacity and economic factor, and anticipating problems that might happen during construction. The tests for the soil investigation are:

1. Deep Boring

Deep boring test is a method of geotechnical research that is used to investigate and gather rock and soil samples from considerable depths below the ground's surface. When an engineering project calls for towering structures, deep foundations, or in-depth exploration of the soil or rock layers, this kind of testing is carried out to get precise data regarding the subsurface conditions at the site. This

test is conducted at four points, 3 points (DB-2, DB-3, and DB-4) with the depth of 60 meters, and 1 point (DB-1) with the depth of 70 meters. This test is using rotary drilling method.

2. Standard Penetration Test

Standard penetration test is a method for assessing how homogeneous or dense granular deposits such as sands and gravels are. Since it provides information on the underlying soil conditions, it is frequently used in the field of geotechnical engineering for the design of embankments, foundations, and other soil-related projects. This test is conducted 167 times with the interval of 1.5 meters using Automatic Trip Hammer.

3. Cone Penetration Test

One method for assessing subsurface conditions and determining the mechanical properties of soil is the cone penetration test. It involves gradually inserting a cone-shaped penetrometer into the ground and recording the resistance the cone meets. The CPT method is widely applied in geotechnical engineering because to its ability to provide valuable insights into soil strength, stratigraphy, and other related geotechnical aspects. Cone Penetration Test was conducted on 2 holes until it reached the maximum conus (q_c) $> 200 \text{ kg/cm}^2$.

4. Laboratory Test

Water content test, unit weight of soil test, specific gravity, Atterberg limit test, sieve analysis tests were tested on 17 samples of UDS and 10 samples from core sample and engineering properties such as Standard Consolidation Test with the maximum pressure of 1600 kPa, UU Triaxial Test on 11 samples of UDS, and CU Triaxial Test on 8 UDS samples were conducted to achieve index parameters.

Creating reports based on the log of boring, N-Value comparison graph with depth, CPT test graph, laboratory test, typical profile soil parameters based on each layer, ground water table, description for each soil parameter on each layer, bearing capacity estimation for shallow foundation and foundation such as precast pile (spun pile) and bored pile with the estimation of land subsidence or consolidation and local soil conditions.

There are several foundation tests conducted, such as PDA Test. An advanced testing tool called the Pile Driving Analyzer is used to evaluate the performance and integrity of driven piles during installation. When assessing the capacity, bearing

resistance, and general behaviour of piles pushed into the earth, the test is especially helpful. The PDA test may be used for quality control, dynamic monitoring, and capacity evaluation.

Excavation of soil involves taking dirt away from a specified spot to make a hole or hollow. This procedure, which is essential to many engineering and building projects, entails excavating, trenching, or removing dirt to shape, level, or arrange the ground in a certain way. In many construction projects, including laying foundations, installing utilities, finishing basements, building roads, and more, excavation is an essential first step.

Soldier pile is a type of retaining wall used to support excavations and stabilize slopes of rock or soil. Soldier piles are a common form of shoring used in both temporary and permanent structures for below-grade building projects. Soldier Pile is also used to retain the load from the road (the position of the soldier pile in this project is located next to the road). In advance of excavation, soldier piles are installed first. They can be drilled and subsequently filled with concrete, or they can be pushed into the earth using a pile driver in certain situations. Since soldier piles may be installed more quickly than other shoring techniques, they are a good choice for projects with constrained timetables. Additionally adaptable to different soil conditions and building needs are soldier pile walls.

Excavation is done for several purposes, such as making room for mining activities, grading for landscaping, utilities (like pipes or sewers), basements, foundations, and utilities. Bulk excavation is the method being used for this project. This kind involves removing a lot of dirt to make significant building projects. To maintain compliance with safety and environmental requirements, local construction rules and laws frequently specify the acceptable techniques and safety precautions for soil excavation.

Capping beam is a horizontal structural element that is often placed on top of vertical components like piles or drilled shafts in a deep foundation system. Capping beams are commonly used while establishing the foundation for a building, bridge, or other major construction. Their primary purpose is to connect and distribute loads among the foundation components, which enhances overall stability and provides a level base for the superstructure.

Lean concrete, commonly known as low-strength concrete or dry lean concrete (DLC), has a lower cement percentage and more aggregates than typical concrete

mixtures. Lean concrete is frequently used in construction projects where the primary objective is to produce a safe and reasonably priced ground or foundation and there is little requirement for strength. Lean concrete for this project was done simultaneously, while the Pile Cap is being worked. The thickness of the lean concrete for this project is at 50 mm.

Pile Cap is a structural component that distribute load from a single pile to a larger foundation. A pile cap protects the foundation from high loads, which can cause structural deformation. The pile cap also serves to reinforce the pile and enhance the foundation's bearing capacity. The pile cover also distributes lateral ground pressure uniformly to the pile. The reinforcement of the pile cap can be seen in the Figure 2.6.



Figure 2. 6. Pile Cap Reinforcement Work

The work for pile cap reinforcement is started by cutting the bored pile that has been installed in the soil. After the bored pile is cut, the reinforcement work can be started. The framework for the pile cap is using the crushed concrete from the pile cap to reduce the cost.

In this project the pile cap is located below the raft foundation which located below the Basement 1. The Pile Cap is using concrete quality of 35 Mpa with the foundation

plan shown as below. With several types of the pile cap used on this project, the plan for the pile cap can be seen in the Figure 2.7. There are several types of the pile cap can be seen in the Figure 2.8 until Figure 2.9.

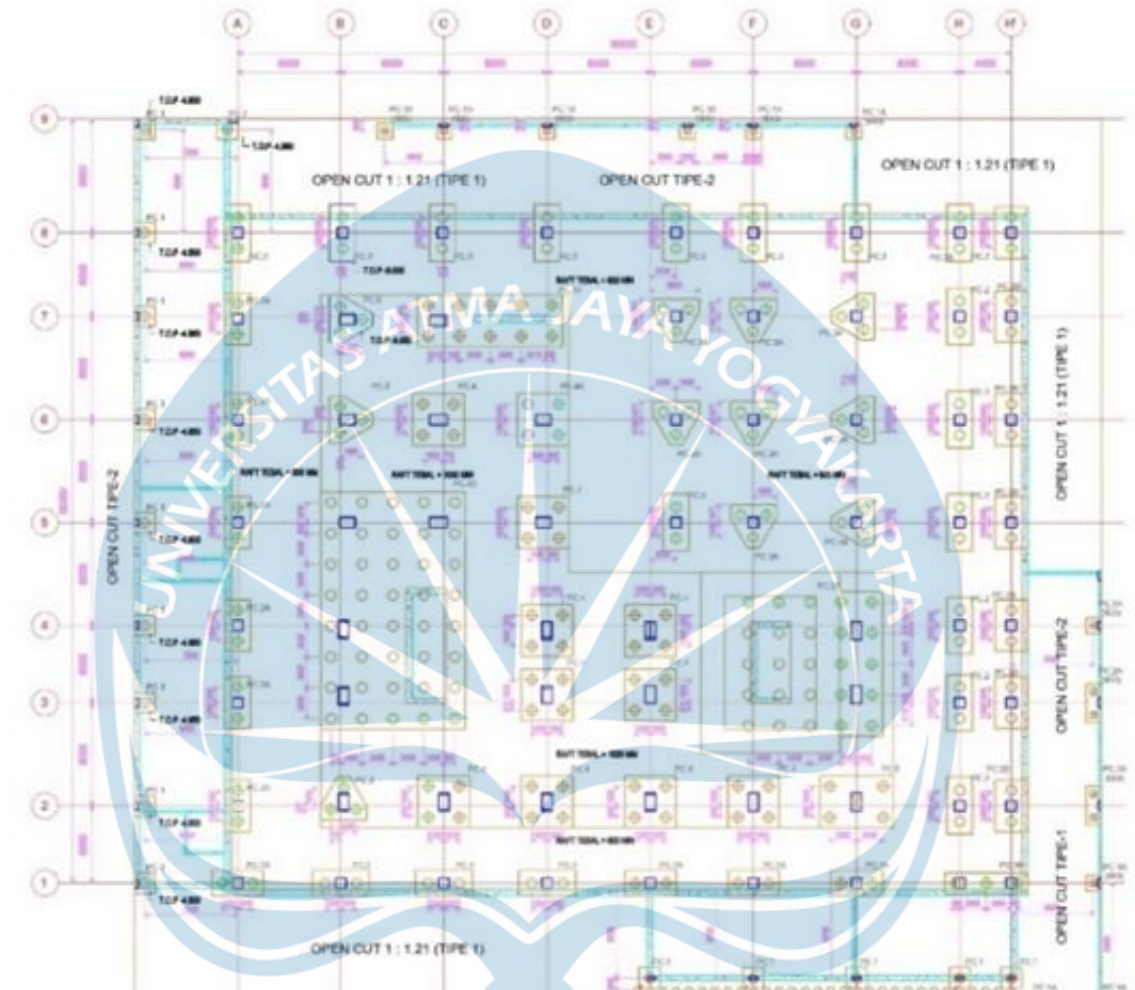


Figure 2. 7. Pile Cap Foundation Plan

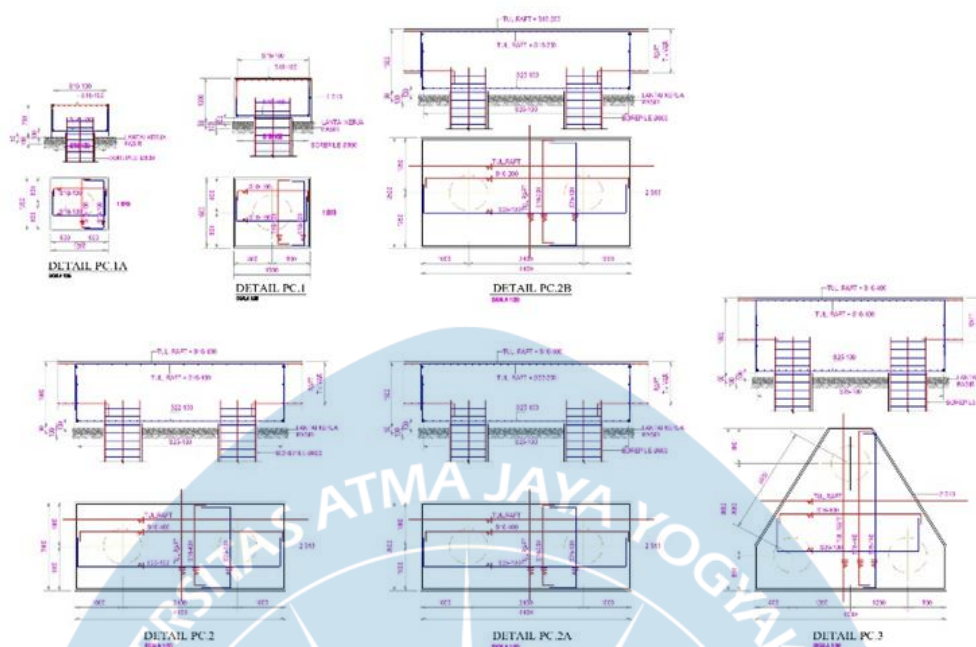


Figure 2. 8. Pile Cap Details

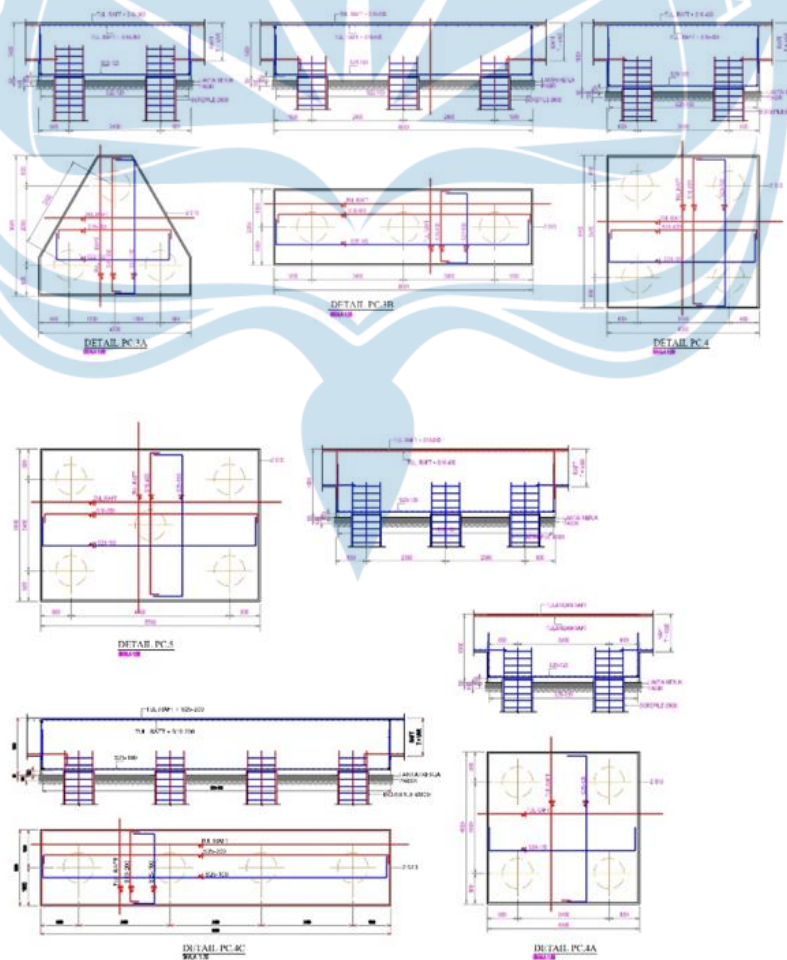


Figure 2. 9. Pile Cap Details

These reinforcements of the pile cap are casted monolithically with the raft foundation, columns, and beams basement 2. The casting is using the mass concrete at the raft foundation method.

Beam is a structure that bears loads from a building and distributes them to columns. The beam also ties the column and prevents the shear force from failing. The shear force is detained by the reinforcement of the beam. Most beams are horizontally oriented, and they are supported at both ends or throughout their length by vertical elements like walls or columns. A beam's primary functions are to prevent bending and transfer weights to the supports. Beams are designed to endure bending moments that result from applied loads, dead loads, and other external loads that are applied. The bending moment introduces tension and compression forces into the beam. Cross-sectional forms, such as rectangle, T-shaped, and I-shaped beams, are shaped by architectural design, load distribution, and structural needs. Beam on each floor of this project is using several dimensions and several reinforcements (Table 2.2).

Table 2. 2. Beam Dimensions

Beam Dimension
B 200x400
B 200x600
B 250x700
B 300x400
B 350x700
B 400x700
B 400x800
B 500x700
B 550x700

These dimensions are using concrete quality of 35 Mpa with slump of 14+2 cm. The dimensions used differently on each floor of this building. The usage of dimensions will be shown below in the Basement 1 (Figure 2.10) and Ground Floor (Figure 2.11).



Figure 2. 10 Beams Dimension Plan Basement 1

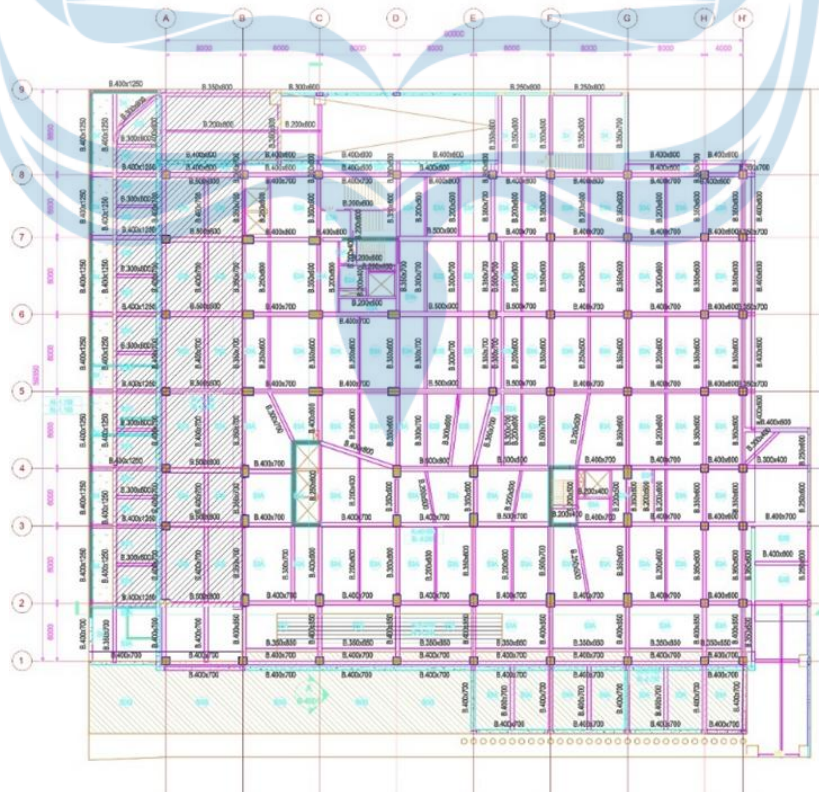


Figure 2. 11. Beams Dimension Plan Basement 2

If there is a different elevation located at the span of the beam, the reinforcement of the beam is cranked. The spacing condition is $\frac{1}{6} h < t < h$, so if there is sloping located at the beam, the cranked condition needs to be checked. If the condition is not possible, it is better to add more beam at that location.

Slab is a structural element withholds live and dead loads on the floor, which will later be transmitted to beams and columns in the lower structure. Concrete slabs play an essential function in multi-story buildings, serving as both floor slabs and slab platforms or roof slabs. Slabs can be differentiated into two types of one-way slab and two-way slabs. Certain slabs are intended to protrude past their supports, creating areas that are cantilevered. In architectural projects, cantilevered slabs are frequently employed to accomplish certain aesthetic or practical goals. Considerations for span length, loading circumstances, support conditions, material qualities, and code compliance are all part of the design and study of slabs. In this project there are several dimensions used for slab (Table 2.3).

Table 2. 3. Slab Dimensions

Slab Types	Thickness (mm)
S1A, S1B, S1C, and S1D	130
S2A and S2B	150
S3A and S3B	200
S4	250

These dimensions are used in different slab on different floor. The thickness of the slab is defined based on the type of the room, this is because of the loads occurred on the room. The placement of the slab for Ground Floor can be seen in the Figure 2.12.

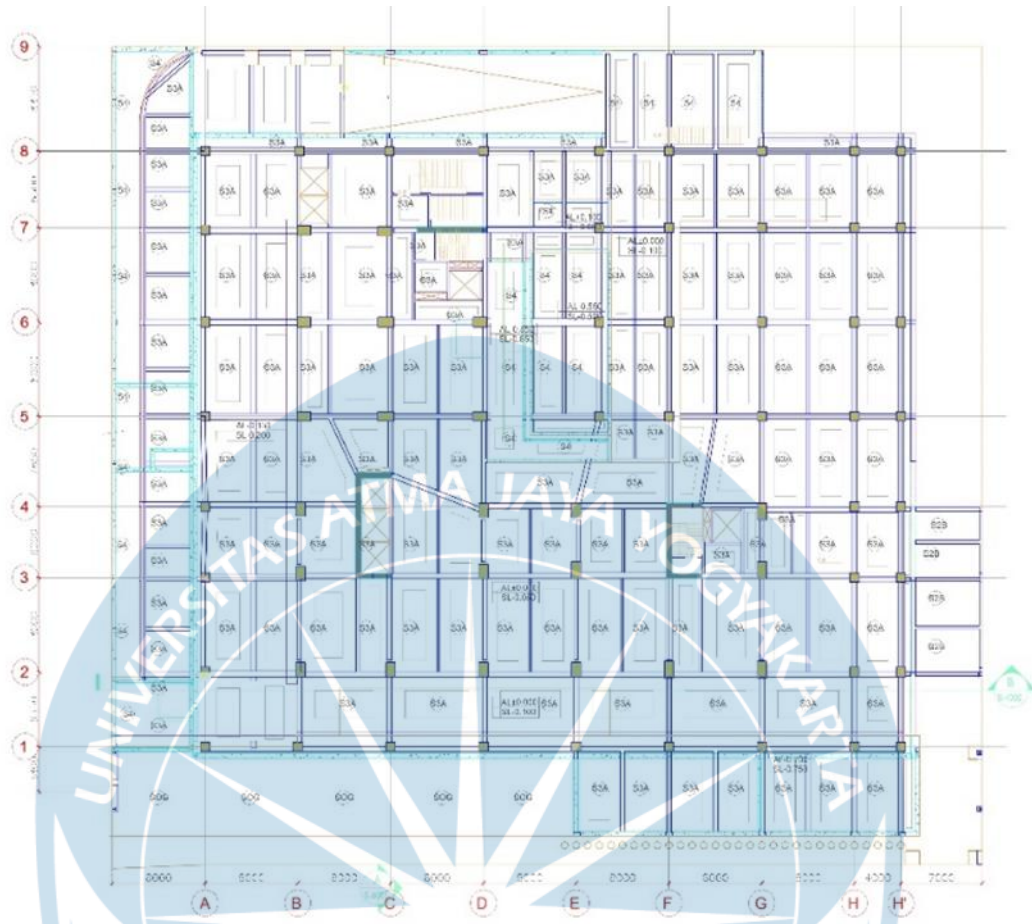


Figure 2. 12. Ground Floor's Slab Plan

Shear wall is a vertical structural which resist loads from wind load, seismic load or any other horizontal load that can cause deformation of the structure. This structure is providing stability and reducing the structural damage risk caused by the seismic load. The location of the shear wall in this project is surrounding pit lift. This is because of the shear wall forms a vertical barrier to prevent the horizontal load form the lift that can cause deformation. Shear wall in this project also acts as column which transfers the axial load into beams and slabs. Shear wall is consisted of the transverse links, flange, and web which makes it different from retaining wall. There are 3 shear walls in this

project, these shear walls are used near the elevator lift of this project. The installation of the shear wall can be in Figure 2.13.



Figure 2. 13. Shear Wall Reinforcement Work

Column is a structural element that takes up axial loads and transfers them from beams and slabs into the foundation as live, dead, or axial loads. There are several types of columns used in construction. The first one is concrete column; this kind of column is usually used in building construction. There is also column using steel reinforced. This kind of column is usually used in high rise building. This kind reinforced column provides proper distribution of the load effectively, so it prevents settling or settlements and collapsing. But reinforced steel column costs more compared to the steel reinforced column. Therefore, the usage of steel reinforced column is for very high-rise building. The second one is steel column; this kind of column is more resistant to the fire compared to the concrete column. The third one is composite column; this kind of column is using reinforced column and the steel column. Different cross-sectional forms, such as rectangular, square, circular, or more complicated geometries, are possible for columns. Several criteria, including structural efficiency and architectural design, impact the choice of form. To withstand lateral pressures like wind loads and earthquakes, columns must be built. To avoiding buckling or large lateral displacement, lateral stability is

essential. The column's design takes the slenderness ratio into consideration. The ratio of a column's least lateral dimension to its effective length is known as the slenderness ratio. To avoid buckling, columns with higher slenderness ratios would need to be handled with caution.

The installation of the column on this project is precast by the workers and carried by tower crane to the spot and then installed by the workers (Figure 2.14). The dimensions of the column each floor and section could be different based on the strength needed for the room or space. The dimension of the column is located at the attachment.



Figure 2. 14. Column Reinforcement Work

Certain columns include extra steel reinforcement to connect the column to the pile cap during installation or attachment. This is only a field installation technique to ensure the column remains upright (Figure 2.15). Certain columns include extra iron reinforcing to link the column to the pile cap during installation or attachment. This is only a field installation technique to ensure the column remains upright. Since the ground floor bears

most of the weight from the higher structure and would otherwise deteriorate, reinforcement of concrete columns on the ground floor often has no connections.



Figure 2. 15. Column Connection Method to Pile Cap

Stair is an element Stairs in civil engineering provide vertical access between floors, with safety, comfort, and aesthetics being key factors. Building norms and standards dictate size, materials, and safety measures to ensure user-friendliness and accessibility. Stairs that are made of reinforced concrete require reinforcement to increase their strength, resilience, and capacity to support applied loads. Furniture, other weights, and people using the stairs may cause bending, shearing, and tensile pressures, which the reinforcing helps to reduce. Construction of stairs depends heavily on the design and specifics of reinforcement, which are typically handled by structural engineers in accordance with project specifications and any relevant building rules. Strict adherence to design guidelines and meticulous attention to detail are required to ensure the staircase's structural integrity and safety.

The elevator car and its related equipment are kept in the recessed space at the base or bottom of an elevator shaft, which is known as the elevator pit (Figure 2.16). The creation of the elevator pit is an essential component of building design and construction,

and it is a fundamental component of the elevator system's overall architecture. The space required for the elevator car to descend and extend below the building's lowest level is provided by the elevator pit. This guaranteed that the elevator vehicle will have enough room to clear the lowest floor.

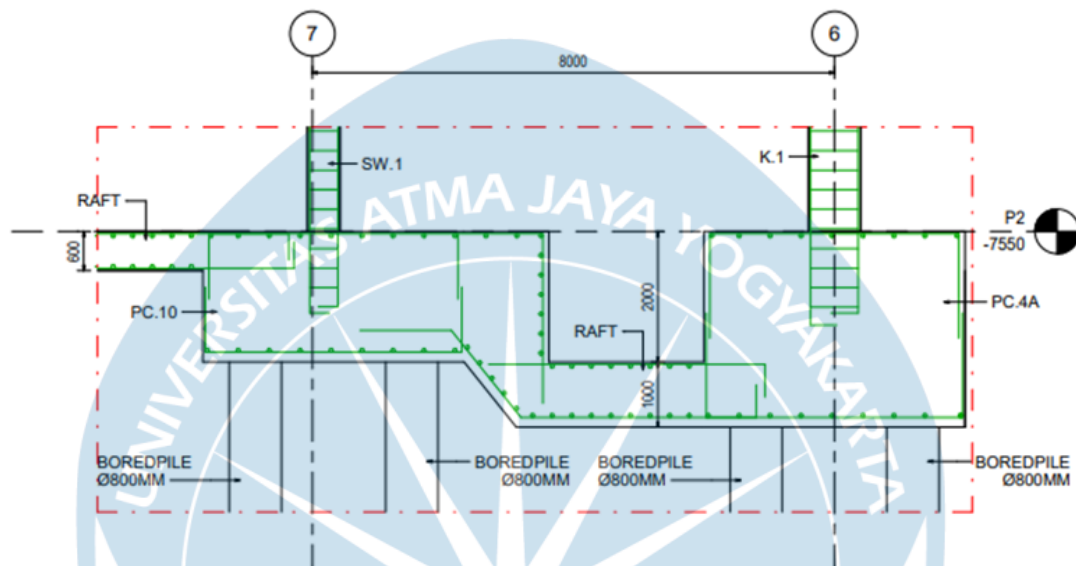


Figure 2. 16. Pit Lift Overview

Water proofing is the process of making a surface or building impermeable to water infiltration. This is a crucial component of construction, especially for damp-prone buildings such as restrooms, tunnels, roofs, and basements. The primary objective of

waterproofing is to avoid water entry since it protects the building's structural integrity and every component. There are several functions of water proofing such as:

1. Reducing Water Damage

The primary purpose of waterproofing is to provide a barrier that keeps water out of the building. Several problems, including as material degradation, reinforcing corrosion, and damage to interior coatings, can result from water intrusion.

2. Preserving the Integrity of Structure

Over time, water may erode a building's structural elements. Waterproofing techniques contribute to the lifespan of the structure by preserving the strength and resilience of structural components.

3. Stopping the Growth of Mold and Mildew

Mold and mildew thrive best in environments that are moist. Waterproofing makes the interior climate of a building more habitable by keeping microorganisms dry and barren.

4. Avoiding Flooding in Basements

Because they are located below ground, basements are especially susceptible to water penetration. By keeping the basement dry and habitable, waterproofing the walls and flooring helps reduce floods.

5. Improving Insulation of Structures

Water can affect a building material's ability to insulate. Waterproofing contributes to energy efficiency and occupant comfort by maintaining the thermal performance of insulation.

When constructing, a variety of waterproofing techniques are used to keep water out of the building. The type of structure, the room's planned purpose, the environment where it will be installed, and financial constraints all play a role in the waterproofing technology selection. There are several types of waterproofing used in this project such as:

1. Crystalline Integral Waterproofing

Concrete may be made waterproof by adding crystalline elements straight into the concrete mixture, a process known as "crystalline integral waterproofing." Non-soluble crystals are created inside the concrete matrix by these components reacting with water and cement hydration byproducts. The concrete's microcracks and capillary pores are filled with crystals, which lowers the material's permeability and

increases its resistance to water infiltration. Potassium silicate and other reactive compounds are included in crystalline materials, including some proprietary admixtures. These additions cause the water and non-hydrated cement particles in the concrete mixture to react, creating crystalline structures in the mixture.

The primary goal of crystalline integrated waterproofing is to make concrete more impervious to water infiltration by lowering its permeability. Concrete is successfully sealed against liquid penetration by the crystalline development. Nevertheless, the value of slump in the concrete remains unchanged by this kind of integral. Crystalline integral admixtures not only waterproof concrete but also enhance to its overall durability. The decrease in permeability aids in shielding the concrete from chemical erosion and freeze-thaw cycles, among other deterioration-causing factors. Crystalline integral admixtures are thought to provide a long-lasting waterproofing effect. The concrete structure's waterproofing qualities may get better with age as the crystals get larger and denser.

2. Coating Waterproofing

The process of coating waterproofing involves adding a waterproof sealant or coating to surfaces to prevent water intrusion. This method is frequently applied to protect a variety of building components, including foundations, walls, balconies, and roofs. The waterproof coatings provide a barrier that shields the surface from weathering and environmental exposure while also keeping water out of the system. There are several types of coating waterproofing such as:

1. Acrylic Coating

Water-based acrylic waterproof coatings are made of acrylic polymers. They come in liquid form and when applied to surfaces like walls and roofs, they produce a flexible, protective layer. Acrylic coatings may be applied outside and are resistant to UV rays.

2. Cementitious Coating

Cement, sand, and polymers are used to create cementitious waterproof coatings. When applied, they give surfaces like masonry and concrete a long-

lasting, breathable, and waterproof coating. Applications for cementitious coatings can be found both indoors and outdoors.

3. Polyurethane Coating

Elastomeric polyurethane waterproof coatings offer a flexible and long-lasting layer. They are frequently applied to decks, roofs, and other weather-exposed surfaces. Polyurethane coatings are resilient to temperature changes and provide good UV protection.

4. Silicone Coating

Silicone waterproof coatings offer superior UV protection and water resistance. They work well on a variety of surfaces, such as metal, stone, and roofing. Silicone coatings create a permeable barrier that keeps water from penetrating while allowing water vapor to escape.

Depending on the kind of coating and the surface to be treated, application techniques for coating waterproofing might include brushing, rolling, spraying, or trowelling. The success of coating waterproofing depends on good surface preparation since the coating requires a sound and clean substrate for optimum adherence. Furthermore, to obtain the required amount of waterproofing, certain coatings may require many layers.

2.2 Project Management

Project Management is a management system that controls every activity on project. This kind of system helps project on utilizing human resources effectively, including implementation of knowledge, skills, tools, and techniques. This system also creating smart strategies to improve the project's efficiency. There are four stages of Project Management which are Planning, Organizing, Implementation, and Supervision.

Planning is the first step on considering every aspect on the project to ensure that the progress is on time. This stage is the most important stage because of the implementation details include budget, time, resources, work safety, health, environmental conditions of site, and other risks. Organizing is the next stage which identifies responsibility of companies (Owner, Consultants, and Sub-Contractor) or individual that collaborates along with contractor on carrying out the project. After defining responsibilities, Implementation is stage were Planning needs improvement. In this stage the realization of Planning will be evaluated such as defining leader for

decision making in the future. Project Manager takes the responsibility of ensuring every work is done according to the budget and time plan. The Supervision stage is required to ensure that the project is completed according to the plan. Project Manager plays important role on ensuring that every progress is done according to the plan and making decisions if there are any changes arise.

- **Owner**

Novotel BSD Project is owned by PT. Serpong Green Hotel. PT. Serpong Green Hotel provides work and paying charges of the task to PT. Total Bangun Persada. The assigner of the first party in the contracting agreement and has the authority to take over the job being done unilaterally. By drafting a letter to the contractor if events occur outside of the contract as specified by law in the work agreement. Owner has responsibilities and duties as below :

1. Assigning service providers (consultants and contractor) for project implementation.
2. Providing facilities and infrastructure needed to contractor.
3. Requesting report periodically regarding work implementation that has been carried out by contractor.
4. Project owners meet once a week to review progress and problems in the project.
5. Directs and supervises the work of the internal contractor.
6. Receives monthly progress updates on work in the field from the construction service provider or contractor.
7. Owner should be capable to keep all construction partners in excellent communication.
8. If the project is finished according to the contract, owner will receive the outcomes of the work from the contractor service provider.

- **Consultants**

Consultant is company , firm, or person who provides consulting services and guidance in a specific sector. Civil consultant is professional who works in the service of civil industry to organize and develop project. They give structural, electrical, and mechanical blueprints, among other things. They often create all development plans, offer relevant opinions and ideas to meet development goals, and sketch precise designs that will be created. There are several civil engineering consultants that used for this project.

- **Structure Consultant**

Structure Consultant is a person or firm with knowledge, skill, and experience in building structure planning and design. It is the role of structural experts to assure the safety and efficiency of the projected building structure using applied regulation on each region. Novotel BSD is using PT. Cipta Sukses as their Structural Consultant. In the construction project, there are several responsibilities and duties of Structural Consultant as shown below:

1. Designing and analysing structure model by defining concrete reinforcements, dimensions for beam, column, slab, and many other aspects needed for construction. They were obligated to make sure that the design is designed using regulation applied in their region (Indonesia is using SNI as its construction regulation). This design must be efficient.
2. Structural consultant aids contractor in carrying out design so that the project owner's request fulfilled.
3. Creating For Construction drawings and Tender drawings for contractor guidance in building the structure.
4. Participating in regular meetings to comprehend project's progress or constraints that contractor faces in building the structure.
5. Supervise the project that has been carried out by contractor so it can be the same with the planning.

- **Architecture Consultant**

Architecture Consultant plays is a person or firm with abilities and expertise in creating architecture and interior designs. It is the role of architectural experts to create design using sketch as well as technology used in the building (architecture aspects). Novotel BSD is using Ferry Ridwan Arsitek as their Architecture Consultant. There are several duties and responsibilities carried out by Architecture Consultant as below:

1. Takes full responsibilities regarding to the architecture aspects in the project as requested by the project owner.
2. Collaborating with contractor in the project realization so it corresponds well.
3. Supervising the architecture progress that has been carried out by contractor to keep the progress in order with the planning.
4. Participating in regular meetings to comprehend and giving advice regarding to the progress or constraints that contractor faced.

- **Foundation Consultant (Vendor)**

Foundation Consultant is a firm with capabilities and experience in designing the foundation aspects for the building. Novotel is using PT. Geo Prima as their Foundation Consultant. There are several duties and responsibilities carried out by Foundation Consultant as below:

1. Before the project is started, they must observe the soil to define the type of soil that will support the building.
2. Designing the type of foundation used for the project.
3. Supervising the soil work conducted on the site.
4. Participating in meetings to comprehend and giving advice regarding to the progress or constraints that contractor faced.

- **Mechanical Electrical and Plumbing Consultant**

Mechanical Electrical and Plumbing Consultant is a person or firm that responsible with design and managing electrical and plumbing system based on the building design. Novotel BSD is using Meraya as their Mechanical Electrical and Plumbing Consultant. There are several duties and responsibilities carried out by Mechanical Electrical and Plumbing Consultant as below:

1. Designing and scheming electrical, mechanical, and sanitation for the building.
2. Ascertain the planning system for electrical, mechanical, and sanitation for the building is based on the owner's request.

- **Supervisor Consultant**

Supervisor Consultant is a person or firm with experiences to supervise so the progress is in accordance with the plan, time, and regulations. Novotel BSD is using PT. Kurniadi Rekajasa with choosing Mr. Sapta Handoko as their representative to supervise the progress of the project. There are several duties and responsibilities carried out by Supervisor Consultant as below:

1. Providing supervision in development and implementation of the project's progress regularly.
2. Providing suggestions for project owner and contractor to assure the progress can be achieved well.
3. Inspecting shop drawings that has been given by contractors as the guidelines for project implementation work.

4. Inspecting and checking material test such as concrete compression test, tensile strength test, and any other tests before the material is used for the project.
5. Assuring all members of contractor is working by procedure on the applied regulation.
6. Giving consent and set the agreement regarding specification proposed by contractor.

- **Contractor**

Contractor is a person or firm or company with skills, knowledge, expertise, and experience in building construction. After receiving the for-construction drawings from consultant, they will learn it and create shop drawing for the work implementation. Contractor is obliged on planning, project management, workers actual implementation, material, and maintenance. Contractor usually cooperates with Sub-Contractor for several works such as diggings works, foundation work (bored pile or spun pile), dewatering works, and many other works. Novotel BSD is using PT. Total Bangun Persada, Tbk as their Contractor. PT. Total Bangun Persada, Tbk creates their team or project management to manage the project. The team is shown as below:

- **Project Director**

Project Director is a person who oversees directing every department in the project, so the progress remains consistent. Project Director supervises each aspect in the project's progress from start until the end of the project. There are several duties and responsibilities carried out by Project Director as shown as below:

1. Directing, coordinating, and developing project systems.
2. Established project plan and procedure.
3. Coordinating with project manager regarding to project's progress.
4. Monitoring project schedule to ensure that project is accordance with S-Curve.

- **General Manager**

General Manager is a person who takes part on planning project and supervising project progress to maintain the progress in accordance with time and budget plan. General Manager also cooperates and coordinate partnerships, project progress, and resources needed on project. There are several duties and responsibilities carried out by General Manager as shown as below:

1. Supervising project progress from preparation of the project, project progress and its regulation on the implementation.

2. Coordinating project progress with Sub-Contractor and its workers.
3. Preventing constraints by creating planning and its solution.
4. Leading and managing human resources and time management properly.
5. Comprehend every single construction aspect needed in the project implementation.

- **Project Manager**

Project manager is a person who oversees project's progress from where it all starts until the end of the project's contract. Project manager is also obligated to core institution, the project including its team, and the project management. There are several duties and responsibilities carried out by Project Manager as shown as below:

1. Guiding team members in understanding vision and mission company, company regulations, quality standard, health management system, risk management, and goals stated by company for the project implementation.
2. Established goals and objectives for each member of the team so the progress is in accordance with the plan stated by the project owner.
3. Directing on resources management such as human resources, material resources, tools, and equipment so it can be used efficiently.
4. Preventing risks or constraints by observing every possibility that might occur and providing solutions or backup plan.
5. Evaluating every single progress that has been carried out by the project and creating final report.
6. Manage every complaint from project owner starting from the beginning of the project until its maintenance by carrying it out efficiently and finished it entirely.

- **Site Manager**

Site Manager is a person who manages every operational in site and progress implementation, so it is done on time with the contract. There are several duties and responsibilities carried out by Site Manager as shown as below:

1. Coordinating chores assignment in the site with project implementation guidance, so it will meet the quality, cost, and time requirements.

2. Checking construction aspects such as site preparation, materials, tools, and equipment based on weekly schedule to request permission for the project implementation.
3. Validate and verify every progress implementation is in accordance with quality standard agreed by Project Owner and PT. Total Bangun Persada, Tbk.
4. Implement and supervise work safety environment with K3L as the guidelines.
5. Participate in the internal auditing and external auditing as stated in the procedure.

- **Quality Supervisor**

Quality Supervisor is a person who oversees by making sure that the implementation of the project qualifies the standard that has been stated by the project owner. There are several duties and responsibilities carried out by Quality Supervisor as shown as below:

1. Supervising every progress made in the site from the starting off until it done according to the work methods.
2. Examining and inspecting on every result carried out by Sub-Contractors.
3. Identify quality and collaborate with team project implementation on achieving solutions.
4. Checking material stocks, tools, equipment, and human resources from Sub-Contractors.
5. Inspect and creating reports regarding to quality for project owner and project management.

- **Surveyor**

Surveyor is a person who measuring, mapping, and monitoring project's progress. Surveyor carried out responsibilities in ensuring that the progress is done accurately and in accordance with the plan. There are also several duties and responsibilities carried out by Surveyor as shown as below:

1. Measuring every necessary aspect as the fundamental aspect quality regarding to the plan specifications.
2. Calibrating measurement tools such as GPS and theodolite regularly.
3. Defining project location, land surveying, marking for project's borderline and position.

4. Inspecting every floor level regularly using measurement tool such as theodolite.
5. Implementing Shop Drawing into the site by learning the condition of the site to achieve the accurate measurement.

- **Mechanic**

Mechanic is a person who performs things such as resolve, maintenance, and machine reparation and preserve project's efficiency. There are several duties and responsibilities carried out by Mechanic as shown as bellow:

1. Maintain every project's tool and equipment in top performance.
2. Arrange tools and equipment permission.
3. Inspecting and Maintaining tools and equipment to qualify the work safety standards.
4. Analysing every possible constraint of tools and equipment and developing solutions for each problem that might occur in the future.

- **HSE Supervisor**

HSE Supervisor is a person who takes responsibility for health, safety, and environmental conditions qualify the standards and regulations applied. Safety work environment is an important factor that must be observed by HSE Supervisor. There are several duties and responsibilities carried out by HSE Supervisor as shown as below:

1. Assuring and preventing every accident possibility to create safety work environment.
2. Putting up safety fences and putting up warnings in places where there are dangers or when project activities are disrupted.
3. Conduct audits and routines at project locations to ensure that each method of work is carried out in a safe and efficient manner.
4. Increasing workplace safety through decreasing the risk of conflict and ensuring the safety of project workers from outside sources.
5. Inspect the use of work safety equipment such as project helmets, vests, safety shoes, and so on while entering the project area.

- **Site Engineer**

Site Engineer is a person who manage technical aspect such as creating Shop Drawings based on the For-Construction Drawings and site condition. Site Engineer is also solving technical changes that might occur or occurred on the site, so the progress

is accordance to the plan and finished on time. There are several duties and responsibilities carried out by Site Engineer as shown as below:

1. Preserving progress made on the site to achieve the quality standards requirement.
2. Assuring that the design of the work is in accordance with the specifications and dimensions.
3. Creating S-Curve based on the realization that has been made on the project and creating weekly report to submit it to the project Owner and Project Manager.
4. Identifying every problem that might occur on the project and creating solutions, so the progress is on the track and qualify the quality standards, specifications, and dimensions requirement.
5. Managing every change that might occur based on the newest request from project Owner and applying it to the project.
6. Inspecting site regularly to ensure that the progress is done according to the newest shop drawings.

- **Drafter**

Drafter is a person who oversees on creating the Shop Drawings for project implementation. Drafter plays a crucial role in ensuring that all engineering components of the project execute effectively and according to requirements from design to implementation. There are several duties and responsibilities carried out by Drafter as shown as below:

1. Generate Shop Drawings following the Site Engineer's directions.
2. Defining and clarifying the For-Construction Drawings by architects and consultants in further depth.
3. Coordinate and explain the work outcomes and drawings with project design stakeholders.
4. Gather For-Construction drawings, Shop Drawings, and other drawings from the beginning until the end of the project.

- **BBS**

Bar Bending Surveyor is a person who oversees on creating the Shop Drawings for project implementation. Bar Bending Surveyor performs role in preserving structural integrity of reinforced concrete constructions and avoiding internal mistakes

in fabrication cutting of the reinforcement. There are several duties and responsibilities carried out by Bar Bending Surveyor as shown as below:

1. Establish and arrange reinforcing steel work implementation programs.
2. Oversee and monitor the progress of field reinforcement work to ensure that it complies with appropriate technical standards and specifications.
3. Conduct inspections and assessments of BBS implementation outcomes in line with design plans and project specifications.
4. Prepare a list of steel reinforcement needs based on the For-Construction drawings created by consultants.

- **Commercial**

Commercial is someone in the role of overseeing the commercial or business elements of the project. Commercial serves in providing project business continuity and ensuring that everything works effectively, according to the contracts, and met the financial targets. In this project, Quantity Surveyor is part of commercial. There are several duties and responsibilities carried out by Commercial as shown as below:

1. Contract management include reviewing and comprehending project contracts, including terms, restrictions, payment schedules, and contractor duties.
2. Coordinate the acquisition of materials, equipment, and manpower projects as needed, while minimizing costs.
3. Connect with subcontractors and other service providers to ensure that work is completed in accordance with the schedule.
4. Monitor and control money expenditure and receipts, as well as project finance reports by controlling the implementation works on the site.

- **Buyer**

Buyer is a person who oversee and arrange the purchase of all supplies, equipment, and other resources needed for the project. Buyers perform an essential role in ensuring that project supplies are ready on time, met the requirement amounts, and within the project budget. There are several duties and responsibilities carried out by Buyer as shown as below:

1. Negotiate with suppliers to secure competitive rates and to guarantee that delivery and payment conditions meet project needs.

2. Create contract processes with suppliers, such as defining contract specifications, delivery schedules, and payment conditions.
3. Controlling procurement expenses to stay within the project budget and reporting any cost variances.
4. Handling any claims or issues that may emerge throughout the procurement process, such as late delivery or flawed items.

- **Stock Keeper**

Stock Keeper is a person who oversees on maintaining, regulating, and monitoring inventory or stock of project supplies, equipment, and resources. Stock Keepers perform an essential part in keeping the project on track by ensuring that supplies of materials and equipment are constantly accessible and in excellent shape. There are several duties and responsibilities carried out Stock Keeper as shown as below:

1. Receive, inspect, and document the arrival of commodities or building supplies at the project site.
2. Maintaining that inventory is always sufficient to fulfil project demands; if stock is running low, order more supplies or equipment.
3. Examine the quality of the items received to verify they fulfil the requirements and specifications.
4. Managing stocks and ensuring the safety of the stocks due to keep the quality of the stocks in good condition.

- **General Affair**

General Affair is a person who is in control of an area of administrative, personnel management, and operational support essential to keep project implementation running efficiently and conveniently. There are several duties and responsibilities carried out by General Affair as shown as below:

1. Oversee the project's overall internal management, including staff and administration, as well as external relations.
2. In the case of a major accident or fire in the project environment, develop and guarantee the availability of project safety plans, and maintain communication with authorities.
3. Ensure that the project conforms with all applicable rules and permissions, such as environmental permits, construction permits, and so on.

- **Administrator**

Administrator is a person who overseeing administrative activities and administration to ensure efficient project operations. Administrator performs an essential role in organizing and supervising diverse. Administrator also assists on meeting the project objectives efficiently. There are several duties and responsibilities carried out by Administrator as shown as below:

1. Archive critical project papers such as contracts, permits, and project reports.
2. Archive drawings such as Shop Drawings.
3. Providing meeting spaces and arranging consumption during meetings to ensure the effective conduct of meetings.
4. Arrange the facilities needed for project operations, such as office space and team housing.

- **Cashier**

Cashier is a person who oversees of transaction management project finance, managing the financial parts of the project, ensuring that payments are received on schedule, and maintaining financial records to ensure that the project is running smoothly. There are several duties and responsibilities carried out by Cashier as shown as below:

1. Track and handle all payments to subcontractors, suppliers, and vendors involved in the project.
2. Evaluate the project budget and check that every expense is within the limits of the budget.
3. Providing financial data and information for audits and project financing.
4. Ensure that all financial transactions and financial reporting are in accordance with applicable financial laws, regulations, and tax responsibilities.
5. Generate project financial reports, such as profit and loss statements, balance sheets, and cash flow, to offer information on the financial performance of the project.

- **Security**

Security is a person who in charge of the project's security, monitoring, and protection, including the people, assets, and facilities engaged in the project. There are several duties and responsibilities carried out by Security as shown as below:

1. Provide visitors to the project with safety guidelines, including the usage of personal protective equipment (PPE).
2. Inspect all incoming individuals and vehicles entering the project.
3. Creating weather monthly report.
4. Handling security issues or accidents on construction sites involves providing first aid and reporting instances to authorities.

Based on the description above, the structural organization of the Novotel Hotel BSD can be seen as above in the Figure 2.17.

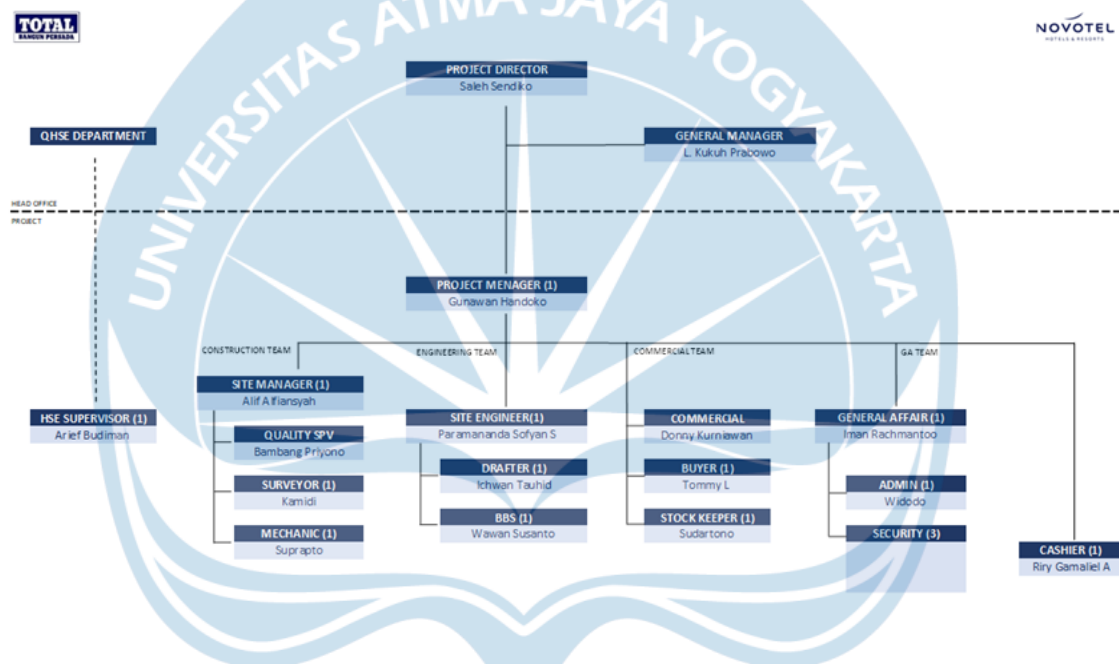


Figure 2. 17. Structural Organization of Novotel Hotel BSD Project

2.3 Internship Project Implementation

Site Engineer is a person who manages technical aspects such as structural aspect and architectural aspect. The role of a site engineer is crucial to ensuring that the construction project is completed in accordance with the design specifications, within budget, and on time. Site engineers oversee resources, communicate with various stakeholders, and address any technical issues that may arise during construction. In this project, author was assigned to do several jobs as shown as below:

- **Mat Foundation Application**

Novotel BSD is using Mat Foundation as their foundation to support the building. Mat foundation is a kind of foundation that is used to disperse a building's weight over a

substantial portion of the ground. It is a slab of reinforced concrete that covers the whole building's footprint and serves as support for the walls and columns. Mat foundations are especially well suited for big, heavy structures with loads that are dispersed widely and are rather considerable. A mat foundation's thickness is normally consistent. However, it might change depending on the soil's properties and structural needs. Having enough rigidity and strength to support the imposed loads is the aim. Mat foundations are frequently utilized in heavy-weight or poorly-soil constructions, high-rise buildings, and industrial buildings. In this project, the volume for the concrete casting is at 4018 m³ for raft foundation itself and for the pile cap. As Site Engineer, we are creating the application for the Mat Foundation based on the site condition. Before the Mat Foundation was started, inspecting batching plan and creating documentation is needed. After that, we can continue on creating Mat Foundation implementation planning. Creating Mat Foundation report which includes the specification of the Raft Foundation, details (thermocouple details, trowel and finishing mapping, tents for covering the concrete casting progress), concrete casting implementation steps, curing method, flow of the truck mixer, calculation for truck mixer needed and the duration estimation, example for test sample identification, flow of the TM for the concrete casting with the explanation for each post, creating google form for data recapitulation, and creating spreadsheet for Mat Foundation duration, and participate on the Mat Foundation implementation. Everyone has their own job desk at their own station or post. The documentation of the slump and temperature check can be seen in Figure 2.18.



Figure 2. 18. Slump and Temperature Check

- **Assisting in Tower Crane (Tie-In) Shear Strength Calculation**

One kind of construction crane that is frequently used in civil engineering and building projects to lift and move large things is the tower crane. Tower cranes are an essential tool for constructing tall skyscrapers and other large-scale structures because of their extraordinary height, reach, and lifting capacity. These cranes typically rise vertically from the building site and are attached to the earth on a concrete foundation. The span of the tower crane in this project is approximately 70 meters with the angle rotation is at 360 degrees.

This project is using tower crane with a tie holding the framework structure of the crane to ensure the safety of the crane itself. Tower crane specification of this project is using BJ-37 for the steel structure profile with $f_y = 240 \text{ Mpa}$ and $f_u = 370 \text{ Mpa}$. Dead load for the crane itself is at 7.85 ton/m^3 and for live load is assumed to be sufficient due to the loading itself is only caused by the operator of the tower crane. The shear ultimate given from the tie-in of the crane (data is based on SAP 2000) is at 592.088 kN. The calculation can be seen in the Figure 2.19 and the view of the tie-in of the tower crane can be seen in Figure 2.20.

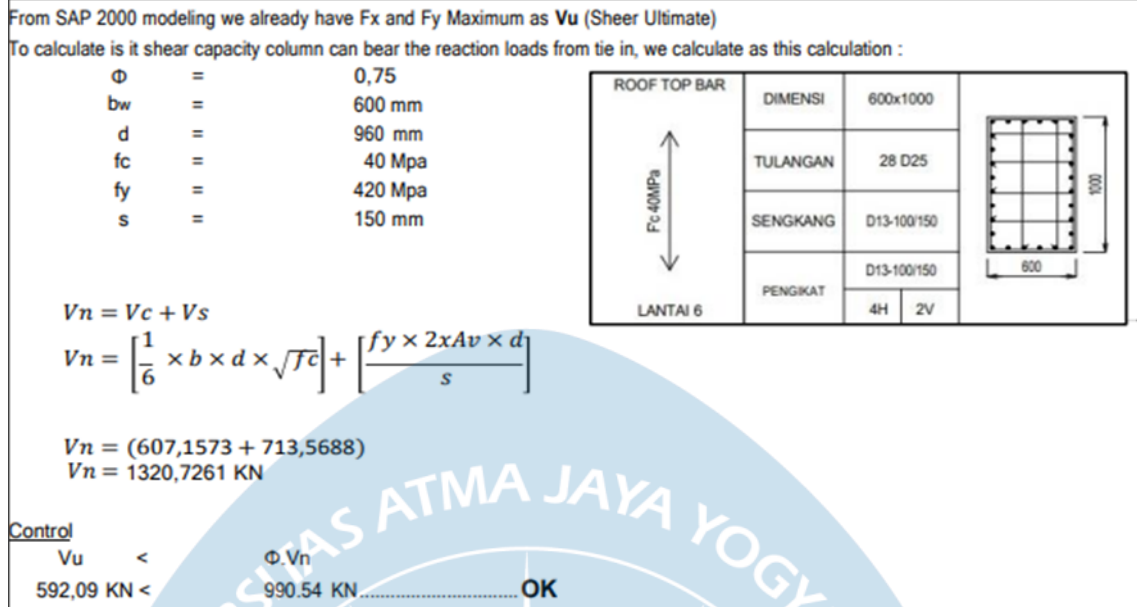


Figure 2. 19. Tower Crane Tie-In Calculation

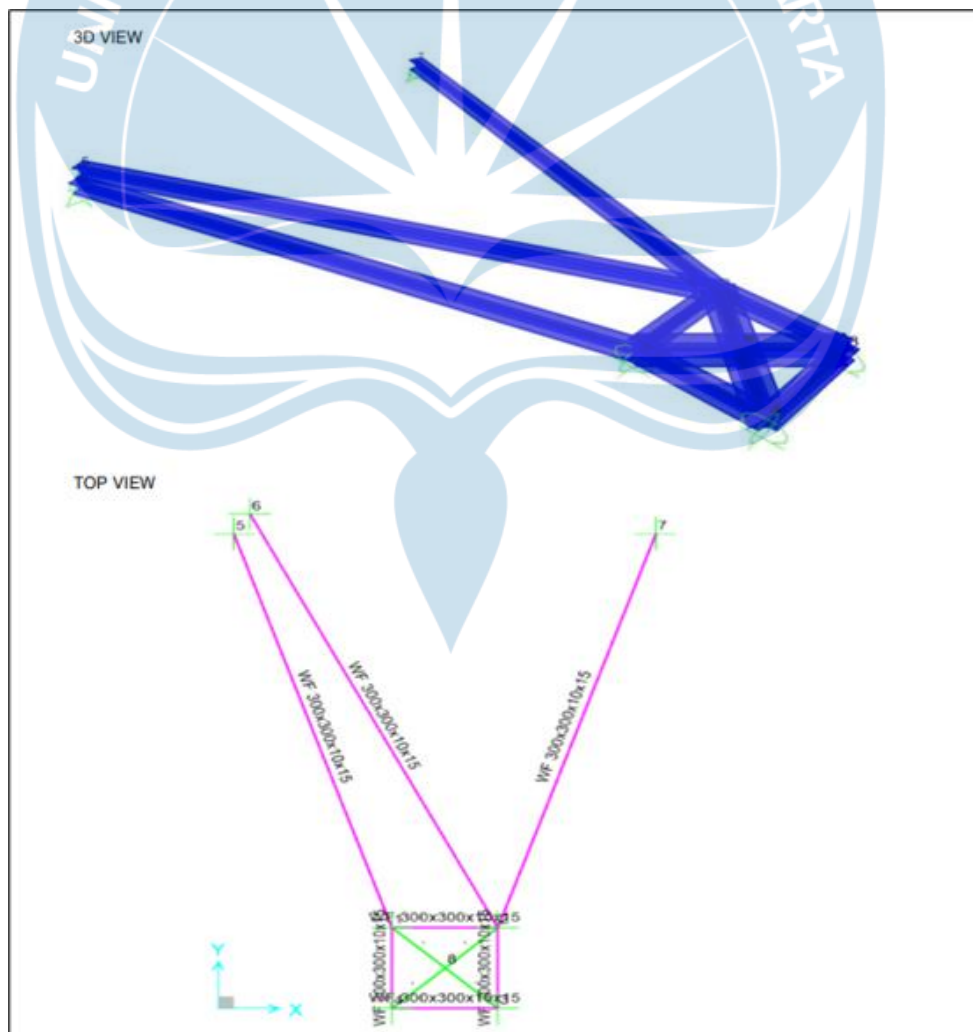
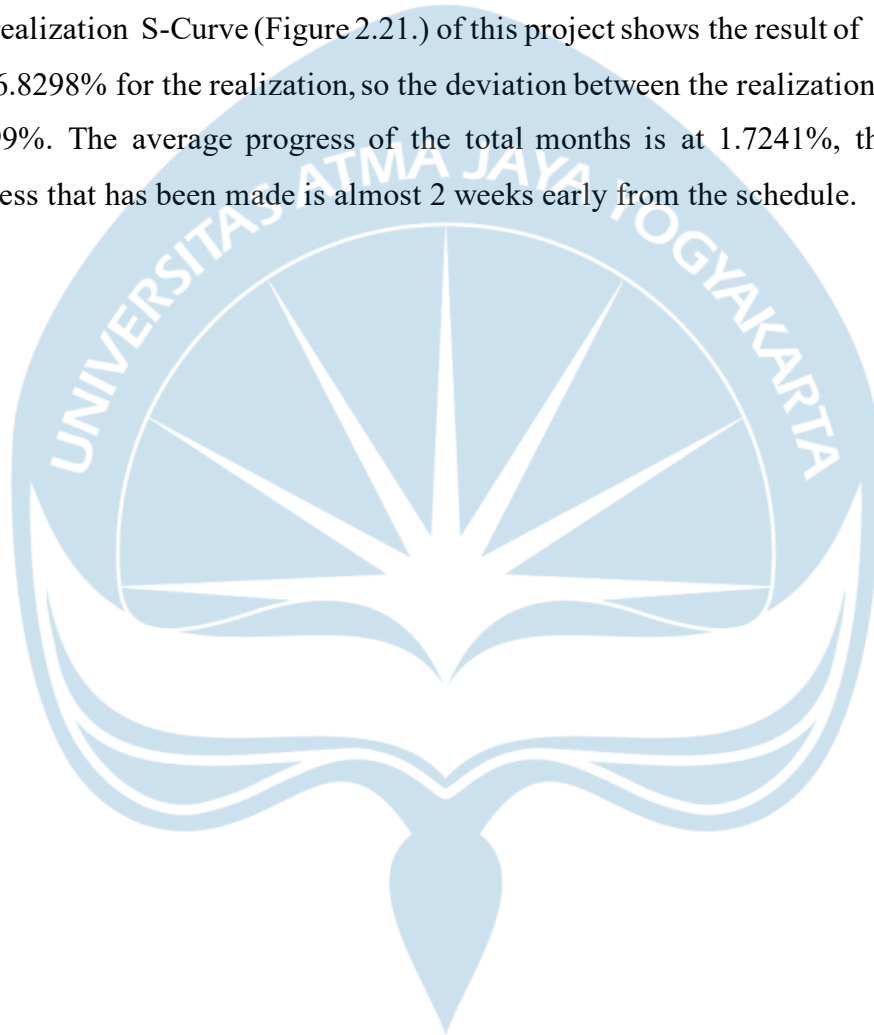


Figure 2. 20. Tower Crane Tie-In Drawing

- **S-Curve Internal and Realization Progress**

S-Curve is a tool used as guideline for project on making progress. S-Curve is also used as scheduling, actual analysis, and risk management for the progress. By creating the realization progress and the internal progress, the potential risk, delays, and early can be seen. Therefore, the next step for risk management can be taken based on the comparison of the realization and the internal S-Curve. The visualization of the internal and realization S-Curve (Figure 2.21.) of this project shows the result of 53.729% with the 56.8298% for the realization, so the deviation between the realization and plan is at +3.099%. The average progress of the total months is at 1.7241%, this means the progress that has been made is almost 2 weeks early from the schedule.



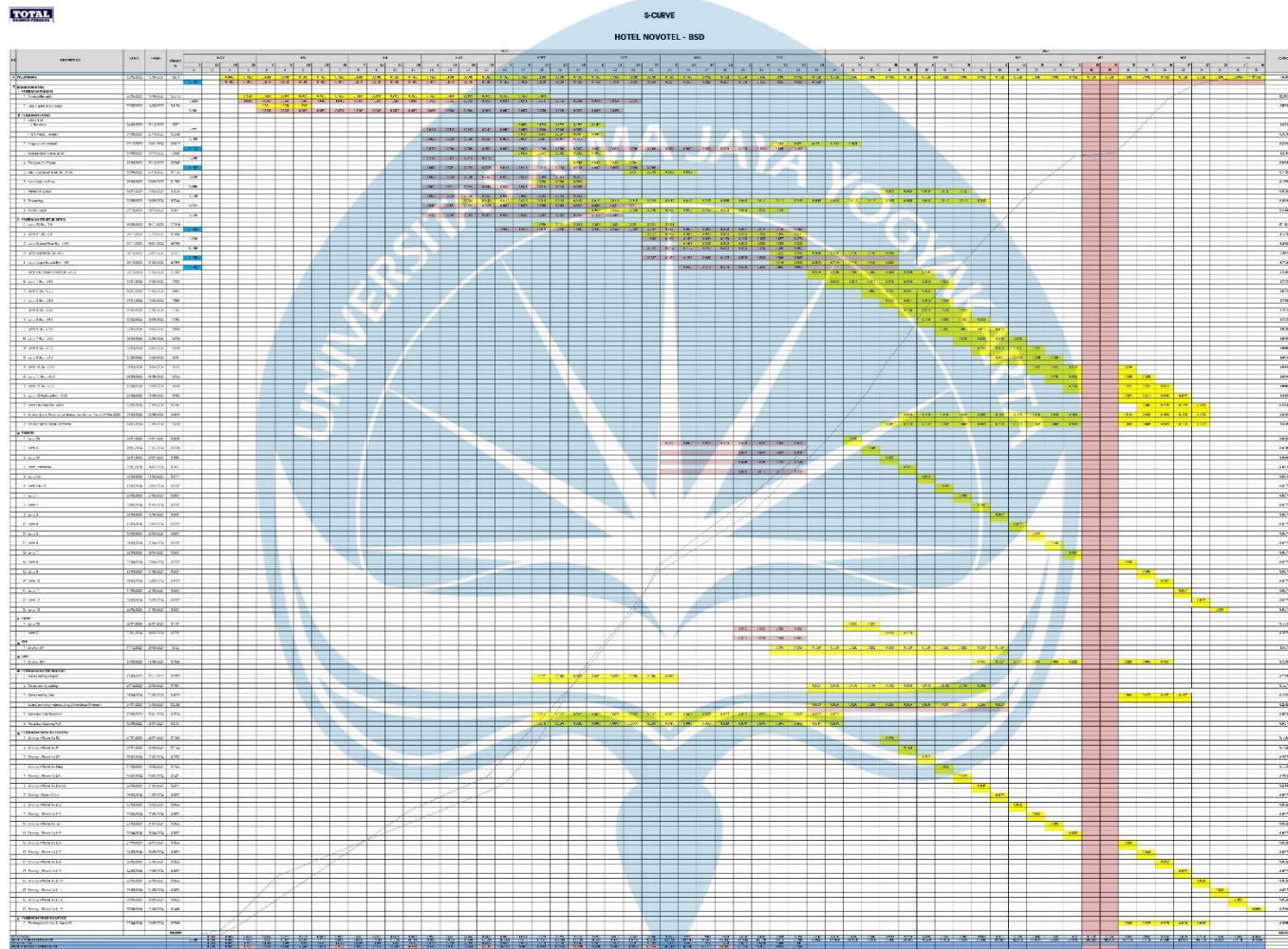


Figure 2. 21. S-Curve Internal and Realization Progress

- **Weekly Progress Report**

A construction project's progress report is a detailed summary of the project's current state and future directions. It acts as a medium for communication between the client, project manager, engineers, contractors, and other relevant parties. Throughout the course of the project, the progress report is usually prepared on a weekly, monthly, or other defined milestone basis. Depending on the details of the project, the report's content may change. Project needs to give report to the headquarters due to the progress on the site. This report can be reported weekly and monthly. This weekly report consists of works that has been on the site, the comparison of plan progress percentage and realization progress percentage with the gap of those percentages, and the documentation of each progress that has been made.

- **Mapping for Basement 1 and Top Of Wall (TOW) Basement 1**

The practice of drawing intricate schematics or pictures of the physical traits and features of a specific piece of land is known as mapping. These depictions, which are sometimes referred to as maps, offer crucial data for organizing, creating, and constructing civil engineering projects. To gather and display spatial data regarding a place's topography, infrastructure, and environmental conditions, civil engineers employ a variety of mapping techniques. The concrete casting quality needs to be checked to know the defect occurred on the site and how to solve and fixed the defect itself. The top of the wall (highest point of a wall) of each basement also needs to be checked again to prevent the improper information between the site engineers and the supervisor on the site. These changes can be caused by the request from the owner regarding to the level of the floor.

- **Checking and Fulfilling Thermocouple Data**

In contractor, thermocouples are frequently used to measure temperature for a range of purposes. The functioning of thermocouples, which are temperature sensors, is based on the Seebeck phenomenon, which describes how a temperature disparity between two different metals or alloys causes a voltage to be formed. The voltage that is produced is directly impacted by the temperature differential.

The thermocouple data needs to be checked on time. This is required to know the differentiate between the temperature in the concrete and the temperature outside of the concrete. There are three thermocouples located in the concrete, the first one is at the bottom of the concrete, the second one is at the middle of the concrete, and the third one

is located at the upper of the concrete. The data was taken using the timeline as shown in Figure 2.22.

No	Tanggal / Jam	Atas T1	Tengah T2	Bawah T3	Δ1 (T1-T2)	Δ2 (T2-T3)
1	10/04/2023					
	17:00:00	78.6	81.5	71.1	7.9	10.4
	19:00:00	77.4	80	69.4	2.6	10.6
	21:00:00	76.3	81	69.8	2.7	11.2
	23:00:00	77.4	79.3	68	1.9	11.3
2	10/05/2023					
	01:00:00	77.3	79.6	68.2	2.8	11.4
	03:00:00	77.2	79.2	67.6	1.6	11.6
	05:00:00	78.4	80.1	68.4	1.7	11.7
	07:00:00	76.8	78.6	66.9	1.8	11.7
	09:00:00	76.2	77.8	65.7	1.6	12.1
	11:00:00	75	76.3	64.4	1.3	11.9
	13:00:00	76.3	77.5	65.2	1.2	11.8
	15:00:00	78.1	79.5	65.2	1.6	14.2
	17:00:00	78.5	79.9	65.3	1.2	14.2
3	10/06/2023					
	11:30:00	75	75.1	62.9	0.1	12.2
4	10/07/2023					
	11:30:00	73.6	73.8	61.1	0.2	12.7
5	10/08/2023					
	11:30:00	70.5	71.0	58.8	0.5	12.2
6	10/09/2023					
	11:30:00	68.7	70.2	57.9	1.5	12.3
7	10/10/2023					
	11:30:00	64.7	63.6	57.6	1.9	11

Figure 2. 22. Thermocouple Data

- **Site Inspection**

Site inspection is a crucial practice that involves the physical assessment and appraisal of a construction site or an existing structure. Obtaining accurate and comprehensive information about the site's condition, identifying any potential issues or hazards, and ensuring that any construction or maintenance activities adhere to safety rules, engineering specifications, and legal requirements are the key objectives of a site inspection. The author visually inspects the site to keep track of the present circumstances and the state of the construction. Site inspections are crucial to ensuring the quality, safety, and compliance of construction projects. Because they aid in the early detection and resolution of issues during the building phase, they are crucial to the overall performance and durability of civil engineering projects.

- **Batching Plan Inspection**

A concrete batching plant is a location where different materials are combined to create concrete. The process of batching or mixing various components to generate concrete is referred to as a "batching plant". Typically, these components include of cement, water, aggregates (such sand and gravel), and additives (if necessary). To guarantee that concrete is produced with the appropriate consistency, strength, and quality, the batching plant is essential. Aggregate of various sizes and kinds is usually stored in many bins in batching plants (sand, gravel, crushed stone). According to the specifications of the mix design, aggregates are apportioned. The cement, an essential component of concrete, is kept in cement silos. Depending on the amount of cement used and the production capacity, the batching plant may include one or more cement silos. In batching plants, water is dosed and kept in tanks so that it may be used in the concrete mix. The hydration process of the cement requires water. In addition to the water tank, there is an admixture storage tank. Additives are occasionally added to the concrete mix to improve workability, setting time, or durability. The additives are kept in tanks and added to the mixture as needed. At the Merak batching facility, electronic control systems automate the batching process. The control system ensures accurate material proportioning, monitors the mixing process, and allows adjustments to meet specific mix design requirements. After the concrete is mixed, a truck mixer or other means of transportation is used to deliver it to the construction site. There may be facilities at batching plants for putting concrete onto trucks.

- **Learning Leadership and Project Management on Site**

In the discipline of civil engineering, leadership is essential to project success and the sector's general growth. Leaders in civil engineering oversee managing teams, formulating strategic plans, and guaranteeing that projects are successfully completed on time and within budget. In the field of civil engineering, effective leaders inspire and encourage their workforce. They create cohesive teams that strive toward shared objectives, promote professional growth, and create an atmosphere that is creative and cooperative. Every division in the contractor has team of its own. Site engineers have bar bending schedule and drafter as one team. Therefore, a site engineer needs to have good communication and know characteristics of each personality of their team to smooth out their teamwork. Site engineers, site managers, and commercial need to work together as one to build the project. In this case, good communication is needed to avoid improper

information for each division. The learning is using the book of “*Kepemimpinan dan Kerja Sama dalam Dunia yang Kompetitif*” (Figure 2.23).

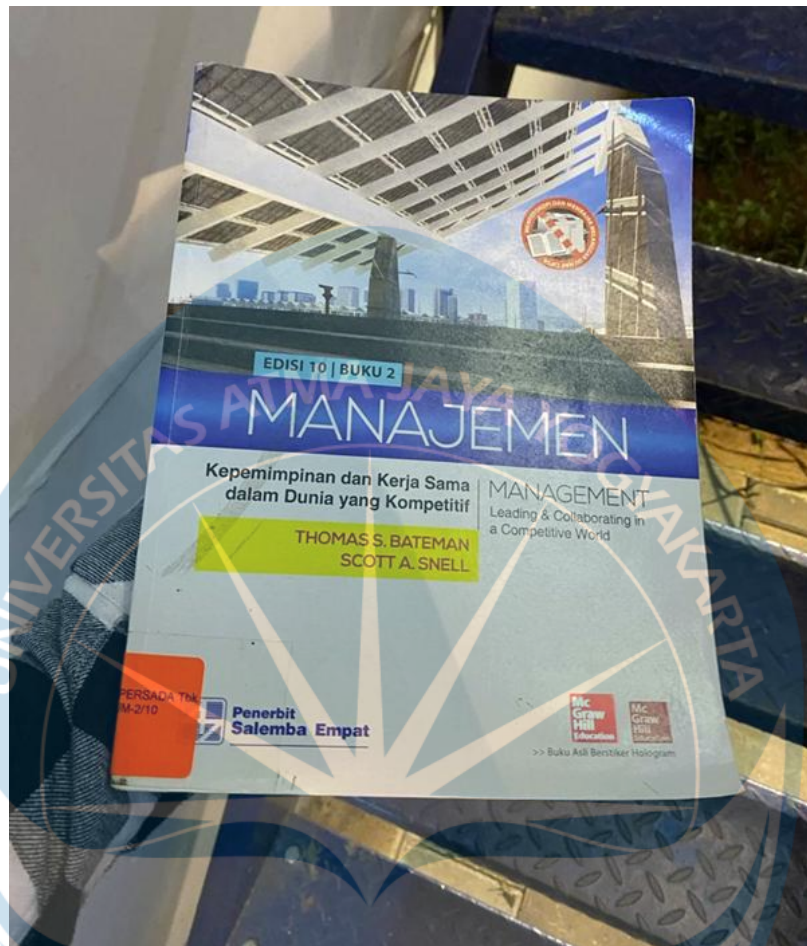


Figure 2. 23. Leadership and Project Management Guide

- **Participating Compressive and Tensile Strength Test and Permeability Test**

Concrete and reinforcement must be checked for the strength and the permeability. Compressive and tensile strength tests are common laboratory methods used to determine the mechanical properties of materials. These tests provide vital information for material selection and structural design by assisting in the determination of a material's ability to support axial loads in either compression or tension. Every 40 tons of reinforcement will be taken 4 samples, 3 samples will be tested for tensile strength test (Figure 2.25) and 1 sample will be tested for compression strength test (Figure 2.24).



Figure 2. 24. Compressive Strength Test



Figure 2. 25. Tensile Strength Test

Testing for concrete permeability is done to determine how well concrete can keep liquids like water and other harsh materials from penetrating into its interior. Concrete's permeability is an important characteristic since too much permeability can cause problems with durability, such as the concrete itself degrading and the reinforcing steel corroding. The permeability of concrete may be measured using a variety of test techniques, one of which is the "permeability test". Permeability test (Figure 2.26) was held to ensure that the concrete will not leak once it's applied on the site.



Figure 2. 26. Permeability Test

- **Mapping Floor Slab**

A concrete defect is any unfavourable or peculiar condition, flaw, or imperfection in a building that might affect its durability, functioning, or visual appeal. Many factors, such as poor construction, inferior materials, unfavourable environmental conditions, faulty designs, or a combination of these, can lead to concrete difficulties. If structures are to be strong and durable, concrete flaws must be identified and corrected.

Basement 2 is casted by using the Mat Foundation principle. This means that the concrete of pile cap and raft foundation are casted monolithically. Because of it, the quality of the concrete must be checked to determine rather there is defect or not. Usually, this kind of checking is held to evaluate the method of Mat Foundation by PT. Total Bangun Persada as its reference for next project.

- **Assisting on Architecture Specification for Tender**

The procedure by which builders submit bids or proposals for a construction project is called a tender. The official, competitive tendering procedure is how clients or project owners choose a contractor to do the construction job. Tenders for the Novotel BSD hotel development project was conducted in a closed tender process. The owner appointed PT. Total Bangun Persada as the prime contractor to complete the construction of Novotel BSD. The project owner selects PT. Total Bangun Persada as the primary contractor due to the company's extensive experience and bids that live up to expectations.

The owner chose PT. Total Bangun Persada as the contractor which will handle the architectural work, nevertheless PT. Total Bangun Persada must submit architectural tender. The specifications of each floor are listed to determine the works that will be held and the goods for the architectural work.

- **Mapping The Architecture Equipment Tender for Each Floor of Building**

Mapping is the process of creating detailed schematics or illustrations of the physical characteristics and features of a particular area of land. These representations, which are often called maps, provide important information for planning, designing, and building civil engineering projects. Civil engineers use a range of mapping techniques to collect and present spatial data about the terrain, infrastructure, and environmental conditions of a location. After defining the specifications for the tender, the specifications are mapped on the AutoCAD. This helps the commercial team on creating the bill quantity of things needed for the architectural tender.

- **Learning on How to Check Beam Dimension between For-Construction Drawings and Shop Drawing**

Verifying the measurements of civil engineering drawings is necessary for building. To guarantee that the produced objects fulfil safety, functional, and legal criteria in addition to their intended purpose, precision in measurements is crucial. Verifying the dimensions guarantees that the built components correspond with the

designer's intention. It is beneficial to confirm that the measurements given in the drawings are precise and adhere to the project's design guidelines. To maintain the structural integrity of a building or infrastructure project, precise measurements are required. For loads to be sustained and pressures to be resisted in line with the plans of the structural design, structural components must have the proper size.

Beam dimension in For-Construction drawings and Shop drawings need to be checked. For-Construction is a group of detailed, accurate drawings providing the information needed for the actual building or execution of a project. These drawings serve as a guide for the project's builders, contractors, and other construction specialists and are a crucial component of the building documentation. The construction drawings, which are often created by engineers, architects, or other design specialists, are used to communicate the design intent to those responsible for carrying out the building activity. The Shop drawing is made based on the site condition. Therefore, the dimension needs to be checked.

- **Creating Drawings for Temporary Office**

Since the site office from of the PT. Total Bangun Persada is only temporary, the drawings (Figure 2.27) of the site office need to be made. The drawings are for report because the site office location is rented by someone else.

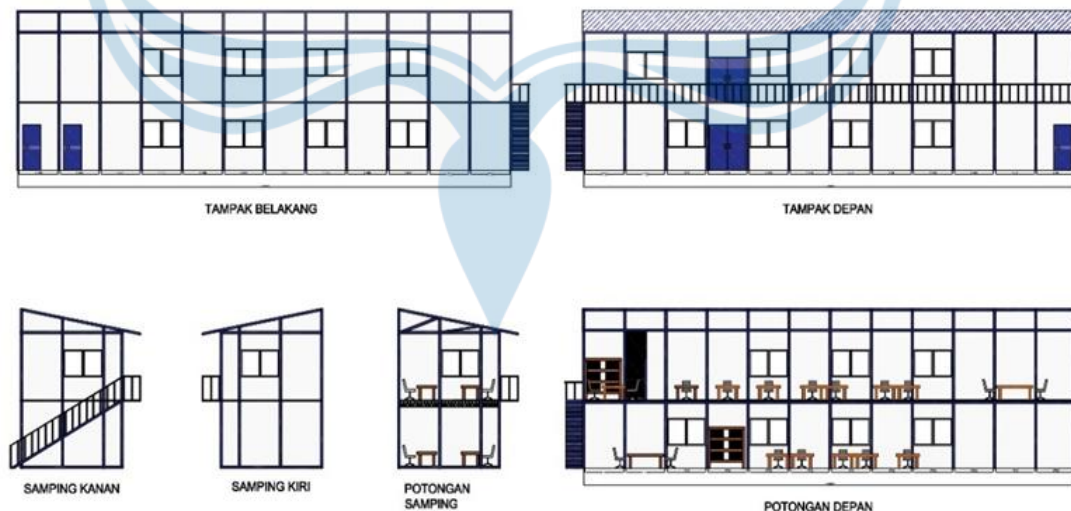


Figure 2. 27. Temporary Office Drawing

- **Meeting with Owner, Structure Consultant, and Architectural Consultant**

Meetings with owner and consultants are necessary regarding to the changes request from the owner. Therefore, to fulfil the owner request, contractor and consultant needs to discuss with the owner (Figure 2.28).



Figure 2. 28. Meetings on December 18th ,2024

2.4 Technical Study Based on Subject

- Mat Foundation Method

This technical study is based on Construction Method and Heavy Weight Equipment subject. The methodical procedure or strategy utilized to create a building, infrastructure, or any other structure is referred to as a construction technique. The term "construction methods" refers to a broad category of practices, strategies, and actions used in the project planning, design, and implementation phases. Numerous variables, such as project specifications, site circumstances, financial limitations, and resource availability, have an impact on these techniques.

The raft foundation concrete casting method in PT. Total Bangun Persada Tbk is usually called Mat Foundation Method. The raft foundation is casted monolithically with the pile cap and the beams of basement 2. The specification for the raft foundation is

shown as below. The method for concrete casting for this raft foundation is using the mass concrete with only 1 zone for the casting.

Table 2. 4. Raft Foundation Specifications

Properties	Unit
Compressive Strength (Raft, Pile Cap, and Tie Beam)	35 Mpa
Slump	14 + 2
Waterproofing Integral	Ex Pentens T-308 2.5 kg/m ³
Waterstop	Hydrophibic Ex Pentens
Max Degree	38 ⁰

One type of foundation that is used in building construction is the raft foundation, which distributes the weight of the structure across a greater area of the ground. It is a large, robust slab that almost "floats" on the earth, bearing the weight of the whole building. Raft foundations are commonly used in areas where differential settling is a problem or when the soil carrying capacity is low. One characteristic that sets raft foundations apart is a continuous reinforced concrete slab that extends beneath the whole building footprint. Typically, the slab is thick and level to distribute the weights uniformly across the underlying soil. This project is using pile raft foundation as the foundation (Table 2.4). This raft foundation distributes the load uniformly.

The raft foundation in this project is using different thickness for each zone. The podium zone is using the thickness of 600 mm (red) and for tower zone of this project is using the thickness of 1000 mm (blue). The plan for raft foundation in this project is shown in Figure 2.29.

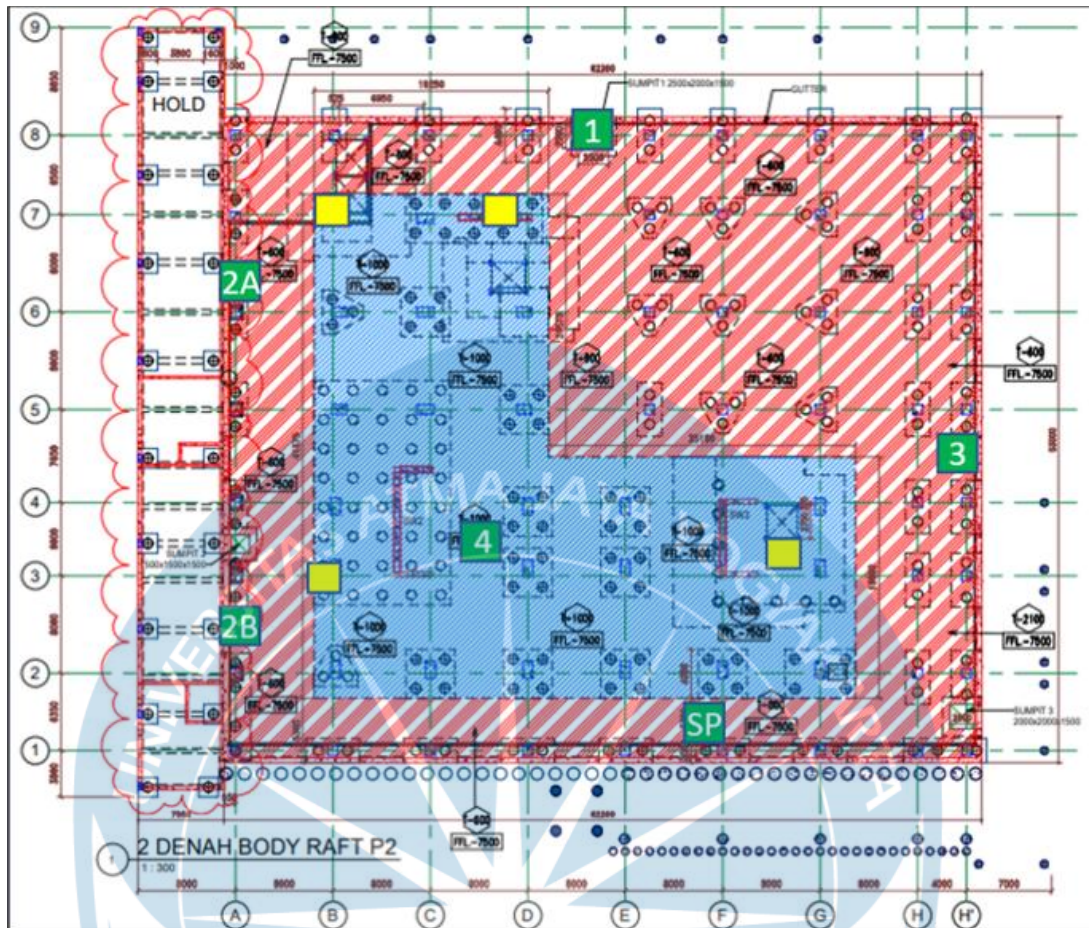


Figure 2. 29. Raft Foundation Plan

Thermocouple is used in this method to check the difference between the temperature of bottom concrete and the upper concrete casted. Based on the ACI 116 R the regulations for temperature checking are every 2 hour the data is collected for the first day, for the second day the data is collected for every 3 hours, and for the third day the data is collected every morning at 11.30 am.

The raft foundation method started after 8 truck mixers arrived at the concrete pump. The concrete pump needs to be given mortar to smooth out the concrete pump for the casting. The supervisor charged at concrete pump needs to check at the edge of the pipe to make sure the mortar is already out from the pipe.

The flow for the truck mixer (Figure 2.30) is already created to smooth out the process for the casting.

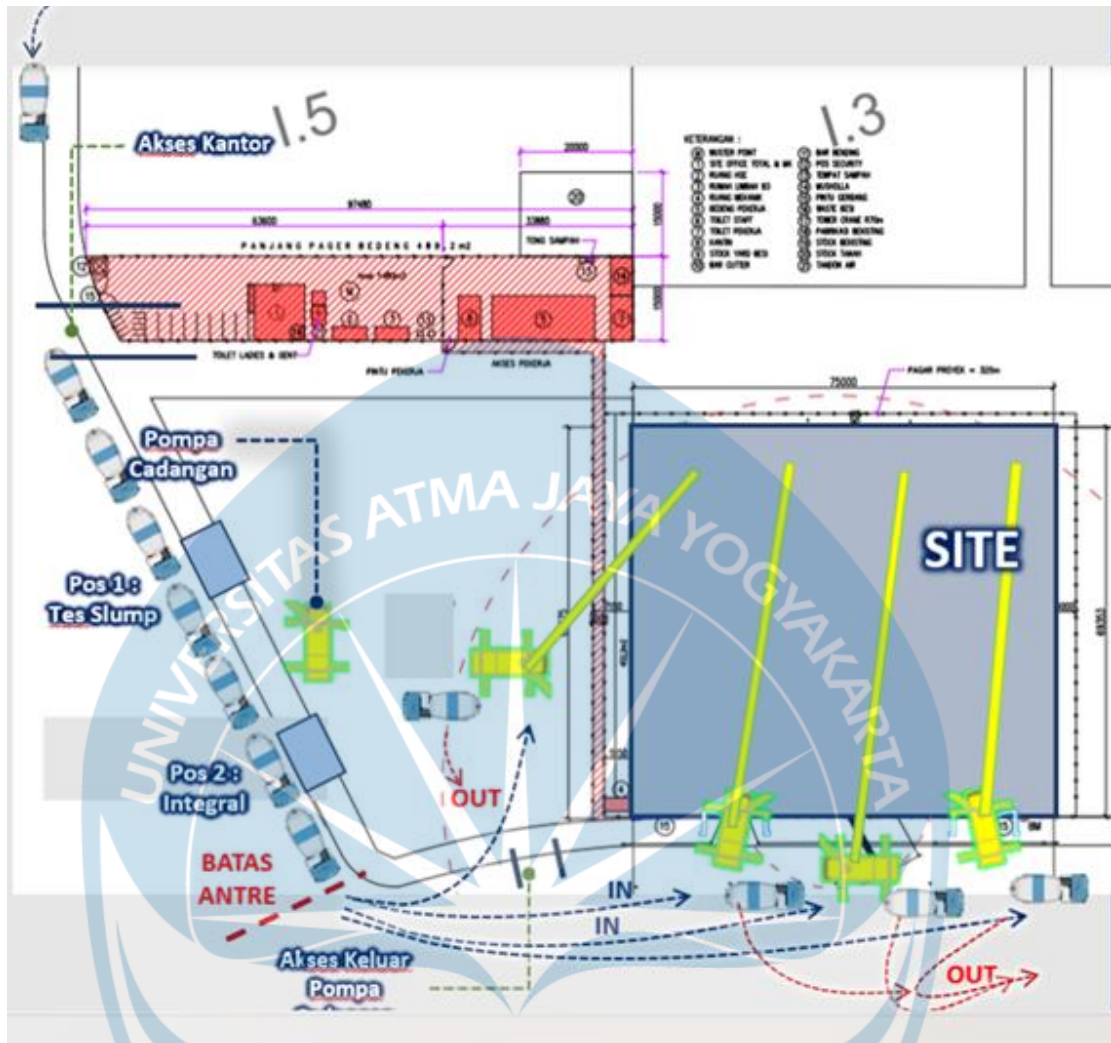


Figure 2. 30. Truck Mixer Flow

Total volume for the concrete casting is at 4016 m³. This volume includes the volume of reinforcement of pile cap and raft. Each concrete pump contributes 100 m³, so the estimated time for the casting is 40 hours. The casting flow was started at the from the top into the bottom or the flow can be seen in Figure 2.31.

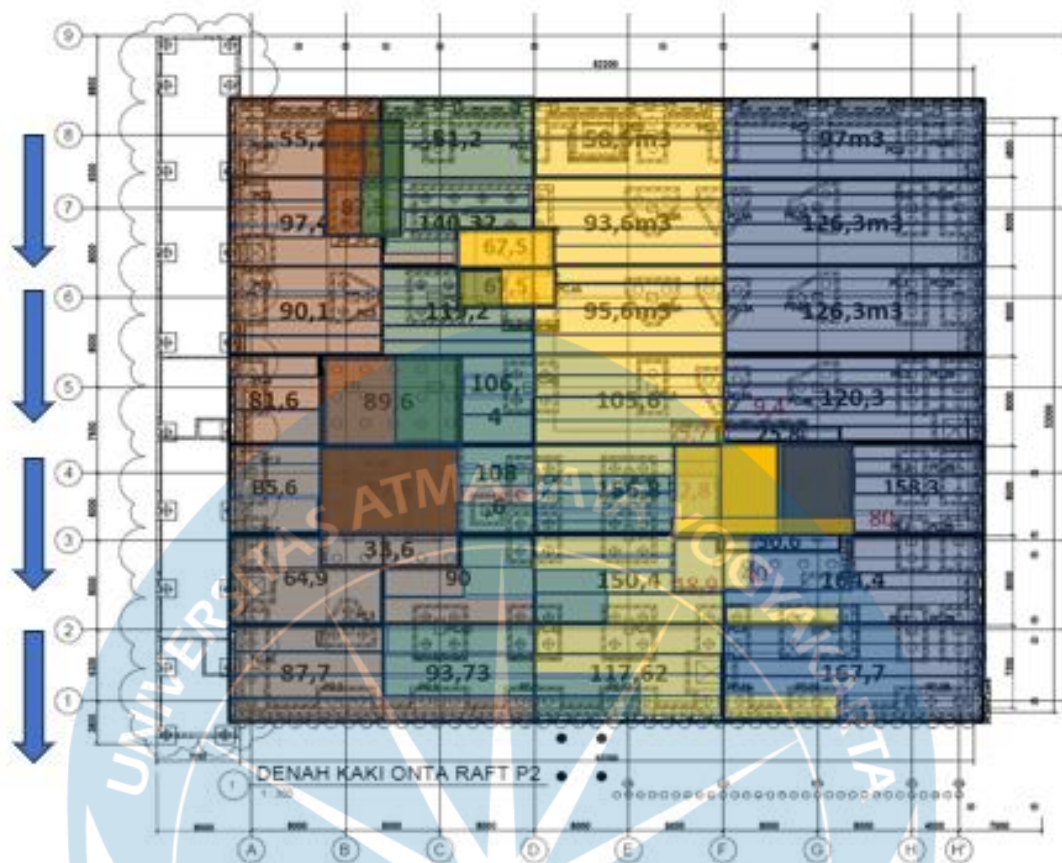


Figure 2. 31. Concrete Casting Foundation Flow

The first post on the truck mixer flow is the slump and temperature slump (Figure 2.32). The supervisor in this post is responsible that the pipe of the truck mixer is sealed when the truck arrived. If the pipe is not sealed, truck mixer is rejected and must go back to its batching plan and switch the concrete in the mixer. Preventing the driver doesn't go back to its batching plan, the supervisor will give card coupon to driver after the concrete is passed the slump and temperature test. The supervisor will supervise the testing for slump and the temperature test and notes the result. The slump allowed is at 14 – 16 mm and the maximum temperature is at 38°. After checking the slump and temperature test, the supervisor will take the card coupon from the documentation team and give it to the driver. The documentation team will input the data on the google form to update the estimated time for the concrete casting.



Figure 2. 32. Slump and Temperature Post

The second post of the truck mixer flow is the integral post (Figure 2.33). The supervisor in this post will receive the card coupon from the driver and the concrete can be mixed with the integral. The integral in this project will not change the value of the slump. After receiving the coupon, they will supervise the integral process to make sure the integral is added properly to the truck mixer. The supervisor also documented the process and fulfilled the form.



Figure 2. 33. Integral Post

The third and the fourth posts are the upper pump (Figure 2.34) and bottom pump (Figure 2.35). The supervisors from both coordinate with each other for the casting of the concrete. They coordinate with each other to inform rather the concrete is casted or not. If the concrete is stuck the bottom supervisor will immediately tell the upper supervisor so the problem, can be solved immediately.



Figure 2. 34. Upper Concrete Pump Post



Figure 2. 35. Lower Concrete Pump Post

After the concrete is casted, trowel finishing, and floor hardener are applied (Figure 2.36). Trowel finishing is the procedure used in concrete building to even out and smooth the surface of freshly poured concrete. A trowel is a hand tool used to smooth and compress the concrete surface. Trowel finishing is often carried out when the concrete is sufficiently hardened to support the weight of the finishing tools but is still pliable. To increase the durability and abrasion resistance of a concrete floor, a material known as a floor hardener is sprayed over the surface. It is particularly useful in areas where the concrete floor is subjected to heavy foot traffic, impact, or abrasion. Typically, floor hardeners are composed of cement, chemical additives, and finely graded particles. Floor hardener used in this project is using 3 kg/m^2 . The plan for trowel finishing and floor hardener is shown as below.

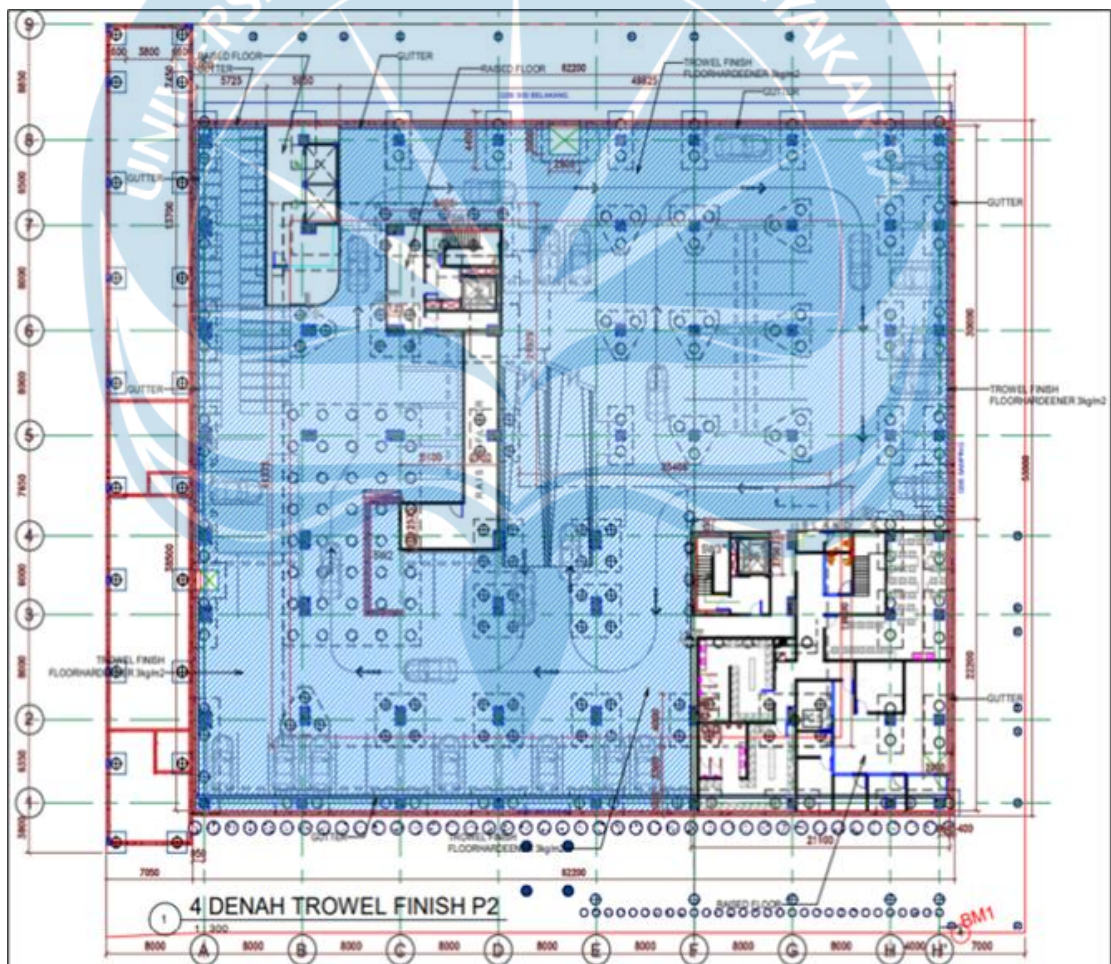


Figure 2. 36. Floor Finishing and Floor Hardener Plan

- **Construction Method Technology**

This topic is based on Construction Method Technology subject. A wide variety of subjects pertaining to the techniques and technologies used in the construction sector are covered under the field of construction method technology.

There are several materials used in this project which aids the construction built with the required specifications. The usage of the integral for waterproofing usually changes the value of the slump. This thing is necessary when it comes to the strength of the concrete. Therefore, this project is using the type of crystallin integral. This kind of integral does not change the value of the slump, so the strength of the concrete fulfils the specification requirement. Injection is also used in this project by using Sika as the material for injection. This kind of injection is used for fulfilling the cracked on the concrete. Sika helps concrete to enhance or return the strength which caused by the cracked and withstand the bearing load capacity.

- **Slab**

This topic is based on Reinforced Concrete Structures subject. The goal of this course is to provide students a thorough grasp of the design, analysis, and construction of reinforced concrete buildings. The course covers both theoretical ideas and real-world applications pertaining to the construction industry's usage of reinforced concrete. The general goal of the reinforced concrete structures course is to provide students the information and abilities they need to use reinforced concrete to build structures that are efficient, safe, and long-lasting.

Slab is a structure which holds the axial loadings from human or things upon it, this kind of structure is usually used in building with beam as its stiffener. There are 2 kinds of slab based on its dimensions. In this project there are several thicknesses of slabs divided into several types (Table 2.5).

Table 2. 5. Slab Dimensions

Slab Types	Thickness (mm)
S1A, S1B, S1C, and S1D	130
S2A and S2B	150
S3A and S3B	200
S4	250

The slab used for the calculation is slab 1A with thickness of 130 mm and beam with dimensions of 400 x 700 as its stiffener more details are explained in Table 2.6. The dimensions and the calculation of the slab is shown as below.

Table 2. 6. Slab 1A on 12th Floor

Properties	Unit
Ly	5563 mm
Lx	4725 mm
h	130 mm
b	1000 m
Fc'	35 Mpa
Fy	420 Mpa
Beam Dimensions	400 x 700
Live Load	2.13 kN/m
Dead Load	3.68 kN/m
Flexural Reinforcement	12
Shrinkage Reinforcement	10
Concrete Cover	25 mm
ln y	5163 mm
ln x	4325 mm

The first step is defining the types of slabs based on the dimensions of the slab, the calculation is shown as below.

$$\frac{Ly}{Lx} = \frac{5563}{4725} = 1.177$$

Based on the calculation above, the type the of slab is a two-way slab because the value is less than 2. After the type of slab is defined, check for the thickness of the slab. The inertia of the beam needs to be defined to define the stiffness ratio of the slab.

$$b_w = 300 \text{ mm}$$

$$h_t = 550 \text{ mm}$$

$$h_f = 130 \text{ mm}$$

$$hw = 550 - 130 = 420 \text{ mm}$$

$$b_{e_1} = bw + 2hw = 300 + 840 = 1140 \text{ mm}$$

$$b_{e_2} = bw + 8hf = 300 + 1040 = 1340 \text{ mm}$$

Based on the calculations above, the value of b_e is taken from the smallest value. Therefore, the value of is at 1140 mm.

$$y_1 = \frac{hw}{2} = \frac{420}{2} = 210 \text{ mm}$$

$$y_2 = \frac{hf}{2} + hw = \frac{130}{2} + 420 = 485 \text{ mm}$$

$$A_1 = hw \times bw = 420 \times 300 = 126000 \text{ mm}^2$$

$$A_2 = be \times hf = 1140 \times 130 = 148200 \text{ mm}^2$$

$$y = \frac{A_1 y_1 + A_2 y_2}{A_1 + A_2} = \frac{126000 \times 210 + 148200 \times 485}{126000 + 148200} = 358.632 \text{ mm}$$

$$I_b = \frac{1}{12} b_w h_w^3 + A_1 (y - y_1)^2 + \frac{1}{12} b_e h_f^3 + A_2 (y_2 - y)^2$$

$$I_b = \frac{1}{12} 300 \times 420^3 + 126000 (358.632 - 210)^2 + \frac{1}{12} 1140 \times 130^3 + 148200 (485 - 358.632)^2 = 7211027144 \text{ mm}^4$$

After defining the inertia of the beam, define the inertia of the slab to define the stiffness ratio of the slab.

$$I_{s1} = \frac{1}{12} L_y h_f^3 = \frac{1}{12} 5563 \times 130^3 = 1018492583 \text{ mm}^4$$

$$I_{s2} = \frac{1}{12} L_x h_f^3 = \frac{1}{12} 4725 \times 130^3 = 865068750 \text{ mm}^4$$

Stiffness ratio of the slab can be obtained by dividing the inertia of the beam with inertia of the slab. The calculation is shown as below.

$$\alpha = \frac{I_b}{I_{s1}} = \frac{7211027144}{1018492583} = 7.08$$

$$\alpha = \frac{I_b}{I_{s2}} = \frac{7211027144}{865068750} = 8.336$$

Define the average of the stiffness ratio of the slab to obtain the minimum thickness of the slab.

$$\Sigma a = \frac{7.08 + 8.336}{2} = 7.708$$

Calculation above shows that the average value of the stiffness ratio is more than 2. Based on SNI 2847:2019 Table 8.3.1.2 (Figure 2.37), defines the minimum thickness of the slab is shown as below.

α_{fm} [1]	h minimum, mm	
$\alpha_{fm} \leq 0,2$	8.3.1.1 berlaku	(a)
$0,2 < \alpha_{fm} \leq 2,0$	Terbesar dari:	$\frac{\ell_n \left(0,8 + \frac{f_y}{1400} \right)}{36 + 5\beta(\alpha_{fm} - 0,2)}$ (b) ^{[2],[3]}
		125 (c)
$\alpha_{fm} > 2,0$	Terbesar dari:	$\frac{\ell_n \left(0,8 + \frac{f_y}{1400} \right)}{36 + 9\beta}$ (d) ^{[2],[3]}
		90 (e)

Figure 2. 37. SNI 2847:2019 Table 8.3.1.2

$$\beta = \frac{\ln y}{\ln x} = \frac{5163}{4325} = 1.194$$

$$h_{\min 1} = \frac{\ell_n \left(0,8 + \frac{f_y}{1400} \right)}{36 + 9\beta} = \frac{5163 \left(0,8 + \frac{420}{1400} \right)}{36 + 9 \times 1.194} = 121.948 \text{ mm}$$

$$h_{\min 2} = 90 \text{ mm}$$

Based on the calculations above, the minimum thickness for the slab is 121.948 mm. Therefore, the thickness for the slab used 130 mm. The slab is clamped with beam of 400 x 700 at three sides (top, bottom, and left), while the right side is shear wall. Because of the position of the slab and beam, the calculation for the loading is following the Table 13.3.2 of PBI 1971 (Figure 2.38) with the interpolation moment in Table 2.7.

Table 13.3.2
Moment in a rectangular slab supporting all four edges due to uniformly distributed load

l_y/l_x		1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	>2.5
I	(M _{lx}) = 0.001 q _u l _x ² X	44	52	59	66	73	78	84	88	93	97	100	103	106	108	110	112	125
	(M _{ly}) = 0.001 q _u l _y ² X	44	45	45	44	44	43	41	40	39	38	37	36	35	34	32	32	25
II	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	36	42	46	50	53	56	58	59	60	61	62	62	62	63	63	63	63
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	36	37	38	38	38	37	36	36	35	35	35	34	34	34	34	34	13
III	(M _{lx}) = 0.001 q _u l _x ² X	48	55	61	67	71	76	79	82	84	86	88	89	90	91	92	92	94
	(M _{ly}) = 0.001 q _u l _y ² X	48	50	51	51	51	51	51	50	50	49	49	49	48	48	47	47	19
IV A	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	48	50	51	51	51	51	51	50	50	49	49	49	48	48	47	47	19
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	48	50	51	51	51	51	51	50	50	49	49	49	48	48	47	47	19
IV B	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	51	54	57	59	60	61	62	62	63	63	63	63	63	63	63	63	63
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	22	20	18	17	15	14	13	12	11	10	10	9	9	9	9	9	13
V A	(M _{lx}) = 0.001 q _u l _x ² X	31	38	45	53	59	66	72	78	83	88	92	96	99	102	105	108	125
	(M _{ly}) = 0.001 q _u l _y ² X	60	65	69	73	75	77	78	79	79	80	80	80	79	79	79	79	25
V B	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	60	65	69	73	75	77	78	79	79	80	80	80	79	79	79	79	25
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	31	30	28	27	25	24	22	21	20	19	18	17	16	16	15	15	12
VIA	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	38	46	53	59	65	69	73	77	80	83	85	86	87	88	89	90	54
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	43	46	48	50	51	51	51	51	50	50	50	49	49	48	48	48	19
VIB	(M _{lx}) = 0.001 q _u l _x ² X	43	46	48	50	51	51	51	51	50	50	50	49	49	48	48	48	19
	(M _{ly}) = 0.001 q _u l _y ² X	13	48	51	55	57	58	60	61	62	62	62	63	63	63	63	63	63
VIB	(M _{lx}) = - (M _{tx}) = 0.001 q _u l _x ² X	38	39	38	38	37	36	36	35	35	34	34	34	33	33	33	33	13
	(M _{ly}) = - (M _{ty}) = 0.001 q _u l _y ² X	38	39	38	38	37	36	36	35	35	34	34	34	33	33	33	33	13

Figure 2. 38. PBI 1971 Table 13.3.2

Table 2. 7. Interpolation Table for Moment Coefficients

l_y / l_x	kM _{lx}	kM _{ly}	kM _{tx}	kM _{ty}
1.1	48	39	48	39
1.2	51	38	51	38
1.177	50.321	38.226	50.321	38.226

$$M_u = 0.001 q_u l_x^2 k$$

$$M_{lx} = 0.001 q_u l_x^2 k = 0.001 \times 8.444 \times 4725^2 \times 50.321 = 9.486 \text{ kNm}$$

$$M_{ly} = 0.001 q_u l_y^2 k = 0.001 \times 8.444 \times 4725^2 \times 38.226 = 7.206 \text{ kNm}$$

$$M_{tx} = 0.001 q_u l_x^2 k = 0.001 \times 8.444 \times 4725^2 \times 50.321 = 9.486 \text{ kNm}$$

$$M_{ty} = 0.001 q_u l_y^2 k = 0.001 \times 8.444 \times 4725^2 \times 38.226 = 7.206 \text{ kNm}$$

After defining the moments for the slab, define the shear capacity of the slab. The shear capacity must surpass the ultimate shear force acts on the slab.

$$V_u = \frac{1.15 q_u l_n}{2}$$

$$V_{u1} = \frac{1.15 q_u l_{ny}}{2} = \frac{1.15 \times 8.444 \times 5163}{2} = 25068 \text{ N} = 25.068 \text{ kN}$$

$$V_{u2} = \frac{1.15 q_u l_{nx}}{2} = \frac{1.15 \times 8.444 \times 4325}{2} = 20999 \text{ N} = 20.999 \text{ kN}$$

$$V_u = 25.068 \text{ kN}$$

The shear force ultimate is used to obtain the value of shear force capacity of the slab. The calculation is shown as below.

$$d_x = h - cc - \frac{D}{2} = 130 - 25 - \frac{12}{2} = 99 \text{ mm}$$

$$d_y = h - cc - D - \frac{D}{2} = 130 - 25 - 12 - \frac{12}{2} = 87 \text{ mm}$$

$$\phi V_c = \phi 0.17 \lambda \sqrt{f'_c} b d_x = 0.75 \times 0.17 \times \lambda \times \sqrt{35} \times 1000 \times 99$$

$$\phi V_c = 74675.717 \text{ N} = 74.676 \text{ kN}$$

Since the value of the ϕV_c is bigger than the V_u , so the slab is safe from the shear force. After checking for the shear force, determine the coefficient for the flexural. The calculation for coefficient flexural is shown as below.

$$k = \frac{M_n}{b d^2} = \frac{M_u}{\phi b d^2}$$

$$k_{lx} = \frac{M_n}{b d^2} = \frac{M_{lx}}{\phi b d_x^2} = \frac{9.486 \times 10^6}{0.9 \times 400 \times 99^2} = 2.689$$

$$k_{ly} = \frac{M_n}{b d^2} = \frac{M_{ly}}{\phi b d_x^2} = \frac{7.206 \times 10^6}{0.9 \times 400 \times 87^2} = 2.645$$

$$k_{tx} = \frac{M_n}{b d^2} = \frac{M_{tx}}{\phi b d_x^2} = \frac{9.486 \times 10^6}{0.9 \times 400 \times 99^2} = 2.689$$

$$k_{ty} = \frac{M_n}{b d^2} = \frac{M_{ty}}{\phi b d_x^2} = \frac{7.206 \times 10^6}{0.9 \times 400 \times 87^2} = 2.645$$

Based on the calculations above, the coefficient flexural can be used for the calculation of the reinforcement ratio. The calculation for reinforcement ratio is shown as below.

$$\rho = \frac{0.85 f'_c}{f_y} \left(1 - \sqrt{1 - \frac{2k}{0.85 f'_c}} \right)$$

$$\rho_{lx} = \frac{0.85f'_c}{f_y} \left(1 - \sqrt{1 - \frac{2k_{lx}}{0.85f'_c}} \right) = \frac{0.85 \times 35}{420} \left(1 - \sqrt{1 - \frac{2 \times 2.689}{0.85 \times 35}} \right)$$

$$\rho_{lx} = 0.00672$$

$$\rho_{ly} = \frac{0.85f'_c}{f_y} \left(1 - \sqrt{1 - \frac{2k_{ly}}{0.85f'_c}} \right) = \frac{0.85 \times 35}{420} \left(1 - \sqrt{1 - \frac{2 \times 2.645}{0.85 \times 35}} \right)$$

$$\rho_{ly} = 0.0066$$

$$\rho_{tx} = \frac{0.85f'_c}{f_y} \left(1 - \sqrt{1 - \frac{2k_{tx}}{0.85f'_c}} \right) = \frac{0.85 \times 35}{420} \left(1 - \sqrt{1 - \frac{2 \times 2.689}{0.85 \times 35}} \right)$$

$$\rho_{tx} = 0.00672$$

$$\rho_{ty} = \frac{0.85f'_c}{f_y} \left(1 - \sqrt{1 - \frac{2k_{ty}}{0.85f'_c}} \right) = \frac{0.85 \times 35}{420} \left(1 - \sqrt{1 - \frac{2 \times 2.645}{0.85 \times 35}} \right)$$

$$\rho_{ty} = 0.0066$$

$$\rho_{maks} = 0.36 \frac{f'_c \beta_1}{f_y} = 0.36 \frac{35 \times 0.84}{420} = 0.0252$$

$$\rho_{lx} < \rho_{maks} = \text{safe}$$

$$\rho_{ly} < \rho_{maks} = \text{safe}$$

$$\rho_{tx} < \rho_{maks} = \text{safe}$$

$$\rho_{ty} < \rho_{maks} = \text{safe}$$

The area of the tensile of reinforcement or the $A_{s.req}$ must defined for the flexural and the maximum spacing.

$$A_{s.req-lx} = \rho_{lx} \times b \times d_x = 0.00672 \times 1000 \times 99 = 665.299 \text{ mm}^2$$

$$A_{s.req-ly} = \rho_{ly} \times b \times d_y = 0.0066 \times 1000 \times 87 = 574.619 \text{ mm}^2$$

$$A_{s.req-tx} = \rho_{tx} \times b \times d_x = 0.00672 \times 1000 \times 99 = 665.299 \text{ mm}^2$$

$$A_{s.req-ty} = \rho_{ty} \times b \times d_y = 0.0066 \times 1000 \times 87 = 574.619 \text{ mm}^2$$

Based on the SNI 2847:2019 Table 7.6.1.1, the calculation for the A_s minimum of the slab shown as below.

$$A_{S \min 1} = \frac{0.0018 \times 420}{f_y} \times A_g = \frac{0.0018 \times 420}{420} \times 1000 \times 130 = 234 \text{ mm}^2$$

$$A_{S \min 2} = 0.0014 \times A_g = 0.0014 \times 1000 \times 130 = 182 \text{ mm}^2$$

$$A_{S \min} = 234 \text{ mm}^2$$

$$A_{s.req-lx} > A_{S \min} = \text{use } A_{s.req-lx}$$

$$A_{s.req-ly} > A_{S \min} = \text{use } A_{s.req-ly}$$

$$A_{s.req-tx} > A_{S \min} = \text{use } A_{s.req-tx}$$

$$A_{s.req-ty} > A_{S \min} = \text{use } A_{s.req-ty}$$

Based on the calculations above, the value of s is using the value of A_s req for the calculation of flexural reinforcement and the maximum spacing for the reinforcement.

$$s_{lx} = \frac{1}{4} \frac{\pi D^2 b}{A_{s.req-lx}} = \frac{1}{4} \times \frac{\pi \times 12^2 \times 1000}{665.299} = 169.995 \text{ mm}$$

$$s_{ly} = \frac{1}{4} \frac{\pi D^2 b}{A_{s.req-ly}} = \frac{1}{4} \times \frac{\pi \times 12^2 \times 1000}{574.619} = 196.822 \text{ mm}$$

$$s_{tx} = \frac{1}{4} \frac{\pi D^2 b}{A_{s.req-tx}} = \frac{1}{4} \times \frac{\pi \times 12^2 \times 1000}{665.299} = 169.995 \text{ mm}$$

$$s_{ty} = \frac{1}{4} \frac{\pi D^2 b}{A_{s.req-ty}} = \frac{1}{4} \times \frac{\pi \times 12^2 \times 1000}{574.619} = 196.822 \text{ mm}$$

After the maximum spacing for each flexural reinforcements are obtained, the spacing used for the reinforcement can be defined. Therefore, the recapitulation for each flexural reinforcement is shown in the Table 2.8.

Table 2. 8. Flexural Reinforcements Recap

Properties	Reinforcement
Dlx	D12-150
Dly	D12-150
Dtx	D12-150
Dty	D12-150

The maximum spacing and the shrinkage reinforcement need to be checked. Based on SNI 2847:2019 the maximum spacing for shrinkage reinforcement must be less than 5h or 450 mm. Obtaining the spacing required for the reinforcement can be using the calculation as below.

$$A_{s\min} = 234 \text{ mm}^2$$
$$s = \frac{1}{4} \frac{\pi D^2 b}{A_{sh.req}} = \frac{1}{4} \times \frac{\pi \times 10^2 \times 1000}{234} = 335.64 \text{ mm}$$
$$S_{\max 1} = 5h = 5 \times 130 = 650 \text{ mm}$$
$$S_{\max 2} = 450 \text{ mm}$$

Based on the calculations above, the minimum value or 335.64 mm is taken for the maximum spacing for the shrinkage reinforcement. Therefore, P10-300 is taken for the shrinkage reinforcement.