CHAPTER II
INTERNSHIP GENERAL ACTIVITY

2.1 Company Background

2.1.1 Company Profile of PT. Krakatau Steel

PT Krakatau Steel is the largest steel company in Indonesia. A state-owned company founded in 1971, PT Krakatau Steel is one of the main steel factories that offers various types of products, including clean water, electric power, steel, industrial engineering, industrial areas, ports, information technology services, and medical services.

Located in the city of Cilegon, Banten, its head office is located at Jl. Industry number 5th Cilegon. The company started its commercial operations in 1971. Apart from always increasing business activities, we continuously make efforts to fulfill our responsibilities for product quality, work safety and environmental security.

PT Krakatau Steel was founded on 31st August 1970, coinciding with the issuance of Indonesian Government Regulation no. 35 of 1970 concerning State Capital Inclusion of the Republic of Indonesia for the Establishment of the Company (Persero) PT Krakatau Steel.

The construction of this steel industry began by utilizing the remaining Trikora Steel Project equipment, namely for the Steel Wire Factory, Reinforcing Steel Factory and Profile Steel Factory. The use of these factories was inaugurated by the President of the Republic of Indonesia in 1977. In 1979, the use of production facilities such as the Sponge Iron Factory with a capacity of 1.5 million tons/year, the Steel Billet Factory with a capacity of 500,000 tons/year, the Steel Billet Factory with a capacity of 500,000 tons/year was inaugurated. Wire with a capacity of 220,000 tons/year and infrastructure facilities in the form of a 400 MW Steam Power, Water Purification Center, Cigading Port, and telecommunications system. In 1983 the operations of the Steel Slab Factory and Hot Sheet Steel Factory were inaugurated. In 1991 the Cold Sheet Steel Factory, which was a joint venture steel factory located in the Cilegon industrial area, merged into the production unit of PT Krakatau Steel, complementing other existing steel factories.

The steel production process at PT Krakatau Steel begins at the iron manufacturing plant which uses a direct reduction process of iron ore with natural gas. The production results in the form of sponge iron are then melted together with scrap iron in the steel making process, namely slab steel factories and billet steel factories.

The steel making process uses electric arc furnace technology followed by a continuous casting process into slab steel and billet steel. Slab steel is hot rolled at a hot rolled sheet steel factory into hot rolled sheet steel in the form of coils, strips, or plates. Some of this hot sheet steel is sold directly to consumers or is further processed at other production facilities, namely cold rolled sheet steel factories. This factory produces cold sheet steel products in the form of hot pickled sheet steel, as well as cold sheet steel with annealing or tempering treatment.

2.1.2 Company Profile of Subholding PT. Krakatau Baja Konstruksi

On 1st September 2021 regarding the Statement of Shareholders' Decision on changes to the articles of association to change the name of PT. Krakatau Wajatama becomes PT. Krakatau Baja Konstruksi which has been approved by the Ministry of Law and Human Rights of the Republic of Indonesia Number AHU-0047369.AH.01.02-2021 on 2nd September 2021 concerning Approval of Changes to the Articles of Association of the Limited Liability Company PT. Krakatau Baja Konstruksi

PT Krakatau Baja Konstruksi is a subsidiary of Krakatau Steel headquartered in Cilegon and participates in the development of the steel industry in Indonesia. To meet raw material needs, inventory management is necessary as a business development strategy to avoid deviations. One of them is to make monthly or annual reports to know the control of raw materials to improve the company's production and sales efficiency.

PT Krakatau Baja Construction is a company engaged in steel production which is a subsidiary of PT Krakatau Steel, equipped with advanced technology in its production and fabrication process to guarantee product quality and meet market demand and the needs of the construction sector in various classes, types and sizes.

2.2 Company Detail Information

Subholding PT. Krakatau Baja Konstruksi was established in Krakatau Steel Industrial Area at 5th Industri St., Ramanuju, Kec. Purwakarta, Kota Cilegon, Banten, Indonesia.

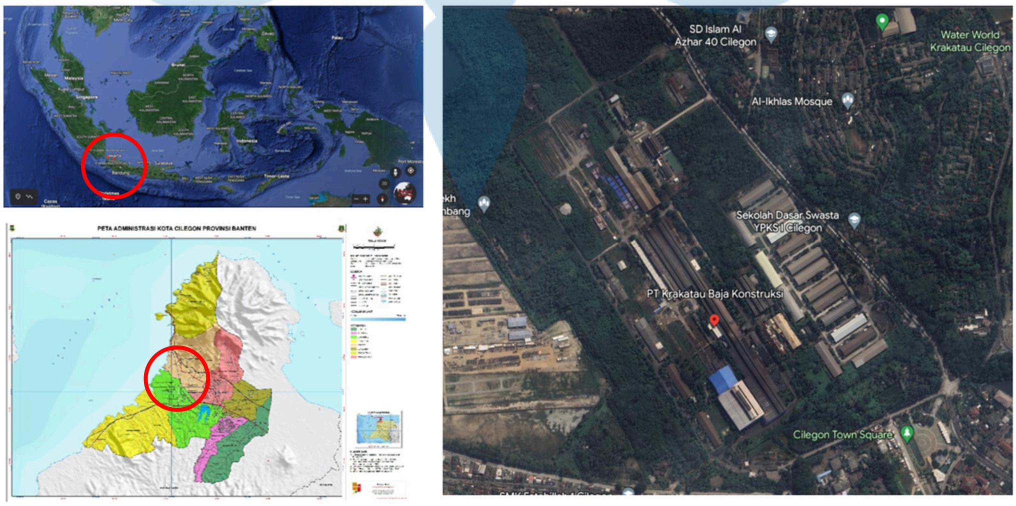


Figure 2.1. Location of the Mill

2.3 Company Data

1. Company	:	PT. Krakatau Steel Subholding PT. Krakatau Baja Konstruksi
2. Work Type	:	Steel Industry
3. Location	:	Cilegon, Banten
4. Division	:	Engineering – Fabrication – Quality Control (Monthly Rotation)
5. Work Scope	:	Steel Processing, Steel Fabrication, Construction Consultant.
6. Work Period	:	15th August 2023 – 15th December 2023

2.4 Technical Data

In PT. Krakatau Baja Konstruksi there are several buildings, that located inside of the PT. Krakatau Steel Industry Area such as:

1. Hot Rolling Mill Section and Bar Mill Section
2. Central Fabrication Division
3. Steel Creative Industry
4. Galvanize Planning
5. Laboratory and Quality Control
6. PT. Krakatau Steel Consultant and Management
7. PT. Krakatau Pipe Industry
8. Administration Office
9. Product Warehouse
10. Billet Yard

2.5 Internship Period

This Work Practice is conducted in four months calendar, starting from 15th August 2023 to 15th December 2023. Working time is fixed from Monday to Friday at 08.00 – 16.30 WIB.

2.6 Structure Organization

The organization and staffing plan have been prepared with due consideration of the project implementation activities and coordination between the Director for the effective and efficient execution of the services. The President Director will take overall responsibility for the whole project implementation, while the Business Development and SCI division will take full responsibility for providing technical and engineering assistance.

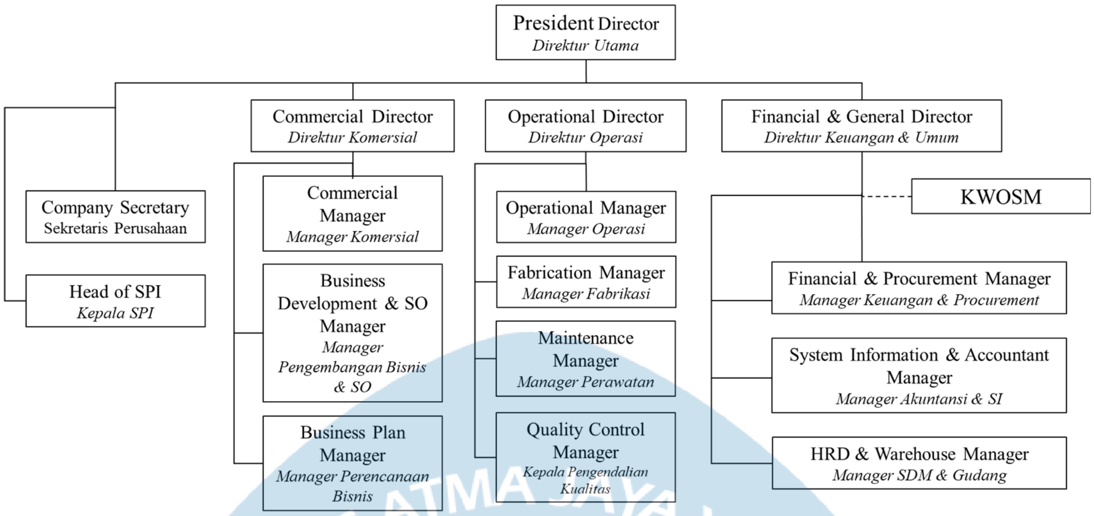


Figure 2.2 The Organization Structure

2.7 Task Key Personnel

The tasks to be performed by the Key Personnel are described below but not be limited to the following:

Table. 2.1 Task of Key Personnel

Num	Position	Description of Tasks
A	**Engineering**	
1	Project Leader	a) Review and recommend the DED in term of constructability. b) Oversee and coordinate all aspects of steel construction projects. c) Ensure that project timelines and milestones are met. d) Scrutinize and review the method of work program and scheme for deployment of plant, equipment, and machinery. e) Develop quantity and quality control procedures and criteria for the acceptance of works. And else.
2.	Architect/Product Engineer	a) Review and recommend the DED in terms of constructability. b) Give consideration and approval architecture works, recommendation and approval before a stage architecture begins.

Num	Position	Description of Tasks
		c) Supervise and inspect any test conducted by the contractor related to architectural aspects and quality of finished material. d) Ensure the architectural work is accomplished in accordance with the technical specifications, drawing and other contract documents. And else.
3.	Structure Engineer	a) Review and recommend the DED in terms of constructability. b) Give consideration and approval architecture works, recommendation and approval before a stage architecture begins. c) Supervise and inspect any test conducted by Quality Control related to structure aspects and quality of finished material. d) Ensure the structure work is accomplished in accordance with the technical specifications, drawing and other contract documents. And else.
4.	Mechanical Engineer	a) Review and recommend the DED in terms of constructability. b) Give consideration and approval mechanical works, recommendation and approval before a stage architecture begins. c) Supervise and inspect any test conducted by the Quality Control related to architectural aspects and quality of finished material. d) Ensure the mechanical work is accomplished in accordance with the technical specifications, drawing and other contract documents. And else.
5.	Welding Engineer	a) Review and recommend the DED in terms of constructability.

Num	Position	Description of Tasks
		b) Develop and qualify welding procedures for various types of steel construction projects. c) Ensure procedures comply with industry codes and standards. d) Collaborate with materials engineers to choose appropriate welding materials for specific applications. e) Consider factors such as strength, corrosion resistance, and suitability for welding processes. And else.
6.	Quantity Surveyor	a) Prepare accurate cost estimates for steel construction projects, considering materials, labour, and other associated costs. b) Analyse project specifications and drawings to determine the scope of work. c) Develop and manage project budgets throughout different phases of construction. d) Monitor expenditures and ensure they align with the approved budget. And else.
7.	Quality Control	a) Develop and implement quality assurance programs to ensure compliance with industry standards and specifications. b) Establish procedures and protocols for quality control inspections. c) Conduct thorough inspections of steel materials, components, and fabricated structures. d) Perform various testing methods, including non-destructive testing (NDT) and destructive testing, to assess the integrity of welds and materials. And else.
8.	Electrical Engineer	a) Design electrical systems for steel structures, including power

Num	Position	Description of Tasks
		distribution, lighting, and communication systems. b) Ensure compliance with relevant electrical codes and standards. c) Collaborate with architects, structural engineers, and other professionals to integrate electrical systems seamlessly into the overall design. And else.
9.	Health, Safety and Environment Officer	a) Develop, implement, and enforce safety policies and procedures specific to steel construction projects. b) Ensure that all workers are aware of and adhere to safety guidelines. c) Organize and conduct safety training programs for construction workers and other project stakeholders. d) Ensure that workers are trained on proper safety procedures and the use of safety equipment. And else.
10.	Entry Data Processing Engineer	a) Input and update project-related data into databases, spreadsheets, or project management software. b) Ensure accuracy and completeness of data entries. c) Track and record quantities of steel materials, components, and other reSources used in construction projects. d) Assist in the preparation of quantity reports for project management.
B.	**Fabrication**	

Num	Position	Description of Tasks
1.	Mechanic	a) Conduct routine maintenance on construction equipment, such as cranes, bulldozers, excavators, and other machinery used in steel construction. b) Perform scheduled inspections to identify and address potential issues. c) Diagnose and troubleshoot mechanical issues with construction equipment. d) Carry out repairs to restore equipment to working condition.
2.	Welder	a) Interpret and understand engineering drawings and blueprints to identify welding requirements. b) Prepare steel surfaces for welding by cleaning, cutting, and shaping the materials as per specifications. c) Choose the appropriate welding method based on the type of steel, thickness, and project requirements. Common methods include arc welding, MIG (Metal Inert Gas) welding, and TIG (Tungsten Inert Gas) welding.
3.	Helper	a) Assist in the transportation and handling of steel materials, tools, and equipment on the construction site. b) Ensure that materials are delivered to the appropriate locations as needed. c) Clean and prepare work areas by removing debris, ensuring a safe and organized environment for construction activities. d) Follow proper waste disposal procedures.

Num	Position	Description of Tasks
4.	Painter	a) Prepare steel surfaces for painting by cleaning, sanding, and removing any rust, dirt, or contaminants. b) Use tools such as wire brushes, sanders, or abrasive blasting equipment for surface preparation. c) Apply primer coatings to steel surfaces to improve adhesion and enhance the durability of the final paint layer. d) Mix paint or coatings according to specifications and project requirements. e) Apply paint using various methods, including brushes, rollers, or spray equipment.
C.	**Supporting Staff**	
	Bilingual Secretary Administration & Financial and Typist Operator Computer Drafter	a) Provide administrative assistance to project managers, engineers, and other construction professionals. b) Assist in managing documentation, filing, and record-keeping. c) Input and update project-related data into databases or project management systems. d) Ensure accuracy and completeness of data entries. e) Provide support to construction workers by helping with logistics, reSource coordination, and miscellaneous tasks. And else.

2.8 Work Discipline Regulation and Implementation

Discipline in work is an important factor that must be considered so that PT. Krakatau Baja Konstruksi can create a good and conducive work environment. Taking this into account, it is deemed necessary to establish a code of conduct for the company's employees, one of which is the determination of working hours. The following are the working hours applied to the PT. Krakatau Baja Konstruksi.

2.8.1 Working Hours

- Hours of Operation: Monday to Friday
- Check in to work: 08.00 WIB
- Break: 12.00 to 13.00 WIB
- Home from work: 16:30PM WIB

In enforcing work time discipline, an absence tool is used in the form of a fingerprint or fingerprint attendance which can detect who and at what time a worker enters based on each employee's fingerprint, as well as the process of recording and reporting automatically using special software.

2.8.2 Uniforms

In addition to the time discipline of the project, it is also necessary to pay attention to the discipline of dress. In this project the clothes used must be safe and comfortable. Such as using a project helmet, project vest, safety shoes, project goggles if necessary, and gloves if necessary. As for the uniforms used by staff employees of PT. Krakatau Baja Konstruksi, on Monday-Wednesday wear office PDL/PDH, Thursday wears a batik shirt and Friday wears free shirt.

2.8.3 Permit for Not Entering Work

For every employee who is unable to come to work due to illness for 1 day or more, there must be proof of a doctor's statement. If there is no doctor's certificate, the company will cut their leave entitlement. For every employee who is absent for reasons other than that, will get their own consideration from the head of the respective division, for employees who will leave the project during working hours must have permission from their respective superiors.

Besides that, discipline also needs to be considered. It's important to be well-behaved and not endanger yourself or others. Matters regarding behavior discipline are also overseen by the Administrator and Team Leader. Discipline in behavior must also be applied by everyone such as contractors, sub-contractors, practical workers, and field workers.

2.9 Parties Involved

2.9.1 Project Owner

The project owner is the first party in the construction contract who owns the project and gives it to another party who can carry it out in accordance with the work contract agreement and provide funds to realize it. The example of the owner of the project such as PT. Krakatau International Port, PT. Krakatau Engineering, PT. Krakatau Pipe Industries, PT. Inti Bangun Sejahtera, PT. Vale Indonesia, PT. Waskita Karya and PT. Wijaya Karya. The project owner has the following duties and authorities:

1. The owner directly appoints a contractor who can be entrusted with carrying out the project or an auction can also be held.
2. Consult with planning consultants.

3. The owner supervises, monitors and controls the contractor's work through a supervisory consultant.
4. Provide decisions and instructions that are closely related to job changes, execution time, and costs.
5. Sign work orders and agreements with contractors.
6. Provide the location where the project will be carried out and the licensing process such as an IMB.
7. Approve or reject changes in the implementation of work.
8. Paying all parties assigned to the project implementation.
9. Receive the work in accordance with the agreement.

2.9.2 Planning Consultant

A supervisory consultant serves as a key stakeholder by leveraging their expertise to enhance project planning, design, and execution. Their oversight and commitment to quality contribute significantly to the successful and efficient completion of construction projects.

Planning Consultants are parties appointed by the owner to express ideas from the owner to be used as a working drawing that is in accordance with the wishes of the owner and fulfills the technical and financial requirements of the owner. In the Project of BTS Tower SST45M 3 Leg, the project is designed by PT. Krakatau Engineering. The rights and obligations of the planning consultant are as follows,

1. Make working drawings implementation. Make work plans and building implementation requirements (RKS) as implementation guidelines.
2. Make a budget plan (RAB).
3. Project the project owner's creative ideas or ideas into the building design.
4. Make changes to the design if there is a deviation in the implementation of work in the field which makes it impossible to carry out according to the contract that has been made.
5. Responsible for the design and calculation of building structures in the event of a construction failure.
6. Take care of building permits (IMB).

2.9.3 Supervisory Consultant

The supervising consultant is a business entity engaged in the supervision of construction executors who functions as a representative or mediator of the project owner. The supervisory consultant carries out communication, consultation, control and control with the contractor. The supervising consultant in a project has the following tasks:

1. Carry out general administration regarding the implementation of work contracts.
2. Carry out routine supervision during project implementation.
3. Publish a project work achievement report to be seen by the project owner.

4. The supervisory consultant provides advice or considerations to project owners and contractors in project implementation work. Correct and approve the shop drawings submitted by the contractor as guidelines for the implementation of project development.
5. Select and give approval regarding the type and brand proposed by the contractor so that it is in accordance with the expectations of the project owner but still guided by the construction work contract that has been made previously.

2.9.4 Steel Fabricator

In addition to their role in ensuring structural integrity, steel fabricators actively participate in project coordination by providing realistic timelines, managing logistics for component delivery, and addressing any challenges that may arise during fabrication. The fabricator's commitment to continuous improvement, incorporation of value engineering principles, and effective communication with other stakeholders, including architects and construction managers, collectively contribute to the overall success and efficiency of construction projects involving steel structures.

The fabricator interprets intricate design drawings and contributes valuable insights into material selection, cost estimation, and adherence to safety regulations. Throughout the fabrication process, the steel fabricator maintains a focus on quality assurance, employing rigorous control measures to guarantee that the produced components align with industry standards. The steel fabricator in a project has the following tasks:

1. Provide expertise in the fabrication of steel components, ensuring they meet design specifications and quality standards. Carry out routine supervision during project implementation.
2. Assist in the selection of appropriate steel materials based on project requirements, including considerations of strength, durability, and cost.
3. Provides advice or considerations to project owners or contractors in project implementation work of fabrication.
4. Work closely with design engineers to interpret and understand design drawings, ensuring accurate fabrication.

2.9.5 Contractor

Their leadership includes effective communication with other stakeholders, such as architects and project owners, to facilitate collaboration. Contractors play a crucial role in quality assurance, conducting inspections and addressing deviations promptly to uphold industry standards and safety regulations. Additionally, their proactive approach to risk management, including the identification and mitigation of potential challenges, contributes significantly to the overall success and safety of the construction project. In a project they have the following tasks:

1. Ensure compliance with contractual obligations and specifications.

2. Collaborate with legal and contractual experts as needed.
3. Identify potential challenges and risks associated with the construction process.
4. Implement proactive measures to mitigate risks and ensure project safety.
5. Efficiently manage reSources, including labor, materials, and equipment.
6. Optimize reSource allocation to enhance project efficiency.

2.10 Project Workflow

The project flow for this endeavor initiates with the engineering phase, a crucial stage where meticulous planning and design take center stage. During this phase, engineers delve into the project requirements, structural specifications, and methods. Comprehensive analysis is conducted to ensure that the proposed structure meets safety standards, load-bearing capacities, and regulatory compliance. The engineering phase lays the foundation for the subsequent stages, providing a blueprint that guides the fabrication and erection processes. Attention to detail in this initial stage is paramount, as it sets the trajectory for the entire project.

Following the meticulous planning and design in the engineering phase, the project seamlessly transitions into the fabrication stage. The conceptualized plans take tangible form as materials are Sourced, and structural components are meticulously crafted. Skilled fabricators employ cutting-edge techniques to shape and assemble the elements of the structure. Precision is key in this phase, ensuring that each component meets the specified dimensions and structural integrity. The fabricated elements are then subjected to quality control measures to guarantee compliance with engineering standards.

Once the fabrication phase is complete, the project advances to the erection stage, where the carefully crafted components are assembled on-site, bringing the envisioned structure to life.

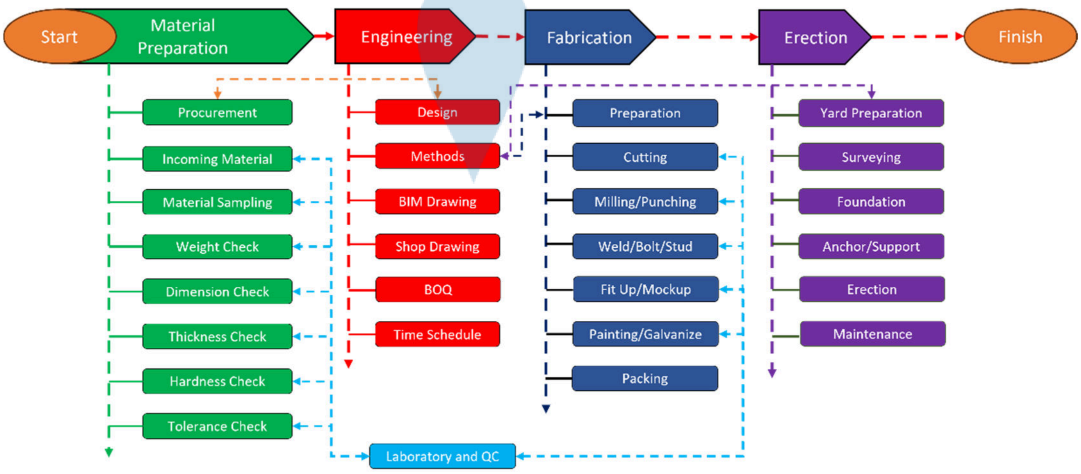


Figure. 2.3 Project Workflow

2.11 Internship Scope of Work

2.11.1 Daily Report and Administration

Work on this daily report is done by walking around the project to see the progress of work in the field. Recording and documenting all work that is being carried out directly according to the location. For incoming materials/equipment as well as weather reports from the Contractors, obtained from logistics staff and security guards. This task is carried out every Monday to Friday according to a predetermined schedule. This report is submitted to the Court every day. The steps for making a daily report are as follows.

1. Site and Works Checklist and Supervision.
2. Observe all the work being done by workers, then record it and document it.
3. Request a list of incoming materials and tools from the logistics staff of the contractors as well as weather reports to the security guard and then record them.
4. Transfer the results of notes regarding work, materials, tools according to the columns provided on the daily report form by the contractors and accepted by the Construction Consultant.
5. Calculating Steel tonnage Needs.
6. Doing Quality Control Work Mapping.

2.11.2 Building Information Modeling

Building Information Modeling (BIM) has revolutionized the design and construction processes in steel construction, providing a collaborative and comprehensive approach to project development. In the realm of steel construction, BIM facilitates the creation of a detailed digital representation of the entire project, incorporating structural elements, material specifications, and construction sequences. This three-dimensional model serves as a centralized hub for project data, allowing architects, engineers, contractors, and other stakeholders to collaboratively visualize and analyze the steel structure from its conceptualization to completion.

Figure 2.4 Building Information Modeling of Direction Keet PT. Hutama Karya at Ibu Kota Nusantara
(**Source:** PT. Krakatau Baja Konstruksi, 2023)

2.11.3 Ferary Sorowako Bridge Fabrication Checklist

Quality control is crucial in ensuring the safety and reliability of steel bridges. A comprehensive checklist for steel bridge fabrication involves meticulous scrutiny at various stages. Firstly, it begins with the inspection of raw materials, where the quality of the steel itself is assessed. The checklist includes verifying the conformity of the material to specified standards, checking for any defects or irregularities, and ensuring proper documentation.

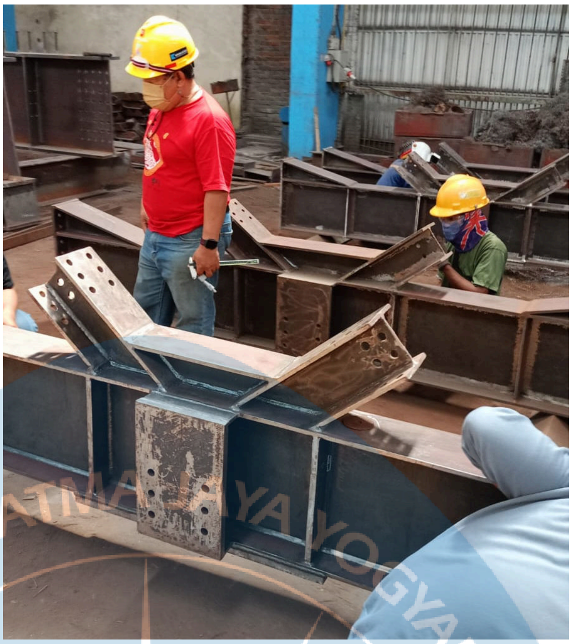


Figure 2.5 Sorowako Bridge Fabrication Checklist
(**Source:** PT. Krakatau Baja Konstruksi, 2023)

Once fabrication commences, the checklist expands to cover welding processes, dimensional accuracy, and the application of protective coatings. Welding inspections are vital, assessing the weld quality, proper penetration, and adherence to welding procedures. Dimensional accuracy is monitored to guarantee precise alignment and fitness during assembly. Finally, the application of coatings is scrutinized for uniformity and corrosion resistance. Regular inspections throughout the fabrication process, guided by a tough checklist, contribute to the overall quality and longevity of the steel bridge.

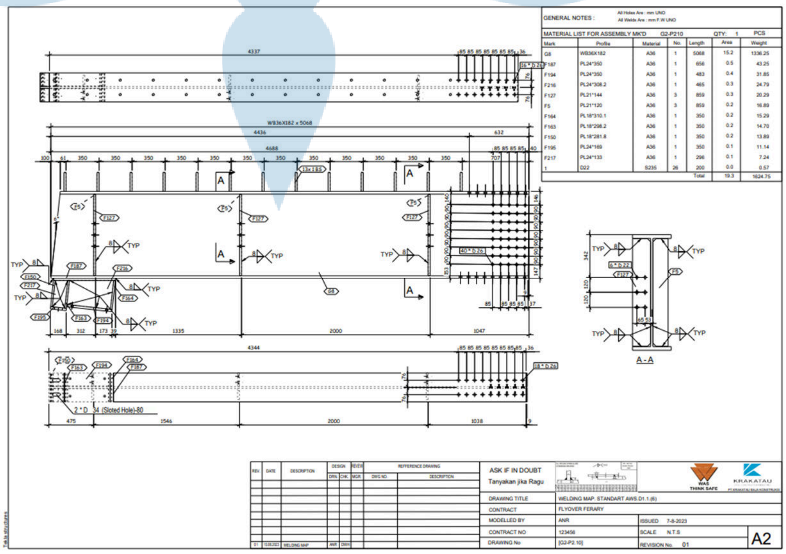


Figure 2.6 Sorowako Bridge Fabrication Shop Drawing
(**Source:** PT. Krakatau Baja Konstruksi, 2023)

2.11.4 Electric Pole PLN JTM 9/200 Fabrication Checklist

The Medium Voltage Network (JTM), often called the primary distribution network, is a part of the electrical power between the main substation and the distribution substation. In distributing electric power to the primary distribution network, 3 channel systems are used, including overhead wire channels, cable channels or area cables and ground cable systems. The Medium Voltage Network used by PLN is 12 KV and 20 KV. The Medium Voltage Network (JTM) construction consists of:

1. (Low Voltage Air System (SUTR) electric poles are supporting structures used to route low-voltage electrical cables in a distribution network. Typically, SUTR electric poles are constructed from sturdy and weather-resistant materials such as galvanized steel or prestressed concrete. Their design is intended to support electrical cables and ensure the safety and reliability of electrical distribution in the area.
2. Medium Voltage Air Lines (SUTM) This is the cheapest construction used to distribute electric power at the same power. This construction is most widely used in Indonesia for medium voltage network consumers. SUTM is also called uninsulated wire network. The most important characteristic of this network is the use of bare conductors supported by insulators on iron or concrete poles. The main parts of this network are concrete or iron poles, cross arms and conductors. Usually, the conductors used are aluminum or AAAC measuring 240 mm2, 150mm2, 70mm2 and 35mm2.
3. Medium Voltage Cable Channels (SKTM) SKTM construction or medium voltage cable channels are safe and reliable for distributing medium voltage electrical power but are relatively expensive for distributing the same data. Compared with SUTM or medium voltage lines, using SKTM will reduce or minimize the risk of operational failure due to external factors or increase electricity safety or security.

Ensuring the reliability and safety of steel electric poles demands a rigorous quality control checklist throughout the manufacturing process. The checklist initiates a thorough examination of the raw materials, scrutinizing the steel for compliance with industry standards. This involves assessing the metallurgical properties, chemical composition, and any potential defects. Documentation is also crucial at this stage, verifying that the Sourced materials meet the specified requirements.

Figure 2.7 Material Thickness Checklist of PLN JTM 9/200 Electric Pole

Moving into the fabrication phase, the quality control checklist expands to encompass the welding processes. Weld quality is paramount, with inspections focusing on the strength, integrity, and proper penetration of welds. In addition to welding, dimensional accuracy becomes a key aspect. Precise measurements ensure that the steel electric poles meet the specified height and diameter requirements. Galvanization and coating processes are also integral components of the checklist, verifying that the poles receive a uniform and durable protective layer to guard against corrosion and environmental factors.

Figure 2.8 Coating and Dimension Checklist of PLN JTM 9/200 Electric Pole

The final stage of the quality control checklist involves a comprehensive inspection of the finished steel electric poles. This includes a visual examination for any surface imperfections, adherence to design specifications, and a final check for dimensional accuracy. Quality control at every stage guarantees that the steel electric poles meet the necessary standards, ensuring the safety and reliability of the electrical infrastructure they support.

2.11.5 Krakatau Steel Pipe Warehouse Fabrication Checklist

The construction of a steel warehouse demands a meticulous quality control checklist to ensure structural integrity, safety, and longevity. Beginning with the raw materials, the checklist scrutinizes the steel for compliance with industry standards, checking for any defects, and verifying proper documentation. The selection of high-quality steel is paramount for the durability and load-bearing capacity of the warehouse structure.

Figure 2.9 Welding Repair Inspection of Warehouse Fabrication

As fabrication progresses, the checklist expands to encompass welding inspections. Welding quality is of utmost importance, with a focus on ensuring proper penetration, strength, and adherence to welding procedures. The dimensional accuracy of the fabricated steel components is also closely monitored to guarantee precise alignment and fit during assembly. This stage includes checks for any imperfections or deviations from design specifications.

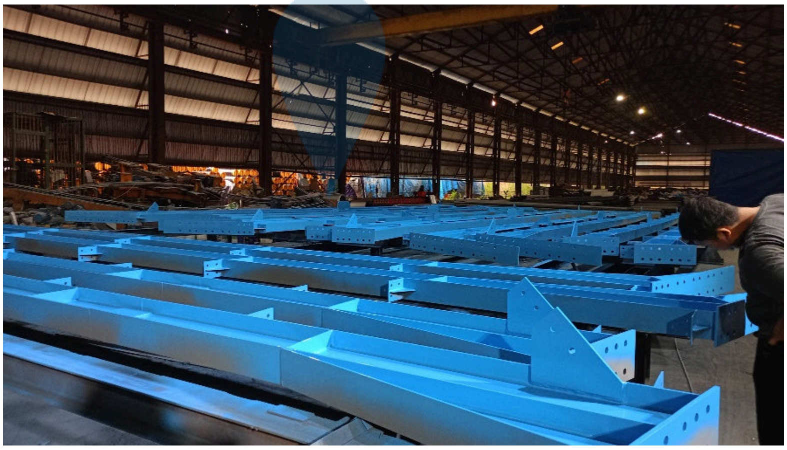


Figure 2.10 Coating Thickness Checklist of Warehouse Fabrication

The quality control checklist extends to the application of protective coatings and finishes. Proper surface preparation and coating thickness are crucial to prevent corrosion and enhance the warehouse's resistance to environmental elements. The final inspection of the assembled steel warehouse involves a comprehensive review, encompassing structural stability, dimensional accuracy, and the overall adherence to design and safety standards. This rigorous quality control process ensures that the steel warehouse not only meets but exceeds the necessary standards for a robust and reliable industrial structure.

2.11.6 Modular Wika Gedung PT. Wijaya Karya Checklist

The construction of modular steel buildings requires a comprehensive quality control checklist to ensure the efficiency, safety, and durability of the structures. Starting with the raw materials, the checklist assesses the quality and specifications of the steel used in the modules. This includes verifying the metallurgical properties, dimensional accuracy, and compliance with industry standards. Rigorous documentation ensures that the Sourced materials meet the necessary requirements for a reliable modular steel building.

Figure 2.11 Checklist of Wika Modular

During the fabrication process, the quality control checklist expands to cover precision in module assembly. Dimensional accuracy is paramount, ensuring that each module aligns seamlessly with others during construction. Welding processes undergo meticulous inspection to guarantee the integrity and strength of connections between modules. Additionally, checks are in place to verify the proper installation of insulation materials and the application of protective coatings, crucial for the building's longevity and resistance to environmental factors.

Figure 2.12 Sandblast and Coating Checklist of Wika Modular

The final stage of the quality control checklist involves a comprehensive review of the fully assembled modular steel building. This includes structural assessments to ensure stability and load-bearing capacity, as well as inspections for any defects or deviations from design specifications. The thorough quality control process guarantees that modular steel buildings meet the highest standards for safety, quality, and performance, providing a reliable and efficient solution for various construction needs.

2.11.7 Hot Mill Product Checklist

The production of hot mill steel profiles necessitates a meticulous quality control checklist to uphold the precision and reliability of the final products. Commencing with the examination of raw materials, the checklist ensures that the steel meets specified standards, evaluating metallurgical properties, and scrutinizing for any defects. Documentation at this stage is crucial, confirming that Sourced materials align with the stringent requirements for manufacturing top-notch steel profiles.

As the hot rolling process unfolds, the quality control checklist widens to encompass an array of critical parameters. Continuous monitoring of temperature and pressure during rolling is paramount to guarantee the desired mechanical properties of the profiles. Post-rolling inspections delve into dimensional accuracy, meticulously ensuring that the profiles align precisely with specified height, width, and thickness requirements. Surface quality checks are integral to this process, detecting any imperfections or irregularities that could potentially impact the performance or structural integrity of the final product.

Figure 2.13 Hot Mill Profile Checklist

Moving to the subsequent phase, the quality control checklist delves into non-destructive testing methodologies. Techniques such as ultrasonic testing or magnetic particle inspection are applied to detect internal flaws or inconsistencies that may not be apparent through visual inspection alone. This step ensures that the hot mill steel profiles maintain a high level of structural integrity and meet the demanding standards required for various applications.

The final stage of the quality control checklist involves the assessment of mechanical properties. Tensile strength, elongation, and hardness tests are conducted to validate that the profiles meet or surpass industry benchmarks. Visual inspections for surface defects or irregularities are carried out to guarantee an immaculate end product. The stringent quality control process throughout hot mill steel profile production is integral to ensuring that the profiles not only meet but exceed the highest standards for strength, precision, and overall quality, catering to diverse applications in construction and manufacturing.

2.11.8 Coal Hopper PT. Krakatau International Port Cigading

The fabrication of a coal hopper involves the construction of a robust steel structure designed to store and dispense coal efficiently. The process begins with detailed engineering and design to meet the specific requirements of the coal-handling system. High-quality steel, often with corrosion-resistant properties, is selected to ensure durability in the harsh environment of coal storage. Skilled welders and fabricators then meticulously assemble the steel components, employing techniques like submerged arc welding to achieve strong and reliable connections.

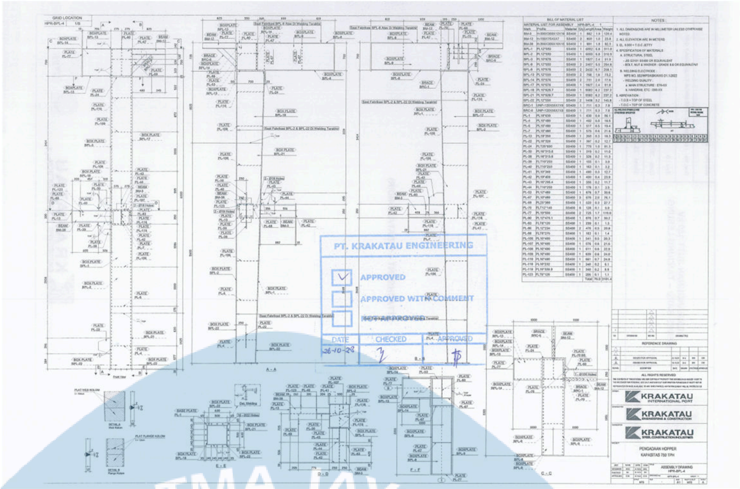


Figure 2.14 Coal Hopper Column Checklist
(Source: PT. Krakatau Baja Konstruksi, 2023)

Figure 2.15 Coal Hopper Column and Truss Checklist

The fabrication process also includes the installation of features such as access doors, discharge chutes, and reinforcing elements to withstand the abrasive nature of coal. Proper surface preparation and coating application are essential to protect the hopper from corrosion and extend its operational life. The final product is a carefully crafted coal hopper that meets industry standards, providing a robust and reliable solution for the storage and handling of coal in various industrial applications.

Figure 2.16 Coal Hopper Plate Girder Checklist

Figure 2.17 Coal Hopper Erecting

2.11.9 Welding Inspection

Welding inspection is a critical process in ensuring the structural integrity and safety of welded components in various industries, including construction, manufacturing, and infrastructure. Highly skilled welding inspectors play a pivotal role in examining weldments for compliance with specified codes, standards, and project requirements. Their responsibilities include visually inspecting welds for defects such as cracks, porosity, or incomplete fusion, and ensuring that the welding process adheres to approved procedures.

Figure 2.18 Welding Porosity Defect

Additionally, inspectors may use non-destructive testing methods such as ultrasonic testing or X-ray examinations to assess the internal quality of welds. Through meticulous inspection, prevention of potential weld failures, ensuring that welded structures meet the highest quality and safety standards.

These are several destructive tests that carried in PT. Krakatau Baja Konstruksi as follows:

a. Tensile Testing

In a steel tensile test, the primary objective is to evaluate the material's mechanical properties, specifically its tensile strength, yield strength, and elongation. The test involves subjecting a standardized specimen of the steel to gradually increasing axial loads until the material undergoes deformation or failure. During the test, engineers measure the applied force and the corresponding deformation to construct a stress-strain curve, which provides valuable insights into the steel's performance under various loading conditions. Tensile strength represents the maximum stress the material can withstand before breaking, while yield strength indicates the stress at which the material begins to exhibit permanent deformation. The elongation, expressed as a percentage, highlights the material's ductility and its ability to stretch before rupture.

The steel tensile test is a fundamental method for quality control and material characterization. By understanding how steel responds to tension, quality control can ensure that structures and components meet safety standards and design specifications.

b. Hardness Testing

Hardness testing is a crucial method employed to assess the resistance of a material to indentation, scratching, or abrasion. One widely used technique is the Rockwell hardness test, where a specified load is applied to an indentation, creating an indentation on the material's surface. The depth of this indentation is then measured, providing a quantitative measure of the material's hardness. Another common method is the Brinell hardness test, which involves applying a known force to a spherical indentation and measuring the diameter of the resulting indentation.

By precisely measuring a material's hardness, engineers can make informed decisions about the materials used in a wide range by its durability and performance.

c. Bend Test

The bend test is a mechanical testing method used to evaluate the ductility and soundness of a material, particularly metals. In this test, a specimen of the material is subjected to bending forces, typically through the application of a specific load, until it deforms or fractures. The bend test helps assess the material's ability to undergo plastic deformation and is especially important in industries where flexibility and resistance to cracking are critical, such as construction and metal fabrication. The test is conducted by bending a standardized sample around a specified radius, and the result is typically expressed in terms of the material's bend angle or the presence of cracks on the outer or inner surface of the bend.

The information gathered from bend tests is vital for quality control and ensuring the integrity of materials in structural applications. It helps engineers and manufacturers determine if a material meets the required standards for bending without failure. This test is particularly relevant for materials used in components subjected to bending or forming processes, providing insights into their ability to withstand deformation and stresses of the structure.

These are several non-destructive tests that carried in PT. Krakatau Baja Konstruksi as follows**:**

a. Ultrasonic Testing (UT)

Ultrasonic testing is a non-destructive testing method widely employed in steel structure quality control to assess the integrity and detect defects within the material. In this technique, high-frequency sound waves, typically in the ultrasonic range, are sent through the steel structure. These waves penetrate the material, and the reflections or echoes from internal interfaces, such as boundaries between different materials or the presence of defects like cracks or voids, are analyzed. By examining the time delay and amplitude of these echoes, inspectors can identify and characterize potential flaws or inconsistencies in the steel structure.

Figure 2.19 Ultrasonic Examination Girder Plate

This method is particularly valuable in ensuring the structural reliability of steel components, as it allows for the detection of hidden defects that may compromise the material's strength. Ultrasonic testing is commonly used in the construction and manufacturing industries to verify the quality of welds, identify material discontinuities, and assess the overall structural soundness of steel elements. The non-destructive nature of this testing method makes it a preferred choice for quality control, providing detailed insights without causing any damage to the steel structure being examined.

b. Magnetic Particle Examination (MT)

Magnetic particle testing is another non-destructive testing method frequently employed in steel structure quality control, particularly for detecting surface and near-surface defects. In this technique, a magnetic field is applied to the steel structure, and ferrous particles (usually iron filings or magnetic powder) are applied to the surface. These particles accumulate in areas of magnetic flux leakage caused by surface cracks, discontinuities, or other defects. The inspector can then visually observe these particle accumulations, indicating the presence and location of potential defects.

This method is highly effective for identifying surface cracks and other superficial flaws in steel structures, making it valuable in industries where the integrity of welds and structural components is critical. Magnetic particle testing is often used in conjunction with other testing methods to ensure comprehensive quality control. It is a relatively quick and cost-effective technique that helps identify issues early in the manufacturing or construction process, allowing for timely corrective actions and ensuring the overall safety and reliability of the steel structure.

c. Visual Examination (VT)

Visual testing is a fundamental and essential method in steel structure quality control, providing a direct and initial assessment of the material's surface conditions, welds, and overall workmanship. This method involves a thorough visual inspection of the steel structure by trained inspectors. They examine the surfaces for any visible defects, such as cracks, discontinuities, surface irregularities, and other imperfections that may affect the structural integrity or performance of the steel components.

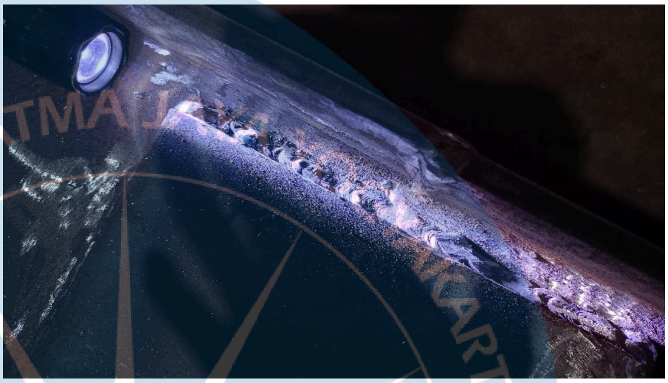


Figure 2.20 Welding Undercut Defect

In steel structure quality control, visual testing is often the first step in the inspection process and serves as a precursor to more advanced non-destructive testing methods. Inspectors rely on their expertise to identify issues that may require further investigation or testing. Visual testing is particularly effective in assessing the quality of welds, as it allows inspectors to check for proper weld bead size, penetration, and alignment. Regular visual inspections throughout the manufacturing or construction process help ensure that the steel structure meets the required standards and specifications, contributing to the overall safety and durability of the final product.

d. Liquid Penetrant Examination (PT)

The welding penetrant test is a crucial non-destructive examination method employed to detect surface-breaking defects in welded joints. This method is particularly effective for identifying cracks, porosity, or other discontinuities that may compromise the integrity of the weld. The process involves applying a liquid penetrant to the surface of the weld, allowing it to seep into any open discontinuities through capillary action. After a specified penetration time, excess penetrant is removed, and a developer is applied to draw the penetrant out of the discontinuities, making them visible for inspection.

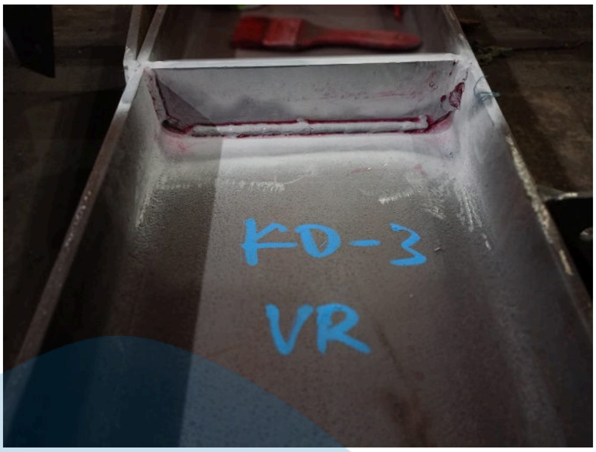


Figure 2.21 Welding Defect Result of Liquid Penetrant

This method is highly sensitive and can reveal flaws that may not be visible to the naked eye. It is commonly used in industries where weld quality is critical, such as aerospace, construction, and manufacturing. The welding penetrant test plays a vital role in ensuring the reliability and safety of welded structures by allowing for the detection and rectification of potential defects before they become a significant concern.

Both destructive and non-destructive testing methods are essential for quality control, ensuring that steel structures meet specified standards and are safe for their intended use. The selection of specific tests depends on factors such as the type of structure, material properties, and project requirements.

2.11.10 Laboratory Test

1. **Steel Bar Tensile Test**

The steel bar tensile test is a fundamental method for evaluating the mechanical properties of steel, particularly its strength and ductility. This test involves subjecting a cylindrical steel specimen, often in the form of a bar, to axial tension until it undergoes failure. The process helps determine key characteristics, such as the ultimate tensile strength, yield strength, and elongation, which are vital for understanding how the steel will perform under different loading conditions.

Figure 2.22 Steel Bar Tensile Test

During the tensile test, a carefully prepared steel bar specimen is gradually loaded in tension until it fractures. The stress and strain applied to the specimen are continuously measured, allowing for the construction of a stress-strain curve. This curve provides valuable insights into the material's behavior under varying levels of stress. The ultimate tensile strength represents the maximum stress the steel can withstand before failure, while the yield strength indicates the stress at which plastic deformation begins. The elongation at fracture measures the amount of deformation the steel undergoes before breaking and is an indicator of its ductility.

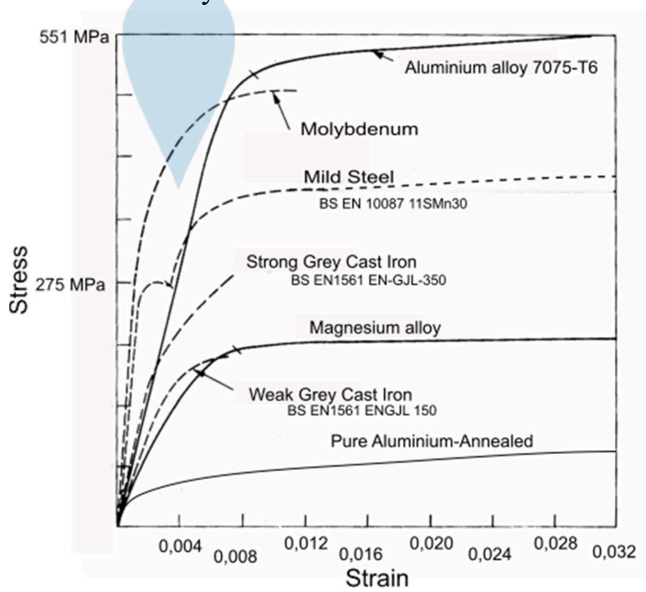


Figure 2.23 Stress-Strain Diagram in Different Steel Material

2. **Steel Profile Tensile Test**

The steel profile tensile test is a crucial method for assessing the mechanical properties of steel profiles, providing valuable information about their strength and deformation characteristics. In this test, a sample of the steel profile is subjected to axial tension until it reaches the point of failure. This process allows for the determination of key parameters such as ultimate tensile strength, yield strength, and elongation, which are essential for understanding how the steel profile will behave under different loading conditions.

Figure 2.24 Steel Profile Specification Check for Tensile Test

Figure 2.25 Steel Profile Preparation for Tensile Test

During the tensile test on a steel profile, a carefully prepared sample is loaded in tension, and the applied force and resulting deformation are measured. The stress-strain curve generated from the test provides a detailed analysis of the material's response to stress. The ultimate tensile strength represents the maximum stress the steel profile can endure before failure, while the yield strength indicates the stress at which plastic deformation initiates. Additionally, the elongation at fracture measures the extent of deformation the steel profile undergoes before reaching its breaking point, offering insights into the material's ductility.

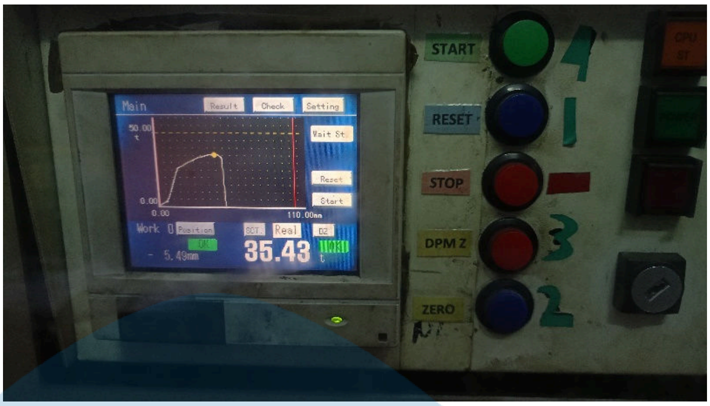


Figure 2.26 Steel Profile Tensile Test Result

The results obtained from the steel profile tensile test are invaluable for engineers and manufacturers involved in the construction and structural design industries. These findings aid in ensuring that steel profiles meet the required standards for strength and performance, contributing to the safety and reliability of structures where these profiles are employed. The tensile test plays a pivotal role in quality control, allowing for the verification of steel profile properties and the optimization of materials for specific applications.

2.11.11 Occupational Safety and Health Check

Occupational Safety and Health Check The definition of Occupational Safety and Health (K3) according to OHSAS 18001: 2007 are all conditions of the work environment and factors that can have an impact on the occupational safety and health of workers and other people (contractors, suppliers, visitors, and guests) in the workplace. K3 aims to protect, guard, guarantee the workforce to create a work system that is safe, healthy, and free from environmental pollution so as to prevent and reduce the occurrence of work-related accidents and diseases, and in the end can increase work efficiency and productivity systems.

2.11.12 K3 Induction (Safety Induction)

Safety Induction is an explanation and briefing on K3 relating to potential hazards, hazard control, required personal protective equipment (PPE), emergency response, and rescue procedures given to new workers and visiting guests. Following the K3 induction is a mandatory requirement for workers or guests to enter the project area.

2.11.13 Toolbox Meeting (TBM)

The Toolbox Meeting (TBM) is held every day at 08.00 – 08.10 WIB led directly by someone from the K3 section. The Toolbox Meeting (TBM) activity was attended by staff, sub-contractor staff, foremen, and workers. During the Toolbox Meeting (TBM) every worker is emphasized to always pay attention to personal safety and always use personal protective equipment, not to underestimate the little things that could risk an accident, and to remind everyone in the field to always use personal protective equipment completely and in accordance with predetermined standards.

2.12 Study Implementation

2.12.1 Building Information Modelling

Tekla Structures, a powerful BIM software, plays a pivotal role in enhancing the efficiency and precision of steel construction design. Tekla allows for the creation of detailed 3D models of steel structures, providing a rich visualization of the entire project. The software integrates seamlessly with various design and analysis tools, allowing structural engineers to validate and optimize the design for structural integrity and performance. Moreover, Tekla's parametric modeling capabilities enable quick and accurate modifications to the steel structure, ensuring that any changes are reflected cohesively across the entire BIM model.

One of the significant advantages of utilizing Tekla in BIM for steel construction is its ability to generate accurate and detailed fabrication drawings. The software streamlines the process of creating shop drawings and construction documentation, reducing the likelihood of errors during fabrication and construction. This not only enhances the overall precision of the steel construction but also contributes to improved communication and coordination among project stakeholders. The collaborative and data-rich nature of BIM, coupled with the advanced features of Tekla Structures, empowers the steel construction industry to achieve higher levels of efficiency, accuracy, and collaboration throughout the entire project lifecycle.

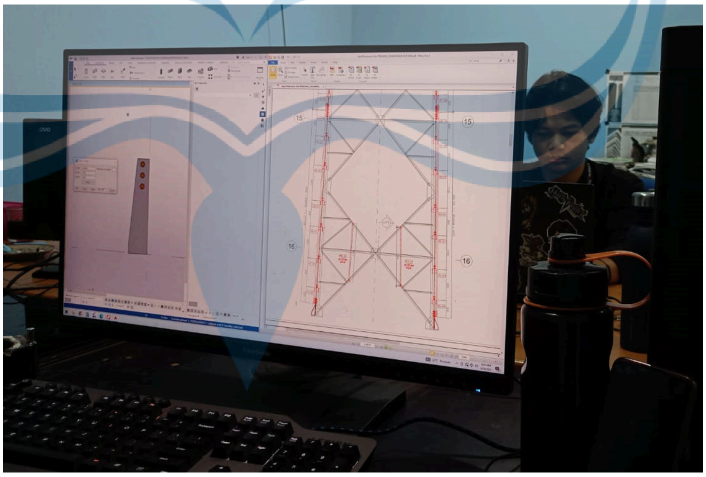


Figure 2.27 Building Information Modelling of Tower Structure using BIM Tekla Structure

The process of transitioning from BIM using Tekla Structures to a detailed Bill of Quantities (BOQ) is a streamlined and data-driven approach in modern construction management. Tekla Structures facilitates the creation of detailed 3D models of steel structures, offering a comprehensive digital representation that includes precise details of beams, columns, connections, and other structural components. Utilizing Tekla's parametric modelling capabilities, quantities of materials and components are automatically extracted based on detailed specifications assigned to each element in the model. This data-rich model serves as the foundation for seamless integration with dedicated quantity surveying tools such as excel, ensuring a smooth flow of information and alignment between the detailed BIM model and the BOQ.

2.12.2 Construction Method and Heavy Equipment

1. Steel Connection Design

In the structural analysis and design of steel structures, a crucial aspect involves the calculation of joints. While structural engineers have abundant calculation tools for members and their cross-sections, a noteworthy observation is that a significant number of construction defects stem from inadequacies in the structural design of joints. Interestingly, tools dedicated to the analysis, calculation, and design of joints are not as prevalent, and their functionality is often constrained to a limited range of joint types.

In the conventional analysis and design of steel-framed structures, joints are typically assumed to be either perfectly pinned or fully rigid. The fully rigid joint prohibits any relative rotation between connected elements, ensuring that the bending moment from the beam's end is entirely transferred to the column. Conversely, the perfectly pinned joint allows unrestricted rotation of connected elements, resulting in zero bending moment at the end of the beam. However, empirical studies reveal that most connections employed in current practice exhibit a semi-rigid nature, displaying behavior that falls between these two idealized scenarios.

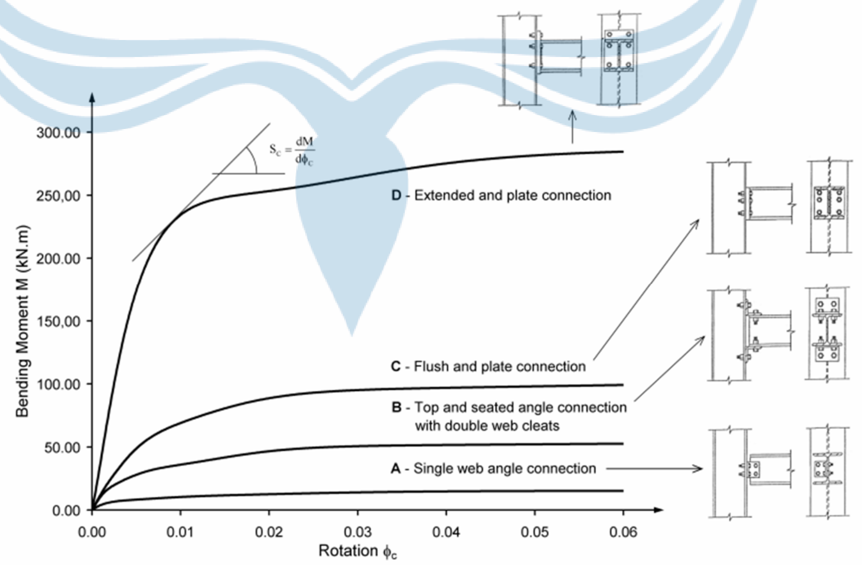


Figure 2.28 Moment-Rotation Curves Represented by Chen-Lui

When investigating connection behavior, it is crucial to assess the transmission capacity of forces from the beam to the column, considering the external loadings on the structure and the chosen solution for establishing the connection. Consequently, nodes may transmit axial load, shear, and/or bending moment, either individually or in combination, ensuring nearly perfect continuity between elements. The impact of axial force and shear force is considered negligible due to their minimal deformations compared to the rotational deformation observed in connections.

2. Structural Welding Code AWS D1.1/D1.1 M:2020

The AWS D1.1/D1.1M:2020 welding code is a vital industry standard published by the American Welding Society. Its primary purpose is to establish guidelines for the design, fabrication, and inspection of welded structures. This comprehensive code encompasses a range of critical aspects, starting with defining its scope and specifying the types of structures and materials it applies to. It serves as a foundational rulebook, ensuring uniformity and precision in welding practices across various projects.

One key focus of the code is the design of welded connections, where it provides detailed rules for creating robust and reliable joints capable of withstanding intended loads. It delves into the prequalification of welding procedures, ensuring a systematic approach to maintaining high-quality welds. Additionally, the code addresses the qualification of welders and welding operators, emphasizing the importance of skilled professionals in the welding process.

The AWS D1.1/D1.1M:2020 not limited to design methods, it extends its guidance to the fabrication and inspection stages. It dictates requirements for material handling, cutting, fit-up, and assembly during fabrication, ensuring a meticulous approach to the welding process. The inspection procedures outlined in the code play a crucial role in guaranteeing that the final welded joints meet the specified quality and performance standards. In essence, this welding code serves as a comprehensive and indispensable reSource for anyone involved in the welding industry, promoting safety, reliability, and consistency in welded structures.

3. ASME Section V Boiler and Pressure Vessel Code Non-Destructive Examination 2023

The ASME Section V of the Boiler and Pressure Vessel Code stands as a foundational document within the engineering community, offering comprehensive directives for Non-Destructive Examination (NDE) procedures. The 2023 edition of Section V represents the latest iteration of these guidelines, incorporating cutting-edge advancements in non-destructive testing techniques. These meticulous standards are integral to upholding the utmost levels of safety and reliability in the design, fabrication, and operation of boilers and pressure vessels.

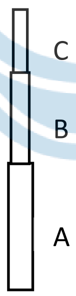
Within the ASME Section V framework, an exhaustive set of procedures and acceptance criteria govern various non-destructive testing methods, including ultrasonic testing, radiographic testing, magnetic particle testing, liquid penetrant testing, and visual examination. Each method is intricately detailed to address specific types of flaws or discontinuities that may exist within materials or welds. Additionally, the code addresses the qualification and certification of personnel engaged in NDE, underscoring the critical role of proficient professionals in ensuring the structural integrity of vital components.

The 2023 edition underscores the ongoing evolution of NDE technology and standards, equipping engineers and inspectors with the latest tools and methodologies for assessing the structural soundness of boilers and pressure vessels. By adhering to the rigorous guidelines delineated in ASME Section V, industries can instill confidence in the design, fabrication, and operational phases, fortified by robust non-destructive examination practices that proactively detect and address potential issues. This commitment ultimately enhances safety and reliability across industrial applications.

4. PLN JTM 9/200 Electric Pole Construction Methods

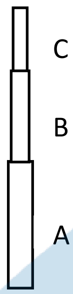
The fabrication of the PLN JTM 9/200 Electric Pole is made by using production pipe of PT. Krakatau Pipe Industries fand must follow the standard of SNI-0068:2013.

Table 2.2 SUTR Electric Pole Fabrication Standard

SPECIFICATIONS OF SUTR POLE			9/100	9/200	9/350	11/200	11/350
	A	Segment Diameter (mm)	139.8	190.7	216.3	190.7	267.4
		Pipe Thickness (mm)	6.0	6.0	7.0	6.0	267.4
		Segment Length (m)	5	5	5	5	5
	B	Segment Diameter (mm)	114.3	139.8	190.7	165.2	216.3
		Pipe Thickness (mm)	3.6	6.0	5.0	4.5	4.5
		Segment Length (m)	89.1	114.3	165.2	114.3	165.2
	C	Segment Diameter (mm)	2	2	2	2.5	2.5
		Pipe Thickness (mm)	180	131	123	233	151
		Segment Length (m)	152	233	304	270	379
	Maximum Flexural on Applied Load (mm)		180	131	123	233	151
	Weight (kg)		152	233	304	270	379

The Electric pole standard above is used only for the SUTR not for SUTM Electric Pole. The 11m length pole is defined as a special type of pole structure and used to satisfy 6m ground clearance at the lowest bracket of the SUTR.

Table 2.3 SUTM and SUTR Electric Pole Fabrication Standard

SPECIFICATIONS OF SUTM AND SUTR POLE			8/200	9/200
	A	Segment Diameter (mm)	190.7	190.7
		Pipe Thickness (mm)	5.0	6.0
		Segment Length (m)	4	5
	B	Segment Diameter (mm)	162.2	139.8
		Pipe Thickness (mm)	4.5	6.0
		Segment Length (m)	2	2
	C	Segment Diameter (mm)	114.3	114.3
		Pipe Thickness (mm)	4.5	4.5
		Segment Length (m)	2	2
	Maximum Flexural on Applied Load (mm)		108	131
	Weight (kg)		180	233

The Electric pole standard above is used only for the SUTM not for SUTR Electric Pole. The 12m length pole is defined as a special type of pole structure and used to satisfy 7m ground clearance at the lowest bracket of the SUTM.

The tolerance value of the table 2.1 and table 2.2 are:

- Outer Diameter : ±0.5%
- Thickness : +10% or -1.2%
- Length : Segment Length ±40mm

Both ends of the pole must be covered with the pole cover and connected by welds. To place the ground wire clamp on the top cover of the pole, it is determined prior to ordering. The points examined include the thickness of the pole sleeve and the thickness of the pole cover.

The entire surface of the pole must be evenly coated with anti-corrosion primer paint (zinc-chromate) with a minimum paint thickness of 50µm.

In the visual inspection process, the entire surface of the pole must be free from defects such as cracks and dents. The axis lines of the pole are measured in linear units. Welded parts should not create water puddles and welding residues on the entire surface of the pole and must be smoothed out. The maximum tolerance for deviation from the axis line is 0.2% of the pole's length.

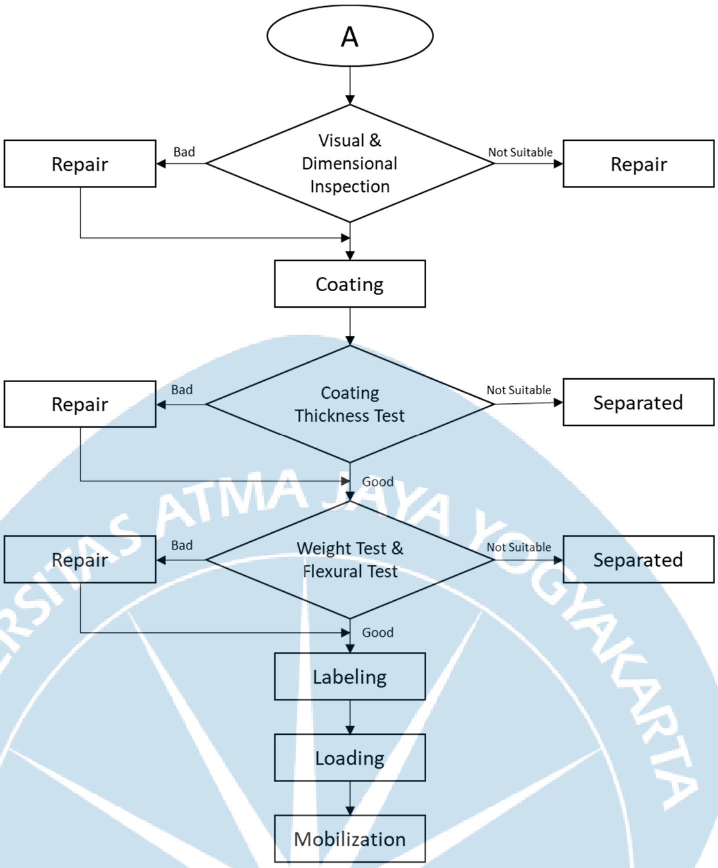


Figure 2.29 SUTM and SUTR Electric Pole Inspection Flowchart

2.12.3 Heavy Equipment Girder Crane

Girder crane is a robust and heavy-duty lifting solution designed to handle substantial loads in industrial settings. With a lifting capacity of 20 tons, these cranes are commonly employed in manufacturing plants, construction sites, and warehouses where the need to lift and move heavy materials is paramount. The girder design enhances stability and strength, allowing for efficient and safe material handling operations.

Equipped with advanced controls and safety features, this 30-ton girder crane ensures precision and reliability during lifting and positioning tasks. The crane's robust construction, including sturdy girders and a reliable hoisting mechanism, contributes to its ability to handle heavy loads with ease. The versatility of these cranes makes them an asset in various industries, optimizing workflow and contributing to the overall efficiency of material handling processes.

Figure 2.30 20-Tons Load Capacity Girder Crane

2.12.4 Steel Structure

PT. Krakatau Baja Konstruksi is participating in the MRT project bidding by assisting in designing Steel Buildings for the 8 Floor Motorcycle Smart Park MRT DKI Jakarta for the operational needs of parking solution. The design aims to be optimal in terms of both economic efficiency and structural strength. This calculation considering the strength and structural recommendations based on modeling and standards applicable in Indonesia.

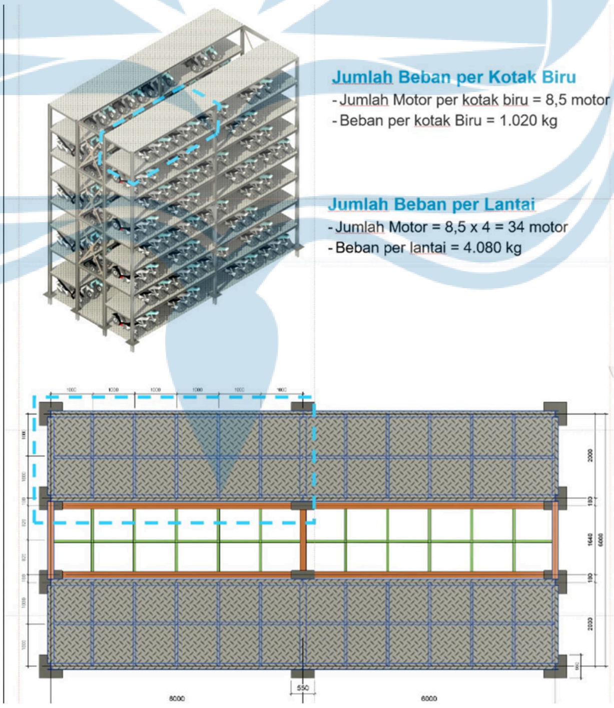


Figure 2.31 Concept from the MRT DKI Jakarta
(Source: PT. Krakatau Baja Konstruksi, 2023)

1. **Design Specification**

The design planning is based on the Indonesian National Standards (SNI), and these standards can be outlined as follows:

1. SNI 1727:2020 on Minimum Loads for the Design of Buildings and Other Structures.
2. PPPURG 1987 on Guidelines for Planning Loads for Houses and Buildings.
3. SNI 1726:2019 on Procedures for Earthquake Resistance Planning for Building and Non-Building Structures.
4. SNI 1729:2020 on Procedures for the Planning of Steel Structures for Buildings.
5. SNI 7860:2020 on Seismic Provisions for Steel.
6. SNI 8460:2017 on Requirements for Geotechnical Design.
7. (Reference) AISC 360-16 on Specification for Structural Steel Building.
8. (Reference) HB212:2002 Design Wind Speeds for the Asia-Pacific Region.

Table 2.4 Material Properties of 8-Floor Motorcycle Park MRT Jakarta

DESCRIPTION	MAIN STEEL STRUCTURE	ANCHOR BOLT
Grade	ASTM A36	ASTM A307
Fy	245 Mpa	245 Mpa
Fu	400 Mpa	430 Mpa
E	19995 Mpa	199995 Mpa
Density	7850 kg/m^3	7850 kg/m^3

2. **Stress Strain Result**

The structural analysis is conducted using the Midas Gen structural analysis program, with a 3D modeling approach for critical combinations of vertical, longitudinal, and lateral loads. The 3D model was constructed as a 3D moment frame. The bracing method is employed to mitigate the damage effects on components caused by lateral loads.

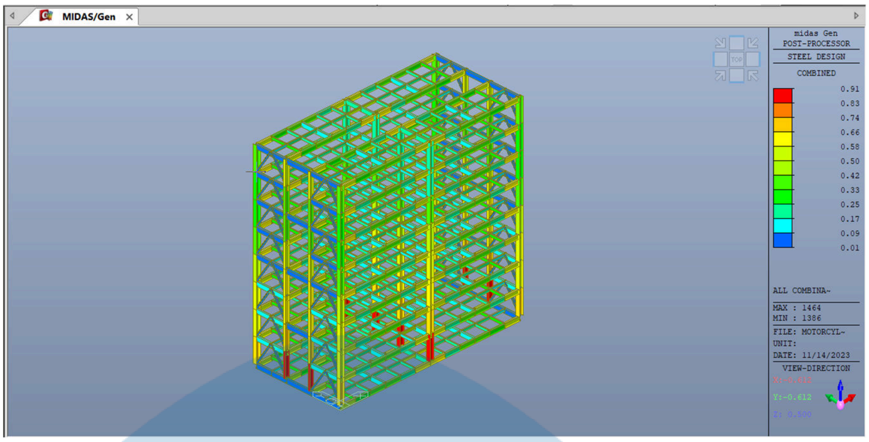


Figure 2.32 Structure Analysis of MRT DKI Jakarta

2.12.5 Building Material Technology

PT. Krakatau Baja Konstruksi produces two types of hot rolled steel product, namely reinforcing steel bar and profile steel such as H-Shape Beam (HB), I Shape Wide Flange Beam (IWF), Channel Profile (CNP), and Angle Profile. The standard use in this production is using Japanese Industrial Standard JIS400-SS400 and American Society for Testing Material ASTM36-A36.

a. Production Process of Deformed and Plain Steel Bar

The billet raw material is heated in a reheating furnace to a temperature of around 1100 to 1180°C using Liquefied Natural Gas (LNG) fuel. Cutting bars according to programs/orders, for example the bar sizes are 6 m and 12 m. After the cutting process is complete, they will be tied using a bundling machine. Below in Figure 2.3 is a flow diagram of the steel bone (thread) production process.

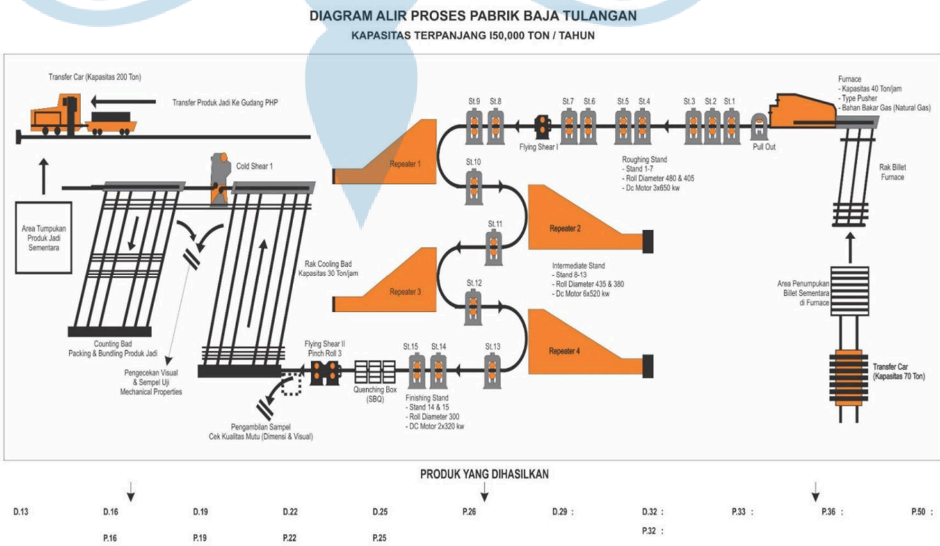


Figure 2.33 Steel Bar Production Process Flowchart
(Source: PT Krakatau Baja Konstruksi, 2021)

Forming is carried out by a rolling or steel forming process by passing the steel or metal between 2 (two) opposing rolls, with a gap between the thickness of the material entering. Before the rolling process, the billet is burned first in a furnace, the fuel used is natural gas which is distributed from a gas pipeline.

The billet is burned in a furnace at a temperature of ±1200°C until it reaches a hardness that can be formed. If the billet that has been heated reaches the desired level and is sufficient for the process, the billet is then pushed out with the help of an ejector to enter the rolling at 1st stand. After going through rolling at 3 stands in a row, each end of the bar is cut by a flying shear machine, after cutting at 3rd stand then continued with the rolling process in 5th consecutive stands. Next, in the finishing rolling process in the last 3 stands, the bar is formed according to the request for the type of bar, namely plain reinforcing steel and threaded reinforcing steel. Then the forming process, the bar passes through the second flying shear. After the steel formation is complete, the product is transferred to the colling bed to cool naturally. Then the iron is cut to size using a cool saw (a steel cutting machine to a certain size for packaging).

b. Production Process of Deformed and Plain Steel Bar

The billet/bloom raw material is heated in a reheater to a temperature of around 1150 to 1200°C. The fuel used is Liquefied Natural Gas (LNG). Bloom has a rectangular or square cross section with a thickness of 150 mm or 100 mm. Below in Figure 2.4 is a flow diagram of the profile steel (bar) production process.

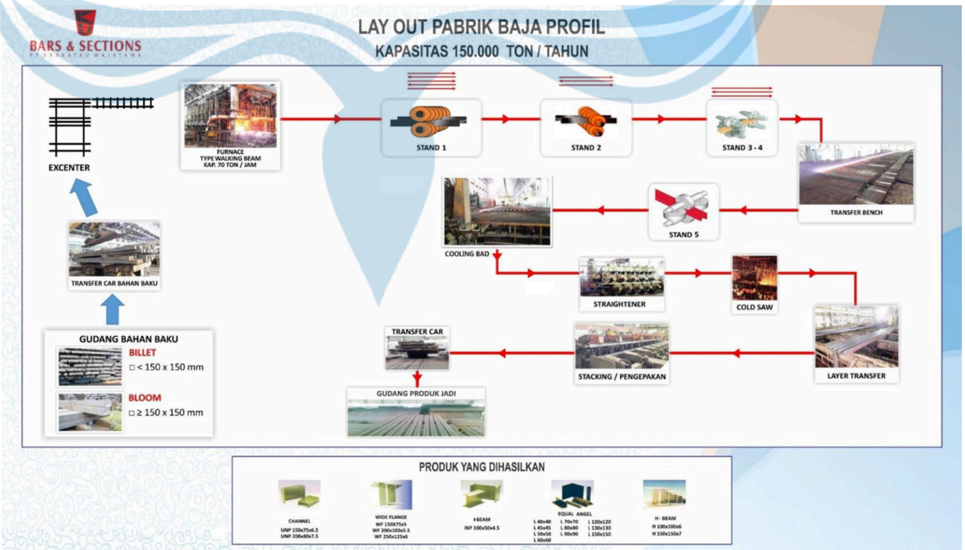


Figure 2.34 Steel Profile Production Process Flowchart
(Source: PT Krakatau Baja Konstruksi, 2021)

Forming is carried out by a rolling or steel forming process by passing steel or metal between 2 rolls in opposite directions, with a gap between less than the thickness of the material entering. Before entering the rolling process, the metal is first heated in a furnace at a temperature of + 12000C until it reaches a hardness that can be formed. As in other hot-working processes, temperature is very crucial for the success of the process.

Ideally the material is heated to a uniform hot temperature, if the temperature is not uniform then the next process will also not be uniform. If the material has been heated for an insufficient time so that the temperature is not uniform, the hot outer part will flow first. Additionally, if the material has undergone further cooling due to previous processing, the cooler surface will be more resistant to deformation.

Cracks or tears in the cold surface may occur as the hot, weak interior tries to drain. Next, the steel is formed by a rolling process in each rolling stand (there are 5 rolling stands). The rolling process rotates with surface speed exceeding the speed of the incoming metal, friction along the interface contacts acting to advance the metal. The metal is clamped, and the elongation is to compensate for the decrease in cross-sectional area.

2.12.6 Final Project Infrastructure II

The streamlined and data-driven method of moving from BIM with Tekla Structures to a comprehensive Bill of Quantities (BOQ) is a contemporary approach in construction management. In this example, the design BTS Telecommunication Tower SST45M material list for the BOQ can be described. Later, the detailed cost and time management of the fabrication of a tower is elaborated further in Chapter V.

A	COMMON BODY								
NO	SECTION	NAME	GRADE	MARKING	PROFILE	LENGTH (mm)	QTY	UNIT WEIGHT (Kg)	TOTAL WEIGHT (Kg)
1	COMMON BODY 1	LEG	SS400	9	L 150 x 15	3000	3	101.27	303.80
		MAIN BRACING	SS400	824	L 60 x 5	2202	3	10.06	30.19
		MAIN BRACING	SS400	825	L 60 x 5	2202	3	10.06	30.19
		MAIN BRACING	SS400	826	L 60 x 5	2112	3	9.65	28.95
		MAIN BRACING	SS400	827	L 60 x 5	2112	3	9.65	28.95
		MAIN BRACING	SS400	831	L 50 x 4	3554	3	10.85	32.55
		CROSS RD	SS400	833	L 40 x 4	1802	3	4.36	13.07
		GUSSET	A36	851	PL 6 x 246	320	3	3.71	11.14
		GUSSET	A36	852	PL 6 x 175	245	3	2.02	6.05
		GUSSET	A36	853	PL 6 x 175	245	3	2.02	6.05
	BASEPLATE ASSEMBLY			**BPL 46**					
		GUSSET	A36	895	PL 15 x 329	440	3	17.05	51.15
		GUSSET	A36	896	PL 15 x 329	440	3	17.05	51.15
		RIB PLATE	A36	898	PL 15 x 160	445	3	8.65	25.94
		BASE PLATE	A36	899	PL 45 x 450	450	3	71.53	214.60
TOTAL							**42**		**833.78**

Figure 2.35 Tekla Material List Output Example of Tower Structure
(Source: PT Krakatau Baja Konstruksi, 2023)