DESIGN OF TRASH COMB OF THE RIVER TRASH COLLECTOR CONVEYOR ON MALACCA RIVER BOAT

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**A thesis submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this thesis entitles "Design Of Trash Comb Of River Trash Collector Conveyor On Malacca River Boat" is the result of my own research except as cited in the references. This thesis report has not been accepted for any degree and is nor concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this thesis, and, in my opinion, this thesis adequate in terms of scope and the quality for the award of the Bachelor Of Mechanical Engineering Technology (Maintenance Technology) with Honours.

Signature : ____________________

Supervisor Name : TS. DR. NUR RASHID BIN MAT NURI @ MD DIN

Date : 24 January 2025

DEDICATION

This thesis is dedicated to both of my parents for their non stop support. For your unwavering love, support, and encouragement throughout this journey, I dedicated this thesis to you. Your belief in me has been my greatest strength, and I am endlessly grateful for your sacrifices and understanding. This achievement is as much yours as it is mine. Thank you for being my pillars of strength and for always inspiring me to reach for the stars. With all my love and appreciation.

ABSTRACT

This research focuses on the design and optimization of a trash comb for the river trash collector conveyor used on the Malacca River boat. The study addresses pollution concerns and inefficiencies in existing trash collection systems, aiming to create a more effective and sustainable solution. Using SolidWorks software, the project involved redesigning the trash comb, analyzing its structural performance, and optimizing it for enhanced functionality. Evaluations were conducted on stress, displacement, strain, and factor of safety to ensure the design's mechanical integrity and durability. The existing design, made from plain carbon steel, demonstrated limitations in corrosion resistance, longevity, and operational efficiency in marine environments. To overcome these issues, the improved design employed galvanized steel, which offers superior durability and resistance to corrosion. The optimized design features precise spacing and geometry, ensuring efficient debris collection while minimizing blockages and enhancing overall system reliability. These improvements not only increase the operational lifespan of the system but also reduce maintenance requirements, making it a cost-effective solution. The results confirm that the optimized design significantly outperforms the original in all evaluated aspects, including durability, environmental sustainability, and efficiency. By addressing key challenges in waste collection, the improved trash comb design provides a practical and robust solution to managing river pollution. This study successfully achieves its objectives, contributing to sustainable waste management practices and offering a valuable improvement to river cleanup operations.

ABSTRAK

Penyelidikan ini memberi tumpuan kepada reka bentuk dan pengoptimuman sikat sampah untuk penghantar pengutip sampah sungai yang digunakan pada bot Sungai Melaka. Kajian itu menangani kebimbangan pencemaran dan ketidakcekapan dalam sistem kutipan sampah sedia ada, bertujuan untuk mencipta penyelesaian yang lebih berkesan dan mampan. Menggunakan perisian SolidWorks, projek itu melibatkan reka bentuk semula sikat sampah, menganalisis prestasi strukturnya dan mengoptimumkannya untuk kefungsian yang dipertingkatkan. Penilaian telah dijalankan ke atas tegasan, anjakan, terikan, dan faktor keselamatan untuk memastikan integriti mekanikal reka bentuk dan ketahanan. Reka bentuk sedia ada, diperbuat daripada keluli karbon biasa, menunjukkan had dalam rintangan kakisan, jangka hayat dan kecekapan operasi dalam persekitaran marin. Untuk mengatasi isu-isu ini, reka bentuk yang dipertingkatkan menggunakan keluli tergalvani, yang menawarkan ketahanan dan ketahanan yang unggul terhadap kakisan. Reka bentuk yang dioptimumkan menampilkan jarak dan geometri yang tepat, memastikan pengumpulan serpihan yang cekap sambil meminimumkan sekatan dan meningkatkan kebolehpercayaan sistem secara keseluruhan. Penambahbaikan ini bukan sahaja meningkatkan jangka hayat operasi sistem tetapi juga mengurangkan keperluan penyelenggaraan, menjadikannya penyelesaian yang kos efektif. Hasilnya mengesahkan bahawa reka bentuk yang dioptimumkan dengan ketara mengatasi prestasi asal dalam semua aspek yang dinilai, termasuk ketahanan, kelestarian alam sekitar dan kecekapan. Dengan menangani cabaran utama dalam pengumpulan sisa, reka bentuk sikat sampah yang dipertingkatkan menyediakan penyelesaian yang praktikal dan mantap untuk menguruskan pencemaran sungai. Kajian ini berjaya mencapai objektifnya, menyumbang kepada amalan pengurusan sisa yang mampan dan menawarkan peningkatan yang bernilai kepada operasi pembersihan sungai.

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In the name of Allah, the most gracious, the most merciful

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Last but not least, I want to thank me, I want to thank for believing in me, I want to thank me for doing all this hard work, I want to thank me for having no days off, I want to thank me for never quitting, I want to thank me for always being a giver and trying to give more than I received. I want to thank me for trying to more right than wrong. I want to thank me for just being me at all times.

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LIST OF SYMBOLS AND ABBREVEATION

UTeM	-	Universiti Teknikal Malaysia Melaka
PPSPM	-	Perbadanan Pembangunan Sungai dan pantai Melaka
3D	-	3 Dimension
2D	-	2 Dimension
CAD	-	Computerized Aided Design
FTKM	-	Fakulti Teknologi Dan Kejuruteraan Mekalniakal
PVC	-	Polyvinyl Chloride
DC	-	Direct Current
N	-	Newton

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CHAPTER 1

INTRODUCTION

1.1 Background

Over the years the Malacca River, one of the most well-known waterways in the state of Malacca, has been left in an increasingly terrible state of pollution. According to Sinar Harian (15 March 2024) reported, quality of the Malacca River was at moderate contaminated since 2021 to 2022 with quality index is 80.1 to 80.3. There are severe ecological and human health risks associated with this pollution for the river and the people that depend on it. A growing population in addition to the expansion of residential areas has had a direct impact on the increase in domestic sewage and solid waste in the river.

In this regard, contamination that has been happen to the river could be great aided by using trash collector conveyor. Previously, authorities of the Malacca just use traditional method to collect solid waste at the surface of the river which is it will take to long time and required a lot of manpower to help clean along the river. Besides, authorities of Malacca River also need to spent high cost when to clean surface of the river which is need to pay the salary of the manpower. In addition, workers only see large and easy to reach trash when cleaning work is carried out where small trash will be left directly in the river and cause the cleaning process to become less efficient.

Trash collector conveyor appears as a critical field of research and development, providing a path way towards more sustainable and efficient trash collection, against the backdrop of rising costing and environmental concerns especially. This study seeks to help or make the cleaning works become more effective and efficient but for surely to recover condition of the river become more clean and free solid waste. Additional, it also may help governments to save costs when need to make cleaning operation due to not having to pay the wages of many workers to carry out cleaning work.

1.2 Problem Statement

The current design is too simple and doesn't effectively address potential challenges. It uses plain carbon steel, which is cheap and easy to get but may not provide the best mix of strength, durability, and corrosion resistance for tough applications. Additionally, the design has inefficiencies that can result in lower performance, higher material usage, or increased operational costs. A more refined and thoughtful approach could improve both the efficiency and suitability of the design for its intended purpose.

The design focuses on a more attractive look by using galvanized steel, which not only looks better but also offers better durability and corrosion resistance, making it perfect for use in aquatic environments. The design is more efficient, effectively collecting different types of debris on the river's surface.

The trash comb is a key part of the trash collector conveyor, capturing and directing waste towards the conveyor system. Its improved design ensures that debris, no matter the size or shape, is easily trapped and guided for removal. The spacing and angle of the comb teeth have been carefully adjusted to maximize debris collection while preventing clogging which could disrupt operations. This improved design balances functionality, durability, and aesthetics, making it highly effective for keeping rivers clean.

1.3 Research Objective

1.0 To design existing trash comb and trash collector conveyor using Solidwork software.

2.0 To analysis the existing design of trash comb to improve design based on material trash comb component.

3.0 To analyze and compare the existing and improve design trash comb.

1.4 Scope Of Research

1.0 Using existing trash collector conveyor that developed by using Solidwork software.

2.0 Using solidwork software to analyze current design trash comb component.

3.0 Improve design trash comb using solidwork software that has been developed by using SolidWorks software

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, relevant literature for a particular research field is identified, evaluated and summarized. It could be looks to the knowledge that has been studied or developed before, which is generally known, what emerges, and how the topic is currently being considered. In this section will be describe the type of conveyer, trash comb design and function, and materials and manufacturing of the trash comb conveyer.

Conveyors, like all material handling equipment, does not provide in, and of itself, any value to the part, product or piece being moved. They do not shape, mold, anoint, or transform a product in any way. These are absolute service processes and a service is indirectly related to the cost of the product by means of being one of the expenses. Here are some of the high-level goals of implementing the conveyors. Minimize actual manual handling. Do all handling operations at the Cheapest rate tier. Use automation to minimize manual steps.(McGuire, 2023)

Belt conveyor is one of the most widely used continuous transport equipment in industrial, this common belt conveyors known with the other name called the belt conveyor. The excess materials can be simply conveyed with continuous transport devices

control over human Weight and Height, A belt conveyor which is applied to different industries must consider reasonable standards and personalized demands, so which industries.such as sterility in the food industry or increased longevity for mining or construction application (Ryba et al., 2024).

2.2 K- chart

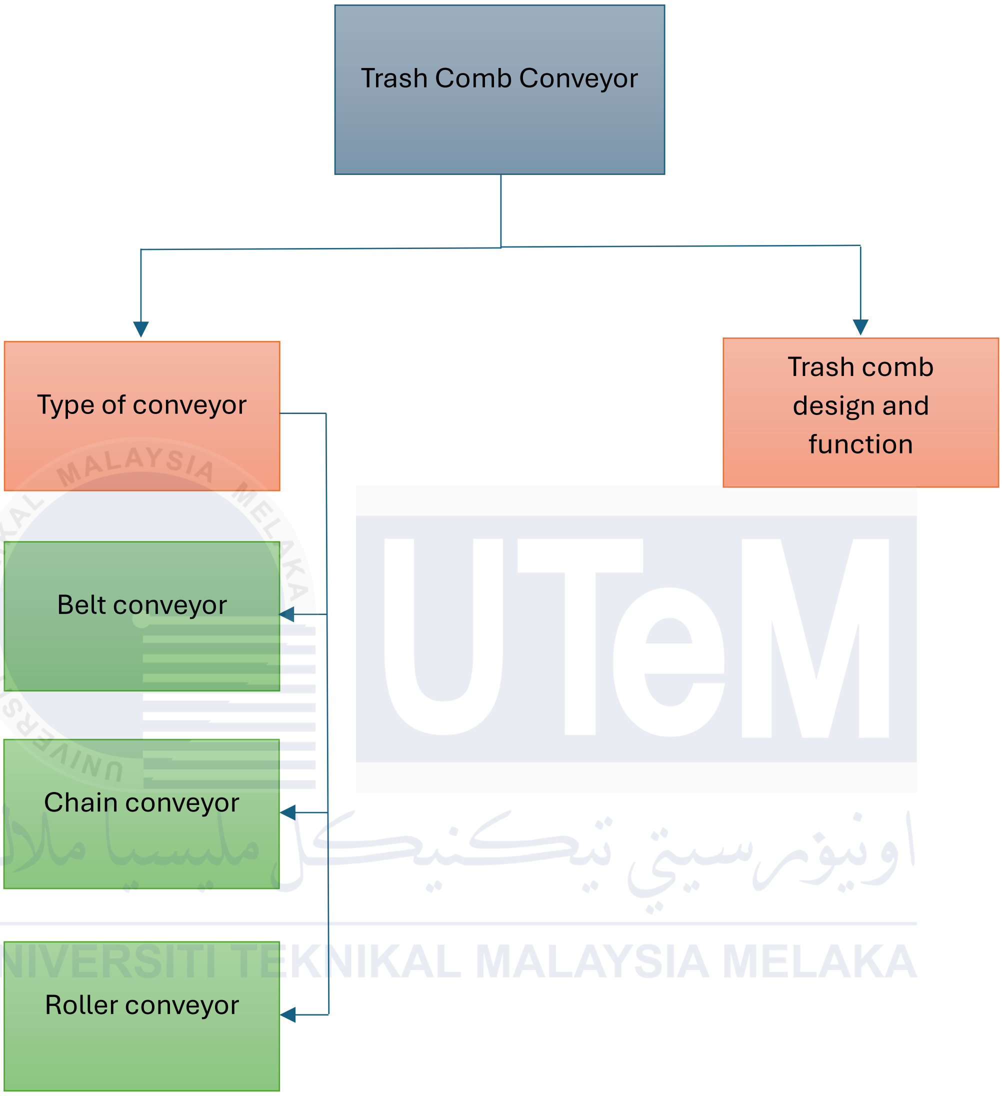

Figure 1.1 K chart

2.3 SolidWorks

SOLIDWORKS is a top 3D design software used in various industries to create detailed 3D models and assemblies. It uses a constraints-based system that allows designers to define shapes with specific dimensions and relationships, making sure the design intent is clear. This software is popular in fields like aerospace, consumer goods, life sciences, transportation, and energy. Professionals such as mechanical engineers, product designers, architects, and electrical engineers use SOLIDWORKS for its strong features. These include a comprehensive CAD library, automation tools, real-time cost estimation, interference checking, and the ability to create 2D drawings from 3D models. SOLIDWORKS uses a parametric design approach, so any changes made to a part are automatically updated in all related drawings and assemblies. This ensures consistency and accuracy throughout the design process. The software has an intuitive user interface with familiar Windows functions, making it easy for both beginners and experienced users. There are also many tutorials and resources available to help new users learn basic concepts like sketches, features, assemblies, and drawings, providing a solid foundation for developing design skills.(Tickoo, 2020)

Figure 2.1 SolidWorks logo

2.4 Advantage of SolidWorks

SolidWorks enhances design efficiency by significantly reducing development time with tools like design tables, configurations, and library features. Design tables automate the creation of multiple part or assembly versions, while configurations allow multiple versions within the same file, and library features provide reusable components, saving time on repetitive tasks. The software also facilitates the conversion of 3D models into 2D drawings, ensuring accuracy through automatic generation of views and dimensional annotations. Any changes made to the 3D model are automatically reflected in the 2D drawings, which can be exported in popular formats like DWG and DXF, boosting productivity, accuracy, and collaboration throughout the design and manufacturing process.(KUSHNIRCHUK et al., 2023)

SOLIDWORKS offers comprehensive simulation and analysis tools that help designers validate their designs virtually, reducing the need for physical prototypes and cutting development costs. Finite element analysis (FEA) examines stress, displacement, strain, and deformation, identifying weak points and ensuring structural integrity. The software also supports thermal and fluid flow analysis, optimizing heat transfer and fluid dynamics. Design optimization tools automate iterations to improve material selection, geometry, and weight. By spotting potential issues early, SOLIDWORKS enhances efficiency, reduces costs, and ensures high-quality, reliable designs.(Hindroyuwono et al., 2024).

SOLIDWORKS is great at connecting design with manufacturing, making it easier to go from idea to production. It provides detailed specifications and simulations to ensure designs can be made efficiently. Designers can create precise models with important dimensions and annotations needed for manufacturing. The software's simulation tools analyze designs under real-world conditions to ensure they are ready for production. SolidWorks also offers cost estimation and manufacturability checks to identify and fix design elements that could make production complex or expensive. By allowing smooth collaboration between design and manufacturing teams, it helps products move quickly from concept to market, reducing development time, minimizing errors, and accelerating time to market, all while maintaining product quality.(Dragne et al., 2022)

SolidWorks helps reduce errors and improve quality by providing robust analysis tools that identify potential design flaws early in the development process. Its simulation features, like finite element analysis (FEA), thermal analysis, and motion studies, allow engineers to test designs under real-world conditions and find issues such as stress points, material weaknesses, or functional inefficiencies before production. This proactive approach minimizes costly revisions, rework, and delays associated with fixing flaws later in the manufacturing phase. By ensuring that designs meet performance, safety, and reliability standards, SOLIDWORKS greatly improves product quality. Additionally, its manufacturability checks and automated validation tools further reduce the risk of errors, streamline the workflow, and instill confidence in the final product while saving time and resources.(Sribna et al., 2024)

2.5 Trash Collector Conveyor On Boat

A trash collector conveyor on a boat is an innovative way to tackle river pollution caused by floating debris. This system operates in rivers, effectively collecting and removing trash to improve water quality and reduce environmental hazards. Equipped with a conveyor mechanism, it captures debris like plastic waste and organic matter, channeling it into onboard storage for proper disposal or recycling. By targeting polluted rivers, these boats help prevent trash from reaching larger bodies of water, such as oceans, where it can cause significant ecological damage. Additionally, it contributes to public health by reducing waterborne pollutants and fostering cleaner communities.

Innovative trash collector boats use conveyor belts to efficiently gather floating debris, integrating advanced technologies like sensors, motors, and control units to automate the process and reduce manual labor. Many designs include ultrasonic sensors and cameras to detect trash and navigate around obstacles, while autonomous navigation systems allow the boats to adapt to various water conditions using real-time data. These features improve efficiency, collect more debris, and lower operational costs, making trash collector boats both environmentally beneficial and technologically advanced solutions for water pollution.(RaviChandra, 2023)

Trash collector boats are adaptable vessels designed to remove floating debris, like plastics, from various water environments such as urban drains, rivers, lakes, and coastal areas. These boats are critical for fighting water pollution, clearing harmful waste that can damage ecosystems and harm aquatic life. By cleaning up waterways, they not only reduce pollution but also improve the look of these areas and support healthier ecosystems. Using trash collector boats is an essential part of efforts to protect and restore our waterways' ecological health.(Masood & Seelam, 2022)

2.6 Galvanize Steel

Superhydrophobic coatings on galvanized steel, usually created through chemical etching and materials like graphene oxide, significantly boost the metal's resistance to corrosion. These coatings form micro-nano sized structures on the surface, enhancing the steel's protective properties. The superhydrophobic surface effectively repels water and contaminants, preventing corrosion and extending the material's lifespan in harsh environmental conditions. This advanced coating technique is a highly effective solution for protecting galvanized steel from the harmful effects of corrosion.(Chen et al., 2023)

The hot-dip galvanizing process can affect the mechanical properties of high-strength steels, reducing their yield strength and tensile strength because of the high temperatures used, which alter the steel's microstructure. This can decrease the hardness of the steel, especially in ultra-high-strength steels, making them more prone to deformation and less able to handle extreme stresses. While galvanizing offers excellent corrosion protection, it's important to consider these effects on the steel's mechanical properties when choosing materials for specific uses.(Najafabadi et al., 2021)

Galvanizing is considered environmentally friendly because it provides long-lasting corrosion protection, reducing the need for frequent maintenance and replacements. This means less resource consumption and waste generation. The extended service life of galvanized coatings not only saves money by minimizing repair and replacement costs but also supports environmental sustainability by cutting down on manufacturing and disposal impacts. Therefore, galvanizing is a cost-effective and sustainable way to enhance the durability and performance of metal structures.(Ibrahim & MacIntyre, 2023)

2.7 Plain Carbon Steel

Plain carbon steel rusts easily, especially in marine environments where seawater speeds up corrosion. This makes it unsuitable for critical uses like submarines, which are constantly exposed to seawater. The ongoing exposure to corrosive elements can weaken the steel, leading to failures that dangerous the vessel's safety and functionality. To avoid these problems, materials with better corrosion resistance, such as stainless steel or coated steel, are preferred for marine applications to ensure they stay durable and reliable.(Tian et al., 2023)

Plain carbon steel has high thermal conductivity, which can cause increased die wear during processes like wire drawing. Since the steel absorbs and transfers heat quickly, it leads to higher temperatures in the die and takes longer to reach thermal equilibrium. These high temperatures create more friction and stress on the equipment, causing the dies to wear out faster. As a result, industries using wire drawing might choose materials with lower thermal conductivity or apply coatings to reduce wear and make the tools and equipment last longer.(Hwang, 2022)

Plain carbon steel is cost-effective but has lower yield and tensile strength compared to high-strength steels, limiting its use in applications needing higher strength and durability, like structural or heavy-duty components. Techniques like flash processing can improve the strength of plain carbon steel, but these add complexity and costs. So, while plain carbon steel is suitable for some uses, it might not always be the best option when high strength is essential.(Guo et al., 2021)

2.8 Trash comb of the river trash conveyor.

Pollution, particularly plastic waste, is a serious concern for river ecosystems, damaging fragile aquatic environments and also being a major threat to human health and the environment as a whole. To tackle this urgent environmental problem, river trash conveyors mounted on boats have been proposed. All of these systems are commercially available solutions, designed to trap, collect, and remove floating debris quickly, and eliminate a portion of the pollution that would otherwise be taken downstream.

Figure 2.2 trash collector machine.

Combating water pollution (especially plastic) using river orchestrates mounted on boats These conveyors come with a device that can trap floating debris and are a pre-emptive measure to avoid the trash passage to larger bodies of water. Finally, recent developments in materials and design have made these systems more energy-efficient and environmentally friendly, representing a significant step toward reducing the environmental impact of their proliferation.

2.9 Introduction of belt conveyor

A belt conveyor is the basic and most common Modul type mechanical handling system that is used to transfer material from one point to another in factories, at most of the places. A conveyor system consists of an endless belt of movable material such as rubber and pulleys that are used to move the belt Once the belt is installed, the motor-driven pulley turns the belt, safely and non-stop along a predetermined track, to transport the materials.

Figure 2.3 belt conveyors

Belt conveyor are used for transporting bulk and packed goods in production lines and material handling. Horizontal, inclined, and even declined sections can be configured on which items can be transported on many different planes, over different paths. Basic Components of Belt Conveyor consist of the following head pulley tail pulley 1 simple supporting frame drive idlers 2 belt the belt consists of layer of material/better to say rubber usually.

The belt conveyor is also prized for its ability to transport large amounts of material extremely fast, crucial to the operations of any high throughput, efficiency driven industry.

For example in manufacturing, they optimize the flow of parts and products between different production areas, as in mining they enable the movement of ore from extraction nodes to processing plants. By rugged applications in agriculture, belt conveyors are used to transfer grains and seeds and increase the productivity of the entire industry.

2.9.1 Belt Conveyors

Belt conveyor can be divide into two situations, for the first situation is the conveyor become horizontal or flat and the second situation is incline conveyor. This two type situation of the position is based on depending on the needed. For example to move the palm tree from the bottom to put into the vessel, so its means this situation need incline belt conveyor. As we known usually horizontal belt conveyor just function to move something such as parcel at the courier warehouse form one point to one point. Based on the journal, when the belt conveyor become horizontal situation the stretch of the belt lower compare to inclined belt conveyor the stretch of the belt more than usual. Energy consumption for inclined belt conveyor also higher than horizontal conveyor because to move the thing going to up. (Opasiak et al., 2022)

Belt conveyor usually are made from rubber. As we known life spent a rubber just a short time period using. These belt may lack of strength required for heavy duty application. When use rubber as belt to the conveyor, it need more attention when the conveyor operates. In short time, the rubber become broke and need to maintain or usually replace the rubber. It can cause the cost of the maintenance become higher because the life spent of the rubber to short. Besides it also can increase the downtime cause by maintaining and replacing the belt. In this journal, to make the belt conveyor become more efficient and durability it was replace from the rubber to knit fabric with monofilament to improve strength and prevention of fraying during operation.(Susumu Shoji et al., 2012)

2.10 Chain conveyor.

Chain conveyors are among the most popular in waste management systems for their ability to convey various kinds of waste materials with great strength and speed. The purpose of this literature review is to identify current trends, future possibilities, and limitations of chain conveyors in waste management as seen from the literature.

Figure 2.4 Chain conveyer

Chain conveyors are one of the most common equipment seen in the different sectors because of its durability and multifacetedness. Typical uses are in the automobile industry for moving vehicles and parts, and in general in the manufacturing industry for heavy products and materials. In other industry sectors the chain conveyor is also used for conveying geological material like ore or minerals, solid waste materials or organic waste, food items and other components. Chain conveyors are desirable because they are built to handle heavy loads and are able to withstand the harsh chain conditions that are synonymous with continuous conveyor use, can accommodate wide variety of materials such as abrasive or lumpy material, and can be purpose-configured to be any length at a variety of speeds and configurations.

The paper mentions the chain type conveyor that is specifically designed to be robust and consists of a driving motor, the transmission shaft, a fixed conveyor belt. Fixed supports, adjustable supports, and synchronous belt supports are arranged to support the conveyor system. Essentially, will be able to get the most out of this configuration especially with adjustability and since it makes it easier to use. The adjustable supports, which have corresponding through holes and nuts in alignment with the screw rods for the belt, that can adjust the tension of the conveyor belt easily. Also, this feature allows the conveyor system to be tailored for different loads or types of material adding to the versatility and productivity of the conveyor system. The design of this type of chain conveyor makes it a great operation are necessary to maintain top performance and productivity.(Ren Haiyan et al., 2017)

These are used to convert products along an assembly line or around a production or warehousing centre and are widespread in the industry. Chain conveyors are designed for conveying heavy unit loads, including pallets, grid boxes, and industrial containers. Manufactured in single or double chain strand configuration The chains take the position under load and the friction will thereby pull the load forward. Chain conveyors are relatively worriless in installation, most important, they require very low maintenance for users.(Kulkarni et al., 2018)

They are part of the class of traction conveyors and use one or more closed chains that circulate around the head and tail end sprockets and transport goods. These assisted by either slides or rollers in different engineering fields to manage gravitational resistance offered by the belt and load. These sliding guides are designed for light duty, low capacity conveyors, i.e., short or semi-portable conveyors, for long systems as would result in power losses and travelling problems. This makes chain conveyors flexible and indispensable within industrial settings, as their chain-sprocket mechanism enables continuous material flow.(Blatnický et al., 2018)

2.11 Bucket conveyor.

A bucket elevator, also known as a bucket conveyor, is a material handling equipment used for the vertical transportation of bulk materials and dry, powdery, and granular materials. It consists of a series of buckets connected to a belt or chain so that they are utilized to carry material from one location to another, with all this means from a lower to a higher level. Buckets, belt or chain to which the buckets are attached, and the drive mechanism that powers the system are major components Block, sprockets or pulleys guide the movement Casing to enclose the system and prevent spillage.

Figure 2.5 Bucket conveyor

Bucket conveyors have multiple uses in many fields, regardless of whether agricultural, in which they are used to carry several thousands for grains and seeds in foods processing, employed to carry numerous ingredients and accomplished products throughout mining together with minerals, employed to move are really and coal; in epoxy and building materials, employed to convey concrete and sand and with waste administration and recycling, taking care of and mailing waste. Bucket elevators have many advantages over other methods of material handling which include the ability of conveying material in direct vertical direction or inclined direction, versatility to suit for handling almost any type of materials, good handling of dust or slurry material and clean environmental area.

It contains an electric motor and a mechanical transmission with a gear; it is mounted on a sliding frame relative to the supporting structure of the upper endmember of the face conveyor. Stars of the drive shaft and chain are mounted on the bearings of the supporting structure and connected through the chain transmission with the mechanical gear. By means of the electric motor, a worm gear and, in turn, tensioning screws of the tensioning apparatus. Also the device is provided with drive — a manual or automatic system of movement, in case of a motor fail, and regulation of a chain tension within a return end station.(Jendrysik et al., 2024)

The conveyor system has consistently established itself as a solid, reliable performer over many years of service; and with good reason. Together with a strong conveying ability, it is easy for the materials to move quickly. These are built to last, which means the system is durable enough to handle daily use. That will enable long base material transportation for industrial applications. Operational costs are likely to be lowered as the conveyor system has lower cost of operation. Since it requires low maintenance, that means it is built for minimal service and keeps you less downtime.(Chen Caixia, 2019)

2.12 Trash comb & functioning.

The trash comb conveyor trash collector is a modern waste management system fabricated to deliver superior services in collecting, separating, and transporting waste materials. The bucket comb chain conveyor, offers an efficient, durable solution for waste conveying, combining the functions of a bucket comb. Many people need effective equipment, where the bucket comb is designed to accurately pick up and sort rubbish for a subsequent proper disposal of different materials. The trash comb conveyor trash collector element combines with those features other critical components offering enhanced operational efficiency, reduced maintenance cost and benefit to the environments, making the trash comb conveyor trash collector a necessity for modern waste management requirements.

To effectively gather trash, the boat uses a conveyor belt system that is positioned at the water's surface. With the forward movement of the boat through the water, the conveyor belt continually rotates. As the boat moves, the floating garbage on the river is pushed towards the conveyor belt. Floating garbage is brought with a spiral conveyor belt into a collection net on the spiral path. The garbage is automatically collected and drained into the collecting net for further hard processing. An essential element of this is a level sensing system which in combination with the kayak-based debris 'paddlewheel' ensures that the boat is picking up a controlled and efficient load of garbage as it makes its way up the rivers without the need for a crew or anyone to staff it during the garbage collection process (Yang Zhanying, 2020).

It has an automated waste collection system under which the bot can collect floating materials and waste from water bodies. This bot is outfitted with special appendages, i.e., nets or scoops, to act as traps when it captures waste. Waste collection is enhanced through the strategic placement of the elements during the cleaning process. Smart sensors and detection technology can detect and locate waste in the water, which the bot and remove it from its way. With the use of such technologies, the bot can quickly identify and gather waste materials of all kinds from the water. The bot would probably have storage compartments or such to keep the collected waste safe. The storage is essential as it allows the bot to continue cleaning for longer periods without requiring frequent waste disposal.(Rohan M. Ingle et al., 2021)

The utility model discloses a river surface rubbish collecting ship. The river surface rubbish collecting ship comprises a ship body, a rubbish collecting cavity is formed in the ship body, a rubbish collecting device is fixedly arranged at the front end of the ship body and comprises water wheels which are symmetrically arranged on the left side and the right side of the ship body, a transmission shaft is connected between the two water wheels, a driving wheel is fixedly arranged on the transmission shaft, a supporting frame is fixedly arranged at the front end of the ship body, a connecting shaft parallel with the transmission shaft is fixedly arranged on the supporting frame, a driven wheel is fixedly arranged on the connecting shaft, the driving wheel and the driven wheel are provided with a rubbish conveying belt, the front end of the rubbish conveying belt is obliquely arranged downwards, a rubbish collecting cover is arranged in front of the rubbish conveying belt, a rubbish outlet of the rubbish collecting cover is arranged towards the working face of the rubbish conveying belt, and the rubbish collecting cover is fixedly connected with the front end of the ship body. Due to the technical scheme, the river surface rubbish collecting ship is simple in structure and convenient to operate, rubbish floating on a river surface and a lake surface can be automatically fished by the rubbish conveying belt immersed in water, hard work caused by manual fishing is saved, and the working efficiency is high.(Xue Qixiong, 2015)

The trash comb is a unique innovation that combines the functionality of a bucket comb with a chain conveyor system. This integration enables efficient waste management and disposal by utilizing the strengths of both components. The bucket comb facilitates the collection and separation of trash, while the chain conveyor ensures smooth and continuous movement of the waste material. Together, they form a robust system that enhances productivity and effectiveness in handling various types of waste. This inventive approach not only streamlines the process of waste management but also contributes to environmental sustainability by optimizing resource utilization and minimizing manual labor. Overall, the trash comb represents a significant advancement in waste handling technology, offering a comprehensive solution for the challenges associated with waste disposal.(Rafi et al., 2021)

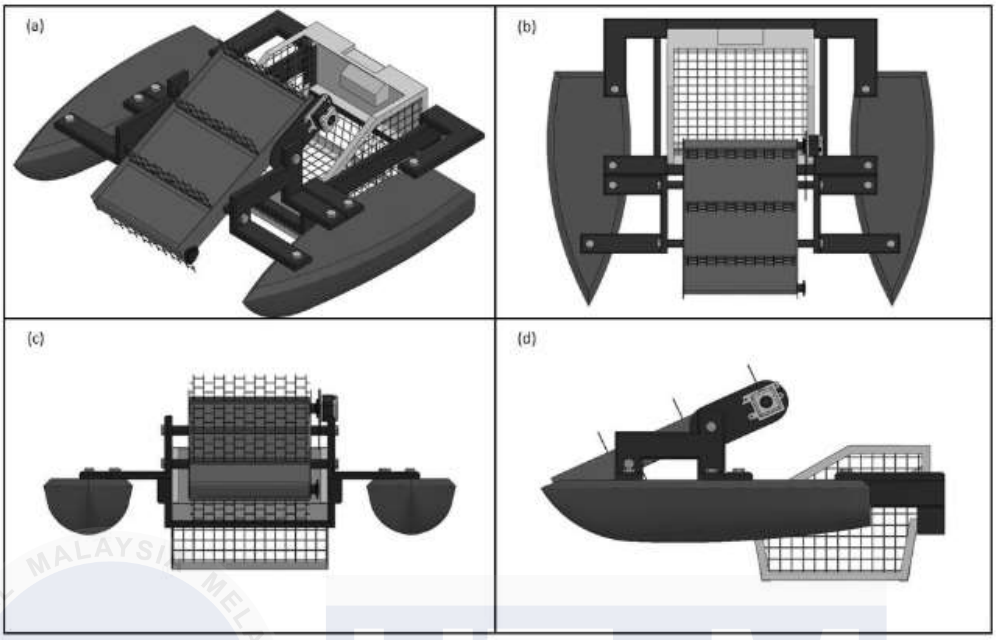

Figure 2.6 3D design of trash conveyor

The conveyor system is a key feature of the trash collector boat, designed to gather floating debris from surface water efficiently. It is a common element in most trash collector boat designs. The conveyor is constructed from aluminum, gasket rubber, and PVC pipe, with wire mesh for collecting trash. It includes a DC motor for speed control, adaptable to the collection area. Additionally, a relay wireless remote control allows for forward and backward movement control within a 300-meter range.(Abdullah et al., 2019)

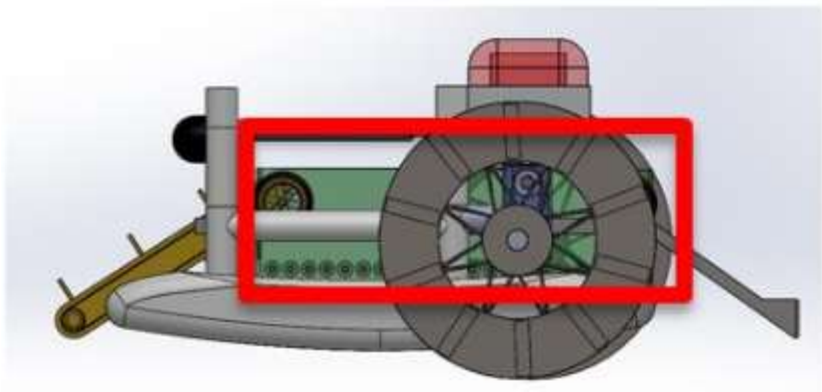

Figure 2.7 sample model of trash collector conveyor

The design of the conveyor is use belt conveyor. The trash comb that is used is also shaped like a plate that is installed at a distance so that it can prevent the trash from falling down again after going up on the surface of the conveyor. based on the design, it is somewhat less suitable and efficient because it can cause the conveyor not only to transport garbage but sand and rocks will also be transported and put into the garbage collection container and in this case can also cause the ecosystem to be disturbed.(Othman et al., 2020)

Table 2.1 Summary of Research

Bil	Literature title	Strength	Weakness	Notable features	Reference
1.	Conveyors application, selection and integration, second edition	Reduce workers and also improve productivity	conveyors do not contribute enhancement to the product.	Minimizing manual step in material handling process.	(McGuire, 2023)
2.	Monitoring of rubber belt material performance and damage	Belt conveyors can use in any type of industries.	Need to regular maintenance according to continuous operation that can cause wear and tear to avoid breakdown.	Belt conveyors easily adapted to fulfil industries needed whether requiring for production and increased durability mining and construction.	(Ryba et al., 2024)
3.	Rollers for belt conveyors in terms of rotation resistance and energy efficiency.	Belt conveyors can be use in either which is horizontal or inclined that based on material handling needed.	Inclined belt conveyors use more energy to move material upwards and could be lead to higher operational costs.	Ability to operate in both situation either horizontal or inclined position, providing versatility for different material handling requirements.	(Opasiak et al., 2022)
4.	Conveyor belt and drivebelt comprising knitted belt, and conveyor device using conveyor belt.	New material enhance durability of the belt and can reduce cost such as maintenance cost.	Initial cost of replacement of the knit fabric belts with monofilament maybe higher	The belt is made from knit fabric that combine with monofilament which is provide strength.	(Susumu Shoji et al., 2012)

5.	Chain type conveyor	This type of conveyor specifically designed to be robust that ensuring durability and reliability.	The components more complex and will take long time consuming.	These conveyor provide necessary motion and ensuring efficient operation.	(Ren Haiyan et al., 2017)
6.	Design of continuous loading vertical chain conveyor.	These conveyors required low maintenance that enable reduce cost of maintenance and reduce downtime.	This type of conveyor less flexible in handling small material compared to others.	The design flexible due to meet different load and operational requirements.	(Kulkarni et al., 2018)
7.	Structural design of soldering station chain conveyor working position.	The mechanism of conveyor ensures continuous flow of material and enhance operational efficiency.	Not suitable for long term cause the system may power losses that can be affected efficiency and performance.	Ensures a reliable and continuous material flow, crucial for maintaining productivity.	(Blatnický et al., 2018)
9.	Operation optimization of a bucket conveyor transporting wastes in the processing plant of a hard coal mine.	The device integrates an electric motor with a mechanical transmission which can offer efficient operation	The integration of multiple components may cause in a complex system that could be difficult to maintaining.	Combining electric mototr with mechanical system can cause balance precision and power.	(Jendrysik et al., 2024)
10.	Horizontal chain bucket conveyor for analysis tower feeding conveyor.	The conveyor prove to be a solid and reliable for a long time.	-	Materials can move quickly through system.	(Chen Caixia, 2019)
11.	River garbage clearing boat	The system operate without any help from workers that can reduce	The system relies on the forward movement of the boat to push rubbish towards	Positioned on water surface, and continually rotates to collect floating	(Yang Zhanying, 2020)

		worker cost and make it more efficient.	the conveyor belt, which limit its effectiveness and slow moving on water.	contamination as boat moves.	
12	River trash collection boat	The bot operate automatically that reduce human intervention and enable continuous cleaning.	The bot must can be use in any water conditions and potential obstacles that can cause long term reliability.	The bot can autonomously collect floating material and waste from the river.	(Rohan M. Ingle et al., 2021)
13.	River surface rubbish collecting ship.	The design is straightforward which is ease for maintenance.	The design primarily target garbage floating on the surface, and it could missing submerged.	The design of the belt, being obliquely arranged downwards at the front end, aids in the effective collection.	(Xue Qixiong, 2015)
14	Design and built a trash skimmer boat as a solution for collecting trash in Indonesian rivers.	Combination with bucket comb and chain conveyor system allow for efficient waste collection.	The implementation of the trash comb system was require a significant initial installation.	Trash comb combines the functionality of a bucket comb and chain conveyor system offering a comprehensive solution.	(Rafi et al., 2021)
15	Design and prototype development of portable trash collector boat for a small stream application.	Constructed with durable material such as aluminum, gasket rubber, and pvc pipe	The remote control has a limited range of 300 meters, which might not be sufficient for larger collection areas.	The use of aluminum, gasket rubber, and PVC pipe provides versatility in different collection scenarios. The relay wireless remote control enables easy operation within 300 meter range.	(Abdullah et al., 2019)

CHAPTER 3

METHODOLOGY

3. 1 Introduction

Methodology section in a research or project is very important as it tells how the object is completed within the limits and objectives of the study. It provides a detailed description of the approach used to perform the study thus making the research transparent, reproducible, and verifiable. This methodology summary describes the study's design, data collection, tools used in the analysis, and the justification for employing each specific method.

The methodology is positioned mainly to ensure that the research study is carried out systematically. It begins with a clear statement or concept of the research questions or hypothesis which set the goal of the entire process. From here, the research design is constructed to identify whether the research is experimental, correlational, descriptive, or some hybrid of these approaches. This design framework helps organize the study in a logical.

This chapter presents the approach used in carrying out this project to a successful. This chapter also show the flow process starting from literature review until the final product fabrication. This chapter includes the project planning flow chart, process designing and fabrication of trash comb conveyor and the final outcome of trash comb conveyor. This chapter also consist of a way of detail process for each section. Detailed procedure on how to design and detailing in design, analysis of the design and simulation analysis in term of structural and static testing and fabrication of product.

3.2 Project Flow Chart

A project flowchart is a visual representation of the steps, actions, and decision making steps that has to be done for the successful completion of a project. It is a visual representation of the flow from start to end with rectangles, circles, and arrows represented by connecting lines. At the beginning, an oval or rounded rectangle indicates to the flowchart and another shape with the same design specifies the end of the project once it's completed.

Tasks or activities are presented as rectangles or squares, each described with a single task or step of the project timetable. In shapes with diamonds decision points open that depend on something can made in a result with several options opened. Connecting arrows or are used to represent the job order and dependencies for a better understanding of the hierarchy of the project. Project flowcharts help project managers and teams visually map their workflows, spot bottlenecks, optimize resources, and ensure that project progresses align with objectives.

3.3 Flow Chart

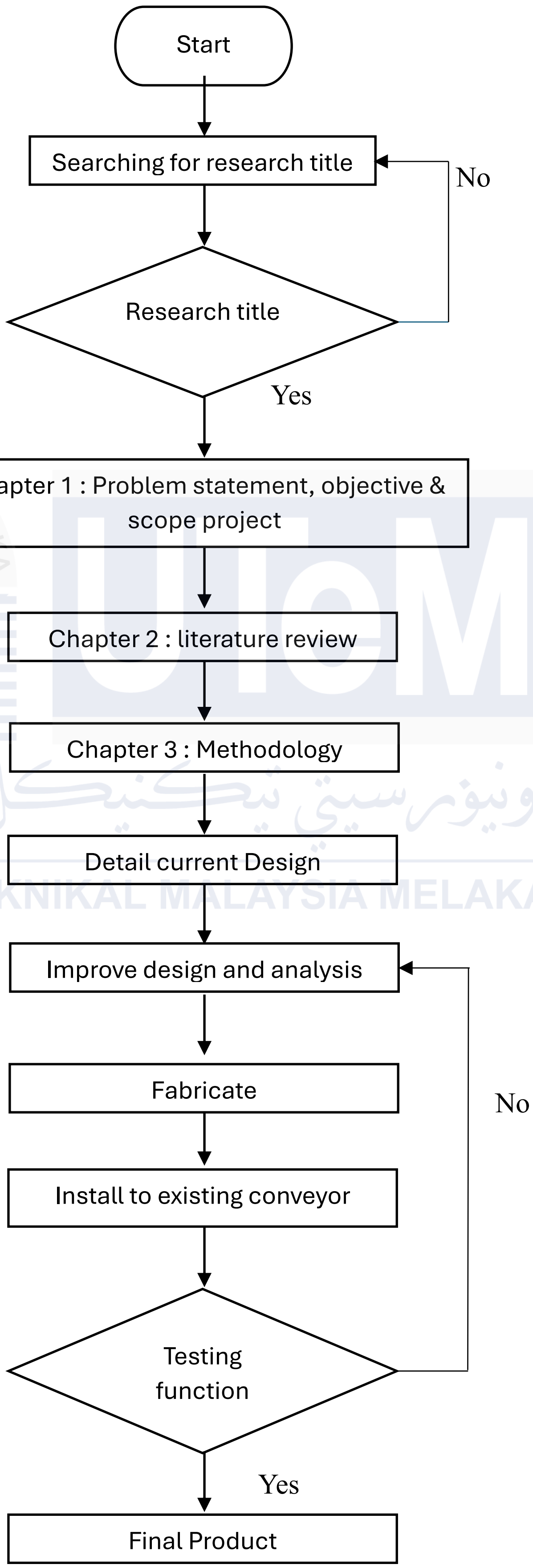

Figure 3.1 Flow Chart

3.4 Current design

In reverse engineering types we need very accurate measuring and dimensioning technique to measure the physical dimension and shapes and other properties those are already be existing items or part. The Reverse engineering is used to analysis and replicate a product design, frequently without having any formal copy of the original CAD models or blueprints. These data points, along with geometric details derived from precise measurement and dimensioning, are fundamental to this process as they become the basis of CAD models, or the digital replacement of the thing.

Advanced equipment such as digital calipers, optical measurement systems, and 3D scanners allow engineers to capture precise measurements for the complex surfaces, curves, and features of the object during the structured reverse engineering initiative. All critical dimensions, tolerances and material properties necessary to reproduce or better the original design are discovered through these measurements. These dimensions can then be expressed in digital Medium using CAD software and then to study the specimen further or to modify or replicate the specimen.

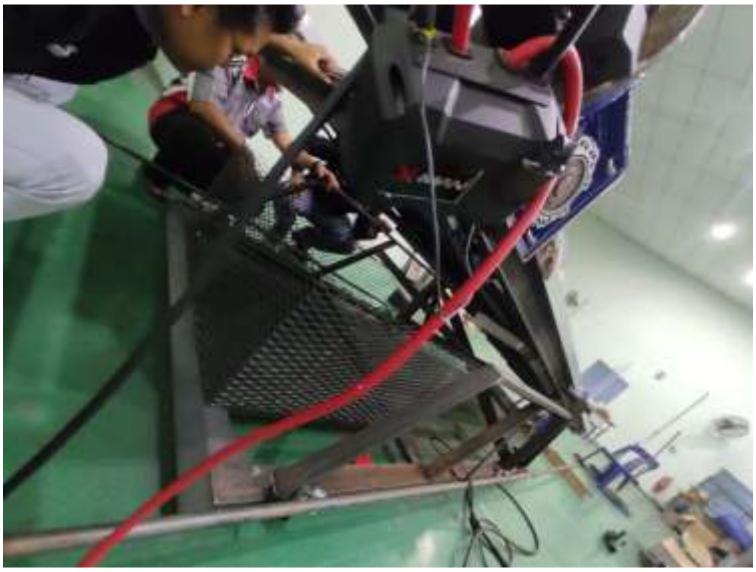

Figure 3.2 Dimensioning current design

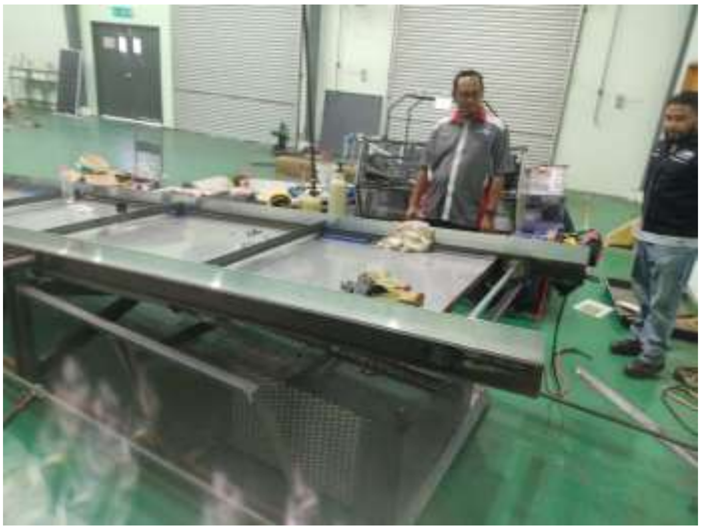

Figure 3.3 Observation on current design

3.5 Detail design

Detail design is a very important stage in the product development process, in which detailed models are created based on the conceptual models. This phase is aimed at evolving the initial concepts to make sure every module and system is further developed and integrated in order to meet the functionality, performance and quality criteria of the desired product. This phase involves detail drawings of components, material selection, manufacturing processes, and detailed plans for assembly and testing.

Detailed pictures of each component and assembly are generated using Computer-aided design (CAD) tools with exact dimensions, tolerances and geometric specifics. In addition to the critical selection of material, the validation of materials may be tested of tensile strength, weight, thermal, and corrosion resistance to comply with the design and industrial standardization. Defining manufacturing processes is as important for high quality and efficient production by listing the machining, forming, casting or additive manufacturing methods required, the corresponding machinery, tooling and parameters.

Tolerance analysis guarantees proper fit and functionality of all components by establishing acceptable variations in dimensions and shapes. Effective tolerance management is essential to prevent issues such as misalignment or excessive wear. Detailed assembly and integration plans are developed, including step by step assembly instructions, tool and fixture identification, and quality control checks for accurate assembly. Prototyping and testing play a key role in the detailed design phase, enabling engineers to create physical models for validation. Prototypes assist in identifying design flaws, validating performance, and collecting feedback for further enhancement, with multiple tests conducted to ensure the product meets specified requirements.

Designing process will come out in three section as shown in figure …, where it will includes process of designing the trash comb, defining the function for every part and cosmetics. Process of designing will utilize the use of application such as SolidWorks or Catia. SolidWorks is used for design visual ideation, modelling, prototyping, feasibility assessment. After finish designing, each part will be assessed. SolidWorks is used to optimize the trash comb such as stress analysis and fatigue predictions. In addition, reduce mass contribute lower cost of material usage, therefore reducing its price. Simulating product durability can provide early result for product development.

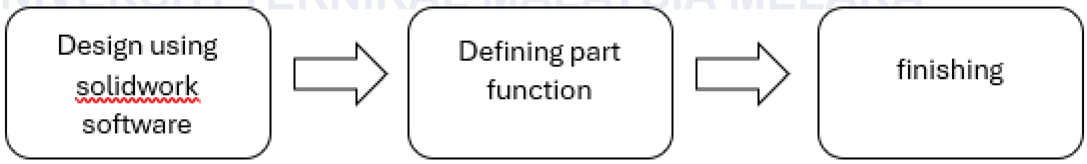

Figure 3.4 Design flow

3.6 Improve design

Optimizing architectural design can greatly improve building performance by boosting energy efficiency, comfort, and natural light. Using advanced methods like artificial neural networks for optimization can achieve up to 24.6% better results than traditional methods. Enhancing designs is an ongoing process of assessing and improving usability, performance, and efficiency to meet user needs and standards. Feedback from users through tests, surveys, and interviews is crucial for finding areas to improve. Design reviews, including tests for durability and heat resistance, help identify weak points and ensure better performance.(Zou et al., 2021)

Evaluating the materials utilized in the design process can make for some large improvements. With the use of improved materials or the borderline to its maximum in production possible materials, the robustness of products can increase, the weight can be reduced and at the same time the (unit) cost of those can be further optimized by the designer. Material optimization is a much broader topic that extends to the search for new materials with superior performance. Improved design may invite a more substantial user, but better ergonomics make the product more usable and a lot more enjoyable. Optimizing the manufacturing process is what can facilitate the simplified design with reduced components, improving the way the assembly is done, and reducing production costs and time.

3.7 Material Selection For Trash Comb

Picking the right material for a trash comb in a trash collector conveyor is a crucial part of designing and building the system. The trash comb's job is to remove debris and keep the conveyor running smoothly. The material we choose directly affects how durable, effective, and long-lasting the trash comb will be under tough working conditions.

The trash comb needs to handle different environmental factors like moisture, rust, and wear and tear from repeatedly coming into contact with waste. It should also be strong enough to endure the continuous stress and strain of regular use but still be lightweight for easy installation and maintenance. We also need to consider the cost, how easy it is to manufacture, and how environmentally friendly the material is, as these factors impact the overall practicality of the design.

By looking at and comparing different materials based on these factors, we can pick the best one to make sure the trash comb works well, is reliable, and lasts long in the trash collector conveyor system. This process of selecting the right material helps balance performance and cost while dealing with environmental and operational challenges. With the right material, the trash comb will not only do its job efficiently but also contribute to a more robust and effective trash collection system. This ensures the system remains functional and reliable over time, making maintenance easier and less frequent.

3.8 Material Advantage And Disadvantage.

3.8.1 Plain Carbon Steel

Table 3.1 Plain Carbon Steel

Advantage	Disadvantage
Cost Effective	Corrosion Susceptibility
High Strength	Brittle
Easily Available	Low Hardness
Good Workability	Fatigue and Wear Resistance
Recyclable	Limited Temperature Resistance

3.8.2 Galvanize Steel

Table 3.2 Galvanize Steel

Advantage	Disadvantage
Corrosion Resistance	Difficult to weld
Durability	Brittle to coating
Low Maintenance	Higher initial cost
Cost Effective	Weight
Environmentally friendly	Limited aesthetic option

3.8.3 Material Choose For Trash Comb

When deciding between plain carbon steel and galvanized steel for the trash comb in a trash collector conveyor, galvanized steel is usually the better choice. Plain carbon steel is strong and durable, but it rusts and corrodes easily when exposed to moisture, chemicals, or outdoor elements. This makes it less suitable for environments where the trash comb may encounter such conditions. In contrast, galvanized steel has a zinc coating that provides excellent protection against rust and corrosion, making it much more durable in wet and harsh environments like those found in trash collection systems.

Although galvanized steel costs more upfront due to the galvanizing process, it requires much less maintenance over its lifetime. The zinc coating significantly reduces the need for repairs or recoating, unlike plain carbon steel, which may need frequent maintenance to prevent rust. While plain carbon steel is cheaper initially, its tendency to corrode can shorten its lifespan and increase long-term maintenance costs. On the other hand, galvanized steel maintains its strength and durability even in tough conditions, making it more cost-effective over time despite its higher initial cost.

Overall, galvanized steel is the better option for a trash comb in a trash collector conveyor because of its superior resistance to corrosion, durability, and low maintenance needs. Plain carbon steel might be suitable for less critical parts, but galvanized steel will perform better and last longer in the demanding conditions typically found in trash collection systems. Additionally, using galvanized steel means fewer interruptions for maintenance, leading to a more efficient and reliable operation. This choice ensures that the trash comb remains effective at removing debris and keeps the conveyor running smoothly for a longer period. Thus, even though it might cost more upfront, galvanized steel's long-term benefits make it the preferred material for this application.

3.9 Final Product

A "finished product" is another name for the end result of a production or manufacturing process whereby refinements, improvements and sub assembly parts are brought to bear. This product represents the climax of the design, engineering and production efforts to fulfill specific requirements, or meet a market demand. In an industrial context, that final product is subjected to precise quality control in terms of performance, safety and reliability in comparison to established performance benchmarks. Consumer products, the end product of market analysis, design creativity, and manufacturing precision, serving the market with a product that matches consumer needs and feelings. The end result is no longer just an insensible entity but often reflects the essence of the producing firm or body of individuals that actually is the brand, serving an important purpose in enhancing customer satisfaction and adding market share and business strategy.

This final product will be tested before handing out to the user. There is part that will be tested which is the trash comb durability. This product will enhance the use of welding method. Material used for this trash comb conveyor is stainless steel, which will provide with good mechanical properties and resistance for the trash comb.

3.10 Solidworks Design

This software is often used in consumer products, transportation, Aerospace, mechanical, and auto manufacturing industries. This software is designed for the creation and simulation of 3D models, complex drawings and more. Geometric properties and relationships can be defined with the help of its parametric modeling features which in turn is easy to revise and update for designers. These arrangements are facilitated in functioning with components, constraints, and connections within SolidWorks, allowing you to put pieces together in more complex arrangements. It provides the capability to generate accurate 2D drawings from 3D models required for manufacturing and documentation needs. Integrated simulation-solving elements allow users to stress, motion, thermal effects and fluid dynamics of designs. SolidWorks has powerful version control and data management capabilities as well.

In addition as SolidWorks is intended to help design as well as making, its data management capabilities are also strong, to balance design data with version control and teamwork. It can be quite useful for many users accessing and making changes to design files at the same time for complex tasks. Often associated with its extensive feature set, ease-of-use and power, SolidWorks enables part and drawing processing together with much more and controls the entire product development process, from concepts through manufacturing. It remains a go-to choice for engineers and designers who are hoping to bring their ideas into reality using CAD software.

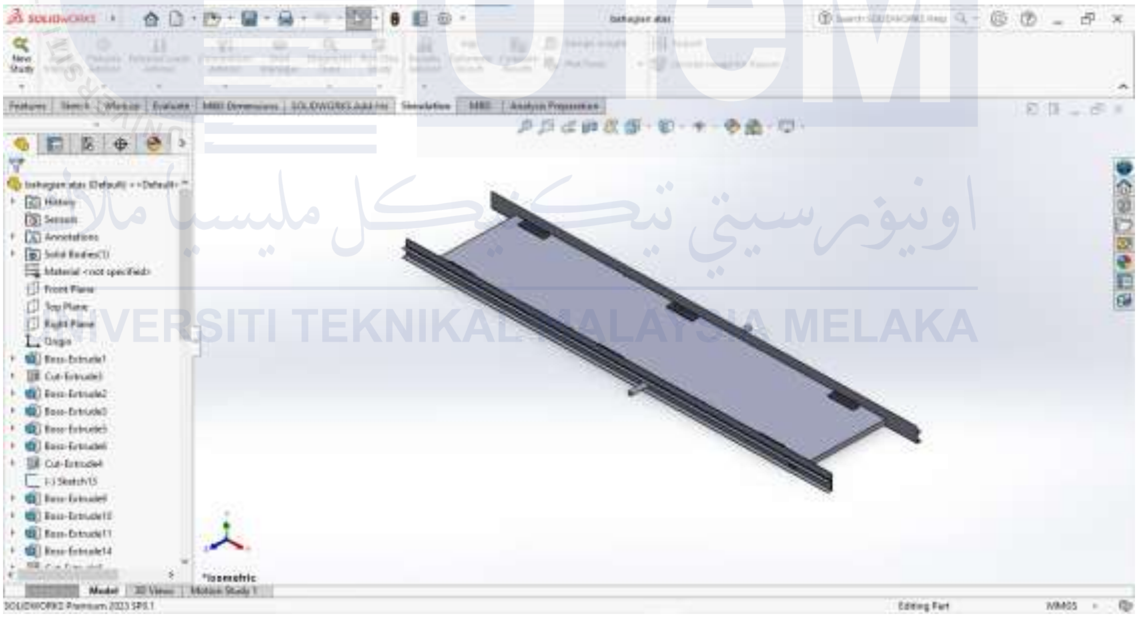

Figure 3.5 Top structure drawing.

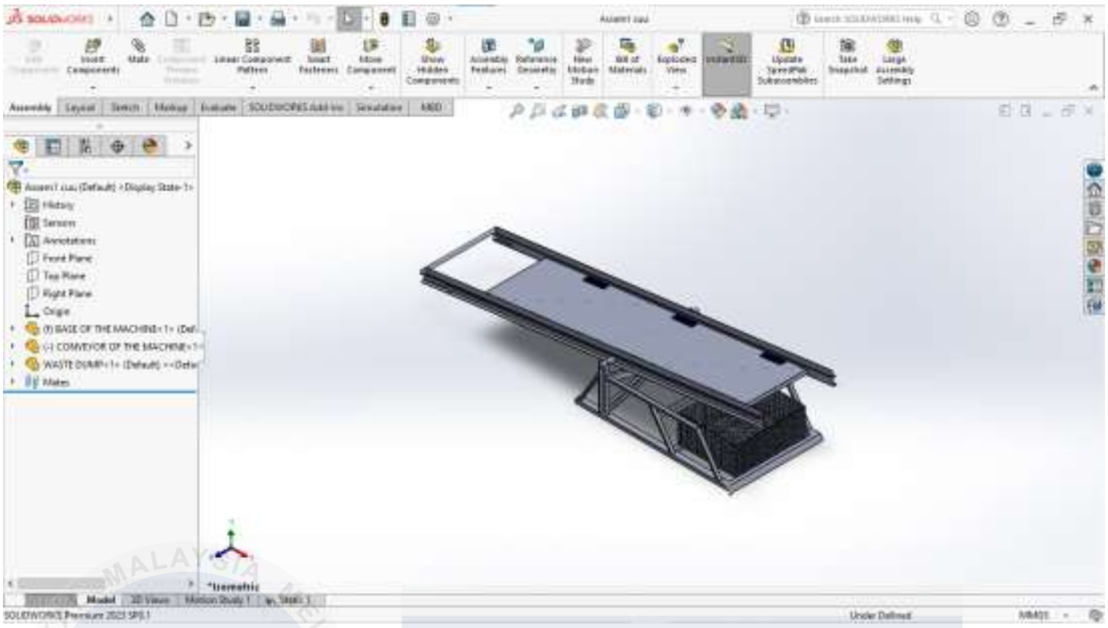

Figure 3.6 Assembly drawing

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

In this chapter, it will cover the details for Trash Comb of Trash Collector Conveyor. This chapter also will be looking towards the structural analysis and comparison between the latest design and the existing design. In addition, optimization process also will be explained further in detail on how to get the best design. Design process include Solidworks software and analysis also optimization towards the latest design. Table 4.1 shows flow chart for chapter 4.

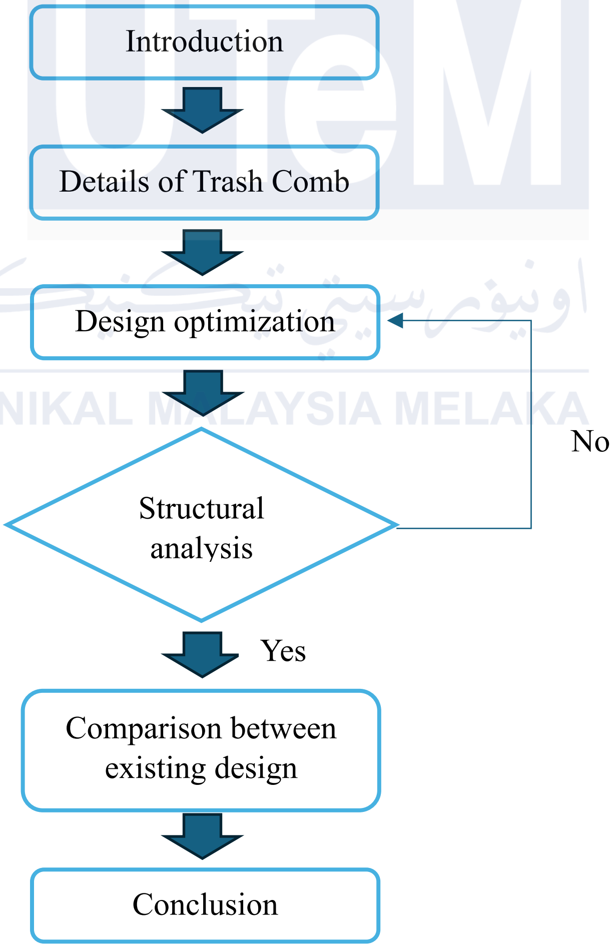

Figure 4.1 Flow chart of decision making

4.2 Trash Collector Conveyor On Boat Device

Figure 4.2 Trash Collector Conveyor device

The trash collector conveyor with a chain-based system is a very effective and long-lasting solution made for use on boats. This system uses a strong chain-driven mechanism to gather and move waste materials, like floating debris or trash on the boat, to a storage area for proper disposal or recycling. The chain mechanism ensures that the collected waste is reliably moved along its path to a storage unit or disposal area.

This system collects trash either from the water surface or specific points on the boat, using its trash comb and lift the debris efficiently. It is made from corrosion-resistant materials galvanize steel which help it withstand the salty marine environment and constant exposure to water. The conveyor is powered by an electric motor, which ensures it works consistently and can adjust its speed to meet different needs. At the end of the conveyor, waste is dropped into a bin or hopper for storage, which can then be taken to the right place for disposal or recycling. By automating the process of collecting and moving waste, This means less manual labor is needed, and the system can handle the tough conditions found in marine environments, making it a reliable and practical solution for trash collection on boats.

4.3 Trash Comb of River Trash Collector Conveyor

The trash comb is a key part of the trash collector conveyor system, designed to make waste collection more efficient in marine environments. Located at the intake or collection point, the trash comb works catches and collects debris, such as plastics, leaves, and other floating trash, while letting water pass through. It's usually made up of a series of strong, evenly spaced tines or bars, crafted from corrosion-resistant materials like stainless steel, to ensure it holds up well in tough marine conditions.The main job of the trash comb is to catch large or blocking debris and guide it onto the conveyor chain, which then moves it to the designated storage or disposal area. This helps prevent clogs and keeps the whole conveyor system running smoothly

4.4 Structure design

The design of the River Trash Collector Conveyor Structure is created using SolidWorks. The measurements are taken based on the actual model of the conveyor structure through reverse engineering techniques. This marks the first step in creating the structure design. The process then proceeds by designing the structure using accurate measurement sizes of the actual structure. All the designs are developed using SolidWorks.

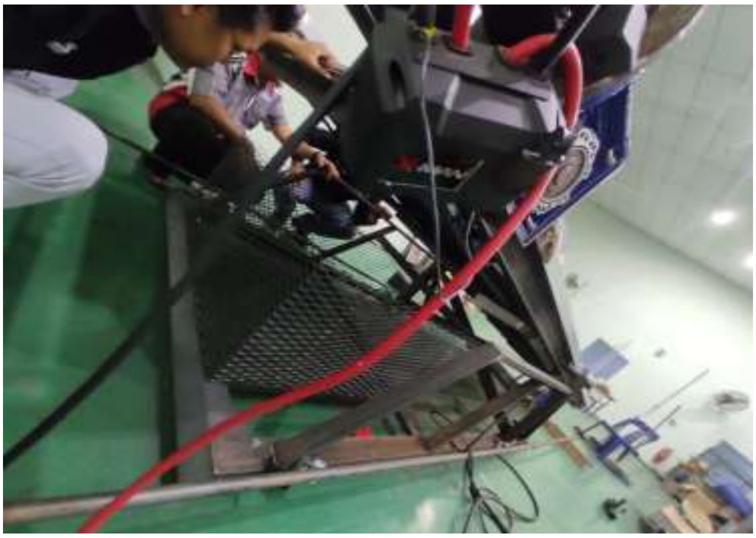

Figure 4.3 Measuring the dimensions of the existing structure.

4.5 Corrosion resistance

The trash comb of the Trash Collector Conveyor is designed with a corrosion-resistant structure to withstand harsh environmental conditions. Galvanizing is considered environmentally friendly because it has a lower environmental impact compared to other coating methods. It provides long-lasting protection for metal surfaces, reducing the need for frequent maintenance, repairs, and replacements. By extending the lifespan of materials, galvanizing conserves resources and minimizes waste, lowering the overall environmental costs of manufacturing, disposal, and maintenance. The durability of galvanized coatings not only makes structures more sustainable but also promotes a more resource-efficient approach in industries where corrosion protection is essential.(Radionova et al., 2024)

4.6 Optimize design

The trash comb of the Trash Collector Conveyor is engineered with an optimized design to maximize efficiency and functionality. This design focuses on enhancing trash collection performance by incorporating features such as precise spacing, streamlined geometry, and durable materials. The optimization ensures effective trash capture while minimizing blockages and energy consumption. By carefully balancing strength, weight, and structural integrity, the design improves the overall operation of the conveyor system. This innovative approach makes the trash comb a critical component for achieving superior performance in waste collection and environmental cleanup efforts.

4.7 Applied Material

The selected material for the structure is Galvanized Steel, as it offers a lighter weight and includes a protective coating to prevent corrosion, making it more suitable for the intended purpose of the structure. This material provides significant advantages over the Plain Carbon Steel currently used in the conveyor structure. Plain Carbon Steel has a much higher mass density, making it heavier, and it does not come with any protective coating to resist corrosion. By choosing Galvanized Steel, the structure becomes not only more durable and resistant to environmental damage but also easier to handle and more efficient due to its reduced weight.

4.8 Applied Force Load

A force is a push or pull that is applied to a part of a structure, and it always acts in a specific direction. It is considered a type of load, which is any external factor that affects the structure. In structural analysis software, you can apply forces of various magnitudes to a structure using the "apply force" tool. When you select a force to apply, it is represented as an arrow on the structure. The value of the force that has been applied is 490.44 N (50 Kg). These arrows are usually shown in purple when selected, making it easy to identify them. Forces can either be concentrated at a single point on the structure, known as a point load, or they can be spread out evenly across an edge or surface, referred to as a distributed load. This ability to apply different types of forces allows engineers to simulate various real-world conditions and analyze how the structure will respond to those forces.

4.9 Characteristics Of The Trash Comb

4.9.1 Existing Trash Comb

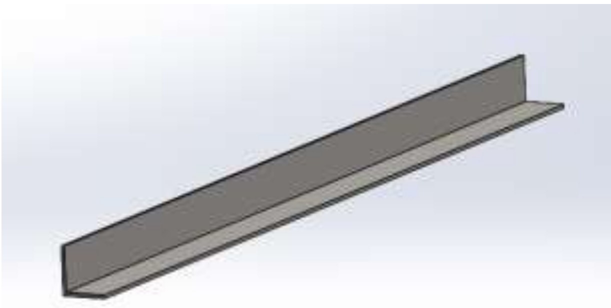

Figure 4.4 Existing Trash Comb

The existing trash comb is made from plain carbon steel, the trash comb is strong and durable, which makes it suitable for handling the continuous mechanical stresses in a trash collection system. It can withstand repeated contact with waste materials without bending or deforming. However, plain carbon steel has a downside it is not naturally resistant to corrosion. When exposed to moisture and harsh marine environments, it can rust and corrode. To address this issue, the trash comb may need to be coated or treated to enhance its resistance to corrosion, thus extending its lifespan. Despite this, plain carbon steel remains a cost-effective material. It offers a good balance between strength and affordability. Its lower initial cost makes it an appealing option, but it may incur higher maintenance costs over time due to potential corrosion problems. By considering these factors, the trash comb can effectively perform its job in the trash collection system, ensuring durability and efficiency in tough conditions.

4.9.2 Design 1 Trash comb

Figure 4.5 Design 1 Trash Comb

The trash comb design 1 have a straight or slightly angled design to improve its ability to scoop and lift debris efficiently, ensuring the collected debris is directed onto the conveyor chain for transport to the storage or disposal area. To withstand the mechanical stresses encountered during operation, the shape of the comb may include additional reinforcements or supports, enhancing its structural integrity and longevity. This ensures that the comb can handle heavy loads and continuous use without deforming.

When made from galvanized steel, the trash comb benefits from the material's strength and durability, making it suitable for handling the mechanical stresses of continuous operation in a trash collection system. The zinc coating on galvanized steel provides an additional layer of protection, ensuring the steel remains strong and durable over time. One of the key advantages of galvanized steel is its excellent resistance to corrosion, with the zinc coating protecting the steel from rust and degradation, even in wet and salty marine environments. This ensures the trash comb remains effective and reliable, with a longer lifespan compared to other materials. While galvanized steel may have a higher initial cost due to the galvanizing process, it offers significant long term cost savings. The reduced need for maintenance and replacements, coupled with the extended lifespan of the material, makes galvanized steel a cost-effective choice for the trash comb in a trash collector conveyor system.

4.9.3 Design 2 Trash Comb

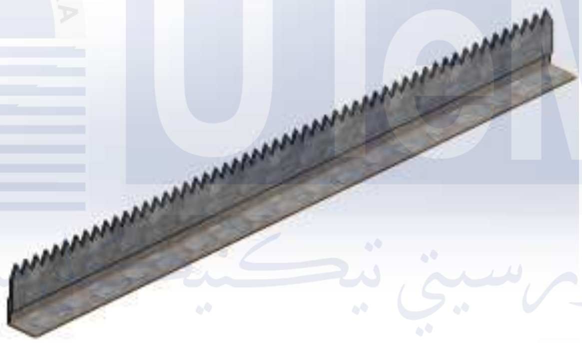

Figure 4.6 Design 2 Trash Comb

The tines or bars of the trash comb are made to be strong and sturdy so they can handle the impact and mechanical stress of capturing debris. They are aligned in such a way to maximize debris capture while still allowing water to flow through smoothly. A straight design is effective for most uses, efficiently trapping debris and directing it onto the conveyor chain. An angled design can offer additional benefits, as the slight angle helps scoop and lift debris more efficiently, particularly when dealing with floating waste. The angled tines guide the debris onto the conveyor chain more smoothly, reducing the chances of clogging and improving overall efficiency.

The trash comb is usually fitted with an attachment mechanism that allows it to be securely mounted at the intake or collection point of the conveyor system. This ensures that the comb remains firmly in place during operation, even when handling heavy loads. The attachment points are reinforced to prevent any detachment or movement of the comb, which could disrupt the debris collection process. Overall, the design and material of the trash comb make it a reliable and efficient component in the trash collector conveyor system.

4.9.4 Design 3 Trash Comb

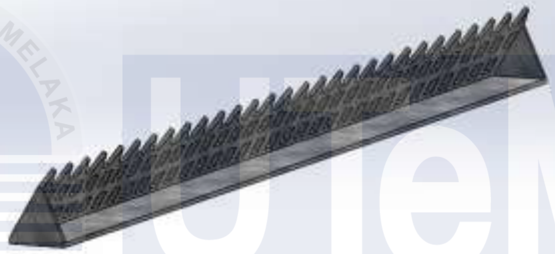

Figure 4.7 Design 3 Trash Comb

A straight design of the trash comb ensures that debris is efficiently trapped and directed onto the conveyor chain. This straightforward design is effective for most applications, providing a reliable solution for capturing and removing debris. An angled design offers additional benefits, with the tines slightly inclined to help scoop and lift debris more efficiently, especially when dealing with floating waste. The angle assists in guiding the debris onto the conveyor chain more smoothly, reducing the chances of clogging and improving the overall efficiency of the system.

The tines or bars of the trash comb are made to be strong and sturdy, made from galvanized steel. They are aligned in a row and evenly spaced, which is crucial for maximizing debris capture while allowing water to flow through smoothly. The tines are positioned parallel to each other, creating a barrier that effectively traps larger pieces of debris. The spacing between the tines can be customized based on the type of debris the system is designed to capture. For instance, narrower spacing is ideal for capturing smaller debris, while wider spacing can handle larger waste materials. This adaptability makes the trash comb versatile for different operational needs, ensuring it can perform effectively in various conditions.

4.10 Analysis For Existing Structure

Conducting a careful and detail analysis of an existing structure is very important in order to identify any weaknesses or flaws in its design. This in-depth examination helps provide a clear understanding of how the structure is performing overall and reveals any potential issues that could affect its safety or stability. During the analysis, various factors such as stress (the internal forces), displacement (how much the structure moves), strain (how much the material deforms under stress), and the factor of safety (how much stronger the structure is compared to what is needed) are examined. These factors help pinpoint specific areas of the structure that may be at risk and require additional support, reinforcement, or even a complete redesign.

Understanding these key aspects is crucial to ensuring that the structure remains reliable and safe for use over time. It also plays a significant role in ensuring that the structure will last for many years without unexpected failures. Furthermore, this analysis helps guide any necessary improvements or modifications that need to be made to bring the structure up to current engineering standards and requirements. By addressing any weaknesses identified in the analysis, we can make the structure safer and more efficient, ensuring that it meets the demands of modern use and is capable of withstanding future conditions.

4.10.1 Material Of Existing Structure

The existing structure is made from plain carbon steel, which is a widely used material in construction due to its affordability and ease of availability. Plain carbon steel is considered a cost-effective choice because it is relatively inexpensive compared to other types of steel and construction materials. Additionally, it is readily accessible in the market, which makes it a convenient option for a wide range of building projects. The low cost and easy availability of plain carbon steel contribute to its popularity in structural applications.

4.10.2 Von Misses Stress Analysis For Existing Structure.

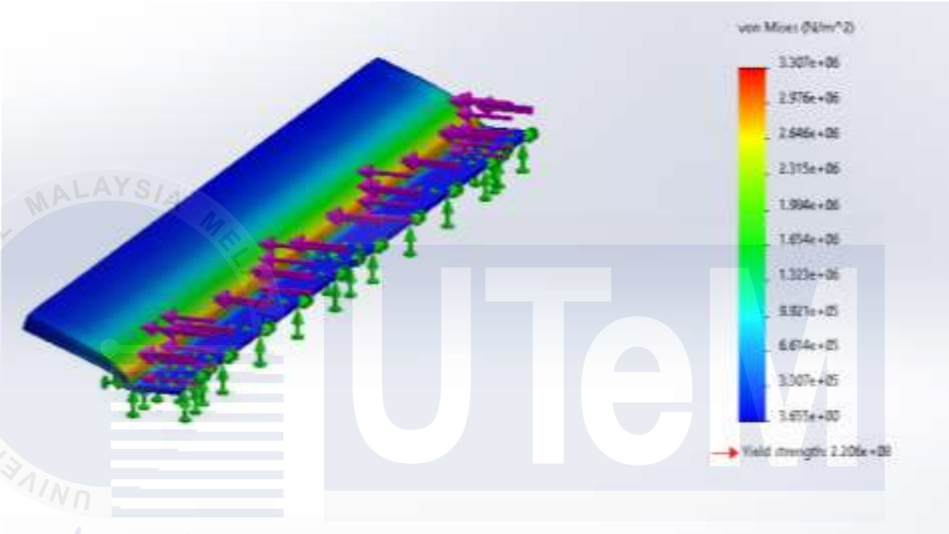

Figure 4.8 Von Misses Stress Analysis For Existing Structure.

The analysis reveals that the maximum stress in the component is 3.307e+06 N/m². This is much lower than the material's yield strength, which is 2.206e+08 N/m². The yield strength is the point at which the material would permanently deform or fail, and since the highest stress observed is significantly below this value, it means the component is not at immediate risk of failing or yielding under the current load conditions. Even though the component appears to be structurally sound overall, the areas with the highest stress (shown in red) should still be closely monitored. These regions are the most critical because if the load increases or if the conditions change, these high-stress areas could become points of failure. This analysis is useful for ensuring that the component can safely handle the applied loads without exceeding the material's strength limits, helping engineers to identify any potential weak spots that might need further attention or reinforcement.

Table 4.1 Von Misses Stress Analysis Existing Structure

Design	Minimum	Maximum	Material
	3.655e+00	3.307e+06	Plain Carbon Steel

4.10.3 Displacement Analysis For Existing Structure

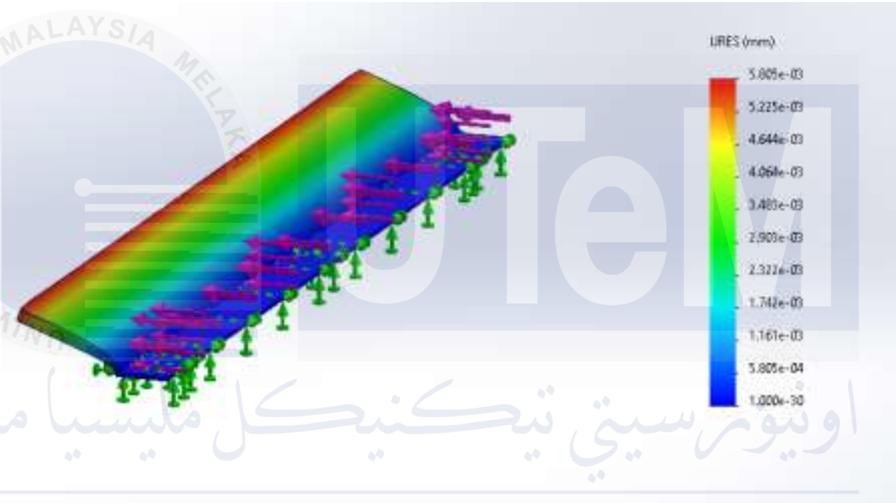

Figure 4.9 Displacement Analysis For Existing Structure

The displacement, measured in millimetres (mm), ranges from dark blue, indicating the least displacement, to red, indicating the most displacement. The analysis reveals that the dark blue areas show minimal displacement, with values as low as 1.000e-30 mm, while the red areas indicate the maximum displacement, reaching up to 5.805e-03 mm. The component exhibits varying levels of displacement under the applied loads or constraints, with the most significant displacement occurring in the red regions. The areas with minimal displacement, shown in dark blue, suggest that these parts of the component are relatively stable and less affected by the applied loads. This analysis is crucial for understanding how the component deforms under the applied loads and ensures that the displacement is within acceptable limits to maintain the structural integrity and performance of the component.

Table 4.2 Displacement Analysis Existing Structure

Design	Minimum	Maximum	Material
	1.000e-30	5.805e-03	Plain Carbon Steel

4.10.4 Strain Analysis For Existing Structure

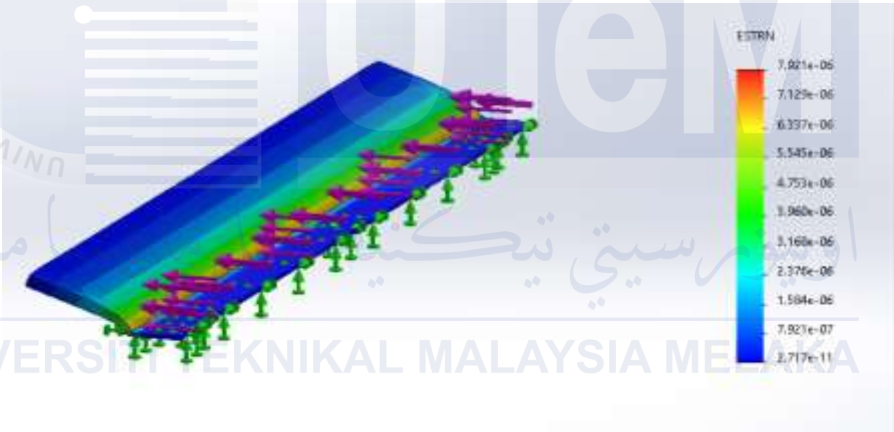

Figure 4.10 Strain Analysis For Existing Structure

The strain values are represented using a color gradient, ranging from dark purple, indicating the lowest strain levels, to red, signifying the highest strain levels. The red regions, showing the highest strain values of approximately 7.921e-06, are areas of concern as they might be more susceptible to deformation or failure under load. Conversely, the darkest purple regions, with strain values as low as 2.717e-11, indicate the most stable parts of the component, less affected by the applied loads. This uneven strain distribution highlights critical areas that require close monitoring to ensure the structural integrity and performance of the component under load. The intermediate strain levels, represented by colors such as yellow, green, and orange, indicate regions that experience moderate strain and warrant attention as well. Overall, this comprehensive strain analysis is essential for evaluating the component's ability to withstand applied loads while maintaining its structural integrity over time. Regular monitoring and targeted modifications based on such analyses can significantly enhance the durability and reliability of the component in its operational environment.

Table 4.3 Strain Analysis Existing Structure

Design	Minimum	Maximum	Material
	2.717e-11	7.921e-06	Plain Carbon Steel

4.10.5 Factor Of Safety For The Existing Structure

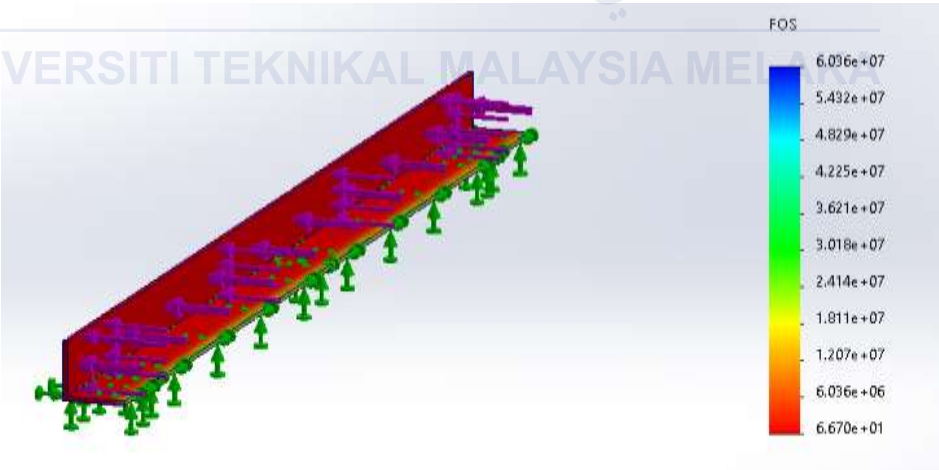

Figure 4.11 Factor Of Safety For The Existing Structure

The FOS is represented using a color gradient from red, indicating low FOS values, to blue, signifying high FOS values, with numerical values ranging from 6.670e+01 to 6.036e+07. The red regions highlight areas with low FOS, suggesting higher stress levels and lower safety margins, making these zones critical and potentially in need of reinforcement to prevent failure. Conversely, the green and blue regions, which indicate higher FOS values, suggest these areas are under less stress and have higher safety margins, making them less critical. The predominant red coloring across the component suggests that many areas are experiencing higher stress and lower safety margins, emphasizing the need for careful monitoring and possible design modifications to enhance durability and prevent failure. Understanding the FOS distribution is essential for maintaining the structural integrity and performance of the component under the given loading conditions.

Table 4.4 Factor Of Safety Analysis Existing Structure

Design	Minimum	Maximum	Material
	6.670e+01	6.036e+07	Plain Carbon Steel

4.11 Analysis For The Structure Design 1, 2 and 3

A thorough analysis of the new design structures (Designs 1, 2, and 3) is an essential step in ensuring their performance meets the necessary standards and requirements. This detailed evaluation provides critical insights into how each design behaves under the expected loading conditions and helps identify any potential weaknesses or areas that might need further attention or improvement. By carefully examining the structural responses, we can determine whether the designs are both efficient and safe.

Key factors considered during the analysis include stress, displacement, strain, and the factor of safety. Stress analysis reveals how forces are distributed throughout the structure, helping to identify areas that may experience high levels of stress and could become potential weak points. Displacement analysis measures how much the structure deforms under load, ensuring it remains within acceptable limits. Strain analysis helps understand material deformation, while the factor of safety provides a measure of how much stronger the structure is compared to the expected loads. Together, these factors paint a complete picture of the design's performance.

This comprehensive evaluation is crucial for pinpointing critical regions in the design that may require reinforcement or optimization to ensure durability and reliability. Understanding these elements not only ensures that the structures can withstand real-world conditions but also provides the confidence that they will remain safe over time. The results of the analysis serve as a guide for making necessary adjustments to the designs, whether through material selection, geometry changes, or additional supports.

4.11.1 Material For The Structure Design Number 1, 2 and 3

The new design structures (Designs 1, 2, and 3) are built using galvanized steel, a material that is widely valued in construction for its strength, durability, and excellent resistance to corrosion. Galvanized steel is created by coating regular carbon steel with a protective layer of zinc. This zinc coating acts as a barrier, preventing the underlying steel from rusting when exposed to moisture or harsh environmental conditions. As a result, galvanized steel has a significantly longer lifespan compared to plain carbon steel, making it an ideal choice for a variety of structural applications.

One of the main benefits of galvanized steel is its superior resistance to rust and corrosion, which is particularly important in outdoor or high-moisture environments where materials are constantly exposed to the elements. The zinc coating not only protects the steel directly but also offers sacrificial protection, meaning it will corrode first before the steel underneath, further prolonging the material’s usability. This makes it highly reliable for structures that need to withstand challenging weather conditions, such as heavy rain, high humidity, or even marine environments.

Although galvanized steel is somewhat more expensive than plain carbon steel, its many advantages often outweigh the additional cost. Its long-term durability means fewer repairs and replacements over the structure's lifespan, making it a cost-effective option in the long run. Additionally, its robust nature ensures the integrity of the design, providing peace of mind that the structure will remain strong and safe for many years.

Galvanized steel is also versatile and can be used in a wide range of structural designs. Its combination of strength and weather resistance makes it a popular material for bridges, buildings, outdoor frameworks, and other critical infrastructure. In projects where long-term reliability and performance are essential, galvanized steel is often the material of choice. By incorporating this material into Designs 1, 2, and 3, the structures are not only built to withstand their intended loads but are also protected against the wear and tear of time and the elements. This thoughtful selection of material ensures that the new designs meet both practical and durability standards, reinforcing their suitability for various structural applications.

4.11.2 Von Misses Stress Analysis For The Structure Design Number 1

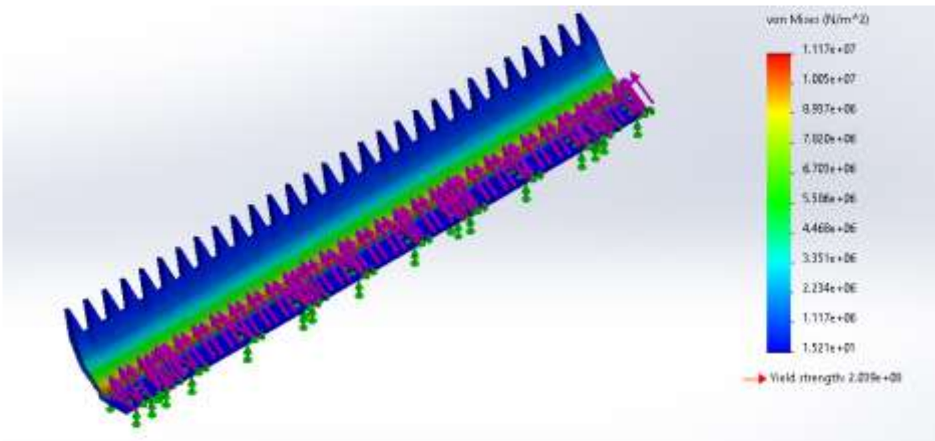

Figure 4.12 Von Misses Stress Analysis For The Structure Design Number 1

The stress values are represented using a color gradient, with blue indicating the lowest stress levels and red representing the highest stress levels. The analysis shows that the highest von Mises stress value is 1.117e+07 N/m², concentrated in certain critical areas near applied loads or structural notches. Despite these high-stress regions, the maximum stress observed is still below the material's yield strength of 2.039e+08 N/m², suggesting that the component is not at immediate risk of yielding under the given loading conditions. The blue regions, indicating the lowest stress levels, show areas of minimal stress, suggesting stable zones within the component. Overall, this analysis helps in identifying critical high-stress areas that may need reinforcement, ensuring the component's structural integrity under the specified loads.

Table 4.5 Von Misses Analysis Design 1

Design	Minimum	Maximum	Material
	1.521e+01	1.117e+07	Galvanize Steel

4.11.3 Displacement Analysis For The Structure Design Number 1

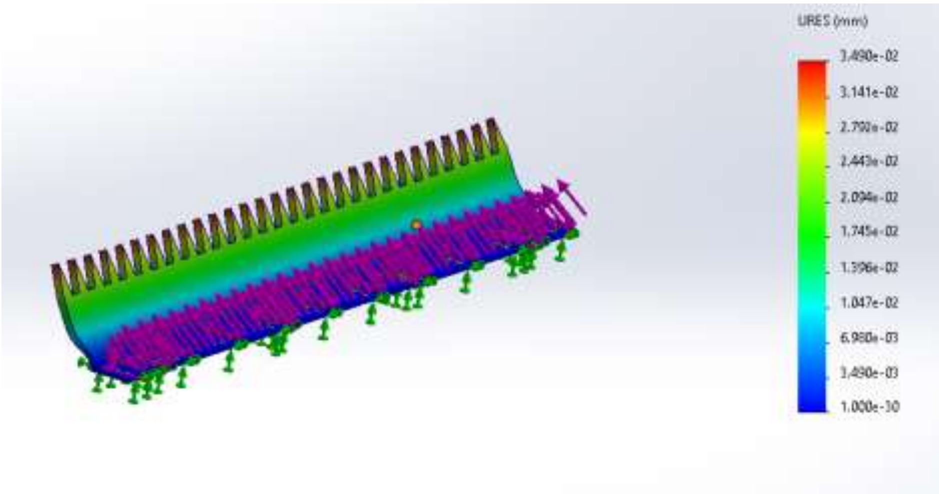

Figure 4.13 Displacement Analysis For The Structure Design Number 1

The displacement magnitude (URES) is represented using a color gradient, ranging from blue, indicating the least displacement, to red, indicating the greatest displacement. The scale on the right shows that displacement values range from 1.000e-30 mm (essentially zero displacement) to 3.490e-02 mm (maximum displacement). The blue regions represent areas with minimal displacement, suggesting these parts of the component are relatively stable and experience little deformation under the applied load. In contrast, the red regions highlight areas with the greatest displacement, indicating significant deformation and potential structural concern. The green symbols at the bottom of the component likely represent boundary conditions or constraints, anchoring it in place and preventing movement at these points. Meanwhile, the purple arrows indicate the direction and possibly the magnitude of displacement at various points on the component, showing how different regions deform under the load. The displacement distribution is uneven across the component, with the greatest displacement occurring in specific regions, likely where the load is concentrated or where the material may be thinner or less rigid. Monitoring these high-displacement areas is essential to ensure they do not exceed acceptable limits, which could lead to failure or compromise the component's structural integrity

Table 4.6 Displacement Analysis Design 1

Design	Minimum	Maximum	Material
	1.000e-30	3.490e-02	Galvanize Steel

4.11.4 Strain Analysis For The Structure Design Number 1

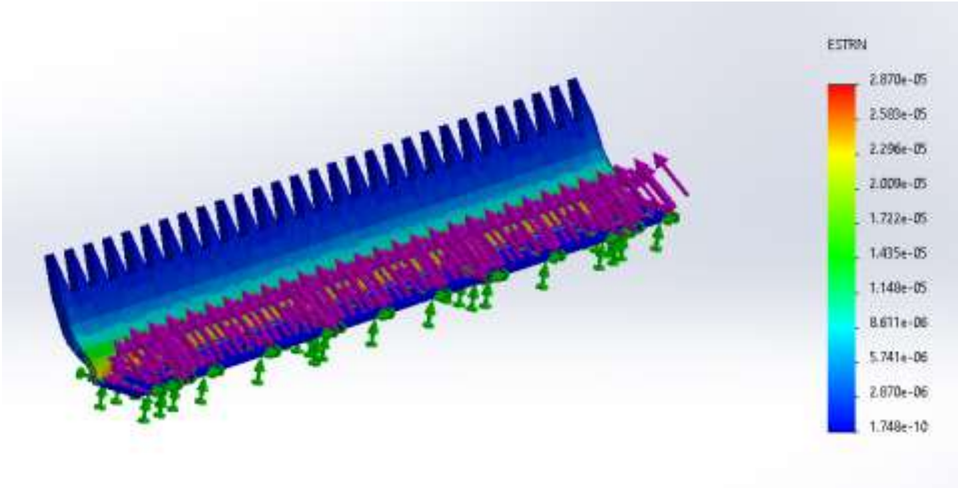

Figure 4.14 Strain Analysis For The Structure Design Number 1

The strain values (ESTRN) are represented using a color gradient, ranging from blue, indicating the lowest strain levels, to red, indicating the highest strain levels. The scale on the right shows that strain values range from approximately 1.748e-10 to 2.870e-05. The red regions indicate the highest strain levels, suggesting these areas are experiencing significant deformation under the applied load, making them critical points that may be prone to failure or require reinforcement. Conversely, the blue regions represent the lowest strain levels, indicating areas of minimal deformation and relative stability. The strain distribution is uneven across the component, with the highest strain values concentrated in specific regions under more stress. The arrows in the image likely represent the direction and magnitude of the applied load or displacement, showing how the component responds to these forces. Understanding the strain distribution is crucial for evaluating the mechanical behavior of the component under load, identifying high-strain areas for potential design modifications or reinforcements to ensure reliability and safety. Overall, this strain analysis helps optimize the component's design for better performance and durability.

Table 4.7 Strain Analysis Design 1

Design	Minimum	Maximum	Material
	1.748e-10	2.870e-05	Galvanize Steel

4.11.5 Factor Of Safety For The Structure Design Number 1

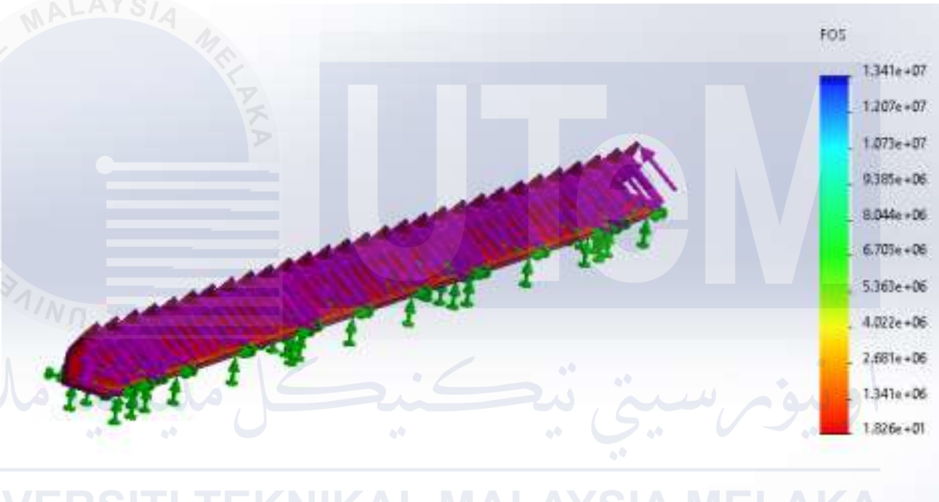

Figure 4.15 Factor Of Safety For The Structure Design Number 1

The FOS values range from 1.826e+01 (18.26) to 1.341e+07 (13,410,000), as indicated by the color bar on the right side of the image. The blue regions indicate the highest factor of safety, meaning these areas have substantial safety margins and are significantly stronger than required for the applied loads. Conversely, the red regions represent the lowest factor of safety, suggesting these areas are closer to failure under the applied loads and are critical points that may need reinforcement or design modifications to ensure safety. The component displays a range of safety margins, with most areas showing relatively high factors of safety, indicating good structural integrity. However, the red and yellow regions highlight potential points of concern where the structure may be closer to yielding or failure under the applied loads. The factor of safety analysis is crucial for evaluating the structural integrity and safety of the component. By addressing the critical points with low FOS, the overall safety and durability of the component can be enhanced.

Table 4.8 Factor Of Safety Analysis Design 1

Design	Minimum	Maximum	Material
	1.826e+01	1.341e+07	Galvanize Steel

4.12 Analysis For The Structure Design Number 2

4.12.1 Von Misses Stress Analysis For The Structure Design Number 2

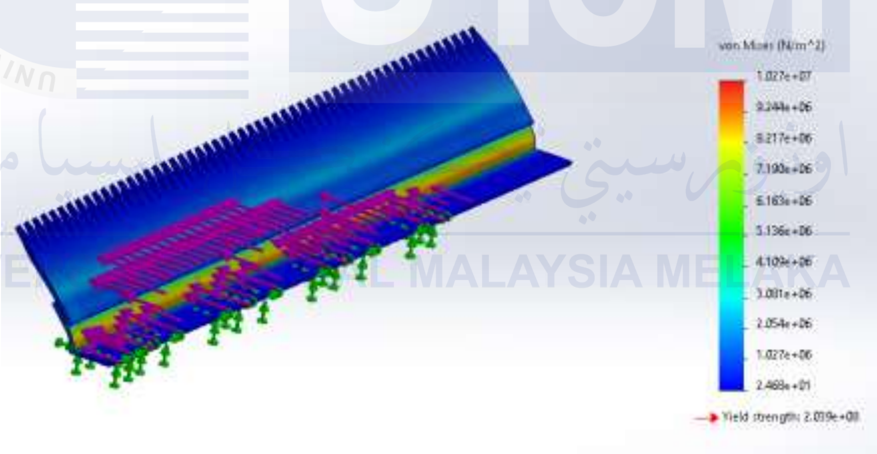

Figure 4.16 Von Misses Stress Analysis For The Structure Design Number 2

The stress distribution is illustrated using a color gradient, ranging from blue, indicating low stress, to red, indicating high stress. The von Mises stress values, represented in N/m², range from 2.468e+01 N/m² (blue) to 1.027e+07 N/m² (red), with the material's yield strength marked at 2.039e+08 N/m². The red regions highlight areas experiencing the highest stress levels, which reach up to 1.027e+07 N/m², while the blue regions show the lowest stress levels, indicating minimal stress. Despite the high-stress areas, the maximum von Mises stress observed is significantly below the material's yield strength, suggesting that the component is not at immediate risk of yielding under the current loading conditions. This analysis is crucial for understanding the stress distribution within the component and identifying critical high-stress areas that may require attention or reinforcement. Overall, the component appears structurally sound, as the stress levels do not exceed the yield strength, ensuring its integrity under the given loading conditions.

Table 4.9 Von Misses Analysis Design 2

Design	Minimum	Maximum	Material
	2.468e+01	1.027e+07	Galvanize Steel

4.12.2 Displacement Analysis For The Structure Design Number 2

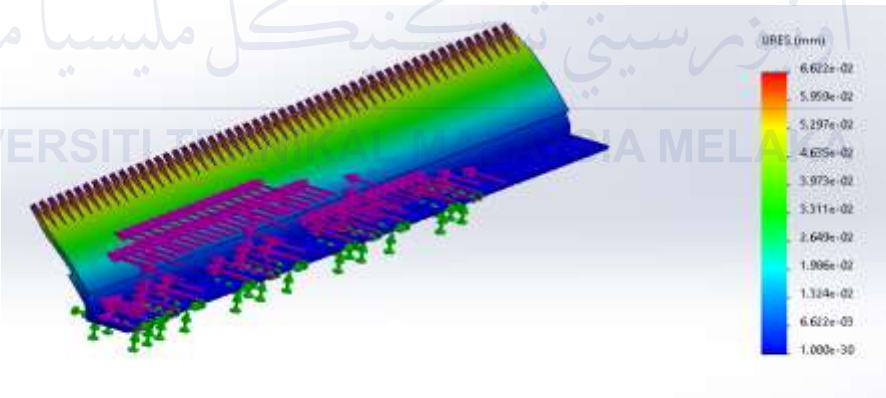

Figure 4.17 Displacement Analysis For The Structure Design Number 2

The displacement values, measured in millimeters (mm), are represented using a color gradient that ranges from blue, indicating the least displacement, to red, indicating the most displacement. According to the legend on the right side of the image, the displacement values range from 1.000e-30 mm to 6.622e-02 mm. The blue regions show areas with minimal displacement, suggesting these parts of the component remain stable and experience little deformation under the applied load. Conversely, the red regions indicate areas with the greatest displacement, suggesting significant deformation. These regions are critical points that may require attention to ensure the component's structural integrity. The green symbols at the bottom likely represent the boundary conditions or constraints anchoring the component, while the purple arrows and lines indicate the applied loads or displacements, influencing how the component deforms. Understanding the displacement distribution is crucial for evaluating the structural performance of the component under load. Areas with significant displacement may need to be reinforced or redesigned to maintain the component's integrity and durability. Regular monitoring and targeted adjustments based on this analysis can significantly improve the component's reliability in its operational environment.

Table 4.10 Displacement Analysis Design 2

Design	Minimum	Maximum	Material
	1.000e-30	6.622e-02	Galvanize Steel

4.12.3 Strain Analysis For The Structure Design Number 2

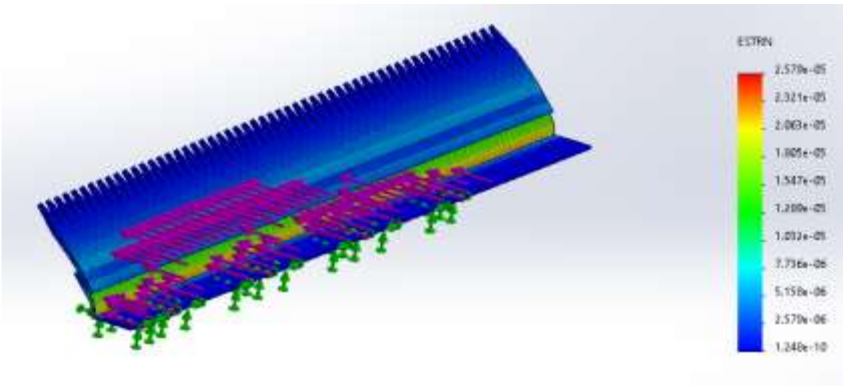

Figure 4.18 Strain Analysis For The Structure Design Number 2

The strain values (ESTRN) are represented using a color gradient, ranging from blue, indicating the lowest strain levels, to red, indicating the highest strain levels. The scale on the right shows that strain values range from 1.248e-10 to 2.579e-05. The red regions in the image highlight areas experiencing the highest strain levels, suggesting significant deformation under the applied load. These areas are critical as they are more susceptible to failure and may require reinforcement. Conversely, the blue regions represent the areas with the lowest strain, indicating minimal deformation. These parts of the component are relatively stable and less affected by the applied load. The strain distribution is uneven across the component, with high-strain areas concentrated in specific regions under significant stress. Identifying these high-strain areas is crucial for assessing potential points of failure and ensuring the component's reliability and safety. Reinforcing or redesigning these critical regions can enhance the component's performance and durability under operational conditions.

Table 4.11 Strain Analysis Design 2

Design	Minimum	Maximum	Material
	1.248e-10	2.579e-05	Galvanize Steel

4.12.4 Factor Of Safety For The Structure Design Number 2

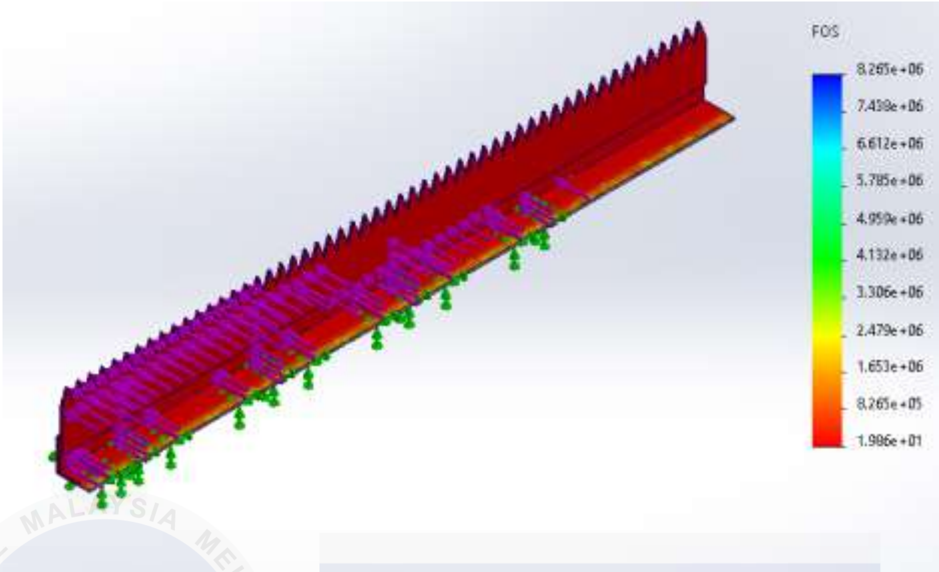

Figure 4.19 Factor Of Safety For The Structure Design Number 2

The FOS scale ranges from 1.986e+01 (19.86) to 8.265e+06, with blue indicating areas with lower safety factors and red indicating areas with higher safety factors. The structure is supported by several green fixtures or supports, and the color distribution on the structure highlights the varying levels of safety factor across different regions. The red regions represent areas with the highest factor of safety, suggesting that these parts of the structure have substantial safety margins and are less likely to fail under the applied loads. Conversely, the blue regions indicate areas with the lowest factor of safety, suggesting these parts of the structure are closer to the failure threshold and may require reinforcement or design modifications to enhance their safety margins. The overall distribution of the FOS shows that most parts of the structure have high safety factors, indicating good structural integrity and reliability. However, the areas with lower safety factors need to be carefully monitored, as they represent potential points of concern. These critical regions may need design improvements or additional support to ensure the structure remains safe and robust under the applied loads. Understanding the FOS distribution is essential for identifying potential failure points in the design and ensuring the overall safety and durability of the component. By addressing the areas with lower safety factors, engineers can enhance the component's performance and reliability under operational conditions.

Table 4.12 Factor Of Safety Analysis Design 2

Design	Minimum	Maximum	Material
	1.986e+01	8.265e+06	Galvanize Steel

4.13 Analysis For The Structure Design Number 3

4.13.1 Von Misses Stress Analysis For The Structure Design Number 3

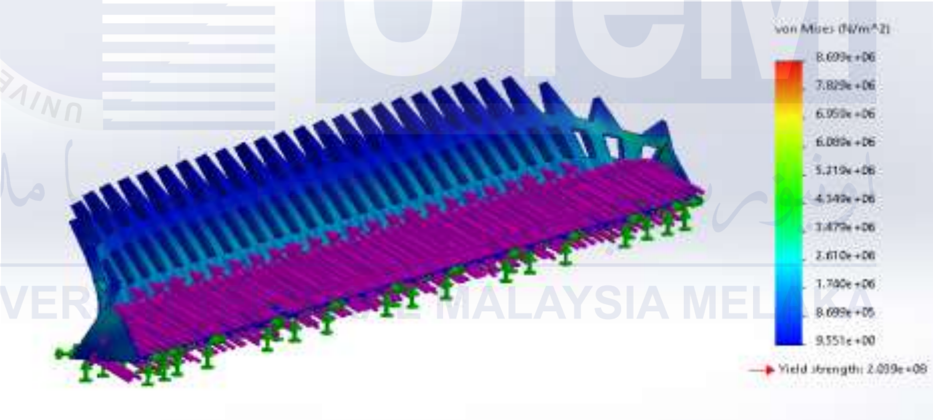

Figure 4.20 Von Misses Stress Analysis For The Structure Design Number 3

The color scale on the right indicates the stress values in N/m², with the lowest value being 9.551e+05 N/m² and the highest value being 8.699e+06 N/m². The material's yield strength is marked with a red arrow at 2.039e+08 N/m². The red regions indicate the highest von Mises stress values, up to 8.699e+06 N/m², suggesting that these areas are critical as they experience significant stress, though still well below the material's yield strength. The blue regions represent the lowest stress levels, indicating areas under minimal stress. The component exhibits varying stress levels, with high-stress concentrations in specific regions, likely around the ribs and supports where loads are applied or where geometric discontinuities are present. Despite the presence of these high-stress areas, the maximum von Mises stress is significantly below the material's yield strength, indicating that the component is not at immediate risk of yielding under the current loading conditions. This von Mises stress analysis is essential for understanding the stress distribution within the component and identifying critical high-stress areas that may require reinforcement. Overall, the component appears structurally sound, as the stress levels do not exceed the yield strength, ensuring its integrity under the given loading conditions.

Table 4.13 Von Misses Analysis Design 3

Design	Minimum	Maximum	Material
	9.551e+00	8.996e+06	Galvanize Steel

4.13.2 Displacement Analysis For The Structure Design Number 3

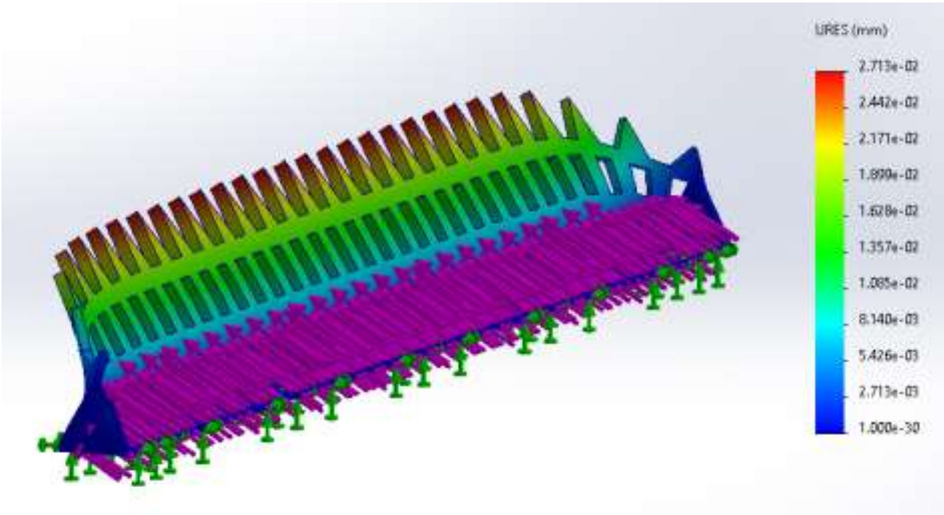

Figure 4.21 Displacement Analysis For The Structure Design Number 3

The color gradient illustrates the magnitude of displacement, ranging from approximately 1.000e-30 mm to 2.713e-02 mm, with blue indicating minimal displacement and red indicating maximal displacement. The geometry of the component is complex, featuring multiple repeating elements, and the analysis shows how different parts deform under load. Green fixtures at the bottom of the component represent the points of support or constraint. This visualization helps engineers understand areas with minimal and maximal displacement, ensuring that the component can withstand applied loads without excessive deformation, which is critical for material selection, design modifications, and safety considerations. Accurate displacement analysis like this is fundamental in predicting the performance and lifespan of the component. It helps in identifying potential failure points and addressing them proactively.

Table 4.14 Displacement Analysis Design 3

Design	Minimum	Maximum	Material
	1.000e-30	2.713e-02	Galvanize Steel

4.13.3 Strain Analysis For The Structure Design Number 3

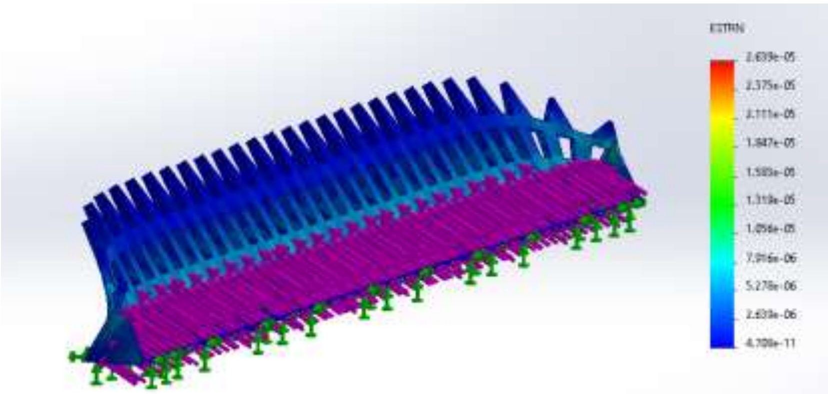

Figure 4.22 Strain Analysis For The Structure Design Number 3

The strain distribution is depicted through a color gradient, with the legend on the right indicating the strain values. These values range from approximately 4.708e-11 to 2.639e-05, where blue indicates the areas with the lowest strain and red indicates the areas with the highest strain. Green fixtures at the bottom of the component represent the points of constraint or support during the analysis. Such strain analysis is crucial for identifying areas that experience the most strain, providing valuable insights into potential points of failure. This information is essential for optimizing the design, improving performance, and enhancing the durability of the component. By understanding where the component is most stressed, engineers can make informed decisions to reinforce those areas, ensuring the overall structural integrity and safety.

Table 4.15 Strain Analysis Design 3

Design	Minimum	Maximum	Material
	4.708e-11	2.639e-05	Galvanize Steel

4.13.4 Factor Of Safety For The Structure Design Number 3

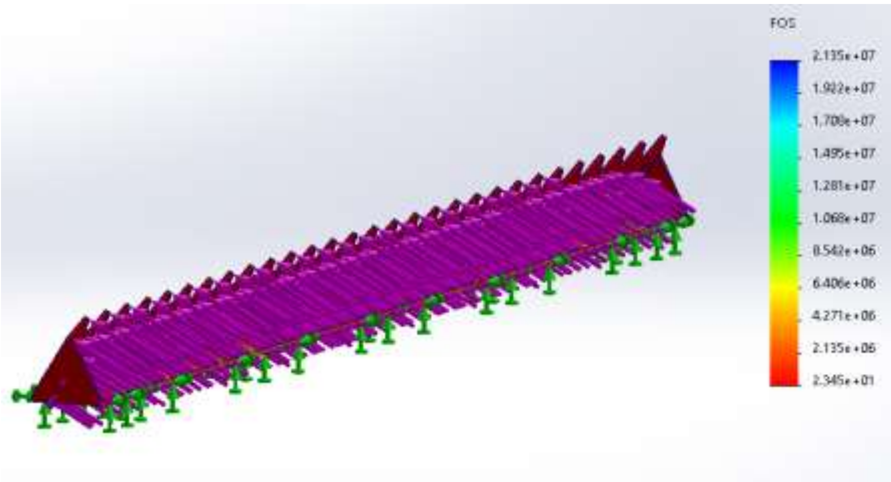

Figure 4.23 Factor Of Safety For The Structure Design Number 3

The strain distribution is depicted through a color gradient, with the legend on the right indicating the strain values. These values range from approximately 4.708e-11 to 2.639e-05, where blue indicates the areas with the lowest strain and red indicates the areas with the highest strain. Green fixtures at the bottom of the component represent the points of constraint or support during the analysis. Such strain analysis is crucial for identifying areas that experience the most strain, providing valuable insights into potential points of failure. This information is essential for optimizing the design, improving performance, and enhancing the durability of the component. By understanding where the component is most stressed, engineers can make informed decisions to reinforce those areas, ensuring the overall structural integrity and safety. Additionally, the detailed visualization allows for the precise targeting of modifications, saving resources and enhancing efficiency. This approach ultimately contributes to the development of more robust and reliable engineering solutions.

Table 4.16 Factor Of Analysis Design 3

Design	Minimum	Maximum	Material
	2.345e+01	2.135e+07	Galvanize Steel

4.13.5 Summary Of Analysis

Table 4.17 Summary of Analysis

Detail	Existing	Design 1	Design 2	Design 3
Stress	3.307e+06	1.117e+07	1.027e+07	8.996e+06
Displacement	5.805e-03	3.490e-02	6.622e-02	2.713e-02
Strain	7.921e-06	2.870e-05	2.579e-05	2.639e-05
Factor Of Safety	6.036e+07	1.341e+07	8.265e+06	2.315e+07

The table compares four designs Existing, Design 1, Design 2, and Design 3—based on stress, displacement, strain, and the factor of safety. The existing design performs the best overall, with the lowest stress (3.307e+06), displacement (5.805e-03), and strain (7.921e-06), and the highest factor of safety (6.036e+07). Among the new designs, Design 3 is the most balanced. It has moderate stress (8.996e+06), the lowest displacement (2.713e-02) and strain (2.639e-05) of the new designs, and a factor of safety (2.315e+07) that is second only to the existing design.

Design 1 focuses on reducing stress but has the highest displacement (3.490e-02) and strain (2.870e-05) of the new designs, with a factor of safety (1.341e+07) lower than Design 3. Design 2 also aims to reduce stress (1.027e+07) but has the highest displacement (6.622e-02) among all designs and a slightly higher strain (2.579e-05) than Design 3, with the lowest factor of safety (8.265e+06) among the new designs. Overall, Design 3 stands out as the best option among the new designs, offering a good balance of improved stress performance, acceptable displacement and strain, and a relatively high factor of safety.

4.15 Pugh Method Analysis.

The Pugh Method Analysis, also called the decision matrix method, is a simple and organized way to compare different design options based on specific criteria. It is useful in engineering and product development when deciding which design works best. For the trash comb of a trash collector conveyor, this method helps choose the most suitable design by comparing alternatives against important requirements.

The trash comb is a key part of the conveyor, helping to remove waste and prevent blockages. Important factors to consider for its design include strength, materials, ease of installation, maintenance, weight, cost, and overall performance. In the Pugh analysis, a reference design (baseline) is picked, and other design options are compared to it. Each design is rated as "better than" "same as," or "worse than" the reference for each requirement. These ratings are added up to find the design with the best overall score.

Using the Pugh Method makes it easier to choose a design that meets the needs of the trash collection system while balancing performance, cost, and ease of use. This method is simple, clear, and helps ensure the best design choice is made.

4.15.1 Pugh Method Analysis

Table 4.19 Pugh Method

Criteria	Existing	Design 1	Design 2	Design 3
Efficient Trash Collection	0	+	0	+
Durability	0	+	0	+
Resistance to corrosion	0	+	+	+
Maintenance	0	+	+	+
Safety In Operation	0	-	-	+
Ease For Installation	0	0	0	0
Cost Effectiveness	0	+	+	+
Environment Sustainability	0	+	+	+
Sum +	0	6	4	7
Sum -	0	1	1	0
Sum 0	0	1	3	1
Net score	0	5	5	7

4.15.2 Pugh Analysis Matrix Summary

The Pugh Matrix analysis compares the existing design with three alternative designs which is design 1, design 2, and design 3. Based on the overall net scores, Design 3 emerges as the most favourable option, achieving the highest score of 7. This high score is attributed to its consistently positive performance across all evaluated criteria, with no negative scores and the highest number of positive assessments (7). In contrast, Design 1 and Design 2 both have net scores of 5 but exhibit some weaknesses, including negative scores in the "Safety in Operation" category, highlighting potential safety concerns.

Examining the criteria-specific observations, Design 3 excels in various critical areas such as efficient trash collection, durability, resistance to corrosion, cost-effectiveness, and environmental sustainability. Additionally, it addresses safety concerns effectively, making it a well-rounded choice. Design 1 performs well in most categories but is slightly outperformed by Design 3, particularly in terms of resistance to corrosion and safety. Design 2, on the other hand, demonstrates limited improvements, with the highest number of neutral scores (3), indicating minimal changes compared to the baseline. Notably, all the designs maintain neutrality regarding ease of installation, suggesting there is no significant variation in this aspect among the designs.

In summary, Design 3 emerges as the best option due to its superior performance across key criteria without any negative scores. While Designs 1 and 2 exhibit some strengths, their safety concerns and lower cumulative positive scores make them less competitive. The "Existing" solution, which offers no improvements, is not a viable option for consideration. Based on this comprehensive analysis, Design 3 is highly recommended for implementation, as it promises enhanced performance, reliability, and overall effectiveness in the intended application.

4.15.3 Summary Of Result And Discussion

Chapter 4 covers the analysis, comparison, and optimization of the Trash Comb in a Trash Collector Conveyor system for marine environments, specifically on boats or rivers. The system uses a chain-driven conveyor mechanism with a trash comb to collect floating debris from the water surface or boats, guiding the waste to a designated disposal area. To ensure durability in harsh marine conditions, galvanized steel is chosen over plain carbon steel due to its corrosion resistance, long lifespan, and reduced maintenance needs.

The trash comb is essential for capturing debris and preventing blockages in the conveyor system. Its design, optimized using SolidWorks software, includes precise spacing, streamlined geometry, and corrosion-resistant materials to ensure efficient performance and minimal energy consumption. Galvanized steel is selected for its excellent rust and wear protection, providing superior durability and cost-effectiveness over time despite a higher initial cost. Detailed analysis of the existing design made from plain carbon steel and three proposed designs made from galvanized steel reveals that Design 3 outperforms the others, demonstrating minimal stress, optimal displacement, and high safety margins.

The Pugh Method comparison assesses key criteria like efficiency, durability, resistance to corrosion, cost-effectiveness, and environmental sustainability, with Design 3 scoring the highest due to its consistent performance across all criteria without negative evaluations. Consequently, Design 3 is recommended for implementation as it enhances the Trash Collector Conveyor system's functionality, reliability, and sustainability, offering improved waste collection efficiency, reduced maintenance costs, and better adaptability to challenging environmental conditions while supporting goals of durability and environmental preservation.

CHAPTER 5

CONCLUSION

5.1 Introduction

This chapter are the last part of this report. This chapter also will explained the conclusion for overall chapter for this Trash Comb of Trash Collector Conveyor on boat. At the end of this chapter also will discussed about the recommendation of this project.

5.2 Conclusion

The first purpose of this project is to design the existing Trash Comb for Trash Collector Conveyor On Boat by using engineering software design SolidWorks software. In this project, SolidWorks is used to construct a 2D and 3D design in the shape of Trash Collector Conveyor. SolidWorks is the main software that used to construct the design. It helps to construct the shape that was dimensioning at the existing design.

Using SolidWorks software, we analyzed and improved the trash comb design by looking at its material. We evaluated stress, displacement, strain, and the factor of safety. Stress analysis showed areas with high stress that could fail, allowing us to modify the design to reduce these stresses and improve durability. Displacement analysis highlighted deformation patterns, and the improved design minimized excessive displacement, ensuring structural stability and functionality. Strain evaluation provided insights into material deformation, showing better strain distribution in the redesigned comb, which reduces material fatigue and extends its lifespan. The factor of safety analysis confirmed that the improved design meets safety standards, with acceptable safety margins under expected loads.

Using the Pugh method analysis, we successfully analyzed and compared the existing and improved trash comb designs based on criteria like efficient trash collection, durability, corrosion resistance, maintenance, safety, ease of installation, cost-effectiveness, and environmental sustainability. Design 3 stood out as the best option, showcasing better trash collection, enhanced durability, and improved corrosion resistance, leading to greater reliability and reduced maintenance. It also excelled in safety, ease of installation, and cost-effectiveness, while meeting environmental sustainability standards. This analysis confirms that Design 3 is superior to the existing and other improved designs, achieving our goals for optimizing the trash comb.

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APPENDICES

Appendices A

GANT CHART

PSM 1 PROJECT PLANNING														
GANTT CHART														
PROJECT ACTIVITIES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
REVIEW CURRENT DESIGN														
CAD MODELLING														
LITERATURE REVIEW														
CAD ANALYSIS														
CHAPTER 1														
CHAPTER 2														
CHAPTER 3														
CHAPTER 4														
PRESENTATION														

PSM 2 PROJECT PLANNING														
GANTT CHART														
PROJECT ACTIVITIES	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
COMPLETE ASSEMBLY														
ANALYSIS ON EXISTING DESIGN														
OPTIMIZE DESIGN 1														
ANALYSIS														
OPTIMIZE DESIGN 2														
ANALYSIS														
OPTIMIZE DESIGN 3														
ANALYSIS														
ANALYSIS RESULT COMPARISON														
CHAPTER 4														
PRESENTATION														