DESIGN IMPROVEMENT OF RIVER TRASH COLLECTOR CONVEYOR STRUCTURE ON MALACCA RIVER BOAT

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (MAINTENANCE TECHNOLOGY) WITH HONOURS

2025

Faculty of Mechanical Technology and Engineering

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HANI MUHAMMAD SYAMIM BIN MADZLI

A thesis submitted
In fulfilment of the requirements for the degree of
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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2025

DECLARATION

I declare that this thesis entitles "Design Improvement of River Trash Collector Conveyor Structure on Malacca River Boat" is the result of my own research except as cited in the references. The thesis report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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Date : 10 FEBRUARY 2025

APPROVAL

I hereby declare that I have checked this thesis, and, in my opinion, this thesis is 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 : 11/2/2025

DEDICATION

This thesis is dedicated to both my parents for their non-stop support. For your unwavering love, support, and encouragement throughout this journey, I dedicate 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

The project of "Design Improvement of River Trash Collector Conveyor Structure on Malacca River Boat" is aimed at design improvement of a river trash collector conveyor structured mounted on boats navigating Malacca River. This thesis examines in detail the technique used in improving the design of current trash collector conveyor structures. SolidWorks software was used to develop the current design of the river trash collector conveyor which every component and part were detailed design using the software. The dimensions of the components and parts were specifically considered in the design of the current conveyor. The project started with a throughout examination and measurement stage utilizing highly accurate tools like vernier calliper and standardise measuring tape to capture key dimensions of the current conveyor structure. 3D model of the conveyor structure was created using SolidWorks after all the dimensions were recorded, where the detailed model of the conveyor structure was created for stress analysis and simulations that been carried out to confirm the design and point out any enhancements also to detect any deficiencies in the current design. This required reanalysing modifications which are meant to show the weakness on the current design. Afterwards, a proposed design will be implemented to the current design to tackle the current design weakness. The SolidWorks design analysis was used to create a new improvement to the design to reduce all the possibilities that direct to design weakness. Initial design analysis makes it possible to argue that this new design does not only increase the structure design but also increase the durability and reliability of the new structure design.

ABSTRAK

Projek "Peningkatan Reka Bentuk Struktur Pemungut Sampah Sungai pada Bot Sungai Melaka" bertujuan untuk meningkatkan reka bentuk struktur pemungut sampah sungai yang dipasang di atas bot yang beroperasi di Sungai Melaka. Tesis ini mengkaji secara terperinci teknik yang digunakan dalam meningkatkan reka bentuk struktur pengumpul sampah yang sedia ada. Perisian SolidWorks digunakan untuk membangunkan reka bentuk semasa konveyor pengumpul sampah sungai di mana setiap komponen dan bahagian dipercayai direka bentuk menggunakan perisian tersebut. Dimensi komponen dan bahagian dipertimbangkan secara khusus dalam reka bentuk konveyor semasa. Projek bermula dengan peringkat pemeriksaan dan pengukuran yang teliti menggunakan alat yang sangat tepat seperti penggaris vernier dan pita pengukur yang diperstandardkan untuk merakam dimensi utama struktur konveyor semasa. Model 3D struktur konveyor dicipta menggunakan SolidWorks setelah semua dimensi direkod, di mana model terperinci struktur konveyor dicipta untuk analisis tekanan dan simulasi yang dijalankan untuk mengesahkan reka bentuk dan menunjukkan sebarang penambahbaikan serta untuk mengesan sebarang kelemahan dalam reka bentuk semasa. Ini memerlukan penilaian semula modifikasi yang dimaksudkan untuk menunjukkan kelemahan dalam reka bentuk semasa. Selepas itu, reka bentuk cadangan akan dilaksanakan ke dalam reka bentuk semasa untuk menangani kelemahan reka bentuk semasa. Analisis reka bentuk SolidWorks digunakan untuk mencipta penambahbaikan baru kepada reka bentuk untuk mengurangkan semua kemungkinan yang membawa kepada kelemahan reka bentuk. Analisis reka bentuk awal membolehkan kita berhujah bahawa reka bentuk baru ini tidak hanya meningkatkan reka bentuk struktur tetapi juga meningkatkan kebolehpercayaan dan kebolehtahanan reka bentuk baru.

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“Last but not least, I want to thank me, I want to thank me 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

FTKM	-	Fakulti Teknologi Kejuruteraan Mekanikal
UTeM	-	Universiti Teknikal Malaysia Melaka
AI	-	Artificial Intelligence
CAD	-	Computerized Aided Design
FEA	-	Fenite Element Analysis
XR	-	Extended Reality
2D	-	2 Dimensional
3D	-	3 Dimensional
CFD	-	Computational Fluid Dynamics
HDPE	-	High Density Polyethylene
RIC	-	Range Inspection Control
BOM	-	Bill of Materials
MHCC	-	Melaka Historic City Council

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CHAPTER 1

INTRODUCTION

1.1 Background

In communities worldwide, rivers serve as vital lifelines, utilized for drinking water, agriculture, transportation, and even as venues for recreational activities. However, it's crucial to note the alarming rate at which cities are expanding, accompanied by the proliferation of industries, leading to the accumulation of vast volumes of waste along river courses, resulting in significant pollution problems and degraded scenic beauty. One such example is the Malacca River in Malaysia, which has been utilized since ancient times but now suffers from severe pollution.

However, even if it's the case that such conveyer constructions are efficient, they often come up against various problems like design constraints low efficiency when running; or high levels of maintenance work involved with them since they were created at first place mostly for garbage cleaning purposes within water at least in terms related to their original design specifications which was intended specifically for dealing only with wastes along coastlines. Such constrains make it hard for them to be as useful as needed in dealing with problems of water pollution in the Melaka area up to other regions far beyond this locality.

Inadequacies in the present designs of refuse collecting boats will be dealt with in this thesis by studying and suggesting new ways for the conveyor system in the Malacca River. Comprehensive examination of designs already made, considering recent engineering theories and ecological methods, is what this study will carry out in the quest for better ways of structural reliability and durability.

1.2 Problem Statement

Although there have been campaigns aimed at reducing pollution along rivers, the Malacca River still experiences notable difficulties due to the accumulation of waste. Now, they are using manual methods to collect trash in the Malacca River. Nonetheless, the efficiency and effectiveness of such methods are limited by certain drawbacks in the design of debris clearing machines. These limitations include subpar conveyor configurations, operation lag, as well as the need for frequent maintenance. Hence, the present debris collection state in Malacca falls short in tackling the enormity of the pollution problem affecting the river's environmental health, as well as impairing the welfare of neighbouring societies.

Therefore, it is so urgent to enhance trash collector boat conveyor structures design for improved performance, maximized debris collection efficiency as well as minimal environmental effects. Attacking these problems successfully asks for creative methods that converge between sustainable practices and prominent engineering frameworks as per Malacca River setting.

1.3 Research Objective

The main aim of this research is to outline a structured approach to addressing the problem statement by evaluating existing designs, proposing improvements, and assessing their performance.

a) To design existing trash collector conveyor using SolidWorks software.

b) To analyse existing trash collector conveyor structure.

c) To design and analyse improve design of trash collector conveyor structure to be more durable and reliable and compare to the existing structure design.

1.4 Scope of Research

The scope of this research is as follows:

- Develop current design of the conveyor structure using SolidWorks software and run a simulation and analysis based on the current design.
- Conduct a design analysis and material analysis based on the current design using SolidWorks software.
- Redesigned the existing trash collector conveyor structure to improve its performance and run a simulation and analysis on the new design.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Rivers are facing more and more pollution today including trash that is dumped into them, this poses a threat to both ecosystems as well as human beings who depend on it for their lives" says some experts; however, others argue that conveyor systems have proved useful when dealing with river wastes this year too." Unlike previous years there were not any new technologies that could help clean rivers from all kinds of rubbish." The purpose of this study is to evaluate what experts know so far about how they clean up such waters: this includes many conveyors. It examines existing designs, identifies limitations, explores recent advancements, and highlights opportunities for improvement. By synthesizing existing research, this review aims to inform the design enhancement of river trash collector conveyor structures on the Malacca River.

2.2 Introduction to CAD Software in Engineering Design

Computer-aided design (CAD) is the use of computer-based software to aid in design modelling, design analysis, design review, and design documentation. Nevertheless, the benefits of CAD can be elevated in combination with artificial intelligence (AI), extended reality, and manufacturing.(Regassa Hunde & Debebe Woldeyohannes, 2022). Newly developed architectural technology mixes Computer-Aided Design (CAD), artificial intelligence (AI), extended reality (XR) and advanced manufacturing processes in the present-day field of structural engineering which is experiencing a paradigm shift. This brings a revolution in the traditional way of designing river trash collector conveyor structures since it has several advantages. CAD plays a key role in this technological synergy by providing sophisticated tools to engineers in the areas of complex design modelling it also enables them to analyse their designs as well as document them. This is the program which designers use when creating 3D models for conveyor structures thus allowing them to assess all the details of this or that structure comprehensively. Further, modern engineering can discard drawbacks and improve on structural specifics, as a result, the general efficiency and sustainability of the design is enhanced.

Figure 2. 1 CAD Software

2.2.1 Overview of SOLIDWORKS

Solid Works modelling is an important tool in concurrent engineering in that the various engineering groups work from a common database: the solid model. In a 2-D CAD (Computer-Aided Design) environment, the design engineer produced sketches of the component, and a draftsman produced 2-D design drawings. These drawings were forwarded to the other engineering organizations, where much of the information was then duplicated. (Howard, William E. (William Edward), Musto, Joseph C, 2022). A vital component of computer-aided design (CAD) software, SolidWorks has undergone constant development since its launch in 1995. Because of its user-friendly interface and ability to model parametrically, CAD has become more accessible to a wider range of designers and engineers, making it an essential tool for all fields. Robust 3D modelling, assembly design, and simulation tools are among the essential characteristics that enable users to precisely and easily define, refine, and analyse complex designs.

The design optimization features of SolidWorks allow engineers to repeatedly enhance the efficiency and effectiveness of these forms of conveyors that fetch litter from rivers henceforth promoting creativity. Further SolidWorks makes the process of design easy with consideration of environmental issues thus permitting creativity in the design itself. SolidWorks' collaborative capabilities facilitate multidisciplinary participation by connecting partners from engineering, environmental research, and local government to jointly develop solutions that are specifically targeted to the problems posed by river pollution. SolidWorks becomes more than simply a tool; it's an instrument for revolutionary change that enables designers to imagine and bring to life a future where our rivers and ecosystems are cleaner and more sustainable.

2.2.2 Advantages of Using SOLIDWORKS

In olden days, it was done by various analysis methods which consumed more time and human power.(Ramesh et al., 2019). In the field of 3D modelling, SolidWorks is a foundation, providing engineers with a strong platform to convert rough sketches into detailed digital models. Because of its parametric design methodology, complicated structures found in river trash collectors may be refined more quickly through loop and change. With tools like advanced surfacing and assembly modelling, designers may carefully create complex representations of trash collecting systems and conveyor systems. This accuracy not only improves the collector's operation but also speeds up the manufacturing process by offering precise construction plans. The capacity to predict and evaluate the trash collector's performance under varied operating situations is essential to the design process. In this way, SolidWorks shines, providing engineers with integrated simulation tools that let them perform in-depth assessments. Designers can evaluate the collector's structural integrity using Finite Element Analysis (FEA), ensuring that it can survive the dynamic forces present in river environments. Furthermore, through accurate flow analysis, Computational Fluid Dynamics (CFD) simulations enable the optimisation of the waste collection system, maximising efficiency and minimising drag.

SolidWorks is known for its ability to build complex structures with unmatched accuracy, including garbage collection systems and conveyor belts. By utilising characteristics such as welding and sheet metal design, engineers can precisely simulate the geometry of conveyor structures, guaranteeing maximum longevity and performance. Furthermore, the assembly functionality of SolidWorks allows components to be seamlessly integrated, allowing for a comprehensive view of the trash collector's design and the identification of possible optimisation opportunities or interference issues. The simulation features available in SolidWorks go beyond simple structural analysis and include material selection, stress analysis, and flow analysis. To assess the structural soundness of conveyor systems and maximise the efficiency of trash collection systems, engineers can model real-world situations. The software's large material library helps with thoughtful material selection by taking environmental effect, corrosion resistance, and durability into account, which ensures the collector's sustainability and lifetime.

2.2.3 Simulation and Testing with SOLIDWORKS

The analysis of spherical indentation test has been numerically simulated using the Finite element analysis, using the SolidWorks simulation software. (Gukop et al., 2020). The design process includes simulation and testing to make sure conveyor systems meet performance criteria and can handle operational issues. With the powerful simulation capabilities that SolidWorks provides, engineers may evaluate structural integrity, simulate real-world scenarios, and optimise design parameters. This talk explores how SolidWorks makes simulation and testing easier, with particular attention on how it may be used for stress testing, fluid dynamics analysis for conveyor systems, and simulating operational environments. SolidWorks offers a framework that allows for remarkably accurate simulation of the conveyor system operating environment. Engineers can simulate the passage of items along a conveyor belt by utilising dynamic simulation capabilities, which consider many parameters like speed, load distribution, and climatic conditions. Through precise simulation of the working environment, designers may pinpoint possible obstructions, maximise conveyor setups, and improve.

Engineers can ensure the structural integrity and lifetime of conveyor components by rigorously stress-testing them using SolidWorks Simulation. Through the application of loads, constraints, and boundary conditions, designers can evaluate the performance of individual parts and pinpoint possible failure sites. SolidWorks offers insights into fatigue life, deformation, and stress distribution through Finite Element Analysis (FEA), allowing designers to improve their designs and reduce failure risks. Conveyor systems are guaranteed to be able to bear the demands of continuous operation in challenging conditions thanks to this iterative method to stress testing. When designing river trash collectors, it is critical to comprehend how water flow affects conveyor systems. Engineers can optimise conveyor topologies, reduce drag forces, and analyse fluid behaviour with SolidWorks' Computational Fluid Dynamics (CFD) simulation features. Designers can find regions of strong turbulence or pressure gradients by simulating water flow patterns. This allows them to optimise conveyor shape for increased efficiency and lower energy use. Furthermore, CFD simulations make it easier to evaluate the collection and sedimentation of debris, which helps designers make judgements about how to minimise potential obstructions and maintenance issues.

2.3 Material and Structural Considerations

During the design process, it is necessary to determine the structures of the hull, the light floating garbage collection device, and the heavy floating garbage collection device, based on the characteristics of small water areas and the collection characteristics of floating. garbage, to finalize the main structure of the robot. (Wang, W., Wu, Q., Zhang, P., & Liu, T. (2024) Conveyor systems are essential for handling commodities and trash in aquatic settings, especially rivers. To guarantee longevity, effectiveness, and environmental friendliness, these systems' design must carefully consider the materials and structural components. This essay explores common materials, durability, maintenance, cost-effectiveness, and unique structural issues associated to river environments. It also explores material and structural considerations for conveyor systems in aquatic environments. A conveyor system's material selection is crucial in wet areas like rivers. These materials need to be resistant to abrasion, corrosion, and extended exposure to the elements. Aluminium, HDPE (high-density polyethylene), and stainless steel are a few of the materials that are frequently utilised. The corrosion-resistant material stainless steel is perfect for withstanding the severe conditions found in rivers. Similarly, HDPE is a common material for conveyor parts because it is lightweight, chemically inert, and resistant to abrasion and corrosion. Both materials have low maintenance needs, which adds to their long-term affordability.

For conveyor systems operating in river environments to be strong and functional, structural factors are essential. Because it is constantly exposed to chemicals and water, corrosion resistance is crucial. HDPE and stainless steel lessen the chance of corrosion, extending the life of conveyor systems and lowering maintenance requirements. Another problem is contaminants, or the buildup of organisms on surfaces. Stainless steel and HDPE are examples of smooth, non-porous materials that minimise biofouling, making cleaning simpler and causing fewer operational disturbances. When conveyor systems encounter trash, branches, and logs in river environments, debris control becomes a major challenge. To avoid debris interference and guarantee continuous operation, structural design elements including offering enough clearance and sturdy construction are essential. Furthermore, in dynamic river environments, conveyor systems must possess flexibility and adaptability. The necessity for durable yet adaptable design solutions is highlighted by the fact that these systems must handle variations in water levels and flow rates without sacrificing functionality or safety. The application of material and structural factors in actual river trash collection systems is demonstrated by two noteworthy case studies. The Ocean Cleanup created The Interceptor, which is resistant to corrosive river environments thanks to its HDPE and stainless-steel components. Its strong structural design and capacity to adjust to changing circumstances make it a practical choice for gathering river debris worldwide. In a similar vein, the Baltimore Water Wheel, which is composed of stainless steel, efficiently controls garbage and biofouling in Baltimore's Inner Harbour. The advantages of corrosion-resistant materials in river environments are emphasised by its sturdy structure and low maintenance needs.

2.3.1 Comparative Analysis of Different Conveyor Design

Selection of conveyor system is carried out according to functional requirements, size shape and weight of material, travelling distance, speed requirements, etc. (Todkar, S., Ramgir, M., & Tathwade, J. R.) (2018). Conveyor systems play a significant role in many different businesses because they make product flow both quick and safe. This literature review compares the use of different conveyor designs in comparable environments. This review tries to provide insights on choosing the best conveyor design for certain industrial applications through examination of major performance measures, environmental constraints, financial considerations, and real-world examples. Conveyor systems make a smooth way to flow products across manufacturing facilities; therefore, they are a key component in modern industrial processes. With many different types of conveyor systems in the market, it becomes difficult to pick the best system for a certain application. Highlighting the performance of different conveyor systems under comparable environmental conditions, this literature review essay tries to make clear the comparative study of those designs. This review attempts to support decision-makers in selecting conveyors by synthesising case studies, industry perspectives, and current research.

A comparative comparison first examines the many types of conveyors, which include screw, belt, roller, chain, and pneumatic conveyors. Each design, in its own way, demonstrates uniqueness based on throughput, speed, energy efficiency, dependability, flexibility, and safety. Roller conveyors provide smooth and low-friction material conveyance, while belt conveyors are known for their high throughput and versatility. Chain conveyors work well in demanding applications, although there can be some noise and energy usage problems. Performance indicators such as throughput rate, speed, energy consumption per unit of material moved, dependability, flexibility, and safety can be used to assess how effective conveyor designs are.

Conveyor system performance is greatly impacted by environmental conditions. Conveyor durability, efficiency, and maintenance requirements can be affected by several variables, including temperature, humidity, dust levels, and the presence of corrosive compounds. Pneumatic conveyors, for example, may be favoured in high-dust settings because they reduce material spillage and contamination. In contrast, due to possible belt degeneration, belt conveyors may need extra maintenance in corrosive environments. As a result, choosing the right conveyor design requires careful consideration of the surrounding environment.

Cost considerations include not only the initial investment, but also long-term operational expenses associated with the conveyor system. While certain designs can carry higher upfront costs, they may provide greater efficiency and less maintenance requirement over their lifespan. Real-world case studies are valuable in providing information on the performance of different conveyor designs in similar environmental conditions. For example, a case study comparing belt and screw conveyors in a mining operation could reveal trade-offs between throughput, energy consumption, and maintenance costs. Essential to the process is consultation with industry experts, engineers, and conveyor manufacturers. Their expertise can enlighten on the subtleties of conveyor performance and provide recommendations specific to an application. In addition, a proper risk assessment is required to evaluate each conveyor design for potential hazards, including those related to safety, maintenance-related downtime, and reliability. Multifaceted analyses of conveyor designs for similar environmental conditions include performance metrics, environment, cost analysis, case studies, consultation, and risk assessments. Synthesizing these elements, decision-makers can make appropriate choices in conveyor selection for efficiency, reliability, and cost-effectiveness in industrial operations. The future of conveyor technology holds a lot of promise in the form of increased efficacy and sustainability of material transportation systems.

Table 2.1 Comparative Conveyor Design

Type	Application	Efficiency	Cost	Maintenance	Environmental Impact
Belt Conveyors	Versatile and suitable for transporting a wide range of materials over long distances.	High efficiency for continuous, smooth transportation.	Higher initial cost compared to some other conveyor types, but cost-effective for long-term use.	Requires regular maintenance to inspect and replace belts, pulleys, and bearings.	Can be energy-efficient if properly designed with efficient motors and control systems.
Roller Conveyors	Ideal for moving rigid items like boxes and pallets in warehouses and distribution centres.	Efficient for handling heavy loads and high-volume applications.	Lower initial cost compared to belt conveyors, especially for basic gravity roller conveyors.	Generally lower maintenance requirements compared to belt conveyors, as there are fewer moving parts.	Gravity roller conveyors can be energy efficient as they rely on gravity for movement, but motorized versions may consume more energy.
Chain Conveyors	Suited for heavy-duty applications and handling items with irregular shapes or high temperatures.	High efficiency for heavy loads and harsh environments.	Moderate to high initial cost depending on the design and materials used.	Requires regular lubrication and inspection of chains, sprockets, and bearings	Can be energy-intensive, especially for motorized chain conveyors, but can be designed for efficiency with proper motor selection and control systems.
Screw Conveyor	Effective for transporting bulk materials such as grains, powders, and slurries.	Efficient for handling certain types of materials but may be less suitable for delicate items or precise positioning.	Moderate initial cost depending on size and materials used.	Requires regular inspection and cleaning to prevent material buildup and ensure smooth operation.	Can be energy-efficient depending on the application and design, especially if operated at lower speeds.
Pneumatic Conveyors	Suitable for transporting dry bulk materials in powder or granular form over short to medium distances.	Can be efficient for certain materials and applications but may require more energy compared to mechanical conveyors.	Generally higher initial cost due to the need for air compressors and pneumatic systems.	Requires regular inspection and maintenance of pneumatic components and air filtration systems.	Can be energy-intensive due to the need for compressed air but may offer advantages in certain applications where dust containment is critical.

2.3.2 Design Principle of Conveyor System

The automated conveyor system, as the core component in the modern manufacturing world, has gained lots of attention from researchers. To optimize the operation of the conveyor system, range-inspection control (RIC) has been considered an efficient strategy to bring this conventional technology to an intelligent level. (T. Wang, J. Cheng, Y. Yang, C. Esposito, H. Snoussi and F. Tao, (2022). The unsung heroes of industrial logistics are conveyor systems, which plan the smooth flow of materials.

But these systems encounter a different set of difficulties when they enter aquatic environments. Let's examine the basic concepts of conveyor design belt, chain, and screw as well as the ways in which engineers address the challenging issues of corrosion, buoyancy, and water. Every kind of conveyor belt, chain, and screw has a unique method for completing the task at hand. Chain conveyors employ linked chains driven by sprockets, screw conveyors use a revolving helical screw blade, and belt conveyors have a continuous loop of material driven by pulleys. These systems guarantee that materials travel in a seamless manner along their intended routes.

2.4 Current River Trash Collection Methods

Trash that was disposed of and deposited in landfill. Alot of garbage that was not properly managed were burned and thronged in the river (Kamarudin et al., 2021). An essential part of environmental conservation, which aims to reduce pollution and protect aquatic ecosystems, is the removal of rubbish from rivers. Globally, a range of approaches and technology are utilised to address the problem of managing river garbage, from sophisticated automated systems to manual cleanup operations. Using nets, boats, and other gear, teams of people manually remove trash from riverbanks and water surfaces during manual clean-up. Even though they take a lot of time and labour, hand cleanup operations are frequently used in places with little resources or where it is difficult to use machinery. Manual trash collection activities in rivers are aided by volunteer initiatives and community-driven clean-up events. The manual system pros are flexibility to adapt to diverse river environments, low initial investment, community engagement opportunities and the cons are Labor-intensive, slow process, limited scalability, reliance on human resources, potential safety hazards for workers.

Technology is used by automated river trash collecting systems to increase productivity and effectiveness. Usually, these systems use booms, skimmers, and floating barriers to catch and gather floating trash before it spreads downstream. Conveyor belts, conveyance mechanisms, and sorting technologies are some of the sophisticated automated systems that effectively remove, separate, and dispose of collected garbage. Sensors and monitoring tools are frequently included in these systems to keep track of debris accumulation and improve collection tactics. The automated on the other hands advantage in High efficiency and throughput, continuous operation, minimal human intervention, scalability for large-scale deployments, potential for remote monitoring and control. The disadvantages can be said higher initial investment, reliance on technology and infrastructure, maintenance requirements, potential limitations in complex river conditions.

2.4.1 Root Causes of River Trash

Water pollution occurs in Malacca state. Specifically, it affects the Malacca River. The main cause of water pollution is factories. (Hua, Ang Kean, and Mohd Zuhdi Marsuki (2014). The accumulation of pollution and waste presents serious issues for Malaysia's most important waterway, the Malacca River. The origins of river rubbish in the Malacca River are examined in this literature study, with an emphasis on the contributions made by locals, factories, and industrial activity. In addition, it looks at how trash volume and composition change with the seasons to shed light on how dynamic river pollution is. This review attempts to contribute to a thorough understanding of the elements influencing river cleanliness and inform sustainable management options by combining available research and empirical data. The Malacca River is like a lifeblood for the city of Malacca, supporting a variety of economic, recreational, and ecological uses. The river, however, is progressively dogged by pollution, the predominant being trash or rubbish. Knowledge of the sources of river trash and their seasonal variation can inform policy on effective mitigation measures and the preservation of the ecological integrity of the Malacca River. This literature review explores the major contributors to river trash and analyses how seasonal factors influence the accumulation and composition of trash.

Several factors contribute to the piling of rubbish in the Malacca River. Mainly, pollution emanates from industrial activities on riverbanks, notably factories and processing plants. Most of the time, these industries directly or indirectly release waste into rivers by stormwater runoff, which piles up plastic wastes, chemical pollutants, and other debris. Littering and poor waste management facilities in residential areas adjacent to the river further contribute to the problem. For this, there needs to be an understanding of the relative contributions of factories, residents, and industrial activities so that effective targeted intervention measures may be initiated. Seasonal variations in volume and composition in the Malacca River are immense. Rainfall and stormwater runoff increase in the monsoon season;

hence, it stands to flush large volumes of rubbish from surrounding areas into the river. This results in an increase in the volume of trash, that is mainly constituted by bottles, plastic bags, and other single-use products. On the contrary, dry seasons might result in low water levels and reduced flows, thereby making the debris that collects along the riverbanks more apparent and concentrated. Grasping seasonal trends is critical for the implementation of timely clean-up operations and formulation of strategies to prevent garbage from accumulating during intense periods.

The accumulation of waste and pollutants in the Malacca River is a permanent issue, as the problems range from inhabitants to factories and industrial works. Changing seasons escalate the problems related to the volume and type of river trash all year round. Understanding these sources and changing seasons of river pollution will enable interested parties to develop focused interventions and management plans to protect the integrity of the ecosystem and the well-being of the Malacca River. Sustained investigation, community involvement, and policy efforts are the components needed toward ensuring that this important river remains clean and sustainable into the future.

Figure 2. 2 Trash along Malacca River

2.5 Finite Element Analysis (FEA) For the Conveyor Structure

Modern structural engineering rest on Finite Element Analysis (FEA) changing the attitude in comprehending, designing and optimizing intricate structures. The software is appreciated for the fact that it offers comprehensive details on how structures behave when subjected to different forces making construction of safer, faster, cheaper engines an easier task. Using FEA in structural analysis has significantly improved this area, providing engineers with a way of simulating numerous behaviours of structures such as linear and nonlinear responses, thermal effects, and dynamic interactions. When designing it allows for precise calculations of distributed forces on areas in structures through discretizing complex geometries into smaller elements and involving numerical methods which help us predict deformation patterns or stresses occurring inside any material system under loading conditions due to realization made by most researchers involved in this work. Thanks to technological advancements in computational capabilities and the availability of sophisticated FEA software tools, using this computational approach is easier now.

Moreover, structural design optimization involves finite element analysis (FEA) plays an important role. They can adjust design parameters in a step manner such that they can determine how these affect the performance of their structures thereby arriving at best solutions whose material usage, costs and weights are minimised. To fulfil an intended design there are various procedures employed like topology optimization, shape optimization and parameter optimization that work hand in hand with FEA. However, the reliability of FEA results heavily depends on efficient validation and verification procedures. To achieve this, we compare FEA predictions with experimental data or analytical solutions using appropriate software for real-world structural systems Validation ensures that simulations are exact copies of real-world occurrences while verification tests if they are accurate or not. In addition, convergence and numerical accuracy in FEA are measured during verification using strict testing procedures. To believe in FEA simulations and that they really suit for the everyday engineering, one needs strong validation and verification systems. Many different industries of engineering make use of finite element analysis i.e. civil, mechanical, aerospace and biomedical engineering. Engineers make use of finite element analysis (FEA) to investigate a wide range of different types of structural systems everything from buildings and bridges to aircraft components, and medical implants.

Finite element analysis (FEA) is very useful in the simulation of complex interactions between the structural mechanics, fluid dynamics and thermal effects. This permits a whole interpretation or comprehension concerning multi-disciplinary engineering issues. Even though there are lots of advantages associated with FEA, it also has its own setbacks which make its use very difficult for engineers. When it comes to applying this method on real life projects, one will find out that a lot needs to be done; ranging from the fact that it is computationally complex to uncertainties in materials' properties among other things and to improve upon this situation, much effort has been undertaken so far with regard to developing better algorithms focusing more on increasing accuracy in predictions as well as ensuring quicker calculations What are the main forms of phrases in English, according to their structure? This question appears easier than and needs an in-depth study. One of the simplest ways to find answers is by dividing phrases into smaller units and looking at each part individually. Phrasal division is used because it gets easier to learn about the system used for building English expressions; additionally, such analysis allows seeing what makes some groups of words work in a particular way.

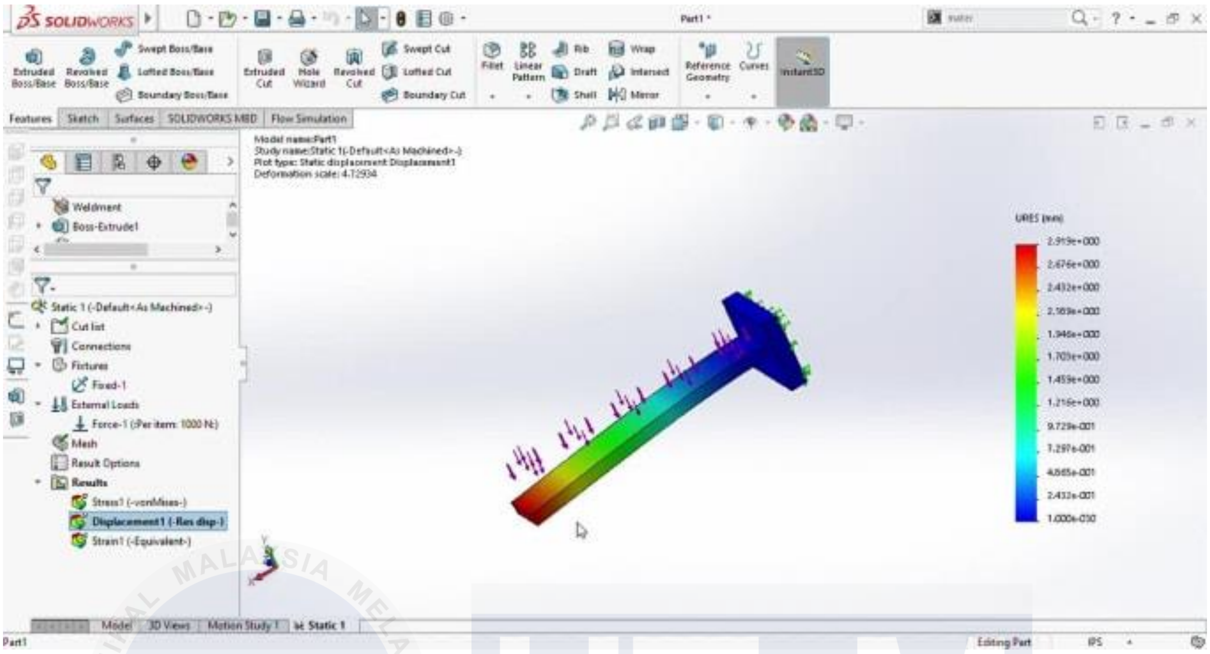


Figure 2. 3 Finite Element Analysis

2.5.1 FEA Evaluation

During the analysis process for conveyor structures, finite element analysis (FEA) serves as a fundamental tool to determine the structural soundness under different loading conditions. This specific type of analysis includes static load examination for checking if the structure can resist forces like the weight of conveyed materials and any outer loads from either supporting structures or equipment. At the same time, dynamic load analysis is privately conducted to determine the reaction towards dynamic forces including vibrations or impacts that may occur while operating. Finite Element Analysis (FEA) is used to analyse how a structure will react to changes in temperature by studying thermal stresses. This includes looking at expansion due to heat to find what is causing stress or distortion caused by changes in temperature that occur within the course of normal use. Moreover, FEA can appraise fatigue damage and failure manners in estimating service life this process helps uncover any likely breaking options. On the other hand, the examination of loading histories as well as patterns of crack growth facilitates anticipating eventual ruin mode that would be useful for developing all necessary preventive measures against tragic failures in advance.

FEA results are heavily impacted by the material picked out for conveyor configurations. Makers of conveyors commonly use structural steels, aluminium alloys, and composite materials in a variety of cases for conveyor development. The Young's modulus, Poisson ratio and yield strength are examples of the material properties contained in the FEA models input parameters. They can optimize safety and reliability of a conveyor structure if engineers select correct materials and input factors. The effectiveness of FEA in optimization of conveyor structure designs was examined in several research and real-life projects. When developing such structures, the use of FEA tools ensures that performance criteria are met precisely; this leads also to reduced use of materials as well as better effectiveness of the entire system. The improvement of conveyor structure optimization for safer and more reliable conveyor systems will be enhanced by continual progress in FEA methodologies and material science.

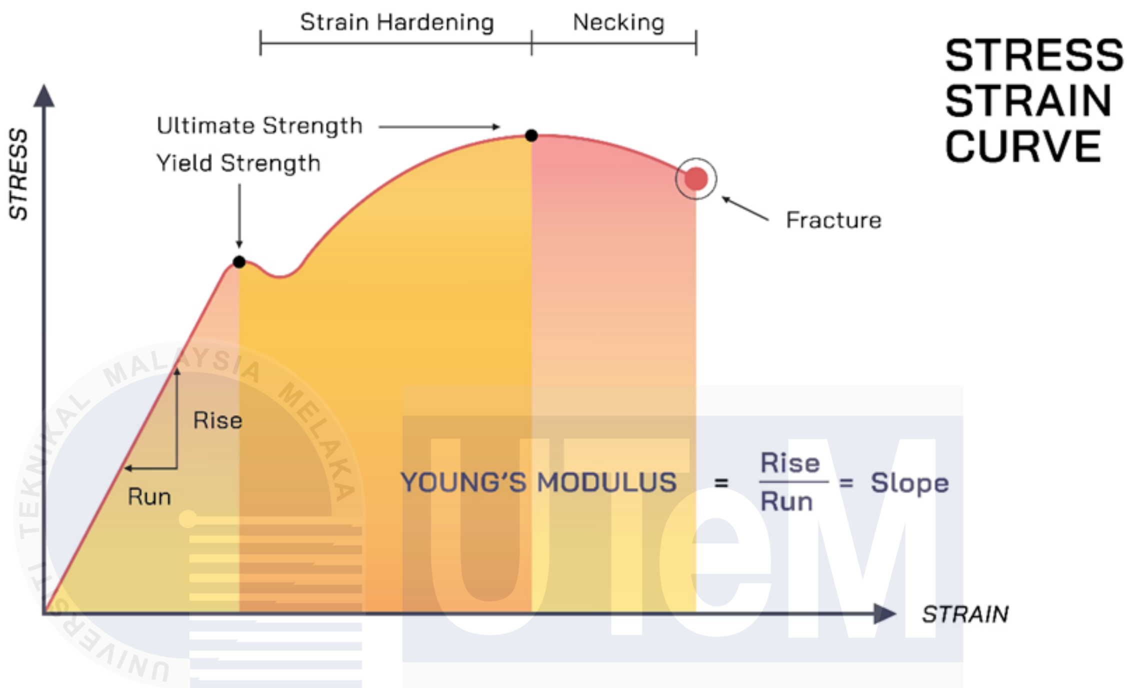


Figure 2. 4 Stress and Strain Curve

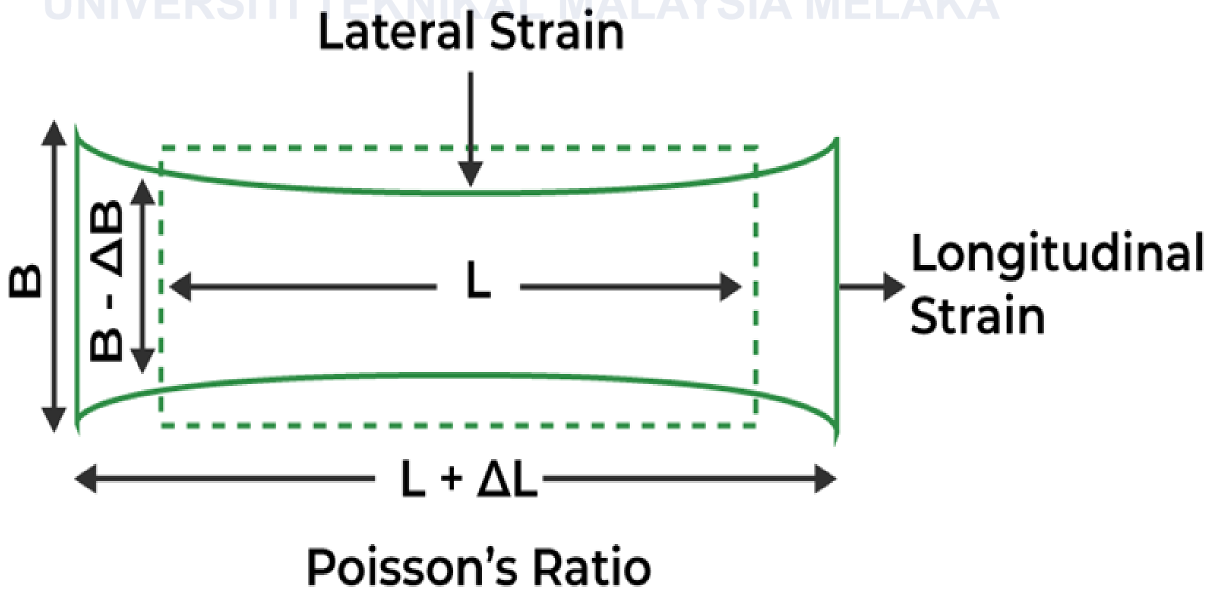


Figure 2. 5 Poisson's Ratio

2.6 Summary of the Literature Review

Pollution in rivers caused by trash dumping increases the need for proper cleaning mechanisms as observed in the Malacca River system. Hence, the purpose of this literature review is to concentrate on conveyor structures designed, optimized and evaluated for river trash collection, particularly focusing on the Malacca River. The review talks about integrating CAD software with SolidWorks to enhance effectiveness, ecological performance as well as teamwork amongst technicians. SolidWorks which are known for its strong capabilities in sophisticated 3D modelling, simulation and materials selection is explored in relation to designing smart garbage collection systems. In addition, different conveyor designs are examined in the review by comparing their performance, adaptability and cost-effectiveness at different environments. The point which is strongly made is that a selection of the best conveyor system should be based on individual requirements and conditions prevailing in nature. Moreover, the research examines the origins of river refuse within the Malacca River citing industrial activities, residential garbage and seasonal differences as sources of pollution and argued that comprehension of these elements is pivotal to come up with efficient clean-up approaches.

Moreover, it is worth considering that: Finite Element Analysis (FEA) is very important in assessing different loads' effect on the structural integrity of conveyor structures. So that engineers can predict complex behaviours and make better designs safer and more reliable FEA has been used. When selecting materials, setting input parameters that are appropriate for use with time-variant data, as well as improving constantly FEA methods are what resultantly lead up to the perfect design of conveyor belt systems. In general, problems and solutions for having technologies to collect litter in rivers are analysed, signifying the requirement for innovation, care for the environment and inclusivity on the part of the society for all issues securing river cleanliness, according to the literature overview

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter presents the approach that been used in carrying out this project to success. This chapter demonstrate the flow and process starting from the scratch until the final product and full analysis is completed. This chapter includes the project planning flowchart, process of engineering drawing, drawing assembly and analysis, and reverse engineering techniques.

This chapter also focusing on the detail process of each of the process that required. Details procedure on how the drawing is established, detail of the analysis, and simulations of the conveyor structure. This methodology involves field observations, data collection, analysis, and design iteration. By synthesizing literature, data, and stakeholder input, we aim to inform urban planners and environmental advocates about effective river waste management strategies.

This research aims at creating equilibrium between people involved in activities as well as natural ecosystems in urban river areas through innovative design modifications. The study is focused on enhancing garbage collection systems so that ecological integrity and cultural importance of rivers like Malacca could be conserved.

3.2 Project Flow Chart

A project workflow can outline the steps and processes that are required to complete a project from start to finish. It usually involves activities such as planning, execution, monitoring, and closing. Workflows may look different depending on project type, team structure, as well as on the main objectives set, but they typically incorporate some stages like setting goals, assigning tasks, scheduling deadlines, cooperating with others involved in the process, monitoring progress, adjusting the course of actions, and bringing the final product. The goal of a project workflow is to ensure efficiency, clarity, and successful project completion.

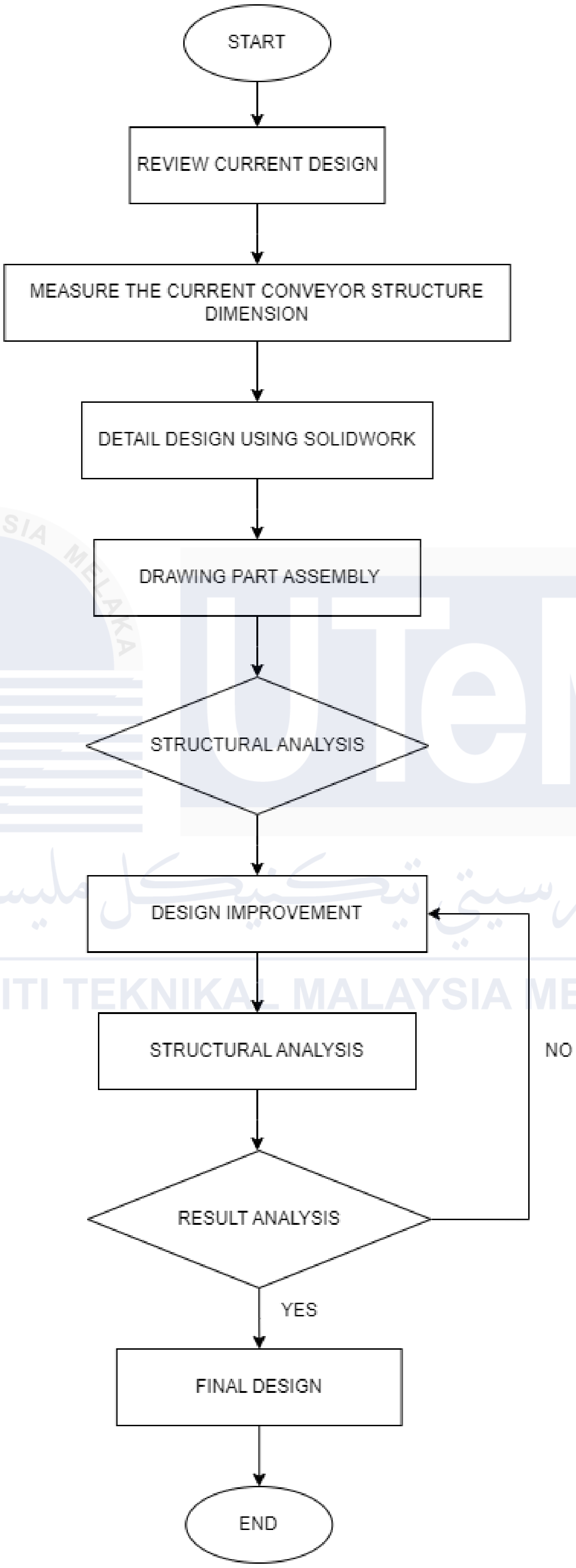


Figure 3. 1 Flow Chart

3.3 Reverse Engineering

A rigorous and methodical way must be taken to improve the performance and functionality of the system of gathering refuse bolshevized from the river boat in Malacca River. The technique defines several carefully thought-out stages, aimed at realizing the required modifications in the design, particularly through reverse engineering. This methodology is built by reverse engineering, with the aim of having a thorough knowledge of the existing conveyor structure and how it operates. This is a stage where current design is taken apart in detail concerning both mechanical and structural parts. We intend to find out the main principles underlying its operations through breaking down the components such as belt on conveyor systems as well as their supporting structures. Additionally, to do a reverse engineering effectively requires a comprehensive investigation into functional settings as well as performance measures for the current conveyor frame. Data must be collected regarding things like material flow rate abilities, waste handling effectiveness, electrical consumption and structural soundness whenever reversed engineering is considered here. Indeed, comparing these real-world observations with the envisioned goals of this garbage collection system enables us to identify spots that need enhancement.

To achieve successful reverse engineering, other similar operational systems are usually analysed for better understanding of the process's essence in this specific environment. This way we can make conclusions, based on a comparison of best-in-class practices with new approaches applied somewhere else, that show where it would be possible to improve designs to avoid repeating them. Such kind of comparison analysis serves only as an inspiration and catalyst towards solving problems creatively. In addition to dissecting the physical attributes of the conveyor structure, reverse engineering encompasses an in-depth examination of the underlying design principles and engineering methodologies. This entails reviewing technical schematics, CAD models, and manufacturing specifications to unravel the intricacies of the original design rationale. By elucidating the design intent behind each component and subsystem, we can discern opportunities for refinement and enhancement.

Figure 3. 2 Current Design Evaluation

3.4 Current Structure Measurement & Dimensioning

It is crucial to get an all-comprehensive measuring instrument of the existing conveyor structure before starting reverse engineering and design improvement. This includes going to the field and using advanced metrological methods for acquiring accurate information about physical characteristics and spatial form of trash collector system. The measurement and dimensioning stage involve detailed engineering drawings and technical specifications that capture geometrical details and other material properties of conveyor structure. This detailed dataset is a founding reference point for later parts of the methodology, making it possible to carry out accurate analysis, simulations and design optimization. Establishing a baseline for comparison and validation during the design improvement process involves meticulously documenting the dimensions, tolerances and geometrical relationships of the current structure. Accurate performance simulations, prototyping as well as iterative optimization iterations are some of the things that are done with this empirical data used in informing both reverse engineering works happening concurrently to make sure that this data is based on hard facts. The phase of measuring and dimensioning is a critical initiating step in the methodology of improving the design of the river trash collector conveyor structure located on the Malacca River Boat. We create a basis for making sensible decisions, performing thorough analyses, and deploying original design solutions by obtaining comprehensive spatial information and geometric characteristics.

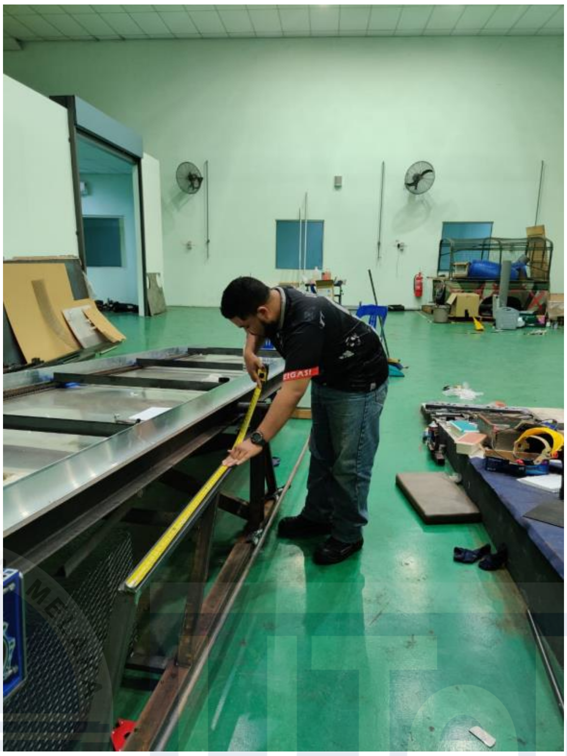


Figure 3. 3 Structural Measuring

Figure 3. 4 Structural Base Dimensioning

3.4.1 SolidWorks Design and Drawing Process

SolidWorks is a robust application of computer aided design which is important to the repeated design changes and definition being made on the system of conveyors intended for upgrading river trash collectors the process that ushers in phase one involves using all that SolidWorks allows in our mind conceptualizes, models and creates simulations of new parts and subsystems. The SolidWorks development process is initiated by preparing elaborate 3D models for the probable force modification of reverse engineering results and concept idea. The aim is to come up with exact digital forms which capture the revised components' geometry, function and relationships based on ideas. After the 3D models are created the next thing to be done is to model the redesigned conveyor system performance and behaviour using SolidWorks simulation tools. Finite element analysis (FEA), motion analysis, and computational fluid dynamics (CFD) simulations are the methods used to assess design variables including structural integrity, stress distribution in materials, kinematics and fluid flow dynamics at different operational states.

In addition, producing detailed engineering drawings and technical documentation is made easy by SolidWorks essential for prototyping, fabrication, and assembly. Our comprehensive 2D drawings adhere to industry standards and regulatory requirements leverage SolidWorks drawing tools and annotation features, thus giving exact manufacturing instructions for fabricated components and assembly guidelines. Optimize the interventions proposed by refining them based on feedback from simulation results, stakeholder inputs as well as prototype testing during the SolidWorks design process. In order words if we iterate 3D models and drawings repeatedly, there is an opportunity for us to find the best design solution which is characterized with three things manufacturability, cost-effectiveness and functional performance.

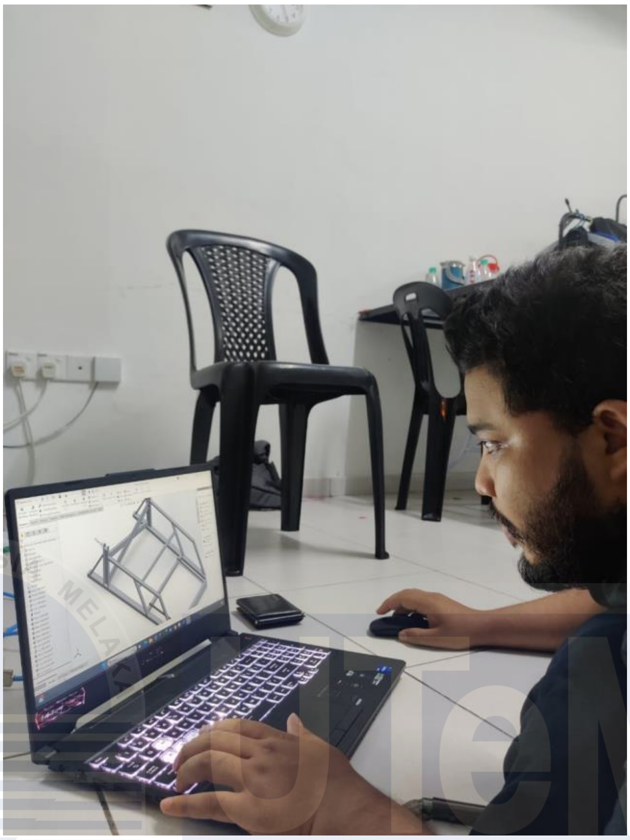


Figure 3. 5 CAD Drawing Process

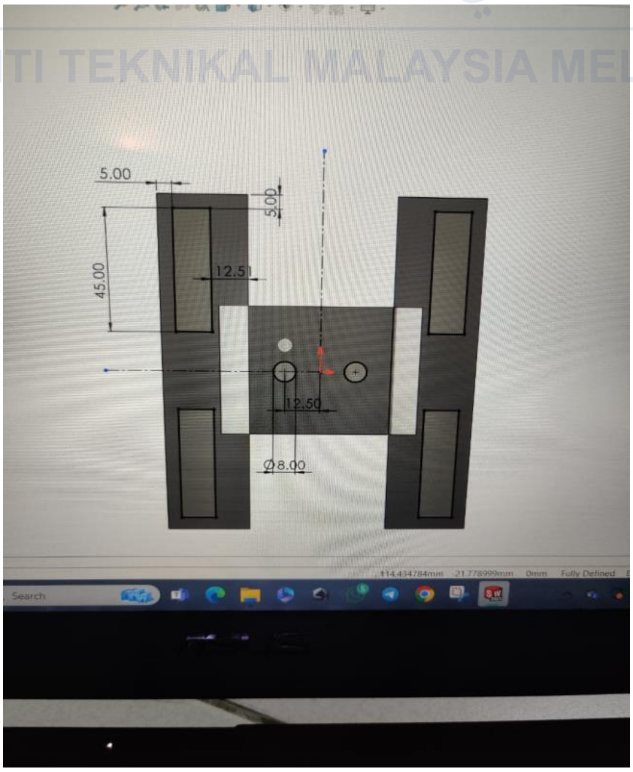


Figure 3. 6 CAD Drawing Dimensioning

3.4.2 SolidWorks Parts Assembly

It is important to unite different parts in a way that they work well together in improving the design of the river trash collector conveyor structure. The joining stage of the SolidWorks part entails the use of SolidWorks assembly tools and functions to synchronize redone parts with the current conveyor system in the most appropriate manner. During this phase, the 3D models of individual components that were designed earlier are imported into a master assembly file using SolidWorks program. Consequently, we use SolidWorks assembly tools for a systematic arrangement, alignment and mating of components to rebuild spatial relationships and functional interactions that are characteristic for a refactored conveyor structure. The assembly facilities in SolidWorks deliver a fantastic actual forum for observing and assessing the tying down process within a pretend three-dimensional room. Achieve the actualization of mechanism, gap and intrusion among parts of the assembly through simulation; this implementation helps to foresee any possible drawing conflicts hence finding solutions to them as well ensuring compatibility and functionality of an integrated system.

In addition, exploded views and animations of the assembly process, which are produced using SolidWorks, provide an explanation of how the conveyor structure's assembly will be carried out and how it will work. So as with this kind of communication aids through which design intentions can be related to stakeholders, such an updated 3D CAD design would help most facilitate group-oriented conflict resolution during production activities. After finishing construction of it, you can use SolidWorks to produce detailed assembly drawings and bill of materials (BOM) that offer a complete description of the assembled conveyor structure. They are important in that manner that they provide necessary information for establishment and servicing, which helps in keeping mistakes at bay any time fabrication is done on it as well as putting in place certain measures ensuring it is acknowledged accurately during its entire lifecycle.

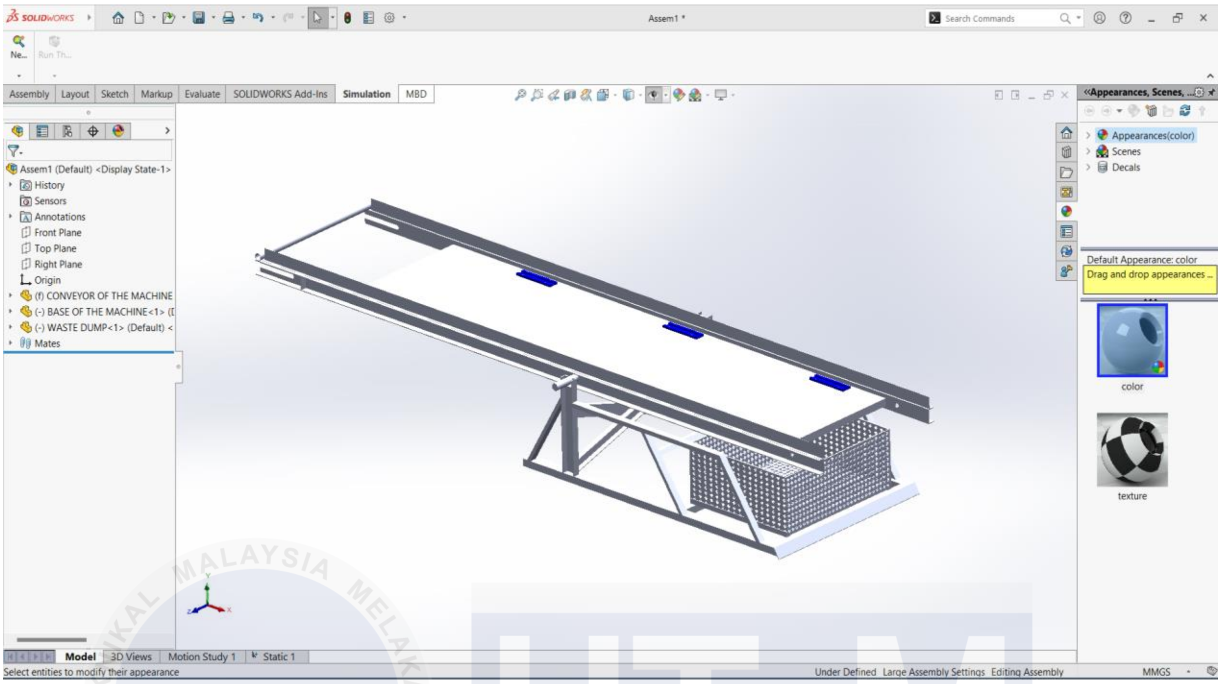


Figure 3. 7 Solid Works Parts Assembly

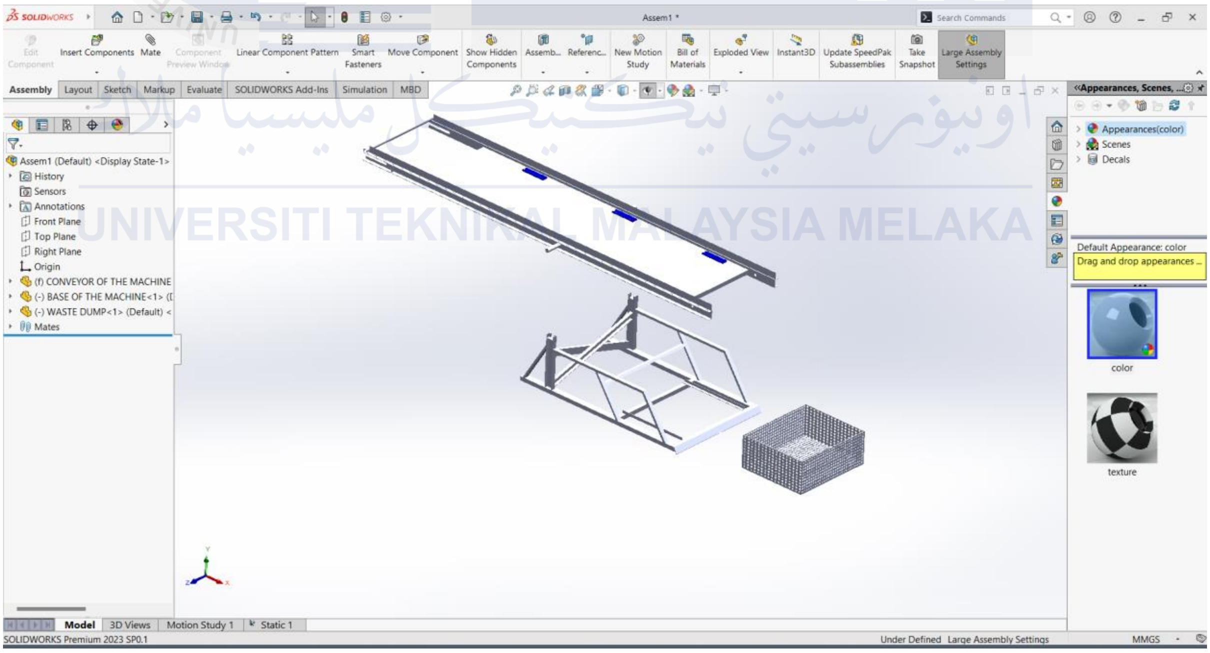


Figure 3. 8 Parts Assembly Exploded View

3.4.3 Finite Element Analysis (FEA) on Assemble Conveyor Structure

Finite Element Analysis (FEA) are done to confirm the design against operational loads and include steps like model property assignment, meshing, boundary condition application etc. Peer design reviews often help in improving the design while making changes according to feedback received from analysis results. We can then develop detailed 2D drawings from this 3D model with various perspectives, measures and tolerance levels for its production. The design undergoes virtual stress tests using Finite Element Analysis (FEA) to ensure it can resist real-world operational loads. Realization of material properties, mesh generation and boundary set up create a thorough simulation giving necessary guidelines and invaluable insights. The use of SolidWorks is a powerful tool beginning from the sketch and extrusion features to simulation and drawing annotations so that we can go through it. In addition to that parametric design and configurations provide flexibility thus allowing simple alterations within different designs created. Due to the design library, frequently used aspects are readily available whenever there is need for the other projects.

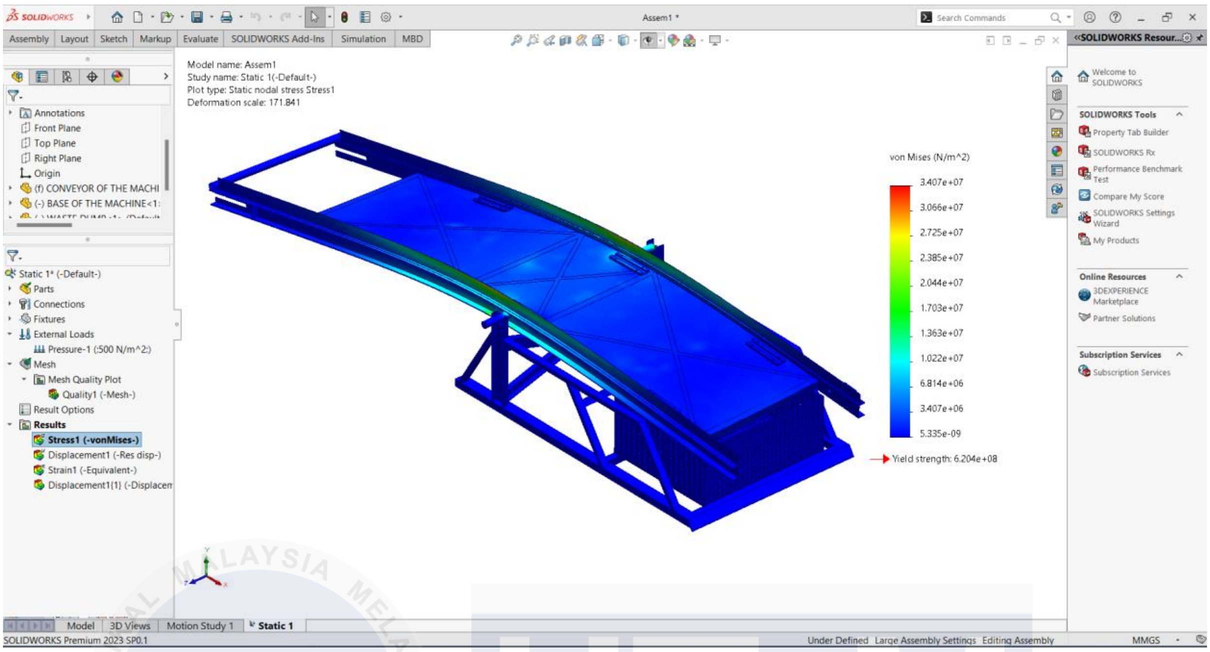


Figure 3. 9 Finite Element Analysis on Complete Assemble Structure

3.5 Optimization of the existing conveyor design

The goal of this project was to optimize the river trash collector conveyor system on the Malacca River boat, focusing on improving its lightweight design, structural durability, and corrosion resistance, while achieving an overall optimized design for better performance and sustainability. The optimization process began with an assessment of the current system. Observation of the existing structure reveals several issues, including heavy weight, material wear and corrosion, and poor structure durability. To address these issues, the new designs was conceptualized with focus on lightweight materials, durability, and corrosion resistant. Materials such as galvanized steel were selected for the structure. In addition, the structural durability of the structure was enhanced minimaxing strain on the structure.

3.5.1 Structure analysis for the optimize design

The structural integrity of the optimized river trash collector conveyor is evaluated through stress analysis, strain, displacement, and Factor of Safety (FoS). Von Mises stress, calculated via Finite Element Analysis (FEA), ensures the conveyor can withstand combined stresses without exceeding material yield strength. Strain is assessed to verify that materials deform within limits, preventing misalignment or inefficiency. Displacement analysis ensures the system remains aligned without excessive movement. Finally, the FoS is calculated to ensure the system's strength exceeds the expected load, with values above 2 indicating a safe design capable of handling extreme conditions.

3.5.2 Structure analysis comparison

As part of the design improvement process, a structure analysis comparison will be conducted to assess and compare the existing river trash collector conveyor structure with the proposed design. This analysis will help to identify key strengths and weaknesses in both the current system and the new design, ensuring that the improved structure delivers enhanced performance, safety, and durability. The main objective of conducting a structure analysis comparison is to evaluate the structural integrity, efficiency, and durability of the existing conveyor structure and compare it to the newly proposed design. The analysis will begin by thoroughly examining the current river trash collector conveyor structure used on Malacca River boats. The analysis will begin by thoroughly examining the current river trash collector conveyor structure used on Malacca River boats and analysing the material selection in the current design for issues related to corrosion resistance. Adjustments to the design may be made based on the simulation results, such as changing the structural geometry or reinforcing certain parts of the system.

This will ensure that the new structure can handle the loads more efficiently while reducing the risk of failure or degradation over time. The results from both the existing and proposed designs will be compared across several key performance metrics. After completing the structure analysis for both the existing and proposed designs, the results will be compiled and analysed to the strengths and weaknesses of both designs will be compared side-by-side to determine where improvements have been made. The analysis will serve as a basis for justifying the final design choices, helping to explain why the proposed design is superior to the current system in terms of safety, durability, and efficiency.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Introduction

In this chapter, it will cover the details design of the Design Improvement of River Trash Collector Conveyor Structure on Malacca River Boat. This chapter also will be looking towards the structural analysis and comparison between the existing design and the latest designs. In addition, optimization process also will be explained further in details on how to get the best design. Design process include SolidWorks software and analysis also optimization towards the latest design. Figure 4.1 show the existing structure design.

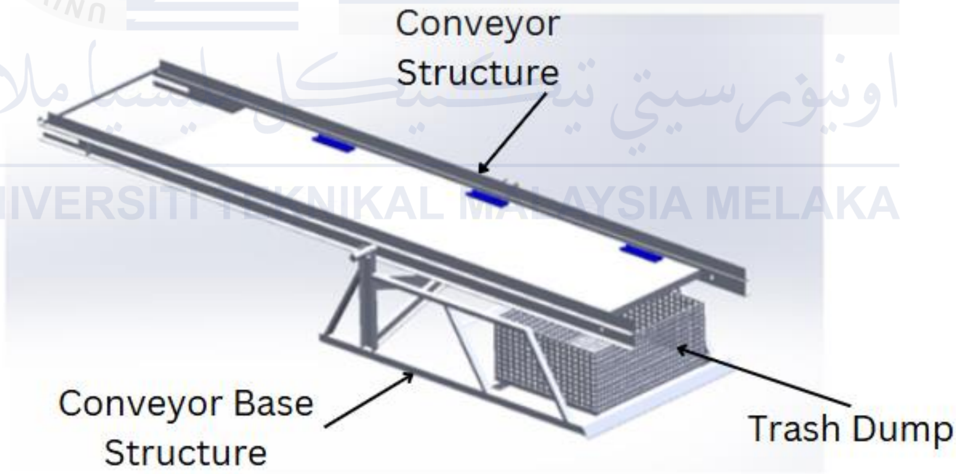


Figure 4.1 River Trash Collector Conveyor Structure

4.2 Detail of the River Trash Collector Conveyor Structure

In the making of River Trash Collector Conveyor Structure Design, there are four main criteria to be considered to achieve the best conceptual design. Figure below shows the criteria of the River Trash Collector Conveyor Structure Design. All these criteria can be achieved by using SolidWorks software.

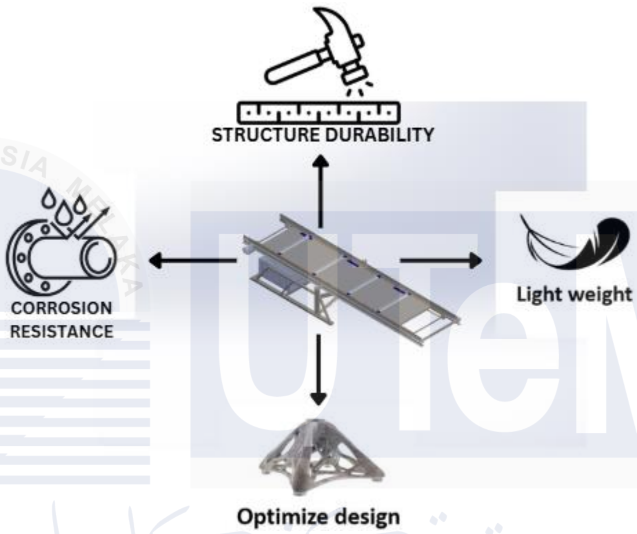


Figure 4.2 Detail of the River Trash Collector Conveyor Structure

4.2.1 Structure Design

The design of the River Trash Collector Conveyor Structure is made by using SolidWorks. The data of the measurement is based on the actual model of the conveyor structure by using the reverse engineering techniques. This is the first process of making the structure design. Then, the process continues by designing the structure using the right measurement size of the actual structure. All the design been made by using SolidWorks.

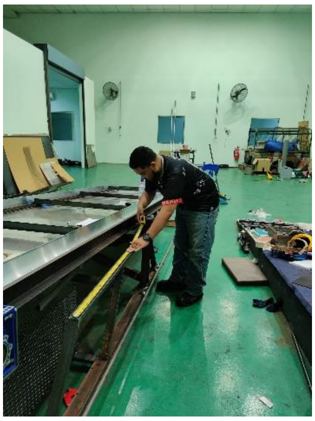


Figure 4.3 Measuring the dimensions of the existing structure design

Figure 4.4 Recording the dimensions of the existing structure for design purposes

4.2.2 Lightweight structure

The primary factors for achieving a lightweight structure include material selection, advanced manufacturing technologies, and thoughtful design considerations. Among these, material selection plays a crucial role in reducing weight while maintaining the necessary structural strength and performance. Lightweight design is essential for improving structural efficiency and reducing material usage, which also leads to cost savings and environmental benefits. However, careful attention must be paid to ensuring that the chosen materials do not compromise factors such as load-bearing capacity, durability, and safety. The ideal material must strike a balance between minimizing weight and ensuring the structure performs effectively under real-world conditions. By prioritizing material selection in this way, an optimized, resilient, and efficient design can be achieved.

Table 4.1 Material Comparison

Property	Plain Carbon Steel (Existing)	Galvanized Steel (Improved)
Material Density	797154.11	782231.56
Coating Material	None	Zinc
Corrosion Resistance	Low	High
Strength	High Tensile	Comparable strength
Longevity	Shorter Lifespan	Longer Lifespan
Durability	Lower Durability	Higher Durability

4.2.3 Corrosion Resistance

For the improved design of river trash collector conveyor structures, such as those in the Malacca River, galvanized steel is an ideal material. Its combination of durability, corrosion resistance, and affordability makes it perfect for environments with high humidity, water exposure, and abrasive conditions. Galvanized steel is made by coating steel with zinc, which acts as a protective barrier against rust and corrosion. In harsh conditions, the zinc corrodes instead of the steel, ensuring long-lasting protection. This makes galvanized steel highly suitable for the challenging conditions of river-based operations, where it can withstand constant water exposure and abrasive waste materials without significant deterioration.

Table 4.2 Material properties

Property	Galvanized Steel	Relevance to the Design
Coating material	Zinc	Provide a protective layer against corrosion
Corrosion resistance	High	Suitable for river environment
Yield strength	250-550 MPa	Adequate for structural support
Longevity	20-50 years	Reduce replacement frequency
Environmental impact	Moderate	Can be recycle after use

4.2.4 Optimized Design

The optimization procedure is to strengthen the structure at the design areas and selects the structure that is strongest that can withstand the force applied to the structure. This aids in maximizing the structure toughness and preventing any deterioration to the structure. This approach not only improves its ability to resist stress but also minimizes the risk of failure or deterioration over time, ensuring the longevity and safety of the structure.

4.3.1 Optimization Condition

4.3.1.1 Applied Material

The material that has been chosen is Galvanized Steel as this material is more lightweight and have the coating function to avoid corrosion which is more suitable for the structure purposed. The current conveyer structure using the Plain Carbon Steel which is heavier mass density compared to galvanized steel and has no coating function. Figure 4.5 and Table 4.3 show the properties comparison between Plain Carbon Steel and Galvanized Steel.

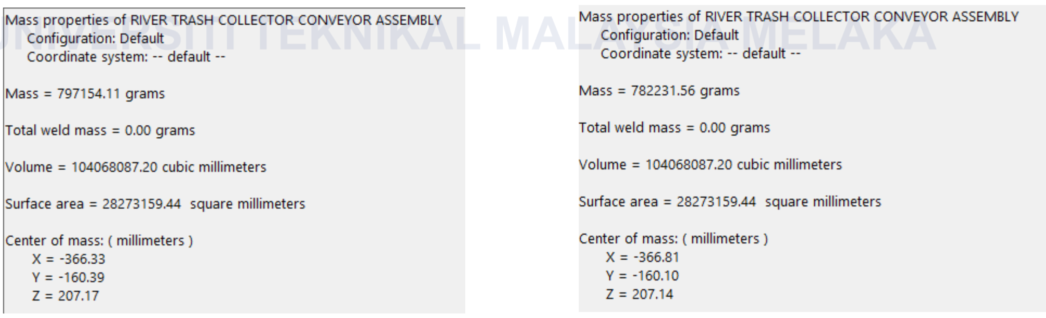


Figure 4.5 Mass properties for both materials

Table 4.3 Material mass comparison

	Plain Carbon Steel (Existing)	Galvanized Steel (Improved)
Mass Density of the Structure (grams)	797154.11	782231.56
Mass Reduction Percentage (%)	1.87	

4.3.2 Applied Force Load

A force is a push or pull in a specific direction on part and it is type of load. It can be applied any value of forces to a structure using the apply force tool on the software analysis function. Forces are represented as arrows that seems purple when selected on the desired area. They can concentrate at a single point on the structure or distributed evenly across the edge or surface.

The applied force loads are 2800N (approximate 285.42kg) which are the conveyor's load that sitting on the conveyor base structure. Figure 4.6 show the exact point of force exerted on the structure.

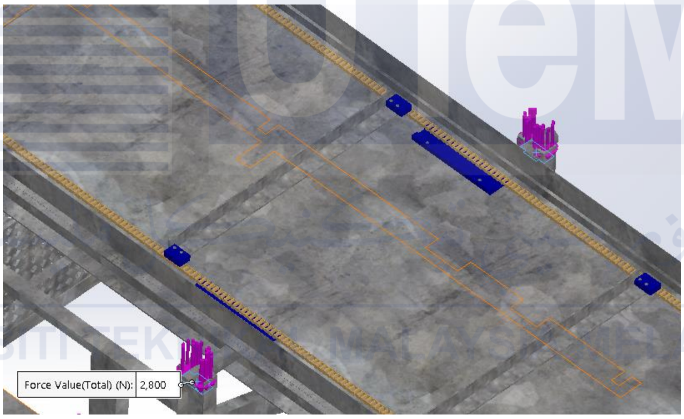


Figure 4.6 Force exerted on the structure

4.4 Design and Analysis of the Existing Structure

Conducting a thorough analysis of the existing structure is essential for identifying any flaws or weaknesses in its design. This detailed evaluation provides valuable insights into the overall performance of the structure and helps uncover potential issues related to its integrity. By assessing factors such as stress, displacement, strain, and the factor of safety, the analysis can pinpoint critical areas that may require reinforcement or redesign

Understanding these aspects is crucial to ensuring the structure's reliability, safety, and long-term durability, while also guiding any necessary modifications or improvements to meet current standards and requirements.

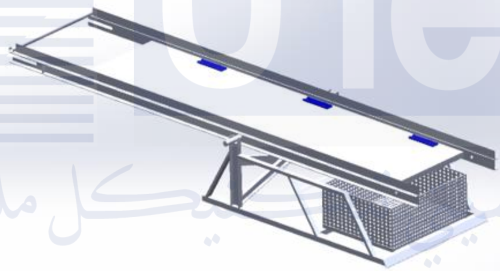


Figure 4.7 Existing Structure Design

For the existing structure design, the main concern at the supporting beam as the highest force exerted on the beam causing deformation on the area. Figure 4.7 show the existing design structure.

4.4.2 Von Misses Stress Analysis for the existing structure

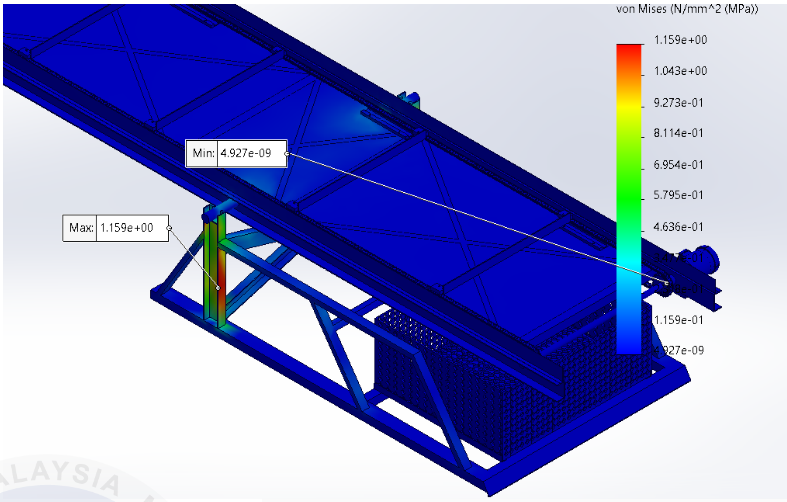


Figure 4.8 Von Misses Stress of the existing design

Figure 4.8 show based on the analysis of the existing structure design; it is evident that the supporting beams require enhancement due to the higher stress levels in this area compared to other regions. The simulation highlights that the stressed area is not only concentrated but also relatively large, indicating a significant potential for structural weakness. These high-stress regions suggest that reinforcing or redesigning the supporting beams is crucial to ensure the structure's integrity and prevent potential failure.

The stress values range from a minimum of 4.927e-09 N/mm² (MPa) to a maximum of 1.159e+00 N/mm² (MPa). Most of the structure is shown in blue, indicating low stress areas that are unlikely to fail. However, higher stress concentrations are found in areas marked in green, yellow, and red, which may be potential weak points for structural integrity. The maximum stress, located in a critical area, suggests the need for reinforcement or redesign to prevent failure. By identifying these high-stress regions, engineers can focus on strengthening or modifying the structure to improve its durability and performance.

4.4.3 Displacement Analysis for the Existing Structure

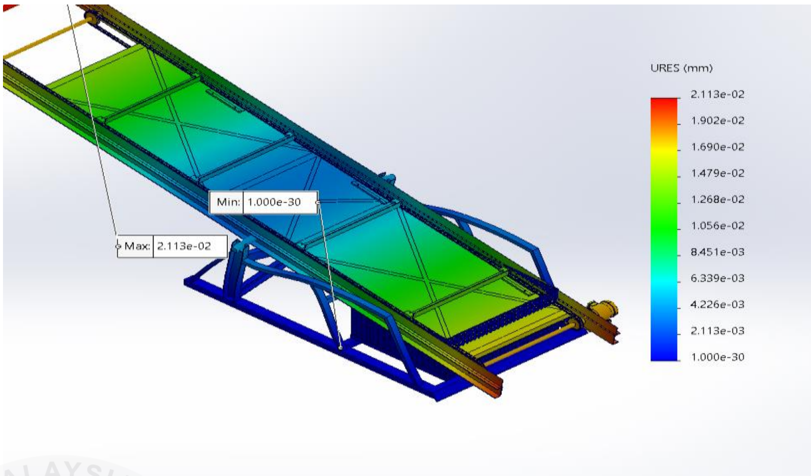


Figure 4.9 Displacement Analysis for the existing structure

Figure 4.9 show the Finite Element Analysis (FEA) provides important insights into the displacement characteristics of the existing structure under applied loading conditions. The displacement values range from a minimum of 1.000e-30 mm to a maximum of 2.113e-02 mm. blue regions, which indicate minimal displacement, suggest that these areas are less affected by the applied load and are structurally more stable. On the other hand, red regions, which indicate maximum displacement, highlight areas where the structure undergoes significant movement or deformation. These high-displacement areas are critical and may require reinforcement or design adjustments to prevent potential failure.

The structure consists of various components and supports, all of which are analysed to understand their behaviours under load. The distribution of displacement values helps pinpoint parts of the structure that are more prone to deformation and could benefit from design optimization. In conclusion, this analysis provides valuable information to improve the structure's overall stability and performance. By identifying areas with high displacement, engineers can focus on reinforcing these critical regions or adjusting the design to enhance the structure's ability to withstand operational loads and maintain its integrity over time.

4.4.4 Strain Analysis for the Existing Structure

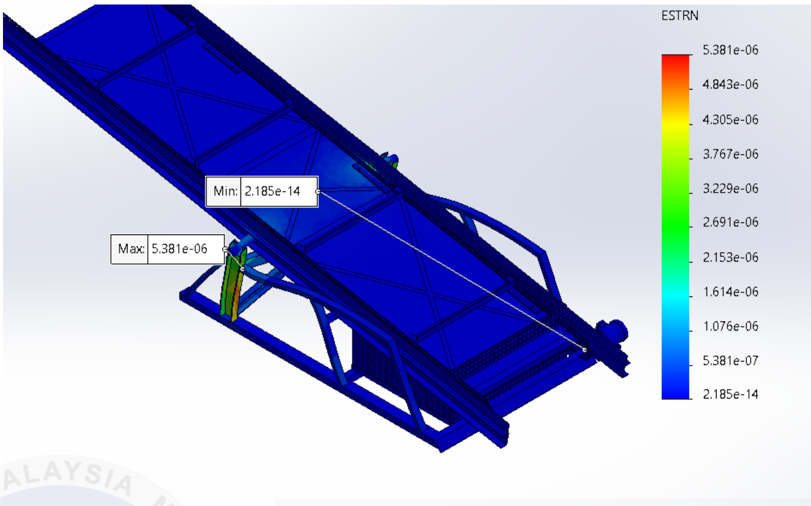


Figure 4.10 Strain Analysis for the existing structure

Figure 4.10 show the strain values range from a minimum of 2.185e-14 to a maximum of 5.381e-06. Blue regions, which indicate minimal strain, suggest that these areas experience the least deformation under load and are structurally more stable. These regions are less likely to become critical points of failure. On the other hand, the green to red regions indicate increasing levels of strain. The red regions, representing the highest strain values, highlight areas where the structure undergoes significant deformation. These critical points may require reinforcement or design adjustments to prevent potential failure.

The simulation labels specific points, indicating the minimum strain value of 2.185e-14 and the maximum strain value of 5.381e-06. The maximum strain areas are crucial for identifying high-strain concentrations, which may require additional attention to ensure the structure's overall integrity and performance. In conclusion, this FEA simulation provides valuable information for reinforcing or redesigning critical regions of the structure. By addressing areas of high strain, engineers can improve the stability and performance of the structure, ensuring it can withstand operational loads and maintain its integrity over time.

4.4.5 Factor of Safety for the Existing Structure

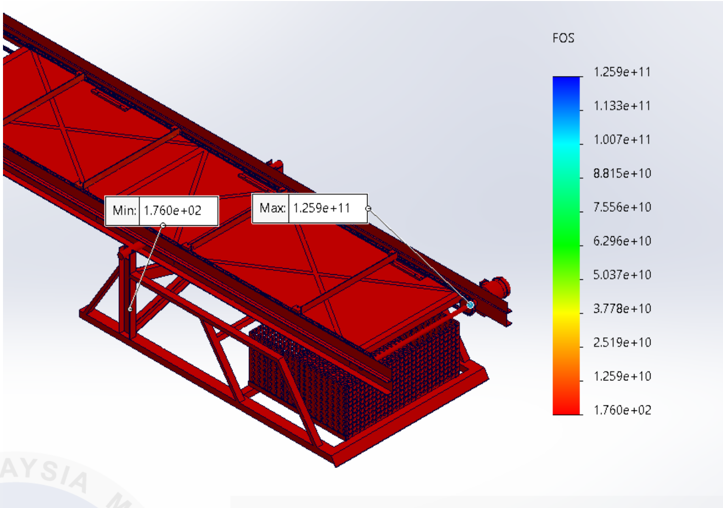


Figure 4.11 Factor of Safety for the existing structure

Figure 4.11 show the FOS values range from a minimum of 1.760e+02 to a maximum of 1.259e+11, with a colour gradient from red (indicating lower FOS) to blue (indicating higher FOS). Intermediate colours represent varying degrees of safety across the structure. Most of the structure appears in blue, signifying regions with a high factor of safety. These areas are less likely to fail under load, indicating that they are structurally robust and capable of withstanding stress. In contrast, specific points on the structure are highlighted, with one point having a minimum FOS of 1.760e+02 and another with a maximum FOS of 1.259e+11. The area with the minimum FOS, shown in red, represents the weakest part of the structure. This critical point is a potential failure zone that may require reinforcement or redesign to enhance its safety and overall performance. In conclusion, the FEA reveals that the structure is generally robust, with high FOS values indicating good safety margins. However, the identified critical point with the minimum FOS underscores the need for targeted improvements to ensure the entire structure can safely withstand operational loads. This analysis is essential for making informed decisions about enhancing the design and ensuring the structure's long-term reliability and performance.

4.4.6 Analysis Summarization for Existing Structure Design

Table 4.4 Summarization of Result Analysis for Existing Design

Analysis	Value
Von Misses Stress	1.159e+00 N/mm^2
Displacement	2.113e-02
Strain	5.381e-06
Factor of Safety	1.259e+11

Based on the Table 4.4 The analysis of the existing structure design reveals important performance and safety parameters. The von Mises stress of 1.159 N/mm^2 indicates the point at which the material may begin to yield under load, highlighting its capacity to withstand stress before permanent deformation occurs. The displacement value of 0.02113 mm shows the extent of deformation, ensuring it remains within acceptable limits and does not compromise the structure's stability. The strain value of 5.381e-06 reflects minimal deformation per unit length, indicating the material's elastic behaviour remains intact. Most notably, the Factor of Safety (FOS) of 1.259e+11 suggests an exceptionally high margin before failure, ensuring the design's reliability and strength. Overall, these parameters demonstrate that the design is safe, robust, and capable of withstanding operational stresses, with continued monitoring essential for maintaining its integrity.

4.5 Design and Analysis of the Improved Structure Design Number 1

Conducting a thorough analysis of the new design structure (Design Number 1) is essential for ensuring its performance meets the required standards. This detailed evaluation provides key insights into the behaviours of the structure under expected loading conditions and helps identify any potential weaknesses or areas for improvement. By assessing critical factors such as stress, displacement, strain, and the factor of safety, the analysis can highlight key regions that may require further optimization or reinforcement.

Understanding these factors is vital for ensuring the structure's reliability, safety, and long-term durability. The analysis also serves as a guide for making necessary adjustments or improvements to the design, ensuring it performs efficiently and meets the latest engineering standards and safety requirements.

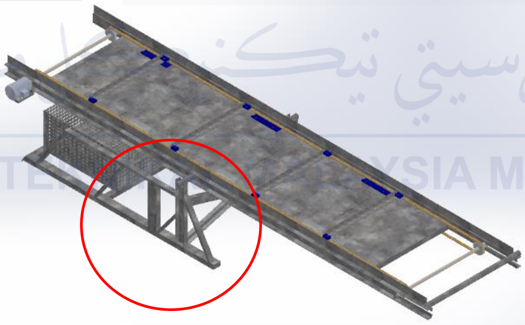


Figure 4.12 Number 1 Structure Design

Figure 4.12 show the improvement on the beam area had been made, but the improvise structure still not enough to sustain the force exerted on the beam as large scale of deformation still occur but still better compare to the existing structure but the stress on the structure has been reduce.

4.5.2 Von Misses Stress Analysis for the Structure Design Number 1

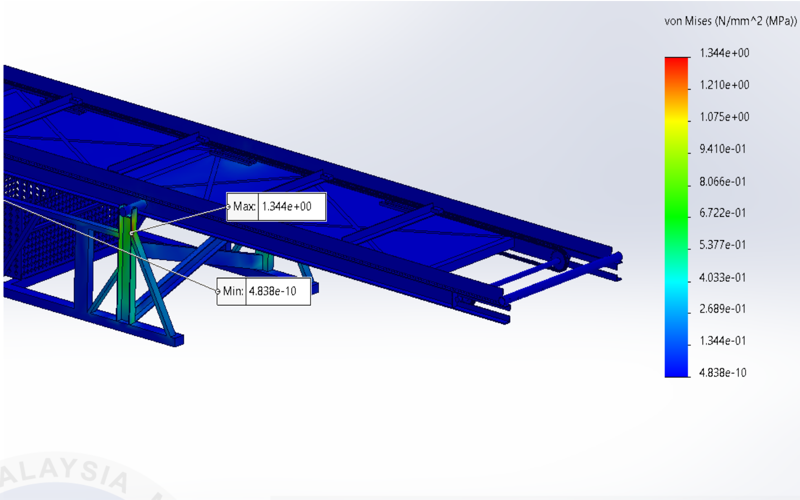


Figure 4.13 Von Misses Stress Analysis for the structure design number 1

Figure 4.13 show the von Mises stress values range from 4.838e-10 N/mm² to 1.344 N/mm². Blue regions represent low stress areas, suggesting minimal risk of failure, while green and yellow indicate moderate stress. Red areas show high stress concentrations, which are potential points of concern for structural integrity. These high-stress points are critical, as they experience the most significant stress and may require reinforcement or redesign to ensure stability. By identifying these areas, the improvement can be focus on strengthening them to improve the structure's durability and performance.

4.5.3 Displacement Analysis for the Structure Design Number 1

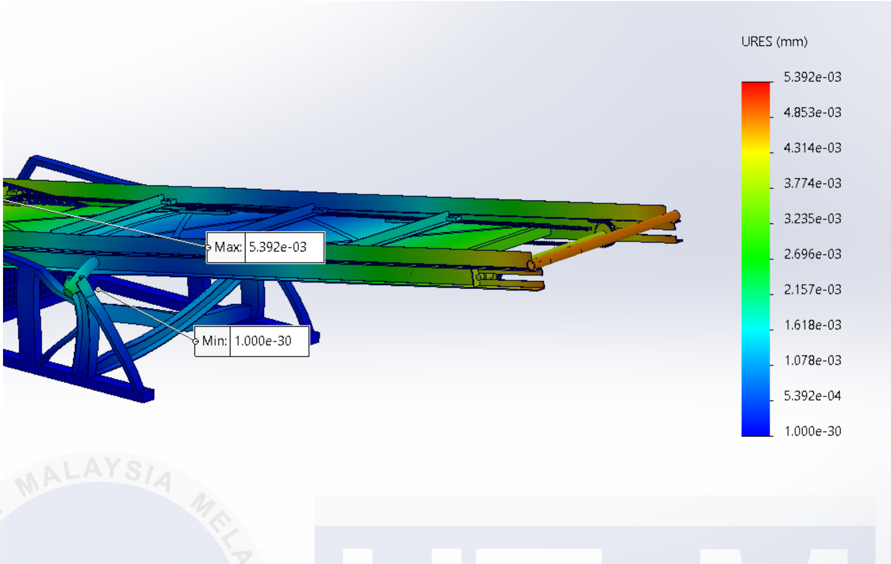


Figure 4.14 Displacement Analysis for the structure design number 1

Figure 4.14 show the displacement analysis provides essential insights into the structural behaviours under load. The blue regions represent areas with minimal displacement, indicating that these parts of the structure are less affected by the applied load, ensuring structural stability and rigidity. These low displacement areas play a key role in maintaining the overall integrity of the structure. On the other hand, the red regions highlight areas experiencing maximum displacement of 5.392e-03 mm. These areas are more prone to deformation under load and could be potential points of concern for structural stability. Identifying these high displacement regions is crucial for understanding potential weaknesses and addressing them through reinforcement or redesign.

In conclusion, the displacement analysis helps identify critical regions that may require additional attention to improve stability and performance. By focusing on areas with high displacement, engineers can make informed decisions to reinforce the structure, enhancing its durability and safety.

4.5.4 Strain Analysis for the Structure Design Number 1

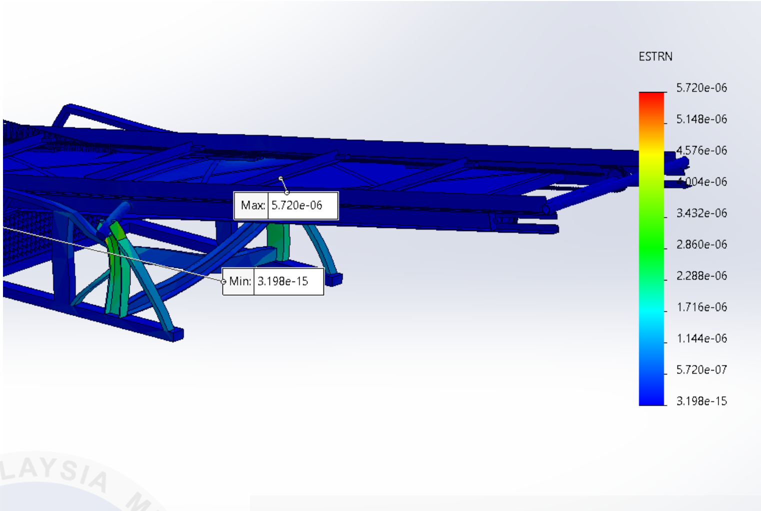


Figure 4.15 Strain Analysis for the structure design number 1

Figure 4.15 show the strain distribution analysis provides valuable insights into how the structure behaves under load. The strain values range from a minimum of 3.198e-15 to a maximum of 5.720e-06, with a colour gradient used to represent the strain levels. Blue regions indicate areas with minimal strain, suggesting these parts of the structure are stable and less likely to deform. These areas are less susceptible to failure and contribute to the overall stability of the structure. The analysis highlights the minimum strain value of 3.198e-15 and the maximum strain value of 5.720e-06. The areas with maximum strain are particularly important, as they could become potential failure points if not addressed.

In conclusion, this FEA provides important insights into the strain distribution within the structural component. By identifying regions with high strain, improvement can focus on reinforcing these critical areas or redesigning the structure to improve its stability and performance. This analysis is crucial for ensuring the structure can safely withstand operational loads and maintain its integrity over time.

4.5.5 Factor of Safety for the Structure Design Number 1

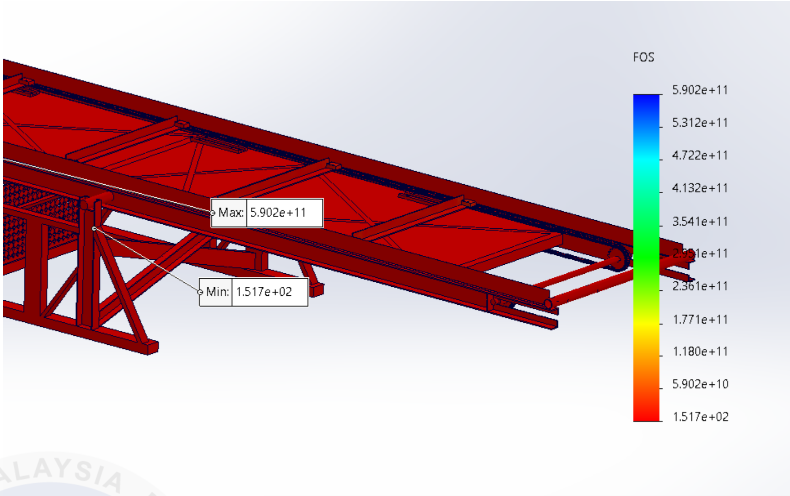


Figure 4.16 Factor of Safety for the structure design number 1

Figure 4.16 show "Structure Design Number 1" reveal that most of the structure exhibits high Factor of Safety (FOS) values, with shades of blue representing these high safety regions. These areas have a safety margin well above the minimum requirement, ensuring strong structural integrity and reliability under varying loading conditions. The maximum FOS of 5.902e+11 indicates that many parts of the structure have an exceptionally high margin of safety. However, a critical point with a minimum FOS of 1.517e+02 is highlighted in red. Although this is the lowest value in the analysis, it still reflects a robust safety margin that exceeds typical engineering standards. The red regions represent areas where the safety margin is lower, indicating higher stress and potential risks. These regions may require further evaluation or reinforcement to enhance the overall safety of the structure.

In conclusion, the analysis shows that "Structure Design Number 1" is generally very safe, with most regions having a high FOS. The minimum FOS, while lower, still provides a strong safety buffer. This analysis emphasizes the importance of focusing on critical areas and making necessary adjustments to maintain structural integrity and ensure reliable performance under operational conditions.

4.5.6 Analysis Summarization for Improved Structure Design Number 1

Table 4.5 Summarization of Result Analysis for Design Number 1

Analysis	Max Value
Von Misses Stress	1.344 N/mm²
Displacement	5.392e-03
Strain	5.720e-06
Factor of Safety	5.902e+11

The analysis of the improved structure design shows significant enhancements over the previous design. The von Mises stress of 1.344 N/mm² is higher than the existing design's value of 1.159 N/mm², indicating that the material in the improved design can withstand greater stress before yielding, enhancing its load-bearing capacity. The displacement is reduced to 5.392e-03 mm compared to 0.02113 mm in the existing design, suggesting that the improved structure experiences less deformation, ensuring better stability. The strain value of 5.720e-06 is also slightly higher than the previous design's 5.381e-06, but it remains minimal, indicating that the improved design stays well within its elastic limit, preventing permanent deformation. Most notably, the Factor of Safety (FOS) in the improved design is 5.902e+11, significantly higher than the existing design's FOS of 1.259e+11, offering a much greater safety margin and indicating enhanced reliability and durability. Overall, these improvements make the new design more robust, stable, and capable of handling higher operational loads, positioning it as a superior choice for practical applications.

4.6 Design and Analysis of the Improved Structure Design Number 2

Conducting a thorough analysis of the new design structure (Design Number 2) is crucial to ensure that it meets the required performance standards and functions as intended under operational conditions. This detailed evaluation helps uncover any potential weaknesses or flaws in the design while providing valuable insights into how the structure behaves when subjected to expected loads. By examining key factors such as stress, displacement, strain, and the factor of safety, the analysis allows to identify critical areas that may need optimization or reinforcement.

Understanding these elements is essential for guaranteeing the structure's reliability, safety, and long-term durability. The results of the analysis provide valuable guidance for making any necessary modifications or improvements to the design, ensuring it meets current engineering standards and regulatory safety requirements. By addressing potential issues early on, Design Number 2 can be refined to ensure it performs efficiently and maintains structural integrity throughout its lifespan. Figure 4.17 show the improved structure design from the design Number 1. The Stress value has been improved three times from the existing design and the large deformation on the structure had been overcome.

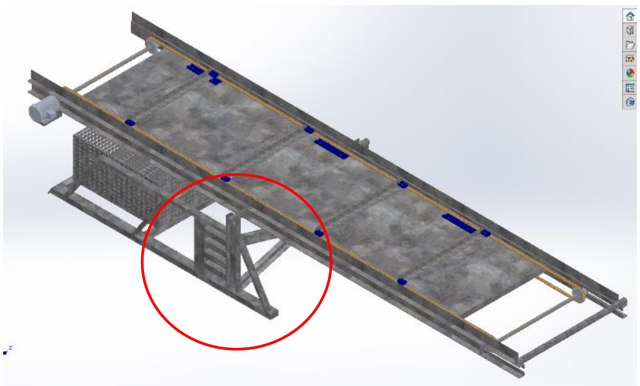


Figure 4.17 Number 2 Structure Design

4.6.2 Von Misses Stress Analysis for the Structure Design Number 2

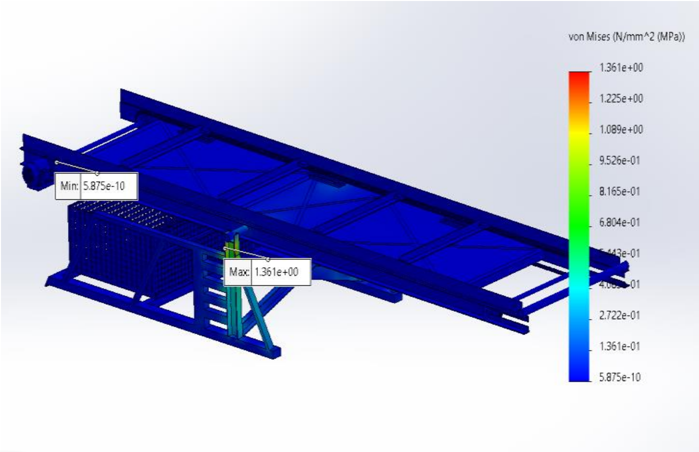


Figure 4.18 Von Misses Stress Analysis for the structure design number 2

Figure 4.18 show the von Mises stress analysis of Structure Design Number 2 provides important insights into how the structure distributes stress under load. The stress values range from a minimum of 5.875e-10 N/mm² to a maximum of 1.361 N/mm². Blue regions indicate areas with low stress, suggesting that these parts of the structure are less likely to experience deformation or failure. On the other hand, the green to red regions show increasing stress levels, with red areas representing the regions under the highest stress. The analysis highlights critical points, with labelled stress values of 5.875e-10 N/mm² and 1.361 N/mm² at the minimum and maximum, respectively. The red regions, where the highest stress occurs, are the most critical areas and may require further investigation or reinforcement to maintain the structural integrity of the design.

In conclusion, the von Mises stress analysis offers valuable data on stress distribution across the structure. By identifying high-stress areas, engineers can target these regions for reinforcement or redesign to enhance durability and performance.

4.6.3 Displacement Analysis for the Structure Design Number 2

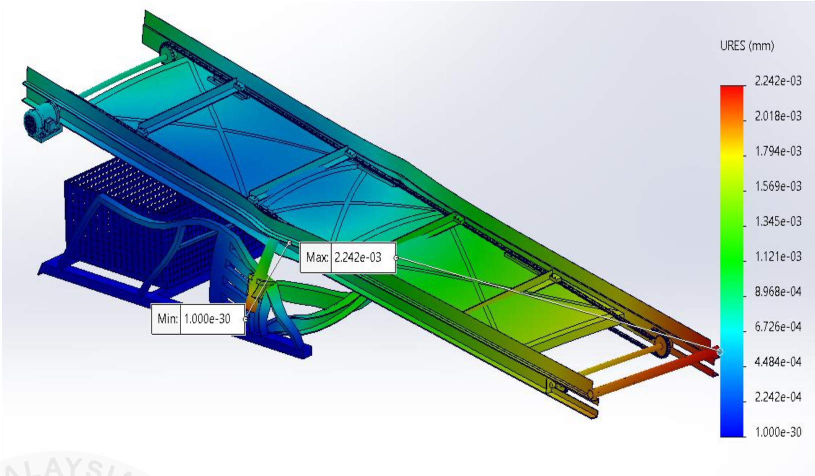


Figure 4.19 Displacement Analysis for the structure design number 2

Figure 4.19 show the displacement analysis for Structure Design Number 2 provides important insights into how the structure behaves under applied load. The displacement values range from a minimum of 1.000e-30 mm (represented in blue) to a maximum of 2.242e-03 mm (represented in red). The blue regions indicate areas with minimal displacement, suggesting that these parts of the structure remain stable and experience negligible deformation under the current load conditions. On the other hand, the red regions indicate areas undergoing the most significant displacement, highlighting potential points where the structure deforms the most. The maximum observed displacement of 2.242e-03 mm represents the critical regions that experience the most deformation. These areas may require reinforcement or redesign to ensure overall structural stability and prevent potential failure. The blue regions with a minimum displacement value of 1.000e-30 mm indicate high stability and minimal movement, ensuring the structure's stability under operational loads.

In conclusion, the displacement analysis reveals key insights into the distribution of deformation in Structure Design Number 2. Areas with high displacement (in red) should be prioritized for reinforcement, while regions with minimal displacement (in blue) show good stability. These findings are essential for refining the design and ensuring the structure can withstand operational loads without significant deformation.

4.6.4 Strain Analysis for the Structure Design Number 2

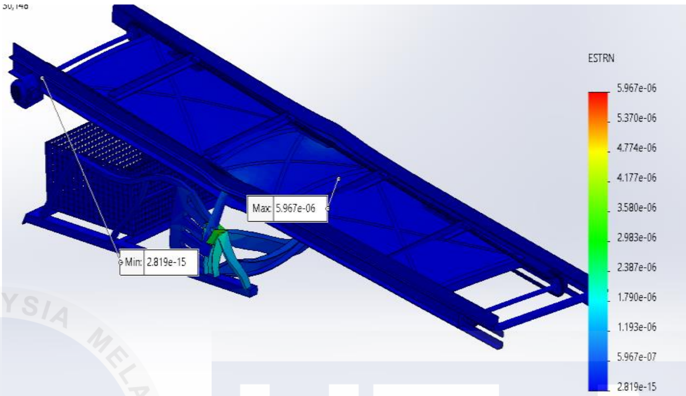


Figure 4.20 Strain Analysis for the structure design number 2

Figure 4.20 show the strain analysis for Structure Design Number 2 provides important insights into how the structure deforms under applied loads. The strain values range from a minimum of 2.819e-15 to a maximum of 5.967e-06. The colour gradient indicates blue regions, which experience minimal strain and are structurally stable, suggesting they are less likely to deform under load. As the strain increases, the regions transition from green and yellow to red, highlighting areas under the highest strain, which are more susceptible to deformation and potential structural failure. The maximum strain, 5.967e-06, is represented in red, marking the regions with the greatest deformation. These critical areas may require reinforcement or redesign to ensure the structure's durability and performance. On the other hand, the minimum strain value of 2.819e-15 suggests negligible deformation in those regions, indicating high stability under the applied load.

The maximum strain, 5.967e-06, is represented in red, marking the regions with the greatest deformation. These critical areas may require reinforcement or redesign to ensure the

structure's durability and performance. On the other hand, the minimum strain value of 2.819e-15 suggests negligible deformation in those regions, indicating high stability under the applied load.

In conclusion, this strain analysis reveals areas of concern where the structure may experience significant deformation, particularly those marked in red. Reinforcement or redesign of these high-strain areas can improve the overall stability and performance of the structure. The regions with minimal strain, marked in blue, indicate good structural stability. These insights are crucial for optimizing the design to ensure the structure can effectively withstand operational loads without excessive deformation.

4.6.5 Factor of Safety for the Structure Design Number 2

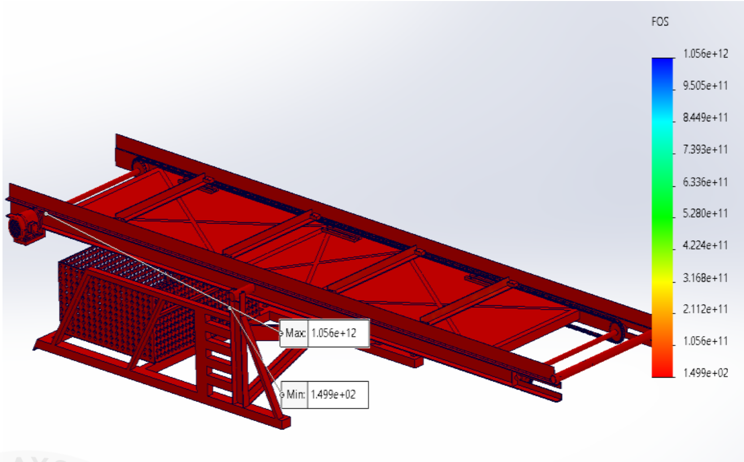


Figure 4.21 Factor of Safety for the structure design number 2

Figure 4.21 show the FEA results for Structure Design Number 2 highlight that most of the structure is coloured in blue, indicating extremely high Factor of Safety (FOS) values. These regions significantly exceed the minimum safety requirements, ensuring the structure's robustness and reliability under various loading conditions. The maximum FOS value observed is 1.056e+12, which suggests an exceptional margin of safety, providing confidence in the structure's ability to handle significant operational loads. However, the analysis also identifies a critical point with a minimum FOS value of 1.499e+02, represented in red. While this value is lower than the rest of the structure, it still exceeds typical engineering safety factors. The red regions highlight areas where the structure experiences the highest stress and lowest safety margins, which may require additional scrutiny or reinforcement to optimize safety and prevent potential issues.

In conclusion, the FEA results indicate that Structure Design Number 2 has a very high Factor of Safety across most of its regions, suggesting the design is highly resilient. Nevertheless, the critical points with lower FOS values point to areas that may require targeted improvements to maintain structural integrity and ensure reliable performance under operational conditions.

4.6.6 Analysis Summarization for Improved Structure Design Number 2

Table 4.6 Summarization of Result Analysis for Design Number 2

Analysis	Max Value
Von Misses Stress	1.361 N/mm²
Displacement	2.242e-03
Strain	5.967e-06
Factor of Safety	1.056e+12

The analysis of the second improved structure design demonstrates significant improvements compared to both the existing design and the first improved design. The von Mises stress of 1.361 N/mm² is higher than the previous values of 1.159 N/mm² (existing) and 1.344 N/mm² (first improved), indicating that the material in the new design can withstand even greater stress before yielding, enhancing load-bearing capacity. The displacement of 2.242e-03 mm is lower than the first improved design's 5.392e-03 mm, suggesting even less deformation and greater stability. The strain value of 5.967e-06 is slightly higher than the first improved design's 5.720e-06, but still minimal, ensuring the material remains within its elastic limit and avoiding permanent deformation. Most notably, the Factor of Safety (FOS) of 1.056e+12 is substantially higher than both the existing design's 1.259e+11 and the first improved design's 5.902e+11, indicating a much larger safety margin and exceptional reliability. Overall, the second improved design outperforms the previous versions in terms of material strength, stability, and durability, making it the most robust and reliable choice for practical applications.

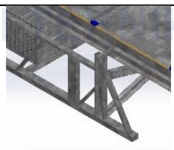
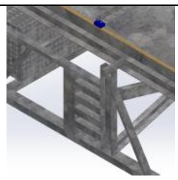
4.7 Analysis Result Comparison Between Existing, First and Second Design

4.7.1 Structure Integrity

4.7.1.1 Conveyor Structure

The structure of the conveyor has been improved and improvised according to the best result of the software analysis. SolidWorks analysis has been used to design the structure of the conveyor and other features are added to compliment the conveyor structure. Table shows the comparison between the existing structure design and the latest two design. Table 4.4 show the comparison between the existing structure design and the latest two improve design.

Table 4. 7 Comparison between the existing structure design and the latest two design

Design	Design Structure	Max Stress Value (MPa)	Materials
Existing		1.159e+00 N/mm^2	Plain Carbon Steel
1		1.344e+00 N/mm^2	Galvanized Steel
2		1.361e+00 N/mm^2	Galvanized Steel

4.7.2 Structure Analysis

This subtopic is about comparison in terms of Von Misses Stress, Displacement, Strain, and Factor of Safety between the existing design and the new best design. This analysis uses 3 different structure design which is existing design, design number 1 and design number 2.

The initial design of the conveyor structure utilized Plain Carbon steel, known for its versatility and availability contribute to its frequent use in a variety of structural designs, despite some limitations in terms of strength and corrosion resistance compared to other materials. However, the stress optimization value of this design was recorded at 1.159 N/mm^2 (MPa). Although the material choice was robust, the relatively lower stress optimization value indicated potential improvements in handling and distributing stress more effectively.

The first new design introduces the use of galvanized steel as the primary material, which is both cost-effective and offers significant corrosion resistance. This redesign resulted in a stress optimization value of 1.344 N/mm^2. The enhancement over the old design suggests an improved ability to withstand and manage the stresses experienced during operation, making this design more efficient and reliable.

The second new design further builds on the improvements seen in the first new design, continuing to use galvanized steel. This iteration achieves the highest stress optimization value among the three designs, recorded at 1.361 N/mm^2. This increment, although slight, underscores the thorough analysis and optimization efforts, resulting in a structure that offers the best performance under load conditions.

Despite the existing design show a lower stress value, the new design outperforms the existing design stress on the key area as the stress area of the existing design is bigger compared to the new design.

The SolidWorks analysis shows that the new designs outperform the existing one in stress optimization area, displacement, strain and factor of safety. The use of galvanized steel in the new designs ensures cost-effectiveness while maintaining quality. Incremental improvements in stress optimization from the Existing design to Design 1 and 2 highlight a focus on structural durability and efficiency.

4.7.2.1 Von Misses Stress Comparison

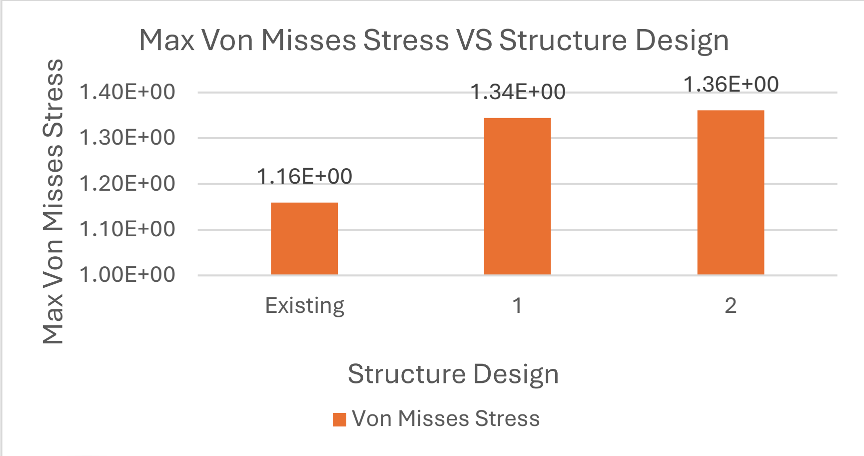


Figure 4.22 Max Von Misses Stress Comparison

Table 4.8 Max Von Misses Stress Comparison

Design	Max Von Misses Stress (MPa)	Improvement Percentage %
Existing	1.159e+00 N/mm^2	-
1	1.344e+00 N/mm^2	15.96
2	1.361e+00 N/mm^2	17.42

Figure 4.22 and Table 4.5 show the provided analysis compares the von Mises stress values for three different structure designs: Existing, Design 1, and Design 2. Von Mises stress is a key measure used to evaluate the yielding of ductile materials under loading conditions, indicating how close a material is to failing. The analysis includes both a bar chart and a table for a detailed comparison of these stress values across the three designs. The Existing Design serves as a baseline with a von Mises stress of 1.16 MPa. This design's stress tolerance is relatively moderate when compared to the new designs. Design 1 shows a significant improvement, with a von Mises stress of 1.34 MPa. This suggests that Design 1 is more capable of withstanding higher stress before yielding, offering better material performance and structural integrity. Design 2 exhibits the highest stress tolerance, reaching 1.36 MPa. This

further improvement indicates that Design 2 is the most robust under stress conditions and provides the best overall performance among the three.

In conclusion, the comparison of von Mises stress values highlights the enhancements made in the new designs over the existing structure. Both Design 1 and Design 2 show improved performance, with Design 2 demonstrating the highest stress tolerance. These improvements reflect successful optimization in the design process, enhancing the component's structural integrity and durability. This analysis is crucial to ensuring that the final design can withstand operational loads effectively and maintain its integrity over time.

4.7.2.2 Displacement Comparison

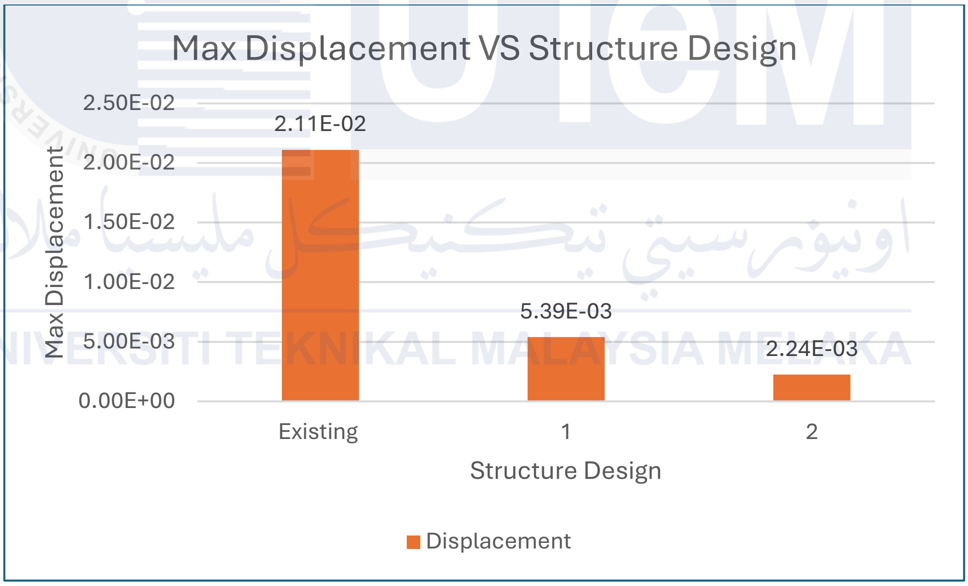


Figure 4.23 Max Displacement Comparison

Table 4. 9 Max Displacement Comparison

Design	Max Displacement (mm)	Improvement Percentage %
Existing	2.11E-02	-
1	5.39E-03	74.40
2	2.24E-03	89.37

Figure 4.23 and Table 4.6 show the comparison of the displacement values for three different structure designs: Existing, Design 1, and Design 2. Displacement is a critical factor in assessing how much a structure deforms under a given load, as it helps evaluate the structure's stability and overall performance. The Existing Design serves as the baseline, with a displacement value of 2.11E-02 mm. This displacement reflects a relatively higher deformation under load, indicating that the existing design might be less stable compared to the new designs. Design 1 shows a significant improvement, with a reduced displacement of 5.39E-03 mm. This reduction in displacement indicates an improved ability of the structure to resist deformation, enhancing its structural stability. Design 2 demonstrates the best performance, with the lowest displacement of 2.24E-03 mm, signifying the highest stability and minimal deformation among the three designs.

In conclusion, the comparison of displacement values highlights the clear improvements made in the new designs. Both Design 1 and Design 2 show substantial reductions in displacement, with Design 2 exhibiting the most significant enhancement. These improvements suggest that the new designs provide superior stability and resistance to deformation, making them more reliable and efficient for practical applications.

4.7.2.3 Strain Comparison

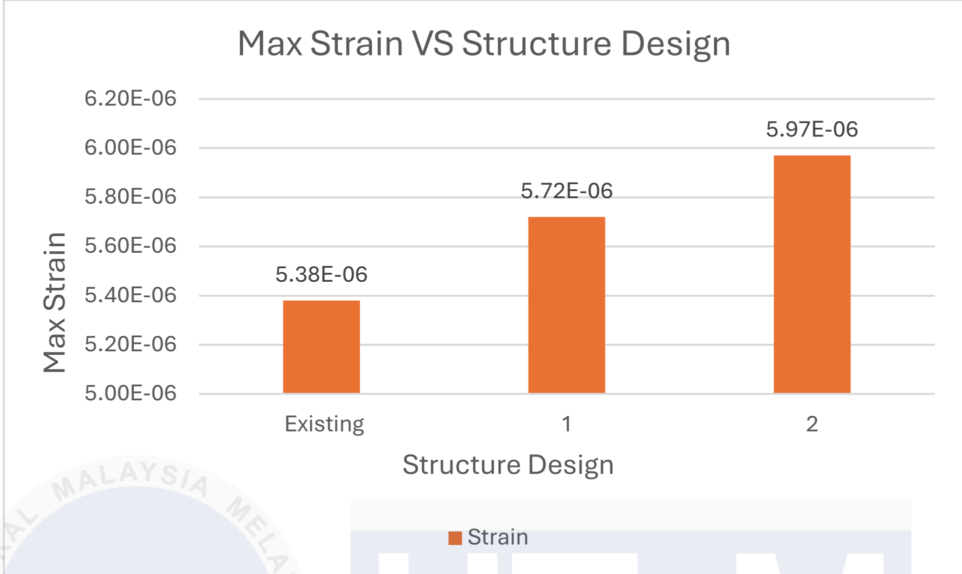


Figure 4.24 Max Strain Comparison

Table 4. 10 Max Strain Comparison

Design	Max Strain	Improvement Percentage %
Existing	5.38E-06	-
1	5.72E-06	6.32
2	5.97E-06	10.97

Figure 4.24 and Table 4.7 show Existing, Design 1, and Design 2. Strain measures the deformation of a material under an applied load, offering valuable insights into the structural integrity and performance of each design. For the Existing Design, the strain is 5.38E-06, providing a baseline for comparison. Design 1 shows a slight increase in strain to 5.72E-06, indicating that it undergoes more deformation under load compared to the existing design. While this increase might suggest some loss in structural rigidity, it could still be within acceptable limits depending on material properties and design goals. Design 2 has the highest strain value of 5.97E-06, indicating that it experiences the most deformation under load.

Although this might suggest greater flexibility, it is essential to ensure that the material can handle this level of strain without failure.

In conclusion, the strain comparison highlights the increased deformation behaviours in both Design 1 and Design 2 compared to the existing design, with Design 2 exhibiting the highest strain. These insights are critical for evaluating the structural performance and guiding decisions on material selection and design improvements to ensure the structure can withstand operational loads without significant deformation or failure.

4.7.2.4 Factor of Safety Comparison

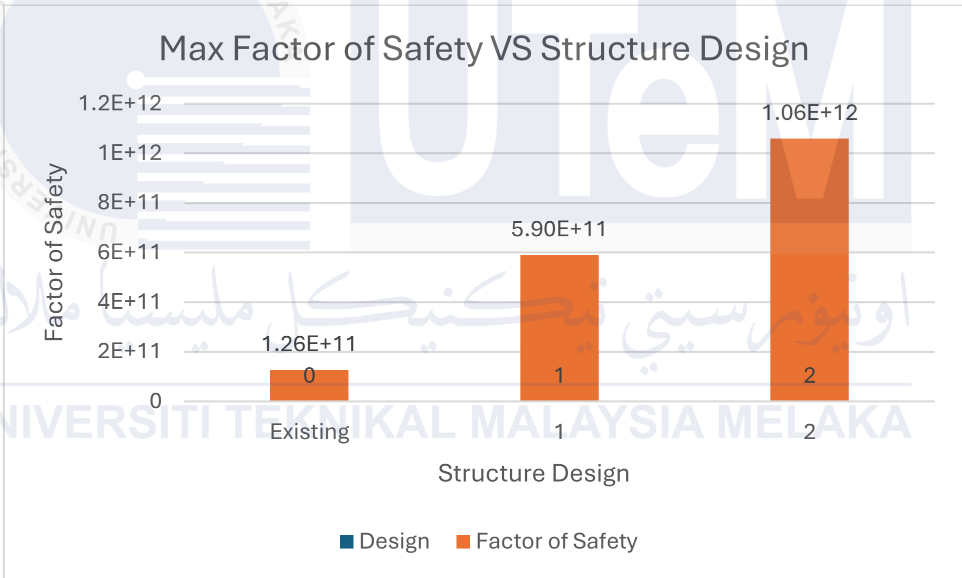


Figure 4.25 Max Factor of Safety Comparison

Table 4.11 Max Factor of Safety Comparison

Design	Max Factor of Safety	Improvement Percentage %
Existing	1.26E+11	-
1	5.90E+11	368.25
2	1.06E+12	741.27

Figure 4.25 and Table 4.8 show the Factor of Safety graph offers a compelling comparison of safety across three structural designs: the original design, New Design 1, and New Design 2. The original design establishes a baseline with a factor of safety of 1.26E+11, reflecting a solid but standard level of robustness. New Design 1 shows a remarkable improvement, with a factor of safety of 5.90E+11, signalling significant enhancements in structural strength. However, New Design 2 outshines both, achieving the highest factor of safety at 1.06E+12, underscoring its superior ability to withstand stress and ensure long-term stability.

This progression clearly demonstrates the power of iterative design and engineering advancements in creating structures that are not only more durable but also safer. The improvements in safety across the designs highlight the critical role of engineering innovation in ensuring the reliability and resilience of structures, making New Design 2 the most secure option for real-world applications.

4.8 Result Summary

The analysis compares the performance of three structural designs Existing, Design 1, and Design 2 across key parameters including von Mises stress, displacement, strain, and factor of safety. These parameters are essential for evaluating a structure's ability to withstand operational loads and maintain stability over time.

Starting with von Mises stress, which indicates how close a material is to yielding under load, the Existing Design serves as the baseline with a value of 1.16 MPa. Design 1 shows a significant improvement, with a von Mises stress of 1.34 MPa, indicating better material performance and structural integrity. Design 2 further improves on this, reaching a stress tolerance of 1.36 MPa, making it the most robust under stress conditions and the highest-performing design.

The next parameter, displacement, measures how much a structure deforms under load. The Existing Design has a relatively high displacement of 2.11E-02 mm, suggesting that it is less stable compared to the new designs. Design 1 shows considerable improvement, with a reduced displacement of 5.39E-03 mm, indicating enhanced resistance to deformation. Design 2 demonstrates the best performance in this regard, with the lowest displacement of 2.24E-03 mm, providing the highest stability and minimal deformation among the three designs.

For strain, which reflects the deformation of a material under load, the Existing Design has a strain value of 5.38E-06, setting the baseline. Design 1 experiences a slight increase in strain to 5.72E-06, suggesting more deformation under load. Design 2 has the highest strain value of 5.97E-06, indicating the most deformation, though this may still be acceptable depending on material properties and design goals.

Lastly, the Factor of Safety (FOS), which measures the structure's margin of safety, shows the most dramatic improvements. The Existing Design has an FOS of 1.26E+11, reflecting a standard level of safety. Design 1 shows a remarkable improvement with an FOS of 5.90E+11, signalling enhanced robustness and safety. Design 2 leads with the highest FOS of 1.06E+12, demonstrating the best safety margin and providing the most reliable performance under various loads.

In conclusion, the analysis reveals that Design 1 and Design 2 outperform the Existing Design across all parameters. Design 2 consistently offers the best performance, with superior stress tolerance, reduced displacement, and the highest factor of safety. These improvements highlight the effectiveness of the iterative design process in enhancing the structural integrity and safety of the component, making Design 2 the most robust and reliable option for practical applications.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Background

This chapter are the last part of this thesis. This chapter will explain the conclusion for overall chapter for this Design Improvement of River Trash Collector Conveyor Structure on Malacca River Boat. In this chapter also will be discussed about the recommendations of this study.

5.2 Conclusion

In this study, the performance of the existing trash collector conveyor design for the Malacca River was critically analysed and compared to two improved designs (Design 1 and Design 2). The primary aim of this research was to address the limitations of the current design by focusing on enhancing its durability, reliability, and overall efficiency. The analysis revealed that both Design 1 and Design 2 significantly outperform the existing conveyor structure, demonstrating superior material strength, stability, and safety.

Design 2 emerged as the most robust option, with the highest von Mises stress tolerance, minimal displacement, and the best factor of safety. These improvements highlight the importance of iterative design in optimizing structural performance, ensuring the system's ability to withstand operational loads. Design 1 also showed substantial improvements over the existing design, although Design 2 was the clear leader in terms of overall performance.

The findings of this research offer valuable insights for future developments in waste collection systems, particularly in the context of the Malacca River. The new design structures provide a more reliable and efficient solution to the pollution issues facing the river, which, in turn, could contribute to improving the environmental health of the area and supporting local communities.

While the improved designs demonstrate promising results, future research could explore further optimizations, such as material selection and energy efficiency, to further enhance the sustainability of these systems. Additionally, incorporating ecological considerations and environmental impact assessments into the design process will be crucial for ensuring that these systems remain effective and environmentally friendly in the long term.

In conclusion, this study contributes to the ongoing efforts to address river pollution in Malaysia and provides a foundation for future advancements in debris collection technology. The proposed improvements not only offer practical solutions for the Malacca River but also set the stage for broader applications in similar contexts globally.

5.3 Recommendation

Objective of this study has been achieved. Design 2 has consistently outperformed the others in all key parameters, including von Mises stress, displacement, strain, and factor of safety. Therefore, it is strongly recommended that Design 2 be selected for further development and implementation in the Malacca River's debris collection efforts. Its superior structural integrity and robust safety margin guarantee long-term durability, minimizing maintenance needs and optimizing operational efficiency in addressing the river's pollution issues.

In addition, further research into alternative materials could yield even more promising results. Investigating corrosion-resistant and lightweight materials would enhance the sustainability and longevity of the conveyor system, particularly in challenging environments such as river systems exposed to water and debris. It is recommended to conduct comprehensive material testing, evaluating factors like cost, durability, and environmental impact, to identify the most suitable options for long-term performance.

Since the existing design has already been developed using SolidWorks, it is recommended to leverage the software's more advanced simulation and analysis features to further optimize the conveyor structure. Tools such as stress analysis, fatigue analysis, and flow simulations can offer valuable insights into the system’s behaviour under various operational conditions. By running these simulations at different operational loads, the design can be refined, leading to enhanced performance and greater reliability in real-world applications.

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APPENDICES

Appendix A Gantt Chart PSM 1

PERANCANGAN PROJEK 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											■			
CHAPER 3												■		
CHAPTER 4													■	
PRESENTATION														■

Appendix B Gantt Chart PSM 2

PERANCANGAN PROJEK 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											■			
ANALYSIS RESULT COMPARISON												■		
CHAPTER 4													■	
PRESENTATION														■