DESIGN AND OPTIMIZATION OF A LIGHTWEIGHT RC AIRSHIP STRUCTURE USING CAD AND FEA

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (AUTOMOTIVE) WITH HONOURS

2024

Faculty of Mechanical and Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor Of Mechanical Engineering Technology (Automotive) With Honours

Faculty of Mechanical and Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2024

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: DESIGN AND OPTIMIZATION OF A LIGHTWEIGHT RC AIRSHIP STRUCTURE USING CAD AND FEA

SESI PENGAJIAN: SEMESTER 1 2023/2024

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DEDICATION

I would like to dedicate this research report to my family, whose unwavering support and encouragement have been the driving force behind my academic journey. Their love, patience, and belief in my abilities have provided me with the strength and determination to pursue this research endeavour.

I also extend my heartfelt gratitude to my supervisor, En. Muhammed Noor Bin Hashim, for his invaluable guidance and mentorship throughout this research project. His expertise, patience, and continuous support have been instrumental in shaping the outcome of this study.

Furthermore, I would like to express my deepest appreciation to the participants who generously dedicated their time and efforts to participate in this research. Their willingness to contribute to this study has been essential in gathering the necessary data and insights.

Lastly, I would like to acknowledge and thank the academic community, my friends, and colleagues for their intellectual discussions, feedback, and inspiration, which have enriched my understanding and perspective in the field of research.

To all these individuals and groups, I dedicate this research report as a token of my gratitude and appreciation for their profound impact on my academic and personal growth. Without their support, this research would not have been possible.

ABSTRACT

This research uses computer-aided design (CAD) and finite element analysis (FEA) methods to design and optimise a lightweight RC (Radio Controlled) airship structure. The objective is to design a lightweight radio-controlled airship without losing its stiffness and strength. Using CAD software, a 3D model of the airship's structure is created, including important components like the envelope, gondola, and propulsion system. During the conceptualization phase, various design factors are taken into consideration, such as aerodynamic efficiency, structural integrity, and weight reduction. The structural components are then analysed and optimised for strength, stiffness, and weight using the FEA method. The stress distribution, deformations, and potential failure areas are determined and addressed through material selection, geometry modifications, and reinforcement techniques by subjecting the model to simulated operating conditions and external forces. To further reduce the airship structure's overall weight without sacrificing its strength and safety, research also examines the incorporation of lightweight materials like advanced composites and alloys. The goal of this strategy is to increase the airship's flexibility, manoeuvrability, and ability to carry payloads. Iterative design refinements and optimisation are made possible by the results of the CAD and FEA simulations, which offer insightful information about the structural performance of the airship. The design parameters are evaluated and changed constantly to create an optimised lightweight airship structure that meets the required performance standards. The outcomes of this research have important implications for the development of light-weight aerial vehicles, such as unmanned aerial systems, surveillance platforms, and air transportation. By offering useful insights into the design and optimisation of lightweight RC airship structures using CAD and FEA techniques, the methodology and findings presented in this study advance the field.

ABSTRAK

Penyelidikan ini menggunakan kaedah reka bentuk bantuan komputer (CAD) dan analisis unsur terhingga (FEA) untuk mereka bentuk dan mengoptimumkan struktur kapal udara RC (Radio Controlled) yang ringan. Objektifnya adalah untuk mereka bentuk kapal udara dikawal radio ringan tanpa kehilangan kekakuan dan kekuatannya. Menggunakan perisian CAD, model 3D struktur kapal udara dicipta, termasuk komponen penting seperti sampul surat, gondola dan sistem pendorong. Semasa fasa konseptualisasi, pelbagai faktor reka bentuk diambil kira, seperti kecekapan aerodinamik, integriti struktur, dan pengurangan berat. Komponen struktur kemudiannya dianalisis dan dioptimumkan untuk kekuatan, kekakuan, dan berat menggunakan kaedah FEA. Taburan tegasan, ubah bentuk, dan kawasan potensi kegagalan ditentukan dan ditangani melalui pemilihan bahan, pengubahsuaian geometri, dan teknik tetulang dengan menundukkan model kepada keadaan operasi simulasi dan daya luaran. Untuk mengurangkan lagi berat keseluruhan struktur kapal udara tanpa mengorbankan kekuatan dan keselamatannya, penyelidikan juga mengkaji penggabungan bahan ringan seperti komposit dan aloi termaju. Matlamat strategi ini adalah untuk meningkatkan fleksibiliti, kebolehgerakan dan keupayaan kapal udara untuk membawa muatan. Penambahbaikan dan pengoptimuman reka bentuk berulang dimungkinkan oleh hasil simulasi CAD dan FEA, yang menawarkan maklumat bernas tentang prestasi struktur kapal udara. Parameter reka bentuk dinilai dan diubah secara berterusan untuk mencipta struktur kapal udara ringan yang dioptimumkan yang memenuhi piawaian prestasi yang diperlukan. Hasil penyelidikan ini mempunyai implikasi penting untuk pembangunan kenderaan udara ringan, seperti sistem udara tanpa pemandu, platform pengawasan, dan pengangkutan udara. Dengan menawarkan pandangan berguna tentang reka bentuk dan pengoptimuman struktur kapal udara RC ringan menggunakan teknik CAD dan FEA, metodologi dan penemuan yang dibentangkan dalam kajian ini memajukan bidang tersebut.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

Primarily, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform.

My utmost appreciation goes to my main supervisor, En. Muhammed Noor Bin Hashim for all his support, advice, and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered. Also, to my co-partner, Sharizan Bin Yunus for all the help and support I received from him.

Finally, sincerely a gratitude to my beloved mom, Pn. Roslina binti Pandak Abdullah, for her encouragement and who have been the pillar of strength in all my endeavors. My eternal love also to all my siblings, Nurul Mazurianaa, Nurul Shafikah, Nurul Ain Husna and Muhammad Mukhriz for their patience and understanding. I would also like to thank my beloved friends for their endless support, love, and prayers. Finally, thank you to all the individual(s) who had provided me with the assistance, support, and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

D,d	-	Diameter
N/m^2	-	Newton per meter square

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CHAPTER 1

INTRODUCTION

1.1 Background

An RC (remote-controlled) airship is a type of radio-controlled aircraft that is designed to be lighter-than-air, meaning it can float in the air using a gas such as helium or hydrogen. It is typically controlled by a pilot on the ground using a radio transmitter. In the first half of the 20th century, airships were widely used for a variety of purposes, but for many years, the advantages of LTA vehicles were overshadowed by the speed, power, and glamour of conventional aircraft. Unmanned, remotely operated, and autonomous airship design, development, and flight testing are the subject of numerous studies being conducted worldwide (Advit Shaikh Aisha Shaikh Shahrukh Hussain Syed Mujtaba, n.d.).

Airships are aerial vehicles that get most of their lift from aerodynamic principles to achieve cruise equilibrium while using significantly less fuel. Around two thousand years ago, the Greek mathematician and inventor Archimedes proposed the aerostatics principle. Due to their simplicity compared to aeroplanes at the time, large hydrogen-filled airships became increasingly popular in the military and civil aviation industries during the first half of the twentieth century. Due to their sensitivity to weather conditions and the difficulty in obtaining non-combustible helium as a substitute for extremely flammable hydrogen gas, airships were abandoned by the aviation industry for a considerable period after the Hindenburg disaster and a few other accidents that followed. This sounded the death knell for airships along with the quick advancements in fixed wing aircraft technology, especially speed and dispatch reliability. Even though airships are outdated technology, they are once again being considered because of the renewed focus on factors such as minimal environmental impact, high payload capacity, long endurance, and low energy consumption (Manikandan & Pant, 2021).

Remote Control (RC) airships are made up of three main components which is the envelope or body, which is filled with a gas and contains the payload and control equipment, the propulsion system, which consists of one or more motors and propellers, and the control system, which includes a radio transmitter and receiver, as well as servos and other components that allow the operator to control the airship's movements. RC airships are often used in hobbyist and enthusiast circles, with competitions and events held for those interested in flying and building their own airships. These aircraft can come in a variety of sizes, from small indoor models to large outdoor models that can reach several meters in length.

1.2 Problem Statement

RC aircraft or drone are limited in their ability to stay aloft for long periods of time due to the amount of fuel they consume and the physical demands on their engines and components. This can be problematic for applications that require extended periods of airborne surveillance or data collection.

Certain applications such as aerial photography or scientific research has a weight that require a platform that can remain stable and relatively stationary in the air. RC aircraft or drone may not be ideal for these applications due to their endurance and stability.

1.3 Research Objective

The main aim of this research is to design a lightweight RC airship without affecting its strength and stiffness. Specifically, the objectives are as follows:

a) To design a lightweight RC airship.

b) To compare a suitable lightweight material for RC airship.

c) To finalize the design using simulation and conduct a series of test flights.

1.4 Scope of Research

The scope of this research are as follows:

a) Identification of the most effective design that can provide the necessary support while keeping weight to a minimum.

b) Identification of the most lightweight and durable materials that could withstand the stresses of flight such carbon fiber, Kevlar, or Mylar.

c) Investigation of optimizing the shape of the airship to enhance performance, efficiency, and safety.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

An airship is a "lighter-than-air" aircraft compared to conventional fixed-wing and rotary-wing aircraft, depends primarily on buoyancy forces rather than traditional lifting surfaces like wings and blades (Stockbridge et al., 2012). A lifting gas that is less dense than the surrounding air provides a lift for aerostats. They are applicable to many different tasks, including aerial photography, surveying, monitoring, and advertising. Blimps and rigid airships are the two main categories of RC airships. Blimps rely on the pressure of the gas inside to keep them in shape and have a flexible envelope. On the other hand, rigid airships have a rigid structure that secures the envelope and enables better control of the shape and movement of the airship. The buoyancy of the gas used to fill the envelope serves as the foundation for the operation of RC airships. Helium is frequently used because it is non-flammable and gives off a lot of lift. The amount of gas in the envelope can be changed, and motors are used to control the thrust-generating propellers. The airship uses a system of fins and rudders, which are managed by the pilot on the ground using a remote control, to regulate its direction and altitude. In general, RC airships are an intriguing technology with many different uses.

2.2 Conventional Airships

2.2.1 Non-rigid Airship

The non-rigid craft are airships that have no solid structure around their gas bag. Hot air balloons and blimps fall under this category (Lanier et al., 2011). Instead, it relies on the lifting gas's internal pressure to keep it in shape. A non-rigid airship's envelope is typically constructed of a flexible, airtight material like nylon or polyester. Non-rigid airship structures allowing for flexibility and simple manoeuvrability. With the pressure of the lifting gas inside, the envelope assumes a more organic shape. Due to its lack of structural rigidity, a non-rigid airship needs to be inflated constantly while in operation to maintain its shape. Historically, these aircraft took off using a "lighter-than-air" launch, where their internal gases provided enough buoyancy to lift them off the ground. Modern non-rigid airships, on the other hand, frequently lift off overweight, requiring the use of propulsive forces such as lifting the nose or angling the engines downward to achieve take off. Since they are simple to build and store, non-rigid airships are the most common type of airship today(Sami et al., 2015). Fig. 1 below shows a typical non-rigid airship with its internal structural layout (Stockbridge et al., 2012).

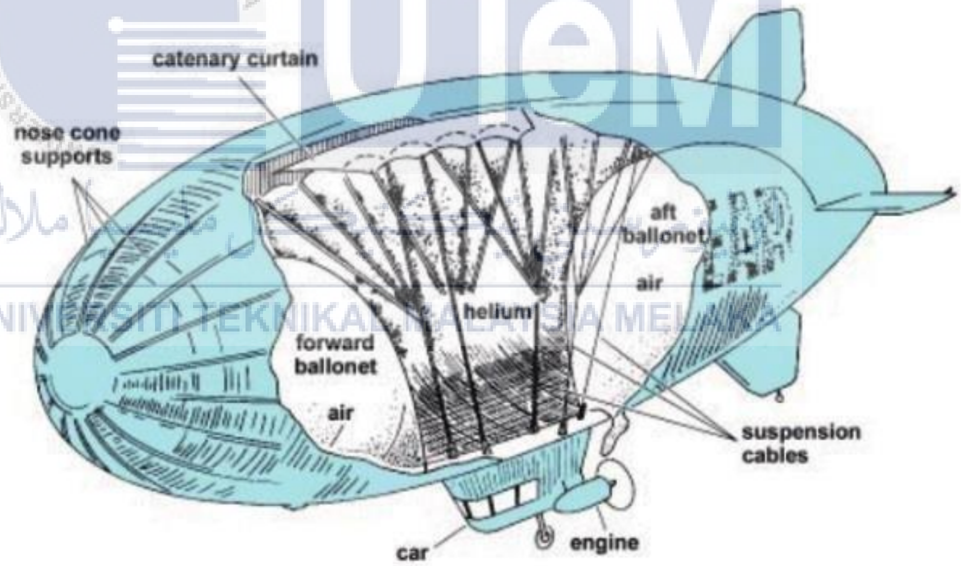


Figure 2.1: Non-rigid Airhip

2.2.2 Semi-rigid Airships

Semi-rigid airships, also referred to as semi-rigid dirigibles or semi-rigid blimps, are a class of lighter-than-air aircraft that combine characteristics of both rigid and non-rigid blimps. It is distinguished by a partially rigid structure that gives the airship shape and stability while retaining some flexibility. Semi-rigids have a structural metal keel that runs longitudinally along the balloon’s base and supports the car, but they also rely on the internal gas to keep the balloon from deflating. The shape of the hull is primarily maintained by an overpressure of the lifting gas, like a non-rigid airship. Having a light framework at the nose and tail could also help the exterior design of the hull (Stockbridge et al., 2012). Semi-rigid airship has a partial framework or keel that runs along the bottom or, occasionally, the top of the envelope, in contrast to rigid airships, which have a rigid framework or structure inside their envelope to maintain their shape. This keel helps to evenly distribute the weight of the engines, gondola, and other equipment along the length of the airship. It is typically made of lightweight materials like aluminum or carbon fiber.

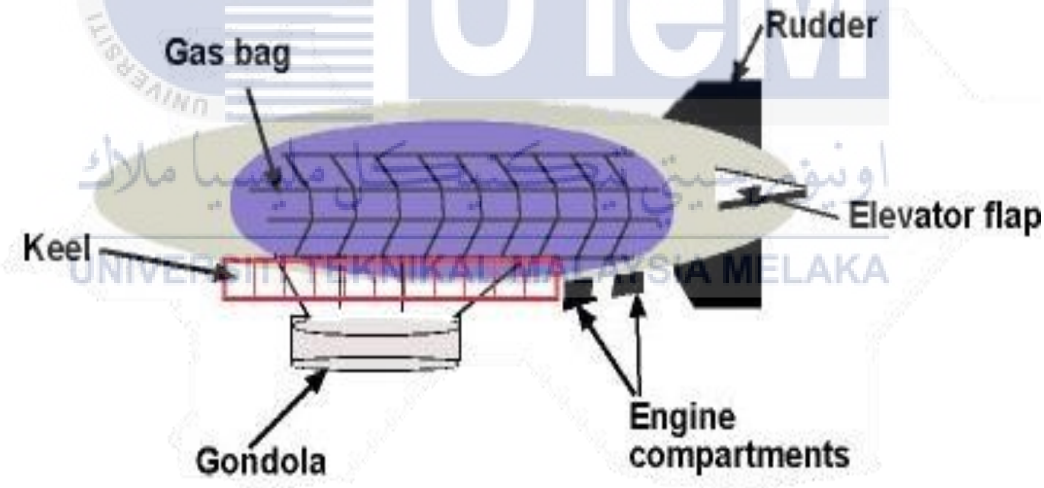


Figure 2.2: Semi-rigid Airship

2.2.3 Rigid Airships

Rigid airships, in contrast to non-rigid and semi-rigid airships, retain their shape from rigid an internal structural framework on which the aircraft’s outer envelope is connected. Non-and semi-rigid airships do this by the internal pressure of lifting gases. A rigid airship can be built much larger with the internal framework than a non-rigid or semi rigid dirigible because there is no chance of stretching because of aerodynamic forces and moments. The airship is filled with numerous gas cells that hold lifting gases inside the internal framework. Using multiple gas cells reduces the likelihood of a catastrophe because most rigid airships are large. Gas compartmentalization improves safety and prevents abrupt loss of significant lift in an (Liao & Pasternak, 2009). Rigid airships have benefits in terms of payload capacity, controllability, and stability, they also have drawbacks. The rigid framework requires complex and pricy construction and maintenance procedures. In addition, rigid airships' large size makes it difficult to handle and moor them, and it makes them vulnerable to weather conditions.

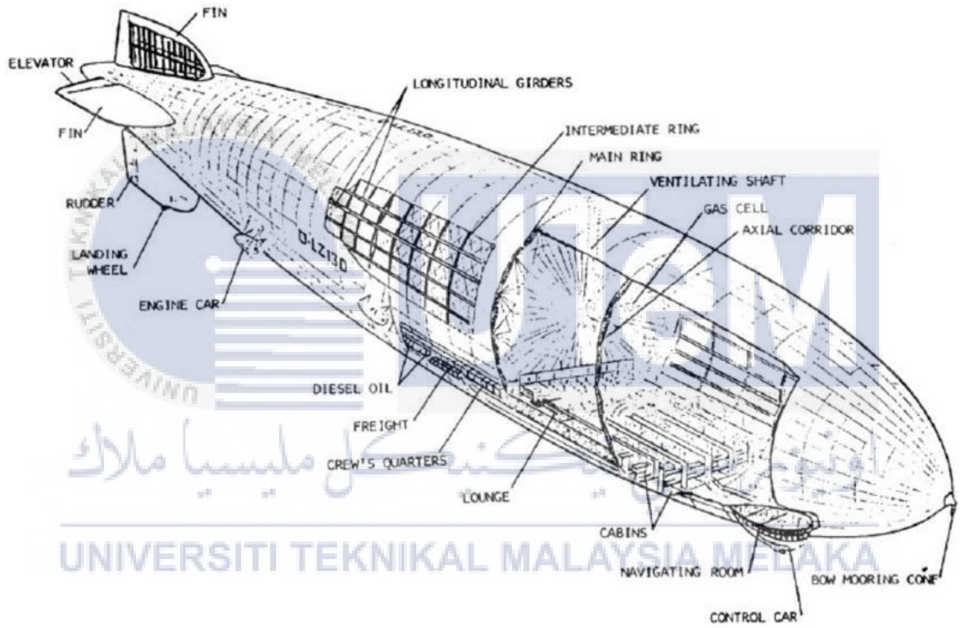


Figure 2.3: Rigid Airship

2.3 Unconventional Airships

2.3.1 Heavy Lift Vehicles (HLVs)

Since the 1980s, new airships have been successfully operated commercially under less strict categories (22b, 2017). Heavy lift vehicles are specialized vehicles or mechanisms used to carry and transport heavy loads when referring to remote-controlled (RC) airships. RC airships, also known as remote-controlled blimps or dirigibles, are lighter-than-air aircraft that use propulsion systems to control their movement and gas-filled envelopes to achieve buoyancy. These airships are frequently employed in a variety of tasks, including aerial photography, surveillance, advertising, and educational studies. To enable heavy lift capabilities in RC airships, several mechanisms can be employed:

Table 2.1: Mechanisms of Heavy Lift Capabilities in RC Airships

Mechanisms	**Explanation**
Gondola or payload compartment	A gondola or payload compartment that is suspended below the gas-filled envelope is a feature of RC airships. This gondola offers room to transport large objects, machinery, or payloads.
Lifting mechanisms	Winches, cranes, or hoists mounted on the gondola are examples of heavy lift equipment for RC airships. The airship can pick up and carry heavy payloads due to these lifting mechanisms.
Attachment points	Multiple attachment points, such as hooks or straps, may be present on the gondola of an RC airship to secure and stabilize heavy loads while in transit.
Power and propulsion	To produce thrust and lift, RC airships need strong propulsion systems. This allows them to carry heavy loads. These systems, which frequently include electric motors or petrol engines, supply the force required to control the airship and balance the weight of the load.

It is significant to note that RC airships' capacity for heavy lifting is constrained when compared to larger, manned airships or conventional heavy lift vehicles employed in the construction or logistics sectors. RC airships are relatively smaller in size and payload capacity, and their lifting capacities are made to support lighter loads appropriate to their scale. In the context of RC airships, the term "heavy lift vehicles" refers generally to the specialized mechanisms, attachments, and lifting capacities built into the airship's design to carry and transport heavy loads or payloads within the bounds of their size and power.

2.3.2 High Altitude Airships (HAAs)

Remotely controlled airships (RC airships) that are built to fly at remarkably high altitudes, usually in the stratosphere, are referred to as high altitude airships (HAAs). These airships offer distinctive capabilities and applications and are especially made to withstand the difficulties of operating in the upper atmosphere. Here are some key features and functions of High-Altitude Airships in RC airship technology:

Table 2.2: Key Features and Functions of High-Altitude Airships in RC Airship

Features	Functions
Long Endurance	HAAs are designed to have a long flight endurance, allowing them to stay in the air for weeks or even months at a time. To run their operations for extended periods of time, they frequently have solar panels or other power sources installed.

Payload Capacity	HAAs can carry more payload than conventional RC airships. They can transport a variety of payloads, such as surveillance gear, communication systems, environmental monitoring equipment, and scientific instruments.
Applications	Applications for HAAs range from scientific research to environmental monitoring, telecommunications, surveillance, and emergency response.
Remote Control and Autonomous Operations	Operators on the ground can remotely control HAAs. They can also include autonomous systems, enabling them to carry out pre-planned tasks or adjust to changing circumstances as they fly.
Communication Systems	HAAs frequently act as platforms for communication, enabling long-distance communication in off-the-grid or disaster trick locations. They can serve as relay stations for cellular network coverage, internet connectivity or data transmission.

Aerodynamic Design	HAAs are made to withstand the harsh conditions found at high altitudes, such as chilly temperatures, thin air, and powerful winds. Their lightweight, yet strong, structures have aerodynamic shapes that are well-suited for effective flight in the upper atmosphere.

The HAA idea also has plenty of benefits over satellites. To match the longitude and latitude at any location on the earth, it can maintain a geostationary position much closer to the planet. Extreme north and south latitudes are not well covered by geostationary satellites because they are 1,700 times farther away. Low-Earth Orbit could provide continuous coverage, but a constellation of satellites would be needed. The HAA can also change its target location over time, and if necessary, it can be grounded, repaired, and put back in the air at any time (Mueller et al., n.d.).

2.3.3 Hybrid Airships

Remote-controlled (RC) airships that combine buoyant lift (from gas-filled envelopes) and aerodynamic lift (from wings or rotors) to achieve flight are referred to as hybrid airships. Between the 1960s and the 1980s, various hybrid airship concepts were created by fusing LTA and HTA in different ways. Airships with wings, lifting-body shapes, multiple conventional hulls, and combinations of buoyant hulls with rotors or rotor system are a few examples of these concept (Zhang et al., 2010). The advantages of both lighter-than-air and heavier-than-air aircraft are intended to be combined in these hybrid designs. Here are some key aspects and features of hybrid airships in RC airship technology:

Table 2.3: Features of Hybrid Airships in RC Airship Technology

Features	Description
Buoyant Lift	The gas-filled envelopes that are used in conventional airships are also used in hybrid airships. As a result of the gas' buoyancy, the airship can float and transport payloads without needing constant propulsion.
Aerodynamic Lift	Hybrid airships use both buoyant lifts and aerodynamic lifts produced by wing or rotor systems. These aerodynamic parts, like fixed wings, lifting bodies, or rotors, provide additional lift and control, enhancing manoeuvrability and versatility.
Enhanced Control	In comparison to pure lighter-than-air designs, hybrid airships have better control and manoeuvrability due to the addition of aerodynamic lift surfaces. This enhances stability, agility, and the capacity to carry out manoeuvrers like hovering, vertical take-off, and landing.

Increased Payload Capacity	Comparing hybrid airships of the same size to pure lighter-than-air airships, larger payloads are typically possible. Greater lifting capacity is made possible by the combination of buoyant and aerodynamic lift, allowing for the transportation of heavier equipment, sensors, or payloads.
Longer Range and Endurance	An increased range and longer endurance are made possible by the hybrid design. The airship can operate for longer periods of time without the need for frequent refuelling or recharging because of to the efficient forward flight made possible by the integration of aerodynamic lift.
Versatile Applications	In RC technology, hybrid airships are used for a variety of tasks, including aerial photography, surveying, cargo transportation, environmental monitoring, and search and rescue operations. These machines are suitable for a variety of tasks in both remote and urban settings due to their combined lift and manoeuvrability.

Technological Challenges	Engineers must manage the transition between buoyant and aerodynamic lift, balance weight distribution, optimize propulsion systems, and ensure structural integrity when designing and operating hybrid airships.

The applications of a conventional airship would be limited if it were used in its unaltered would state because of its slow cruising speed and poor manoeuvrability. The characteristics of HTA and LTA are combined in hybrid airship. In such designs, buoyant lift supports a portion of the weight of the aircraft and its payload, while aerodynamic lift supports the remaining weight. The "best of both world" combination of aerodynamic and buoyant lift results in an aircraft with the high-speed characteristics of HTA and the heavy lifting capability of LTA (Zhang et al., 2010).

2.3.4 Unconventional Body Shapes

Unusual body shapes can offer special benefits in terms of aerodynamics, stability, payload capacity, or aesthetics. Modern advancements in airship design have produced unusual configurations that are very dissimilar from the traditional ellipsoidal and spherical ones. Because the mass-to-volume ratio of this new class of air vehicles is very similar to the density of the fluid it is designed to move, modelling and simulation should take the additional masses into consideration when calculating motion (Tuveri et al., 2014). Here are a few illustrations of unconventional body designs that might be investigated for RC airships:

Table 2.4: Illustrations of Unconventional Body Designs

Illustration	Description
Spherical	A spherical body shape offers inherent structural strength and stability. It offers a large volume for payload capacity and enables better internal component distribution. However, compared to other shapes, it might have more aerodynamic drag.
Triangular Prism	This body shape combines a triangular cross-section with the stability of a conventional airship. The shape of the prism can accommodate equipment or payload within the prism volume, and the flat sides offer aerodynamic benefits.
Disc or Saucer Shape	A disc-shaped body, which was inspired by UFOs, can offer distinct aesthetics and perhaps even better aerodynamics. Because of its streamlined profile, it may have had less drag, but stability and payload capacity may have been compromised.

Winged Body	The airship design may benefit from adding wings to increase lift and manoeuvrability. A central hull with wings attached to it could be part of the body's design, allowing for more efficient and controlled flight.
Teardrop	The teardrop shape offers enhanced aerodynamics and decreased drag. It is like the conventional airship shape but has a sharper point at the front. While retaining stability and payload capacity, it can be a visually appealing option.
Cuboid	A body with a rectangular or cuboid shape might make good use of available room and be stable. It provides flat surfaces for mounting additional features like cameras or sensors as well as for payload distribution and equipment installation.

2.4 Airship Design and Optimization

Remote-controlled airships, also referred to as RC airships, have drawn a lot of attention in recent years because of their adaptability, maneuverability, and potential applications in a variety of industries. The performance, stability, and efficiency of these airships are influenced by their design and optimization. Numerous studies have been conducted on optimization and design over the previous ten years. Several developments have optimized the shape of airship hulls while taking into consideration various Renolds number regimes, but without taking into consideration structural constraints. There are also numerous studied on how to optimize an airship's algorithm (ZHANG et al., 2020). The main findings and trends from the research on the design and optimization of RC airships are summarized in this literature review.

A key component of the airship's design is the envelope's shape. Researchers have investigated a variety of envelope shapes, from conventional ellipsoids and cylinders to novel creations. Reducing drag while maintaining stability and lift capacity has been the main goal. According to studies, while unusual shapes like spheres or triangular prisms offer unique advantages in terms of payload capacity and structural strength, streamlined shapes like ellipsoids offer improved aerodynamics. The envelope shape is parametrized using five variables that can be changed to produce a variety of candidate shapes that adhere to specific geometrical restrictions. A surrogate model is created and assessed against a two-variable test function to predict the drag coefficient of the generated shape more precisely and effectively. In comparison to CFD results, the surrogate model is seen to accurately predict the drag coefficient for the generated shape with less than 1% error (Alam & Pant, 2017).

There has been a lot of investigation into the material selection for the envelope. Investigated materials include reinforced fabrics and innovative composites that are lightweight and strong. These materials provide better overall performance, strength, and gas retention characteristics. The literature emphasizes the significance of choosing lightweight materials that are also resistant to environmental factors like UV radiation and temperature changes.

In the design of an airship, the choice of lifting gas is crucial. The most popular options are helium and hydrogen because of their buoyancy properties. Because it is nonflammable and has a large lifting capacity, helium is frequently used. However, because it is flammable, hydrogen offers an even greater lifting capacity but raises safety issues. To find the best lifting gas for a given application, researchers have examined trade-offs between lifting capacity, availability, safety, and cost.

The key to making RC airships stable and maneuverable is to optimize the control systems. To provide precise control over pitch, yaw, and roll, researchers have concentrated on designing effective control surfaces, such as rudders, elevators, and ailerons. To achieve the best response and stability during flight, it has been investigated how to position and size these control surfaces.

Significant research has been done on RC airship power and propulsion systems. Many alternatives have been investigated, including electric motors, internal combustion engines, and hybrid systems. The emphasis is on enhancing these systems' functionality, losing weight, and developing their endurance. For instance, electric propulsion systems have benefits like low noise, low emissions, and simplicity of operation.

To maintain stability and withstand aerodynamic forces, RC airship structural design is essential. To achieve the best weight distribution and structural integrity, researchers have looked at how internal frames, gondola placement, and payload distribution are organized. The airship can manage a variety of flight conditions while maximizing payload capacity with lightweight materials and careful structural design.

The performance of RC airships must be optimized for aerodynamic reasons. The airship's shape has been streamlined, drag-inducing components have been reduced, and the control surfaces have been improved. The airflow around the airship has been simulated and studied using computational modelling techniques like computational fluid dynamics (CFD). This enables the detection of high-drag regions and the improvement of designs for improved aerodynamic performance.

Despite being created more than a century ago, airship development is currently very motivated. Airships can be used as a mode of transportation for both people and goods, as well as for patrolling, reconnaissance, monitoring, aerial photography, mapping, advertising, and promotion, as well as for communication (Fedorenko & Krukhmalev, 2016). Designing an airship must take payload and mission requirements into consideration. The effects of payload capacity, range, endurance, altitude, and environmental factors on airship performance have been investigated. Whether the airship is used for aerial photography, surveillance, cargo transport, or scientific research, design decisions are made to make sure it can manage the demands of those applications.

In the design of airships, safety comes first. Strong safety measures are required to guarantee the airship's structural integrity, as well as efficient gas containment, fire suppression systems, and clearly defined emergency procedures. Study has also concentrated on crashworthiness, particularly during landing or unforeseen circumstances.

The literature review on RC airship design and optimization exemplifies the field's multidisciplinary nature. It emphasizes the significance of envelope design, components, lifting gas choice, power and propulsion, control systems, structural design, aerodynamics, payload specifications, and safety considerations. Additional study is required to improve current designs, investigate novel ideas, and address issues unique to various applications. Future improvements in RC airship design and optimization will be able to build more effective, dependable, and capable remote-controlled aerial platforms thanks to the findings from this literature review.

2.5 Structures

2.5.1 Structural Design and Analysis

An RC airship's structural design and analysis involve important steps like specifying design requirements, choosing the envelope's shape and materials, designing the internal frame and gondola, performing finite element analysis (FEA), examining loads and stresses, choosing suitable materials with safety considerations, optimizing the design for weight reduction, manufacturing and putting the airship together, and testing and validating the design. Figure (2.4) shows the envelope design for airship that like the shapes of fish (*Jahagirdar*, n.d.).

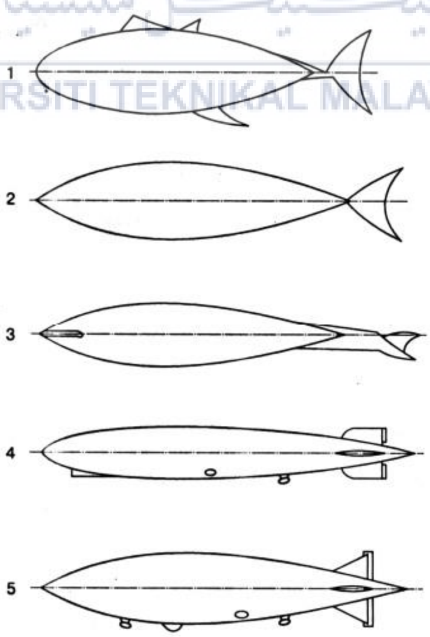


Figure 2.4: Envelope Design for Airship 1- Tunny, 2-Tumak (Cuffy), 3-Whale, 4-Zeppelin, 5- R101

By breaking down a complex geometry into a finite number of elements with simple geometries, the finite element analysis (FEA) technique solves these issues. Additionally, FEA enables strain to be modelled throughout the internal structure as well as across the entire structure's surface. In response to questions about form-function relationships in development and evolution as well as questions about human biology in general, FEA has become more accessible because of improvements in computer processing power (Panagiotopoulou, 2009). By taking these actions, the airship complies with mission objectives and safety regulations while maintaining its integrity, stability, and resistance to aerodynamic forces.

2.5.2 Materials

To improve the structural integrity, durability, and overall performance of RC airships, researchers have investigated a variety of materials and composites. Due to their great strength-to-weight ratio, lightweight reinforced fabrics and advanced composites like carbon fiber have received extensive research. These materials have demonstrated improved gas retention capabilities, environmental factor resistance, and improved overall performance. The choice of materials that are lightweight, low leakage of gas, flexible at low temperatures, and high strength and high tear resistance (Sonawane et al., 2014) has also been the subject of studies. Cost, availability, and manufacturability are other factors that have been considered. The review of the research demonstrates the ongoing efforts to find and create materials that can satisfy the unique needs of RC airships, enhancing their stability, robustness, and success in a variety of applications.

2.5.3 Lifting Gases

Size constraint and lifting force are two major factors that need to be considered when choosing the lifting gases for airship (Macias & Lee, 2021). Helium is by far the most used source for lifting gases in airships of the present. Helium is an inert gas, not flammable like hydrogen. The fact that hydrogen was so frequently involved in early airship disasters like Hindenburg is the main reason it is not used more frequently today. However, there are numerous tradeoffs associated with the use of helium, which researchers explore. For instance, hydrogen is both inexpensive and easily produced, whereas helium is both expensive and has a limited supply. Additionally, helium is less buoyant than hydrogen and has a 7% lower lifting capacity. The buoyancy compensation trade-off is another one that is not always clear from a technical standpoint. The aerostatic lift generated by the helium when an airship takes off with neutral buoyancy is equal to the total weight of the vehicle. The airship's overall weight does, however, decrease as fuel is burned along the way, but aerostatic lift does not. If nothing is done, the ship will eventually gain a lot of positive buoyancy. The airship must have a mechanism for buoyancy compensation because this is undesirable from both a control and structural standpoint. Airships that are filled with hydrogen can simply vent extra hydrogen into the atmosphere to make up for the weight of the fuel that was burned. Helium is more expensive than air, so helium-filled airships are built with a device on the exhaust of the engine to condense and recover the water it contains. To compensate for the weight of the fuel burned, the water is then stored. These water condensers can be bulky and add extra drag when mounted on the airship's skin.

2.6 Research Gap

No.	Author	Literature Title	Purpose	Result
1.	Sonawane et al., 2014	Material Characterization of Envelope Fabrics for Lighter Than Air Systems Multi-lobed hybrid airship View project Multidisciplinary Design Optimization View project Material Characterization of Envelope Fabrics for Lighter-Than-Air (LTA) System	To choose the suitable envelope material for LTA system	• Able to differentiate vary types of materials. • Able to run some test on the materials such as leakage test, strength test and tear resistance test. • Able to determine the suitable fabrics for LTA system.
2.	Stockbridge et al., 2012	Airship research and development in the areas of design, structures, dynamics, and energy systems	To review current modelling methods for airship dynamics and aerodynamics, as well as conceptual design and optimisation methods, structural design and manufacturing technologies, and energy system technologies, to examine the various facets of airship development.	• Able to classify the structure of RC airship. • Able to examine the airship bodies using Computational Fluid Dynamic (CFD) analysis. Able to develop better analytical techniques for aerodynamic, dynamic, and structural modelling.
3.	Zhang et al., 2010	Flight performance analysis of hybrid airship: Revised analytical formulation	To improve flight performance of a hybrid airship.	• Able to show an example of flight performance for a model hybrid airship. • Able to propose a new formula that are derived in a systematic way.

CHAPTER 3

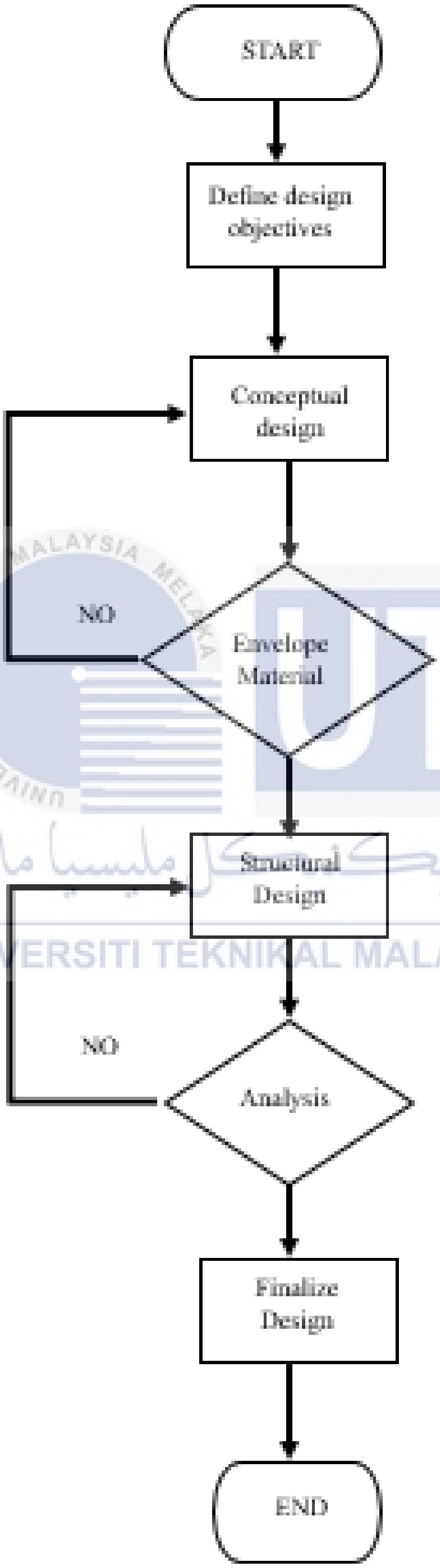
METHODOLOGY

3.1 Introduction

This chapter provides a thorough and detailed overview of the experimental methodology applied. This explanation's main objective is to ensure that the research goal is met. The main goal of this research is to create a remote-controlled (RC) airship that is lightweight while maintaining structural strength and stiffness. The goal is to create an airship that is lighter in weight while still maintaining the structural integrity needed for it to withstand operational loads and maintain stability. The airship may be able to improve its payload capacity, energy efficiency, and flight performance by shedding weight without sacrificing its durability and safety.

To develop an optimized lightweight airship that excels in both maneuverability and structural robustness, this research seeks to investigate novel approaches in material selection, structural design, and fabrication techniques. The ultimate objective is to advance lightweight airship technology, enabling a variety of uses in aerial monitoring, surveillance, and scientific research.

3.2 Flowchart



3.3 Purpose

RC airships are intended to take the place of battery-operated drone applications. It was created using a lifting gas, like hydrogen or helium. Additionally, it has a camera function that allows user to capture the flight. It will be operated remotely from the ground, allowing for the capture of excellent photos or videos from an airship. An airship platform can be used to gather data from there.

3.3.1 Size, Weight, and Flight Characteristics

3.3.1.1 Size

The lightweight remote-control airship is designed with a compact size, allowing for easy manoeuvrability and transportation. Its small dimensions make it suitable for indoor use, such as in conference rooms or exhibition halls, where space is limited. Despite its reduced size, the airship maintains stability and control, making it an ideal choice for recreational or surveillance purposes in confined areas. Its compact design also facilitates quick assembly and disassembly, enabling convenient storage and portability.

3.3.1.2 Weight

The lightweight remote control airship's design places a strong emphasis on the use of lightweight materials, which significantly reduces the overall weight. The airship achieves the ideal weight-to-performance ratio by using cutting-edge composite materials and lightweight components. This lightweight design allows for better energy efficiency, increased manoeuvrability, and longer flight times. It can be used in both indoor and outdoor settings thanks to the lighter weight, which also makes launch and landing easier. Furthermore, the airship's light weight enhances its overall stability and responsiveness to remote control commands.

3.3.1.3 Characteristics

The lightweight remote control airship's design incorporates several of unique characteristics that make it stand out. First, it has superb flexibility that enables precise control and easy travel through various environments. Second, it features a balanced and stable flight system that guarantees steady motion and dependable performance. Advanced sensor technology is also included in the airship, allowing for real-time data collection and environmental monitoring capabilities. It also has an easy-to-use remote-control interface that enables users of all skill levels to use it. The airship's lightweight design also improves its energy efficiency, allowing for longer flight times and lower overall operating costs. Finally, the airship's small size and light weight make it highly transportable and convenient, increasing its adaptability and usefulness in a variety of settings

3.3.2 Environmental Factors

To ensure optimal performance and adaptability, the lightweight remote control airship's design takes a variety of environmental factors into consideration. First, it has materials that are secure and can withstand mild wind conditions, ensuring stability and safe operation. Additionally, the airship's remote-control capabilities enable effective and precise navigation, reducing the possibility of causing damage to the environment, whether it be natural or man-made. Overall, the airship's design places a strong emphasis on environmental sustainability by including elements that reduce its environmental impact and encourage responsible use in a variety of environments.

3.4 Conceptual Design

Table 3.1: Type of Airships and Description

Airship type	Frame material	Lifting gas	Envelope material	Control system	Payload capacity	Purpose
Zeppelin NT	Lightweight materials (carbon fiber composites)	Helium	N/A (rigid)	Advanced radio control system	Variable	Transport, surveillance, various commercial applications
RC Blimp	Lightweight materials (balsa wood or plastic)	Helium	Thin materials (polyester or ripstop nylon)	Radio control systems	Limited (small payloads)	

3.5 Shape and Size

3.5.1 Traditional Blimp Shape

An RC airship's traditional blimp shape can be identified by its ellipsoidal or elongated cylindrical shape. It has rounded front and back ends and resembles a big, long balloon. Due to its aerodynamic qualities and simplicity of construction, the shape is frequently chosen. Traditional blimps used in RC airship designs come in a variety of sizes. Depending on the model and use, they can be anywhere from a few feet to several meters long. Based on variables like the desired payload capacity, flight stability, and maneuverability, the size is selected. The traditional blimp shape offers a balance between simplicity, stability, and aerodynamics, making it a popular option for many hobbyists and smaller-scale RC airship designs. The traditional blimp shape is an ellipsoidal or elongated cylindrical shape, which allows for efficient air displacement, which enables the airship to lift and maintain altitude.

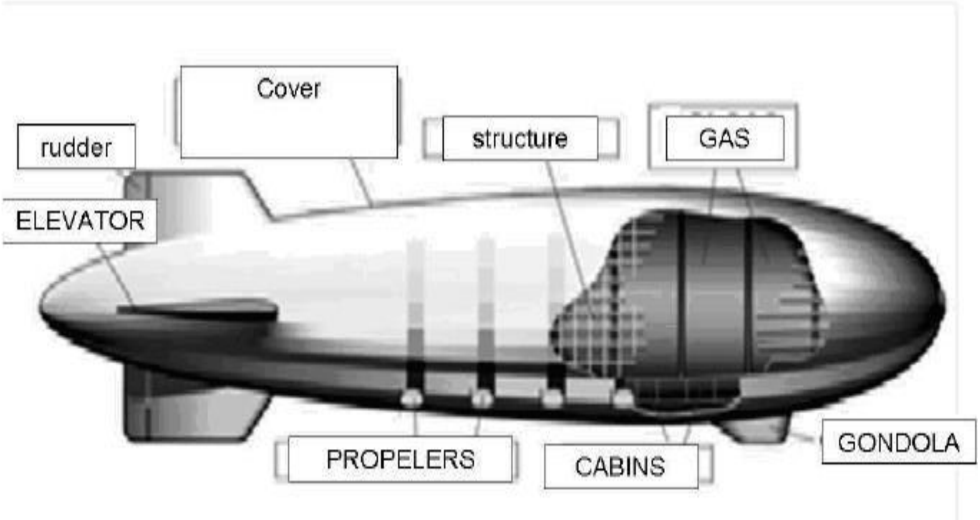


Figure 3.1: Traditional Blimp Shape

3.5.2 Rigid Airship Shape

In contrast to the conventional blimp shape, the rigid airship shape used in RC airship design includes a rigid internal framework for structural support. The overall structure of the airship is strengthened and stabilized by this framework. Like a traditional blimp, the rigid airship maintains an ellipsoidal or elongated cylindrical shape in terms of shape. It has a sleek, rounded front and back that is optimized for aerodynamic performance.

Rigid airships come in a wide range of sizes, from simpler models suitable for hobbyist use to larger, more complicated airships used for business or research. The intended payload capacity, endurance, and specific project requirements are among the elements used to calculate the size. These airships' rigid internal structures enable more control and accuracy while in flight. It makes it possible for the airship to keep its shape and structural integrity despite adverse weather. Additional parts, such as propulsion systems, control surfaces, and payload integration, can be attached to the rigid structure. For more specialized tasks like aerial photography, surveillance, or research, rigid airships are frequently built. They are suitable for heavier payloads and longer flights due to their larger size and improved stability. As a result, the rigid airship shape offers increased structural support and versatility for a variety of applications, from hobbyist to professional use. It combines the well-known ellipsoidal or elongated cylindrical form of traditional blimps with a rigid internal framework.

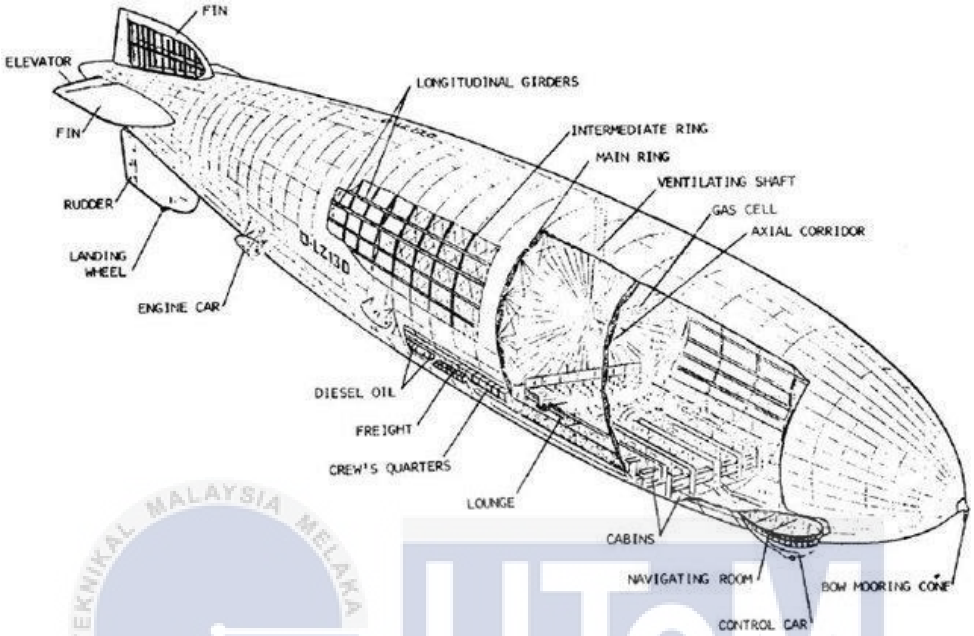


Figure 3.2: Rigid Airship Shape

3.6 Lifting Gas

3.6.1 Helium

A gas that is lighter than air and neither flammable nor toxic is helium. It has no chemical reactions with other substances because it is inert chemically. Compared to hydrogen, helium has a lower lifting capacity. It still offers enough buoyancy, though, to support and sustain the flight of RC airships. Helium is considered safer than hydrogen since it is non-flammable. It does not pose a fire hazard, making it easier and safer to handle, store, and transport. Helium is commercially available and widely used for various applications, including RC airships.

3.6.2 Hydrogen

The universe's lightest and most common element is hydrogen. It creates a risk of fire and explosion because it is extremely flammable and can react with oxygen when there is an ignition source nearby. Compared to helium, hydrogen has a greater lifting capacity. Because of its greater buoyancy, RC airships can carry heavier payloads or fly for longer periods of time. Hydrogen's flammability raises concerns regarding safety. To reduce the risk of fire or explosion, proper handling, storage, and safeguards against ignition sources are essential. Hydrogen is available, but due to its flammability, its use for RC airships may be constrained by regional laws and safety standards.

3.7 Envelope Material

The selection of envelope material for a lightweight RC airship is important as it gives impacts on the performance, durability, and safety of the airship. The envelope, also known as hull or the body of the airship, contain the lifting gas and provides structural intergrity. Table (3.1) shows the description of highlight's requirement of the envelope materials.

Table 3.2: The Description of Requirements Needed on Envelope Material

Requirements	**Description**
Lightweight	Lightweight materials are needed to minimize the overall weight of the airship.
Low leakage of gas	The material must have maximum durability to gas especially helium and hydrogen. These monoatomic gases can pass even through metals.

Flexible at low temperatures	The materials adequate pliability for retraction and maintain sufficient strength at the intense heat encountered during inflation and an impact.
High strength and high tear resistance	The material must be strong enough to carry required payload. If there is any tear on the envelope, it does not spread the gases immediately.

3.8 Structural Design

Figure (3.3) shows an airship design that meets the requirement of lightweight RC airship. The shape of the hull is an aerofoil, as the airship transition from a hover to forward flight, the hulls start to generate lift.

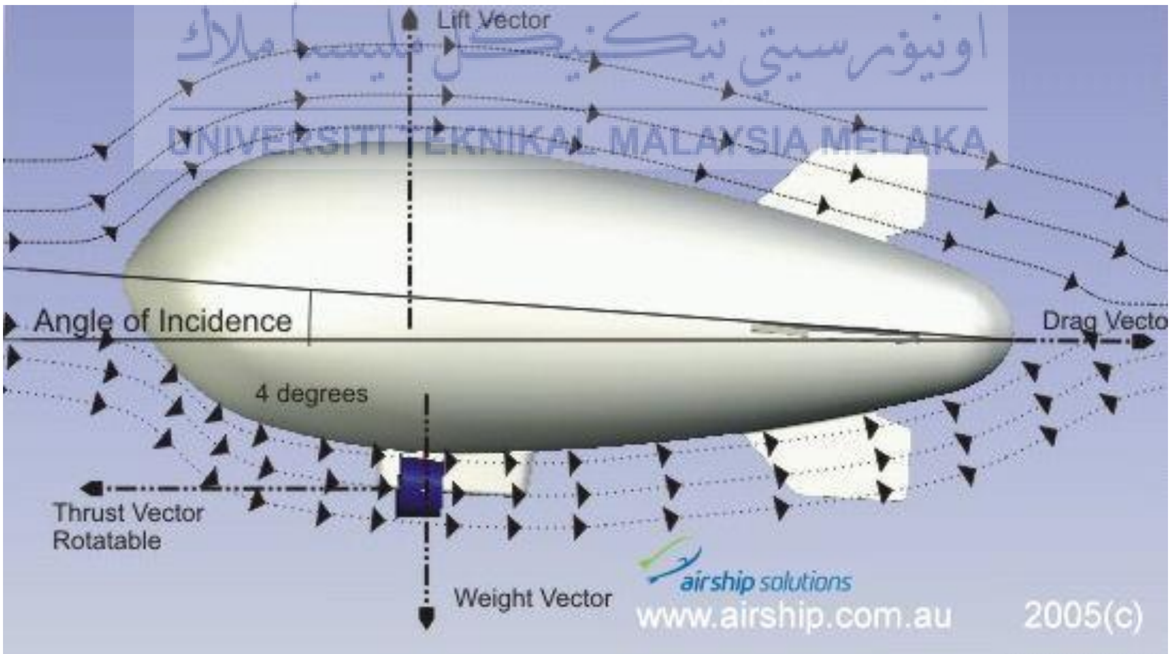


Figure 3.3: Design of RC Airship

3.9 Analysis

Figure 3.4: Sketch for Non-Rigid Airship

Figure 3.5: Sketch for Semi-Rigid Airship

Figure 3.6: Sketch for Rigid Airship

Figure (3.5) shows a non-rigid airship that are commonly known as blimps. It uses higher internal pressure from its lifting gas to maintain its body. Helium gas is filled in the ballonet inside the ship’s outer envelope to provide balancing on its body shape. Figure (3.6) shows a semi rigid airship that have no internal frame to support their envelope. Like non-rigid airships, the shape of the hull is maintained largely by an overpressure of the lifting gas. Figure (3.7) shows a rigid airship where its body is supported by an internal structural framework. With that, this airship has higher capability to be build much bigger. Inside the internal framework, it is filled with multiple lifting gas bags to hold the lifting gases.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents an overview of the improvement in reducing the weight of RC airship without affecting its strength and stiffness. The design of its structure and analysis was shown in CATIA V5 software. This chapter also present the comparison between actual design with its prototype.

4.2 Detail of Lightweight RC Airship

While designing the structure of airship, material selection was implemented. The frames primarily utilize balsa wood sticks for the main structural elements due to their exceptional strength-to-weight ratio. CATIA's material optimization tools were employed to fine-tune the tube dimensions and wall thickness, ensuring structural integrity while minimizing weight. CATIA's simulation tools were utilized to conduct extensive stress analysis, ensuring the frame's ability to withstand flight stresses. Finite element analysis within CATIA helped identify critical stress points and areas for reinforcement, leading to design refinements for enhanced structural integrity without compromising weight.

4.3 Design

The design of lightweight RC airship was constructed according to the previous rigid airship design because of its internal framework that can support the load well. Two designs were approached to compare their ability to carry payload. Equilateral triangles needed for the frame. The triangles are connected on all 3 sides with long bendy strips of balsawood. The frame is the mounting point for most of the airship’s components. Triangles are inherently stable geometric shapes. The fixed angles of an equilateral triangle distribute loads evenly across all three sides. This structural stability is crucial for withstanding the stresses and strains an RC airship might experience during flight. Figure 4.1 and 4.2 show the different sizes of design that has been done in CATIA V5.

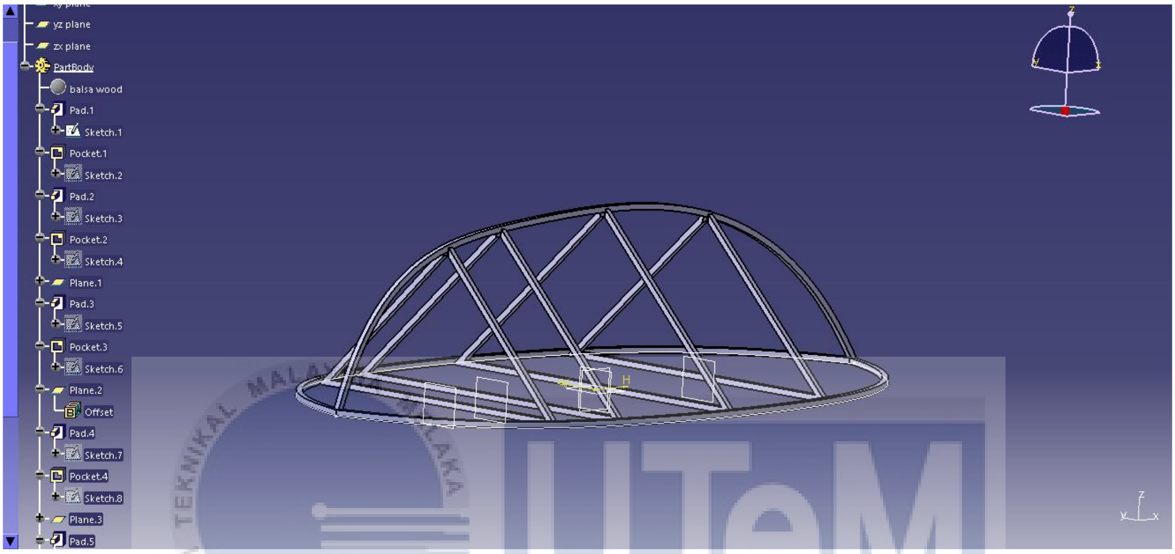


Figure 4.1: Design 1

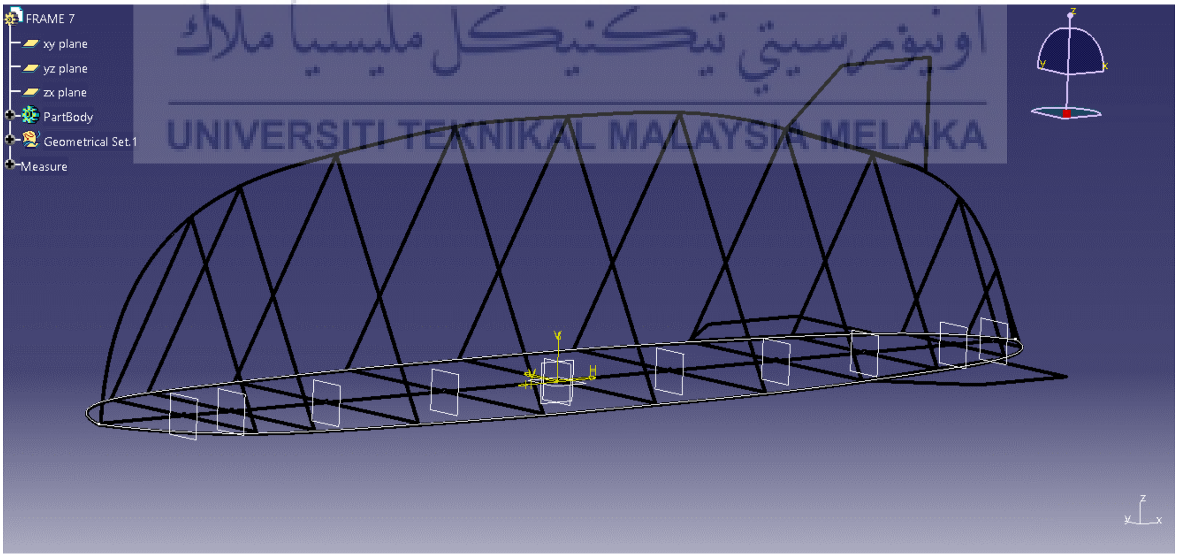


Figure 4.2: Design of Lighweight RC Airship

4.4 Structural Analysis

The analysis carried out requires a comprehensive exploration of critical factors such as Von Mises Stresses, displacements, deformations and safety factors on airframes. Through this process, the objective of designing a lightweight RC airship without compromising its strength and stiffness can be achieved. The analysis's findings are a valuable tool for determining whether strengthening or other modifications are required to improve the overall robustness and reliability of RC airships.

4.4.1 Force Applied

Car control and sensors are a strain for this project. These two weights add up to one kilogram. This has made it clear that the force is 10N. This load was placed at the center of gravity to maintain the balance of the airship. The airship would experience an increase in downward force due to the added weight. This would affect the buoyancy of the airship, which relies on the principle of buoyant force to stay afloat.

4.4.2 Von Mises Stress

The Von Mises Yield Criterion is used to determine the framework's structural soundness. This criterion entails calculating the Von Mises stress precisely and comparing it to the material's yield stress. The main goal of this method is to create a yield criterion specifically for ductile material. The Von Mises Yield Criterion is used in the analysis in order to ensure that the RC airship can support the weight and remain afloat.

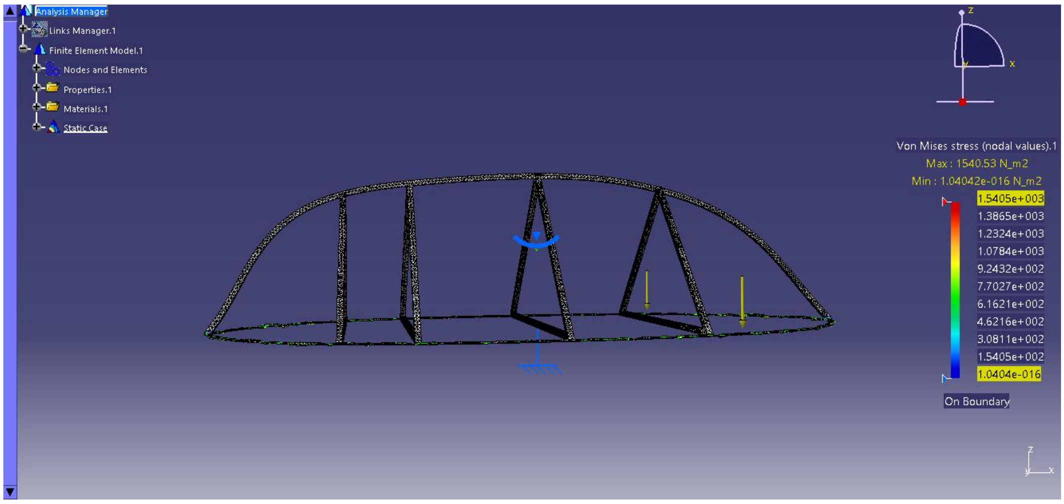


Figure 4.3: Von Misses Stress for Design 1

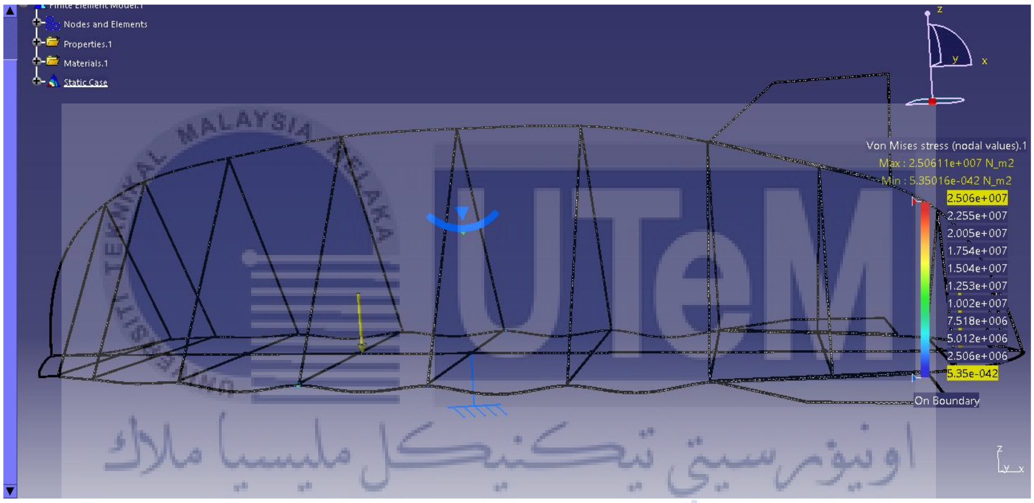


Figure 4.4: Von Mises Stress for Design 2

Table 4.1: The Difference of Von Misses Stress between Two Design

	Value	Design 1	Design 2
Von Mises Stress	Max Value	$1.541e+3\frac{N}{m^2}$	$2.506e+7\frac{N}{m^2}$
	Min Value	$1.040e-16\frac{N}{m^2}$	$5.350e-42\frac{N}{m^2}$

The data presented in Figure 4.3 and 4.4 and Table 4.2 displays the outcomes of Von Mises Stress. The right corner of the figure shows maximum and minimum value of Von Mises Stress.The data indicates that the location of the maximum value of Von Misses Stress is at the balsa wood. This indicates that the material has undergone a range of stress, , with a low value of $1.541e + 3N\_m^2$ and a high value of a $1.040e - 16N\_m^2$ for Design 1 while low value of $5.350e - 42N\_m^2$ and a high value of a $2.506e + 7N\_m^2$ for Design 2.

4.4.3 Displacement

Displacement is described as a vector quantity with both magnitude and direction. It can be visualized as an arrow extending from the beginning to the finish line, denoting the path taken as well as the distance travelled. Given the paramount importance of motion in this undertaking, it is important to carefully review research on displacement's effects. By evaluating the product's potential ability to adapt and respond to changes in position, this analysis aims to provide insightful information about the product's overall effectiveness.

Figure 4.5: Displacement for Design 1

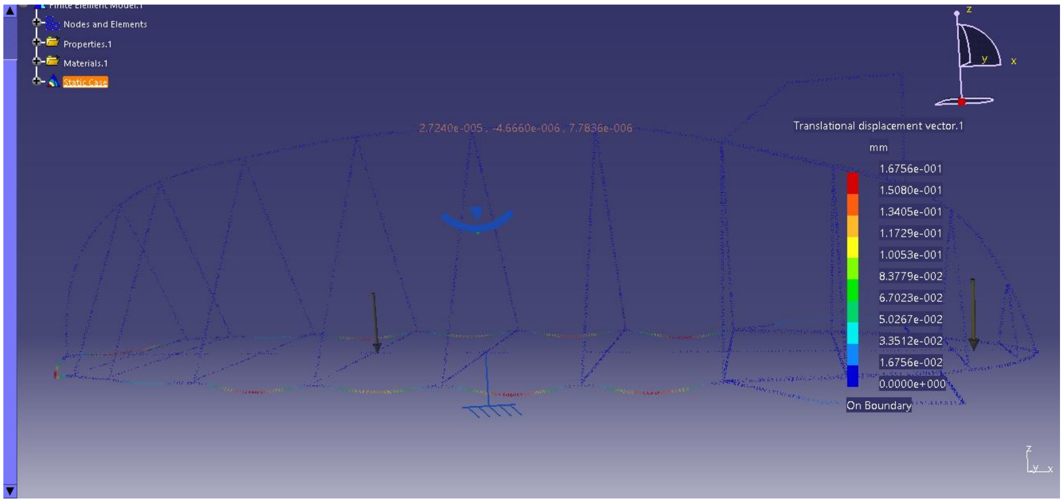


Figure 4.6: Displacement for Design 2

Table 4.2: Maximum and Minimum Value of Displacement for Design 1 and Design 2

	Value	Design 1	Design 2
Displacement	Max Value	1.705e-6 mm	0.1676 mm
	Min Value	0.00 mm	0.00 mm

As can be seen in Figures 4.5, Figure 4.6 and Table 4.2, 0.1676 mm and 1.705e-6 mm was the largest displacement and 0.00mm was the smallest for each design. The airship's internal frame is where the highest displacement is located, as seen in Figure 4.3 and Figure 4.4. Both design's material have suffered displacement ranging from 0mm to 0.1676mm. This value's extremely small magnitude makes it acceptable. The structures might thus carry weight without impairing other components.

4.4.4 Deformation

For lightweight RC airships to maintain structural integrity, aerodynamic efficiency, and safety, deformation analysis is essential. The analysis helps in material selection and design optimization, minimizing unexpected deformations or failures, as these airships prioritize low weight with sufficient strength. Furthermore, deformation analysis is essential for evaluating fatigue and durability concerns, resolving possible weak points, and adhering to rules controlling lightweight airship construction and operation. In general, this analysis is necessary to design lightweight structures that satisfy operating requirements and safety standards and are dependable and efficient.

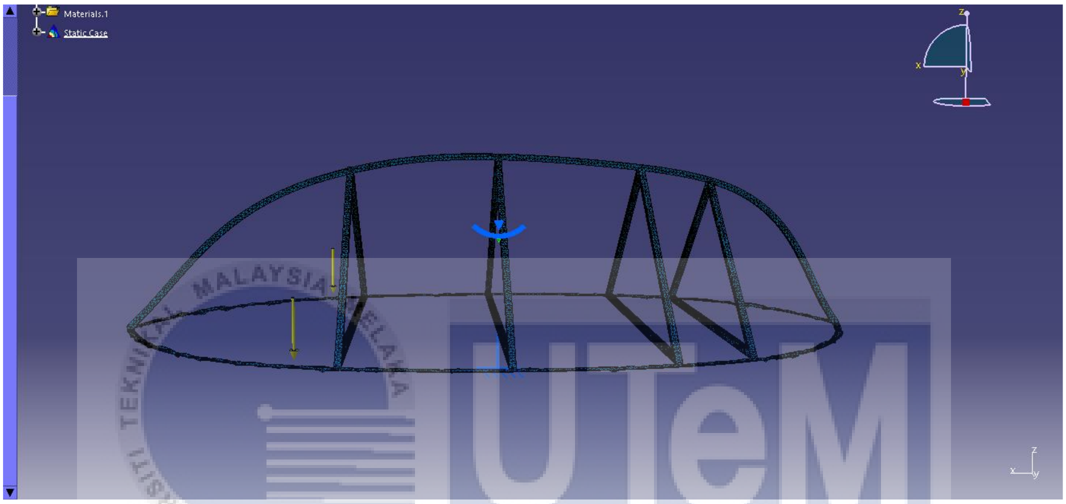


Figure 4.7: Deformation of Design 1

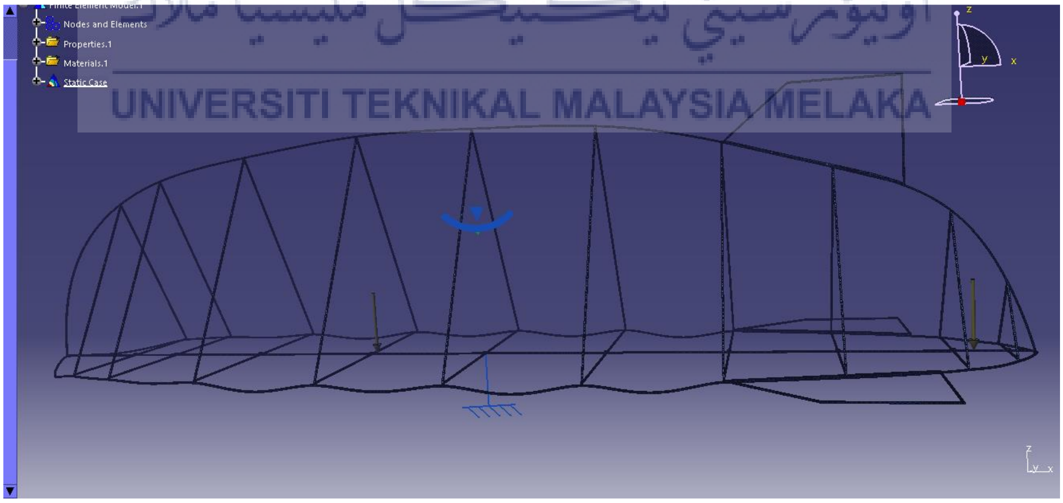


Figure 4.8: Deformation of Design 2

According to Figure 4.7 and 4.8, it proved that balsa wood is the best material for airship structures because of its remarkable strength-to-weight ratio. Balsa wood's low weight makes it possible to build airships that are not only light and manoeuvrable but also have the highest possible energy efficiency. Balsa wood's capacity to maintain its structural integrity under a range of stresses indicates that it is suitable for withstanding the forces involved in airship operations. Furthermore, its buoyancy-enhancing qualities add to the airship's total lift capacity. These results confirm that using balsa wood to build lightweight RC airships is safe.

4.4.5 Factor of Safety

The factor of safety (FoS) is a crucial parameter in the design and analysis of structures, including RC (Radio-Controlled) airships. It represents a margin of safety incorporated into the design to account for uncertainties, variations in materials, unexpected loads, and potential imperfections in construction. The factor of safety is calculated by dividing the ultimate strength of the material or structure by the expected or maximum applied load. In this project, a factor of safety range between 1-1.5 indicates that the structure can withstand loads significantly higher than the expected operational forces, ensuring a level of redundancy and resilience. A higher factor of safety provides a buffer against unforeseen circumstances, contributing to the reliability and safety of the airship during flight.

<u>Calculation for Design 1</u>

$$Factor\ of\ Safety = \frac{Yield\ Strength}{Maximum\ Stress}$$

$$Factor\ of\ Safety = \frac{1.541e + 3\ N/m\hat{}2}{2.506 \times 10^7\ \frac{N}{m^2}}$$

$$Factor\ of\ Safety = 19480.52$$

Calculation for Design 2

$$Factor\ of\ Safety = \frac{Yield\ Strength}{Maximum\ Stress}$$

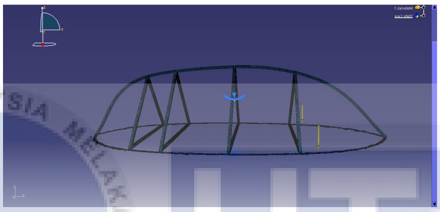
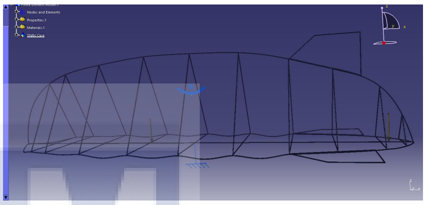
$$Factor\ of\ Safety = \frac{3 \times 10^7\ \frac{N}{m^2}}{2.506 \times 10^7\ \frac{N}{m^2}}$$

$$Factor\ of\ Safety = 1.2$$

The calculation above shows the value of Safety of Factor for Design 2 is 1.2 which is more safer than Design 1. It means that the structure is designed to handle loads up to 1.2 times the maximum expected operational load. Therefore, it is safe to use.

4.5 Overall Analysis

Table 4.3: Overall Structural Analysis

	Design 1	**Design 2**
Size of Balsa Wood (Square)	$8mm \times 8mm$	$2mm \times 2mm$
Von Misses Stress	$1.541e + 3\,\frac{N}{m^2}$	$2.506e + 7\,\frac{N}{m^2}$
Displacement	1.705e-6 mm	0.1676 mm
Deformation		
Weight (kg)	0.123	0.019
Factor of Safety	19480.52	1.2

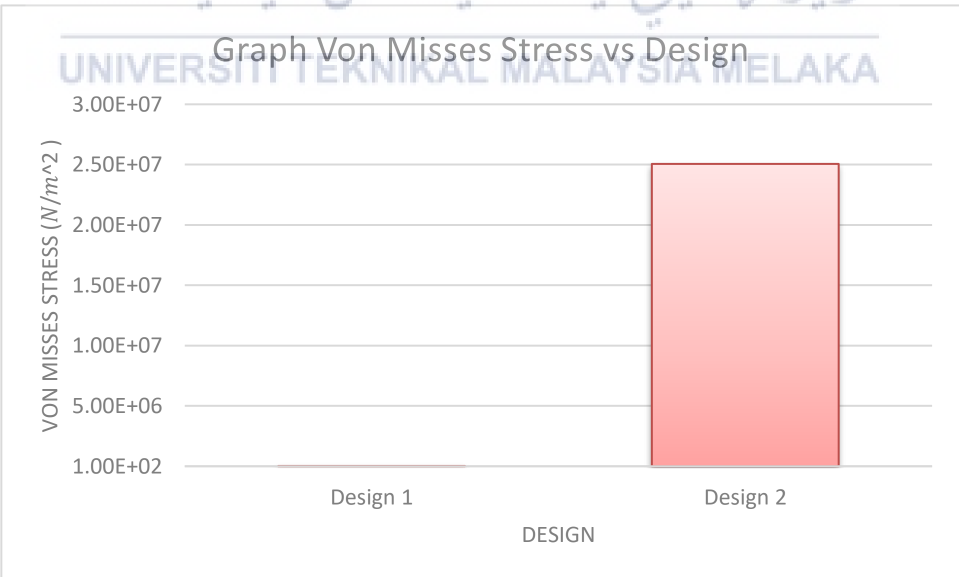


Figure 4.9: Comparison of Misses Stress Between Two Designs

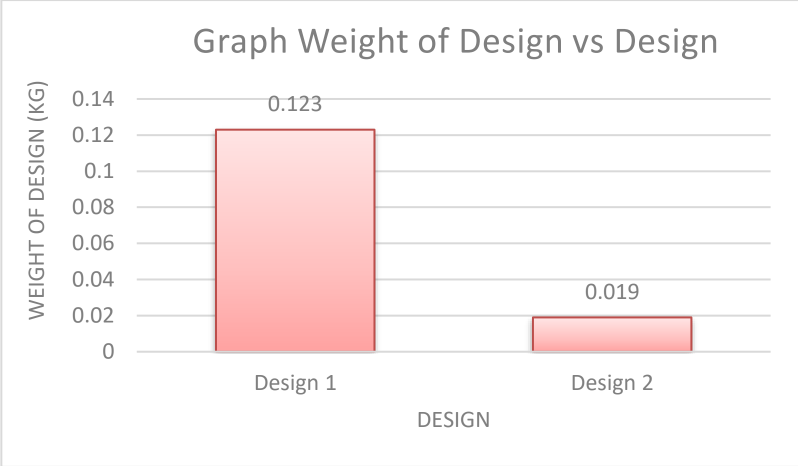


Figure 4.10: Comparison of Weight Between Two Design

From Figure 4.9 and 4.10, the analysis shows that Design 2 was the most suitable and safe structure to be used. Based on its von misses stress, balsa wood will undergo elastic deformation when subjected to stress below its yield strength. Elastic deformation is reversible, meaning that the material returns to its original shape once the stress is removed. Having the most lightweight structure helped it to exhibis a high strength-to-weight ratio, meaning it provides good structural strength relative to its low weight. This can contribute to achieving the desired balance between structural integrity and weight efficiency.

4.6 Test Flight

The prototype built for the flying test in this project is smaller than the anticipated final design, posing challenges to its buoyancy and overall performance. The undersized prototype struggles to stay afloat due to the insufficient buoyant force generated by its scaled-down dimensions, hindering its ability to counteract its weight effectively. This underscores the intricate nature of scaling down a design, affecting crucial aspects such as structural integrity, weight distribution, and aerodynamics. Unfortunately, due to the prototype's size, the last recorded flight test data cannot be displayed. These observations emphasize the need for careful considerations in scaling down designs to ensure the successful translation of intended functionalities and performance from prototype to final product. Figures below show some of the process on building the prototype of airship.

Figure 4.11: Structure of Internal Structure

Figure 4.12: Installing Envelope Material (Mylar Safety Blanket)

Figure 4.13: Full Airship Prototype

Figure 4.14: Weight of Prototype (22g)

Figure 4.15: Side View of the Airship

4.7 Summary

Based on the design optimization and analysis, it shows that the new RC airship design can be used. However, the small prototype demonstrates the technical difficulties in reducing designs for lightweight remote-controlled airships through flight testing. The necessity of careful size reduction that takes structural integrity, weight distribution, and aerodynamics into account is highlighted by buoyancy issues. Important lessons learned from this testing phase highlight how development is iterative and requires revisions to optimize buoyancy systems and material selections. Size constraints prevent the presentation of the most recent flight test data, which emphasizes how crucial it is to improve data recording systems for smaller-scale prototypes. These findings direct future tactics, directing attention toward overcoming obstacles relating to size and honing the airship design for improved performance and stability in later generations.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

In this project, an autonomous lighter-than-air platform was designed and constructed for the purpose of allowing a longer flight times which is ideal for capturing high-quality images or videos for surveillance, filmmaking, or aerial mapping. Optimizing a lightweight RC airship presents a multifaceted advantage across diverse applications. Through the integration of CAD and FEA analysis, this process ensures precise design, structural integrity, and material optimization. CAD facilitates intricate detailing for aerodynamic efficiency and performance enhancement, while FEA simulations identify stress points and enable reinforcement for improved durability without compromising weight. This iterative approach saves time and resources by preemptively addressing flaws or enhancements before physical prototyping. Ultimately, the culmination of these techniques yields an optimized airship that offers superior performance, extended flight times, increased payload capacity, and enhanced maneuverability, catering to a wide array of purposes from surveillance and scientific research to educational endeavors and logistical applications. The integration of CAD and FEA techniques in designing an RC airship enables a comprehensive, iterative approach that maximizes performance while minimizing weight, ultimately resulting in an optimized, high-performing aerial vehicle.

5.2 Recommendations

5.2.1 Advanced Materials Exploration

Investigate and integrate cutting-edge lightweight materials that offer enhanced strength-to-weight ratios. Research in materials science continues to evolve, presenting opportunities for using advanced composites, nanomaterials, or aerogels that could further reduce weight without compromising structural integrity.

5.2.2 Computational Advancement

Leverage advancements in computational methods and simulations beyond FEA. Explore machine learning algorithms for predictive modeling or optimizing aerodynamic shapes. Utilize AI-driven design tools to rapidly iterate and explore a broader range of design possibilities.

5.2.3 Environmental Considerations

Emphasize environmental sustainability by focusing on eco-friendly materials, energy-efficient systems, and minimizing the ecological footprint of airship production and operation.

5.3 Project Potential

The proposed project involves designing and implementing an adaptive modular payload system for lightweight RC airships. This system aims to create a versatile platform capable of seamlessly integrating and switching between various payloads, including cameras, sensors, and cargo modules, catering to diverse missions such as aerial photography, environmental monitoring, cargo delivery, and research. The project focuses on developing modular components, an automated interface for payload recognition, enhanced control systems, and user-friendly interfaces to enable quick configuration changes, ensuring efficiency, adaptability, and scalability for future advancements in aerial technology.

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APPENDICES

Appendix A: Gantt Chart for PSM 1

NO	Project Activities	Plan vs Actual Plan	March			April			May					June			July
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	PSM BRIEFING	Plan						MID-TERM BREAK										
		Actual																
2	Chapter 2: Literature Review	Plan																
		Actual																
3	PSM: Workshop	Plan																
		Actual																
4	Chapter 1: Introduction	Plan																
		Actual																
5	Chapter 3: Methodology	Plan																
		Actual																
6	Chapter 4: Preliminary Result	Plan																
		Actual																
7	Formatting and Grammar Improvement	Plan																
		Actual																
8	Slide Presentation	Plan																
		Actual																
9	Final Improvement	Plan																
		Actual																
10	Final Presentation	Plan																
		Actual																
11	Report Submission	Plan																
		Actual																

Appendix B: Gantt Chart for PSM 2

NO	Project Activities	Plan vs Actual Plan	October				November			December					January			
		Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	PSM 2 BRIEFING	Plan								MID-TERM BREAK								
		Actual																
2	Chapter 4: Result And Discussion	Plan																
		Actual																
3	Chapter 5: Conclusion	Plan																
		Actual																
4	Formatting And Grammar Improvement	Plan																
		Actual																
5	Poster Preparation	Plan																
		Actual																
6	Final Improvement	Plan																
		Actual																
7	Report Submission	Plan																
		Actual																
8	Thesis Summary	Plan																
		Actual																
9	Final Presentation	Plan																
		Actual																

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Puan

PENGKELASAN TESIS SEBAGAI TERHAD BAGI TESIS PROJEK SARJANA MUDA

Dengan segala hormatnya merujuk kepada perkara di atas.

2. Dengan ini, dimaklumkan permohonan pengkelasan tesis yang dilampirkan sebagai TERHAD untuk tempoh **LIMA** tahun dari tarikh surat ini. Butiran lanjut laporan PSM tersebut adalah seperti berikut:

Nama pelajar: NURULNATASHA BINTI ANUAR (B092010018)
Tajuk Tesis: DESIGN AND OPTIMIZATION OF A LIGHTWEIGHT RC AIRSHIP STRUCTURE USING CAD AND FEA.

3. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"
"KOMPETENSI TERAS KEGEMILANGAN"

Saya yang menjalankan amanah,

MUHAMMED NOOR BIN HASHIM
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