Design and Fabrication of Mechanized Automobile Jack

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Certification

This is to certify that **Abdullah Bin Abdul Qayyum Satti** (**19-ME-13), Chaudhary Muhammad Areeb (19-ME-28), Muhammad Abdullah (19-ME-102)** and **Muhammad Junaid Khan** (**19-ME-116)** have successfully completed the final project **Design and Fabrication of Mechanized Automobile Jack,** at the **University of Engineering and Technology, Taxila**, to fulfill the partial requirement of the degree **BSc Mechanical Engineering.**

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Design and Fabrication of Mechanized Automobile Jack

Sustainable Development Goals

SDG No	Description of SDG	SDG No	Description of SDG
SDG 1	No Poverty	SDG 9 ✓	Industry, Innovation, and Infrastructure
SDG 2	Zero Hunger	SDG 10	Reduced Inequalities
SDG 3	Good Health and Well Being	SDG 11	Sustainable Cities and Communities
SDG 4	Quality Education	SDG 12 ✓	Responsible Consumption and Production
SDG 5	Gender Equality	SDG 13	Climate Change
SDG 6	Clean Water and Sanitation	SDG 14	Life Below Water
SDG 7	Affordable and Clean Energy	SDG 15	Life on Land
SDG 8	Decent Work and Economic Growth	SDG 16	Peace, Justice and Strong Institutions
		SDG 17	Partnerships for the Goals

Range of Complex Problem Solving

	Attribute	**Complex Problem**	
1	Range of conflicting requirements	Involve wide-ranging or conflicting technical, engineering and other issues.	
2	Depth of analysis required	Have no obvious solution and require abstract thinking, originality in analysis to formulate suitable models.	
3	Depth of knowledge required	Requires research-based knowledge much of which is at, or informed by, the forefront of the professional discipline and which allows a fundamentals-based, first principles analytical approach.	
4	Familiarity of issues	Involve infrequently encountered issues	
5	Extent of applicable codes	Are outside problems encompassed by standards and codes of practice for professional engineering.	
6	Extent of stakeholder involvement and level of conflicting requirements	Involve diverse groups of stakeholders with widely varying needs.	
7	Consequences	Have significant consequences in a range of contexts.	
8	Interdependence	Are high level problems including many component parts or sub-problems	

Range of Complex Problem Activities

	Attribute	**Complex Activities**	
1	Range of resources	Involve the use of diverse resources (and for this purpose, resources include people, money, equipment, materials, information and technologies).	
2	Level of interaction	Require resolution of significant problems arising from interactions between wide ranging and conflicting technical, engineering or other issues.	
3	Innovation	Involve creative use of engineering principles and research-based knowledge in novel ways.	
4	Consequences to society and the environment	Have significant consequences in a range of contexts, characterized by difficulty of prediction and mitigation.	
5	Familiarity	Can extend beyond previous experiences by applying principles-based approaches.	

Abstract

Design and Fabrication of Mechanized Automobile Jack

The present study aims to design, fabricate, and analyse a mechanized automobile jack using screw mechanism that offers significant advantages over traditional manual jacks, including improved safety, efficiency, and reliability. The problem in the market is the limited availability of efficient and safe lifting jacks for heavy SUVs, especially those requiring manual efforts. The mechanized automobile jack improves safety by reducing physical strain and offering controlled lifting. It enhances efficiency with faster operation and consistent performance. Its reliability is ensured through structural integrity and built-in safety features compared to manual jacks. The mechanism involves the usage of electrical actuation that is operated with the battery. The designing part has been done using SolidWorks software while the load calculations are calculated numerically and verified experimentally. The desired requirements are met by using the manufacturing techniques involving machining. The final product is tested and evaluated to ensure its performance and durability. Its ability to lift heavy loads with ease while reducing the risk of injury makes it an ideal solution for various applications. It’s a new solution for risky event handling that has achieved a load capacity of nearly 2 tons in comparison to the already available, unreliable automatic jacks present in the market. In the future, the mechanized automobile jack can be further optimized for higher load capacities to accommodate larger SUVs and offer increased versatility in material transport applications.

Keywords: Automobile, Screw Jack, Material Handling, Heavy Loads, Incorporating Technology, Mechanized jack, Lifting Loads.

Undertaking

We certify that the final year project titled "Design and Fabrication of Mechanized Automobile Jack" is our own work and has not been submitted elsewhere for assessment. Proper acknowledgments have been made for any material used from other sources.

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NOMENCLATURE

Abbreviation

CNC	Computerized Numeric Control
DC	Direct Current
EN8	Unalloyed Medium Carbon Steel
IOT	Internet of Things
SUV	Sport utility vehicle

Greek Symbol

α	Helix angle
μ	Coefficient of friction
ø	Friction angle

CHAPTER 1

Introduction

Motorized screw jacks have long been regarded as an invaluable tool for those who require an efficient and effortless means of lifting and lowering heavy loads. Operating on the fundamental principle of converting rotary motion into linear motion, these devices consist of a screw and nut mechanism, whereby rotation of the screw results in the movement of the nut along the thread, inducing linear displacement.

The design and operating mechanisms of motorized screw jacks are dependent on various factors such as the load capacity, speed, and efficiency requisite for a given application. The load capacity of a motorized screw jack, for instance, is a function of factors such as the diameter of the screw, the pitch of the thread, and the nature of the screw and nut materials. In a similar vein, the speed and efficiency of these devices are determined by the speed and power of the motor, the pitch of the thread, and the level of friction between the screw and the nut.

The selection of materials and components constitutes a critical aspect of motorized screw jack design. The screw and nut components, for instance, must be fashioned from materials with high load bearing capacity to withstand the stresses generated during operation. Similarly, the motor must be selected based on the requisite torque and speed to ensure optimal performance. The coupling between the motor and the screw must also be designed with efficiency and reliability in mind to ensure seamless power transfer.

This report provides an exhaustive account of the design process, detailing the selection of materials and components, the assembly process, and the testing regime. The results of the performance tests will be presented, with an emphasis on analyzing the factors that influence the performance of the screw jack. The report will also discuss the manifold applications of motorized screw jacks across various industries and outline potential avenues for future research in this area.

1.1 Problem Statement

The growing demand for efficient and accurate heavy-duty lifting equipment has brought to light the requirement for the advancement of mechanized automobile jacks. Despite the prevalent usage of conventional manual screw jacks, they suffer from several shortcomings, such as manual labor, a slow speed of operation, and the possibility of human error. The need for a solution that overcomes these limitations and provides a safer and more efficient approach to heavy-duty lifting applications has become imperative. The challenge lies in designing and fabricating a motorized screw jack that leverages the latest advancements in the field of heavy-duty lifting equipment and meets the demands of the intended application with precision, reliability, and safety.

1.2 Aim and Objectives

The main aim of this study is to develop a mechanized automobile jack that enables female individuals and teenagers to lift vehicles with ease and without the need for manual labor.

The basic objectives of the project are:

- To conduct a comprehensive analysis of the requirements and specifications for the intended application of the mechanized automobile jack.
- To engineer a control system that prioritizes safety and efficiency in the lifting process.

- To assemble the mechanized automobile jack and undertake rigorous testing to ensure its performance and dependability.
- To assess the overall design and functioning of the mechanized automobile jack and identify potential areas for enhancement.
- To provide insightful recommendations for the future advancements and utilization of mechanized automobile jacks in heavy-duty lifting applications.

1.3 Advantages

Following are the advantages of Mechanized Automobile Jack:

1. *Increased Operational Efficiency*: The use of a mechanized automobile jack results in a substantial increase in operational efficiency, allowing for faster and smoother lifting of heavy loads.
2. *Precision Positioning:* With the ability to precisely control the mechanized automobile jack, it is possible to attain accurate positioning of the load, thereby reducing the risk of damage to both the equipment and the load itself.
3. *Reduced Physical Demands:* It eliminates the need for manual labor, thereby reducing the physical demands placed on the operator during heavy-duty lifting.
4. *Enhanced Safety:* It can be operated from a safe distance, thus reducing the risk of injury to the operator, and increasing overall safety during the lifting process.
5. *Improved Control:* It can be controlled through a remote or an automated control system, providing the operator with greater control over the lifting process and increasing accuracy.

6. *Dependable Operation:* The consistent operation of the mechanized automobile jack reduces the risk of human error, thereby increasing reliability and dependability during heavy-duty lifting.

1.4 Disadvantages and Limitations

Following are the disadvantages and limitations of Mechanized Automobile Jack:

1. *Higher Cost:* The cost of a mechanized automobile jack is generally higher than that of a manual screw jack, making it a less economical choice for some users.
2. *Dependence on Power Supply:* It requires an external power source to operate, limiting its use in areas without electrical power.
3. *Maintenance Requirements:* It requires regular maintenance to ensure optimal performance and longevity, which can add to the overall cost of ownership.
4. *Limited Load Capacity:* The load capacity of a mechanized automobile jack may be limited compared to that of a manual screw jack, making it unsuitable for extremely heavy loads.
5. *Complexity:* The mechanized automobile jack is more complex in design and operation compared to a manual screw jack, which can make it less accessible for some users.
6. *Vulnerability to Power Outages*: In the event of a power outage, the mechanized automobile jack may be rendered inoperable, limiting its ability to perform heavy-duty lifting.
7. *Noise:* It may generate a significant amount of noise during operation, which can be an issue in quiet or residential areas.

1.5 Future Recommendations

Future Recommendations for the Enhancement of Motorized Screw Jacks:

- Integration with Renewable Energy Sources: To overcome the dependency on a conventional power source, it is advisable to incorporate renewable energy sources, such as solar power, into the design of future motorized screw jacks.
- *Reduction of Noise Emissions:* To mitigate the disturbance caused by the operation of motorized screw jacks, future designs should strive to reduce the noise emissions generated during their use.
- *Integration with IoT Technologies*: The integration of Internet of Things (IoT) technologies into motorized screw jacks can provide real-time data on performance and usage, as well as enabling remote monitoring and control. This is a recommended avenue for future developments in this field.

1.6 Thesis Outline:

A succinct yet elegant outline of the thesis on the design and fabrication of a mechanized automobile jack could encompass the following aspects: an introduction, a comprehensive literature review, a meticulous methodology, a comprehensive presentation of results and analysis, a conclusive summary along with future recommendations, and an exhaustive list of references. The introduction would provide the backdrop and objective of the project, while the literature review would encapsulate existing research and advancements in the relevant field. The methodology section would elucidate the design and development procedures, along with the trials and experiments carried out. The results and analysis section would exhibit the outcomes of the project, and the conclusion and recommendations section would emphasize the import of the project and suggest areas for future advancements. The references section would encompass a thorough listing of all the sources consulted during the project.

CHAPTER 2

Literature Review

2.1 Introduction

Leonardo da Vinci, a prominent artist, inventor, and engineer of the early 1400s, was among the first individuals to demonstrate the practical use of a screw jack for lifting heavy loads. His design incorporated a threaded worm gear, supported on bearings, which rotated when a worm shaft was turned, driving a lifting screw that moved the load. This principle is still recognizable and in use today [1].

John Wilkinson was a notable inventor in mechanical engineering during the early 1800s. Recognizing the growing need for precision in industry, he understood that providing power alone was insufficient for efficient manufacturing. He and his contemporaries developed innovative technologies, such as lathes and planers, that enabled the production of precise and accurate components. Their contributions revolutionized manufacturing and continue to influence modern engineering practices [2].

In the early 1880s, Frank Henry Sleeper, a young inventor from Coaticook, designed a lifting jack based on the ball bearing principle. His innovative design utilized gearing and a screw to convert rotary motion into linear motion for moving heavy loads with precision and efficiency. Sleeper's lifting jack was a significant technological advancement that demonstrated his exceptional engineering skills and understanding of mechanical principles and remains a significant contribution to the field of mechanical engineering to this day [3].

In the early 1880s, Josiah Barrett, a Mississippi riverboat captain, conceived an innovative idea for a ratchet jack that would efficiently pull barges together to form a "tow" in Pittsburgh. His design, based on the lever and fulcrum principle, allowed for the safe and precise transportation of heavy loads on the Mississippi River. Barrett's ratchet jack was a significant contribution to the transportation industry and remains an important part of mechanical engineering history [2].

In the early 1880s, Arthur Osmore Norton recognized the potential of Frank Henry Sleeper's ball bearing-based lifting jack design and purchased the patent. The resulting "Norton" jack became a widely known and highly regarded tool, manufactured at plants in Boston, Coaticook, and Moline, Illinois. The Norton jack was an important innovation in mechanical engineering, combining ball bearing principles with gearing and a screw for efficient and reliable lifting. Norton's decision to purchase Sleeper's patent demonstrated his entrepreneurial spirit and recognition of innovation in mechanical design, resulting in a tool that remains highly respected and in use in the industry today [4].

2.2 Types of Auto Mobile Jacks

Screw Jack:

A scissor jack is a mechanical device designed to raise a vehicle gradually off the ground for maintenance or repair purposes. The name "scissor jack" is derived from its structure as shown in figure 2.1 below, which comprises diagonal metal pieces that expand or contract in a scissor-like manner. This type of jack is preferred due to its compactness when in the contracted position, making it easy to store and transport [5].

Figure 2.1: Screw Jack [1]

Moreover, scissor jacks are also known as screw jacks, given their utilization of a screw mechanism to lift the weight of the vehicle. Unlike other types of jacks, the screw mechanism is self-locking, ensuring that the jack remains secure under the weight of the vehicle. This safety feature makes scissor jacks a popular choice among mechanics and vehicle owners [6].

Floor Jack:

A floor jack is a specialized lifting device used in the automotive industry to raise vehicles for maintenance and repair purposes. This jack operates using a horizontal piston that applies force to the short end of a bell crank. The long arm of the bell crank provides the vertical motion that lifts the lifting pad, which is kept horizontal with a horizontal linkage. Castors and wheels are typically included in floor jacks, which allow compensation for the arc taken by the lifting pad during its vertical motion [6].

As shown in figure 2.2 below this unique mechanism provides a low profile when the jack is collapsed, enabling easy movement underneath the vehicle. Meanwhile, the significant extension capacity of the floor jack ensures that it can be used to lift even large vehicles effectively.

Figure 2.2: Floor Jack [6]

Bottle Jack:

The bottle jack is a type of hydraulic jack as shown in figure 2.3 used for lifting heavy objects or vehicles. Unlike other jacks that require manual actuation, the bottle jack uses compressed air, such as from a compressor, to power the hydraulic mechanism, making it more convenient and efficient to use [7].

With the elimination of manual actuation, the user saves considerable effort and time in lifting heavy loads. Additionally, some bottle jacks can also be operated manually in the absence of a compressed air source, retaining their functionality and versatility.

Figure 2.3: Hydraulic Jack [7]

Overall, the bottle jack's reliance on hydraulic power and compressed air makes it a reliable and effective tool in the automotive industry and other areas that require heavy lifting. Its ability to switch between manual and compressed air actuation provides additional flexibility, making it an excellent choice for those who value convenience and efficiency [8].

Farm Jacks:

The farm jack is a versatile tool that is used to lift and adjust heavy objects, particularly on farms or in automotive applications. The device shown in figure 2.4 is comprised of a long beam with several holes and adjustable clamps that can be secured with pins, allowing users to adjust the height of the jack to suit their specific needs. By attaching a lever to the clamps, the user can easily move them up or down, making it possible to lift or lower objects with ease.

Figure 2.4: Farm Jack [8]

One of the most common uses of a farm jack is to lift vehicles with high suspensions that would otherwise be difficult to access with a conventional jack. With its ability to adjust to different heights, the farm jack can be a valuable addition to any mechanic's toolkit, as it allows for easy and safe access to the underside of the vehicle for repairs and maintenance [9].

The design of the farm jack is simple, yet effective, with the adjustable clamps providing a secure hold on the beam, ensuring stability during use. The holes in the beam provide multiple options for adjusting the height of the jack, allowing it to accommodate a wide range of objects and applications. The lever used to adjust the clamps is also designed for ease of use, making it possible for a single person to operate the jack with minimal effort [10].

2.3 Categorization of cars based on their weights

Cars that are aimed to be lifted can be categorized according to their curb weights.

- Hatchbacks: < 1000 kgs

  e.g., Swift, Cultus etc.

- Sedans (B & C Segment): 800kgs – 1300 kgs

  e.g., Corolla, Civic, City, Proton etc.

- Sedans (A Segment): 1300kgs – 1800 kgs e.g., Accord, Sonata, Camry etc.

- Crossover SUVs: 1500kgs – 2000kgs

  e.g., Tucson, Sportage, HS etc.

- Pickup Trucks and SUVs: 1800kgs – 3000kgs

  e.g., Revo, Prado, V8 etc.

Categorizing car weights is important because it'll let us to be clearer about the aim of our specific product to get the best results from it [12].

2.4 Forms of Threads use in Screw Mechanism

Two of the most used thread types for power screws are square and I.S.O metric trapezoidal threads as shown in figure 2.5 below:

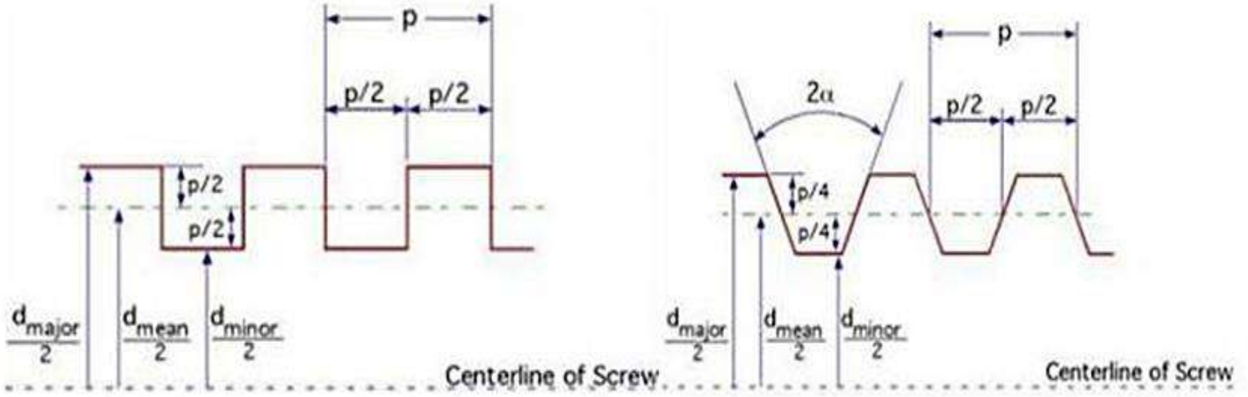


Figure 2.5: Forms of threads used in power screws [7]

2.4.1 Square Thread

A square thread is a type of thread form that boasts a unique square cross-section. This design element provides several key benefits, particularly in high load applications. The square shape offers a broad contact surface and a secure grip, ensuring a strong and stable connection. Additionally, the square thread form minimizes slippage and reduces friction, resulting in a more efficient mechanism for power transmission [13].

The manufacturing process for square threads is relatively simple, as they can be machined using a single point cutting tool. This cost-effective solution makes square threads a viable option for many applications [8].

2.4.2 Acme Thread

The Acme thread is a trapezoidal-shaped thread form that has been widely employed for a diverse range of applications. It is recognizable for its 29-degree included angle, a design feature that strikes a balance between strength and ease of production. This thread form is typically cut onto a cylindrical shaft and finds use in both power-driven and manual mechanisms, including lead screws, jacks, and clamps.

The versatility of the Acme thread is a significant advantage, making it a suitable solution for a variety of industries. Furthermore, the 29-degree included angle simplifies the manufacturing process, resulting in cost savings. The trapezoidal shape offers a robust and stable connection, making the Acme thread a viable option for high load applications [14].

However, it must be noted that the larger thread angle of the Acme thread results in reduced precision compared to other thread forms. Additionally, the wider thread form can lead to increased friction, which may reduce efficiency and require more power to operate.

2.5 Working Principle of Screw Jack:

The principal behind working a screw jack is to convert rotational motion into linear motion. The screw is an important part of the Screw jack, and its working is explained below.

Screw jacks are useful for lifting, holding, and positioning loads in various applications. These devices convert rotational motion into linear motion. The operating principle of a screw jack is like that of an inclined plane [15]. By considering a single pitch of the threads, we can apply the inclined plane equation as follows:

$$\text{Tan}\ (a) = P/\ \pi d$$

Where, 'a' represents the helix angle formed, 'P' is the thread pitch, and 'd' is the mean diameter.

CHAPTER 3

Methodology

The design and fabrication of a mechanized automobile jack is a meticulous and intricate process that demands a thorough comprehension of the principles of mechanical engineering and the latest advancements in the field of heavy-duty lifting equipment. A mechanized automobile jack is an indispensable device that is used to lift substantial loads with precision and accuracy, and its design and fabrication must consider several crucial elements, including safety, efficiency, and reliability.

3.1 Comprehensive Analysis

The initial phase of the design and fabrication process of a mechanized automobile jack entails a comprehensive analysis of the requirements of the intended application. The objective is to understand the state-of-the-art, identify any limitations, and determine the requirements for the proposed mechanized automobile jack. This evaluation must consider various critical factors, such as the weight of the load to be lifted, the height of lift required, the speed of operation, and the environmental conditions under which the device will be utilized. Based on this analysis, the mechanical components of the motorized screw jack, including the screw jack itself, the motor, the gearbox, and the control system, can be carefully chosen and designed.

3.1.1 Components Used

The components are used in designing the mechanized automobile jack and a brief introduction of each component is explained below.

Power Source: For a motor to rotate and properly carry out its operation, it needs a certain amount of power. The power needed for the DC motor will be provided from the car battery. A 12V socket which is present in every car these days will be used to connect the car battery with the motor. In the case of this project, we will directly connect a 12V battery with the motor using connecting wire but for Real-time application, the 12V socket will be used [16].

Arduino UNO and Relay Module: The current which flows from the power source to the motor is controlled by connecting a toggle switch between the source and the motor or either we can control it by using Bluetooth module and relay with combination of Arduino Uno as shown in figure 3.1. The relay module is responsible for starting and stopping the entire operation of the screw jack.

The mobile application serves as a pivotal tool in facilitating the regulation of the rotational movement of the motor. This, in turn, enables the manipulation of the screw jack in a bidirectional fashion, thereby influencing the upward and downward motion. The Bluetooth module works in tandem with the mobile app to affect this regulation, facilitating the seamless control of the screw jack.

Figure 3 1: Arduino UNO and Relay Module [16]

12V DC Motor: The 12V DC Motor receives its power supply from a source, which is regulated by a toggle switch. The toggle switch serves to regulate the direction of current flow within the motor, thereby influencing the behavior of the horseshoe electromagnet housed within the motor.

The electromagnet's orientation ultimately dictates the direction of rotation of the motor's shaft. In essence, this simple yet effective design facilitates the optimal functioning of the motor, enabling it to carry out its intended tasks with precision and reliability. To achieve this functionality, the 6-pin toggle switch employed in the project is appropriately wired, ensuring that the motor's direction of rotation is regulated in accordance with the requirements of the screw jack mechanism. Additionally, the motor as shown in figure 3.2, is linked to the connecting shaft, forming an integral component of the overall system [17].

Figure 3 2: DC Motor

3.2 Design Strategy

Based on the findings from the research and analysis phase, the next step is to develop a conceptual design for the mechanized automobile jack. This includes defining the specifications, determining the size and weight, and creating schematics and blueprints. The design should be based on the desired functionality, reliability, and safety of the product. Key considerations should be given to the type of motor to be used, the design of the screw mechanism, and the materials to be used in the construction. The design should also be optimized for ease of use, portability, and durability.

3.2.1 Design Calculations

2 Ton = 1813 kg

We assumed that half of the car's weight is distributed equally between the front and rear wheels. This ensures an adequate safety margin for the design, as the front wheels are responsible for steering, braking and traction. For safety reasons, we considered 1/3rd of the car’s weight for design.

So, we design Screw Jack for 680 kg mass,

$$W = mg = 680 * 9.81 \ = 6670N$$

For a 1.5 Ton capacity screw jack, the suitable screw is the one whose nominal (major) diameter is 12mm.

Corresponding to the nominal diameter of 12mm, the pitch (p) selected is 1.75 mm.

Core diameter $(d_c) = 10.25mm$

Mean diameter $(d_m) = 11.125mm$

EN8 material is used for lead screw. The ultimate and yield stresses are 450N/mm2 and 230N/mm2 respectively.

Compressive stresses induced in lead screw due to load of 1.5 Ton is given by:

$$F_c = \frac{W}{\frac{\pi}{4} d_c^2} = 80.873\, N/mm^2 \tag{3.1}$$

Safety Factor = 230/80.873 = 2.84

Hence lead screw will bear 1.5 Ton easily.

Helix angle of screw

$$\tan\boldsymbol{\alpha} = P/\ \pi.\ d\ m = 0.085 \tag{3.2}$$

Therefore, $\alpha = 4.91\ ^{0}$

Assuming coefficient of friction between screw and nut,

$$\mu = \tan ø = 0.14 \tag{3.3}$$

$ø = \tan -1(0.14) = 7.97\ ^{0}$

Since ø < e, hence it is a self-locking screw [18].

Turning moment required to rotate screw under design load is given by,

$$T = W\ (dm/2)\ \tan\ (\alpha+\varphi) \tag{3.4}$$

$= (6670)\ (11.125/2)\ \tan\ (4.91\ ^{0} +7.97\ ^{0}) =8.483$ Nm

Effort required to lift the weight,

$$P = W \tan(\alpha+\omega) \tag{3.5}$$

$$= 6670 \tan(4.91+7.97) = 1525\text{N}$$

Shear stress due to torque, $16T/(\pi dc^3)$ (3.6)

$$= (16\times7393)/\pi\ (10.25)\hat{}3$$

$$= 40.14\ \text{N/mm}^2$$

Direct stress is given by.

$$F_s = \frac{1}{2}\sqrt{(F_C^2 + 4F_t^2)} = 56.97\text{N/mm}^2 \tag{3.7}$$

EN8 (Screw material) has 155N/mm ^{2} shear strength.

Safety factor = 155/56.97 = 2.72

Screw Efficiency based on torque equation,

$$\varepsilon = \frac{tan\alpha}{\tan(\alpha+\varphi)} \tag{3.8}$$

$$= \frac{0.085}{\tan(4.91+7.97)} = 37.17\ \%$$

To Check Buckling of Screw

Maximum length of the screw above the nut when lifting the load is 100mm. [18]

$$\text{Radius of gyration } (K) = \frac{1}{4}d_c = \frac{1}{4}\times 10.25 = 2.56mm \tag{3.9}$$

$$\text{Area} = \frac{\pi d_c^2}{4} = 82.47 \text{ mm}^2 \tag{3.10}$$

L/K slenderness ratio = 100/2. 56 = 39.0625

3.2.2 Previous SolidWorks Model

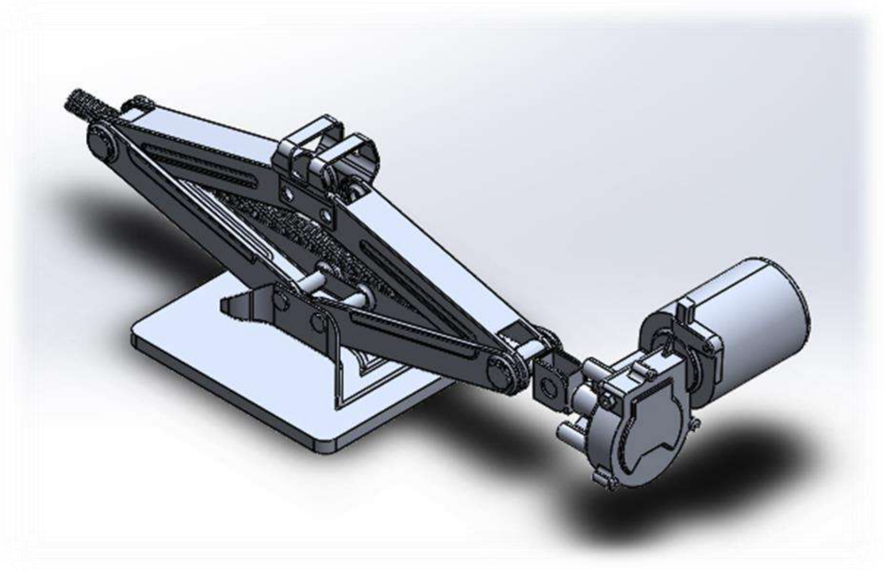


Figure 3 3: Isometric View of Previous Model

3.2.3 Final Design

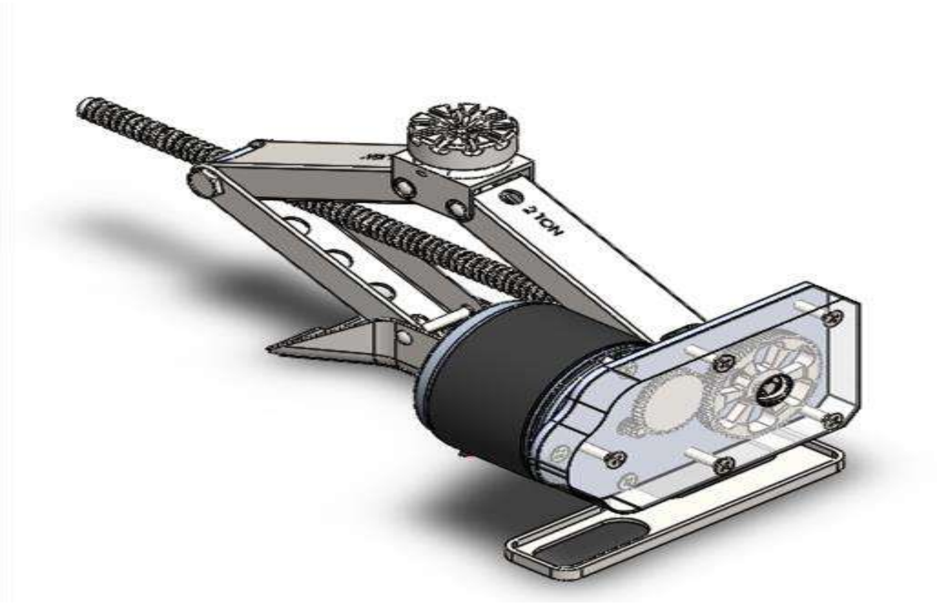


Figure 3 4: Isometric View of Final Design

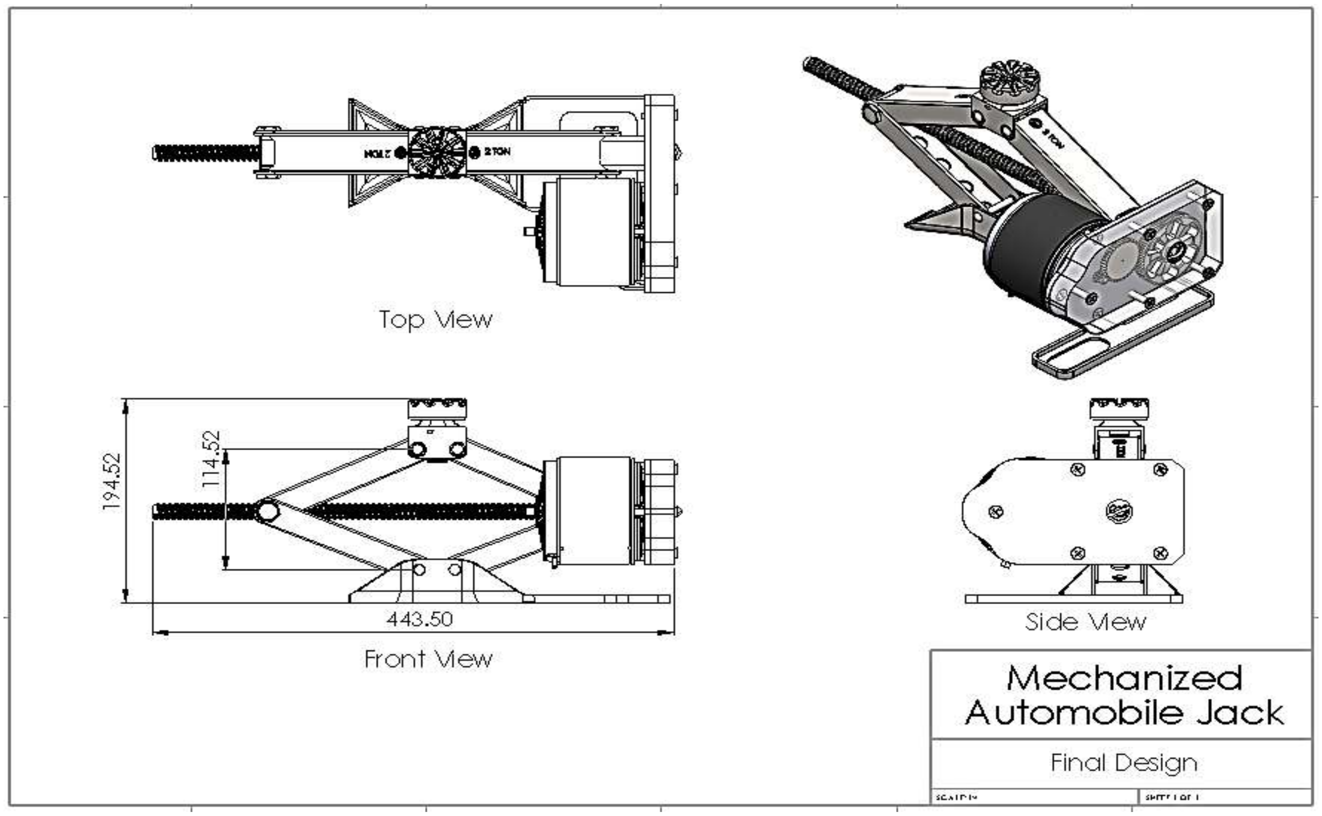
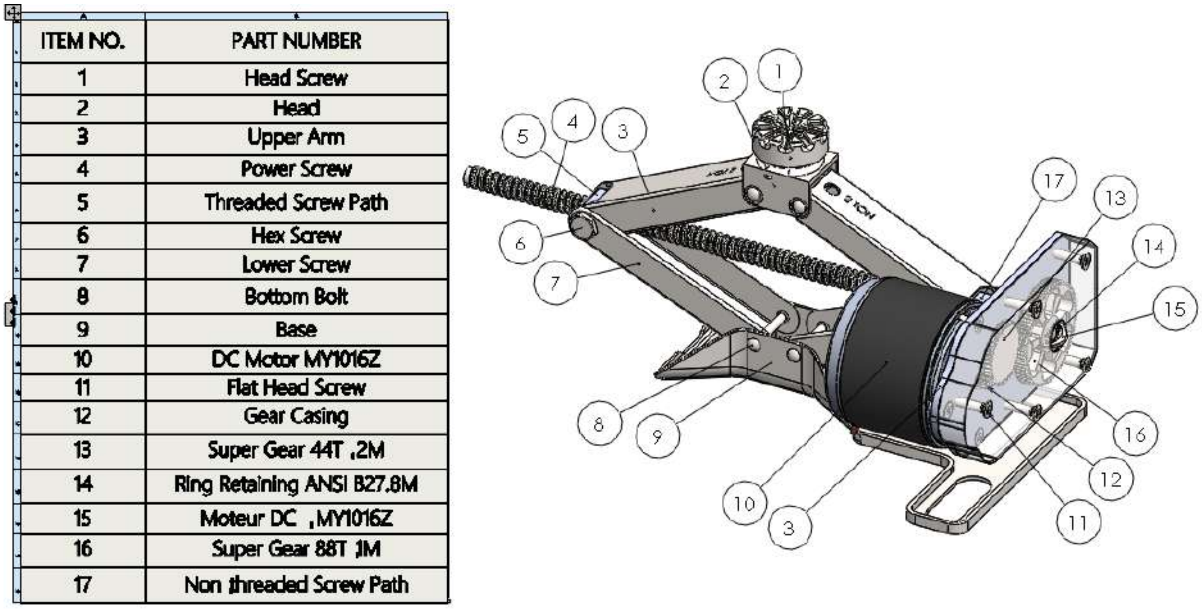


Figure 3 5: Third Angle Projection Drawing of Final Design

3.2.5 Assembly of Mechanized Automobile Jack

A mechanized automobile jack is a device with a crosshatch mechanism, like scissors, used for lifting a vehicle for repair or storage purposes. It works in a vertical manner and has a diamond-shaped configuration when closed. The power screw design of a common scissor jack reduces the amount of force required by the user. Most scissor jacks have four main members driven by a power screw. It is a reliable and efficient device that has revolutionized the automotive industry [4].



ITEM NO.	PART NUMBER
1	Head Screw
2	Head
3	Upper Arm
4	Power Screw
5	Threaded Screw Path
6	Hex Screw
7	Lower Screw
8	Bottom Bolt
9	Base
10	DC Motor MY1016Z
11	Flat Head Screw
12	Gear Casing
13	Super Gear 44T ,2M
14	Ring Retaining ANSI B27.8M
15	Moteur DC ,MY1016Z
16	Super Gear 88T ,1M
17	Non threaded Screw Path

Figure 3 6: Components used in Final Design

The scissor jack is a simple mechanical device designed to lift heavy loads, such as vehicles, with minimal effort. It is operated by turning a small crank, which is typically "Z" shaped and inserted into one end of the jack. The crank fits into a ring hole mounted on the end of the screw, which is the main component responsible for lifting the load.

From figure 3.6, as the crank is turned, the screw turns, and this motion raises the jack. The screw functions like a gear mechanism, with teeth (the screw thread) that engage and move the two arms of the scissor jack, producing work. Despite its straightforward design, the scissor jack can lift several thousand pounds of weight with relative ease.

It is worth noting that proper care and attention must be taken when using a scissor jack to ensure safe and effective operation. It is important to follow the manufacturer's instructions and guidelines, as well as any applicable safety regulations and precautions. By doing so, users can rely on this simple yet powerful tool to lift heavy loads safely and efficiently.

3.3 Control System Development

The next step in the design and fabrication process is to develop an appropriate control system for the mechanized automobile jack. This control system must be engineered to ensure the safety and efficiency of the lifting process and must also have the capability to monitor and control the device remotely if necessary.

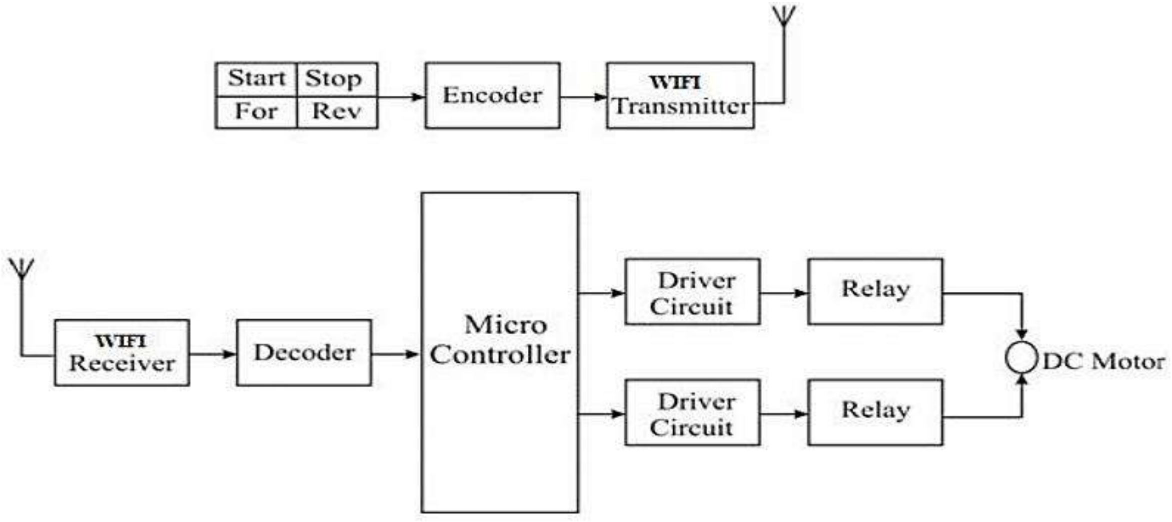


Figure 3 7: Block Diagram of Control System

This project consists of a driver circuit powered by a 12V battery, a microcontroller relay, an IOT app for remote control, a DC motor, and a screw jack model. The battery supplies power to all components once it is connected as shown by figure 3.7. The IOT app keypad is connected to a Node MCU ESP8266 microcontroller, which controls the operation of the mechanized automobile jack. The relay is directly connected to the DC motor. Pressing the start key on the remote causes the motor to operate in the forward direction, while pressing the stop key stops the motor automatically. The forward and reverse buttons on the remote are used to operate the motor in the required directions.

When a high pulse is given to the motor, it rotates in the clockwise direction, and a low pulse causes it to rotate in the anticlockwise direction. As a result, the worm gear rotates and enables the lead screw to rotate in both directions. [19]

3.4 Structural Analysis

Assume that the Scissor Jack is vertically symmetric as shown in figure 3.8 below:

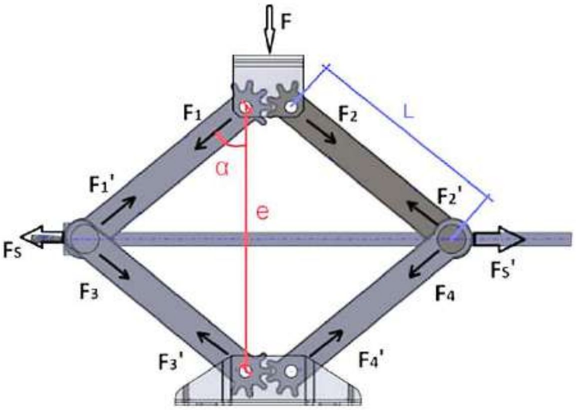


Figure 3 8: Forces in Scissor Jack [17]

length of the arm (from hole center to another hole) = L =140mm

Length from base hole center to top center = e = 170mm

$$Cos\alpha = \frac{e/2}{L} = \frac{170}{2}/140 = 0.607 \qquad (3.11)$$

$$\alpha = 52.6°$$

Now simplify the mechanism and make a free body diagram of top section as shown in figure 3.9 below and figure 3.10 shows the free body diagram of joint of shaft and arm.

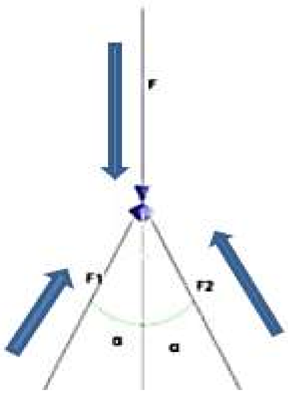


Figure 3 9: Free Body Diagram of Top Section

$$\sum F_x = 0$$

$$F_1 sin\alpha - F_2 sin\alpha = 0,$$

$$\Rightarrow F_1 = F_2 \tag{3.12}$$

$$\sum F_y = 0$$

$$F_1 cos\alpha + F_2 cos\alpha - F = 0,$$

$$\Rightarrow F_1 = \frac{F}{2cos\alpha} \tag{3.13}$$

$$F_1 = F_2 = 5490\,N$$

At the maximum height of the jack's lifting capability, there is a reduction in the angle, resulting in a decrease of the maximum force that can be applied. As a result, it is necessary to analyze the design stresses at the point of minimum raising height where the maximum loading force is expected to act.

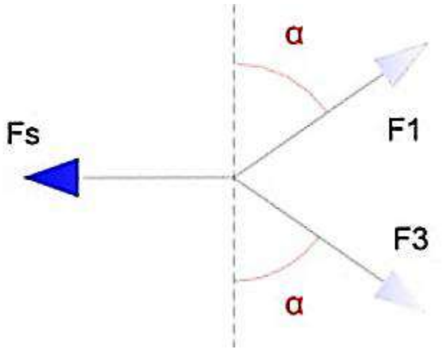


Figure 3 10: Free Body Diagram of the joint of Shaft and arms

$$\sum F_y = 0$$

$$F_1 cos\alpha - F_3 cos\alpha = 0, \Rightarrow F_1 = F_3 \tag{3.14}$$

$$\sum F_x = 0$$

$$F_1 sin\alpha + F_3 sin\alpha - F_s = 0, \Rightarrow F_s = 2F_1 sin\alpha \tag{3.15}$$

$$F_s = 8757\ N$$

We can say that,

$$|F_1| = |F_2| = |F_3| = |F_4| \tag{3.16}$$

because of symmetry.

3.4.1 Design and Analysis for Individual Parts

The structural analysis of the mechanized automobile jack was conducted to assess the integrity and performance of its individual components. This section presents the findings obtained from the analysis, including stress distribution, deformation, and safety factors. The analysis was carried out using Ansys software, with the purpose of validating the design and ensuring that it meets the required structural criteria.

The structural analysis was performed in a step-by-step process. First, the SolidWorks CAD model of the jack was imported into Ansys for further analysis. Each component, including the base, head, arm, and other critical parts, was isolated and analyzed separately to determine their respective stress levels. The material properties of carbon steel were applied to the components for accurate simulation. Boundary conditions, such as fixed supports and applied loads, were defined based on real-world operating conditions.

HEAD

In the structural analysis of the head component of the mechanized automobile jack, a compressive force of 6670N was applied. The head was modeled with fixed boundary conditions at the assigned holes, simulating its connection to other components. The material assigned to the head was carbon steel 1020 annealed, which has a Young's modulus of 212,000 MPa and a Poisson's ratio of 0.29.

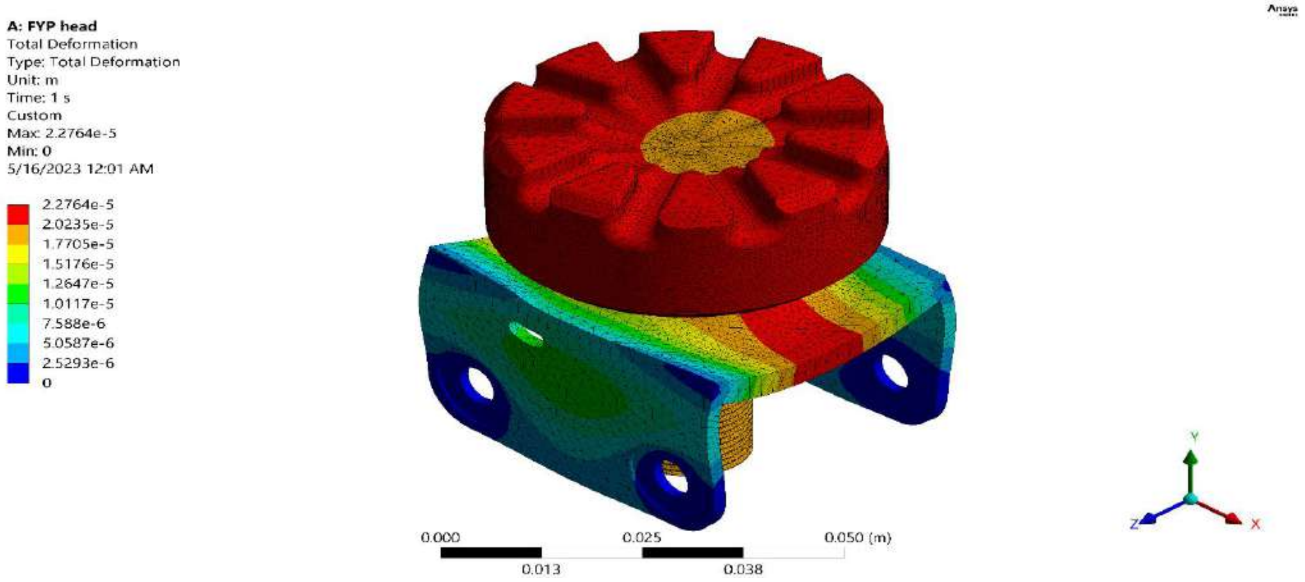


Figure 3 11: Maximum deformation in Head Support

The analysis results indicate that the head experiences a maximum deformation of 0.0227 mm as shown in figure 3.11, under the applied load. This deformation is within acceptable limits, indicating that the head retains its shape and structural integrity without excessive distortion or failure.

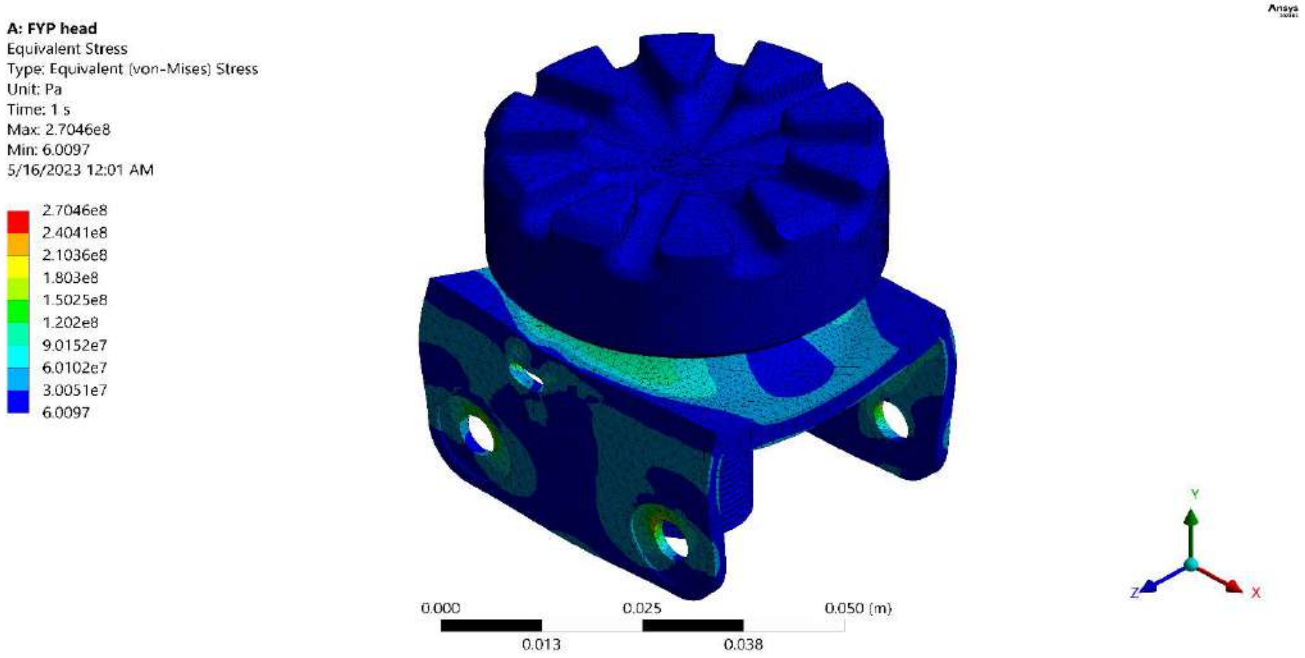


Figure 3 12: Maximum Stress in Head Support

Furthermore, the maximum Von Mises stress observed in figure 3,.12 is 270 MPa. This stress level is below the yield strength of the carbon steel material, ensuring that the head can withstand the compressive force without experiencing permanent deformation or failure.

UPPER ARM

In the structural analysis of the upper arm component of the mechanized automobile jack, an axial force of 5490N was applied at the upper holes section. The lower holes were assigned as fixed supports, simulating their connection to other components. The upper arm was also made of carbon steel 1020 annealed, with a Young's modulus of 212,000 MPa and a Poisson's ratio of 0.29.

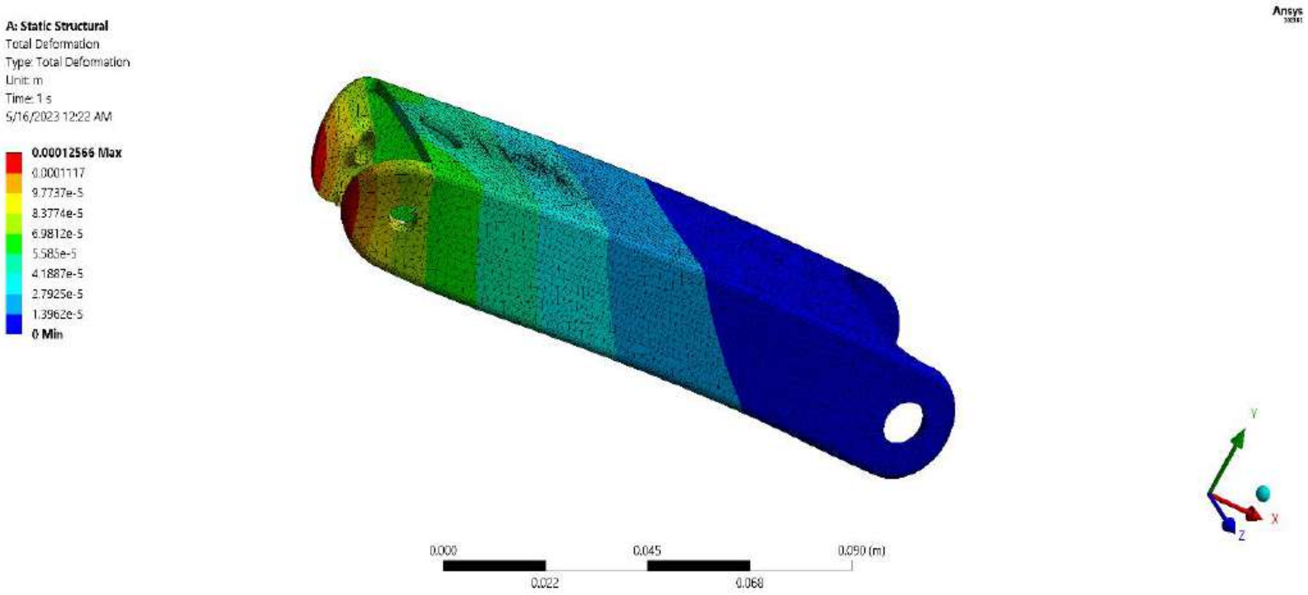


Figure 3 13: Maximum deformation in Upper Arm

The analysis results shows in figure 3.13 above indicate that the upper arm experiences a maximum deformation of 0.125 mm under the applied axial force. This deformation is within acceptable limits, indicating that the upper arm retains its shape and structural integrity without excessive elongation or deformation.

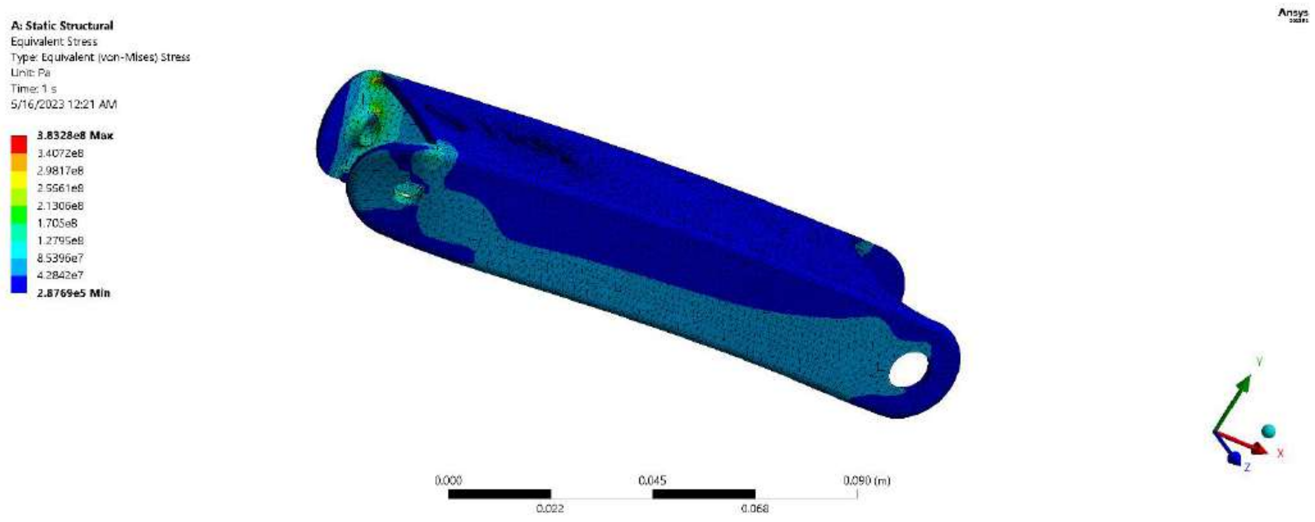


Figure 3 14: Maximum Stress in Upper Arm

Furthermore, the maximum stress observed in figure 3.14 above is 383 MPa. This stress level is below the yield strength of the carbon steel material, ensuring that the upper arm can withstand the axial force without experiencing plastic deformation or failure.

POWER SCREW

Analysis 1:

In the structural analysis of the power screw component of the mechanized automobile jack, an axial tensile force of 8757N was applied. The free end of the screw was subjected to this force, while the top face was assigned a fixed support. The material used for the power screw was carbon steel 1020 annealed, with a Young's modulus of 212,000 MPa and a Poisson's ratio of 0.29.

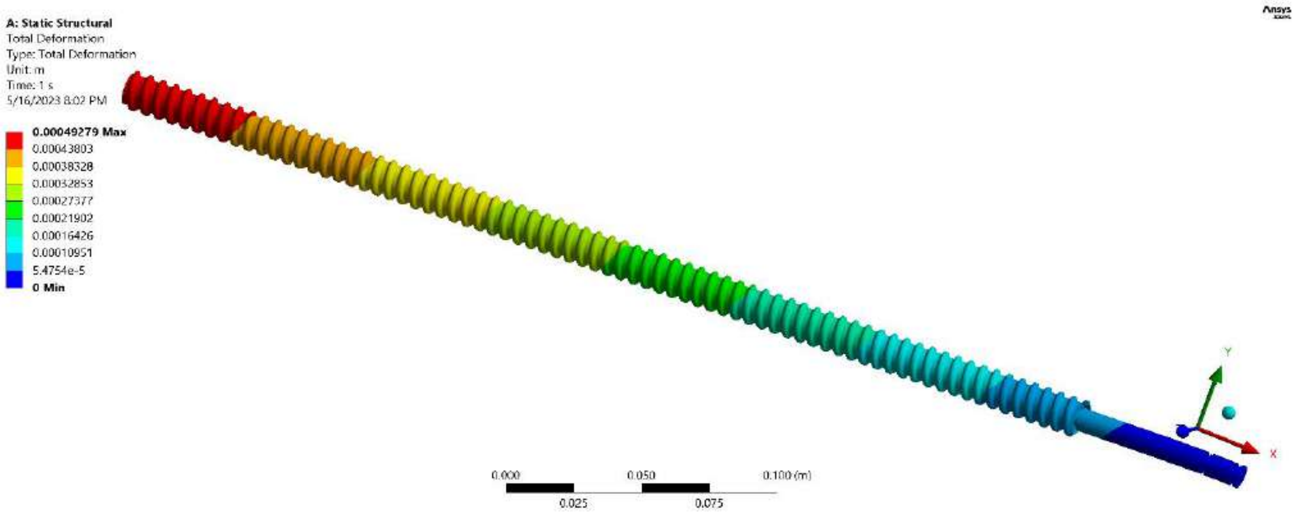


Figure 3 15: Maximum deformation in Power Screw

The analysis results as shown in figure 3.15 reveals that the power screw experiences a maximum deformation of 0.56 mm under the applied tensile force. This deformation is within acceptable limits, indicating that the screw maintains its shape and structural integrity without excessive elongation.

Furthermore, the maximum stress observed in the power screw is 458 MPa. This stress level is below the yield strength of the carbon steel material, demonstrating that the screw can withstand the tensile force without experiencing plastic deformation or failure.

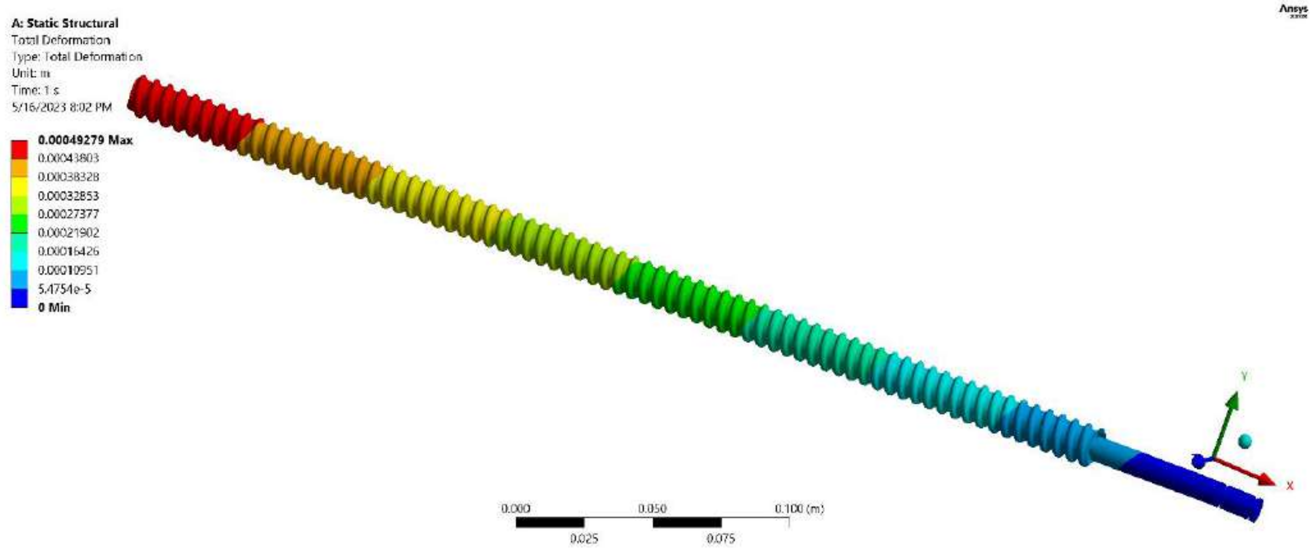


Figure 3 16: Maximum Stress in Power Screw

Analysis 2:

In the analysis of the power screw focusing on torsional stresses, we considered the maximum torque that a human can apply, which is approximately 5.64 Nm. This torque was applied to the head of the shaft or power screw. Additionally, a fixed hinge restraint was applied at the midpoint, while a fixed support boundary condition was applied at the joint with the threaded screw path.

The analysis results indicate that the maximum deformation and stress occur at the head of the shaft. This finding is crucial as it highlights the area of concern that needs to be addressed in the new design. It also explains why the initial design failed to withstand the weight of larger vehicles, such as SUVs.

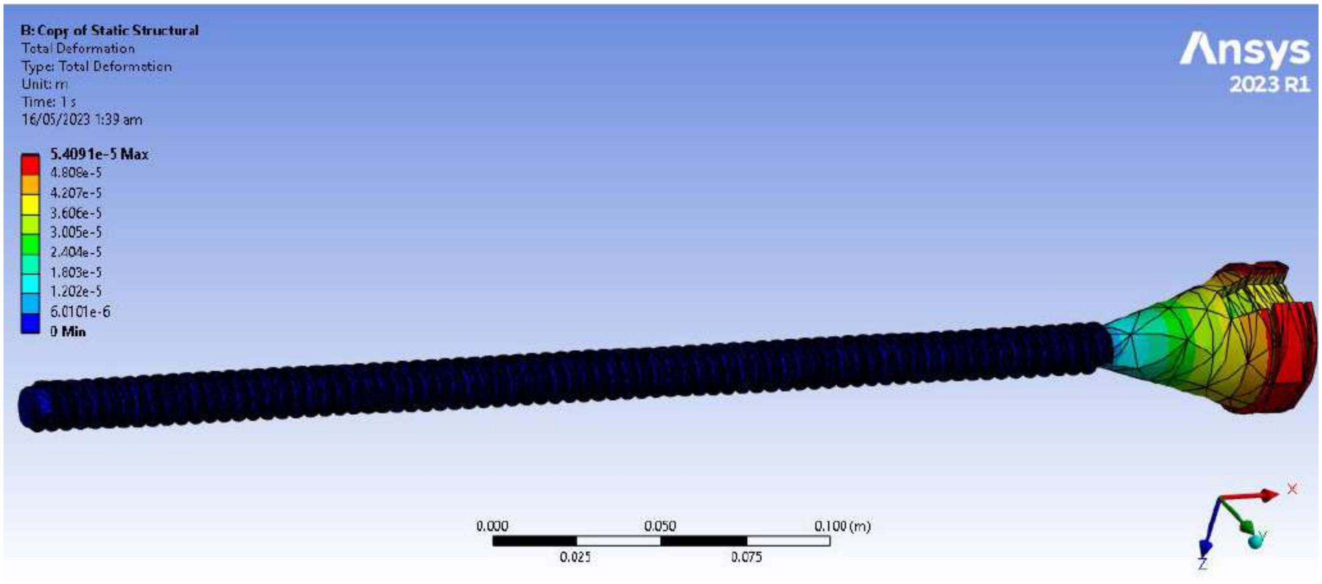


Figure 3 17: Maximum Deformation due to Torque in power Screw

The results show a maximum deformation of 0.054 mm as shown in figure 3.17 above, which indicates a limited amount of displacement within acceptable limits.

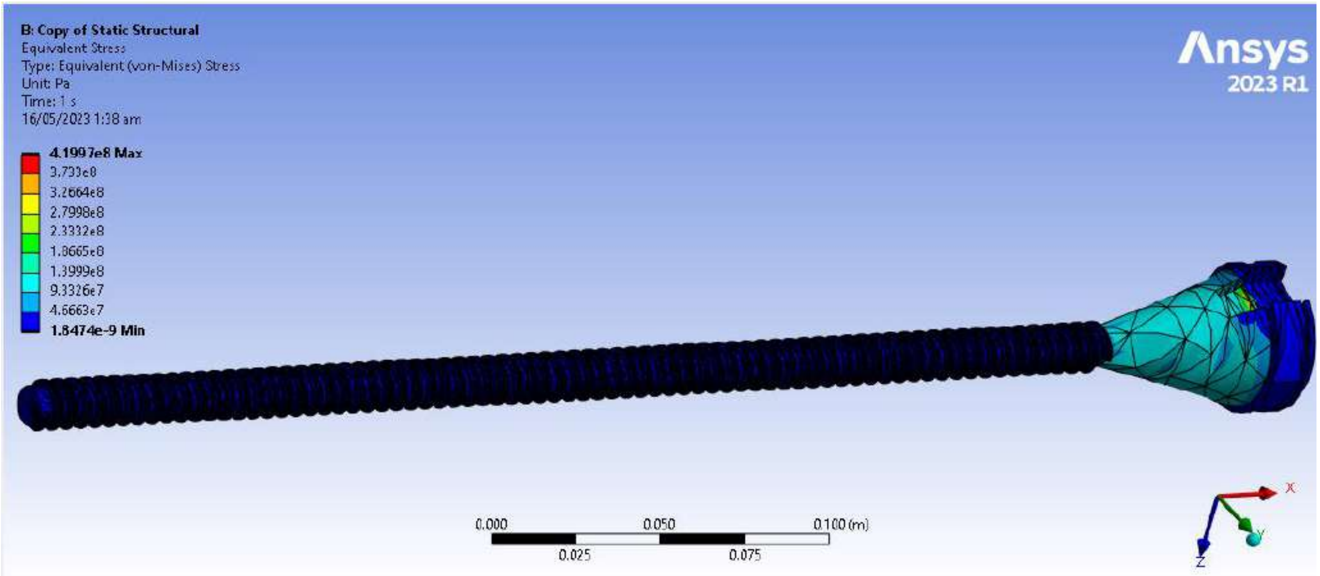


Figure 3 18: Maximum Stress due to Torque in power Screw

Furthermore, the maximum stress observed in figure 3.18, is 419 MPa, which is below the yield strength of the material. This suggests that the power screw can withstand the applied torque without experiencing plastic deformation or failure.

These results highlight the importance of considering torsional stresses in the design of the power screw. The new design, which overcomes the limitations of the previous design, addresses the high stresses observed at the head of the shaft. This knowledge will help in refining the design to ensure that it can effectively withstand the torque and weight requirements of larger vehicles, ensuring the overall structural integrity and reliability of the mechanized automobile jack.

BASE

In the structural analysis of the base component of the mechanized automobile jack, a compressive force of 5490N was applied at the holes corresponding to the lower lifting arms. The bottom face of the base was assigned a fixed support boundary condition, simulating its connection to the ground, or supporting surface.

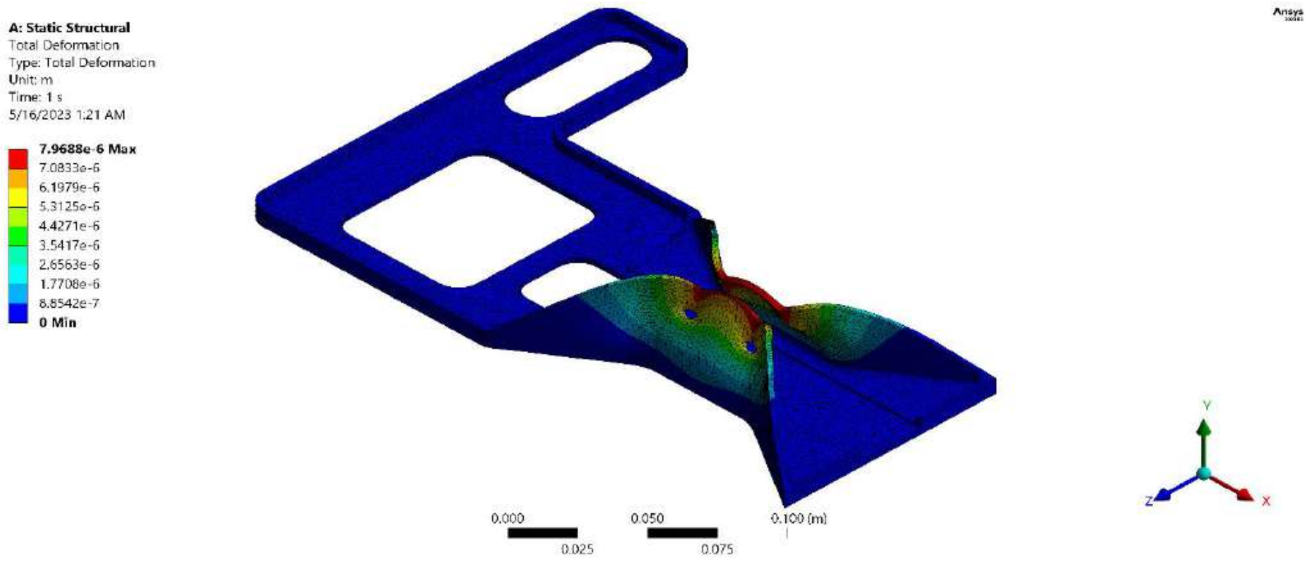


Figure 3 19: Maximum Deformation in Base Plate

The analysis results as shown in figure 3.19 above indicate that the maximum deformation observed in the base is 0.0079 mm under the applied compressive force. This deformation is within acceptable limits, suggesting that the base retains its shape and structural integrity without significant distortion or failure.

Furthermore, the maximum stress observed in the base is 79 MPa as shown in figure 3.20 below. This stress level is well below the yield strength of the carbon steel material, indicating that the base can withstand the applied compressive force without experiencing plastic deformation or failure.

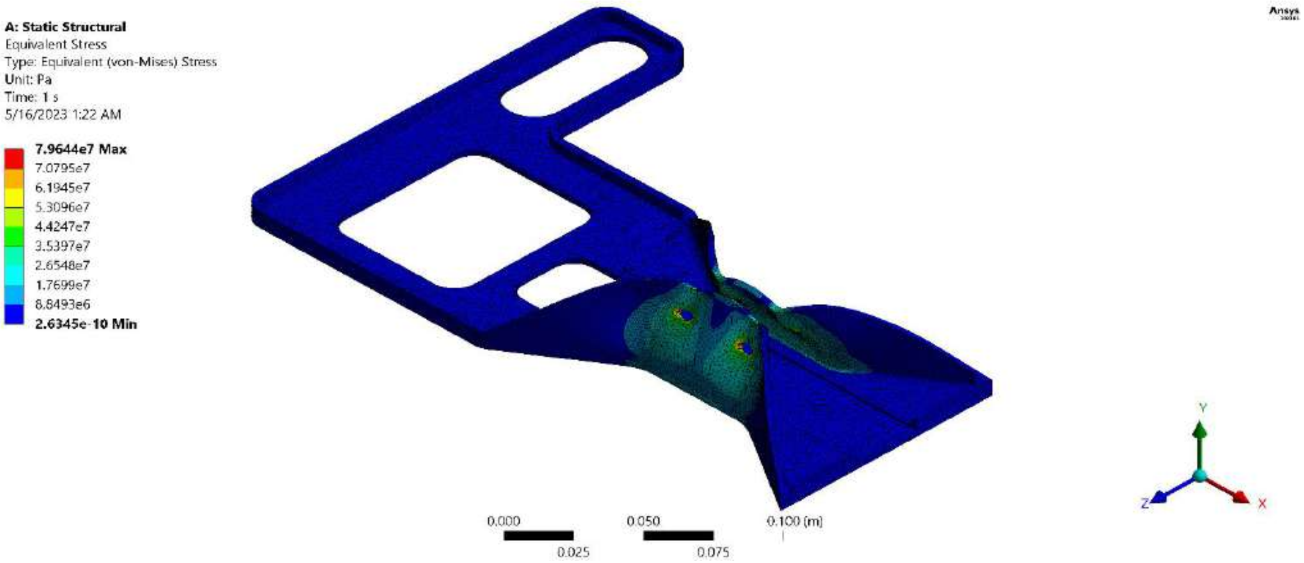


Figure 3 20: Maximum Stress in Base Plate

It is important to note that the low stress levels and deformations observed in the base component provide additional reassurance in the overall performance of the mechanized automobile jack, further supporting the successful functionality of the design.

3.4.2 Result and Discussion

In the structural analysis of the mechanized automobile jack, various components were analyzed to assess their performance and structural integrity. The head component, subjected to a compressive force of 6670N, exhibited a maximum deformation of 0.0227 mm and a maximum stress of 270 MPa. Similarly, the upper arm component, under an axial force of 5490N, experienced a maximum deformation of 0.125 mm and a maximum stress of 383 MPa. The power screw, subjected to a tensile force of 8757N, demonstrated a maximum deformation of 0.56 mm and a maximum stress of 458 MPa. These results confirmed that the selected carbon steel material, with its appropriate properties, maintained structural integrity under the applied loads. Furthermore, the base component, under a compressive force of 5490N, experienced a maximum deformation of 0.0079 mm and a maximum stress of 79 MPa. These findings demonstrated the overall stability and strength of the jack's components, contributing to the successful operation of the mechanized automobile jack.

The analysis results indicated that the design of the mechanized automobile jack was effective in withstanding the applied forces and ensuring structural integrity. The maximum deformations observed in the components were within acceptable limits, ensuring the stability of the jack during lifting operations. The maximum stresses experienced in the components remained below the yield strength of the carbon steel material, indicating that they were able to withstand the applied loads without experiencing plastic deformation or failure. These findings validated the design calculations and affirmed the suitability of the chosen material. Overall, the structural analysis provided valuable insights into the performance and reliability of the mechanized automobile jack, ensuring its capability to safely lift vehicles and meet the desired load capacity requirements.

3.6 Testing and Experimentation

During the testing and experimentation phase, the initial design of the mechanized automobile jack was subjected to real-world conditions by lifting different SUVs. The first test conducted on an Aqua showed no faults, confirming that the design was valid for loads up to 1.2 tons, as previously determined through structural analysis. However, when the jack was tested on a Toyota GLI, two significant flaws were identified.

The first flaw was the bending of the structure, specifically the displacement of the upper arm. This indicated that the initial design was unable to handle the weight and forces exerted by the Toyota GLI, highlighting the need for improvements to ensure structural stability and prevent such deformations.

The second flaw was the lack of a manual operating option in the event of motor failure or issues with the electrical components. This posed a safety concern, as it was essential to have an alternative method to operate the jack manually in case of any unforeseen circumstances.

These flaws were taken into consideration, and the new design was developed to address and rectify these issues. The structural stability was enhanced to prevent bending or displacement of the upper arm, ensuring that the jack can withstand the weight of different vehicle models, including SUVs. Additionally, the new design incorporated a manual operating option as a safety measure, providing a backup method for operation in case of any failures or malfunctions in the motor or electrical system.

These improvements were crucial to ensure the reliability, safety, and versatility of the mechanized automobile jack, addressing the identified flaws from the initial testing phase and ensuring its effectiveness in various operational scenarios.

3.7 Optimization

In the optimization of the previous design, a key modification was made to the connection between the motor and the screw. In the initial design, they were connected using a welding technique, specifically a knuckle joint. However, based on the power screw analysis, it was observed that the maximum stress occurred at the head face of the power screw. To address this, the design was optimized by utilizing a non-threaded screw path.

In the optimized design, the assembly plate was reconfigured to redistribute the weight and load distribution. Specifically, the assembly plate was modified in such a way that it primarily supports the weight of the motor, rather than placing excessive load on the top face of the screw. This optimization aimed to alleviate stress concentration at the critical head face of the power screw, thereby improving the overall structural integrity and performance of the jack.

By implementing this modification, the design achieved a more balanced load distribution and reduced stress concentrations. This optimization ensured that the power screw, which experiences significant forces during operation, could withstand the loads more effectively and minimize the risk of failure or deformation at the critical head face. As a result, the overall reliability and durability of the mechanized automobile jack were enhanced, allowing it to perform optimally under various load conditions and providing greater confidence in its safe and efficient operation.

CHAPTER 4

Fabrication

After completion of the design phase, the fabrication process can commence. This involves the manufacture of the mechanical components and the assembly of the device. The fabrication process involves cutting, welding, and machining to produce precise parts and components. The fabrication process must be carried out with the utmost precision and attention to detail to ensure that the mechanized automobile jack meets the specified requirements and can lift heavy loads with accuracy and stability.

4.1 Material Selection

When selecting the carbon steel material for the fabrication of the mechanized automobile jack, several factors are considered to ensure the desired mechanical properties and overall performance of the jack. The primary considerations include tensile strength, durability, and other relevant characteristics.

Tensile strength is a crucial property that determines the material's ability to withstand applied tensile forces without permanent deformation or failure. The selected carbon steel material should have a high tensile strength to ensure the jack's structural integrity and capacity to lift heavy loads. Typically, carbon steel grades such as 1020 or 1045 are commonly chosen for their suitable tensile strength properties.

Durability is another important aspect to consider, as the jack will be subjected to repeated loading cycles and varying operating conditions. The material should possess excellent resistance to fatigue and wear to ensure prolonged service life. Carbon steel alloys are known for their durability and ability to withstand repeated stresses, making them a suitable choice for the jack's components.

Other relevant characteristics to consider include ductility, machinability, and corrosion resistance. Ductility is crucial to allow the material to undergo plastic deformation without sudden failure, ensuring the jack can withstand higher loads without catastrophic consequences. Machinability is a consideration due to the fabrication process involving CNC machining operations. Carbon steel materials with good machinability enable efficient and precise shaping of the components. Lastly, corrosion resistance is important to prevent degradation due to environmental factors. While carbon steel is not inherently corrosion resistant, surface treatments or coatings can be applied to enhance its protection against rust and corrosion.

The specific carbon steel grade selected will depend on the specific requirements and load capacities of the mechanized automobile jack. Material properties and specifications provided by material suppliers, such as tensile strength, yield strength, and elongation, are considered during the material selection process. Additionally, industry standards and regulations may influence the choice of material to ensure compliance with safety and performance standards.

4.2 CAM Manufacturing

During the fabrication process of the mechanized automobile jack, a crucial step is the creation of a detailed CAD (Computer-Aided Design) model using specialized software such as SolidWorks. This CAD model serves as a virtual representation of the jack and includes all its components, ensuring accurate visualization and design before fabrication begins.

The CAD design process involves several key steps:

- ***Component Identification:*** The first step is to identify and define all the components required for the jack, including the base, head, arm, screw, and motor mount. Each component plays a critical role in the functioning of the jack, and they must be accurately represented in the CAD model.
- ***Component Modeling:*** Once the components are identified, the next step is to create 3D models of each component using the CAD software. This involves defining the shape, size, and specific features of each component. CAD software provides various tools and functionalities to precisely create the desired geometry and ensure accurate representations of the components.
- ***Assembly Modeling:*** After creating individual component models, the CAD software allows for the assembly of these components to create the complete jack assembly. The assembly modeling process involves aligning and connecting the components in the correct orientation and position, replicating their intended relationships in the physical jack. This step ensures that the assembly is properly simulated in the virtual environment.
- ***Design Validation:*** Once the assembly is created, the CAD model can be used to perform various design validations and simulations. This includes analyzing the structural integrity, stress distribution, and other performance factors using simulation tools available within the CAD software. Design changes can be made based on the analysis results to optimize the jack's functionality and ensure its safe and efficient operation.

By utilizing CAD software like SolidWorks, the fabrication process benefits from enhanced visualization, accurate modeling, and design validation capabilities. The CAD model serves as a vital reference throughout the fabrication process, guiding manufacturing operations and ensuring that the final product aligns with the intended design specifications.

4.3 CNC Machining

During the fabrication process of the mechanized automobile jack, the head and arm components are machined using CNC milling operations. This involves utilizing a CNC (Computer Numerical Control) machine, which follows pre-programmed instructions to precisely shape and cut these components according to the design specifications. Here's a detailed explanation of the CNC milling process:

- **CAD Design and CAM Programming:** The design of the head and arm components is created using CAD software, specifying their dimensions, features, and tolerances. The CAD model is then converted into a CAM (Computer-Aided Manufacturing) program, which generates the toolpaths and machining instructions for the CNC machine.
- **Material Preparation:** The head and arm components are typically machined from solid blocks of the selected carbon steel material. The material is securely clamped onto the CNC machine's worktable or vice, ensuring stability during the milling process.
- **Tool Selection:** Appropriate cutting tools, such as end mills or drills, are selected based on the specific machining operations required for the head and arm components. The tool selection depends on factors like the desired surface finish, hole diameter, groove width, and overall geometry.
- **CNC Milling Operations:** The CNC machine operates in a controlled manner, following the pre-programmed CAM instructions to carry out the milling operations on the head and arm components. The machine moves the cutting tool along the defined toolpaths, cutting away excess material and creating the necessary features.
    - ***Cutting Holes:*** The CNC machine uses drills or end mills of appropriate sizes to cut holes of specific diameters and depths in the head and arm components. These holes may

    serve as mounting points, fastener locations, or for other functional purposes.
  - ***Creating Grooves:*** Grooves or channels are machined into components using end mills or specialized cutters. These grooves may facilitate the movement of other components, such as the screw, or accommodate wiring or other necessary elements.
  - **Contouring and Shaping:** The CNC machine carefully follows the defined contours and shapes of the head and arm components, ensuring precise machining and maintaining the desired dimensions and profiles.
- **Surface Finish and Deburring:** Once the milling operations are complete, the head and arm components may undergo additional processes for surface finishing and deburring. This may involve smoothing rough edges, removing burrs, and ensuring a uniform surface finish using techniques such as sanding or polishing.

By utilizing CNC milling operations, the head and arm components are machined with a high degree of accuracy, consistency, and repeatability. The CNC machine precisely follows the programmed instructions, resulting in components that meet the design specifications and requirements. This ensures that the head and arm components fit together seamlessly with other parts of the jack, contributing to the overall functionality and structural integrity of the mechanized automobile jack.

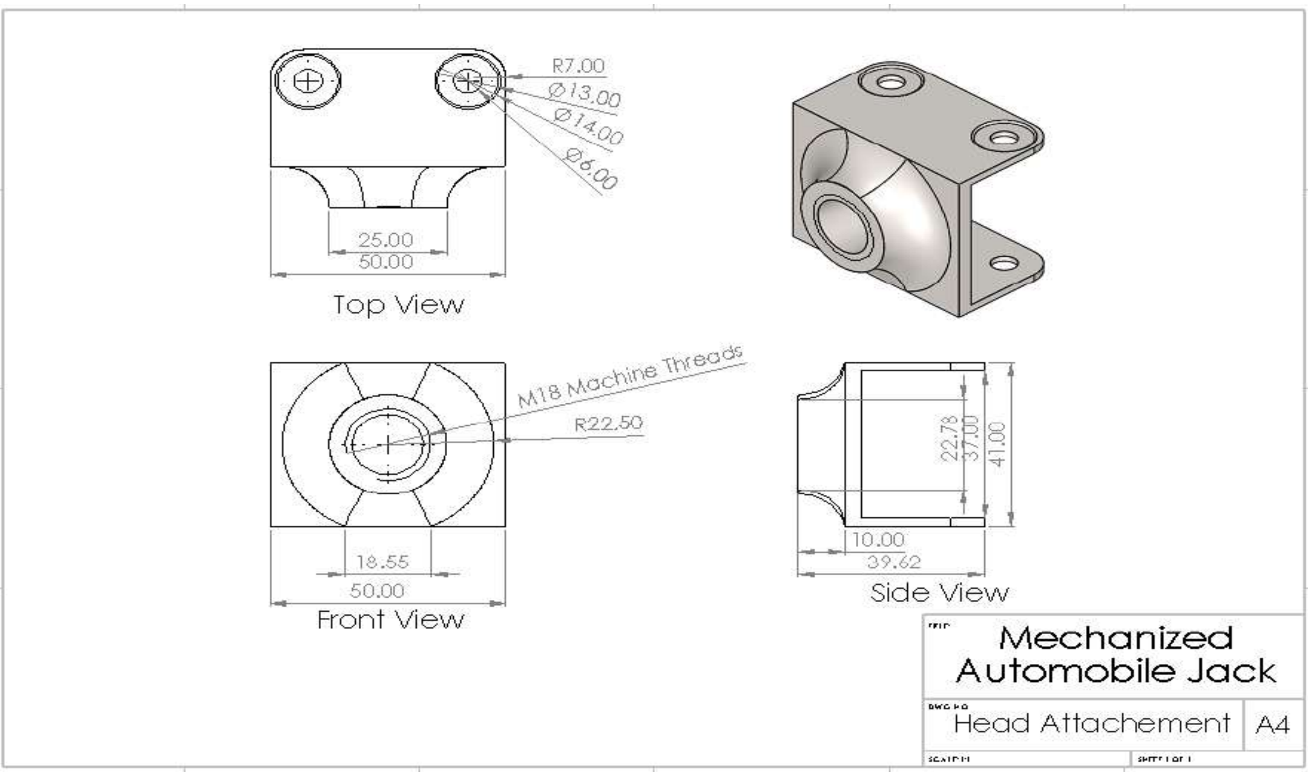


Figure 4 1: 2D detail Drawing of Head Attachment

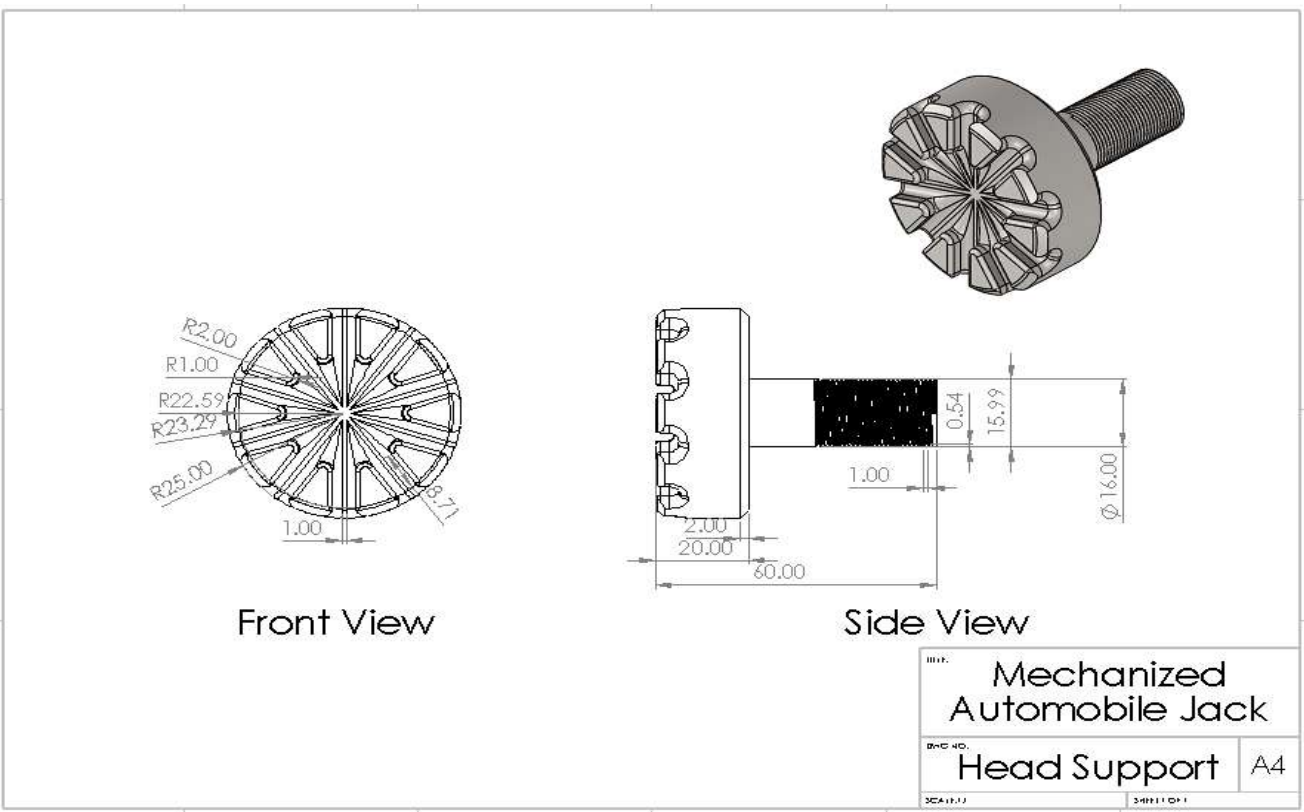


Figure 4 2: 2D detail drawing of Head Support

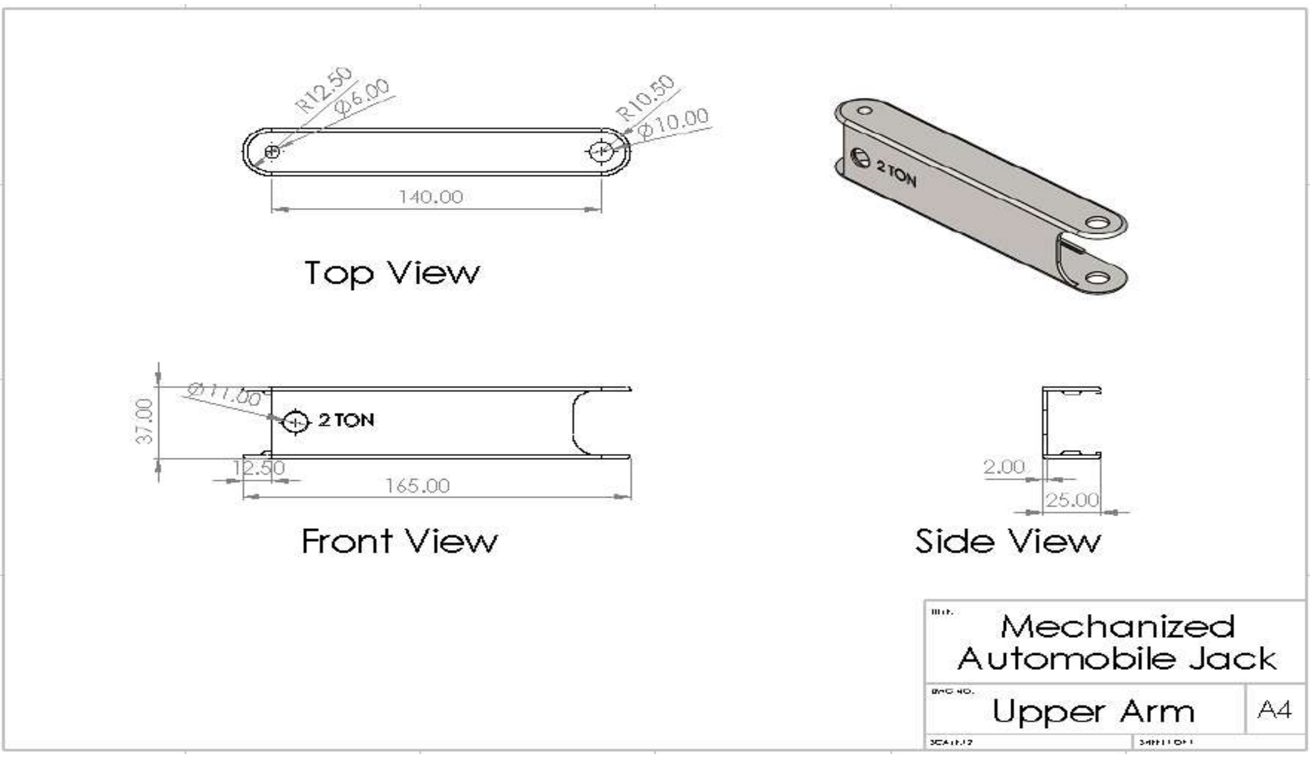


Figure 4 3: 2D detail Drawing of Upper Arm

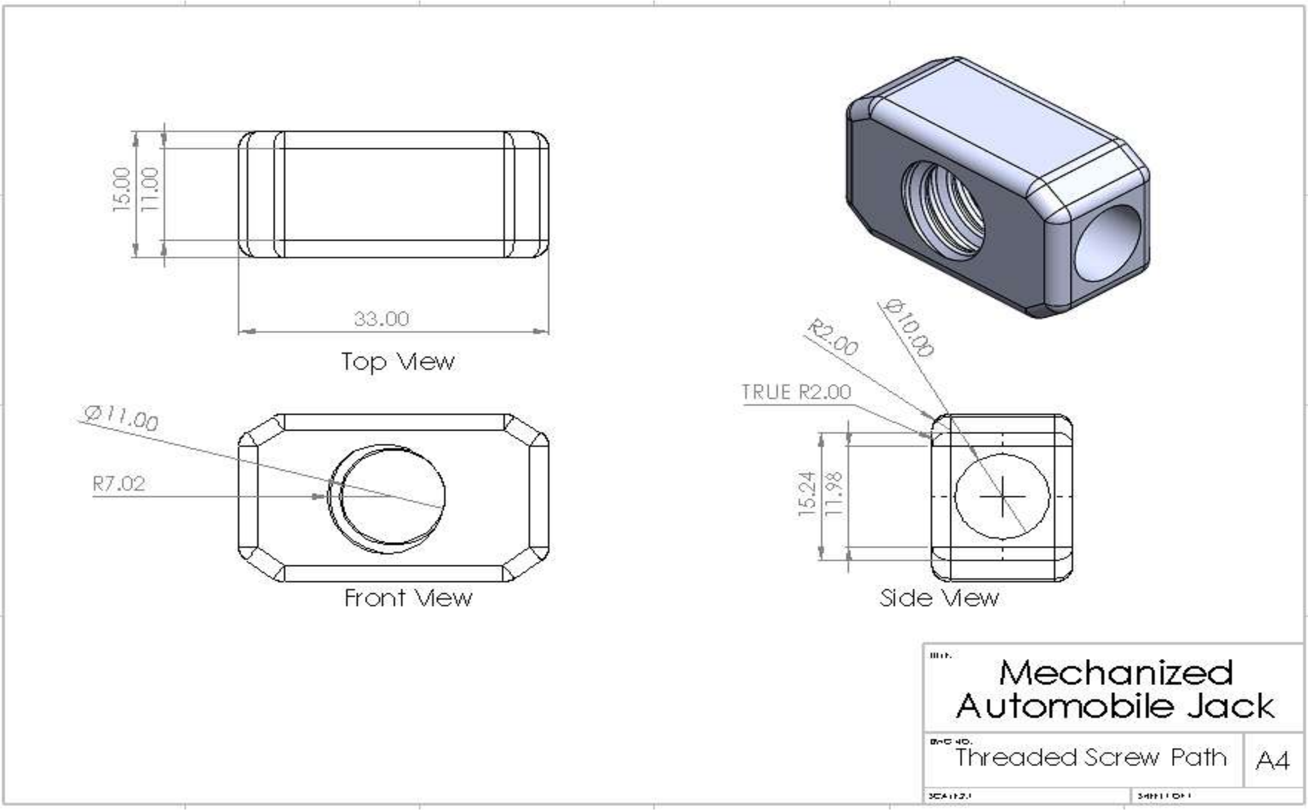


Figure 4 4: 2D detail drawing of Threaded Screw Path

The motor mount, which holds the motor in place, is also fabricated using CNC milling operations. The CNC machine carves out the necessary shapes and holes to securely mount the motor onto the jack.

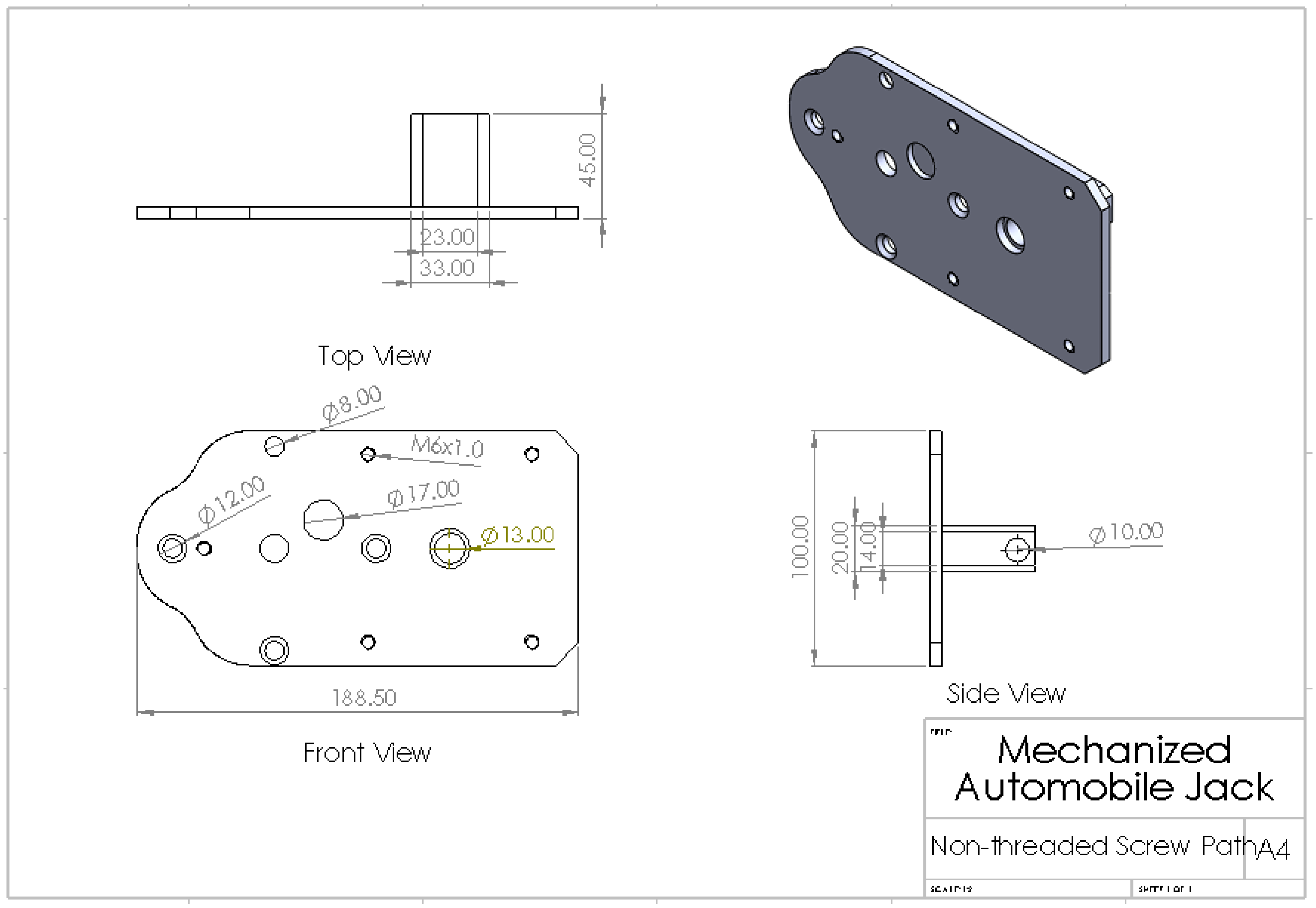


Figure 4 5: 2D detail drawing of Non-Threaded Screw Path Plate

The screw component of the jack is machined using CNC turning operations. The CNC machine rotates the material, and cutting tools shape the screw to the required dimensions and thread profile. This process ensures accurate and consistent screw geometry.

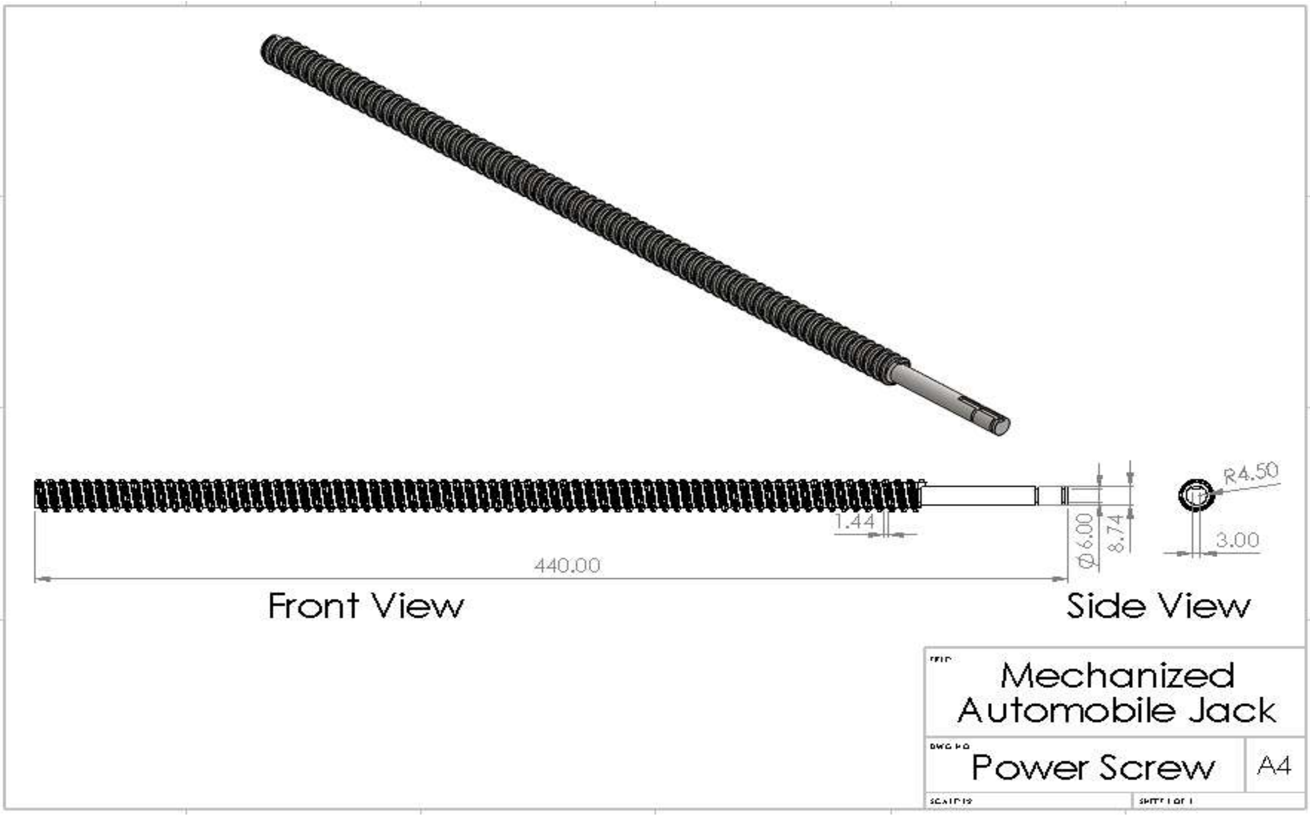


Figure 4 6: 2D detail Drawing of Power Screw

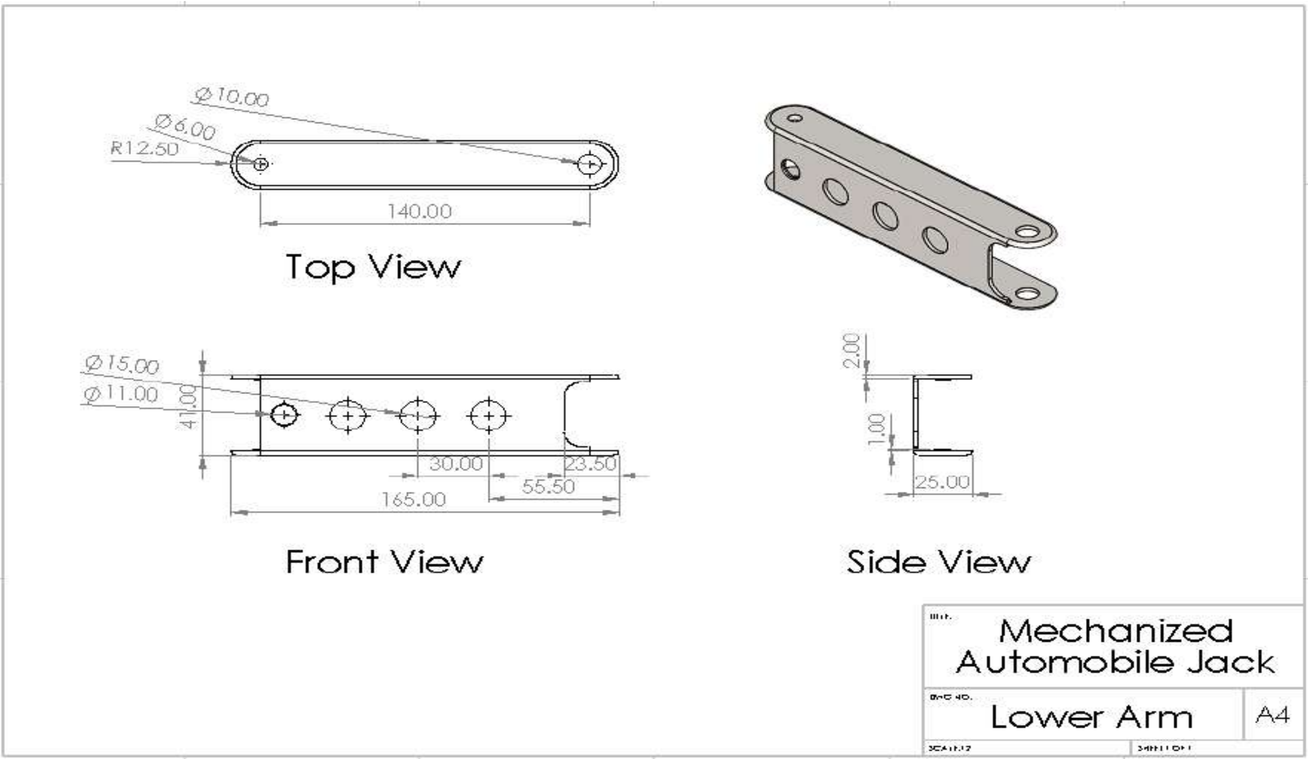


Figure 4 7: 2D detail Drawing of Lower Arm

The base is machined using CNC milling operations. The CNC machine is programmed to cut and shape the base according to the specifications in the CAD model. This includes cutting the required holes, slots, and any other necessary features.

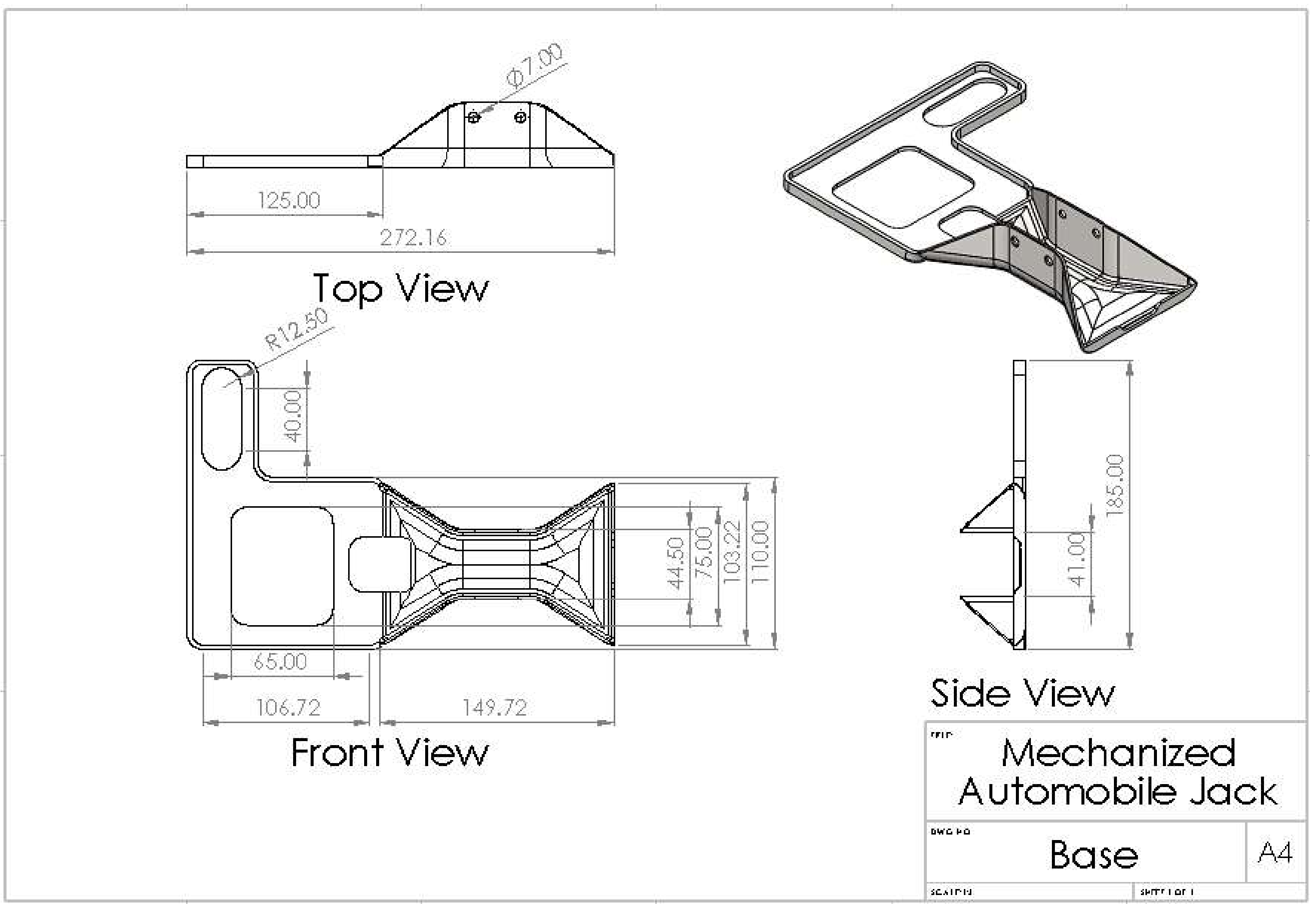


Figure 4 8: 2D detail Drawing of Base Plate

4.4 Assembly and Integration

Once all the individual components of the mechanized automobile jack have been machined, the next step in the fabrication process is the careful assembly of these components. The assembly process involves joining the various parts together to create the complete jack assembly. Here's a detailed explanation of the assembly process:

- ***Threading the Screw into the Base***: The first step is to thread the power screw into the base component. The threaded end of the screw is aligned with the corresponding hole in the base, and the screw is carefully rotated and inserted until it is securely threaded into the base. This ensures a stable and secure connection between the screw and the base.

- ***Connecting the Head and Arm to the Base:*** The next step involves connecting the head and arm components to the base. This is typically achieved using appropriate fasteners such as bolts or screws. The head and arm are aligned with their respective mounting points on the base, and the fasteners are inserted and tightened to securely attach the components together. This connection ensures the structural integrity and stability of the jack during operation.
- ***Mounting the Motor onto the Motor Mount:*** The motor, which provides the power for the jack's lifting mechanism, is mounted onto the motor mount component. The motor is positioned on the motor mount in a way that ensures proper alignment and connection. Fasteners, such as bolts or screws, are used to secure the motor in place, ensuring it remains firmly attached to the jack assembly.

Throughout the assembly process, attention is given to proper alignment, torque specification for fasteners, and ensuring that all components are securely connected. Proper alignment and secure connections are essential for the jack to function correctly and safely during operation.

It is crucial to follow the manufacturer's instructions and engineering specifications during the assembly process to ensure that all components are assembled correctly and in the intended configuration. Adhering to these guidelines helps guarantee the reliability, stability, and optimal performance of the mechanized automobile jack.

By meticulously assembling the various components, including threading the screw into the base, connecting the head and arm to the base, and mounting the motor onto the motor mount, the fabricated jack is transformed into a fully functional unit ready for testing and operation.

Figure 4 9: Fabricated Mechanized Automobile Jack

4.5 Lubrication and Testing

After the fabrication of the mechanized automobile jack is completed, a critical step is the inspection and finishing process. This step ensures that the jack meets the required quality standards and is ready for transportation and storage. The following are the detailed processes involved in inspection, finishing, and packaging:

- ***Inspection:*** The fabricated jack undergoes a thorough inspection to identify any imperfections, defects, or deviations from the design specifications. This inspection may involve visual examination, dimensional measurements, and functional testing. The purpose is to ensure that all components are correctly manufactured, properly assembled, and free from any manufacturing defects that could affect the jack's performance or safety.

- ***Finishing Processes:*** If any imperfections are found during the inspection, they are addressed through appropriate finishing processes. This may include deburring, which involves removing sharp edges or burrs left from machining operations, ensuring smooth and safe handling of the jack. Additionally, polishing may be done to enhance the aesthetics of the jack's surfaces, providing a visually appealing finish.
- ***Surface Protection:*** Once the finishing processes are complete, surface protection measures are taken to prevent corrosion or damage during transportation and storage. This may involve applying a protective coating, such as a layer of paint or corrosion-resistant material, to the exposed surfaces of the jack. Surface protection is essential, especially for outdoor or long-term storage situations, to ensure the jack remains in optimal condition.

By conducting a thorough inspection, addressing any imperfections through finishing processes, and ensuring proper packaging, the fabricated jack is prepared for safe transportation and storage. These steps help maintain the quality and integrity of the jack, minimizing the risk of damage and ensuring that it reaches its intended destination in optimal condition.

Throughout the fabrication process, quality control measures are implemented to ensure that each component meets the required specifications and tolerances. CNC machining operations provide precise and consistent results, allowing for accurate fabrication of complex components. This process ensures the reliability, strength, and performance of the mechanized automobile jack, meeting the desired standards for functionality and durability.

Table 4.1: Experimental Results on various Car Models

Car Model	**Weight (kg)**	**Test Result**
Suzuki Cultus 2007, 1000c	850	Effortless lifting, no issues.
Toyota Aqua 2016, 1500cc	1,240	Smooth lifting, Stable.
Toyota Corolla Grande 2019, 1800cc	1,350	Reliable performance, Steady.
Honda Civic 2018, 1800cc	1,400	Consistent and safe operation.
Honda BRV 2017, 1500cc	1,500	Secure and stable lifting.

The experimental results of testing the mechanized automobile jack on various sedans and SUVs, including the Honda BRV, demonstrate its robust performance and versatility as shown in the above table 5.1. The jack smoothly lifted each car, with no signs of strain or issues. The weight of each car, ranging from 850 kg to 1,500 kg, posed no challenge for the jack, highlighting its capacity to handle different loads effectively. The lifting process was effortless, ensuring the safety of the cars and the users. Overall, the jack exhibited reliable and consistent operation across all tested car models, making it a suitable and dependable solution for heavy-duty lifting tasks in the automotive industry and beyond.

4.6 Cost Analysis

Table4.2: Cost Analysis Table

Item	Quantity	Price
Scissor Jack	1	2000
Relay Modules	2	1800
Power Steering Motor	1	7500
Industrial Wires	8 m	1200
Clamps	2	300
Control Modules	1	1500

Base Plates	1	1200
Car lighter and Socket	1	1600
Spur Gears	3	2100
Steel Block	2	1700
Motor Assembly Steel Cover	1	1800
Motor Assembly Plastic Cover	1	1400
Misc. Items	-	2000
Total:	**-**	**26100/-**

Conclusion

In conclusion, the design and fabrication of the mechanized automobile jack represents a significant milestone in the field of mechanical engineering, particularly in the domain of heavy-duty lifting equipment. The development of this project required a comprehensive understanding of mechanical principles, material properties, and modern fabrication techniques. By integrating technologies like CNC machining, 3D designing, and welding, we were able to create a sophisticated and efficient product. The mechanized automobile jack provides a practical and reliable solution for lifting tasks, particularly in automotive applications. Its automated lifting mechanism reduces the physical strain on users, enhancing safety and preventing potential injuries that could occur with manual jacks. The precise and controlled lifting operation ensures stable and accurate vehicle positioning, minimizing the risk of accidents or damage.

Moreover, the design's versatility extends its usefulness to various industrial applications beyond the automotive sector. The product's ability to lift loads of up to 2 tons opens doors for deployment in manufacturing facilities, construction sites, and other industries where heavy materials handling is required. Looking forward, the success of this project opens avenues for further advancements in lifting machines and material transport technologies. By incorporating mobility mechanisms, the mechanized automobile jack could be adapted to serve as a versatile material transporter within industrial settings. Such advancements would revolutionize the efficiency and productivity of material handling operations, leading to significant cost savings and enhanced production capabilities.

The achieved milestones in this project are noteworthy. With a maximum load limit of 2 tons, the jack demonstrates its capacity to handle substantial loads effectively. Additionally, the motor-generated torque of over 10 Nm ensures robust performance and reliability in various lifting scenarios.

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