PROJECT REPORT - CAR ELECTRIC JACK

Submitted in partial fulfilment of the

Requirements for the award of

Degree of B.Tech. in Mechanical Engineering

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SUBMITTED TO

Department of Mechanical Engineering

SHRI G S INSTITUTE OF TECHNOLOGY & SCIENCE INDORR

452003

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CERTIFICATE

This is to certify that the project entitled “ELECTIC CAR JACK ” is the bonafide work carried out by students of B.Tech., Mechanical Dept., SGSITS, Indore during the year 2021-2022, in complete fulfillment of the requirements for the award of the Degree of B.Tech Mechanical and that the project has not formed the basis for the award previously of any degree, diploma, associateship, fellowship or any other similar title.

DECLARATION

We hereby declare that the project entitled “ELECTRIC CAR JACK” submitted for the B.Tech. Degree is our original work and the project has not formed the basis for the award of any degree, associateship, fellowship or any other similar titles.

ACKNOWLEDGEMENT

We take this opportunity to express our deep sense of gratitude to our guide Prof. Basant Agarwal for his valuable guidance and inspiration in spite of his busy schedule. He devoted himself in completing our task with the admirable excellence. He has taken keep and personal interest in giving us constant encouragement and timely suggestions also to our HOD Prof. Rajkumar Porwal for cheerful encouragement and notable guidance.

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INTRODUCTION TO JACKS

PROJECT MOTIVATION

An automotive jack is a device used to raise all or part of a vehicle into the air in order to facilitate repairs. Most people are familiar with the basic car jack (manually operated) that is still included as standard equipment with most new cars. These days, a car jack is an important tool to have in our vehicle due to unknown upcoming event such as flat tire in our journey. Even so, people who like to rotate their tires themselves or who may install snow tires before the winter and remove them in the spring need to use a jack to perform the job. Changing a flat tire is not a very pleasant experience. Moreover, the 'USMA' report on the Integration and Performance of Women at West Point in Proceedings (July 1998) reveals sex-norming schemes whereby women. Navy studies show that only 12% of women can accomplish the two-person stretcher carry, a requirement critical to ship security. Women may be able to drive a five-ton truck, but need a man's help if they must change a tire. Women have a much lighter skeleton that means, among other things, she can't pull more forces as well as men and are at greater risk of skeletal injuries. Usually the car purposely tries to get a flat tire at the least opportune moments. Like when you are rushing home from work, something emergency, business meeting or in the middle of the woods for instance. You are not going to be able to keep driving, so you are going to have to remove it and install your car's spare tire in its place. This is a waste of time and even will endanger you if you are jacking and changing the tire in hurry. Working near a vehicle that is supported by a car jack can be fatal. In Australia, over the last four years at least 19 people have been crushed and killed by a vehicle while they were working. All the deaths were men and involved the vehicle being lifted or supported in the wrong way. Home mechanics are most at risk of this type of death or injury. In some cases the worker was killed when the vehicle was not secured by chocks and the vehicle rolled on top of them, or the structures used to support the vehicle failed. On average, 160 injuries are associated with car jacks each year. Injuries have ranged from amputation to fractures and crush injuries. The correct use of jacks can prevent death or injury. With the spare installed, you should be able to reach your house or the nearest service station. Furthermore, an organization called the American Lift Institute (ALI) was established to promote improvements in automotive lift technology, especially in the area of safety. As recently as the late 1990s, car lift or jack manufacturers were allowed to declare that their products were safe even though they did not meet any set standard. Thanks to ALI's cooperative venture with the American National Standards Institute, all jacks and lifts must meet a set number of performance standards in order to be ALI/ANSI certified. Improvement in automotive car jack is really needed to make the tool more efficient, user-friendly, practical to use, changes in industry direction and most importantly high safety features.
Further research on car jack is very important.

BACKGROUND

In the repair and maintenance of automobiles (car), it is often necessary to raise an automobile to change a tire or access the underside of the automobile. Accordingly, a variety of car jacks have been developed for lifting an automobile from a ground surface. Available car jacks, however, are typically manually operated and therefore require substantial laborious physical effort on the part of the user. Such jacks present difficulties for the elderly and handicapped and are especially disadvantageous under adverse weather conditions.

Furthermore, available jacks are typically large, heavy and also difficult to store, transport, carry or move into the proper position under an automobile. In addition, to the difficulties in assembling and setting up jacks, such jacks are generally not adapted to be readily disassembled and stored after automobile repairs have been completed. Suppose car jacks must be easy to use for pregnant women or whoever had problem with the tire in the middle of nowhere. In light of such inherent disadvantages, commercial automobile repair and service stations are commonly equipped with large and hi-tech car lift, wherein such lifts are raised and lowered via electrically-powered systems. However, due to their shear size and high costs of purchasing and maintaining electrically-powered car lifts, such lifts are not available to the average car owner. Engineering is about making things simpler or improving and effective. Such electrical-powered portable jacks not only remove the arduous task of lifting an automobile via manually-operated jacks, but further decrease the time needed to repair the automobile. Such a feature can be especially advantageous when it is necessary to repair an automobile on the side of a roadway or under other hazardous conditions. There also reports on car jacks which lead to a serious number of accidents. These are due of safety features that are on conventional car jacks are not enough. A specified jack purposed to hold up to 1000 kilograms, but tests undertaken by Consumer Affairs has revealed that is fails to work after lifting 250 kilograms and may physically break when it has a weight close to its 1000 kilograms capacity. Whilst no injuries have been reported to date, Ms Rankine has expressed concerned about the dangers associated with the use of a vehicle jack that does not carry the weight it is promoted to hold. Tests have proven that the jack has the propensity to buckle well under the weight it is promoted to withstand, and it doesn't meet the labeling or performance requirements of the Australian Standard for vehicle jacks.

REVIEW OF LITERATURE

PRODUCT COMPARISON

Below are analyses two other car jacks that are similar to the jack I wish to design. They represent the two primary models of scissor jacks available; those powered by electricity and those that require manual input.

Picture	Features	Pros	Cons
 Figure 1	• Can lift up to 990kg • Electric motor powered by a 12V DC power source. • Extends 13", compacts to less than 5". • 7' power cord. • Weighs 9kgs.	• The electric motor makes operating the jack simple and easy. • Can operate jack away from the car.	• The added weight of the electric motor hurts fuel economy. • The motor adds cost and the increased complexity of the system creates more opportunity for failure. • Need of an electrical power source could be a hindrance when battery power is not adequate.
 Figure 2	• Lifts 1133 kg. • Extends from 3.75"-15.4". • Mechanical input required.	• The jack's simple design minimizes cost , size and weight, so it can be stored easily. • Does not rely on electricity.	• Operating the crank can be difficult. • Required to be near (practically underneath a 2,000kg object to operate. • Like the product above, there is no stability provided from the sides. • Tools to raise the jack are not interchangeable.

ELECTRIC CAR JACK

The electrically operated jack is the modified jack. It is easy to handle and operate. It is operated through car battery which makes it very comfortable to the users, specially for old age persons and for women.

An electric car jack includes a base frame or housing that is adapted to be placed on the ground underneath the automobile to be lifted. The housing includes motors connected to drive arms connected to a load bridge and plate. The bridge is typically mounted within the drive arms by rods located within slots on the arms enabling the bridge to move upward and downward while being retained within the drive arms. The drive arms typically include drive wheels that rotated and are coupled together by a chain mechanism that assures the coupler moves uniformly. Typically, the motors are operated by the car's battery. The drive from the motor transferred to the worm and worm gear which are connected ahead to the driver gear. This driver gear operates the driven gear by chain mechanism. In this way motors drive the arms, lifting and lowering the load bridge which lifts and lowers the automobile.

1) Extremely low maintenance required.
2) Self contained mechanism with compact design.
3) Robust.
4) Shock absorbent and silent

PRACTICAL ADVANTAGE OF ELECTRIC JACK

Think that the driver is in trip when the tyre breaks, he is obliged to replace one! Changing tyre is a very inconvenient thing, especially by open country highway, in the hot, chilliness weather or the moment raining or snowing.

Using the Manual Jack to change tyre is wasting time and energy. And, some ladies and gentlemen are not enough strength to jack up the automobile by shaking the Manual Jack. But using the electric car jack to change tyre is easy, quick and convenient! Only plug the DC Plug into the vehicle’s cigarette lighter receptacle, set the Electric Jack on the right position which appointed for Jack, then press the button. The Electric Car Jack can easily lift the automobile by itself. It is relaxing to operate. For the lady, tall or fat person, it is a very hard thing to replace tyre. But if you have an Electric Car Jack, every question will be solved. It will be relaxing and easy to replace tyre.

SPECIFICATIONS OF JACK:

Carrying Capacity: 800 kg
Voltage: D C 12 V
Maximum Current: 1.5 A

Minimum height of jack from ground: 15 cm
Maximum height of jack from ground: 31 cm

VARIOUS PARTS OF ELECTRIC CAR JACK

POWER SCREWS

A power screw is employed to convert rotary motion into rectilinear motion. Power screws should produce uniform, slow and powerful motion. The efficiency of power screws should be highest possible so that the power lost is as small as possible. A power screw should posses high resistance to wear and retain its precision for a long time.

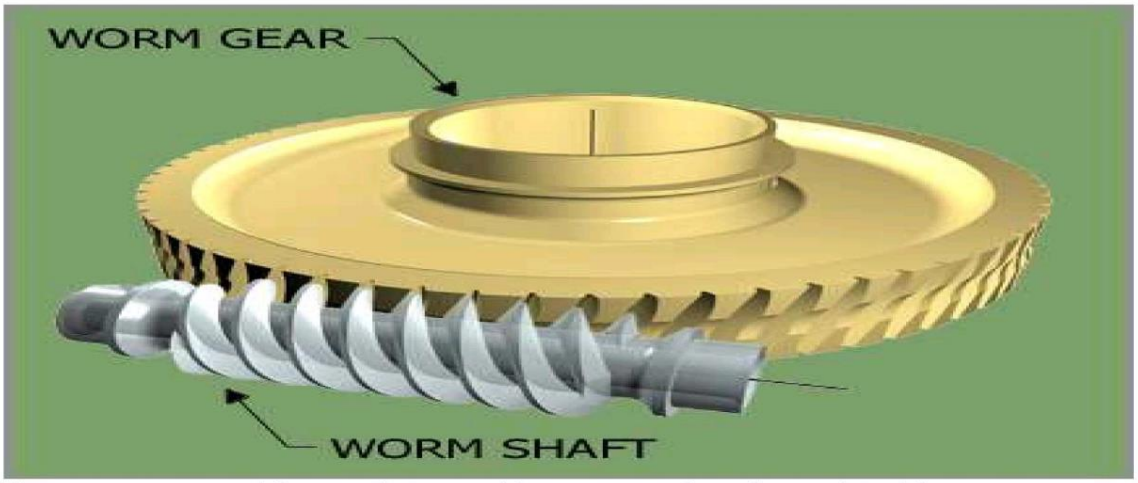
Depending on application of drive, the screws of screw drives are classified into:

1. **Translating screws**: Such drives are used as load drives to transmit large forces at comparatively low speeds e.g. screw jacks, screw presses, valves and pressing screws of rolling mills.

2. **Lead screws**: Serving to accurately transmit motion in lathes, machine tools, measuring instruments and machines such as screw operated tensile testing machine etc

WORM GEAR:

Worm gears are used when large gear reductions are needed. It is common for worm gears to have reductions of 20:1, and even up to 300:1 or greater. A worm drive is a gear arrangement in which a worm (which is a gear in the form of a screw) meshes with a worm gear (which is similar in appearance to a spur gear, and is also called a worm wheel)



Worm gears are special gears that resemble screws, and can be used to drive spur gears or helical gears. Worm gears, like helical gears, allow two non-intersecting 'skew' shafts to mesh. Normally, the two shafts are at right angles to each other. A worm gear is equivalent to

a V-type screw thread. Another way of looking at a worm gear is that it is a helical gear with a very high helix angle. Worm gears are normally used when a high gear ratio is desired, or again when the shafts are perpendicular to each other. One very important feature of worm gear meshes that is often of use is their irreversibility: when a worm gear is turned, the meshing spur gear will turn, but turning the spur gear will not turn the worm gear. The resulting mesh is 'self locking', and is useful in ratcheting mechanisms.

Many worm gears have an interesting property that no other gear set has: the worm can easily turn the gear, but the gear cannot turn the worm. This is because the angle on the worm is so shallow that when the gear tries to spin it, the friction between the gear and the worm holds the worm in place. This feature is useful for machines such as conveyor systems, in which the locking feature can act as a brake for the conveyor when the motor is not turning

Worm Gear As A Speed Reducer

A worm gear speed reducer is the single best method to cut down the speed of an input shaft and amplify torque at the same time. These devices are used in many different industries, around the world, from presses to electric motors and they offer quiet operation with vast power benefits. They also offer a single direction operation, since the gear cannot drive the worm. One of the single most dominant areas in which a worm gear speed reducer is used is the area of manufacturing. The equipment on which items are created, take advantage of the benefits that a worm gear speed reducer provides. The benefits are brought bout through a simple process. If the worm gear has 12 teeth, the gear will revolve at one tooth per revolution of the worm, cutting down the speed of the worm gear by a significant factor, and yet allowing the device to perform admirably well where power is needed. Presses and any machine needed for cutting and drilling are good examples of where a worm gear speed reducer can be used. Electric motors benefit from worm gear speed reducers much more than any other application.

Since a worm gear speed reducer is set up at a right angle to the input shaft, it allows that application to be dramatically scaled down, resulting in a much more compact package. This is ideal in most industries, as space is almost always at a premium. With smaller machinery that still provides all the power necessary for any application, worm gear speed reducers are a natural addition for many different types of machinery.

Regardless of the application, worm gear speed reducers generate a vast amount of friction from the act of metal sliding against metal. Hardened, ground worms and bronze worm gears offer the best combination to combat the metal fatigue that is often associated with these devices and lubrication is essential to the worm gear maintaining proper operation temperatures. Automotive applications that utilize worm gear speed reducers often require very large differential housings to accommodate the large volume of fluid needed.

CHIAN DRIVE

In its simple form a chain drive consists of an endless chain running over two sprockets-driver and driven. A sprocket is a wheel with teeth of special profile. A chain drive operates without slipping like a gear drive and thus provides a positive drive, but where precise timing is required these can't be used. The alignment of the shafts must be more accurate than belt drives. Chain drives find wide applications in agriculture machinery, bicycles, motor cycles, metal and wood working machines, lathes, conveyors, and coal cutters etc.

Advantages of using chain drive:

- As no slip takes place hence perfect velocity ratio is obtained.
- Since chains are made of metal therefore they occupy less space in width than belt or rope drive.
- It gives high transmission efficiency.
- It gives less load on the shaft.
- It transmits more power than belt.
- It permits high speed ratio.
- It can operate under adverse temperature and atmospheric condition.

OBJECTIVES OF THE STUDY

Available jacks present difficulties for the elderly, women and are especially disadvantageous under adverse weather conditions. These presently available jacks further require the operator to remain in prolonged bent or squatting position to operate the jack. Doing work in a bent or squatting position for a period of time is not ergonomic to human body. It will give back problem in due of time. Moreover, the safety features are also not enough for operator to operate the present jack. Present car jack do not have a lock or extra beam to withstand the massive load of the car. This is for the safety precaution in case if the screw break.

Furthermore, available jacks are typically large, heavy and also difficult to store, transport, carry or move into the proper position under an automobile. Suppose car jacks must be easy to use for pregnant women or whoever had problem with the tire in the middle of nowhere. The purpose of this project is to encounter these problems. An electric car jack which has a frame type of design by using electric from the car lighter will be developed. Operator only needs to press the button from the controller without working in a bent or squatting position for a long period of time to change the tire. In order to fulfill the needs of present car jack, some improvement must be made base on the problems statement.

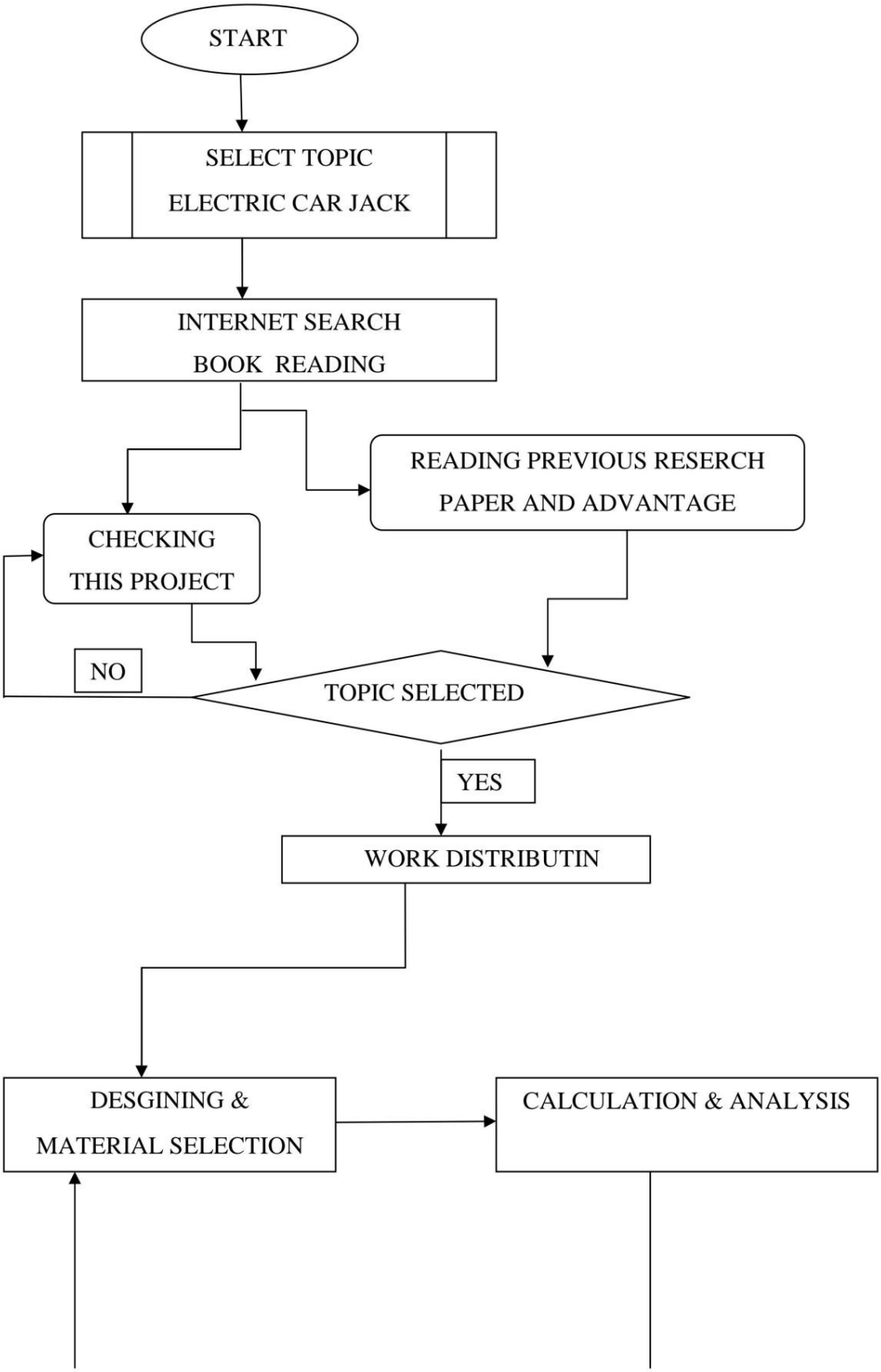
SCOPES

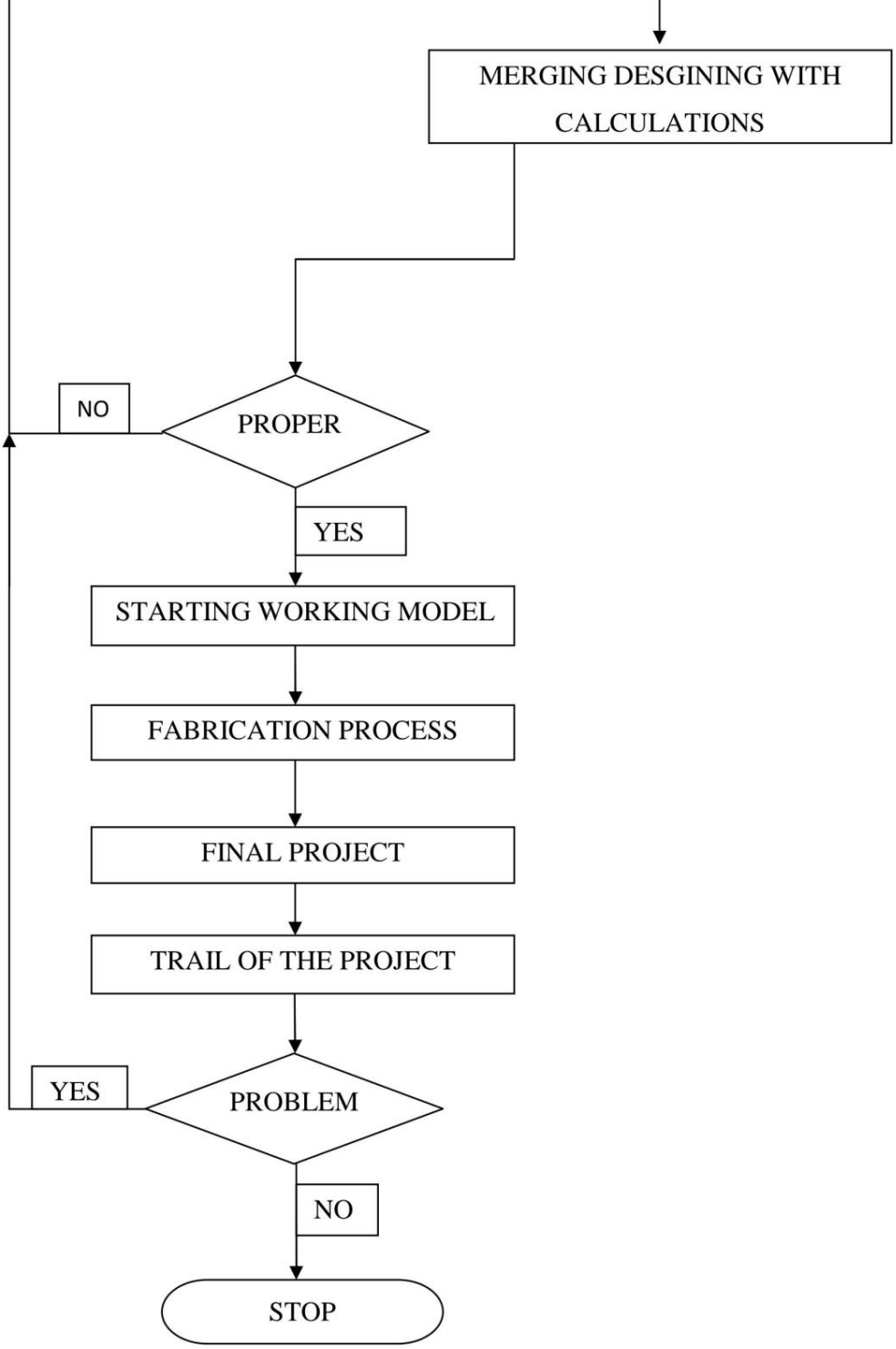
- To design a car jack that is safe, reliable and able to raise and lower the height level.
- To develop a car jack that is powered by internal car power and fully automated with a button system.
- The developed automatic car jack can only withstand below 1000kg of load (Kancil 682kg).
- The developed automatic car jack must be operated on a flat surface.
- The developed automatic car jack is only a prototype and not readily functioning.
- as commercial product.
- The design is based on current scissor jack in the market.
- The developed automatic car jack is only for normal person.
- The developed automatic car jack can only work by using the internal car power (12V).

FLOWCHART AND LOGICAL DIAGRAM

SYSTEM FLOW CHART:

It show how we are approaching to our project goal.



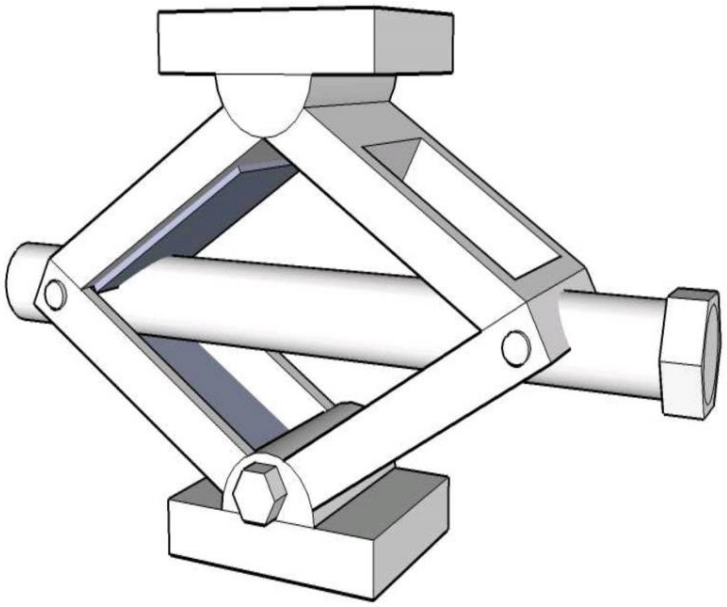

MERGING DESGINING WITH CALCULATIONS
PROPER
NO
YES
STARTING WORKING MODEL
FABRICATION PROCESS
FINAL PROJECT
TRAIL OF THE PROJECT
PROBLEM
YES
NO
STOP

PRELIMINARY RESEARCH AND WORK DONE

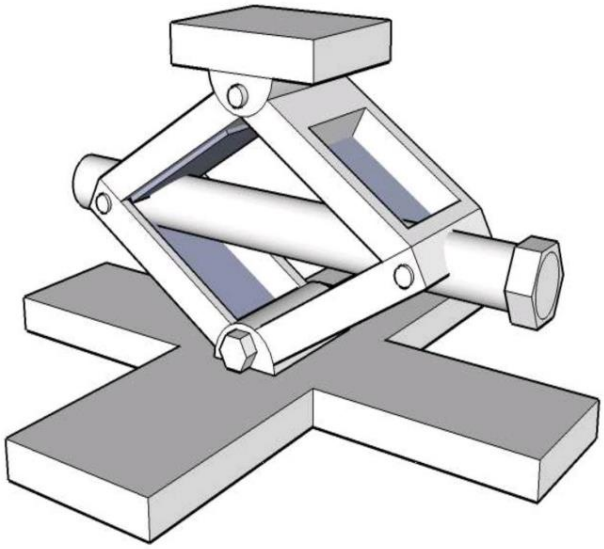
SKETCHES

Show the original hand sketches used to begin the 3D modeling phase of the project. Many of the dimensions and some design aspects of the sketches shown below were changed as necessary by the design during the solid modeling phase.

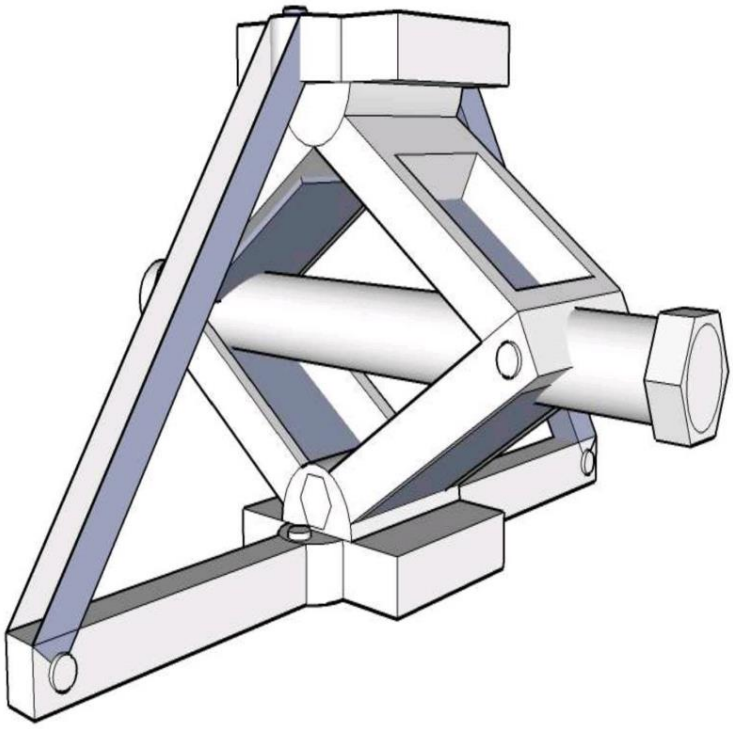
As stated before, the basic design and mechanics of the scissor jack are simplistic and lend little room for drastic change, so any change will be a modification on this base model. Below are three preliminary design concepts sketched.



(a)

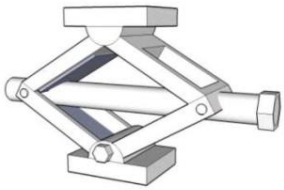
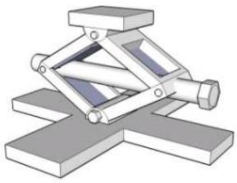
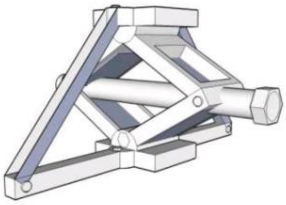


(b)



(c)

Design (a) represents the base model of the scissor jack, it is the most simple. **Design (b)**has an extended base to prevent tipping when the jack is under load. **Design(c)**also aims to prevent tipping, but also adds stability between the top and bottom of the jack .The stabilizing arms on design #3 raise and lower with the jack, lock into place while rising, and, when the jack is lowered, rotate to compact its shape and make storage easier.

Design	Pros	Cons
 1	• Light weight • Simple design (less places for failure) • Cheap • Uses little material • Easy to store	• Small base makes tipping a risk. • No added stability between the top risks a collapse
 2	• Extended base makes tipping less likely. • Simple design	• No added stability between the top and bottom risks a collapse • Shape is not compact, makes storage difficult. • Added material, cost weight
 3	• Adds stability to jack. • Extended base makes tipping less likely. • Prevents collapse • Reduces to a compact shape that is easy to store • Stability added with moderate weight increase	• Added complexity creates more areas for problems • Added components add cost

DECISION MAKING

To help make a decision for the final design, the table below weighs the attributes of each design. The designs are ranked on their performance for each category, the best performance receives a (3) and the worst a (1), the values are then totaled to determine the overall best design. The designs will be assigned values based on their cost, safety, weight and storage (functionality has been omitted from this table because all three designs operate in the same basic manner and are capable of being used with a ratchet). The values for safety will be rated by **5, 10, 15** because of its importance as a design goal.

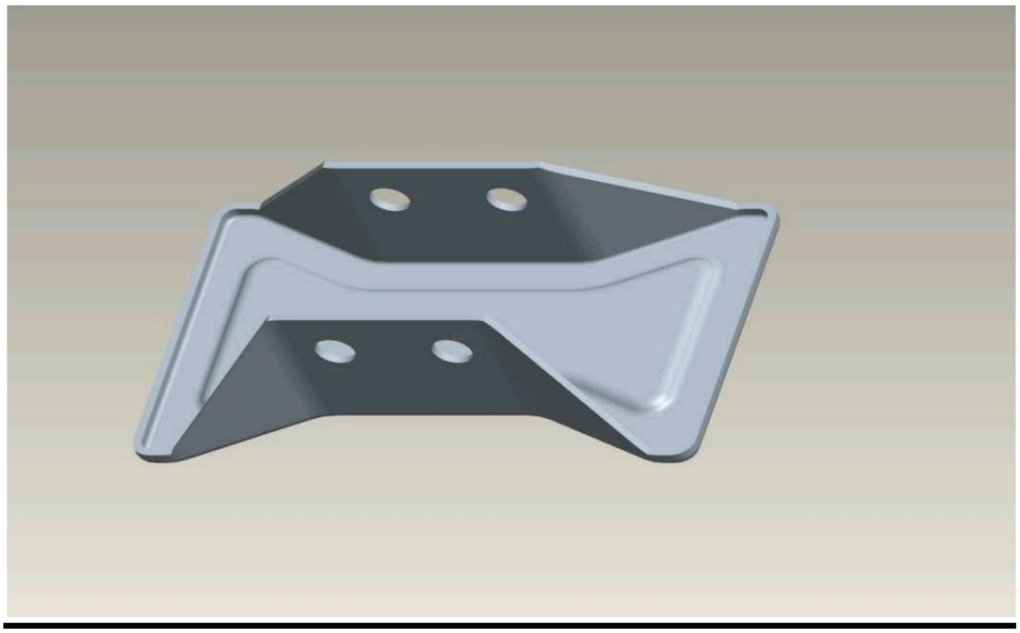
Attribute	Design #1	Design #2	Design #3
Cost	3	2	1
Safety	5	10	15
Weight	3	1	2
Storage	3	1	2
Total	14	14	20

Design #1 uses the least amount of material, so it scored high in cost, weight and storage, but, because of the small amount of material, it is not as safe as the other designs. Design #2 adds safety but also weight, cost and poor storage. Design #3 adds safety without compromising on weight and storage, but adds cost because it has the most parts.

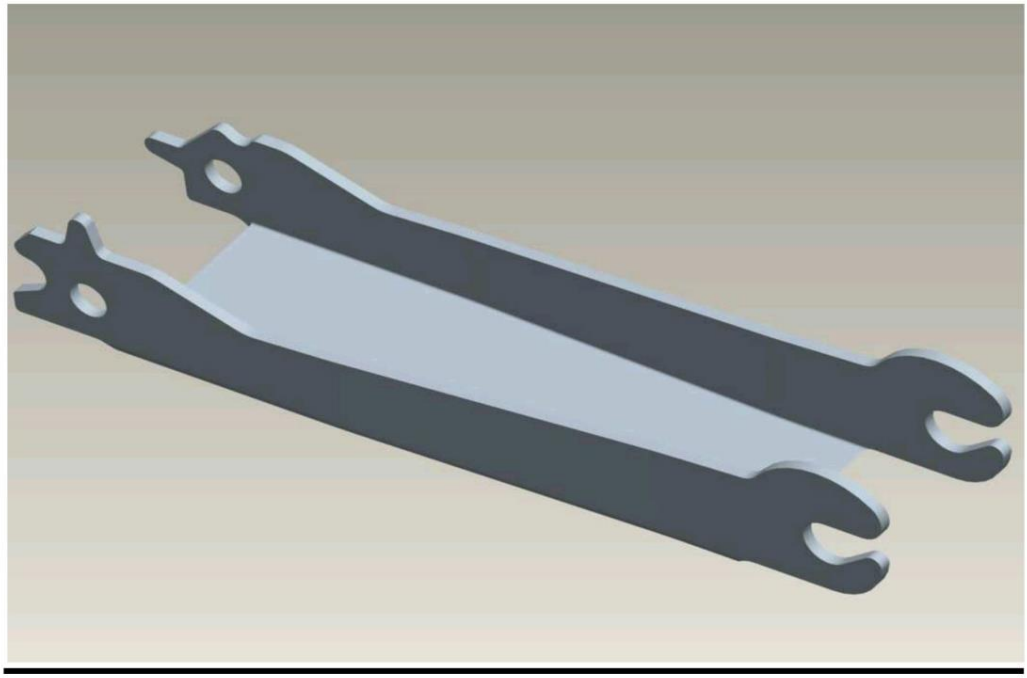
FINAL DESIGN

Design (3) scored the highest in the analysis of alternative designs because safety is extremely important when designing a product that is to lift a 2,000 kg object from

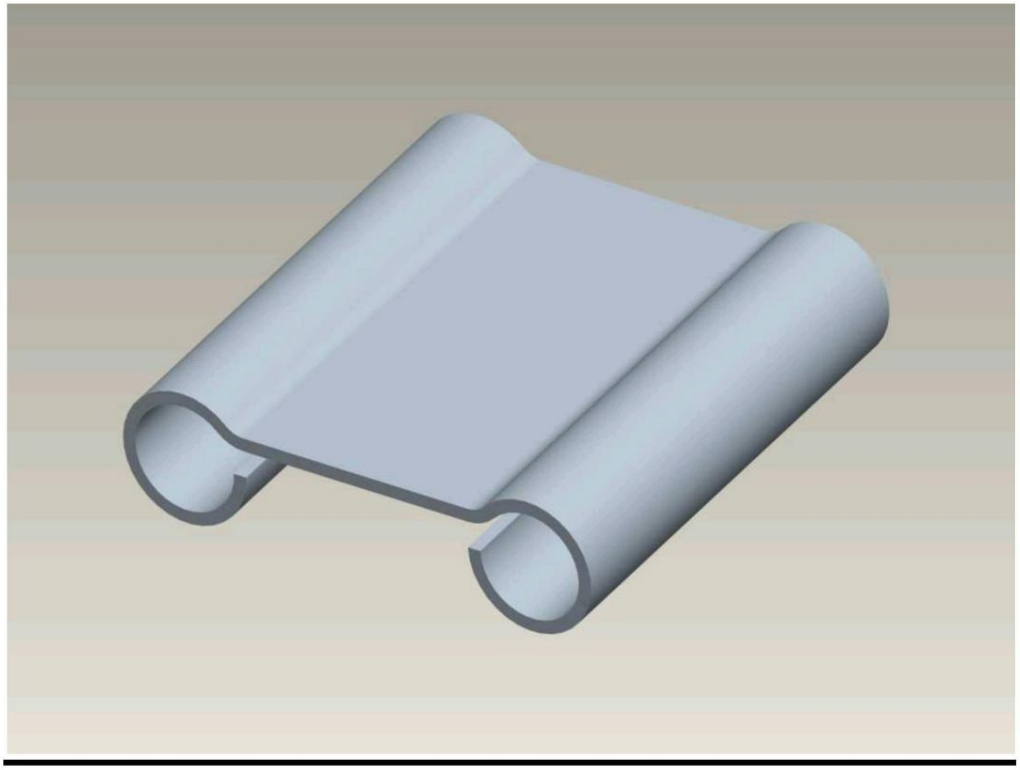
PRO-e Models



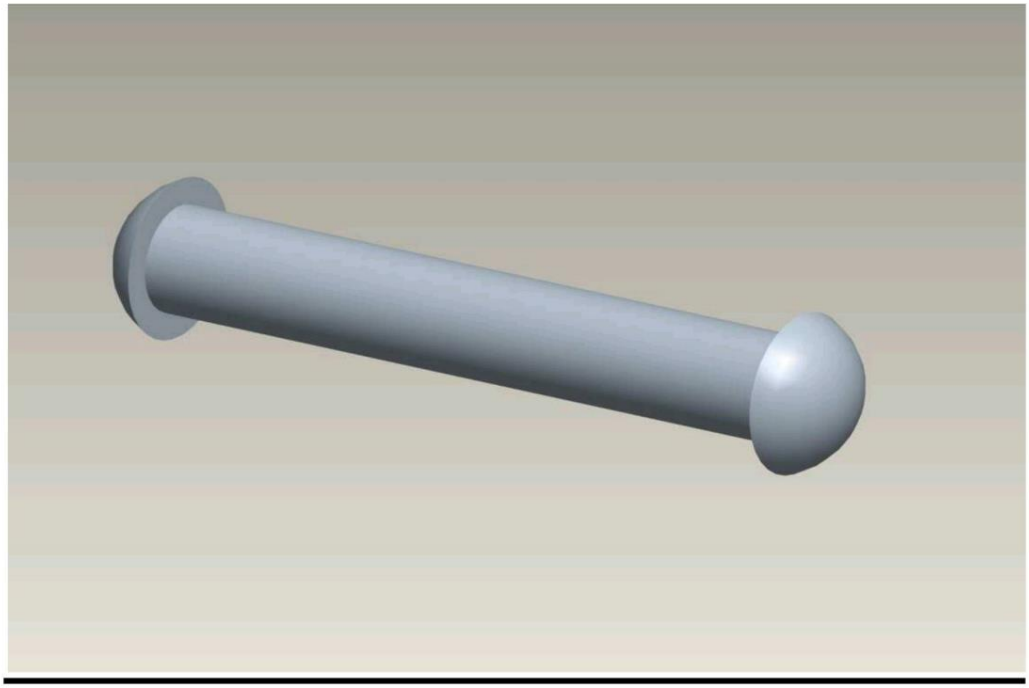
Base frame



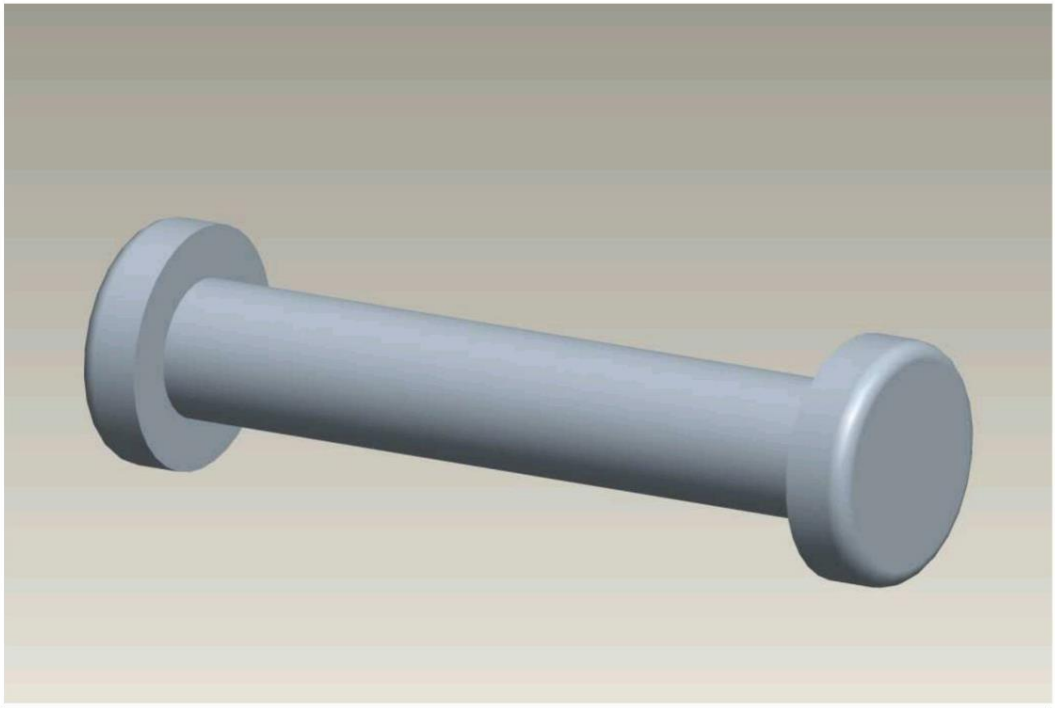
Bottom link



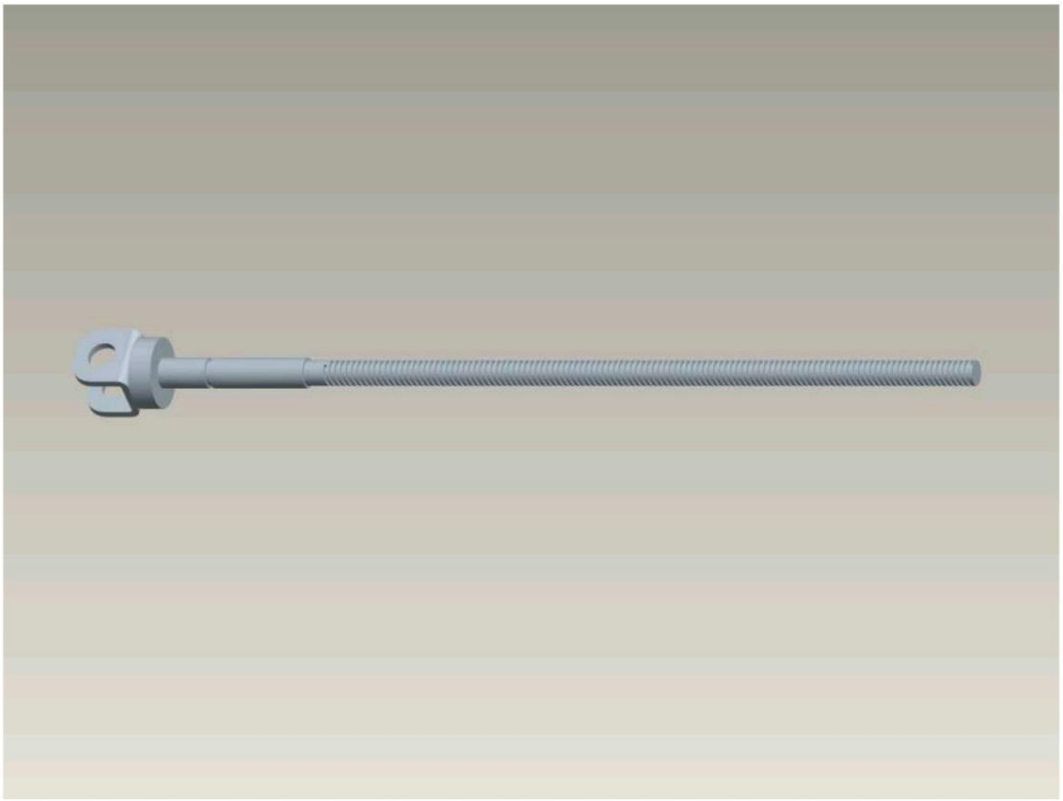
Bottom packing



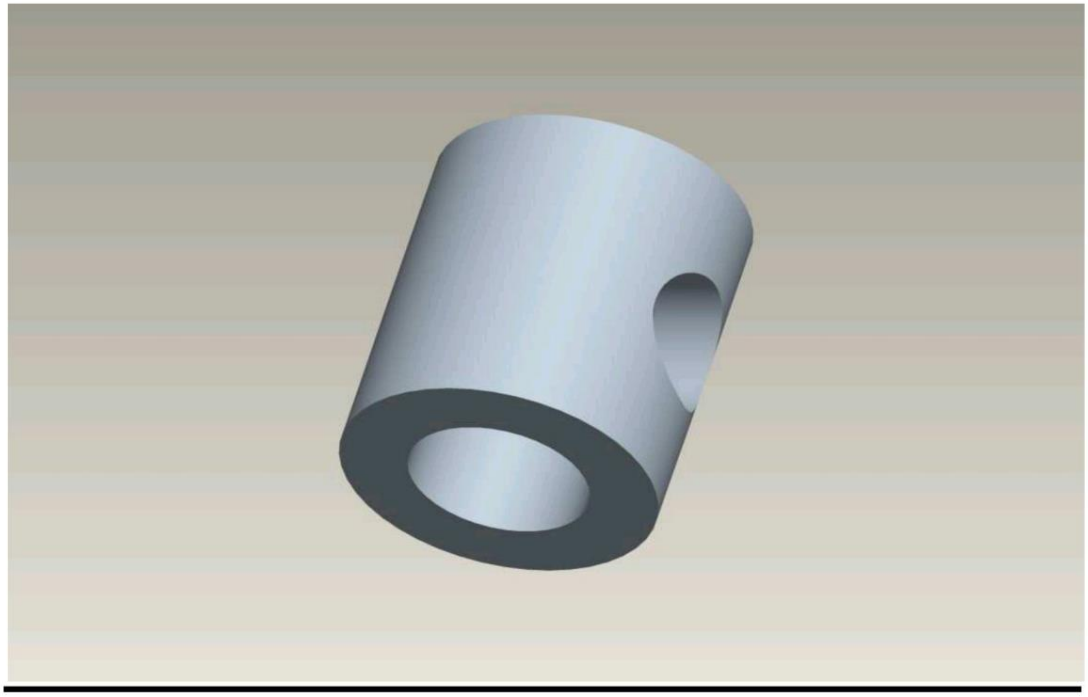
Bottom rivet



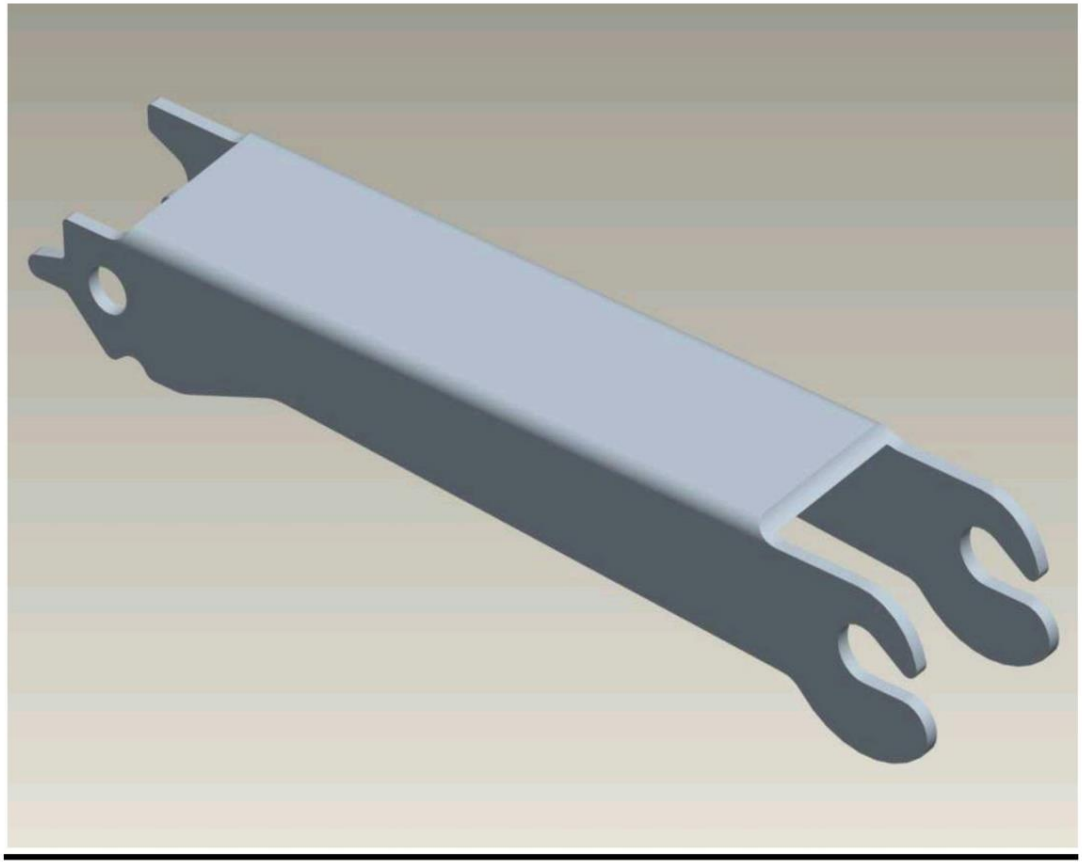
Link rivet



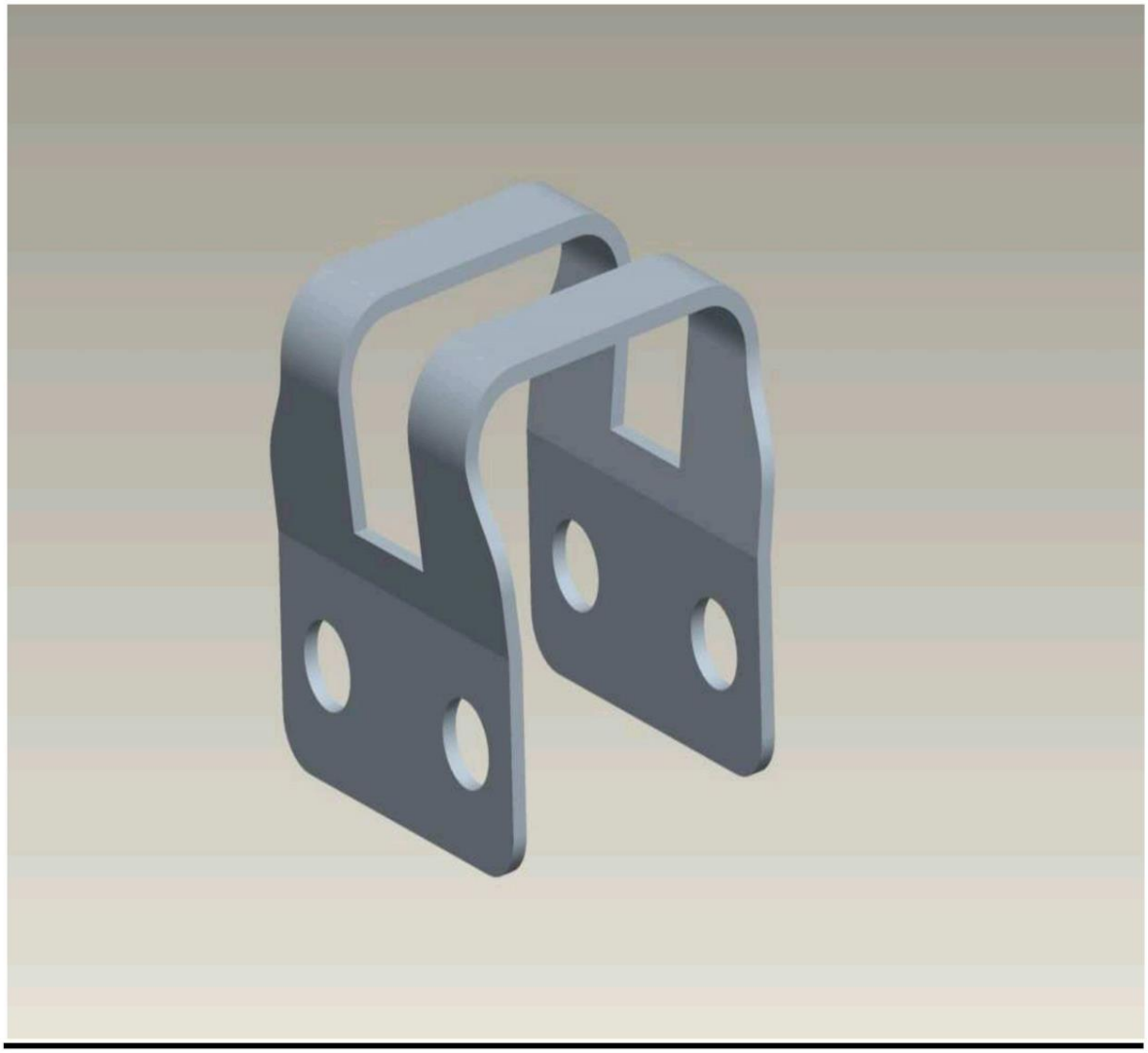
Screw shaft



Coupling nut



Top link



Support frame

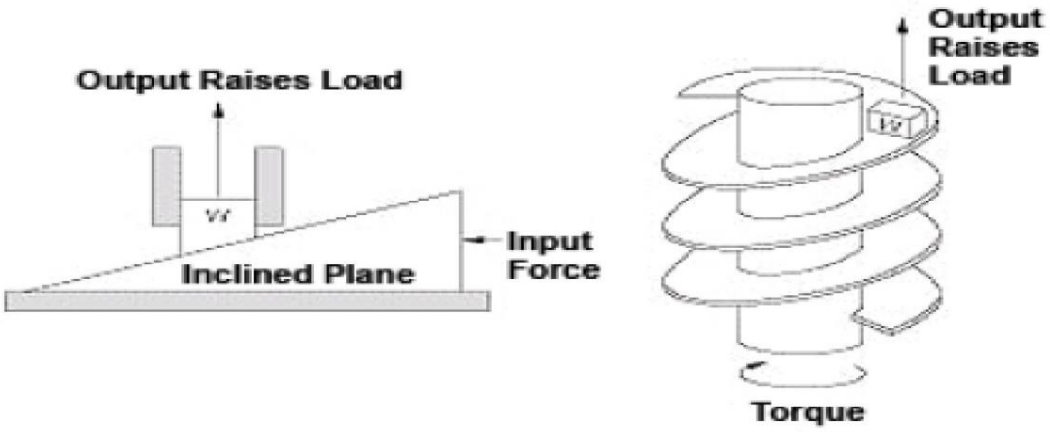
DESING OF POWER SCREW

There are important terms and figures that need to be understood before designing power screws:

1. Pitch: is the distance from a point on one thread to the corresponding thread on the next adjacent thread, measured parallel to the axial plane.

2. Lead: is the distance the screw would advance relative to the nut in one rotation. For single thread screw, lead is equal to pitch.

3. **Helix Angle:** is related to the lead and the mean radius by the equation below;



Basics of power screws

Power screws provide a compact means for transmitting motion and power. They are ideal for replacing hydraulic and pneumatic drive systems as they require no compressors, pumps, piping, filters, tanks, valves or any other support items required by these systems. Also, screws don't leak so there are no problems with seals which are so common to hydraulic and pneumatic systems. And, screw systems are quiet running - no noisy compressors, pumps or exhaust valves. Screw systems are simple, reliable and easy to utilize.

POWER SCREW MOTIONS

There are four distinct motion converting actions that can be produced by power screws and nuts. The two most common involve torque conversion to thrust. In Figure 1, the screw is rotated (torque) and the nut moves linearly producing thrust or the nut is rotated (torque) and the screw moves linearly. The two less common motions involve thrust conversion to torque. In Figure 2, the nut undergoes a linear force (thrust) and the screw rotates or the screw undergoes a linear force (thrust) and the nut rotates. These two motions are commonly referred to as "back driving", "overhauling", or, improperly, "reversing"

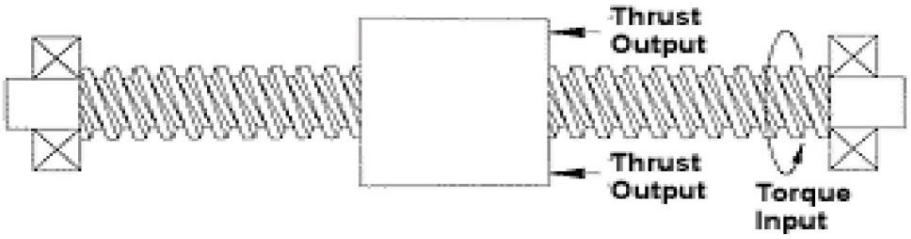


Figure 1

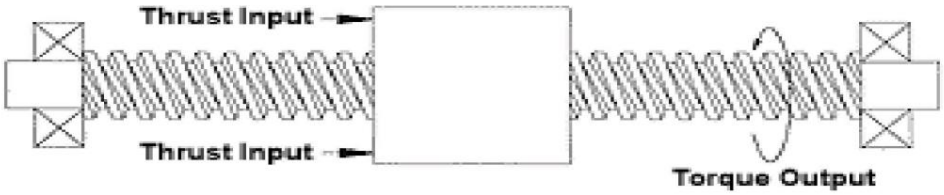


Figure 2

STRESSES ACTING ON VARIOUS COMPONENTS

1. Torsion stress acting on power screw.

$$\tau_{max} \geq \frac{T}{J} j = \frac{\pi d^4}{32}$$

τ_{max}= max torsional stress
T = Torque
d = screw diameter

2. Buckling load acting on lifting frame.

$$\frac{W}{A} \leq C\pi^2 \frac{A}{\left(\frac{L}{K}\right)^2}$$

W=axial load on frames
L=length of frame
C=1for long columns
K= radius of gyration

3. Yielding stress acting on lifting frame.

$$\sigma^T \leq \frac{S_y}{n}$$

σ^T = yielding stress
S_y = endurance limit
n = Factor of safety

4. Bearing stress acting on rivets.

$$\sigma_p \leq \frac{S_y}{n}$$

σ_p= yielding stress
S_y = endurance limit
n = Factor of safety

5. Shear stress acting on rivets

$$\tau \leq .577 S_y/n$$

S_y = endurance limit
n = Factor of safety

$$\tau = \text{shear stress}$$

6. Bending stress acting on coupling joints.

$$\sigma = \frac{m * \frac{d}{2}}{I_x}$$

$$I_x = \frac{\pi(R^4 - r^4)}{4}$$

I_x = polar moment of inertia
R = outer radius
r = inner radius
m = bending moment

POSSIBLE FAILURES AND ERRORS:

A. Unstable center of gravity
B. (Remedy: Weighted rear support brace for balance and lengthened front ¼ floor plates extending under car.)
C. Jack failure due to excess mass being lifted(>2440kgs)
D. Failure of primary bolts due to bending moments and shear stresses.

SUMMARY OF THE WORK DONE

"Impossible is nothing it's just the mind perception and based on root analysis of data". Minor project proved to be most valuable in terms of teamwork and management to us. Also we explored new territories in technical creation. We faced new challenges while designing and analyzing scissor jack by pro-engineer and inventor. The experience gained has provided us confidence in dealing with practical aspects of engineering and will prove to be invaluable as we go into placement season.

WORK TO BE DONE IN FUTURE

1. Calculations;
   - Design of worm
   - Design of worm gear
   - Design of chain drive
   - Design of power screw

2. Pro-e modeling and analysis

3. Assembly of parts

4. Fabrication of various components

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