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Design and Analysis of Center Jack for Cars

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Abstract—
With the increasing levels of technology, the efforts being put to produce any kind of work has been continuously decreasing. The efforts required in achieving the desired output can be effectively and economically be decreased by the implementation of better designs. Power screws are used to convert rotary motion into translator motion. A screw jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The principle on which it works is similar to that of an inclined plane. The mechanical advantage of a screw jack is the ratio of the load applied to the effort applied. The screw jack is operated by turning a lead screw. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor. Pneumatics is a branch of technology that deals with the study and application of pressurized gas in affecting mechanical motion. In this project "Mechanical Project Report on Center Jack for Cars" is designed to make a pneumatic jack that can lift a complete car or an automobile when placed at the car's bottom. These systems are mainly used in industries, factories and are generally plumbed with compressed air. The preference for pneumatic systems is because a centrally and electrically powered compressor is used to power cylinders through solenoid valves and provides motion in a cheaper and flexible mode. The best point of the project is that it can drive a complete system with the aid of Compressed air without any part of the automobile touching the ground. In this project, an electric motor will be integrated with the screw jack and the electricity needed for the operation will be taken from the battery of the vehicle and thereby the mechanical advantage will be increased.

Keywords— Mobile health (mHealth); Healthcare; Privacy; Outsourcing decryption; Key private proxy re-encryption

1. INTRODUCTION

A jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply linear forces. Car jacks use mechanical advantage to allow us to lift a vehicle by manual force alone. More powerful jacks use hydraulic power to provide more lift over greater distance. A scissor jack is a device constructed with a cross-hatch mechanism, much like a scissor. A commercially available scissor jack is shown in Figure 1.

Figure 1: Scissor Jack

A scissor jack is operated by turning a lead screw. It is commonly used as car-jacks. In the case of a scissor jack, a small force applied in the horizontal plane is used to raise or lower large load. A scissor jack's compressive force is obtained through the tension force applied by its lead screw. An acme thread is most often used, as this thread is very strong and can resist the large loads imposed on most jacks while not being dramatically weakened by wear over many rotations. An inherent advantage is that, if the tapered sides of the screw wear, the mating nut automatically comes into closer engagement, instead of allowing backlash to develop (Rajput, 2007). These types are self-locking, which makes them intrinsically safer than other jack technologies like hydraulic actuators which require continual pressure to remain in a locked position. The completed solidworks design of the scissor jack and its members shown in Figure 2. Most scissor jacks

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are similar in design, consists of four lifting arms, a base plate, a carrier plate, two connection members, eight connection pins, a power screw and a crank. This crank is usually "Z" shaped. When this crank is turned, the screw turns, and this raises the 3 jack. The screw acts like a gear mechanism. It has teeth (the screw thread), which turn and move the four arms, producing work. The four arms are all connected at the corners with a bolt that allows the corners to swivel.

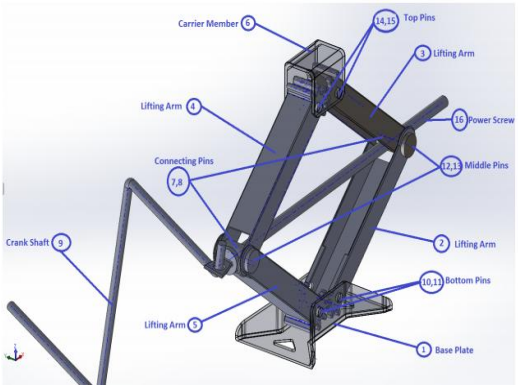

Figure 2: Solid works design of Scissor Jack and its members

The lifting members are made from c-shapes. The web of the lifting member is cut out near the pin connections to allow proper serviceability of the scissor jack at its maximum and minimum heights. Members 3 and 4 have ideal connections to balance the load between the left and right side. The connecting pins are designed with cylindrical shapes and they are subjected to tension instead of compression. The bending moment from the screw shaft creates tension on these members. Other pins are used as fasteners at the various joints of the members. The existence of the jack will depend on the ability of the pin not to fail under sudden shear, tensional and compressive forces.

2. PROCEDURE

The first target is to predict the maximum displacement and maximum stress of the scissor jack. Since the force is applied to the carrier member, I can predict that the maximum displacement will happen at the top side of this member which is shown in Figure 2 (labeled with number 6). Since the maximum force occurs on the screw shaft which is calculated in the force and stress analysis. The maximum stress should be occur joint of the screw and connecting pins.

2.1 Design and Analysis for the Individual Parts

Solid works had been used to create and analyze the geometry under various boundary conditions (restarints) and loading condition (force). The scissor jack had been analyzed for stress and displacement. I have followed the following steps: I- I have started to design with the carrier member which is shown in Figure 6 and its technical drawing is shown in the drawing section. Figure 6: Carrier Member The top surface of the model was loaded with a compressive force of 5886 N, and the holes were fixed as shown in Figure 6. 8 The material is carbon steel (Ck 45) according to manufacturer website. If we don't know the material we can measure the hardness to estimate it's tensile and yield strength. The Ck45 graded steel has the following properties.

Applied Material	Ck45, AISI 1045 Steel
Elastic Modulus	201 GPa
Tensile Strength	625 MPa
Yield Strength	530 MPa T

Table 1: Properties of Ck45 Steel Several studies were performed for creating the mesh. Then, I ran the model for stress and displacement analysis.

Under working condition the jack will lift a vehicle chassis in contact with the top plate when the power screw is rotated through its connecting gear with the pinion when electrical power applied to the wiper motor when plugged to the 12V battery in car. Motor transmits its rotating speed to the pinion gear meshing with the bigger gear connected to the power screw to be rotated with required speed reduction and increased torque to drive the power screw. The power screw rotates within the threaded bore of side member in the clockwise direction that will cause the links to be drawn along the threaded portion towards each other during load-raising process and vice versa. Initially the jack will first be placed below the chassis to be lifted such that at least a small clearance space will exist between the top plate and the vehicle chassis to be raised. Then after power screw will

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be turned so that the top plate makes contact with the car chassis and the clearance space is eliminated. As contact is made, load of car will be increasingly shifted to the top plate and cause forces to be developed in and transmitted through links and side member. The force transmitted through the side member will be transferred on threads of screw. A switching circuit connected to the motor is used to regulate the lifting and lowering process.

3. DESIGN AND DEVELOPMENT OF JACK

Figure 3.1 shows modified toggle jack. The main components of required for development of this jack are: a) Original toggle jack with alteration and replacement of Power Screw and Side members. b) Power screw. c) Gear pair. d) DC wiper motor. e) Bracket and holder to carry motor. Table 3.1 includes details of all components required for building the actual model or prototype of electrically operated toggle jack. Table 3.1 List of component.

Component number	Description	Quantity
1	Top plate	1
2	Upper link	1
3	Link	4
4	Power screw	1
5	Side member	2
6	Bottom link	1
7	Stabilizer base	1
8	Solid block	2
9	Pin	8
10	M10 bolt	5
11	Pinion and hub	1
12	Wiper motor	1
13	Bracket assembly	1
14	M15 bolt	1
15	Gear and hub	1
16	Bracket assembly holder	1
17	Screw collar	1

Figure 2 shows the actual model of electrically operated jack. The prototype is fabricated by making use of the jack and bus wiper motor brought from junk yard. Figure 3.2: Actual model of modified toggle jack.

4. MATERIAL SELECTION

Scissor jacks are usually made of materials that are very strong and are suitable for withstanding heavy loads. The two main materials used for making good quality jacks are Steel and Aluminium. When selecting the material suitable for the construction of the Scissor jack one has to consider the properties that will enable it to function with no expected failure and at the same time the weight and ease of machining the product. Therefore the main areas that can be classified in this case are the strength of the material, weight, ease and cost of manufacturing. Aluminium is around one-third the density of steel at 2.72 mg/m cubed compared to steel's 7.85 mg/m cubed. The light weight and low melting point of aluminium makes it easier and more efficient to machine than steel. Aluminium's fatigue performance is half that of steel, which is an advantage steel has over aluminium in car jack life durability. Therefore Steel is the most viable material selected for the manufacture of the car scissor jack [7] Component number 4, 5and 17 will all use the High Strength Low-Alloy Steel (40Ni2Cr1Mo28 / AISI 4340), material is selected on bases of application. Material Property is given in Table 4.1 below: Table 4.1 Material property

Tensile Strength, Ultimate	931 MPa	135000 psi	
Tensile Strength, Yield	834 MPa	121000 psi	
Elongation at Break	20.2 %	20.2 %	
Modulus of Elasticity	205 GPa	29700 ksi	Typical for steel
Bulk Modulus	140 GPa	20300 ksi	Typical for steel
Poisson's Ratio	0.29	0.29	Calculated
Shear Modulus	80 GPa	11600 ksi	

Table 4.1 Material property

5 CONCLUSIONS

Screw Jacks are the perfect item to push, force, lift, lower and position heaps of anything from two or three kilograms to several tonnes.The need has since quite a while ago existed for an enhanced versatile jack for car vehicles. It is very attractive that a jack get to be accessible that can be worked on the other hand from inside the vehicle or from an area of security off the street on which the vehicle is found. Such a jack ought to alluringly be sufficiently light and be sufficiently minimal with the goal that it can be put away in a car trunk, can be lifted up and conveyed by most grown-ups to its position of utilization, but be equipped for lifting a wheel of a 4,000-5,000 pound vehicle off the ground. Further, it ought to be steady and effortlessly controllable by a switch with the goal that jacking should be possible from a position of wellbeing. It ought to be effortlessly versatile either to a position underneath the vehicle's pivot or some other fortified bolster surface intended to be locked in by a jack.

In this way, the item has been produced considering all the above prerequisites. This specific outline of the mechanized screw jack will end up being gainful in lifting and bringing down of burdens.

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