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# DESIGN, CONSTRUCTION & RESULT OF AN SOLAR POWERED TOGGLE JACK MECHANISM

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## ABSTRACT:

Toggle jacks are simple mechanism used to drive large loads short distance and to lift heavy loads. It also have the advance feature of rotating the parts about their axis where there is not enough space to move the load. The power screw design of a common toggle jack reduces the amount of force required by the user to drive the mechanism. Most of the toggle jacks are similar in design, consisting of eight main members out of whom four are driven by power screw and rest of four by loading condition. A screw is moving part and the nut is stationary part. Both part always works in meshing condition. Therefore these are stresses like shear and tensile stresses induced in materials which are responsible for failure of screw. Different materials of screw and nut can induce different magnitude of stresses so it is necessary to select a pair of material combination in such a way that a pair gives induced stress within safe limit.

**Key Words:**

Critical Load, Max Shear Stress, Max Tensile Stress, Screw-Nut Materials, Toggle Jack

## INTRODUCTION:

A toggle jack is a device which lifts heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Car jacks usually use toggle advantage to allow a human to lift a vehicle by manual force alone. More powerful jacks use hydraulic power to provide more lift over greater distances. Toggle jacks are usually rated for maximum lifting capacity. Photovoltaics' is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. Photovoltaic power generation employs solar panels composed of a number of solar cells containing a photovoltaic material. In today's developing world, the extent of automation is obviously the foremost focus of engineers. But, the automation does not reach to the poorer section of the society as the automation is costly affairs. In a screw jack, rotary motion is converted into linear motion. There are stresses like shear and tensile stresses induced in materials which are responsible for failure of screw. Screw jack must consist of an adequate factor of safety and must be of high mechanical advantage, so that it can withstand sudden jerks which are unexpected. One of the flat surfaces of the screw jack is placed on ground and another flat surface on top side is used to lift the car. A lot of effort is

required for moving the screw jack manually and many times it becomes difficult to operate for an inexperienced person. Though a lot of work has been done in automated solar powered screw jack but only limited work is available for its analysis and mathematical model in automotive vehicles. The present research work is related to design and development of toggle type automated screw jack system using solar energy. A toggle jack is operated simply by turning a small crank that is inserted into one end of the toggle jack. This crank is usually "Z" shaped. The end fits into a ring hole mounted on the end of the screw, which is the object of force on the toggle jack. When this crank is turned, the screw turns, and this raises the jack. The screw acts like a gear mechanism. It has (the screw thread), which turn and move the two arms, producing work. Just by turning this screw thread, the toggle jack can lift a vehicle that is several thousand pounds.

## PRINCIPLE OF OPERATION:

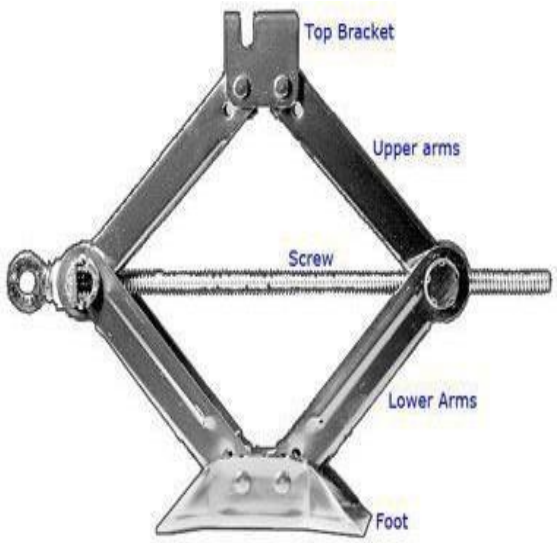
The lead screw is considered as an inclined plane with inclination α. When the load is being raised or lowered, following forces act at a point on this inclined plane. Load (W): It always acts in vertically downward direction Normal reaction (N): It acts perpendicular (normal) to the inclined plane. Frictional force (μN): It acts opposite to the motion. When the load is moving the inclined plane, frictional force acts along the inclined plane in downward direction and when the load is moving down the inclined plane, frictional force acts along the inclined plane in upward direction.

## CONSTRUCTION:

A toggle jack has four main pieces of metal and two base ends. The four metal pieces are all connected at the corners with a bolt that allows the corners to swivel. A screw thread runs across this assembly and through the corners. As the screw thread is turned, the jack arms travel across it and collapse or come together, forming a straight line when closed. Then, moving back the other way, they raise and come together. When opened, the four metal arms contract together, coming together at the middle, raising the jack. When closed, the arms spread back apart and the jack closes or flattens out again.

**COMPONENTS USED:**

- Toggle Jack:




- Typical Toggle Jack:

- **Working of Toggle Jack:**

➢ The jack can be raised and lowered with a metal bar that inserted into jack.
➢ The operator turns bar with his hands in a clockwise direction for makes go up.
➢ When screw lifts load on the platform which placed above will also be raised.
➢ The bar is turned until the jack is raised to level needed.
➢ To lower the jack the bar is turned in opposite direction.

A toggle jack uses a simple theory of gears to get its power. As the screw section is turned, two ends of the jack move closer together. Because the gears of the screw are pushing up the arms, the amount of force being applied is multiplied. It takes a very small amount of force to turn the crank handle, yet that action causes the brace arms to slide across and together. As this happens the arms extend upward. The car's gravitational weight is not enough to prevent the jack from opening or to stop the screw from turning, since it is not applying force directly to it. If you were to put pressure directly on the crank, or lean your weight against the crank, the person would not be able to turn it, even though your weight is a small percentage of the cars.

- DC Motor:

- Solar Panel:

Solar plate is used to absorb the solar energy and stored it in from of electrical energy into the dc battery connected to the solar plate.

- **Working:**

The DC Motor is the motor which converts the direct current into the mechanical work. It works on the principle of Lorentz Law, "the current carrying conductor placed in a magnetic and electric field experiences the force.

• Specification of DC Motor:

1) Power 80 Watt.

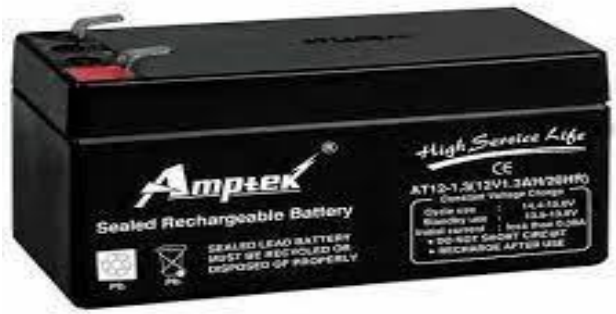
2) No load current 2 amp.

3) Full load current 8 amp.

4) No Load Torque 10Nm.

5) Full Load Torque 50Nm.

- Battery:



A battery works on the oxidation and reduction reaction of an electrolyte with metals. When two dissimilar metallic substances, called electrode, are placed in a diluted electrolyte, oxidation and reduction reaction take place in the electrodes respectively depending upon the electron affinity of the metal of the electrodes. As a result of the oxidation reaction, one electrode gets negatively charged called cathode and due to the reduction reaction, another electrode gets positively charged called anode. The cathode forms the negative terminal whereas anode forms the positive terminal of a battery. To understand the basic principle of battery properly, first, we should have some basic concept of electrolytes and electrons affinity. Actually, when two dissimilar metals are immersed in an electrolyte, there will be a potential difference produced between these metals.

## COMPONENTS OF PROJECT:

1. DC Motor
2. Solar Panel
3. Jack
4. Battery
5. Tools
6. Base Plate
7. Electrical Material

## SAFETY INSTRUCTIONS:

1. The motorized jack works on 12 volt dc supply.

2. Never place yourself or anybody under the vehicle during tire changing operation.

3. Do not use jack on soft ground

4. The motorized jack is designed to lift and lower the low motor vehicles. 5. Jack should be keeping firmly under the vehicle.

## OPERATING INSTRUCTIONS:

Park your vehicle safely away from traffic and on flat surface.

1. Put hazard lights ON .place a safety triangle about 10 meters behind to warn other road users.

2. Ensure that vehicle parking brake is firmly ON.

3. Ensure that vehicle gear box is placed with FIRST GEAR.

4. Remove motorized jack from vehicle and position it so that it is directly under the vehicle jacking point.

5. Keep the jack firmly and press the button according to requirement.

6. Press buttons on control switch according to raising and lowering requirement.

7. After completing the work remove the jack under the vehicle keep in vehicle.

**Results and Discussion:**

Having gone through the detailed design calculations, it becomes necessary to put the respective elements together to form a system represented in Fig. 1. Similarly, Fig. 2 shows the engineering drawing of the solar powered Toggle jack as conceived and fabricated.

The design and development of a solar powered Toggle jack useful in lifting and lowering heavy objects in our industries has been done using available local materials as seen in the Figures.

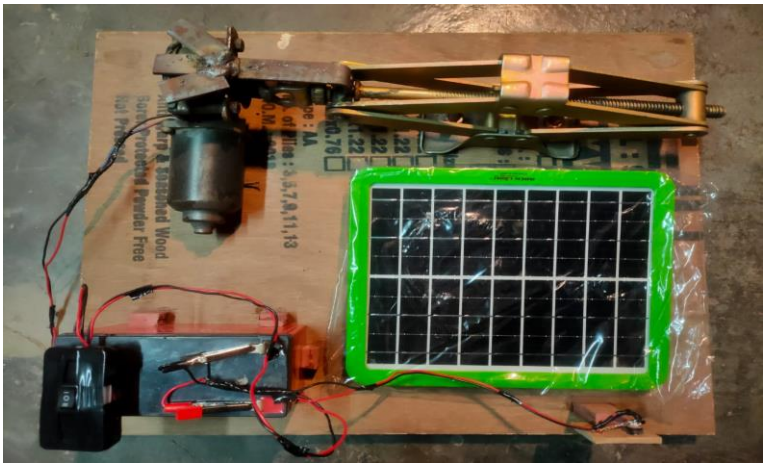
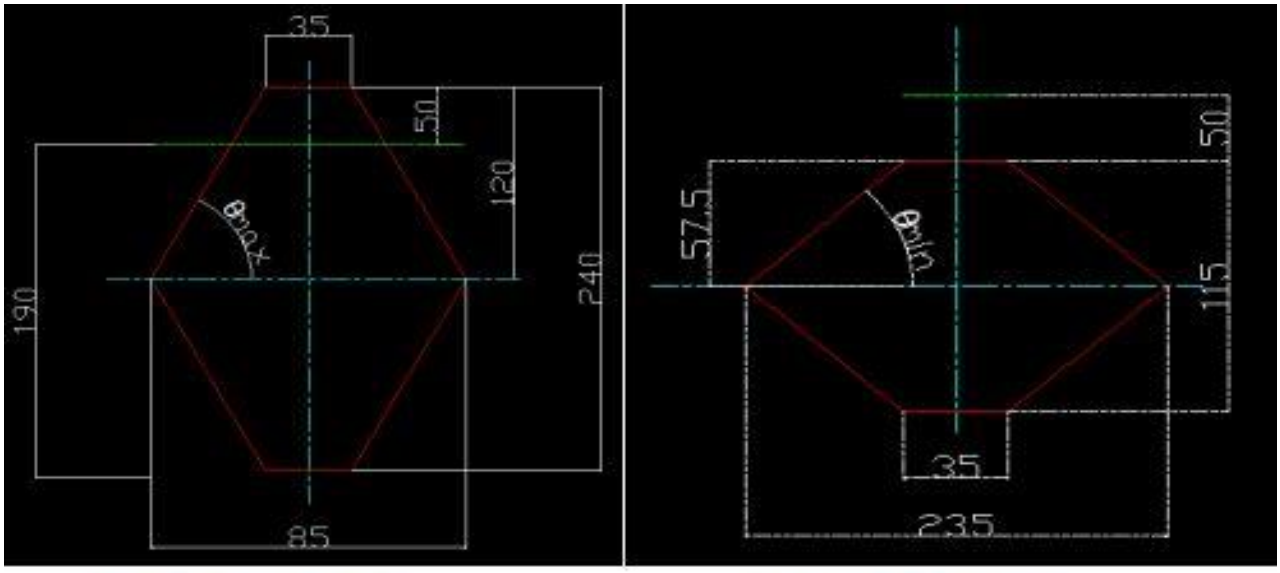


Fig. 1: Diagram of the assembled solar powered Toggle jack




Upper condition lower condition

Fig. 2: Dimensional details of the used developed Toggle jack

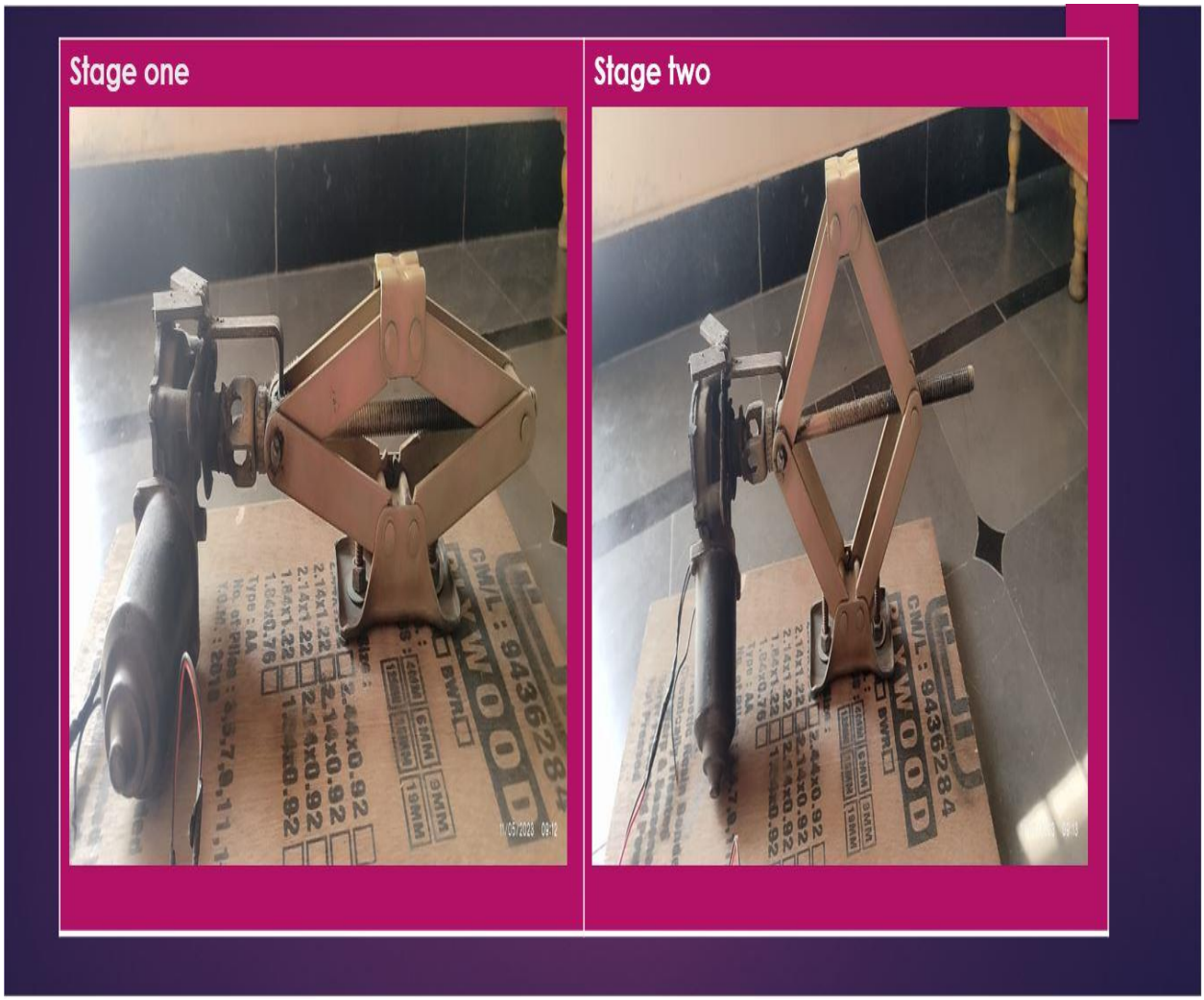



**Image of Jack lower & upper position**

## APPLICATIONS:

1. It is useful in auto-garages.

2. This motorized scissor jack is used for lifting the vehicles.

3. This type of motorized scissor jack can be lift the vehicle load up to 1.5 ton.

4. A solar powered Toggle jack useful in lifting and lowering heavy objects in our industries has been done using available local materials

## FUTURE SCOPE:

• As project is on the automated scissor jack of 1.5 ton capacity. Some modification will be there to make such as lifting capacity of jack can be increase. Also we can change the gear arrangement as project is completed using compounding gear train in future single stage gear train can be used. As in future different types of gears will be used like helical, worm and worm gear etc.

• In case of failure of source the jack can be made detachable. This can be lifted with the help of tommy bar.

## CONCLUSION:

Toggle screw the solar driven automated jack is put under various force analysis so that its performance criterion will not fail in operation. Following conclusion are determined through the appropriate calculations and practical demonstrations a mathematical model was framed to estimate the power requirement at various loading conditions. The model worked effectively in wide range of loading conditions to estimate the power requirement and experimentally validated. Torque required decreases with increase in load.

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