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A Review on Failures of Scissor Jack

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ABSTRACT

This paper relates to a review on failures of scissor jack which is generally used for lifting light motor vehicles (L.M.V) during maintenance. This review is focused on finding various stresses and expected life of various parts of scissor jack like power screw, base plate, etc.

Keywords: Scissor Jack, Failures.

I. INTRODUCTION

The scissor jack is one of the most important mechanical components used for lifting of load in application such as cars, lifts. The cost of jack is a major concern and has forced people to look for alternative jacks that are available abundantly and are cheaper and compact. The different alternatives available are like scissor jack, hydraulic jack, pneumatic jack, floor jack, etc. Amongst these alternatives available, scissor jack is widely used for lifting vehicles. A scissor jack is the most common type of jack which may have encountered as there jacks comes along with cars. It is used for road side repairs. They are light in weight and the cost of the scissor jack is reasonably small and scissor jacks are easy to store and easy to operate at any time and any place in the different environment condition. It is use for the average consumer / vehicle owner. It is simple in design and working, it is having some component like carrier plate, upper arms, lower arms, base plate, middle pins and power screw. The jack is working on the scissor lifting mechanism. The power screw is the heart of scissor jack and scissor jack lift the load with the help of screw and nut interaction of power screw and middle pin. Scissor jack lift the load due to which the rotation motion is converted into linear motion and due this motion it is easy to lift the load and different range of scissor jacks are available according to the different load.

II. LITERATURE AND EXPERIMENTAL EVIDENCE

Screw type mechanical jacks were very commonly referred in jeeps and trucks at World War II vintage. For ex., the World War II jeeps (Ford GPW and Willis MB) were introduced with the Jack, Screw type, Capacity 1 1/2 ton, Ordnance part number 41-J-66. In those days, the 41-J- 66 jack was carried in the jeep's tool box. Screw type jacks preferred continued for small capacity use due to minimum cost of production for raise or lowers the load. It had negligible maintenance. The concept of using a screw as a machine was first demonstrated by Archimedes in 200BC with his device used for pumping water. There is also evidence that screws were preferred in the Ancient Roman world. But, in the late 1400s, the Leonardo da Vinci, who first displayed the method of

use of a screw jack for lifting the loads. Its design used a threaded worm gear, supported on bearings, which is rotated by the turning of a worm shaft to drive a lifting screw to move the load instantly recognizable as the principle used today.

Thomas J. Prather (2009): In this, there was a introduction about vehicle lift system. A drive assembly was mechanically coupled to the piston. The drive assembly was operated in first direction to raise an upper end of the piston with respect to the housing. The drive assembly was operated in a second direction to lower the upper end of the piston with respect to the housing. The drive assembly was coupled to the power supply port which is removable to supply electrical power to the drive assembly.

Farhad Razzaghi (2007): In this, electrically powered jack shown for normally raising and lowering of automobile from ground surface. The mechanism may be used in joining with a typical portable car jack, during which the mechanism constitutes a power drill, a rod, and a numerous jack adapters.

Manoj Patil (2014): In this general article, screw jack is to developed to overcome the human effort. It is actually difficult job to operate for pregnant women and old person. Changing the tire is not a pleasant experience. Especially women can't apply more force to operate. For that, electric operated car jack is introduced

Lokhande Tarachand (2012): This paper referred to optimise the efficiency of square threaded mechanical screw jack by varying different helix angle.

Thrugnanam, Amit Kumar &Lenin Rakesh (2014): - This paper studies design and analysis of screw jack using Pro-E and ANSYS under torque and compressive force as loads, in this analysis determines shear stress induced at the cross section square thread under bearing pressure. Objective of this paper is to study shear stress state of power screw have been considered following design values, Pitch = 6, *Dc* = minor diameter = 30 mm, *Do* = major diameter = *dc* + pitch = 30 + 6 = 36 mm, with the help of this The power screw is designed according to the design process and analyzed using ANSYS software. Model developed is to be validated using theoretical calculations.

Patil Manoj, Nilesh & Udgirkar Gaurav (2014):-This paper deals changing tire effort requirements and that comfort of women in the automobile 4 wheeler vehicles. Women require more effort in the changing tires by using existing manual screw jack. This project concluded that less effort is applied with motor attachment in the modified design; the power screw is rotated through its gear power transmission using electrical power flows through it. Scope of this project is Performance enhancement need to be developed

Egwero Oghenekome,Oladimeji Tolulolope (2014):- This paper involve designing system and also building a unit which could be used to raise up, any car as controlled by receiver and transmitter. Microcontroller controls the receiver circuit. It also consists of designing of an infra-red transmitter circuit which can transmit coded frequency. Scope of this project is to develop the controller to operate screw jack & enhance performance and at the same time minimize the cost of screw jack system development.

Gaurav Shashikant Udgirkar (2014): -Described in their paper, emergency like tire puncher, is a problem mainly we see in cars. Traditional car jacks use mechanical advantage to allow a man to raise up vehicle by manual effort. In this work they used electrically operated Toggle jack using power of car battery. Lifting power increased by the gear ratio. Significance and purpose of this work is modifying existing car jack so that operation can be easier, safe & reliable so that it can save individual's energy
& minimize health risks and problems associated with doing work in a bent or squatting position for long time off period. Car jack developed using software

CATIA &is being analyzed by making use of FEA for checking safety factor & force acting.

Sonu Yadav (2014): -As per this research paper, discussed solar power operated screw jack and cost incurred, operating, making cost is high They used external battery power operating on solar energy, The solar driven automated toggle screw jack is put under various force analysis so that its performance criterion will not fail in operation. Conclusions 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 condition.

To study the reliability and performance of scissor jack, it is tested under various conditions for failure analysis. In this case we will get to know the effectiveness & performance of scissor jack on field, when customer implements it for replacing the tire. The failure analysis is conducted under following cases.

Case I: Justification for failure analysis:

This analysis is required to be conducted due to its critical application under emergency; also it is essential due to following reasons:

A. Impact of the problem

- Impact on customer:
  1. Affecting safety of customer.
  2. Dissatisfaction of customer.
- Impact on Departmental goal:
  1. Quality indicators effected.
  2. Increase in warranty cost.

Case II: Diagnosing the problem:

In this case, the actual area where the jack is failed is detected. Practical tests are conducted for this analysis by physically replacing the jack and results are calibrated for getting the solution by operating the jack for replacement of tire of Bolero. Following results are concluded by performing this case:

Failure I: Arm teeth wear:

The scissor jack is failed due to wear of teeth on both links at lower end. Due to this the jack gets toppled as shown in figure below. Due to the use of jack over and over again, the teeth starts getting wear and after certain time the jack gets toppled from actual position as shown below:

Figure 1 Fig. Teeth Wear of Lower Arm [1]

Failure II: Screw Failure:

This failure is caused after using the jack for certain amount of time. Due to excessive use and high impact on screw, it starts getting wear. Due to this the jack gets toppled from its actual position as shown below:

Figure 2 Fig. Failure of Screw and Arm Teeth [2]

Figure 3 Fig. Toppled Scissor Jack due to Arm teeth [3]

Failure

Failure III: Jack head failure:

After certain duration and use of jack the head of jack starts bending due to the fatigue load acting continuously again & again over the head as shown in figure below. This defect occurs due to improper design of shape and geometry of existing head design.

Figure 4 Failure of Jack Head [2]

Due the fact that power screw nut and screw mate each other with rubbing surfaces the produced friction is much higher compared to other machine elements which mate with rolling surfaces such as bearings. This is the main reason why the degree of efficiency for power screws is between 25 and 70 %. Due to the low degree of efficiency, power screws cannot be used in continuous power transmission applications. This high friction causes the threads to wear out very quickly and the nut or screw had to be replaced. This thread wear can be reduced to a certain extent by changing the thread geometry (profile). According to this, power screws are classified by their thread geometry. The most common are the V, Acme and Buttress profiles. All these profiles are derived from the basic thread profile for power screws, which is the square thread. The square thread profile is the most efficient having the least friction but they are the most difficult to machine so that they are used just for screws that carry high power. The Acme profile has a 30 º profile angle which makes it easier to manufacture but has increased friction caused by the profile angle. Buttress threads have a 3 º profile angle which makes them as efficient as square threads but are easier to manufacture. It`s disadvantage is that it is used where the load force on the screw is only applied in one direction.

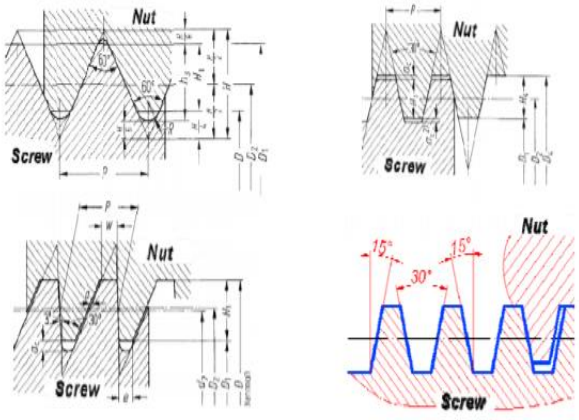

Figure 5 Different thread profiles a) V thread b) Acme thread c) Buttress thread d) New thread [15]

It should be noted that V-threads are less suitable for power screws than other thread profiles such as Acme because they have more friction between the threads. Their threads are designed to induce this friction to keep the fastener from loosening where the power screw follows a totally different design concept which

implies to hold the friction low and so raise up the efficiency.

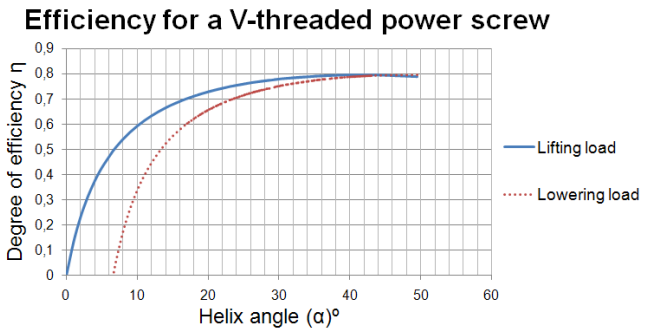

Figure 6 Degree of efficiency plotted against the helix angle for a V-threaded power screw [16]

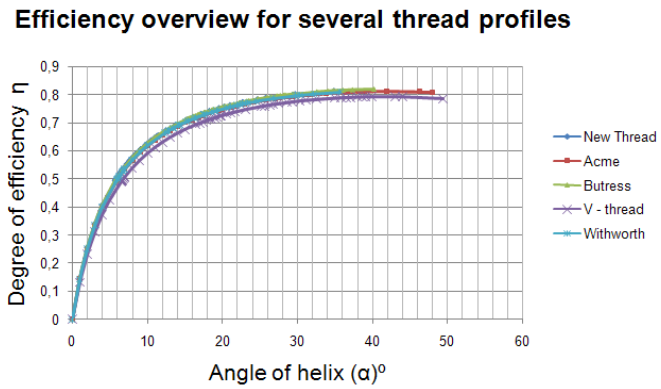

Figure 7 Efficiency comparison between different thread profiles [16]

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. (Comparison on basis of data given in materials and heat treatment processes by o.p. khanna). Component number 4, 5and 17will all use the High Strength Low-Alloy Steel (40Ni2Cr1Mo28 / AISI 4340), material is selected on bases of application.

III. CONCLUSION

The review shows that alloy steel for screw and phosphorus bronze for nut is the best suitable combination for pair. The value shows that if there is a combination of MS – MS, it induces less magnitude of bearing stress in nut. Based on the input parameter & result obtain from the design, as the helix angle increases the efficiency increases up to certain limit after which it decreases, the critical load decreases, the number of threads decreases, turning moment reduces, outer diameter decreases, core diameter decreases, the pitch does not change it remains constant up to certain value & then it reduces.

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