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Analysis and Modification of Scissor Jack

Ekhalak Ansari, Udham Singh, Vikas Jangid, P. S. Raghavendra Rao
Department of Mechanical Engineering School of Engineering and Technology,
Jain University, Bengaluru, Karnataka, India

ABSTRACT
Every manufacturing product requires cost efficient method and its variation in application maintaining its natural structure as well as assign service life keeping failure parameters in mind we are focused on our intention of designing, modifying and analyzing the jack model for actual loads for varying models on different applications. We are keen at making the scissor jack cost effective and at the same time maintaining its strength and life span. Also the new design that made by SOLIDWORKS software can be tested by ANSYS software. The overall strength of the jack is relatively more compared to commercially available screw jacks. Car jacks that are commercially available has some disadvantages such as required more energy to operate, not usable for aged people and cannot be used on the uneven and rough surface. The main purpose and significance of this paper is to design, optimize and standardize the current toggle jack to make the task easier and reliable.

Keywords: *Scissor Jack, Ansys, Solidworks, Analysis, Modification*

1. INTRODUCTION

A jack is a mechanical device which is used to lift device in order to lift heavy loads or to apply great forces for certain specific purpose. The most common form of a jack is car jack, floor jack or garage jack, which lifts vehicles so that the operation can be performed. A scissor jack is a device formed with a cross hatch mechanism similar to that of a scissor so as to lift up a vehicle for repair and maintenance.

Fig.1: Scissor Jack

The scissor jack has a screw thread which turns and thus moves the two arms producing necessary work. The rotation of a screw thread causes the scissor jack to lift a vehicle that weights several thousands of pounds. We have used the traditional scissor jack to make a certain modification and then also work on its analysis. The design of this device will make it more user friendly. The addition of extra parts will add more strength but does not occupy more space as it can be again retracted back to its contact position. The main advantage of this project is to improve the stability and strength. The final product will be newly modelled and provide new approach of modification.

2. Background Work

1) Norman J. Glomski, Kim K. Jackamn "Vertical body with powered lift type tail gate" This relates to vehicle bodies with tailgate lifted to open and close with minimal effort. It does so by providing vehicle design a sideways type of swinging tailgate that swings about vertical axis to open and thus reduces the effort. It offers a simple, cost effective, space saving, easy to install powered

actuator that operates to lift tailgate with reduced effort and also can be operated manually if required.

2) Manoj R Patil, S D Kachave, "Design and Analysis of Scissor Jack" This paper uses the traditional scissor jack and deals with removal of perm ant welds as chances of failure in that area is more. These welds are replaced by rivets. Absence of welds will give less deflection and large accuracy. It also considers the cost estimation and try to reduce unnecessary costs .the main objective of this is to reduce no of parts by simplifying assembly process, remove welding to avoid distortion and reduce weight of jack by changing manufacturability.
3) C.S Dhamak, D.S Bajaj, V.S Aher, G.Nikam, "Design and Standardization of Scissor Jack to avoid Field failure" In this Paper, a unique design of scissor jack is compile to lift low as well as heavy load with different conditions. The main purpose and significance of this paper is to design, optimize and standardize the current toggle jack to make the task easier and reliable. Catia is used to develop and analyze the scissor jack. Mathematical model of design procedure is also made which is supposed to help in standardization of scissor jack design by using MATLAB.
4) Shoei D. Chang, Huey S. Liaw, "Motor driven scissor jack for automobiles" This relates to use of motor driven scissor jack which is using electric power source from cigarette lightening socket of any automobile. The DC motor is driven through deceleration gear box for rotating screw rod clockwise and anticlockwise for raising and lowering of frame. It is also provided with one ultimate switch thus limiting the peak and low break points and prevent it from collapsing thus increasing the safety of the operation.
5) C.S Dhamak, D.S Bajaj, V.S Aher, "Design and optimization of Scissor Jack" This project aims at designing and analysing scissor jack models for various model of automobile. It changes the original one and modify them without sacrificing strength and service life. The failure mode is studied and mathematical model is made analytically as well as theoretically. The modelling is carried out on CATIA and the mathematical model is tested by ANSYS software

3. Problem Statement

- The traditional jacks require more strength in order to lift any device and not suitable for aged and handicapped people.
- Since the width of the base track of the jack is less, it leads to instability during operation and hence reduces work efficiency.
- The normal jacks will be manually operated and hence it enhances risk and reduces safety.
- The welded joints increase tendency of deflection and distortion and eventually lead to failure.
- Due to the diamond shape of the jack, it is more prone to failure and can be used mostly for light-duty work.

4. Objectives

- To increase the width of the base by addition of extra metal plates for improving the stability as well as the strength.
- To modify the existing design in order to increase the load bearing capacity.
- To make the jack automatically operated by using a 12v motor that runs by car battery.
- To use a pneumatic gas spring that reduces the effort required to lift the required equipment.
- To analyse and compare factors such as stress, strain, deflection on both the traditional and modified scissor jack by using ANSYS software.

5. Methodology

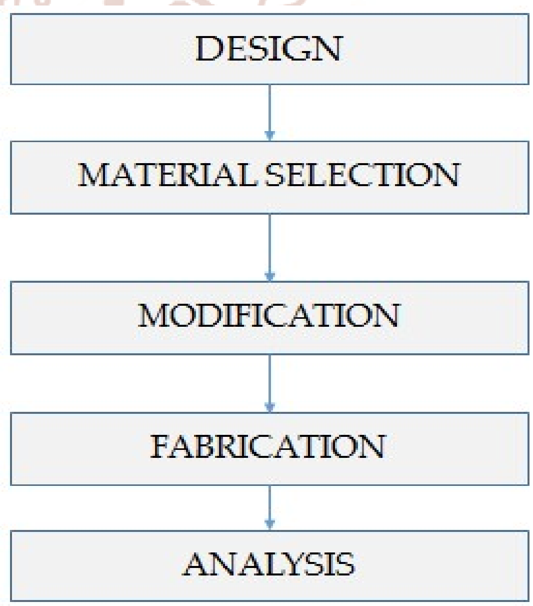

Fig.5: Proposed System

5.1 Material Properties

All the jack devices are generally made up of mild steel. So, the additional material that is considered for this device is mild steel (structural steel) as it will provide same operating properties. The material will be completely designed on plain carbon steel. It provides more resistance to the load before undergoing any strain and deformation. The pneumated gas spring is made up of aluminium and thus is lighter. Some of the properties of materials that are considered are given in the table below.

Density	7850 kg/m3
Coefficient of thermal exp.	1.2e^-5 /c
Specific Heat	434 j/kg/c
Thermal conductivity	60.5w/m/c
Resistivity	1.7e^-7 ohm m
Young's modulus	2 e^11 N/m2
Poisons ratio	0.3
Relative permeability	10000
Reference temperature	22 c
Compressive ultimate strength	0 pa
Compressive yield strength	2.5 e^8 pa
Tensile ultimate strength	4.6 e^8 pa
Tensile yield strength	2.5 e^8 pa

Fig.5.1: Material Properties

5.2 Experimental Methods

The design of this device is done on SOLIDWORKS software and the necessary analysis is done on ANSYS software. For the design part, the fine mesh is used mostly as it is most common. After the design, both the jacks (before and after) modification will undergo analysis where factors such as stress, strain and deflection are obtained and compared.

5.3 FINE MESH

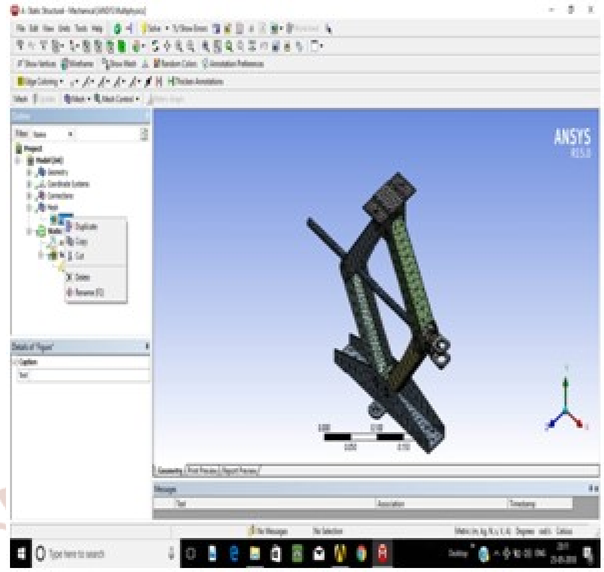

Fig.5.3.1: Fine Mesh before modification

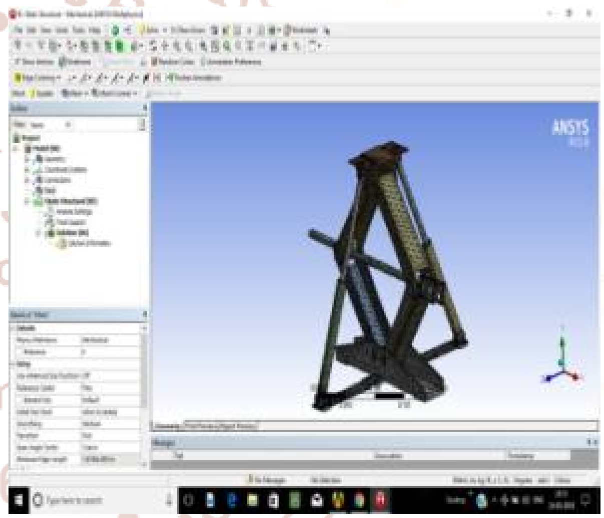

Fig.5.3.2: Fine Mesh after modification

5.4 ANSYS PROCEDURE

- Static-Structural (ANSYS)-(Double Click)
- Engineering Data-Add Material
- Geometry-Impart Geometry-Select material (ok)
- Model-Edit (ok)
- Mesh-Sizing-Relevance Center-Fine
- Mesh-Update mesh
- Static-Structural-Insert-Fixed Support-Select from model-Apply
- Static-Structural-Insert-Force- Select from model-Apply
- Solution-insert-Deformation-Total

- Solution-Insert-Strain-Equivalent (Von Mises)
- Solution-Insert-Stress-Equivalent (Von Mises)
- Solution-Insert-Solve

6. Results And Discussions

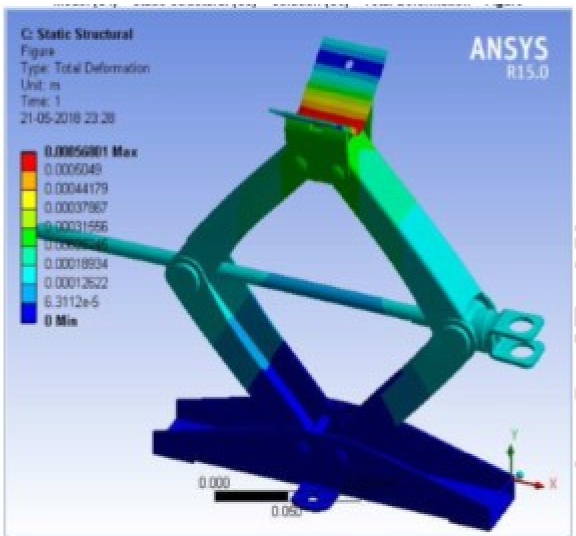

Fig.6.1: Total deformation (Before modification)

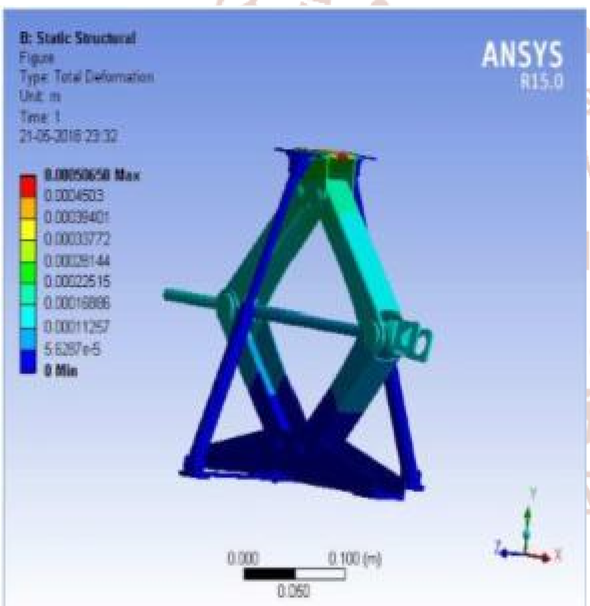

Fig.6.2: Total deformation (After modification)

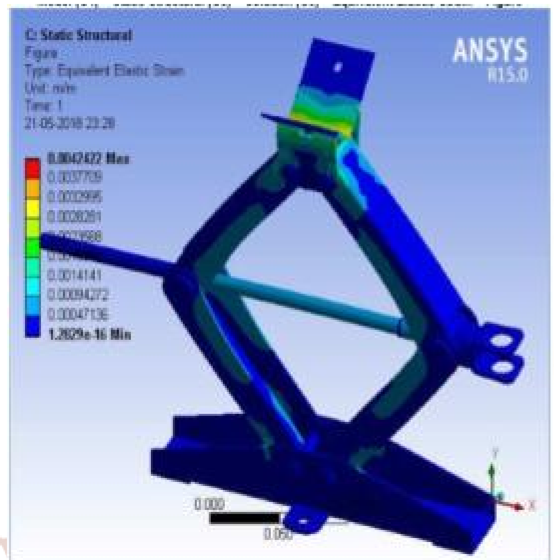

Fig.6.4: Equivalent Elastic Strain (Before modification)

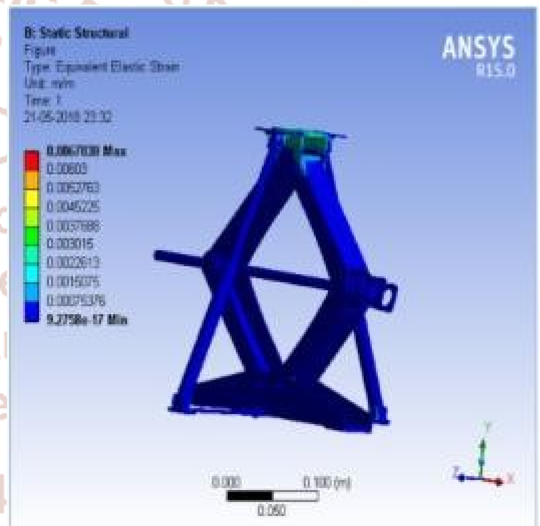

Fig.6.3: Equivalent Elastic Strain (After modification)

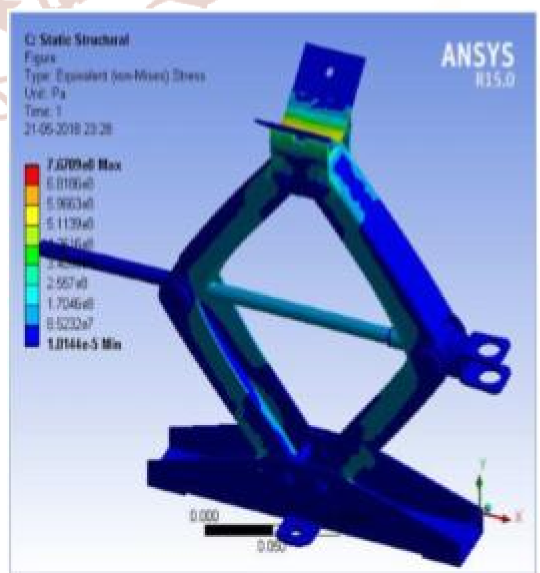

Fig.6.5: Equivalent stress (Before modification)

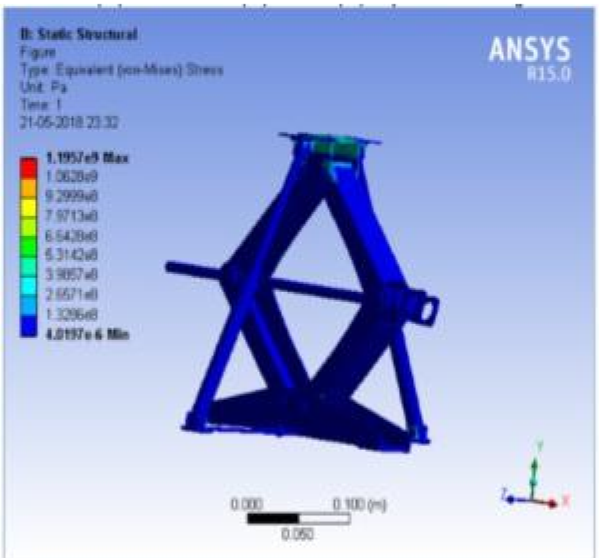

Fig.6.6: Equivalent stress (After modification)

The results obtained shows significant increase in stress bearing capacity thus ultimately increasing the life span of the device. The strain obtained by analysing the both parts indicates that the modified one can prevent the elongation or change in physical. The modified structure will provide more resistance to any distortion as its deformation value is higher.

7. Conclusion

The Design and Analysis of the Scissor Jack is done on SOLIDWORKS and ANSYS software. The model of the traditional scissor jack is modified by using several additional parts such as gas spring, metal plates. The stress, strains and deformation are calculated and compared to that of the normal one. The compared result that has been obtained proved to be optimized and has provided further scope of improvements. The device has been made and it is showing positive results. If it is made in a larger size, it can further be utilized in an automotive as well as other industrial sectors. The extra addition parts that are added are cost effective and prove to be more efficient. The newly formed device can be operated automatically as well as manually which most of the traditional scissor jacks are. It can be operated at even non-uniform surfaces providing great extent of stability. It significantly reduces the effort that is used for the operation of the jack. This also occupies the space very less as the gas springs can be folded very compactly to the body. Overall, the performance of the jack is enhanced and provide a great deal of future use.

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