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Design and Optimization of a Scissor Car Jack for Improvement in Operation

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Abstract- Scissor Car Jack available in the vehicle, are the basic needed equipment in the replacement of tire and relevant works. Jacks are defined as manually operated, hydraulic, pneumatic or motorized automated load lifting device. These available jacks are rarely used in the absence of mechanic or vehicle punctured in remote location, where nearby garages not available or in case of in-house maintenance. As it is completely mechanical and manually operated jack, it has some disadvantages too. Hence to reduce this defect some modifications are done and that are explained in this Paper. The Aim of this modification is, to achieve better results in terms of parameters like functionality, weight and optimistic Model. In this project with the help of some research papers and realistic experiences problems were defined and their resolving methodology is plotted.

Keywords:- Scissor Jack, Kerb weight, loading, and lead screw etc.

I. INTRODUCTION

Screw operated screw jacks have long been known to be useful in lifting applications and especially in situations where it may be desired to level heavy objects. A Particular type of well-known screw operated jack employs a double lead acme screw.
That traditionally has proven to particularly advantageous where extremely massive objects need to raised quickly.

One industry in which jacks have double lead acme screw have been widely used is railroad industry, where the need often has arisen to lift locomotives and rail cars from train tracks for this and similar types of lifting job double led acme screw.

The scissors jack is an adaptation of the screw jack Tire replacement need high efforts to apply in non-ergonomic body condition. This will result in body ache and it is uncomfortable operation. Vehicle load is in tones and to lift quarter of this load healthy person are required. Hence some modifications were done in the actuation area of jack so as to improve the functionality of Jack like battery operated or motorized and geared phenomenon are used to reduce the efforts required in loading of jack.Concentrated areas are studied with the help of literature and also with the guidance of technical industrial persons Variation in the cross Section. Structural stability of jack and reduction in material are the major areas covered in modification

1. Objectives:

- To design a scissor jack, such that it can withstand load of vehicle efficienciently.
- To optimize structure by reducing unnecessary portion of material and that in involving structural stability.
- To reduce efforts required in raising the vehicle load.
- To provide structural stability against bending and sliding of loaded jack on lateral sides.
- To guide & control movement of jack's top in the plane of jack.
- To obtain ease of operation with minimum maintenance.
- To improve the functionality of connecting rod,

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2. Problems in Existing scissor Jack:

- With reference to real life experiences and research papers following problems were identified in the existing model.
- Car Jack is heavy operational equipment and it requires rigorous human efforts to lift the load of vehicle.
- Existing scissor jacks are based on power screw principle, hence required to apply large number of efforts in rotational direction.
- As the Nut dimensions are small, extra connecting features need to add to lift the load. hence connecting bended rod is provided and as the surface is smooth, it will cause loss of efforts due slippage and sliding of connecting rod.
- As Jacks, width is comparatively small than length & height, there may be chance of sliding, bending and major accident when jack is loaded by car weight.
- Need to Provide Structural stability to avoid accidents. As at the operating condition ground may be sloppy or slippery
- Efforts required to raise load are easily applied by healthy young people but in case of emergency old age people, women are unable to operate the jack at such a high loading.
- Failure of Jack head after periodic loading.
- Toppled Screw jack due to arm teeth wear after certain Period of use.

II. METHODOLOGY FOR MODIFICATION IN JACK

- Identification of problems and advantages of existing scissor jack
- Observation of operating condition and as per that prediction of forces and constraints applicable to jack
- 3D CAD Modeling of existing jack named as Base model
- Static structural analysis of Base Model as per designed load and fixation conditions
- Drawing conceptual modification sketches and checking for validation of models
- After selecting best modification model best modification's 3D CAD modeling
- Analysis of modification model in the iterative approach
- Comparing the results and conclusion.

III. LOADING AND BOUNDARY CONDITIONS

Considering the vehicle, Swift with,

Kerb Weight=1200kg

Assuming quarter loading on one wheel = 300kg,
In the worst-case Scenario assuming 500kg Weight

=500 x g (acceleration due to gravity)
=4905

Force applied to be Approx. 5000N,

In the View of Fixation Base of jack is fixed in all DOF and Force is to be applied on top face, in the opened(loaded) condition of Jack

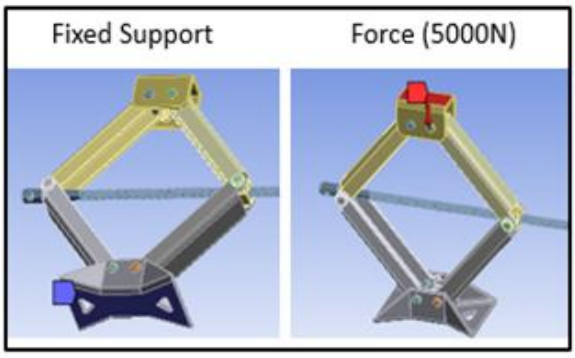

Fig 1. Force applied.

IV. BASE MODEL RESULTS

Base model consists C channel type Arm Members. Engaged such that diagonally load bearing happens, Stress observed in the arm member (low carbon steel) as below,

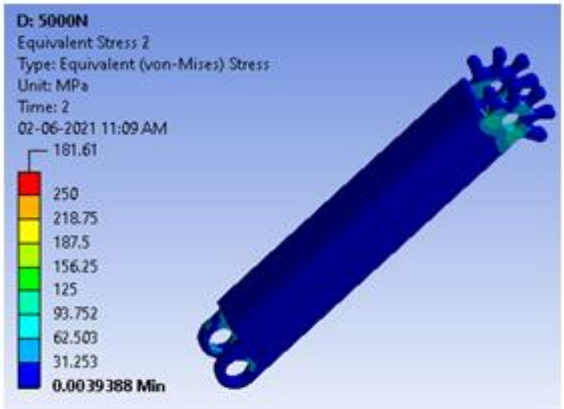

Fig 2. Stress plot (base model).

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And Directional deformation observed is,

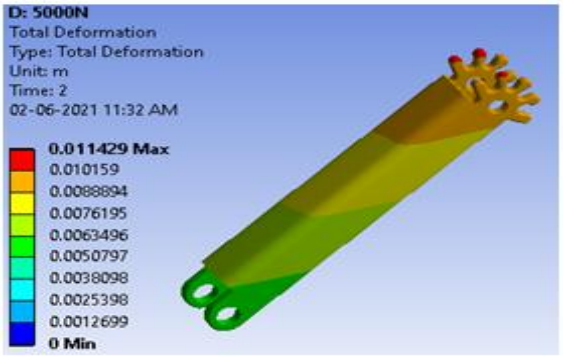

Fig 3. Deformation plot (base model).

Localized stresses observed in notch area, hence there is scope in improvement of cross section

V. MODIFICATION MODEL RESULTS

In the modification model, C type cross section is changed to I section type arm member made by longitudinal slot in the arm member and reduction in material is achieved. Also Notch or Sharp corners are avoided in the stress concentrated area observed in base model. Stresses and deformation observed are as below;

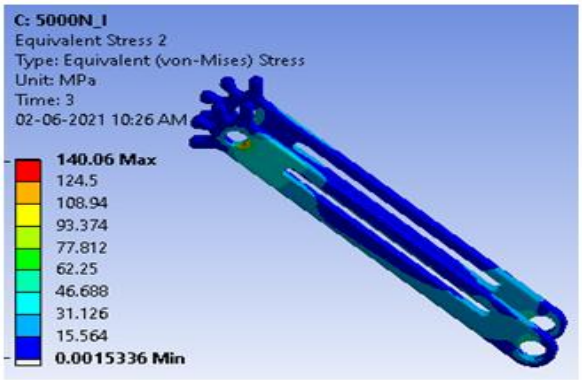

Fig 4. Stress plot (modification model).

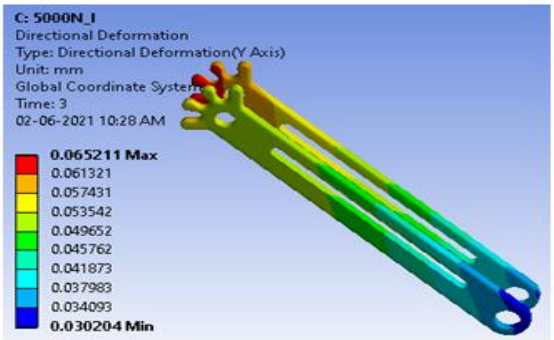

Fig 5. Deformation plot (modification model).

Here stresses observed are less compared to base model and directional deformation is quite similar in both cases. Hence force reaction of model is verified to check whether the total load is taken by the model.

VI. CONCLUSION

In this project, identification problems in existing jack and modification over it is done in the approach of failing criteria, cross section and material reduction. And the results show Improvement in structural capacity and % reduction in material. As this is heavy loaded equipment slight mistake in installation of scissor jack or weak structure may induce major accident and there is chance of heavy injury hence focused area was structural stability in the model. Approximately 11% weight reduction in material is observed in this case

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