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Design and Fabrication of Mechanical Lift for Transportation

Miss. Aishwarya B. Shinde
UG Student
Department of Mechanical Engineering
NBN Sinhgad School of Engineering

Miss. Pranita B. Daphal
UG Student
Department of Mechanical Engineering
NBN Sinhgad School of Engineering

Miss. Pratiksha S. Nilange
UG Student
Department of Mechanical Engineering
NBN Sinhgad School of Engineering

Miss. Vrushali H. Dongre
UG Student
Department of Mechanical Engineering
NBN Sinhgad School of Engineering

Prof. R. K. Nanwatkar
Assistant Professor
Department of Mechanical Engineering
NBN Sinhgad School of Engineering

Abstract

Lift is a simple mechanical device used to raise element or object from ground level to a certain height to perform a specific work with maximum load and minimum efforts. This project describes the design as well as analysis of a mechanical scissor lift which works on the principle of screw jack. The design will be developed keeping in mind that the lift can be operated by mechanical means so that the overall cost of the scissor lift is reduced. Also such design can make the lift more compact and much suitable for medium scale work. Conventionally a scissor lift or jack is used for lifting a vehicle to change a tire, to gain access to go to the underside of the vehicle, to lift the body to appreciable height, and many other applications. But in this case along with lifting a vehicle we are also going to make an effort to move the vehicle to a short distance by incorporating roller mechanism. Finally, the analysis will be carried out in order to check the compatibility of the design values.

Keywords- Scissor Lift, Screw Jack, Hydraulic Lift, Pneumatic Lift, Mechanical Lift

I. INTRODUCTION

Nowadays, on heavy traffic roads or highways, if there is any technical problem in a car there are traffic issues. To avoid traffic problems, we need a mechanism that can lift the car at a particular height and move it aside on the road. So our purpose is to create a mechanism which is operated mechanically by using manual power. Nowadays there are hydraulic and pneumatic lift but in accidental cases or any technical problem it is difficult to carry these systems as they are bulky and also need lot of maintenance but this mechanism is portable and requires less maintenance as compared to pneumatic and hydraulic systems. Now days as every mechanism are getting optimized related to space and portability our aim is to optimize and make a portable lift which is easily accessible and easy to use. The aim is to lift a certain car with a portable mechanically operated lift to do certain work like oil change, under body jobs, car wash etc.

Our aim in this project is to design equipment that would replace or can be an alternate for conventional lifts used to lift cars. To use the mechanical power for lifting car to a certain height. This will help reducing the traffic problems on heavy traffic roads and as we are using mechanical power this will lead to reduce cost of end product as compared to hydraulic and pneumatic based lifts. The main benefit of this model is to reduce the unnecessary cost, reduce the over design, the design will be up to the mark. This model will give new approach to product design. Such as in case of large volume, the cost reduction is more and it will increase the demand of product in market itself. In case of the manufacturing of the scissor jack we can reduce the material of the product by converting the manufacturing process, e.g., Casting into sheet metal, in which the strength of the product remains as it is and the cost of the material will be automatically reduces. Even part reduction by assembly process and no welding joints will give less deflection and the large accuracy.

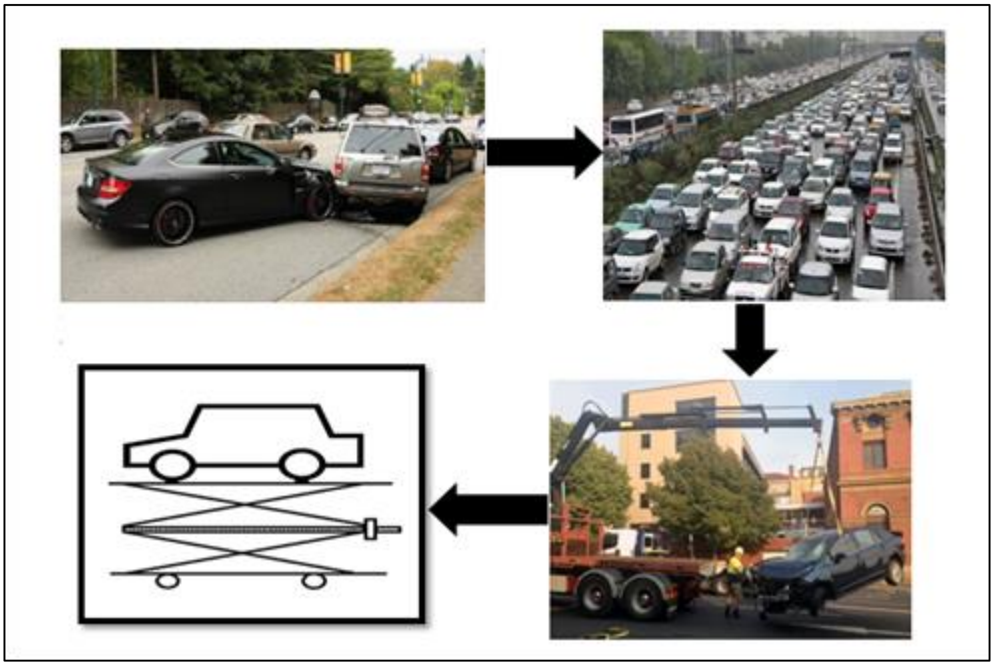

Fig. 1: overview of problem

II. PRINCIPLE

A scissor lift, or commonly called as a table lift, is mainly used to lift people upwards with its crisscrossing foundation supporting beneath the platform. As the platform pulls itself together, it moves upright in the vertical direction and push the platform in accordance with the height and weight. These lifts can be controlled through hydraulic, pneumatic or mechanical power for height extension. Originally delivered in numerous sizes and shapes, it is designed and manufactured as an industrial lift, and has been customized for commercial and comprehensive purposes. Scissor lifts typically operate in two axes of movement and are designed for applications where people and material need only up and down travel (stationary lift), where the lift needs to be moved around to perform work (manually positioned lift), or to access work along a fixed area of travel (rail guided lift).

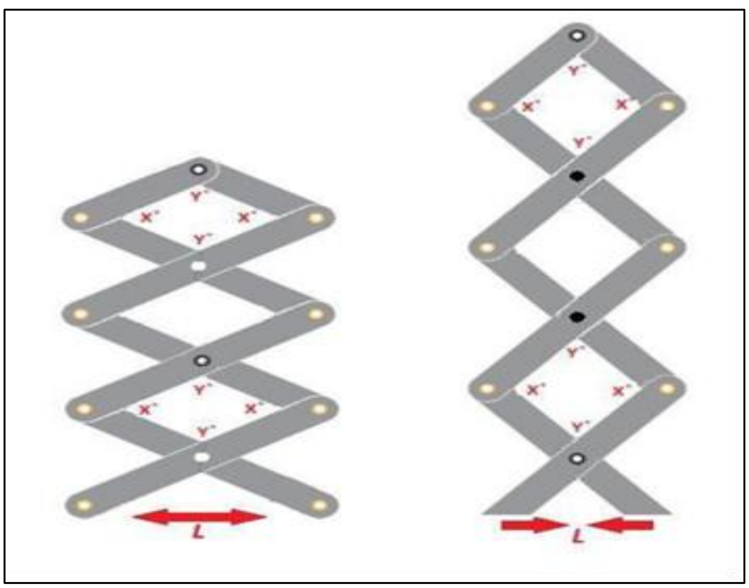

Fig. 2: Scissor Lift Mechanism

A. *Classification*

1) According to Lift Type

1) Single leg set
2) Multiple height

3) Multiple width
4) Multiple length

2) According to Energy Used

1) Hydraulic
2) Pneumatic
3) Mechanical

3) According to Mounting

1) Surface
2) Pit
3) Mobile

Table 1: Comparison between Pneumatic, Hydraulic and Mechanical lift

Types of lifts / Parameters	Pneumatic lift	Hydraulic lift	Mechanical lift
Portability	In this system air compressor is used so it becomes bulky and thus it becomes difficult to carry it on highways.	In this system working fluid is oil and due to its unavailability on highways it is not portable.	Due to use of manual power and lesser weight of the system it is portable.
Maintenance	In this system working fluid is air so there are maintenance problem and on highways it is not possible to maintain this system.	In this system, there are problems such as oil leakage, rust and corrosion so it requires lot of maintenance which is not possible on highways.	In this system, there are mechanical parts and they require less maintenance as compared too other two systems.
Cost	Due to use of air compressor and control valve its cost is higher.	Due to use of hydraulic fluid it becomes costly.	In this system, due to use of simple mechanism hence manufacturing cost is less.
Design	Due to use of various components it is difficult to design	Due to use of various components it is difficult to design	As compared too other two systems it is easy to design.

III. METHODOLOGY

When a Rotating or translational motion is applied to the handle the lead screw attached to the axis of the handle starts revolving. As the two end of the lead screw is connected to both the end of the joints or nodes of the lift the nodes are pulled towards each other and due to the simultaneous movement of the connected links the lift starts lifting upward. The basic principle of this lift is lifting of a car by screw jack as the screw jack lifts the car from one side the pair of this lift will lift the entire car to a certain height and also move the car to short distance using a roller skater mechanism. The main difference between a screw jack and this lift is that screw jack lifts the car partially from one side and it is generally applicable for tire changing when punctured. But this lift will entirely lift the car from ground level to a certain height and the mechanic can perform all the under body work of a car. In case of car failures to move the car alongside of road on a heavy traffic road instead of using cranes we can use this mechanism which is less time consuming as compared to cranes.

IV. DESIGN

A. *The Lift Consists of Several Components*

Those are as given below:

1) Upper Base*:* The upper base will be made of mild steel material and its rectangular cross section. Whereas, the base plate has two rigid supports. These supports are provided for connecting base plate to links.
2) Lower Base*:* The lower base plate is of mild steel material. The upper and lower base is connected by links via fixed supports. While, the other parameters are same as upper base.
3) Links*:* The upper base and lower base are joined with the help of links provided which will be made up of mild steel. Since for buckling of the link in the vertical plane, the ends are considered as hinged.
4) Lead Screw*:* While designing the lead screw the EN24T material is selected. This Material has yield strength of 650 N/mm2 and the ultimate strength is of 850 N/mm2. For further design of lead screw factor of safety is taken as 5.
5) Roller Support*:* The material used for manufacturing of roller is mild steel. Roller support is provided to avoid friction between base and links.
6) Connecting Pins*:* Links, base and other components are connected to each other by using pin connections where, these pins are made of hard steel material.

7) Screw jack-subassembly*:* This subassembly consists of 8 links, and 4 C-connecting sections along with pin connections. The same mechanical screw is used for both the assemblies. This subassembly provides initial lift to vehicle which reduces in human efforts.
8) Worm and Worm wheel*:* The purpose of providing worm and worm wheel arrangement is to reduce human efforts; also it gives perpendicular action of input shaft. It is done for convenient and easy operation of such lift.

B. Design of Components

1) Design of Upper Base

For the dimensions of upper base, we have measured the distance between lower bodies of car without considering the wheels. The upper base will be made by connecting hollow pipe of cross section 20*50mm2 and thickness of 1.6 mm. Thus, the length of upper base will be 1400mm and thickness 1.6mm.

2) Design of Lower Base

As we have considered hollow pipe for upper base in this case we are considering solid pipe as the lower base should be capable of bearing the entire load of lift. The lower base will be made by connection solid pipes of cross section 20*50mm2 and thickness of 7mm. The length of lower base is 1400mm, width is 400mm.

3) Design of Links

According to the availability of rods in the markets we have selected a rod of cross section 40*40 mm2 with a thickness of 1.6mm. And we are further going to analyze whether it will be suitable for our design.

4) Screw Jack Sub Assembly

This sub assembly will consist of 8 links and 4 C-connecting sections along with pin sections. Each link is of 40*20mm2 dimensions with 1.6 mm thickness.

5) Design of Connecting Pins

According to design we have selected mild steel material.
Considering, Load acting on lift =1000kg = 9810N
Ultimate tensile strength of mild steel (S_{ut}) = 841N/mm^2
Yield strength of mild strength (S_{yt})= 248N/mm^2
Factor of safety (f.o.s) = 4
Note: factor of safety is taken as 4 to ensure the safety of the structure. If we consider factor of safety less than 4 the dimensions will increase and the structure will become bulky hence it will not be portable And if we consider factor of safety more than four the dimensions will be very small which will not be suitable for the application.

Permissible stresses, *Tensile stress,* $\sigma_t = S_{yt}$/factor of safety (f.o.s) $\sigma_t = 248/4$ $=62 N/mm^2$ *Shear stress,* $\tau = S_{sy}$/ Factor of Safety (f.o.s) $\tau = 0.5 S_{yt}$/ (f.o.s) $\tau = 0.5*248/4$ $\tau = 31 N/mm^2$ ***S**hear stress in the pin is given by,* $\tau = P/2(\pi/4*d^2)$ *Therefore,* $d = \sqrt{}2P/\pi\tau$ $= \sqrt{}2*9810/\pi*31$ $=14.19mm$ $\approx 15mm$	*By bending failure* *Bending stress,* $\sigma_b = \left[\frac{P}{2} * \left(\frac{b}{4} + \frac{a}{3}\right) * \frac{d}{2}\right] / \left[\frac{\pi * d^4}{64}\right]$ *Where, P = load,* *b = width of roller support* *a = thickness of roller support* *d = diameter of roller support* $\sigma_b = \left[\frac{9810}{2} * \left(\frac{25}{4} + \frac{1.6}{3}\right) * \frac{15}{2}\right] / \left[\frac{\pi * 15^4}{64}\right]$ $\sigma_b = 100.4 N/mm^2$ *Diameter by bending failure will be,* $\sigma_b = \left[\frac{32*P}{\pi * d^3 * 2} * \left(\frac{b}{4} + \frac{a}{3}\right)\right]$ $100.4 = \left[\frac{32*9810}{\pi * d^3 * 2} * \left(\frac{25}{4} + \frac{1.6}{3}\right)\right]$ $d=14.5mm \approx 15mm$

V. CONCLUSIONS AND FUTURE SCOPE

Instead of using hydraulic or pneumatic lift we have used mechanically operated lift which is more cost efficient and portable. We have designed scissor lift in such a way that it has reduced design complexities. All the design calculations are performed taking into consideration the dimensions of car and all the safety issues. Modifications can be done by providing rollers to the lower base so it could be portable. Also by providing upper magnetic base ferrous material can be held easily.

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