Optimization in Application of Mechanical Scissor lift in Industrial Crane Assembly

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Abstract

Scissor lifts are being used for temporary, flexible access purposes as maintenance and construction work or fire fighters for emergency access which distinguishes them from permanent access equipment such as elevators. They are designed to lift limited weights. The contraction of scissor action can be hydraulic, pneumatic or mechanical (via lead screw or rack & pinion system). The main aim of scissor lift is to save the time required for building platforms or temporary lifts. Once the lift is constructed according to the requirement, much time is saved. The portability of the lift can enable the workers to use it at various working areas wherever needed. Considering the cost of lift it is suitable than making temporary platforms at construction sites with the help of bamboo sticks or other material. The maintenance cost is almost negligible as only lubrication is required for only some components. The ultimate aim is to increase the production rate of the company by efficient use of mechanical scissor lift.

Keywords: *Hoists, Girder, Lead Screw, Shear stress, Factor of safety.*

1. Introduction

A scissor lift is a type of system or mechanism that helps in moving the loads in vertical direction. Many tools in the automotive industry are designed to help technicians access to reach difficult places and improve workers comfort. When a technician is working on a vehicle at ground level they have to lean over the vehicle or lie under the vehicle to complete the job or to service the vehicles. These positions are awkward and may strain the technician‘s muscles, joints, ligaments, tendons or bones which may result in decrease of technician‘s efficiency. A solution to this problem is lifting the vehicle to a comfortable working height allowing the technician to work in the fully upright position. The mechanism designed to achieve this function is made up of links, folding supports in two criss-cross 'X' patterns mounted over each other, known as a pantograph. The upward position is achieved by motion by the application of pressure to the intersection of two ‘X’ supports with the help of lead screw. The platform will be having an extending bridge patterns to make sure closer access to the work area because of inability of scissor lift to move in the direction other than vertical direction. Such mechanical scissor lift is to be used for the primary purpose for lifting loads.

It is categorized depending on the power system implemented on the lift. It may also not require any electric power to raise the height, but hydraulic or pneumatic units can also be used for such applications of lifting with reduction in human efforts by using oil pressure and gas pressure respectively.

Moreover sometimes as per the requirement these types of lifts may be observed in combination e.g. mechanical scissor lift can be successively operated manually as well as with the help of pneumatic gun, further it is powered by the resources available at work station.

Pneumatics is a science that deals with the study and application of pressurized gas to produce mechanical motion. Pneumatic systems that are used extensively in industry and factories are commonly incorporated with compressed air or inert gas. This is because a centrally located and electrically powered compressor powers cylinders and other pneumatic devices through solenoid valves.

The only difference in hydraulic and pneumatic lift is that, hydraulic cylinder operates on fluid as a compressing medium where as pneumatic operates on air or gas. So, each lifting mechanism has its own drawbacks and advantages. But, for making the load lift, portability and simplicity in design are also very important aspects that can‘t be neglected. So, for such constraints mechanical system is most suitable over other systems.

Many of the organizations around the world have been using all kinds of scissor lifts. Also, there are some mechanical alternatives are also available which can improve portability, simplicity and by providing proper gearing, input energy is reduced along with the cost. Mechanical lift is another type of scissor lift which works on the principle of screw jack. Because of simple design aspects and simplicity in construction, mechanical lift has wider range of applications over other types of lift mechanisms.

Screw jack is an example of mechanical lift. Screw jack is made by using lead screw of square thread, as per the today‘s condition of cost reduction, we have to find the cost effective solution for application in industry pertaining long term benefits. So, in the production system it is necessary to redesign the various products

for reducing the cost of the product over the same product.

In Industry, the mechanical scissor lift is designed for the following applications-Hoist lifting, Platform lifting, Wheel assembly.

Advantages of mechanical system over other mechanism are explained below:-

Simple in construction.

Portable over other mechanism.

Cost of manufacturing is low.

Lift heavy loads

Easy to find faults. (Diagnose)

Don't consume electric sources for operation. (Operate manually)

No external storage required. (Hydraulic and pneumatic requires tank for fluid and air)

2. Current Process in industry

The industry has been using the overhead crane for the assembly for testing purpose as shown in the figure. This results into various problems such as

Mishandling of the hoists

Waiting for the overhead crane for its availability

More manpower required

Slow production rate

More time required for assembly (for testing purpose).

This results into requirement of minimum of two days for assembling of one hoist, but using the portable scissor lift it would require just 3-4 hours of time.

Fig.: Current process for assembly (for testing purpose)

3. Material Selection

The strength of the material used for the manufacturing has great importance in the efficient working of any mechanism or system. The major requirements of the material here were the availability, hardness, toughness, endurance and maintainability. Hence, we chose Mild Steel for the upper plate, lower plate and mid blocks for lead screw arrangement; whereas the material used for the pins, lead screw, bush, guide bars was EN9-amedium carbon steel.

4. Equations

Torque required to overcome thread friction is

$$T = (W * dm / 2) * (\tan(\phi + \lambda))$$

Stress is given by force to the cross section area

$$\sigma = F / A$$

For self locking, $\phi > \lambda$

$$\tan \lambda = l / (\pi * dm)$$

$$\sigma(per) = Syt / N$$

$$G * \theta / L = T / J = \tau / R$$

3. Component Details

Upper Plate

Lower Plate

Links

Lead Screw

Connecting Pins

Bearings

RollerGθ/L = T/J = τ/r.

Roller Guide bar

Circlip(External+Internal)

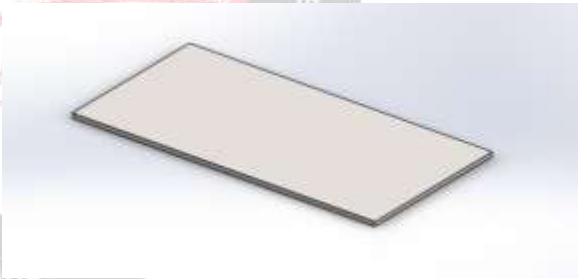

Fig 3.1 Upper Plate

Fig 3.2 Lower Plate

 DOI : 10.18231/2454-9150.2018.1392

Fig. 3.3.1 Link

Fig.3.3.2 Roller

Fig. 3.3.1 Connecting Pins

Fig.3.3.2 Roller guide bars

Fig. 3.3.1 Bush

Fig.3.3.2 Lead Screw

Fig 3.3 Different Components of Mechanical Scissor lift

Base, links and other components are connected to each other by using pin connections where, these pins are made of hard steel material which is having cylindrical cross section of diameter of 16 mm. The roller guide bars are designed such that the roller is subjected to minimum wear i.e. it is designed as a round bar which will have minimum wear during operation of the mechanism. The pins inserted afterthe press fitted bush in the bore everywhere so as to ease the maintenance of the scissor lift as and when required.

By taking the reference of above shown calculations, CAD model of the scissors lift is generated using Solid Works software. The purpose of doing so is to predict that how the model will look after complete manufacturing process. This model is then further analyzed for simulation process. Load, stress and deformation test is carried out and results are obtained by the software. These results are used for further modification. The design process displayed in the paper is made keeping in mind that the lift is to be operated by mechanical means so that the overall cost of the scissor lift manufacturing is minimized. Also such design does make the lift more compact and much suitable for medium scale work as well as heavy load duties. Finally, the analysis is also done in an Analysis software in order to check the compatibility of the design values. Then after analysis of the model the values of the deformations, stresses and strains are checked for their precision and whether the impact on various components is within their permissible strength or not.

Fig 2.4 Assembly Design Model in CAD software

6. Conclusions and Future Scope

Production rate can be increased with such optimization. With designed process explained above the fabrication time of scissor lift can be reduced. Mechanical scissor lift operates on simple principle of screw jack. This consumes less energy as compared to other type of scissor lifts. Also, it makes the lift portable. Height of five feet can be easily achieved. Such design can be widely used in automobile and for production in other industries. Also the further modifications can be incorporated for optimizing the design and fabrication of the lift and further analysis can also be done for better optimization related to scissor lifts. Such mechanical scissor lift can be used in the assembly of hoist on girder (for testing) without waiting for overhead cranes and in turn increasing the production rate of the industry. The scissor lift manufactured will be easy to operate and maintain. The production rate will be drastically increased and the time for testing of the hoists on girder will be reduced to a great extent.

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