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Scissor Lift Operated by Solar System

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Abstract: *The following paper describes the information about fabrication of a simple mechanical scissor lift. Conventionally a scissor lift or jack is used for lifting heavy loads with less effort mainly in industries or any other fields where loads are lifted. It can be of mechanical, pneumatic or hydraulic type. The matter described in the paper is developed keeping in mind that the lift can be operated by mechanical means so that effort required to operate is less for lifting more weight. Also, such design can make the lift more compact and much suitable for medium scale work. This paper also gives information on how scissor lift works with different means (ex- mechanical, pneumatic and hydraulic), basic information about worm and worm gear, rack and pinion, types of lifts, advantages of the scissor lift, different types of gears, gear nomenclature, threads and scissor arms.*

Keywords: Solar System

I. INTRODUCTION

- Elevated work platforms are mechanical devices that are used to give access to areas that would previously be out of reach, mostly on buildings or building sites. They are also known as Aerial Work Platforms (AWPs). They usually consist of the work platform itself – often a small metal base surrounded by a cage or railings and a mechanical arm used to raise the platform. The user then stands on the platform and controls their ascent or descent via a control deck situated there [1].
- Some forms of aerial work platform also have separate controls at the bottom to move the actual AWP itself while others are controlled entirely on the platform or towed by other vehicles. Most are powered either pneumatically or hydraulically. This then allows workers to work on areas that don't include public walkways, such as top-story outdoor windows or gutters to provide maintenance. Other uses include use by fire brigade and emergency services to access people trapped inside buildings, or other dangerous heights. Some can be fitted with specialist equipment, for example allowing them to hold pieces of glass to install window planes. They are temporary measures and usually mobile, making them highly flexible as opposed to things such as lifts or elevators [2].
- However generally they are designed to lift fairly light loads and so cannot be used to elevate vehicles, generators or pieces of architecture for which a crane would more likely be used. In some cases, however elevated work platforms can be designed to allow for heavier loads. Depending on the precise task there are various different types of aerial work platform which utilize separate mechanisms and fuel sources. The most common type is the articulated Elevated Work Platform, (EWP) or 'hydraulic platforms' (and also known as boom lifts or cherry picker).
- A pantograph is connected in a manner based on *parallelograms* so that the movement of one pen, in tracing an image, produces identical movements in a second pen. If the first point traces a line drawing, an identical, enlarged, or a pen will draw miniaturized copy fixed to the other. Using the same principle, different kinds of pantographs are used for other forms of duplication in areas such as sculpture, minting, engraving and milling.

II. WORKING PRINCIPLE

Because of the shape of the original device, a pantograph also refers to a kind of structure that can compress or extend like an *accordion,* forming a characteristic *rhomboidal* pattern. This can be found in extension arms for wall-mounted mirrors, temporary fences, *scissor lifts*, and other *scissor mechanisms* such as the *pantograph* used in electric locomotives and trams [3].

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Figure 1: Top view of scissor lift

A Scissors lifts provide the most economical, dependable, and versatile method of lifting heavy loads. Scissors lifts have few moving parts, are well lubricated, and provide many years of trouble-free operation. These lift tables raise the loads smoothly to any desired height, and can be easily configured to meet the specific speed, capacity, and foot print requirement of any hydraulic lifting application. Each scissors lift is designed and manufactured to meet the industry safety requirements set forth in ANSI MH2 9.1, and is by far the most popular and efficient of all styles of scissors tables used in material handling applications.

II. LITERATURE REVIEW

Man's quest for improvement has never been satisfied. The drive towards better and greater scientific and technological outcome has made the world dynamic. Before now, several scientist and engineers have done a lot of work as regards the scissors lift in general Conventionally a scissor lift or jack is employed for lifting a vehicle to change a tire, to gain access to travel to the underside of the vehicle, to lift the body of the vehicle to appropriate height, and lots of other applications also such lifts can be used for various purposes like maintenance and many material handling operations. The lift can be of mechanical, pneumatic, or hydraulic type.

The design of the lift described within the paper is developed in such a way that the lift is operated by mechanically means by using a pantograph such that the overall cost of the scissor lift is reduced to some extent. In our case, we required the lift is portable and also works without consuming any electric power source so they decided to use a hydraulic hand pump to power the hydraulic cylinder Also a such design can make the lift more compact and much suitable for medium scale work. Finally, the analysis of the scissor lift was done in ANSYS and also all responsible parameters were analysed to check the design of the lift.

This Paper describes the design as well as analysis of a hydraulic scissor lift. 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 Also such lifts can be used for various purposes like maintenance and many material handling operations. It can be of mechanical, pneumatic or hydraulic type. The design described in the paper is developed keeping in mind that the lift can be operated by mechanical means by using pantograph so that the overall cost of the scissor lift is reduced. In our case our lift was needed to be designed a portable and also work without consuming any electric power so we decided to use a hydraulic hand pump to power the cylinder Also such design can make the lift more compact and much suitable for medium scale work. Finally, the analysis of the scissor lift was done in Ansys and all responsible parameters were analysed in order to check the compatibility of the design values [2] "Design, Analysis and Development of Multiutility home equipment using Scissor Lift Mechanism", Divyesh Prafulla Unbale, et al. The conventional method of using rope, ladder lift getting person to a height encounter a lot of limitation.

III. METHODOLOGY

3.1 Components of Scissor Lift

- Scissor Arms
- Platform
- Base Frame

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- Pinned Joints
- Solar Panel

A. Scissors Arms

Leg deflection due to bending is a result of stress, which is driven by total weight supported by the legs, scissors leg length, and available leg cross section. The longer the scissors legs are, the more difficult it is to control bending under load. Increased leg strength via increased leg material height does improve resistance to deflection, but can create a potentially undesirable increased collapsed height of the lift.

B. Platform Structure

Platform bending will increase as the load's center of gravity moves from the center (evenly distributed) to any edge (eccentrically loaded) of the platform. Also, as the scissors open during rising of the lift, the rollers roll back towards the platform hinges and create an increasingly unsupported, overhung portion of the platform assembly. Eccentric loads applied to this unsupported end of the platform can greatly impact bending of the platform. Increased platform strength via increased support structure material height does improve resistance to deflection, but also contributes to an increased collapsed height of the lift.

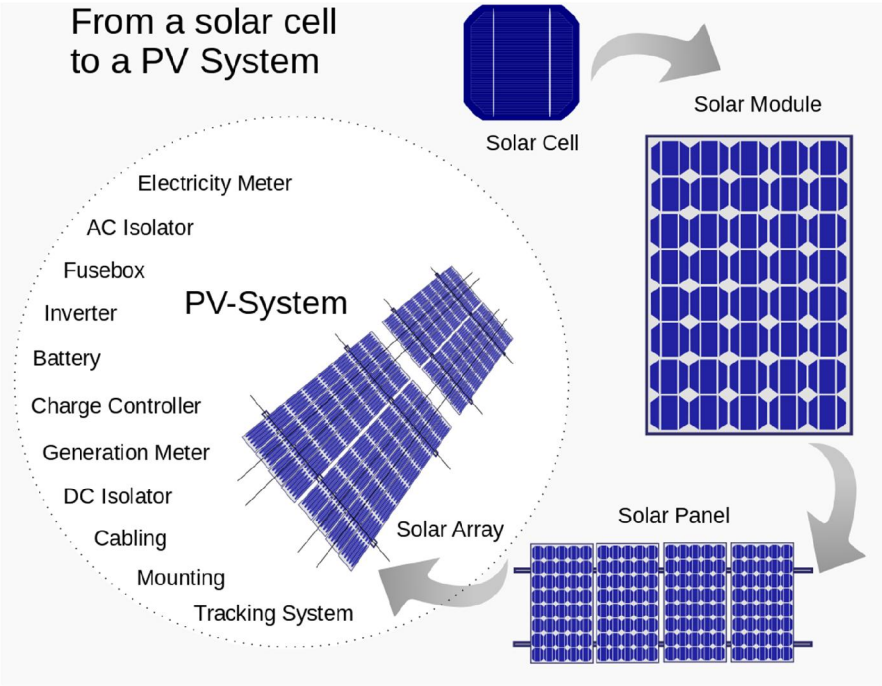
C. Base Frame

Normally, the lift's base frame is mounted to the floor and should not experience deflection. For those cases where the scissors lift is mounted to an elevated or portable frame, the base frame must be rigidly supported from beneath to support the point loading created by the two scissors leg rollers and the two scissors leg hinges.

D. Pinned Joints

Scissors lifts are pinned at all hinge points, and each pin has a running clearance between the O.D. of the pin and the I.D. of its clearance hole or bushing. The more scissors pairs, or pantographs, that are stacked on top of each other, the more pinned connections there are to accumulate movement, or deflection, when compressing these designed clearances.

E.Solar Panel



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A solar cell panel, solar electric panel, photo-voltaic (PV) module or solar panel is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

A solar panel is a flat construction resembling a window, built with technology that allows it to passively harvest the heat of the sun or create electricity from its energy through photovoltaics. Passive solar panels include those used to heat water for home heating and to provide hot water on tap. Most commonly, photovoltaics is assumed when speaking of solar panels.

Photovoltaic solar panels use positively- and negatively-doped silicon working in conjunction with conductors on the alternately-charged surfaces. Electricity is created when photons strike the surface and excite electrons to the point that they leave their valence. Solar panels are increasingly in popularity as solar power has reached price parity with oil and, simultaneously, more and more jurisdictions mandate the use of solar panels or other renewable energy sources in construction of new buildings.

F. Battery

A battery converts chemical energy into electrical energy by a chemical reaction. Usually, the chemicals are kept inside the battery. It is used in a circuit to power other components. A battery produces direct current (DC) electricity (electricity that flows in one direction, and does not switch back and forth).

Using the electricity from an outlet in a building is cheaper and more efficient, but a battery can provide electricity in areas that do not have electric power distribution. It is also useful for things that move, such as electric vehicles and mobile phones. Batteries may be primary or secondary. The primary is thrown away when it can no longer provide electricity

G. Screw Jack

A screw jack is a gearbox assembly (either worm gear or bevel gear) and a transmission product (lead screw, ball screw or roller screw) which through use of a motor is used to convert rotary into linear motion. They can be used to push, pull, tension, lock, unlock, tilt, pivot, roll, slide and lift or lower loads, anything from a few kilos to thousands of tonnes

IV. ANALYSIS REPORT

4.1 Design Considerations

Considerations made during the design and fabrication of a portable work platform being elevated by Screw jack mechanism using of solar energy

1. Functionality of the design
2. Manufacturability

Economic availability, that is general cost of materials and fabrication techniques employed Scissor lift be made up of base platform, upper platform, lead screw, bevel gear, ratchet & pawl, bolt, nut, links and pins. There is no outline strategy accessible for planning these parts. On the basis of specific assumptions, the design for each of the components has been described as follows.

In this section, execution of this outline taking into account the measurement different numerical relations are produced. Here I have calculated normal force, shear force, bending moment and buckling load for how scissor lift link responded for the applied load of 300kg. Then for getting accurate result of strength and stability values (deformation and von-mises stress) by utilizing Ansys software, which can helpful to understand whether our lift can carry required load limit or not.

4.2 Design of Scissor Legs (Link)

In scissor lift these legs are the vertical individuals that permit the platform to change height. Legs are made by Structural steel with the same scissor join height. When operator gives the movement to the lift, Movable ends of the lift will elevate the table to the desired height, making an "X" design with the legs. So that it provides the necessary support for the base platform [13]. If length of the legs increases, the pantograph contracts, height decrease. similarly, if the length decreases while height increases. this is depending on the angle of the link [13].

Cos (θ) = $\frac{}{L}$ and Sin (θ) =

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Table: Scissor lift link position

Angle (θ) Degree	**Length (L)** Meter	**Height (h)** Meter
5	1.6935	0.1481
10	1.6741	0.2952
15	1.6421	0.4399
20	1.5975	0.5814
25	1.5407	0.7184
30	1.4722	0.85
35	1.3925	0.9750
40	1.3022	1.0927
45	1.2021	1.2021
50	1.0927	1.3023
55	0.9750	1.3925
60	0.85	1.4722

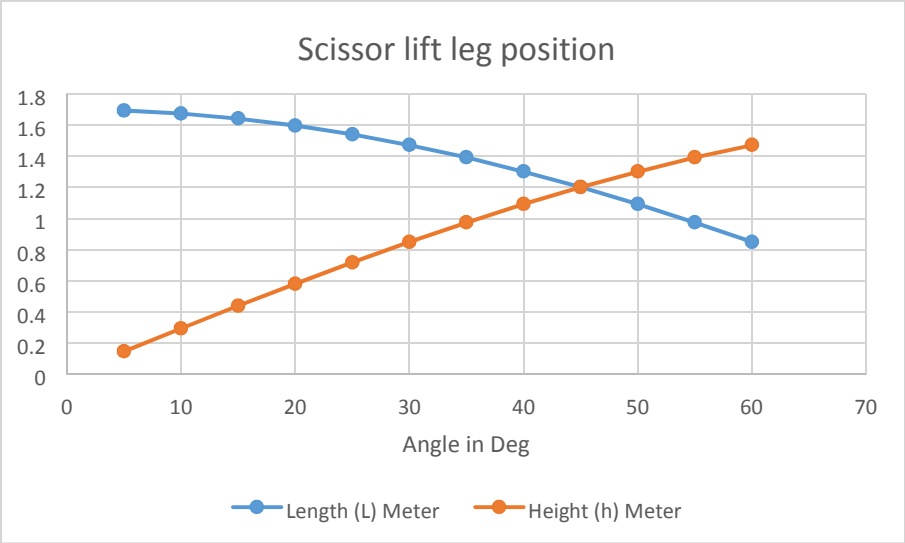

Figure: Scissor lift link position

For only one link it can reach 1.4722-meter height at 60^0, here in our design I have chosen double scissor lift link. So that we can capable to lift about 2.9-meter height

4.3 Design of Base Plate

Usually, in scissor lift the base plate is mounted to the floor. it is constructed using structural steel. It gives the proper balance to the structure additionally it should be rigidly supported from underneath to support the point loading created by the two scissor leg roller and the two scissor leg hinges. The base plate has attached by four wheel.

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Length (l) = 1800 mm
Breadth (b) = 900 mm
Thickness (t) = 6 mm

Input	Formula	Output
Breadth b1=1.8m Height h1=0.9m Thickness t=0.006m	b2=b1-t h2=h1-t A1=b1×h1 A2=b2×h2 A_0 = A1-A2	b2=1.794m h2=0.894m A1=1.62m^2 A2=1.6038m^2 A_0=0.0161m^2
$N_{(60)}$ = 637.178N	Normal Stress (σ_N) = $^{N}{}_{A}{}^{\alpha}$ [19]	σ_N = 39576.27N/m^2
$M\alpha$ = 573.460 N	Bending Stress $M(\alpha)$ σ_M = ____$_{wx}$ [19] Wx = ____Ix $ymax$ Moment of Inertia b $_1h_1^3 - b_2h_2^3$ I_x = 12	I_x = 2.5297 × 10^{-3} m^4 W$_x$ = 2.810 ×10-^{3} m^3 σ_M = 2.04 ×10^5 N/m^2
For Structural steel σ_y=250MPa Factor of Safety =1.5	σ_Z=σ_N+ σ_M	σ_Z=2.435 ×10^5 N/m^2 $\sigma_Z \leq \sigma_y$ So that our design is safe.

Table: Platform calculations

4.4 Design of Upper Plate

The upper plate in a scissor lift is utilized to put the load and exchange it to the lift legs. The outlining of the upper plate is attempted comparative as the base plate. It is likewise comprised of structural steel material. Additional setup of this upper plate gives operator comfortable and security.

Length (l) = 1800 mm
Breadth (b) = 900 mm
Thickness (t) = 6 mm

It is required to design a platform which should serve under heavy load application and withstand high stresses. Structural steel has high compressive and tensile strength, good stability and reliability. Furthermore, it is widely used in industries for manufacturing structural shape steel members, such as c- beam, I- beam, hollow structural section (Rectangular, square and pipe). So that the above mentioned and many other purpose this material should be suitable for our scissor lift [18].

4.5 Design of Lead Screw

Lead screw is an important part in a scissor lift, that takes up the operator or considerable load to be lifted or brought down by lift. A lead screw is a component that converts rotational movement to straight(linear) movement [20]. The most widely recognized frame comprises of a cylindrical shaped shaft with helical grooves or edges called threads around the outside. The fasten goes through a gap another object or medium, with threads within the gap that mesh with the screw's threads. At the point. When the shaft of the screw is turned with respect to the stationary threads, the screw moves along its pivot in respect to the medium encompassing it.

Lead screw can enhance constrain; a little rotational compel (torque) on the [14] pole can apply a substantial hub drive on a heap. The littler the pitch, the separation between the screws' strings, the more noteworthy the mechanical preferred standpoint, the proportion of yield to info constrain.

There is a large contact range among male and female threads in lead screws and this outcome vast frictional loss amid the operation. Because of these frictional misfortunes, lead screws are not exceptionally proficient but generally self-locking. In self-locking lead screws, the load can't bring down itself without an outside exertion. Because of this feature

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it is generally used to hold loads. so that in our scissor lift subsequent to lifting required stature assume in the event that we discharge the hand from handle our framework effectively won't permit to move downwards.

Outer diameter of screw rod, d_0 = 60mm

Root diameter of screw rod, d_1 = 50 mm

Length between supports, L = 2000 mm

Lead or pitch of screw rod, p = 10 mm Mean diameter (d) = d_0 - ^{p} = 55mm^2

Coefficient of friction (μ) = tan ϕ = 0.15

tan α = ^{p} πd = 0.05787

Frictional force

F = μ x P

= 0.15 x 2943

F = 1611.24 N

Force required to rising the load P = W× tan (α + $\phi) = w\left[\frac{\tan\propto + tan\,\phi)}{1-tan\alpha\ tan\phi}\right]$ [20, p. 634]

= 617.12N

Force required to lower the load P = W× tan (α - $\phi) = w\left[\frac{\tan\propto - tan\,\phi)}{1+tan\alpha\ tan\phi}\right]$ [20, p. 634]

= 268.80N

4.6 Bolt and Nut Calculation

Bolt and Nuts are used to connect one end of the link to another end of the scissor lift link.

Basic diameter, D = 40 mm

Screw thread pitch, p = 6 mm

Length of thread engagement, l = 60 mm

Pitch circle diameter, d_p = (D - 0.64952. p) [22]

= 36 mm

Stress Area Formula

Tensile stress area of the (male) screw

$A_t = \frac{\pi}{4}(D - 0.938194.\ p)^2$ [23]

= 1197.77 mm^2

V. CONCLUSION

As we have discussed and analyzed the result, we have prepared a chart for better conclusion analysis the following conclusion.

- The fabrication of Scissor Lift was carried out meeting the required design standards. The portable work platform is operated by Solar which is operated by a motor. The scissor lift can be design for high load also if a suitable high-capacity Screw Jack is used. The scissor lift is simple in use and does not require routine maintenance. It can also lift heavier loads. The main constraint of this device is its low initial cost and has a low operating cost. The shearing tool should be heat treated to have high strength. Savings resulting from the use of this device will make it pay for itself with in short period of time and it can be a great companion in any engineering industry dealing with rusted and unused metals.
- The fabrication of a portable work platform elevated by a Electric Motor was carried out successfully meeting the required design standards. The portable work platform is operated by hydraulic cylinder which is operated by the hand lever. The scissor lift can be designed for high load also if a suitable high capacity of motor is used. The hydraulic scissor lift is simple in use and does not require routine maintenance. It can also lift heavy weights.

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The main constraint of this device is its high initial cost, but has a low operating cost. The shearing tool should be heat treated to have high strength. Savings resulting from the use of this device will make it pay for itself with in short period of time

- The portable work platform is operated by a hydraulic cylinder which is also operated by a hand pump by of a person or an operator working in the company premises is the responsibility of an organization so it is an important thing to give some amount of comfort to the operator. Hence by making this hydraulic lifter we improved the comfort level of the operated working on the machine.
- The natural frequency of lift should not be equal to the external excitation frequency hence no vibration in the lift.
- A portable work platform hydraulic scissor lift is designed for high load resistance.
- The hydraulic scissor lift is simple in use and does not require routine maintenance.
- The scissor lift reduces the complexities in a design and fabrication time was reduced.
- But the limitation of this lift is the initial cost. The design and fabrication of a portable work platform raised by a hydraulic cylinder were carried out meeting the required design standards.
- The portable work platform of a scissor lift is operated by a motor which is operated by a motor.
- The scissor lift can be design for high load also if a suitable high-capacity motor is used.
- It can also lift heavier loads.
- The main objective of this device is its high initial cost but has a low operating cost.
- The good model is mild steel 16 degree.

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