FABRICATION AND TESTING OF HYDRAULIC LADDER

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Abstract - The foremost aim of our project is to design and fabricate a hydraulic operated ladder for the purpose of material handling at required height at faster rate. As a ladder is a vertical or inclined set of rungs or steps where in hydraulic ladder, the hydraulic cylinder is used to lift the platform at a certain height. The construction of hydraulic ladder is same as like a scissor in which, when a hydraulic cylinder pull one of the link of ladder it will lift the platform to a certain height with weight lifting capacity of about 100 to 200 kg. This hydraulic ladder is having more features like accident precaution equipments, rolling wheels and possibly the remote control automated moving mechanism. We expect this new approach to dramatically reduce the cost of hydraulic ladder without any loss of quality, and hence make mass production viable.

Key Words: Hydraulic Ladder, Hydraulic cylinder, Rungs, Scissor.

1. INTRODUCTION

1.1 History:

Screw type mechanical jacks were very common for jeeps and trucks of World War II vintage. For example, the World War II jeeps (Willys MB and Ford GPW) were issued the "Jack, Automobile, Screw type, Capacity 1 1/2 ton", Ordnance part number 41-J-66. This jacks, and similar jacks for trucks, were activated by using the lug wrench as a handle for the jack's ratchet action to of the jack. The 41-J-66 jack was carried in the jeep's tool compartment. Screw type jack's continued in use for small capacity requirements due to low cost of production raise or lower it. A control tab is marked up/down and its position determines the direction of movement and almost no maintenance.

The virtues of using a screw as a machine, essentially an inclined plane wound round a cylinder, was first demonstrated by Archimedes in 200BC with his device used for pumping water.

There is evidence of the use of screws in the Ancient Roman world but it was the great Leonardo da Vinci, in the late 1400s, who first demonstrated the use of a screw jack for lifting loads. Leonardo's design used a threaded worm gear, supported on bearings, that rotated by the turning of a worm shaft to drive a lifting screw to move the load - instantly recognizable as the principle we use today. We can't be sure of the intended application of his invention, but it seems to have been relegated to the history books, along with the helicopter and tank, for almost four centuries. It is not until the late 1800s that we have evidence of the product being developed further.

With the industrial revolution of the late 18th and 19th centuries came the first use of screws in machine tools, via English inventors such as John Wilkinson and Henry Maudsley The most notable inventor in mechanical engineering from the early 1800s was undoubtedly the

mechanical genius Joseph Whitworth, who recognized the need for precision had become as important in industry as the provision of power .A screw jack that has a built-in motor is now referred to as a linear actuator but is essentially still a screw jack. [1]

1.1 Objective Of Study:

- The main objective of the devices used for lifting purposes is to make the table adjustable to a desired height.
- Scissor ladder used to stack, raise or lower, convey and or transfer material between two or more elevations.
- Scissor lift/ladders are specialized type of aerial lift, designed to lift larger loads and deliver at 12 to 15 ft height.
- It can give a very sturdy platform for work high in the air.

1.2 Scope of Study:

- The most basic consideration when choosing scissor ladder is the height you need to reach.
- That's why we can develop hydraulic scissor ladder which most can reach 10 to 15 ft and it can carry 500 lbs to 1000lbs weight.
- Hydraulic scissor lifts provide most economical dependable and versatile method of lifting load and reach high in air.
- Hydraulic scissor ladder have few moving parts are well lubricated and provide many year trouble free operation.
- This ladder raise the loads smoothly to any desired height and can be easily configured to meet the specific speed capacity and foot print requirements of hydraulic lifting application.

1.3 Benefits Of Study:

We found some of the benefits of hydraulic ladder are as follows:-

- Simplicity in operation unlike ladders and mobile scaffolding scissor lifts and incredibly easy to move from place to place.
- More than one person can stand on access platform.
- Capable of working at up to 12 ft.
- It is also very useful for loading and unloading purpose.

2. WORKING PRINCIPLE

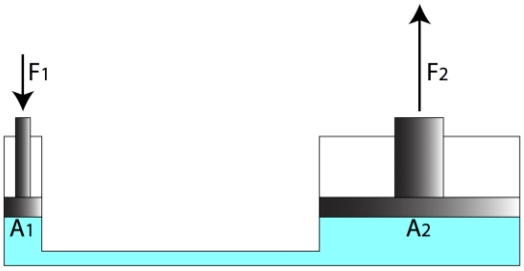


Fig -1: Principle of Pascal law.

Hydraulic cylinder works on the principle given by the French mathematician and physicist Blasé Pascal in 1653 and states that,

"The intensity of pressure at any point in a fluid at the rest is same in all direction."

Theorem Proof:

Consider a very small right angled triangular element **ABC** of a liquid as shown in figure.

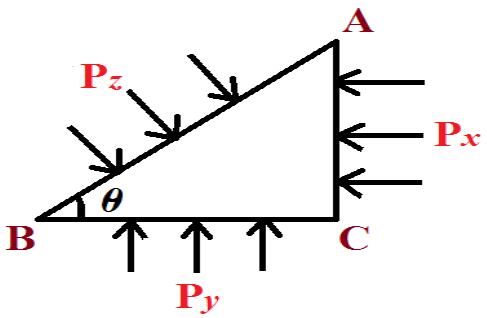


Fig -2: Element of Liquid

Let

- p_x = Intensity of horizontal pressure on the element of the liquid

- p_y = Intensity of vertical pressure on the element of the liquid
- p_z = Intensity of pressure on the diagonal of the triangular element of the liquid
- θ = Angle of the triangular element of the liquid

Now total pressure on the vertical side **AC** of the liquid,

$P_X = p_x \times AC$ ... (1)

Similarly, total pressure on the horizontal side **BC** of the liquid,

$P_y = p_y \times BC$ ... (2)

Pressure on the diagonal side **AB** of the liquid,

$P_Z = p_z \times AB$ ... (3)

Since the element of the liquid is at rest, therefore sum of the horizontal and vertical components of the liquid pressure must be equal to zero.

Now using equilibrium condition for horizontal pressure,

$P_z \times \sin\Theta = P_x$

$\Longrightarrow p_z \times AB \times \sin\Theta = p_z \times AC$

From the geometry of the figure, we find that,

$AB \times \sin\Theta = AC$

$p_z \times AC = p_x \times AC$

$\Longrightarrow p_z = p_x$ ... (4)

Now using equilibrium condition for vertical pressure, i.e.

$p_z \times \cos\Theta = p_y - W$

(Where, *W* = Weight of the liquid)

As the triangular element is very small, the weight of the liquid *W* is neglected, so,

$p_z \times \cos\Theta = p_y$

$p_z \times AB \times \cos\Theta = p_y \times BC$

From the geometry of the figure, we find that

$AB \times \cos\Theta = BC$

$p_z \times BC = p_y \times BC$

$\Longrightarrow p_z = p_y$ ... (5)

Now from equation *(4)* and *(5)*, we find that

$p_x = p_y = p_z$

Thus the intensity of pressure at any point in a fluid, at rest, is the same in all direction.

3. COMPONENTS OF HYDRAULIC LADDER

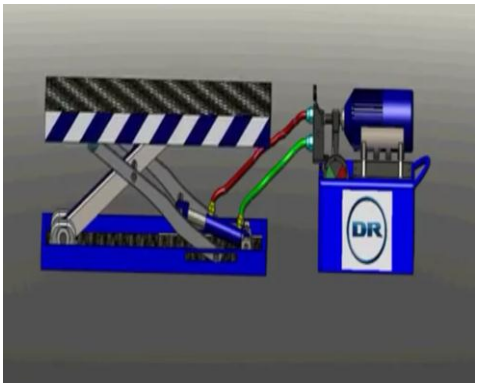


Fig -3: Constructional Diagram

Components in Hydraulic Ladder:

3.1 Hydraulic Cylinder.

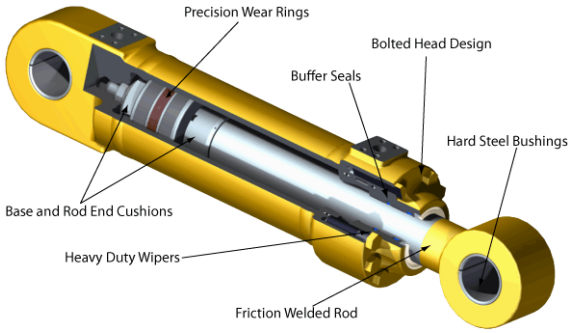
3.2 Linkages

3.3 Nut & Screw.

3.4 Base

3.5 Platform.

3.6 Wheels



3.1 Hydraulic Cylinder.

Fig -4: Hydraulic Cylinder

A hydraulic cylinder is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke. Hydraulic cylinders get their power from pressurized hydraulic fluid which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth.

The barrel is closed on one end by the cylinder bottom also called the cap and the other end by the cylinder head also

called the gland, where the piston rod comes out of the cylinder. The piston has sliding rings and seals. For better and smooth operation we used double acting hydraulic cylinder.

3.2 Linkage

Fig -5: Proposed Linkages

Linkages are an essential part of many mechanisms. They can be used to change direction, alter speed and change the timing of moving parts. In the hammering man example two linked linkages are used to convert the small linear movement of the drive shaft (bottom left) into first a rotational body movement and secondly a fast hammer movement. Compare the speed of the hammer with the speed of the drive shaft. This component is subjected to buckling load and bending load tending to break or cause bending of component .Hence based on strength, plasticity, hardness and to lift or sustain heavy weights we used link of mild steel having length 3 feet.

3.3 Nut and bolt

Fig -6: Nut and Bolt

A nut is a type of fastener with a threaded hole. Nut and bolt assembly is used to hold the collar and moving parts like links, base, platform etc.

3.4 Base

Fig -7: Base

The lowest part or edge of something especially the part on which it rests or is supported. Part which is generally made as strong as it can subtends very high load and vibrations of the overall machine. It is responsible for the stability of the whole assembly; therefore strength, Hardness and stiffness are needed mechanical properties. Hence Mild steel is used.

3.5 Platform

Fig -8: Platform

A flat surface that is raised higher than the floor or ground and that people stand on when performing. In hydraulic ladder it gets up and we can perform our work. It having a rod surrounding to platform for the safety precaution of person or workers. Top platform is made of mild steel angle having dimension 1.8 × 3.1 feet and height of platform is 2.3 feet.

3.6. Wheels

Fig -9: Caster Wheels

A caster is a wheeled device typically mounted to a larger object that enables relatively easy rolling movement of the object. Casters are essentially special housings that include a wheel, facilitating the installation of wheels on objects. Casters are found virtually everywhere, from office desk chairs to shipyards, from hospital beds to automotive factories. They range in size from the very small furniture casters to massive industrial casters, and individual load capacities span 100 lbs or less to 100,000 lbs. Wheel materials include cast iron, plastic, rubber, polyurethane, forged steel, stainless steel, aluminum, and more. Wheel having diameter 15cm diameter we used.

4. WORKING

- When we start the hydraulic motor it rotate the hydraulic pump as it coupled with each other and it causes the entry of oil in cylinder barrel.
- Hydraulic oil exerts the pressure on piston head, Due to this, piston rod of hydraulic cylinder drag (pull) the stainless steel solid rod having roller bearing connected to both end.
- As the scissor arm links are interconnected to each other, when the roller bearing slides in c-channel it lift the whole assembly until the piston rod reach to its extreme position.
- When piston rod reached to its extreme position, the whole assembly is lifted up to the height of 8 feet.
- At the time retraction of oil from cylinder barrel, we use starter mechanism which reverse the rotation of hydraulic pump and it suck the oil from the hydraulic cylinder to the sump and due to this ladder will return to its original position.

In this manner hydraulic ladder works to complete any task which is at particular height

5. ADVANTAGES

- Safety device for emergency power off. When the electricity is failure, the ladder can down by using valve.
- The sliding action of various links is uniform.
- The length of stroke can be varied even within small ranges.
- NO noise, no vibrations and hence smooth operation.
- Inertia losses are less.
- Height can enhance by increasing number of links.

6. DISADVANTAGES

- Initial cost is high.
- Maintenance cost is more.
- Intensive care should be taken while working.

7. APPLICATION

- It is very useful in all small scale industries.
- Move heavy weight material from one place to another.
- For completing any work at high level from ground.
- Loading and unloading of heavy materials from trucks or other vehicles.

8. CONCLUSIONS

- The study information gained from this project will provide an idea about hydraulic ladder.
- All related areas of the hydraulic ladder have been covered including: selection of materials, various links, lifting mechanisms & fabrication of all linkages for better and smooth working.

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BIOGRAPHIES

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