

OPERATING MECHANISM AND DESIGN OF HYDRAULIC SCISSOR LIFT

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ABSTRACT - The following paper shows the operating mechanism and design study of hydraulic lift. This research paper solves material handling and provide comfort to the operator. This paper shows the study as well as design of hydraulic scissor lift components. It can lift upto 300 kg of load with a raise of 3.5ft. the main aim of this research paper is study, design and fabrication of hydraulic scissor lift. In our case lift has to be movable and portable so rollers are provided for motion of lift and also we cant use electric power in this lift so we use hydraulic pump. Hydraulic generate more and accurate pressure. By use of this mechanism and design hydraulic lift became efficient and can operate at industries. The purpose of this research paper is to use all components effectively so that it produce good results with good efficiency.

Keywords - Scissor mechanism, Hydraulic lift, Pantograph, cast iron,

THE INTRODUCTION

A Scissor lift is a type of platform that can move vertically upward or downward. The aim of hydraulic scissor lift is material handling and provide comfort to operator. Hydraulic lift uses hydraulic cylinder to lift or lower the object by applying less force in respect to weight of object. This mechanism integrated to attain this purpose of bend supports with linked criss cross pattern called as pantograph. Factor of safety and all precautions were taken while manufacturing and designing this lift. It also has rollers which make scissor lift movable. It is used in domestic as well as industrial purpose. It can perform uplift and downlift. The uplift is successfully attained by the outside pressure acts on less sets of supports extending the crossing pattern and pushing the platform to perform uplift. It may also have enlarged bridge to permit closer access to area of work.

THE WORKING PRINCIPLE

Hydraulic scissor lift works on the pressurised typically oil. When the oil is pressurized, the piston in the cylinder moves outwards due to which legs of the scissor open. By releasing the pressure of cylinder through pressure releasing valve, the piston moves inward after that scissor legs close then lift moves downwards.

Raising the Lift Table:

The base and platform are attached to the inner end and the outer end of the scissor lift. The base is fixed and the platform is vertically movable. Rollers are fixed at the one end and free at another end.

When the table is moved upward, it is supported with the fluid. The platform can remain in raised position because fluid is held in check valve. According to our requirement, we raise it manually.

Lowering the Lift Table:

The lift table is lowered by opening down valve that allows fluid out of cylinder at controlled rate. This down valve is solenoid operated and a normally closed type valve which means it stays closed until electric solenoid is actuated. If any electric failure occur this feature prevent lift table from lowering. When Solenoid open down valve fluid return to reservoir. Flow control valve is used to controlling how fast the fluid is leaving the cylinder. These FC valves are fixed or non adjustable and typically lift table down speed is matched to lift table up speed

MATERIAL SELECTION

Material selection is done according to each components. so it is required to assess all type of forces and stresses acts on each component. By use this we can select the material according to the mechanical properties of the component. So each component analysis is here

COMPONENTS

- I. Scissors arms
- II. Hydraulic cylinder
- III. Top plat form
- IV. Base plat form
- V. Wheels

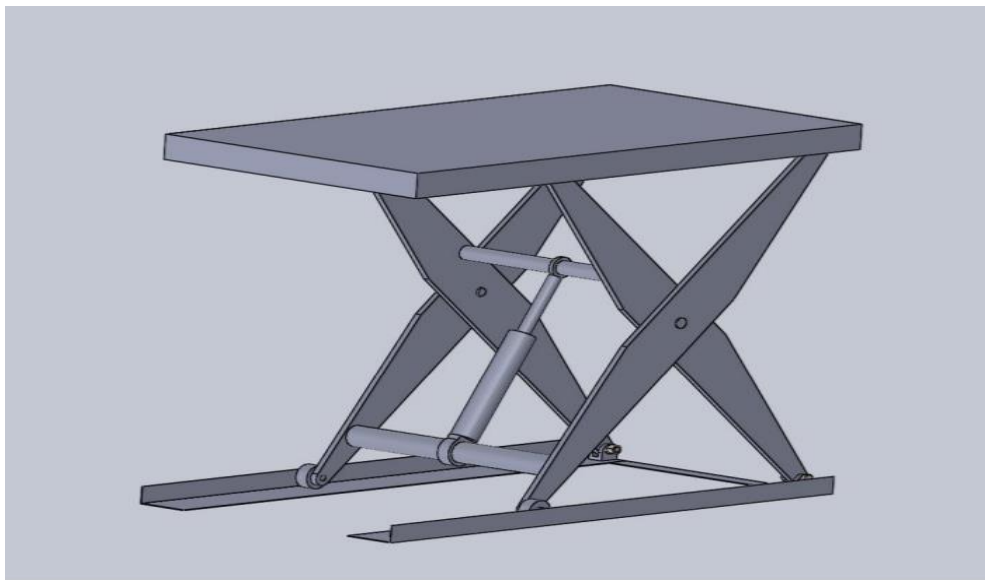
Scissor Arms: Buckling load and Bending load act on scissor arms tend to break or cause bending the component. Stainless steel is used on the basis of strength, stiffness, plasticity and hardness.

Hydraulic cylinder: It is subjected to the compressive force which impose buckling and bending of component. Longitudinal and circumferential stress also generated because of internal compressive stress. Hence mild steel is a good option because of high ductility and hardness.

Top Platform: Strength is required because top platform is subjected to the main load on its base. so material used in base is wood and is mild steel used in part of frame

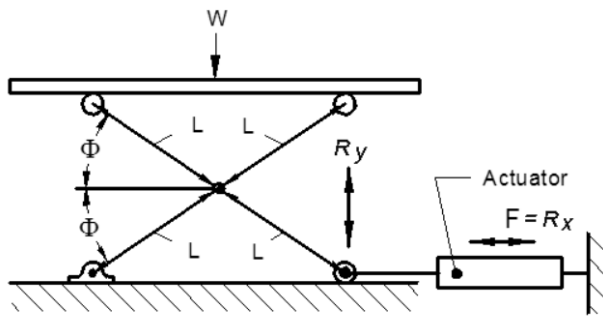
Base Plat Platform: Weight of top platform and scissor arms acts on base. Whole assembly stability based on this Therefore Mechanical properties are needed like strength, hardness etc. so recommended material is mild steel, SAE1020

DESIGN

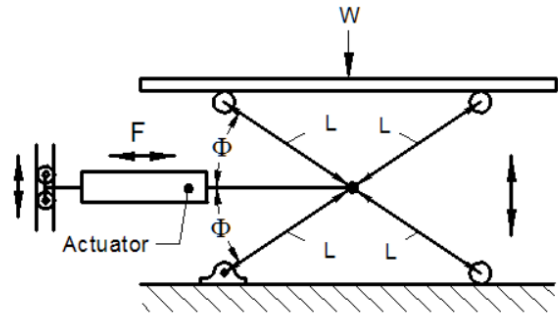


For a scissor lift that has straight equal length arms, i.e. the distance from the horizontal jack screw attachment point to scissor joint is same as the distance from that scissor joint to the top load platform attachment.

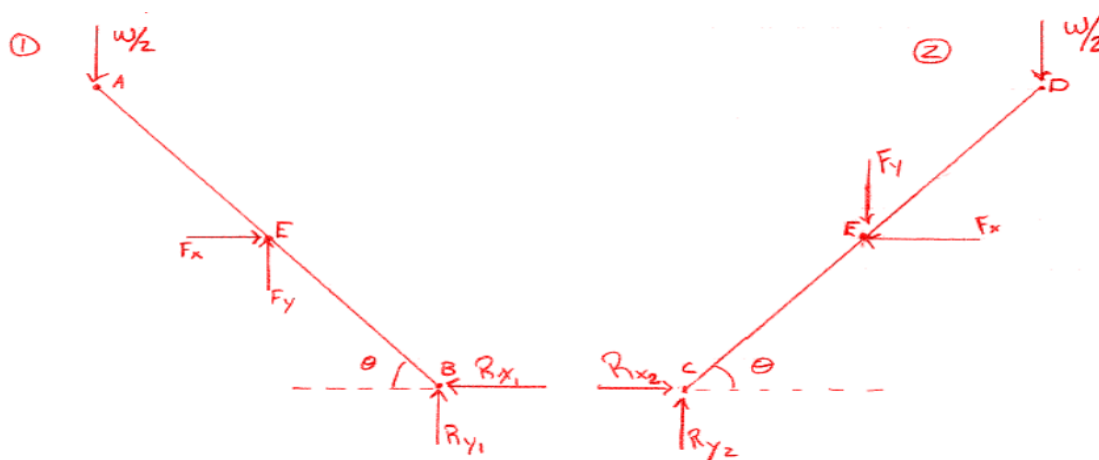
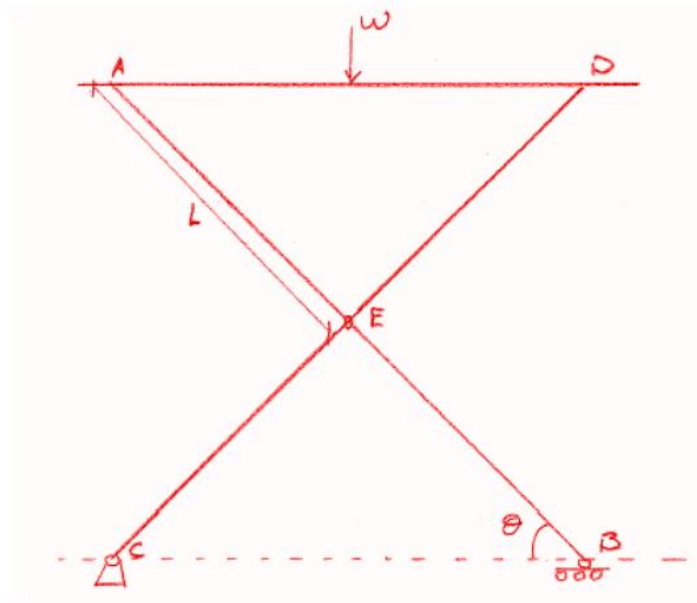
Scissor Jack - Loading Applied at Bottom



Scissor Jack Equation With Load Applied At Center Pin:



Free Body Diagrams:



Static Equations

$$\textcircled{1} \textcircled{A} \sum M_B^{\curvearrowright} = 0 = \frac{w}{2} \times 2L \times \cos(\theta) - F_y \times L \times \cos(\theta) - F_x \times L \times \sin(\theta)$$

$$\textcircled{B} \sum F_{x \rightarrow} = 0 = F_x - R_{x1}$$

$$\textcircled{C} \sum F_{y \uparrow} = 0 = -\frac{w}{2} + F_y + R_{y1}$$

$$\textcircled{2} \textcircled{D} \sum M_A^{\curvearrowright} = 0 = -\frac{w}{2} \times 2L \times \cos(\theta) - F_y \times L \times \cos(\theta) + F_x \times L \times \sin(\theta)$$

$$\textcircled{E} \sum F_{x \rightarrow} = 0 = -F_x + R_{x2}$$

$$\textcircled{F} \sum F_{y \uparrow} = 0 = -\frac{w}{2} - F_y + R_{y2}$$

6 equations, 6 unknown variables

$$\textcircled{A} 0 = \frac{w}{2} \times 2L \times \cos(\theta) - F_y \times L \times \cos(\theta) - F_x \times L \times \sin(\theta)$$

$$F_y = \frac{-\frac{w}{2} \times 2L \times \cos(\theta)}{L \times \cos(\theta)} + \frac{F_x \times L \times \sin(\theta)}{L \times \cos(\theta)}$$

$$F_y = -w + F_x \times \tan(\theta)$$

$$\textcircled{D} 0 = -\frac{w}{2} \times 2L \times \cos(\theta) - F_y \times L \times \cos(\theta) + F_x \times L \times \sin(\theta)$$

$$F_x = \frac{\frac{w}{2} \times 2L \times \cos(\theta) - F_y \times L \times \cos(\theta)}{L \times \sin(\theta)}$$

$$F_x = \frac{w}{\tan(\theta)} - \frac{F_y}{\tan(\theta)}$$

By substitution (eq. A into eq. D)

$$F_x = \frac{w}{\tan(\theta)} - \left(\frac{-w}{\tan(\theta)} - \frac{F_x \times \tan(\theta)}{\tan(\theta)} \right)$$

$$F_x = \frac{2w}{\tan(\theta)} + F_x$$

$$F_x = \frac{w}{\tan(\theta)}$$

$$\text{If, } -R_{x1} + F_x = 0 \quad \text{and} \quad R_{x2} - F_x = 0$$

$$R_{x1} = F_x$$

$$R_{x2} = F_x$$

Therefore,

$$F_x = R_{x1} = R_{x2} = \frac{w}{\tan(\theta)}$$

$$\textcircled{A} \quad -w + F_x \times \tan(\theta) = F_y$$

$$\textcircled{D} \quad \frac{w}{\tan(\theta)} - \frac{F_y}{\tan(\theta)} = F_x$$

$$F_y = -w + \left(\frac{w}{\tan(\theta)} - \frac{F_y}{\tan(\theta)} \right) \times \tan(\theta)$$

$$F_y = -F_y$$

$$F_y = \emptyset$$

For calculating upward reactions

$$\textcircled{F} \quad \emptyset = -\frac{w}{2} - \overset{=0}{F_y} + R_{y2}$$

$$\boxed{\frac{w}{2} = R_{y2}}$$

$$\textcircled{C} \quad \emptyset = -\frac{w}{2} + \overset{=0}{F_y} + R_{y1}$$

$$\boxed{\frac{w}{2} = R_{y1}}$$

In conclusion,

$$R_{x1} = R_{x2} = \frac{w}{\tan(\theta)} \quad F_x = \frac{w}{\tan(\theta)}$$

$$R_{y1} = R_{y2} = \frac{w}{2}$$

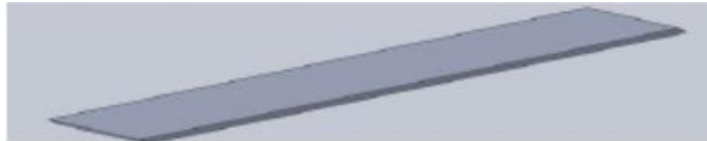
$$F_y = 0$$

MODELLING

All the parts of scissor lift which must be designed and assemble are given below.

Scissor lift platform:

It is required to design a platform which should serve under heavy load application with withstand stresses.



Scissor arm:

In modelling of scissor lifts

scissor arms plays a key role it bears the loads and lift platform.

The maximum extension length and closing length of scissor lift can be observed to the value of raise up to 1828mm when it is opened. This scissor lift can be close up to 150mm when it is closed.



Coupler:

In modelling scissor lift, couplers are fixed joints with support the hydraulic cylinder to lift the plate.



Cylinder:

In modelling scissor lift cylinder are placed to lift the heavy loads on the platform

cylinder of scissor lift All the parts shown above are assembled to form a complete structure of hydraulic scissor lift which is represented in figure below.



ADVANTAGE OF HYDRAULIC SCISSOR LIFT

Hydraulic Scissor lifts are basically used to uplift and downlift products vertically in a crisscross pattern known as pantograph.

While lifting a heavy component where lifting is necessary hydraulic lifts are highly used after lifts. It has been customized for commercial as well as domestic purpose

- Hydraulic scissor lift are easy to operate and it did not need highly skilled labour
- With the help of hydraulic scissor lift we can avoid recurring Strain Energy so bend and stretch are eliminated in this lift.
- With the help of rollers it became movable
- By using scissor lift we can save large amount of time
- Scissor lift also decreases manual labour
- scissor lift can access to reach certain height. With a variety a large prototype can extend till 18m.
- It is cheaper to install than elevator types
- It requires very less floor space
- With the help of hydraulic scissor lift we can evenly distributed weight uplift
- They are easily adaptable to different terrain and climate
- It is very reliable

APPLICATION

It is used for domestic as well as industrial purpose the application of scissor lift include various things

- A scissor lift table can easily used in warehouse with the help of this all heavy items can lift with ease. stack boxes, pallets and other heavy material are used
- Hydraulic scissor lift has provide safe working conditions. It helps to reduce injuries as this can be used in tough conditions
- For construction purpose scissor lift are highly used in various cities.
- Scissor lift can also be used in libraries for taking book at high shelves.
- In military hydraulic lift used for making loading easier for armoured vehicles
- It can also used in domestic purposed
- Hydraulic lift plays a key role in construction industry it helps in forklifts and other transport machinery
- Loading and unloading can be easily done by hydraulic scissor lift.

CONCLUSION

Hydraulic scissor lift can be easily used. It can used in domestic as well as industrial purpose. It can also lift heavier load. Operator can comfortably use this lift because it did not need any high skill. material can also easily handle by this lift. Scissor lift are easy to use and routine maintenance is not required in hydraulic scissor lift. With the help of hydraulic small amount of power can lift big load. For the given dimension our hydraulic scissor lift can lift upto 300 kg of load with a raise of 3m. cast iron are used because of their high machinability and good wearing resistance .it can withstand high load and a good resistance to corrosion. We can further improve this lift by some important modification as there is high scope for improvement. Changes should be done according to commercial as well as domestic purpose. So its efficiency become attractive

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should make it commercially available and attractive. Hence, its wide application in industries, hydraulic pressure system, for lifting of vehicle in garages, maintenance of huge machines, and for staking purpose. Thus, it is recommended for the engineering industry and for com