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Review on Industrial Scissor Lifts

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ABSTRACT

This paper reviews the design and analysis of industrial scissor lift. It gives the brief description of its types and working. Generally, scissor lift is widely used material handling equipment which is used for lifting, lowering the heavy objects and transporting them throughout the plant. It can be operated by mechanical, pneumatic or hydraulic power. This paper explains the method of designing scissor arms as well as the force optimization. The provisions for the safety of the worker while operating the equipment is given in this paper.

Keywords: Scissor lift, Hydraulic, Safety, Analysis.

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I. INTRODUCTION

A scissor lift is mainly used to lift object upwards with its crisscrossing foundation supporting the platform. As the platform pulls itself together, it moves upright in the vertical direction and pushes the platform with respect to the height and weight.

The hydraulic scissors lift is a lift with a system of levers and hydraulic cylinders on which the metal platform is capable of moving in the vertical plane. This is achieved by using of linked, folding supports in a crisscross pattern, called scissor mechanism. Scissors lift is an integral part of most of the workshops and building objects. The key advantage of lifts is that they even offer the best way to organize a technological and industrial process. Besides, almost all lifts give the possibility to change the place of their installation without much effort, which is important in the frequently changing conditions in the production process these days.

fig 1. Industrial scissor lift

II. CLASSIFICATION OF SCISSOR LIFT

1. Classification based on the type of energy used
   (1) Mechanical lifts
   (2) Pneumatic lifts
   (3) Hydraulic lifts
2. Classification based on their mounting
   (1) Permanent
   (2) Portable

III. WORKING

Scissor lift consists of a number of links arranged in form of cross pattern. It converts linear motion between any

two points of arms into vertical movement of the table. This construction gives mechanical advantage factor which is dependent on a position of actuator mounting. Actuator force in scissor lift varies according to position of lift. [3]

fig 2. Closed position [1]

fig 3. Open position [1]

IV. MATERIAL SELECTION

Considering stresses induced in parts of a scissor lift and cost effectiveness most obvious choice of material is mild steel. Mild steel is commonly used and readily available material so it is cost effective. 'Divyesh Prafulla Ubale, Alan Francy, N.P Sherje' in their paper on 'Design, Analysis, and Development of Multiutility home equipment using Scissor Lift Mechanism' have used mild steel for structural members of lift.[1]

V. DESIGN CALCULATION

Calculation of Forces:

The forces acting in scissor can be calculated by considering scissor to be in equilibrium. Then taking summation of all forces in X-direction, Y-direction and moment about fixed point equal to zero.

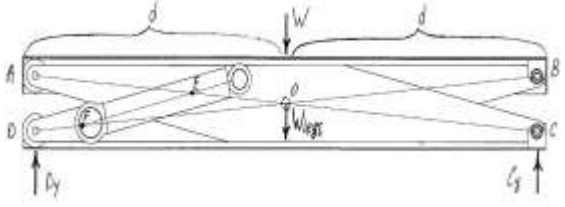

fig 4. Forces in closed position[4]

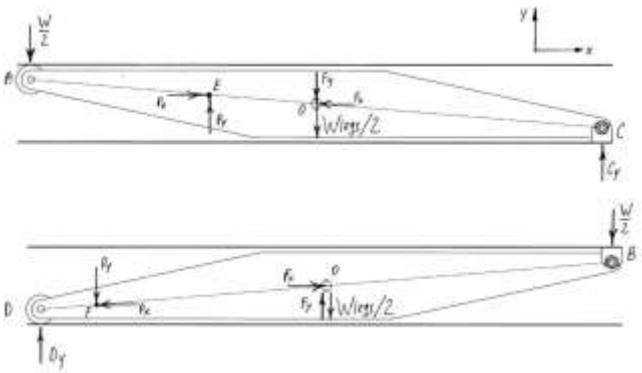

fig 5. Free body diagram in closed position [4]

The free body diagram of this scissor in open position is given below.

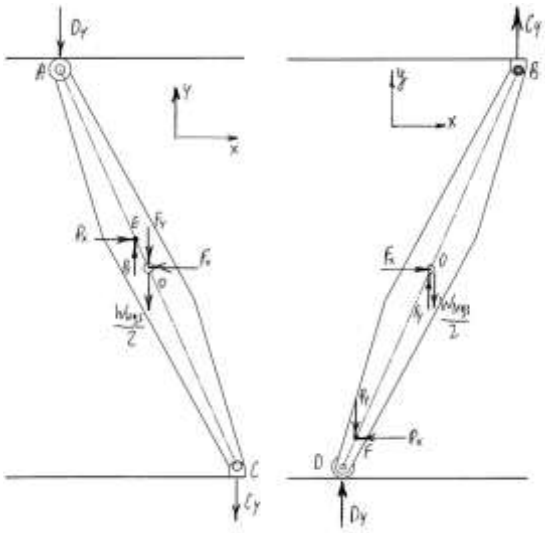

Fig 6. Free body diagram in opened position[4]

Force required by actuator

The force required to be applied by the actuator is given by

$$P = \frac{L \cdot \cos\alpha\left(\frac{W}{2}+\frac{W_{leg}}{4}\right)}{a\sin(\alpha+\beta)} \ldots [4]$$

Optimum force by Actuator:
Basic formula for actuator force

$$F = \left[\left(Hy+\frac{By}{2}\right)+\left(Hx+\frac{Bx}{2}\right)\frac{\tan\theta}{n}\right]\frac{dh}{dl} \ldots [5]$$

Two options are available for scissor mounting

1. Attaching both ends of the actuator to scissor member
2. Attaching one end of the actuator to scissor member and other to a fixed point.

Attaching both ends of actuator to scissor member

$$\frac{dh}{dl} = \frac{[nscos\theta\,[acos\theta+bsin\theta)^2+(csin\theta+dcos\theta)^2]^{1/2}}{(acos\theta+bsin\theta)(-asin\theta+bcos\theta)+(csin\theta+dcos\theta)(ccos\theta-dsin\theta)} \ldots [5]$$

$$\frac{dh}{dl} = \frac{-nDsin\zeta}{(y_{Q90} - y_{Q0}tan\theta)cos(\zeta+\phi)} \quad \ldots[5]$$

VI. ANALYSIS OF SCISSOR LIFT

The analysis for stress and deflection of scissor lift can be done by finite element analysis. Jaydeep M. Bhatt, Milan J. Pandya in 'Design and analysis of an aerial scissor lift' has done stress analysis and deformation analysis using Ansys software to verify the design. [6] By conducting analysis, the stability and the accuracy of single scissor arm for critical loads can be found. [8]

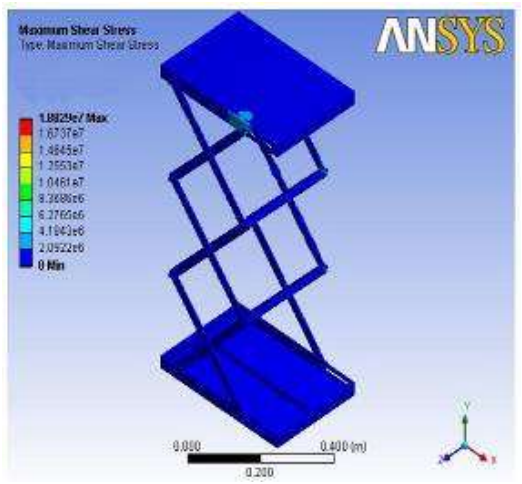

Fig 7. Stress Analysis in ANSYS [6]

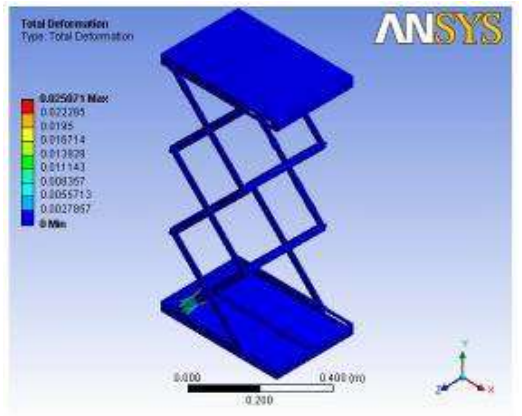

Fig 8. Deformation Analysis in ANSYS [6]

VII. SAFETY REQUIREMENTS

Like other material handling equipment, scissor lifts can also be unsafe to the operator working on it. The various causes that can lead to unsafe conditions are improper handling, irregular maintenance, faulty installation and false design. To avoid this some regulations should be followed in designing phase, manufacturing, installing and operating. Various safety measures should be provided at operating stage like Bevel toe guard, skirts, pit mounting, indicated bar, toe sensors, and enclosures. [7]

VIII. CONCLUSION

This paper studies design, analysis and safety requirements of the scissor lift. It is a versatile material handling equipment which can use hydraulic, pneumatic or mechanical energy as input for its working. For designing, forces can be calculated by considering equilibrium of the system at both the positions, closed and open. The various attachments can be added to the equipment which ensures the safety of the worker operating it and gives the guidelines for handling the unit.

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