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Design of Hydraulic Scissors for Block Lifting and Associated Loads

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Abstract: *There is a wide need to carry blocks and associated loads in housing construction. Hydrualic machines have the potential to bear more loads and provide smooth and quite operations. A design of a scissor hydraulic for blocks and associated loads lifting was thought of and designed. An initial carrying load capacity of 500kg was conceived. Analysis was carried out to determine the load bearing capacity of the machine with respect to the maximum stress, strain and buckling subjected to the system. A prototype was produced and was able to lift a load of 78kg in 120 seconds.*
Keywords: Design, block ,Hydraulic, Associated loads, lifting, scissors

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I. Introduction

Block loading and lifting platforms are mechanical structures that enhance flexible access purpose and many other applications. It can also be used for maintenance and material handling operations. There are several vertical lifting equipment which include mast, cargo, boom and scissor lift. Generally, a scissor lift provides most economical and versatile methods of lifting loads. It is majorly used as compared to other lifting devices in the market because it iseconomically friendly. Scissor liftare classified based on working principles either as mechanical, pneumatic or hydraulic via a lead screw or rack and pinion system **[1]** . By applying force to one or more supports, the connected components extend, resulting in an elongation of the cross pattern, 'X'.

A scissor lift or mechanism is a device used to extend or position a platform by mechanical means. The term "scissor" comes from the mechanic which has folding supports in criss cross "X" pattern. The extension or displacement motion is achieved by the application of force to one or more supports, resulting in an elongation of the cross pattern. The force applied to extend the scissors mechanism may by hydraulic, pneumatic or mechanical (via a lead screw or rack and pinion system).

The need for the use of lift is very paramount and it runs across labs, workshops, factories, residential/commercial buildings to repair street lights, fixing of bill boards, electric bulbs etc. expanded and less efficient, the engineers may run into one or more problems when in use.

The name scissors lift originated from the ability of the device to open (expand) and close (contract), just like a scissors. Considering the need for this kind of mechanism, estimating as well the cost of expanding energy more that result gotten as well the maintenance etc. it is better to adopt this design concept for the production of the machine.

The initial idea of design considered was the design of a single hydraulic ram for heavy duty vehicles and putting it underneath, but this has limitations as to the height and stability, and someone will be beneath controlling it. It was rather found out that; there is a possibility of the individual ascending and descending, to be controlling the device himself. Therefore further research was made to see how to achieve this aim. Before this time scissors lift existing use mechanical or hydraulic system powered by batteries for its operations. Several challenges were encountered in this very design. Some amongst many include; low efficiency, risk of having the batteries discharged during an emergency, extended time of operation, dependent operation, as well as maintenance cost. It is the consideration of these factors that initiated the idea of producing this hydraulically powered scissors lift with independent operator. The idea is geared towards producing a scissors lift using one hydraulic ram placed across flat, in between two cross frames and powered by a pump connected to a motor wheel may be powered by a pump generator. Also, the individual ascending and descending is still the same person controlling it, i.e. the control station will be located on the top frame.

A scissors lift is attached to a piece of equipment having a work station known as scissors lift table that houses the pump, the reservoir, the generator, control valves and connections and the motor. A scissors lift does not go as high as a boom lift; it sacrifices heights for a large work station. Where more height is needed, a boom lift can be used.

Hydraulic scissor lift platform is widely used in the mechanical and manufacturing industries, automatic production lines, hospitals, the basements and physical distribution lines either indoor or outdoor with a considerable extensive space.

In the design of loading and lifting equipment, certain performance factors were put into consideration such as: high loading capability, fast moving velocity and a steady regulation of height of the platform as it expands and contracts. In this regards, material selection plays a vital

role in designing the machine and also influence other factors such as durability, reliability, strength, resistance which affects the overall performance of the hydraulic scissor lift.

A scissors lift is attached to a piece of equipment having a work station known as scissors lift table that houses the hydraulic cylinder, pump, reservoir, generator, control valves and the motor **[**2**]**. A scissors lift does not reach certain heights like a boom lift; it sacrifices height for a spacious work station. Where more height is needed, a boom lift can be used.

This paper focuses on achieving an economical design with a durable and safe loading platform operating in hydraulic principles. Therefore, reference is made to specifications of necessary components which includes, motor, pump, oil tank and hydraulic cylinder. Structural design of the support frame is also considered.

The conventional method of using ropes, ladders and scaffold in accessing a desired height seems challenging considering the weight of load to be carried, convenience, time consumption and much energy expended, the idea of a hydraulically powered scissors lift which will overcome the above stated limitations is used. In order to facilitate the above necessity, a hydraulic scissors lift platform for accessing height with the characteristic ability of lifting steadily, balanced platform with cage of railings and a maximum load carrying ability of 500kg in weight.

The design of loading and lifting platform technology considering hydraulic scissors lift is to enhance flexible access purpose during maintenance with maximum comfort, safety and desired height. It may be used without a necessary external assistance or assistance from a second party due to the concept of the design.

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Loading and lifting platform technology is a form of construction which engages lift mechanism through the application of pneumatic, mechanical or hydraulic principles. This technology is extensively used in locations where other means of access poses higher safety risk due to height consideration, access flexibility and stability **[**3**]**. Recently, lifting platform technology has variations in design to suit different purposes in industry. These various service demands include cleaning services, maintenance activities and material handling. Basically, there are three main classifications of lifting platforms based on working principles. These are telescopic lifts, articulated lifts and scissor lifts.

A scissor lift is a type of construction lift, which is equipped with a steady and safe platform to elevate workers and loads to high areas. Elevating Work Platform of Australia (EWPA) describes it as a work platform which can only move within the vertical plane on which personnel, equipment and materials could be elevated to perform work. Scissors lift is classified based on working principles as follows[4] **:**

i. Hydraulic scissor lift

ii. Diesel scissor lift

iii. Electrical scissor lift

iv. Rough terrain scissor lifts

v. Pneumatic scissor lift.

Hydraulic scissor lifts are powered by hand-operated or engine-driven hydraulic systems. The changing pressure of the hydraulic oil in the machine produces smooth movement during lifting. Hydraulic scissor lift has some advantages when compared to other lifting devices because it eliminates its dependency on power supply. Also, it allows smooth movement without jerking due to steady increase in fluid pressure **[**5**]**. In cold weather, maximum efficiency is not obtainable with hydraulic scissors lift due to high viscosity of oil. Sometime debris from improperly preserved oil blocks oil tubes and at times disrupts proper functioning of the system. However, this issue has been addressed in newer models. Because of its simplicity inoperation, it does not require much training to operate.

Diesel scissor lifts are among the most commonly used lifts on construction sites. The cross- braced system allows .This foldable support which looks like a criss-cross pattern linked together forms a rhomboidal pattern during the displacement motion of the connected parts**.** A minimum accessibility height of 9.14 meters, with certain models extending as high as 18.3 meters. Diesel lift is powered via traditional diesel fuel[6]. This causes noise and releases pollutants into the environment. Therefore, they are usually reserved for outdoor construction sites or areas where there is proper ventilation and noise can dissipate. Their hefty design also provides them with a larger aerial platform.

An electric scissor lift is a mechanical lift and uses electric battery instead of burning fuel. Since they do not emit any toxic gas or cause noise pollution, electric scissor lifts provide a more suitable remedy for indoor spaces, which often have insufficient ventilation[7]. These machines occupy minimal space due to its ergonomic designs.

Rough terrain scissor lift is designed exclusively for outdoor terrain with enhanced features that supports sloppy terrains. It has gradability which measures slope performance capacity of the machine. Typically, it has internal combustion engines which utilises either diesel, petrol or gas. The enhanced productivity provides exceptional traction and speed needed in large construction sites. They have high weight capacity and balanced heavy duty tires with additional safety mechanisms to prevent fall like fall. This makes them ideal for work sites with uneven surfaces and slopes, as well as projects that take place in unfriendly weather.

Platform structure is the top of the lift that is subjected to the weight of the workman and his equipment hence strength is required. It varies in sizes. 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. The extension of the scissors during rising of the lift causes the rollers toroll 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.

Structure material height does improve resistance to deflection, but also contributes to an increased collapsed height of the lift.

The material used for this purpose is mild steel angle bar. This is used because the base frame is responsible for the stability of the platform.

Hydraulic scissors lift base frame forms the bottom structure that rests on the ground. It is subjected to the weight of the top platform and the scissors arms. It is also responsible for the stability of the whole assembly, therefore strength, hardness and stiffness are required mechanical properties for the scissor lift [8, 9].

In hydraulic scissors lift, pins are used to establish connections with other links. The scissor liftis pinned at all hinge points, and each pin has a successive 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.

The hydraulic cylinder is made up of a cylinder barrel and a piston which is connected to a pistonrod that moves back and forth. The piston pushes the oil in the other chamber back to the reservoir. The hydraulic liquid contained in the cylinders of a hydraulic scissor lift is used to power the lift mechanism of the machine. The cylinder could be one, two, or three single-acting depending on applicable demand. These allow the scissor lift table to lift and lower the load to the required height.

In times past, several scientists and engineers have contributed immensely towards the design of scissors lift in general. Hydraulic scissor lift method of design for loading and lifting platform operates on the principles of Pascal law. Several studies investigating the interactions of components and innovative modifications in order to obtain a more efficient and cost effective designs are being reviewed. In essence, they give the design and construction of a hydraulic scissors lift platform a better perspective.

[10**]**concluded that force is also acting on the hydraulic scissor lift when it is extended and contracted. In his work, "Design and Analysis of Hydraulic Scissor Lift" he stated that hydraulic scissor lift should be designed in such a way that it must be portable, compact, and more suitable for the medium type of load handling applications. Therefore, material selection plays a key role in designing a machine and also influence on several factor such as durability, reliability, strength, resistance which finally leads to increased life of the scissor lift.

In the design, manufacturing and analysis of hydraulic scissor lift.[11]found that a scissor lift or jack is employed for lifting a vehicle to change a tire, to gain access to travel to the underneath of the vehicle, to lift the body of the vehicle 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.

The shape of a hydraulic scissor lift is a pantograph its ability to compress or extend like an accordion. This foldable support which looks like a criss-cross pattern linked together forms arhomboidal pattern during the displacement motion of the connected parts . The pantograph which is the lifting mechanism functions like a spring when displacement motion occurs due to application of pressure. Its length and size is defined by the expansion andcontraction of the body of the scissor lift. The hydraulic principle of the fluid operates on Pascal"s Law as shown in Figure 1.

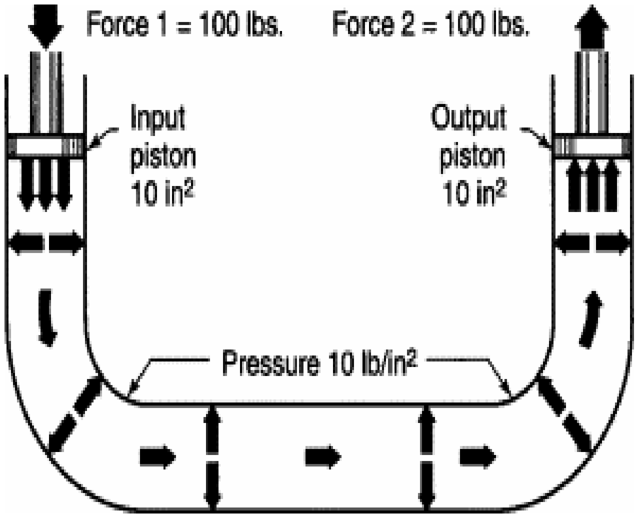

Figure 1: shows schematic of Pascal "s principles in Hydraulic System.

The objective of his research is to achieve a design of a moveable and portable hydraulic scissor lift with rollers or wheels for motion at the bottom side of the lift powered by a hydraulic pump, capable to carry blocks and associated loads in housing construction.

II. Materials and Methods

In this section all design concepts developed are presented and based on evaluation criteria and process developed, and a final design was made.
Considerations made during the design and production include:

a. Functionality of the design

b. Manufacturability

c. Economic availability ie -general cost of materials and fabrication techniques employed.

The lifting mechanism operates by Pascal"s principles of hydraulic as well as a power screw and comprises of five major components responsible for the total functionality of the machine. They are; hydraulic cylinders, base frame, scissor arms, platform structure and power screw. In its operation, the motor forces hydraulic fluid into the double acting cylinder causing it to stroke outwards. The outward stroke propels the scissor legs to be pushed apart thereby raising the platform. A check valve is used to maintain the level of fluid. This allows the operator to maintain the platform at a constant height. The down valve which allows fluid out of the cylinderis employed to lower the scissor lift mechanism as the legs retract. In order to obtain the joint forces, it is assumed that the free body diagrams of the systems are taken into consideration. The device can be operated alternately by turning the wheel linked to the power screw in a clockwise direction to raise the load and turning the wheel in an anticlockwise direction to lower it.

Figure 2 shows the 3D representation of a hydraulic scissors lift.

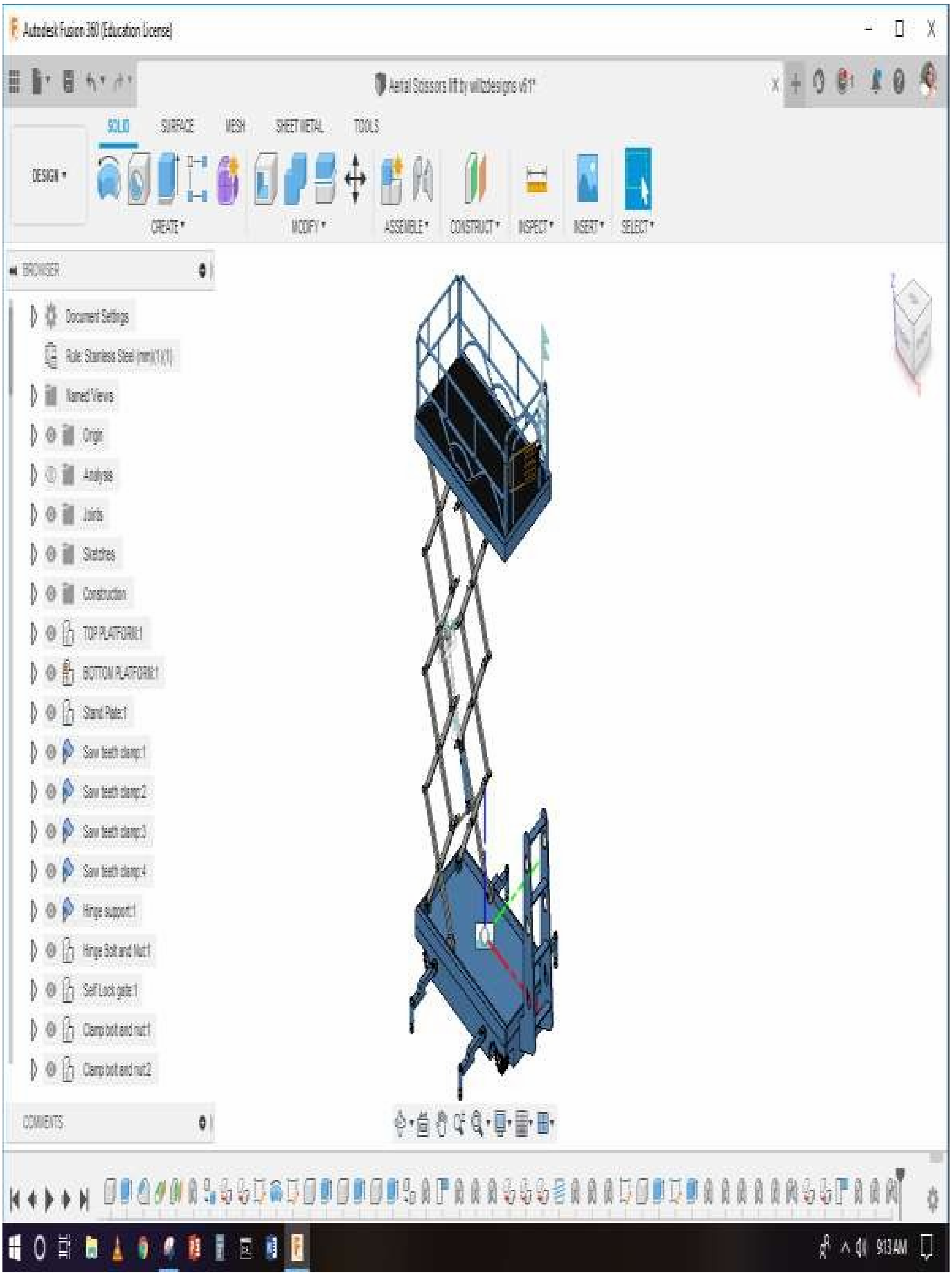

Figure 2.: 3D Representation of the Hydraulic Scissors Lifting Platform

2.1 Design Process

The design process of this mechanism is given in the flow chart in Figure 3.

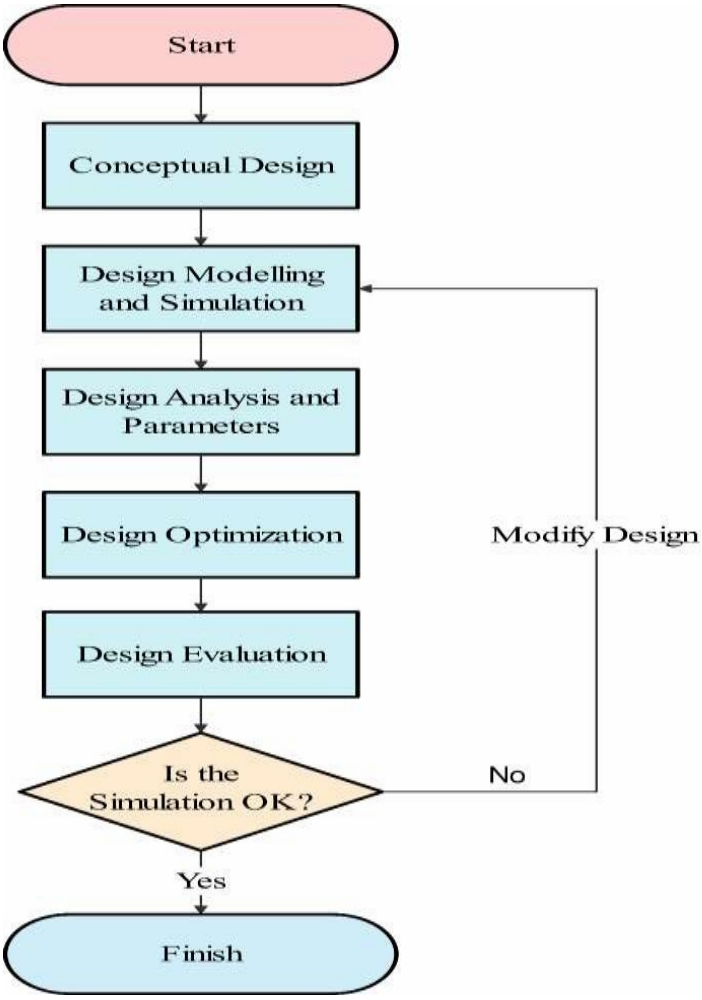

Figure 3: Process Design of Hydraulic Scissor Lift

2.2 Design Theory

Hydraulic systems are used to control and transmit power. A pump driven by a prime mover such as an electric motor creates a flow of fluid, in which the pressure, direction and rate of floware controlled by values. An actuator is used to convert the energy of the fluid back into mechanical power. The amount of output power developed depends upon the flow rate, thepressure drop a cross the actuator and its overall efficiency.

Most lifting devices are powered by either electricity, pneumatic or mechanical means. Althoughthese methods are efficient and satisfactory, there exist lots of limitations and complexity of design of such lifts as well as high cost of electricity, maintenance and repairs does not allow these lifts to exist in common places.

The idea of a hydraulically powered scissors lift is based on *Pascal's law* employed in car jacksand hydraulic rams which states that "pressure exerted anywhere in a conformed incompressiblefluid is transmitted equally in all directions throughout the fluid such that the pressure ratio remains the same.

The hydraulic cylinder (or the hydraulic actuator) is a mechanical actuator that is used to give a unidirectional stroke. It has many applications, notably in engineering. The following are examples of hydraulic cylinder:

Single acting cylinders use hydraulic oil for a power stroke in one direction only. The return stroke is affected by a mechanical in one direction only. The return stroke is affected by a mechanical spring located inside the cylinder. For single acting cylinderswith no spring, some external actin force on the piston rod causes its return.

Double acting cylinder uses compressed air or hydraulic fluid to pour both the forward and return strokes. This makes them ideal for bushing and pulling and pulling within the same application they are suitable for full stroke working only at slow speed which results in gentle contact at the ends of stroke. The hydraulic cylinder is typically made of Mild steel. The cylinder was not custom made because we do not have a reliable machine.

2.3 Design Analysis

The force acting on this section of the lift isdirect compressive force, bending stress and internal compressive pressure

$$P = \frac{F}{A} \qquad 1$$

where;

P is the pressure supplied to the hydraulic cylinder

F is the force needed to hold the scissor lift

A is the Area of the cylinder

In the selection of cylinder, two primary concerns were noted:

a. The strength of the rod. i.e its ability to support a specified load without experiencing excessive stresses.

b. The ability of the piston to support a specified load without undergoing unacceptable deformations.

$$P_E = \frac{\pi^2 EI}{L^2} \qquad 2$$

where;

P_E is the Buckling load

E is the Modulus of elasticity

I is the Moment of Inertia

L is the Unsupported Length

d is the diameter of the cylinder

$$I = \frac{\pi d^2}{64} \qquad 3$$

To avoid buckling (bending) of the strut, the compressive stress σ_E must not exceed the yield stress σ_Y. ($\sigma_E < \sigma_Y$) Because of the large deflection caused by buckling, the least moment of inertia I can be expressed as

$$I = Ak^2 \qquad 4$$

where A is the cross sectional area and K is the radius of gyration of the cross sectional area. i.e

$$k = \sqrt{\frac{I}{A}} \qquad 5$$

$$A = \frac{\pi d^2}{4} \qquad 6$$

Note that the smallest radius of gyration of the column, i.e the least moment of inertia I, must be taken in order to find the CRITICAL STESS OR BUCKLING STRESS OR CRIPPLING STRESS.

$$\sigma_E = \frac{P_E}{A} \qquad 7a$$

Dividing the buckling equation by A, gives

where

σ_E is the compressive stress in the column and must not exceed the yield stress σ_Y of the material i.e $\sigma_E < \sigma_Y$

$$L/K \qquad 7b$$

is called the SLENDERNESS RATIO; it is a measure of the column"s flexibility.

When cylinders are subjected to internal fluid pressure, the following types of stresses are developed:

a. Hoop or circumferential stress.

b. Longitudinal stress.

Hoop stress is produced as a result of forces applied from inside the cylindrical pipe pushing against the pipe walls. Hoop stress is the result of forces pushing against the circumferential cylinder walls. While, longitudinal stress is as a result of forces pushing against the top ends of a cylinder. These forces are derived using *Newton's first law.*

Let d be the internal diameter of cylinder

T be the thickness of cylinder

P be the internal pressure (gauge) in the cylinder

σ_c be the circumferential or hoop stress

σ_L be the longitudinal stress

L be the length of cylinder or pipe,

Then,

Hoop stress, $\sigma_c = \frac{Pd}{2t}$ 8

Longitudinal stress, $\sigma_L = \frac{Pd}{4t}$ 9

Maximum shear stress, $\tau_{max} = \frac{Pd}{8t} = \frac{\sigma c - \sigma L}{2}$ 10

Busting force = pdL 11

Resisting strength = $2Lt\sigma_c$ 12

Busting force = resisting strength ($pdL = 2Lt\sigma_c$) 13

Note: the maximum stress developed must not exceed the permissible tensile stress of the material.

The mechanical system is responsible for the lifting of the loads. It consists of the cross arm (X) which links the top platform and the base and it is power-driven based on specification.

2.3.1 Design of Pins

Pin acts in joining the links with the top and bottom frame. In hydraulic scissor lift, pin undergoes shear stress. Shear stress defined as force per unit cross section area.

Shear stress, $\tau = \frac{P}{2A}$ 14

At maximum extension, an "X" arrangement of the lift moves 0.9m = 900mm.

Total number of tiers of scissors (combined) = 3 Thus, total height of extension = 3 × 0.9

= 2.7m.

Length of base = 1400mm
Width of base = 800mm

Height of base from ground = 500mm

At maximum extension, Angle of inclination = 50°

At maximum extension, distance between two scissors feet = 800mm

Distance moved by sliding foot to full extension = 400mm

For the bearing

Number of ball bearings = 4
Number of shell bearings = 36

Internal diameter of ball bearings = 30mm

Internal diameter of shell bearings = 11mm

External diameter of ball bearings = 50mm

External diameter of shell bearings = 15mm

Pivot pin diameter = 14.6mm

2.3.1 Loading Platform

(Top and Base): Aluminum is used for the loading platform and galvanised steel for the railings. Aluminium 6061 is suitable because it has high resistance to corrosion. Table 3 shows the Mechanical properties of AI 6061.

The dimensions of the loading platform are given as:

Total height of platform = 1400mm.

Total width of platform = 800mm

Total height of platform = 800mm

Permissible load on plat form + platform weight = 300kg = 2.94kN.

A_2 = Inner cross sectional area

For jointed members:
Thickness of rectangular pipe = 3mm
Thickness of angle bar = 3mm.

2.3.2 Scissors Arm

$$Density \frac{Mass(m)}{Volume(v)} \quad 15$$

A_1 = Height × breadth = h × b 16

A_2 = (h – t)(b – t) 17

where;

h is the scissors arm height

b is the breadth

t is the thickness of material.

Volume (v) = area × length

V = AL (m^3) 18

L is the length of the scissor arm

2.3.3 Power screw
Mean diameter of the screw, d1 = 17mm

Core diameter of the screw d_c= 14mm

Pitch of the square thread, P = 6mm

Coefficient of friction between threads, μ =tan φ = 0.2

Effort required to rotate the screw, F_S is given as:

$$F_S = W(\frac{tan\alpha + tan\varphi}{1 - tan\alpha tan\varphi}) \quad 19$$

where $tan\alpha = \frac{p}{\pi d1}$

Torque required to rotate the screw, T is expressed as:

$$T = FS\frac{d}{2} \quad 20$$

The shear stress in the screw by the hydraulic ram is :

$$\tau = \frac{16T}{(dc)^3} \quad 21$$

2.3.4 Design of Scissor Lift with Force applied
F is the force provide by the hydraulic Ram
W is the combined weight of the pay load and plat form
WA is the combined weight of two scissors arms themselves

θ is the angle between the scissors arm and the horizontal.

$$P\sin\theta = \frac{w + wF}{2} \qquad 22a$$

$$P = \frac{w + wF}{2\sin\theta} \qquad 22b$$

where WF is the Frame weight.

$$F = P\cos\theta \qquad 23a$$

$$F = \frac{\theta(w + wF)}{2\sin\theta} \qquad 23b$$

Then,

$$F = \frac{w + wF}{2\tan\theta} \qquad 24$$

3.5 Design Calculations

3.5.1 Scissor Arms:

h =50mm b = 25mm t = 3mm
L = 1200mm
From Equation 16,
The outer cross-sectional area,
A1 = 1250 mm^2
From Equation 17,
A2 = 1034 mm^2
From Equation 16, checking the differences of areas
Cross sectional area of the scissor arm is 216 mm^2

From Equation 18,

The volume= $2.59\times10^{5}mm^{3}$ or $2.59\times10^{-4}m^{3}$

From Equation 15, the mass of the scissor arm is calculated thus,

$\rho = 8.03g/cm3 = 8030kg/m^{3}$

$v = 2.59\times10^{-4}m^{3}$

Mass = 2.08 kg

Mass of one tier = 8.32kg

Gravity = $9.81m/s^{2}$

Weight of one tier of links = 81.62 N

Force is calculated from Equation 24

Θ = 50°

Weight of load, W = 500×9.81 = 4905N

$F = 2092N$

For the three tiers, force =6276N

3.5.2 Hydraulic Cylinder Calculation Area of the hydraulic cylinder:
Diameter of the cylinder, d = 50mm 24

From Equation 6,

∴ $A = 1.9635\times 10^{-3}m^2$

Supplied Pressure:

$A = 1.9635\times 10^{-3}m^2$

F = 6276N

From Equation 1

$P = 31.96bar\ (31.96x10^5 N/m^2$

Buckling Action on Cylinder:

Given:

$I = 3.06 \times 107 m^4$

$E = 193 \times 10^9 N/mm^2$

L = 0.8m

Then

Buckling load,

$P_E = 911kN/mm^2$

(from Equation 5)

$k = 0.012$

(From Equation 7b)

$Slendernessratio = 67$

Since the load required (6276N) is less than the buckling load ($911KN/m^2$), the cylinder issafe in operation.

3.5.3 Stresses on Hydraulic Cylinder:

(from Equation 7a)

$P = 31.96bar$ ($31.96x10^5 N/m^2$

d = 50mm

t = 5mm

$\sigma_c = 15.98MN/m^2$

(from Equation 8)

$\sigma_L = 7.99N/m^2$

Maximum shear stress, (from Equation 9)

$r_{max} = 3.995MN/mm^2$

Busting force = pdL (from Equation 10)

L = 0.8m

d = 50mm

$P = 31.96bar$ ($31.96x10^5 N/m^2$

Busting force = 127.84KN

Resisting strength = 127.84kN (from Equation 11)

Resisting strength = bursting force.

3.5.4 Power screw calculation

Mean diameter of the screw, d_1 = 17mm

Core diameter of the screw d_c= 14mm

Pitch of the square thread, p = 6mm

Coefficient of friction between threads, μ =tan φ = 0.2

$P = 6$ mm

$d1 = 17$ mm

$\tan\alpha = 0.11$

s (from Equation 19)

$F_s = 1555N$

(from Equation 21)

$T = 13217.5Nmm$

Shear stress in the screw due to Torque

(from Equation 22)

$S_T = 24.5Nmm^2$

2.6Analysis of Mechanical Property Requirement of Essential Machine Components It is necessary to evaluate the particular type of forces imposed on components with a view to determining the exact mechanical properties and necessary material for each equipment. A very brief analysis of each component follows thus:

I. Scissors arms

II. Hydraulic cylinder

III. Top plat form

IV. Base plat form

V. Wheels

VI. Power screw

2.6.1 Scissors Arms: this component is subjected to buckling load and bending load tending to break or cause bending of the components. Hence based on strength, stiffness, plasticity and hardness, a recommended material is stainless steel.
2.6.2 Hydraulic Cylinder: this component is considered as a strut with both ends pinned. It is subjected to direct compressive force which imposes a bending stress which may cause buckling of the component. It is also subjected to internal compressive pressure which generates circumferential and longitudinal stresses all around the wall thickness. Hence necessary material property must include strength, ductility, toughness and hardness. The recommended material is mild steel.

2.6.3Top Platform: this component is subjected to the weight of the workman and his equipment, hence strength is required, the frame of the plat form is mild steel and the base is wood.

2.6.4 Base Platform: this component is subjected to the weight of the top plat form and the scissorsarms. It is also responsible for the stability of the whole assembly, therefore strength. Hardnessand stiffness are needed mechanical properties. Mild steel is used.
2.6.5 Wheels: the wheels are position at the base part of the scissors lift and enable the lift to movefrom one place to the other without necessary employment of external equipment like car.

III. Results and Discussion

3.1 Results

After production the machine was put into operation first without placing a load on it. Lifting and lowering operation was done with hydraulic jack as well as power screw. It was observed that its takes 40 to 50 seconds to raise the machine to its maximumheight with the hydraulic cylinder and 50 to 55 seconds with the power screw. Then the machinewas tested by placing a weight of 50kg and the time taken to reach the maximum height was 110 seconds. The machine was further tested with various weights and the results were tabulated as shown in the Table 1.

Table 1: Time taken to raise various load to the maximum height of the machine

S/N	Load, kg	Time to reach the maximum height with the hydraulic cylinder (sec)	Time to reach the maximum height with the power screw (sec)
1	10	66	71
2	2o	69	73
3	30	75	79
4	40	88	97
5	50	110	115
6	78	120	124

3.2 Discussion

The analysis was carried out to achieve the maximum and minimum of stress, strain and buckling. From the result analyses, it can be induced that the design is safe based on rigidity witha safety factor of 1.5. In the structure, the level of stress is significantly low and the effort required to raise a load of 500kg is enough.
Production of the machine commenced immediately a reasonable factor of safety was achievedduring the design. The maximum load that can be carried by the hydraulic scissor lift is 78kg in 120 seconds.

IV. Conclusion

The maximum load that can be carried by this machine is 78kg. It can reach the designed height in 120 seconds. The hydraulic scissor is effective in carrying blocks and associated loads for housing construction. Further work to include electronic controls are needed in this era of artificial intelligence.

It has wide application in industries, hydraulic pressure system, for lifting of vehicle in garages, maintenanceof huge machines, and for staking purpose. Thus, it is recommended for the engineering industry and for commercial production.

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