DESIGN AND ANALYSIS OF HYDRAULIC SCISSOR LIFT BY USING ANSYS

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ABSTRACT

This paper focuses around force following up on the pressure driven scissor lift when it is expanded and contracted. For the most part, a water driven scissor lift is utilized for lifting and holding overwhelming weight segments. Material choice assumes a key job in planning a machine and furthermore effect on a few factor, for example, sturdiness, unwavering quality, quality, obstruction which at long last prompts increment the life of scissor lift. The plan is performed by considering pressure driven scissor lift as a convenient, conservative and much appropriate for medium kind of load application. Plan of water powered framework scissor lift is finished utilizing CATIAV5R20 with appropriate demonstrating and imported to ANSYS V 17.0 for examination. Consequently, the static investigation of the scissor lift incorporates add up to disfigurement load, Equivalent pressure, force, weight was done in Ansys and every single dependable parameter were dissected with the end goal to check the similarity of the outline esteem. The computational estimations of three distinct materials, for example, Carbon fiber, auxiliary steel and Aluminum Alloy are looked at for best outcomes. Key Words: Hydraulic scissor lift, CATIA, ANSYS, Total deformation load, Equivalent stress, Static analysis

I. INTRODUCTON

Scissor lifts are average one of the vertical lifting hardware convenient hoisting work stages . Scissors lift can be utilized indoor or open air with an impressive broad space Their essential capacity is to hoist laborers, instruments, and materials to a coveted working tallness, while enabling the administrator to control the development and position of the lift. Contrasted and traditional strategies for lifting, scissor lift significantly decreases the mental pressure and physical requests on a laborer at raised stature. Along these lines, if a scissor lift is legitimately composed, fabricated, kept up, and properly utilized, it can increment the laborers' profitability as well as their security. Consequently, scissor lifts with various limits and hoisting statures are progressively utilized at numerous working environments. A scissor lift is a convenient, effortlessly expanded and compacted, safe working machine utilized for transportation of medium measured parts to its normal position. A scissor lift is machine which moves vertical way utilizing crosswise 'X' design scissor arms. The required height of the lift is accomplished dependent on

Fig.1.1 Scissor Lift

1.1 Types of Scissor lift

The scissor lifts can be classified as follows:

- Hydraulic lifts
- Pneumatic lifts
- Mechanical lifts

II. METHODOLOGIES

Deflection in scissors lifts can be characterized as the adjustment in height of all parts to the first size of whole gathering i.e from the floor to the highest point of stage deck, at whatever point loads are connected to or expelled from the lift. Every part inside the scissors lift can possibly store or discharge vitality when loaded and unloaded. Deflection happens in all parts of scissor lift i.e Scissors Legs, Platform Structure, Base Frame, Pinned Joints. To lessen stresses and deflection in scissor lift the load should exchange similarly between the two scissors arm combine. Base frames ought to be connected to the surface on which they are mounted.

2.1 Material Selection

Material selection plays a very important role in machine design. Three metals are considered for the analysis of scissor lift is Carbon fiber structural steel and Aluminium Alloy

2.2 Structure Steel Mechanical properties

Table- 1

Material Field Variable	Value	Units
Density	7850	Kg/m³
Young's modulus	2E+05	Mpa
Poisson Ratio	0.30	
Shear modulus	76923	Mpa
Bulk Modulus	1.6667E +05	Mpa
Tensile Yield Strength	250	Mpa
Compressive Yield Strength	250	Mpa
Tensile Ultimate Strength	460	Mpa
Compressive Ultimate Strength	0	Mpa

2.3 Aluminium Alloy materials Mechanical properties

Table- 2

Material Field Variable	Value	Units
Density	7750	Kg/m³
Young's modulus	1.93E+05	Mpa
Poisson Ratio	0.31	
Shear modulus	76664	Mpa
Bulk Modulus	1.6937E+05	Mpa
Tensile Yield Strength	207	Mpa
Compressive Yield Strength	207	Mpa
Tensile Ultimate Strength	310	Mpa
Compressive Ultimate Strength	0	Mpa

2.4 Carbon Fiber materials Mechanical properties

Table- 3

Material Field Variable	Value	Units
Density	1950	Kg/m³
Young's Modulus	300000	MPa
Poisson Ratio	0.30	
Tensile Strength	5090	MPa
Compressive strength	1793	MPa

3.2 MATHEMATICAL ANALYSIS :

3.2.1 COLLECTION OF DATA

Genie GS 2669RT scissor lift (http://www.colle.eu/static/datasheets/42/genie-gs2669rt-en.pdf)

- Total weight including drive system-3309kg
- Weight excluding drive system-2067kg
- Loading capacity of scissor lift- 680kg
- Scissor lift closing height- 780mm
- Scissor lift open height- 9750mm

3.2.1.1 Scissor arm

Depth of section 42.0 mm

Width 92.0 mm

Thickness 5.4 mm

Area of section 11.36 cm^2

Designation 42.0 x 92.0 x 5.4 (mm)

A:Hydraulic specifications

Bore:-130mm

Stroke:-1600mm

Force Capacity:- 18582 N

3.2.2 HYDRAULIC CYLINDER :

The hydraulic cylinder is mounted in inclined position. The total load acting on the cylinder consists of:

- Mass to be put on the lift: = 680 kg
- Taking FOS = 1.5 for mass in pallet = 680kg

  = 680 x 1.5 = **1020** kg
- Mass of top frame= Mass = Density x Volume

  = 7750 x 0.084 = **651** kg
- Mass of each scissor arm = 7.812 kg
- Total mass of twenty Scissor arms = 20 x 7.812 = **156.24** kg
- Mass of cylinder

Volume $= \pi \times h \times r^2 = 3.14 \times 3.715 \times (.01)^2$

Mass = Density x Volume = .001166x 7750 = 9.04 kg

Area $= \pi \times r^2/2 = 3.14 \times (65)^2/2 = 6633.25 mm^2 = 0.00663325\ m^2$

- Mass of cylinder=18kg , No. of Cylinder 02 = **18.08** kg

- Total Mass = 1845.32 kg
- Total load = 1845.32 x 9.81 = 18099.45 N

We get F=18099.45 N Selecting 130 mm bore diameter of the cylinder

The formula used by this calculator to determine the piston cylinder force from pressure and diameter is:

r = ø/2

$A = \pi \cdot r^2 = \pi \cdot (ø/2)^2$

$F = P \cdot A$

$F = P \cdot \pi \cdot (ø/2)$

Area = 3.14 x $(130)^2$ /4= 3848 = 13266.5mm^2

Pressure=(Force/Area)=(18099 /13266.5) = 1.36 MPa = 14 bar

3.2.3 FORCE CALCULATION :

Force = Mass x gravity

= 680x 9.81 = 6870N

Stress = Force / Area Platform

= 6870/(4000 X 1750)

3.3.3 DESIGN OF LINK FOR BENDING:

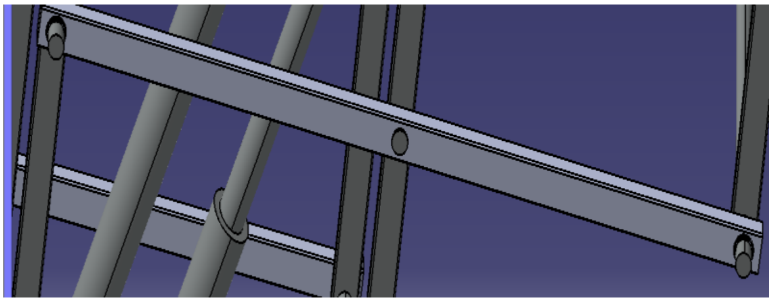


Fig.3.1 Design for link

M/I = б/Y

Where, M= Maximum Bending moment on the link considered as beam.

I= Moment of inertia

Y= Distance of neutral axis from the ends

б = Ultimate value/FOS (Structure Steel)

б = 460/1.45 = 318MPa

3.3.4 DESIGN OF PIN:

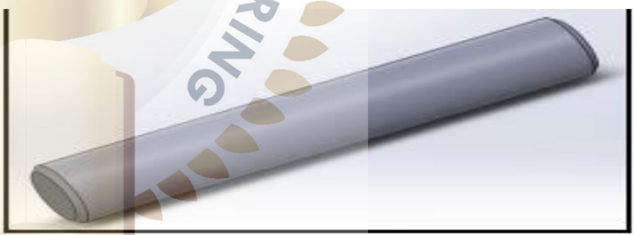


Fig.3.2 Design for Pin

Pin is the major factor in scissor lifter. It played an important role in joining the links with the top and bottom frame. We know that in scissor lifter, pin goes under shear stress. Shear stress defined as force per unit cross section area.

ʋ = 0.5 Yield stress / FOS

ʋ = 0.5 x 250/6 = 20.8 MPa

Where, P = Total force applied on pin (N)

A = Cross section are under in shear (mm²)

$\tau = F/A$

$20.8 = 6870/3.14 x d^2 = 20mm$

III. FINITE ELEMENT METHOD:

By utilizing CATIAV5R20, displaying of scissor lift was done and after that it was foreign to Ansys17.0 for the examination of scissor lift. The objective of lattice in ANSYS Workbench is to give powerful, simple to utilize fitting instruments that will rearrange the work age process. In this water driven scissor lift mechanization coinciding is connected and finish examination of scissor lift was finished.

IV. MODELING

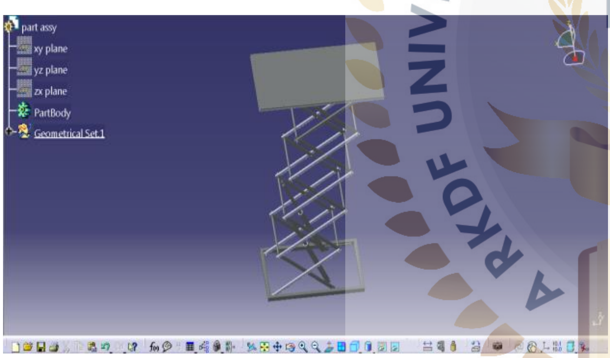
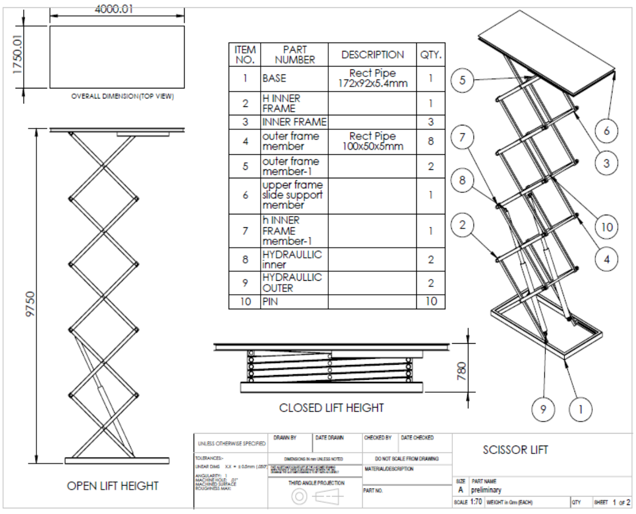


Fig4.1 Scissor lift 3D model on CATIA software



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	BASE	Rect Pipe 172x92x5.4mm	1
2	H INNER FRAME		1
3	INNER FRAME		3
4	outer frame member	Rect Pipe 100x50x5mm	8
5	outer frame member-1		2
6	upper frame slide support member		1
7	h INNER FRAME member-1		1
8	HYDRAULLIC inner		2
9	HYDRAULLIC OUTER		2
10	PIN		10

Fig.4.2 Scissor lift 2D layout

4.1 Scissor lift Specification

Table.4

S.No.	Particulars	Dimensions
1	Scissor lift closing height	780mm
2	Scissor lift open height	9750mm
3	Loading capacity of scissor lift	680kg

4.2 Simulation

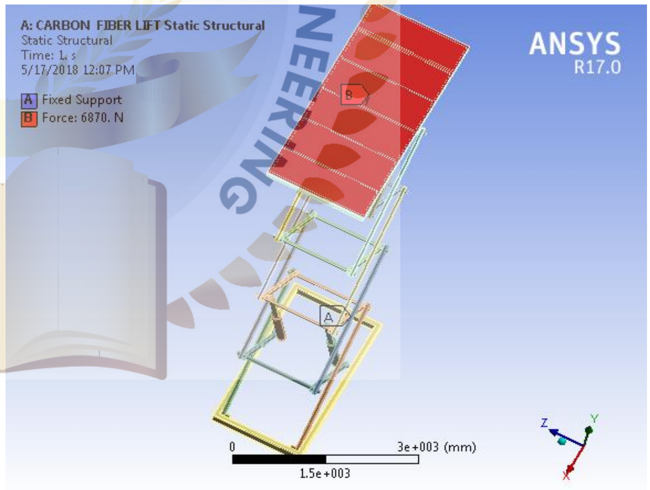


Fig.4.3 Boundary conditions Carbon Fiber materials

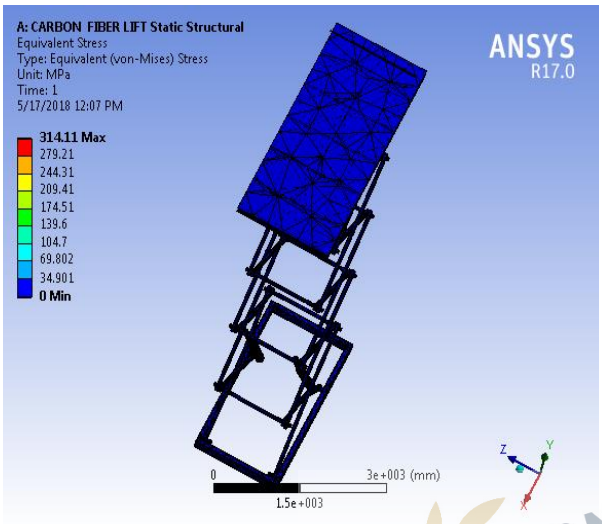


Fig.4.4 Von misses stresses value in carbon fiber

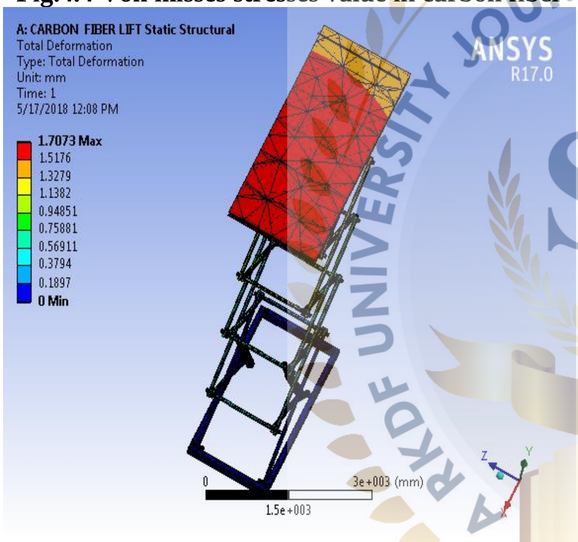


Fig.4.5 Deformation value in carbon fiber

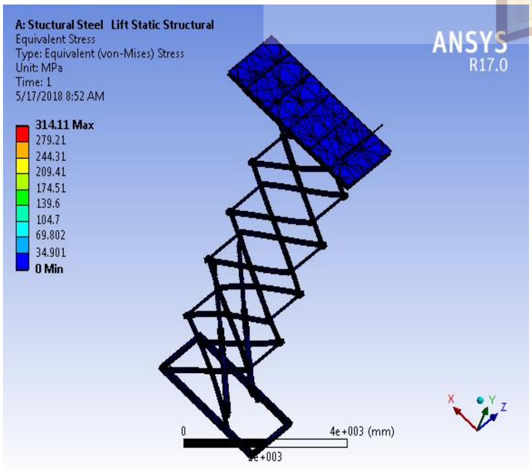


Fig.4.6 Von misses stresses value in Structural Steel materials

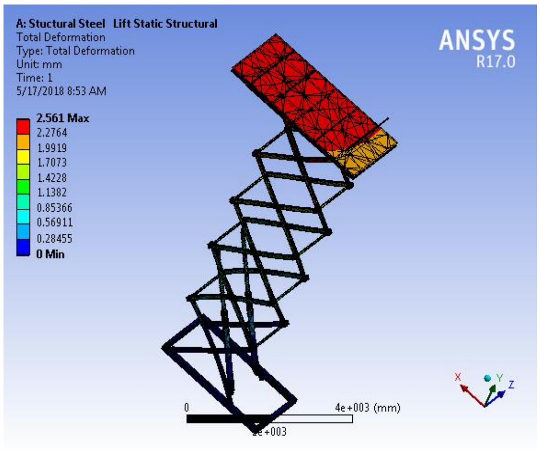


Fig.4.7 Deformation value in Structural Steel materials

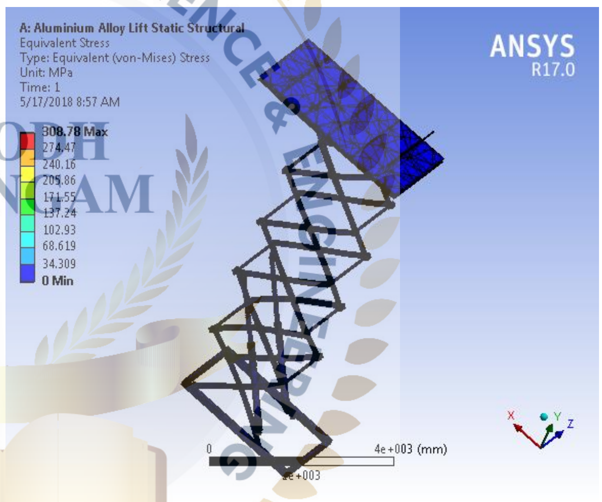


Fig.4.8 Von misses stresses value in Aluminium alloy materials

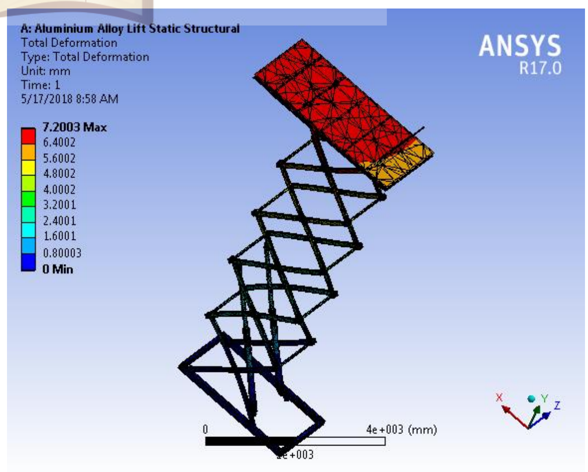


Fig.4.9 Deformation value in Aluminium Alloy materials

V. RESULT & DISCUSSION

The maximum deformations induced in Carbon fiber hydraulic lift is 1.7 mm, Structural Steel deformation is 2.5 mm and Aluminum Alloy deformation 7.2 mm. If we compare corresponding deformations in Carbon fiber 1.7 mm which has less deformation. The equivalent stress induced for two materials respectively Carbon fiber and Aluminium is almost same i.e. 314.11 Mpa, 314.11 Mpa which is greater than the Aluminium Alloy stress 308.8 Mpa.

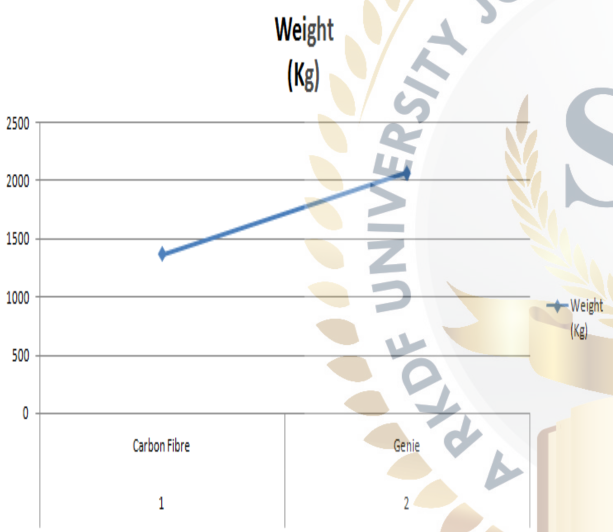


Fig.5.1 Weight comparison charts

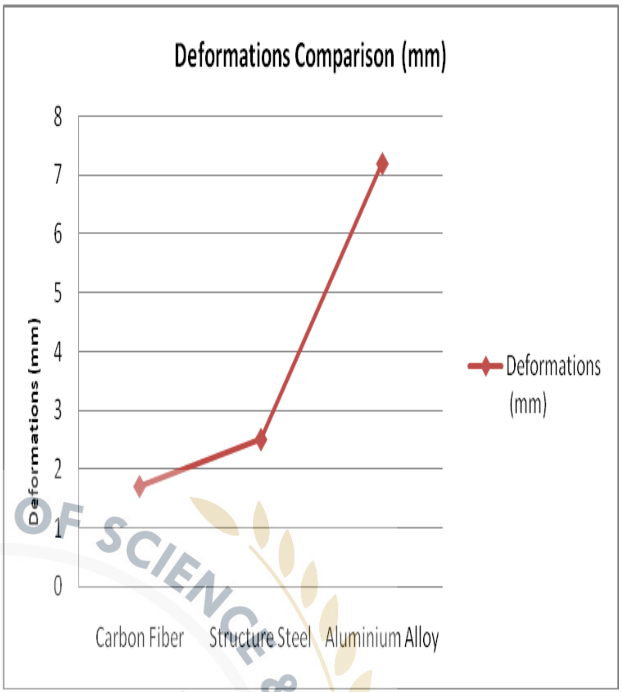


Fig. 5.2 Deformation comparison charts

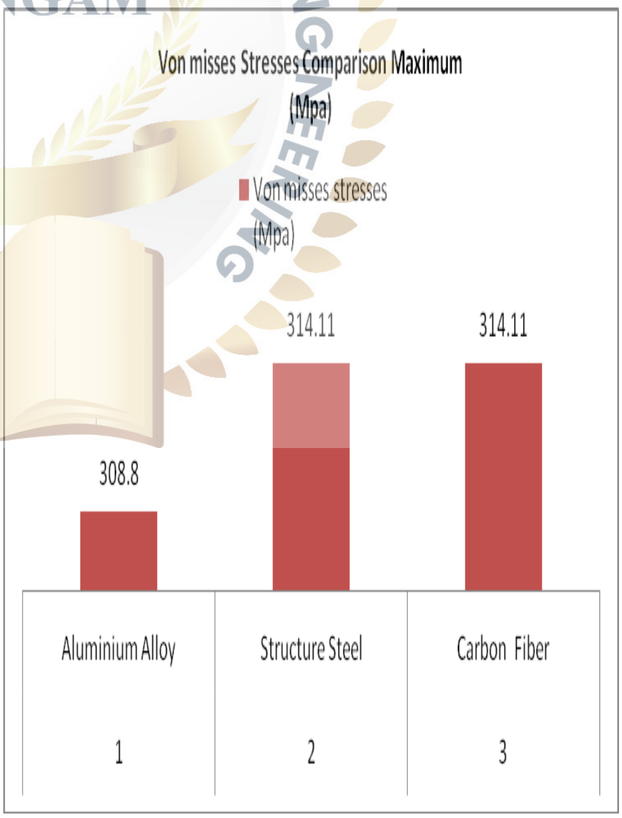


Fig. 5.3 Von misses stress comparison charts

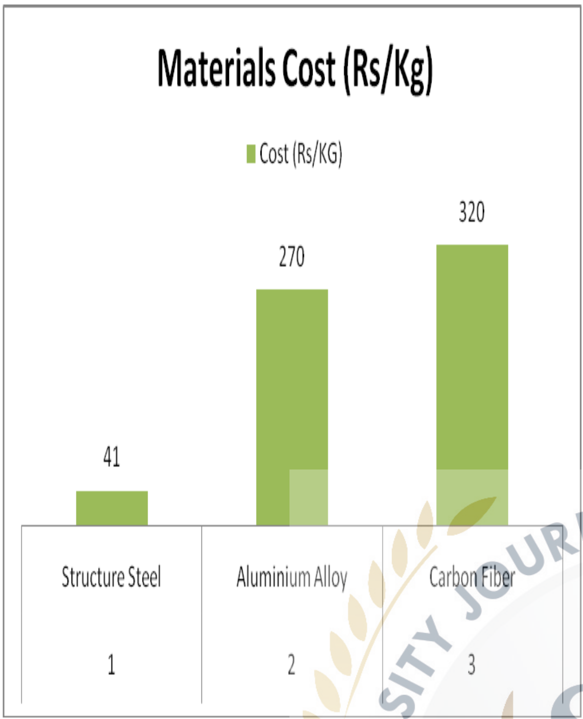


Fig. 5.4 Cost comparison charts

VI. CONCLUSION

From all the experimental analysis performed, it can be seen clearly seen that Carbon Fibre material has extremely lower weight than other conventional materials being use for manufacturing of scissor lift. The design and fabrication of a portable work platform elevated by a hydraulic cylinder was carried out meeting the required design standards. The portable hydraulic scissor lift work platform is operated by hydraulic cylinder which is operated by a motor. The scissor lift can be design for high load also if a suitable high capacity hydraulic cylinder is used. It can also lift heavier loads. The main constraint of this device is its high initial cost, but also 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 spare metals.

Weight Reduction = (2067 – 1364/2067)* 100 = 34%

VII. FUTURE SCOPE

This device has plenty of scope for modifications for further improvements and for operational efficiency, which should make it commercially available and attractive. Hence, it has various 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 commercial production.

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