"Design & Analysis of Hydraulic Scissor Lift"

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Abstract -*This paper is mainly focused on force acting on the hydraulic scissor lift when it is extended and contracted. Generally, a hydraulic scissor lift is used for lifting and holding heavy weight components. 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 increase the life of scissor lift.*

The design is performed by considering hydraulic scissor lift as a portable, compact and much suitable for medium type of load application. Drafting & drawing of hydraulic system scissor lift is done using solid works with suitable modeling and imported to Ansys work bench for meshing and analysis. Hence, the analysis of the scissor lift includes Total deformation load, Equivalent stress, was done in Ansys and all responsible parameters were analyzed in order to check the compatibility of the design value. The computational values of two different materials such as aluminum and mild steel are compared for best results

Key Words: Hydraulic scissor lift, Solid works, Ansys work bench, Total deformation load, Equivalent stress.

1. INTRODUCTON

Any machine part cannot be moved to a desired position with application of less amount of external force. For placing a component in required location, the motion of component follows commonly horizontal or vertical direction. Many machines such as aerial lift, boom lifts, scissor lift, man lift, tele handler, towable lift are used to move machinery and manpower in different directions based on the requirement. A scissor lift is a portable, easily extended and compressed, safe operating machine used for transportation of medium sized components to its expected position.

A scissor lift is machine which moves in vertical direction using criss-cross 'X' pattern scissor arms. The required elevation of the lift is achieved based on the number of criss-cross 'X' pattern scissor arms attached. The scissor lift mechanism is based on linked arms in a criss-cross 'X' pattern which can be folded and extended in exact direction similar to a pantograph. The upward motion is achieved by the application of pressure to the outside of the lowest set of supports, elongating the crossing pattern, and propelling the work platform vertically upwards. The platform may also have an extending 'bridge' to allow closer access to the work area.

1.1 Types of Scissor lift

The scissor lifts can be classified as follows:

- Hydraulic lifts
- Pneumatic lifts
- Mechanical lifts

Hydraulic scissor lifts are very powerful tool for applying a ton of force on the platform plate of component which is equally distributed on scissor arms.

2. METHODOLOGY

Deflection in scissors lifts can be defined as the change in elevation of all parts to the original size of entire assembly i.e from the floor to the top of platform deck, whenever loads are applied to or removed from the lift. Each component within the scissors lift has the potential to store or release energy when loaded and unloaded. Deflection takes place in all parts of scissor lift i.e Scissors Legs, Platform Structure, Base Frame, Pinned Joints. To reduce stresses and deflection in scissor lift the load should transfer equally between the two scissors arm pair. Base frames should be attached to the surface on which they are mounted.

2.1 Single Acting Hydraulic Cylinder

Single acting cylinders use hydraulic oil for a power stroke in one direction only. Some external force acting on the piston rod causes its return. Most applications require a single acting cylinder with the spring pushing the piston and rod to the in stroked position.

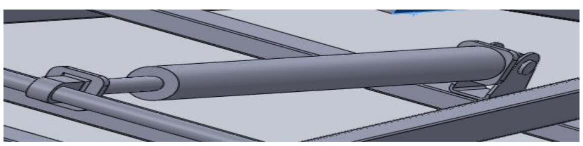


Fig -1: Hydraulic cylinder

2.2 Material Selection

Material selection plays a very important role in machine design. Two metals are considered for the analysis of scissor lift is mild steel & aluminum.

Table 1: Chemical composition of mild steel

Carbon	Silicon	Manganese	Sulphur	Phosphorous
0.16-0.18%	0.40%	0.70-0.90%	0.040%	0.040%

Table -2: Mechanical composition of mild steel

Sl.no	Mechanical composition of mild steel (ms) BS970	
1	Max stress	400-560 n/mm
2	Yield stress	300-440 n/mm
3	0.2% proof stress	280-420 n/mm
4	Elongation	10-14 % min

Table-3: Mechanical properties of Al (6061)

Sl.no	Mechanical composition	
1	Ultimate tensile stress	310 Mpa
2	Modulus of elasticity	68.9 Gpa
3	Ultimate strength	607 Mpa
4	Poisson ratio	0.33
5	Fatigue strength	96.5 Mpa
6	Machinability	50 %
7	Shear strength	207 Mpa
8	Tensile yield strength	276 Mpa

Table 4: chemical composition of (AL) 6061

Silicon	Ferrous	Copper	Manganese	Zinc	Titanium
0.40-0.8	0.7	0.15-0.40	0.8-1.2	0.25	0.15

3. FINITE ELEMENT METHOD:

By using solid work (2010), modeling of scissor lift was done and then it was imported to Ansys14.0 for the analysis of scissor lift. The goal of meshing in ANSYS Workbench is to provide robust, easy to use meshing tools that will simplify the mesh generation process. In this hydraulic scissor lift automation meshing is applied and complete analysis of scissor lift was done.

4. MODELING

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

4.1 Scissor lift platform: It is required to design a platform which should serve under heavy load application and withstand high stresses.

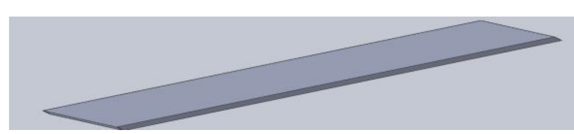


Fig 2: Scissor lift platform

4.2 Scissor arm: In modeling of scissor lifts scissor arms plays a key role it bears the loads and lift platform.

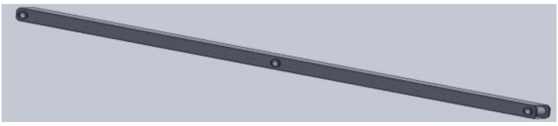


Fig 3: scissor arm

4.3 Coupler: In modeling scissor lift, couplers are fixed joints with support the hydraulic cylinder to lift the plate.

Fig 4: coupler

4.4 Cylinder: In modeling scissor lift cylinder are placed to lift the heavy loads on the platform.

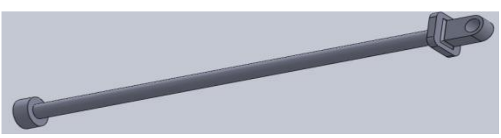


Fig 5: cylinder of scissor lift

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

Fig 6: Various individual parts of scissor lift

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.

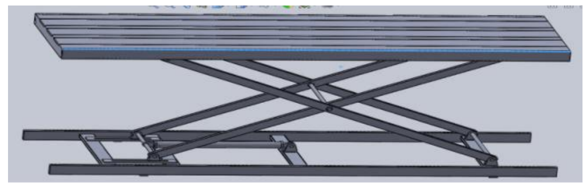


Fig 7: Open scissor lift

The rollers roll back towards the platform hinges and create an increasingly unsupported, overhung portion of the platform assembly.

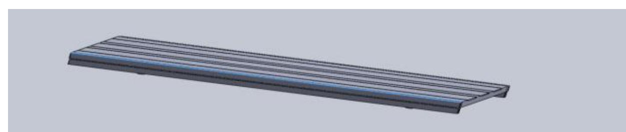


Fig 8: Closed scissor lift

The technical specifications of a Hydraulic Scissor lift is given below in a tubular representation

Table 5: Technical specification

Sl.no	Type	Hydraulic-Scissor Type
1	Capacity	750 Kgs
2	length	6 foots = 1828 mm
3	Lifting height	3 foots = 914 mm
4	Closing height	150 mm

4.5 Wire Frame of Scissor Lifts

The frame is a carriage which serves as a support for the occupant and the other components to be added on. The frame is made of aluminum or stainless steel.

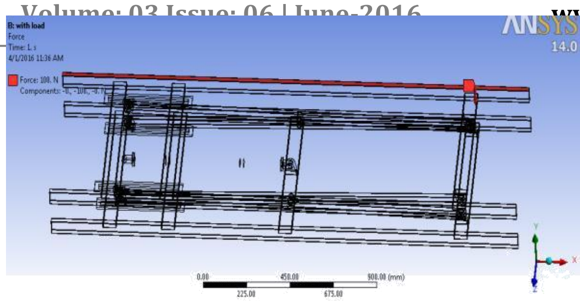


Fig 9: Wire frame of scissor lift

5. ANALYSIS

The mesh influences the accuracy, convergence and speed of the solution. Below figure shows automatic type of triangular meshing.

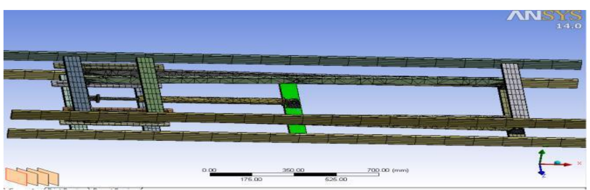


Fig 10: Triangular meshing

Table 6: Nodes and elements

Bodies	Active Bodies	Nodes	Elements
44	31	86745	35478

5.1 For mild steel:

Total deformation of entire scissor lift is evaluated by applying a load of 300 kg. The maximum deformation for mild steel is resulted as 77.851mm and the minimum deformation is 6.143mm. The maximum equivalent stress for mild steel is given as 150.67MPa and the minimum stress value is 1.6083MPa.

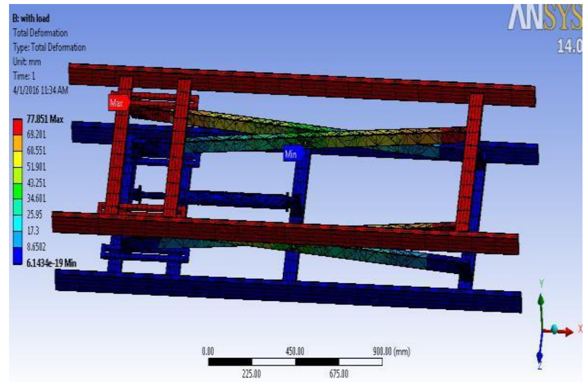


Fig 11: Total deformation load

5.2 For Aluminum:

The maximum deformation for aluminum 147.55 mm and the minimum deformation is 1.75mm. The maximum equivalent stress value for (Al) is 178.41 and the minimum equivalent stress value is 6.307MPa.

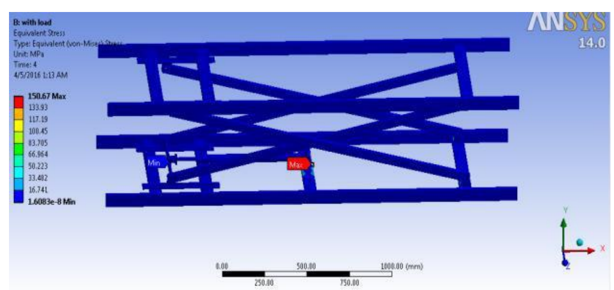


Fig 12: Equivalent stress

5.3 Joint Velocity with Load:

For analysis of joint velocity load with 10mm/s are applied on scissor lift.

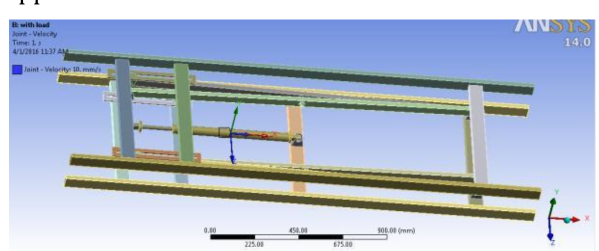


Fig 13: Joint velocity with load

Total deformation load of entire scissor lift is represents in below figure with max & min points.

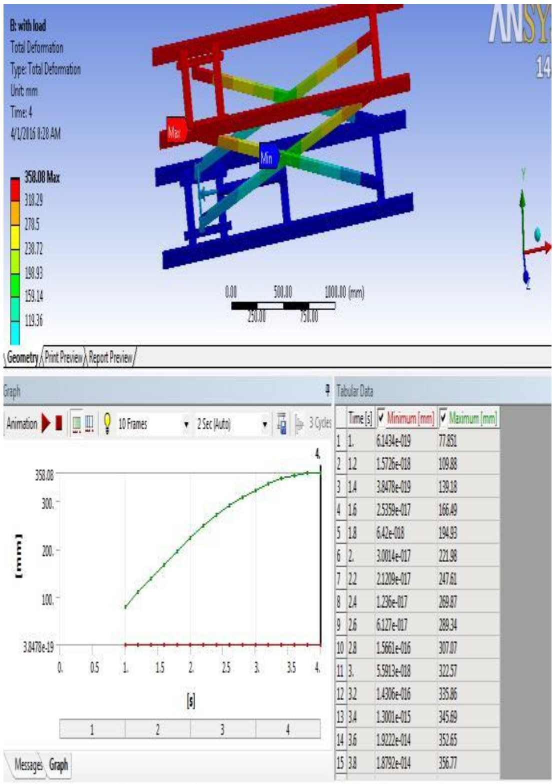
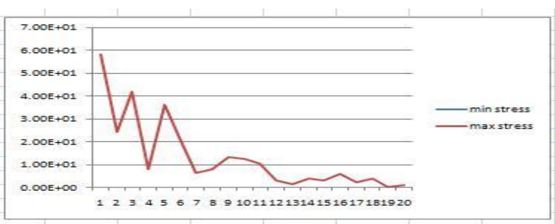


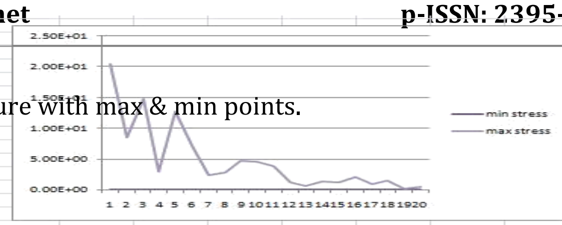
Fig 14: Total deformation graph with load Graph of

total deformation with load(ms)



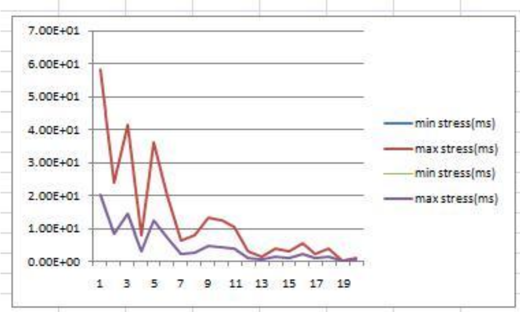
time step	min stres:	max stress
0.35	7.94E-09	58.146
0.55	1.22E-08	24.195
0.75	4.46E-09	41.878
0.875	3.14E-09	7.9902
1	2.36E-08	36.245
1.2	5.79E-09	20.161
1.4	8.82E-09	6.337
1.6	1.23E-08	8.0552
1.8	6.62E-09	13.552
2	1.26E-08	12.657
2.2	1.22E-08	10.615
2.4	5.49E-09	3.1174
2.6	1.40E-08	1.5416
2.8	3.33E-08	3.8816
3	2.25E-08	3.2491

Graph of total deformation with load(Al)



time step	min stres:	max stress
0.35	1.87E-09	20.424
0.55	2.99E-09	8.416
0.75	2.43E-09	14.687
0.875	1.02E-09	2.9308
1	5.84E-09	12.649
1.2	4.93E-09	7.1358
1.4	3.48E-09	2.3517
1.6	3.38E-09	2.7071
1.8	4.95E-09	4.6914
2	3.98E-09	4.4355
2.2	9.26E-09	3.7607
2.4	1.16E-09	1.1544
2.6	3.49E-09	0.60398
2.8	1.07E-08	1.3121
3	1.24E-08	1.1091

Graph of comparing both the stress analysis MS & Al



time step	min stres:	max stres	min stres:	max stress(ms)
0.35	7.94E-09	58.146	1.87E-09	20.424
0.55	1.22E-08	24.195	2.99E-09	8.416
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1	2.36E-08	36.245	5.84E-09	12.649
1.2	5.79E-09	20.161	4.93E-09	7.1358
1.4	8.82E-09	6.337	3.48E-09	2.3517
1.6	1.23E-08	8.0552	3.38E-09	2.7071
1.8	6.62E-09	13.552	4.95E-09	4.6914
2	1.26E-08	12.657	3.98E-09	4.4355
2.2	1.22E-08	10.615	9.26E-09	3.7607
2.4	5.49E-09	3.1174	1.16E-09	1.1544
2.6	1.40E-08	1.5416	3.49E-09	0.60398
2.8	3.33E-08	3.8816	1.07E-08	1.3121
3	2.25E-08	3.2491	1.24E-08	1.1091

RESULTS

In this project the analysis was done on two metals such as mild steel and aluminum alloy using Ansys 14.0 version. The results are shown in the table below

Table 7: Deformation and Equivalent stresses

Sl.no	Metal	Total deformation with load		Equivalent stress (vonmisses stress)		Load	Joint velocity
		Max	Min	Max	Min		
1	Mild steel (MS)	77.85mm	6.1mm	150.6 mpa	1.60 mpa	100 N	10 mm/s
2	Aluminum alloy (AL)	147.5mm	1.7 mm	178.4 mpa	6.30 mpa	100 N	10 mm/s

6. CONCLUSION

Portable work platform hydraulic scissor lift is designed for high load resistance. The hydraulic scissor lift is simple in use and does not required routine maintenance. Both the mild steel and aluminum alloys are good at their different aspects. Mild steel has greater durability strength and it is also cheap and easily available. As these properties plays an important role in designing scissor lift. So in designing scissor lift mild steel has greater importance.

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