DESIGN AND ANALYSIS OF AN AERIAL SCISSOR LIFT BY USING CREO AND ANSYS

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Abstract - Aerial scissor lifts are generally used for temporary, flexible access purposes such as maintenance and construction work or by fire-fighters for emergency access, etc which distinguishes them from permanent access equipment such as elevators. They are designed to lift limited weights — usually less than a ton, although some have a higher safe working load (SWL). The increasing demand of Aerial Scissor Lifts in companies in order to improve their manufacturing flexibility and output by providing variable height access to their work. This is especially true when the work being accessed is raised off the floor and outside an operator's normal ergonomic power zone. In either case, it is much more economical to bring the worker to the work rather than bringing the work to the worker.

Key Words: Sciccor lift, FEA, Creo(Pro-E), Analysis, ANSYS.

1. INTRODUCTION

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 cress 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).

1.1 Statement of the problem

A problem remains a problem until a solution is proffered. With the limitations encountered in the use of ropes, ladders, scaffold and mechanical scissors lifts in getting to elevated height such as the amount of load to be carried, conformability, time consumption, much energy expended etc. the idea of a hydraulically powered scissors lift which will overcome the above stated limitations is used.

1.2 Scope of the study

The design and construction of the hydraulic scissors lift is to lift up to a height of 3.2m and carrying capacity of less than 500kg (500 kilograms) with the available engineering materials. However, there is for academic purpose, a similar project for general carrying – capacity with a selection of better engineering materials.

1.3 Importance / Significance of the study

The design and construction of a hydraulic scissors lift is to lift a worker together with the working equipment comfortably and safely to a required working height not easily accessible. It may be used without a necessary external assistance or assistance from a second party due to the concept of the design. This project will be an important engineering tool or device used in maintenance jobs. Changing of street lights, painting of high buildings and walls around the school environment.

1.4 Aims/Objectives of the study

The project is aimed at designing and constructing a hydraulically powered scissors lift to lift and lowers worker and his working equipment with ease and in the most economical way. The lift is expected to work with minimal technical challenges and greater comfort due to its wide range of application. The device can easily be handled to the site to be used with a tow-van and then powered by a generator. Between the heights of lift (i.e. the maximum height) the device can be used in any height within this range and can be descend immediately in case of emergency, and can be operated independent of a second party

1.5 Principle of operation of a hydraulic lift (extension and contraction)

A scissors lift is a type of platform that can usually only move vertically. The mechanism to achieve this is the use of linked, folding supports in a criss-cross "X" pattern, known as a scissors mechanism. The upward motion is achieved by the application of pressure to the outer side of the lowest set of supports, elongating the crossing pattern and propelling the work platform vertically. The platform may also have extending "bridge" to allow closer access to the work area, because of the inherent limits of vertical – only movement. The contraction of the scissor action can be hyrdaulic, pneumatic or mechanical (via a lead screw or rack and pinion system), but in this case, it is hydraulic. Depending on the power system employed on the lift; it may require no power to enter "desert" mode, but rather a simple release of hydraulic or pneumatic pressure. This is the main reason that these methods of powering the lift (hydraulic) is preferred, as it allows a fail – safe option of returning the platform to the ground by release of a manual valve

2. DEFLECTIONS IN SCISSORS LIFT

Deflection in scissors lifts can be defined as the resulting change in elevation of all or part of a scissors lift assembly, typically measured from the floor to the top of platform deck, whenever loads are applied to or removed from the lift. ANSI MH29.1 - Safety Requirements for Industrial Scissors Lifts states that ". . . all industrial scissors lifts will deflect under load". The industry standard goes on to outline the maximum allowable deflection based on platform size and number of scissors mechanisms within the lift design. Before attempting to discuss how to limit scissors lift deflection, it is important to understand the contributing factors to a lift's total deflection. An open, or raised, scissors lift acts very much like a spring would – apply a load and it compresses, remove a load and it expands. Each component within the scissors lift has the potential to store or release energy when loaded and unloaded (and therefore deflect). There are also application-specific characteristics that may promote deflection. Understanding these Top 10 root causes helps to pinpoint and apply effective measures to limit deflection.

2.1 Scissors Legs

Leg deflection due to bending is a result of stress, which is driven by total weight supported by the legs, scissors leg length, and available leg cross section. The longer the scissors legs are, the more difficult it is to control bending under load. Increased leg strength via increased leg material height does improve resistance to deflection, but can create a potentially undesirable increased collapsed height of the lift.

2.2 Platform Structure

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. Also, as the scissors open during raising of the lift, the rollers roll 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. Increased platform strength via increased support structure material height does improve resistance to deflection, but also contributes to an increased collapsed height of the lift.

2.3 Base Frame

Normally, the lift's base frame is mounted to the floor and should not experience deflection. For those cases where the scissors lift is mounted to an elevated or portable frame, the potential for deflection increases. To effectively resist deflection, the base frame must be rigidly supported from beneath to support the point loading created by the two scissors leg rollers and the two scissors leg hinges.

2.4 Pinned Joints

Scissors lifts are pinned at all hinge points, and each pin has a running 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 running clearances under load.

3. GENERAL OPERATIONS:

3.1 Start with a Sketch:

Use the Sketcher to freehand a sketch, and dimension an "outline" of Curves. You can then sweep the sketch using Extruded Body or Revolved Body to create a solid or sheet body. You can later refine the sketch to precisely represent the object of interest by editing the dimensions and by creating relationships between geometric objects. Editing a dimension of the sketch not only modifies the geometry of the sketch, but also the body created from the sketch.

3.2 Creating and Editing Features:

Feature modeling lets you create features such as holes, extrudes and revolves on a model. You can then directly edit the dimensions of the feature and locate the feature by dimensions. For example, a Hole is defined by its diameter and length. You can directly edit all of these parameters by entering new values.

3.3 Associatively:

Associatively is a term that is used to indicate geometric relationships between individual portions of a model. These relationships are established as the designer uses various functions for model creation. In an associative model, constraints and relationships are captured automatically as the model is developed. For example, in an associative model, a through hole is associated with the faces that the hole penetrates. If the model is later changed so that one or both of those faces moves, the hole updates automatically due to its association with the faces. See Introduction to Feature Modeling for additional details.

3.4 Positioning a Feature:

Within Modeling, you can position a feature relative to the geometry on your model using Positioning Methods, where you position dimensions. The feature is then associated with that geometry and will maintain those associations whenever you edit the model. You can also edit the position of the feature by changing the values of the positioning dimensions.

4. MODAL DRAWINGS:

Fig-1: Base Part

Fig-2: Top Plate

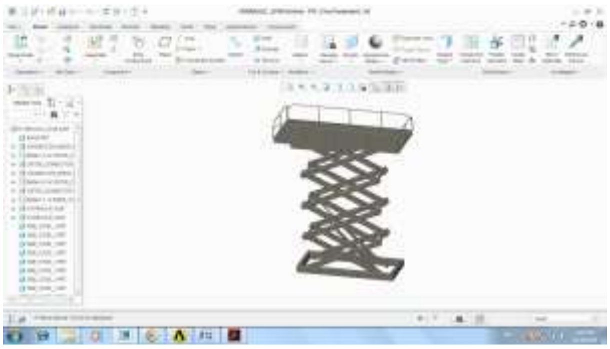

Fig-3: Total Assembly of lift

5. PROCEDURE

In this step the PRO/E model is to be imported into ANSYS workbench as follows:

In utility menu file option and selecting import external geometry and open file and click on generate. To enter into simulation module click on project tab and click on new simulation. By windowing feature pre processor allows the user to enlarge a specific area of the model for clarity and details. Pre processor also provides. , engine block, piping system, pressure vessels, etc-involve transient thermal analyses mechanical structure such as ship hulls, aircraft bodies and machine housing as well as mechanical components such as piston, machine parts and tools.

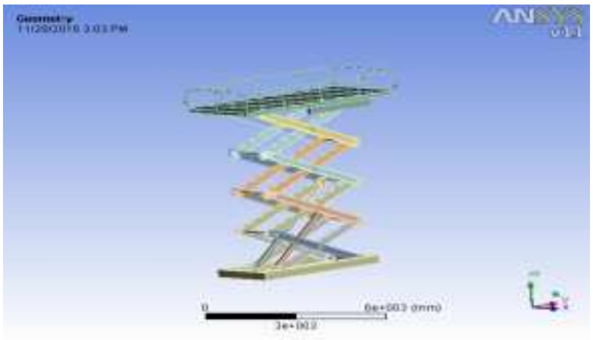

Fig-4: Importing geometry

5.1 Meshing the model:

To perform the meshing of the model these steps are to be followed:

Chose the main menu click on mesh- right click-insert sizing and then select geometry enter element size and click on edge behavior curvy proximity refinement and then right click generate mesh.

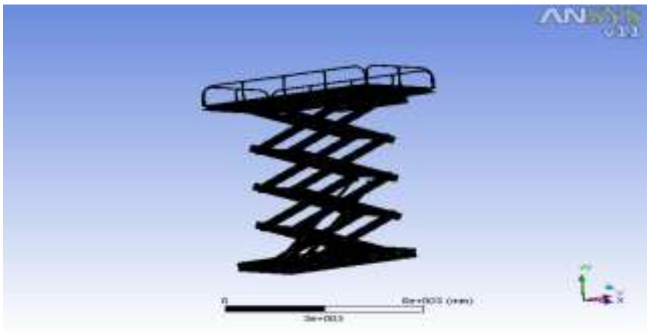

Fig-5: Messing modal

6. BOUNDARY CONDITIONS AND LOADING:

After completion of the finite element model it has to constrain and load has to be applied to the model. User can define constraints and loads in various ways. All constraints and loads are assigned set ID. This helps the user to keep track of load cases.

6.1 Model Display:

During the construction and verification stages of the model it may be necessary to view it from different angles. It is useful to rotate the model with respect to the global system and view it from different angles. Pre processor offers these capabilities. By windowing feature pre processor allows the user to enlarge a specific area of the model for clarity and details. Pre processor also provides features like smoothness, scaling, regions, active set, etc for efficient model viewing and editing.

6.2 Material Defections:

All elements are defined by nodes, which have only their location defined. In the case of plate and shell elements there is no indication of thickness. This thickness can be given as element property. Property tables for a particular property set 1-D have to be input.

Different types of elements have different properties for e.g.

Beams: Cross sectional area, moment of inertia etc

Shell: Thickness

Springs: Stiffness

Solids: None

The user also needs to define material properties of the elements. For linear static analysis, modules of elasticity and Poisson's ratio need to be provided. For heat transfer, coefficient of thermal expansion, densities etc. are required. They can be given to the elements by the material property set to 1-D

6.3 SOLUTION:

The solution phase deals with the solution of the problem according to the problem definitions. All the tedious work of formulating and assembling of matrices are done by the computer and finally displacements are stress values are given as output. Some of the capabilities of the ANSYS are linear static analysis, non linear static analysis, transient dynamic analysis, etc.

7. THERMAL ANALYSIS:

1. A steady state thermal analysis determines the temperature distribution and other thermal quantities under steady state loading conditions. A steady state loading condition is a situation where heat storage effects varying over a period of time can be ignored.

2. A transient thermal analysis determines the temperature distribution and other thermal quantities under conditions that varying over a period of time. The ANSYS/ metaphysics, ANSYS/mechanical, ANSYS/thermal, and ANSYS/FLOTRAN products support transient thermal analysis. Transient thermal analysis determined temperature and other thermal quantities that vary over time. A Engineers commonly used temperature that a transient thermal analysis for thermal stress evaluation. Many heat transfer applications-heat treatment problems, nozzles, engine block, piping system, pressure vessels, etc-involve transient thermal analyses.

A transient thermal analysis follows basically the same procedure as a stead state thermal analysis. The main difference is that most applied loads in a transient analysis are functions of time.

7.1 STRUCTURAL ANALYSIS:

Structural analysis is the most common application of the finite element analysis. The term structural implies civil engineering structure such as bridge and building, but also naval, aeronautical and mechanical structure such as ship hulls, aircraft bodies and machine housing as well as mechanical components such as piston, machine parts and tools.

7.2 ANSYS RESULTS:

7.2.1 Stain less steel

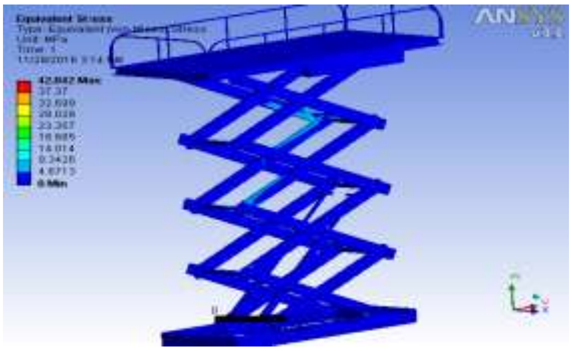

Fig-6: Equivalent stress

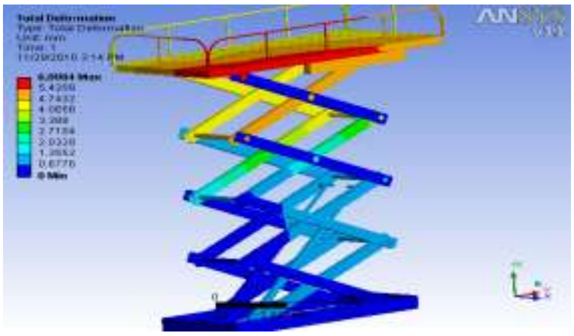

Fig-7: Total Deformation

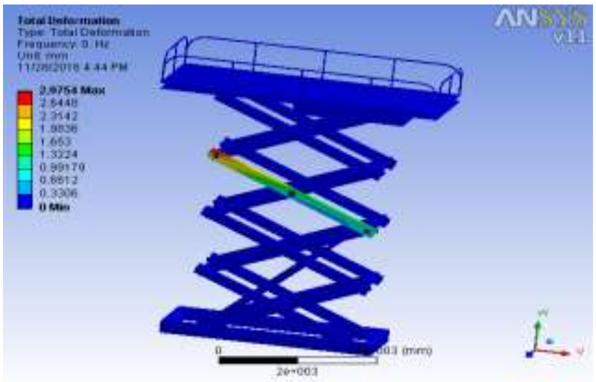

Fig-8: Mode 1

7.2.2 Aluminium alloy

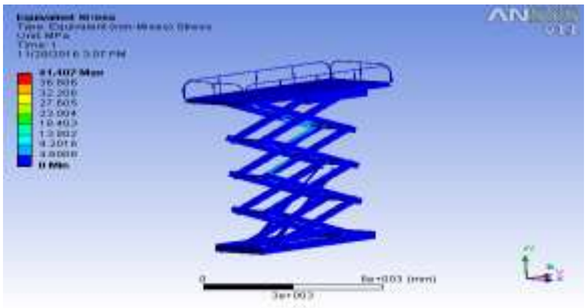

Fig-9: Equivalent stress

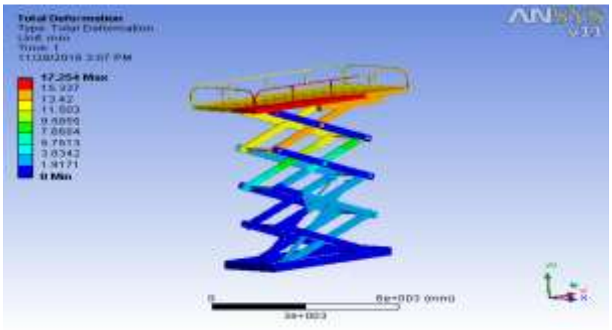

Fig-10: Total Deformation

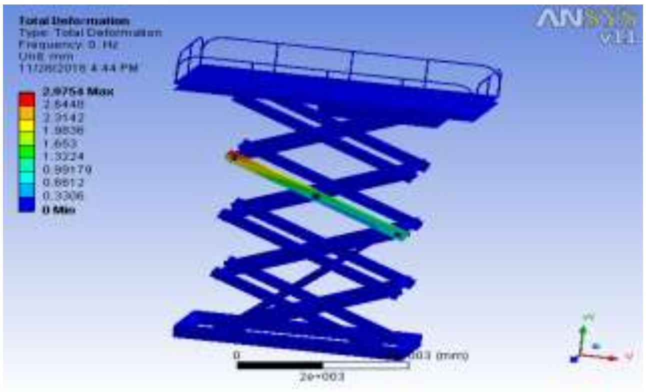

Fig-11: Mode 1

7.2.3 Magnesium alloy

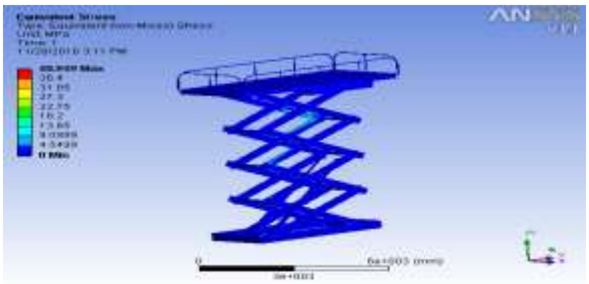

Fig-12: Equivalent stress

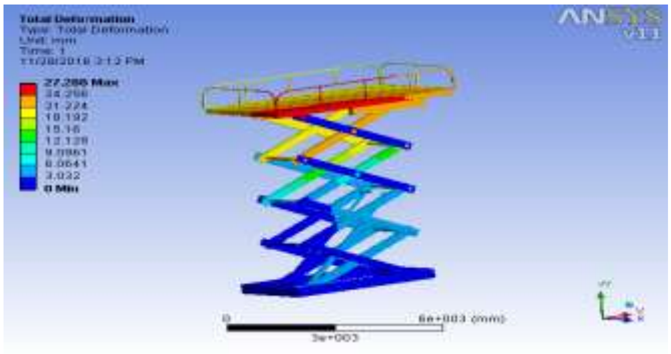

Fig-13: Total Deformation

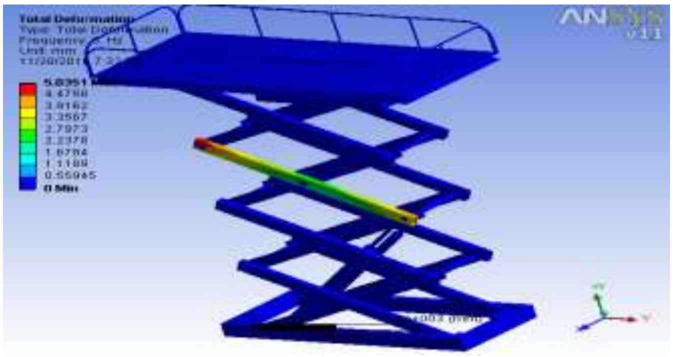

Fig-14: Mode 1

Table-1: Equitant stress and total deformation

Material	Equivalent stress		Total Deformation	
	Min	Max	Min	Max
Aluminum alloy	0	41.407	0	17.254
Magnesium alloy	0	40.949	0	27.288
Stainless steel	0	42.042	0	6.0984

Table-2: Equivalent stress at different modes

Material	Mode 1	Mode 2	Mode 3	Mode 4	Mod e 5	Mode 6
Aluminum alloy	5.036 5	4.486 4	1.289 7	4.683 9	5.3044	4.292 4
Magnesium alloy	5.035 1	4.979 9	5.364 9	5.901 3	762	5.637 4
Stainless Steel	2.975 4	2.652 5	2.604 9	3.140 4	588	2.608

8. CONCLUSION

We have developed a final design that will meet the customer requirements using the determined engineering specifications. The following is a final summary of what we did and how we went about it. Stability, comfort, noise level, and hand control were determined to be the most important requirements. All these requirements have been used in developing our concepts and have been implemented in our alpha design, which was then modified to become our final design. We developed and followed through with a fabrication plan that produced a working product. This plan gave a detailed description of the process needed if our work is to be replicated. The validation tests that we conducted on the final lift produced results that exceeded customer and sponsor requirements. The final design has been broken down into four subsections: the scissor lift, the seat mechanism, the lean bar frame and the wheel locking mechanism. We created each of these subsections separate in the machine shop and fabricated these with the plan we have laid 16 out above. We then assembled these sections together and created our final model.

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