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Analysis of Loader Arm of Pneumatic High Speed Loader

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ABSTRACT

The pneumatic high – speed loader is employed to load and unload the auto sheet components in high speed metal forming press machine. Cycle time of 3 second for loading is required. Loader consists of tubular bridge frames; the tubular frames are mounted on the columns of the press machine. The loader consists of cross travel saddle, and vertical travel saddles, which are provided to have x-y axis, adjusted for the loading arm. The high – speed pneumatic arm is mounted on the vertical saddle. It has a rapid loading movement in and out of the press machine. The loader arm also has up and down motion to pick and place the metal sheet in and out of the press machine; a travel time of 1500mm is completed in less than 1.2 sec. the pneumatic arm then places the metallic sheet on the press tool rapidly completing a loading cycle in complete 3 sec.The 3D models of the loader arm are done in Pro/Engineer by changing the limb lengths. The limb lengths are decreased from 900mm to 700mm and 500mm. In the present thesis, analysis is done in ANSYS. Static and transient analyses are done on the structure for maximum loads. The analysis is performed on the loader arm to optimize the arm from minimum stress and deflection. The model of the loader arm is changed by changing the limb lengths. The present used material is steel; it is replaced with Aluminum alloy 7075.

Keywords: changing the limb lengths, Static analysis, transient analysis.

INTRODUCTION

PNEUMATIC SYSTEMS

Pneumatic systems employ gas that is compressed under extremely high pressure. The practical use of pneumatics comes in putting that compressed gas to use, or should I say the use of the rapid expansion of compressed gas. At its most basic level a pneumatic system holds compressed gas in a specially designed tank and then we release some of that gas into an expandable chamber. The expandable part of the chamber has a rod attached to it so that as it expands the rod moves outward. Sounds pretty simple, right? Well, in theory it is, but it is in application that things get complicated.

HOW PNEUMATIC SYSTEMS WORK

1. Pneumatic systems are as diverse as there are applications for them. There is one common thread however that binds them all together, and that is the power of air. Compressed air to be exact is the way that these systems function. A simple bicycle tire pump is a very good example of how compressed air works. The force of pushing the handle down is compressing the air inside of the pump and forcing it to leave the chamber through a small diameter hole. This action creates compressed air by rapidly and consistently decreasing its volume, creating an expansive force of air leaving the chamber that is controllable.
2. Compressed air runs pneumatic drills, hammers and sprayers. Pneumatic jacks and forklifts use that compressed energy to perform their work functions, which distributes that power as needed in their different applications. Industries such as mining, construction, dentistry and the medical profession all use one form of pneumatic systems or another.
3. Perhaps the most familiar use of a pneumatic system is the drive-thru banking facility in your city. A closed system of compressed air powered by blowers and controlled by computers move cylindrical containers carrying your bank transactions from the drive thru into the bank via a system of vacuum tubes. This is a multi-station,

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two-way system used by the teller, who completes the transaction and returns your container to you.

4. Pneumatic systems designed to perform any number of functions can meet the individual needs of large commercial customers and smaller private ones as well. One-way systems can safely remove large amounts of money from supermarket checkout counters or other applications where contact with the public is unavoidable. Two-way systems can send change back to the station, thus taking all money functions away from the checkout clerk and eliminating the motive for robbery.
5. Medical applications throughout hospital facilities range from sending blood samples within departments, prognosis reports, medications from the pharmacy or anything small enough to fit into the cylinder.

PNEUMATIC HIGH-SPEED LOADER

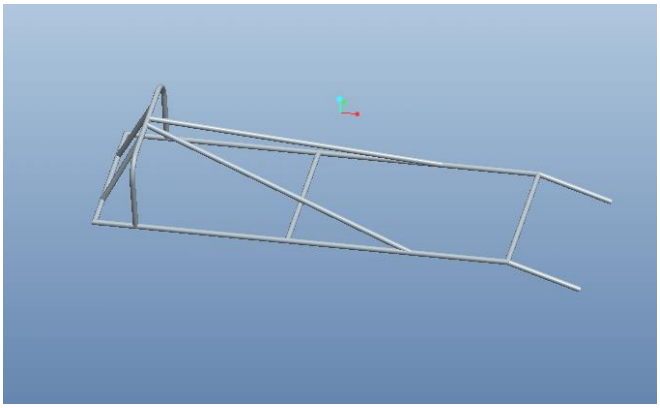
The pneumatic high-speed loader is employed to load and unload the auto sheet components in high-speed metal forming press machine. Cyclic time of 3 second for loading is required. Loader consists of tubular bridge frames; the tubular frames are mounted on the columns of the press machine. The loader consists of cross travel saddle, and vertical travel saddles, which are provided to have x-y axis, adjusted for the loading arm. The high-speed pneumatic arm is mounted on the vertical saddle .it has a rapid loading movement in and out of the press machine. The loader arm also has up and down motion to pick and place the metal sheet in and out of the press machine; a travel time of 1500mm is completed in less than 1.2 seconds hence the name of high speed loader is given to it. The pneumatic arm then places the metallic sheet on the press tool rapidly. Completing a loading cycle in complete 3 seconds. Hence the task was to optimize the loader arm from stress and deflection point of view. And to obtain an optimum design that could show the least deflection in the loader arm.

INTRODUCTION TO CAD & PRO/ENGINEER

Computer-aided design (CAD), also known as computer-aided design and drafting (CADD), is the use of computer technology for the process of design and design-documentation.CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry.

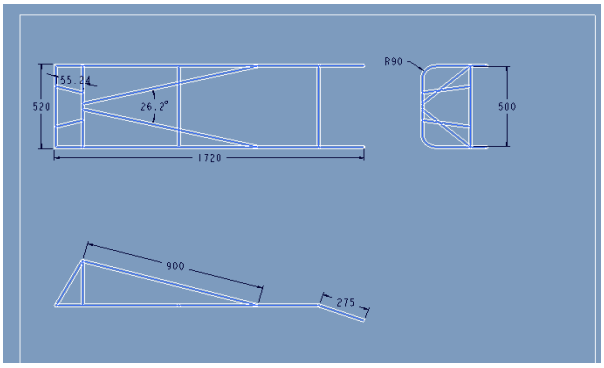
MODELS IN PRO/ENGINEER

ORIGINAL MODEL



Original model

2D DRAWING



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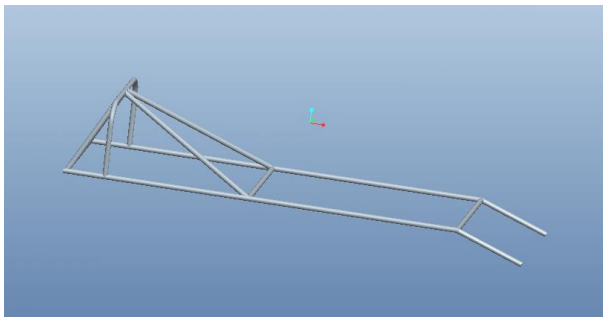
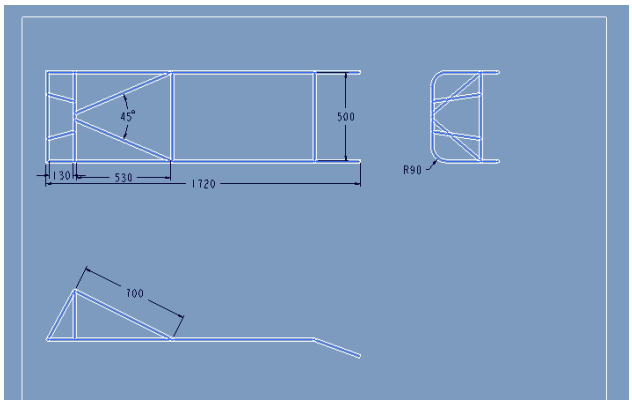
Original model 2D drawing

FIRST OPTIMIZATION



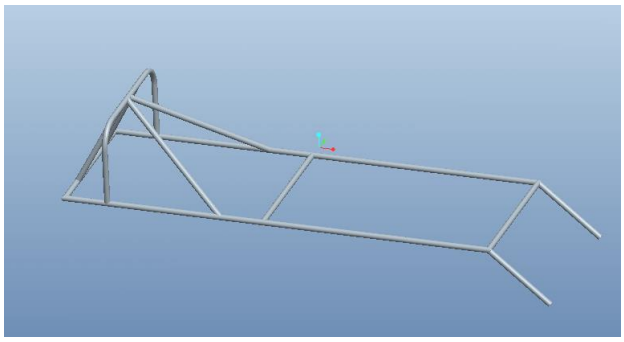
First optimization model

2D DRAWING



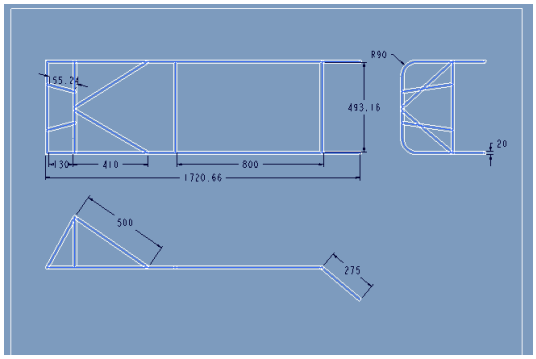
First optimization model 2D drawing

SECOND OPTIMIZATION



Second optimization model

2D DRAWING



Second optimization model 2D drawing

INTRODUCTION TO FEA

Finite Element Analysis (FEA) was first developed in 1943 by R. Courant, who utilized the Ritz method of numerical analysis and minimization of variational calculus to obtain approximate solutions to vibration systems. Shortly thereafter, a paper published in 1956 by M. J. Turner, R. W. Clough, H. C. Martin, and L. J. Topp established a broader definition of numerical analysis. The paper centered on the "stiffness and deflection of complex structures".

Results of finite element analysis

FEA has become a solution to the task of predicting failure due to unknown stresses by showing problem areas in a material and allowing designers to see all of the theoretical stresses within. This method of product design and testing is far superior to the manufacturing costs which would accrue if each sample was actually built and tested.

In practice, a finite element analysis usually consists of three principal steps:

1. Preprocessing:
2. Analysis:
3. Post processing:

INTRODUCTION TO ANSYS

ANSYS stands for Analysis System product. Dr. John Swanson was the founder of ANSYS Inc. In the year 1970 ANSYS was founded in order to establish a technology that facilitates several companies/industries to compute or simulate analysis issues. ANSYS is a general-purpose finite element analysis (FEA) software package that is extensively used in industries to resolve several mechanical problems. FEA is a method of fragmenting a composite system in to small pieces called elements. The ANSYS software carries out equations that regulate the performance of these elements and solves them resulting in an overall description of how system works integrally. The obtained results are displays in a tabulated or graphical form.

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INTRODUCTION TO CFD

Computational fluid dynamics, usually abbreviated as CFD, is a branch of fluid mechanics that uses numerical methods and algorithms to solve and analyze problems that involve fluid flows. Computers are used to perform the calculations required to simulate the interaction of liquids and gases with surfaces defined by boundary conditions. With high-speed supercomputers, better solutions can be achieved. Ongoing research yields software that improves the accuracy and speed of complex simulation scenarios such as transonic or turbulent flows. Initial experimental validation of such software is performed using a wind tunnel with the final validation coming in full-scale testing, e.g. flight tests.

MATERIAL PROPERTIES

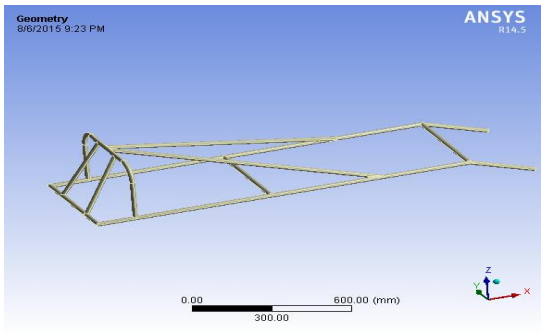
	STEEL AISI 1022	ALUMINUM 7075
DENSITY (Kg/m^3)	7858	2810
YOUNG'S MODULUS (MPa)	20500	71700
POISSON'S RATIO	0.21	0.33
STRENGTH (MPa)	380	572

Material properties

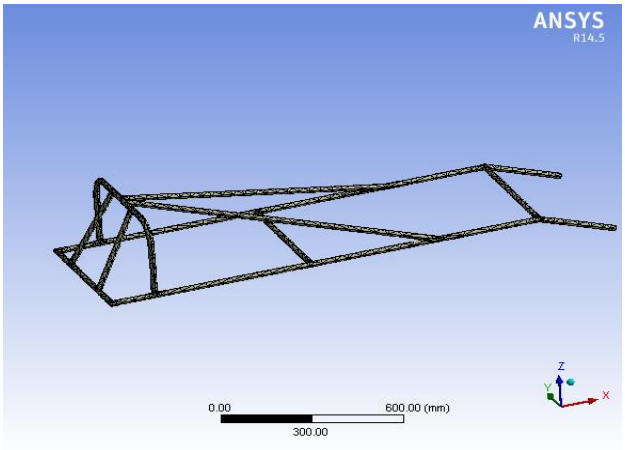
3.2 ANALYSIS OF PNEUMATIC LOADER ARM

3.2.1 STATIC ANALYSIS

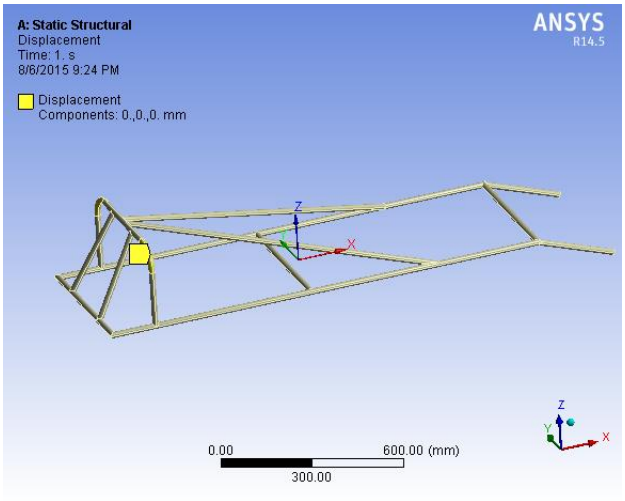
ORIGINAL MODEL



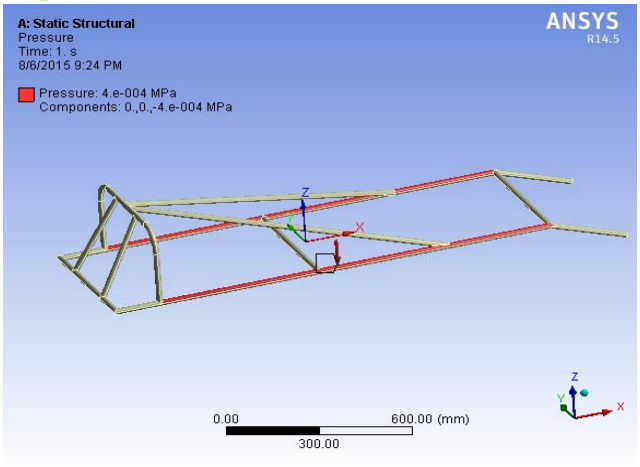
Imported model



Meshed model



Displacement



Pressure

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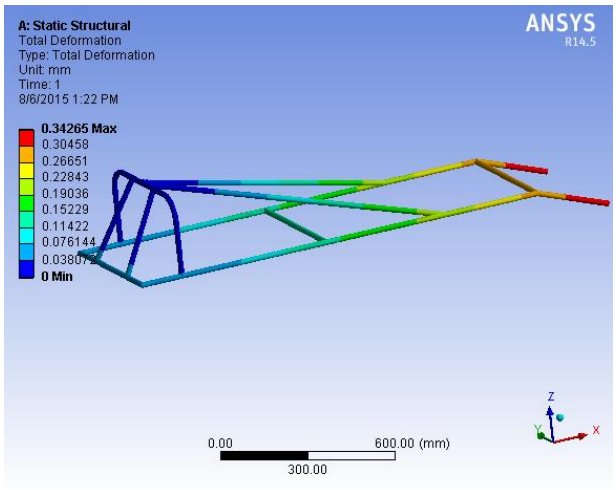
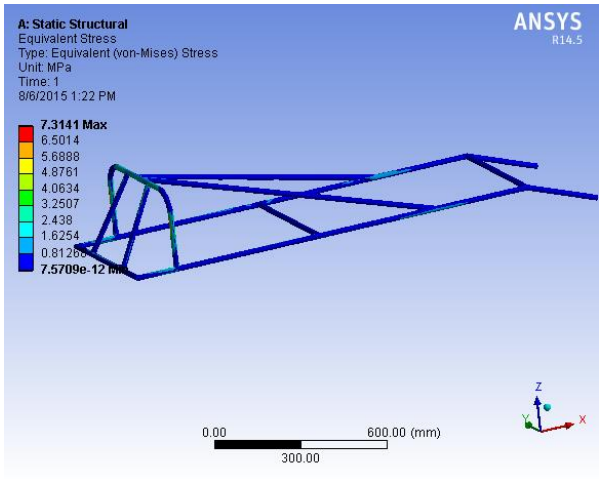
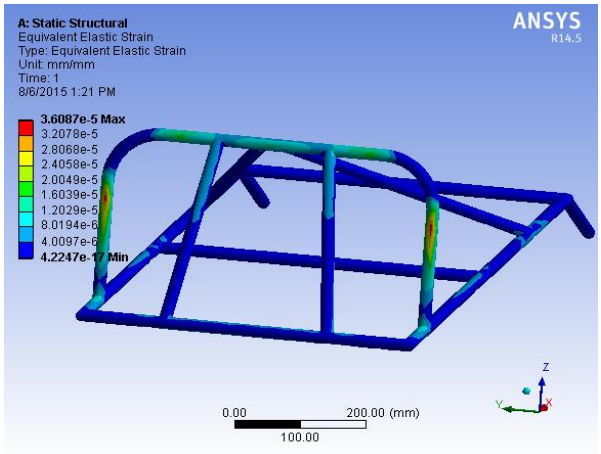
STEEL AISI 1022
TOTAL DEFORMATION



Deformation
VON-MISES STRESS

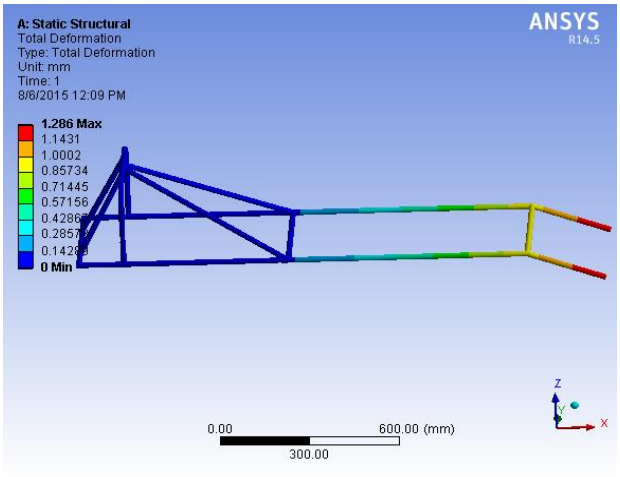


Strain
VON-MISES STRAIN



Stress

FRIST OPTIMIZATION
STEEL AISI 1022
TOTAL DEFORMATION



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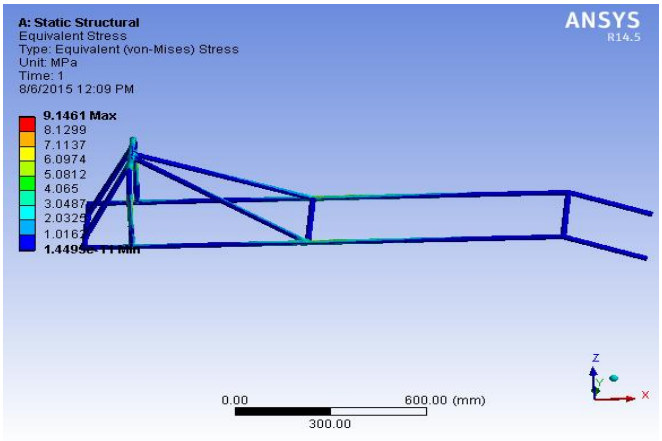
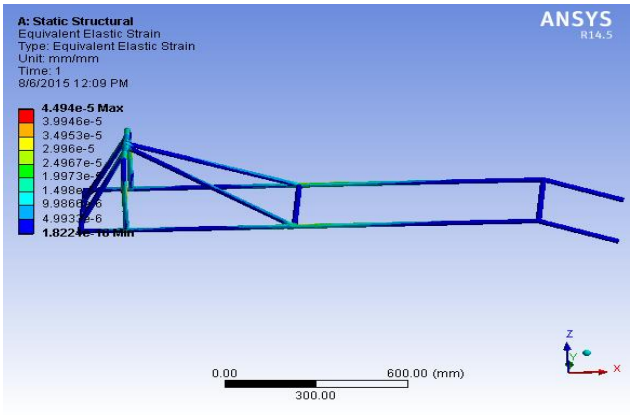


Stress
VON-MISES STRAIN



Strain

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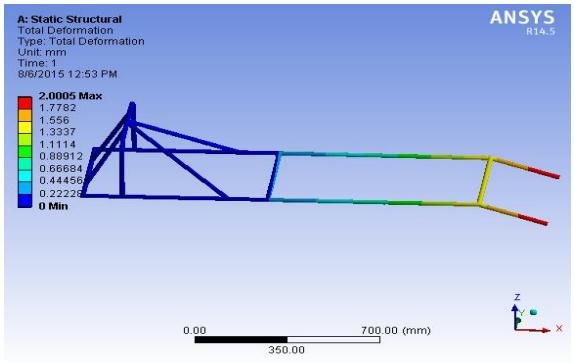
SECOND OPTIMIZATION
STEEL AISI 1022
TOTAL DEFORMATION



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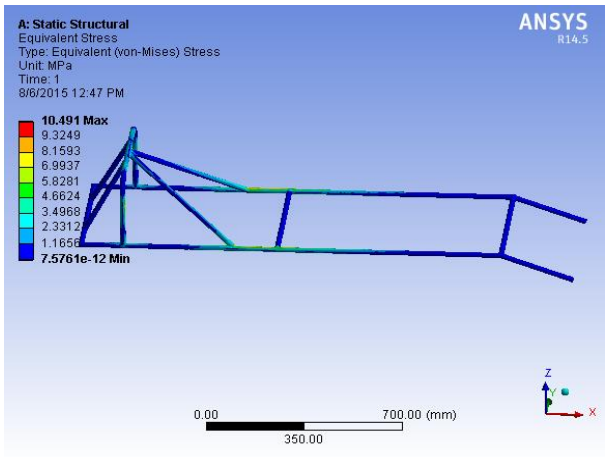
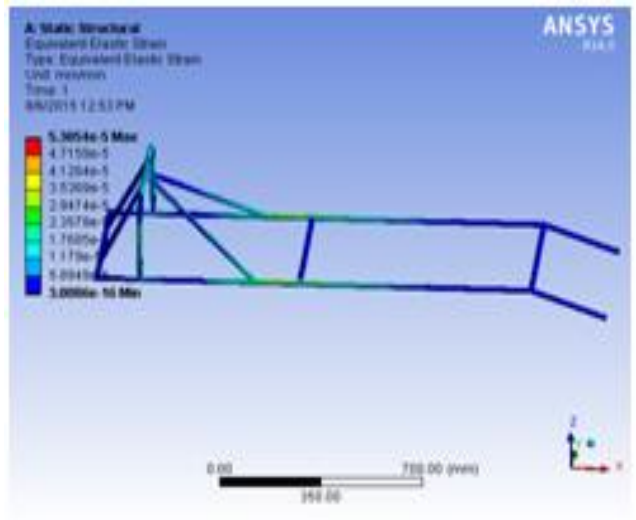
VON-MISES STRESS



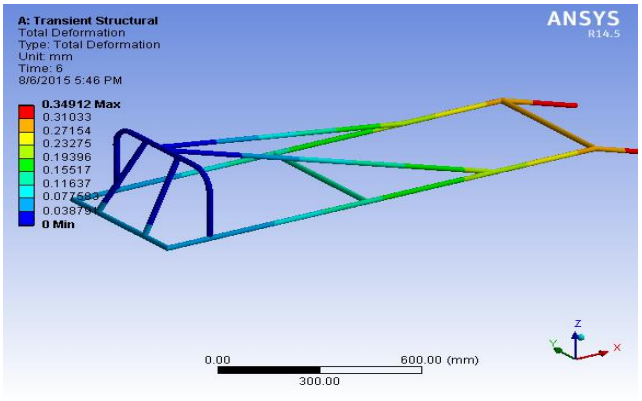
Stress



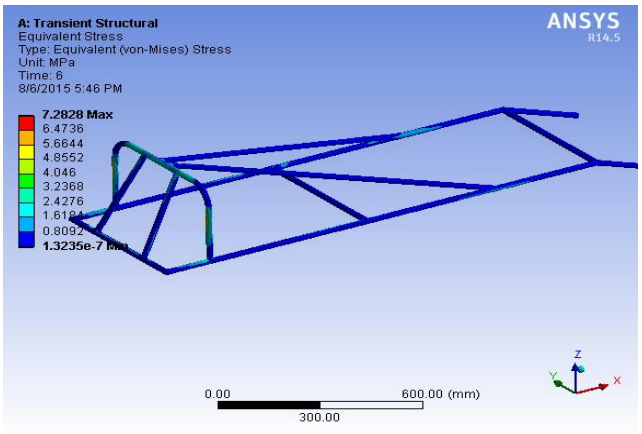
VON-MISES STRAIN

Strain

3.2.2 TRANSIENT ANALYSIS
STEEL AISI 1022
AT 6 SECS
TOTAL DEFORMATION



Deformation
VON-MISES STRESS



Stress
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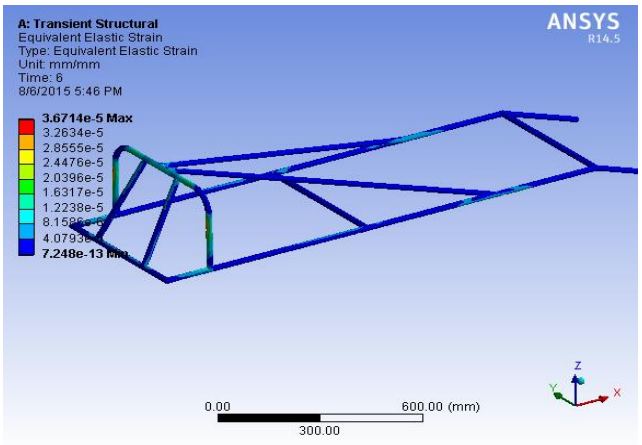

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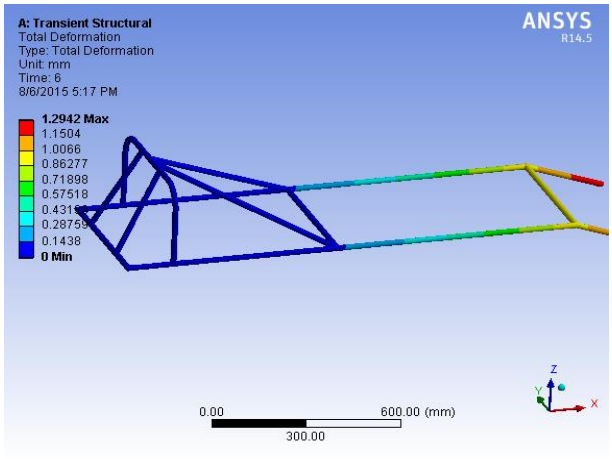
FRIST OPTIMIZATION
STEEL AISI 1022
AT 6 SECS
TOTAL DEFORMATION



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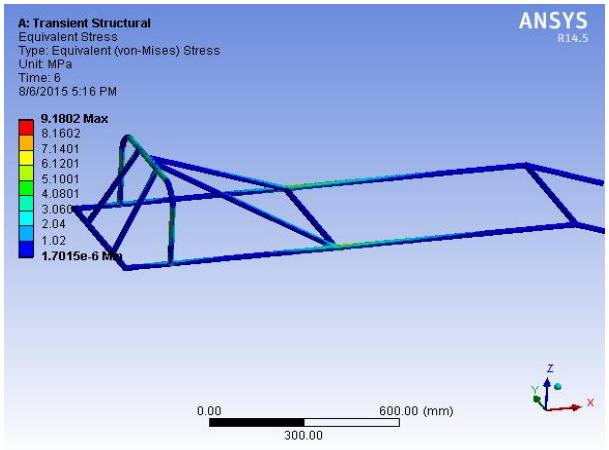
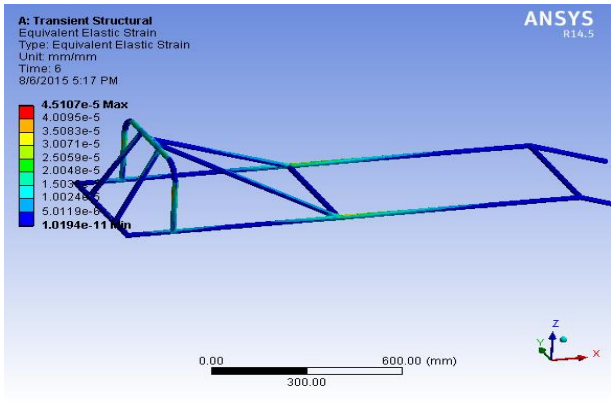
VON-MISES STRESS

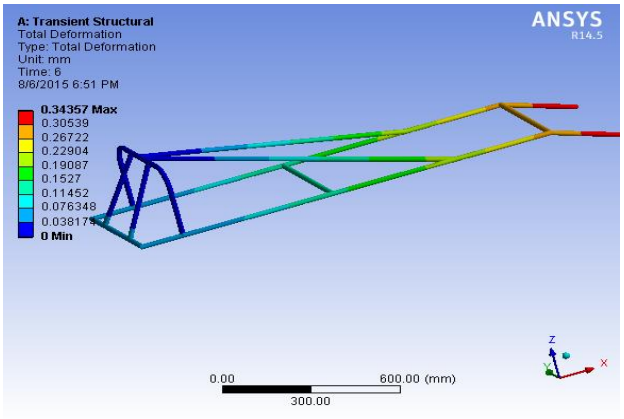


Stress
VON-MISES STRAIN



Strain

SECOND OPTIMIZATION
STEEL AISI 1022
AT 6 SECS
TOTAL DEFORMATION



Deformation
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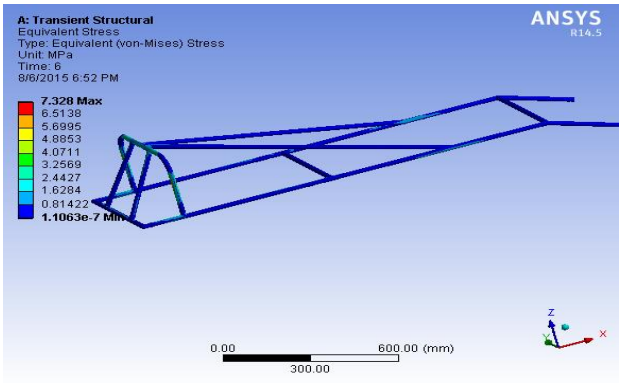

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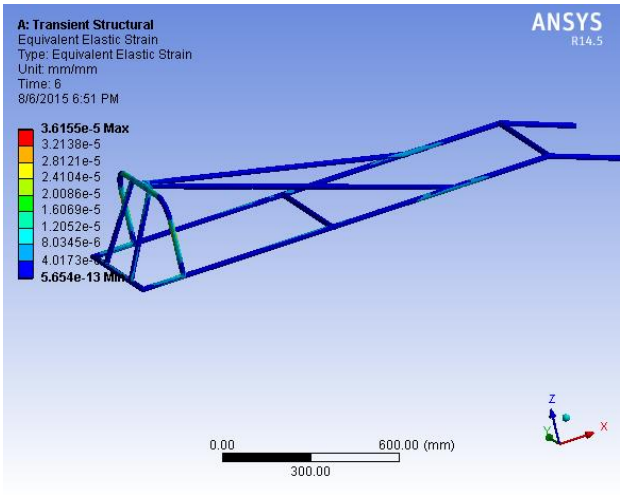

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CONCLUSION

- In the present thesis, analysis is performed on the loader arm to optimize the arm from minimum stress and deflection. The model of the loader arm is changed by changing the limb lengths. The limb lengths are decreased from 900mm to 700mm and 500mm. The present used material is steel; it is replaced with Aluminum alloy 7075.The 3D models of the loader arm are done in Pro/Engineer. Analysis is done in Ansys.
- By observing the static analysis results, the stresses and deformations are increasing by decreasing the limb lengths. But the stress values are slightly deferring which is safe. By comparing the results between materials, the deformations are more for Aluminum alloys than steel but stresses are less for aluminum alloys than steel.
- Transient analysis is performed by increasing the pressures by varying time, at 6secs and 12secs. By observing the analysis results, the stresses are within the range for all materials even at increased pressures. By comparing the results between materials, the deformations are more for Aluminum alloy than steel but stresses are less for aluminum alloys than steel.
- It can be concluded that by decreasing the limb lengths increases the stresses on the arm but the variations in stresses are minimal which is safe under working conditions. And also by decreasing the limb lengths, the weight of the arm decreases. By changing the material from steel to aluminum alloys, the weight decreases and also the stresses are within range. So using aluminum alloys is better.

FUTURE SCOPE

The use of aluminum alloys for loader arm is to be investigated practically since the working conditions will be different from that of conditions taken for analysis. The loads considered in the present work are only loads to be picked and placed, but the use of aluminum alloys for other applications like to loading the work piece from the conveyer belt into the die machine and vice-versa has to be analyzed.

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