An Open Ended Report

on

DESIGN AND ANALYSIS OF A PLASTIC (ABS) CHAIR INSPIRED BY SPIDER WEB.

Submitted in partial fulfillment of the requirement for the course of Automation Laboratory (15EMEP303)

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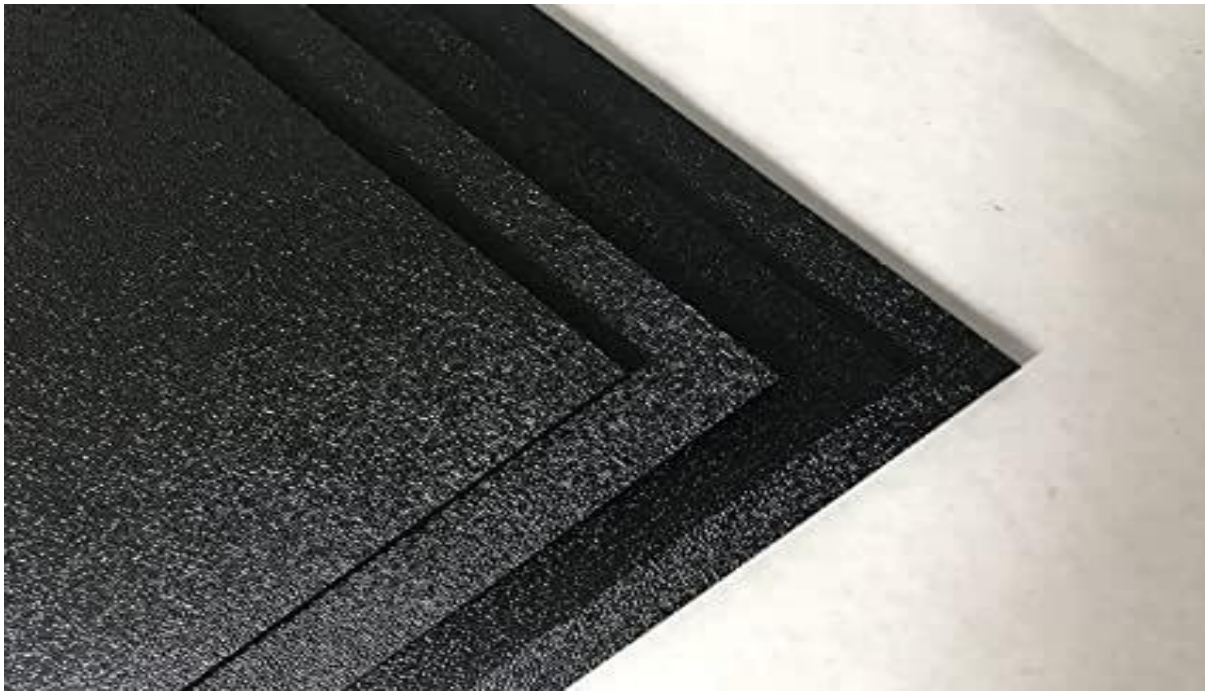
Abstract:

The present paper is aimed at solid modeling and FEM analysis of a chair made up of plastic (ABS) thermoplastic polymer material. This is an attempt to evaluate the feasibility and strength of a plastic (ABS) chair with stiffener mounted below which is inspired by a spider web. As the structural performance and material required of any product is utmost important to the manufacturers, it is essential for the product designers to build a prototype and test it under different loading conditions. Owing to the complexities involved in the deformation process, a powerful analysis technique (finite element analysis) has been applied to validate the product prototype.

MATERIAL&METHODOLOGY:

MATERIAL:

The material used in this project is ABS Plastic or which is referred to as ***Acrylonitrile Butadiene Styrene (ABS).*** ABS is an opaque thermoplastic and amorphous polymer. "Thermoplastic" refers to the way the material responds to heat. Thermoplastics become liquid (i.e. have a "glass transition") at a certain temperature (221 degrees Fahrenheit in the case of ABS plastic). They can be heated to their melting point, cooled, and re-heated again without significant degradation.



Thermoset plastics can only be heated once. The first heating causes thermoset materials to set resulting in a chemical change that cannot be reversed. If you tried to heat a thermoset plastic to a high temperature a second time, it would simply burn. This characteristic makes thermoset materials poor candidates for recycling. ABS is also an amorphous material meaning that it does not exhibit the ordered characteristics of crystalline solids.

ABS has a strong resistance to corrosive chemicals and/or physical impacts. It is very easy to machine and has a low melting temperature making it particularly simple to use in injection molding manufacturing processes or 3D printing on an FDM machine. ABS is also relatively inexpensive, typically fall somewhere

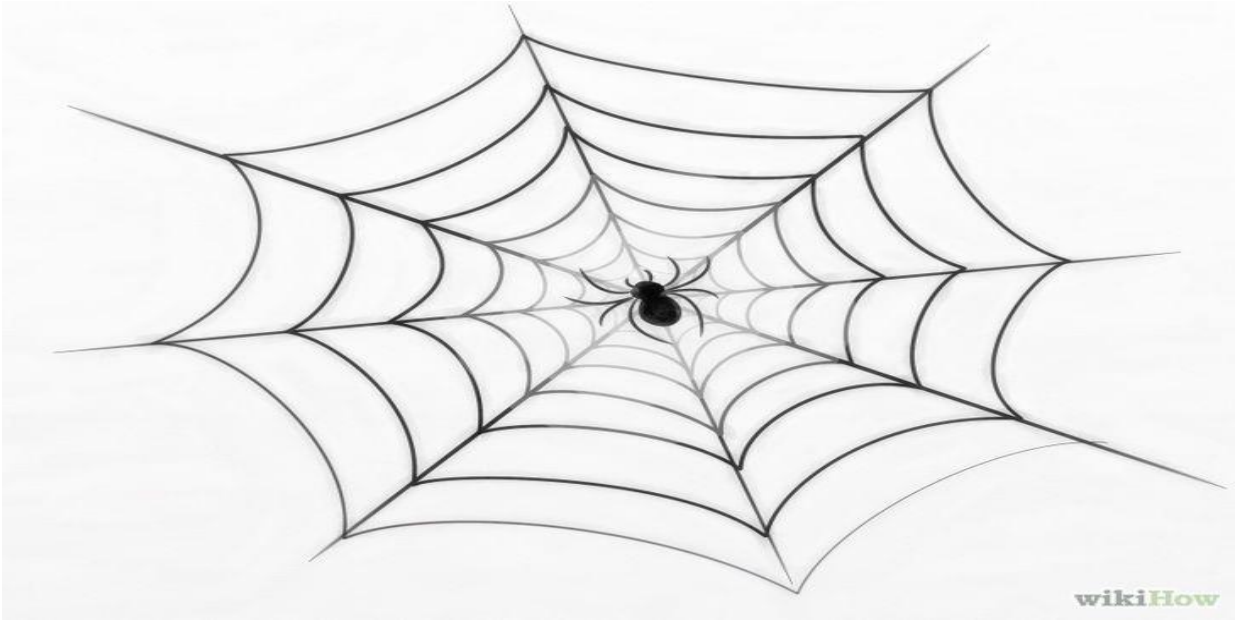
between those of Polypropylene ("PP") and Polycarbonate (“PC”). ABS plastic is not typically used in high heat situations due to its low melting point. These characteristics lead to ABS being used in a large number of applications across a wide range of industries.

PROPERTIES OF ABS:

Property	Value
Technical Name	Acrylonitrile Butadiene Styrene
Chemical Formula	(C8H8)x(C4H6)y(C3H3N)z
Glass Transition	105^0C (221^0
Molding Temperature	204^0-238^0C
Heat Deflection Temperature	980C at 0.46MPa
Tensile Strength	46Mpa
Flexural Strength	74Mpa
Specific Gravity	1.06

METHODLOGY:

Basically our design is an inspiration from the nature or we can call it a nature inspired design. This idea was taken from the nature by observing the intricate designs of the **“SPIDER WEB”.**



Spider web

Spider capture silk is the silk used to form the spiral in webs built by orb weaver

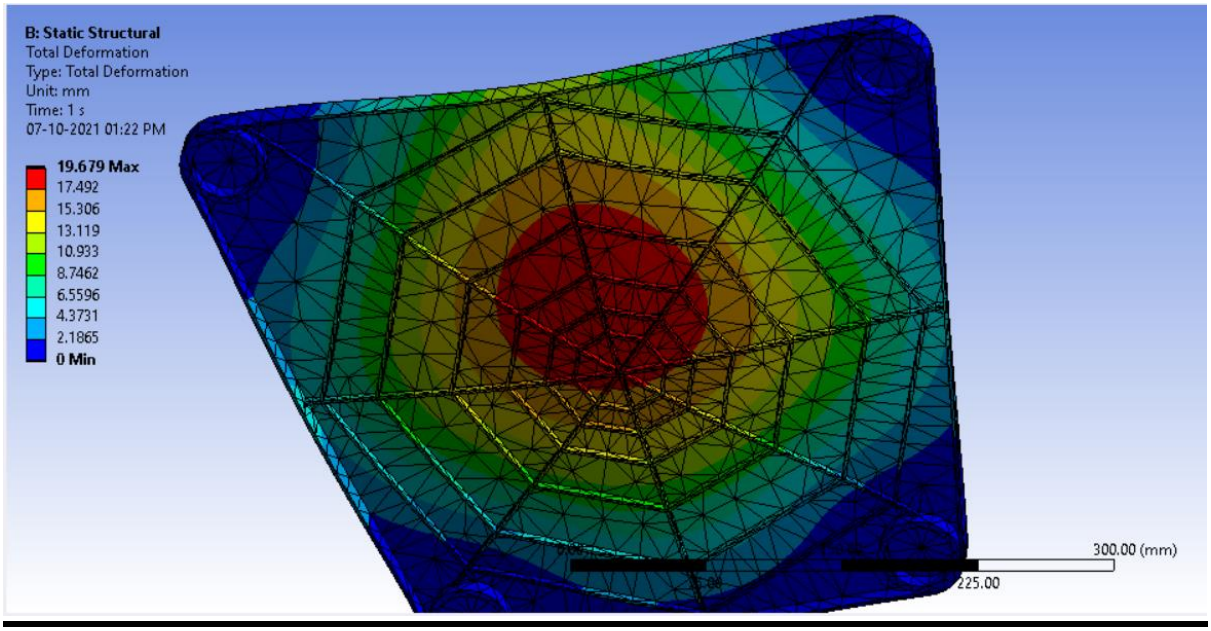
spiders. It is a remarkable material, as strong as Kevlar yet elastic at the same time. Orb weaver capture silk has a tensile strength of 1 GPa but can stretch to 500-1000% its original length before rebounding perfectly to regain its original properties. This is very important in spiral webs, which must be able to survive insects flying into them at speed without breaking and must also not become baggy and loose after being stretched.

Spider silk is made up of long protein molecules called fibroin Parts of the molecule are disordered, however in others it folds neatly into pleated sheets called beta-sheets. The sheets are held in place by networks of very weak bonds between hydrogen and oxygen atoms. The physical shape of the protein means that it is most likely to adopt the configuration that forms the greatest number of these weak bonds, however, because they are so weak, they are easily broken.

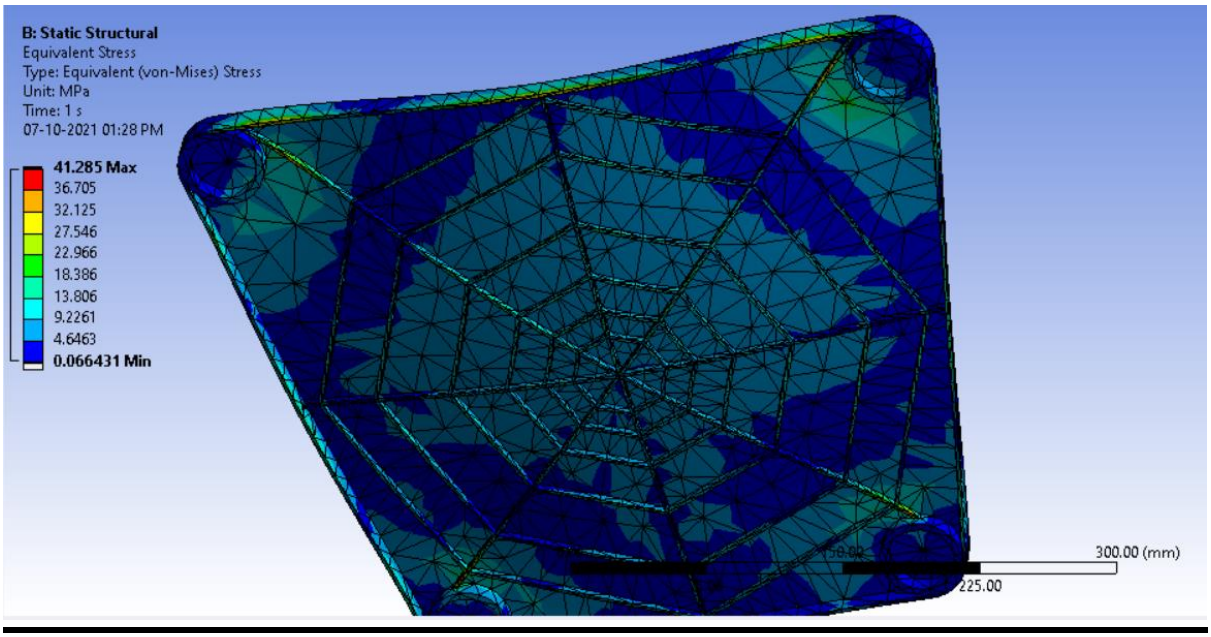
SIMULATION:

1. Model A(5mm with web stiffener)

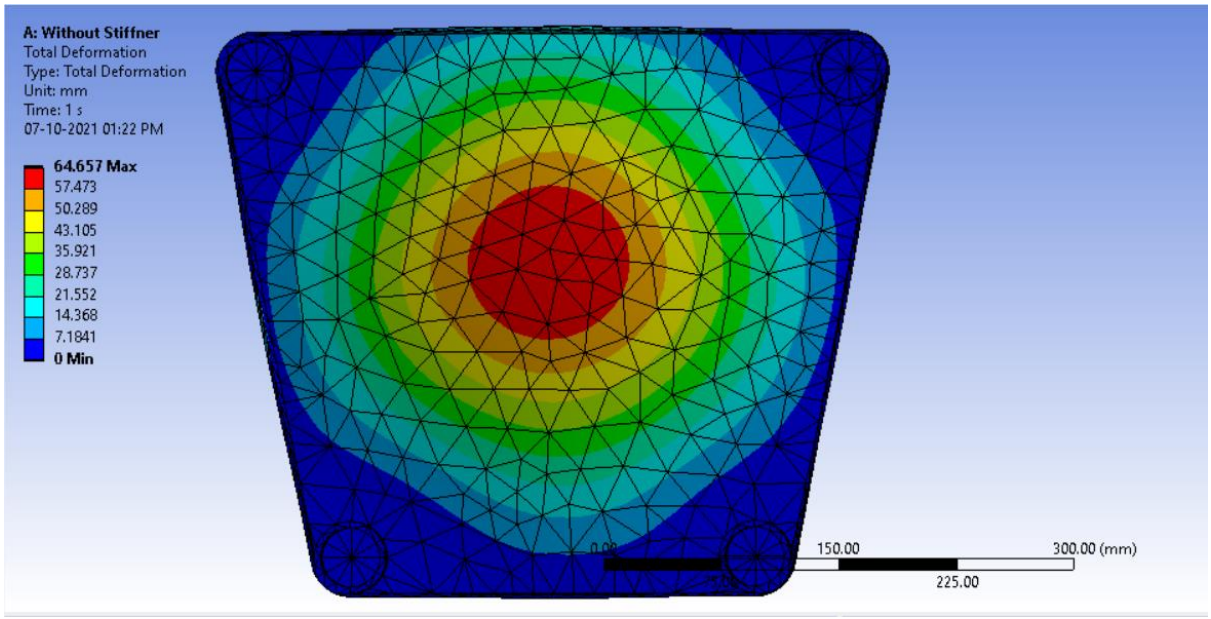
a. [Total deformation]:



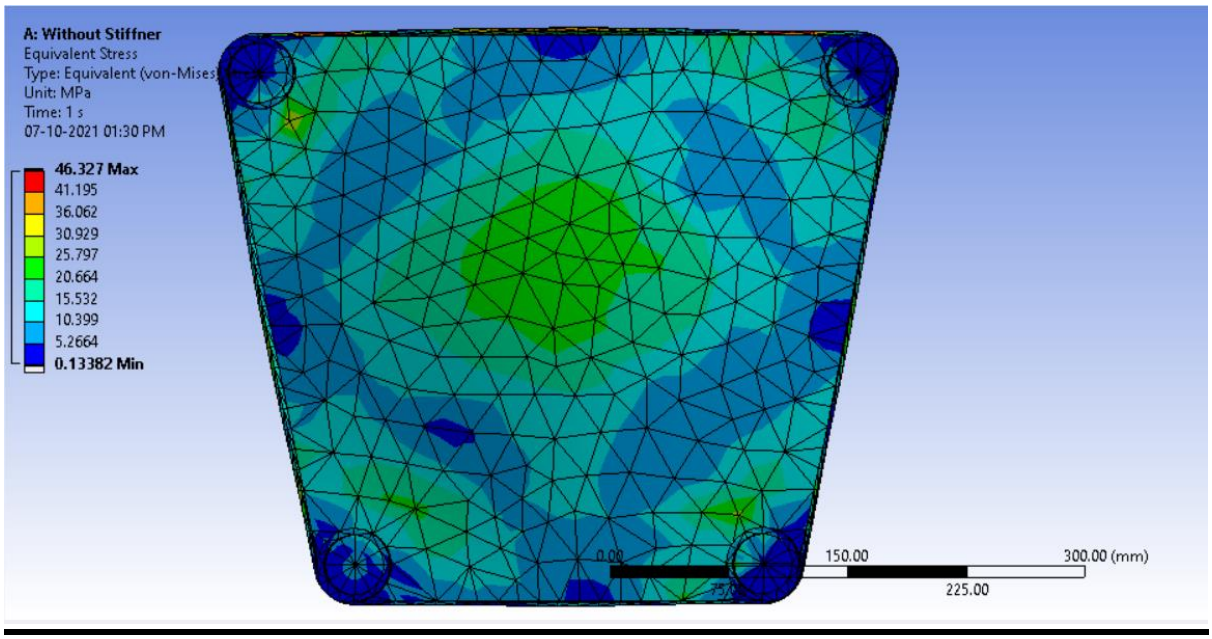
b. [Equivalent stress]



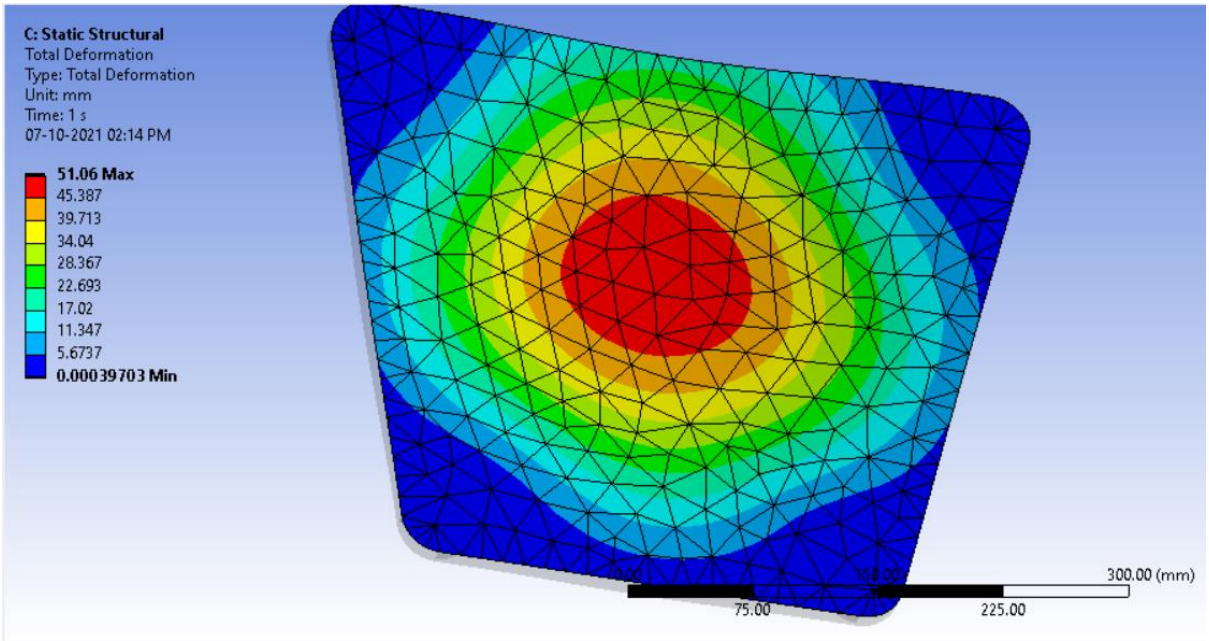
2. Model B(5mm without stiffener)
   [Total deformation]



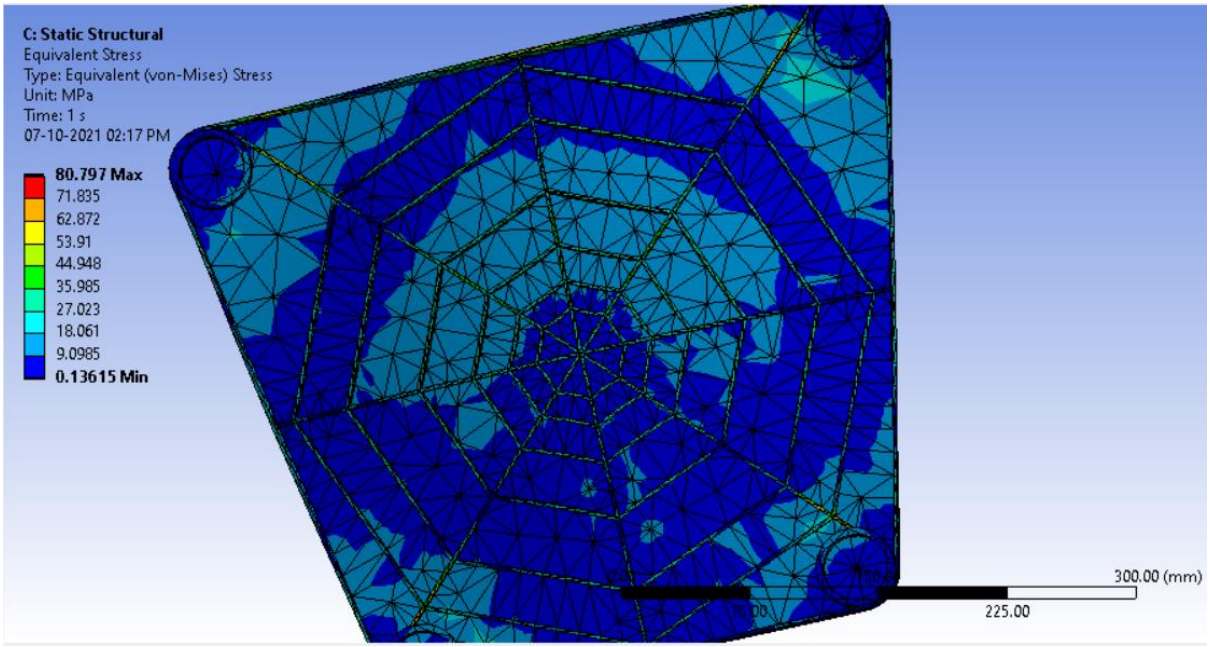
[Equivalent stress]



3. Model C (3mm with stiffener):
   [Total Deformation]:



[Equivalent Stress]:



RESULTS:

From the above research and simulation we have arrived at certain results they are as follows:-

Plastic Chair	Total Deformation	Equivalent Stress
1. Model A	19.67mm	41.285MPa
2. Model B	64.65mm	46.327MPa
3. Model C	51.06mm	80.797Mpa

CONCLUSION:

From the above analysis of a plastic (ABS) chair we can conclude that by adding the stiffeners which is inspired by spider web, we can achieve a good strength to the chair by reducing deformation.

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