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Design and Fabrication of a Mechanic Automotive Backrest for Under Motor Repair Works.

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ABSTRACT
In this study, a mechanical backrest is designed and fabricated to aid the comfortability of the user while performing maintenance and repair works under vehicles, trucks or machineries . The frame of the equipment is made of metal with a length of 50cm, width 40cm and thickness of 3mm cut, joined and welded using arc welding process. The materials used are metal bars, flexible tube, cloth peg, caster wheels and a flash light to enable the user work in dark areas.A cushioned foam is is attached to the equipment to ensure an effective back rest. A computer aided design of parts and a strength analysis was also performed on the caster wheels using solid work simulation software, also a 90kg distributed load was applied impacting on a uniform load of 22.5kg evenly on four wheels and the results from the simulation gave the maximum von mises stress as 10.4NM/S. The performance also showed that the design objectives were met in terms of static and dynamic stability of the backrest which was fabricated at low cost of 21,800 naira
KEYWORDS: Backrest, frame, castors, Design specifications, Automotive

I. INTRODUCTION

Most road side mechanics in Nigeria have the habits of spreading dirty clothes or foot mats on the floor while working underneath of vehicles, an old fashion practice which usually causes back pains and spinal cord injuries to the automobile repairer in the workshop. In order to fix these challenges, the mechanical backrest is used in standard workshops to aid the comfort of the user while doing repair works under a vehicle. A mechanical backrest trolley is a component that has a padded tray, cushion backrest foam with wheels that allows the user to move around during repair works. Some are foldable into chairs with lightening to work in dark places. In this paper the fabrication procedures as well as stress analysis for the caster wheels are conducted and presented in figure 4.3 and figure 4.4. Also a CAD of the parts of the mechanical back rest and solid work simulation are presented in appendix A and B.

II. MATERIALS AND METHODS

Design Components

1. Metal bars
2. Flexible tube
3. Cloth peg
4. Caster wheels
5. Flashlight
6. Foam and covering

Metal bars

The frame is made of metal, with length of 50cm, width of 40cm and thickness of 3mm. From the metal other parts to be used for the tool compartment tray and caster wheel are cut out. For the tool compartment tray, a length of 18.5cm by 3mm is cut out. Then for the caster wheel two parts made of 50cm by 6cm are cut out.

Figure 3.1 Metal bars

Flexible tube

PVC flexible tubing, also known as polyvinyl chloride flexible tubing, or vinyl tubing, is available in sizes from 1/16" to 3" inside diameter. It is made of plastic, with diameter of 1cm and length of 20cm.

Figure 3.2 Flexible Tube

Cloth peg

A clothespin or clothes peg is a fastener used to hang up clothes for drying, usually on a clothes line. Clothespins often come in many different designs.

Figure 3.3 Cloth peg

Aluminum Alloy Caster wheels

A caster (also castor according to some dictionaries) is a wheeled device typically mounted to a larger object that enables relatively easy rolling movement of the object. Casters are essentially special housings that include a wheel, facilitating the installation of wheels on objects.

Figure 3.4 caster wheel

Flashlights

A flashlight (more often called a torch outside North America) is a portable hand-held electric light. The source of the light is usually an incandescent light bulb (lamp) or light-emitting diode (LED).

Figure 3.5 Flashlight

Foam and Covering

Foam rubber (also known as cellular, sponge, or expanded rubber) refers to rubber that has been manufactured with a foaming agent to create an air-filled matrix structure. Commercial foam rubbers are generally made of either polyurethane or natural latex.

Figure 3.6 foam and covering

Design Specifications

Mechanical backrest on the market today fail to meet the requirements of DIY mechanics and car enthusiasts alike. A survey was conducted to determine the needs of the common mechanical backrest user. From the survey results I was able come up with design criteria to meet my needs assessment. Most of the survey responses requested comfort and functionality as a must. Due to this request this work will not only design a strong and functional mechanical backrest, but also one that improves upon the comfort of current mechanical backrest on the market. The design specifications for this mechanical backrest design are as follows:

- Design Load 90kg:
- Factor of Safety: 2
- Length x Width: 50cm x 40cm
- Total Weight 20kg:
- Caster Size: 6.3cm
- Memory Foam Padding for entire mechanical backrest
- Oil resistant fabric to protect Memory Foam Padding.

It is important to note that, for the use of this mechanical backrest, the following boundary conditions must be present:

- Car must be sitting on jack stands with a minimum ground clearance of 60.96cm.
- The floor that the mechanical backrest will roll on must have a hard surface that will accommodate a mechanical backrest ground clearance of 3.175 cm.

These parameters are described in Figure 3.7:

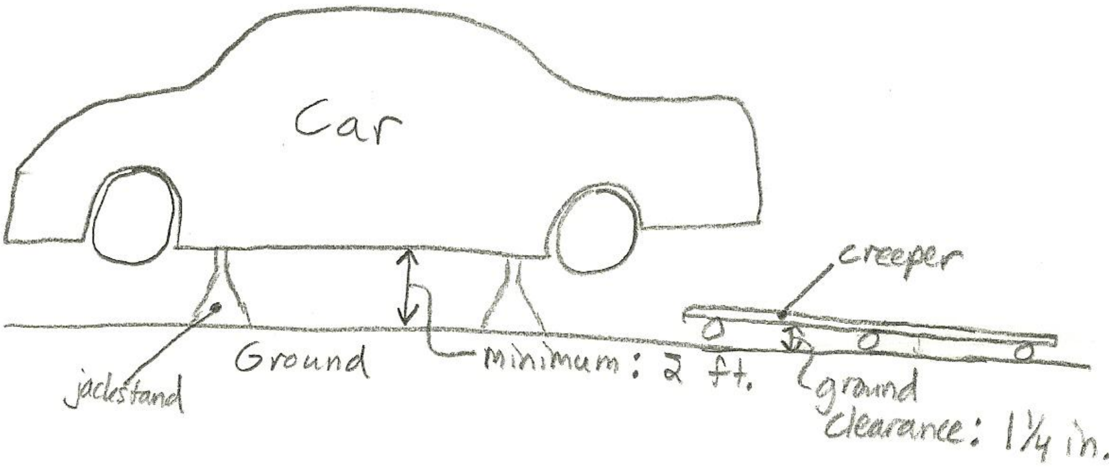

Figure 3.7 mechanical backrest boundary conditions

Design Procedure

Two (2) metal bars of length 40cm by 3cm are cut out and three (3) 1 inch rods are welded in between them, another two (2) metal bars of dimension 50cm by 3cm are also cut out and holes for bolts to hold the caster wheels bored on them, after which they are welded on top the two ends of the first welded frame. The tool compartment tray is now welded on to the assembly and the casters are bolted at the four ends of the assembly. Foam rubber is cut out and clothed after which it is placed into the welded frame. At this point holes should be drilled at the two top corners of the frame and the flexible tube glued into the holes, then the cloth pegs are glued to the top of the flexible tube and lastly the flashlights fixed into the pegs.

III. RESULT AND DISCUSSION

Result

Figure 4.1 A model frame of the mechanical backrest

Properties of Outline Row 4: Aluminum Alloy

	A	B	C
1	Property	Value	Unit
2	Density	2770	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Mo...	
8	Young's Modulus	7.1E+10	Pa
9	Poisson's Ratio	0.33	
10	Bulk Modulus	6.9608E+10	Pa
11	Shear Modulus	2.6692E+10	Pa
12	Alternating Stress R-Ratio	Tabular	
16	Tensile Yield Strength	2.8E+08	Pa
17	Compressive Yield Strength	2.8E+08	Pa
18	Tensile Ultimate Strength	3.1E+08	Pa

90/4 = 22.5KG

Force = 22.5*9.8 = 220.5N

Figure 4.2 1060 Alloy Engineering properties for the caster wheel

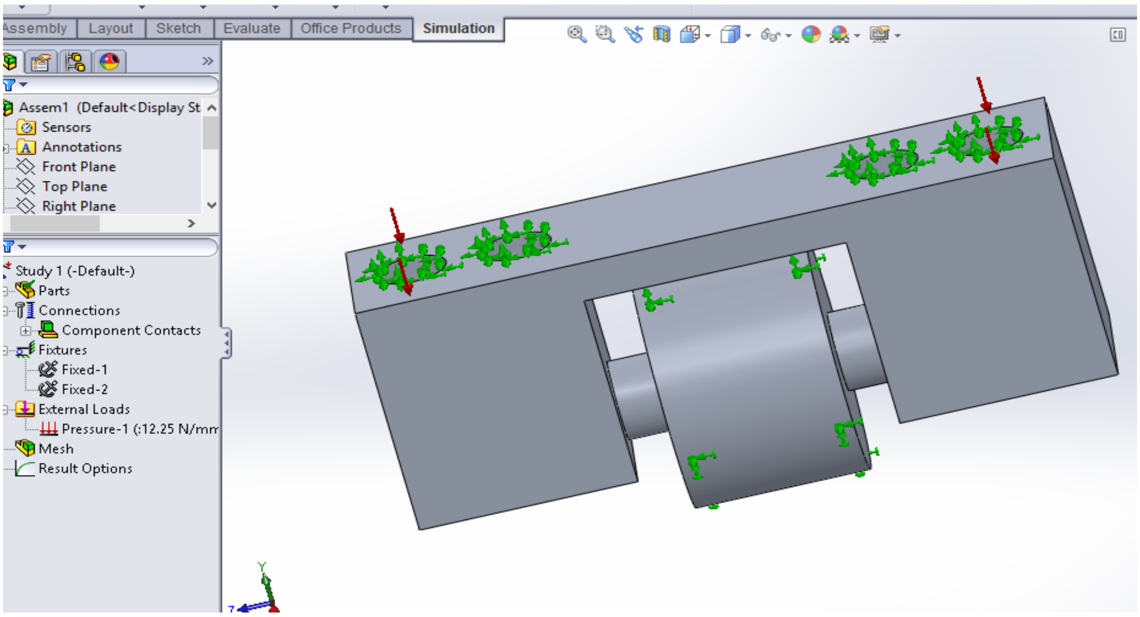

Figure 4.3 Applied pressure on the caster wheel as a result of user load

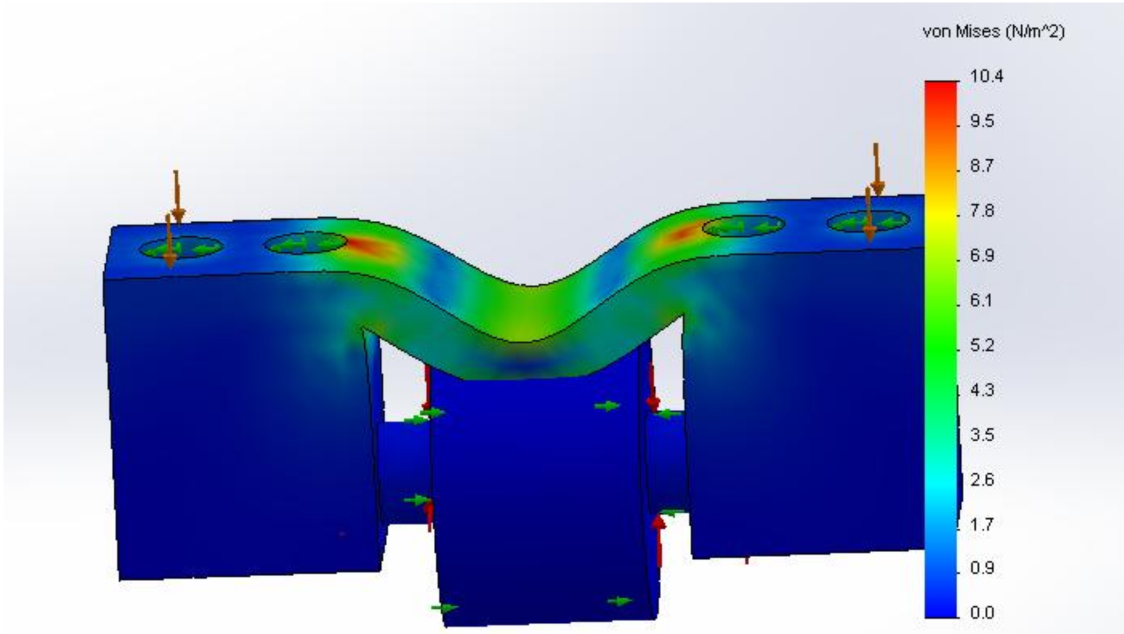

Figure 4.4 von mises stress value for the caster wheel

IV. DISCUSSION

AREA OF EACH TYRE=8*2=16
MASS OF USER=90kg
Weight of user =90*9.8=882N
WEIGHT ON EACH TYRE = 882/4= 220.5N
PRESSURE ON EACH TYRE = WEIGHT/AREA = 220.5/16 = 13.781N/mm^2

A strength analysis was performed on the caster wheels using Solidworks Simulation software. A 90kg distributed load was applied impacting a uniform load of 22.5kg evenly on all four wheels. Result from this simulation gave the maximum von mises as 10.4N/m^2.

V. CONCLUSION

After consulting many professionals and hobbyists, a significant interest was found in this product. The flashlight and tool compartment in this design solves many issues that professionals and hobbyists experience that include ability to see clearly while working and saves the stress of moving out and in trying to get tools.

The alleviation of these pains prevents potential bad sight and body stress further down the road and increases work productivity and comfortability while working. This modified design also improves the safety of the user in terms of visibility which reduces the risk of injury or hazards. This mechanical backrest is virtually maintenance free, and only requires occasional greasing. This product is designed to be priced competitively with other mechanical backrest in the market today. We plan on making a number of changes to improve the operation of the mechanism to make it easier to operate. In addition, these changes will also reduce the overall weight of the mechanical backrest itself.

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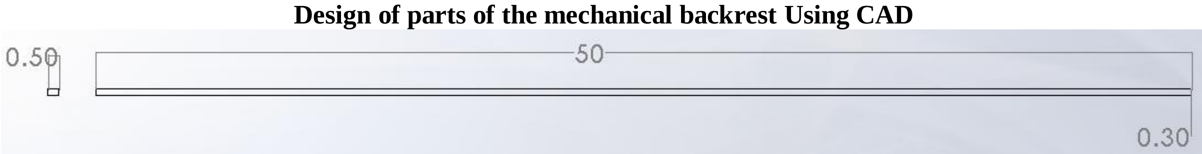
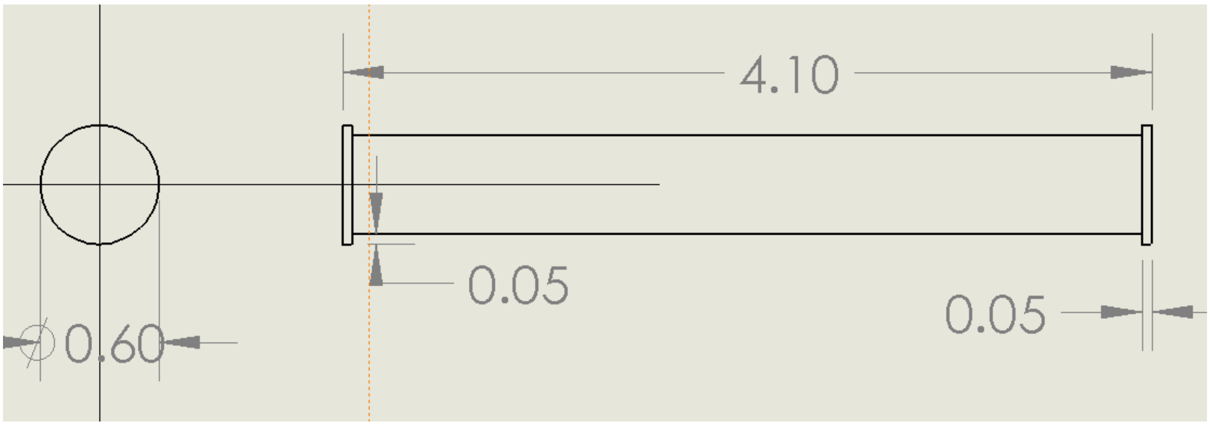
Appendix A

Design of parts of the mechanical backrest Using CAD



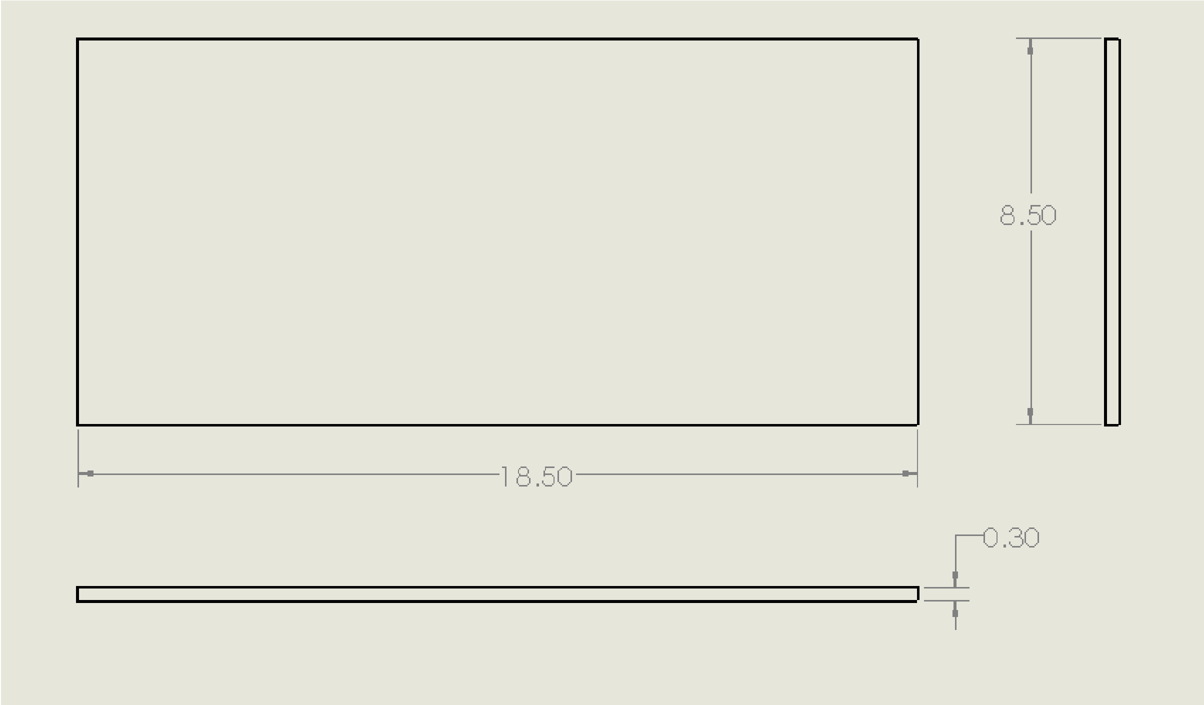
Side rod



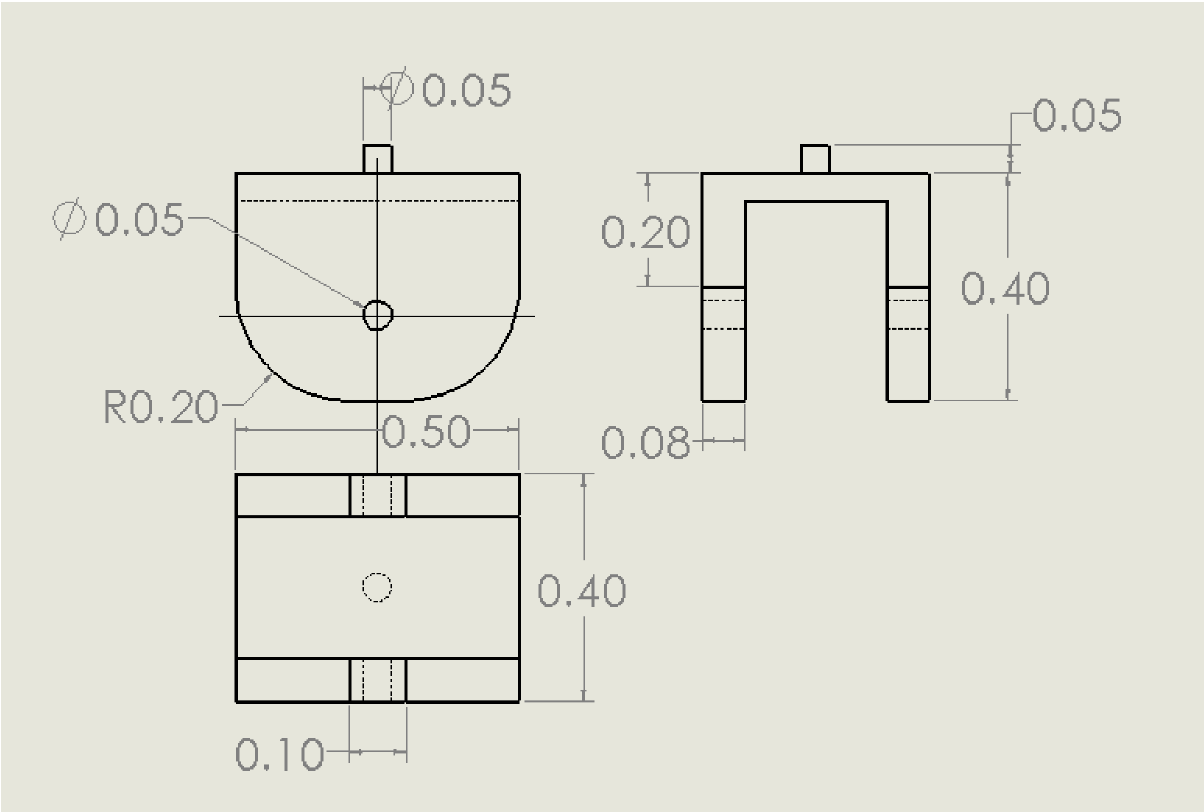
Pin

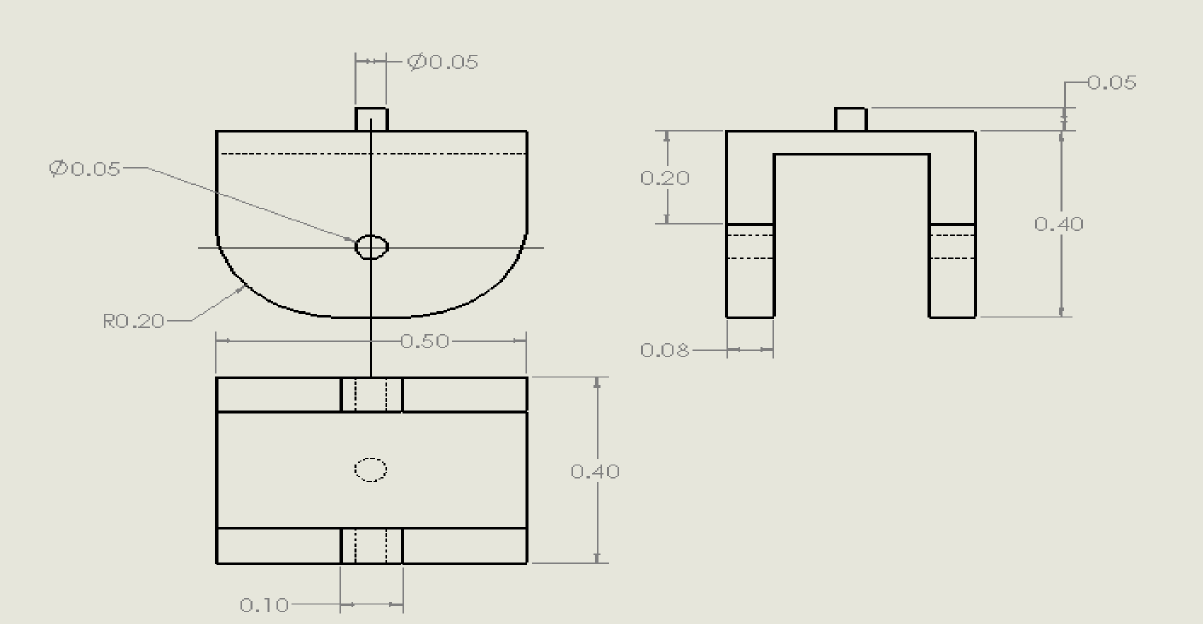
Supporting Rod

Supporting Length

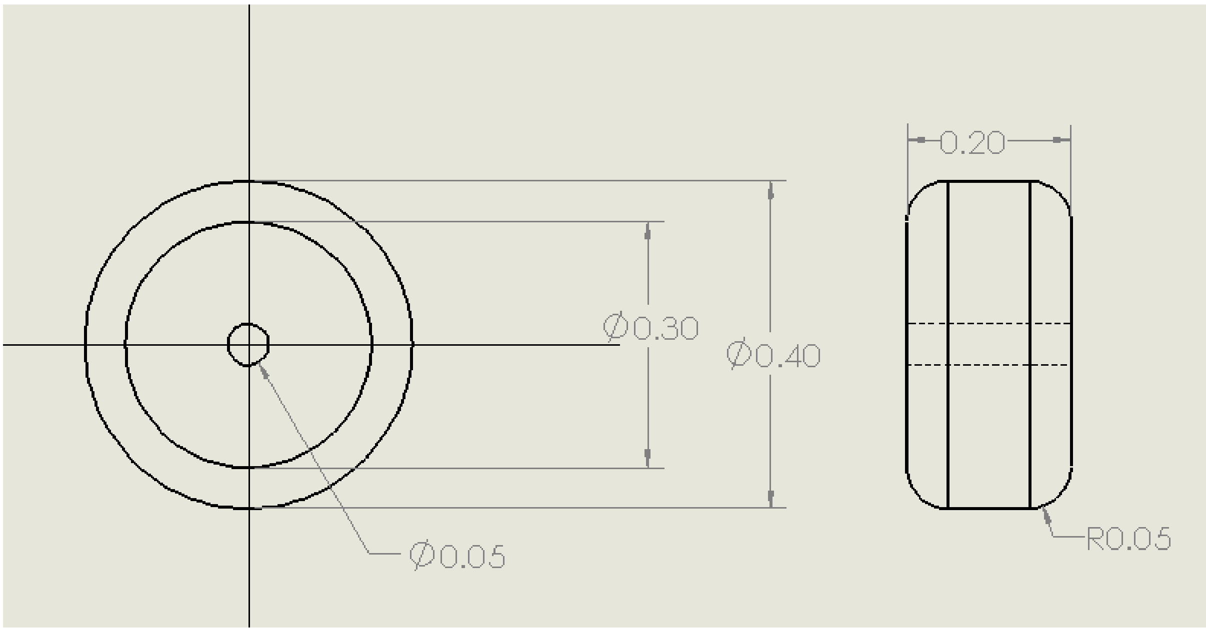


Tray

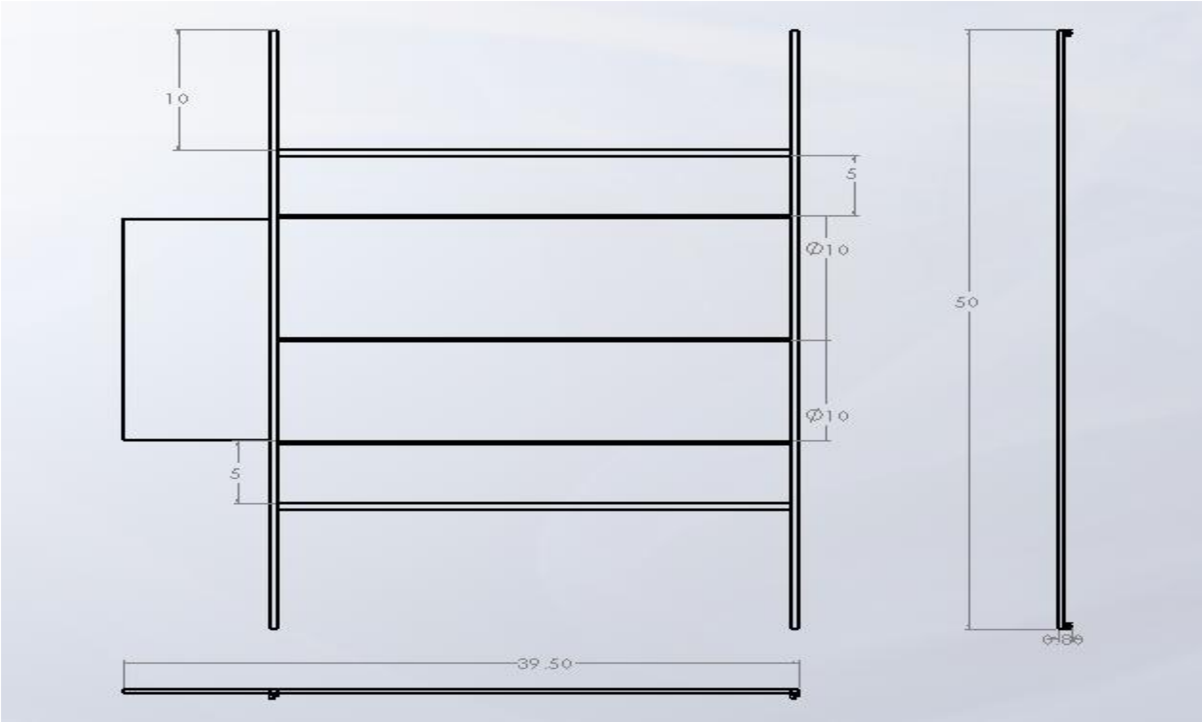




Tyre Support



Tyre



Appendix B

Solidworks simulation

Properties of Outline Row 4: Aluminum Alloy

	A	B	C
1	Property	Value	Unit
2	Density	2770	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Mo...	
8	Young's Modulus	7.1E+10	Pa
9	Poisson's Ratio	0.33	
10	Bulk Modulus	6.9608E+10	Pa
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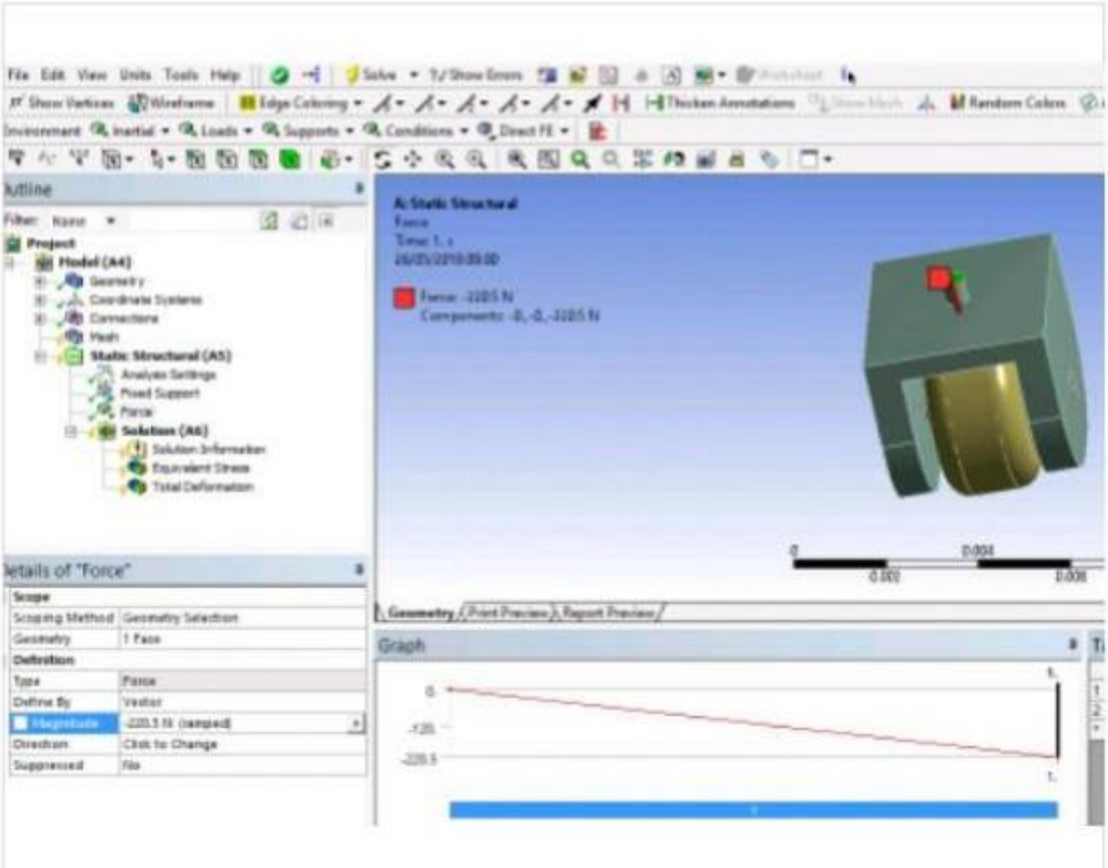
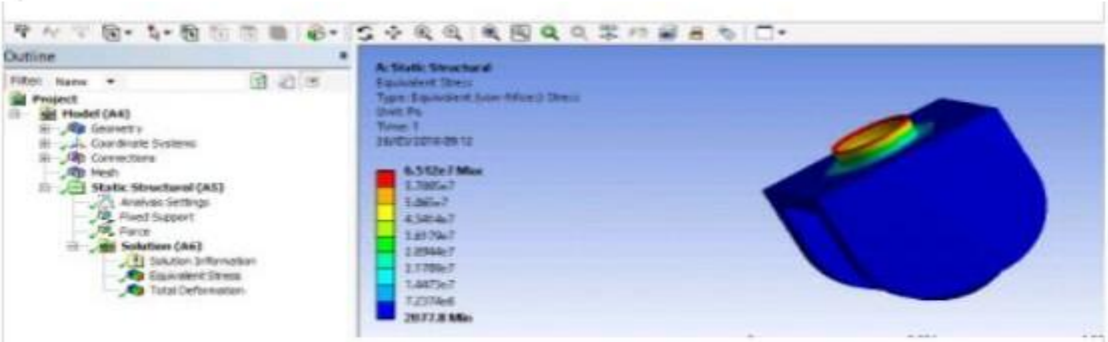
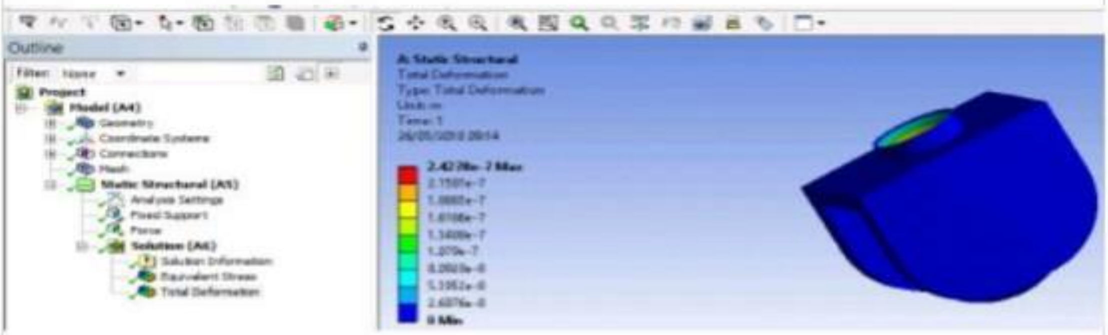




Maximum stress = $6.5x\ 10^{7}N/mm^{2}$



Maximum deformation = $2.42x\ 10^{-7}m$