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DESIGN AND ANALYSIS OF AN ALLOY WHEEL RIM

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Abstract - The wheel rim is the basic structure in the vehicle dynamic and safety system hence, the wheel rim must withstand the Peak loading conditions. Wheel rims can be classified into several types based on their requirement of performance, characteristics, and aesthetic look. The essence of the alloy wheel gives a firm base on which to fit the tire. Its measurements, shape ought to be reasonable to enough oblige the specific tire required for the vehicle.

***Key Words*:** WHEEL, RIM, ALUMINUM, SOLIDWORKS, ANSYS

1.INTRODUCTION

The alloy wheel is the external round design of the metal on which within edge of the tire is mounted on vehicles, for example, autos. For instance, in a four-wheeler the rim is a loop appended to the external finishes of the spokes-arm of the wheel that holds the tire and tube.

Standard car steel alloy wheel is produced using a rectangular sheet metal. The metal plate is twisted to deliver a barrel shaped sleeve with the two free edges of the sleeve welded together. No less than one tube shaped stream turning operation is carried out to acquire a given thickness profile of the sleeve — specifically involving in the zone planned to constitute the external seat a point of slant with respect to the hub heading. The sleeve is then formed to get the rims on each favor a radially internal round and hollow divider in the zone of the external seat and with a radially external frusta-funnel shaped divider slanted at a point comparing to the standard slant of the rim seats. The rim is then aligned.

2.LITERATURE SURVEY

The wheel rim is the basic structure in the vehicle dynamic and safety system hence, the wheel rim must withstand the Peak loading conditions. Several tests like impact and radial fatigue tests were conducted to know whether the material meets the requirement for application in vehicles. In the Design of Alloy Wheel literature review, many researches have been carried out.

J. Stearns, T.S. Srivatsan, A. Prakash, P.C. Lam, [1] Department of Mechanical Engineering, The University of Akron, Akron, OH 44325-3903, USA received 10 April 2003; received in revised form 1 August 2003 observed and concluded as potential methods of applying theradial load have been established and most take on a cosine function form. Application of the cosine function is dependent on tire construction. Influence of inflation pressure is modeled as an equivalent load on the bead seat flange. Inflation pressure does seem to have a direct effect on the state of stress in an automobile rim under the influence of a load of the maximum tire rating. Under the influence of a radial load, the rim tends to ovalize about the point of contact with maximum displacement occurring at the location of the bead seat. Loading method and angle greatly influences the state of stress in the wheel. Experimental evidence indicates that the standard cosine bearing load at a loading angle of 45◦ best matches experimental data. The inside bead seat reveals the greatest deflection and is concurrently prone to loss of air pressure due to dislodgment of the tire on the rim.

Karthik A.S. et al. (2016) [2] Finite Element Techniques are used to find out stress and displacement distribution in vehicle wheels subjected to increase pressure and radial load. The model was made using "CATIA V5" and the analysis was done through "Ansys workbench" finite element package. After comparing the results of different Material model selected like magnesium, aluminum, and titanium are used to check the capacity of the wheel.

Samuel Onoriode Igbudu, David Abimbola Fadare [3] concluded that analysis of different loading functions— CLF, BLF and ELF at deferent inflation pressure of 0.3, 0.15 MPa and 0 MPa at specified radial load of 4750N was carried out on a selected aluminium alloy wheel. Von Mises stress was used as a basis for comparison of the different loading functions investigated with the experimental data obtained by Sherwood et al. while the displacement fields (as obtained from the FEM tool) were used as a basis for comparison of the different loading functions as displacement was not covered by Sherwood.

Jaspreet Singh, et al. (2015) [4] they analyzed Alloy Wheel by static loading using Ansys15.0 and the summery of this Paper was, FEA was performed on aluminum alloy wheel. The results of the vonmisses stress, factor of safety, and total displacement were calculated. Also using reverse engineering results obtained are fine for the design.

Meghashyam-et.al (2013) [5] model of the wheel rim was created with the help of the CATIA

software. Later this CATIA model was imported to ANSYS for analysis work. With the help of ANSYS software the different forces, pressure acting on the component and also for calculating the results. ANSYS static analysis work was done by two different materials taking into consideration like aluminum and forged steel and their relative performances have been observed respectively.

Stearns, J., et al., [6] Analysis of stress and strain distribution in a vehicle wheel: finite element analysis versus the experimental method. The Journal of Strain Analysis for Engineering Design, 2005. 40(6): p. 513-523.

Theja, M.S. and M.V. Krishna, [7] Structural and fatigue analysis of two wheeler lighter weight alloy wheel. IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) e-ISSN, 2013: p. 2278-1684.

P. Meghashyam, S. Girivardhan Naidu and N. Sayed Baba [8] observed the results of both static and modal analysis obtained forged steel is suggested as best material and came to a conclusion that Aluminium wheel rim is subjected to more stress compared to Forged steel. In both cases von-mises stresses are less than ultimate strength. Deflections in aluminium are more when compared to forged steel. Since in both the cases von-mises stresses is less than the ultimate strength, talking deflections into account, forged steel is preferred as best material for designed wheel rim.

Li, M.-L., D.-S. Bi, and J.-K. Hao. [9] Automotive sheet metal SAPH440 and Q235 formability of comparative study. in 2015 International Conference on Material Science and Applications (icmsa-15). 2014. Atlantis Press.

Subrahmanyam, A., G. Naresh, and V. Venkatesu, [10] Microstructure and mechanical properties of rice husk ash reinforced aluminium alloy (A356. 2) metal matrix composite.

3.SOLIDWORKS

Solid Works is a 3D solid modeling package which allows users to develop full solid models in a simulated environment for both design and analysis. In Solid Works; you sketch ideas and experiment with different designs to create 3D models. Solid Works is used by students, designers, engineers, and other professionals to produce simple and complex parts, assemblies, and drawings. Designing in a modeling package such as Solid Works is beneficial because it saves time, effort, and money that would otherwise be spent prototyping the design.

Solid Works Components-Parts

Before we begin looking at the software, it is important to understand the different components that make up a Solid Works model.

Part:

- The first and most basic element of a Solid Works model is a Part.

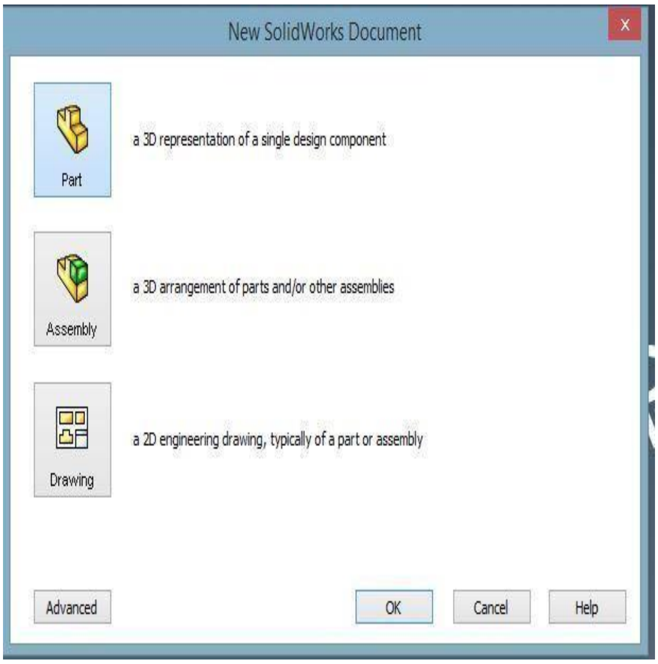
- Parts consist of primitive geometry and feature such as extrudes, revolutions, lofts, sweeps, etc.
- Parts will be the building blocks for all of the models that you will create

Assembly:

- The second component is the assembly. Assemblies are collections of parts which are assembled in a particular fashion using mates (constraints).
- Any complex model will usually consist of one, or many assemblies.

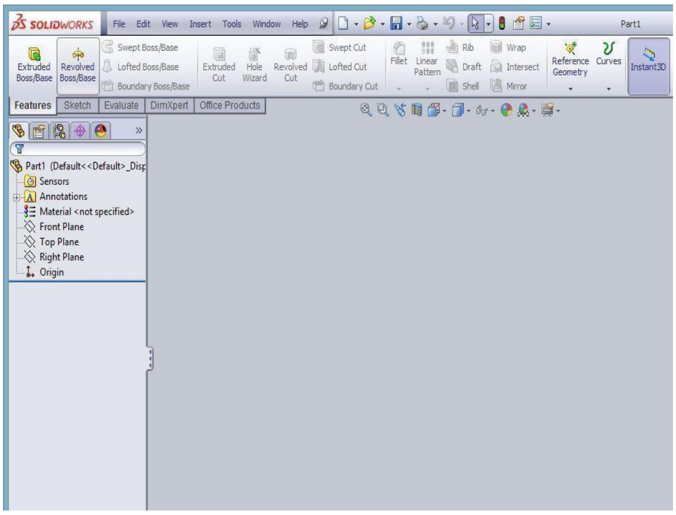
Solid Works – Let's Begin

Solid Works Default Page



- By default, no file is opened automatically when you start the program.
- To create a new file, click on File - New or click the New File icon in the main toolbar.
- This will open the New Solid Works document wizard

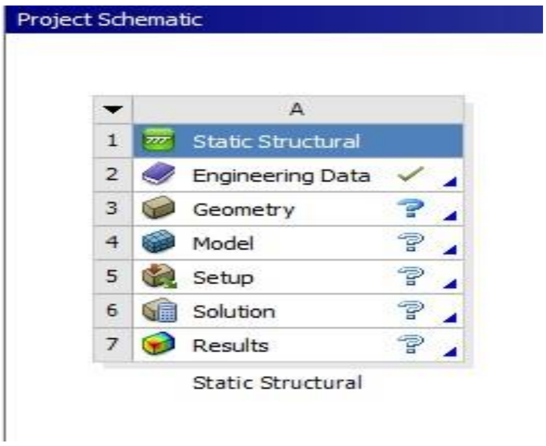
Parts of SolidWorks



SolidWorks Working Environment

Project Schematic Windows

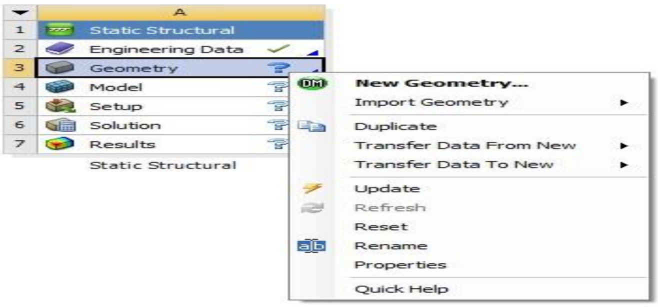
The project schematics windows help manage an entire project drag the analysis system and leave over window



Static Analysis Imported into Project Schematic

Geometry Cell

The geometry cell is used to create, edit or import the

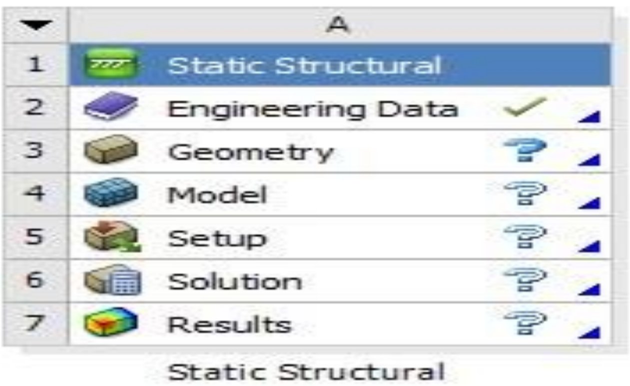


geometry that is used for analysis.

The Menu Displayed on Right Clicking on The Geometry Cell

4 STATIC STRUCTURAL ANALYSIS

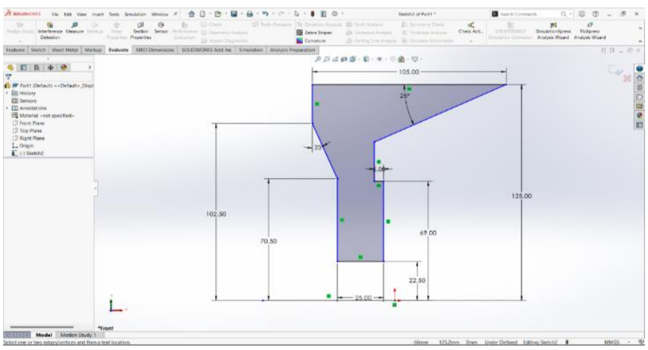
- **Project Objective**



The Static Structural Analysis (SSA) tab

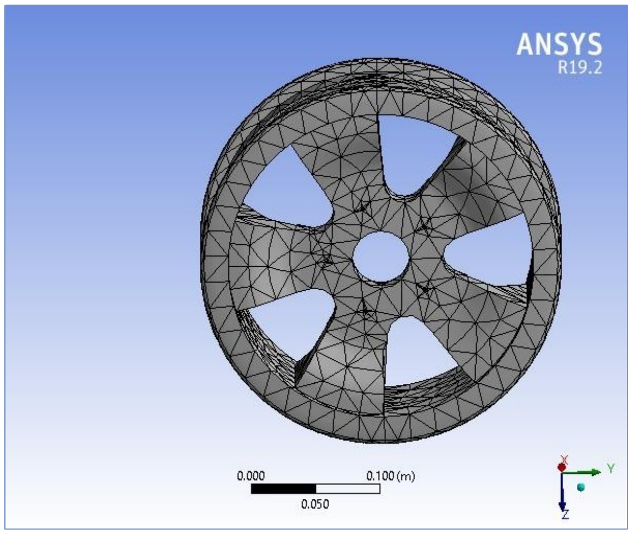
Material

- **Aluminum Alloy NL**



- **Magnesium Alloy NL**
- **Titanium Alloy NL**

Generating The Mesh



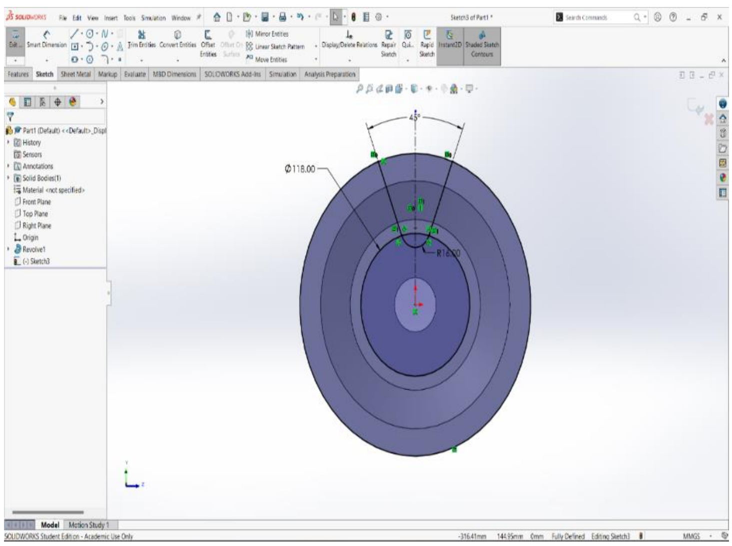
Mesh

5 MODELLING AND ANALYSIS

To create this part body, go to solid works software and click on file new and select part design module. In part design module then go to sketcher tool and select sketcher tool and select required plane.

Sketch:

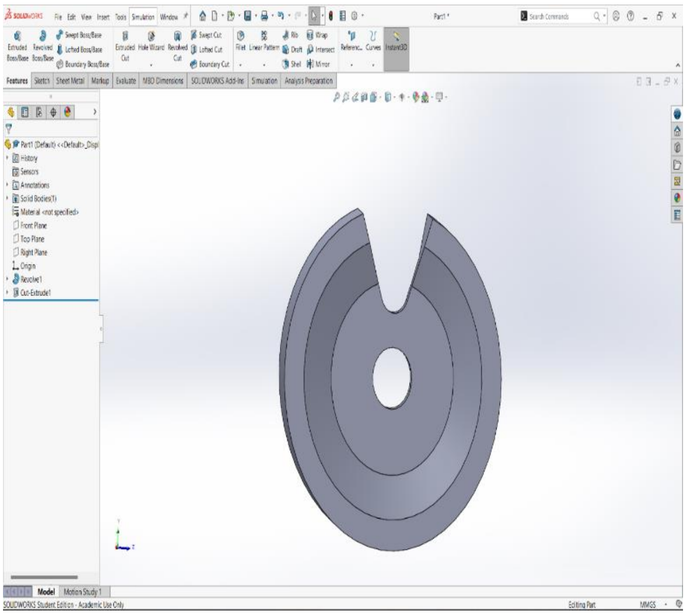
By using sketch tool I created the required dimensions of the object as shown below



Sketch

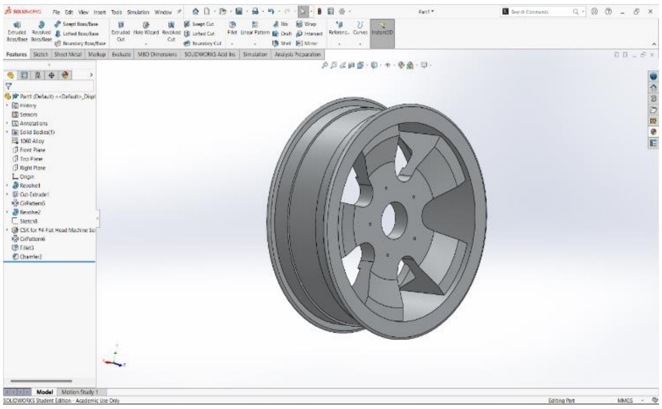
Helix:

Extrude cut:



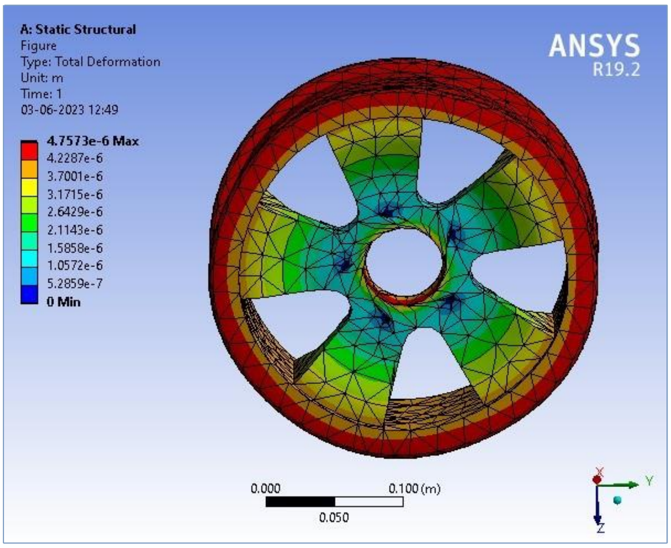
Extrude cut

Final Design of Alloy Wheel:



Alloy Wheel

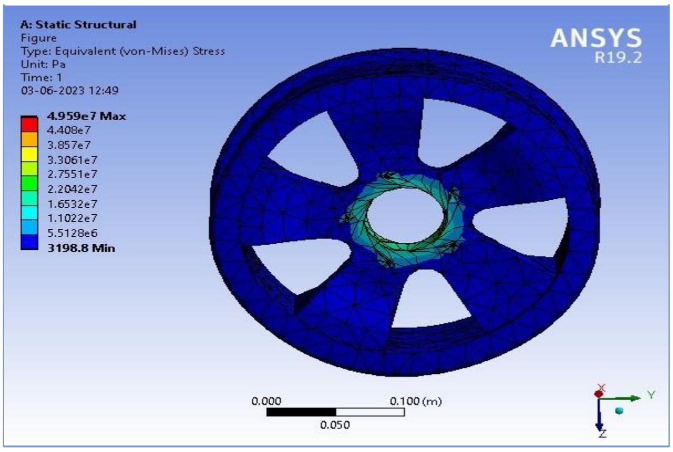
Analysis:

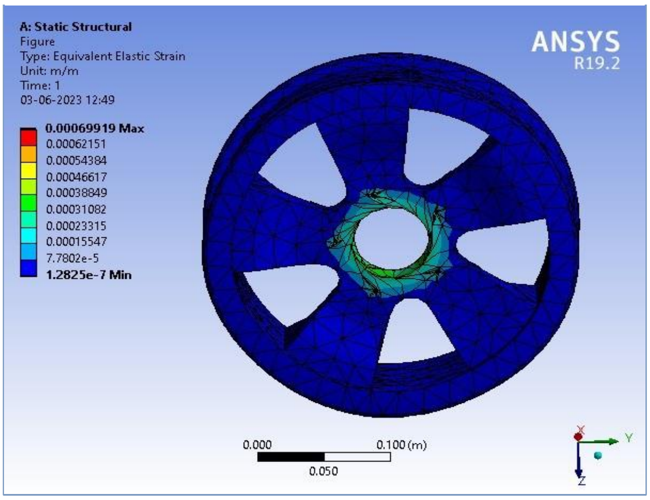


1. For Aluminum Alloy NL

- Total Deformation
- Equivalent Stress
- Equivalent Elastic Strain

The Mini and Max Values of Total Deformation of an Alloy Wheel



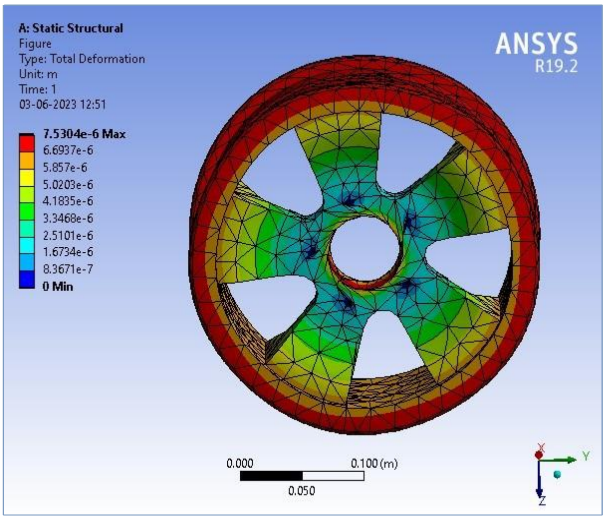


The Maxi and Mini Values of Equivalent Stress

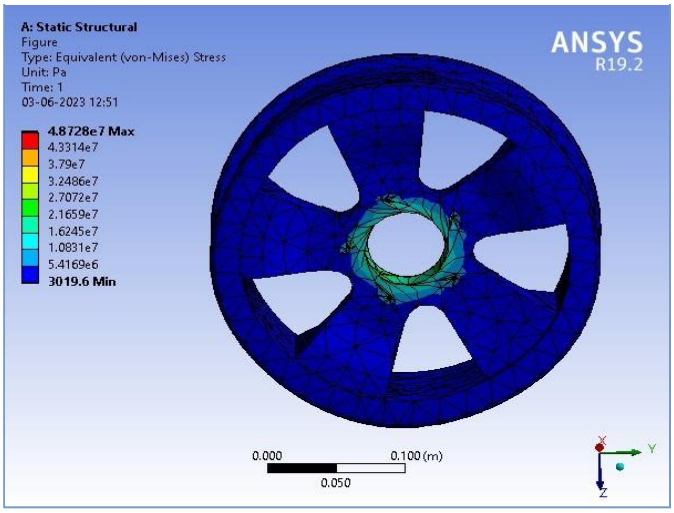
The Maxi and Mini Values of Equivalent Elastic Strain

2. For Magnesium Alloy NL

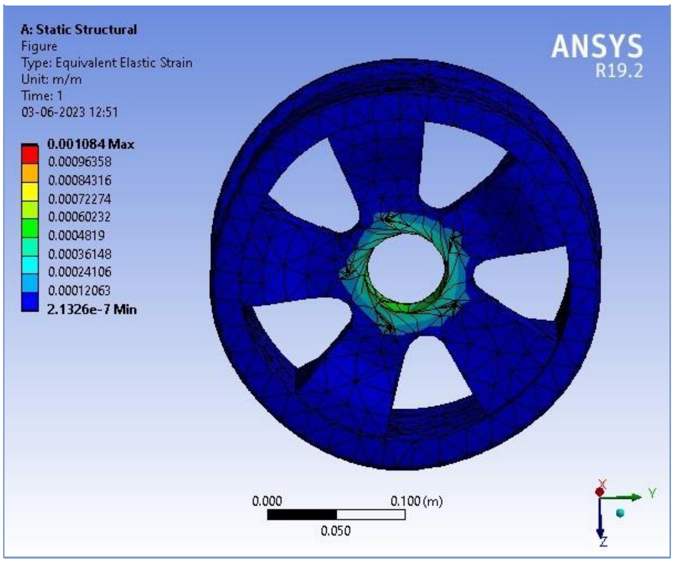
- Total Deformation
- Equivalent Stress
- Equivalent Elastic Strain



The Mini and Max Values of Total Deformation of an Alloy Wheel



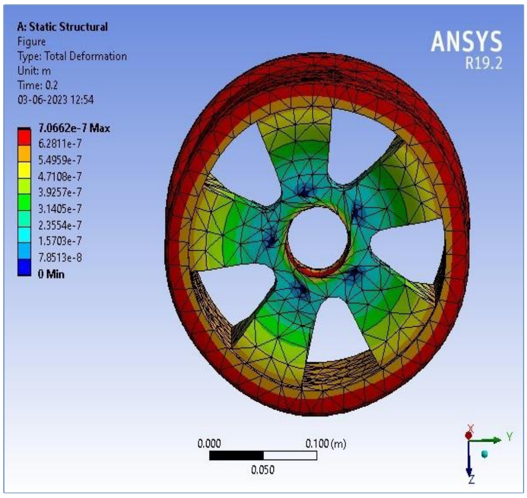
The Maxi and Mini Values of Equivalent Stress



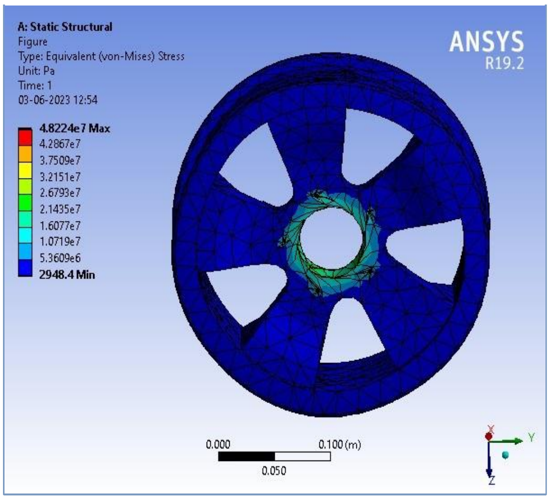
The Maxi and Mini Values of Equivalent Elastic Strain

3. For Titanium Alloy NL

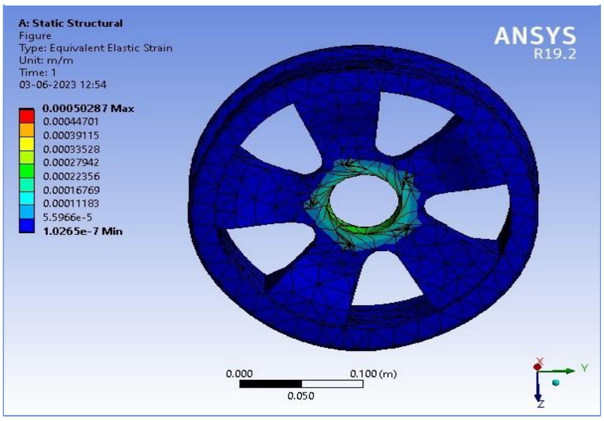
- Total Deformation
- Equivalent Stress
- Equivalent Elastic Strain



The Mini and Max Values of Total Deformation of an Alloy Wheel



The Maxi and Mini Values of Equivalent Stress



The Maxi and Mini Values of Equivalent Elastic Strain

RESULT AND DISCUSSIONS

RESULTS

S. NO	TYPE	TIME (Sec)	Aluminum Alloy NL	Magnesium Alloy NL	Titanium Alloy NL
1	Maximum Deformation [m]	1	4.7573e-006	7.5304e-006	3.5331e-006
2	Maximum Stress [Pa]	1	4.959e+007	4.8728e+007	4.8224e+007
3	Maximum Strain [m/m]	1	6.9919e-004	1.084e-003	5.0287e-004

CONCLUSION

- In this thesis, an alloy wheel is designed and modeled in solid works software. The design is changed to increase the efficiency of the wheel and analysis is done on the alloy wheel by changing the materials Aluminum alloy NL, Magnesium alloy NL, and Titanium alloy NL. And analysis is done by using ANSYS 19.2 programming.

FUTURE SCOPE

- All wheels are not made the same. The performance of an alloy wheel is a direct result of the manufacturing technique employed. The earliest alloy wheels are made of magnesium. They found many problems in such as cracking, corrosion etc.
- Aluminum casting improvements were more widely adopted, the aluminum wheel took the place of magnesium as low cost, high-performance wheels for motorsports. They have a high price tag and easily prone to damage during collisions when compared to steel wheels. So, a new alloy composition is to be developed which achieves the advantages of both steel and aluminum. To overcome cost and attain a light weight and strength of wheel it's better to apply pressure to the cast rim so that mechanical properties of the wheel will change. Designing the wheel lighter helps to reduce the overall weight of the vehicle which reduces the fuel consumption.

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