International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Computational Analysis & Design Study of Car wheel Rim

Vikas Yadav[a], Kamlesh Gangrade[b]*

[a]PG scholar, Department of Mechanical Engineering, SAGE UNIVERSITY, Indore
[b] Assistant Professor, Department of Mechanical Engineering, SAGE UNIVERSITY, Indore

A B S T R A C T

The wheel rim is a highly important component of this car. It carries all of the vehicle's weight. Therefore, great consideration must be given to the wheel rim design. In addition to design, choosing the right material is an important responsibility. High strength, light weight, low cost, dependability, etc. are all desirable qualities in rim design materials. Three different types of material were used in this paper's discussion of a finite element analysis of a wheel rim. Creo 4.0 is used for modelling, and ANSYS is used for analysis. Because it is a common approach to calculate stress and deformation when the load does not fluctuate with time, finite element analysis is used to examine the outcome. Findings when comparedsince aluminium is strong and lightweight, it helps to improve fuel economy. A good material for wheel rim design is aluminium. Three different material types—aluminum alloy, structural steel, and alloy steels taken into account. Compared to other materials, the aluminium alloy exhibits the best performances

.**Keywords**: Creo 4.0, Structural Steel, Stainless Steel & Aluminium alloy

1.Introduction

The stability of the vehicle's wheels must be ensured with extra care because they are crucial to its safety. The development of the wheel has had a significant impact on design, material choice, and production techniques. They are loaded in a complex way, and only improved implicit loading will allow for further wheel design advancement. It is necessary to have precise information of the loads, the mechanical properties, and the permissible stresses of the material in order to design the wheel in the best possible way. The fuel efficiency and gas emissions of automobiles will be considerably improved by the use of lightweight materials for the body and wheels. Alternative materials like aluminium and magnesium alloys,Wheels made of polymer matrix composites (pmc's) rather than steel have a lower weight than steel-made wheels. It is carried out without sacrificing the passengers' comfort, performance, or safety. The use of carbon, which is abundant in nature and inexpensive, to make wheel rims has now begun a revolution in the vehicle industry. Due to rivalry, the automotive industries are under a lot of pressure to produce parts that are both cheap and of optimum design. The parts ought to use less gasoline while operating more efficiently.Consequently, product development is required. Reducing the vehicle's bulk will help with this. The comfort of the passengers is significantly influenced by the wheel and tyre. Without sacrificing the strength of the wheel, the materials used to make this mass are modified from the ones now in use. Because there is less unsprung mass on the lighter wheels, the suspension can follow the path more closely, which improves grip. This results in better handling.

1.1 Requirements

- Manufacturers of automobiles need from their wheel suppliers a high-quality product that not only satisfies all standards for safe operation but also has the strength to withstand severe abuse. The flexibility of style and cosmetic appeal of aluminium wheels, especially after extended use, are their most crucial qualities. Another significant aspect is the generally lower weight, which results in a lower rotary moment of inertia.
- Stiffness
- Static performance
- Fatigue behaviour
- Crash worthiness
- Thermal aspects

2.Modelling

The most common numerical approach is FEM. Linear, nonlinear, buckling, thermal, dynamic, and fatigue analysis applications. When utilizing any commercial software there are 3 steps -

1) Preprocessing- Consumes most the out of the three steps.

2) Processing (or solution) - just click on "Solve"& it's the software's turn to do the job

3) Post processing- Result viewing & interpretation

2.1 Types of analysis

1) Static analysis

2) Fatigue analysis

3) Optimization

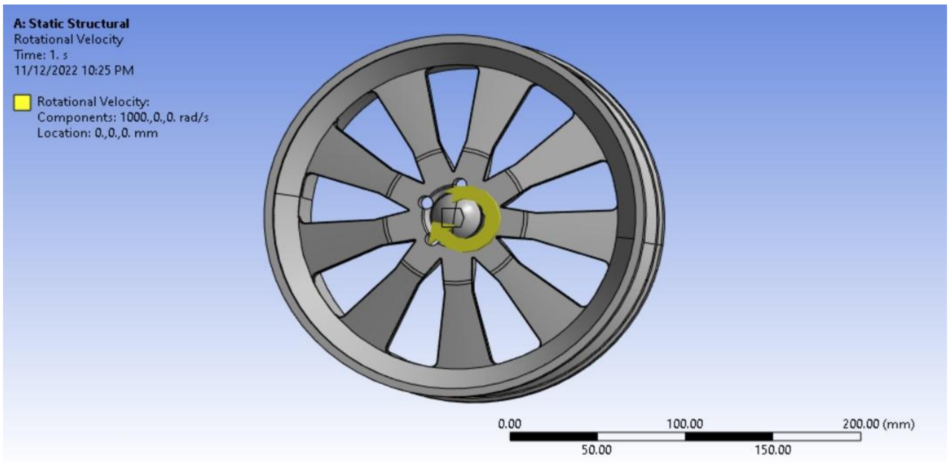

Figure 1 Boundary Condition

Table 1 Basic Geometry Option Condition

Basic Geometry Options	
Solid Bodies	Yes
Surface Bodies	Yes
Line Bodies	No
Parameters	Independent
Parameter Key	ANS;DS
Attributes	No
Named Selections	No
Material Properties	No
Advanced Geometry Options	
Use Associativity	Yes
Coordinate Systems	No
Reader Mode Saves Updated File	No
Use Instances	Yes
Smart CAD Update	Yes
Compare Parts On Update	No
Analysis Type	3-D
Mixed Import Resolution	None
Import Facet Quality	Source
Clean Bodies On Import	No
Stitch Surfaces On Import	Program Tolerance
Stitch Tolerance	0.0000001
Decompose Disjoint Geometry	Yes
Enclosure and Symmetry Processing	Yes

Object Name	*Geometry*
State	Fully Defined
Definition	
Source	C:\Users\admin\Desktop\prt0001.igs
Type	Iges
Length Unit	Millimeters
Element Control	Program Controlled
Display Style	Body Color
Bounding Box	
Length X	85.146 mm
Length Y	219.09 mm
Length Z	219.83 mm
Properties	
Volume	5.1028e+005 mm³
Mass	1.3844 kg
Scale Factor Value	1.
Statistics	
Bodies	1
Active Bodies	1
Nodes	35730
Elements	18846
Mesh Metric	None
Update Options	

2.2 Applying boundaryconditions

Object Name	*Global Coordinate System*
State	Fully Defined
Definition	
Type	Cartesian
Coordinate System ID	0.
Origin	
Origin X	0. mm
Origin Y	0. mm
Origin Z	0. mm
Directional Vectors	
X Axis Data	[1. 0. 0.]
Y Axis Data	[0. 1. 0.]
Z Axis Data	[0. 0. 1.]

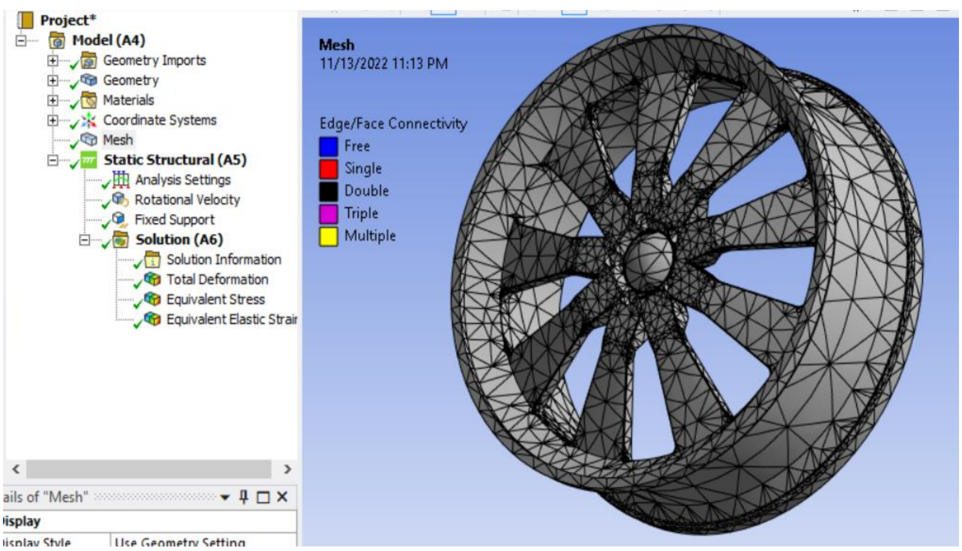

Figure 2 Meshing Condition

Table 2.boundary Condition and geometry details

Object Name	*Mesh*
State	Solved
Display	
Display Style	Use Geometry Setting
Defaults	
Physics Preference	Mechanical
Element Order	Program Controlled
Element Size	Default
Sizing	
Use Adaptive Sizing	Yes
Resolution	Default (2)
Mesh Defeaturing	Yes
Defeature Size	Default
Transition	Fast
Span Angle Center	Coarse
Initial Size Seed	Assembly
Bounding Box Diagonal	321.83 mm
Average Surface Area	572.13 mm²
Minimum Edge Length	0.20968 mm
Quality	
Check Mesh Quality	Yes, Errors
Error Limits	Aggressive Mechanical
Target Element Quality	Default (5.e-002)
Smoothing	Medium
Mesh Metric	None
Inflation	
Use Automatic Inflation	None
Inflation Option	Smooth Transition
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2
Inflation Algorithm	Pre
View Advanced Options	No
Advanced	
Number of CPUs for Parallel Part Meshing	Program Controlled
Straight Sided Elements	No
Rigid Body Behavior	Dimensionally Reduced
Triangle Surface Mesher	Program Controlled
Topology Checking	Yes
Pinch Tolerance	Please Define
Generate Pinch on Refresh	No
Statistics	
Nodes	35730
Elements	18846

3.Results

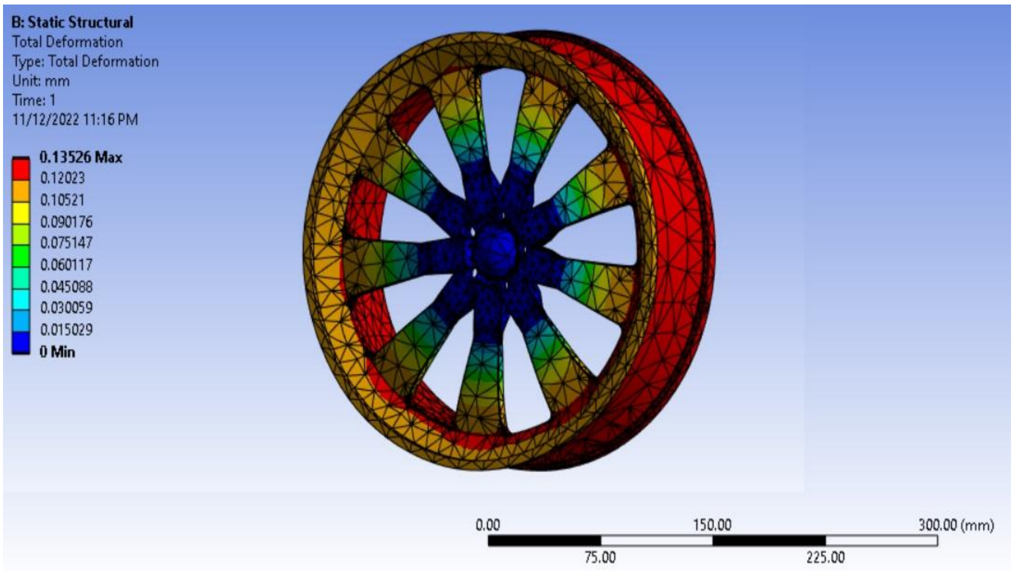

Figure 4 Deformation of Aluminium alloy

The Deformation shown in Aluminium alloy as maximum deformation & Minimum deformation 0.13526 mm & 0.015029 mm respectively. Zero value neglected here taking the next to zero value as mention above as minimum.

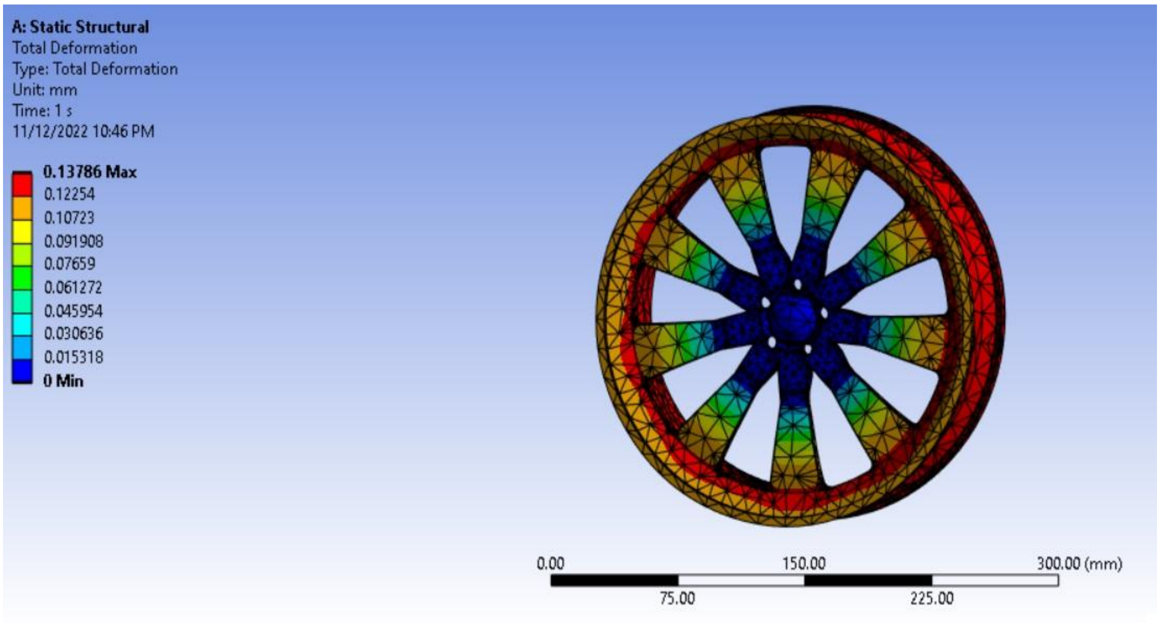

Figure 5 Deformation of Stainless Steel

Now stainless steel shown Deformation as maximum deformation & Minimum deformation 0.13786 mm & 0.015318 mm respectively. Zero value neglected

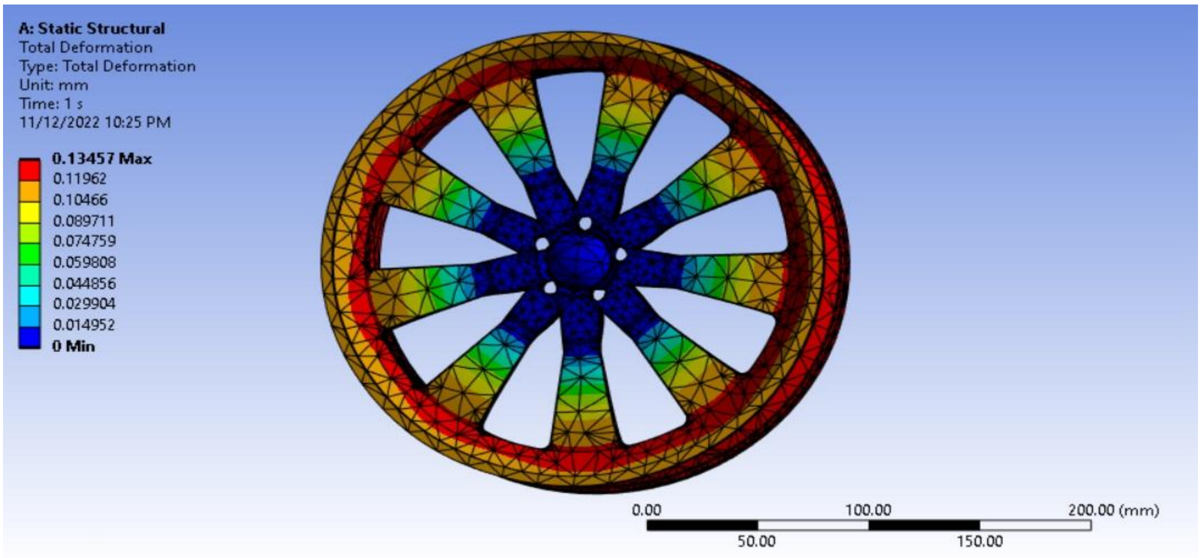

Figure 6 Deformation of Structural Steel

The total maximum and minimum deformation shown in Structural steel are 0.13457 mm & 0.014952 mm respectively. Zero value neglected

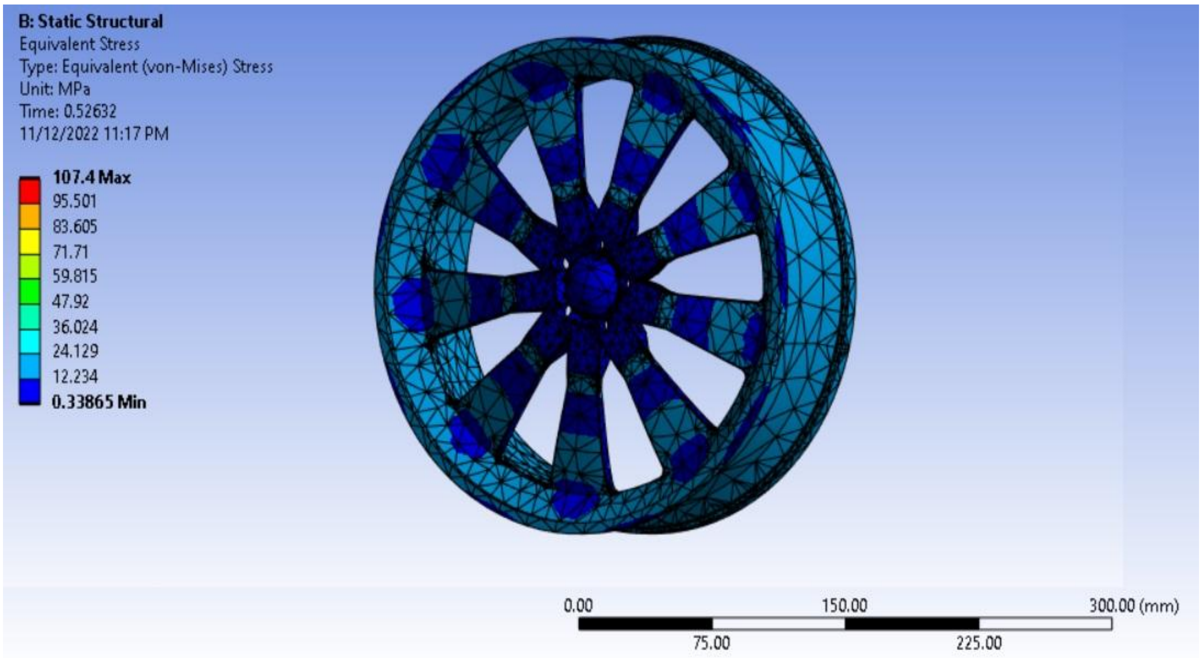

Figure 7 Stress of Aluminium alloy

The maximum and minimum stress value observed into the Aluminium alloy are 107.4 MPa & 0.33865 MPa respectively both the stress value are less than the other two materials

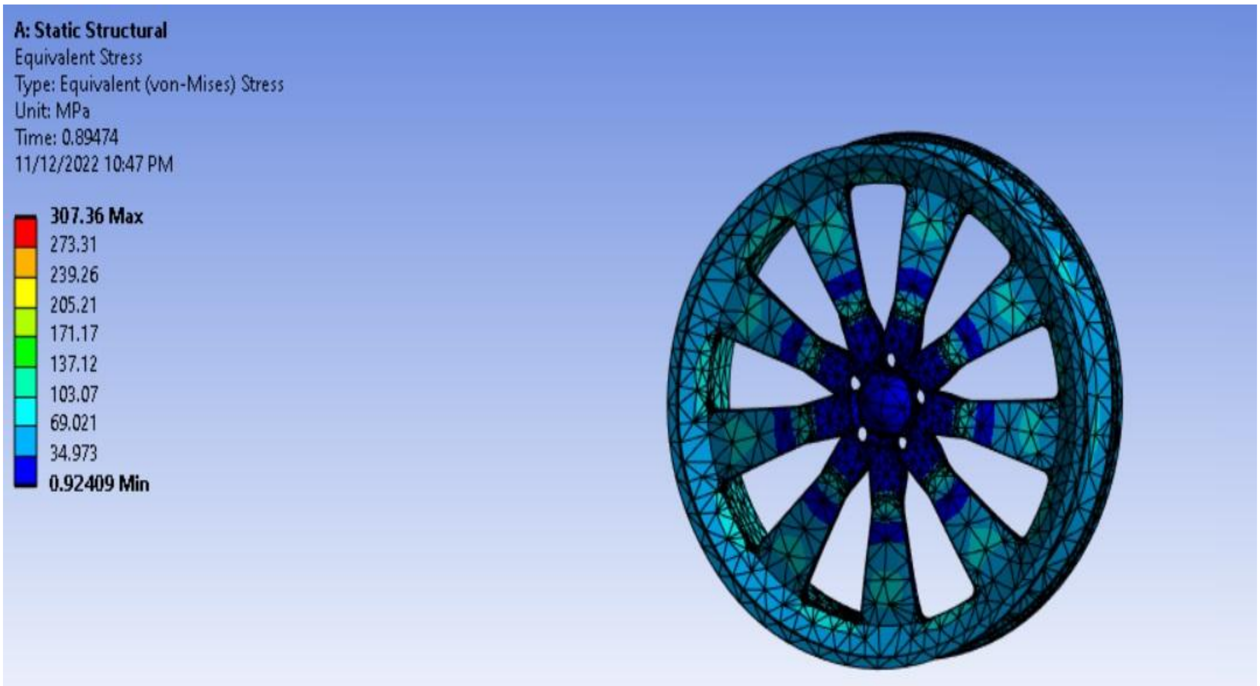

Figure 8 Stress of Stainless Steel

The stainless steel has stress values of 307.36 MPa and 0.92409 MPa. Respectively, although based on observation, the value of stainless steel has a stress that is three times lower than that of structural steel.

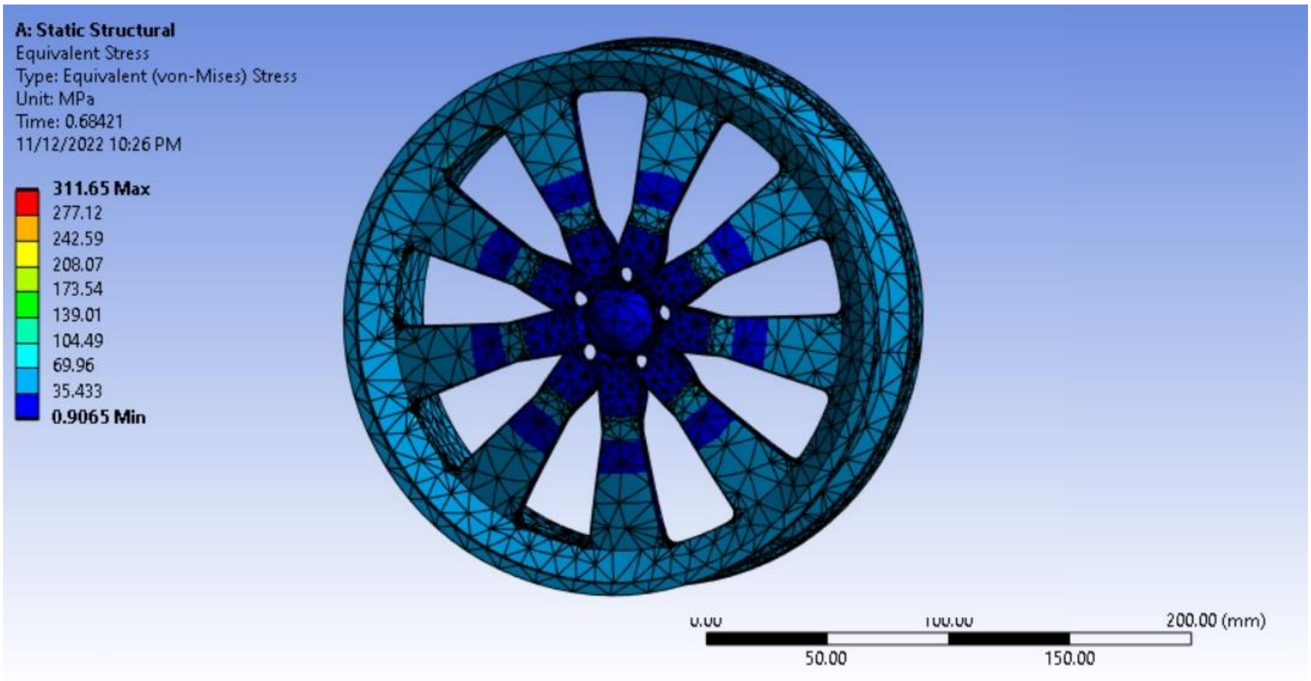

Figure 9 Stress of Structural Steel

The structural steel was subjected to stresses of 311.36 MPa and 0.9065 MPa. Respectively, but according to observation, the stress value of structure steel is less than that of stainless steel, and the stress value of aluminium alloy is more than three times that of structural steel.

4.Conclusion

The wheel rim's CAD model is created in CATIA and loaded into ANSYS for processing. The bolt circle of the wheel rims is fixed, and a force of 1000 m/s^2 is applied around the circumference of the wheel rims made of structural steel, stainless steel, and aluminium alloy. The conclusions drawn from the results are as follows.

1. AL6061 with Elliptical spoke shape have subjected to more total deformation compared to structural steel but lower than the stainless steel as the value 0.13526 mm, 0.13457 mm & 0.13786mm respectively. Due to the deformation in aluminium and structure steel near about same value so both suitable for use.

2. Aluminium Alloy have subjected less von-mises stress compared to Remaining materials like Structural steel & Stainless-steel value as 107.4 MPa , 311.65 MPa & 307.36 MPa respectively

3. Aluminium alloy has a more life compared to remaining materials.

4. Weight of Aluminium is 40 to 50% less weight compared to remaining materials

5. By comparing all result we are suggested that Aluminium with hexagon shape is better material compared to remaining material it is suitable material and this shape manufacturing of Alloy wheel.

6. The cast of the material also low as compare to the remaining other two materials.

References

Aditya Rio Prabowo. Forecasting technical performance and cost estimation of designed rim wheels based on variations of geometrical parameters Journal of the Mechanical Behavior of Materials 2022; 31: 200–211

Monika Namdev. A Study of Design and Analysis of Automobile Wheel Rim Using Different Fillet Radius and Different Y Spoke Angle International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 10 Issue V May 2022

Mr. R. Naveen Kumar Design and Analysis of Alloy Wheel Rim 020 IJRAR March 2020, Volume 7, Issue

G.Ashokkumar Design and Analysis of Wheel Rim by Using Catia &Ansys International Research Journal of Engineering and Technology (IRJET)

Ashish Design and analysis of wheel rim using composite materials and carbon fibres 22/06/2021

S.Arunkumar Design and Material Optimization of an Automobile Wheel Rim by Finite Element Analysis Journal of Xi'an University of Architecture & Technology

Mr. Chintapalli Shekhar Design and Structural Analysis of Car Alloy Wheel Using With Various Materials International Journal of Advance Scientific Research and Engineering Trends July 2020

Kalpesh R.Salunkhe Design, FEM Analysis and of Alloy Wheel Rim of a Four Wheeler International Advanced Research Journal in Science, Engineering and Technology Vol. 4, Issue 9, September 2017

Chaitanya Sureddi Design, Material Optimization and Dynamic Analysis on Automobile Wheel Rim International Journal of Scientific and Research Publications, Volume 8, Issue 11, November 2018

Aaron Ressa Development of a Carbon Fiber Wheel Rim 2013

Liangmo Wang Fatigue Life Analysis of Aluminum Wheels by Simulation of Rotary Fatigue Test Strojniški vestnik - Journal of Mechanical Engineering 57(2011)1, 31-39

Sai Yashwanth Kandukuri

K. Srinivasa Rao Design and Analysis of Alloy Wheels International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06 | June -2017

Dhiraj Bhargav Design and Analysis of Alloy Wheel For Multi-Purpose Vehicle Oct 2018

[Minaj Iqbal Atar. Design of Wheel Rim by Using Design of Experiments 2021 JETIR July 2021, Volume 8, Issue 7

S. Karuppusamy Design and Analysis of Automotive Wheel Rim by using ANSYS and MSC Fatigue Software Asian Journal of Research in Social Sciences and Humanities Vol. 6, No. 10, October 2016, pp. 196-212.

Sreenivasulu Modeling and Fatigue Analysis of Automotive Wheel Rim International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 1, January - 2014 IJERT ISSN: 2278-0181

Maharshi V. Patel Review Paper on Wheel Rim Volume 6 Issue No. 12 International Journal of Engineering Science and Computing, December 201