Design And Analysis Of Alloy Wheel Rim

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Abstract- *Wheel is an important structural member of the vehicular suspension system that supports the static and dynamic loads encountered during vehicle operation. Style, weight, manufacturability and performance are the four major technical issues related to the design of a new wheel andor its optimization. Higher cars typically come with alloy wheels rather than basic steel wheels.*

In this project, first, the motorcycle wheels were made of Titanium Alloy material, Aluminum alloy and Magnesium Alloys. Structural Analysis was performed on these three wheels to identify a better material for manufacturing of the motorcycle alloy wheel with enhanced load bearing capacity. 3D models of the wheels are modeled using Catia and structural Analysis analyses was carried out using ANSYS. The analysis is done with the maximum load focused on rim. Titanium Alloy based wheel rendered higher yield strength and lower strain under loading conditions, besides their inherent property of higher corrosion resistance under testing environments.

Keywords- Structural analysis, wheel rim, Catia v5,complex loading.

I. INTRODUCTION

The wheel is perhaps the most significant discovery of old times. The wheel has developed from nothing more than an oversized bearing to a fully integral part of any modem transportation vehicle. Wheel is an important structural member of the vehicular suspension system that supports the static and dynamic loads encountered during vehicle operation. A wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation while supporting a load (mass), or performing labour in machines. Common examples are found in transport applications. A wheel, together with an axle overcomes friction by facilitating motion by rolling. In order for wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity, or by application of another external force. More generally the term is also used for other circular objects that rotate or turn, such as a ship's wheel, steering wheel and flywheel. Safety and economy are particularly of major concerns when designing a mechanical structure so that the people could use them safely and economically. Style, weight, manufacturability and performance are the four major technical issues related to the design of a new wheel and/or its optimization. The wheels are made of steel, Magnesium alloy and cast/forge Aluminium alloys. Titanium is also being used in the recent alloy wheel models. Generally we have many wheel designs for the same model, how can we decide one is the better one than the other! So for deciding that we have taken a general case (loading conditions) applied on the particular three random designs.

II. PROJECT OVER VIEW

1. Less overall cost
2. They are safe, reliable, energy efficient, durable
3. High energy storage capacity
4. It is independent of working temperatures
5. High power output

ALUMINIUM7050 MATERIAL PROPERTIES

Aluminum alloy:contains 6% aluminium, 4% vanadium and 0.3% to 0.8% nickel and 0.04% to 0.08% palladium.

Aluminium 7050 alloy is a heat treatable alloy. It has high toughness, high strength. It has high stress corrosion cracking resistance. It has electric conductivity of value having 40 percent of copper. 7050 aluminium is known as a commercial aerospace alloy.

Material properties	Values
Young's Modulus E, GPa	121
Poisson' s Ratio,	0.33
Density , kg/m3	2810
Yield Strength, y MPa	455

TITANIUM MATERIAL PROPERTIES

Titanium alloy: contains 5% aluminium, 1% tin, 1% zirconium, 1% vanadium, and 0.8% molybdenum.

Titanium is a chemical element with the symbol Ti and atomic number 22. Found in nature only as an oxide, it can be reduced to produce a lustrous transition metal with a silvercolor, low density, and high strength, resistant to corrosion in sea water, aqua regia, and chlorine.

Material properties	Values
Young's Modulus E, GPa	105
Poisson' s Ratio,	0.287 to 0.391
Density , kg/m3	4510
Yield Strength, y MPa	280

MAGNESIUMMATERIALPROPERTIES

Magnesium alloy: contains 6% Cast alloys, 4% Magnesium casting and 0.04% to 0.08% palladium

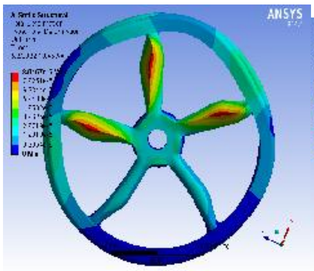
Magnesium alloys are light weight and have high machinability. They are often anodized to improve their corrosion resistance. They are designated using the ASTM and SAE system in which the first part indicates the two main alloying elements in the alloy and the second part represents their percentages.

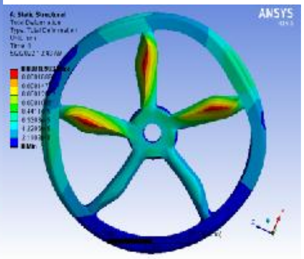
Material properties	Values
Young's Modulus E, GPa	45.5
Poisson' s Ratio,	0.287 to 0.295
Density , kg/m3	1740
Yield Strength, y MPa	200

Total deformation

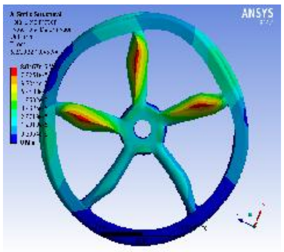
Total deformation is the deformation option that you can see all the deformation results related to your model, in three coordinates (X, Y, and Z).

1) ALUMINIUM ALLOY 2) MAGNESIUM ALLOY





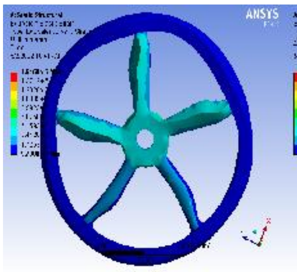
3) TITANIUM ALLOY

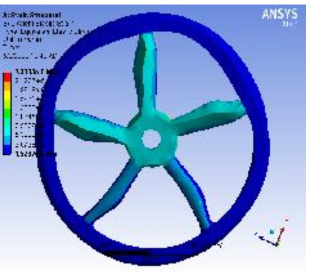


Equivalent Elastic Strain

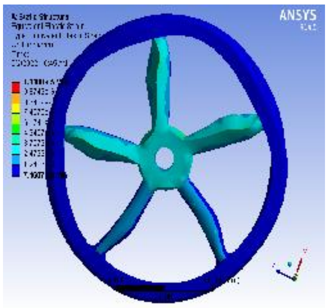
The equivalent elastic strain is defined as the limit for the values of strain up to which the object will rebound and come back to the original shape upon the removal of the load. ("Elastic limit is defined as the point on the stress-strain curve where the object changes its elastic behavior to plastic behavior").

1) ALUMINIUMALLOY 2) MAGNESIUM ALLOY





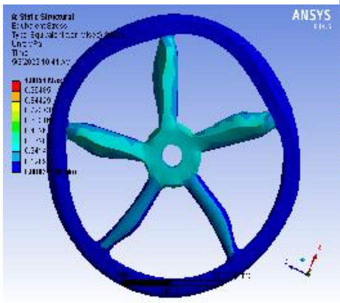
3) TITANIUM ALLOY

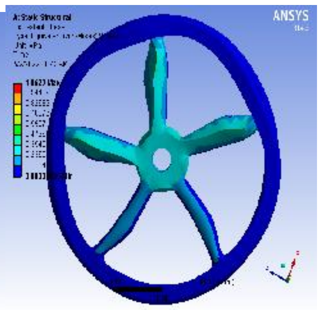


Maximum Principal Stress

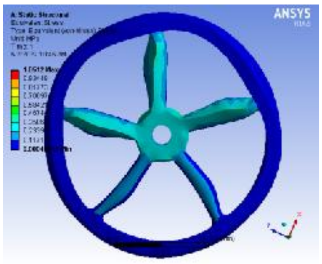
The Maximum Principal Stress results provided by ANSYS corresponds with the principal stress, σ1, you calculate when determining a stress transformation of a state of stress at a specific point.

1) **ALUMINIUMALLOY**
2) MAGNESIUM ALLOY





2) TITANIUM ALLOY



ALUMINUM ALLOY MATERIAL

Results			
Minimum	0. mm	9.7808e-009 mm/mm	3.4139e-004 MPa
Maximum	1.1992e-004 mm	1.5458e-005 mm/mm	1.0854 MPa

MAGNESIUM ALLOY MATERIAL

Results			
Minimum	0. mm	9.7808e-009 mm/mm	3.4139e-004 MPa
Maximum	1.1992e-004 mm	1.5458e-005 mm/mm	1.0854 MPa

TITANIUM ALLOY MATERIAL

Results			
Minimum	0. mm	7.1607e-009 mm/mm	4.0216e-004 MPa
Maximum	8.9157e-005 mm	1.1108e-005 mm/mm	1.0512 MPa

III. CONCLUSION

From the analysis we came to know that all the three designs are safe and are within the standard limits .Among the three designs, simple rim design is more promising than centrifugal rim, followed by pentagonal rim. Among the three materials, steel alloy is the best material followed by aluminium.Magnesium occupies last position as it has more deformation for the same loading conditions. .The results shows, why magnesium alloy material is used for pretty shorter period and restricted only to racing cars. Fatigue analysis prointed towards a better life for aluminium than that of steel alloy wheels. Even though the safety factor is almost equal for both the materials,aluminum is subjected to less damage compared to steel (for same loading conditions). From the above results, we define new material combination, in terms of Al-Mg alloy, which is more promising than other two i.e. these has got less deformations than aluminium and more load bearing when compared to magnesium based wheels. Under the influence of a radial load, the rim tends to vocalize about the point of contact with maximum displacement occurring at the location of the bead seat. 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. Actually failure of alloy wheel occurs mostly at the areas where there is max stress values occur (predicted by analysis software) More deformed areas are also in agreement with theoretical values.

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