Design and Comparative Analysis of Old & New Model Car Wheel Rims with Various Materials

L. Natrayan
PG Scholar
Department of Mechanical Engineering
Selvam College of Technology, Namakkal

P. Santhakumar
PG Scholar
Department of Mechanical Engineering
Selvam College of Technology, Namakkal

P. Dinesh Kumar
UG Scholar
Department of Mechanical Engineering
Selvam College of Technology, Namakkal

R. Mohan raj
Assistant Professor
Department of Mechanical Engineering
Selvam College of Technology, Namakkal

R. Mohandass
Assistant Professor
Department of Mechanical Engineering
Selvam College of Technology, Namakkal

Abstract

The car wheel is the most important thing for load carrying element material even vehicle static and running conditions. Also wheel is affected by steering control and suspension. So we should consider all load acting on the vehicle drives. In our project, design and comparative analysis of old & new model car Wheel Rims. Here our new model rim is BMW Rim, other one old model rim is normal rim like ix35 Hyundai car rim) for more effective analysis. This project is tested to the wheel according to the specification given by the industrial standards, threes kind of test is performed. Later this solid works model is imported to Ansys for analysis work. in the material using aluminium alloy and stainless steel their relative performances have been observed respectively. In addition to this rim is subjected to vibration analysis (modal analysis), a part of dynamic analysis is carried out its performance is observed

Keywords: Wheel Rim., Aluminium Alloy, Stainless steel, ANSYS, Solid Works, Stress, Strain, Total Deformation

I. INTRODUCTION

Its dimensions, shape should be suitable to effectively accommodate the particular tire required for the vehicle. In this study a two various car wheel rim belonging to the disc Wheel category is considered. Design in an important industrial activity which influences the quality of the product. In this Normal and BMW wheel rim is designed by using modeling software Solid works 2012. In modeling the time spent in producing the complex 3-D models and the risk involved in design and manufacturing process can be easily minimized. So the modeling of the wheel rim is made by using Solid works. Later this Solid works model is imported to ANSYS for analysis work. ANSYS software is the latest used for simulating the different forces, pressure acting on the component and also for calculating and viewing the results. A solver mode in ANSYS software calculates the stresses, deflections, bending moments and their relations without manual interventions, reduces the time compared with the method of mathematical calculations by a human. ANSYS static analysis work is carried out by considered two different Design Rim namely Normal Car Rim and BMW car Rim, In the material using Aluminium Alloy and their relative performances have been observed respectively. In addition to this rim is subjected to vibration analysis (modal analysis), a part of dynamic analysis is carried out its performance is observed

II. DESIGN/MATERIAL SELECTION CONSIDERATIONS

A. Stiffness:

Structural stiffness (design dependent) is the basic value to consider when designing an Aluminium wheel to achieve at least the same vehicle behavior as with an equivalent steel wheel. However, material stiffness (Young's modulus) is very little depending on alloy and temper.

All rights reserved by *www.journalforresearch.org*

B. Static Behavior:

Yield strength is considered to avoid deformation under maximal axial efforts (accelerations and braking) and radial ones (plus turning). Misuse cases are considered in relation to tensile strength. Yield tests under pressure are also conducted to check this behavior.

C. Fatigue Behavior:

This is the most important parameter for dimensioning. Finite element software is systematically used during design. Service stresses are considered, including multi-axial stresses as of recently. Rotary bending and rim rolling tests are used to verify these calculations.

D. Crash Worthiness:

Mainly, but not only, linked to stress/strain curves in large displacements. Crashworthiness is beginning to be now simulated. However impact tests systematically check the resistance to accidental collisions such as pavements impacts.

E. Cooling:

Whatever the type of wheel (cast, Stainless, strip, mixed wrought-cast,…), Aluminium dissipates heat more quickly than steel. Further, Aluminium wheels act as a very efficient heat sink. This results in significant improvements of braking efficiency, and a reduced risk of tyer overheating.

F. Style Weight Saving:

Reduction of weight of the unstrung mass of vehicles is a key priority. A compromise has to be accepted if styling requirements dictate different production technologies (s. figure).

G. Dimensional:

A perfect mass balance is a key parameter to avoid significant vibrations. As a result, cast and Stainless wheels are machined. Lightness also reduces vibrations of Aluminium sheet wheels

H. Corrosion:

Cast and Stainless wheels are painted or lacquered after chemical conversion. Strip wheels are polished and varnished or also painted. Even at the uncoated iron/Aluminium disk, or hub interface, no significant corrosion has ever been noticed for any

I. Material of Wheel/Rim (Material):

1) Steel wheel rim: It is a standard type of a rim. Due to its properties, steel is one of the most important engineering and construction material. Steel features great formability, impermeability and durability. Its notch-toughness makes it possible to resist cracks that may lead to sudden collapse of a product structure. Steel is a cost-effective material as it is less exotic material and its manufacturing process is not so complicated. This type of wheels are usually easy to repair. Compared to other materials, one of the main disadvantages of steel is its heavy weight.
2) Alloy Wheel Rim: This automobile part is manufactured from an alloy of magnesium or Aluminium. One of the main benefits is the lightweight that results in better handling and reduction of unstrung weight. When installed on a vehicle, alloy wheels reduce the overall weight that in its turn lead to fuel saving. Compared to steel wheels, alloy rims provide better heat conduction. This improves braking performance as the heat is dissipated from the vehicle's brakes. It also reduces a possibility of overheating. The disadvantage of the alloy rims includes inability to withstand corrosion. It is necessary to apply a paint layer or other coatings to prevent rust. Higher price is another disadvantage of this material. Alloy wheels are also difficult to repair. Unlike steel wheels that are mostly popular among devotees of vintage appearance, alloy rims are commonly used as they are available in dozens of styles and may add stylish accent to vehicle exterior.

III. DESIGN TOOL

A. The Design Process:

The engineering design process is the steps of chassis design construction process. In this chapter explain how Rim was designed and how analysis of the Rim was performed. In this part, explained how Rim is performed. Before the last Rim design got, there are several steps must be considered to make the last result bring the best design. In this part, start from the sketching process, the use SOLIDWORKS 2012 is used in order to create the model of the Rim. The analysis stage used ANSYS WORKBENCH 12.0 to analyze the model of Rim.

B. Modeling Methodology:

Solid Works is a Para solid-based solid modeler, and utilizes a parametric feature-based approach to create models and assemblies. Parameters refer to constraints whose values determine the shape or geometry of the model or assembly. Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel,

All rights reserved by *www.journalforresearch.org*

concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent.

Design intent is how the creator of the part wants it to respond to changes and updates. For example, you would want the hole at the top of a beverage can to stay at the top surface, regardless of the height or size of the can. Solid Works allows the user to specify that the hole is a feature on the top surface, and will then honor their design intent no matter what height they later assign to the can Finally, drawings can be created either from parts or assemblies. Views are automatically generated from the solid model, and notes, dimensions and tolerances can then be easily added to the drawing as needed.

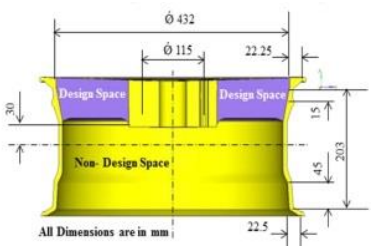


Fig. 3.1: Dimension Of The Model Rim

C. 3D Model Rim

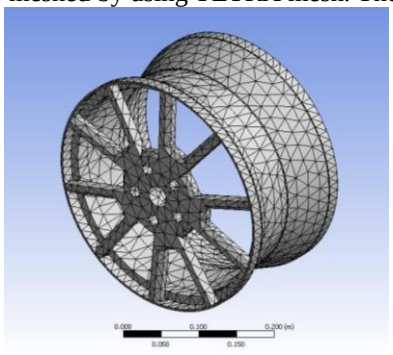

3.2: Normal Rim

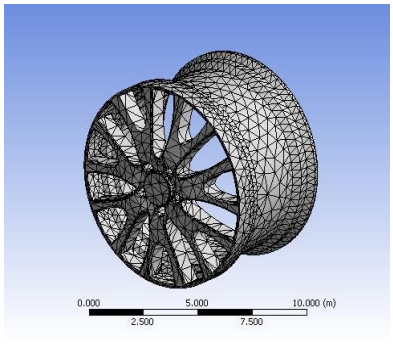

3.3: Model Rim

Parameters can be either numeric parameters, such as line lengths or circle diameters, or geometric parameters, such as tangent, parallel, concentric, horizontal or vertical, etc. Numeric parameters can be associated with each other through the use of relations, which allow them to capture design intent

IV. RESULT ANALYSIS

1) After preparing the model in Solid works it is improved to ANSYS. The file is imported from Solid works by file>import>IGES
2) The imported model is meshed by using TETRA mesh. The meshed model is as follows:


4.1: Mesh View of Normal Rim



4.2: Mesh View of BMW Rim

3) Later this meshed model is defined with two different materials namely ALUMINIUM and STAINLESS STEEL and subjected to static analysis.

A. Preprocessor Stage:

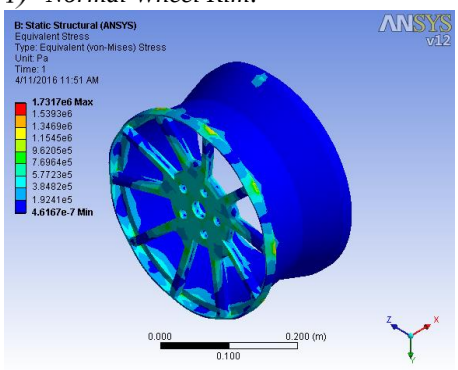
Input data for ALUMINIUM			*Input data for STAINLESS STEEL*	
Young's modulus	*0.71e5N/mm²*		*Young's modulus*	*2.1e5N/mm²*

All rights reserved by *www.journalforresearch.org*

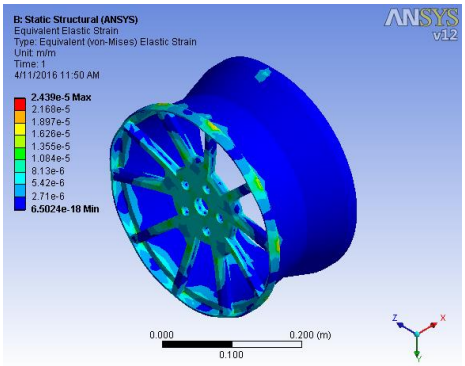
Poisson's ratio	*0.33*		*Poisson's ratio*	*0.3*
Density	*2800kg/m³*		*Density*	*7600kg/m³*
Circumferential pressure	*200 Kpa*		*Circumferential pressure*	*200 Kpa*

B. Results for Aluminium Material Properties Wheel Rims:

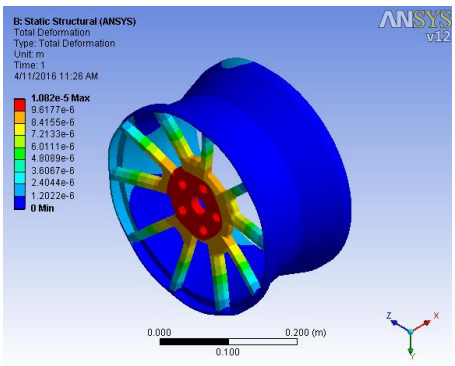
1) Normal Wheel Rim:



4.3: Equivalent stress

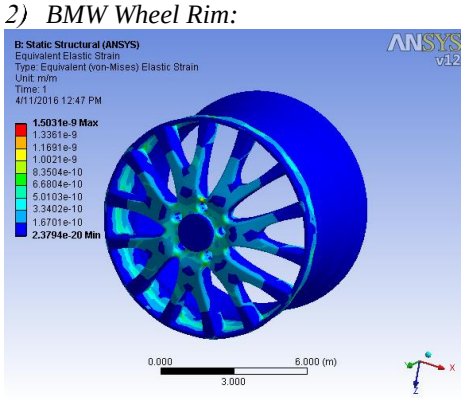


4.4: Equivalent strain

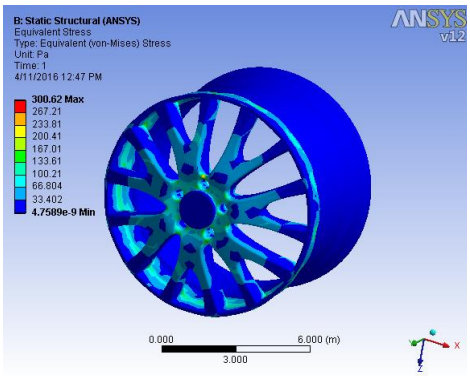


4.5: Total Deformation

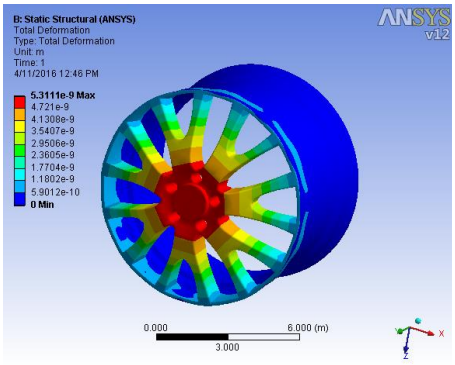
2) BMW Wheel Rim:



4.6: Equivalent stress



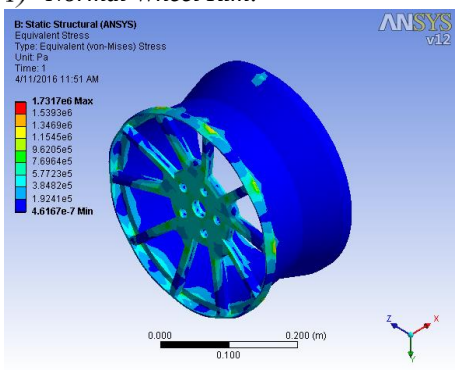
4.7: Equivalent strain



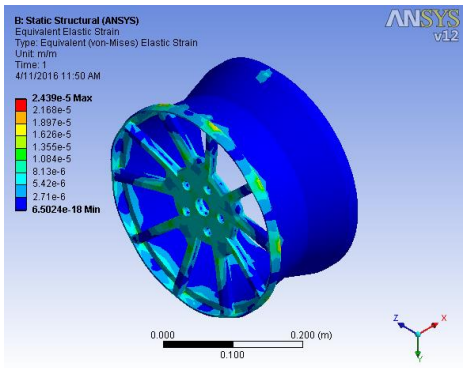
4.8: Total Deformation

C. Results for Stainless Steel Material Properties Wheel Rim:

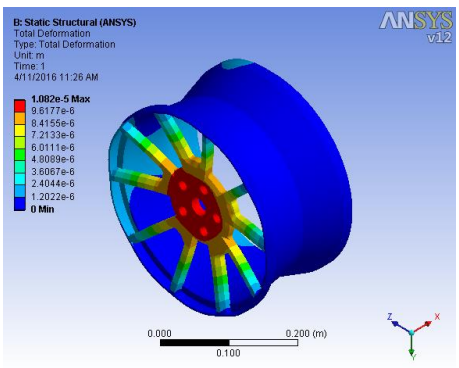
1) Normal Wheel Rim:



4.9: Equivalent stress



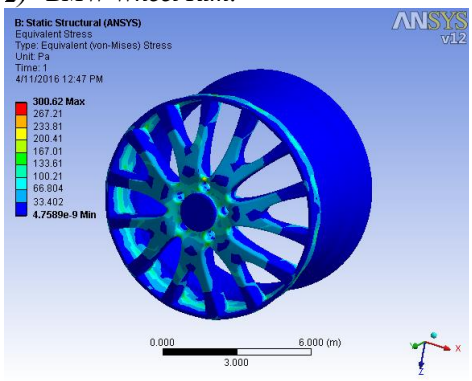
4.10: Equivalent strain



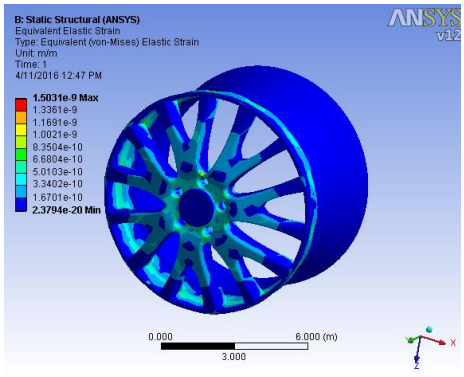
4.11: Total Deformation

All rights reserved by *www.journalforresearch.org*

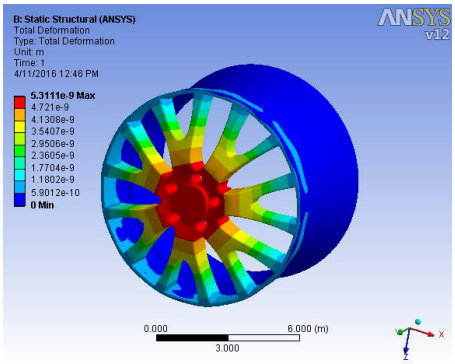
2) BMW Wheel Rim:



4.12: Equivalent stress



4.13: Equivalent strain



4.14: Total Deformation

D. Stress Results Comparison:

Rim Material	*Types of Rim*	*Max/Min*	*Equivalent stress*	*Equivalent strain*	*Total Deformation*
Aluminium Alloy	*Normal Rim*	*Minimum*	$4.6167\ e^{-7}$	$6.5024\ e^{-18}$	*0*
		Maximum	$1.7317\ e^{6}$	$2.439\ e^{-5}$	$1.082\ e^{-5}$
	BMW Rim	*Minimum*	$4.7589\ e^{-9}$	$2.3794\ e^{-20}$	*0*
		Maximum	*300.621*	$1.5031\ e^{-9}$	$5.311\ e^{-9}$
Stainless Steel	*Normal Rim*	*Minimum*	$1.7201\ e^{-6}$	$8.6048\ e^{-18}$	*0*
		Maximum	$1.7581\ e^{6}$	$8.7906\ e^{-6}$	$3.795\ e^{-6}$
	BMW Rim	*Minimum*	$6.1792\ e^{-9}$	$3.0896\ e^{-20}$	*0*
		Maximum	*392.7*	$1.9365\ e^{-9}$	$6.9339\ e^{-9}$

V. CONCLUSION AND FUTURE WORK

CAD model of the wheel rim is generated in CATIA and this model is imported to ANSYS for processing work. An amount of pressure 200 kpa is applied along the circumference of the wheel rims made of both Aluminium & Stainless Steel and bolt circle of wheel rim is fixed. Old & New Model Car Wheel Rims With Various Materials Following are the conclusions from the results obtained:

- Aluminium wheel rim is subjected to more stress compared to Stainless Steel.
- In both cases von-mises stresses are less than ultimate strength.
- Deflections in aluminium are more when compared to Stainless steel.

Since in both the cases von-mises stresses is less than the ultimate strength, talking deflections into account, Stainless steel is preferred as best material for designed wheel rim.

E. Scope for Future Work:

In the above proposed work only pressure acting circumferentially on the wheel rim is only considered, this can be extended to other forces that act on the wheel rim and structural analysis is carried out, this can be extended to transient analysis.

REFERENCES

[1] Fatigue Analysis of Aluminium Alloy Wheel Under Radial Load, International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-2, Issue-1, 2012.
[2] An analysis of stress and displacement distribution in a rotating rim subjected to pressure and radial loads" by P.C.Lam and Srivastam
[3] Stress Analysis of Wheel Rim International Journal of Mechanical Engineering and Research Volume 1 Issue 1 (Page, 34-37), ISSN: 2277-8128.
[4] Application of PEEK Material in Alloy Wheel and its Static Analysis, by Rohit Rajvaidya1, Amit Kushwaha2, Shyam Barode3, Shubham Sharma4, International Research Journal of Engineering & Applied Sciences www.irjeas.com, Volume 1, Issue 1, Jan 2013 – Mar 2013, ISSN: Applied for Page 21-28.
[5] Mechanical Testing methods concerning THE STRESS ANALYSIS FOR A VEHICLE WHEEL RIM, by Alexandru Valentin RADULESCU, Sorin CANANAU, Irina RADULESCU, Mechanical Testing and Diagnosis ISSN 2247 – 9635, 2012 (II), Volume 2, 33-39.
[6] Design and Analysis of Wheel Rim using CATIA & ANSYS, by P. Meghashyam, S. Girivardhan Naidu and N. Sayed Baba, IJAIEM Volume 2, Issue 8, August 2013 ISSN 2319 – 4847
[7] Hiroyuki Watanabe1, Koji Moriwaki, Toshiji Mukai1, Tetsu Ohsuna3, Kenji Hiraga3 and Kenji Higashi2 Materials Processing for Structural Stability in a ZK60 Magnesium Alloy, Materials Transactions, Vol. 44, No. 4 (2003) pp. 775 to 781 #2003 The Japan Institute of Metals express regular article.
[8] Fatigue Life Analysis of Aluminum Wheels by Simulation of Rotary Fatigue Test Liangmo Wang* - Yufa Chen - Chenzhi Wang - Qingzheng Wang School of Mechanical Engineering, Nanjing University of Science & Technology, China
[9] Fatigue properties of a cast aluminium alloy for rims of car wheels. C.Bosi,G.L.Garagnani .
[10] Design Optimization of Formula One Student Sports Car Upright Using Hyper mesh, International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Vol-2, Issue-1, 2012

All rights reserved by *www.journalforresearch.org*