

A Review on Modeling and Analysis of Car Wheel Rim using AUTOCAD & ANSYS

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Abstract- The essence of car wheel rim provides a firm base on which to fit the tire. Its dimensions, shape should be suitable to adequately accommodate the particular tire required for the vehicle. In this paper a tire of car wheel rim belonging to the disc wheel category is considered. Design is an important industrial activity which influences the quality of the product. The wheel rim is modeled by using AutoCAD software. Later this AutoCAD model is imported to ANSYS for analysis work. ANSYS is the latest software used for simulating the different forces, pressure acting on the component and also calculating and viewing the results. By using ANSYS software reduces the time compared with the method of mathematical calculations by a human. ANSYS static analysis work is carried out by considered two different materials namely aluminium alloy and Magnesium alloy and their relative performances have been observed respectively. In addition to wheel rim is subjected to model analysis, a part of dynamic analysis is carried out its performance is observed. In This paper by observing the results of static analysis obtained Magnesium steel is suggested as best material.

Keywords:- ANSYS, AutoCAD, Stress Analysis, Wheel Rim

I. INTRODUCTION

The most significant discovery in old edge claimed as wheel. Safety is a crucial parameter in the vehicle design. So the vehicle is design according to the very stricked rules for the passenger safety. The range starts from steel to non ferrous alloys like aluminium and magnesium is considered as most sophisticated materials to produce wheel. In ancient age wood and steel with spoke design have evolved. But today's modern vehicles use casted metals and forged aluminium rings [p.c.lam et.al]. Experimental stress measurement techniques have been initiated in the late seventies.

In recent years, the procedures have been improved by a variety of experimental and analytical methods for structural analysis (finite element method).

Fatigue life prediction with durability analysis and various reliability methods are used to predict the inherent variation in the engineering structure is also applied for the wheel design. [2] Breaking performance shows effect on the wheel rim parameters: size, weight, design and materials. The wheel rim size governs how much space there is between the rim and brake rotor. If the diameter of the wheel rim is higher there will be a more scope for air flow around the brakes and therefore effective cooling is achieved. The weight of the wheel rim is also an important

parameter. Light weight vehicles are easy to handle.

For the effective breaking system the rotational inertia is also an important factor which goes up with the more weight. Another factor in handling has to do with wheel strength and flex. A more rigid wheel will reduce wheel flex. This is essentially important with low aspect ratio, high performance tires that can be generate high cornering forces. Car wheels are classified in to two main groups, steel wheels and alloy wheels. Alloy wheels are frequently fitted typical during the manufacturing of modern vehicles. All steel wheels to be made up of two pressed components, the rim and the wheel disc, which are welded together.

II. THEORY OF WHEELS

The tire works as a wheel only after it is set up on the rim and is inflated therefore: the tire and wheels assembly affects the function and performance of the vehicle. The tire is designed and manufactured to suit a usual rim and once installed on correct rim the tire will perform up to the preferred level. [1]

A. Rim Nomenclature

1. Wheel: Wheel is generally constituted of rim and disc.
2. Rim: This is a part where the tire is installed.
3. Disc: This is a part of the rim where it is fixed to the axle hub.
4. Offset: This is a space between wheel mounting surface where it is bolted to hub and centre of the line.

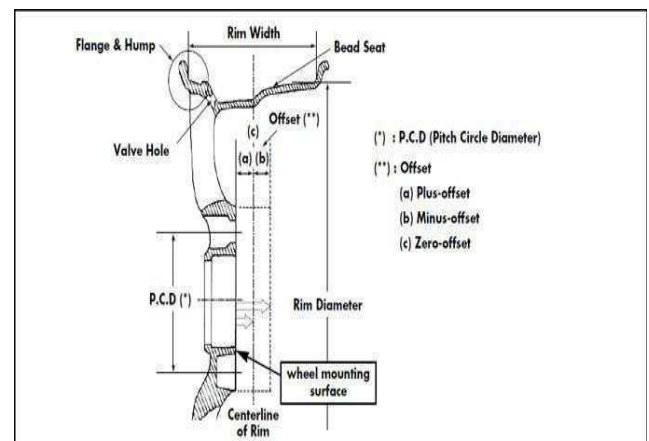


Figure 1. Rim Nomenclature

5. Flange: The flange is a part of rim which holds the both beds of the tire.
6. Bead Seat: Bead seat approaches in contact with the bead face and it is a part of rim which holds the tire in a radial direction.
7. Hump: It is a bump what was put on the bed seat for the bead to prevent the tire from sliding off the rim while the vehicle is moving.
8. Well: This is a part of rim with depth and width to facilitate tire mounting and removal from the rim.

B. Type of Wheel Rim: (Dimensional)

- *Shape of Rim*

Typical rim shape vehicles are made up of the following.

- *Drop Centre Rim*

Drop centre (DC) rim is shaped so there is fine between the bead seat parts which are placed on the both sides of the rim. This makes mounting and demounting of the rim easy.

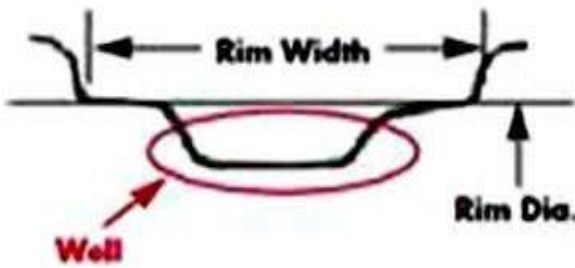


Figure 2. Drop Centre Rim

- *Wide Drop Centre Rim (WDC)*

Wide drop centre rim is mostly the same DC rim. To extend the width of the rim, with a slighter well and a lower flange height, this rim is mostly applied to low aspect ratio tires. This design is presently applied to rims for tires of most passenger vehicles.

- *Wide Drop Centre Rim with Hump*

In addition, this design has a bump, on the beginning of the bead seat area. This bump is to prevent the bead sliding down and air outflow from the rim due to the horizontal force applied to the tire when a vehicle tubeless tires runs at high speed.

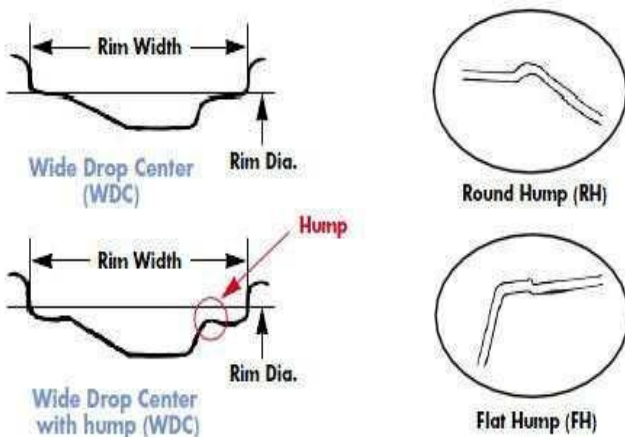


Figure 3. WDC and WDC with Hump

C. Types of Wheel Rim (Material)

Steel and light alloy are the foremost materials used in a wheel rim however some composite materials together with glass-fiber are being used for special wheels [2].

- *Wire Spoke Wheel*

Wire spoke wheel is an essential where the exterior edge part of the wheel rim and the axle mounting part are linked by numerous wires called spokes. Today's automobiles with their high horse power have made this type of wheel Manufacture obsolete. This type of wheel is still used on classic vehicles.

- *Steel Disc Wheel*

This is a rim which practices the steel made rim and the wheel into one by joining (welding), and it is used mainly for passenger vehicles especially original equipment tires.

- *Light Alloy Wheel*

These wheels are based on the use of light metals, such as aluminium and magnesium has come to be popular in the market. This wheel rapidly become standard for original equipment vehicle in Europe in 1960's and for the replacement tire in United States in 1970's. The advantages of each light alloy wheel are explained as below.

- *Aluminium Alloy Wheel*

Aluminium is a metal with features of excellent lightness, thermal conductivity, physical characteristics of casting, low heat, machine processing and reutilizing, etc. This metal main advantage is decreased weight, high precision and design choices of the wheel.

- *Magnesium Alloy Wheel*

Magnesium is about 30% lighter than aluminium and also admirable as for size stability and impact resistance. However its use is mainly restricted to racing, which needs the features of weightlessness and high strength. It is expansive when compared with aluminium

- *Titanium Alloy Wheel*

Titanium is an admirable metal for corrosion resistance and strength about 2.5 times compared with aluminium, but it is inferior due to machine processing, designing and more cost. It is still in developed stage.

- *Composite Material Wheel*

The composite material wheel is different from the light alloy wheel, and it is developed mainly for low weight. However this wheel has inadequate consistency against heat and for best strength.

III. MODELING OF WHEEL RIM

AutoCAD is used for creation and modification of the objects. Design means the process of creating a new object or modifying the existing object. Drafting means the representation or idea of the object. Modeling means create and converting 2D to 3D. By using AutoCAD software create the model of wheel rim [3].

A. Specifications of Model Wheel Rim

Outer diameter = 330mm
Rim width=120 mm

Bolt hole diameter=15 mm
Edge fillet radius = 5 mm

Steps Involved In Design

1. Draw the profile diagram of the wheel rim in the front view as follows.
2. Now revolve the profile body with respect to z-axis by using revolve command. Then we obtain the wheel rim body.
3. By selecting the face of the wheel (top view), the required is drawn on the surface and remove by using subtract operation.
4. By using the circular pattern the specific design is obtained all over the rim.
5. Form holes using subtract operation.
6. Finally using the EDGE FILLET option the side edges are made filleted for final finishing.

Final View of the Wheel rim

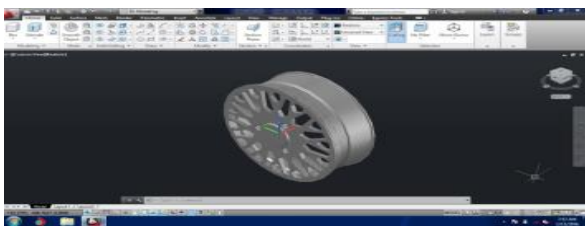


Figure 4.Final View of the Rim

IV. RESULT ANALYSIS

1. After preparing the model in AUTOCAD, it is imported to ANSYS Work Bench.
2. The imported Model is meshed by using the mesh option. The meshed model is as follows

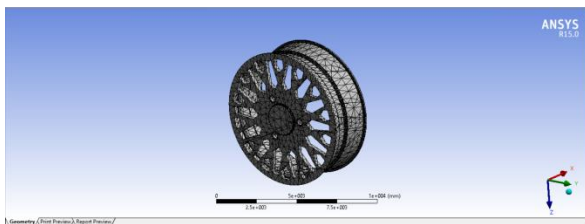


Figure 5 .Meshed Model

3. Later this meshed model is subjected with two different materials namely ALUMINIUM ALLOY and MAGNESIUM ALLOY and subjected to static analysis.

Properties Of Materials:

Input data for ALUMINIUM ALLOY:
Young's modulus= 0.71e5 N/mm²
Poisson's ratio = 0.33

Density = 2800 kg/m³
Circumferential pressure = 21.3kpa

Input data for MAGNESIUM ALLOY:

Young's modulus = 0.45e5 N/mm²

Poisson's ratio = 0.35

Density = 1.8 g/cm³

Circumferential pressure = 21.3kpa

1. After this meshed model is constrained all DOF where the bolts has to be placed.
2. Now the model is subjected to circumferential load of 23.1kpa.
3. Apply the angular velocity 62.8 rps in rotational direction of wheel rim.
4. Select the solve option to apply the loads on the wheel rim.
5. Later do the static analysis to the model.
6. Next solution results the displacement, von mises strain, stress intensity.

Results for Magnesium Alloy Wheel Rim

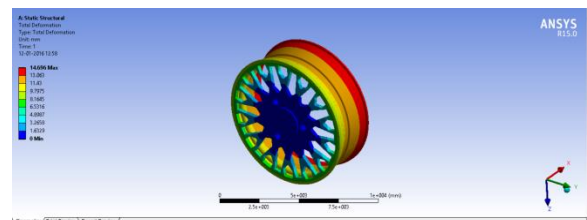


Figure 6.Displacement results

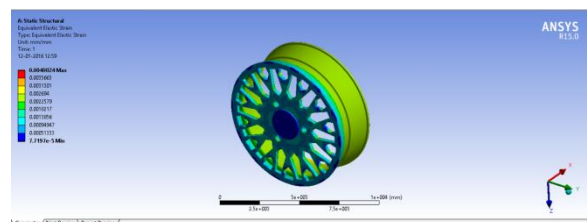


Figure 7.Elastic Strain

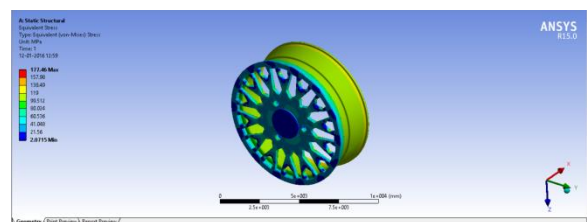


Figure 8.Von-Mises stress

Results for Aluminium Alloy Wheel Rim

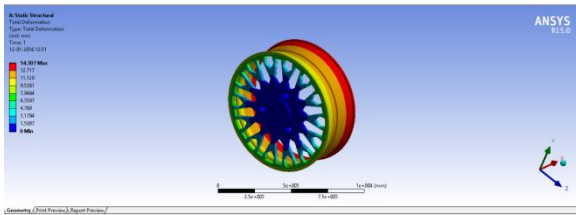


Figure 9. Displacement results

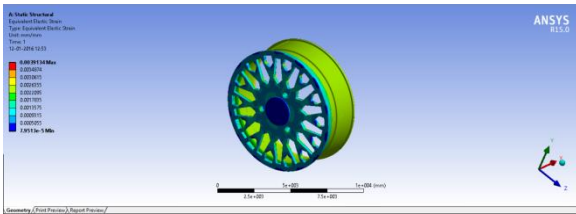


Figure 10. Elastic Strain

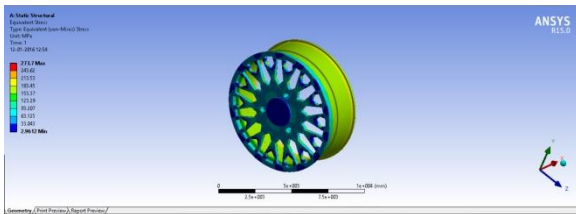


Figure 11 Von-Mises stress

Stresses Results

Type Of Result	For Aluminium Alloy	For Magnesium Alloy
Static Displacement	14.307	14.696
Von-Mises Stress	273.7	177.46
Elastic Strain	0.0039134	0.0040024

Table 1. Results Comparison

V. CONCLUSION

CAD model of the wheel rim is generated in AutoCAD and this is imported to ANSYS for processing work. An amount of 21.3kpa is applied along the circumference of the wheel rims made of both Aluminium Alloy & MAGNESIUM ALLOY and bolt circle of wheel rim is fixed. Following are the conclusions from the results obtained:

1. Magnesium alloy wheel rim is subjected to more displacement compared to Aluminium alloy wheel.
2. In both cases von-mises stresses are less than stress intensity.
3. Aluminum alloy wheel rim subjected to more stresses compared to Magnesium alloy wheel.

Since in both the cases von-mises stresses less than the ultimate strength i.e. stresses intensity, hence deflections taking into account, Magnesium alloy is preferred as best material for designing of wheel rim

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