ISSN (e): 2250 – 3005 || Volume, 06 || Issue, 6|| June – 2016 ||
International Journal of Computational Engineering Research (IJCER)

3D Modeling and Analysis of an Alloy Wheel Rim of Car by using Solid Works& ANSYS: A Review

R K Sahu[1],BinayakMishra[2] ,Manoj Kumar Behera[3]
,
[1,3]*Assistant Professor, Department of Mechanical Engineering, Gandhi Institute For Technology (GIFT), Bhubaneswar*
[2]*Assistant Professor, Department of Mechanical Engineering, Gandhi Engineering College, Bhubaneswar*

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 SOLID WORKS software. Later this SOLID WORKS 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 bestmaterial.*

Keywords:- *ANSYS, Solid Works, Stress Analysis, Wheel Rim*

I. INTRODUCTION

The most significant discovery in old edgeclaimed aswheel.Safetyisacrucialparameterinthevehicledesign. 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. Inancient age wood and steel with spoke design have evolved. But today's modern vehicles use casted metals and forged Aluminiumrings . 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 OFWHEELS

The tire works as a wheel only after it is set up on the rim and is inflated therefore: the tire and wheels assembly affectsthefunctionandperformanceofthevehicle.Thetire is designed and manufactured to suit a usual rim and once installed on correct rim the tire will perform up to the preferred level.

A. RimNomenclature

1. Wheel:Wheelisgenerallyconstitutedofrimanddisc.
2. Rim: This is a part where the tire isinstalled.

3. Disc: This is a part of the rim where it is fixed to the axlehub.
4. Offset: This is a space between wheel mounting surfacewhereitisboltedtohubandcentreoftheline.

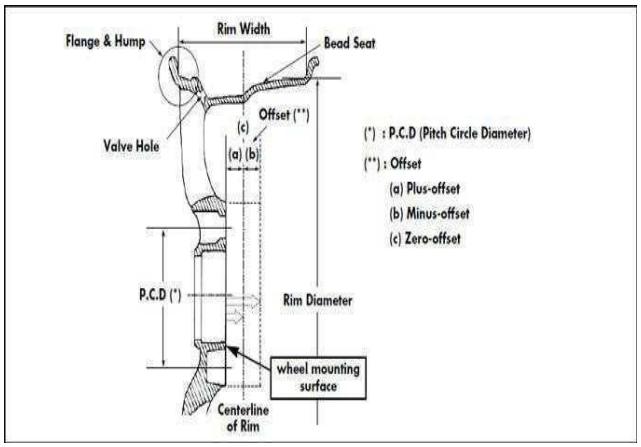

Figure 1.Rim Nomenclature

1. Flange: The flange is a part of rim which holds the both beds of thetire.
2. Bead Seat: Bead seat approaches in contact with the bead face and it is a part of rim which holds the tire in a radialdirection.
3. 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 ismoving.
4. Well: This is a part of rim with depth and width to facilitate tire mounting and removal from therim.

B. Type of Wheel Rim:(Dimensional)

- *Shape ofRim*

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.

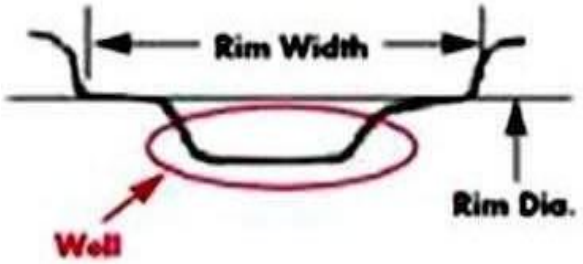

Figure 2. Drop Centre Rim

- *Wide Drop Centre Rim (WDC)*

WidedropcentrerimismostlythesameDCrim.Toextend 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 passengervehicles.

- *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 forceappliedtothetirewhenavehicletubelesstiresrunsat highspeed.

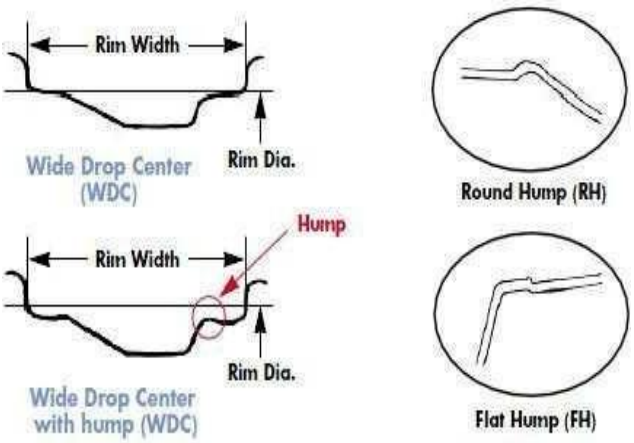

Figure 3.WDC and WDC with Hump

C. Types of Wheel Rim(Material)

Steel and light alloy are the foremost materials used in a wheel rim however some composite materials togetherwith 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 DiscWheel*

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 AlloyWheel*

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 AlloyWheel*

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 AlloyWheel*

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 AlloyWheel*

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

- *Composite MaterialWheel*

The composite material wheel is different from the light alloy wheel, and it is developed mainly for low weight. Howeverthiswheelhasinadequateconsistencyagainstheat and for beststrength.

III. MODELING OF WHEELRIM

SOLID WORKS 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 SOLID WORKS 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 InDesign*

1. Draw the profile diagram of the wheel rim in the front view asfollows.
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 substractoperation.
4. By using the circular pattern the specific design is obtained all over therim.
5. Form holes using substractoperation.
6. Finally using the EDGE FILLET option the side edges are made filleted for finalfinishing.

- *Final View of the Wheelrim*

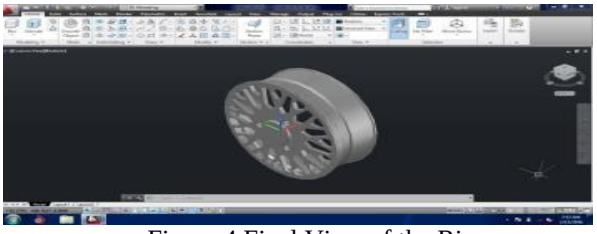

Figure 4.Final View of the Rim

IV. RESULTANALYSIS

1. After preparing the model in SOLIDWORKS, it is imported to ANSYS WorkBench.

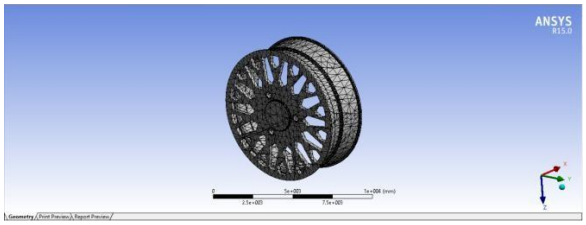

Figure 5 . Meshed Model

2. The imported Model is meshed by using the mesh option. The meshed model is asfollows

3. Laterthismeshedmodelissubjectedwithtwodifferent materials namely ALUMINIUM ALLOY and MAGNESIUM ALLOY and subjected to static analysis.

- *Properties OfMaterials:*

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 beplaced.

2. Now the model is subjected to circumferential load of 23.1kpa.

3. Apply the angular velocity 62.8 rps in rotational direction of wheelrim.

4. Select the solve option to apply the loads on the wheel rim.

5. Later do the static analysis to themodel.

6. Next solution results the displacement, von mises strain, stressintensity.

- *Results for Magnesium Alloy WheelRim*

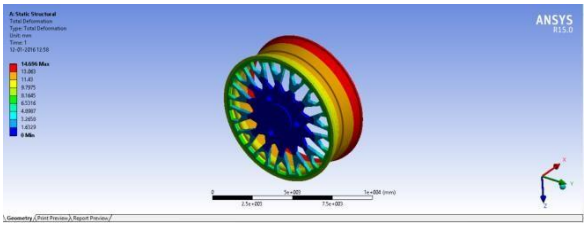

Figure 6.Displacement results

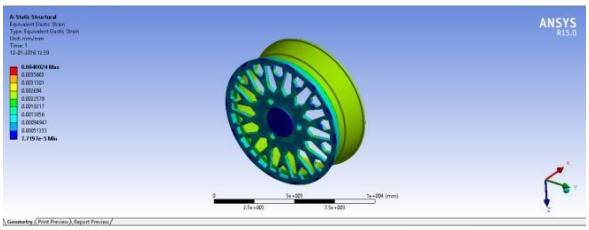

Figure 7.Elastic Strain

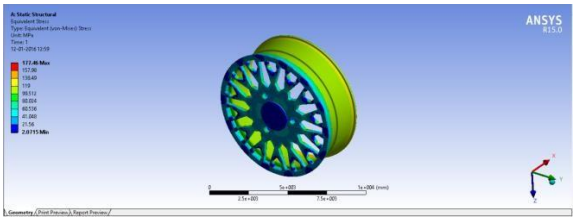

Figure 8.Von-Mises stress

- *Results for Aluminium Alloy WheelRim*

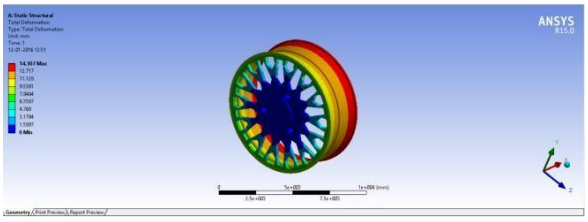

Figure 9.Displacement results

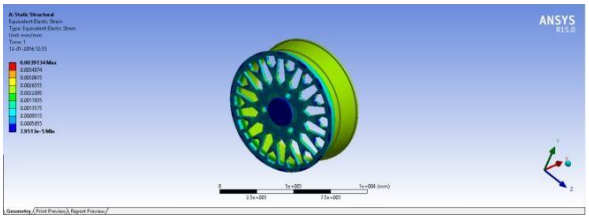

Figure 10.Elastic Strain

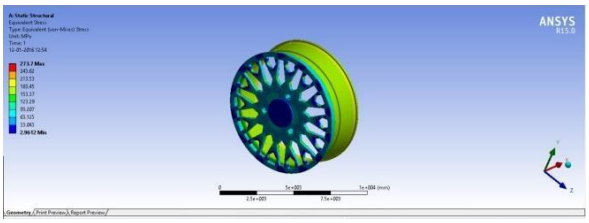

Figure 11 Von-Mises stress

- *StressesResults*

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 Compar

V. CONCLUSION

CAD model of the wheel rim is generated in AutoCAD and this is imported to ANSYS for processing work. An amountof21.3kpaisappliedalongthecircumferenceofthe 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 alloywheel.
2. In both cases von-mises stresses are less than stress intensity.
3. Aluminum alloy wheel rim subjected to more stresses compared to Magnesium alloywheel.

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

REFERENCES

[1]. "An analysis of stress and displacement distribution in a rotating rim subjected to pressure and radial loads" By P.C.Lam and T.S.srivastam

[2]. Stress Analysis of Wheel Rim International Journal of Mechanical Engineering and Research Volume 1 Issue 1 (page 34-37), ISSN: 2277-8128

[3]. Fatigue Analysis of Aluminium alloy Wheel under Radial Load, International Journal Mechanical and Industrial Engineering, (IJMIE), ISSN No.2231-6477, Vol-2, Issue-1,2012

[4]. THE TIRE AND RIMASSOCIATION, INC (1996), "50 C rop Centre Rim Contours", J (ISO) Contour for 14, 15,16 ,18 and 20 diameter designation,pp7.05

[5]. International Journal of Innovative Science and Modern Engineering (IJISME) ISSN: 2319-6386, Volume-2, Issue-6, May2014