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Research Article

ANALYSIS OF MAGNESIUM ALLOY WHEEL FOR FOUR WHEELER

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ABSTRACT

Now a day's an alloy wheels are used in automobiles which are made from an alloy of aluminum or magnesium metals or sometimes a mixture of both. Alloy wheels differ from normal steel wheels because of their lighter weight, which improves the steering and the speed of the car. Alloy wheels will reduce the unsprung weight of a vehicle compared to one fitted with steel wheels. The benefit of reduced unsprung weight is more precise steering as well as a nominal reduction in fuel consumption. Alloy wheels are an excellent conductor of heat, improving heat dissipation from the brakes, reducing the risk of brake failure under demanding driving conditions. At present, four wheeler wheels are made of aluminum alloys. In this work, aluminum alloys are comparing with other alloys. In this work a parametric model is designed for alloy wheel used in four wheeler Design is evaluated by analyzing the model by taking the constraints as ultimate stresses and variables as two different alloy materials and different loads and goals as model is Ford Fiesta.

INTRODUCTION

1. Wheel: Wheel is generally constitute 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. 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
5. Well: This is a part of rim with depth and width to facilitate tire mounting and removal from the rim
6. Offset: This is a space between wheel mounting surface where it is bolted to hub and center of the line.
7. Flange: The flange is a part of rim which holds the both beds of the tire
8. 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

A wheel is a circular device that is capable of rotating on its axis, facilitating movement or transportation while supporting a load or performing labor in machines. Under impact loading conditions, wheel gets deformations. Different types of wheels having different conditions. Racing car wheels are absorbs heat when compared to normal vehicles. Its consists of alloys and low aspect ratio tires. Alloy wheels are an excellent conductor of heat, improving heat dissipation from the brakes, reducing the risk of brake failure under demanding driving conditions. At present, alloy wheels are mostly used in a vehicles having good performance, ride and driving conditions.

Types of Wheels

Steel Wheel

Steel wheels are the first kind of wheels and also the most commonly used wheels. This wheel comprises of many sheets of steel, molded into shape and welded typically together. These are strong and heavy wheels. These are commonly found on all types of vehicles. But, its having more weight when compare to alloy wheels such as aluminium wheel, magnesium wheel.

Rally Wheel

Rally wheels are second kind of wheels. These wheels are also steel wheels. But, higher steel gauge for higher strength. The inner section of a steel wheel is usually welded to the rim along its entire circumference.

Alloy Wheel

Now a day an alloy wheels are mostly used in modern car, motorcycle and trucks. These wheels are made from a combination of alloy of aluminium and magnesium metals.

Advantages of an alloy wheels:

1. Lighter weight but similar strength.
2. Good conductors of heat.
3. Trendy appearance.
4. To improve vehicle handling/performance.
5. Good road to tire contact.

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As the wheels are lighter the handling can be improved with the help of reducing un-sprung mass. This makes the suspension to follow the ground more closely and it provides more grip. It will also reduce fuel consumption when compare to steel wheels. Good heat conduction can facilitate the heat dissipation from the brakes. So, it improves braking performance in driving conditions.

Aluminium Alloy Wheels

Aluminum is the material commonly used for making alloy wheels. It is the metal with features of excellent lightness, thermal conductivity, corrosion resistance, characteristics of casting, low temperature, machine processing and recycling, etc. This metals main advantage is reduced weight, high accuracy and design choice of wheel.

Magnesium Alloy Wheel

Magnesium wheel is about 30% lighter than aluminum and also, excellent for size stability and impact resistance. Recently the technology for casting and forging is improved and the corrosion resistance of magnesium is also improving. Magnesium alloys are considered as the most promising material in 21st century, which possesses attractive properties com-pared to aluminum alloys such as low density, high specific strength and good cast ability. When used as wheel material magnesium alloy are not only able to reduce wheel mass and oil consumption, but also facilitate absorbing vibration and damping the noise emission.

Main properties of magnesium alloy wheels:

1. Light weight
2. High corrosion resistance
3. Low density (1.76 g/cm³)
4. High performance

Problem Definition

Now a day an aluminium alloy wheels are mostly used in vehicles because of excellent thermal conductivity. But, the problems in using aluminium alloy wheels are galvanic corrosion, increased fuel consumption and unsprung mass. Using magnesium alloy the unsprung mass of wheel can be reduced compared to aluminium alloy wheel. Therefore, fuel consumption will be reduced. In this work, magnesium alloy wheel of a car is modeled and analyzed to overcome the above said problems.

Objective

1. To conduct static analysis of alloy wheel using Computer-Aided Design software.
2. Comparison of results of static analysis of aluminium and magnesium alloy wheel.

Introduction to Unigraphics (NX)

"UNIGRAPHICS" is a modeling software which is used for creation and modification of the objects. In NX design and modeling features are available. 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 NX software create the model of wheel rim.

Modeling of the Wheel

1. Open the file Rim.prt
2. Go to insert design features-revolve and select sketch and select vertical axis for vector reference and select the circle for point reference. provide the values for limits column as shown in the above image, and give OK.
3. Go to insert design features extrude and select the sketch as shown below.
4. Select the required plane and draw spoke for the given dimension.
5. For Boolean operation select the revolve geometry as body to subtract.
6. Now click OK to complete the extrude cut option .
7. Go to insert associative copy-pattern feature command.
8. Select vertical axis as vector reference and center point of the revolve geometry as point reference.
9. Draw a circle and extrude as per the required dimensions.
10. Go to insert detail feature –chamfer and select the edges
11. Go to insert associative copy-pattern feature command and select the counter borehole.

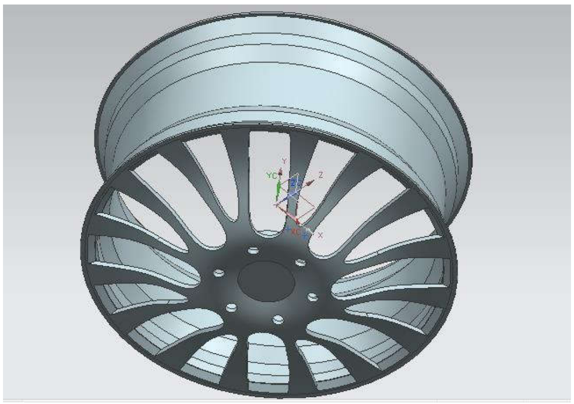


Fig.1 Complete model of alloy wheel

Bounday Conditions

Static analysis is used to determine the displacements, stresses, strains, and forces in structures or components caused by loads that do not induce significant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect to time. The kinds of loading that can be applied in a static analysis include

1. Externally applied forces and pressures
2. Steady-state inertial forces (such as gravity or rotational velocity).
3. Imposed (non-zero) displacements.
4. Temperatures (for thermal strain)

Total Pressure Acting on Wheel

Case:1

$$\frac{W(Curb)}{A} = \frac{1,100X9.81}{196761.05} = 0.05484\ N/mm^2$$

$$P = 0.248 + 0.05484 = 0.30284\ N/mm^2$$

CASE:2

$$\frac{W(curb)\ W(passenger)}{} = \frac{1,100+500\ \ 9.81}{196761.05} = 0.07977\ N/m$$

$$P = 0.07977 + 0.248 = 0.32777\ N/mm^2$$

P = 0.07977 + 0.248 = 0.32777 N/mm²

Analysis

FEA is originally developed for solving solid mechanic problems. ***Static analysis*** – (to determine stress, displacements, von – mises stress etc.,)

1. Preprocessing – to construct a model
2. Post processing – solving mathematical problems
3. Solution – results

Boundary: The surface enclosing the geometry
Solid: Interior + boundary

Meshing

A discrete representation of the geometry that is involved in the problem. It assigns a smaller region to analyze.

3D Tetrahedral Meshing

It is a technique where mesh will apply on the total surface of the wheel with equal element size and four plane faces. It gives accurate results when compare to other types of meshing.

Types of Analysis

Static Analysis

In static analysis, determine the stress, von-mises stress, displacements, maximum and minimum principle stress.

Buckling Analysis

"Buckling‟ loads are critical loads where certain types of structures become unstable.

Eigen value - predicts the theoretical buckling strength of a structure Nonlinear – Nonlinear buckling analysis provides greater accuracy

Table 1 Vehicle Parameters

S.NO	Parpameters	Value
1	Weight of the car	1,100 N
2	Passengers	400 Kg
3	Total load of vehicle	1,500 Kg
4	Pressure on wheel	0.08 N/mm²
5	Perimeter of wheel	1425.56 mm
6	Area of wheel	161883.12 mm²

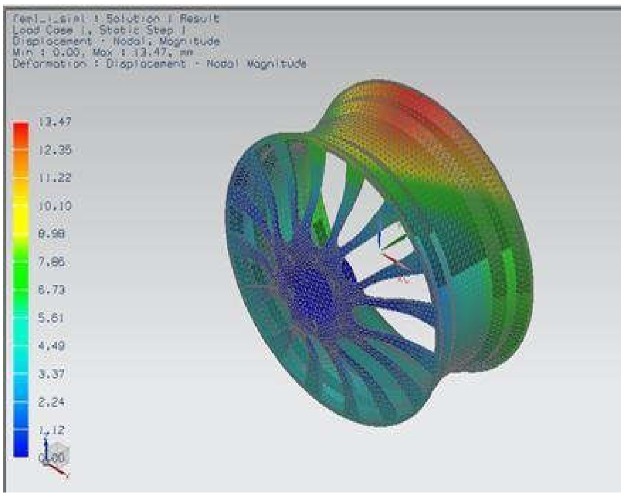
Table 2 Materials and Its Properties

Materials/ Properties	Aluminium	Steel	Magnesium
Yield strength (N/m²)	3.49e+008	2.41275e+008	1.05e+008
Tensile strength(N/m²)	3.59e+008	4.48083e+008	3e+008
Mass density(Kg/m³)	2800	7300	1700
Poisson's ratio	0.33	0.26	0.35
Thermal expansion	3.5e-005 / Kelvin	1.5e-005 /Kelvin	2.5e-005 / Kelvin
Elastic modulus (N/m²)	7.1e+010	1.9e+011	4.5e+010

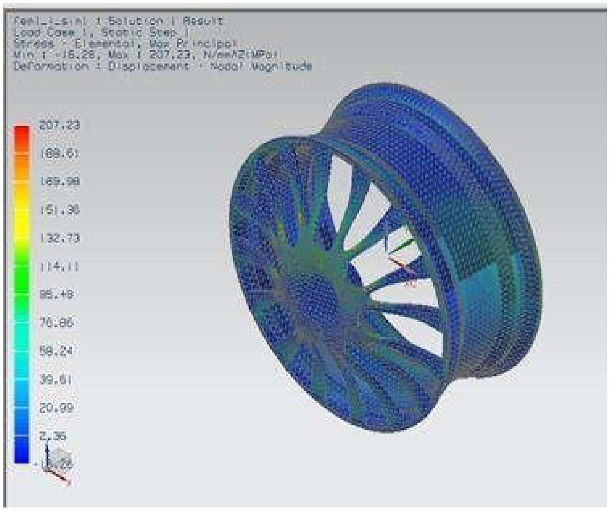
Static Analysis of an Alloy Wheel

Static analysis calculates the effects of steady loading conditions on a structure, while ignoring inertia and damping effects, such as those caused by time-varying loads. A static analysis, however, includes steady inertia loads (such as gravity and rotational velocity), and time-varying loads that can be approximated as static equivalent loads (such as the static equivalent wind loads commonly defined in many building codes).

Displacement of an Aluminium Alloy Wheel



(a)



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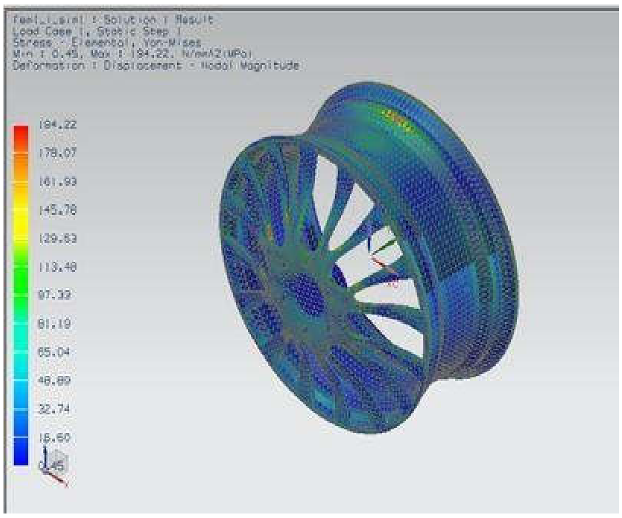
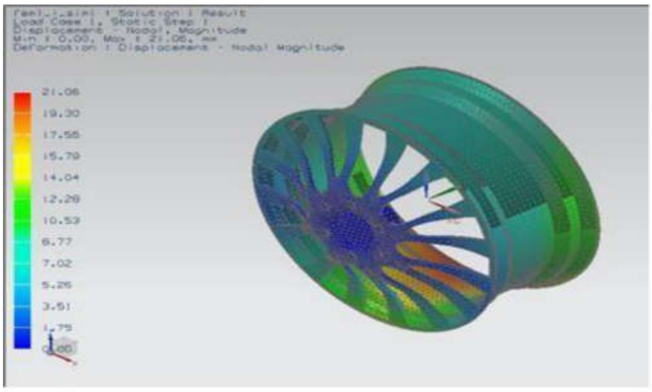


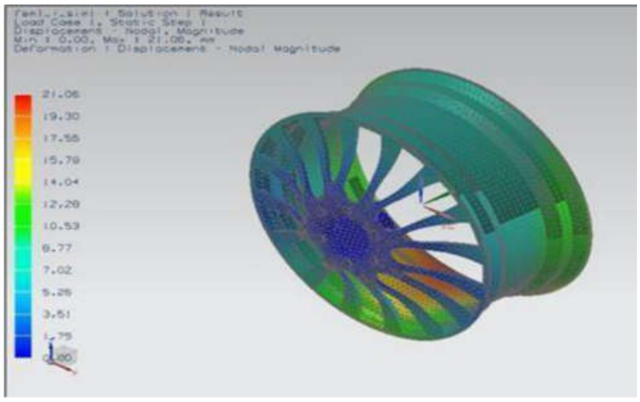
(c)

Displacement of Magnesium Alloy Wheel

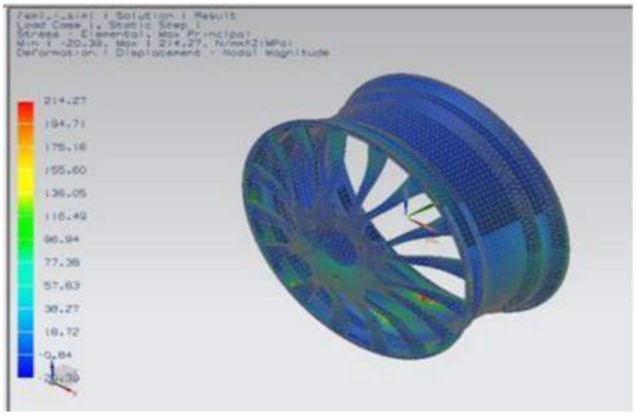


(d)

Displacement of Steel Alloy Wheel



(g)



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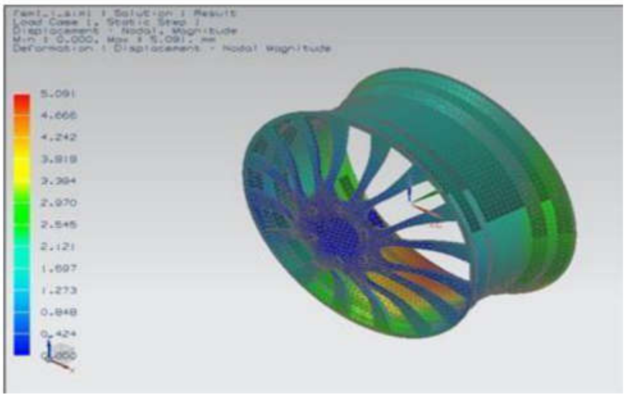
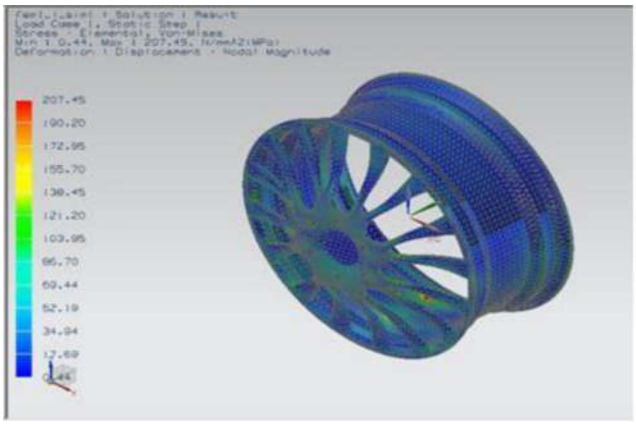
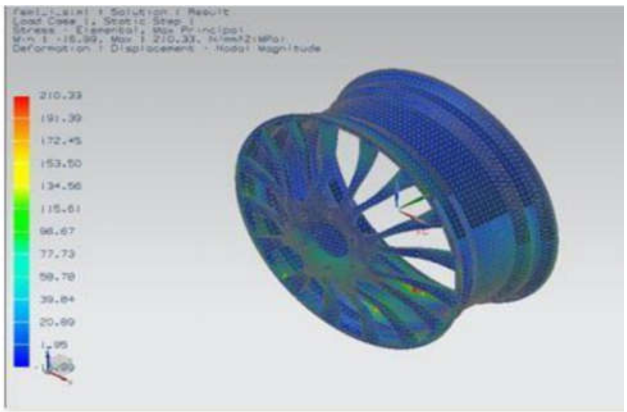


(h)



(f)



(i)

Fig.2 Displacements, Maximum principle stress and Von-mises stress

Fig.2. (a), (d), (g) shows the displacements of an aluminium, magnesium and steel alloy wheels respectively. Fig.2. (b), (e), (h) shows the maximum principle stress of an alminium, magnesium and steel alloy wheels respectively. Fig.2. (c), (f), (i) show the von-mises stress of an aluminium, magnesium and steel alloy wheels respectively.

RESULTS AND DISCUSSIONS

From above analysis, it shows the results such as displacements, maximum principle stress and von-mises stress of an aluminium, magnesium and steel alloy wheels.

Fig.2.(a), (d), (g) refers the displacements of an aluminium (4.260e+00 mm), magnesium (6.355e+00 mm) and steel (1.594e+00 mm)alloy wheels respectively. Fig.2.(b), (e), (h) refers the maximum principle stress of an aluminium (8.931e+004N/mm²), magnesium (9.534e+004 N/mm²) and steel (1.072e+005 N/mm²) alloy wheels respectively.Fig.2.(c), (f), (i) refers the von-mises stress of an aluminium (9.070e+004 N/mm²), magnesium (9.026e+004 N/mm²) and steel (9.762e+004 N/mm²) alloy wheel respectively.

Table 3 Comparision Results of an Aluminium, Steel and Magnesium Alloy Wheels

Parameters	Steel	Aluminium ALLOY WHEELS	Magnesium ALLOY WHEELS
Displacements (mm)	1.594	4.260	6.355
Maximum principle stress (N/mm²)	1.072e+005	8.931e+004	9.534e+004
Von-mises stress (MPa)	9.762e+004	9.070e+004	9.026e+004

CONCLUSION

CAD model of the Wheel is generated in Unigraphics and imported and analyzed. Hub is fixed constrain. Comparing the displacements results of an aluminium alloy wheel, magnesium alloy wheel and steel wheel, an aluminium alloy wheel having higher displacements (4.260 mm) than steel wheel (1.594 mm) and magnesium alloy wheel gets more displacements (6.355 mm) than aluminium wheel. So, It gives better performance as well as mileage during driving conditions. An aluminium alloy wheels are subjected to less stress value when compared to steel. Hence steel is more feasible to be used in wheel than other materials. The analysis results showed that the maximum stress area was located in the bolts and surface of the wheels.

Reference

1. Mohd izzat faliqf, "Simulation test of automotive alloy wheel using computer aided engineering software"
2. T.Siva Prasad & T.Krishnaiah, “A review on Modeling and Analysis of a car Wheel Rim using Catia & Ansys”
3. S.Vikranth Deepak, “Modeling and analysis of alloy wheel for four wheeler vehicle”
4. B.anusha srikanta & P.veera raju, M.tech (PhD),
5. “Geometrical and material optimization of alloy wheel for four wheeler”
6. M.Vamsi Krishna & M. Saran Theja, “Structural and Fatigue Analysis of Two Wheeler Lighter Weight Alloy Wheel”
7. K.Venkateswara Rao & Dr. T. Dharmaraju, “Analysis of Wheel Rim Using Finite Element Method”
8. Berat Baris Buldum, Aydin Sik and Iskender Ozkul, "Investigation of magnesium alloys"
9. M.Sabari Sidik, A.Muas, K.Shahril and A.R.Ab-Kadir, "Design analysis of car wheel rim deformation behaviour under different static loading"
10. Sourav Das,(CAE Analyst), "Design and weight optimization of aluminium alloy wheel"
11. P.Rajarethinam, K.Periasamy, "Design and analysis of Wheel Spokes"
12. Tejas Mulay, Harish Sonawane and Prof.P.Baskar "Design and analysis front wheel under critical load conditions"
13. M.Saran Theja and M.Vamsi Krishna, "Structural and fatigue analysis of a wheel for lighter weight alloy wheel"
14. P.C.Lam and T.S.Srivastam, "An analysis of stress and displacement distribution in a rotating rim subjected to pressure and radial loads"

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