STATIC AND FATIGUE ANALYSIS OF AUTOMOTIVE WHEEL RIM

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Abstract: Rims are critical components for vehicle wheel. The wheel is a device that enables efficient movement of an object across a surface where there is a force pressing the object to the surface. There are so many kinds of wheels are created from the ancient age for the today's world there are two kinds of wheels mostly used. In the present every vehicle was designed with alloy wheels which are more efficient than spokes wheels. In this paper rim designed from the existing dimensions by modeling software. one models is actual which is used in normal/regular vehicles, second one is modified which is used in latest vehicles and the last one is the modification of latest rim. The three rims are analyzed in Ansys by using 4 different materials which are Al alloy ,Mg alloy, Zn alloy & Steel alloy. The results were compared and the best material with best model was proposed to the company.

Keywords: static analysis, fatigue analysis, wheel rim

1. Introduction

The rim of a wheel is the outer circular design of the metal on which the inside edge of the tyre is mounted on vehicles such as automobiles. For example, in a four wheeler the rim is a hoop attached to the outer ends of the spokes-arm of the wheel that holds the tyre and tube.A wheel rim is a highly stressed component in an automobile that is subjected to bending and torsional loads. Because of the long life and high stresses, as well as the need for weight reduction, material and manufacturing process selection is important in rim design. There arecompetitions among materials and manufacturing processes, due to cost performance, and weight. This is a direct result of industry demand for components that are lighter, to increase efficiency, and cheaper to

produce, while at the same time maintaining fatigue strength and other functional requirements .

2.Specification of the wheel

The specification of the wheel used in the project is as follows.

Outer diameter	**450 mm**
Hub hole diameter	**150 mm**
Bolt hole diameter	**20 mm**
Rim width	**254 mm**

Table.1

3.CAD Design of Wheel

3D model of wheel rim is done by using CATIA according to dimensions specified in the Table.1 The wheel rim solid model (.iges file format) is imported to HYPERMESH and the model is meshed with solid tetra element .

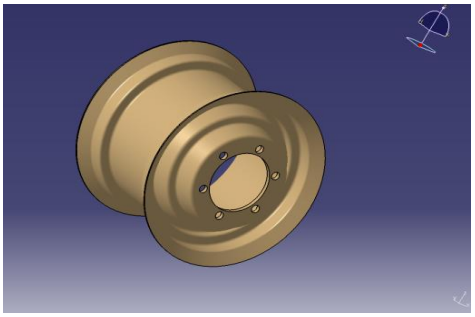


Fig.1 3D Model of the wheel rim

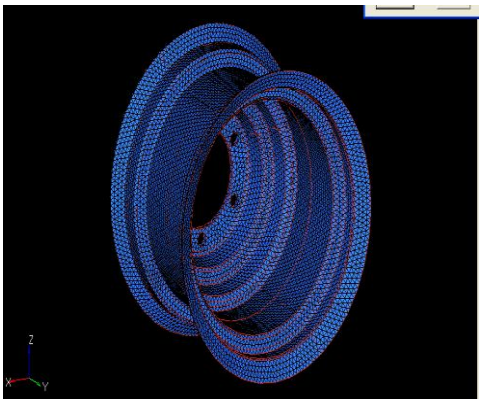


Fig2. Meshing finished model

4.Material properties

Material	**Steel alloy**	**Aluminum alloy**	**Magnesium alloy**	**Forg steel**
Young's modulus (E) N/mm^2	$2.34*10^5$	72000	45000	2100
Yield stress N/mm^2	240	160	130	220
Density kg/m^3	7800	2800	1800	7600

Table.2

5.1 Static analysis result

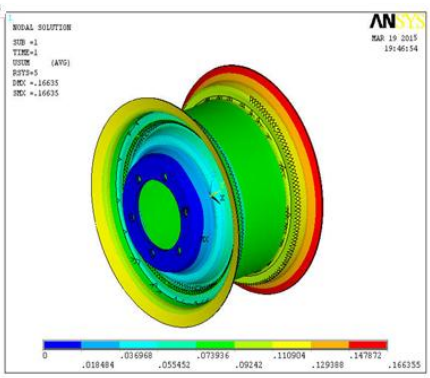


Fig3 a)Displacement=0.166 mm for Steel alloy

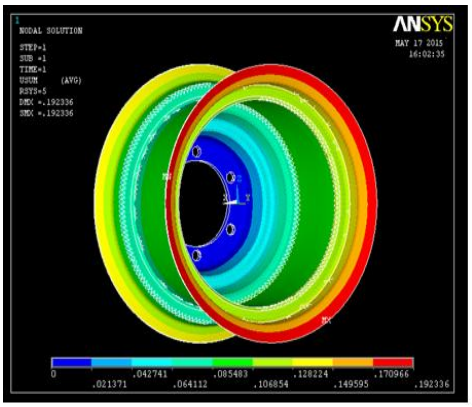


Fig 3D)Displacement=0.1923mm mm Forged steel

Fig3 .Displacment Result for wheel rim

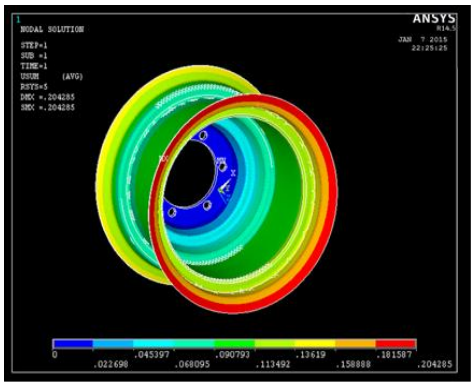


Fig3b)Displacement=0.204mm Aluminium alloy

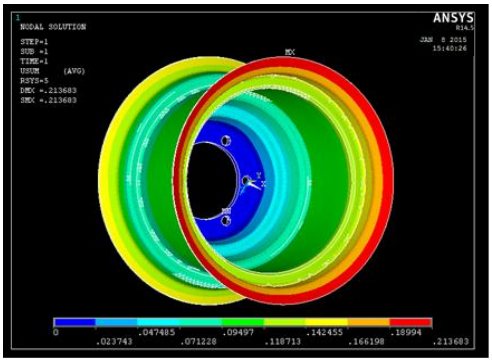


Fig4a. stress for Steel alloy

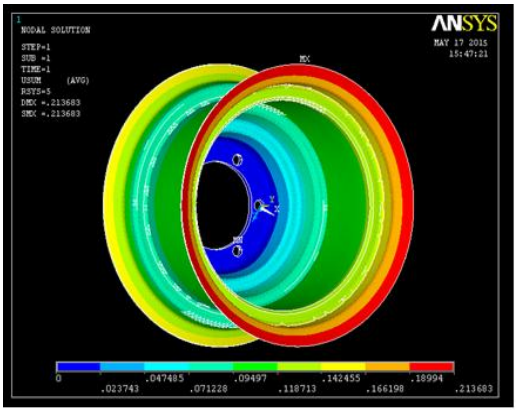
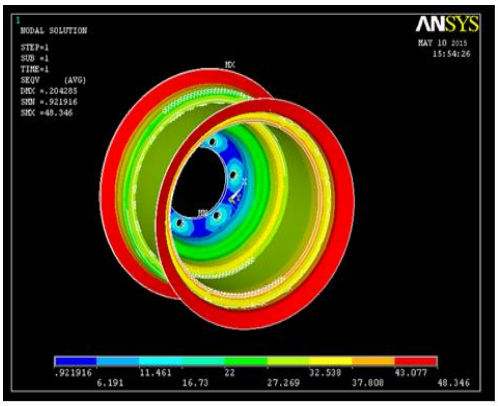


Fig3 C)Displacement=0.2136mm for Magnesium alloy



Fi4b.stress for Aluminium alloy

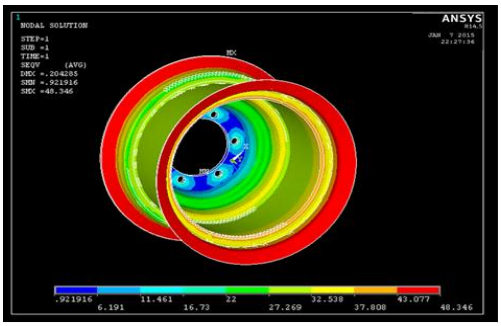


Fig4c. stress for Magnesium(mg) alloy

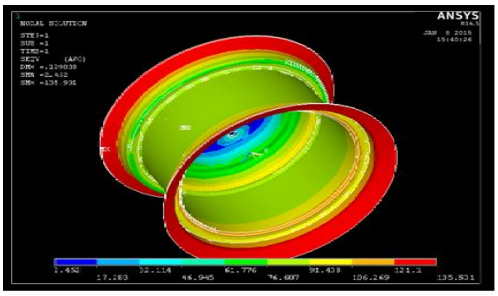


Fig4d. stress for Forged steel

Fig4 . Stress Result for wheel rim

5.2 Fatigue analysis result

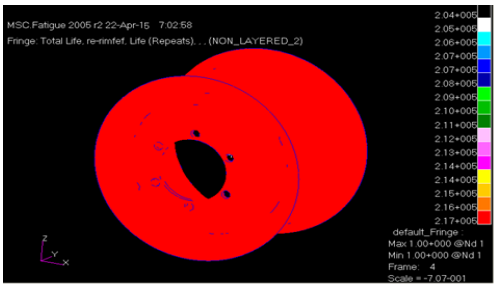


Fig5a. Fatigue strength for Steel alloy

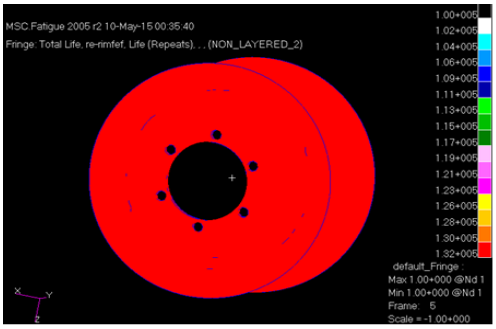


Fig.5b Fatigue strength for Aluminium

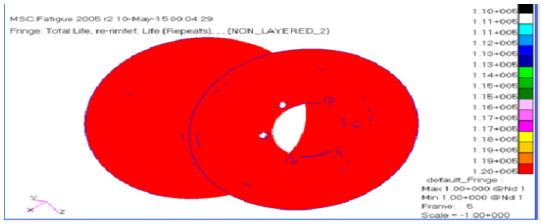


Fig5c. Fatigue strength for Steel alloy

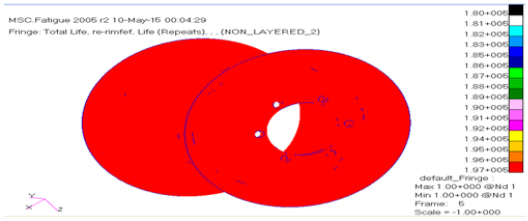


Fig5d. Fatigue strength for Aluminium alloy

Fig5 . Fatigue strength Result for rim

6. RESULT AND DUSCUSSION

1) The von misses stresses developed in steel alloy during static analysis is 140.056N/mm^2 at load 21.3KNthe stress is below yield stress of material for these stress range we have to find at what number of cycles the component is yielding or crack is going to initiates

2) During fatigue analysis of steel alloy the crack is initiating at N_f=2.17*10^{5}Cycles.

3) The von misses stresses developed in aluminum alloy during static analysis is 48.326N/mm^2 at load 21.3KN the stress is below yield stress of material for these stress range we have to find at what number of cycles the component is yielding or crack is going to initiates

4) During fatigue analysis of aluminum alloy the crack is initiating at N_f=1.32*10^{5}Cycles.

5) The von misses stresses developed in Magnesium alloy during static analysis is 32.294N/mm^2 at load 21.3KNthe stress is below yield stress of material for these stress range we have to find at what number of cycles the component is yielding or crack is going to initiates.

6) During fatigue analysis of Magnesium alloy the crack is initiating at

N_f=1.2*10^{5}Cycles.

7) The von misses stresses developed in Forged steel during static analysis is 135.931N/mm^2 at load 21.3KNthe stress is below yield stress of material for these stress range we have to find at what number of cycles the component is yielding or crack is going to initiates

8) During fatigue analysis of Forged steel the crack is initiating at

MATERIAL	**Displacement (mm)**	**Vonmisses stress (Mpa)**	**Fatigue strength (cycles)**
Steel alloy	0.1663	140.056	2.17*10^5
Aluminum alloy	0.204	48.326	1.32*10^5
Magnesium alloy	0.2136	32.29	1.2*10^5
Forged steel	0.1923	135.931	1.97*10^5

N_f=1.97*10^{5}Cycles.

9) From results we can make out ,in steel alloy the Number of cycles to failure (N_f)= $2.17*10^5$Cycles is greater than Aluminum, Magnesium, Forged steel. Hence Steel alloy is more feasible to use than aluminum.

Hence steel alloy have more life and durability compared to aluminum .

7.CONCLUSION

Steel alloy is more feasible to use than aluminum. steel alloy have more life and durability compared to aluminum . steel alloy not to recommend for any type of rims manufacturing and the Mg alloy is good for all types of rims manufacturing in the second place Al alloy may be used. Since in all the cases von-mises stresses is less than the ultimate strength, talking deflections into account, forged steel is preferred as best material for designed wheel rim.

8.REFERENCES

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