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Finite Element Analysis on two Wheeler Alloy Wheel

Manjunath Batli[1], Md.Manazir[2], N. Chitresh[3], Malatesh G[4]
[1,2,3,49]Department Of Mechanical Engineering. B.V Bhoomraddi College Of Engineering And Technology, Hubli-Karnataka, India

Abstract: Aluminium7075 is an established material that is used in a variety of applications. Aluminium 7075 has replaced metals like Aluminium and brass for cost and weight. The design of a motorcycle wheel contains several complexes and attempt has been made to meet the requirements of original equipment manufacturers It is also that material that can meet the needs of more demanding applications where very high or low temperatures or chemical resistance are key operational parameters Aluminium 7075 is an ideal replacement for Magnesium alloy and Titanium alloy as well as other types of metal tubing, and even glass for weight reduction, comparable strength/mass, chemical resistance, hardness, and low extractable. Aluminium 7075 is particularly useful in the automobile industry for its weight. In this project work the entire wheel design of two wheeler was chosen and analysed by applying different load and redesign the wheel again to minimize the deformation and material will be changed from titanium to aluminium7075.The composition of aluminium7075 are:-
1)6%Zinc
2)2.4%Magnesium
3)1.5% Copper
4)0.4% Silicon, iron, manganese, titanium, chromium
Wheel design of two wheeler is made in SolidWorks 2015 and analysis is done in Ansys workbench 15.0 software to determine the various stresses, strain, and Impact and fatigue life of the wheel.
Keywords: Al7075, FEM, ANSYS

I. INTRODUCTION

The design of a motorcycle wheel contains several complexes and attempt has been made to meet the requirements of original equipment manufacturers (OEMs) the design in 6 degree of freedom (DOF) for characteristics and durability has been developed. After designing of wheel, the material should be selected and to go through several analysis test on ANSYS software. By applying different loads in existing Magnesium alloy wheel and analyse the stresses, the material has been changed from Magnesium alloy to Aluminium 7075, Aluminium 7075 with 6%Zinc, 2.4%Magnesium, 1.5%Copper, 0.4%Silicon, iron, manganese, titanium, chromium for the study. In the same design the materials has been changed one by one and applying different loads, and analyse the stresses.

It is concluded that the existing design is not suitable for Magnesium alloy, structural steel. Magnesium alloy will deform at a maximum pressure of 2MPa. So change the design and the materials and analyse the stresses and finally conclude that Aluminium 7075 can be replaced by Magnesium alloy.

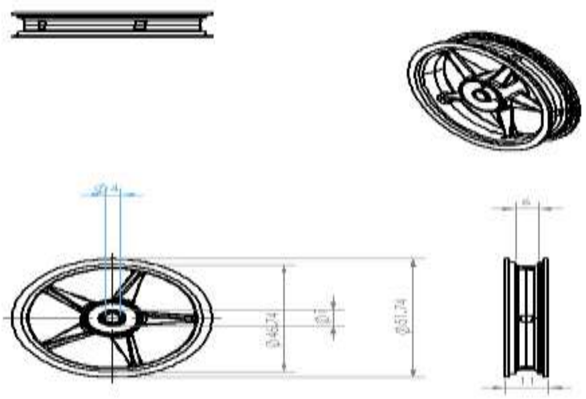
II. EXPERIMENTAL

2.1 General Procedures in Design

Need or Aim |
Synthesis (Mechanism) |
Analysis of Forces |
Material selection |
Design of element |
Modification |
Detailed drawing |
Production

2.2 Design Procedure

With the help of the measuring instrument -Vernier calliper, micrometre, radius Gauges and slip gauges, we have first taken all the dimension of the Aluminium alloy wheel.). After completing the draw the wheel model is then Import in the ANSYS 15 software. Before importing it is first save in IGES or STEP.



2D view of Aluminium Alloy Wheel

III. ANALYSIS FOR ALUMINUM ALLOY

3.1 Analysis Procedure

First of all we have taken the Aluminium 7075 material composition. The alloy contains 6%Zn, 2.4%Mg, 1.5%Cu, and 0.4% Si, Fe, Mn, Ti, Cr.

Design and Analysis of Aluminum7075 Alloy

Was prepared by dispersinghard particles in Aluminium matrix using stir-casting technique. From the design data book –Mechanical property.

Design and Analysis of Two WheelersWheel with Magnesium Alloy

Mechanical property	Value	Unit
Density	1800	Kg m^-3
Coefficient of thermal expansion	2.6E-05	C^-1
Young's modulus	4.5E+10	Pa
Poisson ratio	0.35	
Bulk modulus	5E^+10	Pa
Shear modulus	1.66E^+10	Pa
Tensile yield strength	1.93E^08	Pa
Compressive yield strength	1.93E^08	Pa
Tensile ultimate strength	2.55E^08	Pa
Compressive ultimate strength	0	Pa

Table No.1 Properties of Magnesium Alloy

And these mechanical properties are defined into the material list of ANSYS software data list. For the Static analysis component drawing is call in ANSYS software and then mechanical property is define on magnesium alloy wheel.

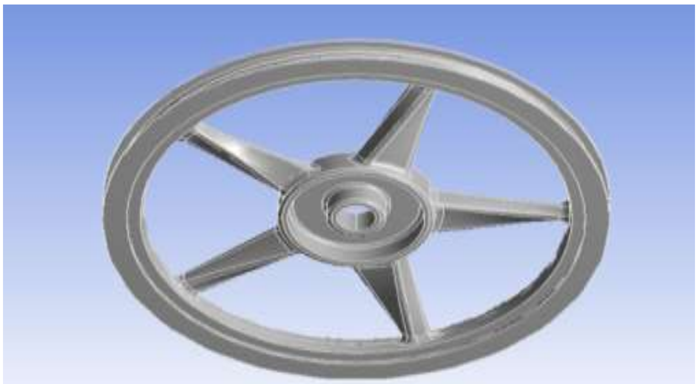


Fig. 2 Static Analysis

IV.STATIC ANALYSIS

4.1 Magnesium alloy wheel
(A) Under
(1) Maximum Inflation pressure on rim circumference 7MPa
(2) Hub fix
(3) Rotation velocity in Z –direction –200 rad/sec

V. ANALYSIS RESULT

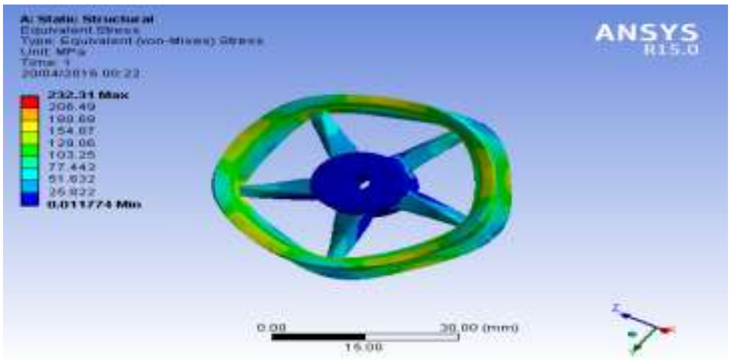


Fig. 3 Equivalent Stress

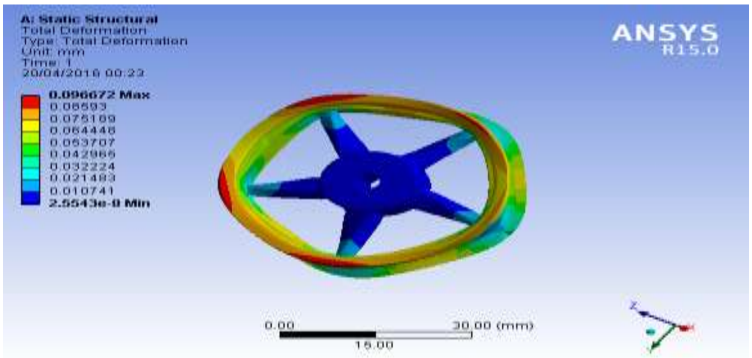


Fig. 4 Total Deformation

VI.RESULT AND DISCUSSION

	Total Deformation	Equivalent Stress
Minimum	0.02576MPa	62MPa
Maximum	0.0966MPa	232Mpa

Table No.2 Results on Static analysis of Magnesium Alloy

From the above fig. it does not deform i.e. it can sustain under Max. Inflation Pressure on wheel 7MPa

VII.ANALYSIS DATA OF AL7075 MATERIAL

7.1 Analysis Procedure

Under same maximum. Inflation pressure on wheel 7MPa, Hub fix and Rotation velocity in Z –direction –200 rad/sec and after defining the mechanical property of different grade of Al7075 on wheel if wheel does not deform thewe can easily replace Magnesium alloy wheel with Aluminium 7075wheel.

Design and Analysis of Aluminium Alloy Wheel

Mechanical Property	Value	Unit
Density	2.81	gcm^-3
Tensile Yield Strength	503	MPa
Compressive Yield Strength	503	MPa
Tensile Ultimate strength	572	MPa
Compressive Ultimate strength	572	MPa
Specific Heat	960	Jkg^-1k^-1
Young's modulus	71700	MPa
Poisson Ratio	0.33	
Bulk Modulus	7029	MPa
Shear Modulus	2695	MPa
Isotropic Relative Permeability	1	

Table No.3 Properties of Al7075

VIII.ANALYSIS RESULT

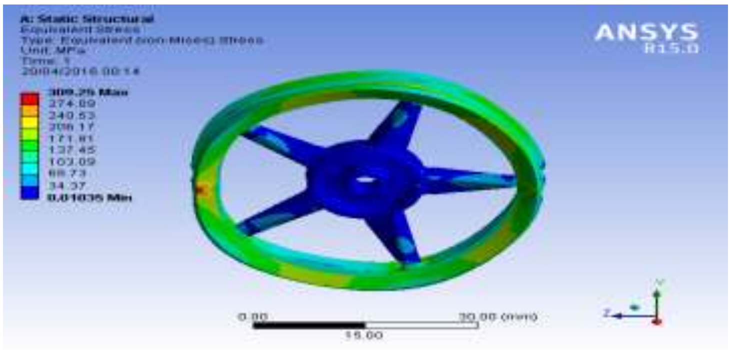


Fig. 5 Equivalent Stress

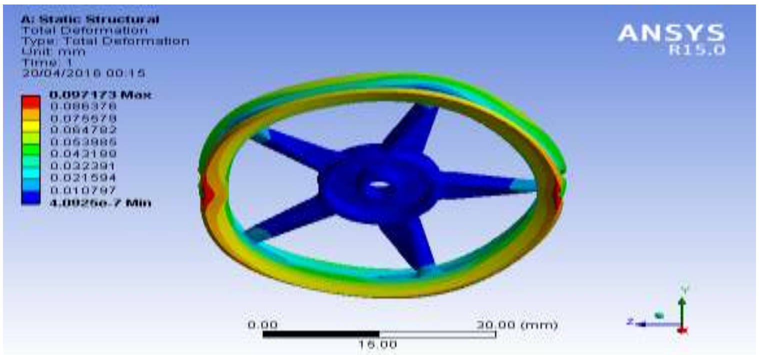


Fig.6 Total Deformation

IX. RESULT AND DISCUSSION

	Total Deformation	Equivalent Stress
Minimum	0.025MPa	82MPa
Maximum	0.096MPa	309MPa

Table No.4 Results on Static analysis of Al7075

As shown in above fig. it indicated that maximum deformation occurred on the aluminium spokes of the wheel i.e. it does not sustain under Max. Inflation pressure on wheel 7.5MPa

Compression only support on inside circumference of hub area:

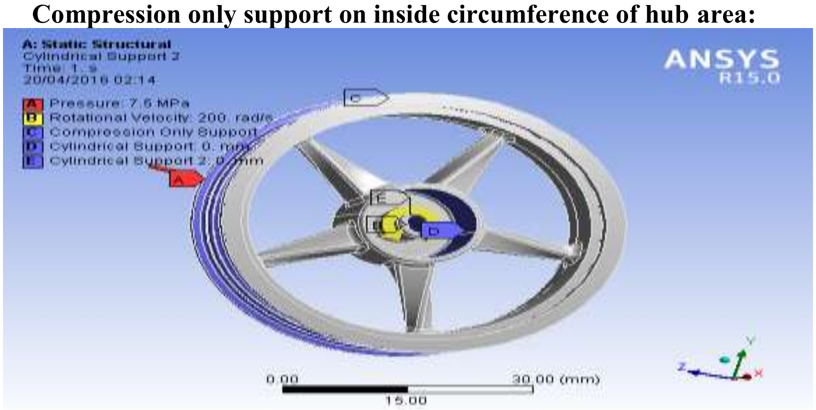
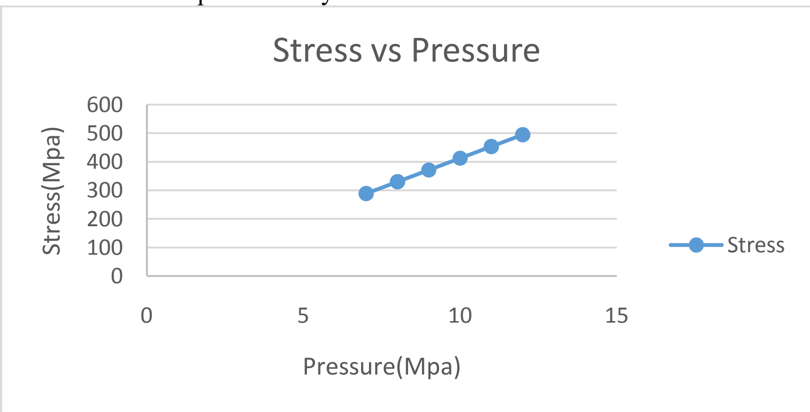
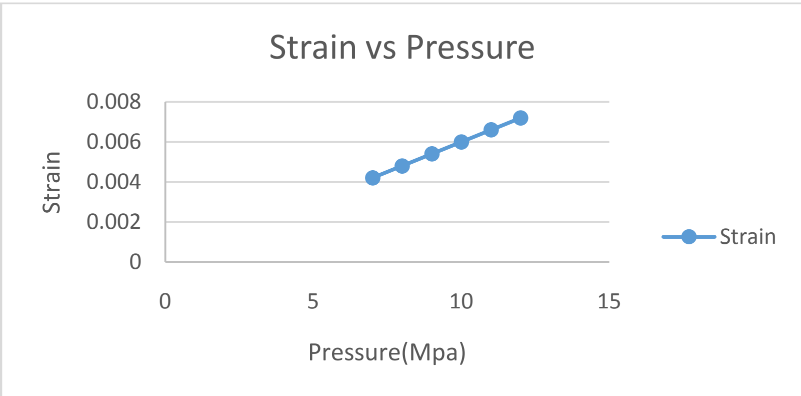


Fig. 7 Compresson Support on circumference

X.Graphical Analysis on Al7075 in Static Structure



As the pressure increases, stress value goes on increases and from the graph we can interpret that the maximum bearing pressure that alloy wheel can sustain is 12MPa.



We can interpret that there is no radical change in deformation w.r.t increasing pressure.

XI. IMPACT ANALYSIS

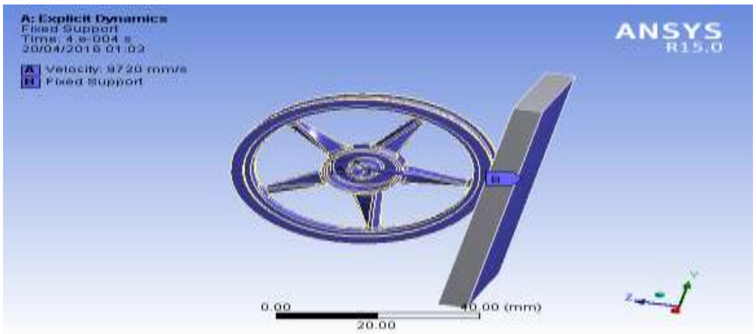


Fig. 8 Impact analysis on Al7075 Wheel Actual height considered is 80mm but for analysis purpose we have taken it as 0.1mm for faster results .The velocity applied is 9720mm/sec in negative Z direction of a wheel as shown in the fig.8A square block made of concrete material is considered as fixed support.

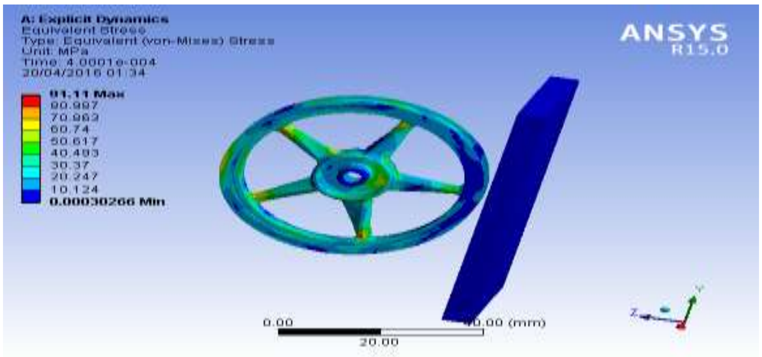


Fig. 9Equivalent Stress

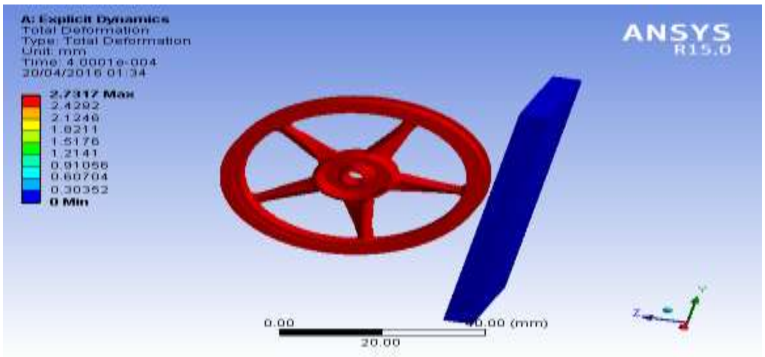


Fig.10Total Deformation

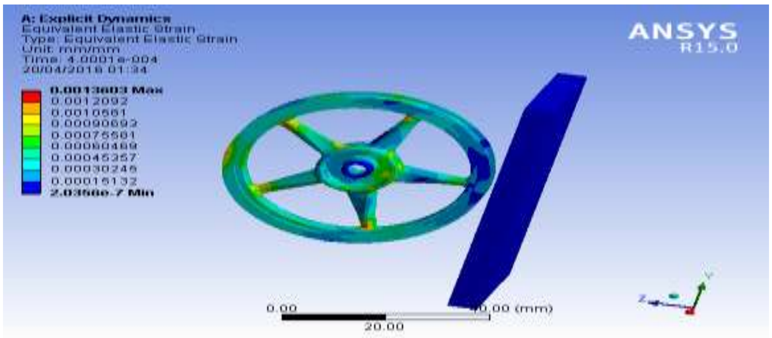
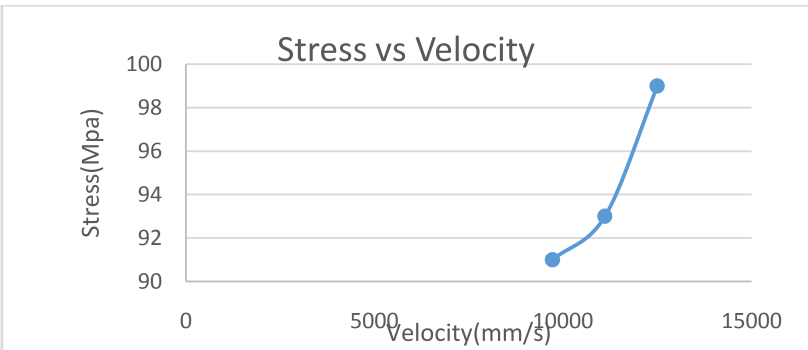
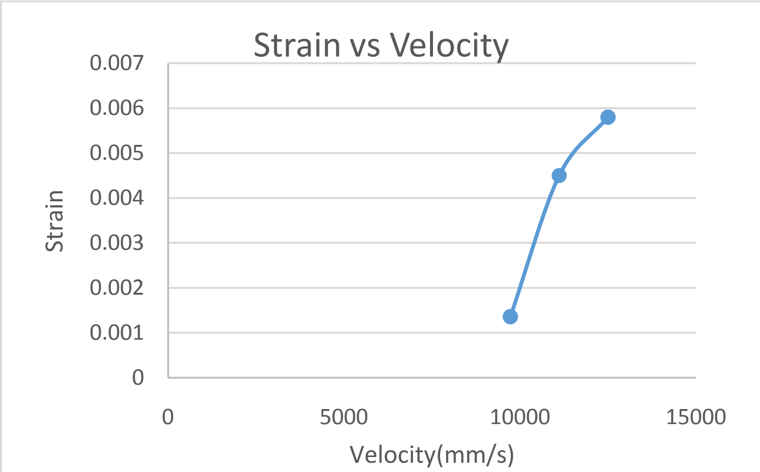


Fig. 11 Equivalent Elastic Strain

XII. Graphical Analysis on Impact Load



At higher velocity stress goes on increasing rapidly, after attaining saturation value the alloy wheel will fail.



There is no radical change in the deformation w.r.t velocity.

XIII.FATIGUE ANALYSISLife

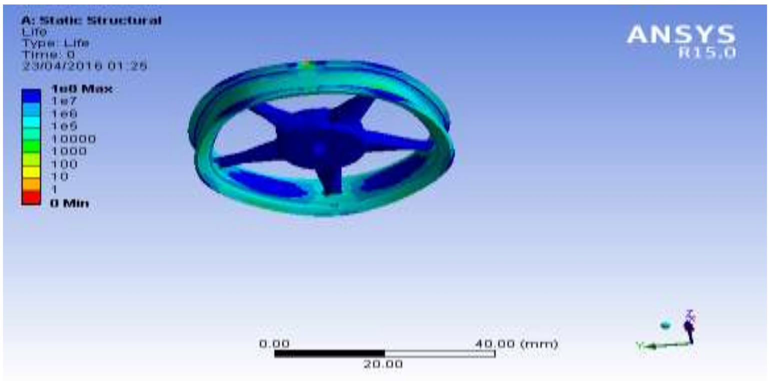
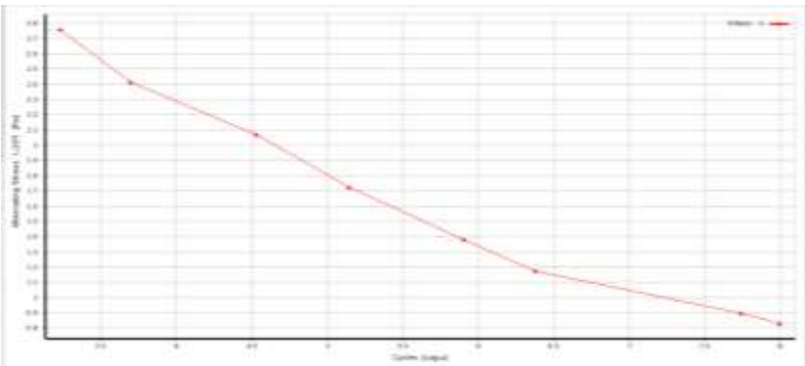


Fig. 12 Fatigue analysis on LifeLife of the wheel is10^6 cycles.

Damage:

Fig. 13 Fatigue analysis on damageStress vs. Number of cycles(S-N) Curve:



Aluminium7075 do not have a distinct limit and will eventually fail even for large stress amplitudes. In these cases, a number of cycles (usually 10^7) is chosen to represent the fatigue life of the material.

XIV.COMPARISON ON ANALYSIS DATA

- It is observed thatAluminium 7075(Yield Strength=503MPa) has high strength to weight ratio when compared with Magnesium Alloy (230MPa).
- Al7075 is less expensive than magnesium alloy
- As Magnesium is reactive in nature it undergo "metallic reaction" early than Al7075.
- Aluminium 7075 is more durable and long lasting whereas it's false in magnesium alloy.
- Magnesium alloy cannot be easily brought into its original shape once it is deformed, but not in case of Al7075.

XV. CONCLUSION

From the above table it is clear that Aluminium7075 is best material than Magnesium alloy

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