Design and Analysis of Alloy Wheels Using Various Mixtures of Alloy

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Abstract: **Alloy wheels are automobile wheels which are made from an alloy of Aluminum, carbon epoxy, E-glass epoxy, S-glass epoxy, Titanium and Magnesium is tested individually or sometimes a mixture of both among them best one is chosen. Alloy wheels differ from normal steel wheels because of their lighter weight, which improves the steering and the speed of the car. The design of a cast aluminum alloy wheel has been optimized using the Finite Element technique. It simulates the behavior of the wheel under it's working load conditions. Styling has always played a very important role in automobile design. This factor as well as the demands of new safety legislation in India and throughout the world makes it a very competitive industry. This often leads to complex car designs which need to be produced and proof tested with a minimum lead time and expenditure. The new designs and manufacturing technologies must be reliable, thus the automobile manufacturer is increasingly investigating and developing new design tools to help improve the quality of their products. Computer aided engineering helps reduce the time necessary to produce a new design. It also improves the quality of design. The quality of alloy wheel is tested using high technology devices in order to achieve the customer's needs and standards according to respective bodies.**

***Keywords*: Alloy Wheels, Aluminum, Ansys.**

I. INTRODUCTION

Components which are manufactured from cast alloys have been widely utilized in automotive industry, due to its high strength to weight ratio, low cost and better fuel consumption. The strength of the spot welds in the uni-body vehicle structure determines the integrity of the structural performance during the vehicle operations. Automotive wheels have complicated geometry and must satisfy manifold design criteria, such as style, weight, manufacturability, and performance. The combination of the stress states and geometric shapes of the spot welds lead to stress concentration that can result in fatigue crack initiation around the spot weld.

The efficiency of machining operation especially milling process is always determined by the material removal rate, tool wear and cycle time. 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. Early wheels were simple wooden disks with a hole for the axle. Because of the structure of wood a horizontal slice of a trunk is not suitable, as it does not have the structural strength to support weight without collapsing; rounded pieces of longitudinal boards are required. The spoke wheel was invented more recently, and allowed the construction of lighter and swifter vehicles.

Materials to produce these wheels have become has sophisticated as a design and materials can range from steel to nonferrous alloys like magnesium and aluminum. Automotive wheels have evolved over the decades from early spoke designs of wood and steel. Carry over's from wagon and bicycle technology, to flat steel discs and finally to the stamped metal configurations and modern cast and forged aluminum alloys rims of today's modern vehicles historically successful designs arrived after years of experience and extensive field testing. Since the 1970's several innovative methods of testing well aided with experimental stress measurements have been initiated.

The handling of a vehicle is always improved with light weight. As in case of ride, the lighter the unsprung weights are more easily controlled in the motion of the tire wheel and the better the adhesion to the road surface. Another factor in handling has to do with wheel strength and flex. A more rigid wheel will reduced wheel flex during cohering and improve tire performance. This is especially important with low aspect ratio, high performance tires that can be generate high cornering forces. Car wheels are divided 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 joined (welded) together.

II. The Design Criteria

i. The wheel is required to be an aesthetically pleasing feature of a car.
ii. It is classified as a safety component of a vehicle.
iii. It is a very highly stressed safety component
iv. Modern car manufacturers have to meet very strict reliability specifications

v. Fuel consumption must be reduced to a minimum, this means that
vi. cars must be as light as possible, because these two factors are directly related
vii. They are required to recycle as much of the material used in the
viii. product as possible and keep all manufacturing costs to a minimum
ix. Car companies are producing cars with a reduced design cycle time.

All these factors lead to a very competitive design process. To ensure the future of the manufacturer it is now vital for them to be able to produce the component quickly, inexpensively with a proven design approach which satisfies the required reliability.

III. EXPERIMENTAL SET UP

CAD Design of Wheel

The CAD design of wheel is prepared based on the standard nomenclature at the outer and the hub region of the wheel. Figure 1 shows the CAD design of the wheel rim before optimization.

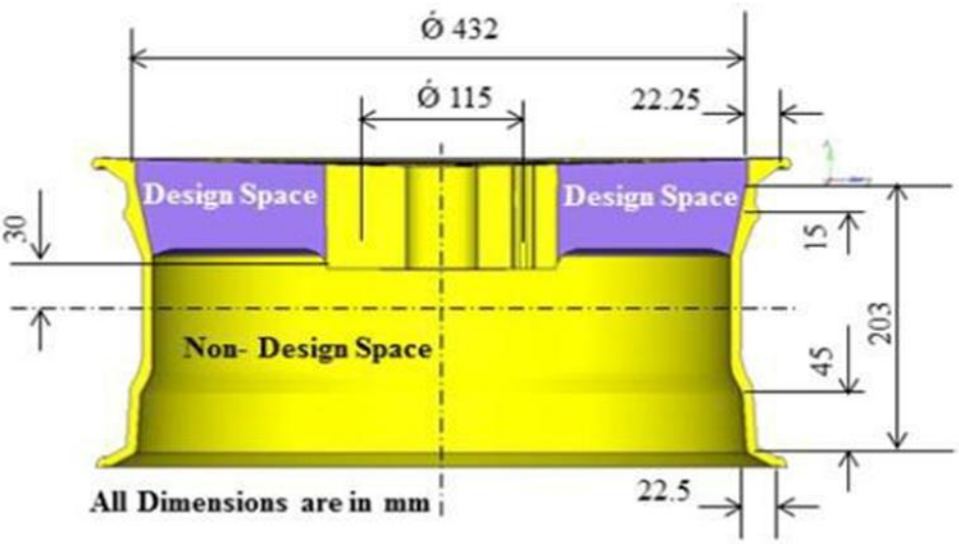

Figure 1: CAD design of rim before optimization

IV. STRUCTURAL ANALYSIS OF CIRCULAR SECTION:

Loads and boundary conditions:

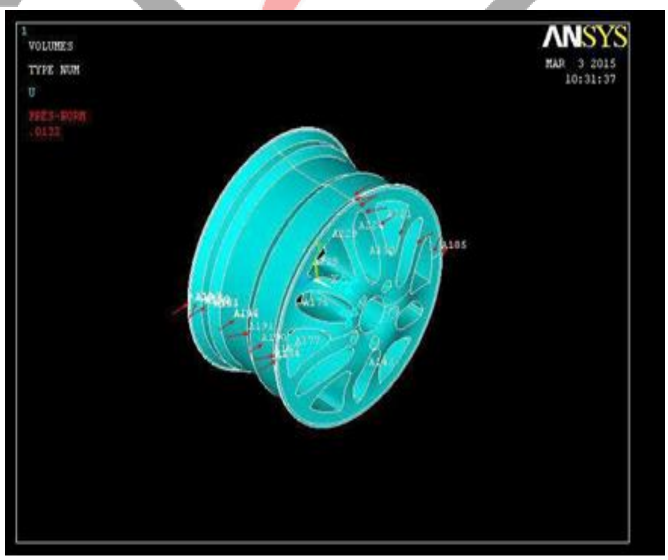

Figure 2: Loads and boundary conditions

Meshing

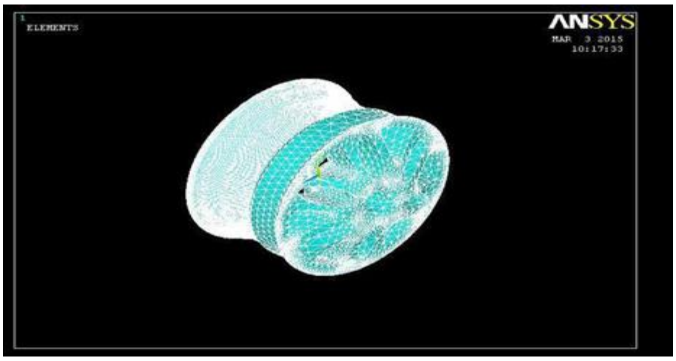

Figure 3: Meshing

i. Aluminum alloy

1. Equivalent stress

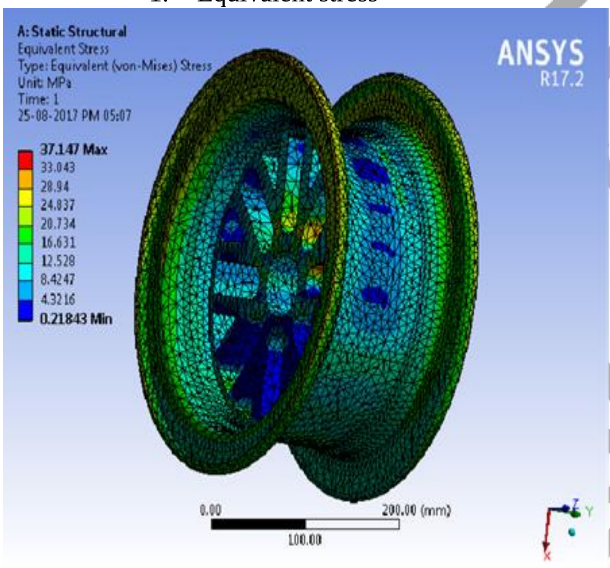

Figure 4: Equivalent Stress

2. Equivalent elastic strain

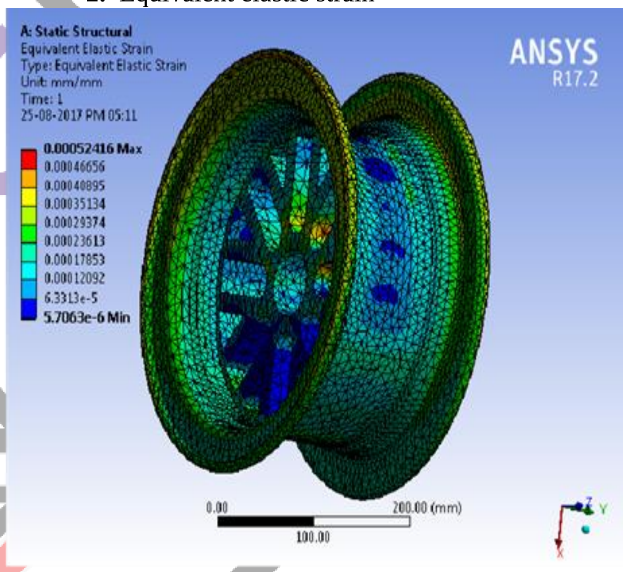

Figure 5: Equivalent elastic strain

3. Total deformation

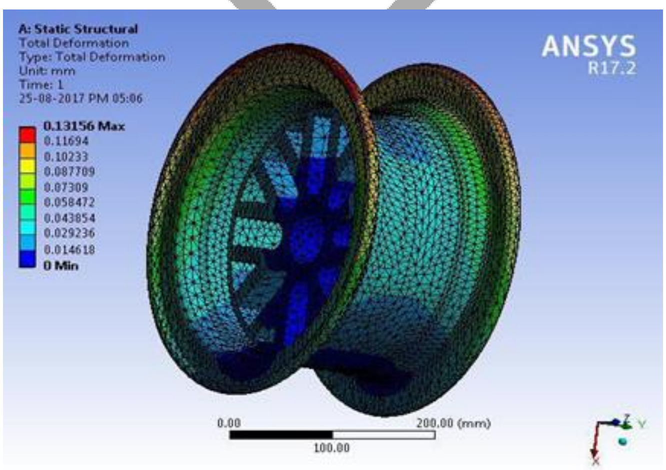

Figure 6: Total Deformation

ii. Carbon/epoxy

1. Equivalent stress 2. Equivalent elastic strain

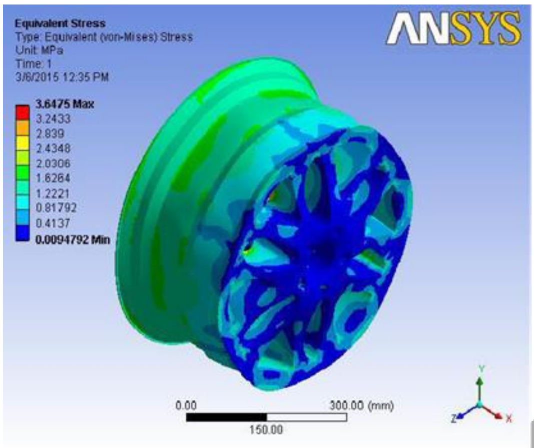

Figure 7: Equivalent Stress

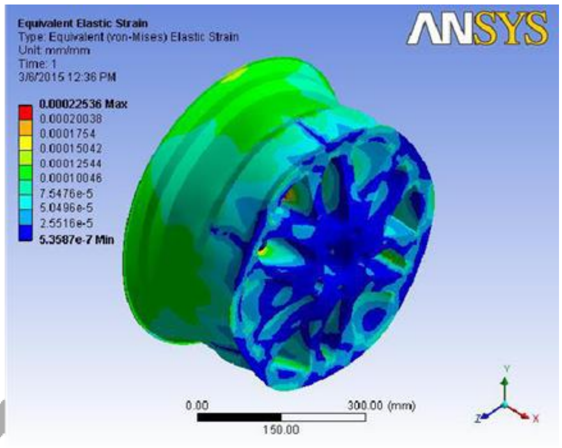

Figure 8: Equivalent elastic strain

3. Total deformation

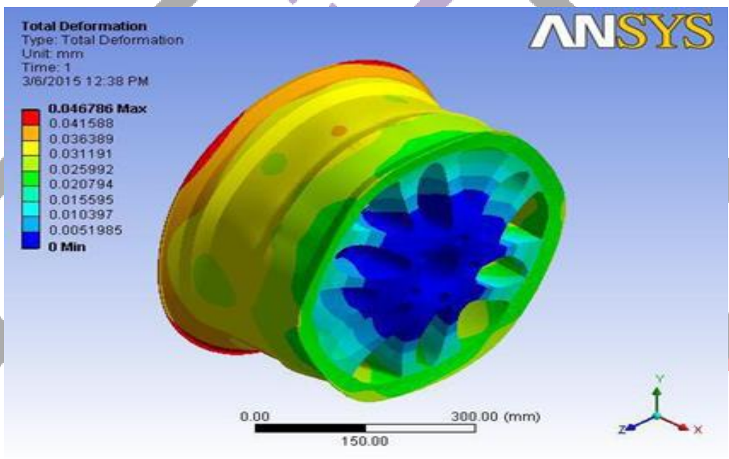

Figure 9: Total Deformation

iii. E-glass/epoxy

1. Equivalent stress 2. Equivalent elastic strain

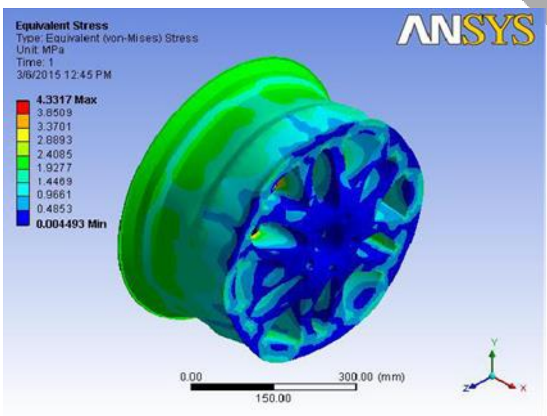

Figure 10: Equivalent Stress

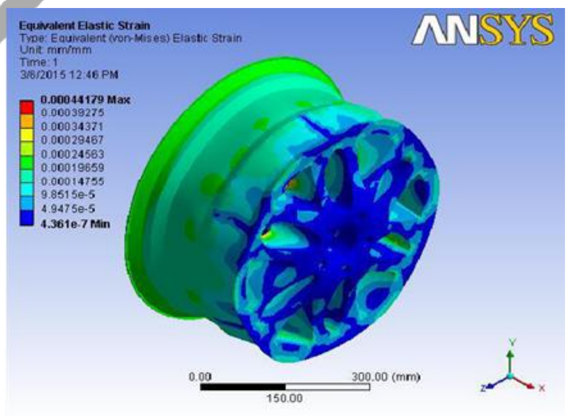

Figure 11: Equivalent elastic strain

3. Total deformation

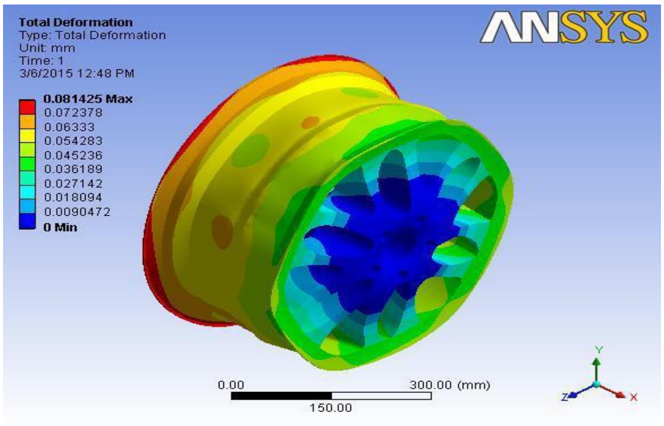

Figure 12: Total Deformation

iv. S-glass/epoxy

1. Equivalent stress

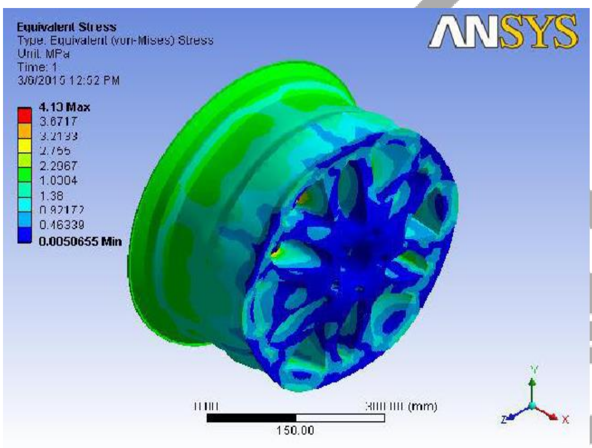

Figure 13: Equivalent Stress

2. Equivalent elastic strain

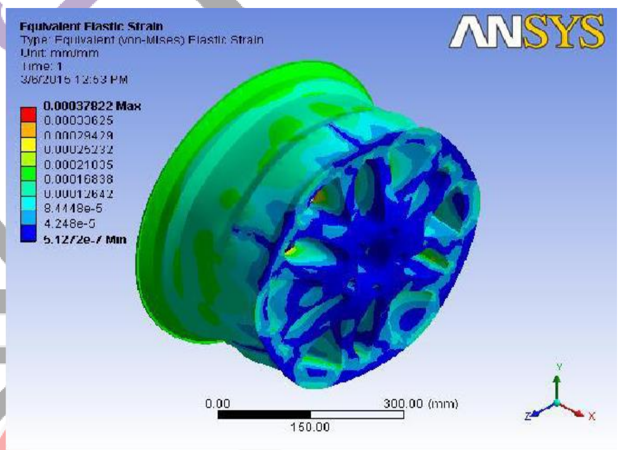

Figure 14: Equivalent elastic strain

3.Total deformation

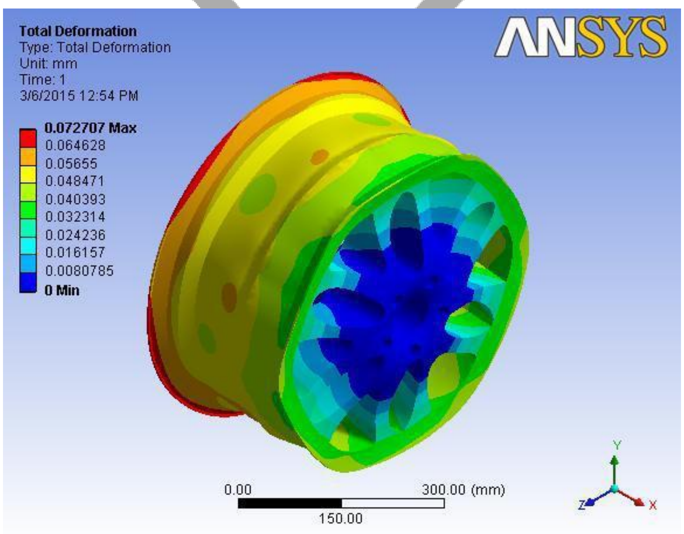

Figure 15: Total Deformation

v. Magnesium alloy

1.Equivalent stress

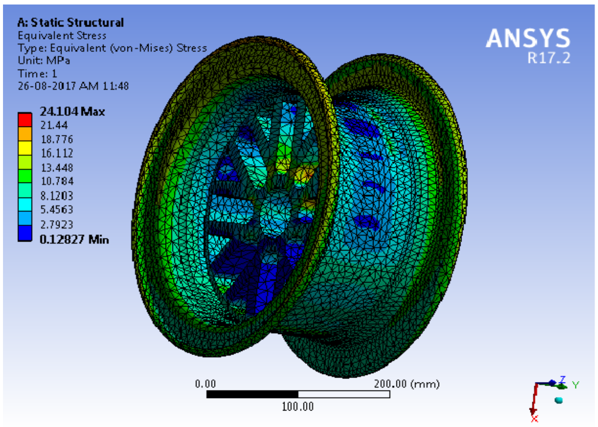

Figure 16: Equivalent Stress

2. Equivalent elastic strain

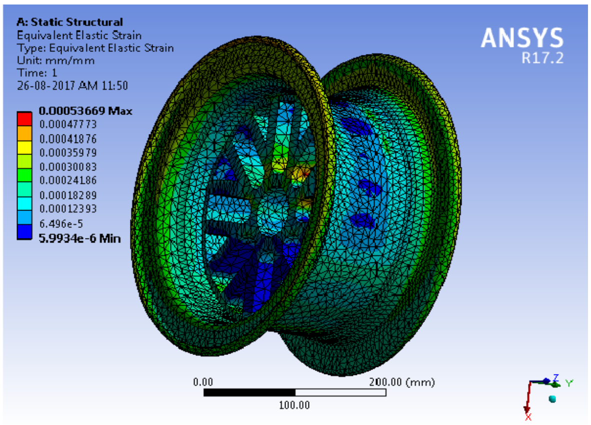

Figure 17: Equivalent elastic strain

3.Total Deformation

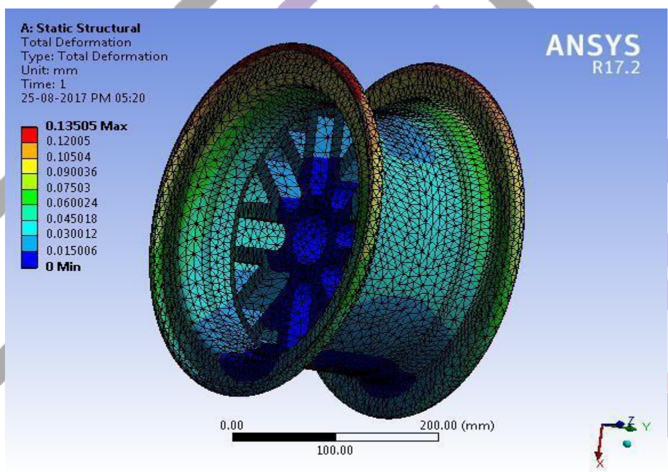

Figure 18: Total deformation

vi. Titanium Alloy

1. Equivalent stress

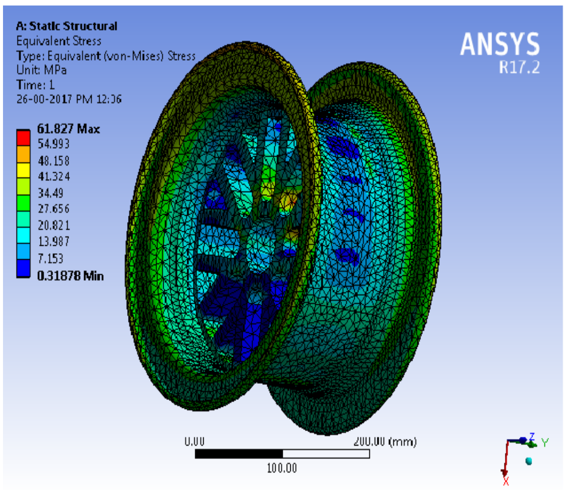

Figure 19: Equivalent Stress

2. Equivalent elastic strain

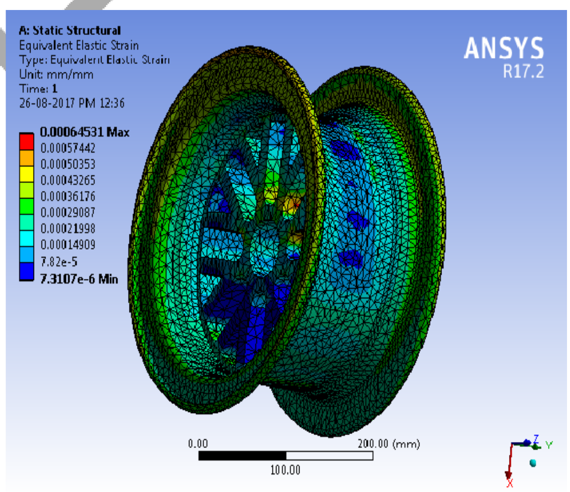

Figure 20: Equivalent elastic strain

3.Total Deformation

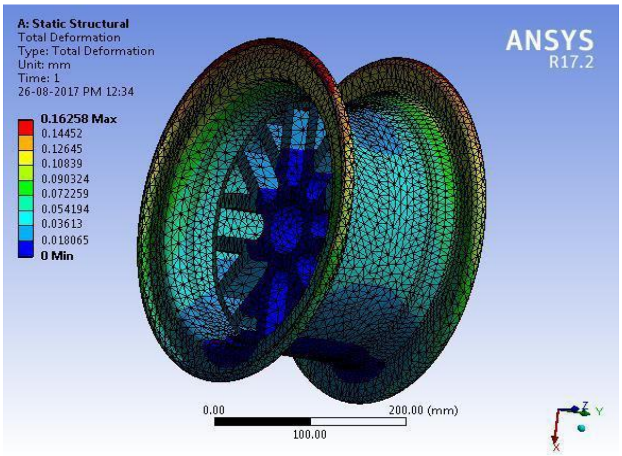

Figure 21:Total deformation

Table 1: Comparison of various Alloy

Properties	Aluminium alloy	Magnesium alloy	Titanium alloy	Carbon/epoxy	E-glass/Epoxy	S-glass/Epoxy
Total Deformation	0.13156 mm	0.13505 mm	0.16258 mm	0.046mm	0.12mm	0.013mm
Equivalent Elastic Strain	5.2416e-004 mm/mm	5.3669e-004 mm/mm	6.4531e-004 mm/mm	2.24531e-004 mm/mm	4.4531e-004 mm/mm	3.7431e-004 mm/mm
Equivalent stress	37.147 MPa	24.104 MPa	61.827 MPa	36.4 MPa	43.3 MPa	41.3 MPa

V. CONCLUSION

From the above analysis on imported design we conclude that aluminum alloy has better sustainable properties when compared to other alloy materials, which has better deformation factors and stress now a days Aluminum alloy is widely used because it has good Equivalent Elastic Strain and deformation coefficient. But composite material has better advantage than aluminum alloy material because of its low weight, low deformation factor and high stress handling properties

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