Analysis of four wheel rim by using peek composites

[1]gnanasekaran m, [2]Praveenkumar j, [3]Prasannakumar m, [4]Logesh e, [5]Lokeshwaran n
[1]Assistant Professor, [2]UG Student, [3]UG Student, [4]UG Student, [5]Assistant Professor
Sri balaji Chockalingam Engineering college,arni 632317

Abstract - **Wheel plays a vital role of vehicle suspension which guides the static and dynamic load during vehicle action. Four wheeler should withstand the load while carries the heavy load of occupants considering self weight also. So that the automotive industries mostly exploring the polymeric material in order to get lesser weight without substantial loss in vehicle quality and reliability.To achieve this weight reduction the material used for manufacturing the wheel rim should be the composite materials with the identical or superior mechanical properties than the conventional rims. The materials used are Polyether ether ketone (PEEK) materials which are expressed as polyether ether ketone. In this project, analysis of the Car wheel rim is carried out for weight reduction. The results of materials are compared with one another and the one with best mechanical properties is considered as the alternate material for the conventional rim wheel. Using this method, the life cycle of the rim was enhanced to 1*10e6 meet their design requirement. On analysis by implementing different PEEK composites we find that PEEK–90 HMF 20 suits the best for manufactured the wheel rim material.**

keywords - **peek composites, wheel rim, SOLIDWORKS & ANSYS Software.**

I . INTRODUCTION

The wheel is a part that permits efficient movement of an object across a surface where there is a force pressing the object to the surface. The spoke wheel rim assembly contributes the major weight addition in motorcycle after engine. To overcome this disadvantage alloy wheels are invented. While comparing all alloy materials aluminium alloy is the best of other alloy materials.1 The automotive industry faces increasing pressure to maximize performance while minimizing weight and cost to produce more fuel efficient vehicles. Composite materials: A new kind of material which is formed due to combination of two or more metals or nonmetals is known as composite materials.

Generally composite materials are lighter and stronger than conventional metals. Thermoplastic composite materials consist of thermoplastic resins as matrix, reinforcement with traditional fibers as thermo sets matrix. They have shown great promise as materials for current and future automotive, aerospace and industrial applications. Composite material wheel is different from the light alloy wheel,2,3 and it is developed mainly for low weight. However, this wheel has inadequate consistency against heat and for best strength.PEEK (polyether ether ketone) polymer continues to successfully replace steel, aluminium, bronze, titanium, and other high–performance materials, because it offers an ideal combination of mechanical, thermal and aluminium spokes logical properties, combined with excellent resistance to grease, oils, acids and all other automotive fluids. PEEK is an ideal replacement for Aluminium alloy. PEEK is particularly useful in the automobile industry for its weight.

II . LITERATURE SURVEY

Some of the researchers research on the field of rim design and analysis Manivannan R et al. has been analysis on reduction of weight of a vehicle wheel, they found that materials are compared with one another and the one with best mechanical properties is considered as the alternate material for the conventional rim wheel. Using this method, the life cycle of the rim was enhanced to 1*10e6 meet their design requirement. On analysis by implementing different PEEK composites they found that PEEK–90 HMF 20 suits the best for manufactured the wheel rim material. Jufu Jiang et al. was prepared on the wheel edge material mechanical properties and microstructure of the AZ91D magnesium amalgam cruiser wheels framed by twofold control shaping and bite the dust throwing and the micrographs that the high weight brought about by fashioning framework results in clear grain refinement of the essential a-Mg and uniform dissemination of the eutectic comprising of the eutectic a-Mg and b-Mg Al. They found that for the assembling of wheel edge through manufacturing framework is included into cold-chamber kick the bucket throwing machine to density the microstructure and evacuate the throwing abandons by methods for the producing weight. They found that on numerical reenactment of bike wheel demonstrated that the speed size in wheel rib was littler than that in different positions. Accomplished by the rapid willing in the infusion methodology and the mechanical properties of the parts can extraordinarily improve by the producing weight.

III. THEORY OF RIMS

The tire rim in as a wheel simply after it is set up on the edge and is expanded accordingly; the tire and wheel get together influences the capacity and execution of the vehicle. The tire is planned and produced to suit a standard edge and once introduced on the right edge rim, the tire will perform up to its favored dimension. It is obviously that the life of the tire will be diminished in the event that it is introduced on an unsatisfactory rim. Once the disc plate is fixed inside the cylinder this assembly becomes a wheel. When designing wheel, two major factors must be considered, such as safety and engineering standards. The wheel mainly consists of rim and spokes [4,5]. The shape and size of the wheel isspecified in standard according to JATMA. In this research, the market is the target to design a lightweight vehicle wheel. Therefore, the design is lightweight while satisfying the safety. The specifications of the wheel: rim diameter 355 mm, rim width is 165 mm, offset ET 45 mm, pitch centre diameter PCD 100 mm, hub centre diameter 59 mm.

Orthogonal experimental design is a common technique for optimization. It is based on probability theory, quantitative statistics and practical experience. The test scheme of the quasi-orthogonal table is arranged, and the results are calculated and analyzed. It is a design method to find the optimal test scheme quickly. The advantage of orthogonal design is that it greatly reduces the test. The frequency of inspection improves the working efficiency. Using orthogonal experimental design can be more efficient for wheel design and analysis. The three dimensional model of the wheel is below.

IV. MATERIAL USED

The molds used in these experiments are. CF/PEEK plain weave fabrics were placed layer by layer. For the molding of the flexible mixed premix, three stages of the heating process were adopted [19–21]. In the first stage, the pre-prepreg was preliminarily compacted by preloading to form the necessary shape of each layer.

Used materials are:

I. PEEK Composites.
II. Aluminium alloy .
III. Magnesium alloy.

4.1 MATERIAL PROPERIES

Table 1.PEEK Composite material properties

NO	Properties		Values
1	Density	(Kg/m3)	1370
2	Young's modulus	(MPa)	22000
3	Poisson's ratio		0.4556
4	Tensile Yield Strength	(MPa)	280
5	Compressive Yield Strength	(MPa)	270
6	Tensile Ultimate Stength	(MPa)	100

Table 2. Aluminium alloy Material Properties.

NO	Properties		Values
1	Density	(Kg/m3)	2685
2	Young's modulus	(MPa)	69000
3	Poisson's ratio		0.3
4	Tensile Yield Strength	(MPa)	229
5	Compressive Yield Strength	(MPa)	250
6	Tensile Yield Strength	(MPa)	279

Table 3. Magnesium alloy material Properties.

NO	Properties		Values
1	Density	(Kg/m3)	1830
2	Young's modulus	(MPa)	16000
3	Poission's ratio		0.35
4	Tensile Yield Strength	(MPa)	450
5	Compressive Yield Strength	(MPa)	372
6	Tensile Yield Strength	(MPa)	345

V.MODELLING OF RIM

Figure 1. Modeling Sketch of Rim model.

VI. RESULTS AND DISCUSSION

VI.1 . Analysis of RIM on ANSYS Software.

Aluminium alloy RIM

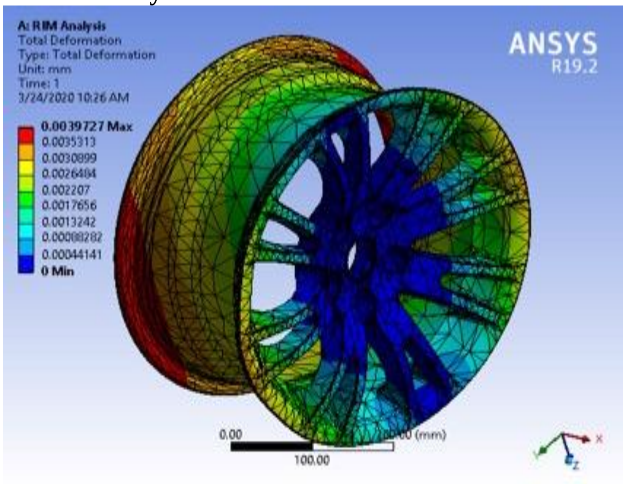


Figure 2. Total deformation of Al-alloy RIM.

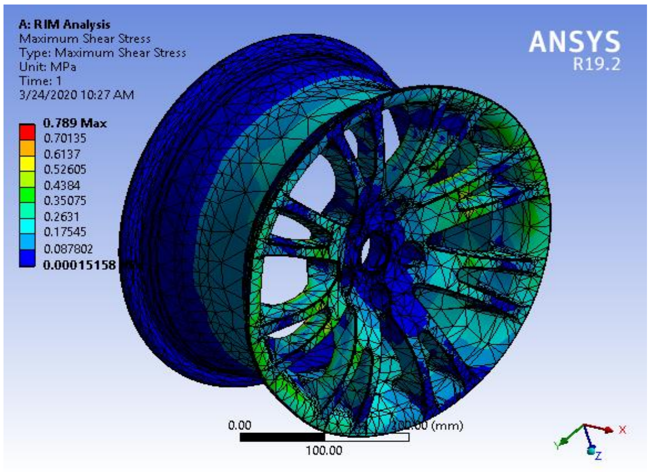


Figure 3. Maximum shear stress of Al-alloy RIM.

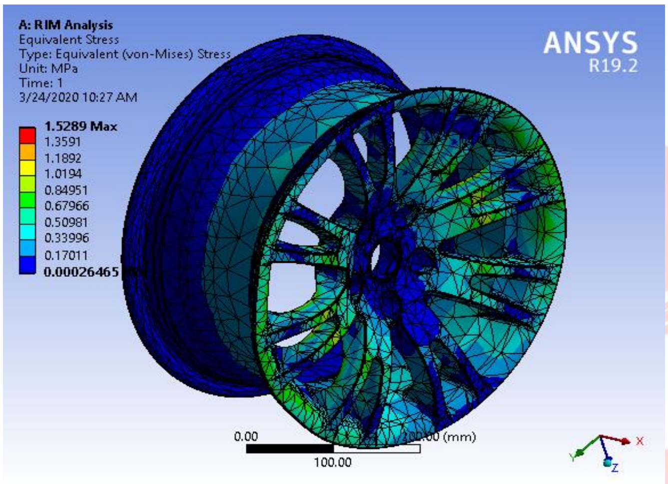


Figure 4. Von-mises stress of Al-alloy RIM.

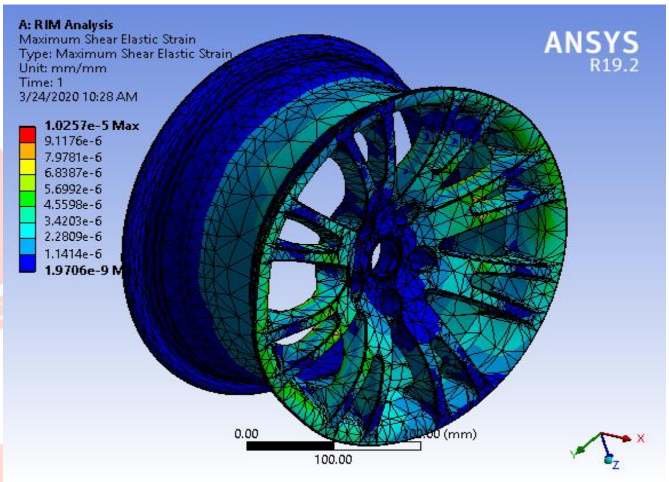


Figure 5. Maximum shear elastic strain of Al-alloy RIM.

MAGNESIUM ALLOY RIM.

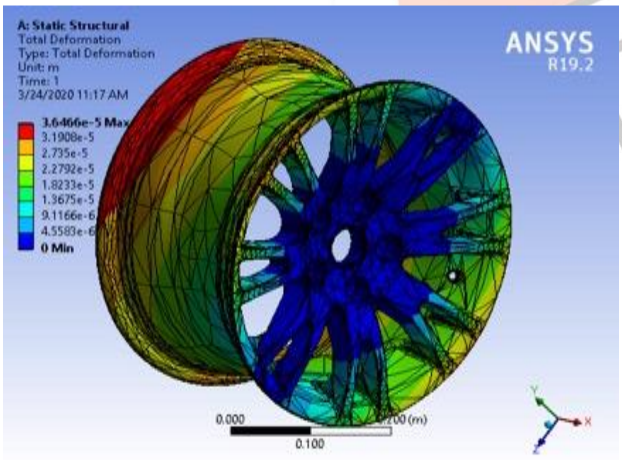


Figure 6. Total deformation of Mg-alloy RIM.

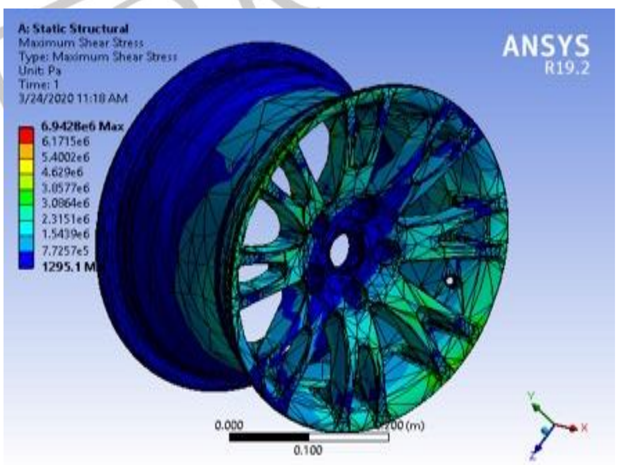
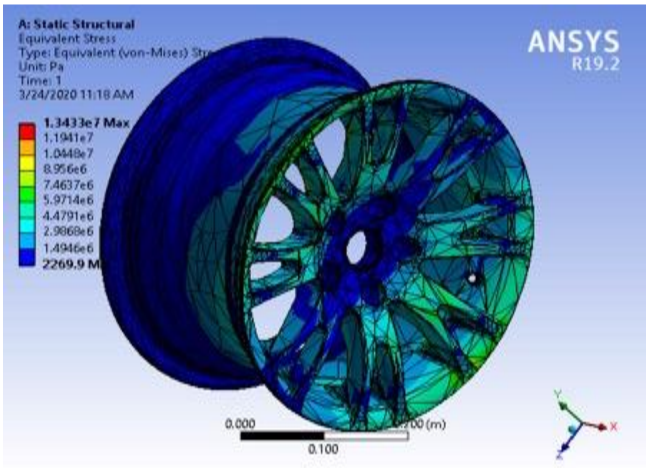


Figure 7. Maximum shear stress of Mg-alloy RIM.



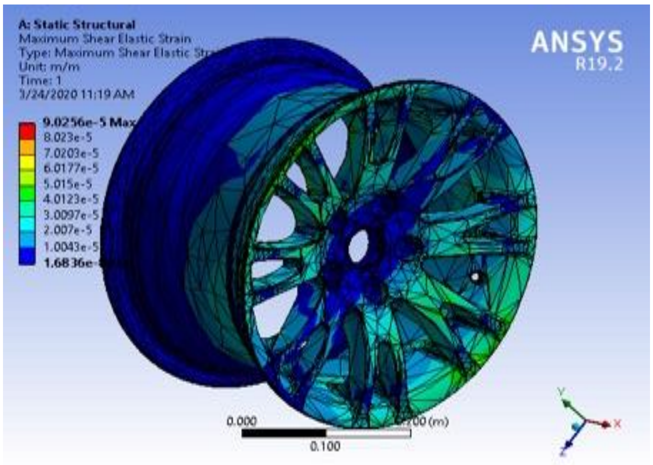
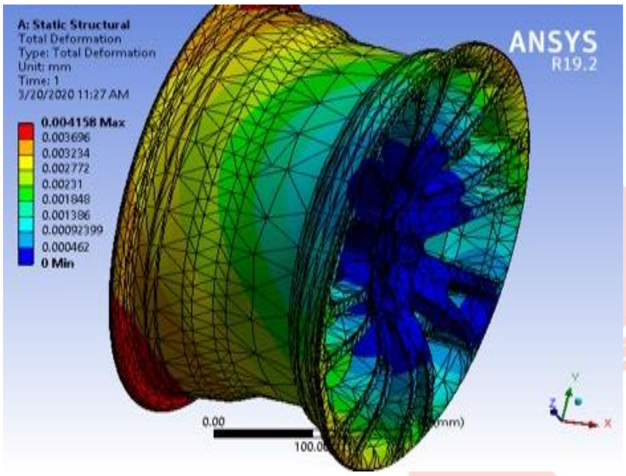


Figure 8. Von-mises stress of Mg-alloy RIM. **Figure 9.** Maximum shear elastic strain of Mg-alloy RIM.

PEEK COMPOSITE MATERIAL RIM.



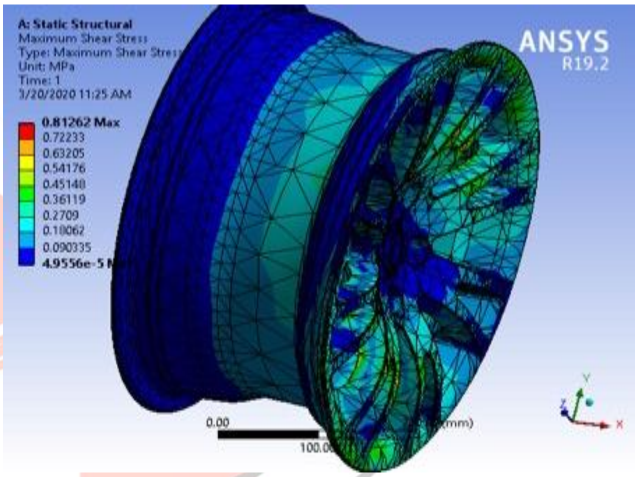
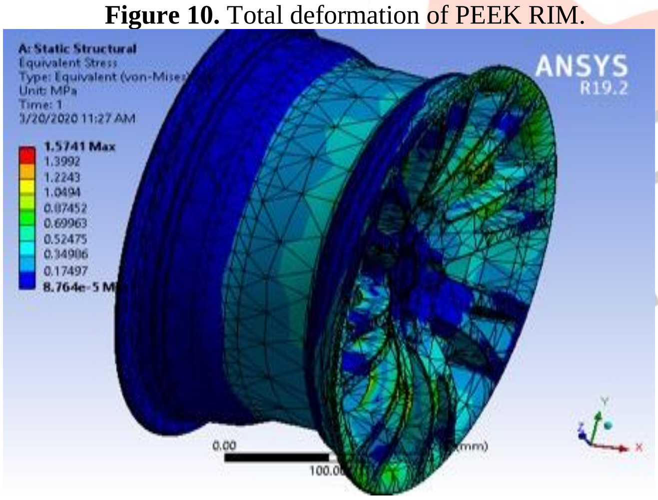


Figure 10. Total deformation of PEEK RIM. **Figure 11.** Maximum shear stress of PEEK RIM.



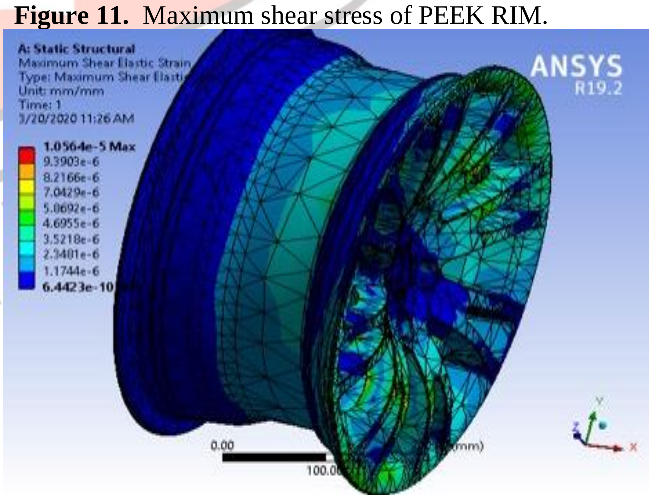


Figure 12. Von-mises stress of PEEK RIM. **Figure 13.** Maximum shear elastic strain of PEEK RIM.

VII. RESULT TABLES

S.NO	Material	Weight ,W (Kg)	Deformation, x(mm)	Von-mises stress, σ (MPa)
1.	Aluminium Alloy	15.761	1.052	14.41
2.	Magnesium Alloy	12.544	0.932	14.43
3.	PEEK Composite Material	8.041	0.851	14.28

VIII. CONCLUSION

Finite Element analysis of the four wheeler rim using Aluminium alloy and PEEK Composites has been done using ANSYS Workbench. The life cycle prediction helps to identify the durability of the material. The rim was modeled as per standards and analyzed for different materials such as Aluminium Alloy, Magnesium alloy, and PEEK (Polyether ether ketone),. From obtained results optimization was carried out.The weight of rim is reduced from 15.761Kg to 8.041Kg while using PEEK material when compare to Aluminium Alloy material. However, the deformation and stress of PEEK material is nearly to Aluminium alloy material. The weight of PEEK 90 HMF 20 material is 8.041kg.

Finally from the results it is clear that PEEK 90HMF20 is best material to replace Aluminium Alloy (A356.2) material owing to reliability and safety aspects.

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