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DESIGN ANALYSIS OF A COMPOSITE RIM FOR DOMESTIC CAR

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Abstract: Fabric composites have good mechanical properties and excellent formability for fabricating complex shapes such as a dome and egg-box panels. Because the vehicle rims made of a fibrous composites have been proved to provide excellent mechanical performances such as high fuel efficiency many efforts have been made to accomplish the mass production of the composite rims. In this project we will develop a composite car rim using existing rim design and test it under real time conditions, software's used for this study are Catia v5 and Ansys 15, in this study we will study the model behaviour of the rim under dynamic conditions.

INTRODUCTION

Introduction of Rims

A rim is a circular device that is capable of rotating on its axis, facilitating movement or transportation while supporting a load (mass), or performing labour in machines. Common examples are found in transport applications. A rim, together with an axle overcomes friction by facilitating motion by rolling. In order for rims to rotate, a moment needs to be applied to the rim about its axis, either by way of gravity, or by application of another external force. More generally the term is also used for other circular objects that rotate or turn, such as a ship's rim, steering rim and flyrim. The rim 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 rims were simple wooden disks with a hole for the axle. Because of the structure of wood, a horizontal slice of a trunk isn't appropriate, because it doesn't have the structural strength to support weight while not collapsing; rounded items of longitudinal boards are needed. The spoke rim was invented more recently, and allowed the construction of lighter and swifter vehicles. There are only a few types of rims still in use in the automotive industry today. They vary considerably in size, shape, and materials used, however all follow identical basic principles. The first type of rim worth mentioning, and by far the most-used rim, is the steel rim. This kind of rim consists of several sheets of steel, stamped into shape and typically welded together. This type of rim is strong, but heavy. They are found on every kind of vehicle from sports cars to the larger pickup trucks; the rims look different but are essentially the same device.

LITERATURE REVIEW

[1] M. Ravichandra, "Design and Structural Analysis of Alloy Rims for Light Weight Vehicles"
At present a four rimer vehicle rims are made of Aluminium Alloys. In this project, Aluminium alloy rim are compared with other Composite Alloys. Namely Carbon epoxy, E glass/epoxy, S glass/epoxy. In this project a parametric model is designed for Alloy rim used in a four rimer by collecting data from reverse engineering process from existing model. The design is evaluated by analyzing the model by taking the constraints as final stresses and variables as 3 totally {different|completely different} Composite Alloy materials and different masses and goals as most outer diameter of the rim and fitting accessories areas like shaft of the axle and bolts PCD of the car. The parametric model is completed in Pro-E and analysis is completed in Ansys twelve.0. Our style and construction of a bucket air cooler by victimization alternative energy is new different to standard energy sources. We tend to embark on produce|to make|to form} AN air cooler that doesn't create any harmful emissions in the atmosphere and supply no pollution within the encompassing. The solar energy because the main energy sources to assist within the project work. it's providing to cooling the space and additionally measured the temperature levels of before and when in absorbed space.

[2] Sourav Das, "Design and Weight Optimization of Aluminium Alloy Rim"
With the design of aluminium alloy rim for automobile application this is carried out paying special reference to optimization of the mass of the rim. The Finite Element analysis it shows that the optimized mass of the rim rim could be reduced to around 50% as compared to the existing solid disc type Al alloy rim. The metallic element analysis shows that the strain generated within the optimized part is well below the particular yield stress of the Al alloy. The Fatigue life estimation by finite element analysis, under radial fatigue load condition, is carried out to analyze the stress distribution and resulted displacement in the alloy rims. S-N curve of the part depicts that the endurance limit is ninety MPa that is

well below the yield stress of the fabric and safe for the applying. The FE analysis indicated that even after a fatigue cycle of 1020, the damage on the rim is found only 0.2%.

[3] Shailesh Pandit, "Review of Automobile Rim Rim Design, Materials and Its"

Over the years loads deal} of labor has done and continues to be continued with great effort to save lots of weight and value of applications. This trend is to produce weight/cost-effective product that meets the rigorous needs. The aim of this paper is to study Automobile Rim Rim Design, Materials and its various Considerations for best design. Review is done for materials and design process used for rim rim.

MODELING

CATIA: There are different modules in CATIA using which a model with required specifications can be designed. Most of the components designed using CATIA are sketched placed and derived figures. Unlike a sketched feature, the placed feature is created without drawing a sketch that defines the shape of the sketched feature. The sketcher workbench provides space and tools for drawing sketches of the solid model.

PART MODELING: The Version five half style application makes it doable to style precise 3D mechanical components with an associate intuitive and versatile program, from sketching in associate assembly context to repetitive elaborated style. Version five half style application can modify you to accommodate style necessities for components of varied complexities, from straightforward to advance. This application, which mixes the ability of feature-based style with the pliability of a mathematician approach, offers an extremely productive and intuitive style atmosphere with multiple style methodologies, like post-design and native 3D parameterization.

ANALYSIS

Structural analysis of model 3 using A356 aluminium alloy

Geometry

Fig: 4.78 Geometry of model 3, A356 aluminium alloy

Mesh

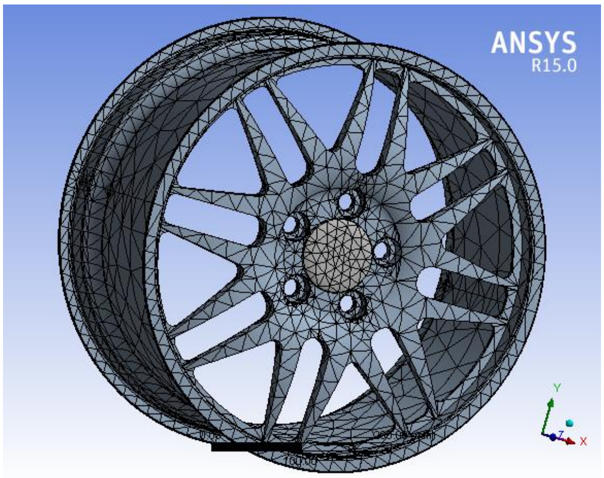

Fig: 4.79 Meshed model 3, A356 aluminium alloy

Boundary conditions

Fig: 4.80 Applying boundary conditions on model 3, A356 aluminium alloy

Structural analysis of model 3 using aluminium/silicon carbide composite

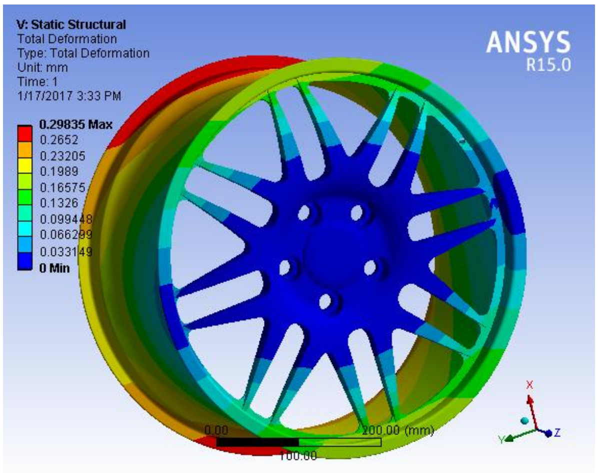

Fig: 4.98 Structural analysis of model 3, aluminium/silicon carbide composite

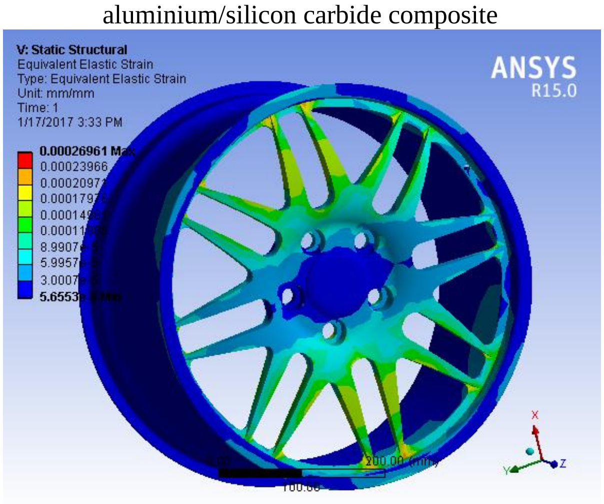

Fig: 4.99 Structural analysis of model 3, aluminium/silicon carbide composite

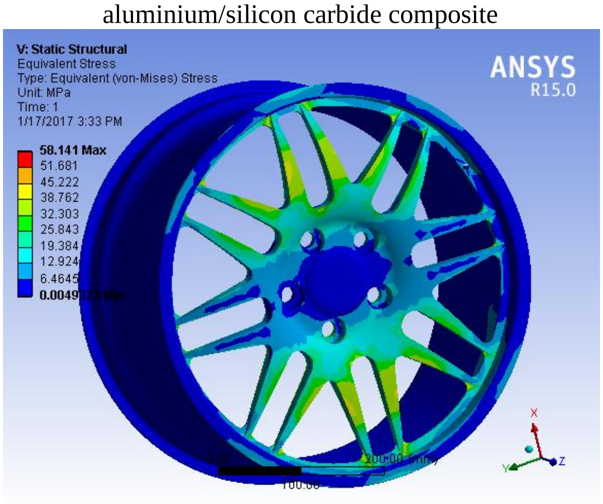

Fig: 4.100 Structural analysis of model 3, aluminium/silicon carbide composite

Modal analysis of model 3 using aluminium/silicon carbide composite

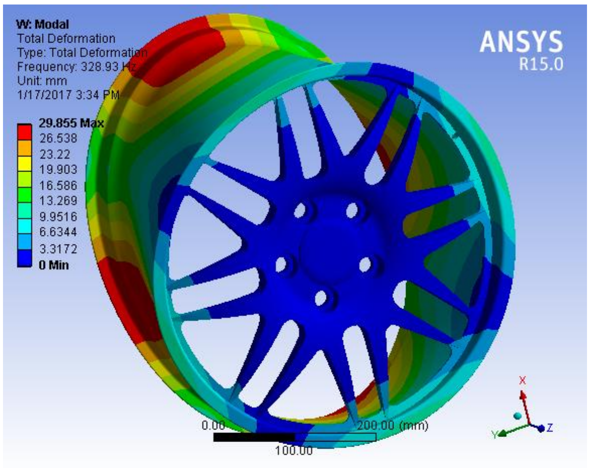

Fig: 4.101 Modal analysis (model 1), aluminium/silicon carbide composite

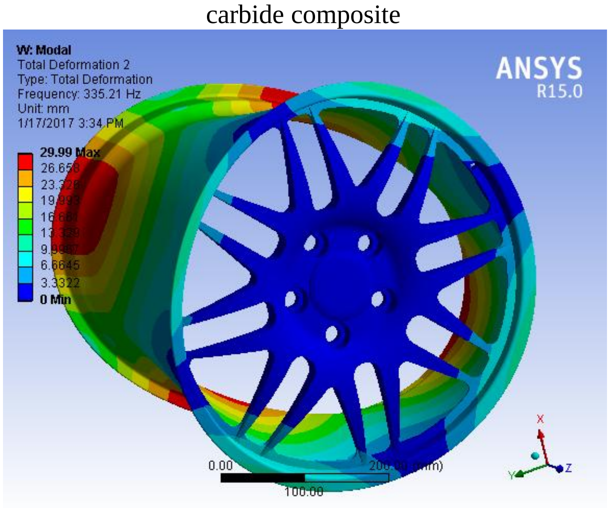

Fig: 4.102 Modal analysis (model 2) of model 3, aluminium/silicon carbide composite

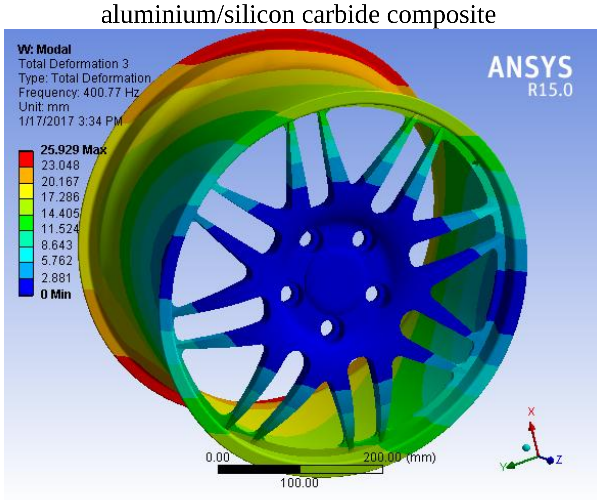

Fig: 4.103 Modal analysis (model 3) of model 3, aluminium/silicon carbide composite

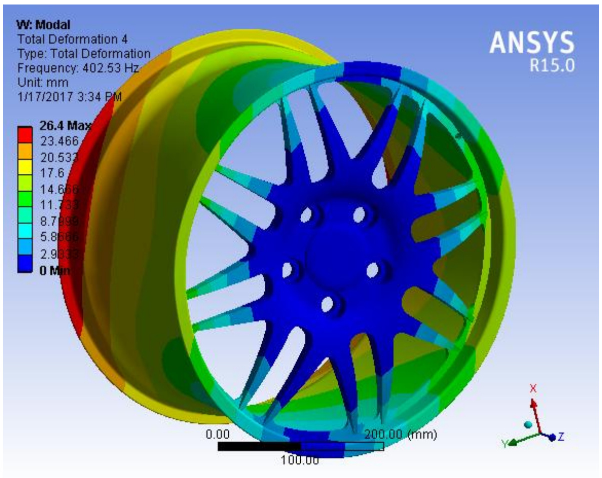

Fig: 4.104 Modal analysis (model 4) of model 3, aluminium/silicon carbide composite

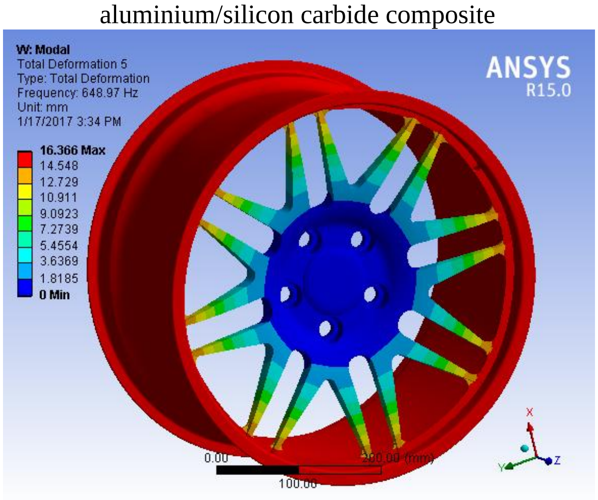

Fig: 4.105 Modal analysis (model 5) of model 3, aluminium/silicon carbide composite

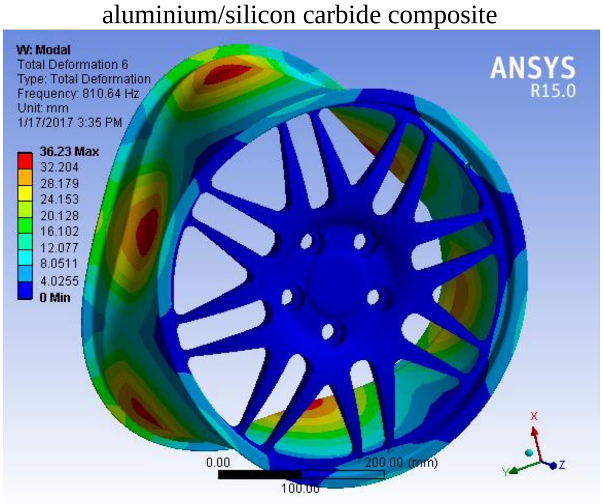

Fig: 4.106 Modal analysis (model 6) of model 3, aluminium/silicon carbide composite

Structural analysis of model 3 using AM60

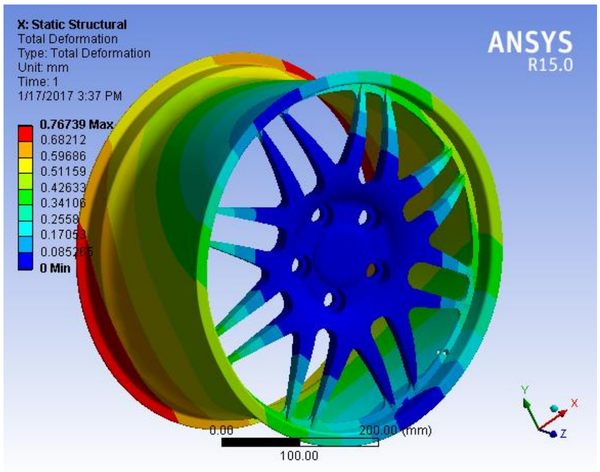

Fig: 4.107 Structural analysis (Total deformation) of model 3, AM60

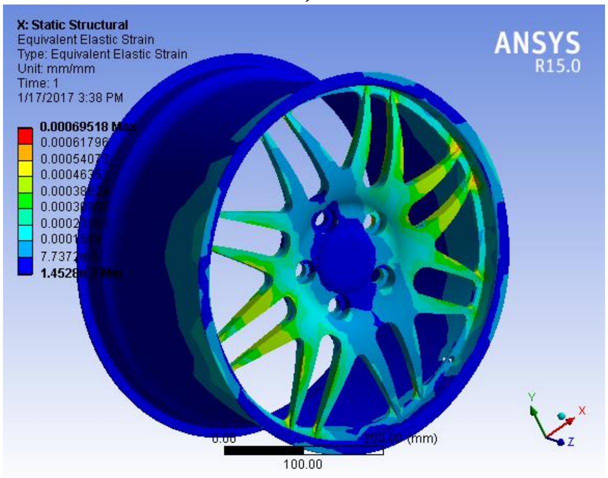

Fig: 4.108 Structural analysis (Equivalent Elastic Strain) of model 3, AM60

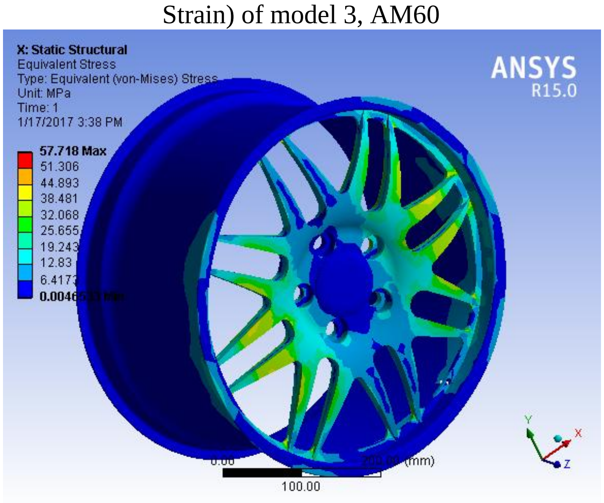

Fig: 4.108 Structural analysis (Equivalent von mises stress) of model 3, AM60

Model analysis of model 3 using AM60

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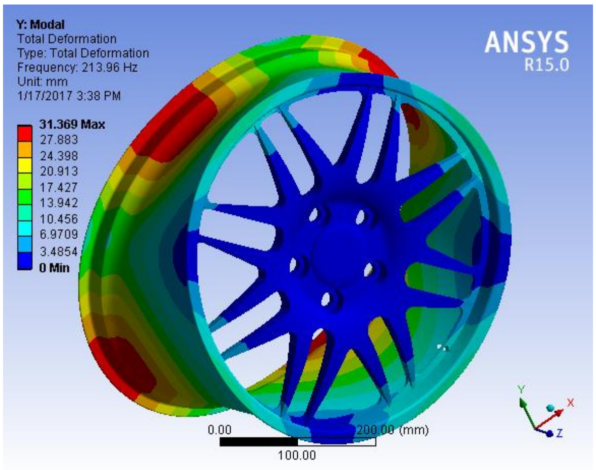

Fig: 4.109 Modal analysis (mode 1) of model 3, AM60

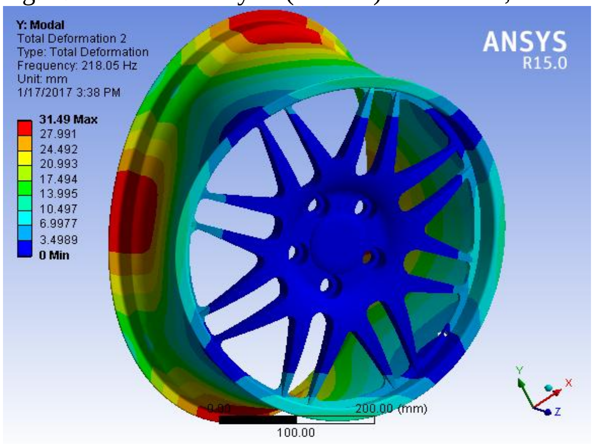

Fig: 4.110 Modal analysis (mode 2) of model 3, AM60

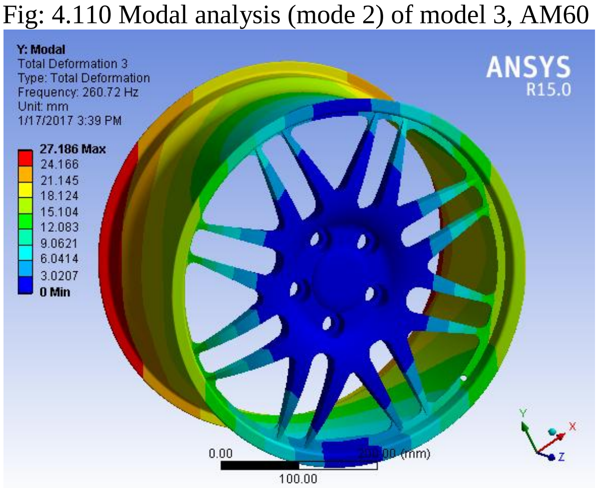

Fig: 4.111 Modal analysis (mode 3) of model 3, AM60

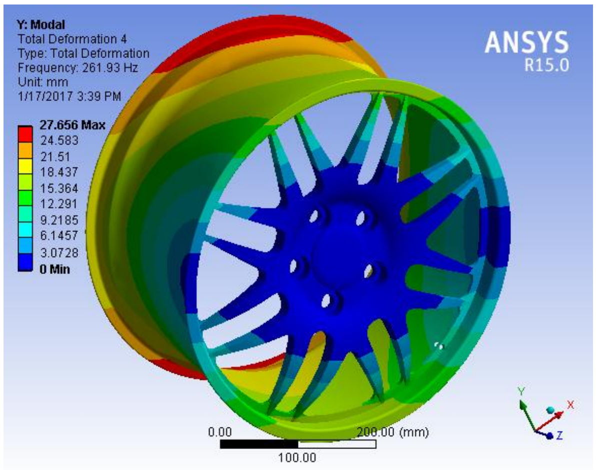

Fig: 4.112 Modal analysis (mode 4) of model 3, AM60

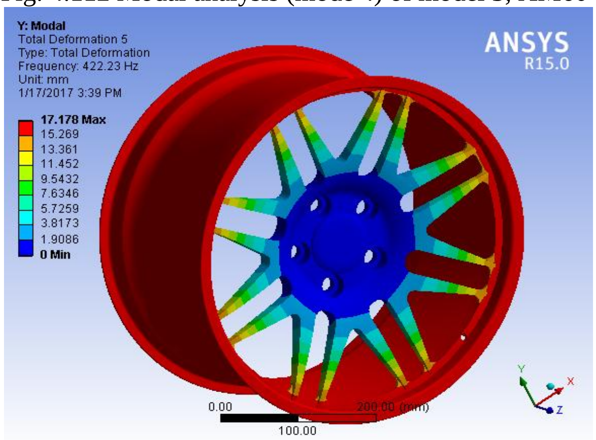

Fig: 4.113 Modal analysis (mode 5) of model 3, AM60

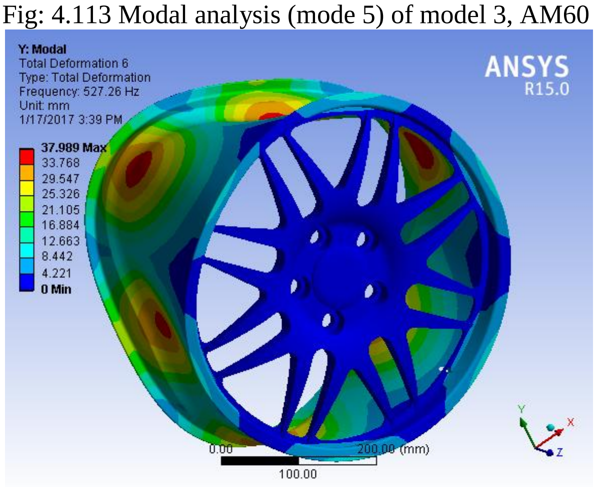

Fig: 4.114 Modal analysis (mode 6) of model 3, AM60

REPORT

Based on the values obtained during the analysis in the ANSYS software, the values are tabulated after more than 5 simulations.

Table: 5.1 Structural analysis of model

model 1	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A356 aluminium alloy	0	5.16E-02	6.09E-07	6.79E-04	1.60E-02	48.207
aluminium alumina	0	8.30E-02	9.97E-07	1.10E-03	1.39E-02	49.528
aluminium/silicon carbide composite	0	1.54E-02	1.05E-07	1.78E-04	1.53E-02	40.92
AM60	0	4.16E-02	3.12E-07	4.78E-04	2.61E-02	42.309

Table: 5.2 Modal analysis of model 1

model 1	A356 aluminium alloy	aluminium alumina	aluminium/silicon carbide composite	AM60
	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]
Mode 1	563.75	547.51	959.48	624.12
Mode 2	563.9	547.67	959.76	624.3
Mode 3	643.47	625.89	1095.7	712.76
Mode 4	643.6	626.03	1096	712.9
Mode 5	817.56	796.07	1392.7	905.9
Mode 6	906.56	883.41	1544.6	1004.7

Table: 5.3Structural analysis of model 2

model 2	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A356 aluminium alloy	0	0.52494	2.09E-07	5.14E-04	1.38E-02	36.518
aluminium alumina	0	0.83677	8.97E-07	8.13E-04	3.14E-02	36.584
aluminium/silicon carbide composite	0	0.16384	5.99E-08	1.59E-04	1.14E-02	36.645
AM60	0	0.42817	3.78E-07	4.15E-04	5.33E-03	36.714

Table: 5.4 Modal analysis of model 2

model 2	A356 aluminium alloy	aluminium alumina	aluminium/silicon carbide composite	AM60
	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]
Mode 1	271.75	265.29	463.28	301.35
Mode 2	272.35	265.89	464.29	302.02
Mode 3	318.5	310.24	542.61	352.96
Mode 4	319	310.74	543.47	353.52
Mode 5	480.2	468.96	818.79	532.61
Mode 6	582.1	565.93	991.06	644.67

Table: 5.5 Structural analysis of model 3

model 3	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
A356 aluminium alloy	0	0.95355	2.86E-07	8.74E-04	1.48E-02	58.11
aluminium alumina	0	1.5242	3.00E-07	1.37E-03	4.75E-03	57.844
aluminium/silicon carbide composite	0	0.29835	5.66E-08	2.70E-04	4.94E-03	58.141
AM60	0	0.76739	1.45E-07	6.95E-04	4.65E-03	57.718

Table: 5.6 Modal analysis of model 3

model 3	A356 aluminium alloy	aluminium alumina	aluminium/silicon carbide composite	AM60
	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]	Frequency [Hz]
Mode 1	192.89	188.44	328.93	213.96
Mode 2	196.48	192.23	335.21	218.05
Mode 3	235.07	229.48	400.77	260.72
Mode 4	236.1	230.5	402.53	261.93
Mode 5	380.35	372.26	648.97	422.23
Mode 6	474.54	466.2	810.64	527.26

These are the values obtained by conducting modal analysis on all the models and using different materials

Table: 5.7 Mass ad volume comparison of three different models

	model 1	model 2	model 3
Volume (mm³)	3.51E+06	2.84E+06	2.48E+06
Mass (kg)	9.4123	7.6237	6.6585

Structural analysis of model 3 using A356 aluminium alloy, aluminium alumina composite, aluminium/silicon carbide composite and AM60

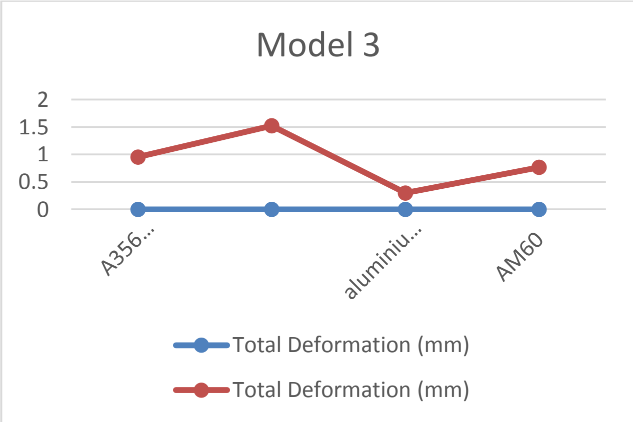

Fig: 5.9 Structural analysis (Total deformation)of model 3 using different materials

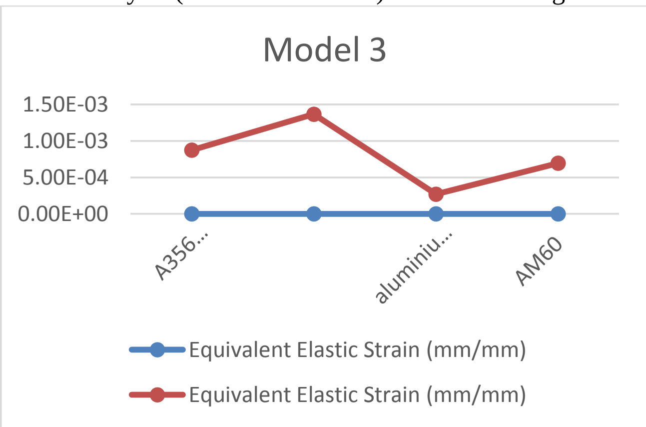

Fig: 5.10 Structural analysis (Equivalent elastic strain) of model 3using different materials

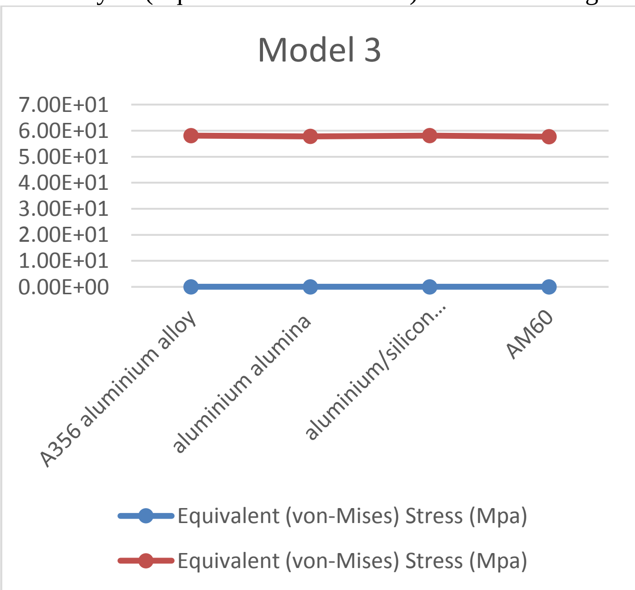

Fig: 5.11 Structural analysis (Equivalent (von-Mises) stress) of model 3 using different materials

Mass ad volume comparison of three different models:

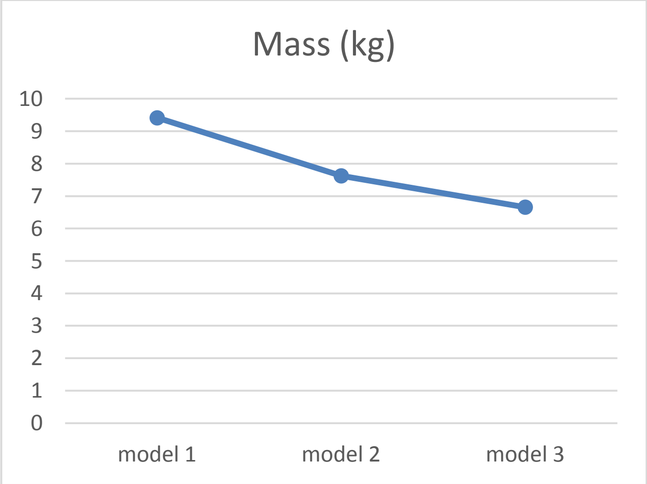

Fig: 5.13 Comparison of masses of all 3 models

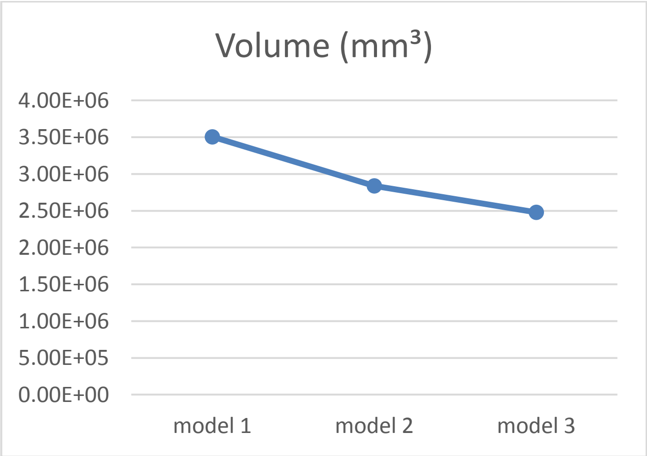

Fig: 5.14 Comparison of volumes of all 3 models

Modal analysis of model 3 using A356 aluminium alloy, aluminium alumina composite, aluminium/silicon carbide composite and AM60

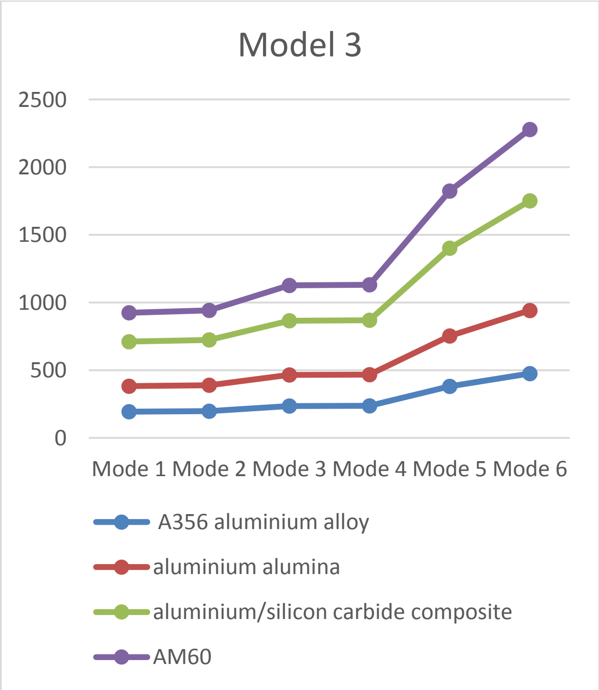

Fig: 5.12 Modal analysis of model 2 using different materials

CONCLUSIONS

From all the tabulated results, the following conclusions were obtained. They are:

- Masses of the models were reduces from model 1 to model 3.
- Volumes of the models also reduced from model 1 to model 3.
- Irrespective of models, the rim made of aluminium/ silicon carbide composite results in very less deformation, von-Mises stress and also strain.
- According to the design point of view the model 3 exhibits excellent properties and characteristics.

From above all, model 3 made up of Aluminium/ silicon carbide composite best suits in strength and reduction of weight aspect.

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