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DESIGN AND ANALYSIS OF METAL COMPOSITE HYBRID WHEEL RIM

K. VENKATA SAI KARTHIK and N. PRAKASH

Automobile Engineering, Hindustan University, CHENNAI (T.N.) INDIA

ABSTRACT

Wheel rim is a critical component of a vehicle, also a connecting point for the wheel to road surface. It is the only part of the vehicle to be in contact with road surface. Wheel rim will transfer the vibrations from wheel to suspension and steady vertical load acting on a wheel rim through the vehicle. These are most influencing factors for comfortable ride and the performance of the vehicle. The only possible factor is to improve the material properties of the wheel rim for better performance and comfort. The work deals with a new designed material that is metal composite hybrid wheel rim. In which friction layer is used in between the composite and aluminium material to enhancing the damping capacity and improving the ride comfort. To find the natural frequencies and stiffness a model is designed using commercial software SOLIDWORKS and the factors are estimated by commercial analysis software ANSYS Workbench. The present work deals the analysis of hybrid wheel rim subjected to vertical load, damping factor and stiffness of material under various condition are found.

Key words: Metal composite hybrid wheel, Friction damping layer, Frequency test, Aluminium, Epoxy.

INTRODUCTION

Vibrations are undesirable for vehicle, owing to the need for structural stability, position control, and durability, performance and noise reduction. Vibrations are of concern to large structures as well as small structures. Vibration reduction can be attained by increasing the damping capacity and/or increasing the stiffness. Metal for vibration damping are mainly metals and polymers because of their viscoelastic character. Polymer is commonly used as a vibration damping material owing to its viscoelasticity since defects may move slightly and surfaces may slip with respect to one another during vibration thereby dissipating energy. The damping capacity depends not only the on the material but also on the loading frequency, as the viscoelasticity as well as defect response depend on the frequency.

*Author for correspondence; E-mail: karthikkvsk@gmail.com

Due to their viscoelastic behaviour, polymers can provide damping. Friction film particularly well knows it's damping ability. However friction materials suffer from low stiffness, which results in rather low value of the loss modulus. Other polymers used for vibration damping include epoxidzed natural friction blend, a nylon-6/ polypropylene blend. In relation to fibrous structural composites, viscoelastic polymeric interlayer between the metals of continuous fibbers' are often used for damping.

In relation to metal and composites viscoelastic polymeric interlayer between the two metals are often used for damping however the presence of inter layer degrades stiffness of the composite particularly when the pressure and forces is high the use of 0.1 micrometer diameter friction layer reduces the damping problem and this particularly attractive when the pressure and force is high the metal and composite with the friction inter layer exhibits a higher value of loss of modulus than when compared to metals. Materials for vibration damping include metals, polymers and their composites. However the materials are attracted to use a friction material to provide some damping .damping enhancement mainly involves microstructure design in the case of metals.

Methodolgy

Design and analysis of metal composite hybrid wheel with friction material for enhancing the damping capacity and improve the ride comfort. A polymer based material that characterized by high specific, high strength and good damping capacity compared to metals.

Step 1: Select a wheel rim with a proper dimensions

Step 2: Select the materials with proper properties

Step 3: Evaluate the specification

Step 4: Design the wheel rim using design software

Step 5: Analysis the bonding strength using analysis software

Step 6: Analysis the natural frequencies of exiting and hybrid wheel

Step 7: Compare the natural frequencies of both wheels

EXPERIMENTAL

Bonding strength

From the modal analysis it was found that as the bonding thickness increased the deformation is decreased and natural frequencies increased. Table 1 lists the deformation and natural frequencies according the bonding thickness and also Figs. 1, 2, 3 shows the deformation and natural frequencies.

Table 1: Bonding strength of sample model

S. No.	Thickness parameters	2 mm	3 mm	4 mm
1	Deformation	13.10 m	11.54 m	10.15 m
2	Natural frequencies	501 HZ	793 HZ	981 HZ

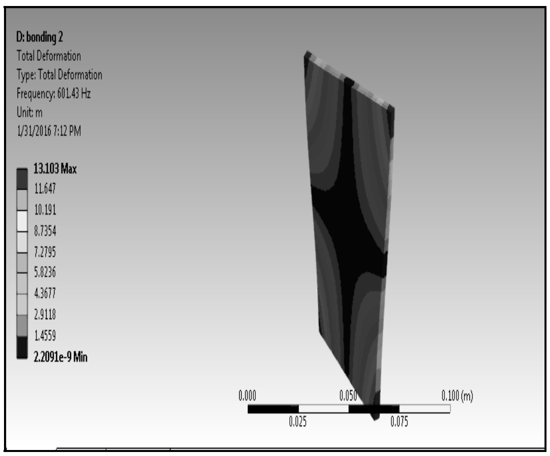


Fig. 1: Bonding strength of 1 mm + 2 mm

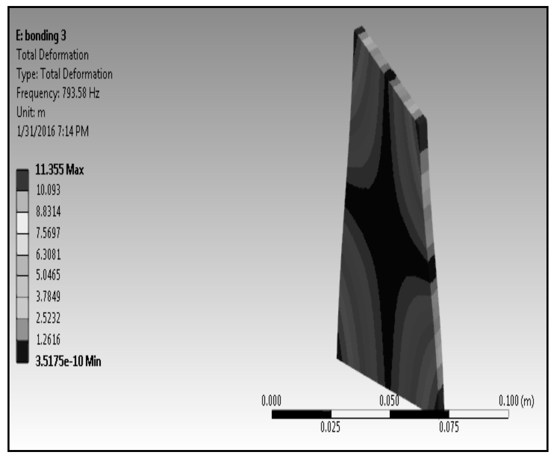


Fig. 2: Bonding strength 1 mm + 3 mm

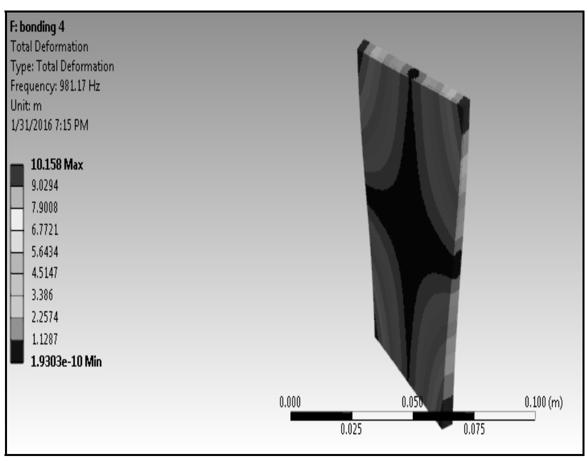


Fig. 3: Bonding strength 1 mm + 4 mm modelling of wheel rim

Table 2: Specification of wheel rim

S. No.	Parameters	Value
1	Tire size	225 mm
2	Rim width	207 mm
3	Flange shape	R
4	Rim size	14 inch
5	Flange height	0.58 inch
6	Aspect ratio	70
7	Offset	80.54 mm
8	BCD	1.504 inch
9	Type	Disc

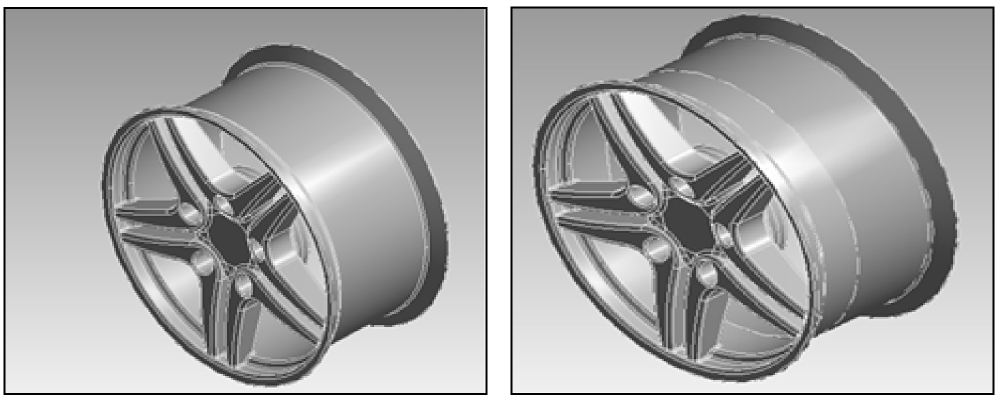


Fig. 4: Existing and hybrid models

SOLIDWORKS is modelling software, which is used for creation and modification of wheel rim. Design means the process of creating a new object and modifying the existing model. Using the Table 3 specification draw models in SOLIDWORKS and the Fig 4. is the models of wheel rim.

RESULTS AND DISCUSSION

- After preparing the models in solid works it is imported to ANSYS workbench
- The imported model is meshed by using the mesh option the mesh model below Fig. 5.

- Later this mesh model is subjected with three materials namely aluminum and it's composite and epoxy and subjected to modal analysis.

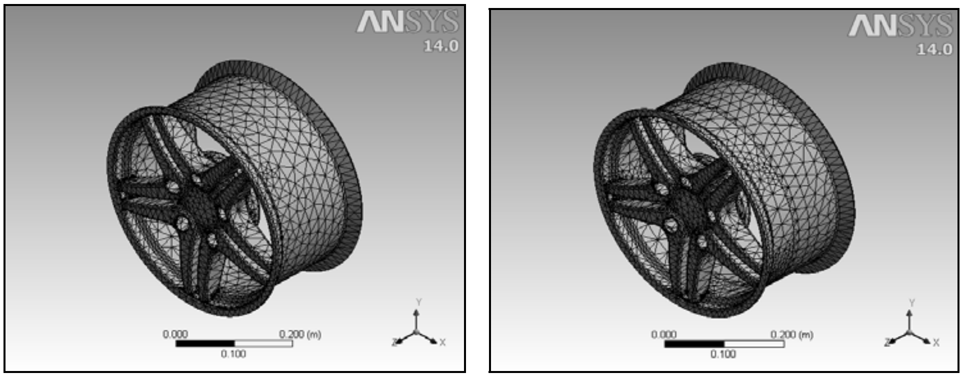


Fig. 5: Meshing model

Material used

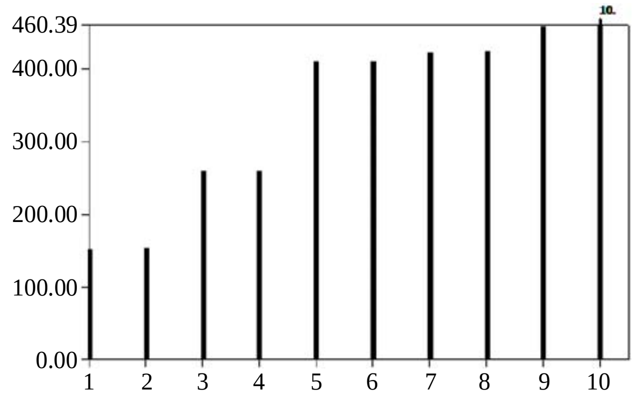
The material used in this design of aluminium- composite hybrid wheel were a aluminium LM25 and its composite, plain weave carbon/ epoxy friction layer and the material properties are listed in Table 4.

Table 3: Properties of materials

S. No.	Properties	Materials		
		Aluminum	Epoxy	Composite
1	Young's Modulus (Gpa)	73	63	69
2	Possions Ratio	0.3	0.33	0.37
3	Density (Kg/M^3)	2700	1300	2900

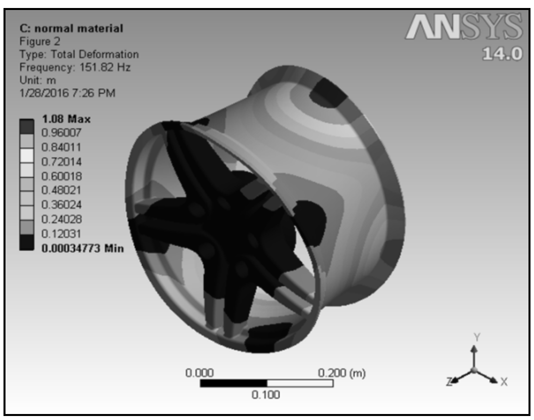
Table 4: Natural frequencies of exsting model

Mode	Frequencies	Mode	Frequencies
1	15179	6	410.22
2	151.82	7	422.77
3	258.73	8	423.66
4	258.81	9	458.16
5	409.56	10	460.93



On x axis modes and y axis frquencies in HZ

Fig. 7: Natrural freqencies of exsting model



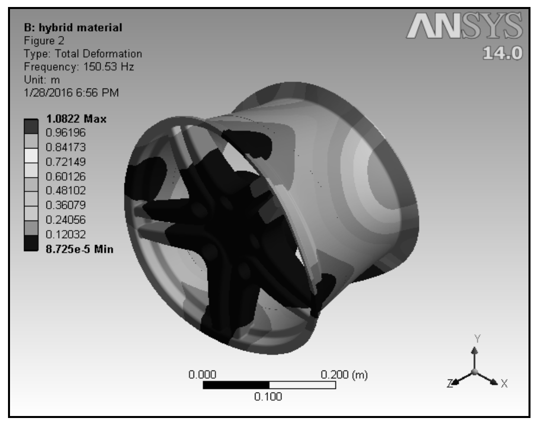
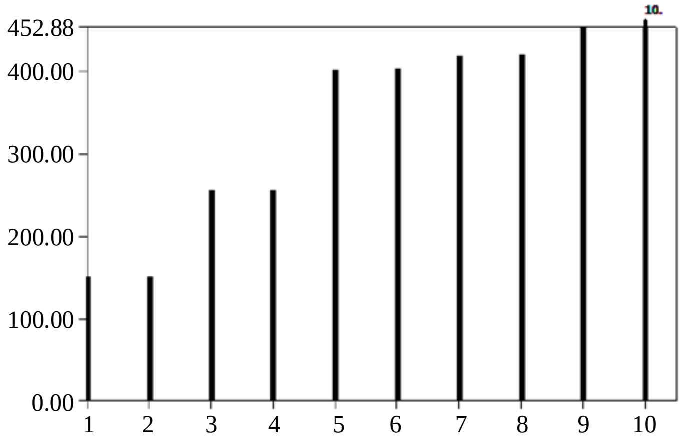


Fig. 8: Natrural freqencies of exsiting model Fig. 9: Natrural freqencies of hybridmodel

Table.5: Natural frequencies of hybrid model

Mode	Frequencies	Mode	Frequencies
1	150.79	6	41.44
2	150.72	7	416.93
3	253.88	8	417.94
4	254.08	9	452.14
5	400.77	10	452.88



On x axis modes and y axis frquencies in HZ

Fig. 10: Natrural freqencies of hybridmodel

CONCLUSION

In order to improve the ride comfort of an automobile by enhancing the vibrations of wheel we designed an aluminium-composite hybrid wheel, subsequently model analysis test carried out to evaluate its performance. By applying epoxy composite to a composite aluminium wheel, the deformation and natural frequencies was enhanced. The equivalent deformation in terms of the 1 node of the hybrid and aluminium wheel 0.120 m (150 Hz) and 0.120 (151 Hz) respectively in hybrid wheel the natural frequencies are reduced by 1% when compared to aluminium. This study is expected to provide substantial information and data for the design of advanced metal-composite hybrid wheel with low natural frequencies and increasing the ride comfort of car, and this technique can be applied to multitude of machine components to enhance various mechanical performance values of metal structure.

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