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Comparison of Damping Characteristics of Aluminium a 356.0 with Respect to Al-Sic-RHA Hybrid Composite

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***Abstract*— In today's growing world with lots of advent in the field of composites, it has becomes very necessary to choose the proper range of matrix as well as the amount of the percentage weight which is to be reinforced in the matrix. In order to determine the damping capacity of metal matrix composite we have to raise a toast with respect to independent damping capacity of the individual reinforcement which is induced in the metal matrix. In this paper we are going to consider the damping capacity of hybrid composite with varying reinforcement proportion, with respect to the Aluminium A356.0. The damping measurements are carried out on the DMA (Dynamic Mechanical Analyzer) at different frequencies with range from 1 Hz to 27 Hz. From which the damping capacity and the storage modulus was found out.**

Index Terms*— *Damping storage Modulus, Dynamic Mechanical Analyzer, Composite.

I. INTRODUCTION

In case of any mechanical equipment the most essential thing is to add a limit to the mechanical vibration. In order to restrict the mechanical vibration it is necessary to select the materials which are having proper as well as appropriate damping and expected stiffness and strength. The damping capacity is the ability of the material, when it vibrates dissipates the heat or mechanical energy. Hybrid composites are now a days on the way of raising a toast to be better substitutes for the conventional alloys because of characteristics like high stiffness high strength and low density [1]. It is important to note that the ashes of controlled burning of agricultural wastes such as coconut shell, rice husk, Banana leaf bagassee or bamboo leaf has been used in Aluminium Matrix composites which has given up to the mark results. Due RHA there is environmental threat to the lands (Due to burning of RHA). But this is the most efficient way of utilization of rice husk ash for which there is no any kind of environmental hazard. The recent research studies have reported that the controlled burning of RHA in turn contains about 85% to 90% amorphous silica. [2].However, under controlled burning conditions, amorphous silica with high reactivity, ultra- fine size and large surface is produced.

Aluminium- silicon alloy and its composites have light weight, high specific strength and good heat transfer ability which make them more appropriate material to replace material made up of ferrous alloys estimating damping characteristics in structures made of different material is a challenging task. Aluminium, its alloys and its composite is the one such superior material which is used on large amount in most of the aerospace, Automobile and manufacturing industry. The damping capacity of the material refers to the ability of that particular material in order to convert mechanical vibrating energy into the thermal energy [3]. Thus higher the damping capacity of the material higher is its ability to reduce the amplitude of vibration.

II. LITERATURE REVIEW

D. S. Prasad and C. Shobha [1] considered the damping behavior of hybrid composites using dynamic mechanical analyzer (DMA). Damping measurements of all the specimens were obtained by dynamic mechanical analyzer (DMA) at different frequencies in air atmosphere. It was observed that the damping capacity increases with the increase in the percentage of the reinforcement. The increase in the damping capacity can be attributed to the increase in dislocation density, which results from the thermal mismatch between the reinforcement and the matrix. Porosity also plays a crucial role in enhancing the damping capacity of the hybrid composites. Saravanan and Kumar [2] in their study the Rice husk ash particle of 3, 6, 9 & 12 % by weight were used to develop metal matrix composites using a liquid metallurgy route. The surface morphology was studied using scanning electron microscope for analyze the distribution of RHA particles. The mechanical properties such as tensile strength, compressive strength, hardness and percentage elongations are studied for reinforced RHA composites. The results revealed that the percentage reinforcement of RHA increased the ultimate tensile strength, compressive strength and harness of the composite.The results showed that, Rice Husk Ash, the agricultural waste generated from milling paddy can be successfully used as a reinforcing material to produce Aluminium Metal-Matrix Composite. It can be successfully used in place of conventional aluminium intensive material. V. Janiwarad, et. al [4] In their study found that the composites with RHA and graphite had more hardness compared to unreinforced aluminium with good damping characteristics. Dora Siva Prasad, et.al.[6] concerned with the measurement of damping behavior in elemental rice husk ash (RHA), fly ash (FA), silicon carbide (SiC) and graphite (Gr) powders. The storage modulus and damping capacity were analyzed. They observed that the damping behavior increases with the increase in the rice husk ash content. Experimental results showed that the addition of fly ash in A356 alloy exhibited improved ambient temperature damping capacity.

III. SAMPLE PREPARATION

The metal matrix composites of A356.0-Sic-RHA was produced by simplest and most economical used technique known as stir casting technique The Al (A 356.0) alloy, which was in the form of ingot . As per the ASTM standards of casting procedure A356.0 was heated to the temperatures of 650ºC in the furnace. Silicon Carbide particulates 5, 10, 15, 20 wt. % was preheated to a temperature of about 600 degree Celsius and added to the molten metal at 730 degree Celsius and the ash was added simultaneously and stirred continuously. The stirring was carried out at 300rpm for 5-8 min. After thorough stirring the molten metal was poured into steel moulds of 10 mm diameter and 30 cm in length and allowed to cool to obtain cast rods.

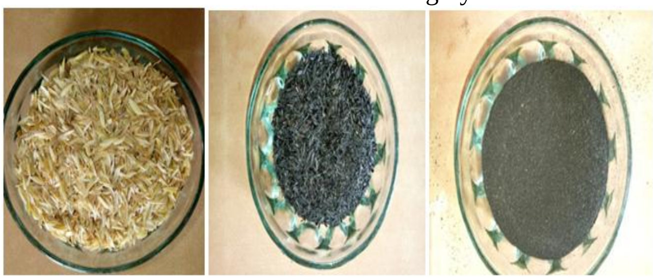
IV. EXPERIMENTATION

A. Experimentation on DMA

In the study RHA (Rice Husk Ash) SiC powder with average. Mesh size below 25 microns are taken The SiC powder is brought from Perfect Sales, Nashik where as the rice husk ash was manufactured in the institute itself.

1) Preparation of Rice Husk Ash

Initially the rice Husk was procured from the nearby area of Trimbakeshwar (Maharashtra) as this husk was containing some amount of moisture the husk was kept in sunlight at temperature of about 35-40 ^{0}C for two days after that the Husk turned its color from yellowish green to ochre yellow after that the husk was kept in dry iron or hot iron surrounding in order to confirm total moisture free rice husk at surrounding temperature as about 150 ^{0}C to 200 ^{0}C. Later on the Husk was kept in an electric furnace with temperature of about 550 ^{0}C to 650 ^{0}C in order to eradicate the carbon suspicious material after which the rice husk ash turned into grayish white color.



(a) (b) (c)

Fig.1 (a) Rice husk (b) Rice husk ash (c) Sieved ash.

Table 1.Chemical composition of Rice Husk Ash

Calcium	Magnesium oxide	Potassium Oxide	Ferric Oxide
0.419%	0.404%	0.344%	0.418%

Table 2 Chemical composition of A356.0

Si (%)	Mg (%)	Fe (%)	Cu (%)	Mn (%)	Ni (%)	Zinc (%)
7.24	0.42	0.084	0.010	0.018	0.025	0.005

2) Apparatus Used for Calculating Damping Capacity

The apparatus used was Perkin Elmer– Dynamic Mechanical Analyzer (Model-DMA 8000) at the frequency range of 1 Hz to 27 Hz using cantilever Method. The test specimens were made of size 45 mmx10mmx3mm for all the experiments. The DMA apparatus is shown below in Fig.2.

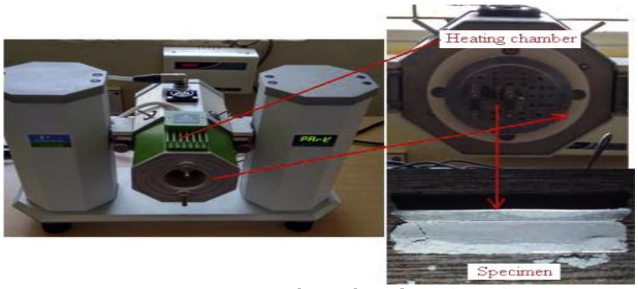


Fig.2 Dynamic Mechanical Analyzer (DMA)

In this experimentation we found out the damping capacity that is tan δ which is based on the following equation [6].

$$M \frac{d^2x}{dt^2} + \eta_v + \frac{S''}{w} + \left(\frac{KE''}{w} \frac{dx}{dt} \right) + (S' + KE')\ x = Fp \sin\omega t$$

M = Mass of the vibrating system
η_v = Viscous Damping
S′& S″ = Complex Stiffness
E′ = Storage Modulus
E″ = Loss Modulus
X= Deflection at end of specimen where force FP Sin ωt is applied.

Therefore the damping capacity with respect to loss modulus and storage modulus is given by as follows [6].

$$\tan\delta = \eta = (E'' \setminus E')$$

Table 3 Chemical composition of various Samples

Composition	wt.% A 356.0	wt.% SiC	wt.% RHA
1	Pure	0	0
2	85	5	10
3	70	10	20
4	55	15	30
5	40	20	40

V. RESULTS AND DISCUSSION

A. Results related to DMA testing.

The table 5 below shows damping capacity of various compositions with respect to frequency.

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Table 4 Damping capacity of samples with respect to Frequency.

Frequency (Hz)	Composition				
	01	02	03	04	05
1	0.0124	0.0129	0.0141	0.0130	0.0233
3	0.0119	0.0161	0.0154	0.0190	0.0318
6	0.0177	0.0209	0.0180	0.0221	0.0333
9	0.0199	0.0261	0.0254	0.0249	0.0425
12	0.0222	0.0270	0.0263	0.0262	0.0502
15	0.0236	0.0274	0.0270	0.0320	0.0522
18	0.2853	0.0267	0.0314	0.0354	0.0540
21	0.0338	0.0332	0.0320	0.0357	0.0577
24	0.0356	0.0339	0.0370	0.0449	0.0760
27	0.0366	0.0444	0.0407	0.0490	0.0796

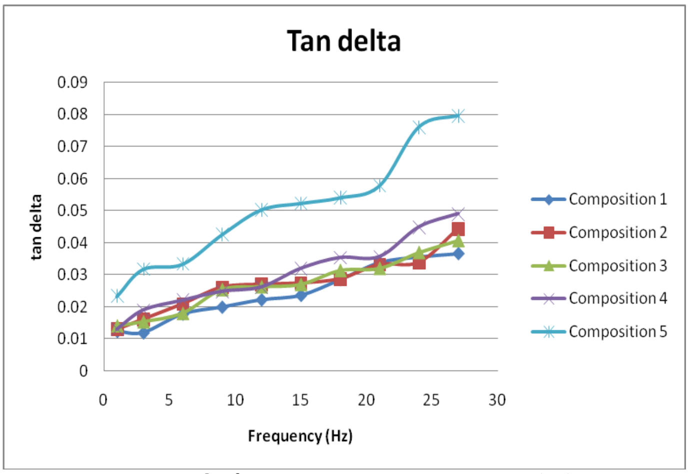

Fig. 3 Graph of Damping capacity V/s Frequency (Hz)

Table 5 Storage modulus of samples with respect to Frequency.

Freq. (Hz)	Composition		
	01	02	03
1	1.5467e+10	1.5470e+10	1.8400e+10
3	1.5493e+10	1.5599e+10	1.8300e+10
6	1.5409e+10	1.5550e+10	1.8200e+10
9	1.5349e+10	1.5538e+10	1.8200e+10
12	1.5336e+10	1.5536e+10	1.8100e+10
15	1.5316e+10	1.5501e+10	1.8000e+10
18	1.5265e+10	1.5497e+10	1.8000e+10
21	1.5214e+10	1.5478e+10	1.8110e+10
24	1.5176e+10	1.5455e+10	1.8001e+10
27	1.5139e+10	1.5297e+10	1.7610e+10

Freq. (Hz)	Composition	
	04	05
1	2.300e+10	2.90e+10
3	2.3104e+10	2.91e+10
6	2.3100e+10	2.90e+10
9	2.300e+10	2.91e+10
12	2.2900e+10	2.89e+10
15	2.2900e+10	2.88e+10
18	2.2800e+10	2.87e+10
21	2.2800e+10	2.87e+10
24	2.2400e+10	2.86e+10
27	2.2100e+10	2.85e+10

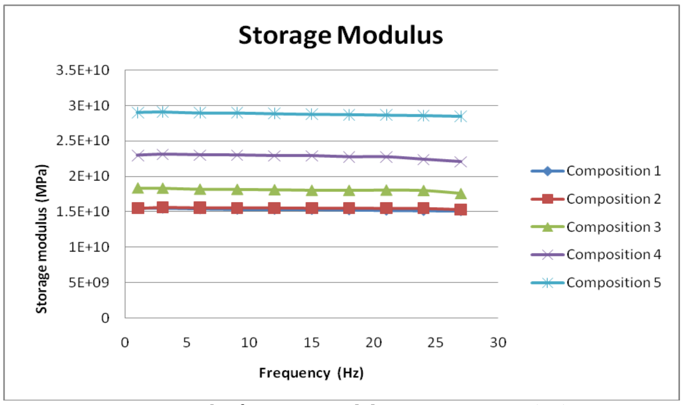

Fig. 4 Graph of Storage Modulus V/s Frequency (Hz)

As shown in the above graph of tan delta V/s frequency it is noted that for composite number 1, as the frequency increases the tan delta increases upto 0.036661 for A356.0.In case of composition 2 with 5 weight percentage SiC and 10 weight Percentage of RHA the value of damping capacity increases upto a point and further on with increase in the frequency its value decreases. The Damping Capacity (tanδ) of composition 3 lies below the composition 2 but above composition 1. In case of composition no.4 the damping capacity is initially below the damping capacity of composition 2 but later on due to increase in the frequency the damping capacity increases considerably. The composition 5 has the highest value of damping capacity (tanδ) with respect to all the noted samples. Whereas in case of storage modulus its value increase with respect to increase in the reinforcement and the graph has decreasing trend.

VI. CONCLUSION

The Damping characteristics of unreinforced A 356.0 alloy and its composites containing 5,10,15,20 weight percentage of Silicon Carbide (SiC) and 10,20,30,40 weight percentage of RHA were studied with respect to the studies done following conclusions were noted.

- The damping capacity of unreinforced alloy was found to be increasing but after a certain point the damping capacity was found to be decreasing with respect to the frequency.
- As the proportion of the reinforcement is increased the damping capacity increases considerably the composition 4 and 5 are having excellent damping capacity. Whereas the storage modulus seems to have a decreasing trend with respect to increase in the frequency.

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