Vibration Mitigation of Engine by Using Composite Materials

G. C. Mekalke , S. R. Basavaraddi

Abstract*: Now a days, Vibration and composite materials are two main growing research areas in industry. Almost all the structural components subjected to dynamic loading in their working life. Vibration affects the working life of the structure, so it is very important in designing a structure. To control the structural vibration and its amplitude, it is very important to know in advance the response of the system. Composite materials give chances to designers and engineers to increase material efficiency, therefore resulting in cost reduction and better utilization of resources. Composites materials applications are wide in aerospace industries, automobile sector, manufacturing industries etc. The present study involves different types of composite materials and extensive experimental works to investigate mitigation in the vibration, generated by the engine. Composite materials are manufactured by the hand-lay-up technique. Different manufacturing techniques are there, out of which hand-lay-up method is used for current research work. From this research, it has proved that sample 1 has more vibration isolation property than traditional rubber pads.

***Keywords*: Composites, Mitigation, Vibrations.**

I. INTRODUCTION AND PROBLEM DEFINITION

There are various types of viscoelastic materials which are available for the absorption of vibrations known as anti-vibration passive damper, but these viscoelastic materials have some disadvantages such as min. life, high degradation rate, less melting point. To overcome the above problems composites materials are widely used in different industry. It is combination of two viscoelastic materials. The comparative analysis of these viscoelastic materials as per the various parameters such as maximum load carrying capacity, vibration displacement, sound level, compressive strength. Based on above analysis one can select the suitable best passive damper for low, medium and high load applications. A 0.5 HP pump is used for this testing. The test of vibration displacement, change in acceleration is checked in FFT analyzer. Here, the actual testing was carried out on a 208 CC Go Kart engine. Due to huge power, the engine has considerable vibration. Though the racing car manufacturers, uses rubber-based mounting, to damp the vibration, still the results are not satisfactory. Still there are considerable losses in the vehicle, due to vibration. Using composite material based on vibration isolators, this project tries to mitigate the vibration.

I. MATERIALS AND ITS PROPERTIES

A] Ethylene Vinyl Acetate Rubber (EVA): - EVA is the copolymer of ethylene and vinyl acetate.

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It's an extremely elastic material, that can be sintered to form a porous material similar to rubber, with excellent toughness. The porous elastomeric material is three times flexible than low-density polyethylene (LDPE), Showing tensile elongation of 750 %, with a peak melting temperature of 250°F (96°C) This flexible porous plastic material has good barrier properties, low-temperature toughness, stress-crack resistance, hot-melt adhesive waterproof properties, and resistance to ultraviolet radiation. Porous EVA has little or no odor and is competitive with rubber and vinyl products in many electrical applications. B] Extended Polyurethane and Polyurethane sheet: It has following advantages, 1. Wide Range of Hardness, 2. High Load Bearing Capacity, 3. Flexibility, 4. Abrasion & Impact Resistance, 5. Tear Resistance 6. Resistance to Water, Oil & Grease 7. Electrical Properties 8. Wide Resiliency Range 9. Strong Bonding Properties 10. Performance in Harsh Environments 11. Mould, Mildew & Fungus Resistance 12. Color Ranges 13. Economical Manufacturing Process 14. Short Production Lead Times. C] Teflon sheet: Polytetrafluoroethylene (PTFE) is a thermoplastic polymer, which is a white solid at room temperature. with a density of about 2200 kg/m3. According to DuPont, its melting point is 600 K. It possesses high strength, toughness and self-lubrication at low temperatures below 5 K. And good flexibility at temperatures above 194 K. PTFE gains its properties from the aggregate effect of carbon-fluorine. D] Solvent based polychloroprene: It has Good resistance against water, formalin solutions, heat and ageing. Atlas M 22 adhesive has initial tack adhesion with an excellent final strength and long processing time.

II. CONSTRUCTION OF THE COMPOSITE

In the first attempt, the composite had been fabricated by using nylon-66, Hitlon (Extended Polyurethane sheet), leather and Teflon. Vinyl ester was used as an adhesive material. But under loading condition, Due to excess use of hardener, the resin and the composite surface gets cracked instead of getting suppressed as shown in Fig 1.

Figure No.1: Cracked Side View of Sample

Composite are fabricated by different materials. (EVA, Solvent based polychloroprene as an adhesive, Extended Polyurethane sheet, Polyurethane sheet, Teflon Sheet.)

Four samples were prepared with different composition, with the same adhesive. As a result, these all four samples not only sustained the self-weight of the test engine but also mitigates the vibrations.
All four samples along with the constituent's elements:

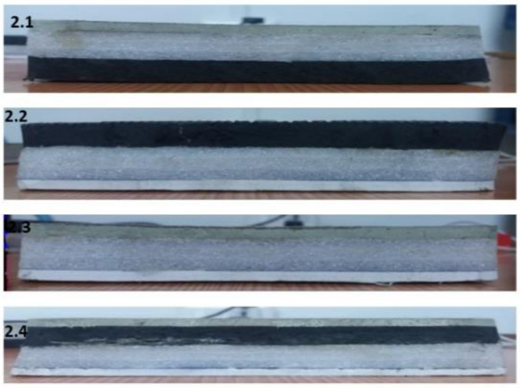

Figure2.1 Polyurethane, Hitlon, EVA; Figure2.2 Teflon, Hitlon, Polyurethane; Figure2.3 Teflon, EVA, Hitlon; Figure2.4 Teflon, Hitlon, Polyurethane, EVA

III. ACTUAL SETUP AND EXPERIMENTATION

FFT Analyzer are used for measuring the vibrations in test engine. FFT analyzer is consisting of, 8 port data acquisition unit, accelerometer, adapters, laptop, license card, various cables and other accessories. Initially, laptop was connected to data acquisition unit through data cable, and then one connection was given to ground from data unit for safety purpose. The accelerometer which senses the vibration of machine, has connected to data unit by one adapter and cable. The Accelerometer has been mounted with the help of wax, on the machine body, Where the vibrations are generated. Then main power supply is given to data acquisition unit. After that license card was connected to laptop. Following Figure shows the connections of the test setup.
Following Figure shows the actual setup of the experiment during the tastings,
Figure 6 shows the Actual Setup of the experiment, Figure 7 shows the direct mounting method (without sample) and Figure 8 shows the mounting of sample1.

Figure 6. Actual Setup of the experiment

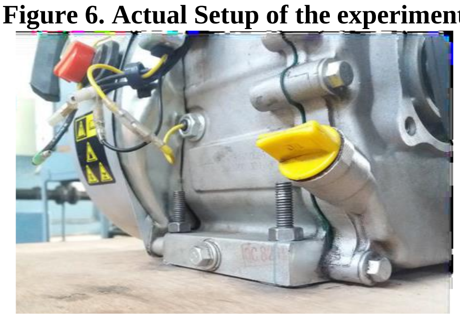

Figure 7. Direct Mounting (Without Sample)

Figure 8. Sample 1 at the Engine Base

IV. GRAPHS

Figure 9 shows the graphs of vibration analysis of engine without base mounting. Figure 9.1 shows a graph of acceleration vs. frequency whereas Figure 9.2 shows a graph of acceleration vs. time

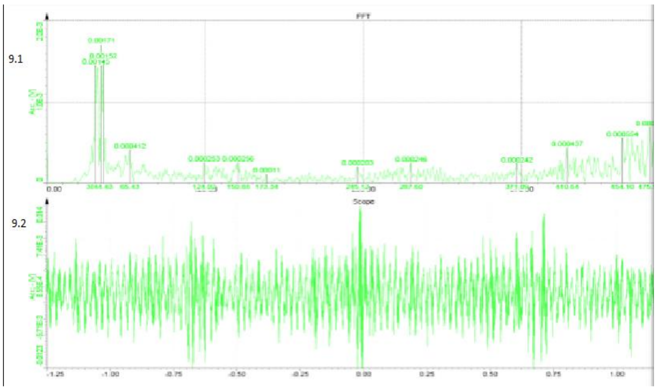

Figure9.Vibration Analysis of Engine without Base Mounting

V. RESULTS AND DISCUSSION

Table 3 shows the comparison between the base mounting and vibration amplitudes. Fig10 shows the graphical representation of table 3. The behavior of any material is based on its elastic properties, the fig 10 shows sample 1 having less vibrational amplitude as compared to others, due to its better elasticity and force transmissibility factor.
Table 4 shows the Cost of Individual Composite and % Reduction in Vibration amplitude. Fig11 shows the graphical representation of table 4. From table 4 and fig 11 it is clear that sample 1 reduces the vibration up to 63.51 % as compared to rubber pad.

Table no. 3. Material and Corresponding Vibration Amplitude

Base Mounting	Vibration Amplitude (mm/s2)
Direct Mounting	0.00171
Sample 1	0.000624
Sample 2	0.00073
Sample 3	0.000778
Sample 4	0.000737
Only Rubber Pads	0.000992

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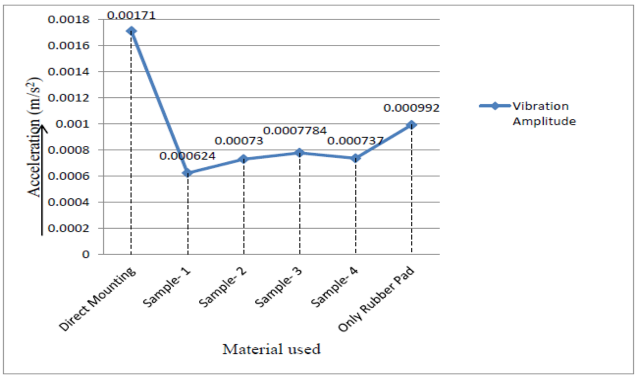

Figure10. Graph Shows the Vibration for Various Materials

Table no. 4. Cost of Individual Composite and % Reduction in Vibration

Sr. No.	Material Used	Cost Per Sample in Rs.	% Reduction in the Vibration
1	Sample 1	51.65	63.51
2	Sample 2	51.65	57.30
3	Sample 3	32.8	54.50
4	Sample 4	57.23	57.30
5	Rubber	13.54	41.98

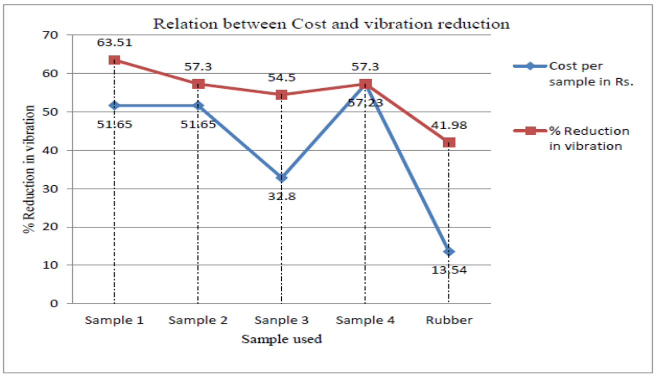

Figure11. Graph of sample vs. Cost of Individual Composite and % Reduction in Vibration

VI. CONCLUSION

The current research work deals with reduction in vibration of engine with the help of composite material. The results show that,

1] Sample 1 has an excellent elastic property as compared to other materials

2] Sample 1 reduces the vibration by 63.51% as compared to rubber pad.

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