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Vibration Testing of Novel Engine Mount: Technical Note

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ABSTRACT:

In order to isolate the vibrations in rotating machineries, engine mounts are used. In this paper, a novel engine mount that is specially designed using fluorocarbon material is experimentally assessed for an improved performance with an existing rubber based engine mount. The changes are made in the dimensions of the existing engine mount for better vibration absorption. Experimental results have shown a considerable benefit in vibration suppression by the engine mount using fluorocarbon more than the ones using rubber.

KEYWORDS:

Vibrations; Engine mount; Fluorocarbon; Tractor engine; Experimental mechanics

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1. Introduction

Engine is the main source of vibrations for any vehicle. Vibrations can be isolated by using a special system to mount an engine in its place. Dynamic stiffness and amplitude of vibration have to be made dependent for achieving this objective. At low frequencies, the stiffness of the active elastomeric mounts will be very high [1-2]. The properties of the material being used should be optimum for withstanding high frequency vibrations. New elastomers like nitrile rubber, polybutadiene rubber and polyurethane were used and compared with natural rubber [3-5]. Marzbani et al [6] designed a hydraulic engine mount for eradication of high frequency vibrations. Jansoon et al [7] detailed a semi experimental method for constructing the excitation force with the help of acceleration data measured. In the following sections material selection, fabrication and experimental analysis have been discussed. In this paper, experimental analysis of a specially designed engine mount is detailed. The materials tested are conventional rubber and fluorocarbon. The tests are carried out at two engine speeds to assess the comparative performance of these two selected materials for the engine mount.

2. Materials and manufacture

Fluorocarbon has high fatigue strength, tear resistance when compared to natural rubber. High stability to temperature changes and resistance to chemicals are added advantages along with its superior mechanical properties. Since natural rubber has more impact strength than fluorocarbon, it is also used in the middle of the mount to take the impact force from the engine and to distribute uniformly throughout the mount. The dimensions of the existing engine mount are modified to account a middle rubber block. The CAD model of die geometry is created by using solidworks software and shown in Fig. 1.

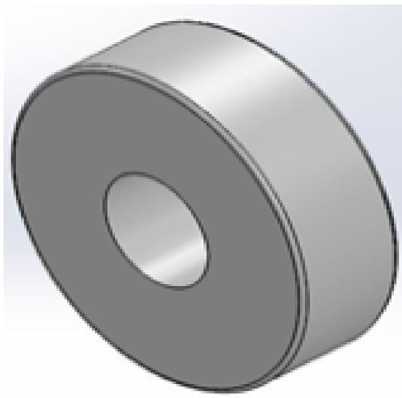

Fig. 1: Model of fluorocarbon mount

The engine mount is fabricated using injection moulding process. A die is used in this process, into which the molten material is injected at very high temperature and pressure. The die is manufactured using hot chamber process. The fabricated FKM mount had its middle part using natural rubber and remaining part is made of fluorocarbon as shown in Fig. 2. The rubber mount is made separately and is fixed at the centre using industrial glue.

Fig. 2: Fabricated fluorocarbon engine mounts

3. Vibration testing

In this work, Simpson's tractor diesel engine is selected for analysis of vibration level in normal conditions and with turbocharger. The vibration measurement is taken with fluorocarbon rubber mount at 750rpm and 1000rpm. The vibrations data are stored for analysis purpose. Integrated electronic Piezoelectric (IEPE) sensors are used to measure the amplitude of vibrations at engine mount and engine head. Figs. 3 to 5 show the vibration testing photographs and the engine mounts.

Fig. 3: Simpson's tractor engine bed

Fig. 4: Sensor mounting on engine head

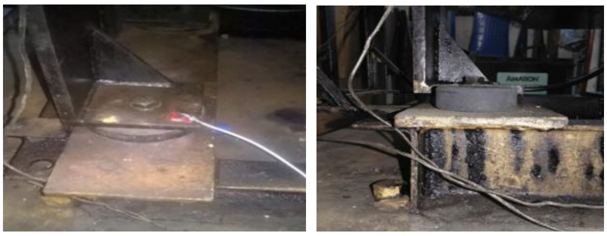

Fig. 5: Clamping of fluorocarbon and rubber mounts

4. Results and discussion

The vibration tests were carried out using the natural rubber mount and fluorocarbon mount. In this work, DEWE Soft is employed to acquire the required vibration data from measurement devices. The obtained experimental results are shown in Figs. 6 to 9. Fig. 6 shows that the variation of vibration levels on engine head is more for the rubber engine mount than for the fluorocarbon engine mount. The peak level of vibrations is more in normal rubber mount. In spite of the torque being moderate at 750 rpm, the variation in vibrations is low. Fig. 7 depicts that the vibration levels of the two mounts showed no variation initially. Therefore, we can conclude that the usage of fluorocarbon rubber mount is better. Fig. 8 shows that the vibration level at 1000 rpm on engine head, which is very low in fluorocarbon. At this speed engine gives out maximum power, which results in heavy vibration, and even at this range mean level of vibrations is achieved. Fig. 9 shows the variation in vibration levels is very much low with respect to the time. With this, we can say that usage of fluorocarbon mount is more advantageous even at high working ranges of engine speed. Table 1 provides a summary of the experimental results. It is clear that the vibrations produced in the fluorocarbon engine mount are less than the natural rubber engine mount. Even the fluctuation in the levels of vibrations is low at high torque and speeds. This increases the durability of the mount.

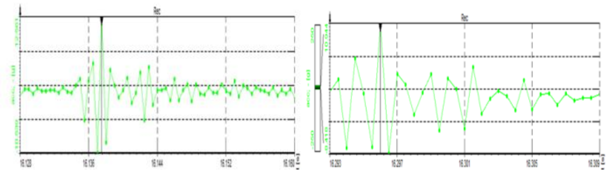

Fig. 6: Acceleration response on the engine head at 750 rpm – Normal rubber (top), Fluorocarbon (bottom)

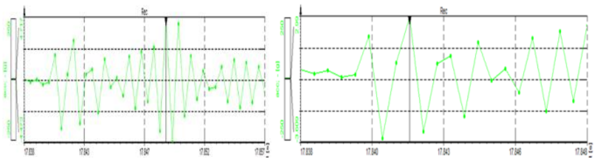

Fig. 7: Acceleration response on the mount at 750 rpm – Normal rubber (top), Fluorocarbon (bottom)

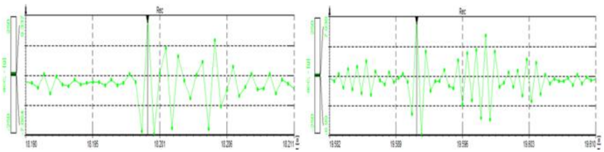

Fig. 8: Acceleration response on the engine head at 1000 rpm – Normal rubber

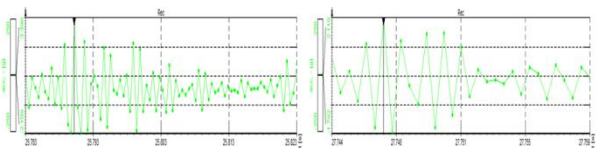

Fig. 9: Acceleration response on the mount at 1000 rpm – Normal rubber (top), Fluorocarbon (bottom)

Table 1: Results of vibration analysis

Material	Engine speed rpm	Vibration in engine head in (g)	Vibration in mounting in (g)
Natural Rubber	750	12.661	4.717
	1000	9.337	3.398
Fluorocarbon	750	10.944	2.99
	1000	7.938	2.119

5. Conclusions

From the experimental analysis, it can be concluded that the vibrations produced in the fluorocarbon engine mount is lesser than the natural rubber engine mount. This increases the capacity of the engine mount to with stand the vibrations for longer time and it ensures the proper functioning of components of engine and comfort of the passengers.

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