

COMPARATIVE STUDY OF VIBRATION ISOLATORS USING PARAMETER ABSORPTIVITY

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ABSTRACT

In this paper, the concept of the output frequency response curve (OFRC) is applied to conclude the absorptivity of vibration isolators with a non-linear anti-symmetric damping curve. Materials wood, natural rubber, polyurethane, wood with rubber pad combination used for damping the vibrations from test rig. The result reveals that a non-linear anti-symmetric damping can significantly increase the absorptivity of the vibration isolators over the resonant frequency region. FFT analyser is used for Vibration and frequency measurement. Results indicate that absorptivity of material is maximum at resonance frequency.

Keywords: *Wood, natural rubber, polyurethane, wood combination, Absorptivity, resonant frequency, FFT analyser.*

I. INTRODUCTION

A vibration isolator is a device that is used inserted between a support base and equipment to reduce the vibration energy transmission from the support base so as to protect the equipment from non-linear vibrations. A magnitude (force, displacement, or acceleration) which oscillates about some specified reference where the magnitude of the force, displacement, or acceleration is alternately smaller and greater than the reference. Vibration is commonly expressed in terms of frequency (cycles per second or Hz). [1] The FFT spectrum analyser samples the input signal, computes the magnitude of its sine and cosine components, and displays the spectrum of these measured frequency components. The advantage of this technique is its speed. Because FFT spectrum analysers measure all frequency components at the same time, the technique offers the possibility of being hundreds of times faster than traditional analogue spectrum analysers. In the case of a 100 kHz span and 400 resolvable frequency bins, the entire spectrum takes only 4 Ms to measure. To measure the signal with higher resolution, the time record is increased. But again, all frequencies are examined simultaneously providing an enormous speed advantage. In order to realize the speed advantages of this technique we need to do high speed calculations. And, in order to avoid sacrificing dynamic range, we need high-resolution ADCs. SRS spectrum analysers have the processing power and frontend resolution needed to realize the theoretical benefits of FFT spectrum analysers. [2]

- **Spectrum**

The spectrum is the basic measurement of an FFT analyser. It is simply the complex FFT. Normally, the magnitude of the spectrum is displayed. The magnitude is the square root of the FFT times its complex conjugate. (Square root of the sum of the real (sine) part squared and the imaginary (cosine) part squared.) The magnitude is a real quantity and represents the total signal amplitude in each frequency bin, independent of phase. If there is phase information in the spectrum, i.e. the time record is triggered in phase with some component of the signal, then the real (cosine) or imaginary (sine) part or the phase may be displayed. The phase is simply the arctangent of the ratio of the imaginary and real parts of each frequency component. The phase is always relative to the start of the

Triggered time record. [2]

- **Damping:** Damping is the phenomenon by which energy is dissipated in a vibratory system. Fourier's theorem states that any waveform in the time domain can be represented by the weighted sum of sine and cosines.

- **Damping Coefficient:** Damping for a material is expressed by its damping coefficient.

$$\text{Damping coeff.} = C = \frac{\text{lb} \cdot \text{sec}}{\text{in}}$$

- **Critical Damping:** A system is said to be critically damped when it is displaced from its static position and most quickly returns to this initial static position without any over-oscillation. The damping coefficient required for critical damping can be calculated using

$$C_c = 2\sqrt{KM}$$

- **Damping Factor:** The non-dimensionless ratio which defines the amount of damping in a system.

$$\text{Damping factor} = \frac{C}{C_c} = \xi$$

- **Resonance:** When the forcing frequency coincides with the natural frequency of a suspension system, this condition is known as resonance.

- **Absorptivity:** it is property of body that determines the fraction of incident vibration or absorbable by the body.[3]

- **Specimen:**

1. Plywood-

Plywood is a sheet material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another. It is an engineered wood from the family of manufactured boards which includes medium-density fibreboard (MDF) and particle board (chipboard). [4]

2. Polyurethane-

Polyurethane (PUR and PU) is a polymer composed of organic units joined by carbonate (urethane) links. While most polyurethanes are thermosetting polymers that do not melt when heated, thermoplastic polyurethanes are a

Is available [5]

3. Natural rubber-

Rubber exhibits unique physical and chemical properties. Rubber's stress-strain behaviour exhibits the Mullins effect and the Payne effect, and is often modelled as hyper elastic. Rubber strain crystallizes. Due to the presence of a double bond in each repeat unit, natural rubber is susceptible to vulcanisation and sensitive to ozone cracking [6]

4. Combination of natural rubber and Plywood –

- **Specification:**

Dimmer: max. Load-12 amp

Input-240V.50Hz

Output: 0-270V.

Dimensions:

1. Plywood-
2. Polyurethane-
3. Natural rubber-
4. Combination of natural rubber and Plywood -

Sensor used: Accelerometer

Test Rig: Single Rotor system



Fig.1 Experimental setup

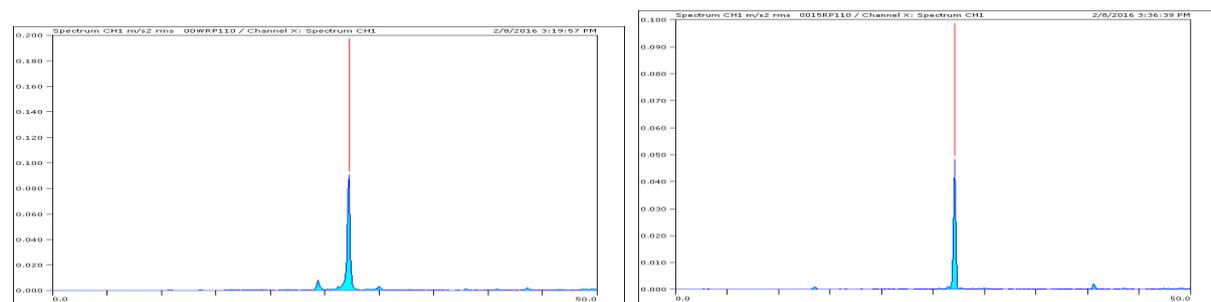


Fig.2 Combination of Plywood and rubber

Fig.3 Natural rubber

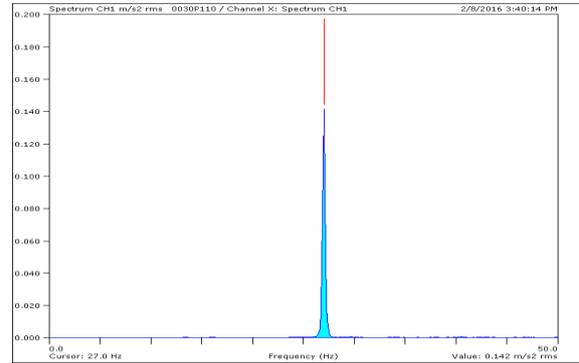
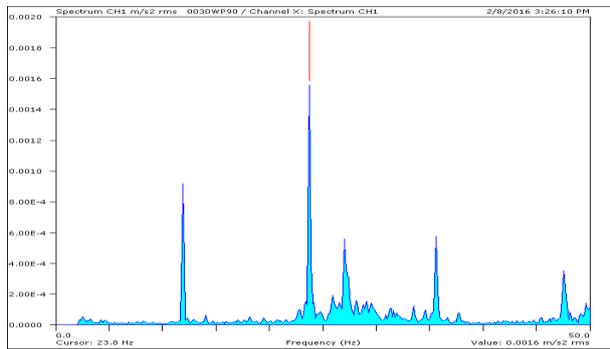


Fig.4 polyurethane

Fig.5 plywood

Result:

Sr.no	Material	Speed (RPM)	Frequency (Hz)	Overall Acceleration (m/s ² RMS)
1.	Plywood	100	27	0.142
2.	Natural rubber	100	27.1	0.0481
3.	Polyurethane	100	23.8	0.0016
4.	Combination of plywood and rubber	100	27.3	0.0907

II. CONCLUSION

1. Vibration Absorption through isolators changes by materials.
2. Maximum vibration damping is done by plywood>Combination of plywood and rubber>Natural rubber>Polyurethane.
3. Elasticity and hardness plays important role in vibration Absorption
4. Slots and change in surface area differs the Absorptivity.

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