Design and Development of Passive Damper

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Abstract - Todays world of the antivibration mounting include the various types of isolators,but it has some disadvantages so the new composite viscoelastic materials are formed.These materials are tested with the help of FFT analyser for calculating the vibration reading.The viscoelastic material used for the various compositions are cork,felt,rubber pad,polyeurathane and epoxy glass.From this best composite selected.

Keyword – FFTA.

I. INTRODUCTION

Vibrations accompany us everywhere and in most cases these vibrations are undesirable. First of all we can mention the vibration of cars and carriages, motors and machine tools, oil and gas platforms, buildings and constructions in a zone of seismic activity, undesirable vibrations of laboratory tables (especially optical), setups, etc. In all these cases an object has to be isolated from the source of vibrations.

A vibration isolator typically comprises a resilient element attached to a mounting plate at each end. Resilient elements include rubbers, elastomers, polymers, metal springs, corks, felts and air bags. The dynamic properties (stiffness and damping) of the isolator determine the level of the transmission of vibration through an isolator. Vibration is isolated by placing properly chosen isolation materials between the vibrating body and the supporting structure.

A. Problem statement

The rubber pad or any viscoelastic material is used as the vibration absorber, but it get attached with C.I. metal. The rubber pad has some disadvantages while using as vibration absorbers, so that the new vibration absorbers is the need for future work. The single viscoelastic material as passive damper has many disadvantages so it need to be overcome by the combination of those. To create different combination of viscoelastic materials, suitability for damping and loads.

II. DESIGN AND EXPERIMENTATION

A. Experimental Study

The aim of experimental analysis is to verify the practical applicability of the passive damper developed. The experimental setup is shown in Fig.The change in natural frequency of real life structure due to the presence of the unbalanced force. It is generally observed that theoretical analysis of structure have some error with respect to actual structure, as model of structure generated for vibration and structure borne insulation through the most modern materials such as Cork,Felt,Rubber Pad,Glass Fibre,Epoxy Resin.The combination of different viscoelastic materials are used for to minimise the vibration and noise of respective machine.The instruments used for experimental analysis are accelerometer, charge amplifier, Fast Fourier Transform (FFT) analyzer and related accessories.The FFT analyzer used have measuring range 10-200 dB, amplitude stability + 0.1 dB, frequency limit 1 Hz to 20 KHz.

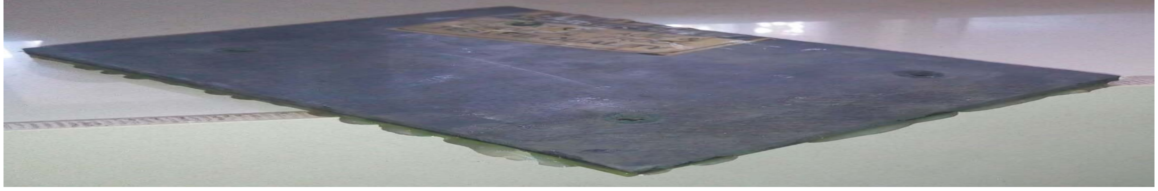

Figure 1.Combination of Polyurethane and Rubber pad.

Viscoelastic material with size 177×147×3 (mm) taken to combine with other material of same size.

Figure 2. Combination of Cork and Felt.

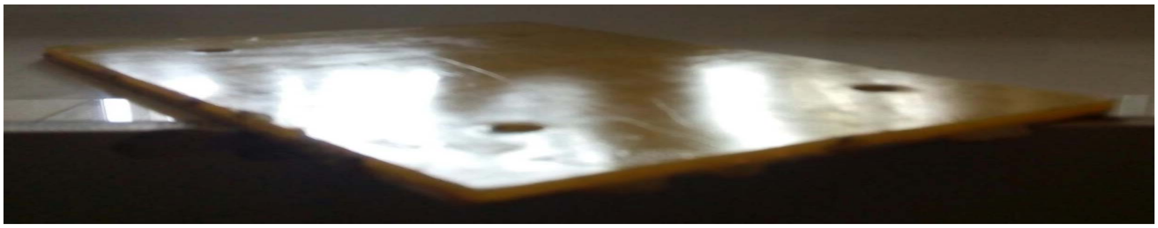

Figure.3. Combination of Polyeurathane and Epoxy glass.

3.4.1 Load displacement test

Figure 4.Test of deflection and maximum load of composite materials on UTM.

Figure 5.Test of deflection and maximum load of composite materials on UTM under compression.

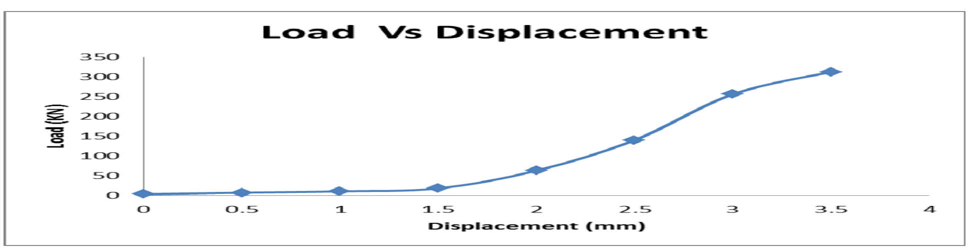

Figure 6.Graph of Load Vs Displacement of Polyeurathane rubber pad material of test on UTM

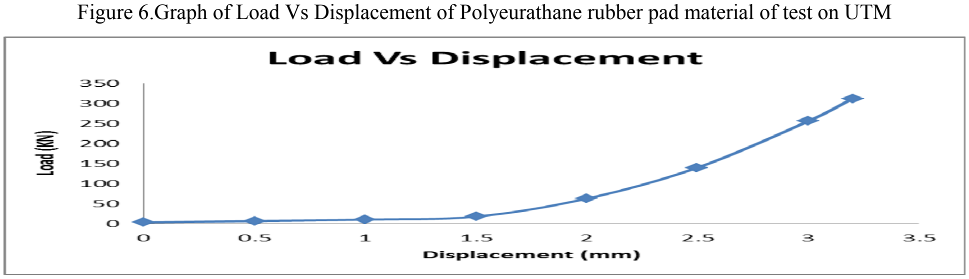

Figure 7. Graph of Load Vs Displacement of Polyeurathane epoxy glass material of test on UTM

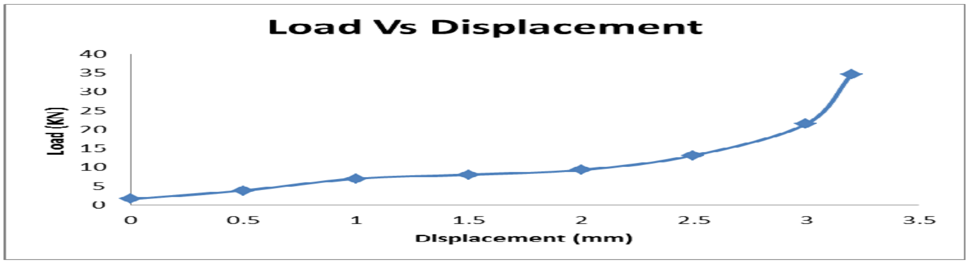

Figure 8.Graph of Load Vs Displacement of Cork felt material of test on UTM.

Table-1 Material specifications as per the various parameter

Sr. No.	Material	Damping Factor (ξ)	Maximum load capacity $(N/mm)^2$	Temperature range (ºC)	Transmissibility (T_r)
1	Epoxy glass	0.013	414	-111-139	0.000327
2	Polyurethane	0.05	10.1	-50-125	0.00115
3	Felt	0.06	0.14	-33-135	0.00138
4	Cork	0.127	0.25	-176-110	0.00293
5	Rubber pad	0.348	9.19	-11-118	0.00801

- The experimental set up is check that all the parts are on their good condition.
- The Speed variable DC motor is used in this experiment.
- In case 1, taking reading on without damper and without unbalanced mass, for that electrical plug is switched on.
- The speed is keep on 1000 rpm.
- There are 4 channels of FFTA, the 2 channels are used.
- As one of that is put on the motor for measuring the vibrations of motor and second is put on the base of motor for measuring the vibrations transfer to the base.
- It gives the time domain and frequency domain graphs of vibration from repective channel.
- The same procedure is follow in case 2 and case 3 of unbalanced without damper and unabalanced with damper respectively.
- This process is follow with polyeurathane-rubber pad, polyeurathane-epoxy glass and cork-felt.
- Compare this material combination on vibration absorb basis and gives the result.

Figure 9. Slotted disc used in Experiment.

Figure 10. Slotted disc with unbalanced mass used in Experiment.

Figure 11.Actual Experimental set up.

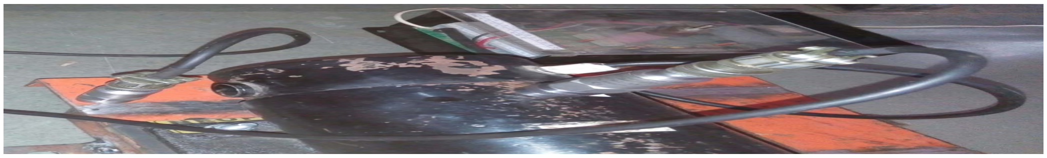

Figure 12.Actual Experimental set up showing accelerometer knob.

Figure 13. FFT used in Actual Experimental set up.

Figure 14.Composite material under the motor base.

III.EXPERIMENTAL READING OF VIBRATIONS WITH FFT

A.Case study

a.Case A

(a) without damper and without unbalanced mass of motor speed 1000 rpm.

Figure 15.Experimental time domain vibration reading of channel 1 & 2 of without damper and without unbalanced mass.

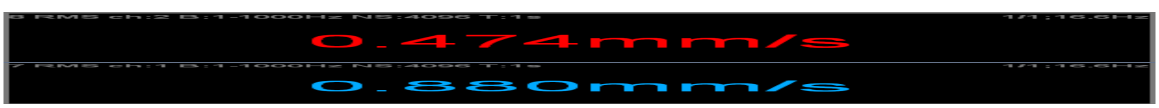

Figure 16.Experimental Frequency domain vibration reading of channel 1 & 2 of without damper and without unbalanced mass.

(b) without damper and with unbalanced mass of motor speed 1000 rpm.

Figure 17.Experimental time domain vibration reading of channel 1 & 2 of without damper and with unbalanced mass.

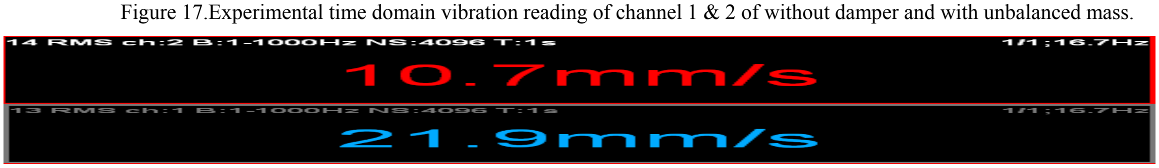

Figure 18. Experimental frequency domain vibration reading of channel 1 & 2 of without damper and with unbalanced mass

(c) without damper and without unbalanced mass of motor speed 2000 rpm.

Figure 19.Experimental noise level reading of channel 1 & 2 of without damper and with unbalanced mass.

Figure 20.Experimental time domain vibration reading of channel 1 & 2 of without damper and without unbalanced mass.

Figure 21. Experimental frequency domain vibration reading of channel 1 & 2 of without damper and without unbalanced mass.

(d) Without damper and with unbalanced mass of motor speed 2000 rpm.

Figure 22. Experimental noise level reading of channel 1 & 2 of without damper and with unbalanced mass.

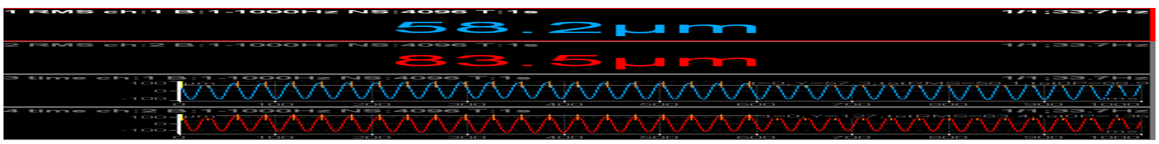

Figure 23.Experimental time domain vibration reading of channel 1 & 2 of without damper and with unbalanced mass.

Figure 24. Experimental frequency domain vibration reading of channel 1 & 2 of without damper and with unbalanced mass.

b.Case B.

(a) With Polyeurathane - rubber pad damper and without unbalanced mass of motor speed 1000 rpm.

Figure 25. Experimental noise level reading of channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

Figure 26. Experimental time domain channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

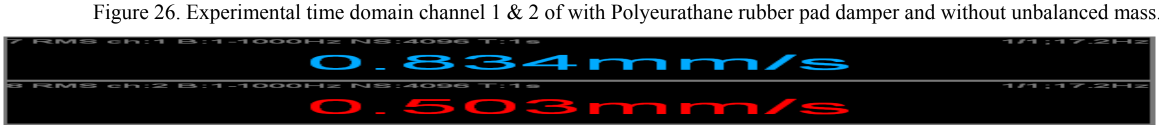

Figure 27. Experimental frequency domain of channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

(b) With Polyeurathane rubber pad damper and with unbalanced mass of motor speed 1000 rpm.

Figure 28. Experimental noise level reading of channel 1 & 2 of with Polyeurathane rubber pad damper and with unbalanced mass.

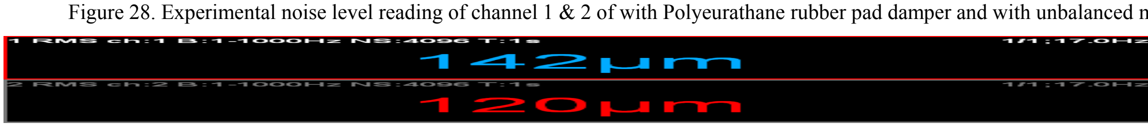

Figure 29.Experimental time domain channel 1 & 2 of with Polyeurathane rubber pad damper and with unbalanced mass.

Figure 30. Experimental frequency domain of channel 1 & 2 of with Polyeurathane rubber pad damper and with unbalanced mass.

(c) With Polyeurathane rubber pad damper and without unbalanced mass of motor speed 1000 rpm.

Figure 31.Experimental noise level reading of channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

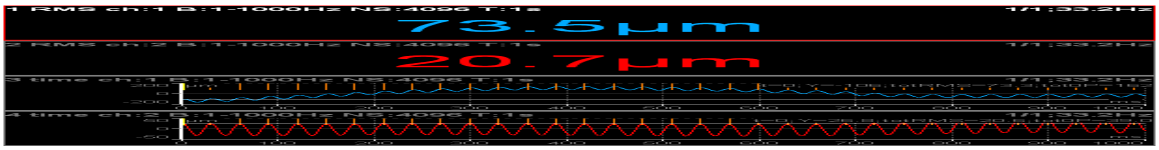

Figure 32.Experimental time domain channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

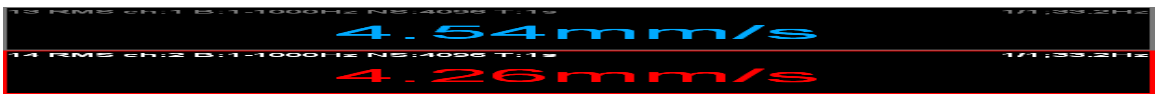

Figure 33.Experimental frequency domain of channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

(d) With Polyeurathane rubber pad damper and with unbalanced mass of motor speed 1000 rpm.

Figure 34. Experimental noise level reading of channel 1 & 2 of with Polyeurathane rubber pad damper and without unbalanced mass.

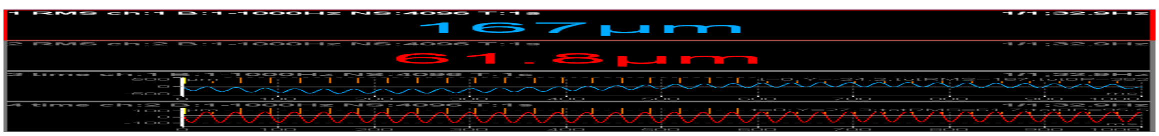

Figure 35.Experimental time domain channel 1 & 2 of with Polyeurathane rubber pad damper and with unbalanced mass.

Figure 36. Experimental frequency domain channel 1 & 2 of with Polyeurathane rubber pad damper and with unbalanced mass.

c.Case C.

(a) With Polyeurathane epoxy glass damper and without unbalanced mass of motor speed 1000 rpm.

Figure 37.Experimental noise level reading of channel 1 & 2 of with Polyeurathane epoxy glass damper and without unbalanced mass.

Figure 38.Experimental time domain channel 1 & 2 of with Polyeurathane epoxy glass damper and with unbalanced mass.

Figure 39. Experimental frequency domain channel 1 & 2 of with Polyeurathane epoxy glass damper and without unbalanced mass.

(b) With Polyeurathane epoxy glass damper and with unbalanced mass of motor speed 1000 rpm.

Figure 40. Experimental noise level reading of channel 1 & 2 of with Polyeurathane epoxy glass damper and with unbalanced mass.

(c) With Polyeurathane epoxy glass damper and without unbalanced mass of motor speed 2000 rpm.

Figure 41.Experimental noise level reading of channel 1 & 2 of with Polyeurathane epoxy glass damper and without unbalanced mass.

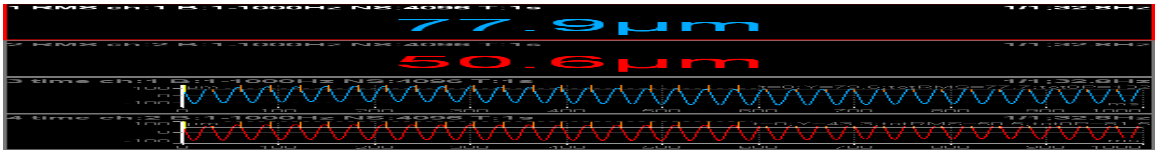

Figure 42.Experimental time domain channel 1 & 2 of with Polyeurathane epoxy glass damper and without unbalanced mass.

Figure 43.Experimental frequency domain channel 1 & 2 of with Polyeurathane epoxy glass damper and without unbalanced mass.

(d) With Polyeurathane epoxy glass damper and with unbalanced mass of motor speed 2000 rpm.

Figure 44. Experimental noise level reading of channel 1 & 2 of with Polyeurathane epoxy glass damper and with unbalanced mass.

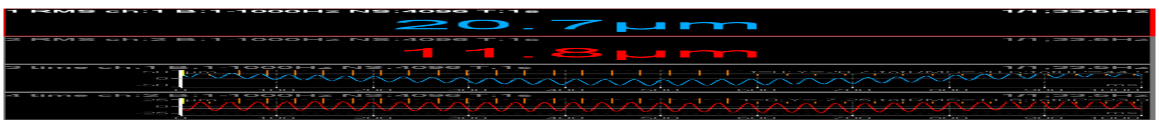

Figure 45.Experimental time domain channel 1 & 2 of with Polyeurathane epoxy glass damper and with unbalanced mass.

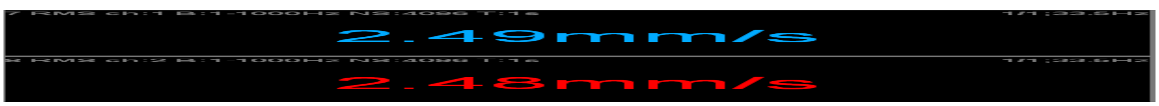

Figure 46. Experimental frequency domain channel 1 & 2 of with Polyeurathane epoxy glass damper and with unbalanced mass.

d.Case D

(a) With Cork felt damper and without unbalanced mass of motor speed 1000 rpm.

Figure 47.Experimental noise level reading of channel 1 & 2 of with Cork felt damper and without unbalanced mass.

Figure.48. Experimental time domain channel 1 & 2 of with Cork felt damper and without unbalanced mass.

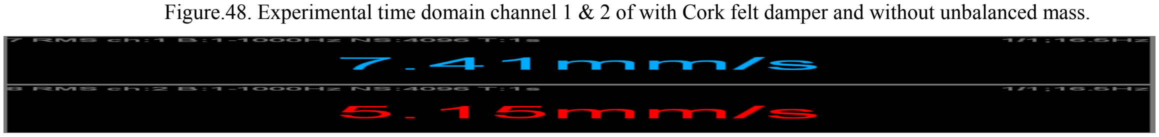

Figure 49. Experimental frequency domain channel 1 & 2 of with Cork felt damper and without unbalanced mass.

(b) With Cork felt damper and with unbalanced mass of motor speed 1000 rpm.

Figure 50. Experimental noise level reading of channel 1 & 2 of with Cork felt damper and with unbalanced mass.

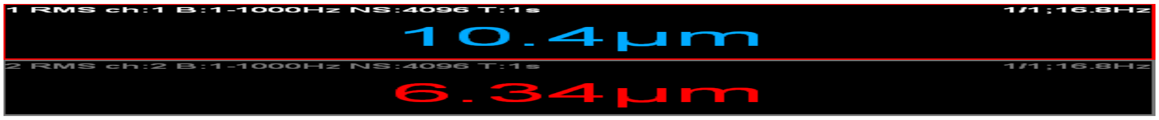

Figure 51.Experimental time domain channel 1 & 2 of with Cork felt damper and with unbalanced mass.

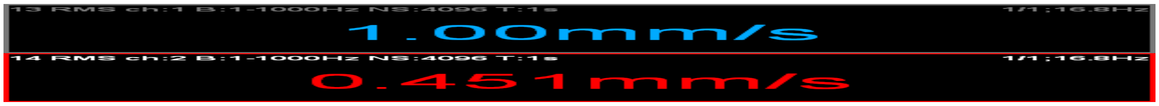

Figure 52. Experimental frequency domain channel 1 & 2 of with Cork felt damper and with unbalanced mass.

(c) With Cork felt damper and without unbalanced mass of motor speed 2000 rpm.

Figure 53. Experimental noise level reading of channel 1 & 2 of with Cork felt damper and without unbalanced mass.

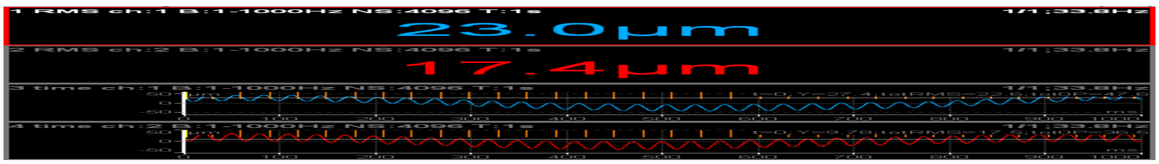

Figure 54.Experimental time domain channel 1 & 2 of with Cork felt damper and without unbalanced mass.

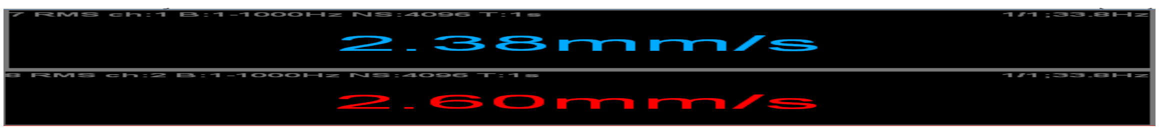

Figure 55. Experimental frequency domain channel 1 & 2 of with Cork felt damper and without unbalanced mass.

(d) With Cork felt damper and with unbalanced mass of motor speed 2000 rpm.

Figure 56. Experimental noise level reading of channel 1 & 2 of with Cork felt damper and with unbalanced mass.

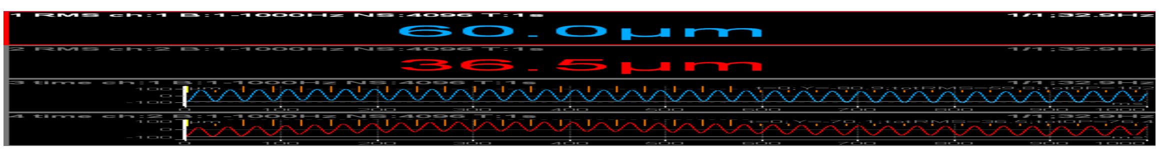

Figure 57.Experimental time domain channel 1 & 2 of with Cork felt damper and with unbalanced mass.

Figure 58.Experimental frequency domain channel 1 & 2 of with Cork felt damper and with unbalanced mass.

IV.RESULT

Table-2 Comparative Analysis of composite material on vibration reduction basis

Sr. No.	Composite material	Sensor	Displacement (µm) (With unbalanced Mass)	Vibration Reduction Displacement (µm)
1	Polyurethane and Rubber pad	Motor	167	105.2
		Base	61.8	
	Epoxy glass	Motor	20.7	

2	and Polyurethane	Base	11.8	8.9
3	Cork and Felt	Motor	60	23.5
		Base	36.5	

Table-3 Comparative Analysis of composite material on transmissibility and sound level basis

Sr. No.	**Composite material**	**Transmissibility** (T_r)	**Sound level dB(A)**
1	Polyurethane and Rubber pad	0.0150	79.5
2	Epoxy glass and Polyurethane	0.0157	79.7
3	Cork and Felt	0.0125	70.68

V.CONCLUSION

From the vibration reading for different composite viscoelasic material it concluded that, the different composite passive damper will be use as for following loading conditions in damping purpose;
1.Low load application- Cork and Felt.
2.High load application- Polyurethane and Rubber pad.

REFERENCES

[1] J.C.Snowden, Rubber like materials, their internal damping and role in vibration, *sound vibration*,1965,2(2), pp.175-193.
[2] D. I. G. Jones, Techniques for measuring damping properties of thin viscoelastic layers, *Journal of Sound and Vibration,* 1972, 24(2), pp.*201-210*.
[3] Shang Teh Wu, Yea Ying Chiu, Yuan Chih Yeh, Hybrid vibration absorber with virtual passive devices*, Journal of Sound and Vibration,* 2007, (299), pp. 247–260.
[4] Rongping Fan, GuangMeng, JunYang, Caichun, Experimental study of the effect of viscoelastic damping materials on noise and vibration reduction within railway vehicles, *Journal of Sound and Vibration,*2009,(319), pp. 58–76.
[5] Mohan D. Rao, Recent applications of viscoelastic damping for noise control in Automobiles and commercial airplanes, *Journal of Sound and Vibration,* 2003(262), pp. 457–474.
[6] Yu Du, Ricardo A. Burdisso, Efstratios Nikolaidis, Control of internal resonances in vibration isolators using passive and hybrid dynamic vibration absorbers*, Journal of Sound and Vibration,* 2005,(286), pp. 697–727.