Damping of structures with viscoelastic material literature review

D.V.Kushare, Pankaj Beldar

***Abstract*— In most of the structures vibrations are not desirable. For better performance we have reduce vibrations by means of active and passive vibration control. As there are many problems with active vibration control, use of passive vibration control comes in picture. There is wide range of viscoelastic materials which can be used as passive constrained layer damping method. In this paper ,scope is to find another materials which can be used as passive damping material. For calculating loss factor obrest beam is used with logarithmic decrement and half power bandwidth method.**

Keywords: passive damping ,viscoelastic materials, logarithmic decrement, half power bandwidth measurement, obrest

I. INTRODUCTION

Rubber is having both elastic and viscous properties. Hence Rubber is used as shock and vibration isolators and/or as dampers. Although the term *Rubber* usually refers to the compounded and vulcanized material. In the raw state it is referred to as an *elastomer* .Vulcanization forms chemical bonds between adjacent elastomer chains and subsequently imparts dimensional stability, strength, and resilience. An unvulcanized rubber lacks structural integrity and will "flow" over a period of time. Rubber has a low modulus of elasticity and is capable of sustaining a deformation of as much as 1000 percent. After such deformation, it quickly and forcibly retracts to its original dimensions. It is resilient and yet exhibits internal damping. Rubber can be processed into a variety of shapes and can be adhered to metal inserts or mounting plates. It can be compounded to have widely varying properties. The load deflection curve can be altered by changing its shape. Rubber will not corrode and normally requires no lubrication.. The authors are required to format their article according to this.

Rubber is essentially an incompressible substance that deflects by changing shape rather than changing volume. It has a Poisson's ratio of approximately 0.5. At very low strains, the ratio of the resulting stress to the applied strain is a constant (Young's modulus).This value is the same whether the strain is applied in tension or compression. Hooke's law is therefore valid within this proportionality limit. However, as the strain increases, this linearity ceases, and Hooke's law is no longer applicable.

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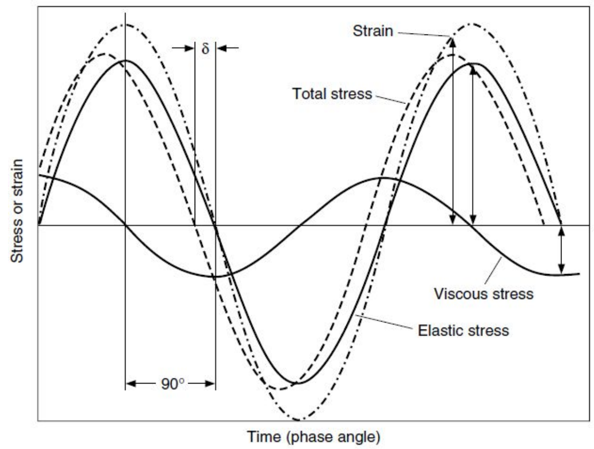

Fig 1- stress-strain plot of viscoelastic materials

II. LITERATURE REVIEW

A scientist kerwin is the first person who develop the analytical theory of passive viscoelastic damping with constrained layer method. It becomes very essential to study constrained layer (cld) and free layer damping(fld) to reduce vibration.

Pravin hujare, anil sahastrabudhe performed the viscoelastic constrained layer experiment with several viscoelastic materials such as polupropylene, pvc, butyl, SBR etc. they had used half power bandwidth method to find loss factor. MATLAB code is used as verification of performance. Obsert beam specimens made by ASTM 756(05) standard[1].

Dr. C.V Chandrashekara studied the Dynamic Analysis of Plate with Viscoelastic Material Patches. They had made various samples with different location of viscoelastic damping plate. They used Two different boundary condition like fixed-free and fixed-fixed boundary conditions .Simulation models were developed using Ansys software by them. The results of analytical model and simulation models are compared. Experimentation is conducted for both base plate and plate with VEM applied, for all three different materials considering the different boundary conditions.[2]

Scott J.I.Walker, Guglielmo S. Aglietti, Paul Cunningham studied the joint damping performance of metal plates, they made samples and tested the samples with accelerometer and sensors. finite element model was tested with ANSYS.[3]

Hasan Koruk, Kenan Y. Sanliturk measure the dynamic properties of the damping material with oberst beam method. Time domain and frequency domain analysis was carried out with different specimens to determine the modal loss factor.[4]

H. Zheng G. S. H. Pau and G. R. Liu studied the Optimization of Passive Constrained Layer Damping Treatments for Vibration Control of Cylindrical Shells. They had developed the theory of passive constrained layer damping (PCLD) for thin shell cylinder to reduce vibration and increase damping. Analytical model was verified by finite element model.[5]

Andrzej Flaga, Jacek Szulej, Piotr Wielgos performed the experiment to campare the determination methods of vibration's damping coefficients for complex structures. They compared The methods, such as collocation method, two energetic methods and half-power bandwidth method concern composite structures.[6]

Rizwan Ul Haque Syed, Muhammad Iqbal Sabir,Prof. Jiang Wei and Prof. Dong Yang Shi studied the Effect of Viscoelastic Material Thickness of Damping Treatment Behavior on Gearbox. CLD change its behavior after certain thickness of damping material under the constant thickness of structural and constrained material thickness. CLD efficiency became worst than the Free-layer or Extensional Damping. It does analyze by modal analysis in FEM software (ANSYS).[7]

Kraige has studied the use of viscoelastic material in landing gear mechanism. He has

Table.1-Designation and Composition of Common Elastomers

ASTM Designation	Common name	Chemical composition
NR	Natural rubber	*cis*-Polyisoprene
IR	Synthetic rubber	*cis*-Polyisoprene
BR	Butadiene rubber	cis-Polybutadiene
SBR	SBR)	Poly (butadiene-styrene
IIR	Butyl rubber)	Poly (isobutylene-isoprene
CR	Neoprene	Poly chloroprene
NBR	Nitrile rubber	Poly (butadiene-acrylonitrile)

III. PROPOSED WORK

Vibration control is a very essential part in several industries such as automobiles, airplanes. There should be less noise and vibration for performance and customer satisfaction. Hence Passive damping technology using viscoelastic materials is widely used to control vibrations and noise. This use of such structure has inspired me to study sandwich damped structure. Constrained and unconstrained layers are a common method to control vibrations. Because of

this measurement of damping factor and related properties of viscoelastic material have greatest importance in today's NVH domain. It is necessary to find optimal modal factor to determine the internal damping characteristics of different materials so that the most suitable material can be selected for certain NVH application. Aiming to maximize the vibration damping of structures with minimum viscoelastic material, some efforts have been also exerted to optimally design PCLD treatments of vibrating structures. My focus of research is devoted to optimization of modal loss factor in passive constrained viscoelastic material used in engineering structures. The goals of this research are mentioned below:

- To predict higher modal loss factor for various viscoelastic material under different condition for improving effectiveness.
- To gather data with help of software to determine damping properties of several viscoelastic materials.

Formulate a reliable prediction on optimized loss factor based on accumulated data of damping materials.

IV. FUTURE SCOPE

Vibration control is most important creation in design phase of compontant. This can be achieved by introducing damping in that component. A different kind of material in future like honeycomb structure and material with negative poison's ratio. Segmentation method may be used in future for enhancing modal loss factor. Viscoelastic material placed in patches in between constraining and base layer to study damping performance is having great interesting area for researcher.

REFERENCES

1. Pravin hujure, anil sahastrabudhe, international conference of advanced manufacturing and material enginnering ,2014
2. Bangarubabu. P, K. Kishore Kumar and Y. Krishna. (2012, March). Damping Effect of Viscoelastic Materials on Sandwich Beams, International Conference on Trends in Industrial and Mechanical Engineering (ICTIME'2012) ,24-25.
3. Scott J.I.Walker, Guglielmo S. Aglietti, Paul Cunningham,' Astudy of joint damping in metal plates',science direct 2009.
4. hasan koruk,' on measuring dynamic properties of damping materials using oberst beam method', proceedings of the asme 2010 10th biennial conference on engineering systems design and analysis esda2010 july 12-14, 2010, istanbul, turkey.
5. H. Zheng G. S. H. Pau and G. R. Liu,' Optimization of Passive Constrained Layer Damping Treatments for Vibration Control of Cylindrical Shells', Journal of Sound and Vibration 212(5), 781-805
6. Andrzej Flaga, Jacek Szulej, Piotr Wielgo,' Comparison of determination methods of vibration's damping coefficients for complex structures', Budownictwo i Architektura 3 (2008) 53-61
7. Rizwan Ul Haque Syed, Muhammad Iqbal Sabir,Prof. Jiang Wei and Prof. Dong Yang Shi, Effect of Viscoelastic Material Thickness of Damping Treatment Behavior on Gearbox, Research Journal of Applied Sciences, Engineering and Technology 4(17): 3130-3136, 2012
8. ASTM E-756-05: Standard Test Method for Measuring Vibration-Damping Properties of Materials.
9. Kerwin, "Damping of Flexural Vibrations by means of Constrained Viscoelastic Laminate," Journal of Acoustic Society of America, 1959, pp. 952-962.
10. Gerald Kress, "Optimization of Segmented Constrained Layer Damping with Mathematical Programming Using Strain Energy analysis and Modal data" Elsevier, Material & Design, 2009.
11. Ross, E. Unger, Kerwin, "Damping of Flexural Vibrations by Means of Viscoelastic laminate" Structural Damping, ASME, New York,1959.