Optimization of Segmented Constrained Layer Damping Literature Review

Avinash Kadam, Pravin Hujare

Abstract*—*constrained layer damping has extensively used since many years to damp flexural vibrations by producing shear forces in between constraining and constrained layer. This creates shear deformation is responsible for dissipation of vibration energy. CLD is a sandwiched structure of viscoelastic material between upper constraining layer and base layer. Enhancing the results of damping efficiency of CLD can be achieved by cutting constraining and constraining layer, this is called as segmentation. The main objective of this paper is to provide guidelines for optimization of segmentation of viscoelastic material in between composite structure.

Index Terms*— *Constrained Layer Damping, Damping, Optimization, Vibration Control.

I. INTRODUCTION

In the design phase of any component vibration damping is considered as important factor. Viscoelastic materials are widely used in many areas to control unwanted vibrational energy due to their better properties of damp out vibrations. It is proved that damping material used in passive damping treatment to improve the performance.

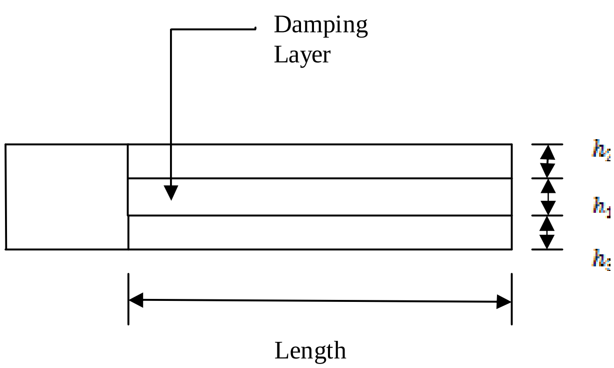

Fig.1 Sandwiched Beam

In the passive constrained layer damping technique the damping material is bonded between constraining layer and base layer. The damping material is sandwiched between upper and lower layer, forms shear motion. Performance of such sandwiched is influenced by different way like varying thickness and cut on the viscoelastic material. As a result of this optimization parameter, volume of Shear rate increases leading to high damping rate. Passive constrained layer damping (PCLD) treatment has been regarded as an effective way to suppress vibration from various structures.

The use of PCLD treatment in the automotive, commercial airplane, appliance and other industries has been growing in the recent years. The eventual application into these industries is made possible by the innovation in manufacturing processes which are cost effective and are suitable for high volume production.

II. LITERATURE REVIEW

Recently uses of damping material are increased in industrial application because of high damping ability. Therefore it becomes essential to optimize for find out optimized internal damping characteristics. Hence below work express the basic in the area of optimization passive constrained layer.

Kerwin is the first who developed a theory to calculate modal loss factor by using viscoelastic material in composite structure. He explains that shear motion of constrained layer causes the losss in vibrational energy in heat. But this is limited for thin structure of viscoelastic material as compared to base layer. [1]

Gerald Kress, Gregoire Lepottevin studied that number of factor which improves damping ability of viscoelastic material. They use segmentation method which improves loss factor by cutting constraining and constrained layer. Mathematical programming is developed by them to find arrangement of cut. They used modal strain energy method for estimation of damping efficiency. [2]

D Ross, E. Unger, E. Kerwin derived a model to predict constrained layer treatment effects. Kerwin was the first to present a theoretical approach of dampened this structure with constrained viscoelastic layer. He stated that the energy dissipation mechanism in the constrained core is attributed to the shear motion. He represented the first analysis of simply supported beam using complex modulus to represent viscoelastic core. D. Ross closely examined the definition of loss factor in terms of energy, especially for high damped composite structure. [3]

Palash Dewangan Studied damping effects by using passive constrained layer damping. He uses RKU method with different viscoelastic core for ensuring damping effect. Experimental method used by him which shows how the amplitude decreases with time for damped system compared to undamped system. Further he also extends his work of finite element analysis with various damping material to show comparison of harmonic responses between damped and undamped systems. [4]

Ramji koona, Ganesh Kumar, M. Lavanya describes modelling of CLD and FLD by RKU analysis. They calculate loss factor by using Oberst and Alfred Schoomer approach with the help of RKU equations. They utilize the finite element methodology to model beam structure and ANSYS software is used for modal analysis. Finally they validate

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result from ANSYS software and result obtained through Oberst beam technique. [5]

A L. Araujo, P. Martins, J. Herkovits & C. A. Mota Soares studied importance of gradient base optimizer with appropriate finite element model for damping maximization. Frequency domain approach is used to solve dynamic problem & complex modulus approach is used for study viscoelastic behavior of material. They maximize the modal loss factor using gradient based optimization with their own model. [6]

Takao & Shigeo Arai studies the relationship between basic properties of vibration damping materials and their vibration reduction performance in body panels of automobiles. As a result it was found that the vibration level of body panels depend not only the loss factor but also on flexural rigidity and mass changed by lamination of damping materials. It was found that considering three parameters and evaluating damping materials more accurately by measuring vibration level of a plain, plate which has the same laminations composition as the vehicle panels. They developed an estimation method for basic properties of damping materials with any lamination compositions which has found to be effective to reduce noise and noise of actual cars efficiently. [7]

Plunket & Lee were the first who investigates optimization parameter for constrained layer damping. They find out the method which reduces vibrational energy by segmenting the constraining layer. Finally they propose that damping is depending on stiffness of constraining layer and loss factor of viscoelastic material. [8]

Vasudeven Rajamohen studies the modal damping characteristics of a rotating beam with distribution of cuts in both the constrained and constraining layer and develops governing equations of motion of a rotating constrained viscoelastic sandwich beam in finite form. Vasudeven investigates significance of the number and location of the segmentation on the modal damping factor using strain energy approach and finite element method. Optimization problem is solved by formulating by combining finite element analysis with optimization algorithms. He suggests damping factor influenced by the location and number of cut on the viscoelastic sandwich beam. [9].

D J Mead and **S Markus** have explored the influence of boundary conditions on three layered beam. They derived the sixth order differential equation in terms of transverse displacement, for a three layer sandwich beam with viscoelastic core. Mead further studied various theories of three layer sandwich beam presented by Yan and dowell, Mead and Markus; computes the loss factors from the theories are presented and compared. [10]

Hasan and **Kenan** find out the effects of various parameters on measured data using an Oberst test rig in an attempt to improve the accuracy of the estimated material properties. They referenced the OBM in some standard and give the detailed information about how to perform Oberst Beam experiment. They also give suggestion to the OBM users so as to avoid undesirable effects of certain p`arameter during such measurements. [11]

P. Bangarubabu, K. Kishore Kumar & Y. Krishna throws light on various types beams used in automotive and aerospace industries for indicating the need for simple methods describes the dynamics of these complex structures. They investigate in order to understand the effectiveness of sandwich structure, the dynamics of bare beam with free and constrained viscoelastic layers. After conducting the experiments by them, predicts the result is that constrained viscoelastic layer provide higher loss factor than free layer. [12].Referring to set of papers, standard and thesis, we get an idea about different methods to measure damping properties of viscoelastic materials for optimization of it. A detailed procedure and precautions is to be taken while testing is studied from research article.

III. PROPOSED WORK

Vibration control is a major concern in several industries such as automobiles. The reduction of noise and vibration is a major requirement for performance and customer satisfaction. Passive damping technology using viscoelastic materials is classically used to control vibrations. The growing use of such structure has motivated 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.

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