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Effect of PCLD Treatment Configuration on Damping Performance of Flexible Cantilever Beam

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Abstract- For many years vibration damping has been an important criterion in the design phase of many engineering applications. Large dissipation capabilities over a wide frequency range are desired. A common solution is to use a constrained viscoelastic material bonded to the vibrating structure. The damping material is applied in a sandwiched configuration. The shear deformation occurring in the viscoelastic core is mainly responsible for the dissipation of energy. In a passive constraining layer damping treatment, a visco-elastic layer and a constraining layer is added to a conventional base beam. Three different types of visco-elastic materials have been used as a core for sandwich beam to ensure damping effect. Four different types of constraining layer materials is used. It is predicted which constraining layer material is giving good damping effect. MATLAB codes have been developed to obtain the results theoretically. The result shows a considerable amount of decrease in amplitude for a damped system as compared to undamped system.

Keywords- -vibration damping,constraining layer,amplitude,MAT LAB.

I. Introduction

Passive constrained layer damping (PCLD) treatment has been regarded as an effective way to suppress the vibrations of thin walled structures and their noise radiation. PCLD of vibration has tremendous potential in reducing fatigue loads and averting instabilities in aircraft wing, helicopter blades and turbine blades. A cantilever beam is a basic model for various parts such as wings. Aerospace, aircraft and satellites structures should be designed to be lightweight because of high cost transportation involved. They are also lightly damped because of low internal damping of materials used in their construction for increased flexibility, which may cause structural instability. This will affect the precision performance of the system. To overcome these difficulties, here the project uses PCLD for vibration attenuation meanwhile increases the life of the system. This was the motivation behind the project. In the past decades, there have been a number of publications with reported formulations and techniques for vibration damping calculations of damped beams and plates. Most of the early works in the field dealt mainly with the treatments by full PCLD coverage.

II. Objectives

The main objectives are stated as follows :

- Aiming to maximize the vibration damping of a cantilever beam with minimum PCLD coverage.
- To study about the effect of PCLD treatment on a cantilever beam with various constraining layer materials and with three types of visco-elastic materials.
- To measure the frequency response of the beam theoretically using MATLAB thorough modal and harmonic analysis.

III. Experimental Procedure

Now consider the constrained layer damping where the damping layer, adhering to the outer surface of the structural element, has a stiff layer attached to its outer surface to the sandwich damping layer. This is called as passive constrained layer damping (PCLD), which consists of a constrained damping material attached to the surface of vibrating structure. When the whole assembly bends, the damping layer is subjected to shear strain, and this cyclic shearing dissipates energy in that layer.

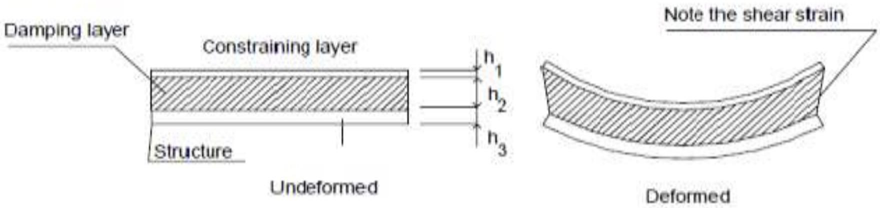

Fig Deformation of constrained layer.

In this project a cantilever beam is chosen and its damping performance improved by decreasing its vibration energy. PCLD treatment is used to improve the damping performance of the beam. Response of the beam is measured theoretically using MATLAB codes. Results were analysed using modal and harmonic analysis.

3.1. Different material combinations

Table - Different types of material combinations

Base Beam	Constraining Layer	Visco elastic Layer
Aluminium	Aluminium ,Steel ,Copper ,Brass	Butyl Rubber
Aluminium	Aluminium ,Steel ,Copper ,Brass	Silicone Rubber
Aluminium	Aluminium ,Steel ,Copper ,Brass	DYAD 606

3.2. Modal Analysis Result of Butyl Rubber

Mode no	Frequency of undamped beam in Hz	Frequency of Damped beam with aluminum as constraining. layer in Hz	Frequency of Damped beam with steel as constraining layer in Hz	Frequency of Damped beam with brass as constraining layer in Hz	Frequency of Damped beam with copper as constraining layer in Hz
1	83.66	81	81	61	61
2	523.51	501	501	341	361
3	1468.67	1381	1421	941	1021
4	2877.44	2701	2781	1841	2001
5	4469.88	4461	4601	3021	3301

3.3. Modal Analysis Result of Silicone Rubber

Mode no	Frequency of undamped beam in Hz	Frequency of Damped beam with aluminum as constraining. layer in Hz	Frequency of Damped beam with steel as constraining layer in Hz	Frequency of Damped beam with brass as constraining layer in Hz	Frequency of Damped beam with copper as constraining layer in Hz
1	83.66	81	81	61	61
2	523.51	481	481	341	361
3	1468.67	1381	1421	941	1041
4	2877.44	2701	2781	1821	1981
5	4469.88	4461	4561	3021	3381

3.4 Modal Analysis Result of DYAD 606

Mode no	Frequency of undamped beam in Hz	Frequency of Damped beam with aluminum as constraining. layer in Hz	Frequency of Damped beam with steel as constraining layer in Hz	Frequency of Damped beam with brass as constraining layer in Hz	Frequency of Damped beam with copper as constraining layer in Hz
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3	1468.67	1401	1421	961	1041
4	2877.44	2701	2781	1821	1961
5	4469.88	4481	4541	3041	3401

3.5 Harmonic Analysis Results of Butyl Rubber

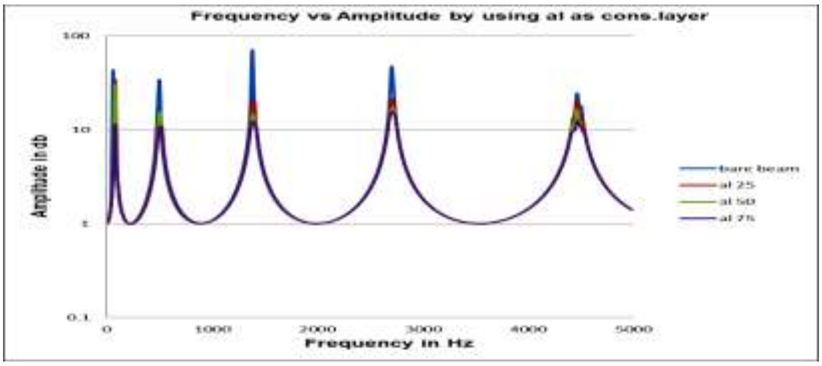

Fig - Harmonic analysis with Aluminium as constraining layer and butyl rubber as core

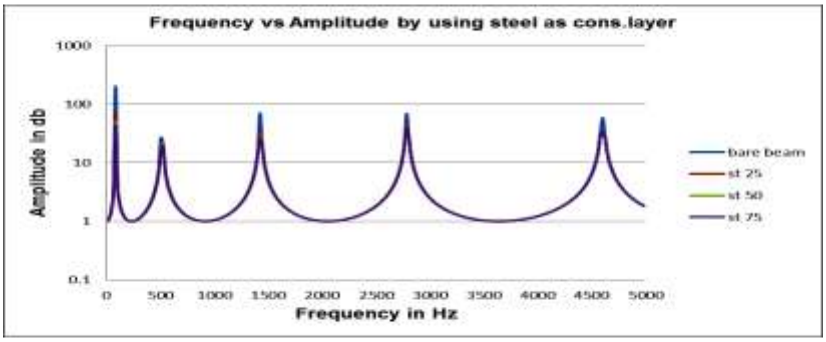

Fig - Harmonic analysis with steel as constraining layer and butyl rubber as core

3.6 Harmonic Analysis Results of Silicone Rubber

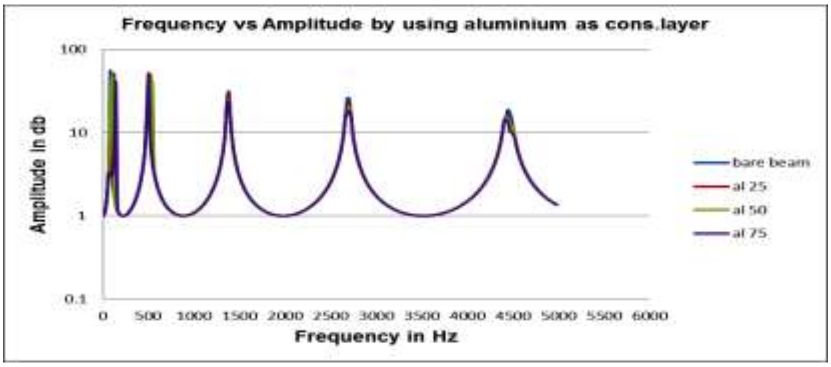

Fig - Harmonic analysis with aluminium as constraining layer and silicone rubber as core

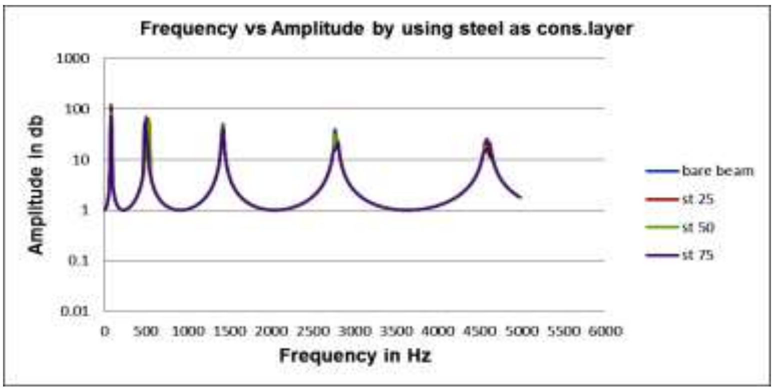

Fig - Harmonic analysis with steel as constraining layer and silicone rubber as core

3.7 Harmonic Analysis Results of DYAD606

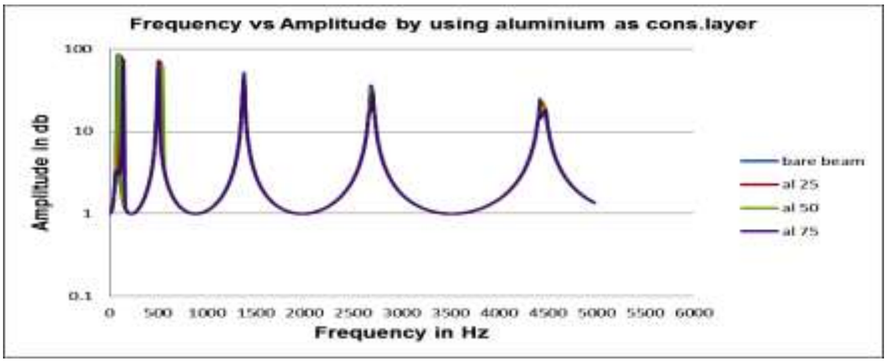

Fig - Harmonic analysis with aluminium as constraining layer and DYAD606 as core

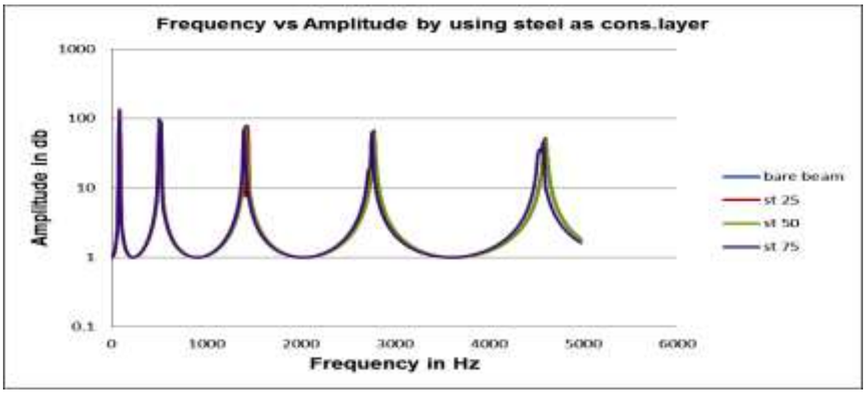

Fig - Harmonic analysis with steel as constraining layer and DYAD606 as core

IV. Conclusion

The purpose of this report is to throw light on constrained layer viscoelastic damping, and trend for its application and to show the response by applying the theory of passive damping in a practical way, as well as with use of finite element analysis. In this report damping treatment has been applied to cantilever beam and frequency response has been shown theoretically. The mathematical formulation of classical viscoelastic theory has been presented and the finite element formulation is also discussed. MATLAB codes have been developed for the theoretical and harmonic analysis. Analytical results show that passive viscoelastic constrained layer damping treatment has a great significance in controlling the vibration of a cantilever beam. The results shows that the system with brass as constraining layer is proved to be very efficient than steel and copper. In the three types of viscoelastic materials used butyl rubber has high damping characteristics as compared with silicone rubber and DYAD606.

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