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PASSIVE VISCOELASTIC CONSTRAINED LAYER DAMPING FOR BUTYL RUBBER (VISCOELASTIC MATERIALS)

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ABSTRACT

Beam is basic components in industrial structural design whose damping properties are often very important to reduce vibration. Viscoelastic materials are generally polymers; there is enormous variability in the composition of viscoelastic materials. Rubber is a unique material that is both elastic and viscous. Rubber parts can therefore function as shock and vibration isolators and/or as dampers. In this research Butyl rubber is viscoelastic material which is acting as the damping layer, steel and aluminum patches are used as constrained layer. Here, change in length of patch and damping layer is varied for constant length and thickness of base layer. The lengths of patches are varied as 25%, 50%, 75% and 100%. These patches also arranged in segment and hybrid. Two sets of specimens are prepared for aluminum and steel constrained layer. Damping characteristics of beam are determined by experimental and analytically by using FFT analyzer and ANSYS software respectively

KEYWORDS: Vibration Damping, CLD, Length of Patch

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INTRODUCTION

Passive damping technology using viscoelastic materials are classically used to control vibration. The steel industry proposes damped sandwich sheets in which a thin layer of viscoelastic material is sandwiched between two elastic face layers. The methods to increase damping can be categorized into two categories: passive damping and active damping. Full-scale implementation of active and semi-active damping treatment has been slow due to high costs and complexity [1]. Passive damping as a well-developed technique, in general, is more simple and cost-effective. Kerwin was the first to present a theoretical approach of damped thin structures with a constrained viscoelastic layer. He stated that the energy dissipation mechanism in the constrained core is attributable to its shear motion. He presented the first analysis of the simply supported sandwich beam using a complex modulus to represent the viscoelastic core [2]. Damping materials could be used as treatments in passive damping technology to structures to improve damping performance, there has been a flurry of ongoing research over the last few decades to either alter existing materials, or develop entirely new materials to improve the structural dynamics of components to which a damping material could be applied [3]. The main focus of this dissertation is to study the complex behaviour of the viscoelasticmaterials, to predict damping effects using method of passive viscoelastic constrained layer damping technology experimentally and to show the nature of response of structures using finite element method [4].

TABLE 2 MATERIAL PROPERTIES [7]

MODELLING AND PROPERTIES

Beams are modelled by using solid plane 183 plane element stresses with thickness element used in ANSYS Software. The size of viscoelastic layer and constraining layer for beams are varied as follows. In the beam constrained layer and damping layer length is varied from 25%, 50%, 75%, 100%, segment and hybrid from the base beam. Totally 11 constrained layer specimens and bare beam also measured the cantilever beam [5].

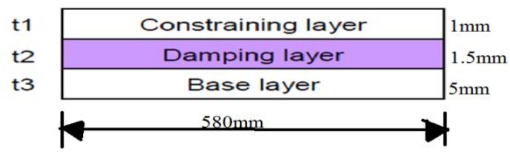

Fig 1: Geometry of beam with viscoelastic core.

TABLE 1 SPECIMEN DIMENSIONS [6]

S. No.	Material Type	Dimension of beam in mm
1	Base layer	580*40*5
2	Fully CLD Damping layer	580*40*1.5
3	fully CLD Constraining layer	580*40*1

S. NO.	Material Type	Young's Modulus (E) [MPa]	Density (ρ) [kg/m³]	Poisson's Ratio
1	Steel	$210*10^3$	7850	0.3
2	Aluminium	$70*10^3$	2700	0.35
3	Butyl Rubber	8.3378	1250	0.0

EXPERIMENTAL SETUP

Specimens are prepared as given in above table 1. These specimens are glued by using Araldite resin. Initially the specimens are prepared for required dimensions and then clamped in the fixture. The FFT analyser is connected to the accelerometer and impact hammer. The accelerometer fixed at specified point for beam as shown in Fig 2.

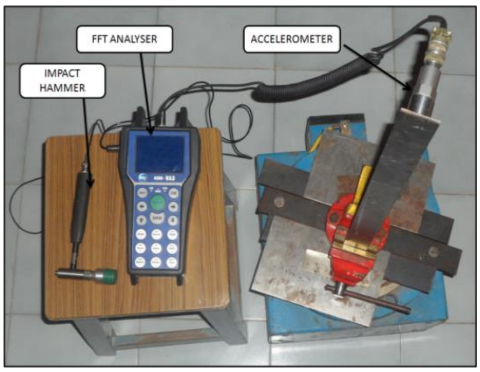

Fig 2: Experimental Setup for beam

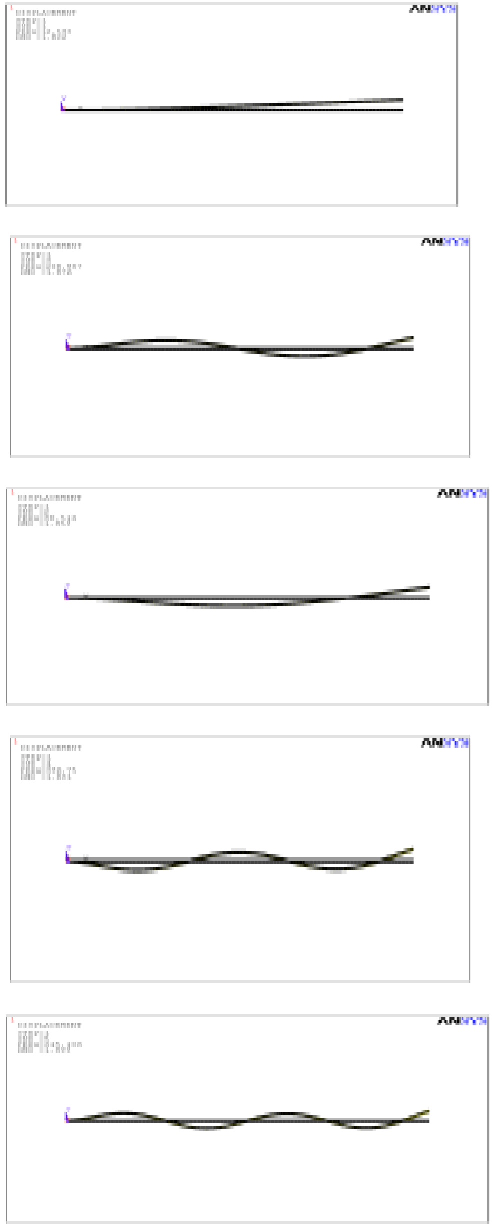

Fig 3: Mode shape for fully CLD Beam

The impact hammer is stricken at specified point, from this amplitude and displacement values are measured. These obtained values are transferred to PC and graph is plotted for comparisons by using FFT software [8].

RESULTS AND DISCUSSION

Modal analysis and harmonic analysis are done for beams using ANSYS software. These results are compared with one another.

Bare beam is compared with 25% length of patch CLD the amplitude value is higher, when compared with steel CLD beam the amplitude higher with respective to aluminium-CLDbeam[9]. For steel 50% length of patch CLD, the damping is higher than bare beam and aluminium CLD beam. For 75% and 100% constrained layer damping aluminium has higher damping compared to steel CLD and bare beam. The compare aluminium CLD the damping factor steel CLD is high [10]. For Segmented beam and hybrid beam the damping of steel CLD beam is lower than aluminium CLD beam [12], [13].

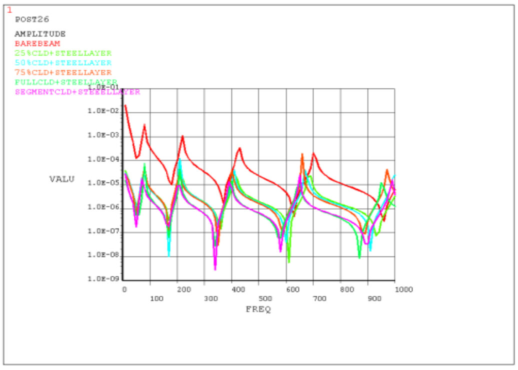

Fig 4:Comparison of Different Length of patches in Steel CLD for beam

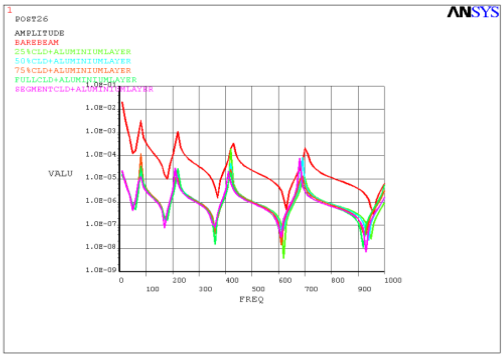

Fig 5: Comparison of Different Length of patches in Aluminium CLD for beam

CONCLUSIONS

From the experimental and analysis results following conclusions are drawn

a) From Experimental and analytical results steel CLD patch has high damping factor than aluminium CLD patch.
b) From the obtained FEA results, the damping factor is high for segmented steel constrained layer damped beam compared to other combination of constrained layer damped beam.
c) From the experimental results Steel CLD patch has high loss factor and damping factor than aluminium CLD patch.
d) From the experimental and analysis result it is identified that the steel segmented damping beam has high damping factor and loss factor.

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