Constrained-Layer Systems Provide Weight-Efficient, High-level Damping

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Constrained-Layer Damping

Damping materials can be used for a wide variety of noise and vibration applications. To take full advantage of their vibration-reducing potential, product designers often must make a choice between using extensional (free-layer) or constrained-layer damping (CLD) systems. While either system will provide good results for thin substrate panels, thick or heavy structures—1/4-inch or thicker—require a CLD system to achieve high damping and effective noise reduction.

Most CLD applications use a three-layer "sandwich" system that is formed by laminating the base layer to a damping layer and then adding a third constraining layer (Figure 1). Typically, the constraining layer is of the same material as the

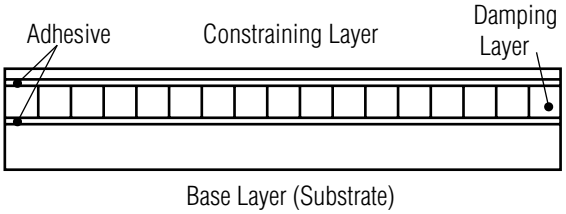

Figure 1: Constrained-layer construction (cross-section).

base layer, but exceptions are common.

In this sandwiched construction, when the system flexes during vibration, the damping material layer is forced into a shape that shears adjacent material sections. This alternating shear strain in the CLD material dissipates the vibration as low-grade frictional heat (Figure 2).

Compared to the free-layer damping technique, CLD systems provide relatively

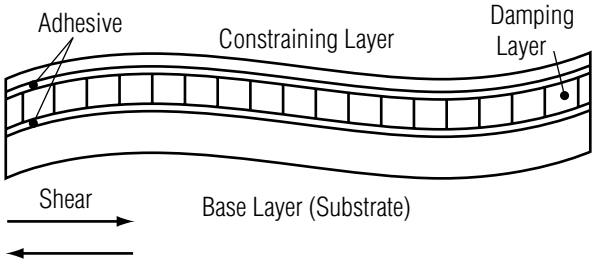

Figure 2: System under vibration (magnified). Note shearing of damping layer as panel flexes.

higher performance as substrate thickness increases. Figure 3 compares typical system loss factors for the two constructions on equivalent steel substrates at constant temperature and frequency. Curve A is 3/16-inch-thick E-A-R ISODAMP® C-2003-19 damping sheet, in free layer application. Curve B is ISODAMP C-1002-06, a 1/16-inch-thick damping layer, applied with a constraining layer one-half the thickness of the substrate.

In both cases, the loss factor decreases as a function of substrate thickness, but the

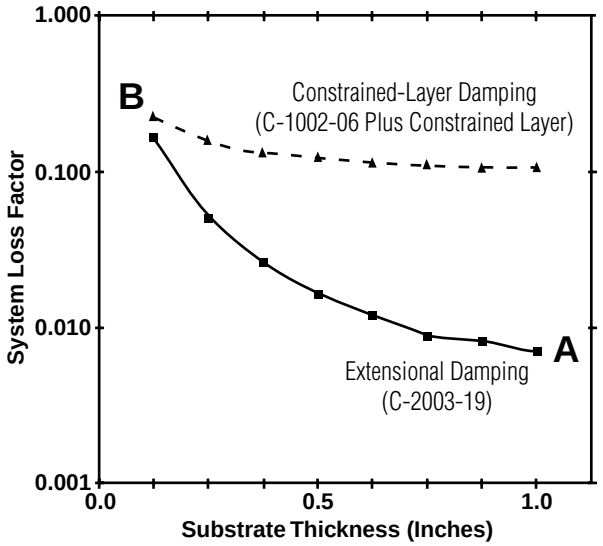

Figure 3: System loss factor vs. substrate thickness (inches).

CLD system is able to maintain a high system loss factor of greater than 0.1 across the range. (This translates to a theoretical noise reduction of 20 dB and more.)

Additionally, in weight-sensitive applications, CLD systems can provide lighter overall constructions than equivalent free-layer systems. Through our extensive work in aircraft noise control, E-A-R Specialty Composites has developed CLD composites—the Aircraft Damping Composites line—that provide both the required high performance and weight efficiency, yet with the installation convenience of a free-layer system. (The ADCs meet strict FAA flame regulations as well.)

For example, installed on the .040-inch-thick aluminum typically used in business jets, E-A-R's ADC-124 (lightweight damping foam and 5-mil aluminum constraining layer) provides higher damping at low temperatures than most, if not all, solid free-layer materials of equal weight.

E-A-R also has developed lightweight, highly damped composite tiles for the U.S. Navy that will reduce the noise radiated by its next-generation submarines. The constrained-layer tiles are designed to provide significant and much-needed weight savings over damping systems currently in use, potentially increasing the ship's overall payload capabilities (Figure 4).

E-A-R manufactures the most complete line of noise, vibration, shock and motion control products available from one source. The company's proprietary urethane and vinyl foams and solid sheet materials are used to control unwanted mechanical energy in OEM product designs, including aircraft vehicles of all types, electronic and electromechanical equipment, appliances, precision equipment and industrial machinery.

More information on E-A-R's extensive lines of energy control materials and on the company's engineering/problem solving capabilities is available from E-A-R Specialty Composites.

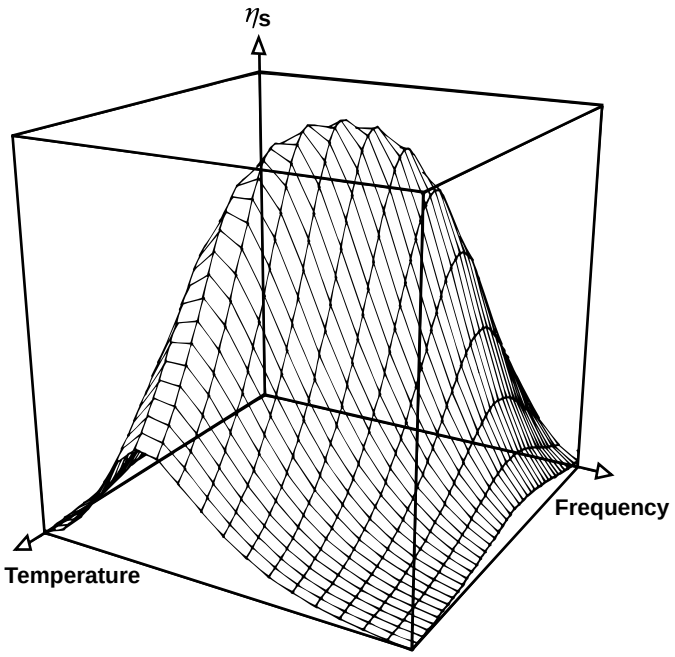

Figure 4: Graph of system loss factor ηs vs. temperature and frequency for Type VI Navy Damping Tile. E-A-R engineers used computer techniques to model CLD systems to determine the optimum choice of materials and geometry. The resulting tiles consist of a unique, multi-layer composite laminate constraining layer and specially formulated ISODAMP damping materials.

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Printed 2.00