EXPERIMENTAL VERIFICATION OF HIGH-STRENGTH COMPOSITE TUBES

HENRI P. GAVIN* AND HUGH V. JAMIESON†

* Civil & Environ. Eng'g
Duke University
Durham, NC 27708, USA
Henri.Gavin@Duke.edu

† Simulation Technologies Inc.
1539 Cooper St.
Durham, NC 2003, USA

The selection of isotropic materials for dynamic structural applications typically involves a trade-off between stiffness and damping [1].Efforts to develop engineering materials with high $E \cdot \tan\delta$ products have involved composites with visco-elastic inclusions, ferro-electric inclusions, fiber-epoxy composites, metal-matrix composites, shape-memory alloys, and magnetostrictive alloys. Many of these composites require expensive constituents (metal-matrix composites), require external power (magnetostrictive alloys), are difficult to machine (shape memory alloys), or require specialized fabrication methods (fiber-epoxy composites and composites with specialized inclusions).

We have found that by filling metallic tubes with thermosetting polymers having a very high Poisson ratio (close to 1/2), structures with high stiffness-to-weight ratios and very high strength-to-weight ratios can be readily fabricated. Furthermore, the polymer in-fill can increase damping significantly. Our analyses show that: (a) thermosetting polymers with high Poisson ratio, and (b) adhesion of the thermosetting polymer to the metallic tube are *critical* to the successful development of these composite structures.

This paper describes (a) the principle of this synergistic behavior; and (b) validation experiments which illustrate the high stiffness, exceptional strength, enhanced damping, and mechanical failure properties of these composite structures.

References

[1] Lakes RS, *Viscoelastic Solids*, CRC Press, 1998.

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