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DAMPING MODELS FOR SHEAR BEAMS WITH APPLICATIONS TO SPACECRAFT WIRING HARNESSES

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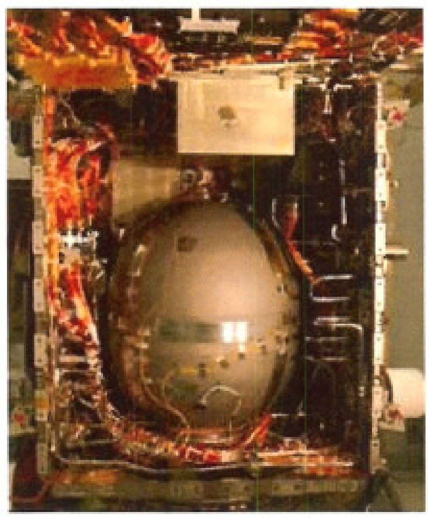
Abstract:

Damping is an important aspect of aerospace structures designed to operate in dynamic environments. Wiring harnesses can significantly affect the dynamics of spacecraft structures. High-fidelity models of the coupled structure-cable dynamic system are needed to accurately predict launch loads and potential control system interactions. A beam model including first-order transverse shear can accurately capture the effects of cable mass and stiffness on dynamic response and provide insight into structural behavior. However, available time-domain damping models are inadequate for use in such a model—common proportional damping models predict modal damping that depends strongly and unrealistically on frequency. Inspired by a geometric rotation-based viscous damping model that provides frequency-independent modal damping in an Euler-Bernoulli beam model, several time-domain viscous damping models are presented that exhibit weaker frequency dependence than proportional damping models. At low frequencies (bending-dominated modes), the models provide modal damping that is approximately constant for the first four vibration modes of a typical spacecraft cabling segment. At higher frequencies (shear-dominated modes), the models yield modal damping that is either directly or inversely proportional to the mode number. Model predictions compare favorably to available experimental data.



Speaker Bio:

Dr. George Lesieutre is Professor and Head of the Department of Aerospace Engineering, and Director of the Center for Acoustics and Vibration at Penn State. He earned a B.S. in Aeronautics and Astronautics from MIT, and a Ph.D. in Aerospace Engineering from UCLA. Prior to joining Penn State, he held positions at SPARTA, Rockwell Satellite Systems, Allison Gas Turbines, and Argonne National Lab. His research interests include structural dynamics of aerospace systems, including passive damping, active structures, and energy harvesting. Dr. Lesieutre served as PI of several major DARPA programs in adaptive structures, and has received five society best paper awards. He is a Fellow of AIAA, and serves on the AIAA Board of Directors. He was a member of the Materials Panel of the recent National Research Council study of the NASA (Space) Technology Roadmaps. He once paddled a canoe from Montreal to the Gulf of Mexico as part of a historical reenactment, and more recently ran a 50-mile ultramarathon.