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Numerical Tools for Designing Multilayer Viscoelastic Damping Devices

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Abstract : Auxiliary damping has gained popularity in recent years, especially in structures such as mid- and high-rise buildings. Distributed damping systems (typically viscous and viscoelastic) or reactive damping systems (such as tuned mass dampers) are the two types of damping choices for such structures. Distributed VE dampers are normally configured as braces or damping panels, which are engaged through relatively small movements between the structural members when the structure sways under wind or earthquake loading. In addition to being used as stand-alone dampers in distributed damping applications, VE dampers can also be incorporated into the suspension element of tuned mass dampers (TMDs). In this study, analytical and numerical tools for modeling and design of multilayer viscoelastic damping devices to be used in dampening the vibration of large structures are developed. Considering the limitations of analytical models for the synthesis and analysis of realistic, large, multilayer VE dampers, the emphasis of the study has been on numerical modeling using the finite element method. To verify the finite element models, a two-layer VE damper using ½ inch synthetic viscoelastic urethane polymer was built, tested, and the measured parameters were compared with the numerically predicted ones. The numerical model prediction and experimentally evaluated damping and stiffness of the test VE damper were in very good agreement. The effectiveness of VE dampers in adding auxiliary damping to larger structures is numerically demonstrated by chevron bracing one such damper numerically into the model of a massive frame subject to an abrupt lateral load. A comparison of the responses of the frame to the aforementioned load, without and with the VE damper, clearly shows the efficacy of the damper in lowering the extent of frame vibration.

Keywords : viscoelastic, damper, distributed damping, tuned mass damper
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