Measurement of Damping in Structures by the Power Input Method

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Abstract

Damping refers to the extraction of mechanical energy from a vibrating system usually by conversion of this energy into heat. Damping serves to control the steady-state resonant response and to attenuate traveling waves in the structure. There are two types of damping: material damping and system damping. Material damping is the damping inherent in the material while system or structural damping includes the damping at the supports, boundaries, joints, interfaces, etc. in addition to material damping.

Since utilizing damping materials is the most common way to reduce resonance responses, accurate measurements of damping are crucial to the proper design, optimization, and modeling of systems from a vibration reduction standpoint. Damping or loss facor measurements are rarely straightforward due to the complexity of the dynamic interaction of system joints, trim, and geometry. Furthermore, a variety of nomenclature exists to denote damping. These include: damping ratio (ζ), log decrement (δ), loss factor (η), loss angle (φ), tanδ, specific damping capacity (ψ), quality factor (Q), etc. Equal to the number of different descriptors for damping levels, there are different test methods.

The various damping test methods can broadly be classified into three groups: a) frequency-domain modal analysis curve-fitting methods, b) time domain decay-rate methods, and c) other methods based on energy and wave propagation [1-3]. Each method has its own set of advantages and drawbacks. One method, the power input method (PIM) from group (c) above, is a powerful method for obtaining frequency-averaged loss factors of structures under steady state vibration.