DEBONDING EFFECTS IN BEAMS TREATED WITH ACTIVE CONSTRAINED LAYER DAMPING

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Abstract

Since recent years, active constrained layer damping (ACLD) has been extensively studied as a new kind of smart materials. The typical ACLD structure consists of the active constraining layer, the viscoelastic layer, and the host structure. The viscoelastic layer made of viscoelastic materials can dissipate the vibration energy of the host structure passively, while the active constraining layer, usually made of piezoelectric materials, can actively dissipate the vibration energy under the driving of applied voltage.

In most studies of ACLD structures, the perfect bonding assumption is adopted that no slips occur between the interfaces of all three layers. Unfortunately, debonding may happen at any location of the interfaces, which may change the dynamic characteristic of the sandwich structure, improve the control cost and reduce the control efforts of active constrained layer damping treatment.

In present study, a detailed mathematical model for the debonded ACLD beam is introduced. In the perfect bonding region, both thickness deformation and shear deformation in the viscoelastic layer are taken into consideration. In the debonding region, different transverse displacements are assumed for active constraining layer and the host beam, just like the perfect bonding region. But the shear deformation in the viscoelastic layer is ignored, while the thickness deformation in the viscoelastic layer is "partially" kept, which is different from the work done by Sun and Tong (removing the viscoelastic layer between the active constraining layer and the host beam). To the authors' opinion, the thickness deformation in the viscoelastic layer exists only when it is negative. The finite element method (FEM) is applied to analyze the coupled vibration of the debonded ACLD beam. And the linear quadratic regulator (LQR) strategy is used for the driving voltage. In order to examine the debonding effects, comparisons are made on natural frequencies, modal loss factors and optimal control gains between the "perfect" ACLD structure and the debonded one. Furthermore, the effect of length and location of the debonding region on natural frequencies, modal loss factors and optimal control gains are also studied.

References

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