Influence of viscoelastic elements on the dissipative properties of electro-viscoelastic structures

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ABSTRACT

Optimization techniques used to find the optimal dissipative characteristics of structures usually include methods in which the basic object is supplemented with elements made of viscoelastic materials. However, this approach has its limitations on the thickness of the viscoelastic layer (added mass to the original product), on the characteristics of the material, as well as on the possible coverage of the structure. With the advent of smart technologies, researchers have centered their attention on another approach which implies that viscoelastic structures are supplemented with elements made of piezoelectric materials connected to external electrical circuits. The presence of such elements provides additional energy dissipation, increasing thereby the damping properties of structures in a wide frequency range. Furthermore, various dissipation mechanisms complement each other in some frequency ranges and govern in other ranges [1, 2].

In this work, we suggest that the dissipative properties of an electro-viscoelastic structure consisting of elastic, viscoelastic and piezoelectric elements can be evaluated on the basis of the problem of natural vibrations. The solution of this problem provides complex eigenfrequencies, the real part of which gives the frequency and the imaginary part - the damping index [3].

For solving the problem of natural vibrations of electro-viscoelastic structures, we have developed the mathematical and finite-elements models of an electro-viscoelastic body and the algorithms and programs for their numerical implementation [4-5].

In order to understand the contribution of different energy dissipation mechanisms to the total energy loss, we have evaluated the influence of only viscoelastic elements on the damping index. The maximum achievable damping of vibrations and the appropriate characteristics of the viscoelastic layer are determined in relation to a number of factors (mechanical characteristics, coverage area, location and thickness). Numerical results are given for the structures of different geometry (plates, shells).

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