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ADAPTIVE PIEZOELECTRIC STRUCTURAL-ACOUSTIC COUPLED SYSTEMS WITH DAMPING INTERFACE

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ABSTRACT

It is proposed to present appropriate variational formulations for linear vibration of elastic structure coupled with an internal inviscid, homogeneous, compressible fluid (liquid or gas), gravity effects being discarded in the presence of a free surface. Hybrid passive/active damping treatments will be investigated for noise and vibration reduction problems. It should be noted that generally, active structural treatments (using for example piezoelectric smart materials) are effective in the low frequency range, while passive structural treatments (such as viscoelastic materials, porous insulation...) are effective for higher frequency domain.

In all the analyzed variational formulations, the structure will be described by a displacement field (the piezoelectric structure being described by an additional electric potential field). Concerning the fluid, instead of a description through a displacement field, a scalar description through a pressure and/or a displacement potential field is chosen.

Dissipative behavior is introduced through a fluid-structure wall damping modeling by local impedance connected with a viscoelastic Kelvin-Voigt type of constitutive equation. When taking into account dissipative structural-acoustic behavior through a local impedance constitutive equation, the problem becomes strongly frequency dependent. In this work, a simplify but rather general constitutive model of Kelvin-Voigt type is used, through the introduction of a scalar interface variable which allows the problem to be reduced to a classical vibration damping problem. This impedance model, though local, may represent relatively satisfactory porous medium (on a rigorous manner, a precise three-dimensional description of the porous medium at the fluid-structure interface would be necessary through Biot type approach).

For piezoelectric structures (active treatments), structural-acoustic conservative formulation are extended in order to take into account electro-mechanical contributions. Here also, appropriate choice of variables has been investigated and leads to the introduction of the electric potential as an additional variable.

For all the formulations, finite element discretization is discussed. Numerical results are then presented in order to illustrate the accuracy and versatility of the methodologies.

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