Structural stability and convergence in piezoelectricity

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Abstract

The deformation of an elastic continuum under the influence of mechanical forces and electric fields is characterized by a set of equations, known as the equations of piezoelectricity. The linearized theory of piezoelectricity is characterized by a system combining hyperbolic and elliptic partial differential equations for the determination of displacement and electrostatic potential.

This work studies the structural stability of the equations of piezoelectricity. Concerning the structural stability, the emphasis is on continuous dependence on changes in the model itself rather than on the external given data. That means changes in coefficients in the partial differential equations and changes in the equations and may be reflected physically by changes in constitutive parameters. In other words, to study the structural stability of a mathematical model means to prove the solution of the corresponding initial boundary value problem depends continuously on the constitutive quantities, which may be subjected to error or perturbations in the mathematical modeling process.

Here, we consider the linear theory of piezoelectricity and suppose the material is inhomogeneous an anisotropic. The parameters in the field equations are the elasticity tensor, the dielectric tensor and the piezoelectric tensor (or coupling coefficient). Using some Rellich identities we derive some structural stability and convergence results, showing how the solution of the considered initial boundary problem depends continuously on the piezoelectric tensor and how the solution of the coupled piezoelectric system converges, in an appropriate measure, to the uncoupled system, as the coupling coefficient tends to zero.

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