Unilateral Contact Problems for Hemitropic Solids – A Boundary Variational Inequality Approach

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In this talk we report on recent progress on the treatment of various contact problems for hemitropic elastic solids by boundary integral methods. This contribution is based on joint work with A.Gachechiladze, R.Gachechiladze, and D.Natroshvili from Tbilisi in Georgia.

Micropolar theory, by including intrinsic rotations of the particles, provides a rather complex model of an elastic body that can support body forces and body couple vectors as well as force stress vectors and couple stress vectors at the surface. Consequently, in micropolar theory all the mechanical quantities are written in terms of the displacement and microrotation vectors. A micropolar solid which is not isotropic with respect to inversion is called hemitropic, noncentrosymmetric, or chiral. Materials may exhibit chirality on the atomic scale, as in quartz and in biological molecules – DNA, as well as on a large scale, as in composites with helical or screw-shaped inclusions, certain types of nanotubes, bone, fabricated structures such as foams, chiral sculptured thin films and twisted fibers.

Here we attack the nonlinear nonsmooth problems of contact without and with friction. We equivalently reduce these problems to boundary variational inequalities with the help of the Steklov-Poincaré type operator. Based on our boundary variational inequality approach we prove existence and uniqueness theorems for weak solutions. We include also the case, when the body is not fixed, but only submitted to force and couple stress vectors along some part of the boundary and is in unilateral contact with a rigid foundation. In this situation of a semicoercive boundary value problem we employ recession analysis and derive necessary and sufficient conditions of solvability.

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