Direct Computation of Stresses in Elasticity

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We describe and analyze an approach to the pure Neumann problem of three-dimensional linearized elasticity, whose novelty consists in considering the strain tensor field as the sole unknown, instead of the displacement vector field as is customary. This approach leads to a well-posed quadratic minimization problem of a new type, constrained by a weak form of the classical Saint Venant compatibility conditions. Interestingly, this approach also provides a new proof of Korn’s inequality.

We also describe and analyze a natural finite element approximation of this problem, which thus allows to directly approximate the strain tensor field, or equivalently the stress tensor field by means of the constitutive equation.