Test of a crack plane identification method using FEM-data of cracked domains

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In a wide spectrum of technical applications, cracks in materials can involve crucial effects like loss of functionality or even destruction of a device. Especially, undesirably cracking occurs in materials which are rather brittle like piezoelectric ceramics, and under situations with extreme or cyclic loads. So, the detection of cracks is an important problem in material control. If the crack does not touch the boundary, a simple visual control is not sufficient to determine it. The goal is, to use nondestructive techniques for the detection of inner cracks. Beside some possibilities of radiation and image processing, a basic idea is the use of outer boundary measurements under certain loads to get informations about the inner geometry of a device or even cracks. From the mathematical point of view, this leads to an inverse problem.

In the literature some approaches are discussed in this sense. Andrieux, Ben Abda et.al. introduced a method which identifies planar cracks using the reciprocity principle in the case of electrostatics (Laplace equation) and also in isotropic linear elasticity. We look on a generalisation of the first part of this method, the identification of the crack plane, to linear piezoelectric material behaviour.

Instead of the use of real data from experimental measurements, FEM allows to compute approximate solutions of boundary value problems in a cracked domain. Using only the FEM-solution on the outer boundary (and no informations about inner geometry) in postprocessing as input data, the correctness of the crack plane identification can be tested. This computation approach further enables to get informations about what measurement resolution levels are sufficient for a adequate accuracy of the inverse detection. It also allows numerical sensitivity studies of the method to data noise, which may offer important informations for practical use.

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