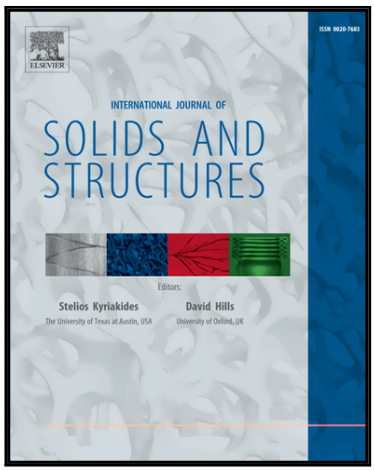

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Randomly Oriented Cracks in a Transversely Isotropic Material

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Abstract

Our work focuses on the calculation of the overall elastic properties of a transversely isotropic material containing multiple randomly oriented circular cracks. We first propose a new methodology to estimate (approximately) the contribution of a single arbitrarily oriented crack in an infinite transversely isotropic media into the overall elastic moduli. This effect is described by a forth rank compliance contribution tensor which serves as the basic building block for various homogenization schemes aimed at calculation of the overall elastic properties of the materials containing multiple inhomogeneities. In this paper we use the Mori-Tanaka-Benveniste scheme which coincides with non-interaction approximation for the case of crack-like inhomogeneities. The approach is illustrated by examples of Berea sandstone and wet bovine dentin.

Keywords: transverse isotropy, cracks, effective elastic properties, randomly oriented

1. Introduction

In this paper, we calculate the overall elastic properties of a transversely isotropic material containing multiple randomly oriented cracks. Our work is motivated by needs in geophysics and biomechanics, where the cracks are typically embedded in microcracked anisotropic background. Dentin, cortical bone, and Berea Sandstone shown in Figure 1 serve as examples. To the best of our knowledge, there are no explicit analytical expressions for the overall elastic properties of a transversely-isotropic material containing randomly oriented cracks. Our approach is based on the results of Guerrero et al (2007), who developed the method to evaluate crack opening