A Unified Definition for Stress Intensity Factors of Interface Corners and Cracks

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ABSTRACT

Based upon linear fracture mechanics, it is well known that the singular order of stresses near the crack tip in homogeneous materials is a constant value -1/2, which is nothing to do with the material properties. For the interface cracks between two dissimilar materials, their singular orders become \(-1/2 \pm i\varepsilon\) and -1/2 due to the singular oscillatory behavior of near tip stresses. The oscillation index \(\varepsilon\) is a constant related to the mechanical properties of both materials. While for the general interface corners, their singular orders depend on the corner angle as well as the mechanical properties of the materials. Owing to the difference of the singular orders of homogeneous cracks, interface cracks and interface corners, their associated stress intensity factors are usually defined separately and even not compatibly. Since homogenous cracks and interface cracks are just special cases of interface corners, in order to build a direct connection among them a unified definition for their stress intensity factors is proposed in this paper. Based upon the analytical solutions obtained previously for the multibonded anisotropic wedges, the near tip solutions for the general interface corners have been divided into five different categories depending on whether the singular order is distinct or repeated, real or complex. To provide a stable and efficient computing approach for the general mixed-mode stress
intensity factors, the path-independent $H$-integral based on reciprocal theorem of Betti and Rayleigh is established in this paper. The complementary solutions needed for calculation of $H$-integral are also provided in this paper. To illustrate our results, several different kinds of examples are shown such as cracks in homogenous isotropic or anisotropic materials, central or edge notches in isotropic materials, interface cracks and interface corners between two dissimilar materials.