Elastic Solutions in the Vicinity of 3D Singular Edges

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Abstract:

The singular solution of elliptic boundary value problems (such as the theory of linear elasticity) is of major importance in engineering practice. Especially, the computation of edge stress intensity functions (ESIFs) is a major part of the total effort needed to determine the fatigue life of flight vehicles. Another significant term is the T-stress which affects the crack propagation and stability. Nowadays, these ESIFs are extracted pointwise along the crack edge in 3D domains from refined finite element (FE) solutions that require a substantial amount of efforts. An elegant and efficient numerical method to extract a functional representation to the ESIFs from coarse FE solutions is the quasidual function method (QDFM). In the first part of the talk we extend the QDFM for the extraction of the T-stress along a 3D straight crack. We discuss the numerical errors that may rise when extracting the T-stress and suggest an algorithm to overcome the influence of such errors.

Thereafter, we extend the QDFM for the extraction of generalized ESIFs along 3D elliptical/part-elliptical singular edges. This is of interest as most cracks tend to propagate along semi elliptical fronts. We present the asymptotic solution for the elasticity equations in the vicinity of an elliptical singular edge. The asymptotic solution is the platform for the extension of the QDFM and it enables the construction of extraction functions to be used in conjunction with the QDFM. We extend the QDFM for elliptical singular edges, first for the simplified Laplace operator, and then to the elasticity system. Numerical examples are provided for the extraction of edge stress intensity functions from FE solutions, demonstrating the accuracy and efficiency of the use of the QDFM.