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A complex potential method for the asymptotic solution of wedge problems using first-order shear deformation plate theory

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Abstract

In the present work a complex potential approach is derived in order to investigate stress singularities in wedges or sharp notches using first-order shear deformation plate theory. The focus is on the calculation of the singularity exponent as a fundamental quantity in fracture mechanics. Isotropic homogeneous and bi-material wedges are considered. The effect of different boundary conditions along the notch faces and the influence of the elastic contrast on the singularity exponent are discussed in detail. Within an asymptotic analysis, the governing PDE-system is solved introducing three holomorphic potentials. The requirement that the boundary and continuity conditions must be fulfilled leads to an eigenvalue problem determining the singularity exponent and the angular distribution of the field variables. The underlying eigenvalue equation is a highly non-linear transcendental equation which in general is solved numerically. For specific bi-material configurations closed-form analytical solutions are obtained. The findings are compared with results from literature and with finite element calculations. It is shown, that the proposed complex potential method is a very efficient approach to study the asymptotic solution behaviour. In contrast to methods based on real-valued eigenfunction expansions the physical requirement that all field variables can take only real values is fulfilled automatically due to the nature of the complex potential formalism. The obtained near fields allow for further applications such as an embedding in numerical methods.

Keywords: V-notch, Reissner Mindlin plates, Complex potential method, Singularity analysis

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1. Introduction

In the framework of linear elasticity, stress singularities typically occur in domains with geometrical or material discontinuities as present in many engineering applications. In solid and structural mechanics, the assessment of such stress concentrations is of fundamental importance and requires a detailed structural analysis. For the application of fracture mechanics concepts (Gross and Seelig, 2011; Weißgraeber et al., 2015), the local stress field in the vicinity of singularities is of particular interest. In fact, closed-form analytical solutions are hardly available

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