Perturbed holes in two-dimensional anisotropic elastic solids

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Abstract

This study explores perturbed holes in finite and infinite two-dimensional anisotropic elastic solids, which is a challenging problem for analytical methods owing to the mathematical complexity involved. The perturbed hole contours, defined as small variations from an ellipse, include a variety of shapes, such as polygons with rounded corners. The hole boundary is assumed to be traction-free. We formulate the problem with the Stroh formalism, which is a complex-variable formalism for anisotropic elasticity, and then use the method of analytical continuation to derive the solution. The solutions are addressed through two distinct approaches: the nonconformal mapping technique and the perturbation method. The nonconformal mapping approach, which directly transforms the solution domain onto the exterior of a unit circle, is recommended for cases where critical points (where the derivative of the mapping function equals zero) lie far from the hole. On the other hand, the perturbation approach, which expands the solution into a series form, is employed for cases where the nonconformal mapping approach falls short. For finite domains containing perturbed holes, a novel set of boundary elements is developed using Green's functions presented in this study. These boundary elements eliminate the need for meshing along the hole boundary, thereby enabling more efficient and accurate analysis of finite problems. Numerical examples validate the proposed solutions through comparisons with results of the finite element method.

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