Evaluation of stress concentration factors and stress intensity factors from remote boundary data

Chyanbin Hwu*, Y.C. Liang

Institute of Aeronautics and Astronautics, National Cheng Kung University, Tainan, Taiwan

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Abstract

Usually, the stress concentration factors (SCFs) for holes and the stress intensity factors (SIFs) for cracks are evaluated by using the data near holes or cracks. However, the abrupt change of the stresses near holes, especially near crack tips, may lead to an unavoidable error. Thus, it is always interesting to find an equivalent formulation for SCF and SIF by using only remote boundary responses (displacements, stresses and strains) cooperating with the necessary geometric data. Through a special boundary element formulation of which the fundamental solution was derived using Stroh’s formalism for two-dimensional anisotropic elasticity, all the internal stresses and strains can be expressed in terms of the boundary (not including the hole and crack boundaries) displacements and tractions. By proper mathematical manipulation, a closed form solution for SIF of the internal crack and SCF of the internal hole, expressed by using only remote boundary displacements and tractions, is derived in this paper. To show that the proposed formula is accurate and efficient, several numerical examples are presented. © 2000 Elsevier Science Ltd. All rights reserved.

Keywords: Stress concentration factor; Stress intensity factor; Hole; Crack; Boundary element; Stroh formalism; Anisotropic elasticity

1. Introduction

It is well known that the largest stress around the hole of an anisotropic body may be several times of the remote stresses, while for a cracked body, the stresses near the crack tip even exhibit a square root singularity. To denote the highest stress concentration caused by a hole or a crack, parameters like the stress concentration factor (SCF) of the hole and the stress intensity factor (SIF) of the crack are usually used. Although several analytical solutions for SCF and SIF can be found in the literature.