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Integrating fracture mechanics into undergraduate design

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Abstract

This paper describes the work that is under progress to develop instructional material and a computer program that will automate linear stress analysis in two-dimension. The computer program can be used in a variety of ways to educate students about the stress behavior near a variety of stress raisers, though the initial effort will be near cracks and other stress raisers in homogenous materials. By automation of stress analysis it is implied that the user will not need to know the methodology used in the computer program and will not need to know how to create the mesh needed to solve the problem. The user would only describe the boundary value problem, which will be facilitated by a user friendly interface and all analysis decision will be made inside the program. Development of e-handbooks on stress concentration factors and stress intensity factors will further reduce the demands on the user in describing the boundary value problems thus shifting the focus from analysis to use of analysis results in design.

1. Introduction

The importance of fracture mechanics, interface mechanics, and stress raisers in homogenous and composite materials is highlighted by the extensive research that has been and is being conducted in each of these areas. Books have been written and there are journals devoted exclusively for publishing research on each of these topics. Yet this impressive pool of knowledge has had little impact on the undergraduate engineering education and hence had little impact on industrial practices. One reason for the small impact of mechanics research on undergraduate education is the required mathematics to teach the mechanics concepts related to fracture, interface stresses, and stress gradients in composites is well beyond the exposure that undergraduate get in a typical engineering curriculum. The mathematics that is so essential in explaining stress behavior near stress raisers is of lesser importance than the intuitive appreciation and understanding of stress behavior in creative *preliminary* structure and machine design as has been demonstrated by the use of stress concentration factor over the past hundred years. If the students could be taught to appreciate the stress behavior near cracks, material interfaces, holes, corners and load discontinuities in traditional materials (isotropic) and composites (anisotropic) and taught how to incorporate this understanding of stress behavior in design, then the door is opened to utilize and apply the research in mechanics to engineering applications.