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Simplified Stress Gradient Method for Stress-Intensity Factor Determination

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Abstract : Several techniques exist for determining stress-intensity factors in linear elastic fracture mechanics analysis. These techniques are based on analytical, numerical, and empirical approaches that have been well documented in literature and engineering handbooks. However, not all techniques share the same merit. In addition to overly-conservative results, the numerical methods that require extensive computational effort, and those requiring copious user parameters hinder practicing engineers from efficiently evaluating stress-intensity factors. This paper investigates the prospects of reducing the complexity and required variables to determine stress-intensity factors through the utilization of the stress gradient and a weighting function. The heart of this work resides in the understanding that fracture emanating from stress concentration locations cannot be explained by a single maximum stress value approach, but requires use of a critical volume in which the crack exists. In order to understand the effectiveness of this technique, this study investigated components of different notch geometry and varying levels of stress gradients. Two forms of weighting functions were employed to determine stress-intensity factors and results were compared to analytical exact methods. The results indicated that the “exponential” weighting function was superior to the “absolute” weighting function. An error band +/- 10% was met for cases ranging from a steep stress gradient in a sharp v-notch to the less severe stress transitions of a large circular notch. The incorporation of the proposed method has shown to be a worthwhile consideration.

Keywords : fracture mechanics, finite element method, stress intensity factor, stress gradient
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