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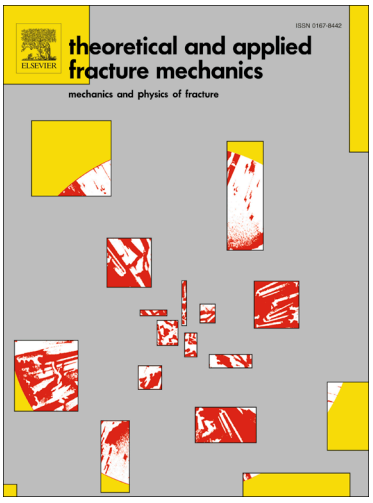

On the evaluation of the flexibility parameters of cracked beams based on the strain energy density theory

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ACCEPTED MANUSCRIPT

ON THE EVALUATION OF THE FLEXIBILITY PARAMETERS OF CRACKED BEAMS BASED ON THE STRAIN ENERGY DENSITY THEORY

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Abstract: In this paper an approach that is able to derive the flexibility parameters in beams with an edge crack based on the strain energy density theory is presented. The method takes into account that the crack in a beam does not propagate in a collinear manner, but due to the presence of the mixed mode, it changes its direction. This allows a description of the phenomenon of the propagation of the crack similar to the experimental evidence. Preliminary results are presented for different position and initial length of the crack.

Keywords: Edge crack; strain energy density; mixed mode; principal tensile stress; Castigliano theorem; Flexibility parameters; Three point bending.

1. Introduction

Cracked structures have always attracted significant interest by researchers. Analytical, semi-analytical and numerical approaches have been employed in order to model a cracked element in a damaged two dimensional structure. One of the most common approaches is the finite element method where the key point is to define the stiffness matrix of the cracked element that can be found as the inverse of the compliance matrix. The compliance matrix of cracked element is given by adding two terms: the first term is the compliance matrix of the intact beam and the second one is the matrix that contains the additional compliances given by the presence of the crack [1,2].

In this paper an approximate method that takes into account experimentally observed mixed mode propagation of the crack **[**3**]** is presented.

The additional compliances depend on crack trajectory, depth and location and are obtained performing energy balance between the external work and fracture work evaluated by means of Strain Energy Density Theory [4,5,6]. The Strain Energy Density Theory has been successful employed to solve many problems in the field of Fracture Mechanics. Some of the latest applications are reported in [7,8,9].

The flexibilities are related to the stress intensity factors. Stress intensity factors for many configurations are available, but solutions for many structural configurations are not present in the handbooks: simple engineering methods which allow an approximate expression of the stress intensity factors are highly valued to design engineers [10]. In this study, the approach presented by Nobile [11,12,13**]** is followed at the early stage of propagation. This approach is based on elementary beam theory equilibrium condition for internal forces evaluated in the cross-section passing through the crack tip, taking into account the stress singularity at the tip of an elastic crack. The results are in reasonable agreement with other expressions given in the literature.

The crack is assumed to be vertical before the loading, then it runs in the direction of the minimum of the strain energy density. Finally, the crack is supposed to follow the direction of the principal tensile stress in the section.

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