

PROCEEDINGS

Over-Deterministic Method and Its Application in Fracture Mechanics

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ABSTRACT

The over-deterministic method (ODM) is dedicated to calculate a small set of unknown coefficients from a large system of equations, by making use of a large number of data points. A displacement over-deterministic method (DODM) developed by Ayatollahi et al. [1] has been employed by for calculating the stress intensity factors (SIFs) as well as the coefficients of the higher-order terms in the Williams' series expansions for cracked bodies. The ODM provides a great idea to easily obtain fracture parameters, combine with finite element method (FEM).

In our work, a stress over-deterministic method (SODM) has been proposed for calculating the SIFs and T-stress at the crack tip for pure mode I, pure mode II and I-II mixed-mode cracks under static and dynamic loads. The effectiveness and computational accuracy of the SODM are verified using static and dynamic numerical examples. The effects of the number of terms in Williams' series expansion, the number and location of the nodes selected around the crack tip, and the mesh around the crack tip on SIFs and T-stress are discussed in detail. Results indicate that the SODM is simple and efficient in calculating the SIF and T-stress at the crack tip under static and dynamic loads.

Moreover, benefiting from the core idea of the ODM, a generalized over-deterministic method (GODM) is proposed to determine the Young's modulus and Poisson's ratio of materials through cracked specimens. A number of numerical examples of specimens with pure mode I, pure mode II and I-II mixed-mode cracks are carried out to verify the effectiveness and feasibility of GODM. The accuracy between the GODM and the traditional uniaxial tensile method for obtaining Young's modulus and Poisson's ratio of materials is verified by experiments using 2024-T3 aluminum alloy. The effects of the term number of Williams' series expansion, the number and location of selected nodes near the crack tip on results are discussed in detail. Results show that the GODM method can effectively and accurately determine the Young's modulus and Poisson's ratio of materials through the cracked specimens.

KEYWORDS

Over-deterministic method; stress intensity factor; T-stress; mixed-mode crack; Young's modulus

Funding Statement: This work is supported by National Science and Technology Major Project (J2019-IV-0003-0070).

Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

References

1. Ayatollahi, M. R., Nejati, M. (2011). An over-deterministic method for calculation of coefficients of crack tip asymptotic field from finite element analysis. *Fatigue Fract Eng Mater Struct*, 34(3),159-176.



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