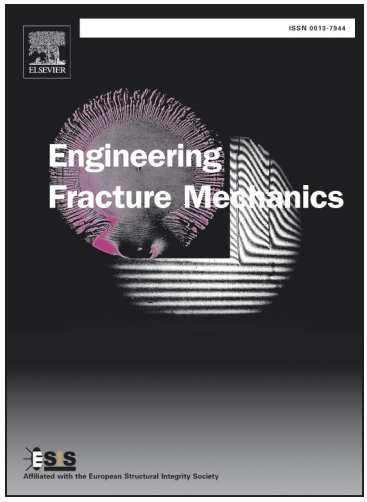

A fracture mechanics-based approach to estimating the endurance limit of notched components

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A fracture mechanics-based approach to estimating the endurance limit of notched components

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Abstract

The fatigue notch effect can be estimated by using fracture mechanics-based support factors. To do so, the SIFs for cracks in notches must be calculated. There is a problem of transferability when 2D reference geometries are used. This can be avoided by modelling 3D cracks in the part being assessed. As demonstrated in this study, this approach is more laborious but leads to better results. The proposed approach was validated using a broad database of different sintered steels. The statistical evaluation showed that the mean value was almost exactly predicted with a relatively small scatter compared to alternative approaches.

Keywords: Fatigue, Notch effect, Support factor, Crack initiation, Endurance limit, Powder metallurgy steel, Surface cracks

1. Introduction

A correct evaluation of the fatigue notch effect is crucial for a reliable computational assessment of the structural durability of components subjected to fatigue loading. The construction design of most engineering components includes notches such as holes, fillets or reductions in cross sections. These are necessary for the part to function. Notches are critical points for the fatigue strength and lifetime of a component because they are potential sites for crack initiation and thus for component failure. The stress concentration at notches leads to inhomogeneous stress fields. However, the material's endurance limit is determined from fatigue tests with unnotched material specimens, where the stress field is homogeneous in the critical cross section.

A size effect or notch effect can be observed when fatigue results are transferred from unnotched specimens to notched components. In other words, the endurable peak stress amplitude is usually considerably higher for the notched component than for the unnotched material specimen: $\sigma_{\mathrm{en}} > \sigma_{\mathrm{e}}$. To estimate a notched component's endurance limit based on the material's endurance limit, a support factor n can be used.

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