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O.P. Ostash, R.V. Chepil, V.V. Vira

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On the assessment of fatigue life of notched structural components

O. P. Ostash*, R.V. Chepil and V. V. Vira

Karpenko Physico-Mechanical Institute, National Academy of Sciences of Ukraine, Lviv, Ukraine

Abstract

The growth of a microstructurally short and a physically small cracks in the fatigue process zone of size d^* and the formation of initial macrocrack of length $a_i = d^*$ in compact tension notched specimens are investigated. The base notch fatigue curve for the assessment of the period of macrocrack initiation in a notched specimens of various shape is considered. The prediction results of the fatigue life N_f of notched specimens (a strip with a central hole or a slit, and a strip with a U-notch of various tip radius) at the stress ratio $R = 0.1$ and 0.5 are presented. Two procedures for the assessment of $N_f = N_i + N_p$, where N_i is the period to macrocrack initiation and N_p is the period of macrocrack propagation up to specimen failure, basing on the unified model of fatigue fracture, are proposed. It is shown that N_f values calculated using these procedures are in good agreement with experimental data. The accuracy of received specimens fatigue life is larger than predicted by the known methods.

Keywords: fatigue life; notched specimens; unified model; fatigue process zone; crack initiation and growth.

Nomenclature

a = crack length

a_c = critical macrocrack length

a_i, l_0, l_i = initial macrocrack length

d^* = fatigue process zone size

da/dN = fatigue crack growth rate

h = notch depth

K_t = theoretical stress concentration factor

$K_f^{\text{cal}}, K_f^{\text{exp}}$ = calculational and experimental fatigue stress concentration factors

l = slit semi-length

$N_i^{\text{cal}}, N_i^{\text{exp}}$ = calculational and experimental number of cycles to macrocrack initiation (of length $a_i = d^*$)

$N_f^{\text{cal}}, N_f^{\text{exp}}$ = calculational and experimental specimen fatigue life

* Correspondence: O. P. Ostash. E-mail: fmidep17@gmail.com

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