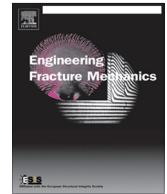




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## Review

# Analytical flaw assessment

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## ABSTRACT

The paper provides a review on analytical flaw assessment methods with the focus on fracture under monotonic loading and fatigue crack propagation. The first topic comprises linear elastic as well as elastic-plastic fracture mechanics approaches. It essentially follows their historical development. Topics which are separately discussed are reference/limit loads, the treatment of secondary stresses, strength mismatch, constraint, unstable crack propagation (monotonic R-curve analyses) and statistical aspects. With respect to fatigue crack propagation the analytical treatment of crack closure and constraint and the determination of the cyclic elastic-plastic crack driving force is discussed. Finally, cyclic R-curve analyses are briefly addressed.

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## Nomenclature

|                    |  |
|--------------------|--|
| $a$                | crack length (crack depth for surface cracks)                                |
| $a_{\text{eff}}$   | plastic zone corrected crack length $a + r_p$ (Section 2.2.2)                |
| $a_i$              | initial crack depth (for cyclic fracture mechanics analysis; Fig. 51)        |
| $a_0$              | initial crack depth (for monotonic fracture mechanics analysis; Fig. 11)     |
| $a_0$              | El Haddad parameter, Eq. (185)   |
| $a^*$              | correction term for modified El Haddad's model, Eqs. (189) and (191)         |
| $a/c$              | crack aspect ratio   |
| $c$                | half crack length at surface (semi-elliptical crack)                         |
| $\bar{c}$          | half length of an equivalent through-thickness crack (design curve)          |
| $C, n$             | fit parameters of the $da/dN-\Delta K$ curve in the Paris regime             |
| $d$                | length of plastic strip (Dugdale model, Section 2.2.3)                       |
| $d_n$              | coefficient (HRR field solution)   |
| $da/dN$            | fatigue crack propagation rate   |
| $E$                | modulus of elasticity (Young's modulus)                                      |
| $E'$               | $= E$ for plane stress and $E/(1 - \nu^2)$ for plane strain conditions       |
| $f$                | crack closure function of the NASGRO equation, Eq. (146)                     |
| $F_Y$              | net section yield load (general)   |
| $F_{YB}$           | $F_Y$ of base plate material (weldments)                                     |
| $F_{YM}$           | equivalent strength mis-match corrected $F_Y$                                |
| $F_{YW}$           | $F_Y$ of weld metal (weldments)  |
| $f(L_r)$           | plasticity correction function (monotonic loading, reference stress method)  |
| $f(\Delta L_r)$    | plasticity correction function (cyclic loading)                              |
| $F^k$              | reserve factor (fracture resistance) in the FAD approach, Eq. (137)          |
| $F^\sigma$         | reserve factor (yield strength) in the FAD approach, Eq. (138)               |
| $G_Y$              | (elastic) energy release rate at the onset of general yield (Eqs. (21)–(28)) |
| $h_1, h_2$         | influence functions (EPRI scheme, Section 2.2.7) for $J$ and $\delta$        |
| $H$                | width or half width of the weld strip (strength mismatch consideration)      |
| $J$                | J-integral (monotonic loading)   |
| $J_c$              | critical J-integral  |
| $J_e$              | elastic component of the J-integral  |
| $J_i, J_{0.2/BL}$  | resistance against stable crack initiation (monotonic loading)               |
| $J_p$              | plastic component of the J-integral  |
| $J^s$              | J-integral due to secondary stresses   |
| $J_Y$              | J-integral at the onset of general yield                                     |
| $K$                | stress intensity factor (K-factor)   |
| $K_{\text{eff}}$   | plastic zone corrected K factor (Section 2.2.2)                              |
| $K^d$              | K factor formally derived from J-integral                                    |
| $K_j^s$            | ligament yielding corrected $K^d$  |
| $K_{\text{mat}}$   | fracture resistance, monotonic loading (general)                             |
| $K_{\text{mat}}^c$ | constraint-corrected $K_{\text{mat}}$ (R6 routine; Eq. (130))                |
| $K_{\text{max}}$   | maximum K-factor in a loading cycle (fatigue crack propagation)              |
| $K_{\text{min}}$   | minimum K-factor in a loading cycle  |
| $K_{\text{op}}$    | K-factor at crack opening (cyclic loading)                                   |
| $K^p$              | K factor due to primary stresses   |
| $K_r$              | ordinate of the FAD diagram ( $= K/K_{\text{mat}}$ )                         |
| $K^s$              | K factor due to secondary stresses   |
| $K_I$              | K-factor for mode-I-crack opening (normal to the crack faces)                |
| $K_{Ic}$           | fracture resistance of the material (small scale yielding conditions)        |
| $L$                | characteristic dimension (EPRI scheme)                                       |
| $L_r$              | ligament yielding parameter for monotonic loading                            |

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