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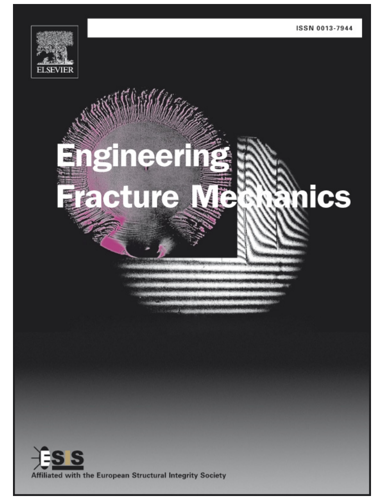


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# PROBABILISTIC ASSESSMENT OF FATIGUE DATA FROM SHAPE HOMOLOGOUS BUT DIFFERENT SCALE SPECIMENS. APPLICATION TO AN EXPERIMENTAL PROGRAM

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## ABSTRACT

With the aim of justifying transferability of fatigue properties of metallic materials from small sized specimens to real components, the influence of specimen shape and size on the fatigue characterization is investigated. Twofold scale effects in the statistical interpretation of fatigue data have been considered in order to allow an equivalent failure distribution function to be achieved indistinctly of the specimen type. The first scale effect, referred to the initiation phase, is related to the specimen surface size and finishing influence. The second one, referred to the propagation phase, is related to the specimen circular cross-section size effect. Assuming LEFM, a non-dimensional crack growth rate curve is derived from the material, allowing the relation between the lifetimes for the different specimens to be found as a function of the crack size and specimen diameter. In this way, the transition crack size between initiation and propagation lifetimes is determined by securing a reasonable correspondence between the modelled and experimental scatter of the experimental results. In order to probe the applicability of the methodology, a fatigue program, developed as cooperation between the Empa-Dübendorf, and the University of Oviedo, is evaluated implying fatigue constant amplitude tests of three samples with homologous specimen shape but markedly different size of 42CrMoS4 steel alloy.

**Keywords**: Initiation and propagation lifetimes; Probabilistic fatigue prediction; Scale effect; *S-N* curves; Transferability

## NOMENCLATURE

$a$, ($a^*$): crack length of the elliptical crack, (*idem, dimensionless*)
$a_0$, ($a_0^*$): initial crack length of the elliptical crack for all specimens (*idem, dimensionless*)
$\boldsymbol{a_{0,d_i}}$ : self-similar crack size corresponding to the diameter $d_i$
$a_i$: intrinsic crack size as proposed by El Haddad et al
$c$, ($c^*$): major axis of the elliptical crack, (*idem, dimensionless*)
$c_0$, ($c_0^*$): initial major axis elliptical crack, (*idem, dimensionless*)
$d$: generic specimen diameter
$d_3$: diameter of the 3 mm thick specimen
$d_8$: diameter of the 8 mm thick specimen
$d_{22}$: diameter of the 22 mm thick specimen
$d_i$: diameter corresponding to the generic "i" specimen (for $i$=3,8 and 22)
$h$: micro characteristic length (grain size)
$H$, ($H^*$): macro characteristic component size, (*idem, dimensionless*)
$K_{min}$: minimum applied stress intensity factor
$K_{max}$: maximum applied stress intensity factor
$\Delta K$ ($\Delta K^*$): stress intensity factor range, (*idem, dimensionless*)
$\Delta K_{th}$, ($\Delta K_{th}^*$): threshold stress intensity fracture range, (*idem, dimensionless*)