BEHAVIOUR OF NOTCHES AND CRACKS OF DIFFERENT SIZE IN CONSTRUCTIONS UNDER CYCLIC LOADING

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The behaviour of differently big notches and cracks in constructions at cyclic loading is described by a general strength characteristic, which is obtained from the mean value of local strength in a characteristic volume V^*, or area A^*, resp. length d^*, Sähn et al (1) (by Neuber: Mikrostützwirkung):

$$\Delta B_{vm} = \frac{1}{V^*} \int_{(V^*)} \Delta B_v(x, y, z)\, dV \qquad (1)$$

$$= \frac{1}{d^*} \int_{(d^*)} \Delta B_v(x)\, dx \qquad \text{if } \Delta B_v \text{ homogenous in y-, z-direction in } V^*$$

ΔB_v is a suitable reference strength to uniaxial stressfield, e. g.

$\Delta B_v = \Delta\sigma_1$	maximum principal stress
$\Delta B_v = \Delta\varepsilon_1$	maximum principal strain
$\Delta B_v = 2\Delta\tau_{max}$	maximum shear stress.

This characteristic according to strength ΔB_{vm} is suitable to value any inhomogenous strength

- under statical and cyclic loading and
- for any material-law.

The transmissability of material characteristics for essentially changed strengthes is possible, if the fracture-mechanism is unchanged and if the specimens resp. constructions are statisticaly equivalent.

The so called replaced structural length d^* is determined in experiments, where the influence of structure is important

- by comparison of endurance limit of statistically equivalent and differently notched specimens
- or by comparison of threshold intensity factor ranges of different small cracks.

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d^* depends substantial on the structure of materials (for instance grain size) and on the reference strength ΔB_v.

It is possible to lead away a size of strength by knowledge from d^* for any one inhomogenous strengthes. So it was found with equ. (1)

- for the threshold stress intensity factor range of small cracks and for the endurance limit of small notches ($\varrho / d^* < 2$), Sähn and Seliger (2):

$$\frac{\Delta K_{th}^{kl}}{\Delta K_{th}} = \frac{1}{\sqrt{1 + d^*/2a}} \qquad (2)$$

- for the crack propagation in sphere near threshold at constant nominal stress amplitude the results are presented in Fig.1 in dependence from ΔK and ΔB_{Vm}, Tokaji et al (3). It can be seen, that the description of experiments with linear-elastic fracture parameters reaches further than generaly is expected.

- for the threshold of macrocrack the dependence on grain size d was obtained in following form

$$\Delta K_{th} = \Delta K_{tho} + \Delta K_d \,(d/mm)^{-1/2} \qquad (3)$$

if for the endurance limit of smooth specimens exists a Hall-Petch-relation

$$\sigma_D = \sigma_{Do} + \sigma_d \,(d/mm)^{-1/2} \qquad (4)$$

You can see, that the crack sensibility decreases with increase of grain size in contrast to the endurance limit of smooth specimens. These results are also proved for fine grain size mild steels by experiments, Schaper et al (4).

REFERENCES

(1) Sähn, S. et al, Technische Mechanik 8 (1987), Heft 4, S. 5 - 17.

(2) Sähn, S. and Seliger, P., Studientexte Bruchmechanik III, TU Dresden, 1986.

(3) Tokaji, K. et al, Fat. Fract. Engng. Mat. Struct. vol. 9, No. 3, 1986, pp. 205 - 217.

(4) Schaper, M. et al, Forschungsbericht, Zentralinstitut für Festkörperphysik und Werkstoffforschung Dresden, 1985.

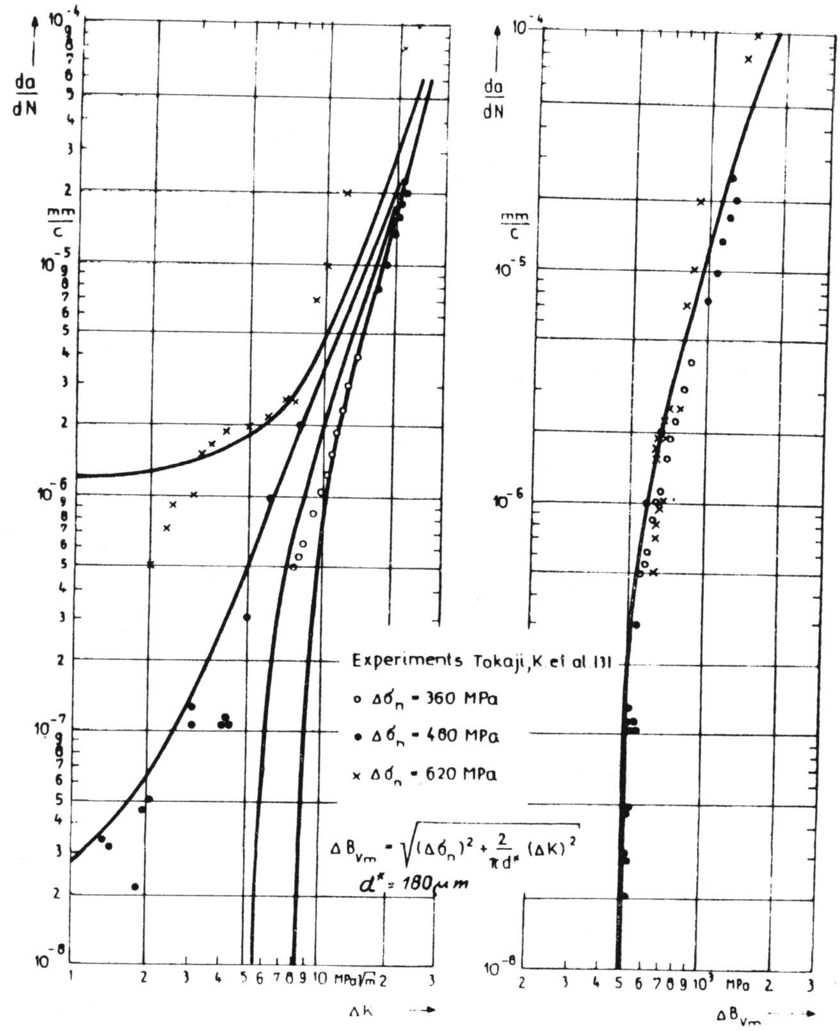

Figure 4 Propagation of small fatigue cracks in a low steel S lo C - fine grained material d= 24 m