PART C: BLUNTING LINE AND INITIATION

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DESCRIPTION OF TASK AND EXPERIMENTAL DETAILS

Two important elements of the EGF Procedure P1-87D are given by the analytical blunting line and by the method for determining the initiation parameters J_i and δ_i. Both elements were to be validated in the second evaluation by extensive scanning electron microscopy.
This work was done on the materials M1 (medium toughness material, steel BS 4360 Grade 50E) and M2 (low toughness material, aluminium alloy 5083-0).

Blunting Line

In the EGF Procedure the analytical blunting line is given by

$$\Delta a_B = 0.4\, d_n \frac{J}{\sigma_o} \tag{1}$$

with

$$d_n = \frac{1.185E}{\pi\sigma_o(1+n)(1-\nu^2)} \left[\frac{2\sigma_o}{\sqrt{3}} \frac{(1+\nu)}{E} \frac{(1+n)}{n^{n/(1+n)}}\right]^{1+n} \tag{2}$$

or alternatively by

$$\Delta a_B = 0.4 d_n^* \frac{J}{E} \tag{3}$$

with d_n^* taken from a diagram.

A number of specimens were loaded in the blunting phase, i.e. prior to the onset of ductile crack growth and subsequently fatigued. The width Δa_B, of the thus obtained stretch zone was measured in a scanning electron microscope (SEM) according to the rules set out in the Procedure.

GKSS-FORSCHUNGSZENTRUM GEESTHACHT GMBH,
D-2054 GEESTHACHT, F.R.G.

Further specimens were loaded beyond initiation and subsequently treated as the former specimens in order to obtain the gradual transition from blunting to ductile crack growth.

Determination of Initiation

The EGF Procedure offers two alternatives for determining J_i and δ_i:

- The critical stretch zone width, Δa_{SZW}, is measured in an SEM, and its intersection with the crack growth resistance curve defines initiation, Fig. 1.
- If the critical stretch zone width cannot be determined in the SEM, then the intersection of the blunting line with the crack growth resistance curve defines initiation, Fig. 1

Both definitions were validated using the mean R-curves from the round robin and the individual data points obtained as described above.

RESULTS

Blunting Line

The Δa values as determined in the SEM and by optical microscopy are plotted in Figs. 2 and 3. The slopes of the blunting line were determined using Eq(2) and the diagram in Fig. A7.2 of the procedure. It was found that Eq(2) gives a slightly higher slope than Fig. A7.2. This difference is not relevant if the ability of the blunting line formulation to model blunting is considered: the measured Δa data are very well represented by the analytical blunting line.
In order to avoid ambiguities, Eq(2) has been removed from the procedure. Figs. 2 and 3 contain only the blunting line slope as determined by the diagram of Fig. A7.2.

Determination of Initiation

Figs. 2 and 3 contain also the relevant information for the determination of initiation. It is clearly seen that the two definitions outlined in Fig. 1 result in very different J_i values.
It is also seen that the intersection of the R-curve with Δa_{SZW} is more consistent with the SEM findings than the J_{iBL} definition. The latter method would yield too conservative initiation values.

Since the intersection between the R-curve and the blunting line is very sensitive with respect to the parameters describing the R-curve, it was decided to drop this method and to regard the intersection of the R-curve with the critical stretch zone as the relevant method to derive J_i and δ_i.

ACKNOWLEDGEMENTS

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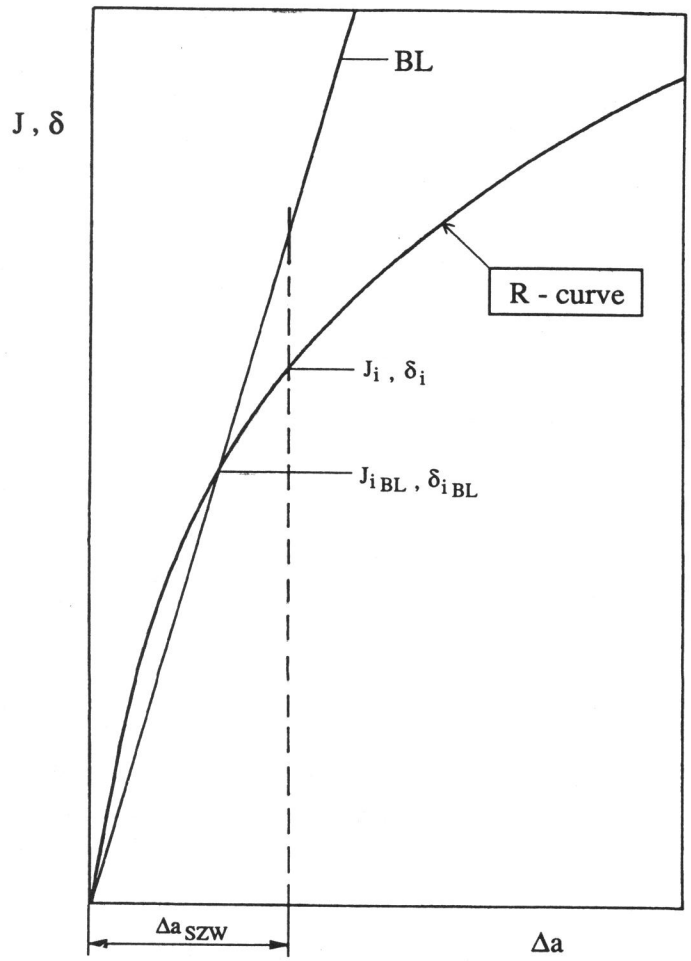

Fig. 1 : Schematic of differently defined crack initiation parameters

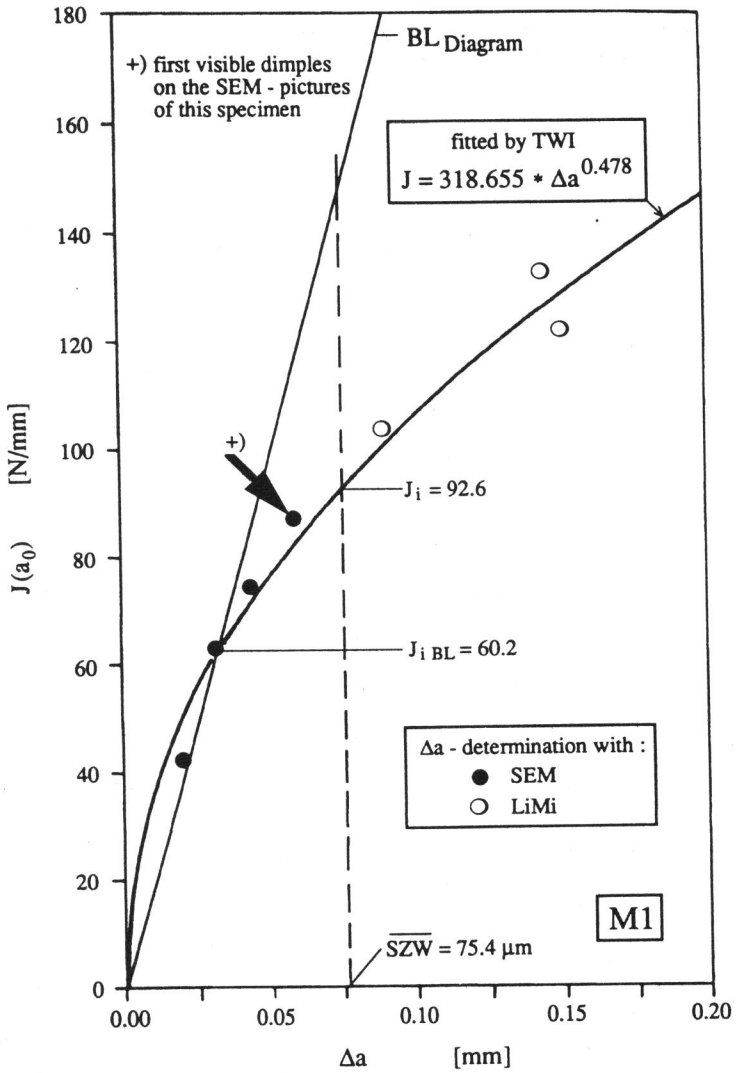

Fig. 2 : J - R - curve of material M1

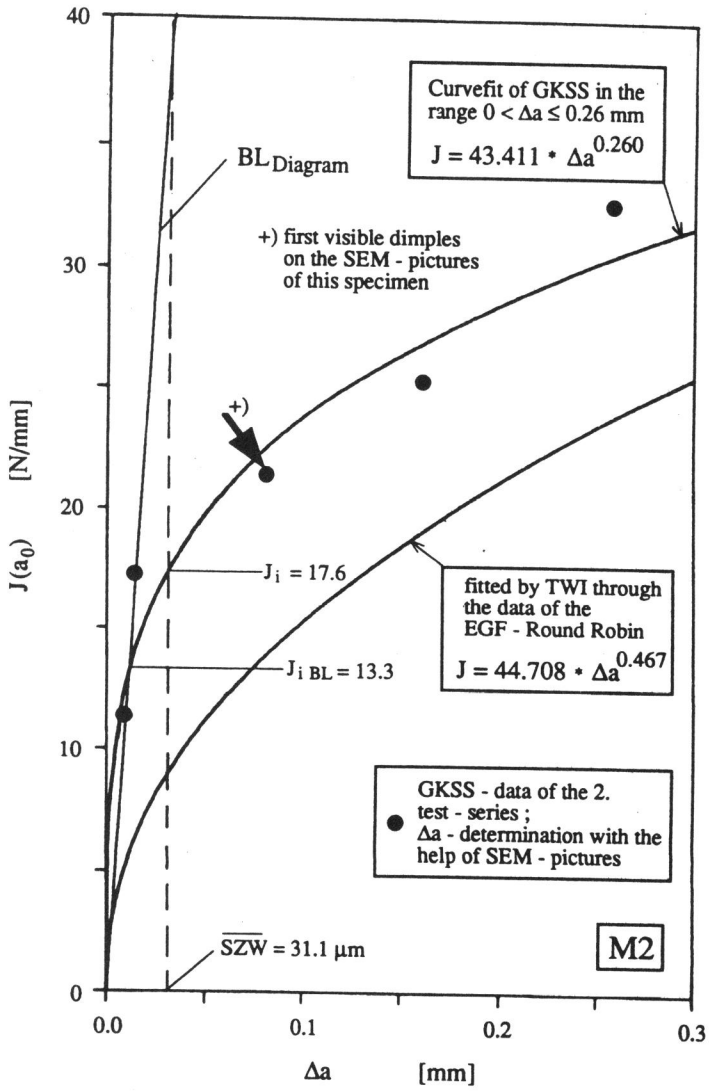

Fig. 3 : J - R - curve of material M2