ESTIMATIONS ON J_{IC} IN VIEW OF FRACTOGRAPHIC ANALYSIS

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The exact location of the initiation point in the stable crack propagation conditions at the J_{IC} test was investigated. A modification of the ASTM test procedure was proposed; it is based on the philosophy that the critical stretch zone width (SZW) is a very representative parameter reflecting direct indications of the ductile tearing onset. The results of the modified method were compared with those of the ASTM procedure. The stretch zone width approach has been shown to be a suitable back-up procedure usefully applicable for the verification of the standard J_{IC} values.

INTRODUCTION

It has been reported (1) that the blunting line obtained according to the ASTM E 813 procedure is not fully representative in the case of J_{IC} determination of heat treated steels since the J_{IC} values obtained are usually greater than those determined by other methods (e.g. JSME S 001-81). In this work, the ASTM E 813 test commonly with the modified procedure based on the average critical stretch zone width Δa_{sz} fractographic measurements as applied for the J_{IC} determination.

RESULTS AND DISCUSSION

The low alloy wrought steel ČSN 41 6341 of a composition equivalent to that of AISI 4340 was heat treated by austenitizing at 840°C for 0,5 h, oil quenched and tempered at temperatures in the range 500-700°C with corresponding σ_y values from 1220 down to 747 MPa.

Three-point bend specimens with L-T orientation

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were prepared according to the ASTM standard E 813. Multiple specimen J_R-curve methods were used to determine J_{IC} fracture toughness value: 1) ASTM E 813 method (Fig.1(a)),and 2) Modified E 813 method (Fig.1(b)). In this method, required conditions for qualifying R-curve regression line are exactly the same as those in the E 813. The initiation point of slow-stable crack growth differs, however, from E 813 and it is defined by the intersection point between a linear regression line and the average critical SZW line (Fig.1(b)). It is evident from TABLE 1

TABLE 1

Tempering temp./^oC/	J_{IC} /kJm^{-2}/		$\Delta \bar{a}_{sz}$	$\frac{dJ}{da}$
	Method 1	Method 2	/um/	/MPa/
500	39	39	15.6	83
600	68	67	24.0	130
650	86	82	25.5	197
700	124	117	41.2	210

that the crack growth initiation evaluated according to the modified method (Fig.1(b)) occurs at a J-value negligibly smaller than the J_{IC} value determined by the ASTM E 813. For the AISI 4340 steel Putatunda and Rigsbee (2) earlier reported a much greater Δa_{sz} value than that presented above. The differences in various observed critical SZW values could have their origin (likely) mainly in the discrepancy in fractographic interpretation of the SZW. Most probably, in the given case as the reported SZW both the blunted and the fine dimpled shear zones (along logarithmic spirals) were taken. This view is supported by the results of the extensive round robin test presented in (3).

The J_{IC} value of the material studied was also determined by the method 3 (Fig.1(c)). There are several alternatives for constructing the blunting line; shown in Fig.1(c). In our work, these different approaches were compared and assesed. Altough the results obtained in this way were not in full accord with those, given in Table 1, we believe that the proposed method can be effectively used for the failure analysis and/ /or as a single specimen J_{IC} determination.

REFERENCES

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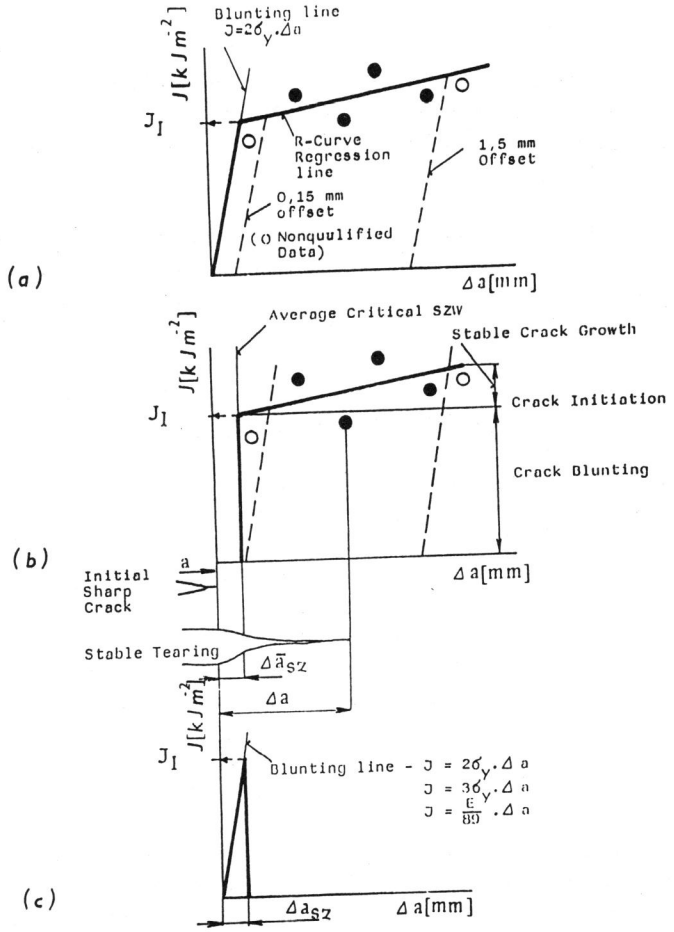

Fig. 1 Test procedure for J_{IC}: (a) ASTM R-curve method,(b) Modified ASTM method,(c) SZW method.