STRETCH ZONE MEASUREMENTS ON DUCTILE STEELS

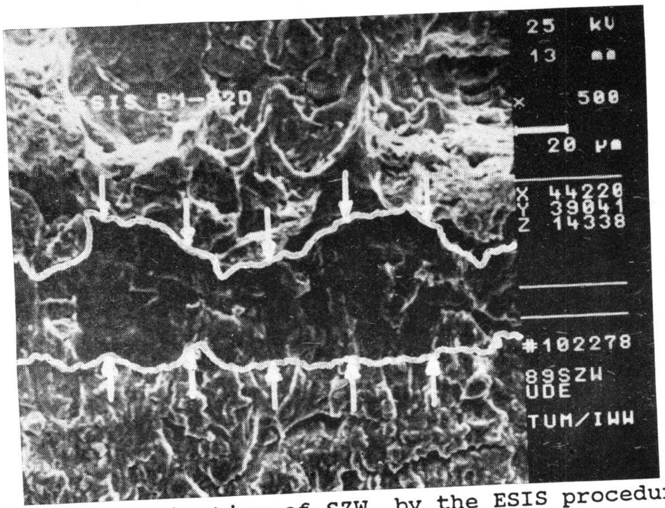
H. Blumenauer*, J. Ude*

Stretch zone measurements were carried out on ferritic and austenitic steels by an image analysing program.
The difference in the $SZW_c:SZH_c$ relationship indicates that strain hardening effects can influence the blunting process and the determination of the crack initiation toughness values.

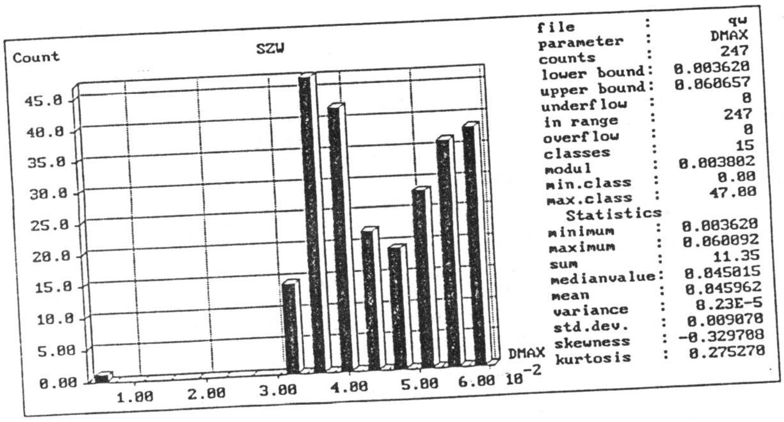
TEST METHOD

The stretch zone is the characteristic feature of the blunting process at the crack tip depending on microstructure, load conditions and constraint. Ductile fracture initiation occurs when the width and height of the stretch zone reach critical values SZW_c and SZH_c. The measurement of these parameters by SEM - although not easy and merely successful by adequate experience - is the only direct and microstructural related method to determine the crack initiation toughness J_i or δ_i (1 - 3). The common practice described in the ESIS procedure P2-91D (4) requires at least 5 measurements at 9 local points. In order to verify and simplify this expensive procedure a computer program "macro" based on the image analysis system IBAS has been developed. It allows to obtain the whole stretch zone profile and the true mean values of SZW_c and SZH_c (Fig. 1).

* Institut für Werkstofftechnik und Werkstoffprüfung, Technische Universität Magdeburg



a) Determination of SZW_c by the ESIS procedure



b) Determination of SZW_c by the IBAS image analysing system

Figure 1 Stretch zone measurements on the steel StE 460

Advantages of this method are
- improvement of reproducibility and accuracy due to reduction of the intrinsic scatter
- more statistics
- including the results to external computer programs, e.g. to constitutive equations of ductile fracture.

Stretch zone measurements were performed on fatigue cracked Charpy specimen after static and impact loading using the ferritic steel StE 460 and the austenitic steel 6CrNiTi1810. Crack resistance curves δ_5-Δa were obtained by the multiple specimen technique; the CTOD parameter δ_5 was measured over a gage span of 5 mm at the original crack tip.

RESULTS AND CONCLUSIONS

The results of the image analysing method are in good agreement with the ESIS procedure (Fig.2).

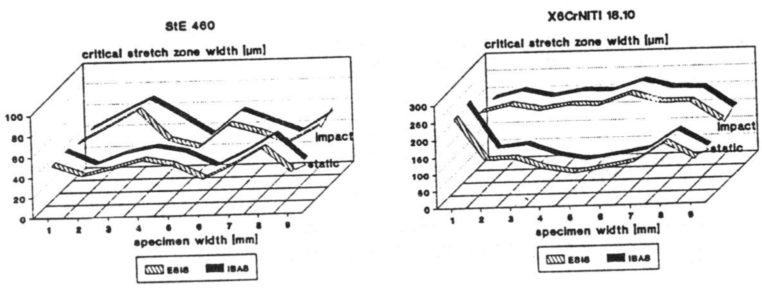


Figure 2 Comparison between the IBAS and ESIS procedure

Both steels show a remarkable difference in the relationship SZW_c/SZH_c:

steel	static	impact
StE 460	0,51	0,70
X6CrNiTi1810	1,03	1,20

This indicates that strain hardening effects need to be incorporated on the blunting process. Adressed to the evaluation of the crack initiation toughness on austenitic steels it appears that SZW_c tends to an overestimation of J_i or δ_i, and in this case SZH_c should be favored (Fig. 3).

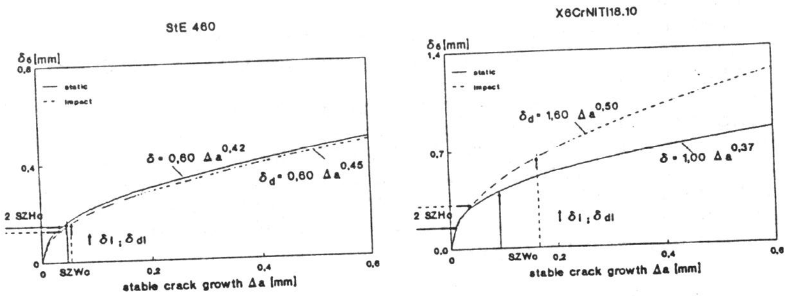


Figure 3 Evaluation of the crack initiation toughness by SZW_c and SZH_c

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