INTRODUCTION

Advancement in the field of the construction of equipment and apparatus, new constructional solutions and better utilization of the available raw materials require, among others, enhanced application of high-strength weldable constructional steel grades.

While, on the basis of extensive experimental results and practical experience, clear concepts exist on the properties and limits of application of ferritic-perlitic and waterquenched structural steel grades, the concept of bainitic steel grades remains still rather incomplete.

The low carbon bainitic steel grade H 75-3 /C = 0.08%/ developed by the Department of Metallurgy and Material Engineering of the Bergakademie Freiberg is thermomechanically treated /low austenitization, controlled high-temperature deformation, and low-temperature final deformation at a high degree of deformation/; afterwards, it is characterized by a microstructure consisting of grained bainite and a percentage of pre-bainitic ferrite increasing with increasing plate thickness (/1/).

Fracture toughness is primarily controlled by the dispersion of the microstructure, the percentage of pre-bainitic ferrite V_{PF}, the percentage and form of sulphides, as well as the amount and distribution of oxydic inclusions (/2/).

According to Peisker (/3/), the specific austenite grain boundary area S_{\gamma} which is a measure for dispersion, i.e. the total boundary surface in relation to the volume unit 1 mm³, shall attain values above 150 mm²/mm³ immediately before the γ-α transformation.

This contribution characterizes the crack propagation resistance behaviour in dependence on the microstructure on the basis of static crack initiation toughness J_{IC}, employing a multi specimen technique.

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Various melts and H 75 - 3 plates /thickness 10-12 mm, yield strength 600-680 MPa/ produced in small-scale and large scale rolling were included into our investigations.

**RESULTS**

The influence of the sulphur content on crack initiation toughness $K_{IC}$ is shown in Figure 1. Very low sulphur contents were attained in one melt by ladle metallurgical treatment /LF process/ in combination with slag treatment and argon flushing. With an S content of about 0.004%, the highly desulphurized melt of H 75 - 3 is characterized by markedly improved crack propagation resistance /Figure 2/. In case of identical metallurgical treatment during melting, crack propagation resistance is controlled by thermomechanical treatment. Thus, an increase of the specific austenite grain boundary area from $S_{gb}=150 \text{ mm}^2/\text{mm}^3$ to $280 \text{ mm}^2/\text{mm}^3$ leads to an increase of $J_{IC}$ from 130 to 180 kJ/m$^2$, i.e. an increase of $S_{gb}$ by 10 mm$^2/\text{mm}^3$ leads to an increase of the crack initiation toughness $J$ by about 4 kJ/m$^2$ /Figure 3/. In case of identical dispersion of the microstructure the resistance to crack initiation and propagation is controlled by the percentage of pre-bainitic ferrite /Figure 4/.

For active design of the properties of H 75 steel grade, one can assume an increase by 5% within the range shown to increase crack initiation toughness by about 12 kJ/m$^2$.

**REFERENCES**


Figure 1 $K_{IC}^J$ vs. $s$ content

Figure 2 Toughness vs. $S$ content

Figure 3 Crack propagation resistance vs. $S_v$

Figure 4 Crack propagation resistance vs. $V_{pf}$