BRITTLE FRACTURE OF WELDED RAILS

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INTRODUCTION

At present rails are produced mainly of pearlitic steel and they are classified in categories, viz.: common steel with tensile strength min. 685 Mpa, steel with increased wearability with tensile strength min. 880 MPa, and special steels with tensile strength min. 1080 Mpa. To join rails to contactless tracks mostly butt flash welding (1) is applied.

The aim of our investigations was to determine the resistance of welded rails to brittle fracture i.e. critical stress intensity factor, their strength, impact resistance and the admissible sizes of defects in the joints taking into account the internal stresses in the rails and joints and also the shape of the fault.

TEST RESULTS AND DISCUSSION

The results of mechanical tests of the joints of welded rails, depending on their properties after rolling or heat treatment have been presented in Figure 1. The admissible sizes of semi-elliptical defects were determined according to Kocanda (2), taking into account the value of critical stress intensity factor of the joint, the external stresses, the internal stresses, the correction factor for the shape of crack equal to 1.75 or 0.75, and the coefficient for surface faults equal to 1.21. The maximum external stresses were determined while taking into account the distance between the sleepers and the maximum wheel load. In the case of UIC60 rails it amounted to 100 MPa. The longitudinal internal stresses at the flash welds were determined by means of trepanation method. It has been found that the internal stresses in the flash weld do not exceed the permissible values for rails, i.e. 200 MPa. The results of these calculations have been presented in Figure 2, where the calculated sizes of defects in welded joints are also shown.

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It has been found that the resistance to brittle fracture of welds is nearly the same as the resistance of rails, whereas the tensile strength and impact resistance of welded joints is somewhat lower than the tensile and impactstrength of rails (Figure 1.) Though defects in the form of non-metallic inclusions up to 0,2 mm in diameter do not endanger the rails and the welded joints, semi-elliptical defects in the form of quenched areas up to 15 mm in depth may constitute a serious danger of brittle fracture. Irregularities in the welding process may cause such quenched areas, i.e. structural notches, which have the same effect as geometrical defects and may lead to brittle fracture.

REFERENCES

(1) Szljapin, W.B., at all "Welding of Rails" (in Russian) Transport, Moskva, USSR, 1977

(2) Kocanda, S., "Fatigue failure of metals" (in Polish) Wydawnictwo Naukowo Techniczne, Warszawa, Poland, 1978

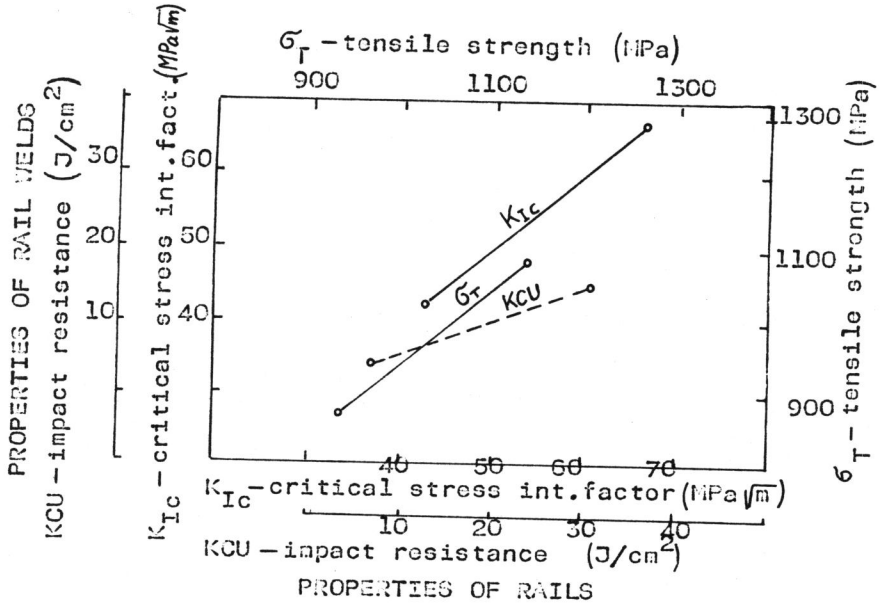

Figure 1 Properties of rail welds versus properties of rails.

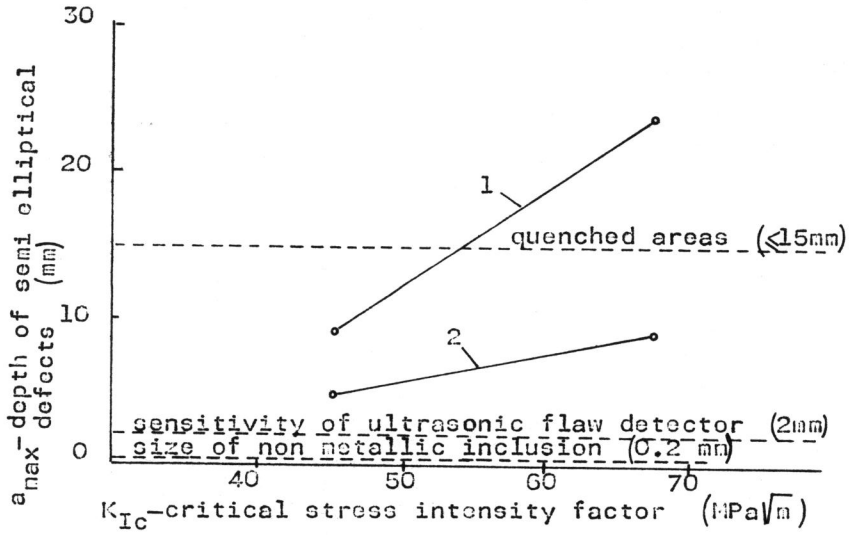

Figure 2 Admissible depth of semi-elliptical defects in rail welds. Correction factor of the shape of crack equal 1.75 /line 1/, 0,75 /line 2/.