Discussion: Fracture mechanics analysis of the fatigue behaviour of spot welds (by L.P. Pook)

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DISCUSSION: "Fracture Mechanics Analysis of the Fatigue Behaviour of Spot Welds," by L. P. Pook.*

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We appreciate the analysis* of our tests [1] in terms of initial S.I.F. very much. In [1] no real attempt was made in this direction because of lack of information on the S.I.F. for this case. The correlation of Pook's equations for the initial K_I and the fatigue limit is good, and they bring the results of the single spotwelds-in-line close together (the error in plate thickness, viz. 7.5 instead of 7 mm (Pook's Fig. 1), does not lead to errors in K of more than 5%). However, it should be noted that high residual welding stresses are present. Even at $R = -1$ no real signs of crack closure are present (this is contrary to tests on stress-relieved specimens).

Correlation at finite life can only be judged from the results of our series II, as for this series the nugget diameters are available [2]. From Pook's Fig. 2a it appears that, on the basis of an uncracked K_I value, the spread in results with regard to a linear $\log K - \log N$ relationship is much larger than the spread with regard to a $\log F - \log N$ relationship. As remarked in [1], crack propagation starts on a rather wide front and is primarily in the thickness direction. The influence of the nugget diameter on the S.I.F. of the growing crack will diminish as the crack grows, and as 'macro' crack growth is an essential part of the fatigue life, the nugget diameter is not a parameter for finite life. Despite this, the correlation with the initial K_I is still good enough to be used as a design parameter for infinite and finite life. We do not understand the overall use of an inverse slope of $3\frac{1}{3}$, instead of the measured value of 3 (our series II, III, and IV) and 4 (oil-treated specimens of series III). It may be interesting to note that for the 56 KF-grade material (thickness 6 mm, central cracked plate, $R = 0$) an inverse slope of 2.82 was measured for $3 \cdot 10^{-6} \leq d\ell/dn < 10^{-3}$ mm/cycle. ΔK for $d\ell/dn = 10^{-6}$ inch/cycle was ~ 5.5 KN/mm $^{3/2}$ ($15 \cdot 10^3$ lb/inch $^{3/2}$), which compares well with [3]. However, a measured inverse slope is not a real constant and depends on material micro-structure and environment.

Concluding we agree, despite the enlarged spread at finite life, with the author that his S.I.F. analysis is encouraging enough to be continued.

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**International Journal of Fracture* 11 (1975) 173-176

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