THE EFFECT OF RESIDUAL STRESSES ON FATIGUE CRACK GROWTH IN WELDED STIFFENED PANELS

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The crack growth rate in welded stiffened panels can be significantly affected by the residual stresses which are introduced by the welding process. The influence of welding residual stress on crack growth rate is accounted for by replacing the nominal stress ratio R in empirical power laws by the effective stress intensity factor ratio R_{eff} [1, 2]. The analysis method is based on the superposition rule of linear elastic fracture mechanics. In the residual stress field, under the cyclic loads, the total SIF range ΔK_{tot} and effective SIF ratio R_{eff} are given as:

$$\Delta K_{\text{tot}} = \left(K_{\text{app,max}} + K_{\text{res}}\right) - \left(K_{\text{app,min}} + K_{\text{res}}\right) = \Delta K_{\text{app}} \tag{1}$$

In this study the distribution of welding residual stresses in the stiffened panel specimen is depicted in Figures 1a and 1b.

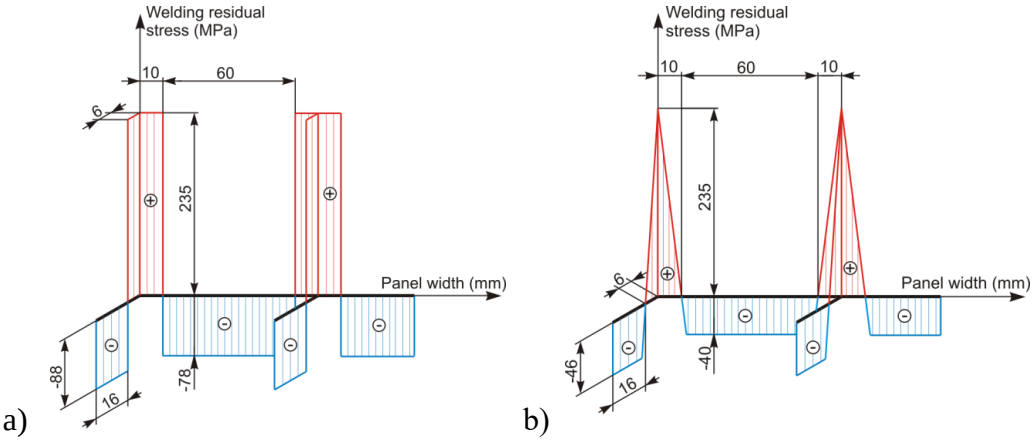

Fig. 1. Welding residual stress distribution: a) rectangular; b) triangular.

Compressive welding residual stresses decreased the total SIF values K_{tot}, and the crack growth rate between the two stiffeners. The Elber and Schijve models, which take into account the effective stress intensity factor ratio, R_{eff}, were implemented to simulate fatigue crack propagation in the test specimen. The simulated crack growth rate was higher in the region of tensile residual stresses, which is in good agreement with experimental results.

References

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