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Fatigue Strength Prediction Using an Effective Stress Model in a Stainless Steel Sheet

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For predicting fatigue strengths of stainless steel sheet, an effective stress model was proposed in consideration of the true stress distribution etc. under bending cyclic loads. The relationship between the fully reversed equivalent stress amplitude and failure cycles treated with the effective stress and Walker model had excellent goodness of fit, showing that the strength coefficient of the *S-N* curve was equivalent to the ultimate tensile strength of the material. The ratio of the alternating stress to mean stress acting on the fatigue strength was 3:1. The Goodman and other conventional relations had insufficient goodness of fit. This research elucidated the substances as summarized in the following, corresponding to Figs. 1-4.

(1) The 0.2 % nominal proof stresses under the plane bending loads were high, about 1.6 times higher than the value obtained by the uniaxial tensile test of the material sheet.

(2) When the experimental data were fitted to the Walker model with the exponent 0.75 based on the nominal stress, the relationship between the fully-reversed equivalent stress amplitude and failure cycles was regressed by the logarithmic approximation and the coefficient of determination was 0.9728. The Goodman and other conventional relations were insufficient in goodness of fit.

(3) In consideration of the true stress etc. under cyclic bending loads, the effective stress model was proposed. The relationship between the equivalent fully-reversed effective stress and failure cycles had a high degree of fit with the model, and the strength coefficient of the *S-N* curve was equivalent to the ultimate tensile strength of the material.

(4) The alternating stress and mean stress did not affect the fatigue strength in the same degree, and the ratio of their degrees was 3:1. The coefficient of variation of the equivalent strength at 2 million cycles by the proposed effective stress and Walker model was 1 %. The Weibull approximation had high goodness of fit and the scatter band was very small.

(5) The measured failure cycles were in good agreement with the life estimated by the proposed model, demonstrating that the fatigue life can be predicted in high accuracy.

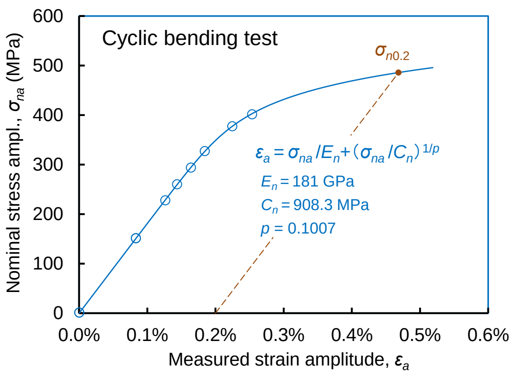

Fig. 1. Nominal stress-strain amplitude curve through cyclic bending tests under fully-reversed loads.

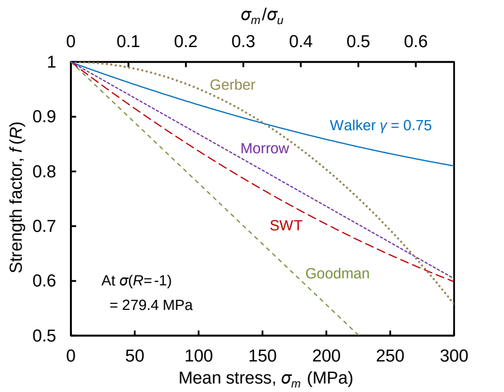

Fig. 2. Strength factor according to mean stress based on the mean stress correction models.

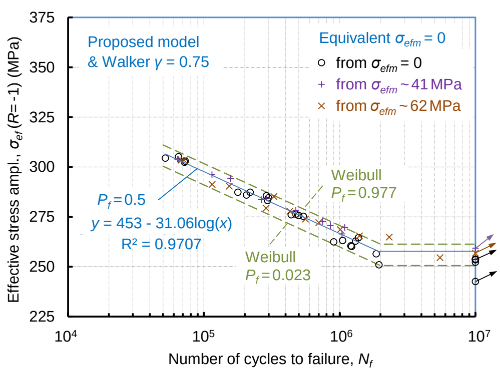

Fig. 3. Equivalent fully-reversed effective stress amplitude versus number of cycles to failure.

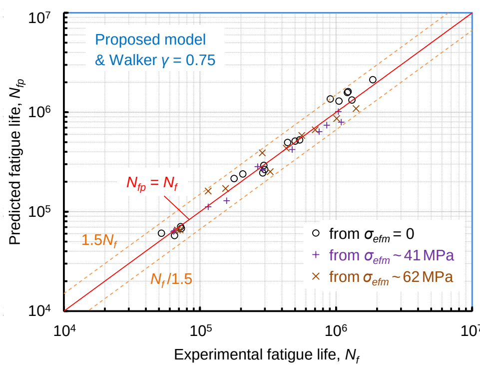

Fig. 4. Predicted fatigue life versus experimental fatigue life based on the proposed model.

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