

PREDICTION OF STRUCTURAL MATERIAL LIFE IN ISOTHERMAL CREEP UNDER COMBINED STRESS CONDITIONS

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This paper proposes a method for the prediction of structural material life in isothermal creep under combined stress conditions verified using experimental data on the durability of tubular specimens of EI437BU-VD heat-resistant nickel alloy at 650 °C under the simultaneous action of an axial and a tangential stress. A power, an exponential, and a fractional power dependence of the time to failure on the equivalent stress were adopted as parametric durability models. Four expressions for the equivalent stress were considered.

Based on experimental data on the durability of tubular specimens of EI437BU-VD heat-resistant nickel alloy at 650 °C, the constants appearing in the expressions for the durability were estimated for each of the four expressions for the equivalent stress using the least squares method.

For each parametric durability model, two types of prediction error were calculated. It was shown that for each model the errors are minimized if the Mises criterion is taken as the equivalent stress.

For the exponential durability model and the Mises equivalent stress, the normal distribution hypothesis for the random durability was tested using the values of its sample vector. Because of the small amount of experimental data, the Shapiro–Wilk statistical criterion was used in the test.

The paper presents graphs of the distribution function and distribution density of the time to failure for tubular specimens of EI437BU-VD heat-resistant nickel alloy at an axial stress of 490.5 MPa, a tangential stress of 245 MPa, and a temperature of 650 °C and the predicted specified life for different values of the load parameters at a fixed confidence probability. At a confidence probability of 0.99, all the experimental values of the time to failure lie on the right of the specified life, as distinct from the values that correspond to a confidence probability of 0.9 and 0.95.

A technique for material creep constant identification is proposed. The technique is based on statistical treatment of experimental creep curves and uses probability theory, mathematical statistics, and optimization methods.

Keywords: *durability, lifetime models, creep constants, time to failure, equivalent stress, prediction errors*

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