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Creep-Integrated Fatigue Equation for Metals

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Abstract

Background - The existing creep-fatigue models are valid over limited ranges of temperatures and frequencies. **Need** - There is a need to develop a creep-fatigue equation that covers the full range of phenomena from pure fatigue to pure creep rupture, and all the intermediate failures. **Method** - By integrating the Manson-Haferd parameter into the Coffin-Manson equation, the creep-integrated fatigue equation is developed and further is validated on three metal alloys: 63Sn37Pb solder, Sn3.5Ag solder and stainless steel 316. **Results** - This new formulation collapses the dispersed strain-life data of the alloys obtained at diverse temperatures and cycle times into a cohesive strain-life formulaic representation. Supported by this result, the method of establishing the material parameters for the creep-integrated fatigue equation is demonstrated. **Originality** –The resulting equation is capable of modelling the full range of creep-fatigue interaction from pure fatigue to pure creep rupture, and the combinations thereof. A method is provided to determine the coefficients.

Keywords: creep-fatigue, creep rupture, linear time-temperature parameter, strain-life.

1. Introduction

The challenge in creep-fatigue modelling is in compounding the damages due to creep and fatigue. The common practice is to assume that creep damage and fatigue damage act independently such that creep-fatigue damage is the linear sum of the two damages [1]. However, this simple and convenient assumption has been found to be invalid. Creep and fatigue damages in metals are known to interact,