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Fatigue life modelling under variable amplitude multiaxial loading: comparison between fatigue criterion and incremental modelling

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Abstract

This study deals with fatigue of a 1045 carbon steel subjected to a cyclic tension-torsion spectrum combining in-phase and out-of-phase loadings and including overload, representative of an automotive chassis loading type. The experimental lifetimes are compared to the results of two different approaches. The first one combines a multiaxial fatigue criterion able to describe out of phase loading and a non-linear damage rule. The second one is based on an incremental mesoscale plasticity/damage model. It is shown that the criterion involving a non-linear damage rule is able to describe the experimental result for full spectrum (with overload) but the identification of the non-linearity is a function of spectrum type. The incremental approach gives better results for both spectra (with and without overloads) and does not need specific parameter identification.

1 Introduction

In the sector of automotive engineering, the car-to-ground connecting components undergo multiaxial cyclic loading. Usual loading corresponds to « smooth » driving on a well-maintained road and is in the range of High Cycle Fatigue (10^6-10^8 cycles), as well as turns or driving on cobblestones, which are however more demanding. Events in the range of Low Cycle Fatigue (1-10^4 cycles) may happen, for example impacts of potholes on wheels. The complexity of automotive fatigue loadings is taken into account by combining different types of multiaxial loadings, representative of in service stresses. In order to forecast lifetime of industrial components, reliable tools capturing the effects of multiaxiality and damage accumulation are needed. This complex topic has been addressed by researchers over the past 50 years with different types of modelling strategies, starting from very simple linear analysis up to complex nonlinear modelling, including different scales or methodologies. A short