Multiaxial high cycle fatigue in C35 steel : characterization and modelling of damage mechanisms

Abstract : This study is dedicated to establish a model of life prediction for a polycrystalline metal subjected to multiaxial complex loading in high cycle fatigue. In order to understand the mechanisms of plasticity and damage to be modelled, a campaign of experiments conducted on a steel type C35 is carried out in the first part of the study. The modelling options are chosen according to this precise observation of mechanisms.

The modelling focuses on the prediction of both infinite life regime and finite life regime (10^5 – 10^7 cycles). To address the first objective, a multiaxial fatigue criterion based on stress invariants is proposed. In spite of a simple formulation, the predictions of the criterion are in very good agreement with a wide range of experimental data conducted on various steels. In regard to the second objective, in order to overcome a purely phenomenological description, a two-scale damage model (macro – meso) integrates the proposed criterion and is formulated in the framework of thermodynamics of irreversible processes allowing to capture as closely as possible degradation mechanisms at mesoscopic scale as well as phase shift effect and non linear fatigue damage accumulation. The incremental formulation of the proposed model is an asset to deal with variable amplitude loadings in future works.

Keywords : Fatigue criterion, Stress invariants approach, Life prediction, Blocks loading, Incremental model, Phase shift effect, Non linear cumulative damage.