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Axial-Torsional Fatigue strength of bonded joints under non-proportional loading

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Adhesive bonding has gained in recent years an increased attention in industrial applications since they allow for a higher stiffness and strength with respect to mechanical connections. Concerning fatigue, adhesive bonding offers longer life than conventional joining techniques. However, in real-world applications however, structures are generally subjected to multiaxial, non-proportional fatigue (MNPF) due multiple loading sources and geometrical features (notches), which requires the assessment through a uniaxial-equivalent fatigue parameter.
In adhesive joints, multiaxial fatigue has been approached under proportional (Multiaxial Proportional Fatigue, MPF) with a few exceptions. The objective of this work is therefore to analyse experimentally MNPF of adhesive joints. For this purpose a bonded butt joint was designed to be tested under simple axial, torsional and axial-torsional MPF and MNPF. A two-component, room temperature-curing epoxy adhesive was selected o bond S235 construction steel. Tests are run at room temperature. In a previous work of the authors, results were analysed according to several pressure-independent, pressure-dependent and critical plane criteria, identifying the Matake critical plane as the one, among those considered, yielding a better correlation of the different loading conditions tested. However, all the criteria analysed are established for the fatigue limit of the adhesive, hence they extension to the finite life region is merely empirical.
In this work a criterion based on the Fatemi-Socie critical plane approach is introduced, where the finite life is explicitly considered, i.e. the criterion becomes effectively predictive for all the fatigue regimes. The results are then compared with the Matake criterion regarding the predicted vs. effective cycles to failure. Although none of the two criteria gives a faithful prediction for all the conditions tested, the Fatemi-Socie one resulted conservative, differently form the Matake one.

Primary authors: MORONI, Fabrizio (Università degli Studi di Parma); MUSIARI, Francesco; PIRONDI, ALESSANDRO (Università di Parma - Dipartimento di Ingegneria dei Sistemi e delle Tecnologie Industriali)

Presenter: PIRONDI, ALESSANDRO (Università di Parma - Dipartimento di Ingegneria dei Sistemi e delle Tecnologie Industriali)

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