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MULTIAXIAL FATIGUE: FROM MATERIALS TESTING TO LIFE PREDICTION

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ABSTRACT

Fatigue damage has special relevance on the life span of mechanical components and structures, as it takes responsibility for a large majority of the registered structural failures in service. The continuous need for the weight reduction and improved design optimization of components and a growing need for greater lifespans of equipment, forced the understanding of the fatigue behavior of materials either under multiaxial loading cycles or under increased number of loading cycles. Fatigue tests were always performed under uniaxial fatigue loads. However, it is generally recognized that multiaxial stresses occur in many full-scale structures, being rare the occurrence of pure uniaxial stress states. In the following, a wide range of multiaxial fatigue failure criteria have been developed that may be applied to different metallic materials. These failure criteria may be classified as strain based for high strain loading conditions or stress based for higher lifespans in the elastic loading regime. These criteria are nowadays used in design optimization also contributing to the weight reduction and improved lifespans of modern equipment. Present manuscript is a review of the main specimens and equipment where research can be carried out for performing multiaxial fatigue tests under bi-axial stress states. Being a personal view, it will be based on the author experience on the performance of multiaxial fatigue tests under axial/torsion loading using mechanical actuated or servo-hydraulic fatigue testing machines or biaxial fatigue tests using electromagnetic actuators in cruciform specimens. Further research is needed and is being carried out concerning multiaxial very high cycle fatigue in order to achieve better improvements in weight reduction of components and structures and also in complex variable amplitude loading with adequate damage accumulation models.

KEYWORDS: Biaxial fatigue; Cylindrical and cruciform specimens, Multiaxial fatigue criteria; Crack paths; Damage accumulation.

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