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Evaluation of different techniques in estimating orientation of crack initiation planes and fatigue lifetime under complex multiaxial loading paths

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Abstract

In the present investigation, the accuracy of two methods, i.e., the Shear Strain-Maximum Variance Method (γ-MVM) and the Maximum Damage Method (MDM), in predicting the orientation of the crack initiation planes was checked by considering several results taken from the literature and generated by testing five different metallic materials under complex multiaxial loading. The γ-MVM postulates that the critical plane is that material plane containing the direction experiencing the maximum variance of the resolved shear strain. In contrast, the MDM defines the critical plane as that material plane on which the accumulated damage reaches its maximum value. In the present investigation, the MDM was applied in conjunction with Fatemi-Socie's (FS) multiaxial fatigue criterion, Bannantine-Socie's (BS) cycle counting method, and Miner's linear rule. The validation exercise being performed demonstrated that both the γ-MVM and the MDM were capable of accurately predicting the orientation of the crack initiation planes in the selected metals. Subsequently, the reliability of three different design methodologies suitable for estimating fatigue lifetime of metals subjected to variable amplitude multiaxial loading was assessed quantitatively by using a number of experimental results taken from the literature. In more detail, Methodology A was based on the MDM applied along with the FS criterion, the BS cycle counting method,