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# Multiaxial fatigue criterion considering the influence of out-of-phase failure and loading condition

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## Abstract

A multiaxial fatigue criterion is proposed, which can be seen as a modification of a previous criterion presented by the authors. The influence of the unique material state can be taken into consideration, as well as the range and mean value of the variables involved in the fatigue parameter for depicting the influence of the loading condition. Definitions of the out-of-phase failure and out-of-phase failure angle are proposed, as well as an out-of-phase failure parameter that can be used to express the interdependent relationship with the out-of-phase failure, in both normal-type and shear-type failure. An explicit physical interpretation of different failure types is proposed. After validation and comparison with experimental results for different loading conditions and materials, it is concluded that the prediction ability of this modified multiaxial fatigue criterion is better than that of the original Lu's criterion, as well as than those of the other commonly used multiaxial fatigue criteria.

## Keywords

Multiaxial fatigue; Failure mechanisms; Critical plane; Life prediction; Out-of-phase failure

## Nomenclature

$FP$  = fatigue parameter

$\gamma_{max}$  = maximum shear strain amplitude

$k$  = material-dependent constant

$\varepsilon_n$  = normal strain

$\Delta\varepsilon_n$  = range of normal strain

$\varepsilon_n^*$  = normal strain excursion

$\Delta\gamma_{max}$  = maximum range of shear strain

$\Delta\sigma_n$  = range of normal stress

$\Delta\tau$  = range of shear stress

$\Delta\gamma$  = range of shear strain

$P_s$  = material state parameter

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