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Cyclic stress-strain relation under high cycle fatigue process
-Elastoplastic constitutive model incorporating cyclic damage-

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Summary: In order to simulate mechanical fatigue phenomena represented by cyclic plasticity such as ratcheting and hysterisis loop, the plastic stretching within a yield surface has to be described, whilst the plastic strain is induced remarkably as the stress approaches the dominant yielding state. The traditional plastic constitutive equation, however, is capable of describing deformation behavior for the stress path only near the monotonic/proportional loading, since the inside of the yield surface is assumed to be an elastic state. In this study, an unconventional plasticity model is proposed for the description of the cyclic loading behavior observed during so-called high cycle fatigue subjected to the cyclic stresses lower than the yield stress. The extended elastoplastic constitutive equation is formulated by introducing both the elastic boundary and the damage concepts. The former is introduced to describe a purely elastic response for the stresses lower than the proportional limit, and the later is to describe the damage effect represented by a progressive degradation of stiffness of materials, which is caused by the accumulation of plastic strain even under the macroscopically elastic condition. The proposed model exhibits a smooth elastic-plastic transition with increase of stress to the dominant yielding state with both plasticity and damage effects. Finally, the extended elasto-plastic model is applied for metals obeying not only isotropic but also kinematic hardening law, and the mechanical responses under cyclic loading condition are examined briefly and compared with the corresponding experimental results for SN490B.