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Linear Matching Method for design limits in plasticity

Haofeng Chen

Summary

In this paper a state-of-the-art numerical method is discussed for the evaluation of the shakedown and ratchet limits for an elastic-perfectly plastic body subjected to cyclic thermal and mechanical load history. The limit load, i.e. the load carrying capacity, is also determined as a special case of shakedown analysis. These design limits in plasticity have been solved by characterising the steady cyclic state using a general cyclic minimum theorem. For a prescribed class of kinematically admissible inelastic strain rate histories, the minimum of the functional for these design limits are found by a programming method, the Linear Matching Method (LMM), which converges to the least upper bound. By ensuring that both equilibrium and compatibility are satisfied at each stage, a direct algorithm has also been derived to determine the lower bound of shakedown and ratchet limit using the best residual stress calculated during the LMM procedure. Three practical examples of the LMM are provided to confirm the efficiency and effectiveness of the method: the behaviour of a complex 3D tubeplate in a typical AGR superheater header, the behaviour of a fibre reinforced metal matrix composite under loading and thermal cycling conditions, and effects of drilling holes on the ratchet limit and crack tip plastic strain range for a centre cracked plate subjected to constant tensile loading and cyclic bending moment.