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Borokinni, A. S.; **Akinola, A. P.**; **Layeni, O. P.**; **Fadodun, O. O.**; **Olokuntoye, B. A.**

Mises flow equations for gradient plasticity with isotropic and kinematic hardening. (English)

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Summary: This work provides a framework for which strain gradient plasticity theories can be investigated and considered admissible in the sense of thermodynamic consistency and maximum plastic dissipation in juxtaposition to the classical theory. The classical plasticity theory, which accounts for the kinematic and dissipative isotropic hardening, is studied through the maximum plastic dissipation principle on the assumption that the plastic flow is associative. By extension, the strain gradient plasticity theories of *E. C. Aifantis* ["On the microstructural origin of certain inelastic models", J. Eng. Mater. Technol. 106, No. 4, 326–330 (1984; doi:10.1115/1.3225725)] and *M. E. Gurtin* and *L. Anand* [J. Mech. Phys. Solids 53, No. 7, 1624–1649 (2005; Zbl 1120.74353)] are investigated, and it is shown that these theories mimic the classical yield criterion, the Mises flow rule, codirectionality law and in addition define elastic region for rate-independent plastic materials. Furthermore, the simple constrained shear problem is considered to demonstrate and show variance in the theories considered. It is shown that Aifantis' flow law differs from that of the classical only in the nonlocal term accompanying the Aifantis' flow rule which involves an energetic length scale; and as this length scale approaches zero, the Aifantis model approaches the classical theory.

MSC:

74C10 Small-strain, rate-dependent theories of plasticity (including theories of viscoplasticity)
74A15 Thermodynamics in solid mechanics

Keywords:

thermodynamic consistency; Burgers tensor; kinematic hardening; maximum plastic dissipation principle; associative plastic flow; yield criterion

Full Text: Link

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