Tutorial Session 8d Homework: Flow Rules

Mentor Guide Questions

1.13 Describe qualitatively the hardening behaviour of metals, the behaviour under load reversal, and the special cases of kinematic and isotropic hardening.

Numerical Questions

1) A sample of material has a uniform tensile stress applied in the x-direction, just short of the yield strength. Holding this x-stress fixed, an additional uniform tensile stress is then applied in the y-direction, also just short of the yield strength. What is the plastic strain?

2) A sample, A, of material which obeys the Mises flow rule has a uniform tensile stress applied in the x-direction, just short of the yield strength. Holding this x-stress fixed, an additional uniform compressive stress is then applied in the y-direction, also just short of the yield strength. A second sample of material, B, is similarly loaded but with the loads applied in the reverse order. Which sample acquires the larger x-component of plastic strain?

Obviously this must be a work-hardening material or the loading conditions described could not be sustained. For clarity assume isotropic hardening (the yield surface just expands uniformly in all directions, retaining its shape).

Would the answer be different for a Tresca flow rule material?

[A qualitative answer to (2) is acceptable, but if you are feeling ambitious you can attempt to find the exact analytic expressions for the x-component of the plastic strain in the case of n = 5 power law hardening and a Mises flow rule].