A two-surface viscoplastic model for saturated clays

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Study description
Experimental tests show that time dependent behavior is significant in Boom Clay [1]. An appropriate model of viscoplasticiy is developed for Boom Clay to assess its impact on the long term evolution of the disposal facility.

Constitutive models

Yield surfaces:
\[ f_{YS} = q^2 + \frac{M^2}{1-k_f} \left( \frac{p'}{p_{ref}'} \right)^{2/3} \left( \frac{\sigma_{yy}'}{\sigma_{yy ref}'} \right)^2 = M^2 = 0 \]

Hardening law:
\[ \frac{dp'}{\epsilon_{v}'} = \frac{\sigma_{ref}}{\lambda - k} \frac{d\epsilon_{v}'}{d\epsilon_{v}'} \]

Dilation ratio:
\[ d = \frac{d\epsilon_{v}'}{d\epsilon_{v}'} = M \frac{\sigma_{yy} - \sigma_{xx}}{k \sigma_{yy}} \]

Viscoplastic strain rate:
\[ \dot{\epsilon}_{v}^{vp} = \dot{\lambda} \frac{\sigma_{ref}}{\eta} \frac{d\epsilon_{v}'}{d\epsilon_{v}'} \]

Results

- The model can describe the time effects on the mechanical behavior (viscosity);
- The model can also describe some important features of natural clays evidenced experimentally such as the limited elastic zone, the smooth transition from elastic to viscoplastic behavior.

Isotropic compression tests at different strain rates:

Drained triaxial tests on Boom Clay:

Undrained triaxial tests on Boom Clay:


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