A standard thermodynamic-based extension of the Modified Cam-Clay model for elastoviscoplastic geomaterials

Simon Raude*†[1] and Goustan Bacquaert[1]

[1]ElectRotechnique et MEcanique des Structures – EDF Recherche et Développement – France

Abstract

In geotechnical engineering, the development of constitutive models for geomaterials is crucial, especially when designing **underground repositories for radioactive waste**. This study investigates the **mechanical behavior of Callovo-Oxfordian (COx) claystone**, a key material used in such repository in France. We propose an advanced **elastoviscoplastic critical state constitutive model** that combines plastic and viscoplastic behaviors within the **Generalized Standard Materials** framework.
In contrast to the **Modified Cam-Clay model,** our approach replaces the elliptical yield criterion with a parabolic one, offering a more accurate description of the shear strength surface for rocks. The proposed model effectively captures both the **instantaneous** and **long-term behavior** of COx claystone, while incorporating the **critical state concept**. Additionnally, to account for the **inherent transverse isotropy** of COx claystone, we propose a straightforward representation of plastic anisotropy. This is achieved using the **tensor representation** framework for oriented solids, initially developed in the 1970s and recently revived for modeling geomaterials.

The model is calibrated using triaxial compression and creep test data on COx claystone, demonstrating its accuracy. The relatively small number of parameters required, compared to other models of similar complexity, allows for a simple and efficient calibration process. Finally, finite element simulations conducted with **Code Aster** validate the model's robustness and applicability for **industrial-scale applications**.

*Speaker
†Corresponding author: simon.raude@edf.fr