11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Mechanized tunneling operations: modeling infiltration processes with consideration of an inverse damage formulation

A. Schaufler*[1], C. Becker[2], H. Steeb[3]
[1] Insitute of Mechanics, Universitätsstr. 150, 44801 Bochum, Germany, schaufler@lkm.rub.de
[2] Insitute of Mechanics, Universitätsstr. 150, 44801 Bochum, Germany, becker@lkm.rub.de
[3] Insitute of Mechanics, Universitätsstr. 150, 44801 Bochum, Germany, holger.steeb@rub.de
www.lkm.rub.de

Key Words: *Infiltration, Porous Media, Mechanized Tunneling.*

In the present contribution, phase transition phenomena are investigated. In order to account for the evolution of hydraulic properties, the Theory of Porous Media (TPM) is extended by the concept of volume fractions to become the Mixture Theory (MT). The presented formulation was mainly developed for the application in the field of mechanized tunnelling. In particular, the evolution of mechanical and hydraulic properties during the backfilling with annular gap grouting mortar of a tunnel lining is investigated.

In the flow of a complex fluid (suspension) through a porous medium, phase transition processes can be identified, i.e., particles that are dissolved in the fluid (fines) attach to the porous medium. This so-called infiltration process is modeled by adding a mass exchange term to the mean field equations. The definition of the mass exchange term can be understood as a constitutive formulation and is depending on the microstructure of the considered domain [1, 2]. Therefore, the homogenized information used for the MT is enriched by a statistical evaluation of the Constriction Size Distribution (CSD) of the porous medium. Comparing the CSD of the porous medium with the Grain Size Distribution of the fines dissolved in the fluid, the infiltrating fraction of fines can be determined [3]. On the one hand, infiltration of fines to a porous skeleton evolves the hydraulic properties (e.g., permeability, porosity) of the porous medium. On the other hand, the mechanical properties of the porous skeleton are also affected by infiltration. Due to infiltration processes, the fraction of solid particles in a volume is increased, which leads to a hardening effect of the porous medium. The modeling of the evolution of stiffness is realized in terms of an “inverse damage” formulation.

REFERENCES

[1] A. Schaufler, C. Becker, and H. Steeb, “Infiltration processes in cohesionless soils”, *ZAMM - J. Appl. Math. Mech.*, vol. 93, no. 2–3, pp. 1–9, 2013.

[2] H. Steeb and S. Diebels, “A thermodynamic-consistent model describing growth and remodeling phenomena”, *Comput. Mater. Sci.*, vol. 28, no. 3–4, pp. 597–607, Nov. 2003.

[3] A. Schaufler, C. Becker, H. Steeb, and A. Scheuermann, “Simulation of the backfilling process with annular gap grouting mortar”, *Proc. Third Int. Conf. Comput. Subsurf. Eng.*, pp. 587 – 597, 2013.