Editorial

Constitutive modeling for mechanical behaviors of geomaterials, new designs and techniques in geotechnical engineering

This Special Issue of the Journal of Rock Mechanics and Geotechnical Engineering (JRMGE) contains 13 papers prepared by international experts on various general topics in geomechanics, rock mechanics and geotechnical engineering. It represents a useful mix of theoretical developments, testing and practical applications. We present in the following brief details in the papers, alphabetically in accordance with the last name of the first author.

Barla presents a review of tunneling techniques with emphasis on the full-face method combining full-face excavation and face reinforcement by means of fiber-glass elements with a yield-control support. This method has been used successfully in difficult geologic conditions, and for a wide spectrum of ground situations. The validation of the method with respect to the Saint Martin La Porte access adit along the Lyon–Turin Base tunnel experiencing severely squeezing conditions during excavation is also included in the paper. The numerical modeling with consideration of the rock mass time-dependent behavior showed a satisfactory agreement with monitoring results.

A review of the disturbed state concept (DSC) for constitutive modeling of materials, interfaces and joints is presented by Desai. The DSC is a unified and hierarchical approach which allows many features of material behavior such as elastic, plastic and creep deformations, volume change, stress path, and microcracking leading to fracture, failure or softening, stiffening or healing under various mechanical and environmental forces. The DSC has opened a new era for accurate and economic analysis and design for problems in geomechanics and geotechnical engineering. Its mathematical framework for solids can be specialized for interfaces and joints, thereby providing consistency in using the same model for both solids and interfaces. The DSC has been validated for geologic and other engineering materials. This study also provides a comprehensive list of publications that have employed the DSC based on elasticity, plasticity, elastoviscoplasticity, damage, fracture, and micromechanics.

Behavior of modeled rockfill materials is studied through testing using a medium triaxial cell under drained conditions by Gupta. The effect of particle breakage is analyzed including the influence of size and confining pressure.

Consolidated drained tests are reported for prototype rockfill materials for two dam projects in India by Honkadavadar and Sharma. An elastoplastic hardening soil (HS) model is used to characterize the material behavior. Procedures for prediction of shear strength and elastic parameters using the index properties and relative density are also included.

The challenging problem of prediction of surface subsidence due to extraction of underground coal seams is the subject of the research by Iwanac et al. The current research includes predictions of the subsidence using the finite element method with a wide range of available constitutive models.

By examining the published total data of 1089 of blast loadings, Kumar et al. proposes a generalized empirical model for peak particle velocity (PPV) under the influence of rock unit weight, rock quality designation (RQD), geological strength index (GSI) and uniaxial compressive strength (UCS). The proposed model can be used to predict blast-induced vibrations in rocks.

Perazzelli and Anagnostou have studied the main aspects of technical feasibility of shallow lined rock cavern (LRC) or shaft related to compressed air energy storage (CAES) under a wide range of geotechnical factors. The paper discusses the conditions for design of such systems involving consistent fluid flow tests.

Laboratory simulation of flow through rough walled single fracture in granite is presented in the paper by Singh et al. with two sizes, 30 mm and 54 mm diameters. The effects of confining pressure, fluid pressure and roughness of fractures are analyzed.

Tarefder et al. examine the stress-strain behavior of pavements including effect of cross-anisotropy in asphalt, base and subbase materials by using the finite element method. Comprehensive laboratory tests are performed to identify the cross-anisotropy and viscoelastic parameters for asphalt, and nonlinear elastic behavior for unbound materials. Model validations include measured field deflections and strains using the falling weight deflectometer (FWD).

Shear behavior of rough joints are examined under constant normal load/stress (CNL) boundary conditions in the paper by Thirukumaran and Indraratna. It is reported that the constant normal stiffness (CNS) boundary condition is more appropriate to define the response of joints in the field, compared to the CNL condition, whose limitations are discussed in the paper.

Xiao et al. present a detailed review on the testing and modeling of rockfill materials (RFMs) using large-scale triaxial tests. Particle breakage and confining pressure are among the important factors that influence the constitutive behavior and dilatancy of RFMs. The state-dependent parameter and particle breakage need to be considered for the development of unified constitutive models of RFMs.

RQD has been essentially the only rock mass classification index for characterization of rock mass and evaluation of mechanical properties, as stated by Zhang, who outlines the key factors for determination of RQD. He evaluates the empirical method based on RQD for finding the deformation modulus and unconfined compressive strength of rock masses in five different sites including thirteen cases. The results are compared with those by using other empirical methods.
Zhang et al. employ a thermomechanical internal state variable theory to analyze the time-dependent behavior of the left bank abutment slope of the Jinping high arch dam by using a geomechanical model and the computer code FLAC. The analyses include various faults and weak structural planes.

The papers in this Special Issue exemplify a variety of topics involving excellent research, theoretical developments, laboratory and field testing, and design applications. We believe they will be useful for researchers, teachers, students and practitioners. We thank the authors for their efforts in preparing valuable papers of high standard that will make this Special Issue of the JRMGE unique and of lasting importance.

Chandrakant S. Desai*
Department of Civil Engineering and Engineering Mechanics, University of Arizona, Tucson, AZ, USA

Yang Xiao1
School of Civil Engineering, Chongqing University, Chongqing, China
E-mail address: hhuxyanson@163.com.

* Corresponding author. Tel.: +1 520 577 9642.
E-mail address: csdesai@email.arizona.edu (C.S. Desai).

Available online 24 March 2016