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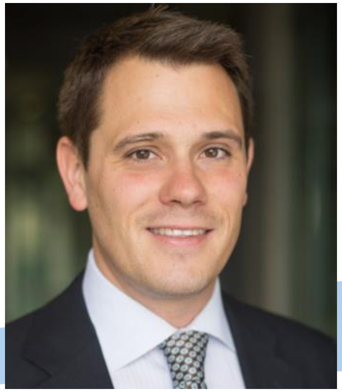

John S. McCartney

John S. McCartney is a Professor in the Department of Structural Engineering at the University of California San Diego, specializing in Geotechnical and Geoenvironmental Engineering. His research interests include unsaturated soil mechanics, geosynthetics engineering, and energy geotechnics. His research in unsaturated soil mechanics has focused on the dynamic response of unsaturated soils, compression response of unsaturated soils to high stresses, hydraulic interaction between unsaturated soils and geotextiles, and impacts of temperature on the behavior of unsaturated soils in geothermal heat exchange and heat storage applications. His research has been recognized by the Quigley award from CGS in 2020, the Walter L. Huber Research Prize from ASCE in 2016, the Casagrande Award from ASCE in 2013, the J. James R. Croes medal from ASCE in 2012, the DFI Young Professor Award in 2012, the NSF CAREER Award in 2011, and the IGS and Young IGS Awards from the International Geosynthetics Society in 2018 and 2008, respectively. He is the chair of the ASCE GeoInstitute Committee on Unsaturated Soils. He is an editor of Computers and Geotechnics, an associate editor of Canadian Geotechnical Journal and serves on the editorial boards of Geotechnical Testing Journal, Geomechanics for Energy and the Environment, and Geosynthetics International. He received B.S. and M.S. degrees in Civil Engineering from the University of Colorado Boulder in 2002 and a Ph.D. degree in Civil Engineering from the University of Texas at Austin in 2007.

Themed Lecture

Seismic Compression of Unsaturated Soils

John S. McCartney, Ph.D., P.E., F.ASCE, Professor and Department Chair, Department of Structural Engineering, University of California San Diego

This theme lecture will focus on the seismic compression of unsaturated soil layers during undrained loading (e.g., earthquakes) and drained loading (e.g., rocking footings, integrated abutment bridges). Lessons learned from cyclic simple shear tests on unsaturated sands under both drained and undrained conditions will be summarized. Drained tests permit isolation of the effects of matric suction on the seismic compression, which provides a restraining effect on volume change in the funicular region of the soil-water retention curve (SWRC). Undrained tests permit evaluation of the combined changes in pore air and pore water pressure in specimens having different initial degrees of saturation, which also influence the effective stress state. The results from the drained cyclic simple shear tests were extrapolated to understand possible limits on the amount of seismic compression, and the undrained cyclic simple shear tests were used to calibrate a semi-empirical elasto-plastic model for predicting the seismic compression of unsaturated sands in the funicular regime during undrained cyclic shearing. Using a flow rule derived from energy considerations, the evolution in plastic volumetric strain (seismic compression) is predicted in the elasto-plastic model from the plastic shear strains of a hysteretic hyperbolic stress-strain curve. The plastic volumetric strains are used to predict the changes in degree of saturation from phase relationships and changes in pore air pressure from Boyle's and Henry's laws. The degree of saturation is used to estimate changes in matric suction from the transient scanning paths of the SWRC. Changes in small-strain shear modulus estimated from changes in mean effective stress computed from constant total stress and cyclic changes in pore air pressure, degree of saturation and matric suction, in turn affect the hyperbolic stress-strain curve's shape. While the model captured trends in hydromechanical variables as a function of shearing cycles well, it underestimated the measured volumetric strain and degree of saturation changes at large numbers of cycles. A linear decreasing trend between seismic compression and initial degree of saturation was predicted from the model while a nonlinear increasing-decreasing trend was observed in the experiments. This may be because post shearing reconsolidation was not considered for soils with higher initial degrees of saturation in the model, which is the focus of future model developments.