# MODELING DEEP WHEEL PENETRATION IN FRICTIONAL/COHESIVE SOILS

**J. P. Hambleton**[a] and **A. Drescher**[b]

[a]Department of Civil Engineering
University of Minnesota
Minneapolis, MN 55455
hamb0025@umn.edu

[b]Department of Civil Engineering
University of Minnesota
Minneapolis, MN 55455
dresc001@umn.edu

Theoretical models for soil-wheel interaction are of interest in many long-standing and emerging engineering applications, including mobility prediction for planetary rovers and assessment of land damage caused by off-road vehicles operating in forests, parks, and wetlands. In these problems, predicting the soil deformation induced by a wheel is crucial. Numerical simulations based on the finite element method (FEM) are being used increasingly to study soil-wheel interaction. Such simulations are largely successful when the soil is cohesive, although difficulties arise when the material is frictional, including numerical instabilities and unrealistic material behavior. In this paper, FEM is used to simulate indenting and rolling wheels on frictional/cohesive soils, considering the large soil deformation occurring in the presence of deep wheel penetration. Emphasis is placed on using relatively simple soil constitutive models to obtain realistic soil response. Essential differences resulting from associated and non-associated material models are presented. Key differences between two-dimensional and three-dimensional simulations are also described. The numerical results are compared with experimental results, obtained using particle image velocimetry to quantify the soil displacement field beneath the wheel in lab-scaled experiments.