Numerical Modeling of Desiccation Cracks in Soils Using the Mesh Fragmentation Technique

Michael Maedo[1], Marcelo Sánchez[1], Osvaldo Manzoli[2], Leonardo J. N. Guimarães[3*]

[1] Zachry Department of Civil Engineering, Texas A&M University, College Station, US

[2] Department of Civil Engineering, São Paulo State University (UNESP), Brazil.

[3] Department of Civil Engineering, Federal University of Pernambuco, Recife, Brazil

ABSTRACT

Desiccation cracks in soils act as a preferential path for water flow and pollutant transport. Drying cracks also affect soil strength and may lead to stability in embankments and slopes. The presence of desiccation cracks can also trigger landslides. Vital infra-structure affected by soil cracking includes levees, road embankments and engineered barriers. Drying cracks generally develop in the soil mass forming a network of cracks with quite regular characteristics. The phenomena of crack generation in soils and sub-sequent propagation is quite complex. A number of factors control the start of the drying crack including soil properties, boundary conditions and soil heterogeneities. In this paper we present the main components of a numerical approach based on the use of high aspect ratio elements. Interface elements based on the damage theory are instrumental to properly model this type of problems involving complex contact between materials. The mathematical formulation of the model is presented in detail alongside with the algorithm for its implementation in a finite element code. The paper also covers the discussion of synthetic benchmarks aimed at exploring the model capabilities, as well as the main results of an experimental campaign conducted to study the actual shear response of orthotropic interfaces, which are used then to validate the proposed mechanical model. This contribution also presents the application of the model to solve as a boundary value problem a real drying test in a soil involving an orthotropic contact surface between materials. The performance of the propose approach in all the cases analyzed was very satisfactory.