Two-Dimensional Finite Element Analysis of Porous Geomaterials at Multikilobar Stress Levels

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(ABSTRACT)

A technique was developed for analyzing and developing mechanical properties for porous geomaterials subjected to the high pressures encountered in penetration and blast-type loadings. A finite element (FE) code was developed to verify laboratory test results or to predict unavailable laboratory test data for porous media loaded to multikilobar stress levels. This FE program eliminates a deficiency in the process of analyzing and developing mechanical properties for porous geomaterials by furnishing an advanced analysis tool to the engineer providing properties to material modelers or ground shock calculators. The FE code simulates quasi-static, axisymmetric, laboratory mechanical property tests, i.e., the laboratory tests are analyzed as boundary value problems. The code calculates strains, total and effective stresses, and pore fluid pressures for fully- and partially-saturated porous media. The time dependent flow of the pore fluid is also calculated. An elastic-plastic strain-hardening cap model calculates the time-independent skeletal responses of the porous solids. This enables the code to model nonlinear irreversible stress-strain behavior and shear-induced volume changes. Fluid and solid compressibilities were incorporated into the code, and partially-saturated materials were simulated with a "homogenized" compressible pore fluid. Solutions for several verification problems are given as proof that the program works correctly, and numerical simulations of limestone behavior under drained and undrained boundary conditions are also presented.