Title
PHYSICAL AND NUMERICAL SIMULATIONS OF SUBSIDENCE IN FRACTURED SHALE STRATA [abstract]

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A symposium on Recent Advances in Geotechnical Centrifuge Modeling was held on July 18-20, 1984 at the University of California at Davis. The symposium was sponsored by the National Science Foundation's Geotechnical Engineering Program and the Center for Geotechnical Modeling at the University of California at Davis.

The symposium offered an opportunity for a meeting of the International Committee on Centrifuges of the International Society for Soil Mechanics and Foundation Engineering. The U.S. participants also met to discuss the advancement of the centrifuge modeling technique in the U.S. A request is being transmitted to the American Society of Civil Engineers to establish a subcommittee on centrifuges within the Geotechnical Engineering Division.

PHYSICAL AND NUMERICAL SIMULATIONS OF SUBSIDENCE IN FRACTURED SHALE STRATA

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The motions of fracture shale strata that overlie a void of increasing size are studied using physical and numerical simulations. The physical simulation is conducted on the Sandia 25-Foot Centrifuge, the largest operating centrifuge in the United States. The physical model described here is composed, primarily, of fractured Devonian shale (to simulate a jointed overburden). For the model scale of 150, the experiment simulates an overburden of 86.3 m. The void beneath this strata is 7.62 m high and its width is increased in four steps from 0 m to 106.7 m. The experiment shows the progressive failure of the overburden, the formation of a failure arch, and, eventually, the formation of a surface subsidence trough. To gain insights into the phenomenology of failure mechanisms and the influence of joints (fractures) on the displacement of the shale strata, the physical simulation is analyzed using three numerical techniques. The first is the "BLOCKS" model that treats the rock strata as an assemblage of blocks. The equations of motion for each block are solved using an explicit integration operator. The displacements, rotations and collisions of each block are calculated in the model. The other two techniques are based on finite element techniques and the previously described "rubble" element. The first finite element model uses an explicit formulation for each joint in the overburden and the second incorporates the joints directly into the element. In the former, the joints are treated as "slip surfaces" and in the latter the joints are formulated in a continuum theory as a "ubiquitous joint" element. The predictions of these analyses agree with the response of the physical model.