Project Summary

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Dynamic Response and Large Deformations

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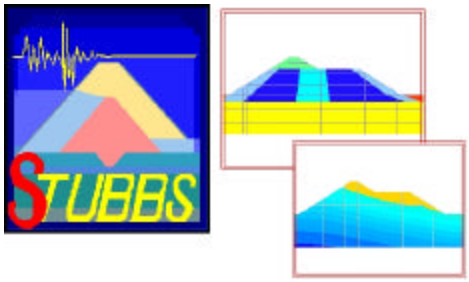
Purpose: To provide a statement of limitations and capabilities of existing codes; to assess those numerical formulations and algorithms that are well suited for analysis of earth- and rock-fill dams; to provide a comprehensive 3-D analysis capability that is well documented, easier to use, easier to maintain, and verified and validated for several cases; and provide guidelines for numerical analysis of dynamic response and large deformations of earth- and rock-fill dams.

Problem: A numerical prediction capability is needed to assess the level of damage the design earthquake ground motions will cause to a dam, and to assess the effectiveness of planned remedial measures. Numerous codes for deformation analysis are being developed and promoted by their authors. These codes suffer from problems such as: 1) many codes are proprietary and inaccessible except by contract, 2) all these codes are difficult to use, and 3) none of the codes has been proven to provide very accurate predictions of large deformations.



Accomplishments: A prototype analysis code was developed covering the full range of features required for analysis of large deformations caused by earthquakes. These features include: 1) time integration scheme for equations of motion, 2) fluid flow equations fully coupled to equations of motion, 3) non-linear constitutive model based on effective stress, 4) constitutive equations for partially saturated flow (to model movement of free water surface), 5) energy-absorbing boundaries, and 6) initialization of static state. The explicit time integration method used to develop prototype code was replaced by robust, implicit time integration. Calibration procedures for the constitutive model were extended to consider number of cycles to liquefaction. Large deformation relationships were fully incorporated into the new time integration scheme. The constitutive model was extended to 3-D large deformation capability. Integrated static and dynamic portions of code with PC-based user interface produced a comprehensive analysis system. A major effort of FY01 was to use the code as a tool to interpret results of centrifuge experiments on liquefaction of deep layers, an exercise that also helped refine the STUBBS model.

Benefits: Accurate prediction of earthquake-induced deformations and damage is the key to making well-informed seismic safety and remediation decisions for embankment dams. This work unit will provide an improved code for making these predictions.

Final Product: STUBBS: Large Deformation Constitutive Model for Comprehensive Analysis Package for Geotechnical Engineering