Project Summary

US Army Engineer
Research and Development Center
Waterways Experiment Station

August 1999

Public Affairs Office Ž 3909 Halls Ferry Road Ž Vicksburg, MS 39180-6199 Ž (601) 634-2504 Ž http://www.wes.army.mil

Pore Pressures and Drainage During CPT

Principal Investigator: Dr. Richard W. Peterson, (601) 634-3737

Technology Challenge: Certain soils, such as silty and sandy soils, do not lend themselves to conventional undisturbed sampling techniques. In situ penetration tests, such as the Cone Penetration Test (CPT), are routinely used to investigate these soils. However, there is an inherent degree of uncertainty in analyses based upon in situ test results. Closed-form solutions for determining the stress-strain and strength characteristics from CPT are generally not available. The effects of pore pressures and drainage on the interpretation of the data have largely been ignored; the result is a mixture of total and effective stress parameters that are dependent on soil type, equipment, and test procedures. A methodology for interpreting in situ penetration test results developed experimentally from comprehensive, full-scale laboratory tests is needed.

Status of Project: Cone penetration tests were conducted in instrumented, back-pressure saturated specimens of silty sand molded in a large stress chamber. Miniature pore pressure transducers and earth pressure cells were embedded in the soil at selected locations as each specimen was molded. The test data indicated that penetration resistance was dependent upon specimen density and the horizontal effective stress. Induced pore pressures were dependent upon time and distance from the penetrometer. On the face of the cone, itself, induced pore pressures were small, i.e., slightly positive, zero, or slightly negative. Within the zone of influence of the expanded cavity, the maximum values of induced pore pressures were relatively large close to the penetrometer but decreased with distance from the penetrometer. When penetration was stopped to monitor the dissipation of the induced pore pressures, pore pressures within the zone of influence of the expanded cavity began to decrease immediately. Along the face of the cone penetrometer, pore pressures increased for a period of time before they decreased.

Interpretation of Test Results: Numerous theoretical models for interpretation of CPT were examined. None of the models addressed the condition of partial drainage. Although little technology is available for interpretation of the CPT in partially drained soils, an explanation of the induced pore pressure phenomena is postulated. As the cavity was expanded due to the insertion of the penetrometer, the soil in the zone of influence surrounding the penetrometer was generally densified, which would explain values of positive induced pore pressures. It is believed that the smaller values of induced pore pressures at the face of the cone itself were likely caused by an averaging effect of the negative induced pore pressures due to intense shearing and dilation of the soil along the

penetrometer plus the positive induced pore pressures in the expanded cavity due to the insertion of the device.

Recommendations: The piezocone penetrometer may not provide a direct measure of the maximum of pore pressures induced during penetration because of shearing of soil along the penetrometer. An approximation of the maximum induced pore pressure at the immediate proximity of the cone penetrometer may be obtained by stopping the penetration test and monitoring the dissipation of induced pore pressures at the CPT. The data should be examined to ensure that 95- to 100 percent of the induced pore pressures have equilibrated before the test is stopped. To interpret the data, the pore pressures should be expressed as a function of the square root of time. The maximum positive induced pore pressure can be estimated by constructing a line through the linear portion of the relationship and extrapolating to time t_0.