

INTRODUCTION

The characterization of the behavior of soil under loading is a complex task. The finite element method has in recent years been a useful tool in analyzing structures, structures on soil and soil-structures. An emphasis has been placed on use of nonlinear plasticity soil models to more accurately capture the soil response. Recent work has focused on effective stress analysis, the ability to not only calculate the soil stress but also to calculate the pore fluid pressure.

The use of an effective stress model has application in analysis of ocean floor soils, nearshore and offshore structures, and in seismic analysis. Oscillations in loading, whether from wave action or seismic shaking, produce a dynamic loading that can induce significant increases in pore pressure. The increase in pore pressure can reduce allowable capacities and increase deformations from a reduction in effective confining stress. Under extreme conditions flow slides and liquefaction occur. Although liquefaction has been identified as a phenomenon for 20 years, soil-mechanics is just beginning to understand the interaction of stress confinement and drainage path, which occurs in the field such as under a foundation or around a pile. For example, common engineering practice in the evaluation of seismically induced soil liquefaction considers level ground conditions away from the structure. Shear stresses from the structure are not considered. Present design guidelines for pile foundations are based on static load considerations.

Recent earthquakes, particularly those in Alaska, Japan, and Chile, have emphasized the high damage threat the soil liquefaction phenomenon poses to waterfront structures. In the 1960 Chilean earthquake (magnitude 7) quay walls, sheet piles, and sea walls were damaged by liquefaction of loose, fine, sandy soils. In the 1964 Alaskan earthquake (magnitude 8.4) severe damage to Anchorage, Cordova, and Valdez occurred including large-scale land slides as a result of liquefaction. Japanese earthquakes (Niigata, 1964, magnitude 7.5; Tokachi-Oki, 1968, magnitude 7.8; Nemuro-Hanto-Oki, 1973, magnitude 7.3; Miyagi-Ken-Oki, 1978, magnitude 7.4) experienced severe waterfront damage to wharfs, bulkheads, quay walls, piers, and conventional structures. The majority of the damage sustained in waterfront areas was primarily from liquefaction of loose, cohesionless sands.

Effective stress techniques are of interest in understanding pile behavior. Pore pressure builds up during the driving process and then dissipates gradually.

This report will document work performed during FY82 investigating use of the effective stress soil model. Funding for this task was obtained jointly from the Navy and the Department of the Interior. Tasks performed include:

1. Development of cyclic degradation function (Contract with Professor Prevost, Princeton University).