SIMULATION OF LATERAL SPREADING OFGENTLY SLOPING LIQUEFIED GROUND

ImanVAEZI
M.Sc., Shahid Beheshti University, Tehran, Iran
me@liquefaction.ir

AliNOORZAD
Assistant Professor, Shahid Beheshti University, Tehran, Iran
a_noorzad@sbu.ac.ir

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ABSTRACT

This paper is focused on the simulation of the lateral spreading phenomenon and the anticipated maximum surface displacements of sloping ground. An innovative numerical methodology is proposed employing a generalized plasticity model implemented in a finite element code (Chan, 1988)which has been thoroughly validated against VELACS centrifuge liquefaction experiments (Arulanandan and Scott, 1993). The results of numerical analysis compared with experimental measurements indicate that the proposed numerical model has the capability to simulate the lateral spreading phenomenon.Then this model has been used to find out the effect of frequency of input motion on the magnitude of soil displacement. The results demonstrate that the amount of maximum displacement is significantly decreased by increasing the magnitude of frequency.

INTRODUCTION

The lateral movement of a liquefiable layer on gently slopes is the most visible and devastating type of liquefaction-induced ground failure. Occurrence of liquefaction in sloping ground causes large deformations on ground surface, which may lead to several meters in some cases. Recent earthquakes have shown that this phenomenon causes severe damages to coastal structures, piers of bridges and life-lines, by exerting large lateral forces.Fortunately, there exist methods today which can be used for the design of such structures against lateral spreading (e.g. P-y analysis). However, their accuracy depends greatly on the ability to estimate the anticipated lateral ground displacements and their variation with depth.

NUMERICAL METHODOLOGY

In this research, a fully coupled two-dimensional dynamic analysis based on effective stress formulation using saturated porous media considering fluid movement has been used to simulate the lateral spreading and evaluate the amount of deformations occurred in liquefiable soils(Zienkiewicz et al., 1999). The governing equations are developed for saturated porous media based on the extension of Biot formulation(Biot, 1955, 1956). The cyclic elastoplastic behavior of soil under earthquake loading is modeled using the generalized plasticity theory composing of a yield surface together with non-associated flow rule proposed by Pastor and Zienkiewicz (Pastor et al., 1990).A fully explicit dynamic finite element method and a fully coupled (u-w) formulation are employed in a computer code to analyze soil displacements and pore water pressures(Taslimian et al., 2012).