Amirkabir University of Technology
(Tehran Polytechnic)
Vol. 45, No. 2, Winter 2013, pp. 21-23

Amirkabir Journal of Science & Research (Civil & Environmental Engineering)
(AJSR - CEE)

Experiments on the Instability of Loose Sandy Slopes Due to Rise in Water Level

V. Masoumifard[1], S. M. R. Imam [2*], R. Rasouli[3]

1 - M.Sc Student, Department of Civil and Environmental Engineering, Amirkabir University of Technology, Tehran, Iran
2- Assistant Professor, Department of Civil and Environmental Engineering, Amirkabir University of Technology, Tehran, Iran
3- M.Sc Student, Department of Civil and Environmental Engineering, Amirkabir University of Technology, Tehran, Iran

(Received 06 Feb 2010; Accepted 07 Apr 2013)

ABSTRACT

In a soil mass, a rise in pore water pressure leads to a decrease in the mean effective normal stresses, while the vertical loads due to surcharge may experience small changes. Under such loading, very loose and loose sands may initially experience small volumetric expansion, and then start to contract significantly as failure is approached. These large contractions can lead to the increase in pore water pressure and, consequently, failure of the soil mass under poor drainage conditions. In this paper, an experimental model is used to examine slope instability resulting from rise in water level. It was noticed that the main factor controlling the mode of failure was initial density, but other factors such as method of increase in pore pressure, distribution of pore pressure, and geometry of the test tank also influenced failures.

KEYWORDS

Static liquefaction, Flow Slide, Pore Pressure, Embankment Failure, Slope Instability

* Corresponding Author, Email: rezaimam@gmail.com

1- BRIEF INTRODUCTION

Failures of slopes made of loose granular soils due to rise in water level may be attributed to one or a combination of different mechanisms. One mechanism is the decrease in soil shear strength due to saturation and loss of suction in the unsaturated soil, leading to instability at the current slope angle, and subsequent stabilization at a milder slope. Another possible cause is related to the tendency of very loose granular soils for contraction when subjected certain stress paths involving decrease in mean effective stress, Very loose granular soils have been observed to experience substantial contractions when subjected to loading with constant, or near constant shear (deviatoric) stress, but with decreasing mean effective normal stress. Previous laboratory tests have shown that in such cases, substantial volume contractions may initiate at stress states corresponding to mobilized friction angles well below failure. Such volume contractions observed in drained loading can result in the development of excess pore pressures in undrained or semi-drained loadings, if drainage path is long enough, or soil permeability is low enough, resulting in loss of shear strength of the soil and failure of the slope. If the rate of rise in water level is high, especially in laboratory model testing, seepage forces may also initiate slope instability. In natural slopes made of loose granular soils, other mechanisms such as dissolution of cementations may also be responsible for loss of shear strength and slope failure when water level within the slope rises.

2- METHODOLOGY

In the current paper, experiments on the failure of slopes resulting from rise in water level are described. Some aspect of the design of the test tank such as the method of introduction of water into the tank and then into the soil slope tested, separation of the soil tested from the coarser grain filter material, effects of boundary conditions, rate of rise of water level, etc. are discussed.

3- MAIN CONTRIBUTIONS

Observations on the tests carried out on slopes made of a local, very loose, fine sand in the tank built are then described. The tests were carried out on slopes made of moist-tamped, very loose sands and showed that such slopes fail as a result of rise in water level and stabilize at slope angles substantially lower than those at which the original slope was made. It was also noticed that final slope at which the sand stabilizes also depends on the time rate of the rise in water level. Possible causes of the slope failures are discussed based on the observations made during testing.

4- SIMULATION RESULTS

The following sample figure shows the status of the slope after collapse resulting from rise in water level. The post-failure slope angle is about 25 degrees which is substantially lower than the angle of repose of the sand, estimated at about 34 degrees, indicating the effects of various mechanisms on the failure of the slopes.

5- MAIN REFERENCES

[1] Eckersley, J. D.. "Instrumented laboratory flow slides", Geotechnique 40, No. 3, 489-502, 1990.

[2] Imam, S. M. R., Morgenstren, N. R., Robertson, P. K., and Chen, D. H. a. "Yielding and flow liquefaction of loose sand", Soils and Foundations, 42(3): 19-31, 2002.