SHEAR BEHAVIOUR OF SATURATED SANDS WITHIN SHEAR ZONE OF RING-SHEAR TESTS UNDER NATURALLY DRAINED CONDITION

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1.INTRODUCTION

Landslides in which an initial rock slide or earth slide is, at least partially, showing the liquidized flow-type motion associated with the liquefaction diagnostic are very intricate and difficult phenomena confronting the geotechnical engineers. Flow-type landslides are generally characterized by high mobility and long run-out distance which are far beyond that expected, followed by a great damages of serious losses of lives and properties. With the progress of regional development into unstable hillside areas under the pressure of expanding population and urbanization, the responsibility of landslide hazards on the socioeconomic aspects has been considerably enlarged. In order to study the high speed long run-out motion of liquidized flow-type landslides, the shear behaviour of saturated sandy soils is examined, employing an intelligent type ring-shear test apparatus. This study is especially focused on the excess pore pressure generation/dissipation in the shear zone under the naturally drained condition (drainage valves of shear-box are open).

In order to examine the influences of normal stress acting on the sliding surface and shear speed on the reduction of shear resistance subjected to large shear displacement (60 m), two series of ring shear test are conducted. The first series are conducted under the different total normal stresses (from about 50 kPa through 470 kPa) by the same shear speed. The second series are conducted with the different shear speeds (from about 3 mm/sec through 100 mm/sec) under the same total normal stress of about 470 kPa. The change in bulk permeability (permeability of the specimens in the shear box of ring-shear test apparatus) before and after the shearing is examined by giving head pressure to the specimens. The change in grain size distribution is also examined by taking the specimen from the shear zone after shearing. In this paper, authors proposed the new index “potential for rapid flow phenomena (P_f)” as the ratio of coefficient of internal friction during motion (ϕ_m) to coefficient of apparent friction (ϕ_a), to express the extent of liquidization of soils.

2.SAMPLE

Two kinds of specimen material of quite different grain crushing susceptibility are used in this study. One is weathered granitic sands taken from the source area of a typical liquidized landslide in Japan with large grain crushing susceptibility, consisting mainly of 77 percent of quartz, and 23 percent of feldspar, the grains being angular with D_{50} = 1.2 mm, Uc = 3.4, Gs = 2.61. The other is fine silica sands with comparatively small susceptibility to grain crushing, consisting of 92 to 98 percent of quartz and a little amount of feldspar, the grains being angular with D_{50} = 0.048 mm, Uc = 2.8, Gs = 2.63.

3.EXPERIMENTAL RESULTS and ANALYSIS

3.1 Test Results of Silica Sand Sample

In the naturally drained ring shear tests on the saturated silica sand specimen, no reduction of shearing resistance during shearing up to 60 m shear displacement were observed in this study, in which total normal stress ranged from 50 kPa through 470 kPa and shear speed 3 mm/sec through 100 mm/sec. The change in bulk permeability before and after shearing was at most one-order, and very small change in grain size distribution was observed to explain that little grain crushing was caused within the shear zone. The obtained P_f values are almost the same as unity in any tests.

3.2 Test Results of Weathered Granitic Sands Sample

3.2.1 Effect of Total Normal Stress

The greater reduction of shearing resistance during shearing was observed in accordance with total normal stress. A test with largest total normal stress of 470 kPa, the minimum apparent friction angle mobilized was as small as 6 degrees, which, probably, should be considered flow-like motion different from sliding one. The change in bulk permeability was as great as three-order to show the formation of the less-permeable shear zone. Great amount of grain crushing and large P_f values are obtained in sequence with total normal stress.

3.2.2 Effect of Shear Speed

As found in the results above, the shear resistance decreased its value in agreement with shear speed to show flow-like motion. The great change in bulk permeability (approximately four-order) and grain size distribution, and large P_f were observed. These results explained that the greater total normal stress or shear speed produced the larger excess pore pressure generation rate within shear zone due to grain crushing than the dissipation rate which was lowered by the formation of resulting less-permeable shear zone. It could be inferred that, once a large landslide gets a high mobility, the landslide could keep the reduced shearing resistance to accelerate it flowing down a long distance.

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