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Modeling of rainfall induced slope failure using geocentrifuge

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Rainfall induces slope failure and debris flow which are considered as one of the major natural disasters. The scope of such failure is very large and it cannot be studied easily in the laboratory. Traditionally, small scale model tests are used to study such problem. Knowing that the behavior of soil is affected by the stress level, centrifuge modeling technique has been used to simulate more realistically full scale earth structures.

In this study, two series of tests were conducted on slopes under the centrifugal field with and without the presence of rainfall. The soil used was a mixture of sand and 15 percent fines. The slopes of angle 60 degrees were prepared at optimum water content in order to achieve the maximum density. In the first series of tests, three different slope heights of 10 cm, 15 cm and 20 cm were used. The gravity was increased gradually until slope failure in order to obtain the prototype failure height. The slope model was cut after the test in order to obtain the configuration of failure surface. It was found that the slope geometry normalized by the height at failure provided unique results.

Knowing the slope height or gravity at failure, the second series of tests with rainfall were conducted slightly below the critical height. That is, after attaining the desired gravity, the rainfall was induced in the centrifuge. Special nozzles were used and calibrated against different levels of gravity in order to obtain desired rainfall intensity. Five different rainfall intensities were used on the 15-cm slopes at 80g and 60g, which corresponded to 12 m and 9 m slope height, respectively. The duration until failure for different rainfall intensities was obtained. Similar to the first series of tests, the slope model was cut and investigated after the test. The results showed that the failure

surface was not significantly affected by the rainfall. That is, the excess pore pressure induced by rainfall generated slope failure.

The prediction curves of rainfall intensity versus duration were obtained from the test results. Such curves are extremely useful for disaster management. This study indicated feasibilities of using centrifuge modeling technique in simulating rainfall induced slope failure. The results obtained may also be used for validating numerical tools.