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Determination of strength behaviour of slope supported by vegetated crib walls using centrifuge model testing

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The crib retaining structures made of wooden/bamboo logs with live plants inside are called vegetative crib walls which are now becoming popular due to their advantages over conventional civil engineering walls. Conventionally, wooden crib walls were dimensioned based on past experiences. At present, there are several guidelines and design standards for machine finished wooden crib walls, but only few guidelines for the design and construction of vegetative log crib walls are available which are generally not sufficient for an economic engineering design of such walls. Analytical methods are generally used to determine the strength of vegetated crib retaining walls. The crib construction is analysed statically by satisfying the condition of static equilibrium with acceptable level of safety. The crib wall system is checked for internal and external stability using conventional monolithic and silo theories.

Due to limitations of available theories, the exact calculation of the strength of vegetated wooden/bamboo crib wall cannot be made in static calculation. Therefore, experimental measurements are generally done to verify the static analysis. In this work, a model crib construction (1:20) made of bamboo elements is tested in the centrifuge machine to determine the strength behaviour of the slope supported by vegetated crib retaining wall.

A geotechnical centrifuge is used to conduct model tests to study geotechnical problems such as the strength, stiffness and bearing capacity of different structures, settlement of embankments, stability of slopes, earth retaining structures etc. Centrifuge model testing is particularly well suited to modelling geotechnical events because the increase in gravitational force creates stresses in the model that are equivalent to the much larger prototype and hence ensures that the mechanisms of ground movements observed in the tests are realistic. Centrifuge model testing provides data to improve our understanding of basic mechanisms of deformation and failure and provides benchmarks useful for verification of numerical models. In this case this test is mainly carried out to verify the stability analysis and deformation characteristics of a bamboo crib wall.

Models of crib wall of dimensions 37x13x10 cm and 37x13x14cm were placed inside a Plexiglas box of internal dimensions of 42.5x42.5x30 cm and slope was formed leaving a space about 10 cm in the front. The model crib wall tests were all performed at 40-70 times earth's gravity. This means that the 5 mm diameters bamboo rods in model used represents a prototype diameter of 20-35 cm. The horizontal and vertical displacements were measured with the help of three displacements sensor fixed horizontally and one sensor fixed vertically at the top of the model crib wall.

All together nine tests were carried out with varying model parameters. Standard medium sand and coarse sand were used as fill material in the testing. Two wall heights variations and three slopes variations were used in the testing. The test model was constructed either compacted or uncompacted. The compaction in the model was carried out by hand to about 90% of the Proctor density. Three slopes inclinations were used. For flat slope the slope angle was less than 25°, and for steep slope it was 25°-35° and for extremely steep slope it was $> 35°$. The test results and conclusions are presented in this paper.