

Abstract

Effect of Unsaturated Soil Properties on Piping Susceptibility in Water Retaining Structures

Background

This research focuses on the Herbert Hoover Dike (HHD) and the soil it was built with. The HHD is a 143 mile earthen dam in South Florida around Lake Okeechobee. It was constructed in the 1920s by the United States Army Corps of Engineers (USACE) after thousands in the area were killed in a flood. It has been under various repairs since 2001 and USACE has invested 1.4 billion to make improvements to the seepage barriers (cutoff walls) and the water control structures (culverts). This is because the original dam was built on coarse grained materials including gravel, rock, limestone, sand, and shells, which are very erodible materials. Climate models have suggested that climate change will cause an increase in lake levels and will expose the unsaturated soil of the embankment which could cause potential failure through piping and erosion. The completed research will help to fill the gap of knowledge about the susceptibility of such materials to piping and erodibility.

Methodology

This research will consist of two experiments with the soil samples taken from the dike. The first test is the filter paper test for characterizing the soil water characteristic curve (SWCC). The curve describes the relationship between the matric suction and water content of unsaturated soils. This information is needed to analyze seepage, erosion, and volume change problems with the soil. To perform this experiment, a direct contact between the filter paper and the soil sample is obtained. Water will transfer from the soil sample to the dry filter paper during a minimum period of seven days. The filter paper can then be weighed to determine its moisture content and therefore the matric suction which will be equal to that of the soil. By testing multiple samples at different drying periods, a drying curve can be obtained.

The second experiment is the small scale piping model. This experiment is performed to correlate piping susceptibility with the SWCC. A Plexiglass box will be constructed with two compartments. One compartment is for water to keep a constant head and the other will be for the soil. A pipe will be inserted in the middle of the soil, packed down, and the pipe will then be removed to leave behind a hole. The water will be released and allowed to run through the hole and the effects of the water on the soil will be recorded with a camera.

Progress

Currently, we have submitted orders for the supplies needed in both the filter paper test and the small scale piping model experiments. Once we have received the purchased items, the box can be built. Bill Russo who is a lab manager on campus will be building the box for us. A site trip to the dike is set in order to view the area and visit the nearby quarry where we will be collecting buckets of the soil needed for the experiments. During these trips, we will also be meeting with one of the engineers who works on the dike, in order to gather more information.

Updated Progress

To this point we have purchased the supplies required for the filter paper tests and small scale piping model experiment. We took a trip to the Herbert Hoover Dike and visited the engineers from the Army Corps of Engineers that are working on the dike repairs. During this trip to Lake Okeechobee, we collected 10 buckets of soil from a nearby quarry, which will be used to complete our future experiments. This soil is close to the exact soil being used on the HHD project. In addition, we were given soil samples from the site by the representatives of the USACE. All collected samples from both the quarry and the site itself have been placed in the civil engineering laboratory. With the collected soil samples, we have performed initial index testing, including a sieve analysis test in order to determine the size distribution and we have begun to prepare for specific gravity, hydraulic conductivity, compaction and a direct shear test. All index tests are to be completed prior to our filter paper testing which will occur soon given our recent collection of the ordered items, and then the final experiment will be the small-scale piping experiment.