Research on Unsaturated Test of Residual Clay in Southeast Coast

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Abstract: Typhoon rainfall is the main inducing factor of landslide disasters in Fujian Province. Rainfall infiltration causes changes in dynamic parameters such as water content of slope rock and soil and surface displacement. The disaster process of landslide disaster has the characteristics of rapid occurrence, short process, and no obvious signs of deformation, so it is difficult to pre-determine the hazard body. Original samples of residual cohesive soil were sampled on site, and an indoor unsaturated strength test was carried out. The influence of changes in moisture content caused by rainfall on the strength characteristics of residual cohesive soil was analyzed. The test results showed that the shear strength of the disabled cohesive soil varies with the strength characteristics of the residual cohesive soil. It differs depending on the water content. The smaller the water content, the greater the matrix suction of the soil, and the greater the shear strength, which is of great significance for subsequent studies on the mechanism of landslide hazards.

1. Introduction
Typhoon rainfall is the main inducing factor of landslide disasters in Fujian Province. In particular, mass landslide disasters are triggered by typhoon and rain. Mass landslide disasters are the product of the coupling of geological and meteorological factors. The duration of heavy rain, continuous rainfall, and rainfall history factors such as rainfall intensity and rainfall intensity have a significant positive correlation. Rainfall infiltration causes changes in dynamic parameters such as water content, osmotic pressure, and surface displacement of the deformed slope and their mutual influences are implicitly related. In terms of temporal and spatial distribution, typhoon seasons are characterized by high frequency and mass occurrence, and a large number of disasters occur in a relatively short time and in a certain area. At the same time, the disaster process has the characteristics of rapid occurrence, short process, and no obvious signs of deformation. Therefore, it is difficult to pre-determine the hidden hazards of disasters, or there are too many hidden hazards. At present, there are no effective scientific and technological methods to determine the hazards of each hazard. As a result, it is difficult to grasp the timing of the transfer, and there are too many people to transfer and avoid danger. Long, high cost,
difficult work, and even affect the normal production and life of the people. Therefore, an in-depth study of the mechanism of the instability of hidden hazards caused by typhoons and rains can provide a theoretical basis for disaster prevention and mitigation, and minimize casualties and reduce economic losses.

The physical model test of landslide simulation is an important means to reveal the mechanism of landslides. There are quite a lot of experimental studies on landslide simulation at home and abroad, which not only helps people understand the mechanism of landslide occurrence, but also can obtain new enlightenment from landslide research.

The field test is the test that best reflects the actual situation, but it is also the most expensive. If the test slope is damaged, it may even endanger the casualties of the on-site personnel. For example, in the field test in Kawasaki (Kawasaki) of Japan in 1971, the test slope suffered rapid slippage damage, which exceeded the pre-estimated impact range, affecting the people present and causing a major casualty accident involving 15 deaths of technicians and photojournalists. The accident also stagnated Japan's research on field landslide tests until 1985, when Yagi and others restarted relevant research.

In recent years, in order to further study the mechanism of rainfall-induced landslides, a large number of field tests and full-scale tests have also been carried out. Cai Zhengyin et al. [1-3] conducted full-scale model tests of rainfall-induced landslides using variable slope test tanks. The changes in pore water pressure in the soil body were measured and discussed. Liu et al. [4] conducted full-scale test studies on flow-type landslides. The test results showed that the rise of pore water pressure of the slope is an important cause of landslides, and the soil compression after sliding. The soil under the slope compresses the soil skeleton and generates excess pore water pressure. Zhao dongsheng et al. [5-7] conducted artificial rainfall tests on expansive soil slopes in Zaoyang, Hubei and conducted in-situ monitoring, which also enabled people to have a better understanding of the impact of rainfall infiltration on slopes. Ochiai et al. (2004) conducted a field simulation of a mobile landslide. Observations on the field showed that the landslide process first slipped, then flowed, and finally developed into a debris flow, which flowed for 50m in 17s.

2. Test methods and test equipment

2.1 Test method
The soil sample is cut into a sample with a diameter of 7cm and a height of 14cm, and the initial water content is measured. After the sample is installed, the initial water content of the sample is changed by back pressure, and the stress path test is performed after reaching the predetermined water content.

Figure 1. Test sample
2.2 Test equipment
This test uses the latest unsaturated soil stress path test equipment of WF Company. This instrument can realize stress path test of saturated soil, shear test (stress control and strain control type), stress path test of unsaturated soil, shear test of unsaturated soil, etc. The pore pressure, air pressure and confining pressure can be automatically controlled by computer, data can be collected automatically, and the pressure can be accurately controlled with an accuracy of less than 1kPa. The confining pressure control range is 2000kPa, the air pressure is 2000 kPa, the back pressure is 1500 kPa, and the air intake value is high. The clay plate reaches 1500 kPa, which meets the pressure required by the test. (Left to right: computer, pressure chamber, water pressure controller, volume change controller, servo controller and sensor for controlling and collecting data)

3. Unsaturated soil variable water content strength test

3.1 Test process
Saturate the ceramic plate and not install the sample, close the valves of the pressure chamber, and fill the pressure chamber with airless water. Then open the drain valve of the pressure chamber and apply a pressure of 300~400kPa until more water is discharged from the drain valve to flush the bubbles collected under the ceramic plate, open the flush valve, and let airless water flow through the spiral groove under the ceramic plate to rinse For 30 seconds, close the flush valve. Load the test piece with a moisture content of 5%, turn on the computer, open the drain valve, and apply a 5kPa confining pressure (σ3). After the test deformation is stable and the drainage is stable, record the corresponding values, and use them as the zero point of deformation and drainage. Simultaneously apply the same amount of confining pressure and air pressure to the predetermined suction value, keeping the difference between the two at 5kPa, until the deformation and drainage are stable. The standard of stability is: body deformation does not exceed 0.01cm3 for 2 hours continuously, and drainage does not exceed 0.01cm3 for 2 hours continuously, and the duration is not less than 48 hours. Apply the first level of confining pressure to make (σ3-ua) equal to the predetermined value until drainage and deformation are stable. After the specimen is consolidated, start shearing, select the shear speed, the general axial strain rate is 0.0022~0.003mm/min, until the peak of (σ1-σ3)-εa curve appears. During the shearing process, flush the air at the bottom of the ceramic plate every 8-10 hours. After the specimen is damaged, the next level of load is applied. Under confining pressures of 100, 200, 300, and 400 kPa, the consolidation drainage test was carried out to control and measure the matrix suction, and the relationship between the adsorption strength of the unsaturated soil and the matrix suction, water content, and saturation was obtained.

Figure 2. Test equipment
3.2 Typical test curve
In the strength test of unsaturated soil under the condition of controlling the suction of the matrix, that is, the water content, the typical test curve obtained is shown in Figure 3.

![Unsaturated soil triaxial test curve (Vertical compressive stress 200kPa)](image)

Figure 3. Unsaturated soil triaxial test curve (Vertical compressive stress 200kPa)

4. Unsaturated soil strength test results
According to the results of this experiment, the extended Mohr-Coulomb failure envelope is sorted out, as shown in Figure 6-15. The shear strength of unsaturated soil is higher than that of saturated soil. Due to the adsorption friction in the framework of unsaturated cohesive soil, its value is not affected by the applied stress, but is greatly affected by the suction of the soil matrix. It increases with the increase of matrix suction. For unsaturated soil with different water content, although the internal friction angle of the soil is almost the same, the cohesion is very different. That is to say, the shear strength of the soil varies with the water content. The smaller the water content, the greater the matrix suction of the soil, and the greater the shear strength. Conversely, the greater the water content, the smaller the matrix suction of the soil, and the smaller the shear strength. When the water content becomes saturated, its value decreases rapidly and gradually approaches the strength value of saturated soil.
5. Conclusion
The indoor soil physical and mechanical properties test of typical residual cohesive soil samples and the unsaturated soil test under the dry-wet cycle are used to obtain the change law of the internal water content of the slope under the control of the heavy rainfall process and the cumulative deformation effect of the internal slope caused by the process. Unsaturated soil test results show that the shear strength of residual cohesive soil varies with water content. The smaller the water content, the greater the matrix suction of the soil, and the greater the shear strength. It is useful for subsequent studies on the mechanism of landslide disasters.

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