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The Influence of Law of Freeze -thaw Cycles for the Strength Parameter of Intact Loess

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Key words：freeze-thaw; Intact loess; strength parameter; triaxial shear test; stress characters

Abstract：At present, the research is not enough for the correlation of loess strength parameter and freeze-thaw cycles in domestic.The paper aims how the change of freeze-thaw cycles influence the stress characters of intact loess by consolidated drained triaxial shear test for the Shanxi loess.The results showed that: the strength parameter of intact loess decreases with the increasing of freeze-thaw cycle.The reduce of strength parameter c is obvious with the increasing freeze-thaw cycles. The reduce of strength parameter j is not obvious with the increasing freeze-thaw cycles.

Introduction

The main reason for the change of soil mechanical properties by freezing and thawing is the change of soil structure, which is the connection force between soil particles and the rearrangement of soil particles. The influence of freeze-thaw on the engineering properties of soil can be roughly analyzed from two aspects: the soil water properties, the physical properties and the soil mechanical properties. Jiang Zong-bin et al[1] think that under the same times of freezing-thawing cycles，shear strength increases with increasing of confining pressure. Under the sameconfining pressure，internal frictional angle，cohesive strengthand shear strength present the tendency of reducing first and thenincreasing with the increase of the times of freezing-thawing cycles，however moisture content presents the tendency of increasing first then reducing with the increase of the times of freezing-thawing cycles. The turning point is about in the position of 7times. Wang Jing et al[2] think that the elastic modulus increases with confining pressure increase for the same kind of soil under the same freeze-thaw cycles.Elastic modulus with the same confining pressure decreases with the of freeze-thaw cycles; Under the same confining pressure and the same freeze-thaw cycles, elastic modulus increases with the plasticity index. The exponential function is adopted for multiplenonlinear fitting. The relationship between elastic modulus and confining pressure, plasticity index, freeze-thaw cycles is obtained and shows a good correlation. Bi Gui-quan et al[3] think that At the end of freeze-thaw cycle, there was a small settlement in samples, which resulted probably from soil particle rearrangement caused by strong freezing and thawing action. In addition, freezing and thawing actions decreased gradually the dry density of loess samples. The dry density in upper part was larger than that in bottom part.The studies showed that: the freezing thawing cycles can lead to the engineering properties of

the soil great changes, which lead to deformation and even instability of engineering facilities in cold areas. However, for the law of strength parameter and freeze-thaw, there is rare research on the intact loess [4]-[11].

The conventional static triaxial tests are the commonly methods to study the strength characteristics.With the help of consolidated drained triaxial tests to research the characteristics of intact loess for different freeze-thaw cycle. The research have certain theoretical significance for the study of loess freeze-thaw characteristics. At the same time, it provides reference for the future research of loess structural and strength.

The loess of test

The loess of tests is taken from certain foundation at the Jinnan district, in a depth of 4m below the surface, which is brownish yellow, silty clay, soil evenly, with a small amount of worm holes. The soil samples have been whittled to length 30cm~45cm cube in the field,with the plastic wrapped well and indicated the vertical direction, transported back to the laboratory. The natural moisture content of soil samples was 9.8%.

Test Instruments and Test Method

Test Instruments

The test instrument is the conventional triaxial shear apparatu. The pressure will directly load to the roof through counterproductive of fixed beam gantry, The steel ring and pressure sensor will measure pressure.

The test instrument of freeze-thaw is the constant temperature and humidity box which is produced by a instrument factory of nanjing. The temperature control precision is higher.

Test Method

Prepare four group intact triaxial specimen (diameter 3.91cm, height 8cm). Adjust the freezing temperature (minus twenty degrees), record the time, after 12 hours, adjust the temperature (thaw temperature is 5 degrees), start the thawing stage, after 12 hours, take out the soil sample and carry out the three axis test. The number of freeze-thaw cycles was 1 times, 2 times, 4 times and 8 times.Configure pressure was separate 100 kPa, 200 kPa, 400 kPa for consolidated drained shear test of Each group sample(the number is four); specimen installed before applying confining pressure, open the drain valve to consolidation, start motor to cut after the end of consolidation. The final shutdown standard is to see the soil samples which have obvious cracks or dislocation or axial deformation reaches 12mm.

Test Results and Analysis

The influence of cycle times on strength characteristics of intact loess

According to formula 1:

$$t = c + s \tan f \qquad (1)$$

The law of intact loess shear strength changing with freeze-thaw cycles is indicated in figures 1 to 4:

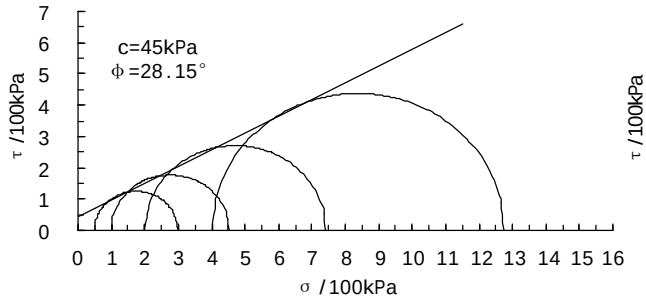


Figure 1. Shear strength lines for cycle times 1

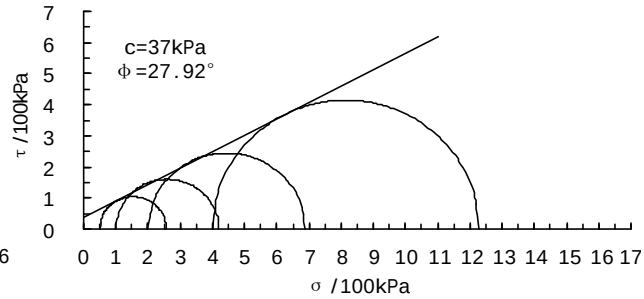


Figure 2. Shear strength lines for cycle times 2

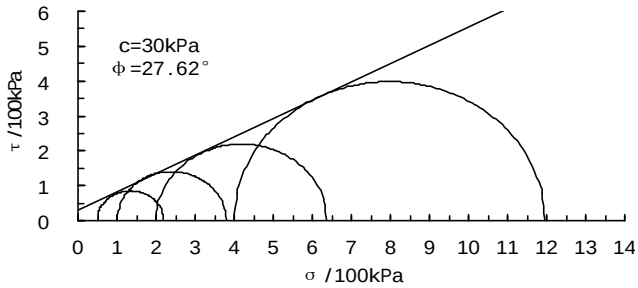


Figure 3. Shear strength lines for cycle times 4

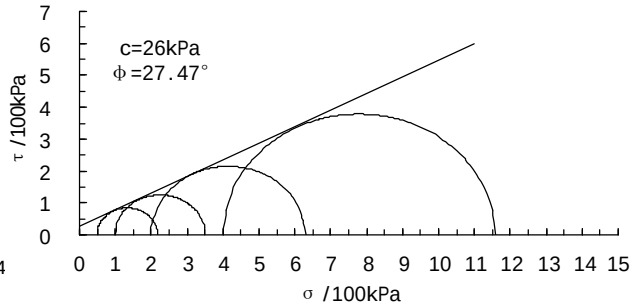
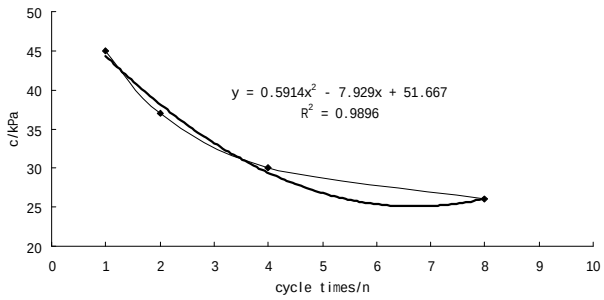


Figure 4. Shear strength lines for cycle times 8

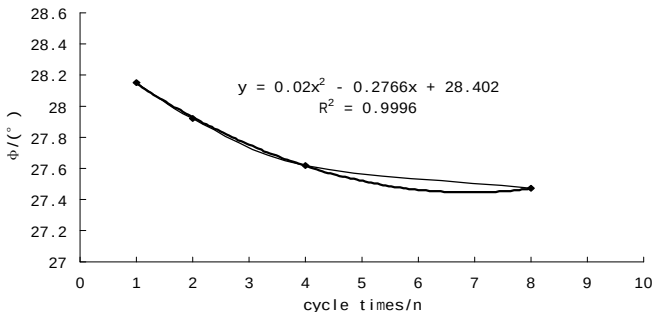
Figure 1-4 show that the strength parameter of intact loess decreases with the increasing of freeze-thaw cycles.

The law of strength parameter changing with freeze-thaw cycles for intact loess

The law of intact loess strength parameter under different freeze-thaw cycles is indicated in figures 5:



（a）Parameter c



（b）Parameter *j*

Figure 5. Relationship between strength parameter and freeze-thaw cycle times

Figure 5 show that with the increase of freeze-thaw cycles, the strength reduce. The reduce of strength parameter c is obvious with the increasing freeze-thaw cycles. The reduce of strength parameter *j* is not obvious with the increasing freeze-thaw cycles.

According to Figure 5,the relationship of strength parameter and freeze-thaw cycles can be converted to the following formula:

$$c = 0.5914n^2 - 7.929n + 51.667 \quad (2)$$

$$f = 0.02n^2 - 0.2766n + 28.402 \quad (3)$$

According to formula 2, formula 3, to predict the strength parameter for certain freeze-thaw cycles, have some theoretical significance for the relation research.

Conclusions

In this paper, conventional triaxial test apparatus and the constant temperature and humidity box is applied to study the strength parameter of intact loess under different freeze-thaw cycles. The main conclusions are as follows:

(1) the strength parameter of intact loess decreases with the increasing of freeze-thaw cycles.

(2) The reduce of strength parameter c is obvious with the increasing freeze-thaw cycles. The reduce of strength parameter j is not obvious with the increasing freeze-thaw cycles.

Acknowledgements

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