Study on creep characteristics of unsaturated sericite schist residual soils

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Abstract. Sericite schist is an extremely soft rock, which is characterized by obvious rheological properties and large creep deformation. The residual soil of Sericite schist is in unsaturated state for most of the time. When encountering water, it interacts with water, which has a great influence on its strength. In this paper, one dimension and three axis creep tests of Sericite schist residual soil are carried out by using unsaturated quadruple consolidation apparatus and unsaturated triaxial creep apparatus. The results show that the creep process of the residual soil can be divided into three stages: rapid growth stage, slow growth stage and stable stage. The creep deformation of triaxial test is larger than that of one dimension.

1. Research background
Creep of soil refers to the phenomenon that the deformation of soil increases with the increase of time. Creep behavior of soil has a great impact on engineering. For example, in practical engineering, the stability of foundation settlement slope has a great influence on tunnel construction deformation, and the compressive strength of Sericite schist residual soil is low, and affected by rainfall and groundwater, the unsaturated characteristics are obvious, which has a significant impact on its long-term use. It has obvious rheological properties, large creep deformation, and there is a complex relationship between creep and particle size, which has an important impact on engineering performance. It is necessary to study on the creep characteristics of unsaturated soil creep property research, especially the analysis of the stress. The relationship between deformation and time is a hot topic at home and abroad. Since the international conference on soil mechanics and foundation held after 1953, the research on unsaturated creep characteristics has been widely concerned[1].

Wang Kai etal[2] carried out triaxial creep test on Nanping tunnel landslide slip zone soil. It was found that the creep characteristics of this kind of clay can be described by Xi yuan model. The long-term strength of soil can be obtained by using superposition principle and isochronous curve method. The creep parameters increase with the increase of confining pressure, and the extent of long-term strength decreasing with the increase of confining pressure also increases. Jamel kamoun etal[3] carried out triaxial creep tests on disturbed soil samples with different saturations. The test results show that under the fixed stress level, the initial saturation degree and the second invariant of strain tensor have similar change trend, and the change of axial creep strain is semi logarithmic function with time.Bhat D. R et al[4] studied the residual strength of cohesive soil on the sliding surface of landslide. The test results show that creep failure starts only when the applied shear stress (i.e. creep...
stress) is greater than the residual strength, and there is no creep effect on or below the residual strength. Taking sericite schist eluvial soil as the research object, the one-dimensional creep test and triaxial creep test under different conditions were carried out in this paper, and the unsaturated creep characteristics of sericite were studied, which provided theoretical guidance for the development of practical engineering.

2. Test soil sample and physical and mechanical parameters
The test material is from the residual soil of Sericite schist of Dalin railway in Yunnan Province, which is gray and belongs to the lower Paleozoic Lancang group sericite, sericite quartz schist and carbonaceous sericite belt. Affected by the structure and weathering, the rock is seriously broken and highly weathered, forming a large number of residual soil as shown in Figure 1. The basic physical property test is carried out, and the test results are shown in Table 1.

Figure 1. Residual soil of Sericite schist.

| Table 1. Physical parameters of Sericite Schist eluvial soils. |
|---------------------------------------------------------------|
| specific gravity (Gs) | liquid limit (%) | plastic limit (%) | plasticity index (Ip) | maximum dry density (g·cm⁻³) |
| 2.76 | 20.35 | 8.15 | 12.20 | 2.10 |

3. One dimensional creep deformation characteristics
3.1. Experimental method
Silk mica schist eluvial soil moisture content had obvious effects on the deformation, the existence of the matrix suction has a great influence on the structure of silk mica schist one-dimensional creep deformation mechanism of the residual soil, using FGI - 20 unsaturated quadruple consolidation apparatus for the control matrix suction of creep test according to take a certain quality of soil, equipped with the moisture content of 10% soil samples, let stand for 24 h using the standby system soil mould, will be made 6.18 cm 2 cm soil sample soil sample tests, the control matrix suction respectively 0, 50, 100 200 kpa, A one-dimensional creep test was carried out for the net vertical stress of 50, 100, 200, 300KPa.

3.2. Test results and analysis
Through unsaturated one-dimensional creep test, the relation between axial displacement variation with time is shown in Figure 2 can be seen from the figure 2, the creep curve of silk mica schist eluvial soil can be roughly divided into three stages: the first stage for the rapid growth stage, this stage deformation is growing rapidly, mainly concentrated in 0 ~ 300 min, and at this stage the rate of change of as net increase with the increase of the vertical stress, but the existence of matrix suction, will reduce the rate of change; The second stage will be a slow growth stage, which mainly focuses on 300~3500min. The deformation quantity in this stage continues to increase, but the growth rate is slower than that in the first stage. Third stage to stable stage, the creep deformation with time growth growth area net steady state when the vertical force is the same, with the increase of matrix suction, the axial deformation decreased, the increase of the matrix suction can reduce spun silk mica schist of eluvial soil creep deformation from Figure 2 can see clearly that creep deformation with net increase with the increase of the vertical stress.
4. Unsaturated triaxial creep test

The unsaturated triaxial compression test for controlling the matrix suction and the net normal pressure was carried out using an unsaturated triaxial creeper manufactured by Yongchang, Jiangsu Province. The instrument consists of a table piece, a loading part, a sample pressure chamber, a pressure chamber control cabinet, and a data acquisition system. Pore gas pressure = 0-500KPa, sensor measurement accuracy error is 0.2% FS; pore water pressure = -50-1000KPa, measurement accuracy error is 0.2% FS; volume change $\Delta V = 0-50cm^3$, accuracy error is 0.2% FS; Axial deformation = 0-16 mm.

4.1. Test procedure

1. Samples preparation with the moisture content is 10% of the soil sample, sealed 24 h backup made the soil quality, soil sample calculation using the unsaturated triaxial creep apparatus supporting system of soil mould, by the compaction method in three layer after each layer of the compaction compaction soil samples to shave, so that the next layer of soil samples and has better compaction combined with compaction part, prevent delamination.

2. The unsaturated creep test of sericite schist residual soil under net confining pressure of 100kpa and matric suction of 50, 100, 150, 200kpa was carried out by unsaturated triaxial creep. The creep test was carried out by graded loading. The test was loaded in 5 stages.

3. Saturate the clay plate before test, and then make the sample.

4. Suction consolidation at this stage, to ensure the matrix suction of the soil is changeless, exert a net confining pressure to keep soil samples produced in the process of consolidation within the matrix.
suction is changeless, balanced consolidation pressure to volume change within 2 h are less than 0.01 mm, and after drainage stability (consolidation), you can add axial force consolidation, in order to avoid damage to the rubber mold, the applied pressure shall not exceed the confining pressure.

5. According to the unsaturated shear test, the soil sample failure stress was obtained under the same suction load. The test was applied in 5 stages. The net confining pressure was kept unchanged during the test, and the load was applied step by step.

6. For the unsaturated creep test, the time interval of data collection is very important. If the data are not collected according to the time requirement, it will have a great impact on the test results. The time interval after that is 120min\textsuperscript{5}.

4.2. Test results and analysis

According to the test results, the relationship between axial strain and time is plotted. The test results are shown in Figure 3.

By figure 3 of the triaxial creep curves can be seen that the matrix suction phase at the same time, with the increase of the vertical stress is applied, the strain increases gradually, until the first six level of loading, the specimen failure can also be found on the first level load, the strain is small, and required less time to reach steady state, can be found that the secondary load ShiJiaShi, matrix suction is greater than the load value or differ with the applied load size is not large, as applied load increases, the axial strain value increases gradually, and can be found that as the load increases, stabilize the time.
required to also need to be longer. It is found that the unsaturated triaxial creep test of sericite schist residual soils is different from that of one-dimensional soils, and there are three distinct stages: the initial stage of rapid creep and load application; The second stage is the stage of attenuated creep. In this process, the creep deformation slows down, the rate decreases, and the larger the load applied, the more obvious the deformation characteristics of this stage are. The third stage is the stable creep stage. When the time is long enough, the creep deformation tends to be stable gradually.

5. Conclusion
In this paper, the unsaturated creep tests of sericite schist residual soils under different conditions are carried out, and the unsaturated creep laws of sericite schist residual soils under different matric suction and net vertical stress are obtained.

1) When making a one-dimensional creep test found that under different matrix suction conditions when the creep curve of silk mica schist eluvial soil can be roughly divided into three stages: the first stage for the rapid growth stage, this stage deformation is growing rapidly, at this stage the rate of change of as net increase with the increase of the vertical stress, but the existence of matrix suction, will reduce the rate of change; The second stage will be a slow growth stage, the deformation quantity in this stage continues to increase, but the growth rate is slower than that in the first stage. The third stage is the stable stage, and the creep deformation increases with time.

2) When the net vertical force is the same, the axial deformation decreases with the increase of matric suction, indicating that the increase of matric suction can reduce the creep deformation of sericite schist residual soil.

3) It can be found from the unsaturated triaxial creep test that when the first and second grade load is applied, the creep develops slowly and has less time to reach stability. When the third grade and later loads are applied, the creep develops rapidly until the sixth grade load is applied and the sample is destroyed.

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References
[1] Li X.N, Feng J,Wu X.Y, et al.(2015), Experimental study on creep characteristics of unsaturated foundation soil J. Journal of railway science and engineering, 12 : 1047-1051.
[2] Wang K, Zhu B.L, Yu G, et al.(2019), Experiment on unsaturated creep characteristics of soil in landslide zone of nanping tunnel .J. Journal of southwest university of science and technology: natural science, 34 : 62-66.
[3] Jamel K.M, Mounir B.S. (2018),Creep behavior of unsaturated cohesive soils subjected to various stress levels.J. Arabian Journal of Geosciences, 11:77.
[4] Bhat D.R, Yatabe R, Bhandary N.P. (2014), Creeping Displacement Behavior of Clayey Soil in A New Creep Test Apparatus.J. Geotechnical Special Publication, 236:275-285.
[5] Zhu Y.B. (2014), Study on unsaturated characteristics of soft rock clastic soil interlayer in badong formation of yiba expressway .D. China university of geosciences.