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Consolidation and Pore Pressure Characteristics of Remolded Unsaturated Loess Under Isotropic Stress

Yajun Jia[1, 2, *], Cunli Chen[1, a] and Dengfei Zhang[1, b]

[1]Civil Engineering and Architecture Institute, Xi'an University of Technology, Xi'an, China
[2]Gansu Forestry Technological College, Tianshui, China

*Corresponding author e-mail: 2051738839@qq.com, [a]416200570@qq.com, [b]littlemuch722@sina.com

Abstract. Loess is a typical unsaturated soil. The unsaturated constitutive model of loess is an important research direction of loess engineering characteristics. In this paper, the constant load K0 consolidation tests of unsaturated undisturbed loess with different water content are carried out, and the effects of water content on secant modulus, stress-strain characteristics and lateral pressure coefficient are analyzed.

1. Introduction

Loess is the main regional soil in northwestern China, with special structure and special sensitivity to water [1]. The change of water content caused by the change of groundwater level, precipitation infiltration or improper discharge of domestic production water is coupled with the load transmitted by the building, which will inevitably reduce the strength of the loess and increase the deformation, affecting the normal use of the building [2]. In the triaxial test of soil, the method of soil consolidation is usually carried out by isotropic consolidation, that is, the test piece is consolidated under confining pressure. However, at present, the triaxial tests on coarse-grained soil are almost all based on the shear test under the conditions of isobaric consolidation. The research on various types of tests under K0 consolidation conditions at home and abroad is mostly directed to fine-grained soil and coarse-grained soil. There are few studies on K0 consolidation experiments [3]. According to the study, loess has obvious regional differences, and the properties of loess deposited in different climate and time in the same area are also different. According to the study, loess has obvious regional differences, and the properties of loess deposited in different climate and time in the same area are also different [4]. Loess not only has a series of unique internal material components, but also shows unique morphological characteristics. In our country, the distribution range is also very wide, and the distribution is continuous and its characteristics are typical [5].

Loess is a soil-like deposit formed in the Quaternary period about 2 million years ago. It is widely distributed in the world, accounting for one tenth of the global land area. It is distributed in the forest grassland and desert grassland zones in the middle latitude of the southern and northern hemispheres intermittently in the East-West direction [6]. In order to meet the needs of large-scale infrastructure construction, geotechnical engineering circles have devoted themselves to the study of physical and mechanical properties and engineering characteristics of loess. A lot of laboratory tests and in-situ tests have been carried out on Loess in different areas, and many remarkable achievements have been achieved [7]. Many scholars in the geotechnical field have done a lot of research on the relevant characteristics of western loess, but the data on the deformation characteristics and time effect of the soil during the K0 consolidation process of saturated remolded loess are rarely published [8]. Due to the needs of basic engineering construction, it is mainly to study the basic properties, deformation characteristics and strength of loess. In addition, it also analyzes the collapsibility, bearing capacity and engineering measures needed to meet engineering safety in engineering practice. Problems encountered in actual engineering. For the soil in the natural ground of K0 consolidation state, the stress and strain properties determined by the conventional triaxial test of initial isobaric consolidation must have certain errors. The K0 consolidation triaxial shear test can simulate the foundation soil more accurately. Stress strain and strength properties [9].

2. Methodology

The natural soil layer is usually formed by consolidation under lateral non-deformation conditions, that is, in the K0 state, and in the process of deposition and consolidation, the soil particles tend to form a certain arrangement direction, and the strength of the soil in the arrangement direction is Deformation is different from other directions. In the construction of houses, highways, railways, water conservancy and bridges, the deformation of the soil has become an important topic that plagues the geotechnical engineering community. The deformation characteristics of the soil are also increasingly influenced by scholars. The emphasis [10]. The highway embankment load can be regarded as an infinitely long uniform load. When the thickness of the subgrade compressible soil layer is thin and the embankment width is large, the stress and deformation of the soil at the settlement control point of the embankment are close to the side state, that is, the K0 state. Soil is a porous, multi-phase, loose deposit, and the geotechnical problems are complex. Indoor geotechnical tests should ignore secondary influencing factors and highlight the main influencing factors. By studying the internal structure of loess, the composition, morphology, pore characteristics, arrangement and cementation of particles are understood. The essence of deformation strength and collapsibility of loess is expounded from the point of view of micro-structure. The time when the pore water pressure reaches its peak is related to the loading rate. The loading rate is small, and the peak point appears in the loading stage. From the upper part to the lower part of the Loess layer, the compactness shows an upward trend, the strength increases gradually, while the compressibility and permeability decrease continuously, and the collapsibility also shows a downward trend.

Table 1. Physical Property Indicators of Graphs.

Experiment item	Test parameters			Conclusion	
Liquid-plastic limit test	Liquid limit w_L and plastic limit w_P (%)	Liquid index I_L and Plasticity index Ip		$10 < Ip < 17$ Rigid plastic Silty clay	
	w_L=36.54 w_P=25.46	I_L=0.18 Ip=14.29			
Particle analysis test	Coefficient of inhomogeneity Cu 11.68	Curvature coefficient Cs 2.91		Cu>10, $1 < Cs < 3$ Good gradation	

In this paper, the static triaxial test system is used to test the consolidation of saturated remolded loess specimens under continuous loading with K0. The consolidation deformation characteristics of K0 are studied and discussed. The basic physical properties of the tested loess are measured by indoor geotechnical tests as shown in Table 1.

The structural characteristics of loess refer to the characteristics of the particles or groups of soil particles and the pore associated with them, as well as their general arrangement in space. Loess is widely distributed in Northwest and North China, with a total area of 640,000 square kilometers. In addition, infrastructure construction and ecological environment improvement are closely related to loess in the implementation of the western development strategy. As well as the need to make a correct judgment on many tendentious opinions in recent years in the study of Loess mechanics, these facts call for the new revitalization and development of Loess mechanics. The structural characteristics of loess consist of the skeleton particles, fine particles and pore, their general arrangement in space, and the relationship between cementation structures. The research on loess mechanics has also achieved innovative results, such as the stress-strain relationship of loess and the establishment of constitutive model under static and dynamic forces, and the dynamic strength characteristics of loess under different humidity and density. The microstructure and mineral composition of loess in the typical loess distribution area of China were analyzed by scanning microscopy and X-ray diffraction. The mineral composition of loess in each region was basically the same, but the microstructure was obviously different, and there were obvious regional changes.

In the K0 consolidation test under continuous loading conditions, the axial stress increases linearly with time, and the higher the loading rate, the faster the axial pressure increases. The relationship between axial stress and time at different loading rates is shown in Fig. 1.

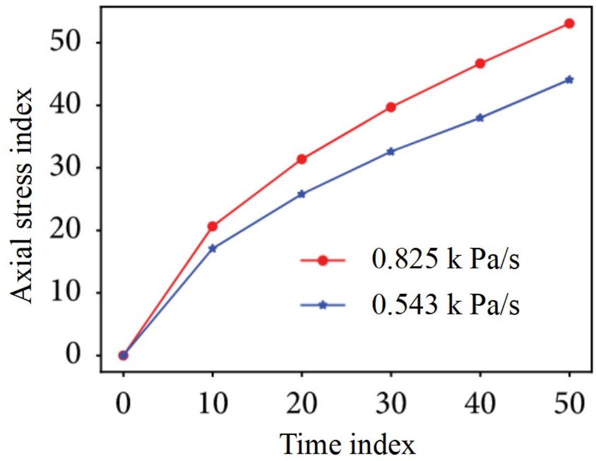

Figure 1. Relationship between axial stress and time at different loading rates.

The axial strain also increases with time, and the trend with time is related to the loading rate. The relationship between axial strain and time at different loading rates is shown in Fig. 2.

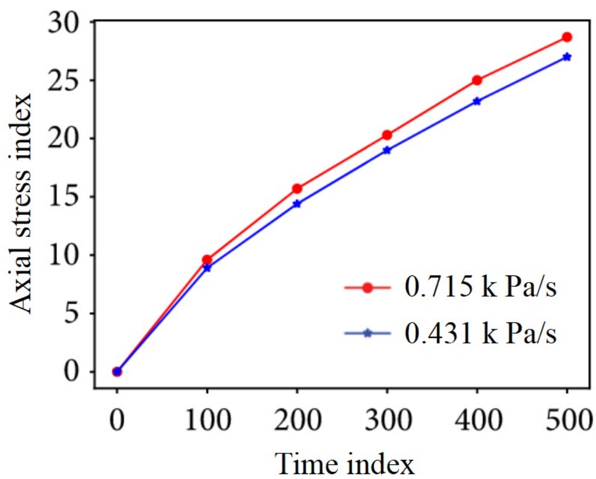

Figure 2. Relationship between axial strain and time at different loading rates.

3. Result Analysis and Discussion

The loess is widely distributed all over the world. Due to the large differences in geography, geology and climatic conditions, the loess in different areas shows obvious differences in sediment thickness, stratum characteristics and physical and mechanical properties, but there are also commonalities. In order to actively respond to the call for the development of the western region, the state has continuously increased the intensity of infrastructure construction in the western region of China, especially in the northwest. In addition, it is also found that the regional variation characteristics of loess microstructure and the collapsibility of loess collapsing from northwest to southeast are consistent. This finding embodies the close relationship between loess collapsibility and microstructure. Therefore, the microstructure of loess is classified according to its variation law, which is used for the evaluation of loess collapsibility. By analyzing the micro-structure types of the Late Pleistocene loess in different geomorphic units and the corresponding physical and mechanical properties such as natural water content, unit volume density, dry density, void ratio, liquid-plastic limit and self-weight collapsibility coefficient, it is pointed out that the change laws of the two geomorphic units are consistent in the region. The physical and mechanical properties and engineering characteristics of loess and loess-like soils are of great significance to practical engineering applications. For the needs of large-scale practical engineering construction, it is urgent to study the physical and mechanical properties and engineering characteristics of loess and loess-like soils.

Since the reform and opening up, China's national economy has become increasingly strong, and the state has continuously increased its investment in the development of the western region. The structural property of soil is a general term for the geometric characteristics (including the skeleton and pore characteristics) and the connection characteristics of soil. By studying the changes of microstructure and physical and mechanical properties on the same section, it is concluded that the self-weight pressure of the overlying soil layer on the section increases from top to bottom, and the clay content increases gradually. Soil-forming process is becoming stronger and stronger. Microstructure changes from scaffold macropore to cemented structure combination. The physical and mechanical properties of loess gradually improve from top to bottom, and both of them have the same variation law in the same section. The peak value of soil sample with larger loading rate appears in the stage of stabilization. This is because the loading rate is high, the confining pressure is applied to the soil sample in a relatively short time, the pore water pressure increases sharply, the excess pore water pressure cannot dissipate, and the pore water pressure will continue to increase to the peak value after loading. It has long been found that the brittle failure of structural clay, the collapsibility of loess and the swelling of expansive soil are important factors such as soil structure, soil stress-strain relationship, pore water pressure-strain curve, consolidation curve, etc. There is a significant relationship between the structure of the soil. Therefore, some problems encountered in the construction of the yellow soil foundation have attracted more and more attention, and research on the solution to these problems is imminent.

4. Conclusion

The K0 consolidation test of remolded saturated clay was carried out at different loading rates. The relationship between stress time of soil under different loading rates was analyzed and discussed. The static side pressure coefficient K0 was also studied with time. The relationship of change. Studies have shown that the curves of the secant modulus as a function of axial strain are substantially parallel for soil samples with different water contents. The larger the water content, the smaller the secant modulus value corresponding to the same strain. Moreover, the static side pressure coefficient has a process value, and the change with time is related to the magnitude of the loading rate. The peak values of deviational stress and axial strain vary with the loading rate. The larger the loading rate, the smaller the corresponding two peaks. The axial compression mainly comes from the loading stage. The higher the loading rate is, the faster the compression height increases in the loading stage, and the smaller the compression amount reaches after the loading stage. The pore water pressure rises and dissipates in the whole test process, and there are peaks. When the loading rate is small, the pore water

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pressure reaches its peak value and dissipates and decreases. When the loading rate is high, the peak point appears in the steady-state stage, and the higher the loading rate, the higher the pore pressure increase rate is, and the larger the pore pressure peak is.

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