Study on the acid environment to the sensitivity of soil

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Abstract. In this research, the tests of collapsible sensitivity of loess in acid environment were carried out. On the basis of this experiment, this author draw on the experience of predecessors, and put forward two indexes of collapsibility sensitivity evaluation of loess and its site, which are the time to complete 90% of collapsibility and collapsibility coefficient. The method was verified by taking the site with excessive collapsibility as an example. The results show that the method can accurately reflect the collapsibility sensitivity of collapsible site, and has certain guiding significance for engineering construction on collapsible site. In addition, the method is simple, scientific, and can be combined with the current specifications. It is easy to be accepted and promoted by the industry, and is a useful supplement to the existing few researches on loess collapsibility sensitivity.

1 Introduction

The sensitivity of loess collapsibility is generally considered as the difficulty, speed and size of loess collapsibility after water immersion. It is different from collapsibility of loess, but they are related to each other. The Loess with high collapsibility may have weak collapsibility sensitivity, and the Loess with low collapsibility may have stronger collapsibility sensitivity than the Loess with high collapsibility, so the damage may be greater than that of the Loess with high collapsibility. Therefore, the study of loess collapsibility sensitivity is as important as the study of loess collapsibility, which is of great significance to the engineering construction in loess area. However, there are few studies on loess collapsibility sensitivity at home and abroad [6] [7] [8], and there is no method to evaluate loess collapsibility sensitivity that can be widely recognized and promoted.

In this study, nitric acid is used to dissolve salt crystal cementation rapidly. Different concentrations of nitric acid are added to the immersion solution of loess collapsibility test. The collapsibility sensitivity indexes of loess, such as collapsibility coefficient, stability time and collapsibility rate, are tested under different acidic environment and pressure. In contrast with the conventional collapsibility test, the change and mechanism of cemented connection in collapsibility and collapsibility sensitivity of loess are reflected. In addition, in order to further promote the construction of geotechnical engineering in collapsible loess area, another important purpose of this paper is to interpret the characteristics of loess collapsibility sensitivity based on some data of this test, and on this basis, combined with the experience of predecessors, put forward a scientific and fair method which can be closely linked with the current specification, It is easy to be accepted and popularized to evaluate the collapsibility sensitivity of loess.

2 Characteristics of collapsibility sensitivity of loess

The sensitivity of loess collapsibility is various. For example, some sites collapse rapidly after being soaked in water, while others need to be soaked for a long time to produce collapsibility. Some sites can collapse when they are soaked in a small area, while others need to be soaked in a large area to collapse. The final reason is that there are many influencing factors. In addition to the salt crystal cementation mentioned in the above test, it is also affected by water content, plasticity index, permeability coefficient and other factors. Some other researchers have done research on these aspects [6] [7] [8], which will not be repeated in this paper. To sum up, the evaluation of loess collapsibility sensitivity is complex and difficult to evaluate if every influencing factor and every manifestation are considered. However, if we start from the definition of loess collapsibility sensitivity, we can understand its essential meaning, that is, the difficulty, speed and size of loess collapsibility after immersion, It will be found that the performance of collapsibility sensitivity can be accurately measured by only two physical indicators, that is, the magnitude of collapsibility deformation and the speed of collapsibility rate. This paper will explain the evaluation method based on these two indexes in combination with some relevant data of this experiment.

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3 Evaluation of collapsibility sensitivity of Loess

3.1 Evaluation of collapsibility time

In Figure 1, the collapsibility coefficients of soil samples under distilled water solution at 200 kPa and 800 kPa are about 0.06. However, it can be seen from Figure 2 that the stability time of the three solutions varies greatly at 1600kpa, 184, 214 and 394 min respectively. It is very small that there is such a big difference in the acidity of the immersion solution on the site, but the same situation will occur when the water solution is immersed in different soil samples [8]. Therefore, collapsibility sensitivity is an important characteristic of loess collapsibility. In this paper, the two indexes of collapsibility sensitivity, collapsibility rate and collapsibility deformation, are described respectively.

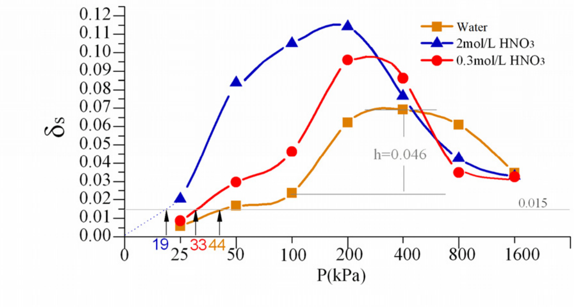

Fig.1 Comparison of coefficient of collapsibility

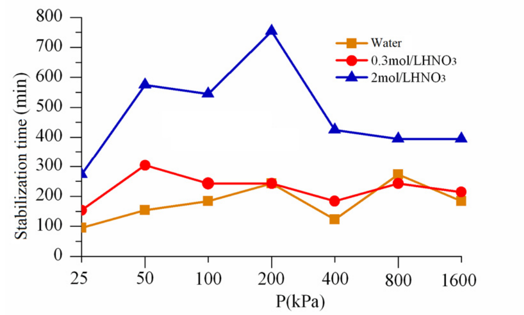

Fig.2 Comparison of stability time of collapse

Under the condition that the total amount of collapse is constant, the shorter the stable time of collapse is, the faster the average rate of collapse is, and the earlier the time of collapse is. Therefore, this paper uses the time to complete 90% of the total amount of collapse as an index to reflect the speed and difficulty of collapse. The total amount of collapsibility is defined as the total amount of deformation when the collapsibility deformation is stable, that is, when the hourly collapsibility deformation is less than 0.01mm, as specified in the code for construction in collapsible loess area (gb20025-2004). The advantage of using 90% of the total collapsible time is that the last 10% of the collapsible time is removed.

When the collapsible test is completed according to the current specification, the last 10% of the collapsible time is often several times of the previous 90% of the collapsible time. Some soil samples may affect the performance of the previous sensitive period because the latter 10% of the collapsible time is too long or too short, Therefore, the time to remove this part of the collapsibility can more accurately reflect the speed and difficulty of collapsibility sensitive period.

Choosing the time to complete 90% of the total amount of collapsibility can more accurately reflect the difficulty and speed of collapsibility sensitive period of loess, which is more in line with the requirements of collapsibility sensitivity evaluation. Many data collected in this paper show that [8] (as shown in Table 3, No. 11 is the test result), most of 90% of the total collapsibility is completed within 5-60 minutes. Therefore, in this paper, those who can quickly complete 90% of the total collapsibility in less than 5 minutes are divided into one level, and those who can slowly complete more than 60 minutes are divided into one level. For most of those who can complete this process in 5-60 minutes, they are divided into two levels - fast and slow, as shown in Table 4. The time required to complete 90% of the total collapsibility is shown in table t.

3.2 Evaluation of collapse magnitude

The Another characteristic of collapsibility sensitivity, which is the magnitude of collapsibility, can be measured by collapsibility coefficient. The coefficient of self weight collapsibility varies with the buried depth. For soils with the same coefficient of self weight collapsibility, the coefficient of self weight collapsibility may vary with the change of overburden pressure [6] [7]. Therefore, it has strong variability and is not easy to be evaluated uniformly, so it is not suitable to be selected as the evaluation index. In most countries of the world, there is a unified test method for collapsible coefficient (see section 4.3.3 of building code for collapsible loess area gb20025-2004 for specific method). It is easy to formulate a unified evaluation standard, and there is a clear division of collapsible coefficient in the code. Therefore, in order to correctly reflect the size of soil collapsible deformation, and to match with the current technical criteria, and facilitate the promotion of this method, this paper directly selects the method of "building code for collapsible loess area" gb20025-2004 4.3.3 to measure the collapsible coefficient, and divides it into three grades according to the method of 4.4.2. As shown in Table 4.

3.3 Comprehensive evaluation

In general, after the statistics of many collapsibility test results collected, t (the time required to complete 90% of the total collapsibility) is divided according to the speed and probability of occurrence, and the collapsibility coefficient of loess is directly divided according to the method of 4.2.2 of building code for collapsible loess area. Finally, the collapsibility sensitivity is determined by these two elements, which can be divided into four grades according to the order from weak to strong. The evaluation method is based on the definition or essential meaning of collapsibility sensitivity and belongs to comprehensive index evaluation method. Its scientificity and practicability will be verified in the section of 4.3 collapsibility sensitivity evaluation example.

Table 1. Results of loess collapsibility tests

No	Collapsible deformation (0.001 mm) / Percentage			Stability time (h)	I_c
	5 min	30 min	Stability		
1	200/0.44	350/0.77	455/1	4.5	0.023
2	600/0.61	874/0.88	990/1	4	0.050
3	105/0.13	280/0.88	838/1	7	0.042
4	220/0.5	393/0.9	436/1	2.5	0.022
5	300/0.38	348/0.44	796/1	4	0.040
6	180/0.58	302/0.97	312/1	1.5	0.016
7	285/0.19	403/0.27	1506/1	8	0.075
8	825/0.46	1315/0.73	1800/1	6	0.09
9	78/0.24	168/0.51	335/1	4.5	0.017
10	496/0.71	688/0.99	697/1	1.5	0.035
11	1080/0.87	1176/0.95	1243/1	4	0.057
12	1328/0.85	1437/0.92	1562/1	2.5	0.078
13	227/0.64	288/0.81	355/1	2.9	0.018
14	558/0.45	830/0.67	1240/1	6.5	0.062

Note: Collapsible deformation (5, 30 min, and stability), settlement values of a soil at 5, 10 min, and getting stability after collapsible deformation begins. Percentage (5, 30 min, and stability), the stability collapsible deformation is regarded as 1; the ratio of collapsible deformation values at 5 and 30 min to the stability collapsible deformation. Stability time, time required when the collapsible deformation of a soil gets stability (the collapsible deformation is less than 0.01mm/h

Table 2. Grades of collapse sensitivity in loess

I_c (%) / T (min)	$0.015< I_c \le 0.03$	$0.03< I_c \le 0.07$	$I_c>0.07$
$60<T$	Slight	Slight	Moderate
$15<T\le 60$	Slight	Moderate	Moderately severe
$5\le T\le 15$	Moderate	Moderately severe	Severe
$T<5$	Moderately severe	Severe	Severe

4 Conclusion

(1) Through the study of stability time, it is found that compared with distilled water solution, collapsible loess needs longer time to complete collapsible deformation in acid solution, because hydrogen ions in acid solution and insoluble salts such as calcium carbonate in Loess need sufficient time to react, thus prolonging the collapsible time.

(2) Through the study of deformation rate, it is found that the sensitive range of collapsible loess in acid solution and distilled water solution is different. Under the action of hydrogen ion, salt crystal cementation can be more easily decomposed, resulting in the collapsible sensitive pressure range of acid solution significantly reduced.

Acknowledgements

This work was supported by the China Postdoctoral Science Foundation (Grant No. 2020M673617XB), the Open Research Fund of State Key Laboratory of Geomechanics and Geotechnical Engineering, Institute of Rock and Soil Mechanics, Chinese Academy of Sciences (Grant No. Z020019), the special Foundation for High Level Talents of Xijing university (Grant No. XJ20B12).

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