Mechanical Properties and Dry-Wet Cycle Effects of Strongly Weathered Mudstone

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Abstract: Mudstone is Mainly Formed by Extrusion, Dehydration, Cementation and Other Epigenetic Effects, and It is Rich in Clay Minerals. as a Kind of Strong Weathered Rock, Weathered Mudstone is Mostly Hard, It is Easy to Dissolve When It Meets Water, and It Has Certain Expansion and Contraction. the Strong Weathered Mudstone Will Have Corresponding Changes in Physical Properties under the Effect of Dry and Wet Circulation. Based on This, This Paper Firstly Summarizes the Related Theories of Physical Properties and Dry-Wet Cycles of Strongly Weathered Mudstones. the Effects of Dry-Wet Cycles on the Physical Properties of Strongly Weathered Mudstones Are Determined by Direct Shear Experiments and Cbr Experiments. the Experimental Results Show That the Shear Strength of the Strongly Weathered Mudstone Decreases Gradually and the Cbr Strength Decreases Continuously with the Increase of the Number of Cycles of the Wet and Dry Cycle Effect.

1. Introduction

1.1 Literature Review

Wang Yakun, Zhang Wenhui and Chen Tao Believe That the Disintegration Properties of Weathered Mudstone Are Affected by Climate, Especially under Seasonal Climate Conditions. through the Dry-Wet Cycle Test and Its Results Analysis, It is Proposed That the Dry-Wet Cycle Effect Will Destroy the Original Geological Structure of the Land, Expand the Pores of the Mudstone Soil, and Reduce the Cohesion. At the Same Time, They Also Found That as the Number of Dry and Wet Cycles Increased, the Cohesion and Internal Friction Angles Fluctuated First and Then Decreased, and the Expansion Rate Gradually Decreased (Wang et al., 2013). Wang Mingfang, Yu Hongming and Deng Xinzheng Believe That the Gypsum Rock Has Degraded under the Action of Dry and Wet Circulation. Therefore, the Deterioration Characteristics of Gypsum Rock Have Been Studied. It is Found That the Two-Dimensional Particle Flow Method Can Be Used to Accurately Simulate the Mechanical Properties of Gypsum Rock. It is Concluded That the Rock Mass Mechanical Parameters Decrease with the Increase of the Number of Dry and Wet Cycles (Wang et al., 2018). Dong Bo, Wang Hongxing and Zuo Qingjun and Others Believe That in Actual Work, the Variation of Mechanical Properties Before and after the Disintegration of Mudstone Should Be Mastered. Therefore, the Strength Test is Carried out for Mudstone, and the Strength of the Mudstone is Greatly Attenuated after Soaking in Water. the Cycle Has a Significant Impact on Mudstone Strength (Dong et al., 2016). Chen Tao, Zhang Wenhui, and Lan Riyan et al. Discussed the Physical Properties and Water Stability of Weathered Mudstones for Roadbed Cracking and Other Roadbed Diseases. It is Proposed That the Weathering Mudstone Water Stability is Extremely Poor, and the Cbr Value of Weathered Mudstone after a Certain Dry-Wet Cycle Unable to Meet the Requirements of the Roadbed Standard (Chen et al., 2012). Zhang Xianwei, Kong Lingwei and Li Hongcheng Believe That the Research on Zimbabwe's Mudstone Residual Soil Plays an Important Role in Overseas Engineering Construction. Therefore, on This Basis, They Proposed That the Babwe Mudstone Residual Soil Has Weak Expansibility and Low Pressure Solidity, and Confirmed That Zimbabwe Mudstone Engineering Properties Are Controlled by Its Physicochemical Composition and Structural Characteristics (Zhang et al., 2018). .

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1.2 Purposes of Research

Weathered mudstone is sensitive to changes in environmental humidity, and is affected by environmental humidity. Various physical properties of weathered mudstone will change. In the season of frequent precipitation, the moisture content of weathered mudstones rises rapidly, and the mudstone rock structure disintegrates in water. In the season when precipitation is scarce, the surface water of the soil evaporates continuously, the groundwater level decreases, the moisture content of the weathered mudstone is greatly reduced, and the mudstone rock body is continuously deformed and contracted, causing the soil surface to crack. The effect of dry and wet circulation has great influence on the construction of the project. It is important to study the change of the strong weathered mudstone under the effect of dry and wet circulation, which is important for the study of landslide mechanism and engineering hazard prevention. Therefore, this paper briefly describes the related theories of dry-wet cycle effect and physical properties of strongly weathered mudstone. The direct shear test and CBR experiment on weathered mudstone are carried out to determine the changes of physical properties of experimental samples.

2. Overview of Relevant Theory

Strongly weathered mudstone is a clastic sedimentary rock stratum with continental sedimentation as the main cause, which is generally formed by collision and folding of sandstone and argillace sandstone. In the natural state, the mudstone shape is relatively complete, and because the mudstone belongs to soft rock, its mechanical properties are relatively good. Sandstone is a hard rock, which has a high hardness and is brittle and variability. Compared with sandstone, mudstone is not strong in water permeability due to its own characteristics, hydrophilicity has an advantage, and its resistance to weathering is poor. (Zhong et al., 2018). Due to the influence of gravity on the slope where the rock is distributed, the sandstone and mudstone are differentially deformed, and the shape changes correspondingly with the change of the external environment. In the Loess Plateau, due to the good permeability of mudstone, the occurrence of seepage or groundwater infiltration, the mudstone is affected by the self-weight of the rock mass and the permeated water is enriched in the surface of the mudstone to finally soften the mudstone, which promotes the reduction of the shear strength of the mudstone. . Therefore, when the underwater pressure of the road area and the external wind force are affected, the surface of the rock mass is prone to collapse and damage due to instability, which causes the construction of the project to be affected, endangering personal safety and property safety. A large number of studies have shown that the mudstone has a gentle slope angle, and the strength is reduced and the stress release is sufficient after water immersion. The mudstone slip layer has poor stability and strong complex activity. It can be seen that the landslide phenomenon is a macroscopic performance that lasts for a long time due to the high water content of the mudstone.

In the case where the mudstone is subjected to loads, the surface of the mudstone is consolidated. Consolidation is essentially the process of soil compaction. In the initial stage, the soil consists of both soil particles and water in the pores (Zhou et al., 2019). After the soil is squeezed, the pores shrink, the water is removed, and the pores gradually dissipate as the water disappears and the external force is squeezed. At this time, the load on the mudstone is carried by the soil particles, the density between the particles increases, and the macroscopic performance of the rock mass is sedimentation. Seepage consolidation is a basic physical property of the soil, affecting the final state of the pores of the rock mass. From a macro perspective, this property is essentially the effect of the number and size of soil skeleton pores on the rock mass (Deng et al., 2018). In the same external environment, the larger the soil pores in the weathered mudstone, the better the consolidation compression performance and the better the water permeability. The soil consolidation and water permeability interactions are negatively correlated, and the consolidation rate is related to the water outflow velocity in the soil. During the consolidation and compression process of the rock mass, the position of the soil particles changes, resulting in a stronger and more stable soil structure and a smaller soil permeability coefficient.

3. Experimental Materials

3.1 Experimental Materials

As the experimental material, weathered mudstone has a natural moisture content of 16.0% to 23.0%, a density of 2.0 to 2.10 cm ^{3} , a free expansion ratio of 42.5, and a plasticity index of 18.

3.2 Experimental Methods

3.2.1 Direct shear test

The experimental samples were prepared from soil samples prepared in-house. First, the weathered mudstone is crushed, and the crushed weathered mudstone is passed through a 2 mm filter screen. Using the laboratory materials, the moisture content of the weathered mudstone after the sieve was adjusted to 13.5%, and the moisture content of the experimental material was uniform. Next, the dry density of the experimental sample was maintained at 1.92 g•cm-3, and the height of the experimental sample was maintained at 2 cm and the radius was maintained at 3.09 cm by the static compression method. Five experimental groups were set up in the experiment, and four samples were set in each group and numbered 1, 2, 3, and 4. Finally, a group of experimental groups were incubated for one day and then subjected to a fast shear test. After the dry and wet cycles were carried out in accordance with the test plan, the other four groups were subjected to a fast shear test. The sample was immersed in an aqueous solution for 24 hours to saturation, and then naturally air-dried in the laboratory. The moisture content of the sample after air drying was kept consistent at 13.5%, and a process of immersion to air drying was completed, that is, a dry-wet cycle was completed. After each dry and wet cycle, the fast shear test can be carried out after 24 hours of curing.

3.2.2 CBR experiment

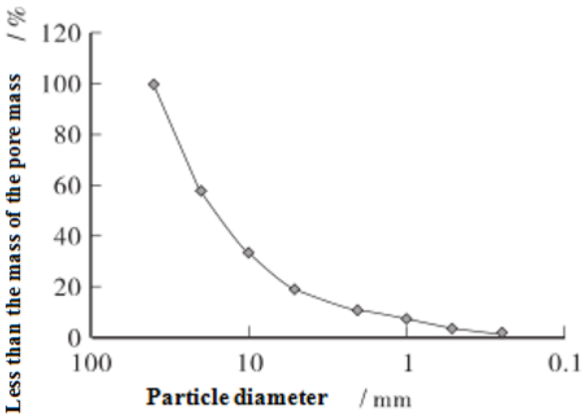

Fig.1 Weathered Mudstone Particle Curve

Weigh 50kg of weathered mudstone raw material, crush it and transfer it to 20mm filter sieve, filter it through filter sieve and seal it in sealed bag for 24h, so that the water content distribution is uniform, and the optimal moisture content is consistent with other experimental samples. According to the screening results of Fig. 1, the mudstone materials of different particle sizes are compacted in the sample container to avoid experimental errors due to uneven particle distribution. When compacting mudstone materials, the experimental materials can be compacted in three layers using a static pressure method. The weathered mudstone vessel has a size of 2.177dm3, a radius of 76mm and a height of 0.12m. The compacted experimental material is sprinkled until liquid is oozing out of the bottom of the sample. When the content of the aqueous solution in the container did not pass through the container and overflowed, the addition of water was stopped and it was immersed for 24 hours. During the soaking of the experimental sample, the amount of expansion of the test sample was read by reading the dial gauge data. After the immersion is completed, the moisture in the container is poured out, the experimental material is air-dried, and the humidity is still maintained at 13.5%. The pressure measurement experiment group controls the circulation process, and the pressure test group maintains the pressure during air drying and immersion. Since the air drying process may be too slow, manual drying can be performed outside the CBR tube. Throughout the process, the dial gauge data is continuously recorded to indicate the amount of expansion. After 2, 4, and 6 dry and wet cycles, the experimental samples were placed in an aqueous solution for 4 days and then subjected to a CBR experiment.

4. Experimental Conclusion

This experiment found that the effect of dry-wet cycle can cause the intensity of strong weathered mudstone to change, and the climate has obvious influence on the strength of weathered mudstone rock mass. Therefore, the influence of season and climate on the road surface strength should be considered when determining the stability of the subgrade slope before the construction process. It can be seen from the experimental results that as the number of cycles of dry and wet circulation increases, the shear strength of weathered mudstone decreases and the CBR strength decreases. The main reason is that the dry and wet circulation has destroyed the soil structure, causing the mudstone structure to collapse, the pores in the rock mass are enlarged, the cohesion is reduced, and the internal friction angle is also slightly reduced. After two wet and dry cycles, the shear strength curve of the experimental samples decreased rapidly in the early stage and stabilized in the later stage. According to the data, the expansion rate of weathered mudstone is related to the number of cycles of dry and wet circulation effect, which is negatively correlated. The sample used in this experiment is disturbed soil. Since it has been separated from the original geological structure and becomes an independent sample, this experiment can not obtain the original layered structure and fissure effect of the soil. In the direct shear experiment, the size of the experimental sample is small, which is quite different from the actual size of the weathered mudstone, which is easy to cause large experimental error and difficult to observe.

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