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Effect of Freeze-Thaw Cycle on Shear Strength of Lime-Solidified Dispersion Soils

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Abstract

The freeze-thaw cycle of saline soil in the seasonal frozen area will produce diseases such as frost heave and thaw settlement, road frost boiling, collapse and uneven settlement. In order to reduce the occurrence of these undesirable phenomena, it is often necessary to improve the saline soil in engineering. In this paper, the typical carbonate saline soil in the west of Jilin Province, China is taken as the research object. By adding different content of lime (0%, 3%, 6%, 9%, 12%, 15%), the change of mechanical strength of lime solidified saline soil under different freeze-thaw cycles (0, 1, 3, 6, 10, 30, 60 times) is studied. The mechanical analysis is carried out by combining particle size analysis test and SEM image. The test results show that although repeated freeze-thaw cycles make the soil structure loose and the mechanical strength greatly reduced, the soil particles agglomerate obviously after adding lime, its dispersion is restrained by the flocculation of clay colloid, and the shear strength of soil is improved by the increase of the cohesive force between clay particles, and the optimal lime mixing ratio of the saline soil in this area is 9%.

Keywords: Saline Soil; Freeze-Thaw Cycle; Lime Improvement; Particle Size Analysis; SEM Image.

1. Introduction

The western part of Jilin Province is located in the southwestern part of China's Songnen Plain. It is one of the world's three major soda alkaline soil distribution areas, and is also the largest area of soda alkaline soil in China [1-4]. In the past 20 years, not only the total area of saline soil has expanded rapidly, but also the degree of soil salinization has increased greatly, and the ecological environment is very fragile [5, 6]. In order to alleviate land degradation and improve the ecosystem, Jilin Province has started the water diversion project of the lower Nenjiang River and the second Songhua River to wash the salinized land to achieve the purpose of restoration of cultivated land, grassland and wetland environment [7, 8]. Because of the high content of Na^+ in the soil of this area, its dispersity is relatively large, which has been fully proved in many scholars' research. Xudong et al. (2015) verified the dispersion of shallow soil in Qi'an area by means of pinhole test, particle test and double gravity meter [9, 10]. Yan Han studied the initial freezing point of dispersive saline soil in this area [11]. At the same time, because the soil in this area is highly dispersed, and often develops a large number of macro-micro fissures, obvious structure and large non-uniformity of mechanical properties, it is often easy to cause bank collapse, slope instability and other engineering accidents, so it is necessary to improve the engineering properties of saline soil in this area. In the early stage of soil improvement, the research is mainly limited to the observation of its macro properties, and the research on its indicators and improvement mechanism is less. After the 1990s, with the development of micro equipment, the micro research of improved soil began to be common, and the exploration of improved mechanism gradually became the mainstream direction. Ambarish G and Chillara S study the

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