Scientia Iranica A (2013) 20(4), 1145–1152

Sharif University of Technology
Scientia Iranica
Transactions A: Civil Engineering
www.scientiairanica.com

Experimental study on the mechanical properties of clayey soil under different freezing apparatus temperatures and freeze-thaw cycles

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Received 7 June 2012; received in revised form 1 October 2012; accepted 21 January 2013

KEYWORDS
Freeze-thaw cycles; Moisture content; Cohesion; Internal friction angle; Clayey soil.

Abstract. The aim of this study is to investigate the mechanical properties of clayey soil with different moisture content. Two groups of clayey soil with different moisture content were prepared as samples. One group of samples was subjected to eleven freeze-thaw cycles under a constant freezing apparatus temperature in an enclosed apparatus. The other group was subjected to one freeze-thaw cycle exposed to a decreasing freezing apparatus temperature in an enclosed apparatus. A series of triaxial compression experiments were conducted on both groups of samples. The first experimental results indicated that the mechanical properties of the clayey soil changed after the freeze-thaw cycles under constant freezing apparatus temperature, and cohesion decreased with an increased number of freeze-thaw cycles and increased moisture content. In addition, the internal friction angle increased with the number of freeze-thaw cycles and decreased with increased moisture content. However, the moisture content of the clayey soil had a greater influence on cohesion than the internal friction angle. Additional experimental group results indicated that the internal friction angle of the clayey soil diminished with a decrease in the freezing apparatus temperature and increased moisture content. Finally, cohesion increased with a decrease in either the freezing apparatus temperature or moisture content.

1. Introduction

In seasonally frozen ground regions, freeze-thaw damage is one of the major problems in hydraulic engineering, such as in the case of canal linings in Northern China. Seasonal frost heave can cause severe damage to foundations and buildings. During seasonal freezing, the frozen depth may proceed to the buildings by one to two meters and, occasionally, even more. Canal linings in seasonally frozen ground regions suffer from surface scaling, bulging, cracking, uplift and collapse under freeze-thaw cycles. The main reason for these issues is that under the canal lining of soils, the mechanical properties of the soil are affected by the freeze-thaw cycles.

The mechanical properties of soils are also influenced by several factors, including moisture content, soil type, temperature, and bulk density [1-5]. Freeze-thaw cycles can be treated as a weathering process, which considerably changes the engineering properties of soils due to cryogenic action [6,7].

For geotechnical engineering undertaken in such regions, special attention should be paid to the freeze-thaw cycles [8]. The strength of soils is especially sensitive to freeze-thaw cycles and moisture content.

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