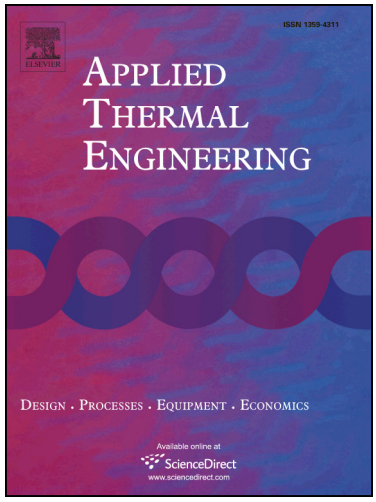

Experimental and modeling investigation of the thermal conductivity of fiber-reinforced soil subjected to freeze-thaw cycles

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Experimental and modeling investigation of the thermal conductivity of fiber-reinforced soil subjected to freeze-thaw cycles

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Abstract

The thermal conductivity of fine-grained soil, both unreinforced and reinforced with randomly oriented basalt, glass, and steel fibers, was tested by means of the transient hot-wire method with a Quickline-30 Thermal Properties Analyzer. The thermal conductivities of specimens were determined as a function of fiber volume fractions, freeze-thaw cycles, and temperature through laboratory studies. Thermal conductivity of the fiber-reinforced soil decreased for all freeze-thaw cycles and temperature values. The most remarkable reduction of thermal conductivity was measured on all ratios of the steel fiber-reinforced soil and 1% basalt fiber-reinforced soil. Moreover, the statistical-physical model proposed by Usowicz was applied to evaluate the thermal conductivity of fiber-reinforced soil by considering soil-fiber composites and environmental factors. The results showed a close match between the values estimated by the statistical-physical model and the experimental values for various fiber-reinforced soils in a wide range of fiber ratios, temperatures, water contents, and freeze-thaw cycles.

Keywords: Thermal Conductivity, Freeze-Thaw, Fiber-Reinforced Soil, the Statistical-Physical Model

1. Introduction

Soil thermal conductivity is a significant parameter of the thermal balance of ground surfaces, which is a prime factor in the damage to engineered structures caused by thaw settlement and frost heave. Also, the soil thermal conductivity helps to investigate the depths of freeze-thaw cycles and the heat transfer rates during thermal stability predictions in cold regions [1].