Uniwersytet Przyrodniczy we Wrocławiu
Instytut Budownictwa

Kinga WITEK

ANALIZA WPŁYWU ZAWARTOŚCI FRAKCJI PYŁOWEJ I IŁOWEJ NA PROCESY ZAMARZANIA GRUNTÓW DROBNOZIARNISTYCH

ROZPRAWA DOKTORSKA

Promotor: dr hab. inż. Krzysztof Parylak
Promotor pomocniczy: dr inż. Wojciech Kilian

Wrocław, 2018

ANALYSIS OF EFFECT OF SILT AND CLAY FRACTION CONTENT ON FREEZEING PROCESSES OF FINE-GRAINED SOILS

Summary

In many geotechnical engineering issuess, one of the leading problems is frost heave. Both in the cognitive and engineering aspects, these issues have been developed since the 30s of the last century in many countries. Despite the introduction to the construction practice of a series of simplified criteria for classifying soils in terms of their frost susceptibility, there is still no unambiguous relationship between the granulation of soil and their susceptibility to frost heave. The annual economic losses caused by these phenomena are very large.

Also in the cognitive aspect of the processes of the formation of this phenomenon, the same ground conditions affecting the size of the frost heave haven't been determined so far. Among the many hypothesis, the following are considered most likely: the Everett hypothesis in 1961, Miller's secondary heave theory from 1972, and the adsorption force theory developed by Takagi in 1978. In this work, an experimental attempt to link the mechanisms of these hypothesis with the results of tests on the frost heave of four soils classified in terms of granulation, according to Casagrande's criterion, as very frost-susceptible soil or frost-susceptible soil.

The main assumptions for research purposes were to determine the effect of silt and clay fraction on the frost heave height. The tested soils were characterized by a varied content of silt fraction, which together with smaller ones was 30%, 40%, 50% and 70%, and variable clay fraction content in particular soils 0%, 0%, 5% and 21%. In addition, the rate of heat transfer inside the samples during the freezing process was determined.

Freezing tests were carried out in a climate chamber specially adapted for this purpose, with a built-in two-part styrofoam container holding once 6 identical samples, performing a total of 72 samples. Its lower part was immersed in water kept at a constant temperature above zero, and the lateral surroundings of the samples were filled with dry sand, creating insulation from negative temperatures. The total freezing process at a temperature of -10°C lasted 160 hours.

The obtained results of the variability of temperatures over time have shown that in the profiles of samples of non-cohesive soils the rate of heat transfer is greater than in the case of cohesive soils. This confirms the conditions that the more non-cohesive ground has a higher thermal conductivity coefficient, i.e. better heat exchange capacity.

On the basis of the obtained results of the frost heave, it was shown that the largest frost heave exhibits silt with the highest total content of silt and clay fraction of 70%, and the smallest increase in sample height in the freezing process shows silty sand with the smallest sum of both fractions.

On the basis of the analysis of the results of the investigated soils (in the range of fi=0-21% and $f\pi$=19-65%), the presence of clay fraction, but in connection with the presence of the silt fraction determines the frost heave. In very frost-susceptible soils also the content of the silt fraction affects the size of the frost heave, but to a degree more than twice lower than the content of the clay fraction.

The presented issues have cognitive significance, and the determination of the magnitude of the impact of individual fractions on the size of the frost heave can allow qualification of the soils in terms of their susceptibility to frost heave.