STEPS Students Report

Pavel Kotov (Researcher)
Faculty of Geology, MSU

My research at the University of Tokyo was be devoted to studying behavior of soil to simulate the conditions of shelf. It is necessary to assess the carrying capacity and stress-strain state of the system "construction-basis", to choose calculation methods. And this is impossible to make without detailed laboratory studies. The geotechnical engineering laboratory University of Tokyo has large selection of devices and equipment. High pressure triaxial compression testing machine was more important for me, as it is possible to simulate the behavior of soils at great depths. I conducted some tests on sandy soil during my stay. We have obtained that the relationship between the normal and tangential stress at a pressure greater than 500 kPa is nonlinear.

Conducting experiments using the large Shaking Table (size 3.0m × 2.0m× 1.5m) were very helpful for me. The test's preparation was about 1 week. Apparatus is for carrying out the test model liquefaction under 1G. Desirable because it is hard to liquefaction stress level is lower than the real ground, and the soil is to tighten the loose. There are pore water pressure gauge and an accelerometer to record the change in pore water pressure rise and acceleration due to vibration. Thus, we can understand the behavior of the soil in earthquakes using such experiments.

I studied also behavior of silica sand under repeated liquefaction using triaxial apparatus. Similar cyclic stress ratio (CSR) and number of cycle to liquefy relationship can be observed in each liquefaction stage. The result shows that liquefaction resistance increase with number of stage. In double amplitude strain effect study, CSR Constant test, strain history of 1% and 2% have greater liquefaction resistance than the other.

The next stage of my work was to study numerical simulation of thermo-hydro-mechanically coupled processes during ground freezing and thawing. Fully coupled thermo-hydro-mechanical (THM) processes in the freezing and thawing phenomena of ground are studied numerically. Fully saturated frozen soil composed of soil, water and ice is modeled as a homogeneous three-phase mixture (theory of multiphase mixture) and the governing equations of frozen ground are accordingly derived by combining the individual governing equations constituting phases with consideration of interaction between phases, especially water and ice phases. Those governing equations are solved by the finite element method with simple supplementary equations representing mechanical / hydraulic / thermal characteristics of frozen soil. But it is mostly theoretical formulations for modeling the THM process. Therefore, the program of experiments to verify this model has been developed. Experimental research I carried out in the laboratory of Mechanics of soils (Lomonosov Moscow State University). Process modeling experiments will be carried out Hiroyuki KYOKAWA at Tokyo University. In the future, we are going to publish articles on the subject.