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Topic of master thesis: “Deformation of quay sheet pile wall under the effect of ice and ice-rich soil thermal expansion in conditions of high north”

I have arrived to UNIS in the beginning of 2014. For one year I have been taking several courses on frozen ground engineering and ice mechanics, and finally decided to write my master thesis there.

The topic of my thesis is “Deformation of quay sheetpile wall under the effect of ice and ice-rich soil thermal expansion in conditions of high north”.

The problem of unexpected quay deformations in the conditions of high north is not completely studied yet. I was offered by Alexey Marchenko to examine two objects on Svalbard: new harbor in Longyearbyen near power plant and coal terminal on Kapp Amsterdam, Svea (Fig. 1).

a. Longyearbyen harbor, right side.

b. Examined fragment of Kapp Amsterdam coal terminal

Fig. 1. Pictures of examined objects

Kapp Amsterdam

To obtain the deformation rates I have made several scans with REIGL laser scanner and compared them with previous ones. The comparisons can’t be presented in this paper because the work is not completely finished yet.

Four pressure sensors were installed in the ice inside of cofferdam box under the quay, also 4 sensors had been installed before on the sheet pile wall before (see Fig.2). In addition, a thermistor string have been measuring temperature distribution in the ice for almost 1 year.

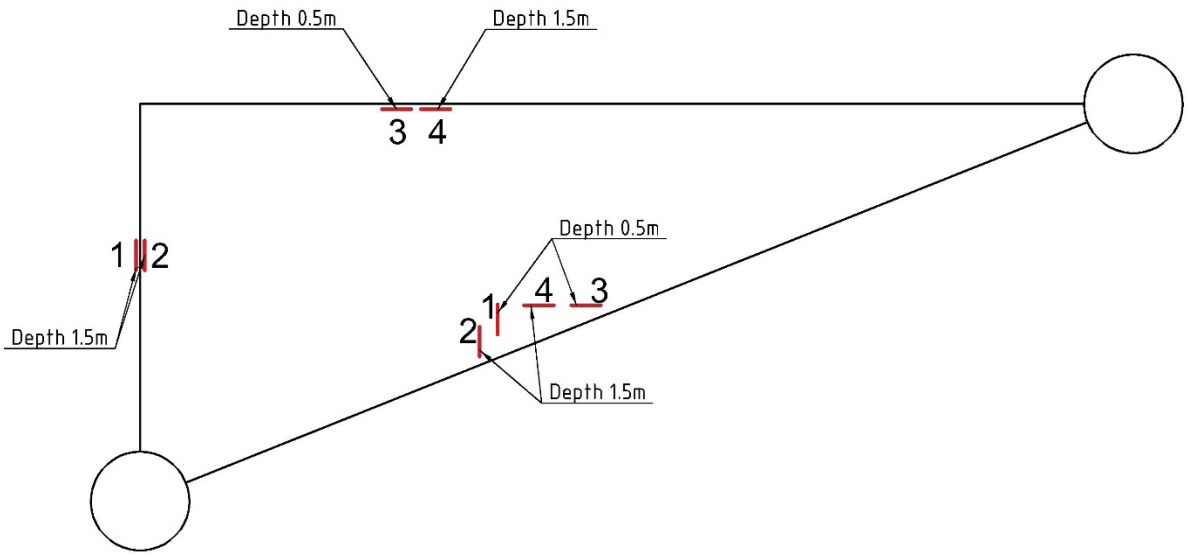

Fig. 2. Scheme describing positions of pressure sensors

The measurement were being taken for one week. Fig. 3, 4 shows dependencies of ice pressure on temperature and tidal cycle.

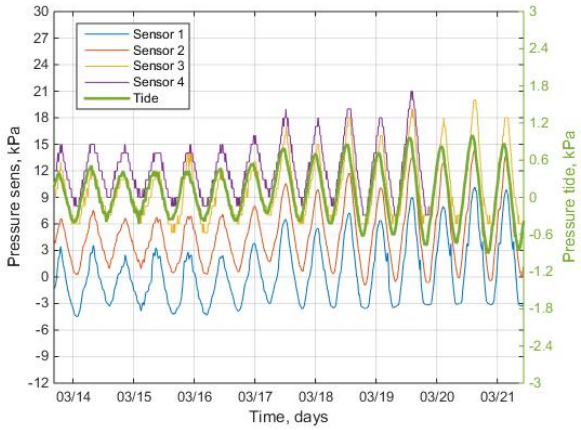

Fig. 3. Sensors installed inside of cofferdam box.

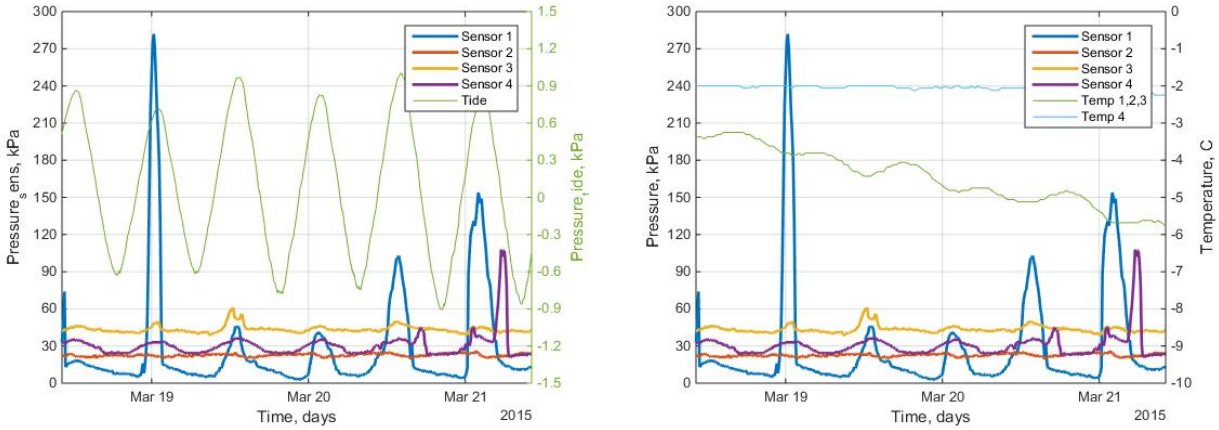

Fig. 4. Sensors installed on cofferdam in comparison with tide and temperature.

It can be seen that pressures on and inside the cofferdam follow tidal cycle and almost independent from ice temperature. I am sure that there should be some dependencies but it requires much longer period of observation to detect them.

As one can see on the Fig. 3 sensors 3 and 4 experience maximal pressures because they are faced perpendicular the shore line and they are not affected by coast damping, unlike in happens with sensors 1 and 2. The same process makes pressure variations of sensor 2 from the Fig. 4 negligible.

Longyearbyen harbor

The laser scans comparison showed some deformations for the last year which are shown on the figure 5.

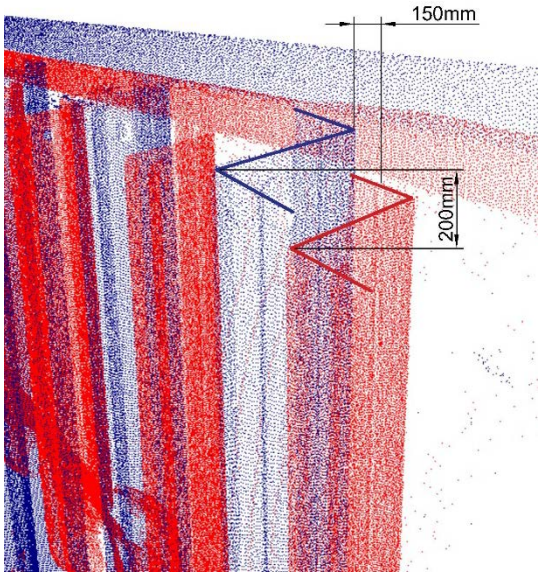

Fig. 5. Deformations of Longyearbyen harbor sheetpile wall

It was decided to do an experiment modeling frozen ground expansion inside sheet pile wall. A steel pipe was taken and was filled with saturated sand. The temperature was changing from freezing point to -25°C and back to freezing point several times. Pressure on the pipe was measures by Tescan pressure sensor. Thermal expansion of the soil was measured by Fiber Bragg grating sensors. Also soil temperature was measured by 3 different temperature sensors. Fig. 6 shows the equipment used in the experiment.

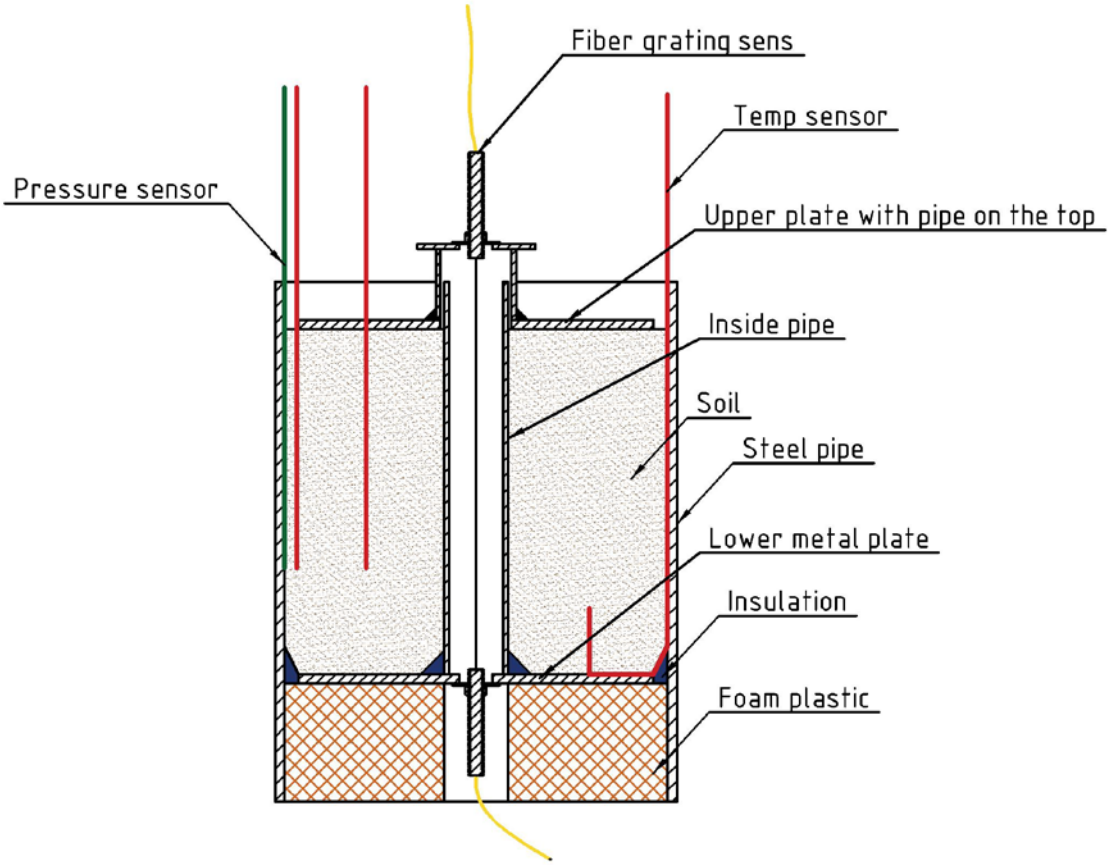

Fig. 6. Experiment with pipe

The point of the experiment was to obtain the dependencies of soil thermal expansion and pressure on the wall. The experiment is not finished yet, so the results can not be presented in this paper.

The results of observations in the field and experiments will be collected and combined in order to understand some tendencies in the behavior of quay structures in Arctic conditions.