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SOIL SAMPLE ANALYSIS FOR SSC

Fieldwork and laboratory work for soil sample analysis were done as part of the AT-205 "Frozen Ground Engineering" course in March 2004. The fieldwork was done outside the actual UNIS building and not far from the area were the new SSC building will be built. The work consisted of *Drilling and collecting of soil samples*: drilling of soil samples was conducted on 4 March 2004 by a team of two workers and a drilling machine from Leonard Nilsen and Sønners Store Norske Kompani. Maximum drilling depth was approximately 12.7 meters and soil samples for laboratory analysis were planned to be collected throughout the whole depth. Problems with finding the correct drilling and penetration velocity made that the first couple of core samples could not be used. Therefore only the samples of good quality coming from depths of interest (9.3 to 12.7 meters) were taken for further analysis.

Laboratory work

Salinity: To find the salinity, some soil sample was compacted in a small cylinder with filter in one end. In the other end, compressed air was extracted in. The water was pressed out, due to the high pressure, in a cup. Then a drop of water was placed on a refract-meter to test the salinity.

Water content: The water content w represents the percentage in mass of water in a determined sample. In other words, it is the weight of water (W_w) divided by the weight of the grains (W_s): $w = \frac{W_w}{W_s}$. To determine W_s, we dry the sample in an oven at a temperature of 105°C during 24 hours. Then, we can directly find W_s and W_w is obtained by soustraction between the wet sample weight (taken before the drying) and the dry sample weight.

Density of frozen soil: The density of the frozen soil is the total weight of the sample (W) divided by the volume (V) of the sample. $\rho = \frac{W}{V}$. No problems to determine the weight (W). But, to obtain a correct volume, we have to considerate that our sample is a cylinder. However, it is not an exact cylinder shape so that we determine the diameter taking two measures in two different axis and we use the average for the volume calculation. We repeat the operation for the length. Then the formula is: $V = L\frac{\pi \cdot D^2}{4}$, where D – the average diameter; L – the average length.

Density of solid particles ρ_s: we used the pyknometer method. We put a small amount of soil in the pyknometer, and then we fill it with distilled water. Afterward, we place the pyknometer in a vacuum to eliminate all the air, which could stay in the soil pores. After roughly 15 min in the vacuum, we measure the weight of the pyknometer with sample and water. Then, we dry the sample to know the mass of the grain (W_s). To finish, we determine the volume (V_s) using the finally known value of the pyknometer with only water. In fine, we can calculate the density of solid particle: $\rho_s = \frac{Ws}{Vs}$.

Grain size distribution: The aim is to see the grain size repartition of our soil. Because of that our soil contains very fine grains, we need two different operations to obtain the global grain size distribution. Firstly, we take a sieve column composed by different mesch size. We can separate all our soil components from the coarse grains to the fine particles of 0.074 mm size. At the beginning, we use wet soil. Then, for the two last sieve (the two smallest), we dry the grains so that it is maybe more precise because it is easier to separate each grains. We measure the weight of the different dry particles retained in each sieve and it is possible to deduce the distribution until the grain size 0.074 mm (smallest mesh). $P(\%) = \frac{g}{G} \times 100$ – dry weight of a given fraction on a certain sieve, G – dry weight of a total soil sample used in the sieve analysis. Secondly, we determine the grain size distribution for the particle with size below 0.074 mm using the hydrometer method. We take the rest of the sieve particles, we dry it and we add one liter of distilled water mixed with one gram of dispersant agent. In effect, this method is based on the gravity and the dispersing agent prevents the particles from sticking together and creating a heavier grain. With the hydrometer, we measure the density of the water at different time and we can determine the grain size repartition using the Stock's law.

Plastic limit: to find the plastic limit we rolled the soil into trigs with a diameter of 3mm. When the string crumbled and cracked it was weighed and dried, and the water content for the plastic limit was found. Because of some reasons we did not do this test.

*Liquid limit: f*or this test the Cassagrande apparatus was used. A soil sample was filled in the cup and a grove was made. The cup hit the "floor" with 2 rpm.

Uniaxial compression test: for a uniaxial compression test a sample with height two times the diameter is needed. The tests was carried out on the uniaxial/creep test machine "KNEKKIS". The machine records the load and the strain. For the two tests, a strain rate of 1% pr minute was used.

Unconfined creep test: the test was carried out on the uniaxial/creep test machine "KNEKKIS". The sample was given a constant load of 70% of the maximum load found from the compression tests.

Unfrozen water content: the Cassagrande method was used to carry out a number of liquid limit tests with different water content. The number of blows was plotted against water content, so the water content for 25 and 100 blows could be found.

The results of the laboratory work were as follows:

<u>Discussion of the results</u>

Water content: The two samples have quite different shape of the water content curve. The difference in water content between the two samples might have to do with how well dried the sample is.

Density of frozen soil: As there are only two tests at two different depths no certain conclusions can be drawn other than that the density seems to be increasing with increasing depth and that the low figures might have to do with a high water content in the sample

Density of solid particles: Also here the base for drawing any conclusions are to small and all that can be said is that the different results from the different samples seems to correlate well.

Salinity: The salinity shape is a bit shaky in the beginning, which could be the result of drainage through the soil layers, but stabilises further down and shows an increase in salinity with increasing depth. This could suggest some influence of seawater in the soil as the samples were taken so close to the sea.

Grain size distribution: In order to get the grain size distribution two samples were sieved through a pile of different sized mesh. This sieving was done by many different people and with different accuracy, which could be the explanation to the quite different classification of the soils that were the result. Another explanation could be that the soil layers actually are that mixed.

Uniaxial compression test: The two curves shows that the two samples were different in strength. Sample number one could take almost double the load as sample number two but still the two samples behaves similar. This could be explained with the fact that the soils are to begin with quite similar but where sample number one is more or less uniform, sample number two has ice grains included.

Plasticity: The test was done but cannot be trusted since the samples were well graded.

Creep test: The plot shows a typical behaviour for a viscous elastic material. The strain rises quickly in the beginning until it reaches its elasticity limit and then it flattens out.