MATERIAL TESTS: DESCRIPTION OF TEST METHODS

The **water content** of a material (aggregate to be stabilised, fly ash, fibre sludge, filtercake) is the ratio of the quantity of water removed from the wet material (m_m) in the course of drying in an oven up to a constant mass value and the dry material mass (m_d). The general drying temperature is 105 °C for most of the samples; the calculation is according to formula

$$w = \frac{m_m - m_d}{m_d} * 100\%$$

Loss of Ignition (LoI) will describe the content of the organic matter of the material. This can be characterised by the weight loss a dried material sample (m_d) will suffer in the course of heating as the organic matter will be combusted and lost at a very high temperature (550 / 800 °C for at least 1 hour). The residual mass is m_i. This weight loss is expressed in dry weight percentage, and called Loss of Ignition (LoI):

$$LoI = \frac{m_d - m_i}{m_d} * 100\%$$

Particle Size Distribution will be determined by sieving and/or by a sedimentation tests. For example, in the (dry or wet) **sieving** procedure a dried sample is poured through sieves of different grades (e.g. 2, 0,063, 0,04 mm …). The total quantity of fine particles (e.g. <0,063 mm) can be calculated from the difference with respect to the masses passing the grades. In a **sedimentation test**, or the Areometer test, the grain size is determined on the basis of the settling rate of the particles in a liquid (according to Stokes' Law). The settling rate is measured by a specific gravity hydrometer, which is placed on a prefabricated solution on certain intervals. The maximum grain size in this test has to be less than 2 mm, i.e. for some materials the sieving with 2 mm sieve is needed. If the sample contains more than 2 % of organic matter, it should be treated with hydrogen peroxide to eliminate organic matter.

The **compactibility** of the materials is being determined by using the modified Proctor test while simultaneously determining the maximum bulk density (dry), $\gamma_{d,max}$, and the optimum water content, w_{opt}, of the material. The resultant relative compaction or compaction rate is D [%]= $(\gamma_d/\gamma_{d,max})*100$. For example, during the follow up of the construction the real-scale compaction results can be compared with this maximum D-value; the result is very good in case the obtained bulk density of the road course is more than 90 % of the maximum D-value.

Unconfined Compression Strength, UCS, is a standard test where a cylindrical test piece is subjected to a steadily increasing axial load until failure occurs. The axial load is the only force or stress applied. The rate of the load is 1 - 2 mm/min. If there does not occur any noticeable failure, the maximum value of the compression strength is taken when the deformation (change of height) is 10 %. Usually, the test will be made on test pieces after at least 28-30 days stabilisation. The Figure 1 below shows the test in progress.

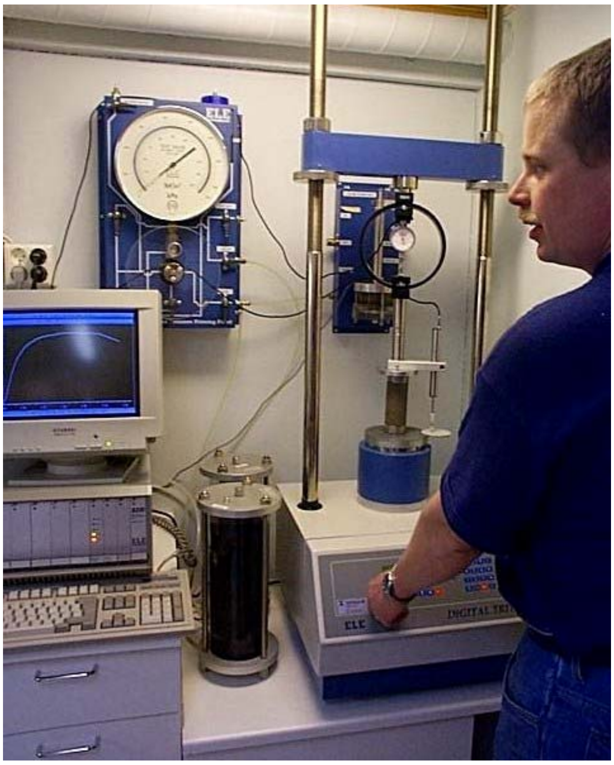

Figure 1: Unconfined compression test in progress. SCC Viatek Ltd, SGT.

Frost susceptibility test will determine the material's resistance to frost. A test piece will be compacted in a plastic cylinder and the test will start after 28 days stabilisation, and after the test piece has been saturated with water. The frost susceptibility will be tested with special test equipment that allows the upper side of the test piece to become frozen (- 3oC) and the under side to remain thawed (+ 1oC) and absorb water on a capillary carpet. At the start, during water saturation, the load on the test piece is around 20 kPa. The load on the test piece can be varied during the test, but normally it is around 3 kPa. The frost susceptibility will be determined by measuring the settlements or frost heave of the test piece over a certain time period. Segregation potential, SPo [mm2/h], can be calculated on the basis of the frost heave. The bigger the value of SPo, the more susceptible to frost is the material. After the test, the frost susceptibility can additionally be assessed by visual assessing the condition (eg. softening and lenses) and by determining the strength (UCS) of the test piece after the frost susceptibility test.

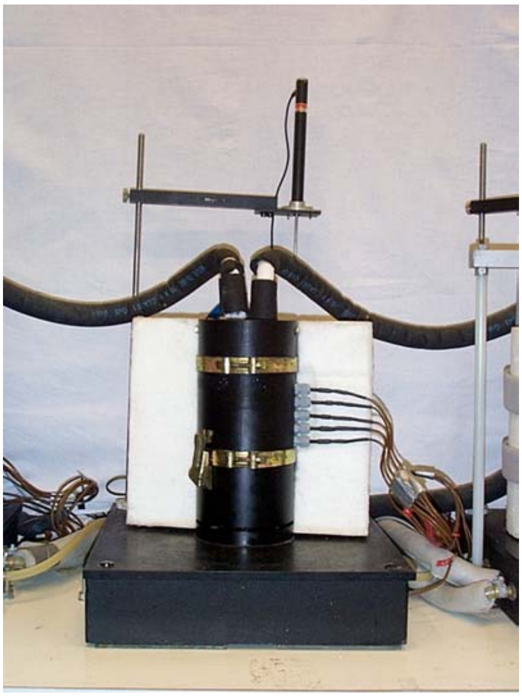

Figure 2: Frost susceptibility test. SCC Viatek Ltd, SGT.

Freeze-thaw durability test will determine the material's resistance to freezing and thawing cycles. Freeze-thaw tests are made according to a suggested test method of the Technical Research Centre of Finland (VTT:"Tien rakennekerroksissa käytettävän hydraulisesti sidotun materiaalin pakkas-sulamiskestävyyskokeen suoritus "): The test piece that has been stabilised for 28 days will be placed in a container on a capillary carpet. Water will be absorbed by the test piece through this capillary carpet. After 4 hours the test piece will be placed in a freezer, the temperature of which will be decreased from room temperature to freezing (-18 ^{o}C). The test piece will remain at this temperature for 8 – 16 hours. The test piece will then be rotated by 180^{o} and placed on the capillary carpet for thawing, after which the former stages will be repeated. These cycles will be repeated 12 times. The condition of the test piece will be controlled at all times during the test. After the test is completed, the strength (UCS) of the test piece will be determined

Soft wall permeability test with constant pressure is carried out according to the recommendations of the Environment Centre of Finland. A test piece inside a rubber membrane will be subject to an 3-dimensional pressure in a test cell. Water will be conducted through the test piece from a front container to a back container, and the water level differences of the containers will be measured. Water flows upward inside the test piece when there is higher pressure in the front water container than in the back container. The simple formula to calculate the water permeability factor is as follows:

$$k = \frac{Q * L}{A * t * H},$$

where k = water permeability [m/s]; Q = quantity of water seeping through a test piece [m^3]; L = height of the test piece [m]; A = area of the cross-section of the test piece [m^2]; t = time [s]; H = height of the water level [m]

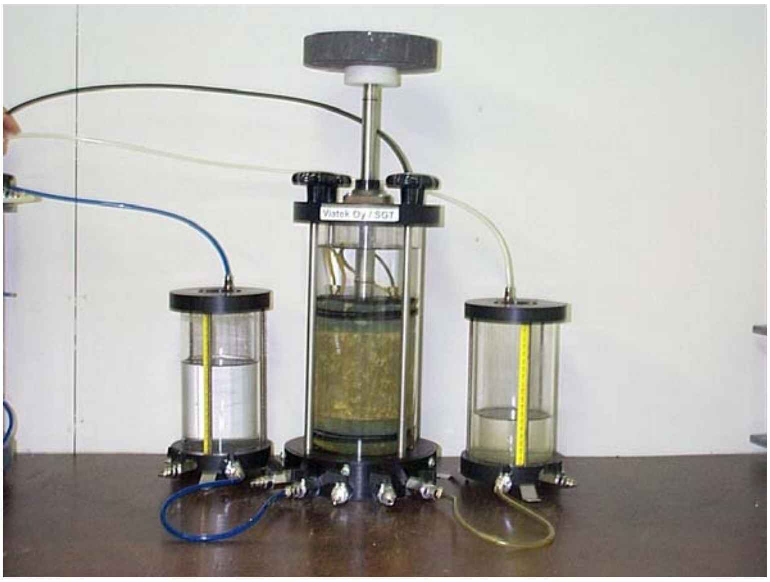

Figure 3: 3-axial water permeability test equipment. SCC Viatek Ltd, SGT

The environmental tests include the determination of the total content of potentially harmful substances or elements in the material, and the long-term leaching of these substances or elements from the material into its environment. The soil conditions, pH and the structural application itself are those factors that finally affect the transport of the harmful substances or elements in the environment.

The total content will be determined by ICP-MS/AES after treatment of the dried material according to EN 13656 (extraction into nitrogen acid and dispersion by microwaves) at the chemical laboratory of GTK (Geological Survey of Finland). The results will be compared with the available recommendations for guide values of clean / polluted soil.

The leaching will be determined according to a Dutch standard (NEN 7343), an up-flow percolation test for inorganic constituents in the laboratory of SCC Viatek Oy, SGT. The leachates will be analysed by GTK (ICP-MS/AES), and the results will be determined at L/S 10 (L/S is the rate of percolated Liquid to the Solid substance) as mg of constituent / kg of material (dry). The results will be compared with the available recommendations for guide values for leaching.

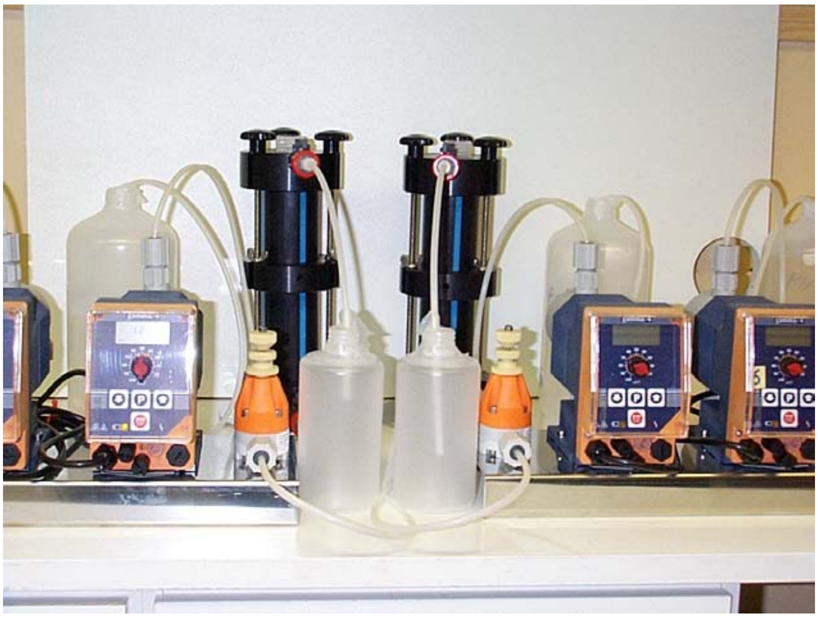

Figure 4: Column test. Leaching test according to NEN7343. SCC Viatek Ltd, SGT.