TK04 Application Note

Taking soil samples for thermal conductivity tests

General

Please follow the instructions in this application note for taking disturbed and undisturbed soil samples to allow reliable thermal conductivity measurements with the needle probe method whose results are representative for the sampled terrain.

If you have any questions please contact us **before taking the samples**: mail@te-ka.de or +49-(0)30-455 66 71.

Number of samples

Natural materials like soil samples are always more or less inhomogeneous. For this reason, several samples should be taken from different locations of the site to be investigated in order to account for the range of variation in thermal conductivity. A single value cannot be considered representative of a larger area.

Undisturbed samples

Undisturbed samples are taken with a tube sampler. Undisturbed samples are required if the thermal conductivity of the unmodified material should be determined as encountered in the field.

Sample size: Standard tube sampler 100 mm diameter / 120 mm height. Please contact us for smaller samples or different diameters. The cylinders must be completely filled (to the upper edge).

Moisture content: Thermal conductivity strongly depends on moisture content (maximum value in saturated state, minimum value in completely dry state). If the moisture content at the time of measurement is unknown, results are of no informative value. If the moist samples should be tested as delivered, the customer is responsible for moisture determination. When measuring in dried or saturated state, the moisture content of the samples is adjusted by us.

Packaging: Samples must be properly wrapped to prevent water from running out during transport and to avoid drying out of the material. Caps must be sealed with adhesive tape. Sample containers must be packed shockproof to keep the soil structure undisturbed during transport.

Please note the hints on grain size distribution!

Disturbed samples

Loose soil is sampled in the field (e.g. from a trial pit, with an excavator or a shovel), and is used to produce samples for the measurements. This method is suitable if the material to be tested will be used on a construction site (e.g. for backfilling a cable trench) and the resulting thermal conductivity on site should be determined.

Compaction / Proctor test: The samples must have the exact water content and compaction that will be used later on site. For sample production, the results of a so-called Proctor test (**Proctor density** and **optimum moisture content**) and the desired **degree of compaction** are required (for an explanation of the terms, see the glossary on the last page). The Proctor test can be ordered from us (please contact us before taking the samples in order to arrange shipping directly to the soil laboratory).

Required sample amounts: 3 kg per material for sample production, another 10 kg for a Proctor test.

Packaging: Any.

Please note the hints on grain size distribution!

Important: grain size distribution

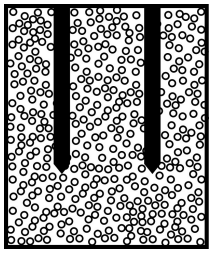
Thermal conductivity is defined for homogeneous materials only. Soil samples can be considered homogeneous if their grain sizes are sufficiently small compared to the probe diameter (2 mm) and the penetration depth of the measurement. Grain sizes up to 1 mm have proven ideal; small proportions of coarser grains up to approx. 10 mm are no problem. Too many coarse constituents could cause:

- sample production problems (compaction is not uniform)
- difficulties in collecting undisturbed samples (tube samplers cannot be driven into the soil, sample containers are incompletely filled, soil structure is loosened)
- difficulties in inserting the probe for measuring
- irregular heat propagation in the sample during measurements (results may be falsified)

In extreme cases, measurements are impossible because either the probe cannot be inserted into the samples or heat propagation during the measurement differs so much from the theory that the measuring curves cannot be evaluated.

In case of doubt, please contact us before placing the order and taking the samples to establish whether measurements will be possible (a photo of the material and/or the grain size distribution curve would be useful for this purpose).

Rule of thumb/simple test: The material is suitable for measuring if a 2 mm thick and 70 mm long nail can be inserted or driven into the samples without hitting any obstacles and without being deflected (which would cause cavities).



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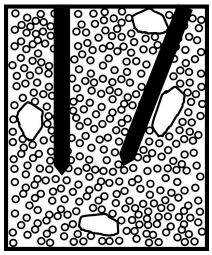
grain sizes up to 1 mm



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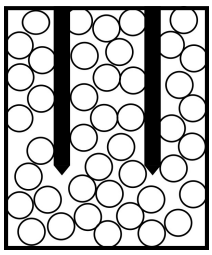
grain sizes up to 1 mm
small amounts of grain sizes 1-10 mm



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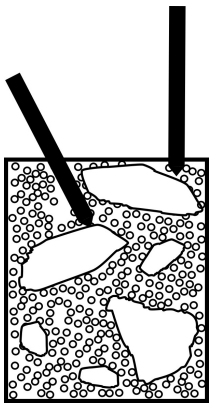
grain sizes larger than 1 mm
finer grain sizes missing
insufficient contact between probe and sample



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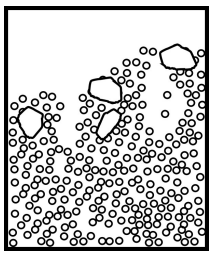
very large components
probe cannot be inserted into the sample



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sample container not completely filled
sample structure loosened during transport, contact problems, values not representative for sampled material

Glossary

Proctor test: How well soil materials can be compacted depends on their water content. The Proctor test is used to determine the maximum density and the corresponding moisture content for a standardized compactive effort.

The test consists of compacting the material at different moisture contents into a test cylinder using a standard drop weight and determining the (dry) density by weighing the dried soil filling and dividing it by the cylinder volume. Plotting the densities against the corresponding water contents yields a bell curve. The maximum density and its corresponding moisture content are obtained from the peak point of the compaction curve.

Proctor density: The maximum density determined from the Proctor test for the soil material tested.

Optimal moisture content: The moisture content corresponding to maximum density as obtained from the Proctor test.

Degree of compaction: How well a sample is compacted can be expressed as a percentage of Proctor density. A degree of compaction of 100% means that the sample has Proctor density. For backfills on construction sites (e.g. for cable trenches), often a degree of compaction of 97% of the Proctor density is used.