GTC Kappelmeyer® – Measurement Methods

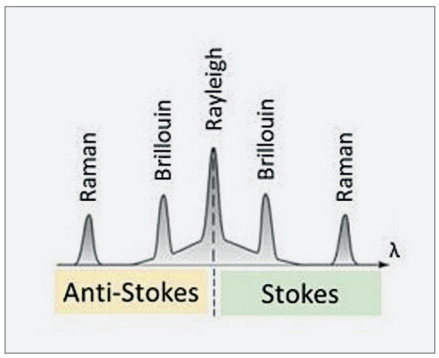
The Brand GTC Kappelmeyer®

In January 2017 the company GTC Kappelmeyer® was integrated into the Solexperts group. As the independent brand GTC Kappelmeyer® we offer from the location in Karlsruhe besides the previous measuring technology in the field of thermal leakage detection, all services of the Solexperts group.They include distributed fibre optic temperature measurements and distributed fibre optic strain measurements.

More than 500 km of dams, dikes, many lock constructions and more than 200 sealed excavation pits were examined successfully. The following methods are generally used:

Temperature Sounding Method

A measuring cable with temperature sensors is inserted into a hollow rod, which was rammed into the ground. After a thermal adjustment phase, the ground temperatures are measured in various depths with a portable precision measuring device. Existing temperature anomalies can be localised on site.



Fibre optic temperature measurements

Fibre optic temperature measurements are based on the backscattering of a short laser pulse (<10 ns) that is coupled into the glass fibre. The temperature determination takes place via Raman spectroscopy of the backscattered light. With the intensity ratio of Stokes and Anti-Stokes lines, the temperature is calculated. The spatial assignment of the measurements takes place by a very precise time measurement, allowing for the speed of propagation of light within the glass fibre. For cable lengths of up to 10 km, a temperature measuring precision of better than 0.1°C and a spatial resolution of about 0.7 m is achievable.

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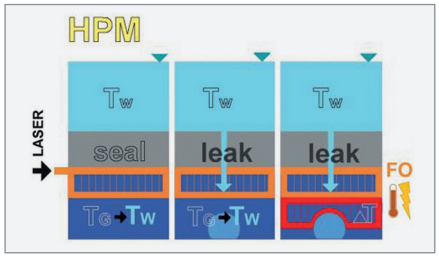
Gradient Method

If the temperature difference between the surroundings of the optical fibre and the water is high enough, the onset of leakage is detectable by a decreasing temperature gradient between the temperatures of the undisturbed ground and the seepage water. This method depends on seasonal temperature fluctuations.

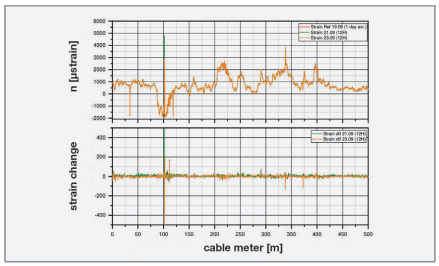


Heat-Pulse-Method

In case of an insufficient temperature difference between the surroundings of the optical fibre and the water, a hybrid cable with copper wires is used. By heating the cable, an increase of temperature is recorded that is lower in areas of leakage. This method is independent of seasonal temperature fluctuations.

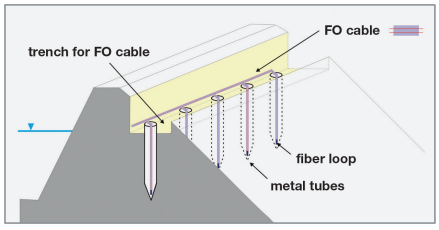
Frost-Pulse-Method

A refrigerant is inserted into a temperature sounding tube. Subsequently, the temperature rise is measured with temperature sensors and then it is interpreted analogously to the HPM. Therefore, no electrical energy is essential.



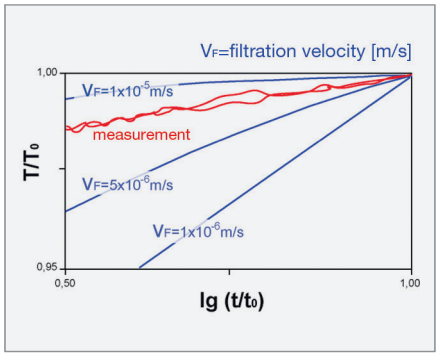
Fibre optic strain measurements

Deformations and movements underground are detectable with a resolution of up to 0.2 m and an order of 10 µm/m. Even (micro-)fissures within the fabric of concrete are detectable. A single mode glass fibre can be dilated up to approximately 10 000 µm/m (1%). Thereby, the coating needs to transmit any change of strain precisely.



Retrofit Method

For the surveillance of structures, the fibre optic measuring technology can be installed subsequently. Therefore, e.g. temperature sounding tubes are rammed into an embankment and supplied subsequently with bend optimised hybrid fibre optic cables.



In-situ determination of the pore velocity

With the Heat-Pulse-Method it is possible to determine pore velocities of 10^{-7} m/s to 10^{-2} m/s in-situ. During the heating phase, a specific temperature increase is observed, which depends on the thermal conductivity, the heat capacity and the flow velocity of the seepage water, respectively the ground water. Comparing the measured temperature rise with numerical calculated values, the pore velocity of the fluid becomes determinable. It is possible to determine the pore velocity with the Gradient Method in-situ, if a temporal variation of the seepage water temperature is available.