Inclinometers

Displacements orthogonal to a bore hole are measured with tilt sensors (inclinometers) or permanently installed cross-shift measuring chains (deflectometers). To take measurements with the inclinometer, tubing is inserted in the bore holes. The annular gap between the tube and the bore hole wall is filled with cement mortar or damp material. The inclinometer, which is inserted in the bore hole on a measuring line, consists of a probe of either 0.5 or 1 m in length with two built-in pendulums arranged on mutually vertical planes. Spring-loaded rockers, each with two guide wheels, are positioned at both ends of the probe so that the guide wheel track fits exactly in the grooves of the tubing. The guide grooves ensure that the measuring axis of the inclinometer is the same for each measurement on moving through the bore hole in half or full meter steps during a measuring cycle. The measuring principle of a pendulum is illustrated in Fig. 1.

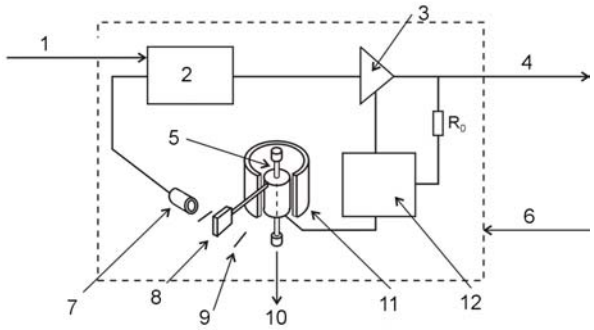

Fig. 1 Inclinometer pendulum with optical position sensor

1	Voltage	2	Electronics module
3	Amplifier	4	Output signal
5	Clamping band	6	Leakproof housing
7	Position sensor	8	Pendulum
9	Stop	10	Vertical axis
11	Motor	12	Filter

Any rock displacements occurring between two measurements will cause the inclination of the tubing to change. This change results in a different angle of inclination between the pendulum (vertical) and the measuring axis. The measured value is indicated as the sine of the angle of inclination or as a displacement in millimetres. For evaluation purposes, the individual measured values are joined together to form a progression. With careful measurements the measuring accuracy lies at $\pm 2 \times 10^{-4}$ of the measuring step ($\pm$ 0.2 mm/1 m). Inclination measuring tubes can also be installed together with extensometers in the same bore hole, enabling displacements both parallel and transverse to the bore hole axis to be taken.

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97