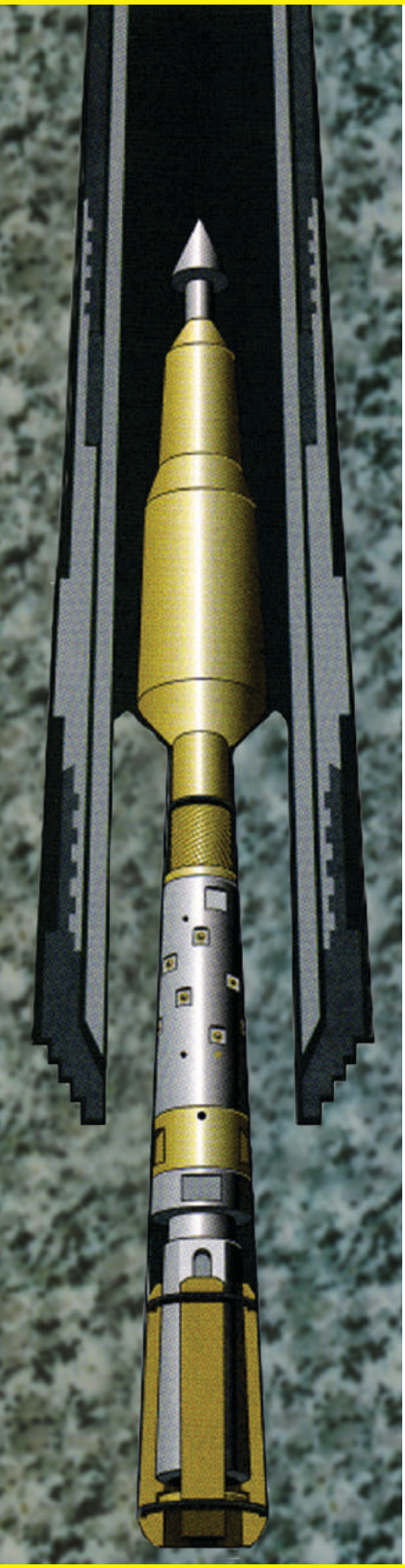
IN-SITU STRESS TEST BY OVERCORING
IST

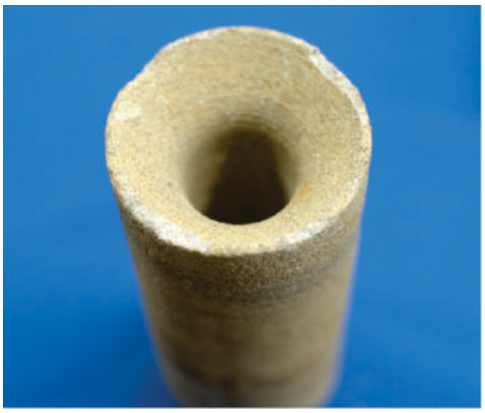


Sigra's proprietary in-situ stress measurement tool is a biaxial device which measures the deformation of a borehole perpendicular to the tool during overcoring. To calculate the stress field, an assumption is made for the axial stress. This is usually considered to be the overburden stress for vertical exploration borehole. Tests can be completed in as little at 1.5 hours and successfully conducted in holes up to 2000 m in depth.

Sigra's in-situ stress tools have been successfully used in some 2500 stress measurements at depths ranging from 1.5 m to 1000 m. The In-situ Stress tool has been incorporated into geotechnical investigations for most major tunneling projects in Australia since 2014 including the WestConnex, Sydney Metro and the Melbourne Metro Rail projects. Sigra has conducted testing in Botswana, South Africa, Serbia, USA, Australia and New Zealand. The compact system allows for economical transport to any location in the world.

Procedure

When the normal HQ or PQ wireline coring operation reaches the stress test depth, the driller's inner core barrel is replaced with Sigra's countersink bit. The countersink bit is dropped down hole and latches in to the HQ latch assembly. The purpose of the countersink bit is to remove any upstanding core stump and create a cone depression to guide the pilot hole tool. The countersink bit is withdrawn by the wireline winch.



Core sample with countersink and pilot

The second stage involves pumping a pilot hole drill to the bottom of the hole. Utilising the drill string rotation and water pressure, the pilot hole drill creates a 500 mm long and 26 mm diameter hole. The pilot hole drill is then withdrawn by the wireline winch.

The third stage involves lowering the in-situ stress tool into the pilot hole where the triple wedge system locks the tool in to place. The drill rods are then pulled back so the on-board magnetometers and accelerometers can detect the inclination and azimuth of the tool free from magnetic interference.

The core barrel is then pumped into the rods and coring commences. As the bit progresses past the pin locations on the tool, the change in pilot hole diameter caused by overcoring is recorded in the on-board logger.

At the end of overcoring, the core and the tool are pulled to surface inside the inner tube of the core barrel. The data is then downloaded to a laptop and analysed by a Sigra engineer. A preliminary assessment of the test result can be made rapidly on site.

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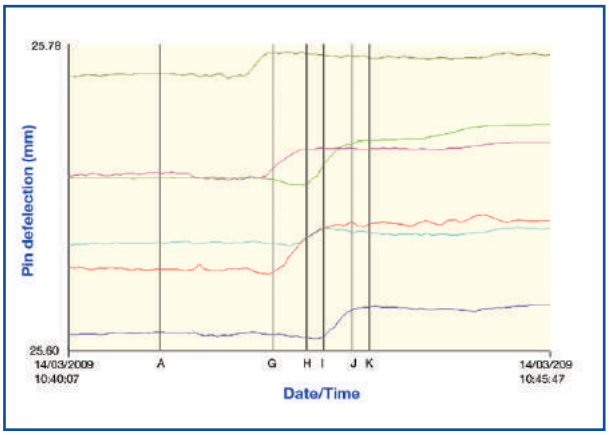
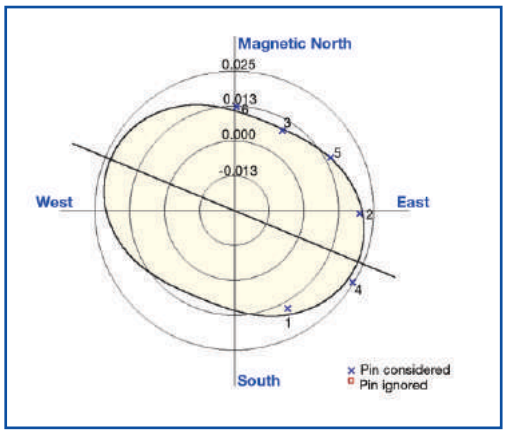
Stress Analysis

After the successful completion of a test, the core sample is transported to Sigra's laboratory for material property testing. Sigra has the in-house capability to perform uniaxial and triaxial compressive testing along with the ability to determine the Biot's coefficient of a core sample. Core samples are normally tested for the secant unloading Young's modulus and Poisson's ratio. The results of the laboratory testing are incorporated with the deformation information to arrive at the biaxial stress field perpendicular to the borehole. Because the orientation of the tool is measured, the direction of the principal stresses can be found.

Sigra provides a report that includes material test information, stress and tectonic strain analysis, and the ratio of material stress to strength. Sigra may also interpret the stress regime.



Example of pin deformation with time during overcoring



Example of best theoretical deformation fit to real diameter change points

Drill Rig Requirements

The drilling needs to be set up for normal Boart Longyear HQ or PQ wireline coring for compatibility with Sigra's IST system. The rig pump, drive head motor and pressure gauges need to be in good working condition to provide successful measurements. Excessive vibration causes problems with measurement, as does pulsating drilling fluid which loads the pilot hole. These issues are generally managed by proper drilling technique.

Core sample prepared for testing in the laboratory

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