



APPLICATION SPOTLIGHT

MicroWIS™

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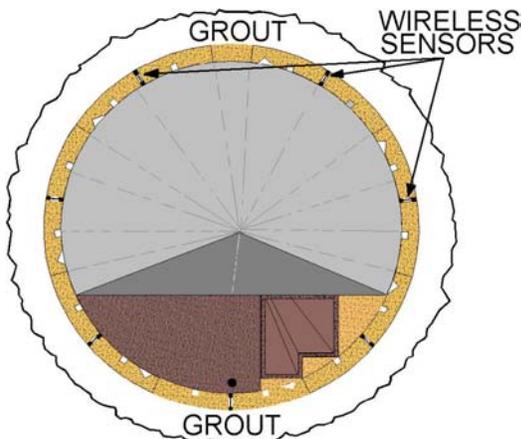
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Pressure Monitoring in Tunnels – Invocon, Inc.

Invocon's Microminiature Wireless Instrumentation System (MicroWIS) is currently being used to monitor external grout pressure during construction of two tunnels in the Netherlands. Government regulations require that strict controls be used during construction in order to insure that the tunnels will maintain integrity for 100 years or longer. Therefore, the grout pressure is monitored at several locations during the construction phase to verify that it meets quality and safety requirements.

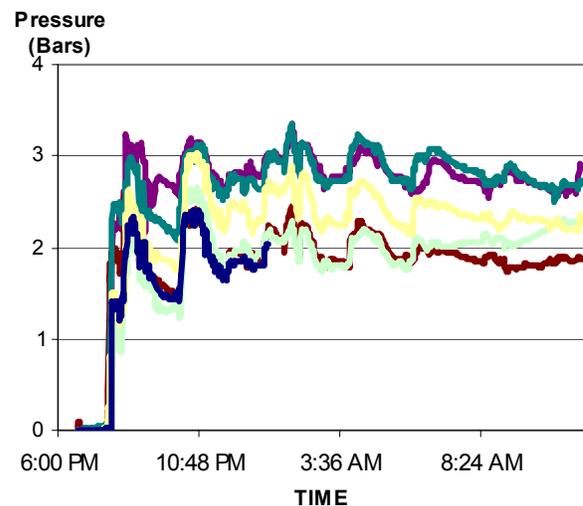
When boring tunnels through soft earth, proper grout pressure is critical because it governs the amount of grout that is deposited on the outside of the tunnel. This ultimately determines the water-seal and durability of the tunnel throughout its useful life. Another important reason to maintain proper grout pressure is that it will influence surface elevation of the ground directly above the tunnel. When the grout pressure becomes too low during construction, the surface can sink. This is undesirable in a country where much of the land is at or below sea level.



Cross section of instrumented tunnel

The tunnel cross section depicted above shows multiple sections required to build the tunnel along with the miniature wireless pressure sensors. Wired systems are not practical for this application due to the nature of the Tunnel Boring Machine (TBM). The TBM is a large structure, several hun-

dred meters long used to dig through the soft ground and assemble the tunnel. Since the TBM is constantly moving and contains so many parts, wires are difficult to route safely and can be easily broken or cut.



MicroWIS Grout Pressure Profile

The MicroWIS units are installed in specific concrete sections prior to their installation in the tunnel. As the sections are placed in the tunnel, the receiver is activated and begins graphing and recording data from all nearby units. As the units pass through the pressure seal, the indicated pressure begins to reflect the outside pressure and then begins to decrease over the next few days until the grout is completely cured. The graph above shows the output from six transducers during the first 18 hours of monitoring. This data demonstrates the pressure variations encountered with respect to both time and sensor location.

Although MicroWIS units are capable of sampling at up to once per second, lower sample rates were appropriate for the nature of this testing.

The wireless nature of this system greatly simplified the installation process and eliminated the risk of broken data and power cables at the construction site.