

**renesco**<sup>®</sup>  
Geotechnik



# INNOVATIVE HYBRID INJECTIONS

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## INJECTION SEALING WITH A HYBRID INJECTION AGENT

Although polyurethane (PUR) resin injection can be used to seal aquiferous fissures, the process is very expensive, while pure cement slurry can only be used in certain cases due to leaching concerns. However, Renesco has developed a method that combines the advantages of both approaches and now offers hybrid injection-sealing solutions. The process is ideally suited to fissures and highly aquiferous gravel bodies. Water ingress can be stopped economically.

### Strong water ingress causes stop of driving operation

Renovation work is currently underway on a pumped-storage plant in Switzerland, with a new water-catchment and a 2,300-meter pressure tunnel under construction. During the driving operations for the pressure tunnel, a massive water ingress of 134 liters per second was observed. This was not only unexpected, but also meant driving had to be stopped. Sonic drilling showed that the fissures varied greatly in terms of their opening width. The first step was to stop the water ingress in the tunnel. After that, all fissures had to be sealed in advance with an injection screen (see figure 1). The rock also needed to be stabilized, and this was done using an injection agent and a unique injection process. The glacial deposits in the tunnel of Nations project in Geneva is also highly aquiferous. The driving operations were interrupted, with all attempts cement injections were unsuccessful. The water ingress was stopped by hybrid injections.

### Hybrid injections designed for hydrogeology

The newly developed hybrid-injection method sees the cement slurry mixed with PUR resin just before being

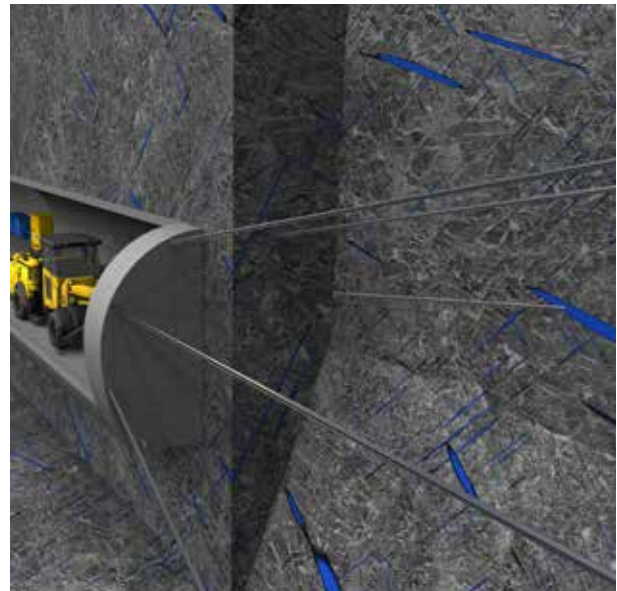


Figure 1: Boreholes for advance injection screen

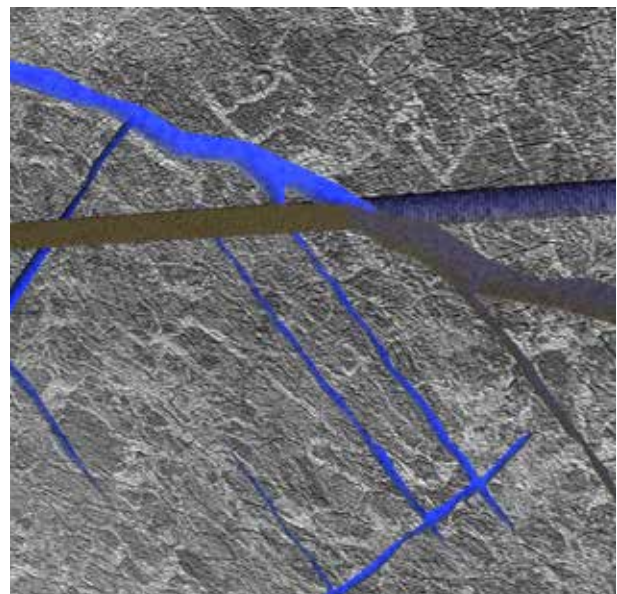
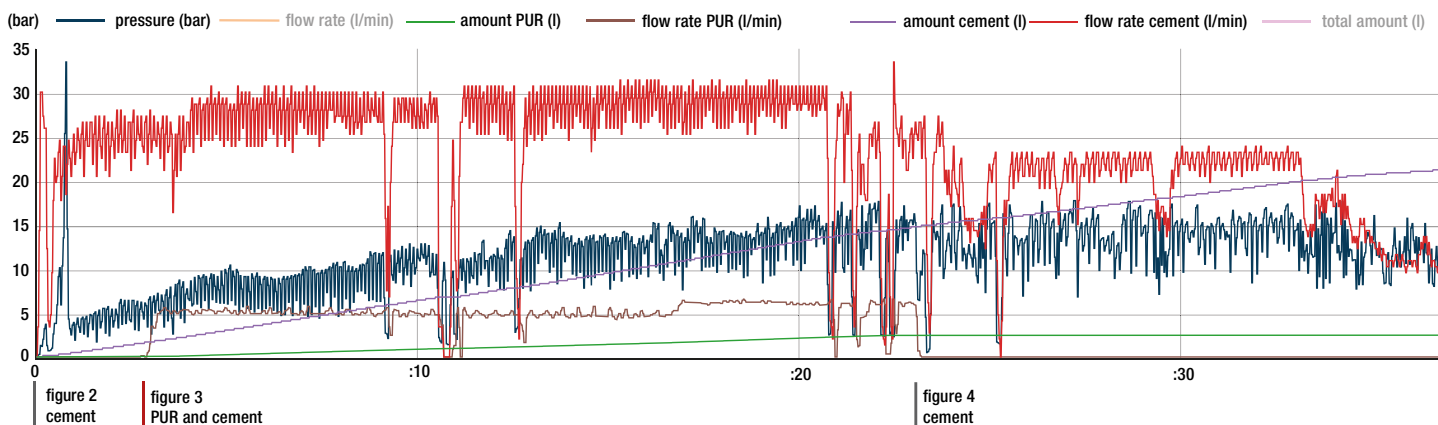


Figure 2: Leaching of cement slurry in larger fissures

Data record of the polyurethane-supported hybrid injection as-built, all injection parameters are recorded and can be integrated into a BIM model



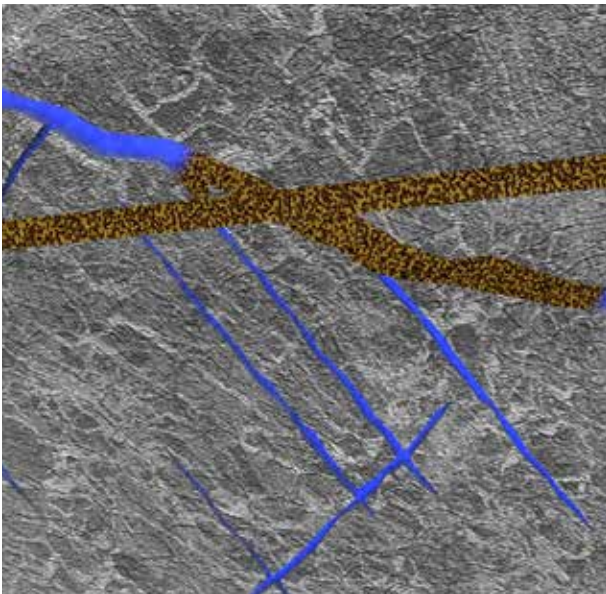


Figure 3: Injection of PUR-reinforced cement slurry into larger fissures

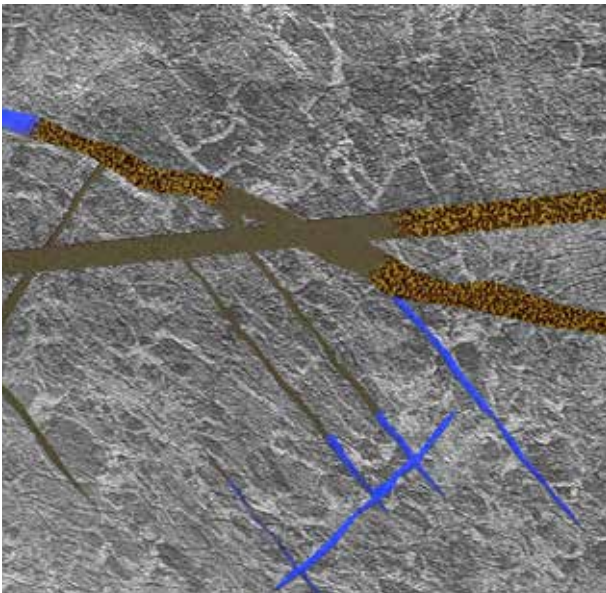


Figure 4: Larger fissures are sealed, smaller fissures are filled with cement

injected into the borehole. As a rule, the proportion of PUR resin varies between 0% and 40%, and can be progressively increased or decreased during injection. The resin pump switches on and off automatically. This innovative injection control mechanism allows engineers to adjust the positive properties of cement and PUR resin to the exact hydrogeological conditions in the rock.

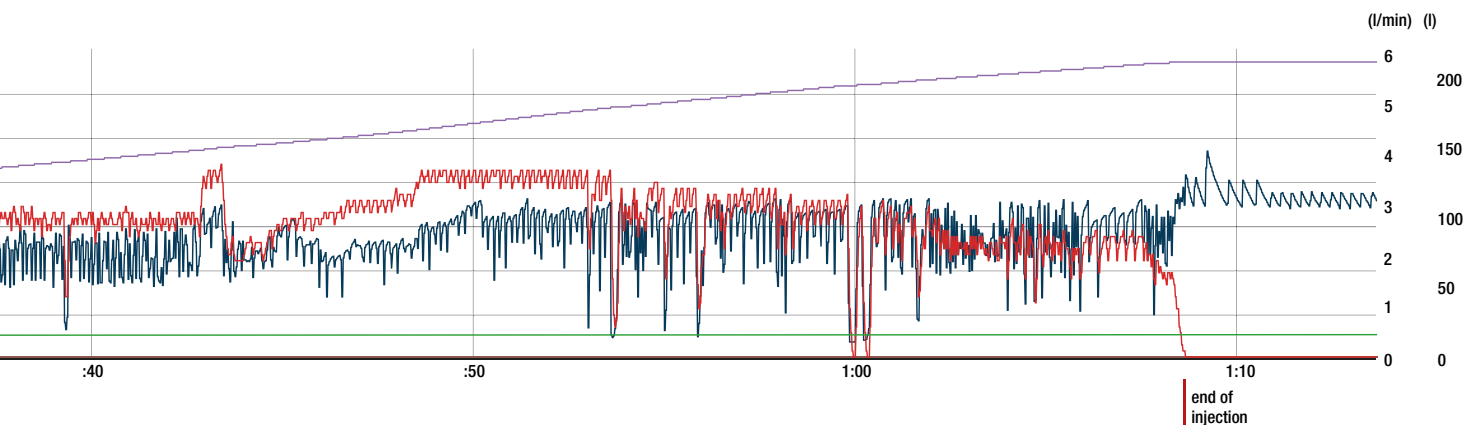
If an immediate increase in pressure is detected in a borehole when pure cement slurry is injected, no PUR resin is added as the cement slurry will be sufficient to seal the smaller fissures. However, if the injection agent drains out without an increase in pressure (see figure 2) or if there is any leakage into the tunnel, PUR resin is added (see figure 3). The PUR-resin-cement-slurry hybrid is then able to seal larger fissures with water ingress in the tunnel (see figure 4). Pure cement slurry subsequently penetrates the smaller fissures as part of the same process (see figure 4).

### The advantages of the system

- Economic injections to prevent water ingress
- Slurry properties can be adjusted during the injection process
- Waterproofing and consolidation combined in one construction process
- PUR resin added automatically
- Detailed data recording of injection parameters on all components
- Data integration into BIM as-built model



QR-Code and link to video  
[tinyurl.com/renesco-hybrid-injection](https://tinyurl.com/renesco-hybrid-injection)







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