



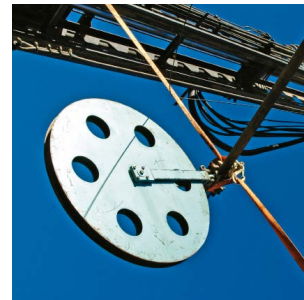
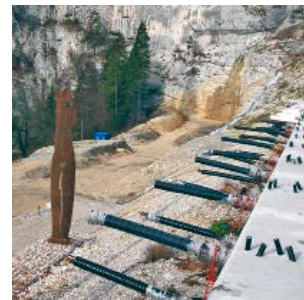
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Geotechnology  
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Hydrogeology  
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Monitoring  
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# SOLExperts

*Swiss Precision Geomonitoring*



**Innovative and client-oriented solutions for  
geotechnical and hydrogeological projects**

**Solexperts AG rests on a firm foundation with over 30 years experience of highly qualified personnel providing support in geotechnical and hydrogeological projects with proven measurement concepts, globally-recognised measuring systems and techniques, instrumentation, monitoring and field testing methods.**

The team consists of an inter-disciplinary group of specialist engineers and geologists in the fields of geotechnical engineering, hydrogeology and geodesy as well as IT specialists, electronics engineers and mechanics. In the office, in the workshop and on site the team is responsible for the development and production of measurement systems, executing complex measuring tasks and the implementation of new measuring techniques.

Solexperts has developed a good reputation with our clients, local authorities, government departments and construction firms for being reliable, dynamic and innovative.

Examples of our activities:

Geotechnical and hydrogeological measurements for civil engineering risk management of projects in difficult ground conditions.

More than 20 years of developing advanced, innovative and leading edge measurement and test systems for the characterisation of host rock for nuclear waste repositories. Many of the Solexperts® systems and techniques have been applicable in civil engineering projects.

Solexperts, together with Prof. K. Kovári, has developed hiDCon, a concrete with high deformation capacity for use in tunnels driven through squeezing and swelling rock where highly deformable and load bearing structural elements are needed.



Stand-Pipe Multi-Packer System (SPMP)



Pipe arch survey at Frutigen



Installation of «Mega-Packer» in Mont Terri



Workshop for the manufacture of measuring instruments





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Geotechnology  
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Monitoring  
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Underground rock mechanics laboratory Bure, Département Meuse (F): shaft equipment



▶ **GEOTECHNOLOGY**

- Line-wise displacement measurement .....
- Borehole extensometer .....
- Point-wise displacement measurement .....
- Inclination / deviation measurement .....
- Deformation / force measurement .....
- Rock mechanics tests .....
- Temperature measurement .....
- Vibration measurement .....
- Borehole measurement .....
- Pile load tests .....

▷ **PRODUCTS**

- Trivec · Sliding Micrometer · Sliding Deformeter · Borehole Inclinometer · MagX .....
- Sol Extensometer · Magnetic Extensometer · Reverse Head Extensometer .....
- Modular-Extensometer .....
- Distometer · Joint Opening Measurement · Surface Extensometer .....
- Clinometer · Clino-Sensor · Clino-Chain · Deflectometer Chain .....
- Curvometer · Deformeter · Dilatometer · Measuring Anchor .....
- Hydrofrac / Hydrojack Systems · Load Plate .....
- Temperature Sensor · Temperature Measuring Chain .....

▶ **HYDROGEOLOGY**

- Groundwater monitoring .....
- Hydraulic borehole tests .....
- Undergr. rock mechanics laboratory tests .....
- Water well and well repair .....

▷ **PRODUCTS**

- Multi-Packer Systems · Multi-Port Sampling Systems · Piezo Press .....
- Heavy Duty & Standard Double Packer Test Systems · Pump-Down Packer Systems .....
- Modular (Mini-) Packer Systems · Pore Pressure Systems · TDR-Packer Systems .....
- Pump System without Standpipe · Swage Packer .....



**SERVICES**

- Consulting
- Instrumentation
- Measurements / Evaluation
- Maintenance / Repairs

▶ **MONITORING**

- Data acquisition .....
- Sensors .....
- Evaluation and visualisation .....

▷ **PRODUCTS**

- GeoMonitor · Solo-GeoMonitor · Solexperts Datalogger · Trivec · Dilato · DQ .....
- Displacement · Load Cell · Pressure · Tilt · Strain · Total Stations .....
- Digital Level · Distance Meter · Vibrating Wire Transducer · Flow · Temperature .....
- Chemo-physical Sensors .....
- Data Management · Web-DAVIS · Trical · Dilato · HUGO (Igor) .....

▶ **TUNNELLING**

- Deformable concrete elements .....

▷ **PRODUCTS**

- hiDCon – highly Deformable Load Bearing Concrete .....

▶ **SERVICES**

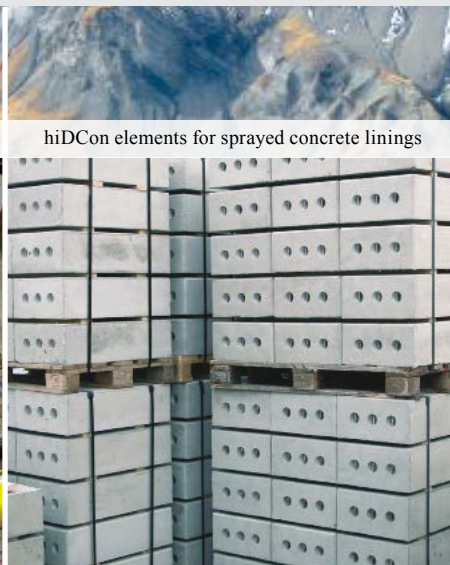
- Consulting · Quality Control



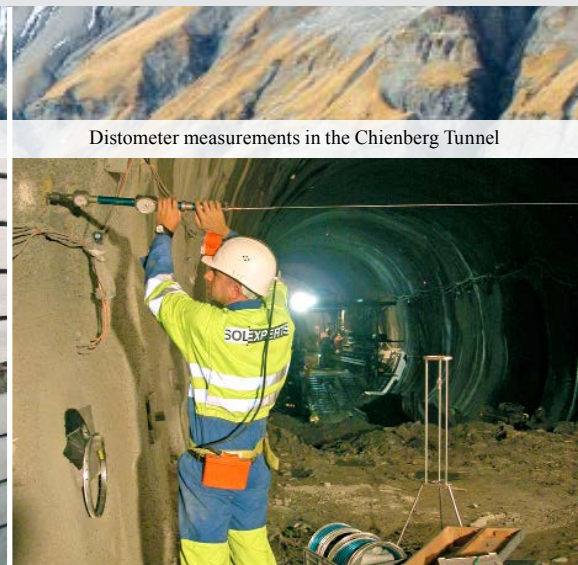
Calculations alone do not provide a complete and reliable picture of the interaction between the earth and an underground construction. A much more detailed picture is obtained when geotechnical measurements are included. The interdisciplinary team from Solexperts has broad experience in geotechnical instrumentation and our wide range of testing equipment makes us well prepared to collaborate with planners, public authorities and construction companies to obtain data that provides a much more complete description of conditions at the site.



Inclinometer measurements, Luzernerring (Basle)



hiDCon elements for sprayed concrete linings



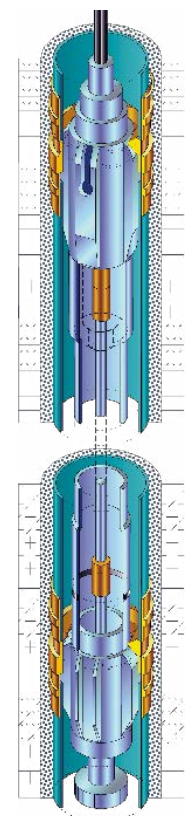
Distometer measurements in the Chienberg Tunnel

**Tunnels und caverns**

Excavation of an underground opening causes stress redistribution in the surrounding rock that results in deformations. The size of the deformations depend on the geotechnical material parameters. Predicted behaviour of the rock and function of the support systems can be verified by geotechnical measurements (displacement measurements, etc). Timely geotechnical measurements make it possible to intervene if the stability of the ground is endangered. Therefore, geotechnical measurements form an important part of every safety analysis. When tunnelling in urban areas it is often necessary to also monitor the behaviour of neighbouring structures.

**Excavations**

The hazard scenarios for ground excavations are many fold: Collapse of the slurry wall during construction; ground failure processes when drilling for pile walls; failure of ground anchors; hydraulic failure or loss of bearing capacity at the base of the excavation. For safety reasons it is essential to carry out measurements on the slurry wall (especially inclination measurements) and routinely check displacements at the top of the wall. Solexperts automatically makes these types of measurements using motorised theodolites (total stations), tilt meters, extensometers, line-wise measurements, etc.



Trivec detail



## Geotechnology

### Unstable slopes

Erosion at the foot of slopes or changing groundwater conditions can lead to slides involving large volumes of material. If the displacement vectors along a profile and the pore water pressures are measured the sliding mechanism can be estimated. Continuous monitoring of potential landsides near important traffic arteries and urban areas provides real-time data and evaluations (via alarm-functions) so warnings and preventative actions can be taken before large movements happen. The automatic transfer of data to the Internet allows engineers to review the site conditions both numerically and graphically from anywhere in the World.

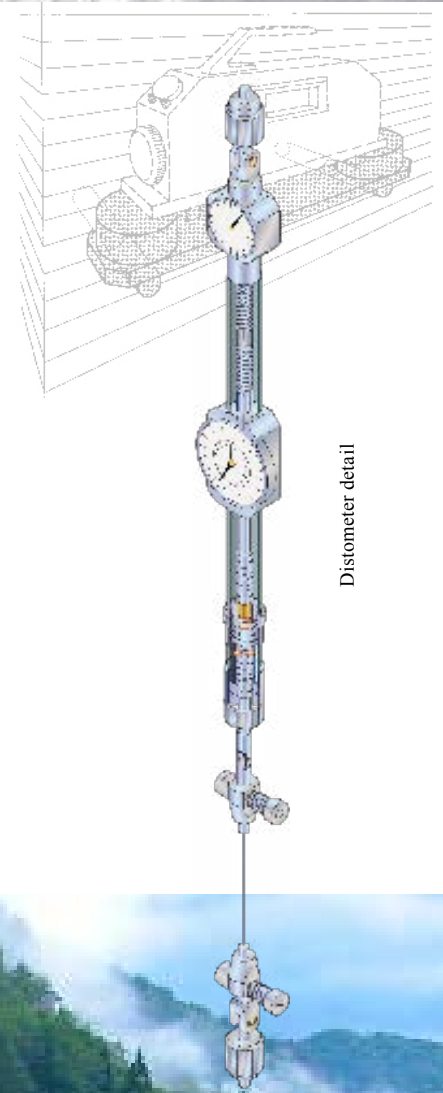
### Earth and concrete dams, locks

The safety requirements for earth and concrete dams are very high because a failure

could have catastrophic consequences. Geodetic and geotechnical measurements form a vital part of the safety management. Instruments developed by Solexperts, like the Sliding Micrometer, are well known for their high reliability and accuracy. Automatic measuring systems, like the Solexperts GeoMonitor, can continuously monitor and overview the measurements and allow comparison of data from year to year.

### Survey, piles, embankments

How can you evaluate the behaviour of structures on a scale of 1:1 using geotechnical measurements? The engineers at Solexperts are very familiar with monitoring and test methods to optimize pile dimensions and to determine the bearing capacity or settlement behaviour of large embankments.



Distometer detail



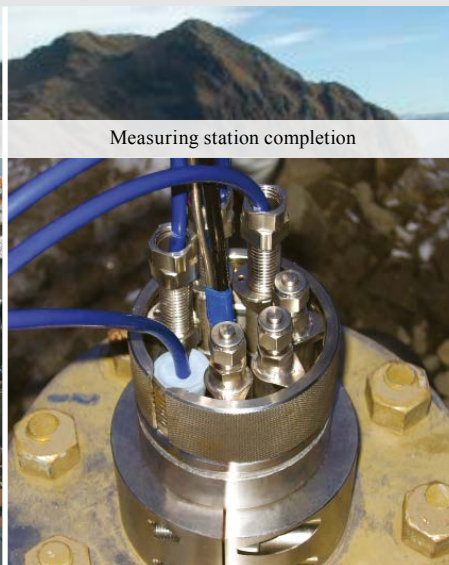
Highway A16 Transjurane, New development, Section Roches-Moutier, Canton Berne: Trivec measurements in a pile wall



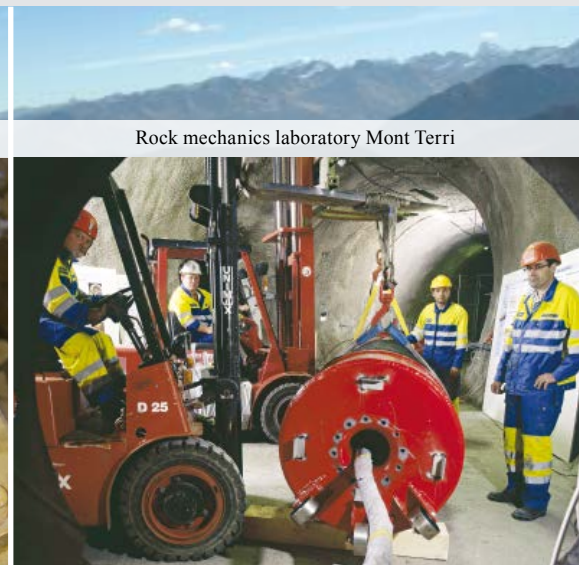
**Groundwater is an important natural resource that must be protected. Yet at the same time, groundwater can be a risk factor in civil engineering projects as well as a transport medium for contaminants. The broad experience of Solexperts is valued when working with such complex issues. Our wide range of groundwater monitoring systems together with our extensive field investigation experience allows us to create a solution that fits our clients needs.**



In-situ tests in Emosson



Measuring station completion



Rock mechanics laboratory Mont Terri

**Site investigations for nuclear waste disposal**

Solexperts is collaborating with national and international organisations on the disposal of radioactive waste. These include NAGRA (Switzerland), ANDRA (France), BfS/BGR (Germany), ENRESA (Spain), SCK-CEN (Belgium) und CRIEPI/JAEA (Japan).

Nuclear waste disposal demands the highest quality requirements for instrumentation, test procedures, data analysis and reporting.

Hydrogeological investigations in formations exhibiting very low permeability require highly specialised technical know-how, testing methods and instrumentation. This acquired «know-how» is integrated into the complete range of activities of Solexperts.

**Hydrogeological characterisation**

In-situ tests are carried out within the framework of preliminary hydrogeological investigations in order to plan efficient dewatering systems for tunnels, embankments or excavation works or better estimate the risk of water in-flow.

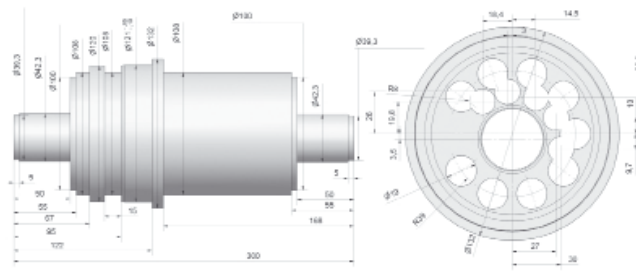
An extensive list of references including base tunnel projects like the Gotthard, Lötschberg, Brenner and LTF (Lyon-Turin Ferroviaire) witnesses to our technical competence and the reliability of our testing equipment – with borehole tests down to as much as 2500 m depth.



Multi-Port Sampling System (MPSS)



▼ Hydrogeology ▲



Multi-Packer-System (MPS)

**Test and monitoring systems**

What are the seepage paths present during groundwater contamination? What are the hydrogeological parameters of contaminated land and hazardous landfill sites? In order to determine these values we utilise the most modern testing and monitoring systems. Today this technology is also applied to hydrogeological investigations for geothermal projects and to the search for suitable host rocks for the permanent storage of CO<sub>2</sub>.

**Services**

We offer individualized complete solutions. Our team of hydrogeologists, geologists and technicians is responsible for instrumentation, hydraulic testing and data interpretation. Having our own machine shop along with engineering, software and hydrogeology departments enables us to take a project from the conceptual design meeting our client's specific requirements to installing our test and monitoring systems and finally to testing and data evaluation.



Planned pump-storage scheme Nant de Drance, Emosson, Canton Valais: hydraulic and rock mechanics borehole tests



## SOLEXPERTS® MONITORING – Data acquisition and monitoring systems for geotechnical and hydrogeological applications

The GeoMonitor simultaneously monitors a wide range of sensors and instruments (including vibrating wire and digital sensors). System components connect via a single cable making the setup relatively simple, decrease wiring costs and improving reliability. Sophisticated alarms provide a range of checks and actions. Measured data can be exported in many formats and uploaded to the World Wide Web for near real-time viewing with Web-DAVIS.



Data acquisition and evaluation on site



Remote station



Geotechnical instrumentation

### GeoMonitor – Hardware and software

The GeoMonitor system consists of a rugged field PC, a Watchdog (for self-monitoring of the system), loggers, sensors, and GeoNodes (connecting out of the ordinary analogue and digital sensors to the system). Analog, vibrating wire, digital, motorized optical levels and total stations can all be simultaneously monitored significantly reducing the overall measurement time. Measurements may be used in complex mathematical real-time calculations and statistics. Sophisticated alarms provide a range of measurement checking options. Alarm actions include email, sms, fax, new recording rates and switches for

lights, horns, valves, etc. Data are stored in an ODBC database and can be exported in a number of formats. The real-time graphic options are very powerful and flexible. Plots can be saved in a wide range of formats. The system can be remotely controlled and data can be transferred to the office or an ftp site. The GeoMonitor system is password-protected and built to withstand harsh field conditions and perform reliably over years of use. GeoMonitor is the ideal solution for monitoring structures and geotechnical and hydrogeologic projects of all sizes.

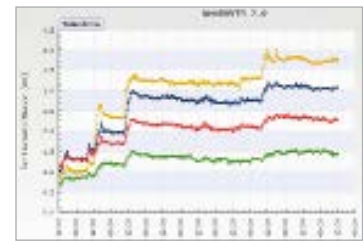


Two views of the GeoMonitor software platform





Monitoring



Different views of the Web-DAVIS software platform

### Web-DAVIS data visualisation

Web-DAVIS (the Solexperts Internet Data Visualisation tool) provides near real-time graphical and numeric reports of monitoring data, alarm actions and other information. Personnel responsible for the project can access Web-DAVIS at any time and from any pc connected to the Internet via a password-protected website. The locations of sensors are shown using project-specific diagrams and plans for a

quick overview of the project. With just a few mouse-clicks custom and predefined graphics and tabular reports of monitored data and other information (e.g. photos, logbooks, drilling profiles, etc.) can be accessed. Data can even be downloaded to your pc for further analysis. Web-DAVIS provides near real-time viewing of field projects in secure, easy to understand reports from the comfort of your desk.



Aarburg bypass, Canton Aargau: Monitoring of excavations

► TUNNELLING ————— ▷ hiDCon – highly deformable concrete elements

**Tunnels are being driven through increasingly complex geological formations that are difficult to control. Solexperts, in cooperation with Prof. Kovári, has developed hiDCon, a high deformation concrete for applications in squeezing and swelling rock. The hiDCon elements can deform plastically by up to 50% for a specified load, providing a constant resistance force that results in a high strength deformable tunnel lining.**



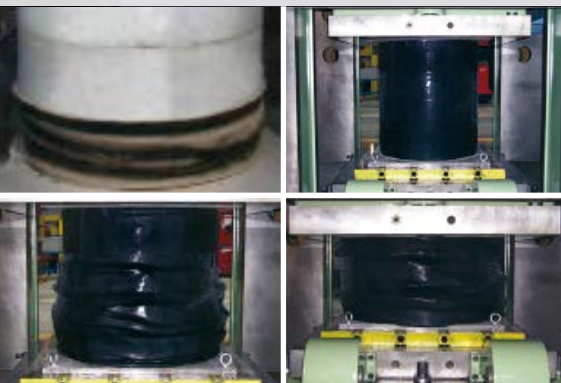
Zones of strongly squeezing rock had to be traversed during the construction of the Lötschberg base tunnel, Switzerland, and in a section of the Lyon-Turin (LTF) tunnel. Conventional relatively rigid tunnel linings based on the resistance principle proved to be inadequate. Solexperts, together with Prof. K. Kovári, has developed hiDCon, a high deformation concrete for these types

of conditions. Due to its unique properties hiDCon elements provide a constant resistance force that results in a deformable tunnel lining of high strength. Another example showing the advantages of using hiDCon elements in swelling rock is the restoration of the Chienberg road tunnel, Switzerland. Here a 480 m section of tunnel that passes through strongly swelling an-

hydrite has been successfully repaired using hiDCon elements that form a modular yielding system. Properties of the hiDCon elements can be adjusted to meet the needs of each specific project. Experienced civil engineers at Solexperts are ready to assist in designing an optimal solution for your project.



Loading test on hiDCon foundation elements



hiDCon beam element for sprayed concrete linings



hiDCon foundation elements in the Chienberg tunnel



► GEOTECHNOLOGY ————— ▷ PILE LOAD TESTS

**Pile load tests are carried out to determine the ultimate load and serviceability limits in pile foundations: In-situ tests provide information about the ground/pile characteristics allowing optimisation of the required diameter, length and number of piles.**

For pile load tests the load is applied in steps using hydraulic press. The load is precisely controlled by monitoring forces at the top of the pile and adjusting the hydraulic pressure in the press. Vertical

displacements at the top of the pile are continuously measured using displacement transducers attached to a measuring beam or via a motorised digital level. Strain distribution depends on the type

of pile and is measured using a Sliding Micrometer, extensometers or strain gauges. Solexperts offers an integrated system for execution and remote control of pile load tests.





Geotechnology

Hydrogeology

Monitoring

▶ HYDROGEOLOGY ————— ▷ BRENNER BASE TUNNEL

**Large sections of the planned, approximately 55 km long, Brenner base tunnel between Innsbruck (A) and Franzensfeste (I) passes through rock highly stressed by tectonic action.**

Between October 2004 and December 2005 Solexperts carried out more than 140 hydraulic tests in 35 exploration boreholes to depths of 1200 m along the future Brenner tunnel alignment. Among

other things the permeability of the rock and the piezometric heads were evaluated. Solexperts used its specialized «heavy duty» double packer system, data acquisition and evaluation software.

▶ MONITORING ————— ▷ TUNNEL LUZERNERRING (BASLE)

**To connect the French motorway A35 to the existing Swiss motorway N2 «Osttangente» the Luzernerring tunnel had to be constructed in the city centre of Basle.**

The tunnel passes beneath the entire track system of the existing St. Johann railway station, a bridge, buildings and roads. As part of the project's risk management Solexperts used a GeoMonitor system to monitor both geodetical and geotechnical measurements. Settlements and displacements of the ground surface, at bridges, buildings and the roads were mon-

itored. Near the railway tracks additional monitoring devices including two robotic tachymeters (total stations), a motion controlled digital level and extensometers were also used. Two geophones were installed to measure vibrations in critical areas. The tunnel's pipe roof reinforcement was monitored using a Clino-Chain during the excavation stages. Convergence

in the tunnel and settlements at the ground surface were manually measured.

All these data and more were available over the Internet to the client, the project engineers, the construction firm and the partners using the Solexperts password secured Web-DAVIS system.



Geotechnology: Pile loading tests



Hydrogeology: Brenner base tunnel



Monitoring: Luzernerring Basle





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**Geotechnology**  
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Measuring systems and services in the fields of geotechnology and hydrogeology.

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