DSI UNDERGROUND

DSI Underground Spotlight 1

2018

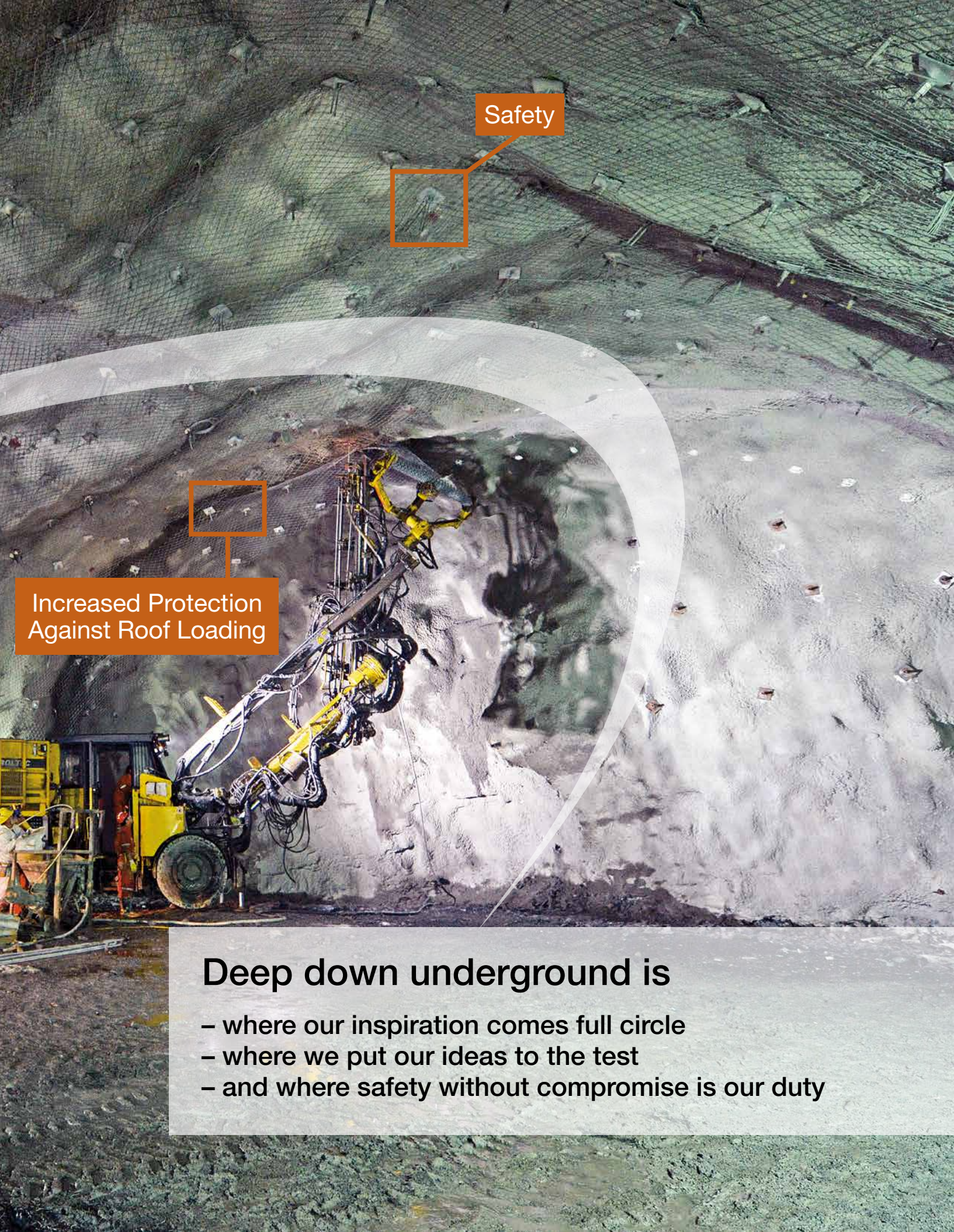
English

Local Presence – Global Competence

Delivering the Support You Need

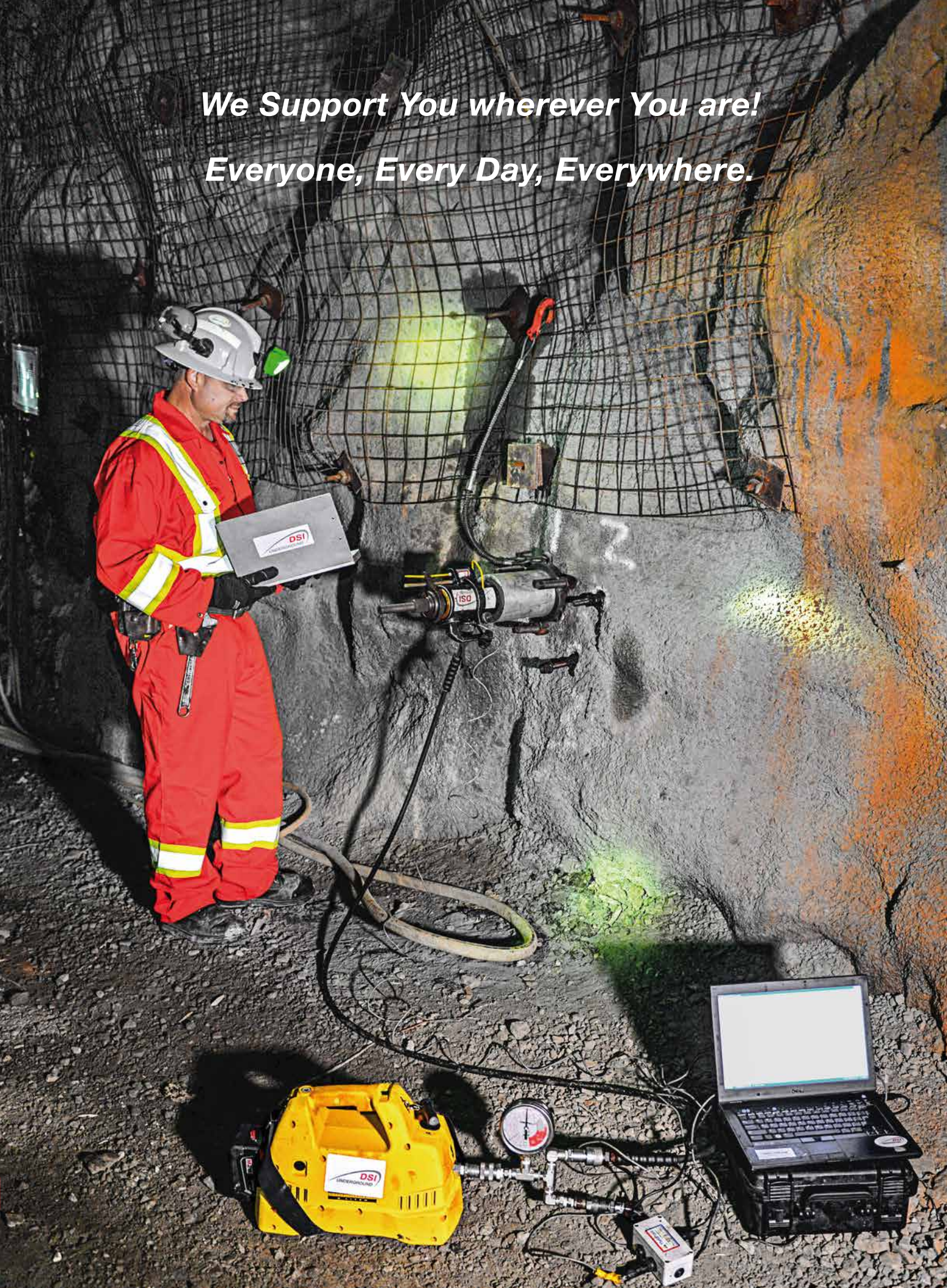
As a leading system supplier, we satisfy the demands of our customers in 70 countries around the world with the most extensive product range available on the market.

As a one-stop shop supplier, we provide you with system solutions that are customized to suit your specific needs.



Deep down underground is

– where our inspiration comes full circle
– where we put our ideas to the test
– and where safety without compromise is our duty


We Support You wherever You are!
Everyone, Every Day, Everywhere.

Dear clients, business partners and employees,

I am pleased to bring you up to date concerning some of the recent developments with regards to our company, DSI Underground.

We continued to make progress with the separation of the DSI Group into two companies. DSI Underground and DYWIDAG-Systems International have different target markets, demand drivers and have very limited synergies. The split has increased management focus, customer value and development opportunities for both companies and is proving very effective.

DSI Underground has continued its growth journey by way of completing several acquisitions but also through ongoing investment into our manufacturing plants. Our continued focus on optimising our operations and embedding efficiencies across the organisation are the foundation for our cost-competitiveness. But of course, there is always more work to do.

Since December 2017, we have completed a number of acquisitions. Each of these acquisitions will contribute to the future development of our company: Heintzmann Australia, Mining World Argentina and Fero Strata. The acquisition of Fero Strata, Perth is a major milestone for our company and will allow us to better service our clients in underground hard rock mining across Australia by adding galvanizing and mesh manufacturing processes into DSI Underground Australia's manufacturing capability. This acquisition will drive continous investment in R&D and will increase our exports to African and Asian mining services markets from Australia. The owners of Fero will become shareholders in DSI Underground's global mining business. The acquisition remains subject to the competition regulator's approval in Australia.

Our industry is in the middle of an industrial and technical revolution often referred to as "Digitalization" and "Industry 4.0". Increased connectivity and smart devices are opening up the opportunity to further integrate ourselves into the supply chains and services of our clients by networking with suppliers and customers and implementing Smart Factory Strategies into our production processes. This is a great opportunity and an exciting journey for the entire industry.

DSI Underground continues to be a fast growing company with a track record of achievement and success; it is our job to make sure this successful journey continues. We supply high quality products essential to safety and efficiency in the underground mining and infrastructure sectors. We are sector leaders and remain very optimistic about the future in industries where quality and safety are paramount.

Michael Reich
CEO DSI Underground


X-TREME
FASLOC

Interview with Mark Brandon, Global COO DSI Underground

Mark, would you mind telling us about yourself and your family?
I have been married to my wife Becky for 38 years. We have 2 children and 2 grandchildren with another grandchild on the way.

What are your favorite leisure time activities?
I enjoy spending time with my family and grandchildren, and I also travel quite a bit of the time (fishing and skiing).

What is your favorite food?
Based on my travels, I am not sure I even have a favorite – but I do enjoy seafood.

[Gerhard Kahr, Marketing Director Communication]
Mark, thank you very much for your candid answers. I think that our readers will be able to get a good impression of you. I promise not to pose any additional questions about you and your personal life. But now, let's proceed with the interview – I have prepared a long list of questions.

What was the key reason for your decision to join DSI Underground?
In connection with the Jennmar transaction, I was already deeply involved with the international locations. Therefore, this move made good sense in order to provide a sense of continuity for the various groups as well as to assist with the integration process.

What is it that makes working for DSI Underground interesting for you?
The varieties of cultures and manufacturing processes as well as the cooperative work relationships that we have across the globe.

Is there anything you had imagined differently before starting to work for DSI Underground?
Not really, as I was so involved with the international locations from my days with Jennmar.

Has your new position been as you expected it to be so far?
As with any dynamic business, the position changes as the needs change. This keeps the job very interesting, as in a single day, you can discuss HR issues, equipment, steel cost, customer relations, business strategy, logistics or finished goods pricing.

Which are the key areas you are planning to work on in 2018/2019?
Operational KPIs to allow the various regions to do benchmarking, environmental reporting and general cost efficiency.

Which are the most important challenges you think DSI Underground will have to face in the next 12 months?
The volatility of steel prices and the potential impact of even a small trade war between the US and China could have a ripple effect throughout the minerals market. Incorporating our move to a digital environment is another challenge.

What is the most important message you would like to convey to our employees today?
We as a company need to take full advantage of the resources we have across the globe and do what is best for the DSI Underground family.

What do you find makes lean management so powerful when it is done well?
In a flat organization such as ours, the decision making is done in a very short time, allowing us to take advantage of opportunities that could otherwise slip away in a bureaucratic and slow organization.

What indicators do you follow to evaluate progress?
As a group, we are looking to evaluate progress in many different areas.
On the operations side, we use several different KPIs to monitor performance and progress. In our global initiatives, we are looking at indicators such as new sales.
In Health & Safety, we tend to look at the number of recordable incidents and their severity.

What is on the horizon for DSI Underground in general? Are there new things to come?
We continue to evolve as a company along with our customers and their requirements. We are constantly increasing our product offerings in order to support our customers' requests. This includes installing our first mesh machine in Indonesia or building a state of the art chemical facility in Mikolow, Poland, for example. Another example is the formation of a new Joint venture in Mongolia to provide in country manufacturing to our customers.

What will be the key for success?
We will need to listen to our shareholders, customers and teammates and be flexible and agile enough to satisfy the demands.

What are your goals?
I want to help make DSI Underground the safest, most cost effective and profitable ground support company in the world. Furthermore, we will continue to serve as environmental stewards for our communities.

How do you think the company will change in two years, and how do you see yourself creating that change?
I believe that, with the current direction of the company, we will see consistent growth through both organic growth and acquisitions over the next 2 years. This growth will solidify our position as the world leader in ground control products and technology. I do not believe I will be creating that change. It will happen through the team work of the entire group focused on a common goal.

[Gerhard Kahr, Marketing Director Communication]
Thank you very much for taking the time for this interview.

The NorthConnex Tunnel: DSI Underground supplies High Quality Products for Australia's longest Road Tunnel

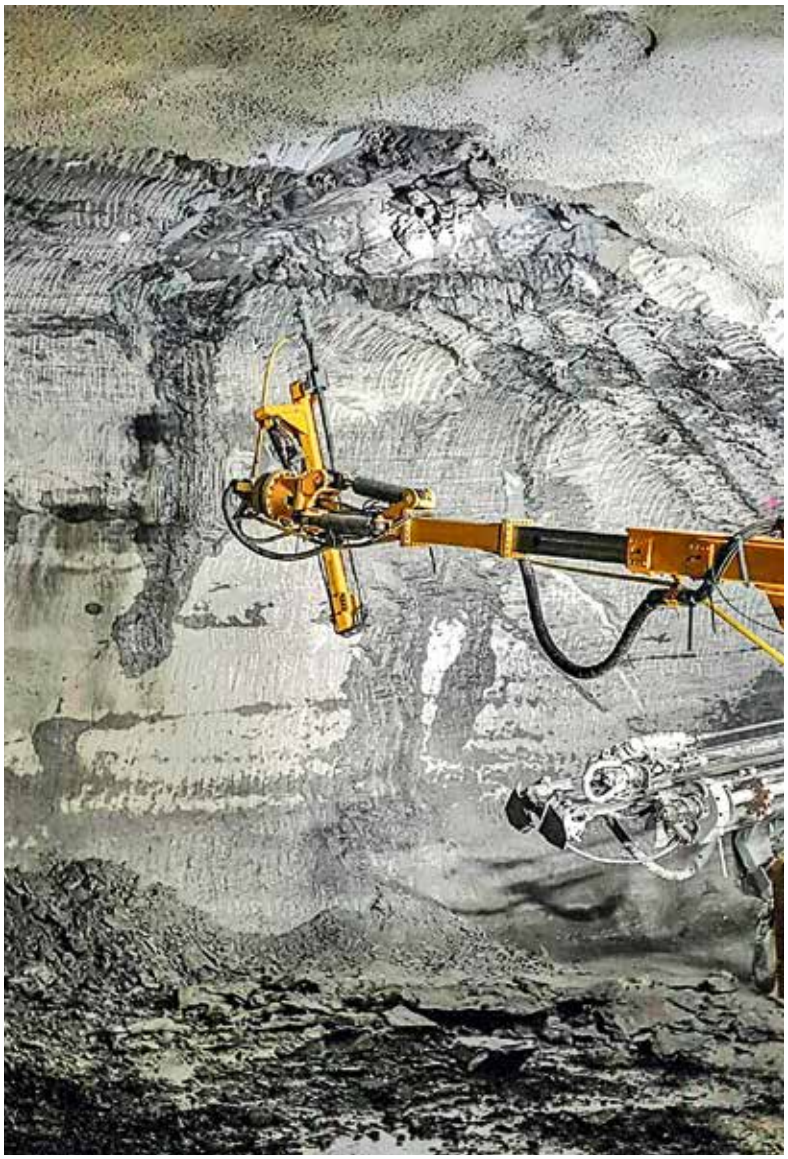
Once completed, the NorthConnex Tunnel will be one of the longest road tunnels in Australia. The approx. 9km long double tube tunnel north of Sydney connects the M1 motorway near Wahroonga with the M2 motorway in West Pennant Hills, thus connecting the city's north to the 110km long bypass known as the Orbital Network. This will bring relief to Pennant Hills Road, which is being used by more than 5,000 trucks per day.

The tunnel tubes have a height clearance of 5.3m and are designed for a long-term capacity of three lanes, but will initially operate with two lanes and one breakdown lane in each direction.

A tunnel section of approx. 22km had to be excavated for the main and access tunnels of the NorthConnex project. More than half of the tunnel is located at a depth of over 60m; the deepest part is approx. 90m deep. To stabilize the advancement, DSI Underground Australia supplied 476 Types P-140-25-32 and P-200-32-40 PANTEX Lattice Girders with arch lengths of roughly 20-23m. Furthermore, 190,000 post-groutable CT-Bolts with double corrosion protection were used for immediate primary roof support that were produced by DSI Underground Australia in their Newcastle factory. As permanent ground support products, both systems are designed for a service life of 100 years.

Furthermore, DSI Underground supplied soil nails, rock bolts and other ground support products consisting of 20, 25, 28, 32 and 40mm Ø, Grade St 500 *GEWI*® Bars and supplied the equipment needed for stressing and testing.

Due to the limited time frame, the ground support products were installed in a 24 hour operation with up to 14 roadheaders and roofbolters. This required an optimal supply chain, product management, planning and cooperation between the project teams and DSI Underground Australia. The company's local production was an advantage because the systems could be delivered to the jobsite just in time.



Owner
NorthConnex Company Pty Limited, Australia
General Contractor
Transurban Limited, Australia
Contractor
Joint venture Lendlease Bouygues, consisting of Lendlease Corporation Limited and Bouygues Construction Australia Pty, both Australia
Consulting Engineers
ASJV and joint venture Aurecon-SMEC, both Australia

Unit
DYWIDAG-Systems International Pty. Ltd., BU Civils, Australia
DSI Underground Scope
Development, production, supply, technical support, test installation, rental of equipment
DSI Underground Products
476 Types P-140-25-32 and P-200-32-40 PANTEX Lattice Girders, 190,000 double corrosion protected CT-Bolts™, 20, 25, 28, 32 and 40mm *Ø GEWI*® Soil Nails and Rock Bolts

Safe Underground Impermeabilization: DSI Underground supplies Mineral Bond Silicate Resin to the Frasers Mine

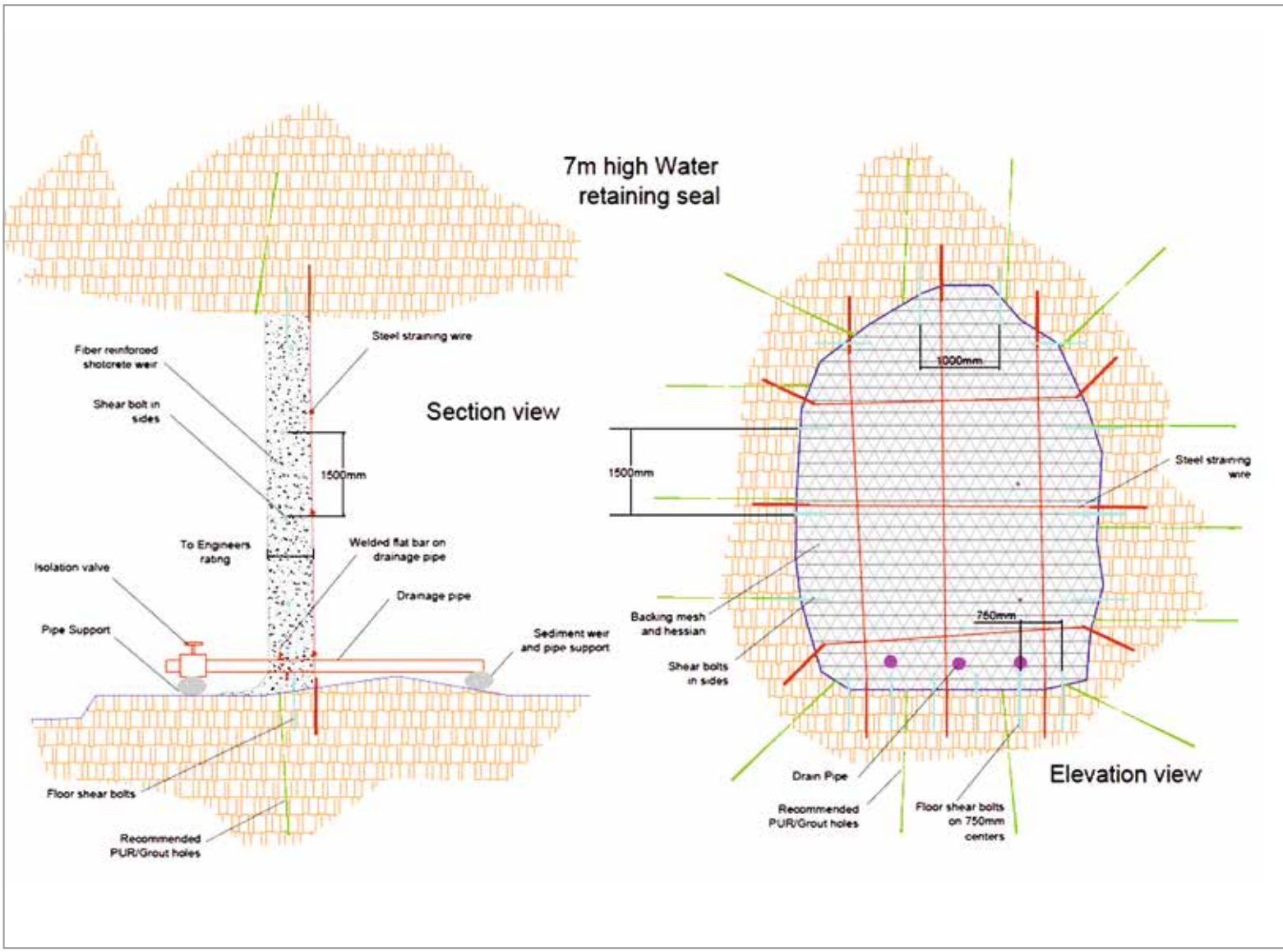
The Frasers Underground Mine is located 100km north of Dunedin on New Zealand's South Island. At this location, OceanaGold extracts gold by underground mining. At the mine, several previously mined areas had to be sealed off with rated water retaining bulkhead seals. Originally, large and expensive plug seals were planned, the costs for which would have been disproportionately high. Mastermyne, a specialist mining service provider, suggested using mineral bond urea silicate resin to consolidate the ground, reducing the thickness of the seals and overall costs.

In this solution, a 7.1m high by 6m wide water retaining bulkhead containing water drain pipes was built at one of the stopes. The old trial stope site required a 2m high and 6m wide water retaining dam wall. In a third stope, an old decline had to be sealed off that was allowing blast fumes to enter the underground working after an embankment slip in the surface mine.

The problem was that fractured ground around the drive area where the two bulkhead walls were to be built would allow water to ingress through the broken ground with a potential to flood areas of the mine and render the bulkhead seals ineffective.

Working with Mastermyne, DSI Underground Australia suggested pumping Mineral Bond Urea Silicate Resin into the strata around the drive to consolidate the ground and eliminate the water passage around the bulkhead seal sites. Mineral Bond was chosen as it is a non-expanding resin which is unaffected by water, remains flexible and develops a strength of 40mPa. Holes were drilled to a depth of 3m around the perimeter of the drive directly at the seal site location. The holes were packed off using BVS40 borehole packers attached to R28 GRP bolts which were installed into the holes to provide additional strength.

The first stope required a water retaining bulkhead seal with 14 injection holes evenly spaced around the perimeter of the drive.



This site consumed 520l of Mineral Bond placed in the backs and hanging wall shoulder where the ground appeared to have a higher fracture network. The old trial stope site required 6 injection holes around the lower perimeter of the drive. This site consumed 1,030l of Mineral Bond in the lower walls and floor area, where the ground was badly fractured.

On both sites, the product showed good migration through the ground with leakage from the area appearing up to 4m away from the borehole collar. Both the injection work and seal construction were safely completed within acceptable timeframes.

Operator
OceanaGold Corporation, New Zealand
General Contractor
Mastermyne Group Ltd., Australia

Unit
DYWIDAG-Systems International Pty. Ltd., Australia
DSI Underground Scope
Production, supply, technical support
DSI Underground Products
1,550l of Mineral Bond Urea Silicate Resin

Milestones in the Application of the Squeezed Connection for the AT – Pipe Umbrella System

The squeezed connection newly developed by DSI Underground Austria for a fast and safe connection of pipe umbrellas is a decisive step in the development history of the AT – Pipe Umbrella System. The system ensures a simple, fast and cost-efficient connection of pipe umbrella tubes.

Contrary to standard threaded pipe connections for pipe umbrella systems, the squeezed connection eliminates the weakening of umbrella pipes in the connection area. To establish the squeezed connection, a pre-manufactured beveled pipe end is inserted into the already installed tube, and both tubes are force and form fitted within a few seconds using a hydraulic hollow jack.

The squeezed connection results in increased bending stiffness in the connection area in comparison to conventional threaded tubes. Furthermore, the load-bearing capacity of the connection is more than 50% higher than the elastic design value of default pipe umbrella tubes.

The advantages of the system speak for themselves, and DSI Underground Austria has already supplied the AT – Pipe Umbrella System with squeezed connection for the following projects:

- Chantier Ligne 4 Paris, France
- Stein, Lind and Untersammelsdorf Tunnels, Austria
- Granitztal Tunnel Chain, Austria
- John Hart Hydro, Canada
- Koralm Tunnel, KAT3, Austria
- Hirschhagen Tunnel, Germany
- Eglinton Crosstown LRT, Canada

The advantages of the squeezed connection are:

- Enhanced working safety:
  - Pipe umbrella pipes are connected automatically.
  - An integrated drill rod wrench allows a safe disconnection and connection of the drill steel
- Proven cycle time savings:
  Detailed investigations have shown that the total time for connecting pipe umbrella tubes can be reduced by more than 50%, leading to considerable time savings and sustainably enhancing profitability

- Superior capacity:
  Increased load-bearing capacity (elastic and ultimate moment) in comparison to the standard threaded connection. This allows the use of thinner-walled pipe umbrella tubes while achieving the same or even higher load-bearing capacity
- Enhanced utilization rate:
  Less material consumption, easier transportation and handling
- Quality control:
  The squeezed connection eliminates quality defects at pipe connections

DSI Underground Austria has received several more requests for quotation for the AT – Pipe Umbrella System featuring the new, innovative squeezed connection that improves installation safety on tunnel job sites around the world every day.

The Semmering Base Tunnel: Safe Tunneling at the Froeschnitzgraben using DSI Underground's Support Products

The 27.3km long Semmering Base Tunnel, together with the Koralm Railway, forms part of the Baltic-Adriatic Axis. The current project consists of three contracts. The double tube railway tunnel between the towns of Gloggnitz and Muerzzuschlag is located south-west of Vienna and will shorten traveling time between Vienna and Graz by 30 minutes to approx. 2 hours.

The Froeschnitzgraben Tunnel, the 13km long middle section of the Semmering Base Tunnel, is being built under Contract SBT2.1. The tunnel is being advanced in both directions from the Froeschnitzgraben intermediate access south of the town of Steinhaus.

The intermediate access consists of two 10m Ø, 400m deep shafts. At the bottom of the shafts, a 400m long longitudinal cavern and transverse caverns are being built that will later be used as a subterranean emergency station for trains.

The approx. 8.6km long eastern section towards Gloeggnitz is being excavated using two tunnel boring machines. In this area, the tunnel is mainly advanced in gneisses and schists with minor localized faults and little water ingress in competent rock mass.

Advancement of the western section towards Muerzzuschlag is being realized conventionally on a length of 4.3km using the New Austrian Tunneling Method (NATM). The west drive is mainly characterized by the prominent nappe boundary between the Wechsel unit consisting of gneisses and the Semmering unit consisting of gneisses and greenstones. There is a thick fault zone consisting of quartzites, phyllites and aquiferous carbonates in this area.

Here, an approx. 200-300m long zone with heavy water ingress was expected. Furthermore, high water pressure was likely to be encountered in this area.

To stabilize advancement in this challenging section, DSI Underground Austria supplied OMEGA-BOLT® Expandable Friction Bolts among other products. In the west drive, the DYWI® Drill Hollow Bar System was used.

DSI Underground also produced and supplied PANTEX Lattice Girders, AT – LSC Elements, SN Anchors, tubespiles and AT – TUBESPILE™ for this major project. DSI Underground's reliable ground support products contributed to a safe and efficient advancement of the Froeschnitzgraben Tunnel.

Owner
ÖBB Infrastruktur AG, Austria
General Contractor
Implenia AG, Switzerland

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Production, supply
DSI Underground Products
OMEGA-BOLT® Expandable Friction Bolts, DYWI® Drill Hollow Bar System, PANTEX Lattice Girders, AT – LSC Elements, SN Anchors, tubespiles, AT – TUBESPILE™


FM4

The St. Kanzian Tunnel Chain: DSI Underground supplies AT – Pipe Umbrella Support Systems with efficient Squeezed Connection

The St. Kanzian Tunnel Chain near Voelkermarkt in Carinthia, Austria, forms part of the 130km long Koralm Railway that will establish a direct connection between Graz and Klagenfurt. The tunnel chain, consisting of six tunnels, is located in the Mittlern-Althofen section in the western part of the Koralm Railway. Currently, the Untersammelsdorf, Stein and Lind Tunnels with a total length of 2,595m are being excavated.

Photos reprinted courtesy of Baresel GmbH, Austria

Tunnel Portal: Installation of AT – Pipe Umbrellas

The core parts of the approx. 5km long section are the 2,100m long Stein Tunnel – the third largest tunnel of the Koralm Railway – and the 495m long Lind Tunnel. Except for a 565m long Stein Tunnel section that is being constructed using the open cut method, the two single tube tunnels are driven in accordance with the New Austrian Tunneling Method (NATM). Approximately 350,000m³ of subsoil must be removed for the Stein Tunnel and 90,000m³ for the Lind Tunnel.

The Stein Tunnel has a maximum overburden of 39m. The tunnel is being excavated from both portals with an advanced top heading in unconsolidated ground. The Lind Tunnel has an overburden of approx. 32m. Advancement is carried out from the west portal mainly through phyllites that are overlain by a stratum of up to 15m thick lacustrine sediment.

In both tunnels, AT Pipe Umbrella Systems were used for efficient support in difficult ground. For this purpose, DSI Underground Austria supplied 6 Type AT – 139, 139.3 x 6.3mm Pipe Umbrellas with squeezed connection including an AT – Squeezing Unit.

Blasting Advance in the Tunnel

Installation of Reinforcing Mesh in the Tunnel

The squeezed connection ensured the fast and safe implementation of pipe umbrella installation work. Furthermore, the squeezed connection developed by DSI Underground offers enhanced load-bearing capacity in comparison to conventional systems.

Additionally, other high quality ground support products by DSI Underground were used for stabilizing the advancement: SN Anchors, the DYWI® Drill Hollow Bar System, AT – TUBESPILE™ Self-Drilling Spiles, lattice girders and the AT – 76 Drainage System.

Owner
ÖBB-Infrastruktur AG, Austria
General Contractor
Baresel GmbH, Austria

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Production, supply, technical support, supervision, test installation
DSI Underground Products
6 Type AT – 139 Pipe Umbrellas with squeezed connection, SN Anchors, DYWI® Drill Hollow Bar System, AT – TUBESPILE™ Self-Drilling Spiles, lattice girders, AT – 76 Drainage System

The Hagen Residential Community in Linz: DYWI® Drill System stabilizes Excavation

Recently, the Hagen Residential Community was built at the Poestling Mountain on Wolf-Huber Street in Linz. The project includes 3 villas with 40 condominiums and 55 underground parking spaces.

Since the excavation borders a local street, the necessary steep embankment was stabilized by an anchor wall covered in shotcrete. To ensure a fast and safe installation of the anchors, the HABAU Hoch- und Tiefbaugesellschaft m.b.H. company, Austria decided to use self-drilling hollow bar anchors.

To tie back the steep embankment, DSI Underground Austria produced and supplied a total of 1,100m of R 32-210kN, 3 and 4m long DYWI® Drill Hollow Bar Anchors including the necessary accessories consisting of nuts, anchor plates, couplers and drill bits.

General Contractor
HABAU Hoch- und Tiefbaugesellschaft m.b.H., Austria
Architect
archinauten – dworschak+mühlbachler architekten zt gmbh, Austria

Unit
DSI Underground Austria GmbH, Austria
Scope
Production, supply
Products
1,100m of R 32-210kN, 3 and 4m long DYWI® Drill Hollow Bar Anchors including accessories

New High Speed Railway Section with *GEWI® Plus* Micropiles: Extension of the Nordbahn near Vienna

Within the scope of the Nordbahn railway extension from Vienna North to Bernhardsthal, the affected sections are being widened to a high speed cross section of 4.70m. Work also includes the strengthening of several existing structures to permit the creation of a high speed railway section.

This project also includes the existing Weidenbach railway bridge in the Gaenserndorf-Weikendorf section. The bridge had to be extensively reinforced and stabilized using a *GEWI® Plus* Micropile foundation.

Since work was carried out underneath the bridge, which resulted in height restrictions, the *GEWI® Plus* Micropiles were supplied to the jobsite in segments with a maximum length of 4.75m and then extended to the total pile length by couplers. The permanent *GEWI® Plus* Micropiles are double corrosion protected by a corrugated plastic duct with an inner cement mortar layer between the corrugated duct and the steel tendon.

For the posterior foundation of the bridge, a total of 561m of 43mm Ø, 43TR S670/800 *GEWI® Plus* Micropiles was installed. 18 15.35m long *GEWI® Plus* Micropiles and 18 14.25m long *GEWI® Plus* Micropiles were used. 32 micropiles were installed complete with pile heads designed for compression loads. To prevent seepage of the cement mortar into the soil, DSI Underground Austria also supplied 600m of 145mm Ø fabric tubes.

Owner
ÖBB-Infrastruktur AG, Austria
Subcontractor
Swietelsky Baugesellschaft m.b.H., Austria
Engineering
POTYKA & PARTNER ZT GmbH, Austria

Unit
DSI Underground Austria GmbH, Austria
Scope
Production, supply
Products
561m of 43mm Ø double corrosion protected (DCP) *GEWI® Plus* Micropiles including accessories, 600m of fabric tubes

Immediate Measure using *GEWI® Plus* Bar Anchors: Stabilization of a Rock Fall near Vorau

In November 2016, a large rock fell onto L 405 Vorau Road near km 22.7 between the towns of Vorau and Rohrbach in Styria, Austria. As a result of this rock slide, the L 405 was closed to traffic in this area.

In order to permit a partial reopening of the road, immediate steps were required. The rock face was stabilized from the road using a crane mount from which approx. 750m of boreholes and rock anchors had to be installed. Furthermore, the partly fractured rock was stabilized using 1,200m² of rock mesh.

To stabilize the rock fall, DSI Austria supplied 950m of 28mm Ø, 3-12m long *GEWI® Plus* Bar Anchors including accessories.

Due to the fractured rock, the 150 *GEWI® Plus* Bar Anchors had to be installed with fabric tubes from a telescopic work platform. For this purpose, the *GEWI® Plus* Bar Anchors were fitted with 900m of 90mm Ø fabric tubes.

Owner
Amt der Steiermärkischen Landesregierung, Fachabteilung 16, Austria
General Contractor
SWIETELSKY Baugesellschaft m.b.H., Austria
Contractor
SWIETELSKY Baugesellschaft m.b.H., Austria
Consulting Engineers
GDP ZT GmbH, Austria

Unit
DSI Underground Austria GmbH, Austria
Scope
Production, supply
Products
150 28mm Ø, 3-12m long *GEWI® Plus* Bar Anchors, 900m of 90mm Ø fabric tubes

New Hybrid Anchor Plates: The Verwall Suspension Bridge near St. Anton am Arlberg

In the popular Verwall Mountain Range near St. Anton am Arlberg, Austria, a new suspension bridge has been built for pedestrians and cyclists. The iron steel cable bridge is 20.5m high and approx. 35m long. To secure the foundation and the viewing platform of the bridge, 9 permanent, 6.30-8.30m long 28 and 35 TR *GEWI® Plus* Anchors were installed into stable rock at the abutment.

Safety cables, personal protective equipment for the personnel and special equipment for drilling were used during the work.

This project was the first geotechnical application of hybrid anchor plates with 15° angle compensation. Hybrid anchor plates consist of ultra-high-strength fiber-reinforced concrete that cannot corrode. Due to the optimized packing density of the different admixtures and the addition of fibers, the concrete has a very high compression strength of approx. 180 - 220MPa. When thermally treated, the targeted strength can be reliably reached within a few days.

Hybrid anchor plates, which are considerably lighter than conventional steel plates, are produced in accordance with ETA (European Technical Approval/Assessment), approval number 13/0463, and have been approved for permanent use.

The main advantages of hybrid anchor plates are:

- Approx. 50% weight reduction
- Up to 30 degree angle compensation can be achieved; the plate is concreted with angle compensation
- Use of stainless steel caps is possible since there is no contact corrosion. Stainless steel hulls are concreted into the plate
- The ETA for domed anchor nuts, which are used together with hybrid anchor plates, has been available since 2013

Furthermore, DSI Underground Austria provided technical support on site and rented the equipment needed for installing the permanent *GEWI® Plus* Anchors.

Owner
Municipality of St. Anton, St. Anton Tourism Association and Energie und Wirtschaftsbetriebe (EWA), Austria
General Contractor
HTB Baugesellschaft m. b. H, Austria
Planner
Ingenieurbüro Brandner, Austria

Unit
DSI Underground Austria GmbH, Austria
Scope
Production, supply, technical support, rental of equipment
Products
9 permanent, 6.30-8.30m long 28 and 35 TR *GEWI® Plus* Anchors including hybrid anchor plates and domed anchor nuts

AT – Pipe Umbrella System with innovative Squeezed Connection stabilizes the Advancement of Metro Line 4 in Paris

Line 4 is one of the 16 lines of the Paris metro system that currently connects Porte de Clignancourt in the north of the city with Mairie de Montrouge in the south. The line crosses the center of Paris and is connected to important regional train stations. Currently, Line 4 is one of the most used lines in the entire subway system. After the opening of the current last stop, Mairie de Montrouge, Line 4 will be extended for about 1.9km towards the south with the two new stations Verdun-Sud and Bagneux.

Verdun-Sud will have a double track configuration and Bagneux will have a three-track layout. Furthermore, Bagneux will be connected to Line 15, the Red Line.

This project can be considered a trial project for the global Grand Paris Express, where occupational safety will be a major consideration. Excavation was carried out in limited space conditions. In addition, the ground was difficult, and the urban environment required special care regarding stability and the limitation of possible surface settlements.

The AT – Pipe Umbrella System was used as a pre-support system in ground conditions prone to settlements in the future station areas; it was supplied by DSI Underground Austria in cooperation with ROBODRILL. Four AT – 114 Pipe Umbrellas (114.3mm x 6.3mm) with squeezed connections and the AT – Automation Unit were used.

The fast and safe implementation of the pipe umbrella installation was ensured by the special ALWAG Systems squeezed pipe connection. Installation of the pipe umbrella system was carried out using air flushing.

The customized ROBODRILL jumbo was perfectly adapted to the AT – Automation Unit for creating the squeezed connection and to the AT – Pipe Umbrella Support System. In the course of first-time installation, technical support was provided by a DSI Underground Austria team on site.

The average production time in challenging ground conditions was 8 15m long tubes in 10 hours.

Owner
Syndicat des Transports d'Ile-de-France (STIF), France
General Contractor
Dodin Campenon Bernard, France
Subcontractor
ROBODRILL SA, France

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Production, supply, technical support, test installation
DSI Underground Products
4 AT – 114 Pipe Umbrellas (114.3mm x 6.3mm) with squeezed connection, AT – Automation Unit

BULLFLEX® Roof Support Backfilling System: Repair of the Wingles Canal near Lille

The 8km long Wingles stream crosses below Federal Road RN 47 between the towns of Lens and La Bassée south-west of Lille in northern France. During inspections using a 3D scan and ground radar, several areas damaged by corrosion were detected on the water-bearing metal tube. The tube had two 4cm and 8cm wide cracks and showed a slight curvature in one area. To safely accommodate the loads of the road located above, the tunnel tube had to be repaired and strengthened accordingly.

During construction work, traffic disruption on the RN 47 road had to be kept to a minimum. Repair work was carried out inside the tube using a protection cage. The sediment carrying water was pumped off to permit installation of ground support.

TH profiles used for reinforcement were preassembled to two round arches, that were then connected forming rings inside the tube and installed in regular intervals. Afterwards, BULLFLEX® groutable hoses were installed into the gap between the TH profiles and the tube wall and were filled using fast setting ready-mixed mortar. Finally, cross linking profiles were installed using bolts.

The 7m long, 320mm Ø BULLFLEX® groutable hoses with integrated filling and check valves ensured a complete closure of the gaps between the tube wall and TH profiles despite the irregular form of the tube.

The BULLFLEX® Roof Support Backfilling System provides a full load distribution instead of point loading and ensured the transition from a passive to an active support system. Full embedding of the steel profile leads to an enhanced utilization rate and may even allow the use of the next smaller profile type.

Owner
Direction Interdépartementale des Routes Nord (DIR Nord), France
General Contractor
BOUYGUES Travaux Publics RF, France

Units
DSI France SAS, France,
DSI Underground Spain S.A.U., Spain,
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Supply, technical support
DSI Underground Products
7m long, 320mm Ø BULLFLEX® groutable hoses with integrated filling and check valve

BULLFLEX® O-Ring Sealings ensure a safe Entering and Exiting of Tunnel Boring Machines during the Construction of the Emscher Canal

The Emscher is a tributary of the Rhine River that was used as an open sewer due to land subsidence caused by mining in the Ruhr area in Germany. Now that the area is no longer mined, subterranean sewage canals are being built for the Emscher, and the surface streams are being restored. The main Emscher Canal structure is 51km long and leads from Dortmund to the town of Dinslaken. The sewage canal is located at a depth of 10-40m and consists of reinforced concrete tubes with interior diameters ranging from 1.60 to 2.80m.

The 35km long section between Dortmund and Bottrop is being built by Wayss & Freytag. The tube advancement was carried out using 9 full section tunnel boring machines (TBMs) and one road header. In total, approx. 15,000 reinforced concrete tubes were pressed in for the construction of the sewer canal. 130 excavations that were up to 40m deep had to be realized as starting or end shafts for the TBMs.

The Emscher Canal is currently one of the largest tunneling job sites in Europe. The large number of working points from which the work was carried out represented a special challenge. In order to ensure the safety of the tunneling work in an urban environment, DSI Underground Austria supplied BULLFLEX® O-Ring Sealings for pipe jacking which ensured a safe entering and exiting of the TBMs.

O-ring Sealing Systems are primarily used in combination with TBMs. BULLFLEX® Structural Sealings consist of patented textile hoses made of high-strength fabric, which are filled with concrete, featuring an excellent sealing and high load-bearing capacity. The hoses are available in different dimensions, allowing an optimum alignment to the excavation dimensions or support perimeter. All system components are light-weight as well as easy to transport and install.

The O-ring seal is installed in the annulus between lining segment rings and the outer shell or ground. The first BULLFLEX® hose seals the annular gap between the sealholder and the TBM shield skin. The second BULLFLEX® hose secures the seal between the excavation line and the segment ring. This way, the system offers efficient sealing against water and compressed air.

The system offers the following additional advantages:

- Proven safety against failure of the sealing function in all working phases during passing-by of the TBM
- Special hose-in-hose system for TBM launching applications
- Easy handling on-site due to light-weight components
- Shrink free, UV resistant material
- High resistance against tearing; no longitudinal seams
- Inflation can be achieved using various filling media

DSI Underground supplied a large number of BULLFLEX® Structural Sealings in diameters of 2 to 3.5m for a safe start and reception of the pipe jacking operations at the Emscher Canal.

Owner
Emschergenossenschaft und Lippeverband, Germany
General Contractor
Wayss & Freytag Ingenieurbau AG, Germany
Subcontractor
Epping Rohrvortrieb GmbH, Germany

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Supply, installation, engineering services, technical support
DSI Underground Products
BULLFLEX® O-Ring start and reception sealings for the pipe jacking operations

DSI Underground Ground Support Products stabilize the Advancement of Tunnel Structures on the Bar-Boljare Motorway

The Bar-Boljare motorway project is currently the largest infrastructure project in Montenegro. The motorway will connect Bar – one of the most important harbors at the south Adriatic coast – with the town of Boljare at the border of Serbia and Montenegro.

The project will promote the economic development of the entire country. Furthermore, travel time from the capital city of Podgorica to the city of Kolasin located in the north will be shortened from 1 hour 15 minutes to a mere 30 minutes.

The motorway has a length of approx. 165km and is being built with 2 lanes in each direction. 60% of the section will be bridges and tunnels. Due to the routing over a mountain range, the construction of the motorway is complex.

Currently, the first, 40.871km long section from Mokovak to Matesevo is being built.

The General Contractor CRBC was awarded the contract to build the complete route from Bar to Boljare and has divided the new motorway into 4 sections. DSI Underground Austria is supplying all 4 sections with ground support products for tunneling. Currently, the 15km long Vjeternik, Mrke, Vilac, Kosman and Jabučki Krš Tunnels are being advanced.

To drive these tunnels, DSI Underground is supplying Type R32 to T76 DYWI® Drill Hollow Bar Anchors among other products. In this system, drilling, installation, and optional grouting are carried out in a single operational step. The installation process has proven itself in difficult ground conditions.

Furthermore, DSI Underground is supplying lattice girders for the construction of the tunnels. The lattice girders ensure an immediate support in the open span area.

Contrary to standard solid-web girders, lattice girders are entirely integrated in the shotcrete lining; porous zones and shotcrete spray shadows are avoided.

In addition, SN 25 Anchors, pumps for cement injection, GRP anchors, resin cartridges and various accessories are used for the construction of the different tunnels.

Owner
Department for Transportation and Maritime Affairs of Montenegro, Montenegro
General Contractor
China Road and Bridge Corporation Montenegro Branch (CRBC), Montenegro
Subcontractor
BEMAX LLC, Montenegro and Skladgradnja D.O.O., Croatia
Design/Construction Supervision
Monteput d.o.o., Montenegro

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Production, supply
DSI Underground Products
Type R32 to T76 DYWI® Drill Hollow Bar Anchors, lattice girders, SN 25 Anchors, pumps for cement injection, GRP anchors, resin cartridges, accessories

A safe Home for Bats: DSI Schaum Chemie stabilizes Nature Reserve in Poland

One of the products of DSI Schaum Chemie, Poland, has found an interesting application; namely in securing and stabilizing the Szachownica Cave, which is one of the most important winter habitats for bats in Poland. The cave is located in limestone rock of the Kraków-Wieluń Upland. It represents an interesting and rare cave system, different from other caves that occur in this area.

At the site where a limestone quarry was operated for several decades until 1962, this rare cave system was accidentally discovered. The lime exploitation and changes in the prevailing conditions led to the partial destruction of the cave system. The main problem was the destruction process of the main cave floor, which was artificially enlarged during limestone exploitation. An intense erosion process, frequent rock falls and a partial degradation of the rock mass in the cave were observed.

Due to the presence of rare varieties of animals, a geological nature reserve was established in the area and named Szachownica (Chessboard). The protection of the cave biotope that included four different species of bats that regularly winter here was the first priority. Altogether, 11 species of flying predators – more than 2,000 specimens – have found shelter in the Szachownica Cave.

Since the bats are protected by EU law and it is of great importance to maintain their population, a project aimed at protecting the biotope was implemented. The protective measures are based on an expert study for which laboratory tests of the limestone and a stability analysis of the corridors and halls of the cave were carried out.

To ensure the security of the animals wintering in the cave, stabilization work was carried out during the summer months, i.e. from June to September. In the first stage, the roof was temporarily protected with pillars located in the areas with the greatest risk of caving accidents.

Then, the dense network of cracks in the roof was filled and glued using more than 87,000kg of the two-component organic mineral adhesive VERPENSIN® produced by DSI Schaum Chemie. This product has an excellent compatibility with this type of rock and does not have any adverse impact on the animals.

Apart from gluing, truss and mesh linings were also installed. Naturalists monitored all the work, and the requirements for the injection agent, the truss components and all other types of measures were very stringent. Following the work inside the cave, a stabilization of the cave opening was completed.

The cave is not open to tourists. The measures helped to preserve this important habitat for the bats.

Unit
DSI Schaum Chemie sp. z o.o, Poland
DSI Underground Scope
Production, supply
DSI Underground Products
87,000kg of the two-component organic mineral adhesive VERPENSIN®

DSI Underground Austria holds Global Tunneling Workshop 2017

From October 3rd to 5th 2017, DSI Underground Austria held its Global Tunneling Workshop 2017 in Pasching, Austria. 50 participants including DSI Underground employees, business partners, and exclusive distributors from all over the world attended the event.

The goal was to bring together key DSI Underground Tunneling people for international networking and for determining a global approach on key product lines and technologies. Another important reason for organizing the workshop was to provide a forum for technology transfer from Tunneling to Mining and vice versa.

The product focus during the event was on forepoling systems and chemical injection. Various business cases were presented that showed ways for winning key projects, enabling participants to engage in a mutual learning process by sharing practical experiences.

Main topics included innovative ground control solutions, global Tunneling product initiatives as well as achieving a holistic customer approach.

During the event, participants were given a tour of DSI Underground's production plant.

Another highlight was a visit and underground tour of the Froeschnitzgraben job site that is part of the Semmering Base Tunnel.

On the last day, individual sessions were carried out in four working groups: chemical injection, design forepoling systems, business case pipe umbrella, and self-drilling auxiliary support systems.

DSI Underground supplies Ground Support Products and Injection Resins to the Polyak Eynez Mine, Turkey

The Polyak Eynez Mine is located in Kinik in the province of Manisa in western Turkey. The mine is currently being developed; two vertical shafts and two parallel inclined haul headings are planned. Currently, one of the inclined haul headings is being advanced with an ensuing, approx. 3,400m long basis drift at the seam level. The drift is being mined using a road header.

The two vertical shafts with a total depth of 800m each are being mined by a Chinese mining company. The mine's coal reserve amounts to approx. 200 million tonnes. Starting at the end of 2017, a seam with a thickness of approx. 20m will be mined using Top-Coal Caving and the longwall method.

Approx. 5 million tons of coal per year will be mined here. The longwall operations are fully mechanized, and the drifts are advanced using road headers.

Within the scope of the mine development, DSI Underground is supplying 2,500mm long rock bolts including shear pin nuts, 25 x 500mm FASLOC® Resin Cartridges with reaction times of 60 seconds and additional system accessories.

During the last MINEXPO exhibition in Istanbul, Turkey, in December 2016, the relationship between DSI Underground and the owners of the Polyak Eynez Mine was enhanced and DSI Underground was asked to present its range of injection resins and other chemical products for underground coal mining on site.

The application presentation was carried out on site both above and below ground. For this presentation, experienced application technicians of DSI Underground used high performance pumps and mixers at 1:4 and 1:1 ratios and were thus able to successfully show the application of the injection resins Strata Bond HA, Mineral Bond, Mineral Bolt and Mine Fill produced by DSI Underground.

DSI Underground was able to position itself clearly as a capable producer and system supplier of high quality, reliable chemical products and systems.

The owner has green listed all the products that were presented by DSI Underground. Thus, the products that have been successfully tested for reliability, quality and application are now approved for use at the Polyak Eynez Mine.

Owner
Polyak Eynez Mine, Turkey

Unit
DSI Underground Austria GmbH, Austria

DSI Underground Scope
Production, supply, technical support

DSI Underground Products
2,500mm long rock bolts including shear pin nuts, 25 x 500mm FASLOC® Resin Cartridges, system accessories, Strata Bond HA, Mineral Bond, Mineral Bolt, Mine Fill

Injection Resins Stabilize Brown Coal Extraction at the Cayirhan Mine, Turkey

The Cayirhan brown coal deposit is located near the town of Beypazar, approx. 120km west of Ankara in Turkey. With approx. 2,000 employees, the Cayirhan Mine mines around 6.3 million tons of meta-lignite for generating electricity per year.

The mine is divided into 4 areas and is exclusively developed via horizontal drifts. The coverage is approx. 200-400m, and the mine contains a coal reserve of around 400 million tons.

The deposit consists of a seam that is divided by a middle layer of strata which decreases from west to east. Since the strata layer is too thick in places and the longwall thickness would be larger than 5m, the double longwall method is used in some areas. In 2 areas, ore is extracted in thicknesses of approx. 4.5m using a single longwall. Coal is mined using a modern longwall technique. The seam drifts are mined using road headers.

Within the scope of brown coal mining, the drive crossed a geological fault zone in which highly fragmented rock prevailed. Initially, the drive was stabilized using the product Strata Bond supplied by DSI Underground. Further along, cavities were encountered that were stabilized using Mine Fill Injection Foam. This injection foam simultaneously prevents possible dust explosions.

Within the scope of a comprehensive test, DSI Underground demonstrated the application of Strata Bond HF Injection Resin and Mine Fill HF Injection Foam to the mining engineers of the Cayirhan Mine.

By virtue of the successful on site test, the miners were convinced of the reliability of the injection resin and injection foam produced and supplied by DSI Underground. For the tests, DSI Underground provided the necessary pumps, injection lances and additional accessories.

Furthermore, DSI Underground also supplies resin cartridges, 25-500, with reaction times of 30 seconds to the mine.

Owner
Cayirhan Mine, Turkey

Unit
DSI Underground Austria GmbH, Austria

DSI Underground Scope
Production, supply, technical support, rental of equipment

DSI Underground Products
Strata Bond Injection Resin, Mine Fill Injection Foam, resin cartridges, 25-500

Application Test of Injection Resins at the Soma Eynez/Demir Mine, Turkey

The Soma Eynez/Demir Mine is located in the province of Manisa in western Turkey. Since March 2015, meta-lignite, used for generating electricity, has been mined at this location. Since the start of the second mine site at the beginning of 2016, 10,000t of coal are mined per day.

The area that is being mined is divided into smaller areas by several geological fault zones. Exploration is being realized via two parallel inclined rock headings. The total coverage is 400-600m at a depth of approx. 150m. The mine has a coal reserve of approx. 36 million tons and seam thicknesses between 12m and 30m.

The Longwall Method with Top Coal Caving is being used for excavation and the mine produces in up to 3 levels. In the drives, road headers, drilling and blasting as well as the Ripper method are used.

The owner Koc-Holding, Demir Export has been regularly using the Strata Bond HA, Mine Bond and Mineral Bond Injection Resins produced by DSI Underground for over a year. Within the scope of an application training, the correct application of the products produced and supplied by DSI Underground was demonstrated. During the presentation, DSI Underground also introduced the Mine Fill Injection Resin to the interested mining engineers. This product rounds off DSI Underground's range as a reliable system supplier.

The Mine Fill tests showed that DSI Underground's technical team and the management team are working hand in hand to provide their customer with the same product with different characteristics for a perfect adaptation to different geological conditions.

In addition to the high quality of the products, innovative technical solutions, on-site support, a seamless logistics process and management support are part of the package provided by DSI Underground.

In addition to the injection chemicals, DSI Underground also supplied 2.25m long GRP Anchors, 25 x 500 resin cartridges with reaction speeds of 30 and 180 seconds, 25mm Ø THREADBAR® Anchors with shear pin nuts and various accessories.

Owner
Koc-Holding, Demir Export A.Ş., Turkey

Unit
DSI Underground Austria GmbH, Austria

DSI Underground Scope
Production, supply, technical support

DSI Underground Products
Strata Bond Injection Resin, Mine Bond, Mineral Bond, Mine Fill Injection Resin, 2.25m long GRP Anchors, 25 x 500 resin cartridges, 25mm Ø THREADBAR® Anchors

Rocbolt Technologies expands Resin Production in South Africa

Recently, a survey was undertaken to identify manufacturing inefficiencies at the Rocbolt South Africa plant in Kempton Park near Johannesburg. Several factors need to be addressed to achieve Rocbolt's aim of sustainably increasing production output. Furthermore, some major system functions needed change to enable the correct process flow.

The following key aspects were determined in the survey:

Factory

- Transporting the resin from pre-mix operation to the Kp Machines was complex
- The Kp Machines were coupled to designated CFDS, thus interchangeability was limited
- Commissioning of a bulk resin storage tank

Logistics

- The premises did not include sufficient space to offload or load enough trucks per day
- High transport costs due to small loads, mainly due to site restrictions in loading bay

Within the scope of the expansion, the first step was to optimize the production process. This also included the installation of manufactured storage bins to fully de-couple the production of the resin cartridges from the packing operation.

Furthermore, the cycle for the daily transportation of all finished FASLOC® Resin Cartridges to the RBT Main facility was adjusted. The complete packing operation was relocated into an adjacent warehouse. During the move, all boxes stitching machines were moved out of the factory.

The resin cartridge production was divided into four new, completely separate production lines. Furthermore, additional pipelines and two new pre-mix tanks were installed so that the existing tanks 3 and 4 could be moved.

To ensure continuous monitoring of the complete production and for quality control, a main control station was erected that is fitted with 4 HMI controlled touch screens.

Furthermore, building rehabilitation work was carried out, the bulk tanks were equipped with level sensors, and the complete packing operation was moved to a packing and logistics center incorporated in the steel plant.

Thanks to these measures, the productivity was sustainably enhanced and the scrap rate was decreased by 3-4%.

DYWIDAG Systems stabilize the largest Excavation for a Single Project in South Africa: The new Discovery Office Building

Currently, a new office building is being constructed north of Johannesburg, South Africa for the insurance and financial services company Discovery in Sandton. The centrally located 87,000m² office building will offer room for more than 5,000 employees that are currently working in four different buildings.

The 24,435m² excavation represented a major challenge to all parties involved due to its size and to the work that had to be completed within 12 months. First, the existing buildings occupying the site had to be demolished. The last part of the construction site could only be vacated 4 months after commencing the project.

The final excavation volume reached 565,000m³; this includes 180,000m³ of hard rock blasting. Afterwards, gunite had to be applied on a surface of 15,540m². These quantities surpass those of any single super basement in South Africa.

The excavation support design had to accommodate a 33m high vertical face hard-up against the heavily used Rivonia Road. The highly variable and complex ground conditions necessitated constant lateral support, design reviews and meticulous co-ordination between lateral support, earthworks, blasting and demolition contractors. Furthermore, in some places, the constant presence of subterranean water lead to instability so that geotechnical systems were also needed in these areas.

A layer of pegmatite was encountered along the south and eastern elevations, necessitating anchor systems with between 60 and 70% higher load-bearing forces.

As a result of the exceptionally high soil faces to be retained, high capacity DYWIDAG Strand Anchors with load-bearing capacities in excess of 100t each and exceeding 24m in length were installed along Rivonia Road and along the existing buildings. In addition, steel section walers weighing more than 300kg each were utilized to distribute the additional anchor forces among the soldier pile members.

In total, Rocbolt Technologies supplied anchor systems for stabilizing 15,540m² of excavation walls. For this purpose, 1,311 12-14m long DYWIDAG Strand Anchors and 943 25mm Ø *GEWI*® Soil Nails were used that were installed in layers.

Owner
Joint Venture, consisting of Growthpoint Properties Ltd. and Zenprop Property Holdings (Pty) Ltd. Co, both South Africa
Subcontractor
Franki, a Keller Company, South Africa
Engineering
Pure Consulting (Pty) Ltd., South Africa
Consulting Engineers
Morta and Pentad Engineering Limited, both South Africa

Unit
Rocbolt Technologies (Pty) Ltd., South Africa
Rocbolt Scope
Production, supply
DSI Underground Products
1,311 12-14m long DYWIDAG Strand Anchors, 943 25mm Ø *GEWI*® Soil Nails

Challenging Excavation Stabilization using DYWIDAG Systems: The new Old Mutual Head Office in Sandton

The Old Mutual insurance company is currently building a new head office in the center of Sandton north of Johannesburg, South Africa. The building is directly located at the subterranean station of the Gautrain regional train. The new building includes 8 basement floors and offers space for additional offices and shops.

The highly unpredictable geology represented a significant challenge. The excavation support design had to be altered to suit the changing rock levels in the course of the project. The anchor design was only concluded after the soldier pile installation along the complete excavation had been carried out.

The eastern face of the project is situated directly over the Gautrain tunnel, which made blasting and foundation work difficult. At the northern face, the common boundary wall with the adjacent building had to be kept intact and therefore stabilized for the new basement. To complicate matters, the new proposed basement depth exceeded that of the neighboring building's existing basement. Movement had to be restricted to a bare minimum here and a comprehensive stabilization design was successfully implemented.

Due to the close proximity to the Gautrain station and the adjacent properties, construction tolerances and methods were closely monitored to ensure the stability of the excavation walls.

Furthermore, the teams for earthwork, blasting and geotechnical work had to cooperate closely.

A dead-man anchor solution was used that was combined with localized gunite-thickening for retaining and stabilizing the gunite and pile wall in the north. Precision drilling had to be carried out for the dead-man anchor installation. Although drilling "blind" and despite the fact that very little room for error could be afforded, an extremely successful outcome was achieved. The existing wall was successfully retained without any damage to property.

For stabilizing the different excavation walls, Rocbolt supplied a total of 860 600kN and 750kN capacity DYWIDAG Strand Anchors as well as 920 DYWIDAG Soil Nails in individual lengths of 3 to 12m.

Owner
Old Mutual Life Assurance Company (South Africa) Limited, South Africa
Contractor
Franki, a Keller Company, South Africa
Consulting Engineers
WSP | Parsons Brinkerhoff, South Africa, AECOM, South Africa and Coffey Projects, Kenya

Unit
Rocbolt Technologies (Pty) Ltd., South Africa
Rocbolt Scope
Production, supply
DSI Underground Products
860 DYWIDAG Strand Anchors, 920 3-12m long DYWIDAG Soil Nails

Redevelopment of the Village Walk Site in Sandton using DYWIDAG Systems

In June 2014, the decision was taken by Eris Property Group to demolish the Village Walk Shopping Center in Sandton, a city north of Johannesburg, South Africa, and to build an office tower, a residential tower and another building containing shops on these premises. A 7 story underground parking garage is planned underneath.

In the first phase, the existing boundary walls with the Balalaika and Protea Hotels had to be stabilized. The second and final phase included the excavation and lateral support to the new proposed basement layout, including the demolition and removal of the existing 4-basement parking garage.

Construction was complicated by time constraints as well as by the challenging stabilization of the adjacent property structures and the heavily used roads. The lateral support of the up to 24m deep excavation was also complicated by water-bearing and often saturated silt. Copious amounts of ground water from approximately 12m below original ground level had to be accommodated to maintain access throughout the site.

A meticulous approach was undertaken to separate the old parking basement structure from the surrounding hotels. Concrete beams and slabs were strategically cut and removed to allow the safe demolition of the old structure. The existing basement wall was then supported by ground anchors. New “columns” were installed below the existing boundary wall and anchor force through these doubled in order to offer the necessary support.

Stable support in the rapidly altering geology was achieved through a combination of strand anchors, rock bolts and soldier piles. 1,187 temporary DYWIDAG Strand Anchors in lengths of 12 to 20m were installed for the lateral stabilization of the excavation. Furthermore, 663 DYWI® Drill Hollow Bar Anchors were used as rock bolts.

The anchor systems for lateral support were designed using the observational method. Realistic soil parameters were used for the design of the lateral support and expected wall movements and anchor forces obtained for various stages of the construction. The performance of the anchor systems was then monitored and compared with predicted deflections and forces. Where movement or forces exceeded the anticipated values, additional anchor systems were installed.

Thanks to the meticulous planning and execution combined with the efficient anchor system, work was successfully completed.

Owner
Eris Property Group, South Africa
General Contractor
Franki, a Keller Company, South Africa
Consulting Engineers
SIP Project Managers, South Africa
Engineering
Aurecon Group Brand (Pte) Ltd., South Africa
Architect
Boogertmann + Partners, South Africa

Unit
Rocbolt Technologies (Pty) Ltd., South Africa
Rocbolt Scope
Production, supply
DSI Underground Products
1,187 temporary, 12-20m long DYWIDAG Strand Anchors, 663 DYWI® Drill Hollow Bar Anchors

DSI Underground supplies high-quality Ground Support Products for the new Ottawa Light Rail Transit Confederation Line

In Ottawa, Ontario, in Eastern Canada, the existing light rail transit network O-Train is being extended towards the east, west and south by a total of 30km. Construction of this largest infrastructure project in the city's history started in 2013 and is expected to be completed in 2018.

DSI Underground Factory Picture – PANTEX Lattice Girders

DSI Underground Factory Picture – DYWI® Drill (upper picture)

A 2.5km long Confederation Line tunnel is being built that will form the heart of the line through the city center with three downtown underground subway stations. One of the most challenging parts of the project was the construction of the caverns required for the approximately 120m long station platforms, which have already been designed for a future expansion when more light rail lines will be added to the system.

The tunnel is being advanced using the New Austrian Tunneling Method (NATM) from the western and an eastern portals as well as from a centrally located launching shaft. The tunnel is advanced using road headers through limestone and sporadic clay and sand deposits.

DSI Underground Systems provided a wide range of ground control solutions for several stages of the project. Initially, an AT – 89 Pipe Umbrella Support System was used as a pre-support measure for the portal areas. To ensure a safe working environment and stable conditions at the tunnel face, the AT – 76 Drainage System was used for dewatering.

Furthermore, DSI Underground produced and supplied 3- and 4-bar PANTEX Lattice Girder Systems. The 4-bar lattice girders served for cavern support in the subway stations and the 3-bar lattice girders for connecting the side drifts.

Additionally, DSI Underground supplied pre-support in terms of various DYWI® Drill Spiles and forepoling boards for sections in difficult ground.

General Contractor
Joint Venture Ottawa Light Rapid Transit Constructors (OLRT- C), consisting of ACS Infrastructure Canada Inc., EllisDon Inc., SNC-Lavalin Inc., Dragados Canada Inc., all of them Canada

Consulting Engineers
Dr. Sauer & Partners Corporation, Canada

Unit
DSI Tunneling LLC, USA

DSI Underground Scope
Production, supply, technical support

DSI Underground Products
PANTEX Lattice Girders, AT – 89 Pipe Umbrella System, AT – 76 Drainage System, DYWI® Drill Spiles, forepoling boards

Forepoling Systems for safe Excavation: The Quarters Tunnel on the new TransEd Valley Line LRT in Edmonton, AB

Currently, the City of Edmonton's public transportation system in Canada is being expanded by the addition of a new line: the Valley Line. In total, the Valley Line will be 27km long, connecting Mills Woods in the south-east via the center of Edmonton to Lewis Farms in the west.

The first stage, a 13.1km long section, includes the route from Mills Woods to 102nd Street with 10 stops and one elevated station. In this section, the two 400m long tunnel tubes connecting downtown to the river valley are being built. In the area of the tunnel portal, where the tunnel emerges above-ground, there are several critical building structures, the stability of which had to be ensured.

To ensure a safe and efficient advancement, DSI Underground supplied the 139.7 x 6.3mm AT – Pipe Umbrella System with threaded nipple couplings. This system is a special development of DSI Underground: Instead of a cut thread, an additional steel nipple with an inner and outer threaded connection is pressed into and welded onto both ends of the pipe umbrella tube.

This threaded nipple connection provides an elastic design load and stiffness in the elastic range which is equal to that of a standard pipe. Furthermore, the section modulus at the coupling is as least as large as the section modulus of the standard pipe. As a result, the installed pipe umbrellas increase the stability in the working area by transferring loads in the longitudinal direction and decreasing excavation induced deformations.

For the new Valley Line, DSI Underground also supplied Type R32-360 DYWI® Drill Hollow Bar Spiles and the AT – 76 Drainage System.

Owner
City of Edmonton, in partnership with TransEd Partners consortium, consisting of: Arup, Bechtel Corporation, Bombardier Inc., EllisDon Corporation, Fengate Capital Management Ltd., IBI Group Inc., and Transdev, all of them Canada
Consulting Engineers
BeMo Tunnelling GmbH, Austria

Units
DSI Tunneling LLC, USA, DSI Underground Austria GmbH, Austria
DSI Underground Scope
Production, supply, technical support
DSI Underground Products
139.7 x 6.3mm AT– Pipe Umbrella System with threaded nipple couplings, Type R32-360 DYWI® Drill Hollow Bar Spiles, AT – 76 Drainage System

Major Order for the AT – Pipe Umbrella System with Squeezed Connection: The Eglinton Crosstown Light Rail Transit Project in Toronto

The Eglinton Crosstown Light Rail Transit Project in Toronto, Canada will extend along Eglinton Avenue from Mount Dennis (Weston Road) to Kennedy Station on a length of 19km with 25 stops. Of the 19km long line, 10km will be underground. The underground section was excavated by 4 Tunnel Boring Machines (TBMs) in a double tube tunnel with inner tube diameters of 5.75m.

Four stations are being excavated using the New Austrian Tunneling Method (NATM): Oakwood, Avenue, Laird and Leaside. For these stations, DSI Underground Austria has been awarded a supply contract for a self-drilling pipe umbrella support system.

The soft ground conditions in an urban environment represented a special challenge. In this area, glacial deposits created a complex distribution of heavily over consolidated till layers, separated by interstadial stratified deposits of glaciolacustrine clay, silt, and sand.

The AT – Pipe Umbrella System, 139.7 x 6.3mm, with squeezed connection is used as a forepoling system for the excavation of the 4 above-mentioned stations for a total drilling length of approx. 120,000m. The squeezed connection permits a safe, fast and efficient installation of the pipe umbrellas. DSI Underground was able to convince the client quickly of the advantages of this system and thus to provide both a technically sound and commercially competitive proposal. DSI Underground's technical expertise and close contact with the prospective client in the course of the quotation phase was key to success from the very beginning. Furthermore, DSI Underground provides technical support on site. DSI Underground, Austria has been co-operating with ROBODRILL headquartered in Genas, France, for many years.

Together, both companies promote technological developments enhancing safety and efficiency of tunnel advancement. ROBODRILL is a pioneer of automated drilling systems with over 30 years of experience and is able to offer a complete package of tailored drilling solutions to each underground project.

For the Eglinton Crosstown LRT Project in Toronto, ROBODRILL adapted the AT – Automation Unit with the innovative squeezed connection perfectly to the drilling jumbos produced by ROBODRILL. The systems were also optimized to suit the expected geological conditions. In close cooperation between ROBODRILL and DSI Underground, a perfect system unit was created that ensures a safe, fast and fully automated installation of the pipe umbrellas.

Owner
Metrolinx, Canada
General Contractor
Joint Venture Crosslinx Transit Solutions, consisting of: EllisDon, SNC-Lavalin, Aecon and ACS - Dragados
Consulting Engineers
Dr. Sauer & Partners Corporation, Canada

Unit
DSI Underground Austria GmbH, Austria
DSI Underground Scope
Design, development, production, supply, installation, engineering services, technical support, supervision, test installation
DSI Underground Products
approx. 120.000m of the AT – 139.7 x 6.3mm Pipe Umbrella System, drilling and grouting accessories, AT – Automation Unit

DYWI® Drill Hollow Bar Anchors ensure fast Site Development at the Borden Gold Mine in Canada

Goldcorp, a globally active mine operator, is the largest gold miner in Ontario's north-east. Near the town of Chapleau in Ontario, Canada, the company is making new gold deposits accessible with the Borden Gold Project.

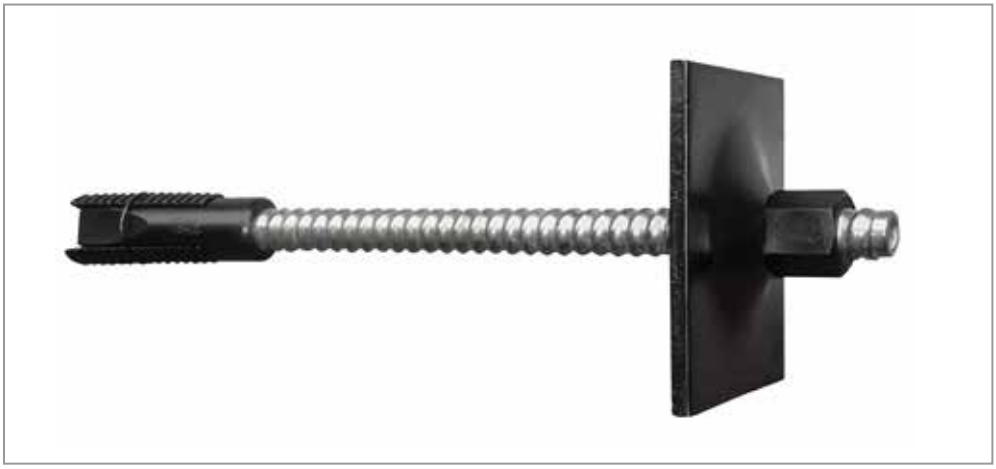
The excavation of a portal and the construction of an access ramp started in the first quarter of 2017. A 30,000t bulk sample will be extracted to confirm the existence of gold deposits in this hard rock mine.

Even prior to accessing the portal, DSI Underground Canada formed part of a technical committee to assist in the rapid development of the mine. Experienced DSI Underground engineers proposed alternate solutions to the generic methods of ground support. The typical resin and rebar support that is used in northern Canada would have prolonged the startup due to limitations of extreme temperatures.

For this reason, the mine decided to use the DYWI® Drill Hollow Bar Anchor as an efficient ground support product to ensure a rapid development of the portal. The DYWI® Drill Hollow Bar Bolt is installed using either air or hydraulically driven rotary drills, which ensures high rates of installation and good directional stability. Furthermore, the ground within the borehole is consolidated.

With resin grout, the use of which is a potential issue due to unsuspected climate, the idea is to create an active first pass support by tensioning the bolt with the shell that thus contains the rock mass in tension. This way, the bolts can be grouted at a future date. Now, a time-saving and innovative alternative to this system is available: DSI Underground's new, pumpable resin system. This method ensures a rapid development cycle. Thanks to the use of this resin system, the Borden Mine will be able to drive the portal quickly and safely and to access the bulk sample in an efficient manner.

DSI Underground also participated in what has been referred to as a training camp for the Borden mine. At the training facility, DSI Underground assisted in the installation of the shell on the DYWI® Drill Hollow Bar Bolt to give the operators involved a first-hand trial of the performance and installation of the bolt.



DSI Underground will continue to provide technical support as well as perform pull tests during start up and also when required throughout the project. Furthermore, DSI Underground will carry out installation audits, show procedures for different applications, and provide any other support needed in the progress of the mine.

In order to ensure a direct supply of the mine with the high quality ground support product, DSI Underground has founded a joint venture with Three Nations Drilling (a First Nations Company), who have a stake in the land on which the mine will be operating. Thanks to this joint venture, DSI Underground is now the only ground support supplier for the Borden Mine. The proceeds of the joint venture earnings go back into the three communities represented by Three Nations to help with social, educational and health care development in areas that had been previously separated from readily available health care.

Owner
Goldcorp Inc., Canada

Unit
DSI Underground Canada Ltd., Canada

DSI Underground Scope
Production, supply, technical support

DSI Underground Products
DYWI® Drill Hollow Bar Bolts, pumpable resin

Investing in the Future: Expanding Friction Bolt Production Capacity in Canada

The Canadian Mining Market has seen the use of friction bolts grow substantially over the past few years. The main reason for this increase is the addition of the face bolting process. This addition alone has resulted in a 100% increase in the demand for 46mm Ø friction bolts. The demand for other friction bolt sizes, ranging from 33mm to 49mm, has also incurred a 40% plus increase in consumption.

DSI Underground's Sturgeon Falls Plant, the leading manufacturer for these bolts in Canada, identified that their current manufacturing capacity was insufficient to keep up with the increased demands and market growth, even with increased machine uptime.

To meet the increase in demand both from potentially new and existing customers, additional supply was procured from plants within DSI Underground.

To maintain the strong market position of DSI Underground Canada as a leading and low-cost producer of friction bolts, a second friction bolt line was transferred from DSI Underground Peru to Sturgeon Falls.

The benefits of this allocation go further than increasing manufacturing capacity. The new production line has also allowed for further trimming in production costs of all friction bolt products.

The new addition to the roll form also reduces the current number of changeovers needed, therefore increasing the overall machine uptime. Now that DSI Underground Canada is no longer dependent on a single roll former, the local long-term supply of friction bolts for Canadian customers has been achieved.

27m long AT – 139 Pipe Umbrella stabilizes the Chinatown Station Cross-Cut in San Francisco

Within the scope of the Central Subway Project in San Francisco, the Muni Metro T Third Line is being extended via SoMa and Union Square to Chinatown. By directly connecting the existing T Third Line to the city center, public transportation in one of the most populated areas of San Francisco will be considerably improved. The approx. 2.7km long section runs underground and includes 4 new stations.

The northernmost of the new subway stations is Chinatown Station, which is excavated using the New Austrian Tunneling Method (NATM). Chinatown Station is divided into four sections: Station Headhouse, Cross-Cut Cavern, South Platform Cavern, Crossover Cavern, and North Platform Cavern.

DSI Underground is supplying high-quality products and systems for the approx. 18 x 14 x 21m large cross-cut cavern that has a cross-section of 210m² and is being excavated at a depth of 17.3m. Driving is carried out in highly fractured rock and sandstone as well as weathered sandstone. The cross cut is being advanced from the headhouse shaft. The left and right sides are excavated concurrently before the top and bottom center drifts are realized. Lattice girders, steel arches and fiber-reinforced shotcrete are used for standard ground support. For side drift and pocket excavation support, face bolts and self-drilling spiles were installed and additional dewatering was carried out.

Due to the projects' location in a heavily developed urban environment, advancement had to be carried out with special care. For this purpose, DSI Underground supplied the AT – 139 Pipe Umbrella System (139.7mm x 8.0mm).

The distinctive feature was that the system was drilled as a single umbrella with a length of 27m in a total of 67 drills.

The drilling unit used for the AT – 139 Pipe Umbrella featured optimum performance so that the desired drilling length was efficiently reached and a safe working environment was ensured.

DSI Underground also supplied the following high-quality ground support products:

- AT – TUBESPILE™ Self-Drilling Spiles
- DYWI® Drill Hollow Bar System
- AT – 76 Drainage System
- AT – TUBESPILE™ Vacuum Lances
- GRP face bolts
- Forepoling boards

Experienced DSI Underground employees provided on-site technical support, thus ensuring that the excavation work progressed smoothly.

Owner
San Francisco Municipal Transportation Agency (SFMTA), USA
General Contractor
Tutor Perini Corporation, USA
Contractor
Frontier-Kemper Constructors, Inc., USA
Consulting Engineers
Dr. Sauer & Partners, USA
Consulting
BeMo Tunnelling GmbH, Austria

Units
DSI Underground Austria GmbH, Austria and DSI Tunneling LLC, USA
DSI Underground Scope
Production, supply, engineering services, technical support, supervision
DSI Underground Products
AT – 139 Pipe Umbrella System, AT – TUBESPILE™ Self-Drilling Spiles, DYWI® Drill Hollow Bar System, AT – 76 Drainage System, AT – TUBESPILE™ Vacuum Spiles, GRP face bolts, forepoling boards

DSI Underground supplies high quality Ground Support Products for the Minera El Roble Mine in Mexico

The Minera El Roble Mine is located in northern Mexico in the town of Velardeña in the Federal State of Durango. The mine is owned by Industrias Peñoles SAB de CV, one of the largest mine operators in Mexico.

Zinc, silver and lead have been extracted from this underground polymetallic mine since 2008. Minera El Roble extracts 2 million tons per year that are sent to a refinery in Torreon, 100km north-east of the mine, for further processing.

DSI Underground Mexico is supplying high quality ground support products and systems to the mine that are used to stabilize the drifts. The products supplied include 25mm x 2,400mm GRP Anchors.

The lightweight fiberglass system is easy to use in challenging conditions. At the same time, the anchors feature high tensile load-bearing capacity.

Furthermore, DSI Underground produces and supplies 19mm x 2,400mm headed rebar rock bolts and 28mm x 305mm FASLOC® Resin Cartridges to ensure that the anchors reach a high load-bearing capacity immediately following installation.

The Minera El Roble Mine is continuously attended to by DSI Underground Mexico's specialists, and the mining personnel attend training sessions on a regular basis.

Owner
Industrias Peñoles SAB de CV, Mexico

Unit
DSI UNDERGROUND MEXICO S.A. de C.V., Mexico

DSI Underground Scope
Production, supply

DSI Underground Products
25mm x 2,400mm GRP Anchors, 19mm x 2,400mm rock bolts, 28mm x 305mm FASLOC® Resin Cartridges


JA-07

The Rofomex Mine: Phosphate Mining with high quality Products and Systems by DSI Underground

The Rofomex Mine is located in the south of the Baja California Peninsula, Mexico, near the city of La Paz. The mine is one of the few natural deposits of phosphate rock on the Pacific Rim. The operator, Petróleos Mexicanos (Pemex), Fertilizer Division, is a government-owned oil company.

The phosphate rock is mined using the room and pillar method with low profile continuous miners and shuttle cars. Mining is being carried out in the Humboldt Layer that has an average thickness of 1.2m. It is the primary phosphate-bearing rock unit within the San Gregorio Formation. The low seam height of this deposit makes mining very difficult.

Afterwards, the phosphate rock is transported outside by conveyor belts and trucked to the Concentration Plant in the San Juan de la Costa Complex. Then, concentrate is sent by ship to the fertilizer plant in Lázaro Cárdenas in Michoacán, Mexico.

The roof is supported by rock bolts that are installed using both mechanized and manual bolters. Since 2007, DSI Underground Mexico has been supplying the mine with high quality ground support products manufactured by DSI Underground.

This includes 1.5m and 2m long, 19mm Ø headed rebar rock bolts and anchor plates. Other products from the DSI Underground range that are supplied to the Rofomex Mine include size 14 W straps as well as accessories such as drilling bars and drill bits. DSI Underground is also supplying 16mm Ø cable bolts. Long cable bolts can be easily installed in the limited space on site and have a high load-bearing capacity at a low weight per meter.

The anchor systems are installed together with 23mm x 760mm FASLOC® Polyester Resin Cartridges. The cartridges ensure an immediate, high load-bearing capacity of the anchors.

Owner
Petróleos Mexicanos (Pemex), Fertilizer Division, Mexico

Unit
DSI UNDERGROUND MEXICO S.A. de C.V., Mexico

DSI Underground Scope
Production, supply

DSI Underground Products
19mm Ø rebar rockbolts, size 14 W straps, drilling bars, drill bits, 16mm Ø cable bolts, 23mm x 760mm FASLOC® Polyester Resin Cartridges


DSI
UNDERGROUND

DSI Underground supplies high quality Ground Support Products to the Minera Tizapa Mine in Mexico

The Minera Tizapa Mine is located in Central Mexico in the town of Zacazonapan, 180km west of Mexico City. The mine is a subsidiary of Industrias Peñoles SAB de CV, one of the largest mine operators in Mexico.

In this underground mine, ore containing zinc, lead and copper has been extracted since the beginning of the 1990s.

Minera Tizapa extracts 880,000t per year and has a concentration plant from which the raw materials are transported to the Pacific ports for export – especially to the port of Lazaro Cárdenas.

DSI Underground Mexico is supplying special quality ground support products and equipment to the mine to stabilize the galleries. The products supplied are 15.2mm cable bolts and the necessary equipment for stressing.

Recently, DSI Underground Mexico assisted the mine during the reinforcement of rock strata in a very complicated, unstable area.

DSI Underground's technical personnel helped the miners with the correct installation of the cable bolts and with the professional use of the Mark 2 Cable Tensioner.

Thanks to this successful application, the mine was able to secure a large rock mass and to continue extracting mineral using the long hole mining method.

The mine is continuously supported by DSI Underground Mexico's specialists.

Owner
Industrias Peñoles SAB de CV, Mexico

Unit
DSI UNDERGROUND MEXICO S.A. de C.V., Mexico

DSI Underground Scope
Production, supply

DSI Underground Products
15.2mm cable bolt coils, Mark 2 Cable Tensioner

The Cuiabá Mine: Very Deep Gold Mining with Ground Support Products by DSI Underground

The Cuiabá Gold Mine in the federal state of Minas Gerais in Brazil has a long history. The first site development by the Dias and Gomes families dates back to the year 1740. In 1985, large scale extraction started with 1.2 thousand tons per day of mined mineral.

The mine has been undergoing expansion since 2005, and the drifts of the mine located in the mountains attained the sea level at a depth of 1,019m in 2008. From 2011 to 2015, more than a million ounces of gold were mined at the Cuiabá Mine.

DSI Underground Brazil has co-operated with the owner AngloGold Ashanti since 2009.

The DSI Underground team is supporting the operator with training sessions and offers support in the application of the ground support products produced and supplied by DSI Underground. As the mine extracts gold in increasingly deeper layers, DSI Underground also supports the owner with specific tests for new products and technologies.

Furthermore, DSI Underground supplies the mine with the products and systems necessary for stabilizing the drifts.
3m long 22mm Ø rock bolts are used for stabilization. The products manufactured and supplied by DSI Underground also include 28 x 300mm FASLOC® Resin Cartridges.

Owner
AngloGold Ashanti Córrego do Sítio Mineração, Brazil

Unit
DSI Underground Systems Brasil Indústria e Comércio Ltda., Brazil

DSI Underground Scope
Development, production, supply, technical support, test installation

DSI Underground Products
22mm Ø THREADBAR® rock bolts, 28 x 300mm FASLOC® Resin Cartridges


DSI
UNDERGROUND

Systems for different geological Conditions: The Pilar Mine in Minas Gerais

The Pilar Mine near the town of Santa Bárbara in the Federal State of Minas Gerais, Brazil, is a gold mine that is operated by Jaguar Mining.

The underground mine is one of two mines forming part of the Caeté Complex that has a capacity of 2,200t per day. In the fourth quarter of 2016, the Caeté Complex processed 115,000t of ore and produced 9,308 ounces of gold.

DSI Underground Brazil and the operator Jaguar Mining have a strong partnership in which DSI Underground develops alternative products and technologies permitting the mine to achieve its mining targets.

The geology at the Pilar Mine includes sections with fractured rock as well as sections with hard rock, which represents a challenge in terms of supplying the mine with the matching products for ground support.

To stabilize the drifts, DSI Underground produces and supplies 2.4m long, 22mm Ø rock bolts as well as accessories and the equipment needed for installation. Furthermore, DSI Underground produces and supplies 2.4m long OMEGA-BOLT® Expandable Friction Bolts.

Bonding forces between the friction bolt and the rock mass are caused by form closure and friction transfer between the borehole wall and the rock bolt which is expanded by hydraulic pressure.

The anchor systems are installed together with 28mm x 450mm FASLOC® Resin Cartridges ensuring that the anchor systems develop their load-bearing capacity immediately.

DSI Underground's service package also includes permanent training for the mine personnel, field tests underground and the development of new mining strategies in co-operation with the owner.

Owner
Jaguar Mining Inc., Brazil

Unit
DSI Underground Systems Brasil Indústria e Comércio Ltda., Brazil

DSI Underground Scope
Development, production, supply, technical support, test installation, rental of equipment

DSI Underground Products
2.4m long, 22mm Ø rock bolts, 2.4m long OMEGA-BOLT® Expandable Friction Bolts, 28mm x 450mm FASLOC® Resin Cartridges

Introduction of Rocbolt Resins (Australia)

J-Lok Resins Australia was originally founded in 2008 by J-Lok USA and South African technology partners. The aim of J-Lok was the manufacture of high quality resin cartridges to provide an alternative to a monopoly supply for the Australian coal mining industry, for hardrock mining, civil construction and for tunneling.

Resin Cartridges Production

In August 2014, DSI Underground purchased a 49% stake in J-Lok Resins, forming a new joint venture named Rocbolt Resins. This joint venture was converted to a 50/50 joint venture in February 2016.

Since late 2015, Rocbolt Resins Pty Ltd, (Australia) has been successfully managed by Andrew Sykes, who is ably supported by a dedicated team of specialists.

Some of the employees have been with Rocbolt Resins since it was formed in 2008.

The workforce has, in the space of just over a year, increased from 30 up to approximately 80 people and reflecting the diversity within Australian culture. Every day, Australians, Samoans, New Zealanders, Philippinos, Britons, Bosnians, Serbians, and a Peruvian work together in the team.

Australia is home to one of the safest mining industries in the world, both in hardrock and in coal. Rocbolt Resins continues to contribute to this statistic by providing products and system solutions that enhance safety in mines.

Every day brings different challenges to Rocbolt Resins, which invariably makes each day totally different.

Storage Tanks

Andrew Sykes

November 2016 was an all-time record production month for Rocbolt Resins: 1,064t of resin capsules were manufactured in a single month. All manufactured capsules are carefully monitored and timed, and some capsules are also stored off site at distributors. Recently, Rocbolt Resins installed a new compressor system and 3 separate production lines, making the production process much simpler.

In August 2016, a resin cartridge manufacturing line from Germany was installed along with a new design of mixing/blending facility to manufacture the cartridge used in the advanced self-drilling OneStep Bolt System.

Rocbolt Resins supplies a vast portfolio of resin cartridges and is flexible to meet varying customer requirements. The resin cartridges are available in 6 different speeds, 6 diameters, and lengths varying from 300mm up to 3,400mm, with multiple packaging requirements.

In May 2017, Rocbolt Resins transitioned its Quality Management System to the upgraded ISO 9001 standard. Furthermore, the management of critical spare parts and plant maintenance was improved.

Rocbolt Technologies, South Africa

Rocbolt Technologies is a 50/50 joint venture between DSI Underground and Jennmar that strives to be the foremost manufacturer and supplier of specialized products and systems to the South African underground mining and geotechnical construction industries. The joint venture provides a complete package of ground control products, engineered solutions and new product developments to its South African customers. Through this joint venture, the resources and products of two of the world's leading suppliers of quality mining, tunneling and geotechnical solutions have been combined.

The 3,000m² resin cartridge manufacturing facility, strategically situated in Johannesburg, permits the production of a wide range of high quality resin capsules. Currently, 70-80 employees are working on 4 production lines. As Rocbolt has been continuously producing at the limit of its existing production capacity, the company is planning to significantly increase production by the addition of more production lines.

The complete production process is being continuously and closely monitored by a Quality Assurance System. The production of resin capsules forms part of Rocbolt South Africa's core competency. The finished resin cartridges are transported to the nearby steel plant every day, where they are once more inspected, packaged and centrally stored for distribution to customers.

The 13,000m² steel plant, employing approximately 280 workers, is also strategically located in Johannesburg.

Rocbolt South Africa produces approximately 500,000 rock bolts and accessories per month. This means that, every month, approximately 1,500 to 2,000t of steel bars and 450t of coiled steel are processed to produce mining anchors and accessories in the steel plant. The production of the comprehensive range of mining bolts will be further enlarged as the company is planning to build up additional production capacity for manufacturing expansion shells and cable bolts.

Furthermore, Rocbolt has actively and strategically advanced the production and supply of Geotechnical products and systems in South Africa.

Rocbolt Steel Plant

Rocbolt Resin Cartridge Manufacturing Facility

Steel Plant, Production

Resin Cartridges Production

Today, the product range includes all established strand and bar anchors – both temporary and permanent –, DYWI® Drill Hollow Bar Anchors and high quality products and systems for Tunneling.

The two facilities enable the company to provide an unparalleled level of support to all customers in Southern Africa. Furthermore, Rocbolt South Africa is continuously and strategically expanding the export ratio of high quality ground control products and systems into adjacent countries. Currently, products are being exported to Zimbabwe, Botswana, Swaziland, DRC, and Zambia. Additional export options have offered themselves as far away as Mali, Burkina Faso, Ghana and also Tanzania, to where the mining products produced in South Africa are transported by truck over distances of up to 2,400km.

Rocbolt South Africa is a leading system supplier with a strong market position that is reinforced by high quality and innovative products and systems. The experienced staff of skilled personnel provides a comprehensive range of premium ground support products, systems and engineered solutions.


ROCBOLT

Rocbolt Technologies China Ldt: An Introduction

The personal history of Dr. Yajie Wang, the General Manager of Rocbolt Technologies China Ltd.

Dr. Wang is a native of China, where he received both his Bachelor and Master's Degree in Mining Engineering. Dr. Wang graduated in 1996 from West Virginia University. In 1999, he was named Vice President-Engineering, Keystone Mining Services, LLC.

Throughout his career in mining, Dr.Wang has conducted many ground control projects including roof control design, pillar design, or mine layout design. He has published more than 20 papers in mine ground control.

Dr. Wang developed the yieldable support system and has solved many roof support difficulties faced by many coal mines in China. Today, he is a well-known expert in roof support in China and holds an important position in several roof support committees.

The history of Rocbolt Technologies China Ltd.

Jennmar (Jining) Mine roof support products Co., Ltd. was founded in 2004 in Jining city as a branch of Jennmar in China with its major business focus being in research, design, manufacture and technical service on mine roof support products.

During the last decades, Dr. Wang as the General Manager has brought in fresh technologies and products. He has made a great contribution to the business of mine roof support products, and his developments in this field have been recognized across the country.

In April 2016, DSI Underground purchased a 50% stake in Jennmar (Jining), forming a new joint venture called Rocbolt Technologies China Ltd.. Jennmar and DSI Underground are planning to work together to optimize resources, integrate markets, and develop new technologies and products.

Rocbolt Technologies China Ltd. is a global manufacturing center for mine roof support products. In the next 3 to 5 years, the export business is expected to be 3 to 5 times larger while the company will maintain its current market share on the Chinese market.

Introduction of Rocbolt Technologies China Ltd.

All employees are dedicated to offering best quality products and best services to their customers and will continue to work hard to support their company.

Rocbolt Technologies China Ltd. currently has shearing, threading, and reducing equipment, a cable line, a roll former, and a welding line among other equipment. As the orders have increased since Rocbolt China was formed, the company is planning to increase production capacity by adding production lines such as a cable line, a friction bolt production line and an all thread bolt production line. Rocbolt Technologies China Ltd. is using the ISO 9001 Quality Management System and their Quality Assurance System to monitor the complete production process as well as the entire management process.

Currently, the products are being exported to Canada, Australia, Spain, Russia, the Philippines and Mongolia. Skilled staff, the management system and sufficient equipment enable the company to provide good quality ground support products for all customers all over the world.

Imprint

Published by
DSI Holding GmbH
Destouchesstrasse 68, 80796 Munich, Germany
Phone +49-89-30 90 50-200
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Design and Editorial Content
DSI Holding GmbH
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Design, Layout, Typesetting and Picture Editing
d-formen.de, Volker Heise
Solingen, Germany

Printing
Holzer Druck und Medien
Weiler im Allgaeu, Germany

Picture Credits
The St. Kanzian Tunnel Chain: DSI Underground supplies
AT – Pipe Umbrella Support Systems with efficient Squeezed Connection
Photos reprinted courtesy of Baresel GmbH, Austria

This publication is printed in English (3,000) and German (3,000)

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04250-1/09.2018-4.000 he ho