Ground Control Solutions for Tunneling and Mining
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DSI’s Business Activities in the Underground Construction Market

DYWIDAG-Systems International (DSI) is a global market leader in the development, manufacturing, and distribution of systems and products for the construction industry.

ALWAG Tunnelausbau Gesellschaft m.b.H. was merged into DYWIDAG-Systems International GmbH., Austria. The goal of this merger was to create a consistent presence on the Austrian market while simultaneously strengthening the international distribution of the innovative ALWAG Systems. DSI continues to use the well-known brand name ALWAG on the market.

DSI Austria’s main business is the development, manufacturing, and distribution of entire product lines and system solutions for Tunneling, Mining, and Special Foundations. In conformity with DSI’s mission statement “Local Presence - Global Competence”, DSI Austria is oriented towards its customers’ needs and offers the advantages of complete product lines of DSI, which are adjusted to individual customer requirements. All underground construction activities in Europe, the Middle East, and Africa (EMEA) are coordinated by DSI Austria.

DSI Austria’s product range includes a wide variety of anchors, rock bolts, and support systems, as well as the well-known series of the field-approved AT-SYSTEM. The AT - Casing System, as part of this series, is just one example for DSI Austria’s high quality systems. It permits the cost-effective and practical implementation of static support, injection, or drainage drills. The POWER SET Self-Drilling Friction Bolt and AT - TUBESPILETM as well as the LSC™ Element, which offers support for squeezing rock ground conditions, also form part of DSI Austria’s innovative system solutions.

Product Range
DSI Austria’s extensive product range includes:

- Anchors and Rock Bolts
  - Rebar Rock Bolt; Mechanical Anchor; GEWI® Anchor and Rock Bolt; GRP Rock Bolt; DYWI® Drill Hollow Bar System; OMEGA-BOLT® Expandable Friction Bolt; POWER SET Self-Drilling Friction Bolt; Friction Stabilizer; CT-Bolt™; DSI Resin Cartridges

- Spiles
  - Rebar Spile; Injection Spile; IBO - Self-Drilling Spile; AT - TUBESPILETM

- Rock Support
  - PANTEX Lattice Girder; LSC™ Element; Forepoling Board; Underground Beam

- AT - Casing System
  - AT - Pipe Umbrella Support System; AT - Drainage System; AT - GRP Injection System; AT - Automation Unit

- Injection and Waterproofing Systems
  - DYWI® Inject Systems; DSI Waterproofing System; RIA Rotary-Injection-Adapter; Flow-Pressure Meter; Mortar-Mixing Pump; Injection Packer, Injection Lance and Gunite Pipe
Technical Support & Services

DSI provides technical support as well as on-site product management carried out by a team of experienced technicians and supervisors. Our service team is available for general and product-specific questions related to:

- Design, testing, and evaluation of ground control systems
- Self-Drilling ground control technology
- Layout and optimization of lattice girder support
- Pipe umbrella support and drainage drilling works
- Accomplishment and monitoring of injection works
- Testing of product usage properties

Research & Development

All R&D activities of DSI Underground EMEA are coordinated by the Regional Head Office based in Pasching, Austria. As a result of the consolidation of its activities, DSI provides a full range of ground control products globally, backed by technical support and innovative system solutions. This has already led to a more effective customer service, benefiting from the transfer of technology made possible by this consolidation:

- Preparation of National and European Technical Approvals
- Self-Drilling ground control solutions: one-step anchors, rock bolts, and forepoling elements featuring immediate load-bearing capacity
- Rock bolt automation: fully automated bolting attachment units for underground construction
- AT – Pipe Umbrella Support System: various innovative pipe connections tailored to customer demands
- LSC™ Element: improved yielding support element for advances dealing with squeezing or swelling ground conditions
- Numerical simulations, laboratory and field tests of DSI’s products: understanding of the in-situ behavior of ground control solutions
Anchors, Rock Bolts, and Spiles

DYWI® Drill Hollow Bar System and IBO - Self-Drilling Spiles

Fields of Application

The DYWI® Drill Hollow Bar System is used successfully for reinforcing poor ground, cohesive and non-cohesive soils, and in case of unstable boreholes. IBO - Self-Drilling Spiles are used as a fast and efficient pre-support system.

- Tunneling and Mining
  - Rock bolting
  - Face anchoring
  - Reinforcement ahead of the tunnel face
  - Foot piles
  - Tunnel portals, trenches, and cut-and-cover areas

- Special Foundations
  - Reinforcement of excavation pit walls, dam foundations, and slopes
  - Anchorage of retaining walls and noise barriers
  - Pile foundation and buoyancy control

AT - TUBESPILE™

Fields of Application

In Tunneling, spiles are generally used for local reinforcement ahead of the tunnel face. The AT - TUBESPILE™ is installed self-drilling in a one-step operation and is suitable for safe and time-optimized excavations in loose rock or soil. Optionally, the AT - TUBESPILE™ is also available as a vacuum lance system for active ground drainage.

Main Advantages AT - TUBESPILE™

- One-step installation procedure
- Safe and fast installation using standard drilling equipment
- Optimization of the excavation geometry and increased advance per round
- Easy adjustment to changing ground conditions
- Careful ground treatment due to self-drilling installation
- Minimization of over-excavation and additional convergence
- Immediate reinforcement after the AT - TUBESPILE™ installation is accomplished
- Unproblematic installation in case of unstable boreholes
- Optionally available with perforation holes for drainage or injection purposes
- Higher moment of inertia against bending compared to standard rebar spiles
**OMEGA-BOLT® Expandable Friction Bolt**

**Fields of Application**

The main application of the OMEGA-BOLT® Expandable Friction Bolt is temporary rock reinforcement in Mining and Tunneling. 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.

**Main Advantages OMEGA-BOLT® Expandable Friction Bolt**

- Immediate full load bearing capacity over the complete bolt length
- Low sensitivity against vibrations caused by blasting works
- Safe and simple installation
- No additional building material required for installation
- Flexibility in case of differing or varying borehole diameters
- Quality check during every single installation
- Different customized high-pressure pumps available

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**Friction Stabilizer Bolt**

**Fields of Application**

- Systematic reinforcement of underground excavations
- Rock bolting in hard rock mining
- Additional reinforcement and utility bolting

**Main Advantages Friction Stabilizer Bolt**

- Easy and fast installation procedure
- Both hand-held and fully automated installation possible
- Immediate load-bearing capacity after installation
- Low sensitivity to ground movements
**Rock Bolts**

**POWER SET Self-Drilling Friction Bolt**

**Fields of Application**
- **Tunneling and Mining**
  - Rock bolting
  - Face anchoring
- **Rock fall and rock slide protection**
  - Anchorage of avalanche barriers
  - Instant protection in case of rock fall hazard

**Main Advantages POWER SET Self-Drilling Friction Bolt**
- Simultaneous drilling and installation
- Installation using standard drilling machines
- Immediate load-bearing capacity after installation
- Direct load transfer over the entire bolt length
- High shear resistance (shear strength > tensile strength)
- Safe, easy, and time-optimized installation procedure
- No injection or grouting necessary
- Ergonomic and safety-related advantages for the workforce

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**CT-Bolt™**

**Fields of Application**
- Systematic permanent reinforcement of underground excavations
- Ground support for areas with limited or no access during operational lifetime
- Mining: permanent roadways and excavations

**Main Advantages CT-Bolt™**
- Combination rock bolt
- Application as temporary and long-term ground control system
- Immediate point anchorage in terms of an expansion shell anchor
- Post-grouting assembly features double corrosion protection
- Fully automated or manual bolt installation
Rock Bolts

Rebar Rock Bolts and SN-Anchors

Fields of Application
- Systematic rock bolting in Tunneling
- Rock reinforcement in Underground Mining
- Installation under stable borehole conditions
- Utility and hanger bolts

Main Advantages SN-Anchors
- Long-term proven bolting system
- Effective standardized installation procedure
- SN-Anchors with ALWAGRIP Special Rib Geometry for increased bond available upon request

DSI Resin Cartridges

Fields of Application
- Two-component resin cartridge for underground applications
- Installation in combination with rebar rock bolts
- Resin grouting for rehabilitation works and bolting where immediate load-bearing capacity is required

Main Advantages DSI Resin Cartridges
- Maximum bonding capacity due to optimized components
- Durable and sound resin grouting
- Constant and customized gel times
- Water-based resin cartridge system
Fields of Application
PANTEX Lattice Girders have been developed for the special demands in the field of tunneling. The PANTEX system has been extensively tested and used successfully for numerous tunnel projects throughout the world.

Main Advantages PANTEX Lattice Girders
- Immediate support in the excavation area
- Utilization as a template when applying shotcrete
- Easy and quick assembling, simple handling
- Optimum bond and interconnection with the shotcrete lining
- Simple adjustment and shaping to the excavation geometry
- Ideal bearing for spiles and lagging boards
- Spiles may be installed both above or through the lattice girders

Fields of Application
- Support for squeezing ground conditions
- Application in combination with a primary shotcrete lining or precast concrete lining segments

Main Advantages LSC™ Element
- Warranty of supporting forces of the tunnel lining for squeezing rock mass conditions
- Controlled stress distribution and yielding ability
- Avoidance of overstraining of the tunnel lining in terms of rupture processes and consequential damages
- Ideal utilization of the load-bearing capacity of the shotcrete lining
- Well defined load-deformation characteristics
- Displacement-controlled limitation of axial forces
- Project specific adjusted geometry and yielding forces
- Tunable to the rock mass conditions using FEM simulation
AT - Casing System

Fields of Application

The AT - Casing System is a system solution that is adjusted to customer needs. This overburden drilling system is used for underground pre-support, ground injection, or drainage works.

Standard structural properties

AT - Pipe Umbrella Support System
- AT - 76: 76.1 x 5.6
- AT - 89: 88.9 x 6.3
- AT - 114: 114.3 x 6.3
- AT - 139: 139.7 x 8.0
- AT - 168: 168.0 x 12.5

AT - GRP Injection System
- AT - 76/GRP

AT - Drainage System
- AT - 76/DR
- AT - 118/DR

AT - Pipe Umbrella Support System

Fields of Application
- Tunneling in heterogeneous, soft, or subsidence sensitive ground
- Tunneling through fault zones
- Unstable ground conditions at the working area
- Shallow tunnels in urban areas

Main Advantages AT - Pipe Umbrella Support System
- Support of the tunnel wall close to the heading
- Distribution of loads in the longitudinal direction
- Ground improvement ahead of the tunnel face by grouting
- Reduction of subsidence due to ground improvement and load distribution
- Drainage and ground support also by non-injected casing tubes
**AT - Casing System**

### AT - Drainage System and GRP Injection System

#### Fields of Application AT - Drainage System
- Drainage of the ground ahead of excavation
- Drainage of endangered slopes or embankments to prevent landslides

#### Fields of Application AT - GRP Injection System
- Ground improvement ahead of TBM cutting wheels
- Tunneling through zones of heterogeneous, soft, or subsidence sensitive ground

### AT - Automation Unit

#### Fields of Application
The AT - Automation Unit is used for the automated installation of the AT - Casing System. To accomplish optimized pipe umbrella drilling works, the unit is mounted onto standard underground drilling machines.

#### Main Advantages AT - Automation Unit
- Time efficient pipe umbrella drilling
- Cost reduction due to lower installation times
- Remote controlled manipulation
- Increased operational safety
- Lower demand for personnel
- Reduction of non-productive times
- Lower head room for pipe umbrella drilling necessary
- Smaller saw tooth profile – less over-excavation and shotcrete consumption
### DYWI® Inject Systems

**Injection Resins, Foam Resins, and Gels**

<table>
<thead>
<tr>
<th>Product Segment</th>
<th>Product Group</th>
<th>PURE 8031</th>
<th>PURE X 8032</th>
<th>PURE 8034</th>
<th>PURE X 8034</th>
<th>SILO 8041</th>
<th>SILO 8042</th>
<th>GELE 8061</th>
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<tbody>
<tr>
<td><strong>Product Designation</strong></td>
<td>Polyurethane Injection Foam Resin</td>
<td>Accelerator for Polyurethane Injection Foam Resin</td>
<td>Polyurethane Injection Resin</td>
<td>Accelerator for Polyurethane Injection Resin</td>
<td>Silicate Injection Foam Resin</td>
<td>Silicate Injection Resin</td>
<td>Acrylate Injection Gel</td>
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<td>Rock stabilization</td>
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</table>

- **DYWI® Inject PURE 8031** is a 2-component polyurethane injection foam resin for sealing against water and for stabilizing unconsolidated rock masses in Mining and Tunneling.
- **DYWI® Inject PURE X 8032** is a curing accelerator for the 2-component polyurethane injection foam resin.
- **DYWI® Inject PURE 8034** is a 2-component polyurethane injection resin for permanent sealing in aquiferous ground.
- **DYWI® Inject PURE X 8034** is a curing accelerator for the 2-component polyurethane injection resin.
- **DYWI® Inject SILO 8041** is a 2-component silicate injection foam resin for immediate sealing against flowing water.
- **DYWI® Inject SILO 8042** is a 2-component silicate injection resin with excellent adhesive properties that cures quickly and solidly.
- **DYWI® Inject GELE 8061** is a 3-component polyacrylate injection gel for the efficient sealing against ground water.
Main Advantages DYWI® Inject Systems

- Easy handling and effective injection
- Ecologically inoffensive – CFC and halogen free
- Suitable for drinking water areas
- Stable for storing and processing – resistant against acids and bases

High Pressure Pumps and Packers

- DYWI® Inject 8096 2-component high pressure pump type MT is an air driven pump with a fixed mixing ratio for processing DYWI® Inject resins and foam resins
- DYWI® Inject 8097 2-component high pressure pump Type GELE is an air driven pump with a fixed mixing ratio for processing DYWI® Inject gels
- Injection packers are used for the targeted injection of resins and gels into the foundation

Fields of Application

- Protection of structures against ground water
- Permanent waterproofing of underground tunnels
- Water sealing for excavations
- Waterproofing of excavation pits, dams, or for slope stabilization
- Application in building construction: waterproofing of basements, garages, or flat roofs

Main Advantages DSI Waterproofing System

- Quick and easy to install
- Easy handling on-site due to lightweight design
- Self-healing properties of the hydrophilic, water-reactive polymers
- Waterproof even if the system is damaged during installation
- Special welding equipment or specially trained personnel are not required
- Safe solution for sealing tiny cracks and voids in concrete
- Special formulations for salty water conditions are available upon request
- Economic and environmentally sound alternative to synthetic liners, bituminous products, and coatings
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