



**Foundations, underpinning**



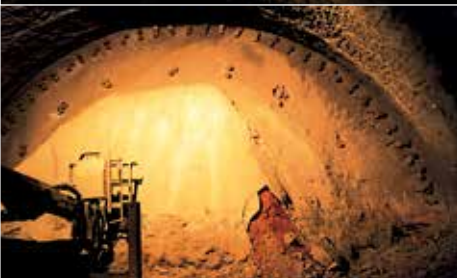
**Anchorage**



**Slope stabilisation**



**Tunnelling**



## **TITAN Injection Pile**

One system – many applications.

# TITAN Injection Pile

National Technical Approval Z-34.14-209

## Broad range of applications – one system

The TITAN Injection Pile consists of a ribbed steel tube and a grout body made from a cement suspension. The system is permanently interlocked with the existing soil and is suitable for tensile, compressive and cyclic loads up to 2022 kN in permanent and temporary applications according to a National Technical Approval. TITAN Injection Pile

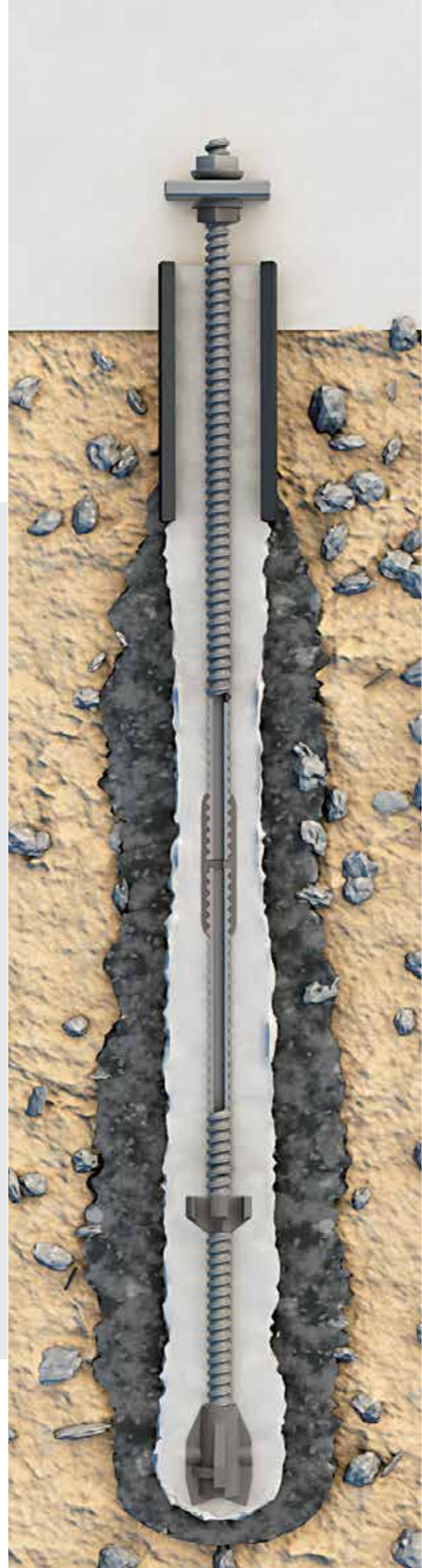
- as a compression pile for foundations,
- as a tension pile for tying back retaining structures,
- for stabilising slopes, embankments and rock faces,
- in tunnelling.

The intention of this brochure is to provide a brief overview of the system and the various applications. Detailed information about TITAN Injection Piles can be found in the application brochures and on the Internet at [www.ischebeck.de](http://www.ischebeck.de) or simply speak to your contact at ISCHEBECK.

---

TITAN micropiles comply with DIN EN 14199 "Execution of special geotechnical works – injection piles" and in Germany their use is regulated by National Technical Approval Z-34.14-209 issued by the German Institute of Building Technology (DIBt).

---



### Foundations, underpinning



### Anchorage



### Slope stabilisation



### Tunnelling



#### Advantages for designers

- Approved system
- Quick, dependable planning
- Versatile – also suitable for difficult boundary conditions
- Can be used in all soil types

#### Advantages for contractors

- Standard method irrespective of type of application
- Suitable for use on confined sites
- Fast progress on site
- Unaffected by changing soil conditions
- No additional plant necessary

#### Advantages for clients

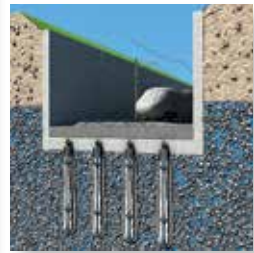
- No ongoing costs for monitoring tests
- Permanent corrosion protection
- Highly reliable installation method
- Avoids a major intervention in existing works
- Economic system



## Foundations, underpinning and preventing uplift

The TITAN Injection Pile can be used as a micropile complying with DIN EN 14199 to transfer tensile, compressive and cyclic loads to deeper load-bearing strata.

- Can also be installed with compact, lightweight equipment
- Easy-drilling, low-vibration solution
- Suitable for use on cramped sites
- Permanent solution
- Minimal settlement



### Installation in historic building

Underpinning works at St. Georg Monastery, Heggbach

More headroom was required in the basement which meant the existing foundations had to be underpinned in order to lower the basement floor slab by 1.50 m. Using the ISCHEBECK bayonet system it was possible to produce empty holes by uncoupling and withdrawing the steel tendon at a prescribed depth.



### Noise barrier foundations

Koblenz–Trier railway line in Moselle valley, Bullay station  
Special foundations near an underpass

- The large spacing of the foundations made it necessary to install 4 No. TITAN 52/26 and 2 No. TITAN 40/20 injection piles.
- These piles can carry both tensile and compressive forces.



**Underpinning**

Electricity pylon, Leutkirch  
Heavier ice loads made it necessary to underpin a pylon with TITAN 103/78 injection piles. The return flow of the cement was pumped away in a controlled manner to prevent spoiling this nature conservation area.



**Foundations for bridge abutments**

Gasterntal, Bernese Oberland, Switzerland  
Flooding had swept away the old bridge. TITAN 40/16 injection piles were used in the foundations for the new bridge abutments.



**Protection against uplift**

Cargo City, Frankfurt  
A total of 636 No. TITAN 40/20 injection piles in lengths from 5.00 to 7.00 m were drilled through the water with a 3.00 m long recoverable section in order to secure the underwater concrete slab against uplift. Each end plate was positioned at the right level together with drilling in one operation. Expensive operations involving divers to attach the end plates were therefore not required.



## Anchorage

The TITAN Injection Pile can be used as a micropile complying with DIN EN 14199 to transfer tensile, compressive and cyclic loads to deeper loadbearing strata.

- The alternative to prestressed anchors to DIN EN 1537
- For temporary and permanent works
- Monitoring unnecessary
- System components can compensate for horizontal and vertical angles
- The analysis of the lower slip plane is carried out in a similar way to prestressed anchors to EAU 2012 (Recommendations of Committee for Waterfront Structures, Harbours & Waterways)



### Anchoring sheet piles

Magdeburg inland port; pier, Elbtor district, Hamburg

- Installation of 25–30 m long TITAN 103/51 injection piles
- A casing surrounds the uppermost 12 m of each anchor pile in order to create a structural separation between the anchor and caisson or other existing structures



### Anchoring a retaining wall

B258 road, Nürburg–Meuspath

- Further netting and footway
- Sheet piles anchored with TITAN 40/20
- Lengths between 7.0 and 16.5 m
- System components can compensate for angles (spherical collar nut + end plate with spherical recess)



**Refurbishing of sloping retaining wall**

Wolfratshausen Berg

- Installed through almost vertical existing wall
- Drilling rig secured to an excavator via winches
- Only half of the road had to be closed



**Excavation shoring**

New company premises for DMOS GmbH, Dresden

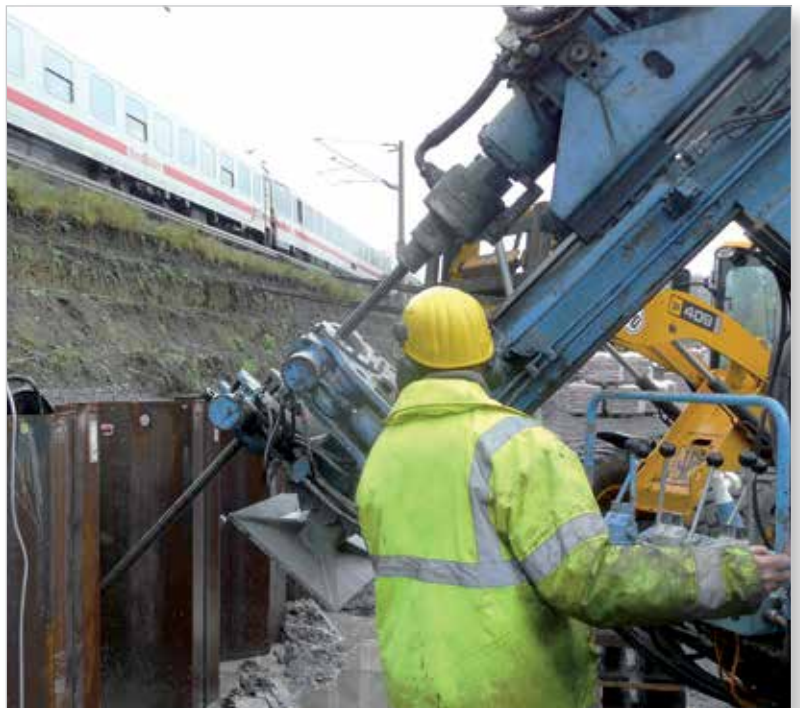
- Excavation shoring in the form of a soldier pile wall
- Wall tied back with TITAN 40/16 and 52/26 anchors



**Verge stabilisation** B33 near Nussbach

A capping beam had to be added to an existing retaining wall below a hillside road.

- TITAN 40/20 raking and vertical piles to resist traffic and impact loads
- Mounting the drilling unit on a mini-excavator meant that only half of the road had to be closed.



**Embankment upgrade**

Braunschweig–Hannover railway line, Wierthe

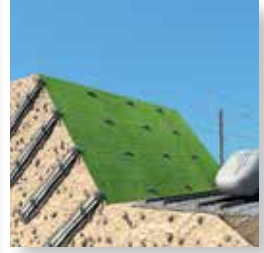
- TITAN 52/26, 195 piles
- Installation monitored with measuring/control system
- Average length 15 m
- Top 3 m galvanised



## Slope stabilisation

The TITAN Injection Pile can be used as a soil nail to DIN EN 14490 for reinforcing soils and increasing the tensile and shear strength.

- Trouble-free installation in places with difficult access
- Noise, low-vibration operations
- For temporary and permanent applications
- Low site set-up costs
- Simple installation, also from railway tracks



### Rock protection in Valais

Lötschberg railway, Bern–Brig, Switzerland  
The anchors were drilled through the loose rock with the help of a cement suspension. Air flushing was used in the rock and the voids filled in a subsequent operation, which optimised the installation work in the granite.



### Stabilising a railway embankment

Upgrading the Wilhelmshaven–Oldenburg line for the rail link to the Jade Weser Port.

- TITAN 30/11, 3300 piles
- in lengths of 8–12 m (total length 35 000 m)



### Slope stabilisation railway line near Wolfratshausen

To protect the tracks against falling rocks, the 25 m high slope was secured with steel wire netting anchored in the ground.

- 9 m long TITAN 40/16 injection piles drilled from walking excavator
- Excavator secured by winches fixed at top of slope
- Additional corrosion protection (duplex) to top 3 m of each injection pile





**Slope protected with reinforced sprayed concrete**

Excavation shoring, Polchin Zdroj, Poland  
Ideally adapted to terrain contours and plan layout.



**Slope stabilisation**

Tröglhang, Garmisch-Partenkirchen  
In the course of the Alpine Ski World Cup in 2011, the pistes were realigned and also widened in some instances. A tunnel was built below the Tröglhang using the cut-and-cover method, which required the following anchors:

- TITAN 30/11 for tying back the surface protection system (for later planting) at the head of the works
- TITAN 40/16 for soil nailing with sprayed concrete facing as excavation shoring
- TITAN 40/20 for tying back timber anchorwalls for widened entrance area



**Soil nailing with additional DRILL DRAIN<sup>®</sup> filter nails**

Securing an excavation in Kappl, Tyrol  
In order to protect the sprayed concrete facing against slope seepage and formation water, 9 m long filter nails were installed on an approx. 25 x 25 m grid.

- The horizontal deep drain consists of a TITAN 40/20 hollow steel tendon and a pumpable filter material that is injected and after setting remains permeable to air and water.
- Installation was carried out with the excavator-mounted drilling rigs customarily used for soil nailing.
- Any formation water occurring drains out via the filter nails (readily visible in the photo)

## Tunnelling

The TITAN Injection Pile can be used when tunnelling through loose rock:

- For securing the tunnel profile
- As a pipe umbrella for securing the tunnel entrance or working face
- As a system of radial anchors for reducing deformations in the tunnel according to the NATM
- For tunnel floor stabilisation with partial-face driving
- For jet grouting as an alternative to a pipe umbrella
- For refurbishing existing tunnels
- As roof bolting: predetermined yielding coupler accommodates rock movements
- IQ Quickset Roofbolts: extra rapid-hardening two-part silicate resin



### Slope protected with reinforced sprayed concrete

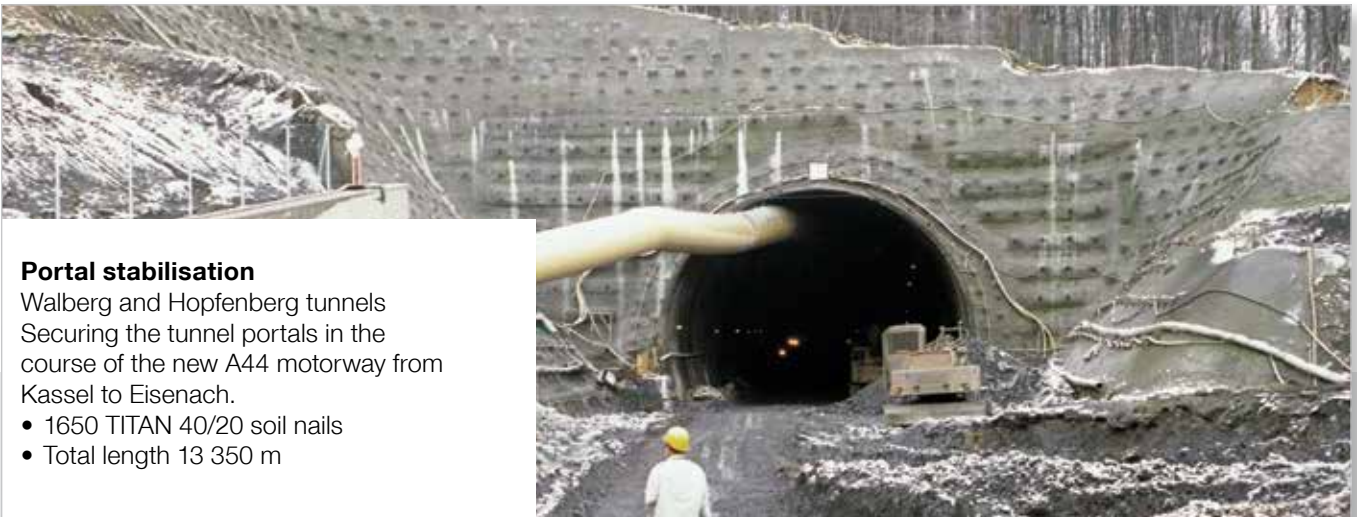
Soil nailing for Laliki Tunnel, Poland  
Portal stabilised with duplex-coated injection piles.



### Portal stabilisation

Walberg and Hopfenberg tunnels  
Securing the tunnel portals in the course of the new A44 motorway from Kassel to Eisenach.

- 1650 TITAN 40/20 soil nails
- Total length 13 350 m







### **Portal stabilisation**

Escape tunnel for Felderhalde Tunnel, Isny, Allgäu  
Securing the portal profiles (east and west) with TITAN 40/20  
injected spiles to form a composite canopy:

- 21 spiles 15 m long at a spacing of 300 mm per portal
- To ensure accurate drilling, the holes were drilled with a pilot bit consisting of a carbide shouldered bit plus a 750 mm long steel guide rod.

### **Tunnel stabilisation**

Pipe umbrella for Santiago di Chile underground



### **Partial-face driving**

Santiago di Chile underground  
Jet grouting



## TITAN Injection Pile – the system at a glance

### **TITAN hollow steel tendon with 3-in-1 function**

The ribbed steel tube made from fine-grain structural steel functions as a sacrificial drilling rod, injection tube and reinforcing bar. The low number of components guarantees effective working and flexible adaptation to site and ground conditions.

- Design loads between 135 and 2022 kN per injection anchor
- Up to 250 bar grouting pressure

### **Reinforcing bar made from fine-grain structural steel grade S 460 NH**

- Tough, ductile steel
- No sudden failure
- Satisfies all demands placed on reinforcing steel

### **Injection tube**

- Drilled hole inevitably filled completely with the cement suspension starting from the bottom up
- No separate casing necessary
- Tube with high buckling and bending resistance
- Flushing and drilling fluid stabilises the drilled hole like a diaphragm wall

### **Drilling rod with continuous TITAN thread**

- Can be shortened or lengthened as required
- Self-locking thread = no counternuts necessary
- Optimum thread form for good shear bond





**Head details for every application**

- Standardised
- Verified typical calculations

For further information please refer to our brochure on pile head details.

**Grout body**

- Corrosion protection
- Transfers forces from hollow steel tendon to surrounding soil via bond and skin friction

**Coupler**

- For cyclic and dynamic loads
- Optimum transfer of impact energy
- Impervious up to 250 bar

**Centraliser**

- Helps to ensure a stable direction during drilling
- Ensures a consistent cover of cement grout

**Drill bits**

Available in 13 sizes for every type of soil.

**Permanent corrosion protection**

The special geometry of the thread limits the formation of cracks in the grout body even under heavy loads.

Crack widths remain below 0.1 mm and therefore satisfy the stipulations of the DIBt: the TITAN Injection Pile is approved for permanent applications **without** the need for additional corrosion protection measures.

---

National Technical Approval Z-34.14-209

---



The photos show an anchor excavated and cut through for test purposes. The interlock between hollow steel tendon, cement grout cover, filter cake and soil is readily visible. The hollow steel tendon and coupler are fully embedded and therefore protected against corrosion.



In the case of special requirements, e. g. exposed steel tendons, we can offer the following as well:

- Hot-dip galvanising
- Duplex coating
- Stainless steel – resists corrosion without the need for a covering of cement grout



## One method for all applications

Installed according to National Technical Approval Z-34.14-209

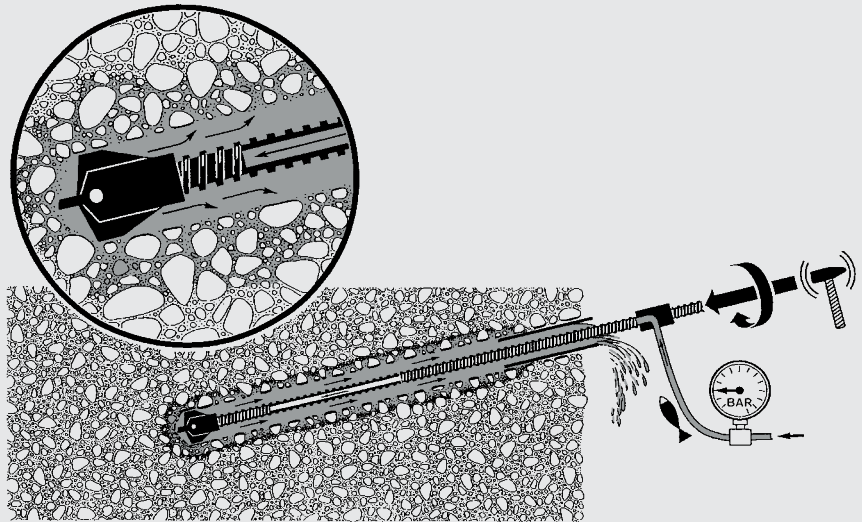
### One operation – two steps

Irrespective of the ground conditions and the particular application, TITAN Injection Piles are always installed using the same method.

- Can also be used in changing soil conditions
- No separate casing required
- No multi-stage grouting

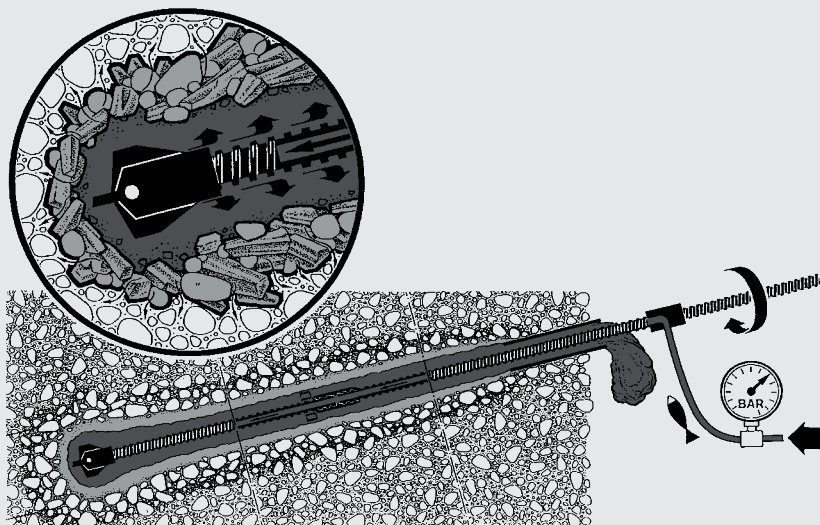
### Step 1: Direct drilling

- A cement suspension is injected through the hollow steel tendon and forced out through the lateral flushing apertures in the drill bit.
- The cement suspension functions as a flushing and drilling fluid to prevent the sides of the hole from collapsing.
- The cement forms a mechanical interlock with the microstructure of the soil (filter cake).



### Step 2: Dynamic grouting

- The fluid of step 1 is displaced by a stiff cement suspension ( $w/c = 0.4-0.5$ ).
- A grout body forms, creating a high shear bond with the soil.
- The required minimum injection pressure of 5 bar is always achieved.







**Hand-held pneumatic hammer drill**

For installing small steel hollow tendons, TITAN 30 to TITAN 40.



**Excavator-mounted drilling equipment with hydraulic drive**

For installing small to medium-sized steel hollow tendons, TITAN 30 to TITAN 52.



**Anchor drilling rigs**

Universal crawler track-mounted units for installing all TITAN hollow steel tendons.

**Suitable hammer drills**

TITAN 30/...	Atlas Copco COP 1036, 1038, 1238; SIG PLB 291 A; TAMROCK HL 438; Krupp HB 5, HB 11, HB 15, HB 20; Eurodrill HD 1001, HD 1002; Klemm KD 204, KD 511; Morath HB 23; TEI TE 300 HT
TITAN 40/...	Atlas Copco COP 1036, 1038, 1238; SIG PLB 291 A; TAMROCK HL 438; Krupp HB 11, HB 15, HB 20; Eurodrill HD 1001, HD 1002; Klemm KD 204, KD 511, KD 1011; Morath HB 70; TEI TE 300 HT
TITAN 52/...	Krupp HB 25, HB 35; Eurodrill HD 2004; Morath HB 100; Klemm KD 511, KD 1011, KD 1215; TEI TE 500 HT
TITAN 73/...	Krupp HB 35, HB 45, HB 50; Klemm KD 1011, KD 1215; Morath HB 100; Eurodrill HD 2004, HD 4010;

**Pressure-grouting plant**

TITAN 30/...	35 l/min	Pressure-grouting plant with water regulation, turbo mixer for colloidal mixing,
TITAN 40/...	50 l/min	1 mixing receptacle + 1 reservoir, duplex plunger pump, up to 100 bar
TITAN 52/...	70 l/min	Manufacturers: Scheltzke, Obermann, Häny, Morath
TITAN 73/...	90 l/min	
TITAN 103/...	120 l/min	
TITAN 127/...		

Drilling rate: 0.3–1.0 m/min, approx. 50 r.p.m., flushing pressure 10-15 bar. Note: Compared with drilling holes in rock for explosive charges, reducing the drilling rate and the percussive action to approx. 1/3 is recommended. We recommend using rotary percussive plant for installing TITAN Injection Piles.



## 16 Permanent anchorage

New works for the 2014 Olympic Winter games in Sochi, Russia. The retaining wall around the shooting range for the biathlon and cross-country skiing stadium is secured with permanent anchors. The 25 m high contiguous piling wall has been tied back with TITAN tension piles.

- Lengths of 18-39 m at a rake of 10-15°
- Anchors installed:  
TITAN 73/53 (94 pcs.)  
TITAN 103/78 (163 pcs.)  
TITAN 103/51 (634 pcs.)

Concrete forming & supporting systems



Trench shoring systems



Geotechnical systems

