ISCHEBECK TITAN

Slope and portal stabilisation

Temporary tunnel stabilisation

Permanent anchorages

TITAN for tunnels and mining

A self-drilling system –
many applications

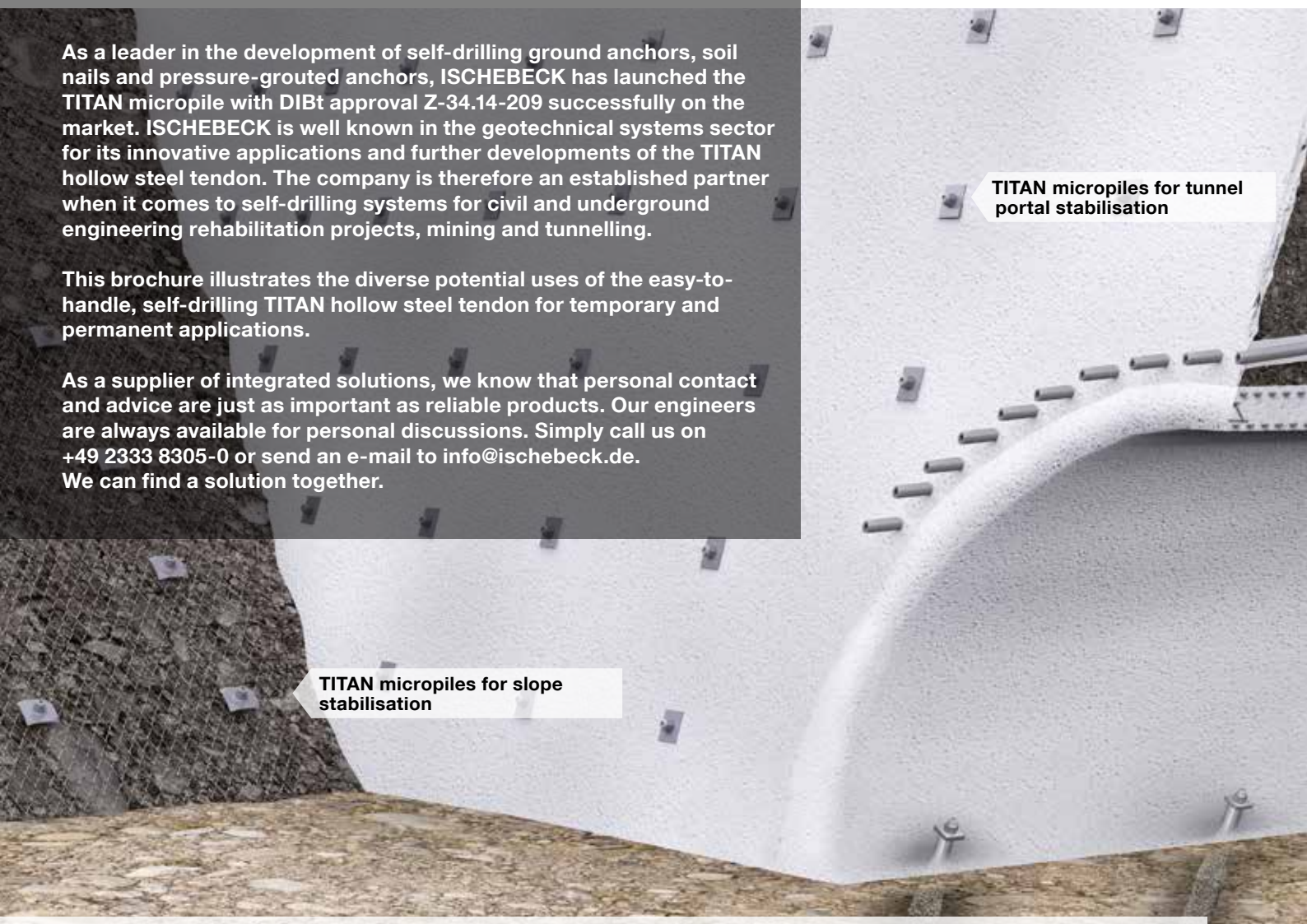
TITAN micropile
DIBt approval Z-34.14-209

TITAN system
A self-drilling system with many applications

As a leader in the development of self-drilling ground anchors, soil nails and pressure-grouted anchors, ISCHEBECK has launched the TITAN micropile with DIBt approval Z-34.14-209 successfully on the market. ISCHEBECK is well known in the geotechnical systems sector for its innovative applications and further developments of the TITAN hollow steel tendon. The company is therefore an established partner when it comes to self-drilling systems for civil and underground engineering rehabilitation projects, mining and tunnelling.

This brochure illustrates the diverse potential uses of the easy-to-handle, self-drilling TITAN hollow steel tendon for temporary and permanent applications.

As a supplier of integrated solutions, we know that personal contact and advice are just as important as reliable products. Our engineers are always available for personal discussions. Simply call us on +49 2333 8305-0 or send an e-mail to info@ischebeck.de. We can find a solution together.



TITAN micropiles for tunnel portal stabilisation

TITAN micropiles for slope stabilisation

Advantages for clients

- Proven in many challenging situations
- Economical
- Highly reliable installation method
- Fast progress on site
- Ductile steel grade (high deformation reserves = greater safety)

Advantages for designers

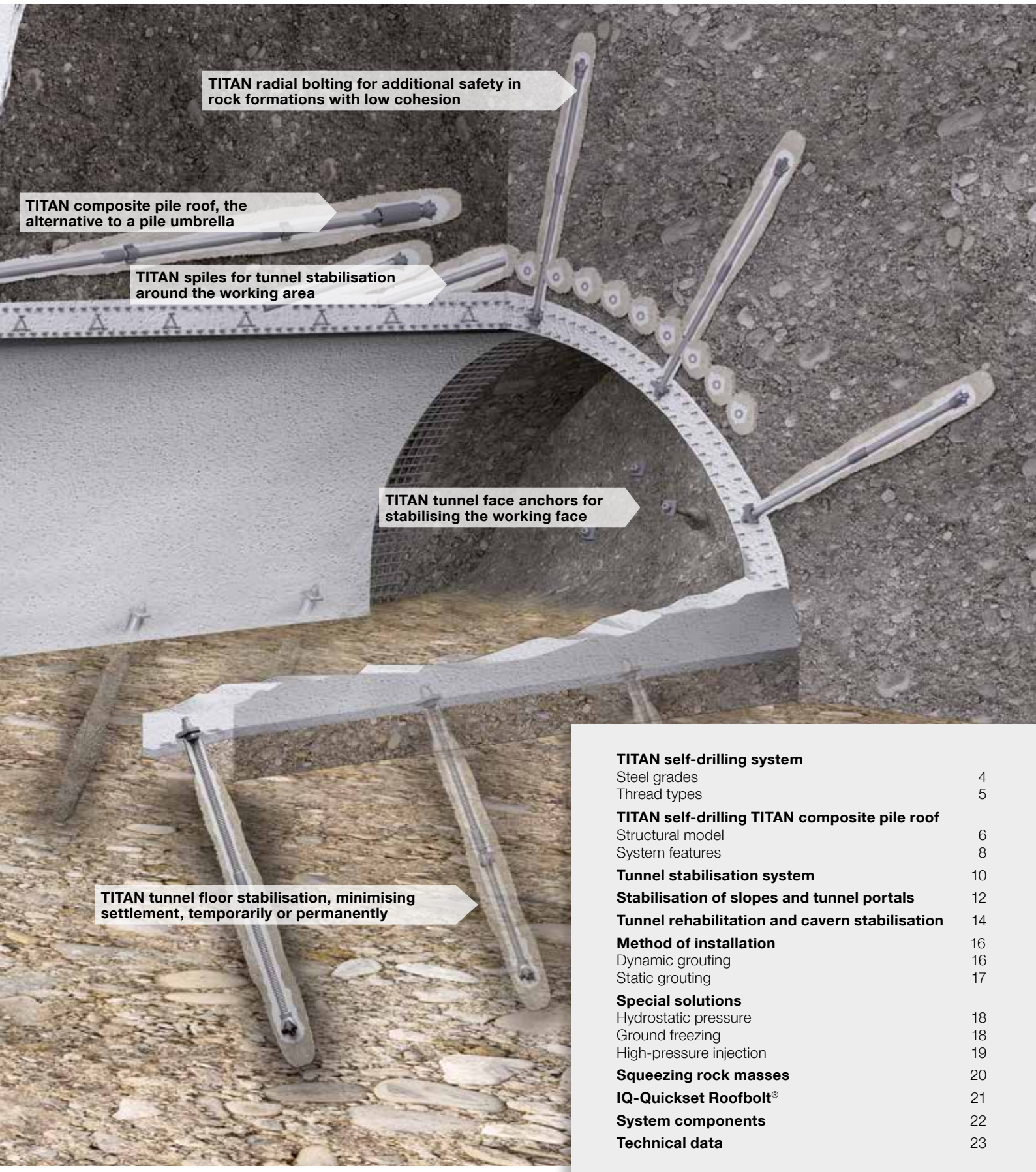
- Standardised and straightforward system
- Comprehensive support from manufacturer
- Stabilisation of problematic geology (dynamic grouting)
- Ductile steel grade (high deformation reserves = greater safety)
- Can also be used where accessibility is restricted

Advantages for contractors

- Easy to use
- Fast progress on site
- Design depth is reached even in boreholes at risk of collapse.
- Responds readily to changing geology
- Uses existing installation and grouting plant
- Ductile steel grade (high deformation reserves = greater safety)
- Support from ISCHEBECK engineers

TITAN micropile
DIBt approval Z-34.14-209
Design life: 100+ years

ISCHEBECK TITAN



TITAN self-drilling system

Steel grades

Requirements regarding reinforcing steel properties
The hollow steel tendons of self-drilling systems are used in accordance with the following standards:

DIN 21521 Rock bolts for mining and tunnelling
DIN EN 1537 Ground anchors
DIN EN 14199 Micropiles
DIN EN 14490 Soil nailing
Hollow steel tendons are classed as reinforcing bars according to DIN EN 10080/DIN 488 and Eurocode 2 (DIN EN 1992).
The following steel grade is required for class B:

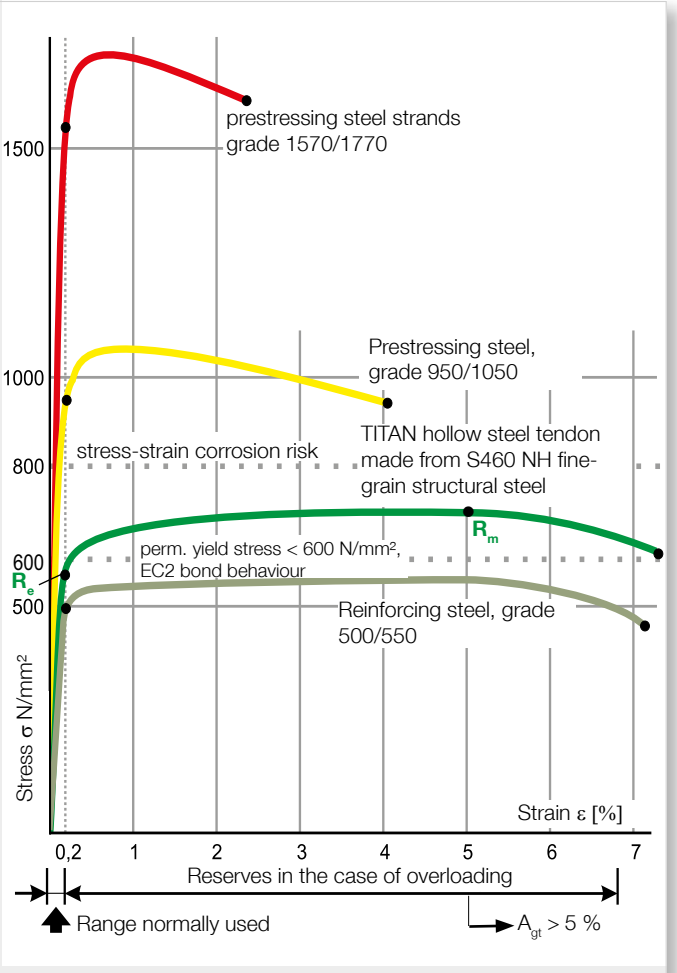
- Yield stress $f_{y,k}$: 400–600 N/mm²
- Yield stress ratio $(f_t/f_y)_k$ or $R_m/R_e \geq 1.08$
- Elongation at maximum load ε_{uk} or $A_{gt} \geq 5.0\%$

TITAN hollow steel tendons are manufactured from hollow sections to DIN EN 10210 under the provisions of the above standards and comply with all the all the main requirements of steel reinforcing bars.

Requirements regarding self-drilling installation
Self-drilling systems are installed with a rotary percussive action. A tough, ductile steel with a high notched impact strength is necessary for the high loads that occur during the process. Therefore we use fine-grain structural steel grade S460NH for our TITAN hollow steel tendons, which is not sensitive to stress corrosion cracking. The notched impact strength of this steel is W ≥ 40J (at -20° C), well above the values of general structural and pre-stressing steels (27J and 15J respectively). This key property greatly reduces the risk of damage during installation.

Safety requirements
Due to its high ductility, the steel used in our products reacts with highly uniform strain in the event of overload. If the overload remains constant, visible deformations occur first before the component fails. Sudden failure is therefore ruled out.

It is for these reasons that we do not offer **high-strength steels** with a yield stress > 600 N/mm².



Corrosion protection

TITAN hollow steel tendons for permanent applications are reliably protected by the surrounding body of cement grout. The following additional measures can be employed to improve the corrosion protection for special applications:

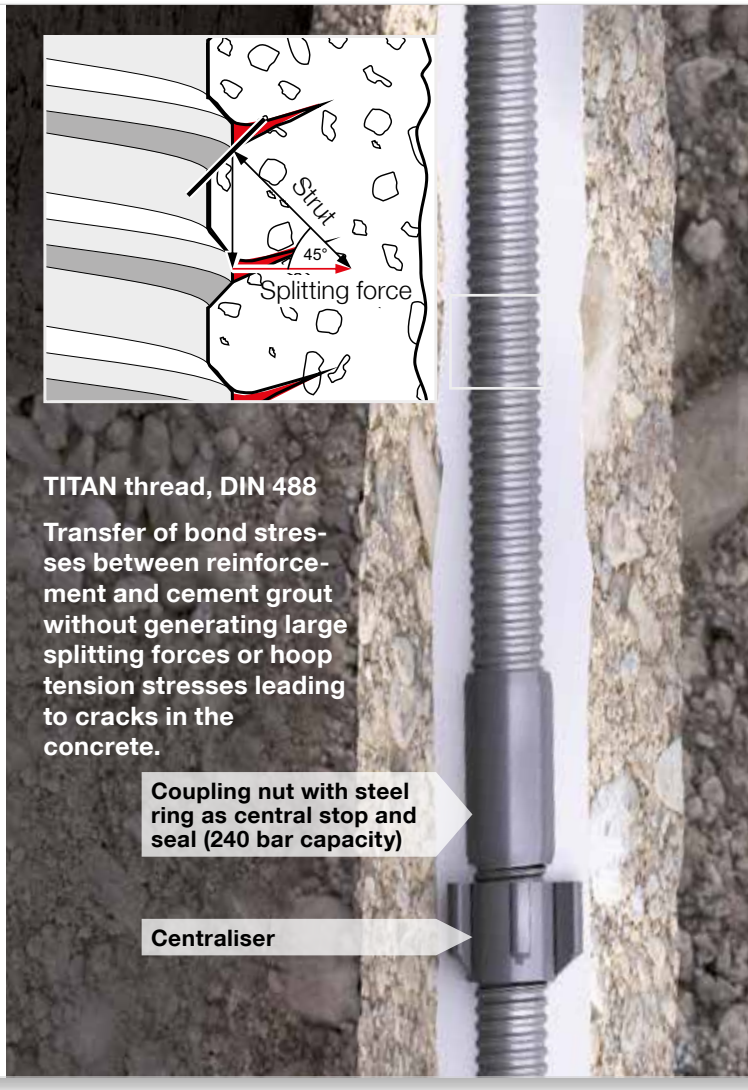
- Hot-dip galvanising
- Duplex coating
- Stainless steel

TITAN thread
Reinforcing bar thread

In order to transfer the loads from the steel tendon (i.e. reinforcement) to the surrounding grout body, it is necessary to create a shear bond between them. The effectiveness of the shear bond essentially depends on the geometry of the ribs.
Therefore, the geometry of steel reinforcing bars to DIN EN 10080/DIN 488 and EC2 (DIN EN 1992) must comply with two main requirements:

- The dimension of the relative rib area f_R is the key parameter for the quality of the bond. The relative rib area for the rebar thread of the TITAN system is f_R = 0.14–0.25. It is therefore much higher than the relative rib area of ribbed reinforcing bars (f_R = 0.056).
- A flank angle $\alpha > 40°$ is required to limit the splitting forces. In the TITAN system the flank angles of the inclined rib surfaces are $\alpha \geq 45°$ (drilling rods with rope thread $\alpha \approx 17°$).

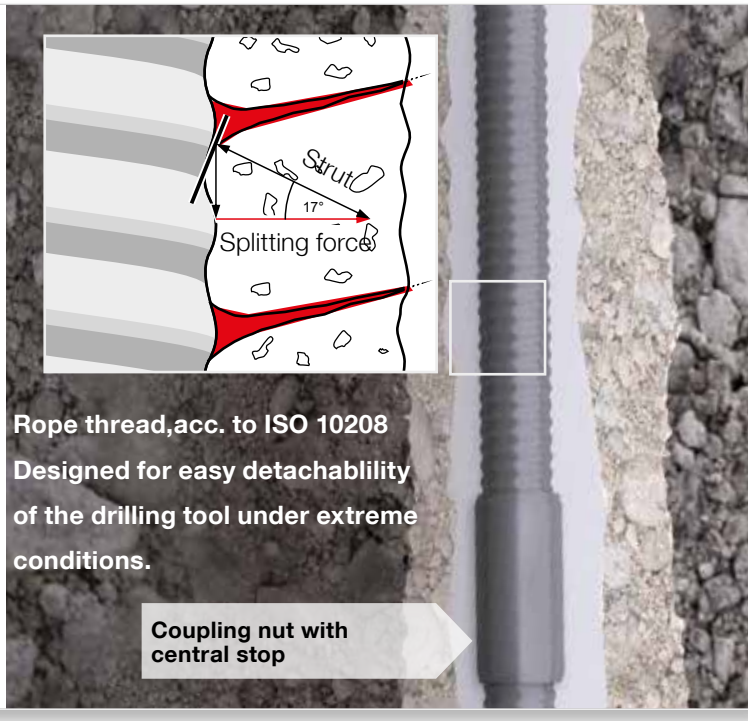
The crack widths in the grout body at maximum load therefore stay below the maximum permissible width of 0.1mm to maintain permanent corrosion protection. Those are the main reasons why the building authorities have approved the TITAN system.



R-thread
Drilling rod with rope thread

Drilling tool threads (e.g. R32 and R38) are round (or rope) threads to ISO 10208 “Rock drilling equipment; left-hand rope threads”. This type of thread is optimised for quick detachability under high loads in confined conditions.

However, such threads do not satisfy the requirements for reinforcing steel regarding shear bond and crack width limitation. For drilling rod or rope thread a rip relationship cannot be specified.
The flank angle of 17° does not meet the requirement of the standard for reinforcing steel (a ≥ 40°).

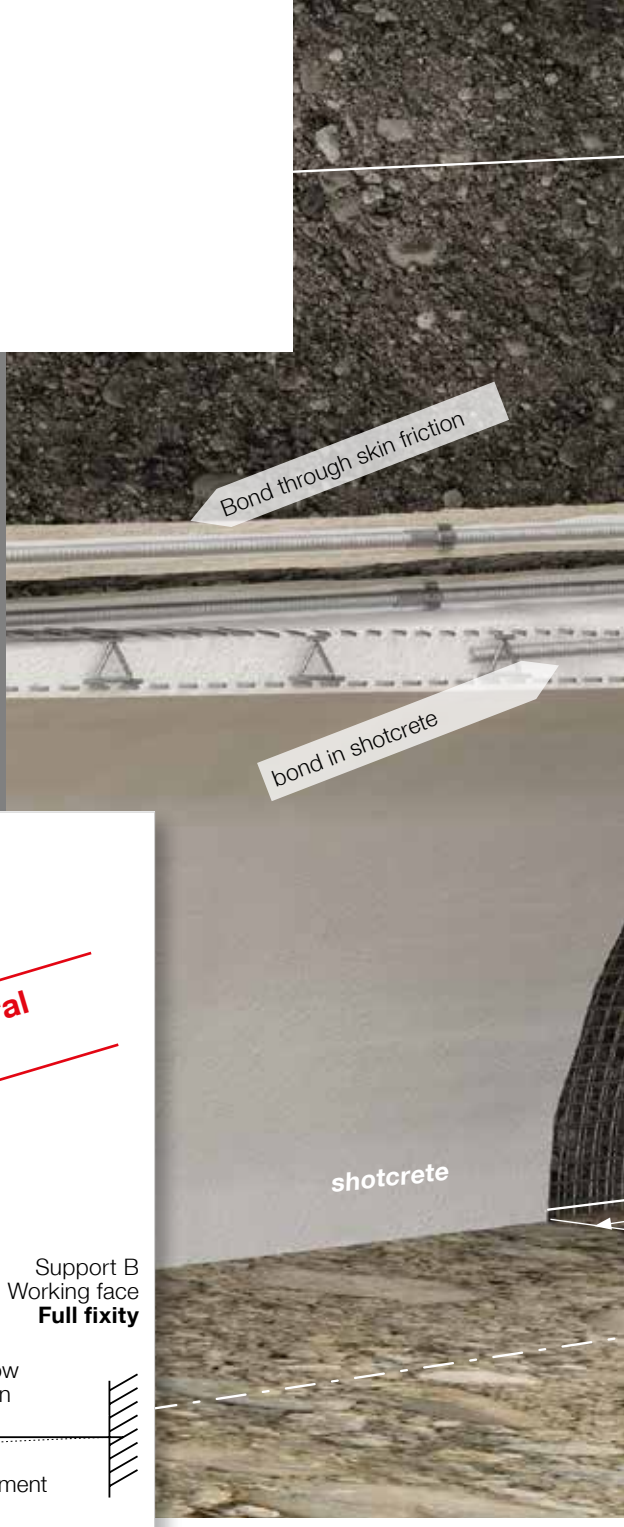


TITAN composite pile roof – structural system

The alternative to a pipe umbrella

The main feature of the TITAN composite pile roof is the improvement to the self-supporting behaviour of the rock formation in the funnel area in front of the working face. Installing reinforcement helps the rock formation to support itself when using the NATM*. Reducing the exploitation of the strength of the rock mass results in greater relative safety.
The aim is to drive as long as possible without problems, without interruptions.
Powerful finite element methods are available for the structural modelling. The result is a considerable potential for saving steel compared with conventional pipe umbrellas.

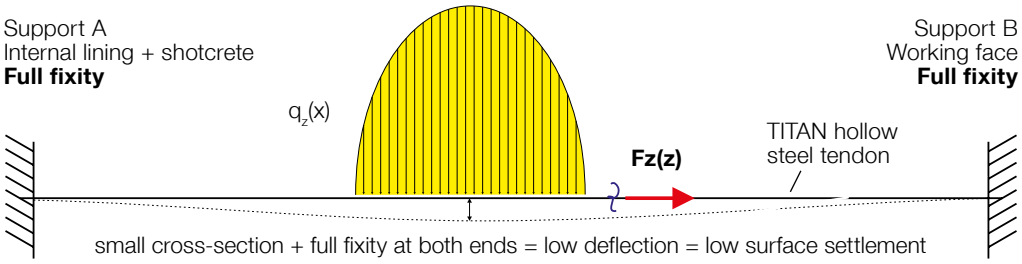
*** NATM: New Austrian Tunneling Method**



TITAN composite pile roof: tensioned cable model

- The loadbearing action is based on the shear bond between the TITAN hollow steel tendon (the reinforcement) and the surrounding dynamically and radially grouted rock mass. This is possible thanks to the TITAN thread (rebar thread).
- The tendon is a slender bar, a “tensioned cable”, fixed between two restrained supports.
- The strain in the hollow steel tendon is critical.

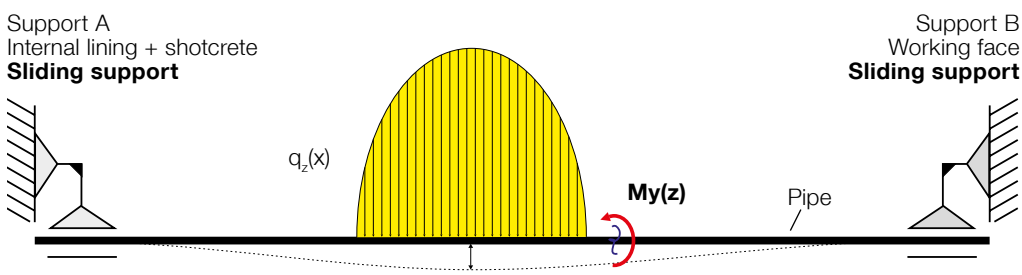
new structural model



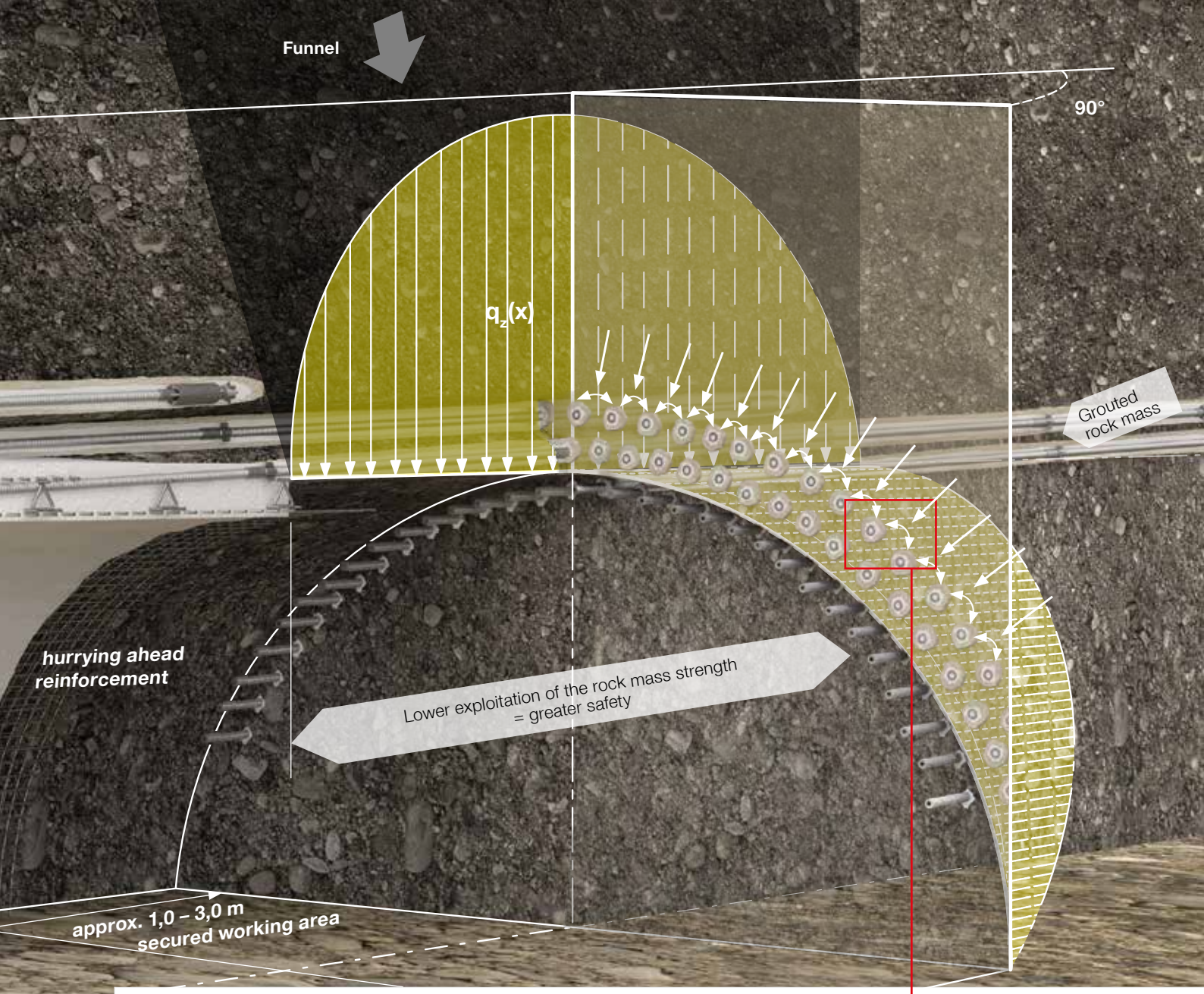
small cross-section + full fixity at both ends = low deflection = low surface settlement
-> Activation of large axial forces

As a comparison: Conventional pipe umbrella as a beam

- Unrestrained support since virtually no bond with the rock.
- The bending stiffness $E \cdot I_y$ of the pipe is critical.



large moment of inertia = low deflection = low surface settlement
-> Large bending moments can be admitted

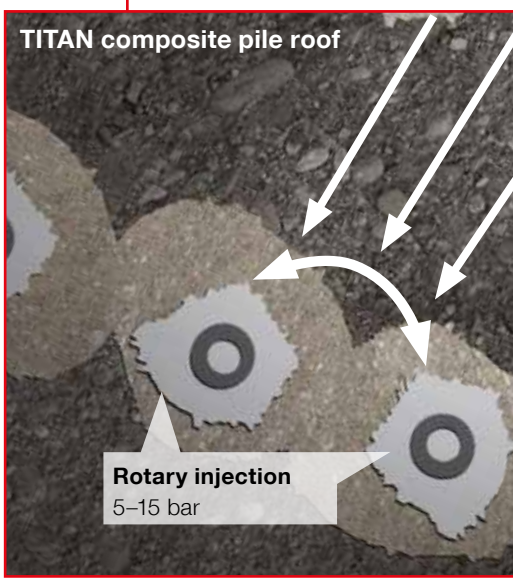


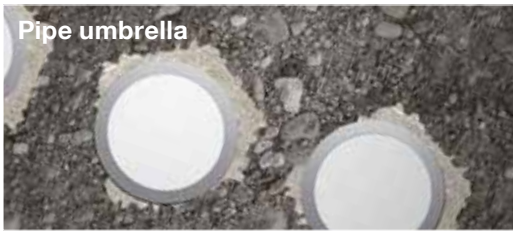
TITAN composite pile roof

- Bond between TITAN hollow steel tendon and grout body as well as between TITAN tendon and shotcrete
- Interlocking effect creates bond between grout and rock mass
- TITAN hollow steel tendon fixed at both ends
- Designed for tension (design of the lower layer for tension)
- Characteristic steel stress for bond = max. 500 N/mm²
- Steel cross-section A = 900 mm² (TITAN 40/16)
- Hole diameter = Ø90 mm (TITAN 40/16)
- Grout body up to Ø140 mm for hole diameter Ø90 mm plus injection into rock formation
- Relative exploitation of rock mass strength $\lambda < 0.85$
- Small hole diameter results in less disruption of the rock formation
- Dynamic grouting results in a distinct improvement to the rock structure
- Arching effect between the TITAN hollow steel tendons
- In case of 2-layer-composite pile roof, design of composite pile roof as double reinforced beam

As a comparison: conventional pipe umbrella

- Sliding support at both sides
- Designed for bending and shear
- Characteristic steel stress for bond = max. 105 N/mm²
- Steel cross-section A = 4073 mm² (Ø140 × 10 mm pipe)
- Hole diameter Ø150 mm (Ø140 mm pipe)





TITAN composite pile roof – system features

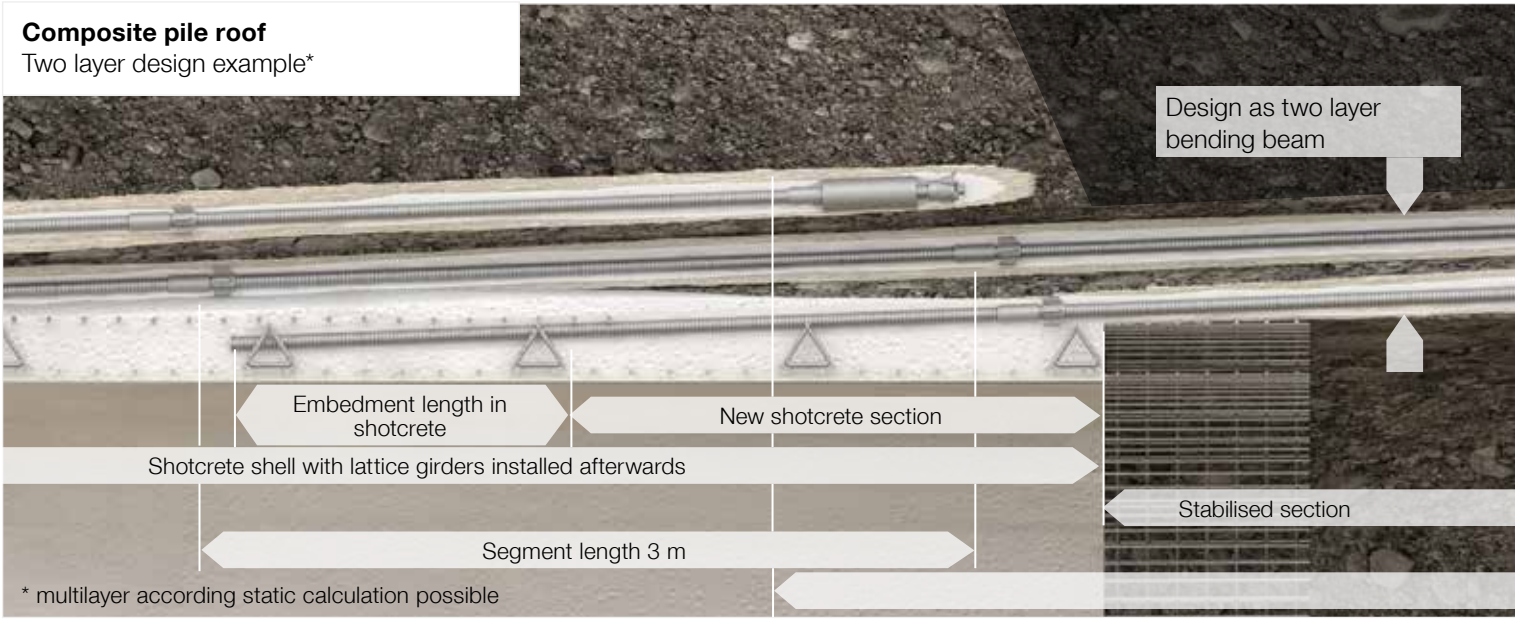
Temporary forepoling for trouble-free tunneling

Patent No. 102 34 255

Applications
- Tunnel support in rock with low cohesion or in loosely bedded soils
- Tunnel support in fault zones
- Stabilisation around tunnel entrance

Practical advantages for contractors
- Steel weight savings of up to 80%
- Uses the same drilling method as for installing anchors and spiles
- Easy handling due to small steel cross-sections
- Bolt pockets and sawtooth profiles are unnecessary or can be made much smaller
- No need for drill string extraction
- Filling of openings and valves is unnecessary
- No connections sensitive to bending
- Rock injection continuous over entire bore length
- Flushing and grouting pressures and flow rates can be regulated over the pressure-grouting plant with double plunger pump and recorded with flow rate/pressure logger

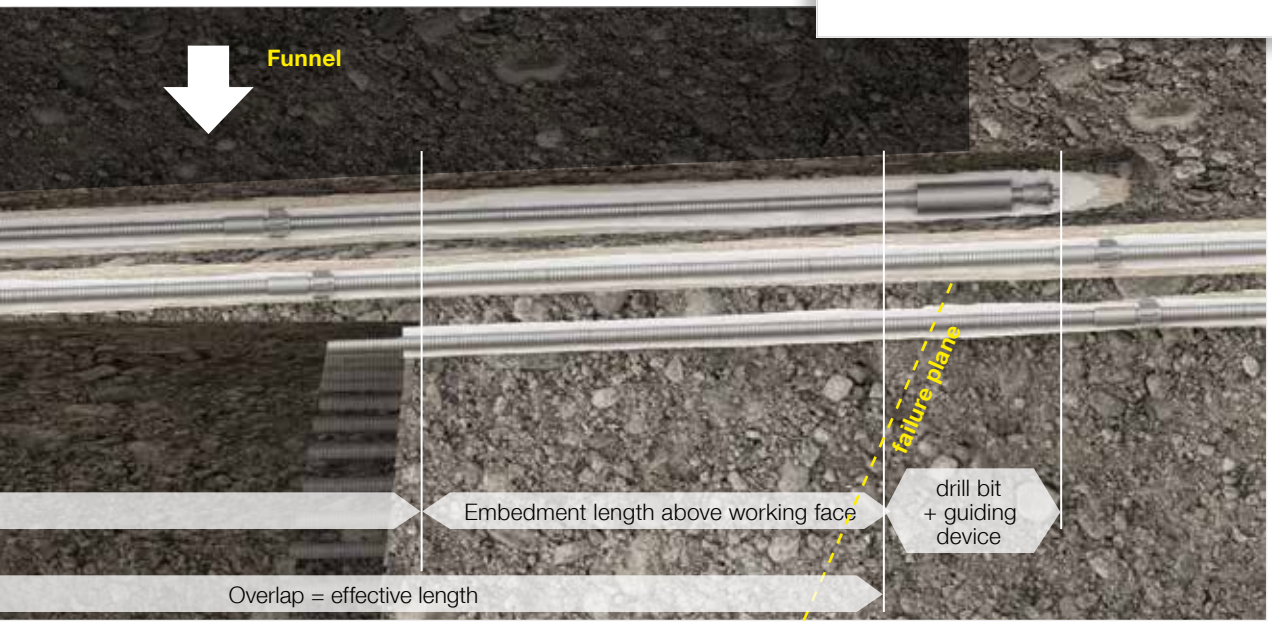
Composite pile roof
Two layer design example*



Coupling nuts instead of labourious pipe joints

The hollow steel tendons of the TITAN composite pile roof are primarily loaded in tension. That means it is possible to use tried-and-tested coupling nuts with a central stop and pressure seal:

- without loss of cross-section
- approved by the building authorities for alternating tension/compression
- approved by the building authorities for dynamic loads
- central stop ensures optimum transfer of impact energy during drilling



Tunnel stabilisation

Radial and rock bolts – tunnel face anchors – self-drilling spiles – tunnel floor reinforcement – TITAN composite pile roof

Hollow steel tendons with the TITAN thread are used when the bond behaviour is critical for the level of safety required.
The advantages of the self-drilling system are:
- **Variable applications**
- **Especially advantageous in rocks/soils with low cohesion**
- **Simple to install in unstable boreholes**
- **No stalling when drilling across clefts**
- **Drilling and installation in one operation**
- **Stabilisation of the borehole with cement slurry (optional)**
- **Dynamic grouting during drilling (optional)**
- **Grouting assured over full depth of borehole**
- **No need to extract drill strings**

Self-drilling spiles
(grouting spiles)

- For stabilisation ahead of working face
- For safeguarding operations at the working face
- Ground improvement through dynamic grouting (optional)
- Temporary
- With perforations on request

A

Rock bolts
Radial bolting

- Anchoring system
- Can accommodate rock pressure
- Local stabilisation of blocks and fault zones
- Follow-up rock stabilisation
- Ground improvement through dynamic grouting (optional)
- Temporary

B

Tunnel face anchors

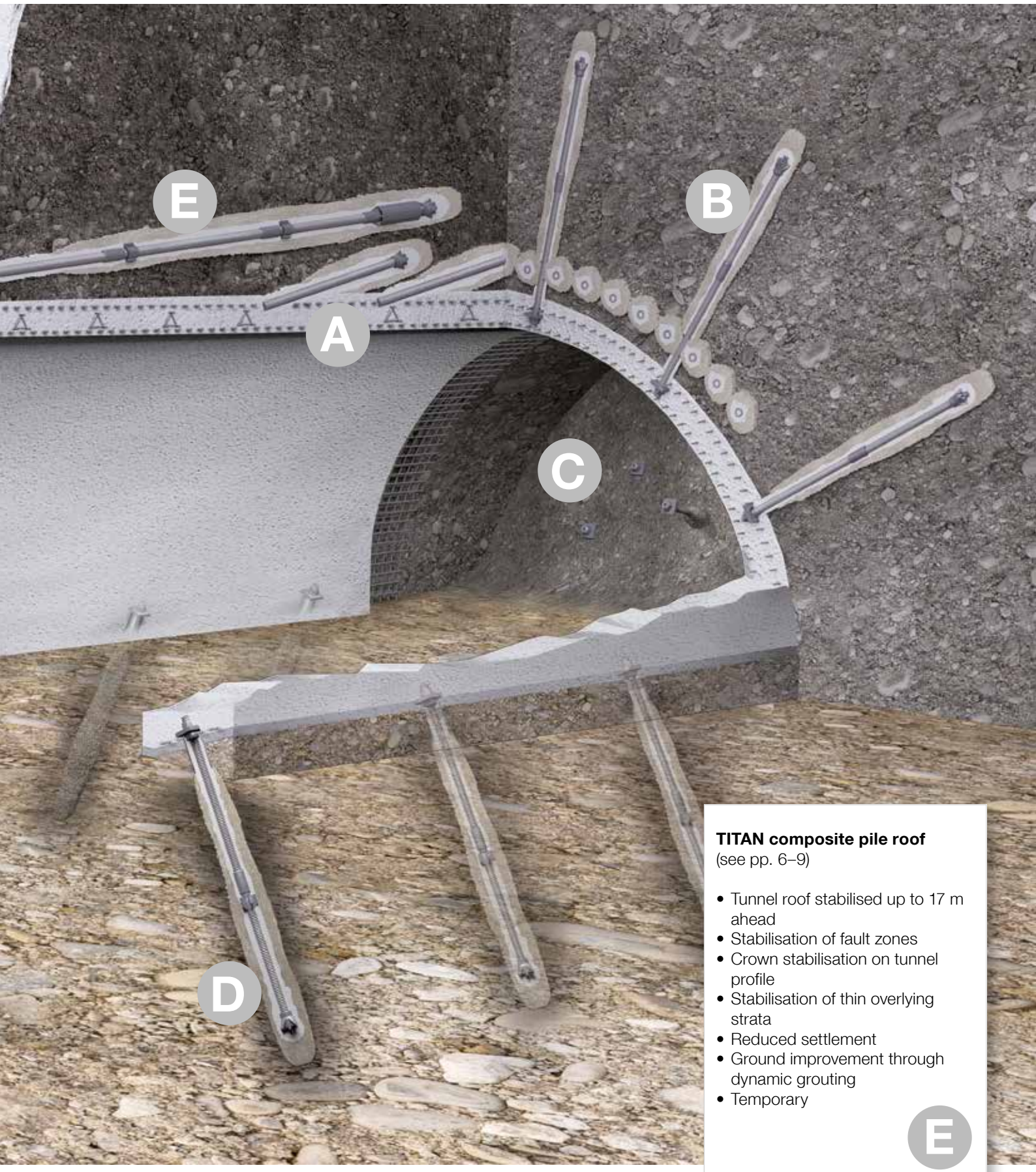
- Stabilisation of working face in squeezing rock masses
- Stabilisation of working face when using pipe umbrellas or TITAN composite pile roof
- Ground improvement through dynamic grouting (optional)
- Temporary

C

TITAN tunnel floor reinforcement

- For strengthening the base of the tunnel arch
- Designed to DIBt approval Z-34.14-209
- Temporary or permanent

D



TITAN composite pile roof
(see pp. 6–9)

- Tunnel roof stabilised up to 17 m ahead
- Stabilisation of fault zones
- Crown stabilisation on tunnel profile
- Stabilisation of thin overlying strata
- Reduced settlement
- Ground improvement through dynamic grouting
- Temporary

E

Stabilisation of tunnel portals and slopes

Soil nailing and shotcrete stabilisation, temporary or permanent (100+ years)

PERMANENT
DIBt appr. Z-34.14-209
100+ Years

The stabilisation of tunnel portals and slopes is covered in DIN EN 14199 and DIN EN 14490. The soil nails are in the form of TITAN micropiles, which are approved for permanent applications according to DIBt approval Z-34.14-209. According to DIN EN 1990, Table 2.1, category 5, permanent means 100+ years without any restrictions.

The DRILL-DRAIN® system is installed using the same drilling method.

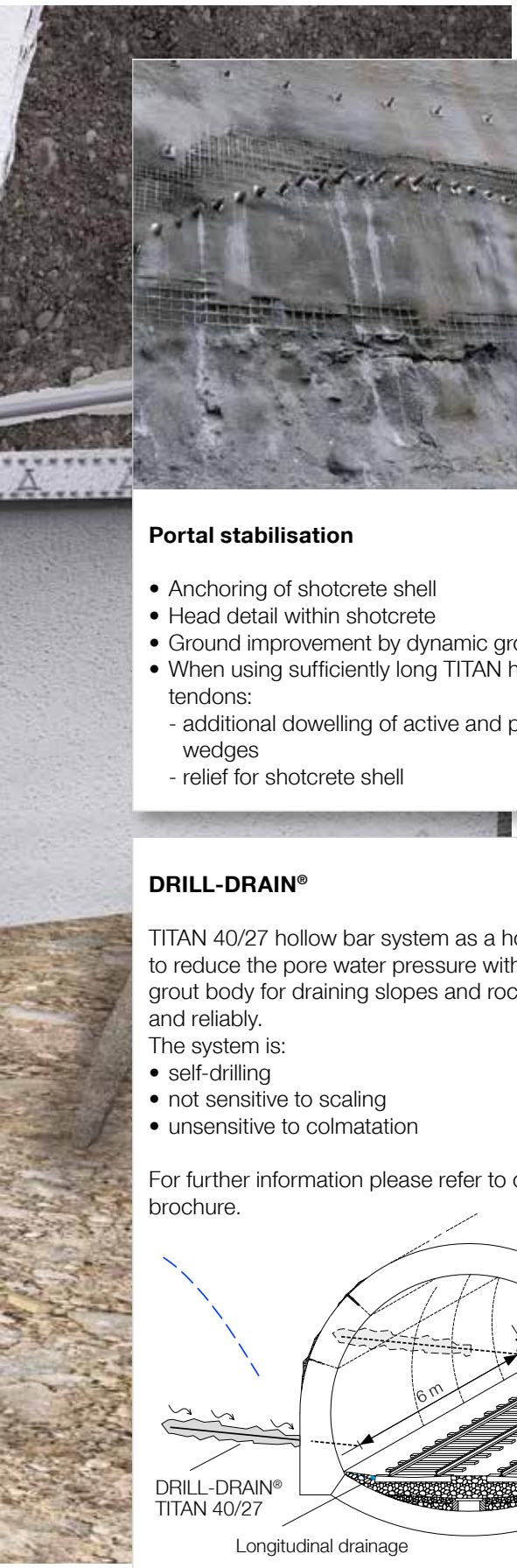
TITAN micropile for slope stabilisation

TITAN micropile for tunnel portal stabilisation

Claw Plate
- for lightweight protective netting
- 5° angle compensation spherical collar nut

Washer Plate (domed)
- for shotcrete
- 5° angle compensation spherical collar nut

Angle Adapter Plate
- For use together with washer plate (domed)
- Compensates for angles of up to ± 36 °
- Self-centring



Portal stabilisation

- Anchoring of shotcrete shell
- Head detail within shotcrete
- Ground improvement by dynamic grouting
- When using sufficiently long TITAN hollow steel tendons:
  - additional dowelling of active and passive soil wedges
  - relief for shotcrete shell

Slope stabilisation

- Installation of reinforcement in the ground
- Dowelling of active and passive soil wedges
- Ground improvement by dynamic grouting
- Fixing of protective netting or geotextiles
- Exposed components are hot-dip galvanised

DRILL-DRAIN®

TITAN 40/27 hollow bar system as a horizontal drain and to reduce the pore water pressure with special, permeable grout body for draining slopes and rock formations safely and reliably.
The system is:

- self-drilling
- not sensitive to scaling
- unsensitive to colmatation

For further information please refer to our DRILL-DRAIN® brochure.

Shortly after installation

Six years after installation -
the drainage of the subsoil is clearly visible

Tunnel rehabilitation and cavern stabilisation

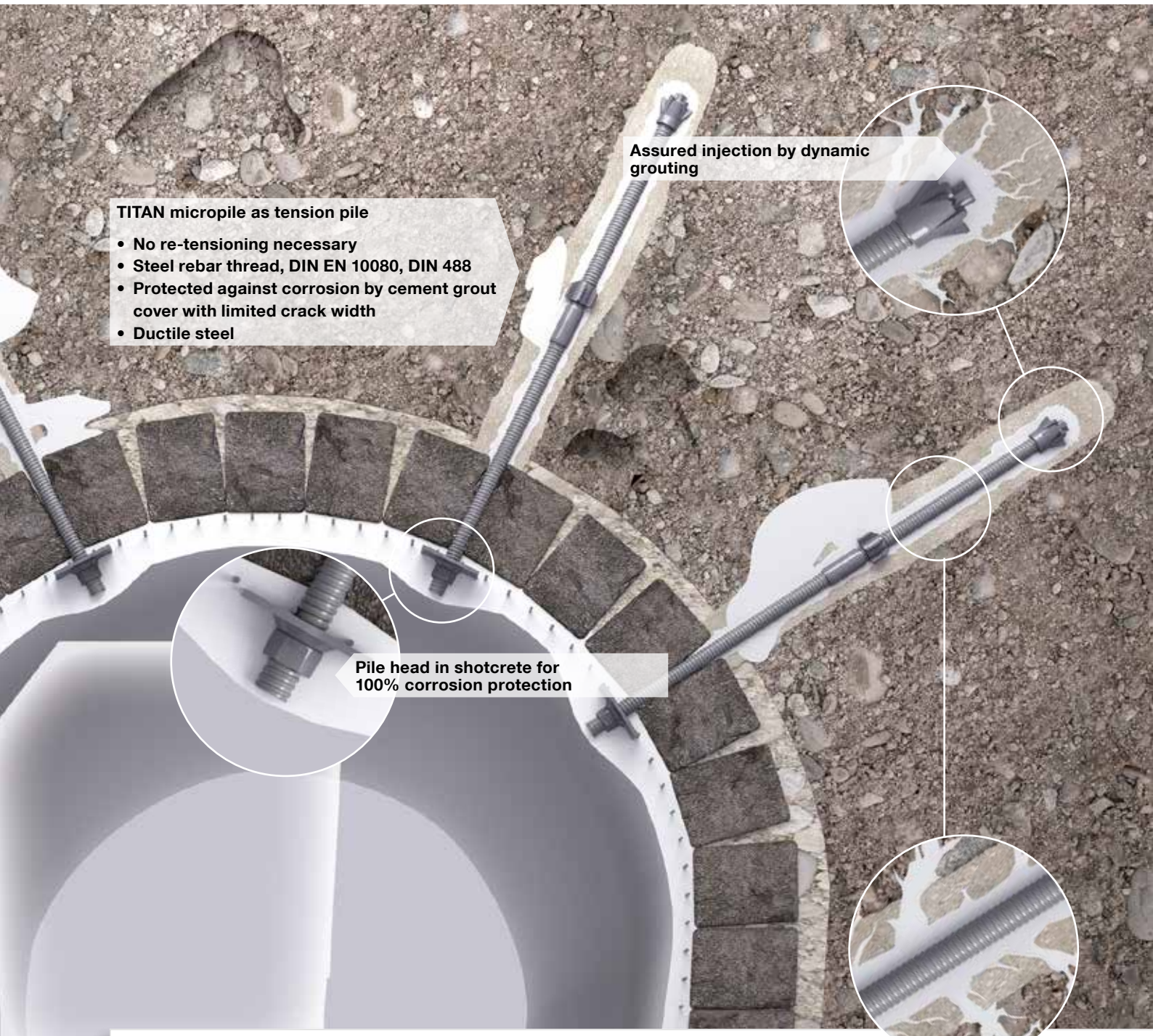
Permanent anchoring 100+ years

Self-drilling TITAN micropiles according to DIBt approval Z-34.14-209 are suitable for permanent retaining structures of internal masonry linings, shotcrete shells and for permanent stabilisation of brittle rock formations and individual blocks. According to DIN EN 1990, Table 2.1, category 5, permanent means 100+ years without any restrictions.

Examples of applications:
- **Tunnel rehabilitation/reinforcement**
- **Cavern stabilisation**

Retaining structures

- Tying back with TITAN micropiles
- Approved by the building authorities
- Self-drilling
- Dynamic grouting
- Ground improvement



Corrosion protection included
The cement grout cover provides protection against corrosion. To achieve permanent corrosion protection, no crack width in the grout body may exceed 0.1 mm (crack width limitation). The TITAN system complies with this requirement.

Extra corrosion protection
In case of special requirements, such as big cavities, aggressive mountain water or exposed head construction, optional corrosion protection can be provided:
- Hot-dip galvanising
- DUPLEX protection
- Stainless steel (INOX)

Stainless steel (INOX)
- National Technical Approval DIBt Z-30.3-6
- Suitable for highest class of resistance - IV/severe (chlorides, sulphur dioxide, mine water)
- Suitable for concentrations of pollutants (e.g. in road tunnels) and seawater

Method of installation

Dynamic grouting

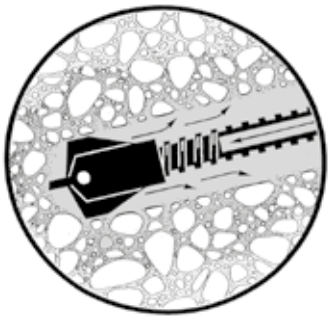
The TITAN system is installed according to the National Technical Approval. The approval prescribes borehole stabilisation and immediate dynamic grouting with a cement suspension via the drill bit in unstable soil and unconsolidated rock. Grouting does not interrupt the installation procedure. The advantage of this method is the continuous working process and also the creation of an excellent interlock between the soil or unconsolidated rock and the grout body. The grain structure, cracks and clefts are reliably filled with grout.

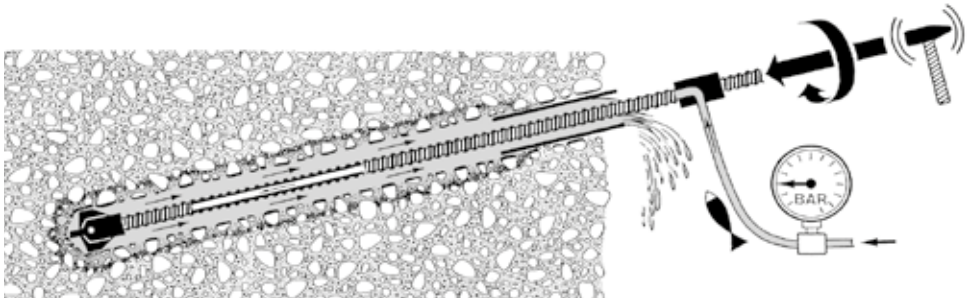
Comparatively high skin friction values are even achieved in problematic soils. The prerequisites for dynamic grouting are a flushing head on the rock drill and powerful pressure-grouting plant. This method has been proved worthwhile in many projects. To seal the end of an upward-inclined borehole, a preventer can be adapted to fit the existing drilling equipment.

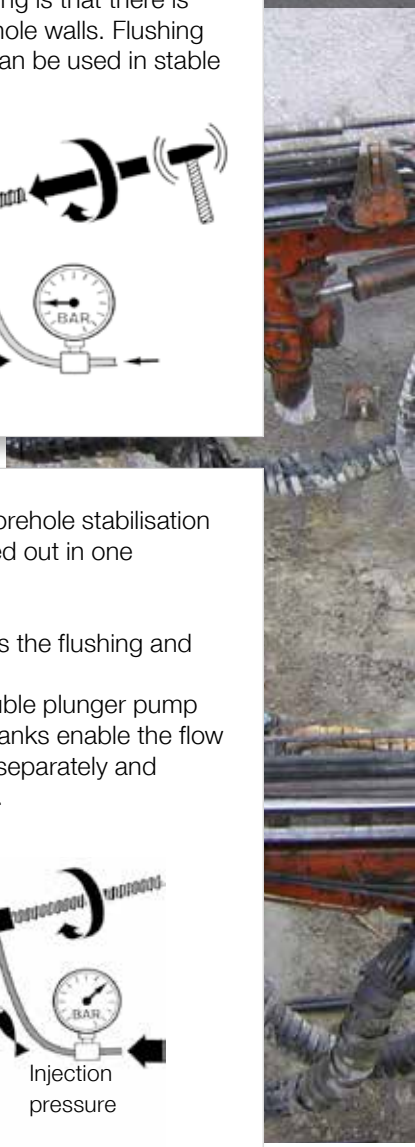
Borehole stabilisation:
Drilling with flushing and supporting fluid

A thin cement slurry is generally used for this, which is ejected from the openings in the drill bit during rotary percussive drilling. It supports the borehole against collapse and transports the cuttings to the surface.

Some of the cement infiltrates the structure of the soil or rock. This primary injection significantly improves the shear bond between the grout body and soil or rock. The difference between this and air flushing is that there is no loosening or relieving of the borehole walls. Flushing fluids without stabilising properties can be used in stable boreholes.



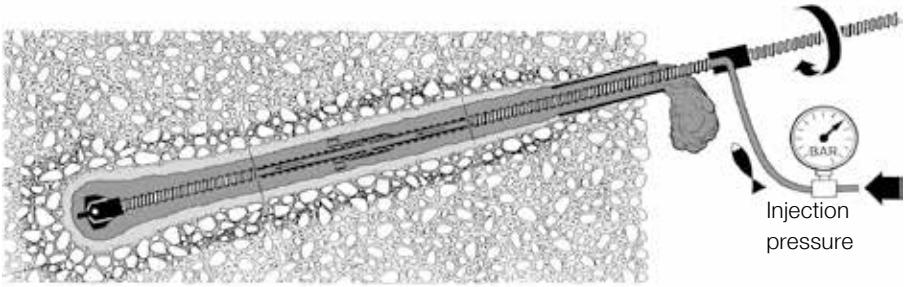




Dynamic grouting:
Rotary injection of grout

A stiff cement suspension or special anchor mortar, matched to the installation conditions and properties of the soil or rock, is injected with increasing pressure while the drill hammer is still rotating. This process is also known as rotary injection. During this, the flushing/supporting fluid is displaced by the grout and forced into the soil or rock. Depending on the installation conditions, it can be advisable to use grout to stabilise the borehole right from the beginning. Borehole stabilisation and dynamic grouting are then carried out in one process.

- Post-grouting is unnecessary.
- A flow rate/pressure logger records the flushing and grouting pressure.
- Pressure-grouting plant with a double plunger pump and separate mixing and storage tanks enable the flow rate and pressure to be regulated separately and guarantees a continuous process .



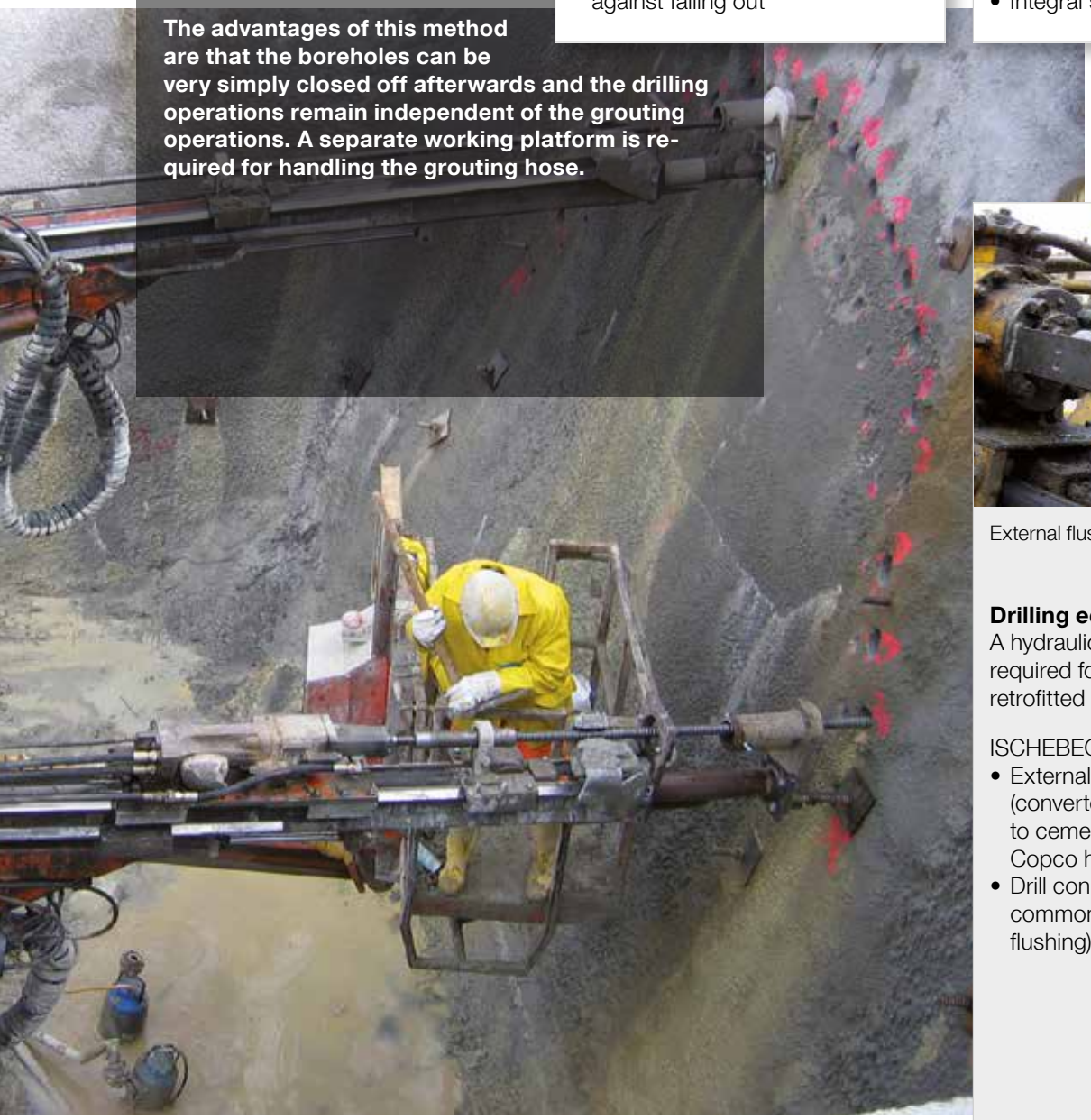
For temporary stabilisation in essentially stable boreholes, self-drilling systems in underground tunnelling and mining operations are usually drilled and subsequently grouted in separate operations:

1. **Drilling the hollow bar system with air or water flushing**
2. **Move drilling rig to next borehole position.**
3. **Carry out static grouting via grouting hose.**
4. **Move grouting hose to next borehole.**

The advantages of this method are that the boreholes can be very simply closed off afterwards and the drilling operations remain independent of the grouting operations. A separate working platform is required for handling the grouting hose.

Bore hole stopper - screw on type
- For sealing boreholes prior to static grouting
- Cannot fall out
- Secures the system against falling out

Grouting connector for static grouting
- Hose cannot get twisted
- Connecting thread and hose are uncoupled
- Integral sealing system



External flushing head

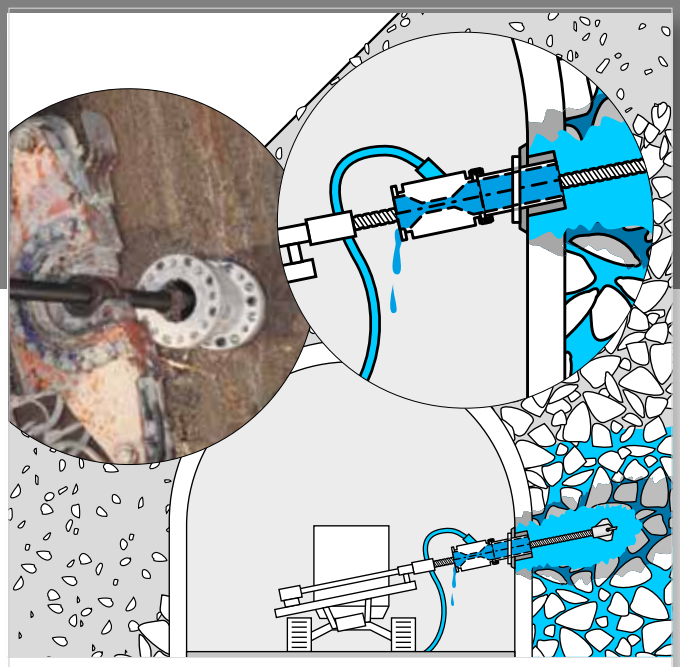
Drilling equipment
A hydraulic clamping unit is required for installation. This can be retrofitted to most tunnel jumbos.

ISCHEBECK can provide:
- External flushing heads (converted from air/water flushing to cement flushing, e.g. for Atlas-Copco hammers)
- Drill connectors for the most common rock drills (for air flushing)

Self-drilling special solutions

Hydrostatic pressure – ground freezing - high-pressure injection

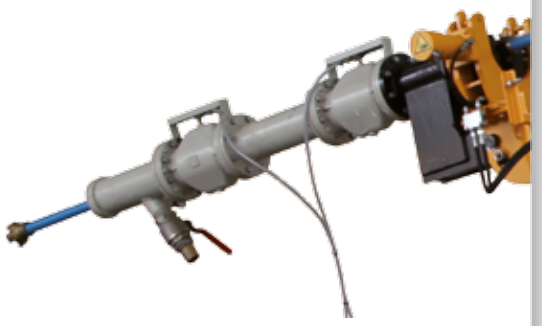
Building tunnels means responding flexibly. The rock formation through which a tunnel is driven is rarely homogeneous, instead often poses unexpected challenges. Therefore, our engineers have developed engineering solutions that can be adapted to your specific requirements.



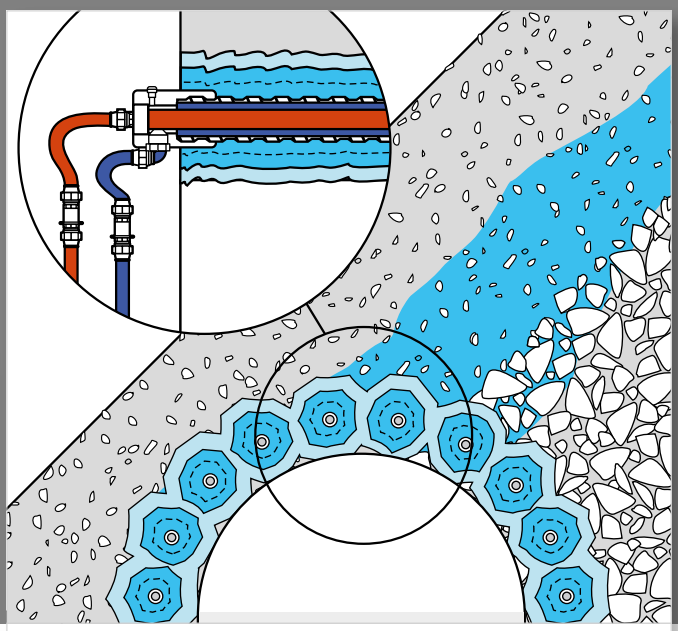
Hydrostatic pressure

The use of self-drilling systems in the presence of hydrostatic pressure calls for coupling sockets and centralisers to be guided through the sealing system. The **TITAN Preventer** is therefore equipped with:

- pressure chamber system
- backflow valve
- control panel
- flanged pipe



Preventer can be retrofitted (trial model)



Ground freezing*

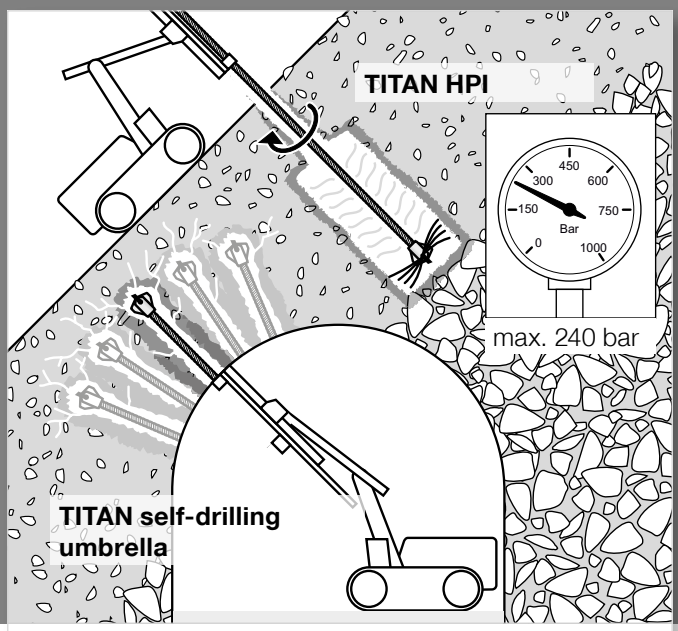
We can supply the self-drilling **TITAN 73/53 Geothermal Energy Pile** for ground freezing. The drill bit is sealed with a packer at the base of the hollow bar system and the circuit for the refrigerant is provided via coaxial pipework. The connection to the complete cooling circuit is via the top of the borehole.

- Low-temperature steel down to -20°C, with modification down to -140°C
- Brine as thermal transfer fluid (down to -32°C) in closed system, or nitrogen (down to -140°C) in open system
- High-pressure socket seals for max. 240 bar
- Self-drilling construction of frozen columns, frozen umbrellas and frozen soil bodies
- Dynamic grouting improves the degree of efficiency (no voids)
- Soils or rocks are not loosened or relieved
- Good availability of standard materials

Typical applications:

- Shafts
- Tunnel boring machine (TBM) entrance areas
- Cut-off walls
- Sealing base of excavation
- Stabilising tunnel roof for hydroshield TBM below thin overlying strata

* currently undergoing development



High-pressure injection (HPI)

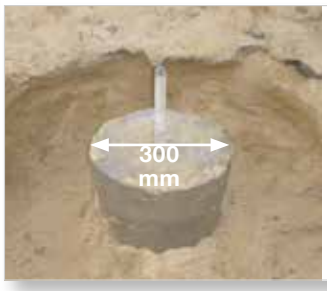
Self-drilling **TITAN injection anchors**, fitted with high-pressure coupling nuts (with seals for max. 240 bar), can be used to reach and grout fault zones or for TITAN high-pressure injection columns with pressures of up to 240 bar in unconsolidated rock or soft soils.

- Easy to use above and below ground
- Not tied to grouting valves at fixed depths
- Grouting pressure and flow rates can be individually adjusted to suit depth reach
- Success of injection can be checked with GIN value (Grouting Intensity Number = pressure x volume)
- Documentation by way of flow rate/pressure logger for every depth reached consecutively and in stages
- Return flow permits conclusions regarding presence of water and clefts
- Can be grouted with all conventional injection products, e.g. DORODUR 135 special hydraulic binder for injections
- No problems with packers
- No need to extract casings

TITAN self-drilling umbrella
A group of individual TITAN injection spiles forming a fan-type umbrella by way of specific injections in order to stabilise fault zones in rock formations prior to further driving.

High-pressure coupling nut for TITAN system
with seals for max. 240 bar

Grouting pressures
of up to 240 bar possible



TITAN High-pressure injection
Grout body injected into loose sand

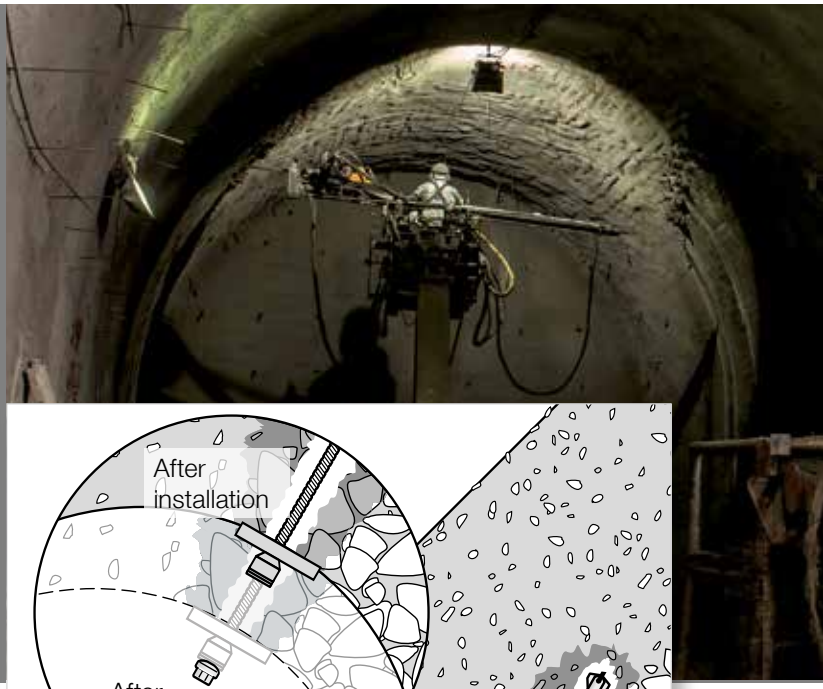
TITAN High-pressure injection HPI-clay bit with carbide nozzle

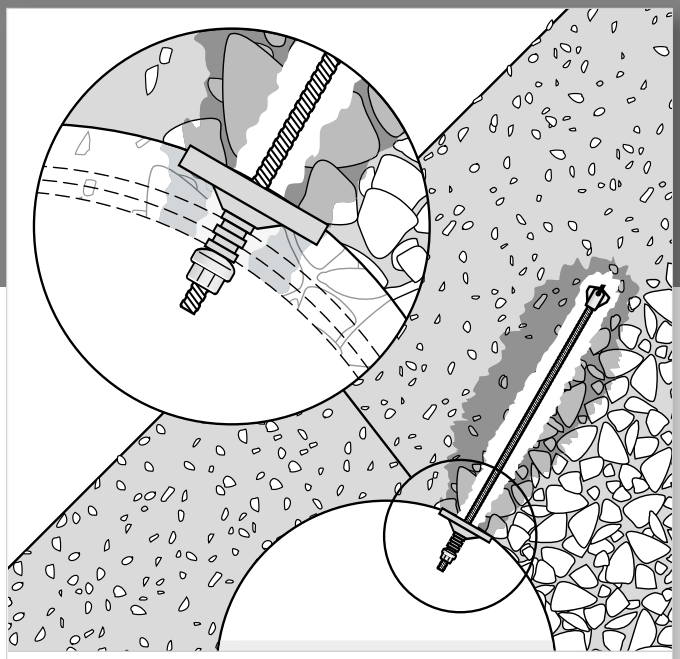
Soil mixes with injected grout

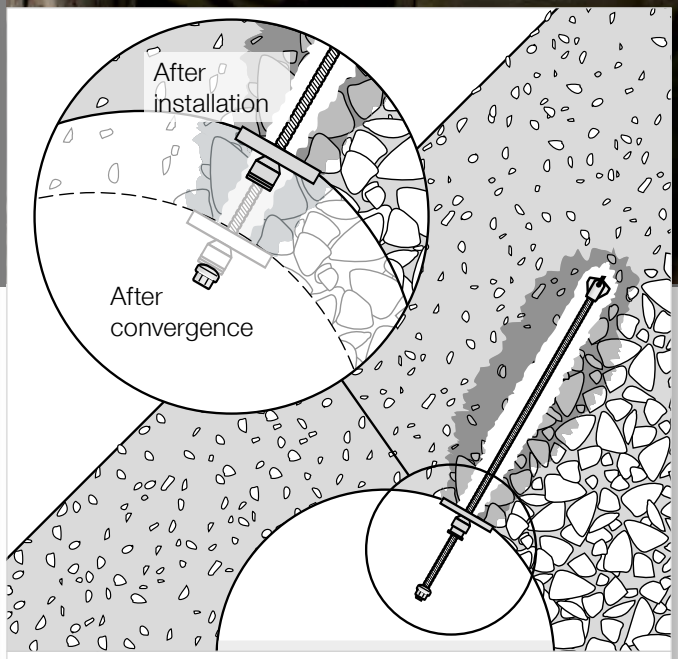
Squeezing rock masses

Load stage indicator – TITAN Convergence Controlled Rock Bolt

Safety in tunnelling is priority. So it's important to detect dangers as early as possible with simple indicators.
Active rock pressure endangers crews and progress. The load stage indicator and the TITAN convergence anchors help, not only to measure the active rock pressure, but also to absorb it. This gives the opportunity to take other security measures.







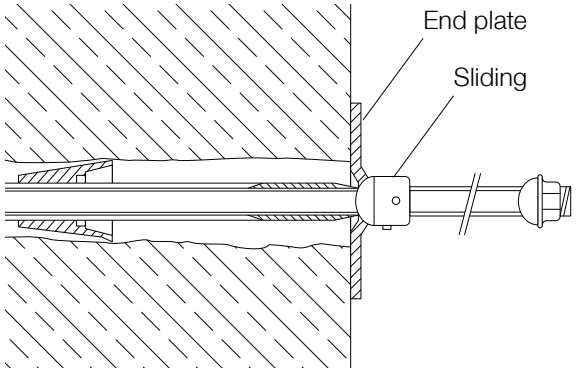
Detect load increases with load stage indicator
The load stage indicator (LSI) is used to identify load increases at an early stage. It shows load increases by deforming in three stages giving enough time to install additional anchors as required.

- Load stages:
  70 kN – 160 kN – 180 kN (TITAN 30/11)
  200 kN – 300 kN – 400 kN (TITAN 40/16)
  70 kN – 150 kN – 180 kN (R32)
- Up to 30 mm deformation
- German Mining Inspectorate (LOBA) approval 8.24.6-28-4
- Can be checked visually at any time
- No risks due to burst nuts

Absorb load increases with TITAN CCRB (TITAN Convergence Controlled Rock Bolt)
If severe deformations in squeezing rock masses are expected during the planned design life of a rock bolt, then TITAN rock bolting with constant resistance adapts flexibly to the deformations.

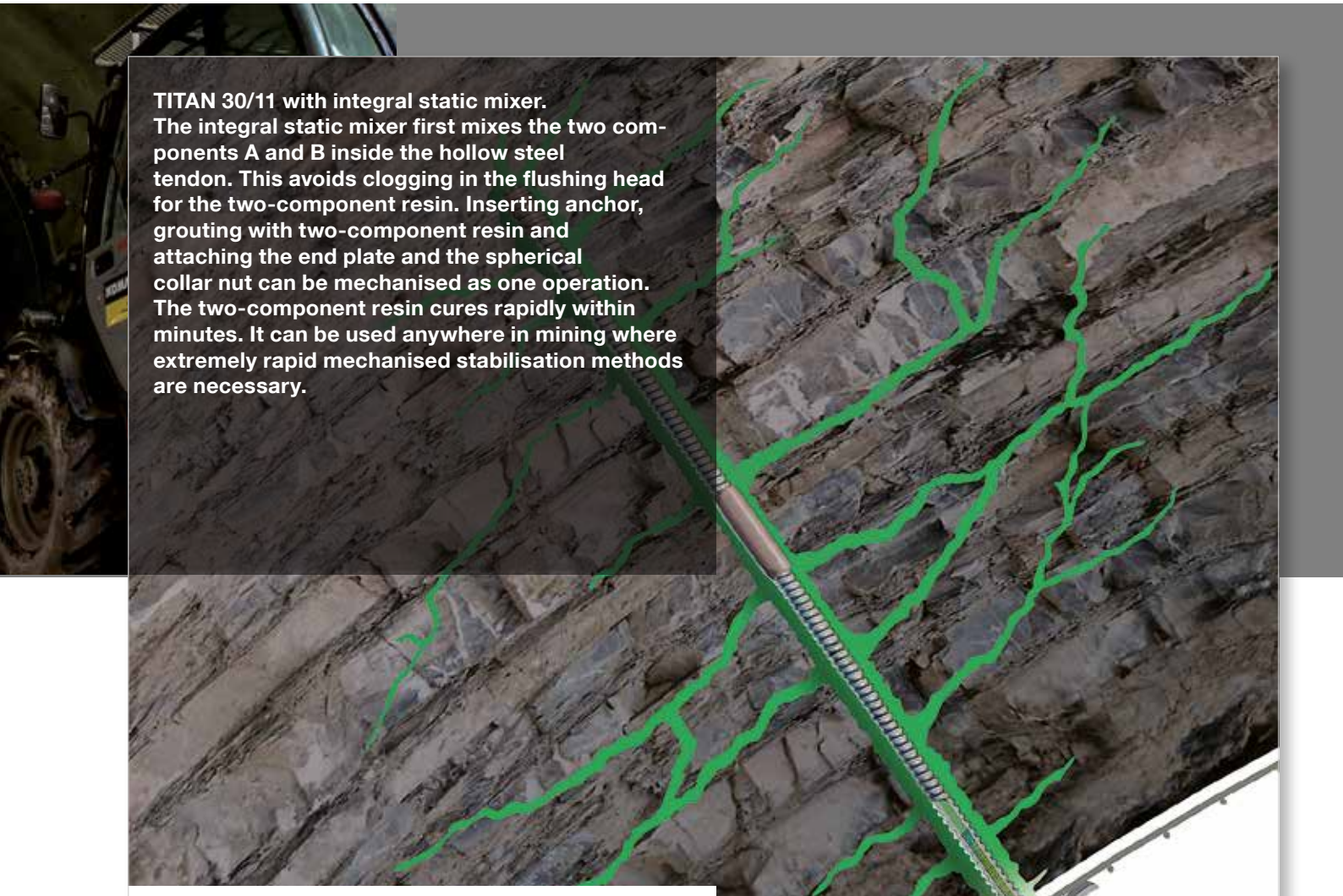
- Sliding load adjustable between 50 kN and 250 kN
- Max. load indicator of sliding nut = 450 kN
- Max. sliding distance travel = 400 mm

Load stage indicator
Easy to use without geodetic surveys



IQ-Quickset Roofbolt®

2-components-resin anchor



**TITAN 30/11 with integral static mixer.
The integral static mixer first mixes the two components A and B inside the hollow steel tendon. This avoids clogging in the flushing head for the two-component resin. Inserting anchor, grouting with two-component resin and attaching the end plate and the spherical collar nut can be mechanised as one operation. The two-component resin cures rapidly within minutes. It can be used anywhere in mining where extremely rapid mechanised stabilisation methods are necessary.**

The **IQ-Quickset Roofbolt®** is a self-drilling anchor that is drilled and grouted with a two-components resin in one operation. It is used for immediate stabilisation of tunnel roofs and shafts in ore and coal mining and for TBM driving. The rapid-curing/hardening silicate resin fills and seals the annular gap and all other clefts and voids. Curing takes place immediately and the anchor can be loaded after a very short time.

- It is ideal where boreholes collapse and represents an alternative to adhesive cartridges and friction stabilisers
- Working from a secure area improves safety and efficiency
- Self-drilling anchor easily lengthened by coupling nuts
- Semi-automatic or step-by-step installation are both possible
- Extremely fast and safe

Internal static mixer ensures thorough mixing of 2-components resin.

System components

Drill bits – centralisers – coupling nuts – spherical collar nuts – washer plates

Drill bits
can be supplied for the most diverse geology conditions. Adaptors are available so that drill bits can be used with different hollow steel tendons to adjust the hole diameter. A selection from our wide range:

Cross Cut Drill Bit
Dense sand and gravel
with obstructions > 50 S.P.T.[1)]

Button Drill Bit
Weathered rock[2)], phyllite, slate, mudstone; strength < 70 MPa

Carbide-Y-Cross Cut Drill Bit
Dolomite, granite, sandstone; strength 70–150 MPa

Carbide Button Drill Bit
Concrete or rock[2)]; strength > 70 MPa

Carbide Cross Cut 3-step Drill Bit
For drilled holes with a stable direction and for faults in the ground

- All drill bits include venturi flushing outlets
- Illustrations of drill bits are typical only; forms and colours may differ from those shown here.

[1)] standard penetration test
[2)] The compressive strength of a rock mass lies well below that of the rock material itself because of the faults that are present in almost every situation. The thumb rule is: the compressive strength of a rock mass can be assumed to be 10–20% of that of the rock material itself. (source: Prof. Dr. Ourosch Thuro, Chair of Engineering Geology, TU München)

Head plates
can be supplied for the TITAN system according to DIBt approval Z-34.14-209.
- Designed for deflection in stiff components
- Chamfer at both sides centres the spherical collar nut

Centralisers
- For centring the TITAN hollow steel tendon within the grout body
- For coverage with cement grout all sides = permanent corrosion protection

Washer plates
can be supplied in different sizes
- Designed for punching in soft materials, e.g. shotcrete
- Strong 3D plate form for stability and secure seating of spherical collar nut
- The shape of the plate is crucial for its deflection, not just its thickness.
- Test load 150 kN (for 200 × 200 × 8 mm, according to test certificate No. 11 0633 6 97 MPA NRW)

Spherical collar nuts
- for angle compensation up to 5 ° together with washer plates

Coupling nuts
- with central stop
- for TITAN system with steel ring for improved impact energy transfer and sealing up to 240 bar

Expansion shell for TITAN 30
- according to DIN 21521
- borehole - Ø 46 - 56 mm
- load bearing capacity F_k = 150 kN
- contact area 60 cm²
- suitable for injection
- can be loaded immediately

TITAN system

Designation	Unit	TITAN 30/16	TITAN 30/11	TITAN 40/20	TITAN 40/16	TITAN 52/26	TITAN 73/56	TITAN 73/53	TITAN 73/45	TITAN 73/35	TITAN 103/78	TITAN 103/51	TITAN 103/43	TITAN 127/103
Nominal diameter D_{steel}, outside	mm	30	30	40	40	52	73	73	73	73	103	103	103	127
Nominal diameter D_{steel}, inside	mm	16	11	20	16	26	56	53	45	35	78	51	43	103
Effective cross-section A_{eff}	mm²	340	415	730	900	1250	1360	1615	2239	2714	3140	5680	6024	3475
Ultimate load F_u	kN	245	320	540	660	925	1035	1160	1575	1865	2270	3660	4155	2320[4]
Characteristic load-carrying capacity R_k to German approval[1]	kN	155[2]	225 (250)[3]	372	490	650	695[2]	900	1218	1386	1626	2500	3015[2]	1800[2]
Force at 0.2% elongation $F_{0.2,k}$ (mean value)	kN	190	260	425	525	730	830	970	1270	1430	1800	2670	3398	2030
Weight	kg/m	2.7	3.29	5.8	7.17	9.87	10.75	13.75	17.8	21.0	25.3	44.6	47.3	28.9
Left-/right-hand thread	-	left	left	left	left	left right	right	right	right	right	right	right	right	right

[1] In the case of permanent tension loads and a cement grout cover c < 45 mm, the load-carrying capacity must be reduced according to approval Z-34.14-209.

[2] An approval for these sizes is not yet available. For TITAN 30/16, 73/56, 103/43 and 127/103, the values were interpolated in a similar way to the approval.

[3] A characteristic load-carrying capacity of 250 kN may be assumed for TITAN 30/11 for temporary applications (≤ 2 years).

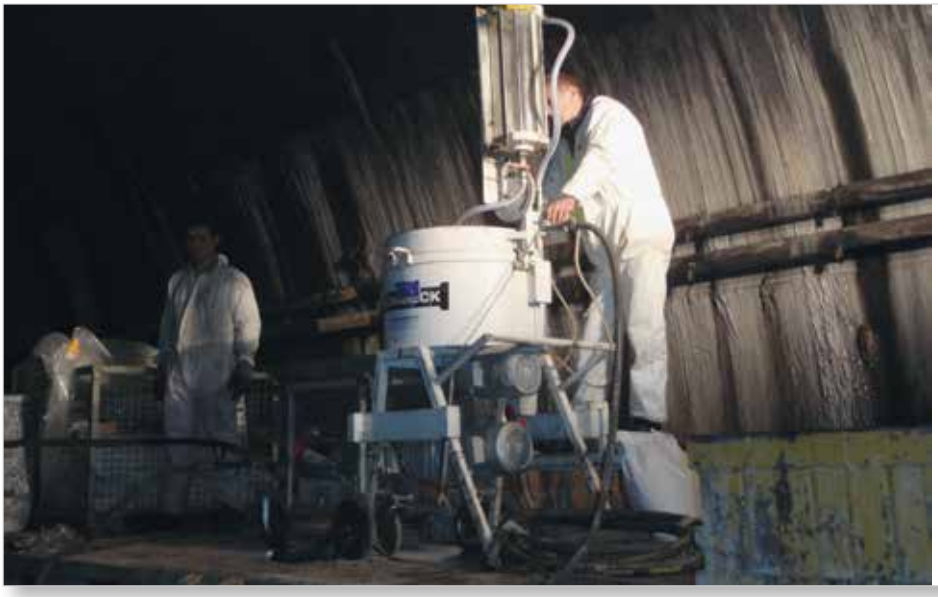
[4] Only applies to hollow steel tendon without coupling socket. The ultimate load for coupled hollow steel tendons is 2048 kN.

Many detailed solutions for the engineering practice

For example, bayonet coupling for the final section of a TITAN composite pile roof. The final segment of the hollow steel tendon can be disconnected after drilling and extracted so that the hollow steel tendons do not get in the way in the event of overbreak.

TITAN composite pile roof around tunnel entrance
Los Domínicos station, line 1, metro tunnel, Santiago, Chile
Stabilising the portal cuts with TITAN 40/20 hollow steel tendons to form a TITAN composite pile roof:

- 21 spiles 15 m long at a spacing of 300 mm per portal
- To ensure accurate drilling, the holes were drilled with a 750 mm long steel lead collar behind the Carbide Cross Cut 3-step Drill Bit.



DRILL-DRAIN®
Underground railway tunnel refurbishment in Rome with DRILL-DRAIN® and Preventer
Specific lowering of the ground-water table around the tunnel for eliminating leaks in the tunnel shell.

- 1 pc. of DRILL-DRAIN® on each side left and right in tunnel cross-section, 6 m long, 0.5 m above track level
- Spacing in longitudinal direction of tunnel = 6.0 m

The photos reproduced in this brochure represent momentary snapshots of work on building sites. It is therefore possible that certain facts and circumstances do not fully correspond to the technical (safety) requirements.

Certified Management-System to DIN EN ISO 9001:2015 DVS ZERT

ISCHEBECK® TITAN

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