DSI Solid Bar-System

Geotech



SANDVIK



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About us

Driving underground operations

Sandvik Ground Support is the global leader in providing cutting-edge support solutions for mining and tunneling. In addition, we are a key player in pioneering system solutions for specialized foundation engineering. We operate in over 70 countries and employ approximately 3,000 professionals, including engineers and technical specialists with deep expertise in geotechnics and underground construction. With a comprehensive and market-leading portfolio that includes everything from micropiles and rock anchors to state-of-the-art injection systems and high-performance resin cartridges, we provide robust and reliable support for excavation sites, slope stabilizatin, tunnel structures, and mines. Our mission is to help customers advance their projects – both underground and above ground – by ensuring maximum safety, efficiency, and progress. While other suppliers offer standardized products, we leverage our extensive experience to develop project-specific solutions, meticulously designed to address unique challenges. These solutions are crafted, refined, and tailored in close collaboration with our customers to ensure they meet the highest industry standards and specific project requirements.

Accredited to the internationally recognized ISO 9001:2015 standard and backed by world-class production facilities and rigorous internal quality assurance, we consistently meet even the most demanding delivery timelines and order volumes – all while upholding the highest levels of quality, precision, and safety. Our global logistics network ensures reliable and on-time deliveries, with customized solutions to meet diverse customer needs. Thanks to our continuous production and 24/7 availability, we enable seamless construction site operations, minimizing downtime and maximizing productivity. Our highly skilled team of experts, strategically positioned across all key markets, offers in-depth technical support, precise recommendations, and expert consultation. Whether on-site, through remote assistance, or via specialized training and rigorous testing, our dedicated team is committed to overcoming challenges, optimizing performance, and driving projects to successful completion.
We are your trusted partner in strengthening your company, empowering your teams, and enhancing their capabilities. With our expertise and innovation, we help you tackle the complexities of foundation engineering – both today and in the future.



Reinforcing progress

Humanity would not be where it is today without construction. Every structure, every building, and every piece of infrastructure must be built on a solid foundation. Every excavation and cut must be properly secured, and with the increasing frequency of extreme weather events, the need for slope stabilization has never been greater.
At Sandvik Ground Support, we stand as a trusted and experienced partner, offering solutions that secure progress for both our customers and society. We are your:

— **Cost-efficient partner**
From tailored solutions that meet your exact requirements to seamless on-site implementation – our motto is: everything from a single source. We design the best product, optimize its application, and leverage global expertise to find the most effective solution for your construction site.

— **Honest and transparent partner**
Our tested, proven, and certified systems undergo continuous internal and external quality monitoring – ensuring the highest level of reliability and project success.

— **Reliable partner**
With our robust global supply chains, we minimize delays and ensure smooth project execution. Should conditions change during implementation, we work alongside you to develop alternative solutions, ensuring your project reaches a successful conclusion.

— **Efficient partner**
By integrating the latest technologies and innovations, we enhance your productivity and performance – enabling faster and more cost-effective project completion.

— **Experienced partner**
With the assurance of having direct access to the expertise and long-standing experience of our specialists, even the most complex challenges can be overcome.

With our products and services, we don't just reinforce the ground – we strengthen your team, drive your success, and support you in overcoming challenges on the construction site and beyond.

Proven system solutions

As a trusted partner in specialized foundation engineering, our products and systems are successfully integrated into countless projects worldwide. Wherever we operate, our expertise and reliability add measurable value to operations, accelerate construction progress, and contribute to the economic growth of cities, regions, and countries.
Our system solutions cover the full spectrum of geotechnical applications – ranging from solid-bar micropiles and strand anchors to self-drilling hollow-bar systems. Additionally, we offer state-of-the-art innovations, such as the AT – Pipe Pile System, alongside a diverse portfolio of injection systems – ensuring an optimal solution for every challenge.
Backed by our highly skilled team of engineers, we have the expertise to master even the most complex applications and challenges. When required, we design and develop customized solutions that precisely align with project-specific demands. Furthermore, we provide comprehensive training programs and on-site assembly supervision, ensuring seamless integration and optimal system performance.
Today, as cities expand underground and construction projects become increasingly ambitious, we continuously evolve – leveraging cutting-edge technologies to support our partners in building safer and more sustainable infrastructure.
Working side by side with you, we help drive progress – safely, efficiently, and with a long-term vision.





Manufacturing competence

Sandvik Ground Support manufactures products and system solutions for mining, tunneling, and geotechnical applications in 45 regional production facilities worldwide. With a workforce of over 3,000 employees, we manage highly sophisticated and logistically demanding systems on a global scale. Our combination of international expertise and strong local presence enables us to provide superior service while reducing delivery times for our customers.

Outstanding examples of our cutting-edge, fully automated production clusters include the global DSI Hollow Bar Competence Center in Pasching, Austria, and the Global Competence Center for Injection Technology and Resin Cartridges in Mikołów, Poland.

In Austria, load-bearing elements of the DSI Hollow Bar System are produced, with the portfolio ranging from the R32 series (hollow bars with a nominal diameter of Ø 32 mm and round threads) to the T76 series (hollow bars with a nominal diameter of Ø 76 mm and trapezoidal threads).

Each year, up to 22,500 tons of raw material are processed into over 5.6 million meters of hollow bar components.

Our production process is reinforced by a comprehensive quality assurance system and an in-house research & development (R&D) division, ensuring continuous product innovation and optimization.

In Poland, seven fully automated production lines are dedicated to manufacturing injection and cartridge systems.

By integrating production with a dedicated R&D department and an advanced testing facility, we offer customer-specific solutions that maximize innovation, efficiency, and output. Annually, we produce over 20,000 tons of injection resin and manufacture more than 20 million resin cartridges.

For products we do not manufacture in-house, we rely on a network of trusted, long-standing partners who adhere to the same rigorous quality standards and testing protocols – ensuring reliability, consistency, and excellence across our entire supply chain.







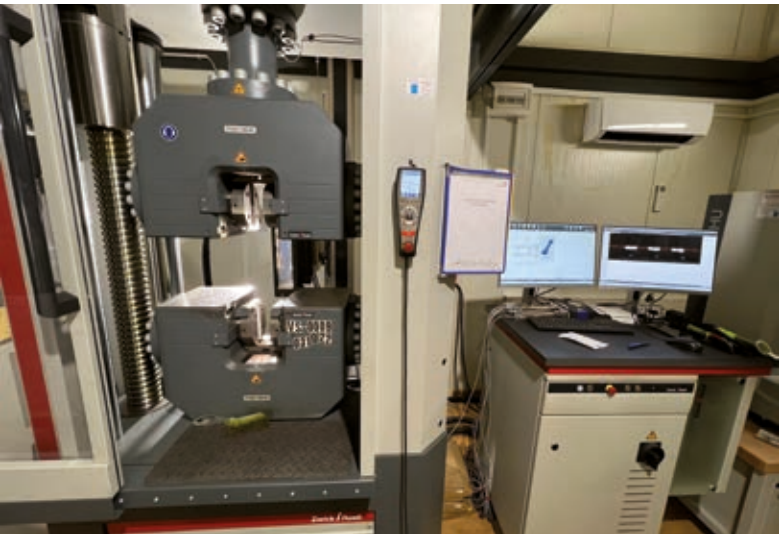
Quality management

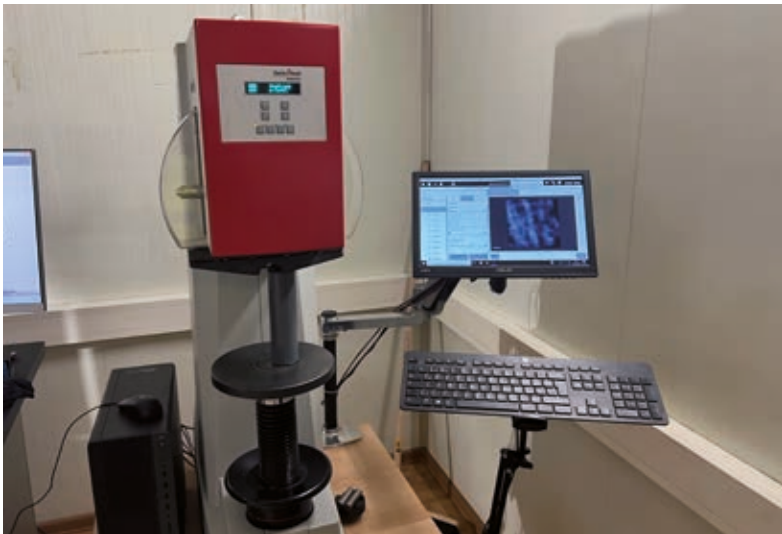
At Sandvik Ground Support, safety and quality are our top priorities and the foundation of everything we do. To ensure that quality-related requirements are met across all areas – from development to application—our production facilities are certified according to ISO 9001. Regular internal and external audits not only verify compliance with existing standards but also actively drive the continuous improvement and evolution of our quality management system.

Quality is not a one-time goal – it is an ongoing process. This philosophy aligns with one of the core principles of total quality management (TQM): continuous improvement and rigorous evaluation. We are committed to TQM on a global scale and operate in accordance with its three fundamental principles:

- **Total**
  Full integration of all employees in the quality management process, ensuring that every individual contributes to the production of our high-performance products and systems.
- **Quality**
  A customer-centric approach, where all business activities are aligned with client requirements and expectations.
- **Management**
  A leadership philosophy based on participation, teamwork, and accountability, fostering a culture where management leads by example at all levels. Ensuring the highest quality standards requires a highly skilled team of experienced experts, supported by state-of-the-art tools and equipment. The Competence Center of Sandvik Ground Support Austria is equipped with advanced testing technology, including:
- **High-performance horizontal tensile testing machine – DSI Hotz 3000/250 (max. 3,000 kN, sample length: 3 m)**
  This machine enables static tensile tests on bars and combined tensile-slip tests on systems with diameters up to 63.5 mm, ensuring compliance with the highest industry standards.
- **Vertical tensile testing machine – Zwick/Roell Z1200 (max. 1,200 kN)**
  This machine is primarily used for in-process quality control and features an optical strain measurement system to determine stress-strain-curves during static tensile tests.
- **Universal hardness tester – Zwick/Roell ZHU250CL (HRC, HV, HB)**
  This device enables non-destructive hardness testing, ensuring material quality across a wide range of materials. It can also perform hardness tests on small components such as cast nuts, ensuring precision and reliability.
- **Surface profile measurement device – Marsurf PCV**
  To verify compliance with tolerance specifications for thread forms in bars and accessories, the device scans the thread and automatically compares it with the required reference values.
- **Comprehensive selection of field equipment for anchor tensioning and tensile testing**
  Our testing capabilities extend beyond the laboratory to in-situ applications. We conduct standardized pile, nail, and anchor tests, as well as project-specific quality controls and field trials for new product developments.

Sandvik Ground Support collaborates globally with leading universities, private research institutions, and certified testing facilities in the fields of research and development, continuous quality monitoring, certification processes, and on-site construction testing. With this extensive expertise, we can offer customized support for on-site quality control, specialized inspection tools for various products, and in-situ testing solutions upon request.





System description

The DSI Solid Bar-System for geotechnical applications consists of tested, certified, and proven components designed for specialized foundation engineering. The system is available in various bar diameters, steel grades, and corrosion protection options, ensuring that the optimal solution is available for every load requirement and environmental condition. This flexibility guarantees maximum performance, durability, and safety, making it an ideal choice for a wide range of geotechnical applications.









Key features

- Load-bearing elements made of solid bars with hot-rolled coarse-thread ribs
- Solid bars in different steel grades are uniquely identifiable by their specific diameter-thread combination, ensuring clear traceability
- Installation in cased boreholes for all soil conditions (uncased drilling possible in stable ground)
- Fully threaded coarse thread for continuous threadability
- Certified for multiple applications with national and international approvals
- Proven and reliable system with decades of successful use
- Consistent base components across various applications, complemented by optimized accessories tailored to specific project requirements

Key advantages

- Extremely durable, construction-site-ready coarse thread, designed for harsh conditions
- Easy extension or shortening thanks to fully threaded, continuous threadability
- Customizable head and coupling configurations tailored to specific project requirements
- Suitable for installation in any orientation, even in confined spaces
- Cost-effective design with various steel grades, diameters, and corrosion protection systems
- High drilling precision ensured by cased borehole installation
- Robust and cost-efficient head construction for long-term reliability









Quality control

The comprehensive services offered by Sandvik Ground Support include the design, engineering, and planning of all systems, as well as quality management, construction supervision, and on-site support (e.g., pile testing, anchor tensioning, and more). To meet the ever-increasing demands of modern specialized foundation engineering, Sandvik Ground Support has implemented quality assurance processes based on the principles of total quality management (TQM). For our customers, quality means safety and reliability. Our goal is to ensure the highest product quality and safety throughout the entire manufacturing and distribution process – delivering solutions that perform with precision and durability.



Application areas

DSI Solid Bar-Systems are used in a wide range of geotechnical applications, including:

— Slope stabilization and soil nailing
— Retaining structures for excavations and other earth cuts
— Uplift protection for foundations in groundwater environments
— Deep foundation support for buildings
— Tensile and compressive anchoring of infrastructure structures, such as wind turbines, transmission towers, and bridge piers
— Rockfall protection
— Ground improvement and underpinning of existing foundations
— Anchoring of bridges and abutments
— Harbor and marine constructions

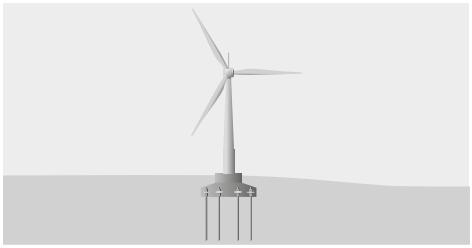
DSI Solid Bar-Systems can be used in both passive (e.g., micropiles, soil and rock nails) and prestressed applications (e.g., soil and rock anchors). In prestressed systems, DSI Solid Bar-Systems offer significant advantages over strand-based systems, including a simpler head construction, easier tensioning, and the ability to adjust prestress levels after installation.

Another key advantage of prestressed solid bar systems is their significantly reduced slip during load transfer, compared to strand-based systems. This characteristic makes prestressed solid bar systems particularly suitable for shorter free lengths.
For specific applications, country- and region-specific certifications apply, including European (ETA) certifications, German (DIBt) and Austrian (BMK) approvals.
Certifications are typically valid for a fixed period and must be renewed or re-applied for upon expiration. Throughout their validity, compliance is continuously monitored and verified through internal and external audits.
The latest information on current approvals can be found on our website or through local Sandvik Ground Support offices.
Beyond geotechnical applications, threaded steel systems are also widely used in other fields, including:

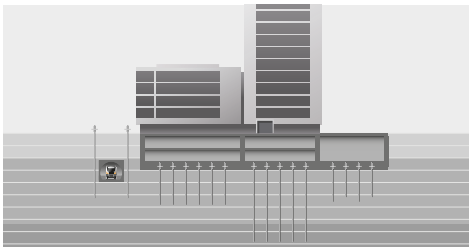
— Prestressing systems
— Reinforcement connections
— High-strength reinforcement
— Bracing for steel structures
— Tensile members in hall construction

Micropiles

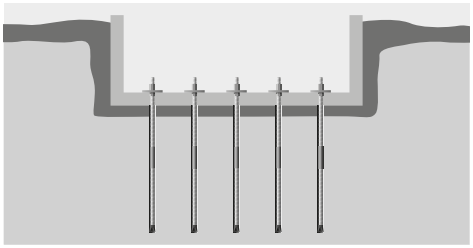
Foundation and underpinning



Pile foundations



Uplift protection

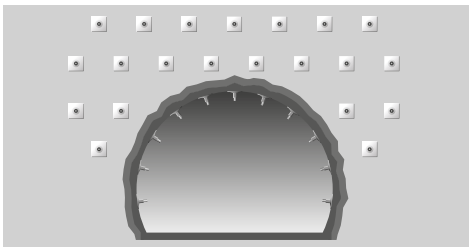




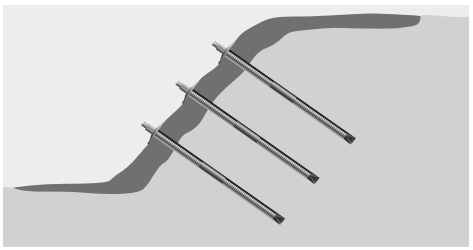


Soil nails

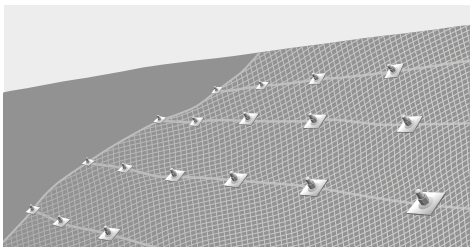
Portal stabilization



Slope stabilization



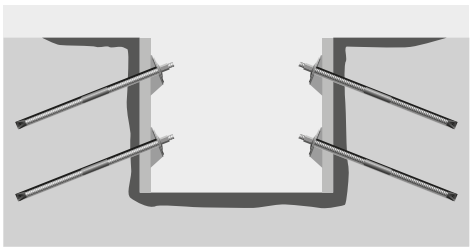
Rockfall protection



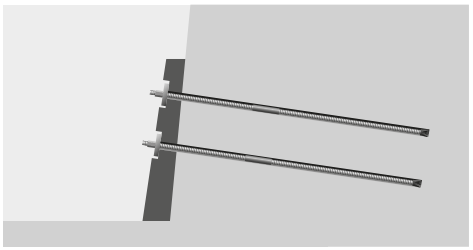


Grouted anchors

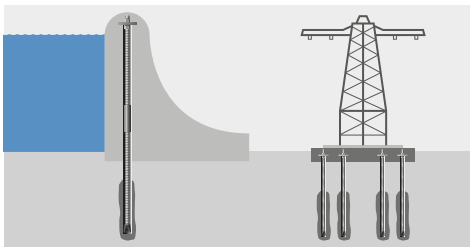
Retaining structures



Tension anchors



Structural anchors





System components

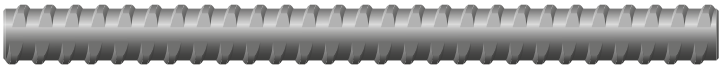
Steel tendon

DSI Solid Bar-Systems are available in various steel grades and thread configurations, ensuring optimal performance in tensile, compressive and alternating load applications.

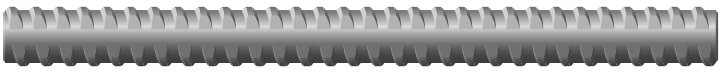
— Fully threaded ribbed bar for continuous adjustability
— Suitable for use as a tensile or compressive member
— Steel grade 500/550 and 550/620: reinforcement steel, left-hand thread, Diameter range 12-75 mm
— Steel grade 555/700: reinforcement steel, left-hand thread, Diameter range 57,5-63,5 mm
— Steel grade 670/800: high strength reinforcement steel, right-hand thread, Diameter range 18-75 mm
— Steel grade 950/1050: prestressing steel, right-hand thread, Diameter range 18-47 mm
— Steel grade 835/1035: prestressing steel, right-hand thread, Diameter range 57-75 mm

With a wide range of steel grades, diameters, and thread directions, DSI Solid Bar-Systems provide reliable, high-strength solutions tailored to specific engineering and construction requirements.

Thread bar with left-handed thread (e.g. S 500/550)



Thread bar with right-handed thread (e.g. S 670/800)

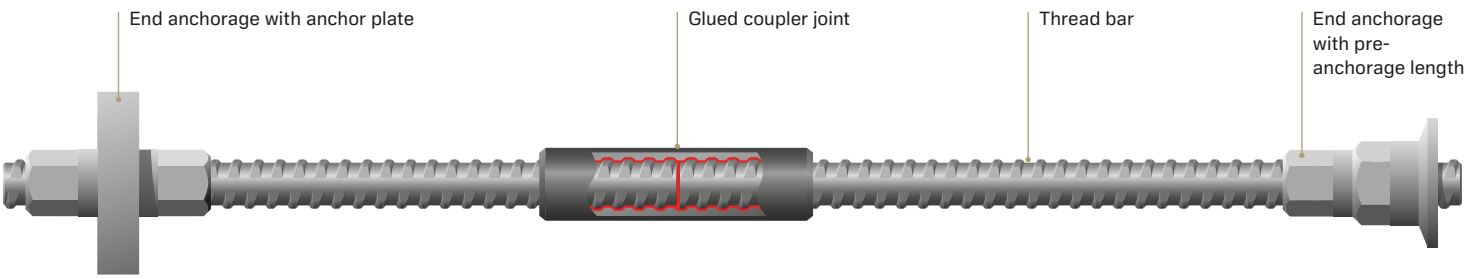


Technical specifications

Nuts
— Standard types: spherical collar nut and hexagonal nut
— Lock nut: used in pile head constructions for pure tension or compression applications
— Anchor nut with collar: alternative to hexagonal nut for pile head constructions
— Anchor piece: alternative pile head construction
— Reinforcement technology: long anchor nut

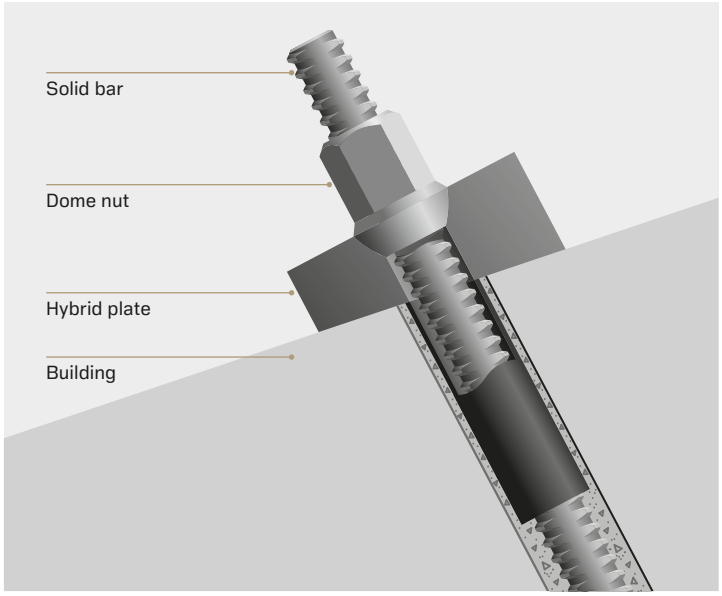
Plates
— Domed plates: for soil nails and rock anchors
— Solid plates: used in micropiles and reinforcement applications
— Anchor plate with cone: for soil nails and grouted anchors
— Solid plates with tube: suitable for temporary or permanent anchors
— Reversed anchor head: custom application
— Plate with welded pipe section: allows angular compensation using a spherical collar nut
— Alternative to nut & plate combination: anchor piece or double anchor piece

Further accessories
— Welded attachments: used in reinforcement applications
— Turnbuckle: reinforcement technology
— Transition piece: reinforcement technology



Coupler joints

— Continuous internal thread for seamless connection
— Load-bearing capacity equivalent to the corresponding solid bar
— Permanent applications: secured with DSI bond adhesive or fixed with two lock nuts
— Contact coupler with inspection window: designed for pure compression loads
— Coupler with set screws: specifically for grouted anchor applications
— Reinforcement applications: long coupler or hexagonal coupler with two extended lock nuts
— Reducing coupler: enables connection between load-bearing elements of different nominal diameters



Hybridanker-plate

Hybridanker-plates are made from UHPFRC (Ultra-High-Performance Fiber-Reinforced Concrete) and are used as plates for transferring anchoring forces into the ground. Their load-bearing capacity has been proven both through calculations and extensive testing. These plates are certified with a European approval (ETA). Advantages of Hybridanker-plates compared to conventional steel plates are:

— Exceptional durability and high resistance to corrosion
— Customizable geometry to meet specific project requirements
— Significantly reduced weight for easier handling and installation
— Angle adjustment up to 30° possible with a single plate
— Development of tailored, project-specific solutions
— Integrated threaded inserts for anchor caps in standard or stainless steel execution
— Provisions for grouting and venting ducts
— Embedded PE pipes for advanced corrosion protection systems

With their superior strength, flexibility in design, and long-term corrosion resistance, hybrid anchor plates provide an innovative and highly efficient alternative to traditional steel plates.



Additional accessories

For various applications, additional accessories are required to ensure optimal system performance and durability. These include:

— Spacers
— Corrugated and smooth sheetings
— Protective caps
— Coupler tubes
— Heat shrink sleeves

Technical details and further information on these and other components are available directly from us or within our official approvals and certifications.



Special accessories

Expansion shell anchors

Expansion shell anchors are high-performance, instantly load-bearing anchoring solutions for both solid bar and hollow bar systems. They are commonly used in rock anchoring applications and for securing single-sided formwork. In the installation process, tensile load-bearing elements made of threaded bars are equipped with a pre-mounted expansion shell anchor and inserted into a pre-drilled and cleaned borehole. The load capacity is activated by tensioning the anchor head (nut and plate), enabling immediate force transmission. For enhanced load capacity and corrosion resistance, post-grouting of the borehole is possible. To ensure optimal performance, the ground – typically rock or reinforced concrete – must be capable of absorbing the expansion forces of the anchor. As load-bearing capacity varies by project, on-site load tests must be conducted to determine actual performance. Key advantages of expansion anchors are:

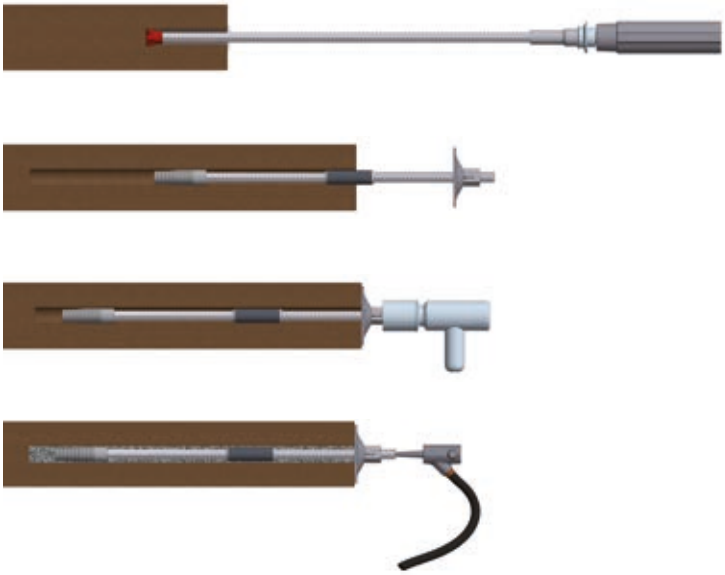
— Fast and easy installation with minimal handling effort
— Immediate load-bearing capacity upon tensioning
— Effective anchoring even in water-bearing boreholes
— Easily adjustable anchor length for project-specific requirements

With their fast installation, immediate load transfer, and adaptability to challenging ground conditions, expansion anchors offer a reliable and efficient anchoring solution for demanding geotechnical and structural applications.



Installation process

— Drilling the borehole: create a borehole according to specified dimensions, ensuring it is approximately 150 mm longer than the installed rock anchor.
— Insertion of the assembled expansion anchor: insert the pre-assembled expansion anchor into the borehole. The expansion anchor must fit tightly against the borehole wall to ensure proper force transfer.
— Pre-tensioning: apply pre-tension using an impact wrench or an appropriate tensioning tool to activate the expansion mechanism.
— Optional post-grouting: if required, post-grouting can be performed to enhance load capacity and/or improve corrosion resistance.



Properties

Steel grade	Bar diameter $Ø_s$	Nominal outer diameter $Ø_{e,nom}$	Length L	Weigth G	Recommended drill hole diameter $Ø_b$
S 550/620	16 mm	32 mm	92 mm	0.22 kg	33-34 mm
	25 mm	49 mm	120 mm	0.60 kg	50-52 mm
	32 mm	59 mm	150 mm	1.00 kg	60-62 mm
S 670/800	18 mm	39 mm	110 mm	0.44 kg	40-42 mm
	25 mm	49 mm	120 mm	0.60 kg	50-52 mm
	30 mm	59 mm	150 mm	1.00 kg	60-62 mm

Ring and eye nuts

To facilitate the attachment of external components – such as rockfall protection nets, steel cables, and utility conduits – to installed DSI solid bars, various specialized nut types have been developed.

Ring nut
The nut itself is designed as either a hexagonal or round profile and is capable of transferring the full tensile load of the bar. The welded ring lug is engineered according to specific application requirements and typically carries only a portion of the bar load. This design combines two functions: the DSI solid bar serves as a geotechnical load-bearing element. Additional external loads are transferred into the system via the welded ring.
Typical applications:

— Securing tools or safety chains during construction
— Attaching cables, wire ropes, or protective mesh systems

Eye nut
Instead of a steel loop, this nut features a welded steel plate with a stamped or drilled hole. Like the ring nut, the nut itself is designed to transfer the full tensile load, while the welded attachment is designed separately based on application-specific requirements.
Typical applications:

— Mounting measurement devices or other tools
— Attaching rockfall protection nets

Key benefits of ring and eye nuts

— Secure and reliable attachment points for external materials
— Dual functionality: load transfer and external attachment
— Application-specific customization for different load requirements

These specialized fastening solutions provide a versatile and robust way of integrating external components into geotechnical and structural systems.











Technical data

DSI solid bars are available in various steel grades and diameters. The three main steel grades are:

— Reinforcement steel: S 500/550, S 550/620, and S 555/700
— High strength reinforcement: S 670/800
— Post-tensioning (PT) steel: S 835/1035, S 950/1050

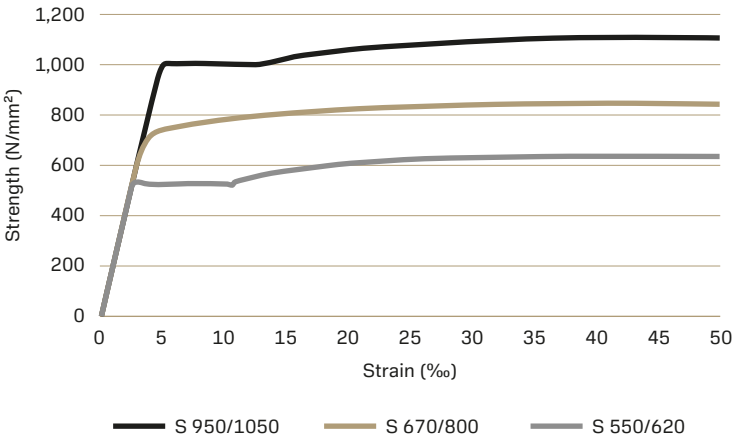
Mechanical properties

Steel grade	Symbol	Reinforcement S 500/550	Reinforcement S 550/620
Diameter range	$Ø_s$	12-75 mm	12-75 mm
Yield strength	R_e (f_{yk})	500 N/mm²	550 N/mm²
Ultimate strength	R_m (f_{tk})	500 N/mm²	620 N/mm²
Ratio	$(R_m/R_e)_k$	≥ 1.08	≥ 1.08
Elongation at maximum load	A_{gt}	≥ 5.0 %	≥ 5.0 %
Fatigue strength at an amplitude of $2{\cdot}\sigma_A$ with an upper limit of $0.6{\cdot}\ R_e$ and N = $2{\cdot}10^6$ load cycles	$2{\cdot}\sigma_A$	$Ø_s$ = 20-32 mm: 120 N/mm² $Ø_s$ = 40-75 mm: 100 N/mm²	$Ø_s$ = 20-32 mm: 120 N/mm² $Ø_s$ = 40-75 mm: 100 N/mm²

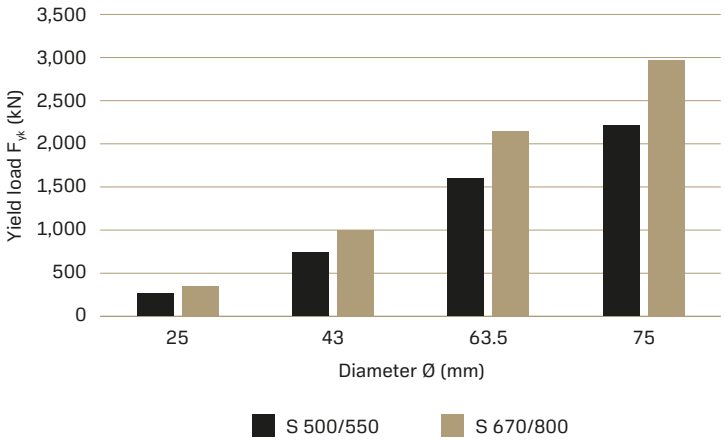
Steel grade	Symbol	High strength reinforcement S 670/800	PT-bar S 950/1050	PT-bar S 835/1035
Diameter range	$Ø_s$	18-75 mm	18-47 mm	57-75 mm
Yield strength	R_e (f_{yk})	670 N/mm²	835 N/mm²	950 N/mm²
Ultimate strength	R_m (f_{tk})	800 N/mm²	1,035 N/mm²	1,050 N/mm²
Ratio	$(R_m/R_e)_k$	≥ 1.10	—	—
Elongation at maximum load	A_{gt}	≥ 5.0 %	≥ 5.0 %	≥ 4.0 %
Fatigue strength at an amplitude of $2{\cdot}\sigma_A$ with an upper limit of $0.6{\cdot}\ R_e$ and N = $2{\cdot}10^6$ load cycles	$2{\cdot}\sigma_A$	$Ø_s$ = 18-43 mm: 150 N/mm² $Ø_s$ = 50-63.5 mm: 120 N/mm² $Ø_s$ = 75 mm: 100 N/mm²	$Ø_s$ = 18-32 mm: 180 N/mm² $Ø_s$ = 36-40 mm: 137 N/mm² $Ø_s$ = 47 mm: n. a. [1]	—

1) n. a. = not available.

Stress-strain-curve



Yield load



Characteristic data

Steel grade	Nominal diameter $Ø_s$	Nominal cross section A_s	Nominal weight g	Nominal weight g	Yield load F_{yk}	Ultimate load F_{tk}	Design yield load F_{yd} [1]
S 500/550	12 mm	113 mm²	0.9 kg/m	1,124 m/to	57 kN	62 kN	50 kN
	14 mm	154 mm²	1.2 kg/m	826 m/to	77 kN	85 kN	67 kN
	16 mm	201 mm²	1.6 kg/m	633 m/to	100 kN	110 kN	87 kN
	20 mm	314 mm²	2.5 kg/m	407 m/to	160 kN	175 kN	139 kN
	25 mm	491 mm²	3.9 kg/m	260 m/to	245 kN	270 kN	213 kN
	28 mm	616 mm²	4.8 kg/m	207 m/to	310 kN	340 kN	270 kN
	32 mm	804 mm²	6.3 kg/m	159 m/to	405 kN	440 kN	352 kN
	36 mm	1,018 mm²	8.0 kg/m	125 m/to	510 kN	560 kN	443 kN
	40 mm	1,257 mm²	9.9 kg/m	101 m/to	630 kN	690 kN	548 kN
	43 mm	1,452 mm²	11.4 kg/m	88 m/to	726 kN	799 kN	631 kN
	50 mm	1,963 mm²	15.4 kg/m	65 m/to	980 kN	1,080 kN	852 kN
	57.5 mm	2,597 mm²	20.4 kg/m	49 m/to	1,299 kN	1,428 kN	1,130 kN
	63.5 mm	3,167 mm²	24.9 kg/m	40 m/to	1,584 kN	1,742 kN	1,377 kN
	75 mm	4,418 mm²	34.7 kg/m	29 m/to	2,209 kN	2,430 kN	1,921 kN
S 550/620	16 mm	201 mm²	1.6 kg/m	633 m/to	111 kN	125 kN	97 kN
	20 mm	314 mm²	2.5 kg/m	407 m/to	173 kN	195 kN	150 kN
	25 mm	491 mm²	3.9 kg/m	260 m/to	270 kN	304 kN	235 kN
	28 mm	616 mm²	4.8 kg/m	207 m/to	339 kN	382 kN	295 kN
	32 mm	804 mm²	6.3 kg/m	159 m/to	442 kN	498 kN	384 kN
	36 mm	1,018 mm²	8.0 kg/m	125 m/to	560 kN	631 kN	487 kN
	40 mm	1,257 mm²	9.9 kg/m	101 m/to	691 kN	779 kN	601 kN
	43 mm	1,452 mm²	11.4 kg/m	88 m/to	799 kN	900 kN	695 kN
	50 mm	1,963 mm²	15.4 kg/m	65 m/to	1,080 kN	1,217 kN	939 kN
	57.5 mm	2,597 mm²	20.4 kg/m	49 m/to	1,428 kN	1,610 kN	1,242 kN
	63.5 mm	3,167 mm²	24.9 kg/m	40 m/to	1,742 kN	1,964 kN	1,515 kN
	75 mm	4,418 mm²	34.7 kg/m	29 m/to	2,430 kN	2,739 kN	2,113 kN
S 670/800	18 mm	254 mm²	2.0 kg/m	503 m/to	170 kN	204 kN	148 kN
	22 mm	380 mm²	3.0 kg/m	336 m/to	255 kN	304 kN	220 kN
	25 mm	491 mm²	3.9 kg/m	260 m/to	329 kN	393 kN	286 kN
	28 mm	616 mm²	4.8 kg/m	207 m/to	413 kN	491 kN	359 kN
	30 mm	707 mm²	5.6 kg/m	180 m/to	474 kN	565 kN	412 kN
	35 mm	962 mm²	7.6 kg/m	133 m/to	645 kN	770 kN	561 kN
	43 mm	1,452 mm²	11.4 kg/m	88 m/to	973 kN	1,162 kN	846 kN
	50 mm	1,963 mm²	15.4 kg/m	65 m/to	1,315 kN	1,570 kN	1,143 kN
	57.5 mm	2,597 mm²	20.4 kg/m	49 m/to	1,740 kN	2,077 kN	1,513 kN
	63.5 mm	3,167 mm²	24.9 kg/m	40 m/to	2,122 kN	2,534 kN	1,845 kN
	75 mm	4,418 mm²	34.7 kg/m	29 m/to	2,960 kN	3,534 kN	2,574 kN
S 950/1050	18 mm	214 mm²	2.0 kg/m	510 m/to	230 kN	255 kN	200 kN
	26,5 mm	551 mm²	4.5 kg/m	223 m/to	525 kN	580 kN	457 kN
	32 mm	804 mm²	6.5 kg/m	153 m/to	760 kN	845 kN	661 kN
	36 mm	1,020 mm²	8.3 kg/m	121 m/to	960 kN	1,070 kN	835 kN
	40 mm	1,257 mm²	10.2 kg/m	98 m/to	1,190 kN	1,320 kN	1,035 kN
	47 mm	1,735 mm²	14.1 kg/m	71 m/to	1,650 kN	1,820 kN	1,435 kN
S 835/1035	57 mm	2,581 mm²	21.0 kg/m	48 m/to	2,155 kN	2,671 kN	1,874 kN
	65 mm	3,331 mm²	27.1 kg/m	37 m/to	2,780 kN	3,447 kN	2,417 kN
	75 mm	4,418 mm²	35.9 kg/m	28 m/to	3,690 kN	4,572 kN	3,209 kN

1) $F_{yd} = F_{yk} / \gamma_s = F_{yk} / 1.15$

Corrosion protection measures

All geotechnical systems can be categorized based on their intended service life into three main classifications:

— **Temporary systems**
- Planned service life: up to 2 years
- Typically, no corrosion protection is required

— **Semi-permanent systems**
- Planned service life: between 2 and 7 years (in some cases up to 50 years)
- Corrosion protection requirements depend on national regulations and environmental conditions

— **Permanent systems**
- Planned service life: more than 2 years, up to 100 years
- Comprehensive corrosion protection is essential for long-term durability

The definition of semi-permanent and permanent systems varies by country and national standards. However, the key factor in system design is the distinction between temporary and permanent applications, as well as the required service life.
For temporary systems, corrosion protection is generally not necessary. However, for applications exceeding two years, corrosion protection must be carefully planned and implemented to ensure durability and structural integrity.

Types of corrosion protection
Corrosion protection measures are classified into two levels:

— **Single corrosion protection (SCP)**
- Encapsulation with grout
- Sacrificial steel thickness (abrasion rate compensation)
- Galvanization (zinc coating)
- Protective coatings

— **Double corrosion protection (DCP)**

A detailed table outlining common corrosion protection methods is provided below:

Measure	Abbreviation	Description	Main application
Grout cover protection	GCP	Cement mortar coverage without additional protection.	Primarily for temporary systems.
Sacrificial thickness addition	STA	Cement mortar coverage with additional material allowance based on annual corrosion rate, considering soil aggressiveness.	Planned service life: up to 50 years.
Zinc cover protection	ZCP	Load-bearing elements are hot-dip galvanized with a zinc coating that degrades over time. The coating thickness and soil corrosion level determine the service life.	Planned service life: up to 50 years.
Coating cover protection	CCP	Load-bearing elements are protected against corrosion using epoxy or powder coating.	Applied where enhanced surface protection is required.
Double Corrosion Protection	DCP	Dual-layer protection required by EN 1537, ensuring that the outer layer protects the inner one during handling and installation. Typically consists of cement grout (first layer) encapsulated within a PE corrugated pipe (second layer).	Mainly for permanent systems, with a planned service life of up to 100 years.
Duplex coating	–	Combination of galvanization and powder coating for enhanced protection.	Used in highly corrosive environments requiring extended durability.

In addition to the primary corrosion protection methods listed above, other protective measures can be applied in special cases. These are less common but may be used in exceptional circumstances where standard methods are insufficient.
Some of these advanced protection techniques include:

— **Cathodic corrosion protection**
Uses an electrochemical process to prevent metal corrosion, typically applied in highly aggressive environments such as marine or underground installations.

— **Heat-shrink sleeve with corrosion protection compound**
A protective shrink sleeve is applied over the load-bearing element, containing corrosion-inhibiting material to provide an additional sealing layer against environmental influences.

These methods are rarely required but may be considered for special applications where extreme corrosion resistance is necessary.

Double corrosion protection

Double corrosion protection (DCP), in accordance with EN 1537, refers to a two-layer protection system ensuring maximum durability and resistance to environmental degradation. In this system:

— The steel load-bearing element is encased in a minimum 5 mm thick cement grout layer, providing alkaline protection to prevent steel corrosion. Also resin can be used, if the usability is proven.

— A plastic sheathing pipe (minimum 1.0 mm thick) serves as an additional barrier, protecting against water infiltration and external environmental damage. Alternatively a steel pipe can be used as well.

This dual-layer system ensures long-term corrosion resistance and structural integrity, even in highly aggressive environments.

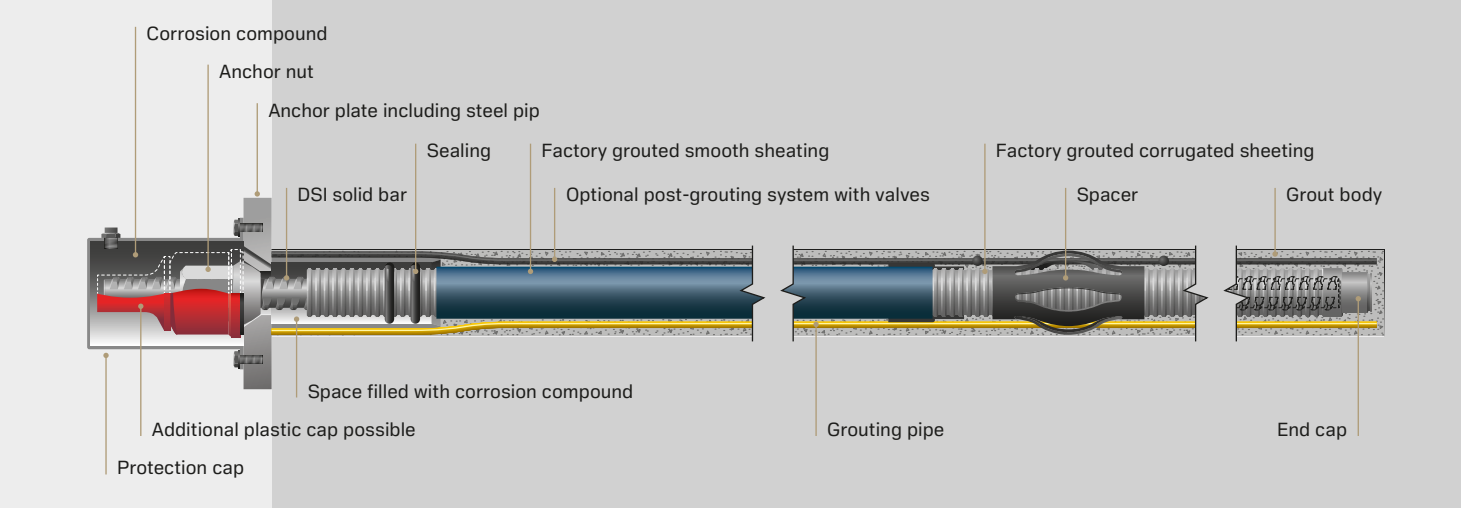
Technical specifications

— Complies with EN 1537 double corrosion protection standards
— Minimum 5 mm grout coverage
— Minimum 1.0 mm plastic sheathing pipe
— Designed for a service life of up to 100 years

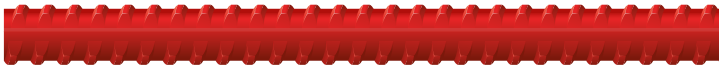
Key advantages

— Factory-prepared for maximum quality control
— Superior corrosion protection, even in highly corrosive environments
— High installation precision through cased borehole drilling

With its robust design and compliance with the highest industry standards, DCP provides an advanced and reliable solution for permanent geotechnical applications.



Duplex-coating



A duplex coating system, as defined by EN ISO 12944-5, consists of a combination of hot-dip galvanization and one or more additional protective coatings. This dual-layer protection mechanism enhances corrosion resistance by combining the sacrificial properties of zinc with the barrier protection of an additional coating.
The powder coating ensures that the zinc layer remains intact for an extended period, significantly increasing the system's longevity.

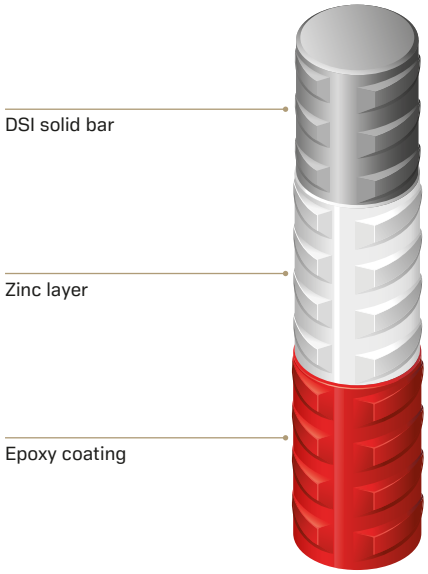
Technical specifications

— Compliant with EN ISO 12944-5 standards
— Protective coating system categorized under corrosion class C5-M (suitable for marine and highly corrosive environments)
— Available in various coating colors (standard: blue)
— Hot-dip galvanization according to EN 1461

Key advantages

— Superior corrosion protection, leading to an extended service life
— Synergy effect: extends the lifetime factor by up to 2.5 times compared to single-layer coatings
— High resistance to abrasion and mechanical wear

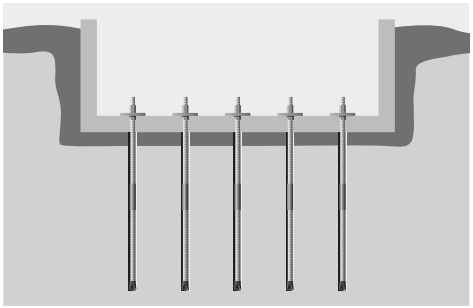
With its enhanced durability and extended corrosion protection, the duplex coating system is ideal for demanding geotechnical and industrial applications, ensuring long-term reliability and performance.



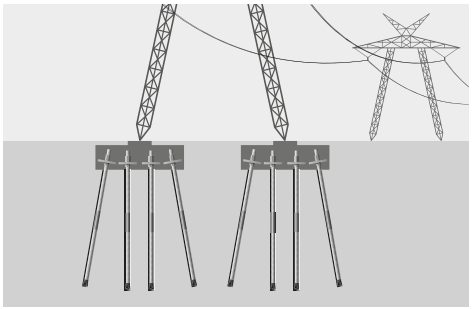
Micropile

Applications

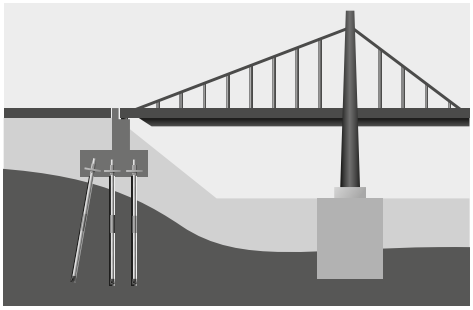
Uplift protection



Foundation

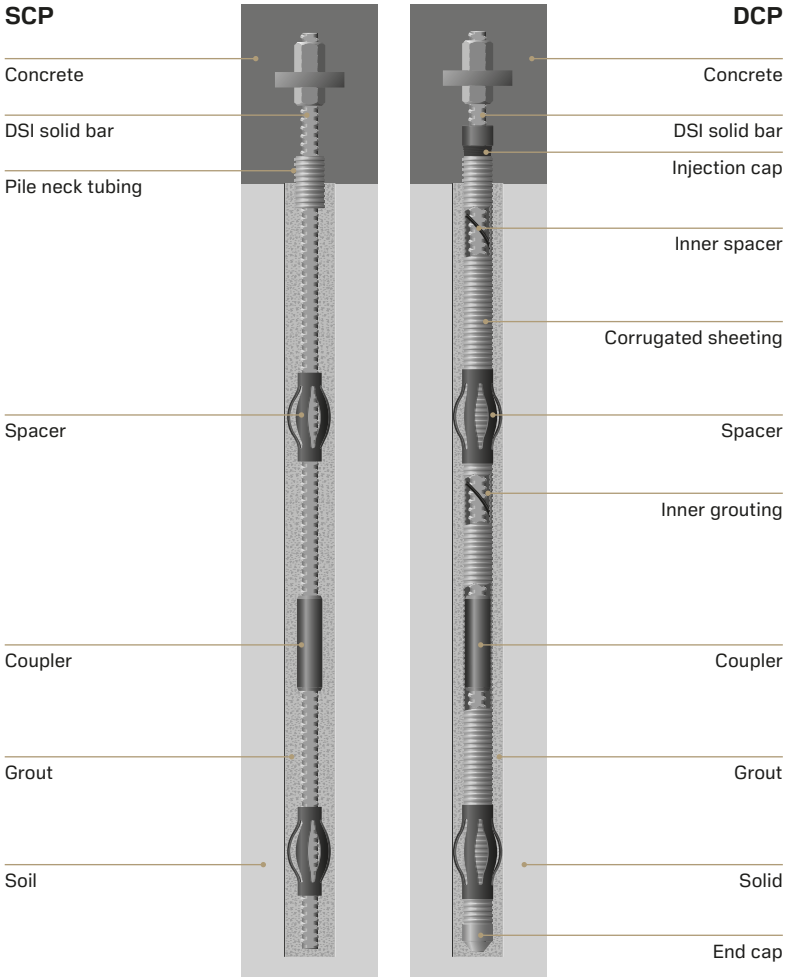


Abutment



Basics

Deep foundations can be implemented using pile foundations. In the case of bored piles, a distinction is made between large-diameter bored piles and micropiles. Micropiles are defined as piles with a borehole diameter of up to 300 mm. Typically, a solid bar or a hollow bar is used as the central load-bearing element. DSI solid bar micropiles are primarily installed using cased drilling techniques, ensuring high precision and stability. They are widely used in both new construction projects and the rehabilitation or reinforcement of existing structures. Solid bar micropiles are available in three steel grades: S 500/550, S 550/620, and S 670/800 and a diameter range from 22 mm to 75 mm. The corrosion protection strategy must be selected based on the planned service life and soil conditions: for temporary applications (e.g., foundations for temporary support structures), single corrosion protection (SCP) is typically sufficient. For permanent applications (e.g., deep foundations of building structures), double corrosion protection (DCP) is recommended to ensure long-term durability and structural integrity. With their high load-bearing capacity, flexible installation options, and adaptable corrosion protection, DSI solid bar micropiles provide a reliable foundation solution for both temporary and permanent applications.



Characteristics

— **Manufacturing process**
Cast-in-place concrete pile, installed on-site.

— **Installation method**
The load-bearing element is inserted into a pre-drilled (cased) borehole and subsequently grouted with cement mortar to ensure structural integrity.

— **Load transfer into the pile**
Tensile and/or compressive forces are directly transferred from the structure to the pile head. Some slip movement may occur and must be considered in the structural design.

— **Load transfer into the ground**
Micropiles transfer loads through skin friction, end-bearing pressure (tip resistance) or a combination of both. To enhance load transfer, single or multiple post-grouting processes can be implemented using grout injection tubes attached to the load-bearing element.

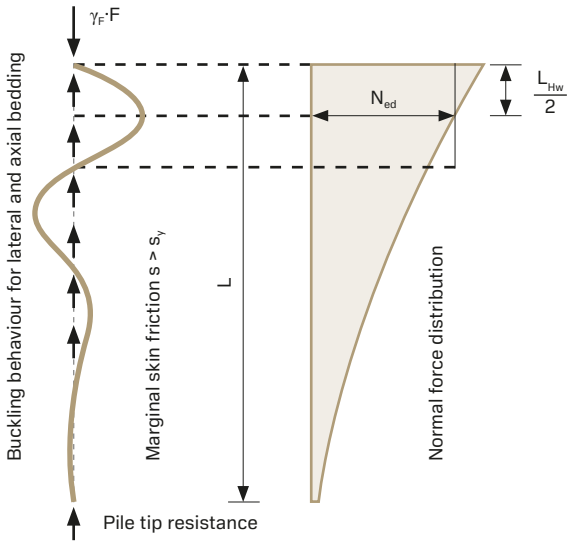
— **Recommended corrosion protection systems**
- Temporary application: encapsulation (basic protection)
- Semi-permanent application: sacrificial thickness (STA)
- Permanent application: double corrosion protection (DCP)

Buckling resistance

Micropiles subjected to tensile and typically also compressive forces are designed based on a cross-sectional verification, considering:

— Axial force capacity (normal force verification)
— Normal force-moment interaction (combined loading verification)

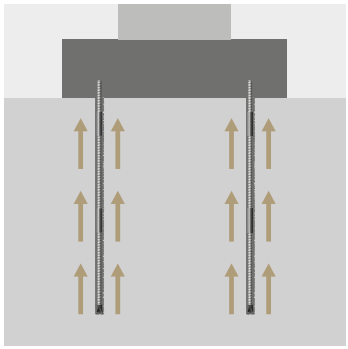
Additionally, potential horizontal and vertical displacements must be considered to ensure structural stability. For compressive micropiles transmitting loads through very soft soil layers, buckling verification is required. In this case, bending stress due to imperfections must be considered in addition to the axial compressive force acting on the pile. Proper structural analysis and buckling resistance assessments ensure the safe and reliable performance of micropiles in various soil conditions.



Skin friction and tip bearing

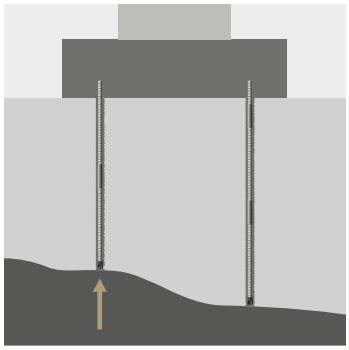
Micropiles primarily transfer loads through skin friction. This friction is activated during the grouting process, depending on the soil properties. Empirical data provides insights into the achievable resistance for different soil parameters. In-situ tests can be conducted for a more accurate determination of the actual load-bearing capacity.
If a micropile is embedded in rock or very dense material, high loads can be transferred through tip resistance. However, in such cases, special attention must be given to buckling behavior.
In-situ tests can also provide valuable data on the actual load-bearing performance and potential buckling risks.

Skin friction



Friction piles rely on force transfer between the pile surface (grouted body) and the borehole wall.

Tip bearing



End-bearing piles support the structure and transfer loads at the bottom of the borehole as well as within the grouted body.

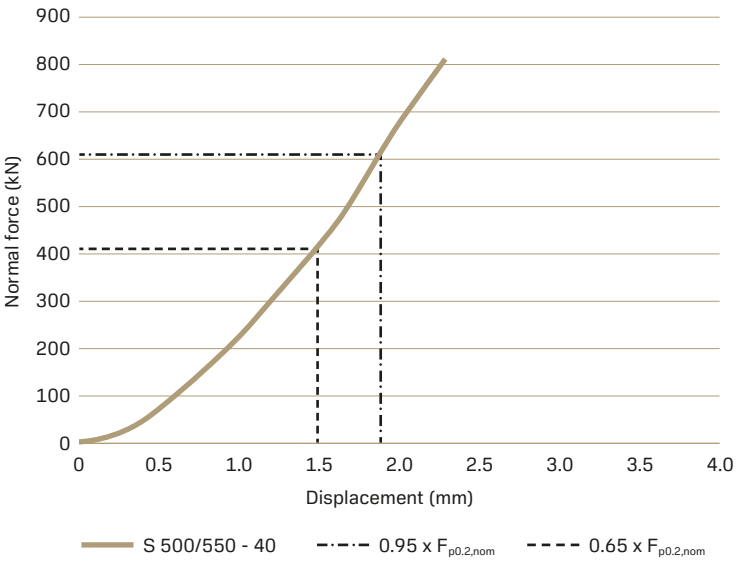
$$P_{cr} = \frac{\pi^2 E_p I_p}{(KL)^2}$$

Legend:
P_{cr} = Buckling load (kN)
E_p = Elastic modulus of the equivalent pile cross-section (kN/m²)
I_p = Moment of inertia of the equivalent pile cross-section (m⁴)
L = Length of the pile section without lateral support (m)
K = Buckling coefficient:
1.0 = Hinged/hinged support
0.7 = Fixed/hinged support (soft clay)
0.5 = Fixed/fixed support (voids or fault zones)

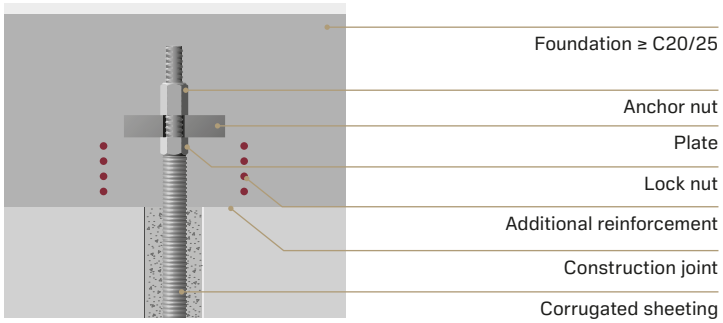
Pile head constructions

Since the pile head is typically embedded in concrete, no special corrosion protection measures are required. The pile head can function as a load transfer element within the concrete using an anchor plate (full load transfer) or an anchor piece (with a bond length).
The design depends on the type of load, whether tensile, compressive, or cyclic loading. Additionally, split tensile reinforcement must be installed in accordance with applicable approvals.
In the transition area between the pile and the foundation, a pile sleeve may be required depending on the load conditions.
This limits crack width in the transition zone. To minimize slip in the pile head construction, it is designed with adhesive bonding for enhanced stability.

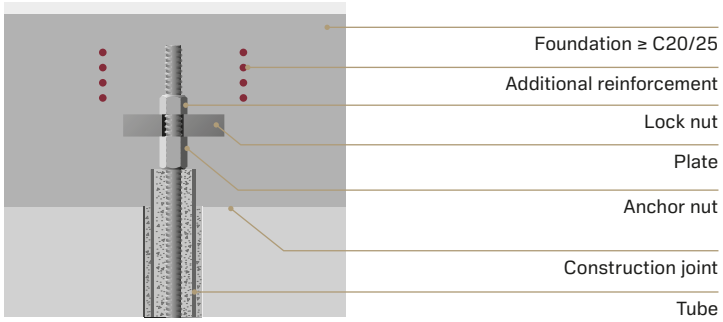
Load-transfer test



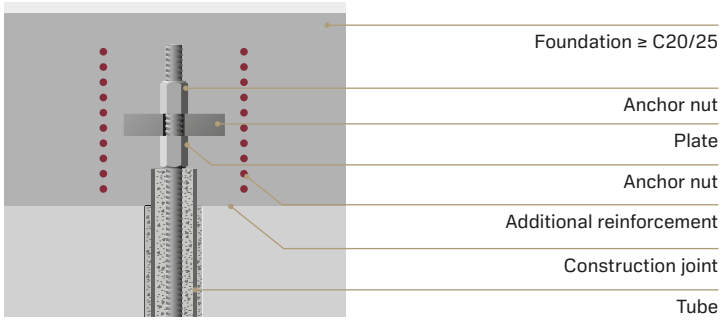
Tension loading



Compression loading



Alternating loading











Coupling connection

Coupler connections ensure the full transfer of force from one pile segment to the next. It is crucial that these connections do not introduce excessive deformations compared to a continuous rod. Otherwise, this could lead to overstressing of the cementitious cover or the bond between the pile and the grouting body. Coupler connections are categorized based on their load-bearing conditions: tension, compression, or cyclic loading.

— **Compression loading**
When transferring purely compressive forces, the rods can be butt-jointed, with the coupler merely serving as a horizontal positioning aid to secure the alignment of the rods.

— **Tensile loading**
For tensile forces, the coupler joints must be designed to minimize slippage. This can be achieved either through hydraulic preloading or adhesive bonding of the couplers.

— **Cyclic loading (alternating tension and compression)**
In cases where the load alternates between tension and compression, it is essential to limit displacement within the coupler in both directions. This can be achieved through: Hydraulic torquing, where the lock nuts take over the force transmission under compression and must be appropriately dimensioned. Adhesive bonding, ensuring a firm connection to withstand both tensile and compressive forces. This approach ensures the structural integrity of the pile connection while preventing excessive stress on the surrounding materials.

DSI Bond Glue System

There are two methods available to minimize slippage in coupler joints and anchorages:

— Hydraulic torquing using lock nuts
— Adhesive bonding with the DSI Bond System

Both systems achieve similar performance results; however, the use of the DSI Bond System offers several advantages:

— Elimination of lock nuts
— Significant reduction of torque moments
— Simplified handling and installation
— Lower installation effort compared to hydraulic torquing

These technical and operational benefits contribute to a more cost-effective solution. Furthermore, the adhesive bonding of coupler connections and end anchorages is already included in the relevant approvals.
The following table provides an overview of the required adhesive quantities and corresponding torque moments for different diameters.

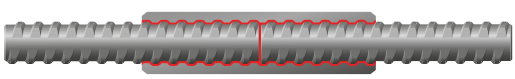
Temperature	Processing time	Minimal curing time [1]
+40 °C	1.4 min	15 min
+35 bis +39 °C	1.4 min	20 min
+30 bis +34 °C	2 min	25 min
+20 bis +29 °C	4 min	45 min
+10 bis +19 °C	6 min	1:20 h
+5 bis +9 °C	12 min	2:00 h
0 bis +4 °C	20 min	3:00 h
-4 bis -1 °C	45 min	5:30 h
-5 °C	90 min	5:30 h

1) If the sleeve connection is exposed to moisture, the minimum curing time must be doubled.

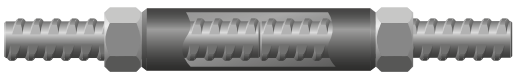
Bar Ø	Standard coupler		Pre coupled connection		Torquing moment
	Amount of glue [2]	Strokes of pump	Amount of glue [2]	Strokes of pump	
22 mm	20 ml	3	10 ml	1.5	0.8 kNm
25 mm	26 ml	4	13 ml	2	0.8 kNm
28 mm	30 ml	4.5	15 ml	2.5	0.8 kNm
30 mm	40 ml	6	20 ml	3	1.0 kNm
35 mm	55 ml	8.5	22.5 ml	3.5	1.0 kNm
43 mm	75 ml	11.5	37.5 ml	6	1.2 kNm
50 mm	90 ml	14	45 ml	7	1.2 kNm
57.5 mm	110 ml	17	55 ml	8.5	1.2 kNm
63.5 mm	160 ml	25	80 ml	12.5	1.2 kNm
75 mm	180 ml	28	90 ml	14	1.2 kNm

2) Cartridge size: 410 ml.

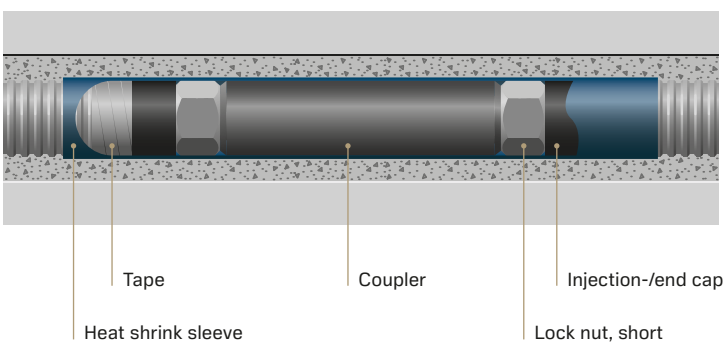
Glued coupling connection (SCP)



Torqued coupling connection (SCP)



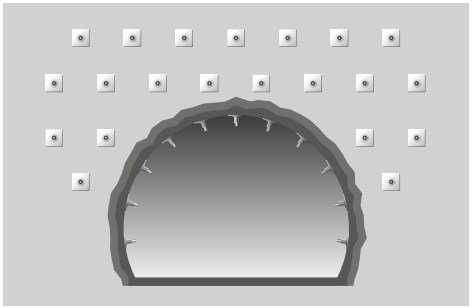
Coupling under tension load (DCP, torqued)



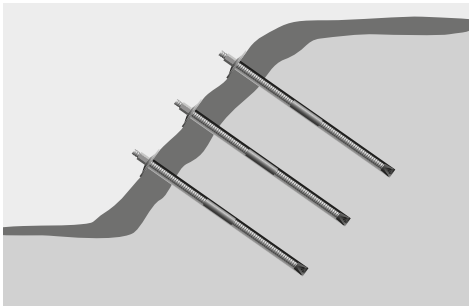
Soil nail

Applications

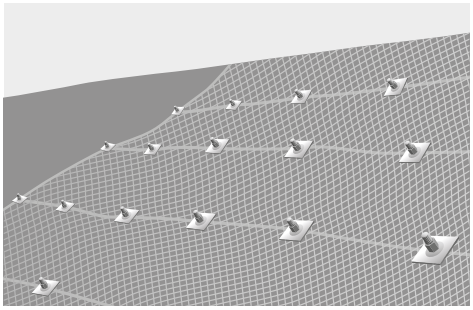
Portal stabilization



Slope stabilization

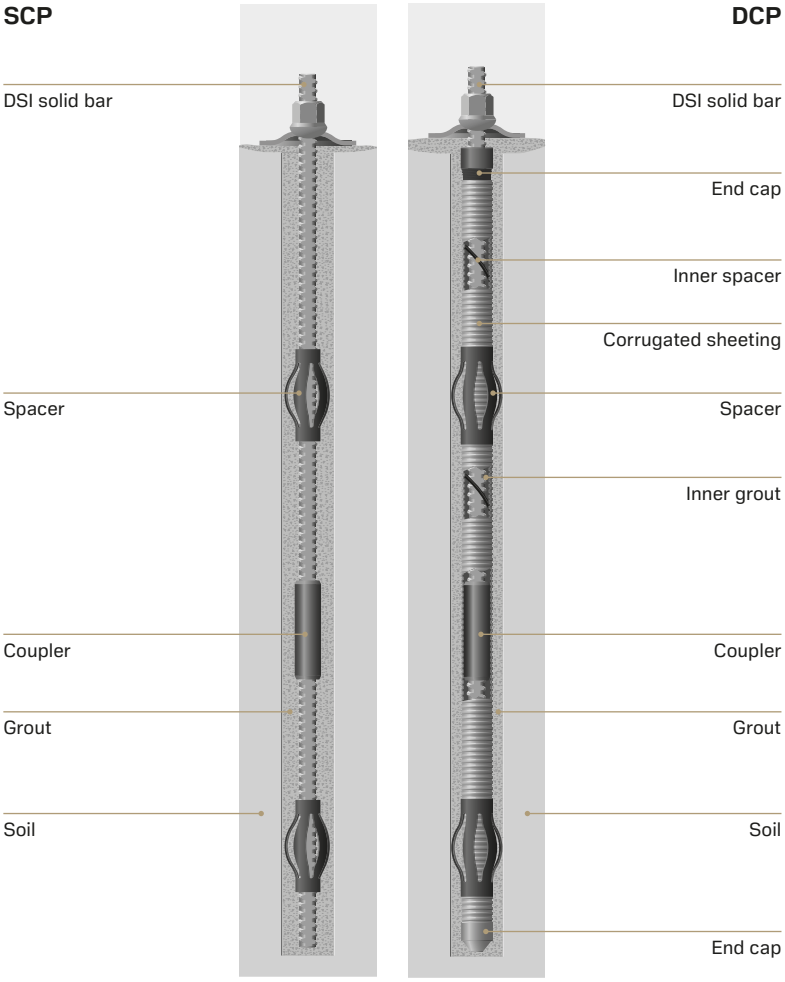


Rock fall protection



Basics

Soil nailing is an advanced geotechnical technique widely employed to stabilize naturally unstable slopes, reinforce excessively steep existing slopes, and enhance the structural integrity of retaining walls and embankments. This method provides an efficient, cost-effective solution for improving soil stability in various civil engineering and infrastructure projects.
In underground applications, soil nails are also known as rock nails or bolts. The fundamental principle behind soil or rock nailing is the installation of longitudinal reinforcement elements within the ground, creating an integrated stabilization system. Unlike ground anchors which are actively tensioned, and tension piles, soil nails function as a passive system – installed without pre-tensioning. By reinforcing the soil mass, soil nails increase the load-bearing capacity of the entire structure. They function as a network of reinforcement elements, effectively counteracting tensile and shear forces to prevent soil displacement or failure.
The optimal nail spacing is a crucial design consideration, ensuring that individual nails collectively contribute to the stability of the overall system.
Before the installation of soil nails, the exposed surface is typically reinforced using shotcrete, precast concrete panels, geotextiles, or wire mesh to provide immediate structural support. The design and execution of the nail head system depend on specific project requirements, soil conditions, and the intended service life of the structure. DSI solid bar soil nails are engineered for high-performance soil reinforcement and are typically installed in cased boreholes, followed by cement mortar grouting to ensure durability and long-term stability. These nails are available in three high-strength steel grades: S 500/550, S 550/620 and S 670/800. They come in a range of diameters from 16 mm to 75 mm, offering versatility for a wide array of geotechnical applications.



Charakteristics

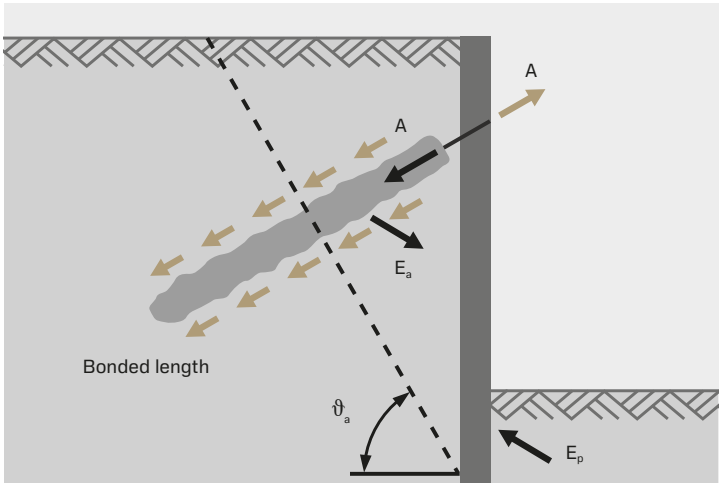
— **Location and method of installation**
Cast-in-place concrete nail, installed on-site.

— **Installation method**
The load-bearing element is placed into a (cased) pre-drilled borehole, which is then filled with cement mortar.

— **Force transmission to the nail**
Tensile and shear forces are transferred into the reinforcement bar via bond friction along the shaft. The nail head construction only transfers surface-level forces into the nail.

— **Recommended corrosion protection systems**
- Temporary application: encapsulation
- Semi-permanent application: sacrificial corrosion rate
- Permanent application: double corrosion protection

Principle of soil nails



A = Axial force
ϑ_a = Angle of friction
E_a = Active earth pressure
E_p = Passive earth pressure



Nail head construction

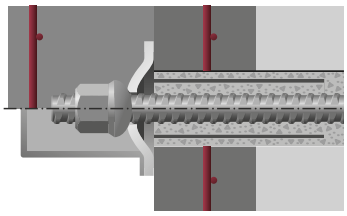
The nail head construction of soil nails can be designed as either embedded in concrete or exposed. Available head plate options include solid plates with or without a conical shape or dome plates. Depending on the selected plate type, either an anchor nut or a spherical collar nut is required for transferring the load from the plate to the reinforcement bar.
Embedded nail head constructions (with minimum concrete cover as per standards) do not require additional corrosion protection. However, exposed nail heads must be protected according to the intended service life.

Temporary application
— Intended service life: ≤ 2 years
— No corrosion protection required
— Optional: plastic protective cap

Semi-permanent application
— Intended service life: ≤ 30 years
— Steel or plastic protective cap filled with corrosion protection compound
— Alternative option: galvanized version

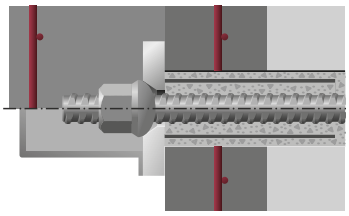
Permanent application
— Intended service life: ≤ 100 years
— Steel cap filled with corrosion protection compound
— Plastic protective cap filled with corrosion protection compound
— Nail shaft protection tube (if no double corrosion protection (DCP) is applied)

Domed nut and domed washer



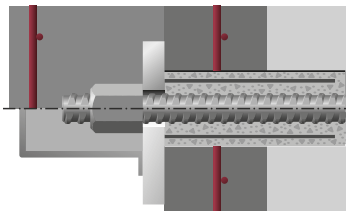
For Ø 16-35 mm

Domed nut and anchor plate with cone (angle correction)



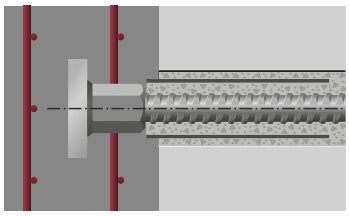
For Ø 16-75 mm

Hex nut and steel plate



For Ø 16-75 mm

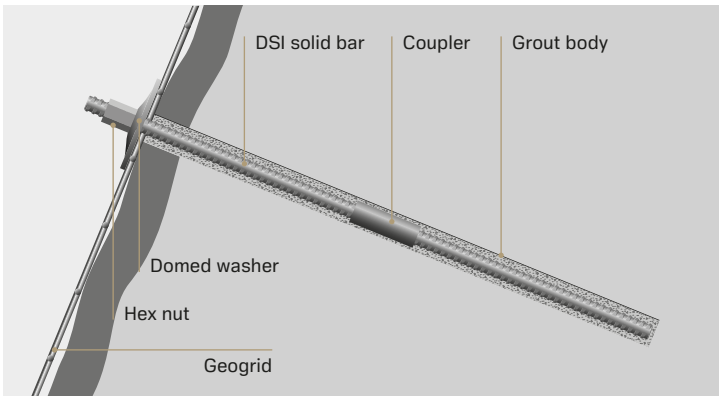
Inverse nail head

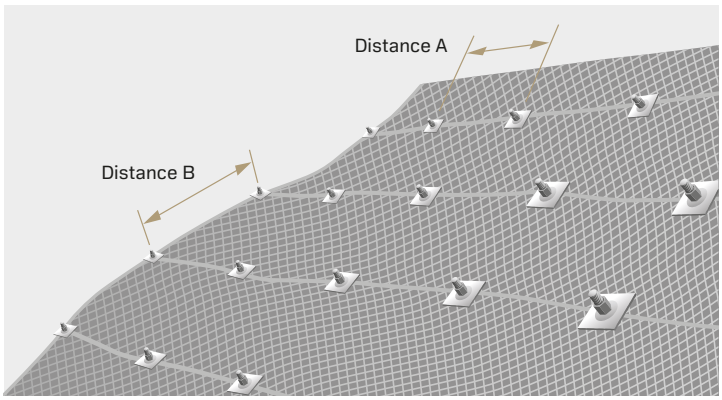


For Ø 16-50 mm



Rock fall protection







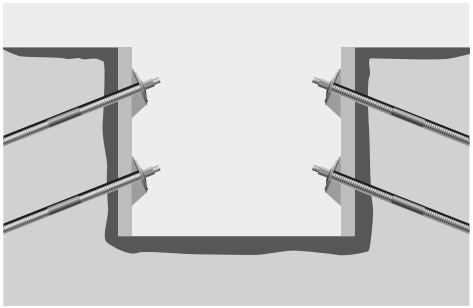




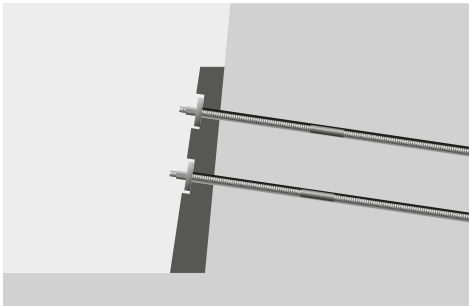
Grouted anchor

Applications

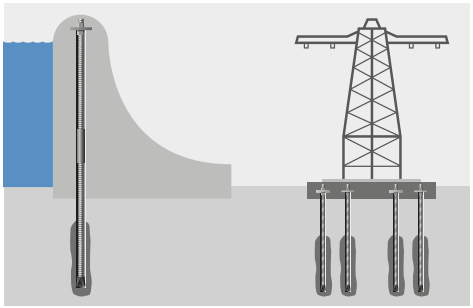
Tie backs



Anchorage



Building anchorage



Basics

Grouted anchors are structural elements used in civil engineering for both above-ground and underground applications. Unlike passive reinforcement systems, grouted anchors are actively pre-tensioned, allowing anticipated deformations to be mitigated or eliminated entirely. These anchors are used in temporary applications, such as excavation pits and retaining walls, or in permanent applications, such as slope stabilization and the anchoring of masts or other infrastructure.
Soil and rock anchors are categorized into three key system components:

- **Bonded length/anchor length**
  The anchor is embedded in the borehole and secured with cement grout, allowing it to transfer loads through both bonding and friction with the surrounding load-bearing ground.
- **Free length/debonded section**
  The tendon (tension member) is decoupled from the borehole wall and grout using a sheath or duct, which is sealed at the reinforcement bar or corrugated pipe. This unbonded section allows the anchor system to be tensioned freely without resistance.
- **Anchor head**
  The anchor head transfers the anchor load to the anchored structure, such as precast or cast-in-place concrete anchor beams.

Solid bar anchor systems are installed in pre-drilled, cased boreholes and then grouted with cement mortar. In stable soil conditions, installation can also be carried out in uncased boreholes. The grouting process is performed using injection tubes attached to the anchor, ensuring proper distribution of grout within the borehole.
For challenging or unstable ground conditions, additional post-injection tubes or anchor sleeves can be used to enhance the load-bearing capacity within the bonded zone. Depending on the intended service life, both temporary and permanent pre-drilled ground anchor systems are available.
A specialized type of grouted anchor is the removable anchor, which incorporates a detachable connection either at the transition between the free and bonded sections or at the end of the bonded length. These anchors use compression bodies to achieve anchorage.
Removable anchors are primarily used in temporary or semi-permanent applications, particularly in urban environments, where permanent anchors left in the ground could obstruct future development on adjacent properties or render construction impractical.

Charakteristics

— **Location and method of installation**
Soil and rock anchors, grouted on-site.

— **Installation method**
The load-bearing element is placed into a pre-drilled, cased borehole, which is then filled with cement grout.

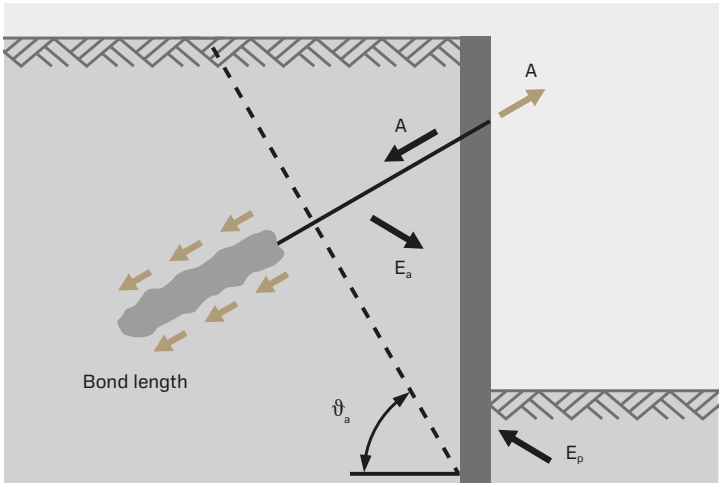
— **Force transmission in the anchor**
The load is transferred directly from the anchor head to the structure. The pre-tensioning of the anchor helps to anticipate and minimize deformations.

— **Load transfer to the ground**
In the bonded zone, the load is transferred from the anchor to the surrounding soil or rock through bond friction. To enhance load transfer capacity, single or multiple post-grouting injections can be applied. For this purpose, post-grouting tubes are attached to the steel tendon.

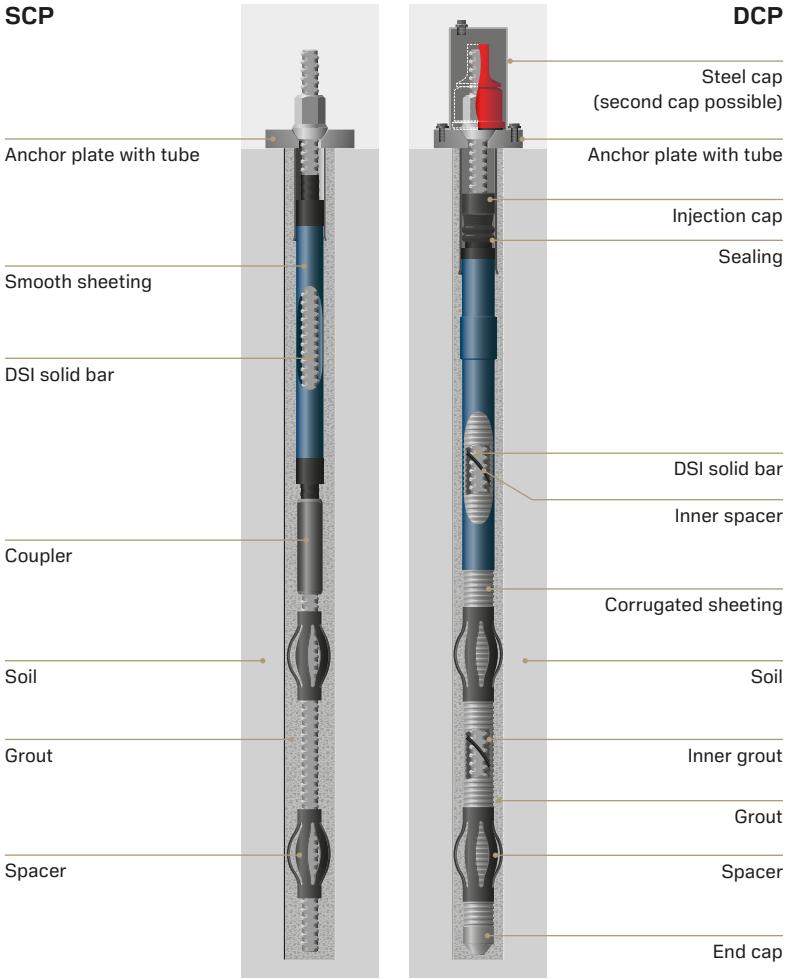
— **Recommended corrosion protection systems**
- Temporary application: encapsulation
- Permanent application: double corrosion protection

Since prestressing steel must not corrode, the sacrificial corrosion rate (abrostrate) is only applicable when using reinforcing steel as the load-bearing element.

Tie back system



A = Axial force
ϑ_a = Angle of friction
E_a = Active earth pressure
E_p = Passive earth pressure



Correlation of torque moment and axial force

DSI solid bar torque moment DMS			Tension force ±20 %						
Small	**Medium**	**Large**	**12 mm**	**16 mm**	**20 mm**	**25 mm**	**28 mm**	**32 mm**	**40 mm**
0.15 kNm	—	—	12 kN	25 kN	—	—	—	—	—
0.20 kNm	—	—	17 kN	31 kN	31 kN	—	—	—	—
0.25 kNm	—	—	19 kN	44 kN	35 kN	—	—	—	—
0.30 kNm	—	—	21 kN	53 kN	43 kN	—	—	—	—
0.35 kNm	—	—	—	60 kN	50 kN	—	—	—	—
0.40 kNm	0.40 kNm	—	—	66 kN	58 kN	38 kN	36 kN	31 kN	33 kN
0.45 kNm	0.45 kNm	—	—	73 kN	68 kN	42 kN	42 kN	38 kN	36 kN
—	0.50 kNm	—	—	77 kN	75 kN	47 kN	46 kN	43 kN	39 kN
—	0.60 kNm	—	—	—	86 kN	56 kN	55 kN	50 kN	46 kN
—	0.70 kNm	—	—	—	104 kN	65 kN	65 kN	60 kN	53 kN
—	0.80 kNm	0.80 kNm	—	—	114 kN	76 kN	75 kN	68 kN	61 kN
—	0.90 kNm	0.90 kNm	—	—	—	85 kN	86 kN	75 kN	67 kN
—	1.00 kNm	1.00 kNm	—	—	—	98 kN	101 kN	87 kN	77 kN
—	—	1.20 kNm	—	—	—	117 kN	124 kN	104 kN	92 kN
—	—	1.40 kNm	—	—	—	176 kN	146 kN	120 kN	107 kN
—	—	1.60 kNm	—	—	—	—	172 kN	137 kN	124 kN
—	—	1.80 kNm	—	—	—	—	—	152 kN	137 kN
—	—	2.00 kNm	—	—	—	—	—	166 kN	153 kN



Anchor head constructions

The anchor head construction must be designed to minimize bending stresses in the reinforcement bar. Therefore, a plate with a conical shape and a spherical collar nut is generally used. This design allows for minor angular deviations of up to approximately 3°. For larger, planned angular deviations between the anchor plate bearing and the anchor, an angle compensation system must be incorporated. This can be achieved through either a steel construction or conical UHPFRC (Ultra-High Performance Fiber-Reinforced Concrete) anchor plates.
Key design considerations for the anchor head:

— Intended service life
— Planned angular deviation
— (Permanent) force measurement
— Re-tensioning capability
— Load reduction capability

Temporary application
— Intended service life: ≤ 2 years
— Steel or plastic protective cap for mechanical protection

Permanent application
— Intended service life: ≤ 100 years
— Steel cap filled with corrosion protection compound
— Plastic protective cap filled with corrosion protection compound
— Alternatively, the head can be wrapped with a corrosion protection bandage
— If necessary, a second steel cover can be added for additional mechanical protection of the corrosion protection cap

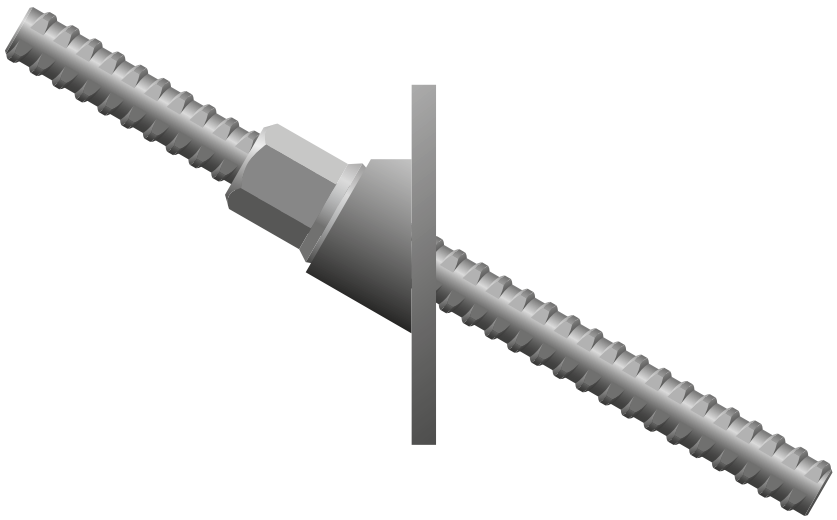
References











Marine ties

Basics

Tension anchors and horizontal anchors are only partially considered traditional anchors (as described in the ”grouted anchors” section). They are primarily used for connecting or anchoring sheet pile walls, particularly in harbor construction. In such applications, forces are either transferred between two sheet pile walls (”short-circuited”) or absorbed through passive anchoring systems, such as deadman anchors.
The anchor head and coupling design must be configured to compensate for inaccuracies and ensure that the anchor head construction transmits the load evenly to the anchor beams at the intended angle.
Since tension anchors must typically withstand extremely high loads, large diameters (Ø > 40 mm) are commonly used.

Charakteristics

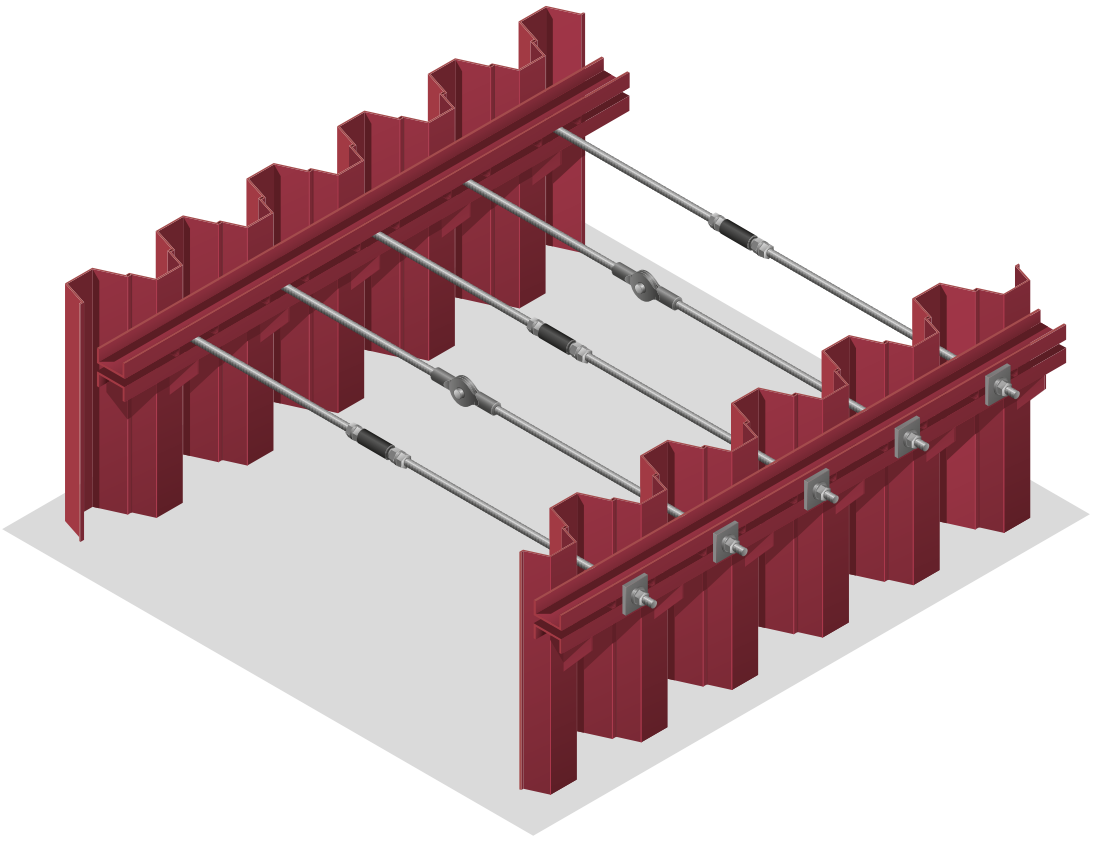
— **Location and method of installation**
Horizontal anchors are installed on-site and either remain ungrouted in the ground or are freely accessible in the open air.

— **Installation method**
The load-bearing element is installed along its entire length with free accessibility and may be backfilled later if necessary.

— **Load transmission to the anchor**
The load is transferred directly from the anchor head to the structure. Pre-tensioning can be applied to anticipate and minimize deformations, but generally, only a low pre-tensioning force is applied to ensure a force-fit connection.

— **Load transmission to the ground**
The load is transferred either via a deadman anchor or directly from one anchor head construction to another.

— **Recommended corrosion protection systems**
- Temporary application: sacrificial corrosion rate
- Permanent application: sacrificial corrosion rate, galvanization, duplex coating, or double corrosion protection

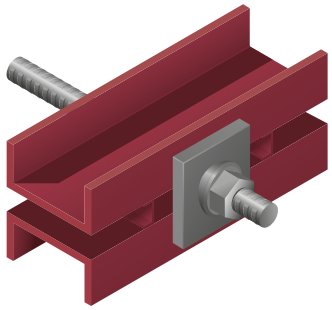


Head constructions

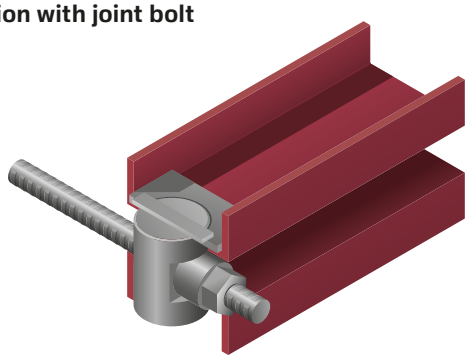
The head construction must be designed to minimize bending stresses in the reinforcement bar. This can be achieved using a plate with a conical shape and a spherical collar nut or by implementing specialized head constructions such as eye fittings or threaded bolts. The corrosion protection must be adapted to the intended service life and may include the following measures:

— Steel or plastic protective cap for mechanical protection
— Steel or plastic protective cap filled with corrosion protection compound
— Steel components galvanized and/or coated

Standard connection: anchor plate and domed nut



Connection with joint bolt



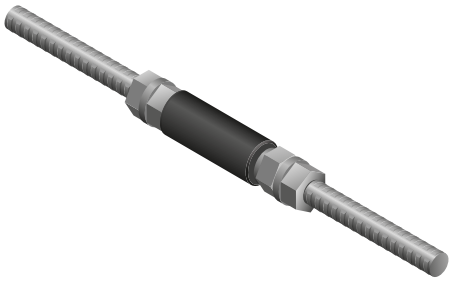
Coupling connections

Horizontal anchors are typically installed in such a way that the rods themselves are not rotatable. As a result, conventional coupler connections are difficult or even impossible to assemble. Additionally, coupler connections must compensate for installation inaccuracies, particularly angular deviations. For this reason, special connection systems are used for tension anchors. These include:

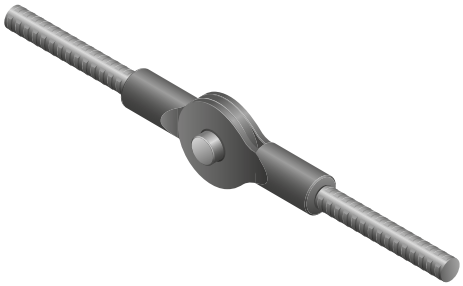
— Bolt connections
— Eye fittings
— Turnbuckles, etc.

Turnbuckles also allow for the application of a low pre-tensioning force through the coupler connection, ensuring a secure and force-fit system.

Coupling connection: angle correction impossible



Eye-piece: angle correction in one direction possible





Transportation, storage, and installation

The installation of geotechnical systems is always tailored to specific applications and construction site conditions.
The following provides an overview of general guidelines and recommendations for the transportation, storage, and installation of our products. Detailed instructions are available upon request.



Transport

When transporting the systems, it is essential to ensure that:

— The rods are not thrown or dropped,
— No damage occurs to the rods or their corrosion protection, particularly coatings and plastic sheathing (DCP – double corrosion protection),
— Factory-installed lifting loops are used for loading and unloading,
— On-site transportation is carried out by hand, on the shoulder, or using carrying straps,
— Sufficient support points are used when lifting with a crane hook,
— The products are protected against corrosion as per project requirements.



Storage

When storing solid bars, the following precautions must be taken:

— Store off the ground and keep free from contaminants.
— Protect from corrosion as per project requirements (e.g., cover or store under shelter for temporary protection).
— Choose support points carefully to prevent damage to corrosion protection (avoid sharp edges) and to minimize deflection due to the system's own weight.



Installation

The installation of geotechnical systems is carried out in pre-drilled boreholes. For DSI Solid Bar Systems, boreholes are typically drilled using casing. Uncased drilling is only possible in very stable or rocky ground conditions.
After the drilling process, the drill string must be removed, and the borehole must be cleaned accordingly before proceeding with the installation.
If the system consists of multiple rod segments, they can be pre-assembled before installation or inserted piece by piece into the borehole, depending on the available space. However, individual segments must be secured to prevent accidental slippage during assembly.

Key considerations during Installation:

— Ensure that corrosion protection remains undamaged.
— Required spacers (spring baskets) must be placed at the specified intervals before installation.
— Coupler joints must be assembled correctly before or during installation, adhering to specifications such as adhesive quantity, tightening torque, and lock nut.
— Temporary protective transport measures must be removed.
— Grouting tubes must be installed and secured properly.
— Grouting must be performed from the lowest point of the borehole upwards.
— Grouting parameters (quantity, pressure, etc.) must be documented.
— If necessary, post-grouting should be carried out after the appropriate curing time.
— The anchor head construction must be completed according to the specified requirements.
— Corrosion protection must be fully maintained.
— Quality assurance must be traceably documented throughout the entire transport, storage, and installation process.





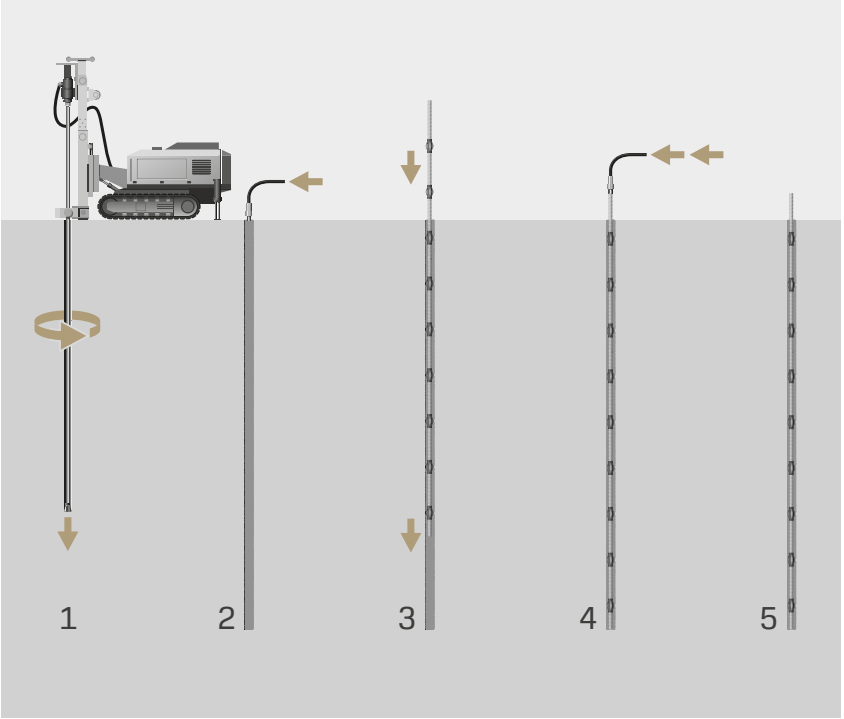






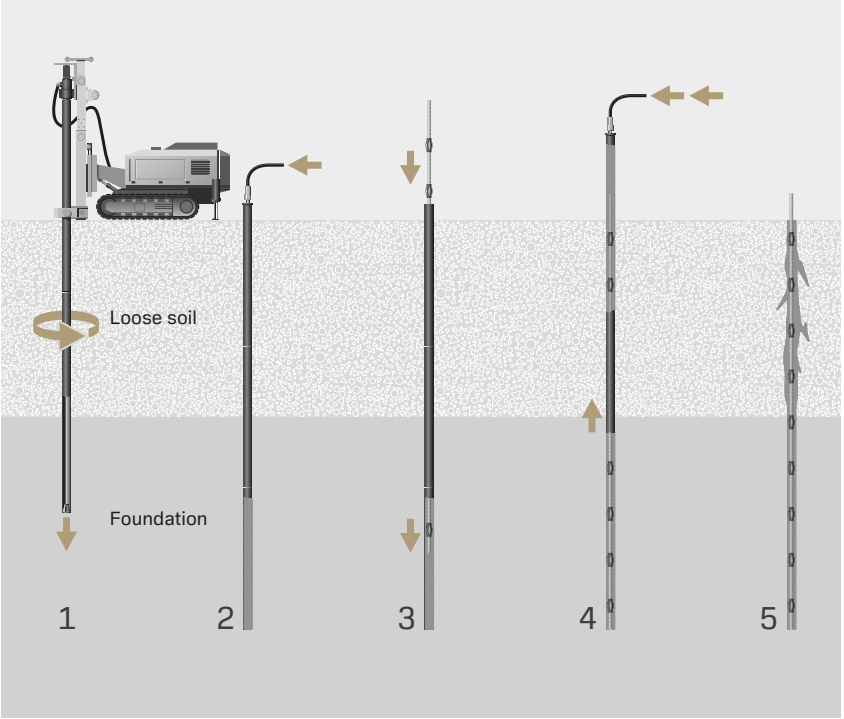
Stable ground conditions (stable boreholes)

1. Drilling of a cased or uncased borehole
2. Partial or full grouting of the borehole with cement mortar
3. Installation of the DSI Solid Bar System as a single load-bearing element or in segments with coupler connections
4. Complete grouting of the borehole
5. Post-grouting if necessary



Unstable ground conditions (unstable boreholes)

1. Drilling of a cased borehole
2. Partial grouting of ⅓ of the borehole
3. Installation of the DSI Solid Bar System as a single load-bearing element or in segments with coupler connections
4. Simultaneous withdrawal of the casing and grouting of the borehole
5. Single or multiple post-grouting (for cohesive soils)




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Injection technics

DSI MAI® mixing pump

Introduction
DSI MAI® mortar mixing pumps are designed for extremely demanding conditions and are successfully used worldwide in tunneling, mining, and geotechnical applications. They play a critical role in securing slopes, embankments, and excavation pits.
The DSI MAI® 400 NT is the most widely used mortar mixing pump in civil and foundation engineering. Additional types of mortar mixing pumps are available, as listed in the table below and can be provided upon request.

Key advantages
— Robust construction with easy handling
— Lightweight design for improved mobility
— Simple operation and maintenance due to its modular structure
— Short start-up and cleaning time
— High delivery rate with consistent pressure
— Adjustable pumping performance
— Versatile, multi-purpose equipment
— Maximum process reliability
— Eco-friendly design with stainless steel components, galvanized frames, and abrasion-resistant plastic parts
— Easy cleaning
— Reverse operation mode for enhanced functionality

Area of application








Sector	Material	Application	DSI MAI® 440 GE	DSI MAI® 400 NT	DSI MAI® 400 EASY	DSI MAI® 400 HD	DSI MAI® 400 EX	DSI MAI® PICTOR
Tunneling, dams, shafts	Cement, anchor grout, premixed mortar	Soil and stone	XXX	XXX	X	XXX	—	—
		Void filling	XXX	XXX	X	XXX	—	—
		Hollow bars	XXX	XXX	X	XXX	—	—
Mining	Cement, anchor grout, premixed mortar	Hollow bars	—	—	—	XXX	XXX	—
		Spraying	—	—	—	—	XXX	—
Geotechnics	Cement, geothermal mortar, grout	Geothermics	XXX	XXX	X	XXX	—	—
		Cased drilling	XXX	XXX	XX	XXX	—	—
		Void filling	XXX	XX	X	XX	—	—
Building construction	Cement, premixed mortar, grout, plastering	Void filling	XXX	—	—	—	—	XX
		Precasted elements	XXX	—	—	—	—	XXX
Restoration	Cement, premixed mortar, fire precautions, plastering	Spraying	XXX	—	—	—	—	XXX
		Underfilling	—	—	—	—	—	XXX
		Sealing	—	—	—	—	—	XXX
		Repair mortar	XXX	—	—	—	—	X
		Protective and final layer	—	—	—	—	—	XXX

—: not suited, X: limited suited XX: suited, XXX: perfectly suited

System parts DSI MAI® 400 NT
— Pumping unit
— Mixing unit
— Drive system
— Protective grid with bag opener



Accessories
— Tools
— Water pump
— Automatic polarity control
— Cleaning device
— DSI MAI® 440 GE
  - Compressor
  - Spray and filling guns
  - Cover hood for silo feeding
  - Dosing pump
— Pressure sensors for grouting
— Pressure-flow recorder DSI MAI® LOG for data logging

Technical data

Parameter/type	DSI MAI® 400 EASY PLUS	DSI MAI® 400 NT	DSI MAI® 440 GE
Nominal power	4.0 kW	6.2 kW	10.0 kW
	5.4 hp	8.3 hp	13.4 hp
Gear	290 rpm	200 rpm	200 rpm
Pump capacity	16 l/min	8-34 l/min	5-54 l/min
	4.2 gal/min	2.1-9.0 gal/min	1.3-14.3 gal/min
Working pressure	25 bar	40 bar	40 bar
	360 psi	580 psi	580 psi
Length	1,616 mm	1,755 mm	2,010 mm
	63.5 in	69.1 in	79.1 in
Width	580 mm	570 mm	750 mm
	23 in	22 in	30 in
Height	900 mm	960 mm	1,030 mm
	35 in	38 in	41 in
Filling height	900 mm	960 mm	1,030 mm
	35.4 in	38 in	41 in
Total weight	136 kg	230 kg	360 kg
	300 lb	507 lb	794 lb

DSI MAI® LOG pressure-flow recorder



Introduction
The revolutionary DSI MAI® LOG pressure-flow recorder enables precise and traceable documentation of ground improvement processes while ensuring compliance with predefined injection stop criteria.
This measurement device is specifically designed for demanding construction site conditions and provides accurate injection monitoring in mining, tunneling, and specialized deep foundation projects.
Both the flow rate and injection pressure are measured using separate sensor modules, and the user-friendly interface allows seamless integration with DSI MAI® mortar mixing pumps for easy operation.

System description
The flow rate and grouting pressure are individually recorded for each borehole. The tamper-proof data logging is controlled via a user-friendly touchscreen terminal for easy operation.
The intuitive interface and integrated software allow the seamless export of work data into a spreadsheet program, offering a major advantage for construction sites. Real-time data display ensures immediate access to critical information.
With the DSI MAI® LOG data import software, all recorded data can be easily transferred to a laptop or PC and imported into a spreadsheet program.
The data is then presented in a comprehensive summary with graphs and tables for analysis.

Key advantages
— Robust design and easy handling
— Real-time recording of pressure, flow rate, and volume
— Automated analysis of work data
— Data transfer via CompactFlash card or USB
— Software for seamless integration into spreadsheet programs
— Mountable on a tripod for optimized handling on construction sites
— Automatic shutoff when a predefined pressure or volume is reached or exceeded
— Pump control compatibility with DSI MAI® 400 GE and 400 NT
— Users can independently adjust settings based on the injection material used
— Configurable measurement units:
  - Pressure: 6/40 bar (90/580 psi)
  - Flow rate: 4/12 m^3/h (140/425 ft^3/h)

Equipment



Hydraulic hollow-piston jacks are used for tensioning DSI Solid Bar Systems. Two different options are available:

— Metallic version made of steel or aluminum
— Carbon fiber-reinforced plastic (CFRP) version

Advantages of each version
The metallic version is highly robust and can withstand potential operational errors, such as eccentric loading or accidental drops, with less risk of damage compared to CFRP models.
However, due to their significantly lower weight, CFRP jacks are now the preferred choice for most applications. They provide a weight reduction of 60 % or more, making them easier to handle and transport on-site.

Portable hollow-piston cylinders in lightweight CFRP design

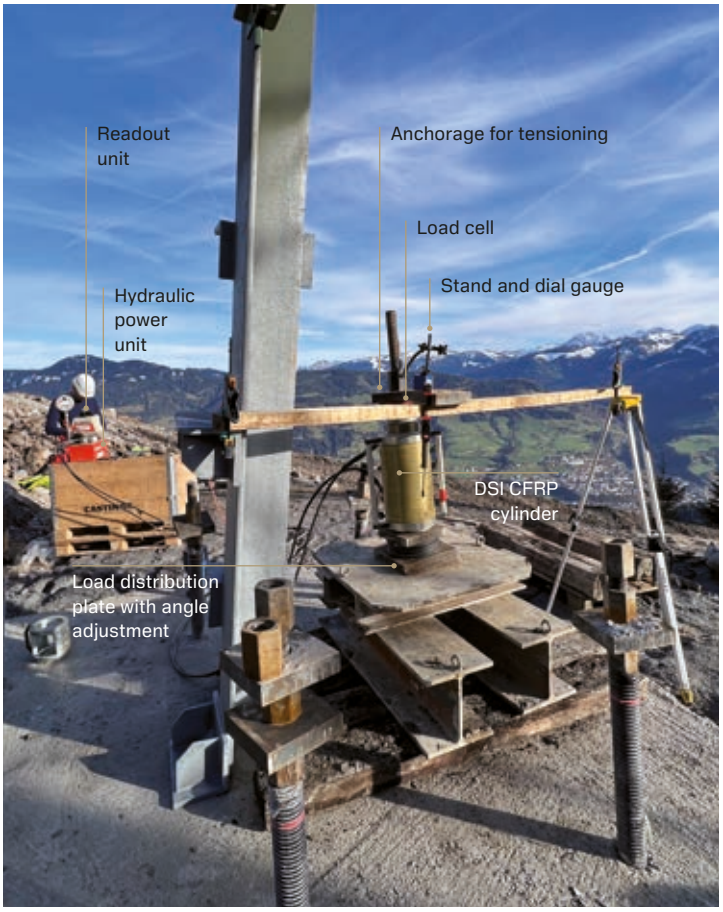
Lightweight CFRP (carbon fiber-reinforced plastic) hollow-piston cylinders ensure easy, fast, and efficient positioning and handling. In most cases, lifting equipment is not required for transport and installation. These cylinders are primarily used in bridge construction, prestressed concrete applications, and foundation engineering.
The standard range of these cylinders offers compression forces from 80 t to 500 t. In geotechnical applications, CFRP lightweight cylinders provide a significant advantage. A commonly used model for these applications weighs only 25 kg but delivers an impressive performance capacity of 120 t.
Additionally, external pressing cylinders and tensioning devices can be attached to CFRP hollow-piston cylinders for tensioning and testing bar and strand anchors with minimal effort.

Key advantages
— Easy to operate and universally applicable
— Significantly reduces physical strain on personnel
— Hydraulic retraction for fast cylinder reset
— Overload protection and pressure relief valve to prevent damage from overpressure
— High-quality scraper rings on the piston rod to prevent dirt and debris intrusion
— Impact protection with aramid fiber reinforcement
— Corrosion-resistant due to high-quality materials and advanced coatings
— Operating pressure: 700 bar
— Available in standard and custom sizes

Accessories

To ensure the best performance and versatility of CFRP hollow-piston cylinders, we offer a wide range of accessories. These components have been developed in collaboration with our specialists, ensuring practical and user-friendly solutions designed by professionals, for professionals. Available accessories include:

Accessory	Description
Tensioning bushings	For tensioning and testing strand anchors
Centering adapters	For tensioning bar anchors and testing all bar systems
Tensioning chairs	Available with or without a screw chair
Hand pump	Hydraulic hand pump for manually tensioning the cylinder
Hydraulic power units	Electric hydraulic pumps for efficient tensioning of the cylinder
Hydraulic wedge-locking device	For pre-locking strand systems hydraulically, reducing slippage
Load cells	For analog or digital force measurement
Stand and dial gauge mounting system	For fixing dial gauges to measure deformations



DSI CFRP hollow-piston cylinders (compressive force: 80 to 500 t, working pressure: 700 bar)

Type	Maximum force	Cylinder lift	Outlet	Weight	Dimensions (Ø and height)	Piston area
80 t	897 kN	100 mm	90 mm	17 kg	190 x 280 mm	115.4 cm²
100 t	1,018 kN	150 mm	90 mm	24 kg	212 x 328 mm	144.1 cm²
125 t	1,264 kN	180 mm	90 mm	29 kg	224 x 362 mm	180.6 cm²
140 t	1,438 kN	250 mm	105 mm	40 kg	251 x 448 mm	200.9 cm²
180 t	1,829 kN	250 mm	110 mm	52 kg	276 x 441 mm	261.3 cm²
200 t	2,006 kN	250 mm	130 mm	68 kg	312 x 463 mm	286.6 cm²
250 t	2,511 kN	250 mm	130 mm	83 kg	334 x 490 mm	358.7 cm²
320 t	3,208 kN	300 mm	150 mm	120 kg	387 x 548 mm	458.0 cm²
360 t	3,609 kN	250 mm	150 mm	102 kg	376 x 481 mm	515.7 cm²
420 t	4,219 kN	250 mm	110 mm	113 kg	380 x 506 mm	602.7 cm²
480 t	4,821 kN	150 mm	140 mm	117 kg	563 x 412 mm	688.8 cm²
500 t	5,000 kN	360 mm	180 mm	217 kg	456 x 653 mm	724.3 cm²

Measurement and testing equipment

Load cell

Load cells are used for short-term and permanent monitoring of anchor forces. They are typically installed beneath the anchor nut, positioned between two plates, and connected to an analog or digital reading device.
For hard-to-reach locations, wireless solutions are available, allowing for remote load monitoring without the need for direct access.

Key features
— Load capacity ranging from 800 kN to 10,000 kN nominal force
— Nominal force corresponds to continuous load capacity
— Short-term overload capacity of +30%
— Elastic stainless steel construction for durability
— Suitable for harsh environments, including acidic or chloride-rich conditions such as road tunnels and bridge undersides
— Protection rating: IP68 (dustproof and waterproof)
— Integrated temperature sensor for precise monitoring
— Built-in signal amplifier for enhanced data accuracy
— Insensitive to long cable lengths and electrical interference
— Measurement signal output in both V and mV/V
— Automatic identification of the load cell via integrated memory, storing location, cell number, installation date, etc.
— Durable, UV-resistant, acid-resistant, and oil-resistant signal cables
— Waterproof Lemo connector for long-lasting performance
— Optional surge protection for added reliability
— Customizable cable length between the load cell and the reading device

This high-precision measurement system ensures reliable monitoring of anchor forces, improving safety and performance tracking in critical geotechnical and structural applications.





Portable reading device for all load cells with mobile app compatibility

A highly popular solution for reading load data from load cells is a portable reading adapter with smartphone connectivity. Using a dedicated mobile app, users can retrieve, view, and store measurement data conveniently.

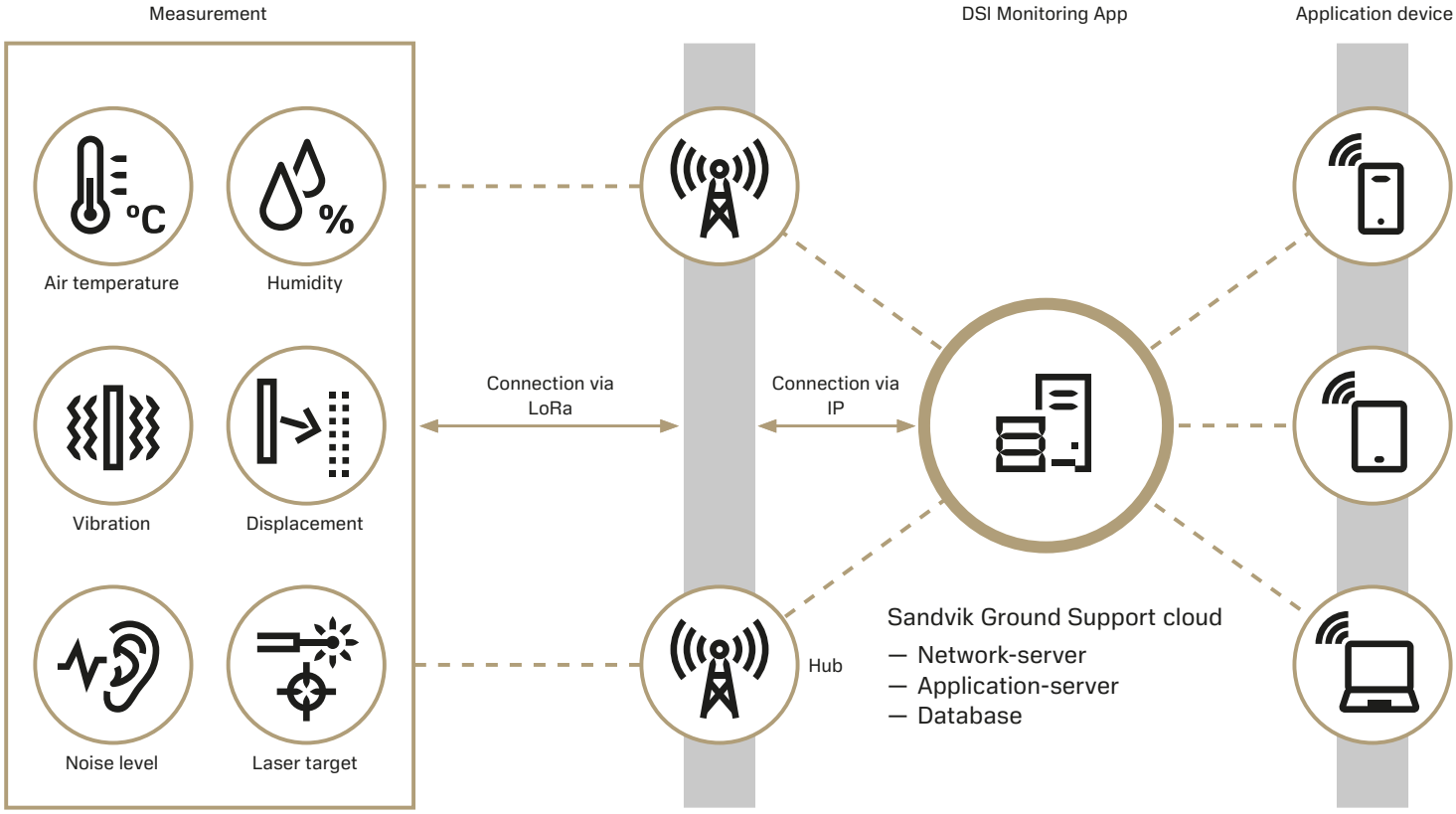
Key features

— Displays real-time load force and temperature of the load cell
— Shows the serial number of the load cell
— Displays user-entered details such as device ID, construction site location, etc.
— Force resolution: 1 kN
— Temperature resolution: 0.5 °C
— Operating temperature range: -25 °C to 50 °C
— Powered by smartphone battery (no additional power source required)
— Lightweight: < 2 kg
— High-impact plastic housing, designed for extreme conditions:
  - Airtight
  - Shockproof
  - Break-resistant
  - Waterproof (IP67-rated)
  - Sand and dustproof
  - Acid-resistant
  - Pressure-resistant
— Graphical display of measurement data
— Storage of measurement values for future reference
— Export of measurement data as a CSV file for easy reporting and analysis

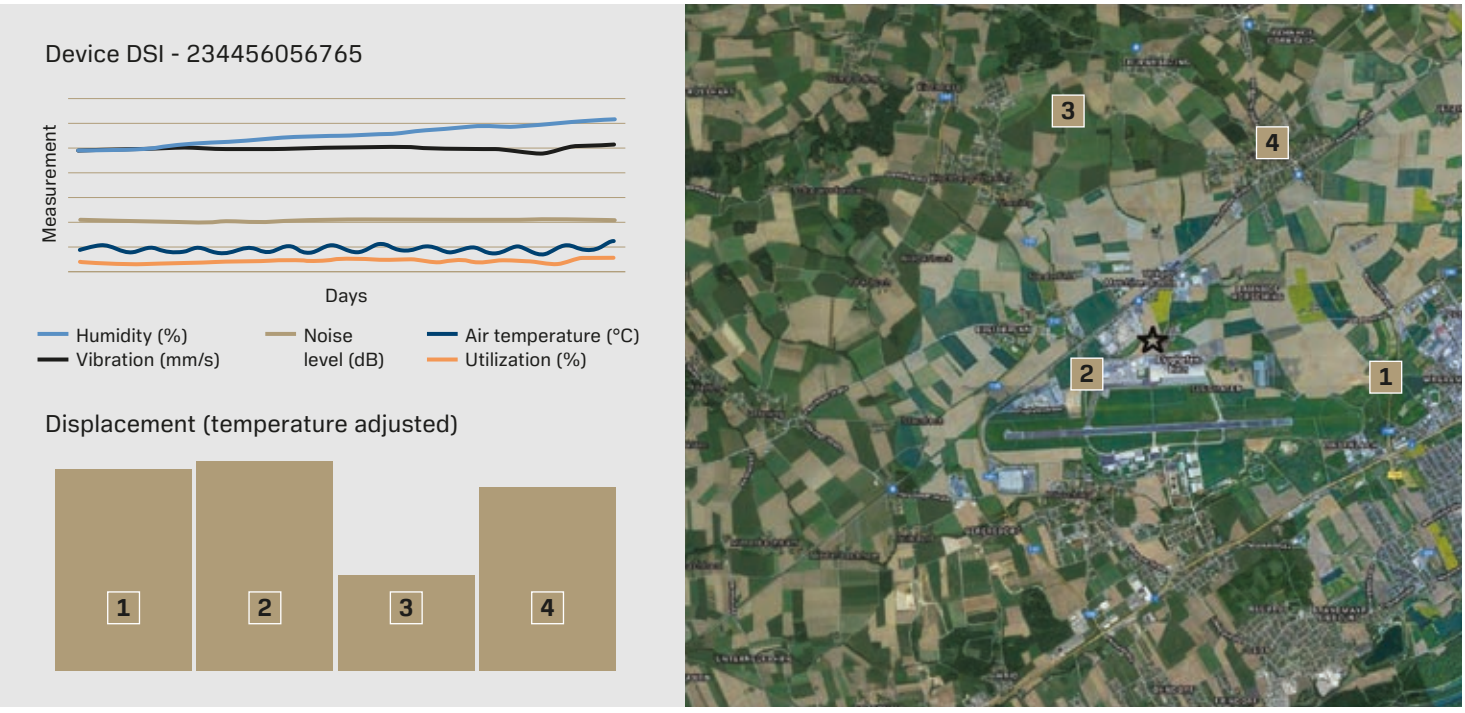
This rugged and compact solution ensures efficient, real-time monitoring of anchor forces, offering a convenient and portable method for accurate data tracking on construction sites.



DSI monitoring applications (data transmission)



Geotagged visualization



Further references

Norm	Description
DIN 8061: 2016	Unplasticized polyvinyl chloride (PVC-U) pipes – General quality requirements, testing
DIN 8062: 2009	Unplasticized polyvinyl chloride (PVC-U) pipes – Dimensions
DIN 8074: 2011	Polyethylene (PE) – Pipes PE 80, PE 100 – Dimensions
DIN 8075: 2018	Polyethylene (PE) – Pipes PE 80, PE 100 – General quality requirements, testing
EAD 160004-00-0301: 2016	European Assessment Document for post-tensioning kits for prestressing of structures
ETAG 013:2002	Guideline for European Technical Approval of post tensioning kits for prestressing of structures
ISO 15835-1: 2018	Steels for the requirement of concrete – Reinforcement couplers for mechanical splices of bars – Part 1: Requirements
ISO 15835-2: 2018	Steels for the requirement of concrete – Reinforcement couplers for mechanical splices of bars – Part 2: Test methods
ÖNORM B 1997-1-1: 2021	Eurocode 7: Geotechnical design – Part 1: General rules – National specifications concerning ÖNORM EN 1997-1 and national supplements
ÖNORM B 1997-1-3: 2015	Eurocode 7: Geotechnical design – Part 1-3: Pile foundations
ÖNORM B 4456: 2021	Geotechnic – Durability of anchorages
ÖNORM B 4707: 2017	Steel for the reinforcement of concrete – Requirements, classification and testing
ÖNORM B 4758: 2014	Prestressing steel – Requirements, classification and conformity assessment
ÖNORM EN 10025-2: 2019	Hot rolled products of structural steels Part 2: Technical delivery conditions for non-alloy structural steels
ÖNORM EN 10083-3: 2006	Steels for quenching and tempering – Part 3: Technical delivery conditions for alloy steels
ÖNORM EN 10216-1:2014	Seamless steel tubes for pressure purposes – Technical delivery conditions – Part 1: Non-alloy steel tubes with specified room temperature properties
ÖNORM EN 10217-1:2019	Welded steel tubes for pressure purposes – Technical delivery conditions Part 1: Electric welded and submerged arc welded non-alloy steel tubes with specified room temperature properties
ÖNORM EN 12501-1: 2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil Part 1: General
ÖNORM EN 12501-2: 2003	Protection of metallic materials against corrosion – Corrosion likelihood in soil Part 2: Low alloyed and non alloyed ferrous materials
ÖNORM EN 14199: 2016	Execution of special geotechnical works – Micropiles
ÖNORM EN 14490: 2010	Execution of special geotechnical works – Soil nailing

Norm	Description
ÖNORM EN 1537: 2015	Execution of special geotechnical works – Ground anchors
ÖNORM EN 1990: 2020	Eurocode – Basis of structural and geotechnical design
ÖNORM EN 1992-1-1: 2018	Eurocode 2: Design of concrete structures Part 1-1: General rules and rules for buildings
ÖNORM EN 1997-1:2014	Eurocode 7: Geotechnical design Part 1: General rules
ÖNORM EN 206:2017	Concrete – Specification, performance, production, and conformity
ÖNORM EN 445:2008	Grout for prestressing tendons – Test methods
ÖNORM EN 446:2008	Grout for prestressing tendons – Grouting procedures
ÖNORM EN 447:2017	Grout for prestressing tendons – Basic requirements
ÖNORM EN ISO 1461: 2022	Hot dip galvanized coatings on fabricated iron and steel articles – Specifications and test methods
ÖNORM EN ISO 17855-1: 2015	Plastics – Polyethylene (PE) moulding and extrusion materials Part 1: Designation system and basis for specifications
ÖNORM EN ISO 22477-1: 2019	Geotechnical investigation and testing – Testing of geotechnical structures Part 1: Testing of piles: static compression load testing
ÖNORM EN ISO 22477-2: 2022	Geotechnical investigation and testing – Testing of geotechnical structures Part 2: Testing of piles: static tension load testing
ÖNORM EN ISO 22477-5: 2019	Geotechnical investigation and testing – Testing of geotechnical structures Part 5: Testing of grouted anchors
ÖNORM EN ISO 683-1:2018	Heat-treatable steels, alloy steels and free-cutting steels Part 1: Non-alloy steels for quenching and tempering
ÖNORM EN ISO 9001: 2015	Quality management systems – Requirements
RVS 08.22.01: 2013	Grouted anchors, nails and grouted piles subjected to tension (GPT)
ÖNORM EN 13438	Paints and varnishes – Powder organic coatings for hot dip galvanised or sherardised steel products for construction purposes
ÖNORM EN 15773	Industrial application of powder organic coatings to hot dip galvanized or sherardized steel articles (duplex systems) — Specifications, recommendations and guidelines
ASTM A153	Standard specification for zinc coating (hot dip) on Iron and steel hardware
ASTM A775	Standard specification for epoxy-coated steel reinforcing bars

All dimensions, weights, quantities, and specifications are those applicable at the time of this publication and may be amended from time to time. Please contact your local representative for final confirmation of any key specifications.

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