DYWIDAG

Tunnelling product range

dywidag.com

Engineered underground: DYWIDAG Tunnelling support solutions

Our operational model of Local Presence, Global Competence, extends to our range of products and services to the tunnelling sector. With over 150 years in the surface and underground construction sector, our customers benefit from a wealth of expertise and experience across the DYWIDAG Group.

We understand that each tunnel has different geological conditions and engineering requirements. We therefore offer targeted solutions and provide the right active and passive ground support methods for each tunnel project, including both new construction and rehabilitation of existing tunnel structures.

We have recently introduced our range of monitoring solutions, supported by our cloud-based platform, which collects sensor data and presents it to our customers in a clear and logical manner. Your project is covered by real time insights, increasing the protection of your asset and providing you with important information, to allow informed decisions of safety, construction progress and ground behaviour.

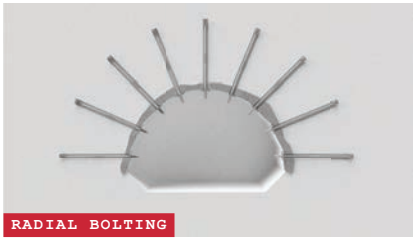
We help translate complex underground challenges into practical engineering solutions. As infrastructure demands increase, DYWIDAG continues to develop reliable systems that enhance the safety and efficiency of underground construction.

Our support to the tunnelling sector includes:

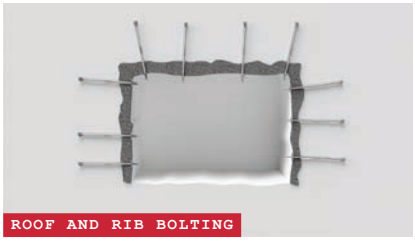
- Ground support systems.
- Monitoring and data management.
- Technical consultation and engineering support.

Fields of Application

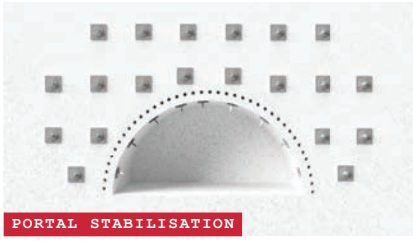
FOREPOLING AND FACE BOLTING



RADIAL BOLTING

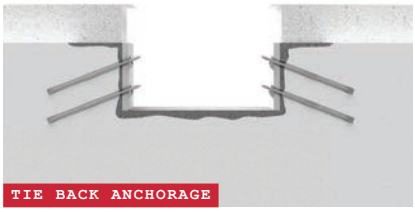


ROOF AND RIB BOLTING



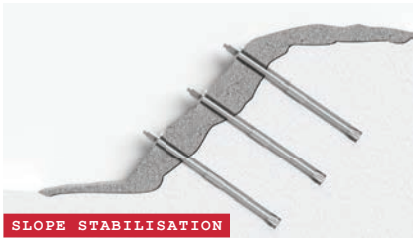
PORTAL STABILISATION

FOOTWALL STABILISATION



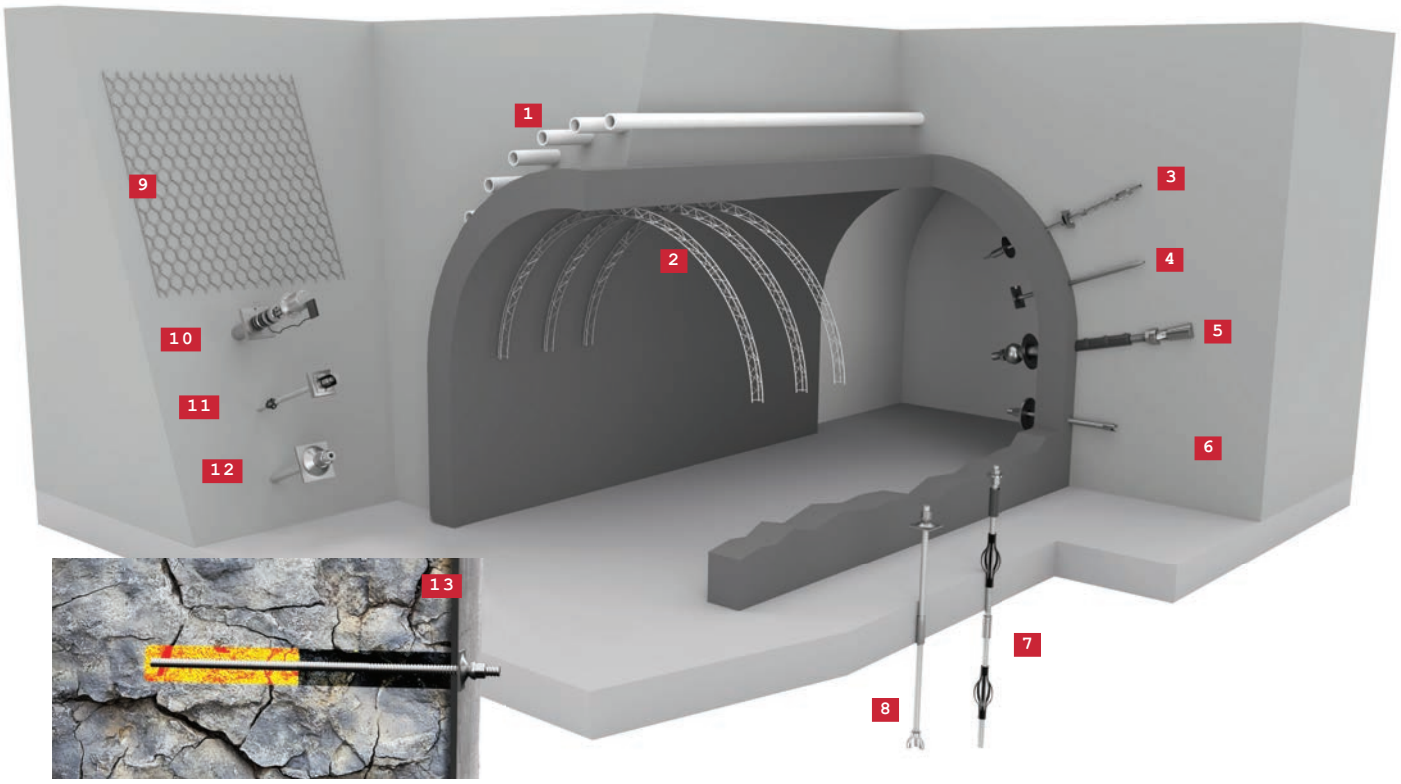
TIE BACK ANCHORAGE

UPLIFT CONTROL



SLOPE STABILISATION

Tunnelling Solutions



Infrastructure Intelligence

1 DYWIDAG Canopy Tube
2 DYWIDAG Lattice Girder
3 DYWIDAG Cable Bolts
4 DYWIDAG Friction Bolts
5 DYWIDAG Combo Bolts
6 DYWIDAG GFRP Threadbar
7 DYWIDAG Threadbar Anchor
8 DYWIDAG Hollow Bar Micropile
9 DYWIDAG High Tensile Hex Mesh
10 DYWIDAG Smart Anchor
11 DYWIDAG Rock Bolts
12 DYWIDAG Hollow Bar Soil Nails
13 DYWIDAG Resin Cartridges

DYWIDAG Canopy systems

DYWIDAG canopy tubes (also known as umbrella tubes and roof spiles) are widely used as inclined roof pre-support over the crown of the tunnel and tend to be installed in advance of tunnelling. This method ensures stability of the soil or rock formations, thus increasing workplace safety and ensuring continuity of tunnel excavation.

The methodology provides arched and overlapping fans in particularly weak ground. The modular system ensures that the desired length can be achieved quickly and easily. The colour coding applied to each tube makes the sequential installation efficient and reduces the risk of errors on-site.

DYWIDAG offers a wide range of diameters and lengths. The system can be installed using fully mechanised self-drilling technology and conventional face bolting/jumbo drilling rigs, providing flexibility in application methods.

Fields of application

- Tunnel portals.
- Cross passages.
- Water control.
- Ground injection.

Key features

- **Improved excavation efficiency:** Canopy tubes allow for faster and more controlled excavation processes.
- **Cost-effective:** Reduce overall project costs by minimising the need for additional ground treatment.
- **Water control:** Canopy tubes can assist in managing groundwater ingress during excavation.
- **Reduced settlement:** Minimises surface settlement, protecting overlying structures and utilities.
- **Versatility:** Different connection types (standard thread, squeezed, and nipple) available to maximise capacity and limit settlement deformation. Optional higher grade steel pipe available for challenging geotechnical conditions.

DYWIDAG Lattice Girders

DYWIDAG Lattice Girders are a common application support for weak rock formations in combination with sprayed concrete, offering immediate support at the excavation face. They are easy and quick to assemble, requiring simple adjustments to shape to the excavation geometry.

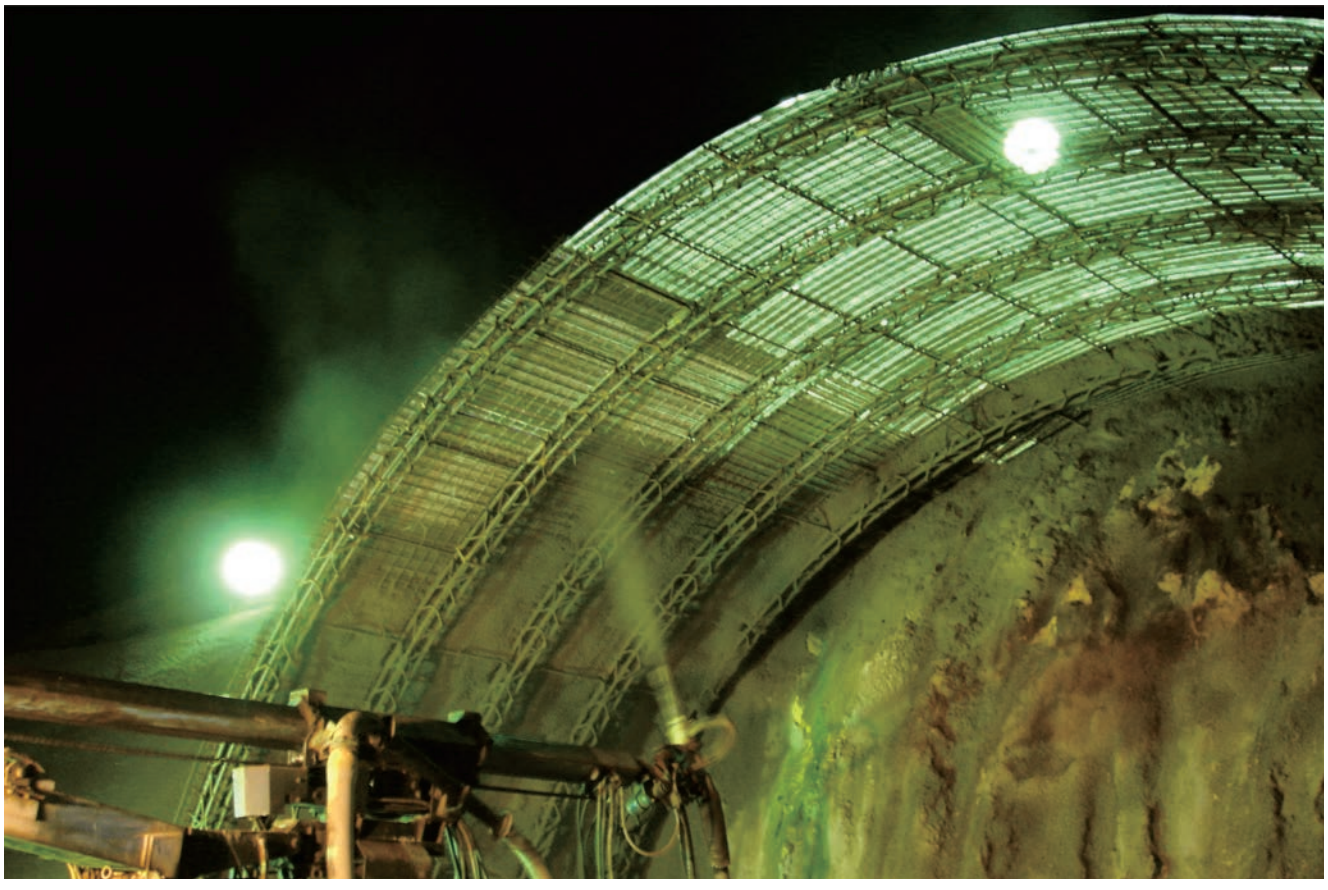
Lattice girders serve as an ideal template for shotcrete application, often prior to a typical final concrete lining e.g. for a traffic tunnel. Lattice Girders ensure optimal bonding and integration with the shotcrete lining, creating a robust and uniform tunnel support system. Additional rock bolting can be undertaken through the lattice girders to provide additional support.

Fields of application

- Initial excavation support
- Combined with sprayed concrete for temporary and permanent support
- Varying tunnel dimensions

Key features

- **Lightweight, strong structure:** Provides quick reinforcement.
- **High-strength steel composition:** Ensures reliable support.
- **Versatility and adaptability:** Customisable dimensions and configurations make them suitable for various ground conditions and tunnel shapes. Can be adjusted on-site to accommodate geological variations.
- Available in 3 or 4 bar design spider or butterfly stiffeners or cages.



THE INN JV HYDROELECTRIC POWER PLANT, AUSTRIA

DYWIDAG Friction bolt

Friction bolts (also known in some regions as split-sets) are simple ground support bolts comprising a split tube tapered at the insertion end to facilitate installation. The bolts are percussively driven into a borehole which is smaller than the manufactured outer diameter of the bolt, thereby immediately creating radial support in the surrounding rock.

The primary advantages of friction bolts lie in their simplicity and effectiveness. Unlike traditional rock bolts requiring time-consuming grouting, these bolts offer immediate support upon installation, making them invaluable in scenarios demanding rapid stabilisation.

They demonstrate flexibility, accommodating ground movement in the dynamic environments typical of mining and tunnelling operations. They've proven particularly effective in softer rock formations and as temporary support during tunnel excavation.

Fields of application

- Temporary/Shorter life support.
- Weak rock conditions.
- Layered formations
- Rehabilitation work.
- Roof and wall support.

Key features

- **Immediate support:** These bolts provide immediate support upon installation, unlike grouted bolts that require curing time.
- **Simple installation:** quickly and easily installed using standard rock bolting equipment.
- **Flexibility:** accommodates some rock movement without failing, making them suitable for dynamic ground conditions.
- **No grout required:** eliminates the need for grout mixing and pumping equipment, simplifying the installation process.

DYWIDAG Combo-bolt

The DYWIDAG Combo-Bolt is a reliable solution to permanently stabilise rock masses during excavation of tunnels and caverns, as well as slope reinforcement. These bolts combine the immediate support of mechanical anchors with the long-term stability of fully grouted systems.

In tunnelling, combo-bolts are particularly useful for stabilising rock masses in areas with varying geological conditions, providing both immediate and long-lasting reinforcement to the excavation walls. The assembly bolting system adopts combination technology, providing immediate mechanical support for unstable rock masses and optimisation of the borehole size.

The prefabricated polyethylene sheathing and grouting bell allow the pressured grout to be pumped from the inner sheathing to the end of the bolt, fully and efficiently grouting the borehole.

Combo-bolts can be installed quickly, allowing for rapid advancement of mining operations whilst ensuring worker safety and minimising the risk of rock falls or cave-ins.

Corrosion Protection options

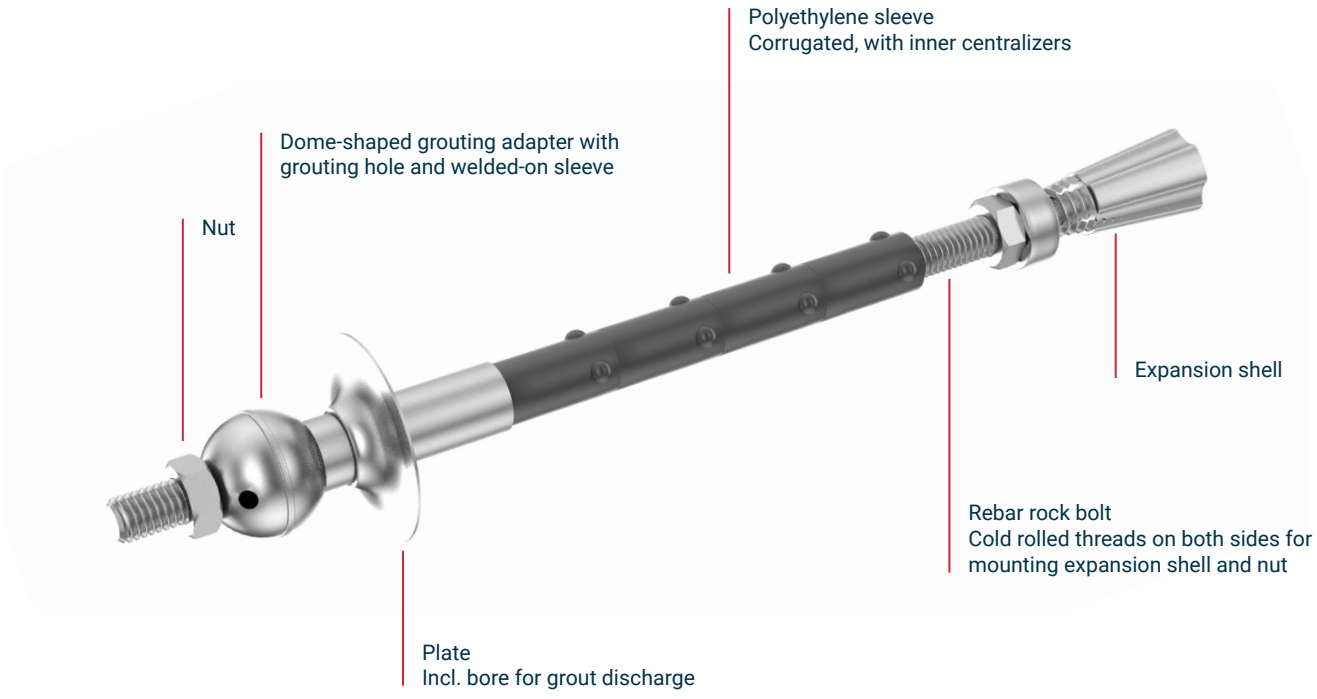
- Plastic sheathing and hot-dip galvanized (HDG) rebar.
- Plastic sheathing and epoxy powder coating of rebar.
- Plastic sheathing, hot-dip galvanizing, zinc phosphating, and epoxy powder coating of rebar.

Fields of application

- Tunnelling.
- Caverns.
- Slope stabilisation

Key features

- **Durable lifetime:** Up to 120 years.
- **Rapid installation:** Increases productivity and allows for faster project progression.
- **High tensile strength and shear resistance:** Provides robust support even in challenging ground conditions, enhancing overall structural stability.
- **Cost-effective:** Offers a single solution where multiple systems might otherwise be needed, potentially reducing overall project costs.
- **Vertical installation:** Favourable system for upward installation and grouting.



DYWIDAG Cable bolts

In underground construction, dealing with rock mass instability is a key challenge, with significant implications for safety, productivity, and structural performance.

Due to their high capacity and long length options, cable bolts are an excellent choice in high stress areas such as intersections and/or large excavations. Their robust design ensures effective reinforcement of fractured and weak rock formations, making them suitable for a wide range of underground applications.

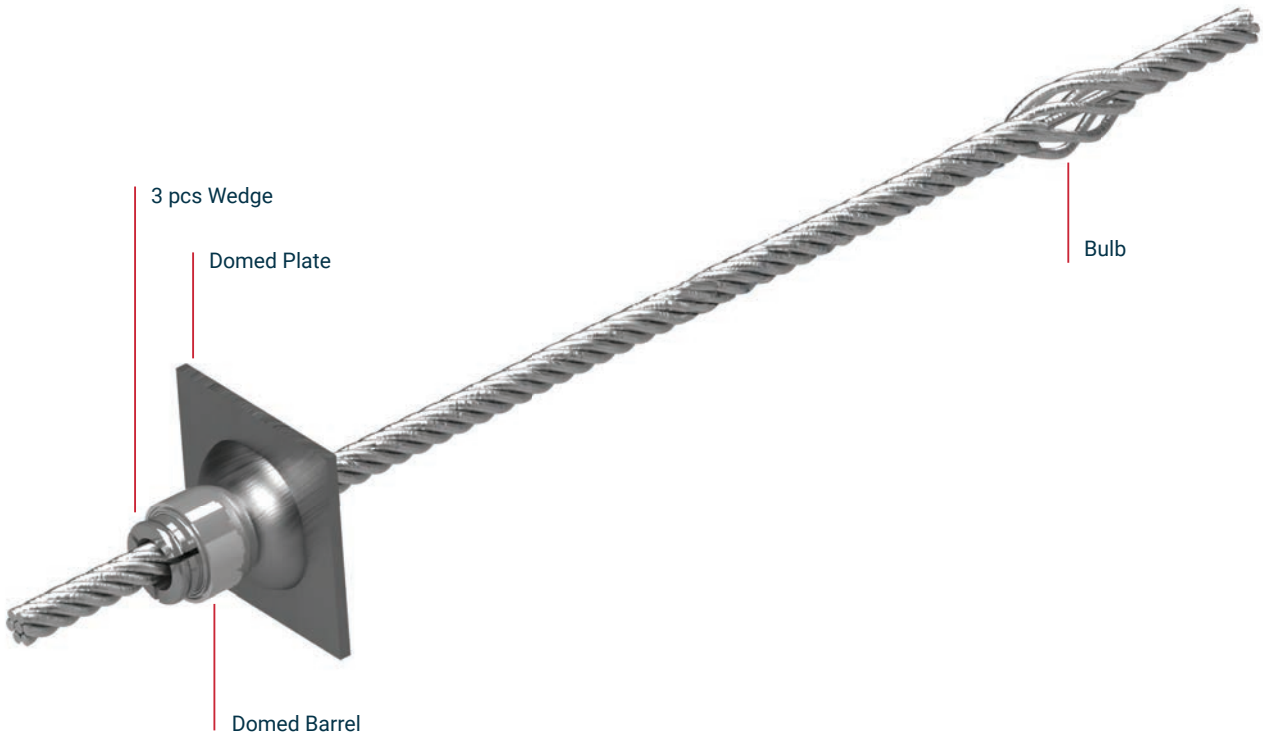
The cable bolts work by transferring loads, preventing rock movement, and reinforcing the walls, roof, and/or floors of underground spaces, as well as surface openings. This approach not only enhances safety but also improves efficiency and ensures the long-term durability of your project.

Fields of application

- Large excavations.
- Cross passages.

Key features

- High load capacity.
- **Long lengths available:** suitable for complex stress environments.
- **Versatility:** Cut lengths or reels mean they are adaptable to confined working spaces.
- **Customisation:** Can be cut to any specific length.
- **Compatibility:** Integrates seamlessly with other support systems like shotcrete and mechanical bolts.
- **Installation flexibility:** Works with 25-55mm hole diameters.



DYWIDAG DYWI® Drill hollow bar system

The DYWIDAG DYWI® Drill hollow bar is a fully threaded self-drilling system designed for loose or collapsing soils, eliminating the need for casing. Its hollow bore design allows simultaneous drilling and grouting, enhancing efficiency in ground support applications. Engineered with a left-hand thread for rotary percussive drilling, it ensures optimal performance and versatility.

Crafted from high-grade steel tubing, the DYWI® Drill hollow bar is cold rolled to form standard rope or "T" thread profiles, ensuring durability in various drilling scenarios. A comprehensive range of accessories, including drill bits, adaptor sleeves, couplers, nuts, and bearing plates, complements the hollow bar system, facilitating seamless integration into diverse project requirements.

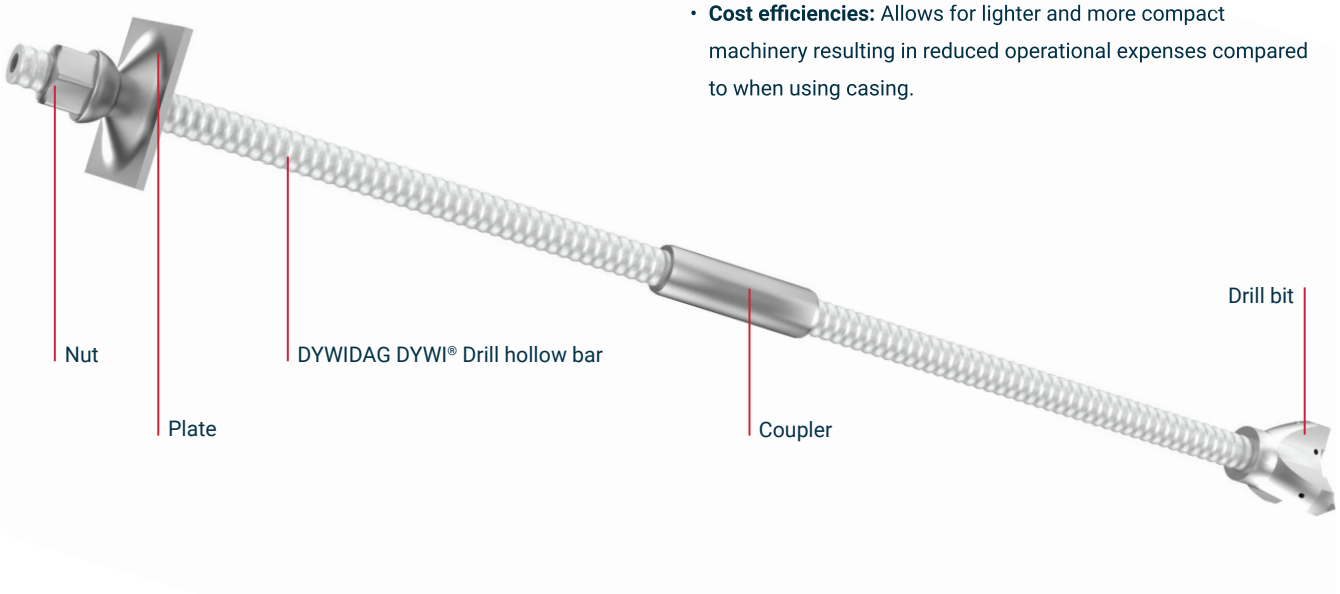
Furthermore, the DYWI® Drill hollow bar system offers a variety of injection adaptors and drill tooling options, ensuring compatibility with a wide range of drilling equipment. With its robust construction and versatile capabilities, the DYWI® Drill hollow bar system is a trusted solution for ground support and reinforcement needs.

Fields of application

- Slope stabilisation.
- Excavation support.
- Tunnels.
- Foundations.
- Mining and quarrying.
- Retaining structures.
- Coastal protection.

Key features

- **Versatility:** Can be used in a wide range of applications, including soil nailing, Micropile construction, ground anchoring, rock bolting, and tunnelling.
- **Compatibility with accessories:** Compatible with a variety of accessories, such as drill bits, adaptor sleeves, couplers, nuts, and bearing plates, allowing for seamless integration into diverse project requirements.
- **Speed and ease of installation:** Designed for rapid and easy installation using standard drilling equipment, reducing labour costs and project timelines.
- **Dual functionality:** The tendon doubles as a drill rod and grouting conduit, simplifying installation and boosting efficiency in ground support applications.
- **Cost efficiencies:** Allows for lighter and more compact machinery resulting in reduced operational expenses compared to when using casing.



DYWIDAG High Tensile Hex Mesh and Low Carbon Hex Mesh

DYWIDAG mesh systems offers durable, easy-to-install solutions for slope stabilisation, providing strong protection against rockfall and soil instability with superior corrosion resistance and design flexibility.

This fully tested, patented, and approved system has high tensile and punching strengths, ensuring robust protection against rockfall and soil instability.

The lightweight design allows for easy installation and is easy to cut. The mesh features Class A ZnAl coatings, offering superior corrosion resistance and longevity.

For projects requiring the utmost in corrosion protection, we also offer stainless steel options, ensuring the system maintains its integrity even in the harshest conditions.

The comprehensive range of mesh systems has been carefully designed to complement DYWIDAG's range of existing slope stabilisation products.

Manufactured in Europe with technical approvals, this competitively priced system offers a dependable and cost-effective choice for your geotechnical needs.

DYWIDAG HTH MESH APPLICATION: RAILWAY EMBANKMENT

Uses

- Rockfall protection.
- Landslide mitigation.
- Slope stabilisation.

Applications

- Embankments & cuttings.
- Marine and Coastal.
- Quarry faces.
- Tunnels.
- Mines.

Key Features

- **High-tensile strength**
  Exceptional resistance to deformation and failure under heavy loads, ensuring lasting stability.
- **Lightweight**
  Easy installation and cutting of panels, saving time and effort on-site.
- **Simplified plate design**
  Cost-effective and designed for seamless compatibility with all DYWIDAG bars.
- **Superior durability**
  Class A ZnAl coatings and optional stainless steel, ensure long-term performance, even in extreme conditions.
- **Cost-effective**
  Competitive pricing combined with straightforward installation and extended durability.

DYWIDAG GEWI® THREADBAR AND HTH MESH

Compatible Products

- DYWI® DRILL hollow bar.
- GEWI® Threadbar.
- Stainless steel threadbar.
- DYWI® DRILL stainless steel hollow bar.
- Combination bar.
- All accessories.

DYWIDAG Threadbar anchor systems

DYWIDAG provides a wide range of ground anchors to cover all anchoring requirements for your tunnel project.

DYWIDAG Threadbar anchors are an active tensioned ground anchor system designed in compliance with the current BS8081 and EN1537 codes and standards.

Ground anchors are categorised as pre-stressed active systems with both bonded and free length section. The free length section serves to prevent the transfer of loads into unsuitable material, ensuring adequate elongation of the tendon for pre-stressing requirements.

In the bonded section, the anchor is securely fixed within the borehole using grout, facilitating the transfer of forces to the load-bearing ground through bond and skin friction.

Conversely, in the free length, the bar is uncoupled from the borehole via smooth sheathing, enabling unrestricted extension for tension application.

The anchor head facilitates force transfer to the substructure, thereby providing structural support. Monitoring of anchor forces can be achieved through the installation of load cells or via real-time monitoring utilising the smart anchor system, a specialised innovation by DYWIDAG.

Fields of application

- Tunnel support and reinforcement.
- Underground mining.

Key features

- **Versatility:** DYWIDAG Threadbar anchors provide versatility through their use of coarse GEWI®, GEWI® Plus and pre-stressed steel, thread along the entire length, enabling seamless on-site length adjustments with suitable accessories and equipment.
- **Active tensioning:** These anchors are actively tensioned, ensuring a reliable and secure connection to the ground or structure they support.
- **Bonded and free length sections:** Incorporates both bonded and free length sections, allowing for precise control over load transfer and elongation requirements.
- **Monitoring capabilities:** Enables the monitoring of anchor forces through load cells or real-time monitoring systems such as the DYWIDAG Smart anchor technology, allowing for proactive maintenance and ensuring long-term stability.
- **Ease of installation:** Threadbar anchors typically offer straightforward installation procedures, reducing construction time and labour costs.

DYWIDAG THREADBAR ANCHOR WITH PARTIALLY REMOVABLE TENDON

DYWIDAG THREADBAR ANCHOR WITH FULLY REMOVABLE TENDON

DYWIDAG THREADBAR ANCHOR SYSTEM

DYWIDAG Resin Cartridges

In tunnelling and underground construction, ensuring the stability of rock formations is critical for safety and operational efficiency. The DYWIDAG resin cartridge is designed to provide rapid, high-strength anchoring for rock bolts and cable bolts, delivering secure and long-lasting ground support in tunnels, roadways, and mining environments.

Each cartridge contains polyester resin and catalyst, housed in a leak-proof casing to prevent contamination and ensure ease of handling. Once inserted into a pre-drilled borehole, the resin is activated by the rotational action of the rock bolt, causing the components to mix and cure rapidly. This process eliminates delays, reduces installation complexity, and provides a consistently strong bond, even in demanding geological conditions.

By reinforcing tunnel walls and ceilings, the DYWIDAG resin cartridge mitigates ground movement, enhances structural integrity, and helps control water ingress—key concerns for engineers working in underground excavation. Its proven performance across diverse rock types and environmental conditions makes it an essential solution for ensuring both worker safety and project longevity.

Fields of application

- Tunnelling
- Underground mining.
- Rock fragmentation support.
- Water seepage management

Key features

- **Rapid Curing at Room Temperature** – Enables quick installation, reducing downtime and increasing efficiency in tunnelling and mining operations.
- **High Bonding Strength** – Ensures a secure and durable connection between the rock bolt and surrounding strata.
- **Reliable Anchoring Force** – Provides consistent reinforcement, even in fractured or unstable ground conditions.
- **Leak-Proof Cartridge Design** – Prevents premature leakage, ensuring controlled resin mixing and optimal performance.
- **Versatile Performance** – Suitable for various rock types and geological conditions, making it ideal for tunnelling, mining, and underground construction. Can be used alongside mesh, shotcrete and other ground support.

COFFS HARBOUR BYPASS, AUSTRALIA

DYWIDAG Glass fibre reinforced bolts

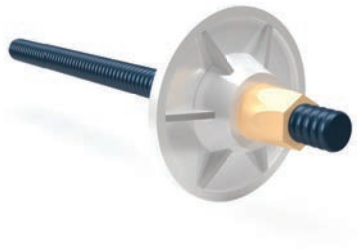
DYWIDAG's range of GFRP bolts comprise composite materials designed for high-performance reinforcement in demanding projects, particularly in tunnelling.

Combining the strength of glass fibres within a polymer resin matrix, our bolts offer a lightweight yet high tensile load bearing alternative to steel.

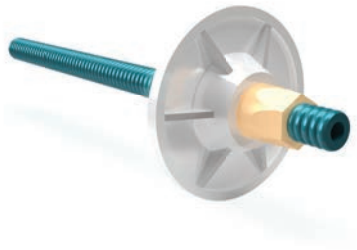
DYWIDAG GFRP is highly resistant to corrosion, with a design life of up to 100 years.

One of the main benefits of GFRP is the ability to cut through GFRP ground support once installed, providing significant advantages when only temporary support is required.

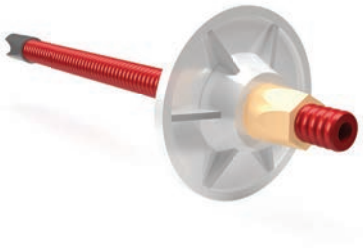
Available in different versions:



CS - Fully threaded solid bars



CH - Fully threaded hollow bars



CR - Fully threaded self-drilling hollow bars with advanced, resistant composite structure

Fields of application

- Tunnelling.
- Slope stabilisation.
- Mechanical excavations – TBM
- Temporary and permanent rock bolting
- Forepoling
- Radial bolting
- Aggressive ground conditions

Key features

- **Easy to cut:** Advantages in temporary applications e.g. soft-eyes & temporary land approvals.
- **Corrosion resistance:** Extends service life in aggressive environments.
- **Lightweight:** Easier handling and installation.
- **High tensile strength:** Comparable to steel, allowing for efficient load transfer.
- **Non-conductive:** Eliminates risk of electrical conductivity in electrified tunnels.
- **Low relaxation:** Maintains tension over time, ensuring long-term stability.
- **Reduced magnetic interference:** Ideal for use near sensitive equipment

EXAMPLE OF GFRP SOFT-EYE FOR TBM EXCAVATION

DYWIDAG Strand anchor systems

DYWIDAG provides a wide range of strand anchors to cover all anchoring requirements for your tunnel project.

Strand anchors, manufactured from flexible steel wire strands, are tailor-made and installed in a single continuous length, adhering to the BS8081 standard. Primarily utilised for anchor lengths surpassing 20 metres or when solid threadbars are impractical due to access limitations, they offer versatile solutions. Supplied in coiled form to the site, these anchors can be unwound directly into boreholes, offering significant advantages, particularly in tunnel or basement projects.

Additionally, strand anchors address situations where anchor capacities exceed available threadbar strength ranges. With each 15.2mm compact strand having an ultimate load of 300kN, multiple strands can be integrated into an anchor. The maximum number of strands used is determined by the installer's available stressing equipment. In conventional strand anchors, all strands originate and terminate at the same point.

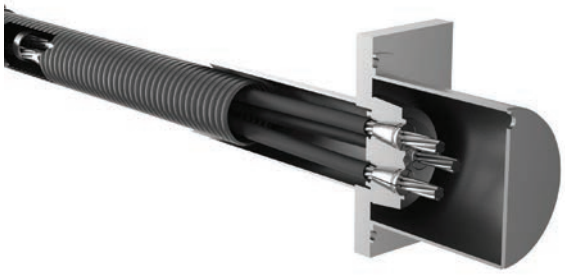
The multi-stage strand anchor addresses the need for higher anchor loads in challenging ground conditions, overcoming limitations posed by conventional ground anchors, which are typically restricted to a maximum fixed length of 10m reference BS8081 and EN1537. It ensures uniform load distribution across the entire bond length, enhancing stability in diverse soil types. This solution employs a progressive anchoring mechanism, adapting dynamically to ground variations and minimising localised stress concentrations.

Fields of application

- Tunnelling.
- Underground mining.

Key features

- **High load capacity.** Strand anchors can support high loads, making them suitable for heavy-duty applications such as bridge construction, retaining walls, and deep foundation systems.
- **Monitoring capabilities:** Strand anchor systems can allow for real-time monitoring of load and deformation, enabling proactive maintenance and ensuring structural safety over time.
- **Cost-effectiveness:** Despite their high load capacity and durability, strand anchors often offer cost-effective solutions compared to alternative methods, particularly in projects where the longer the strand length, the greater the economic advantage they offer over alternative methods.



DYWIDAG STRAND ANCHOR SYSTEM

DYWIDAG MULTI-STAGE STRAND ANCHOR SYSTEM

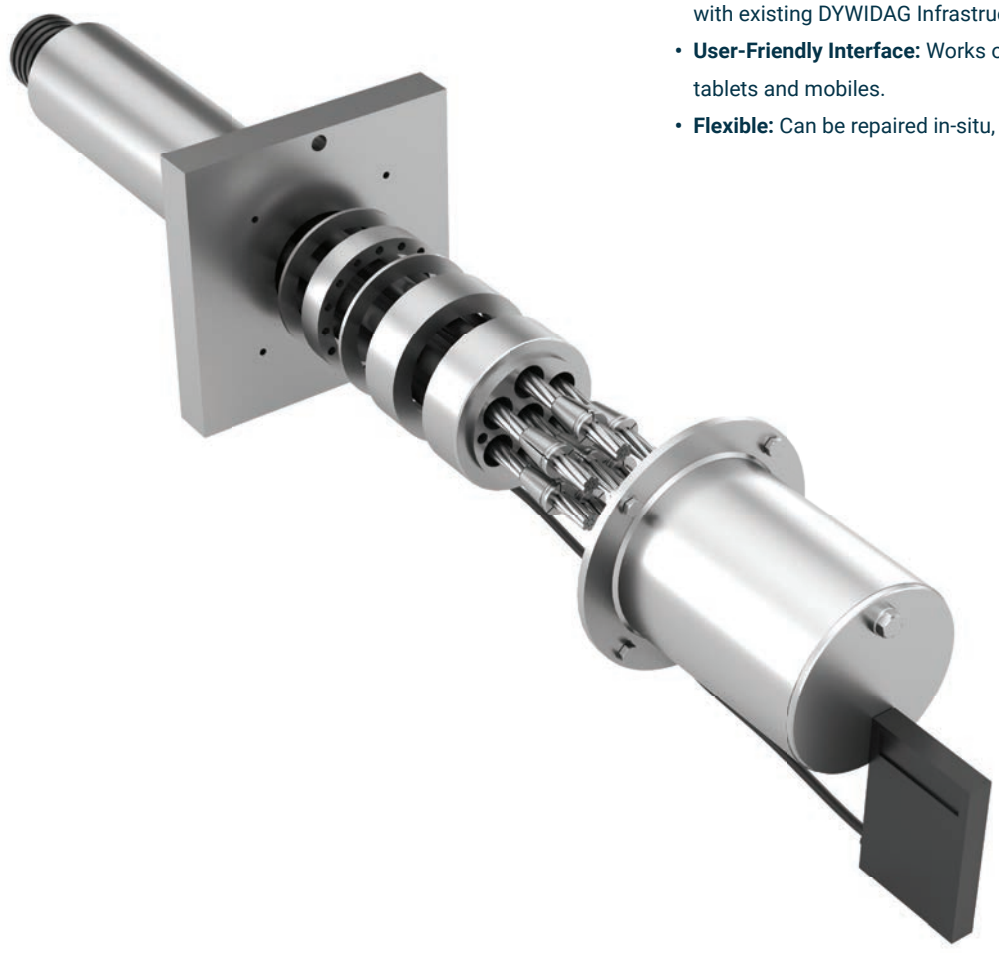
DYWIDAG Smart Anchor for intelligent tunnel monitoring

In the demanding environment of underground construction, structural integrity monitoring has never been more critical.

The DYWIDAG Smart Anchor transforms traditional anchoring systems into intelligent monitoring networks, providing real-time insights into tunnel stability and structural movement.

The Smart Anchor system continuously monitors and records changes in force, delivering precise measurements of load fluctuations within the tunnel structure, including temporary works environments during construction, using DYWIDAG's cloud-based data platform, Infrastructure Intelligence.

In the event of unexpected occurrences, the system provides immediate, real-time assessment of structural integrity, allowing engineers to make informed decisions quickly.



Fields of application

- Tunnelling.
- Retaining walls & slopes.
- Deep excavations.

Key features

- **Enhanced Safety:** Immediate notification of any structural changes or concerning measurements.
- **Proactive Maintenance:** Enables early detection of potential issues before they become critical.
- **Remote Access:** Monitor tunnel conditions from anywhere with an internet connection.
- **Digital Twin:** Enables users to navigate the virtual site from their desks.
- **Easy Integration:** Plug-and-play sensors seamlessly connects with existing DYWIDAG Infrastructure Intelligence platform.
- **User-Friendly Interface:** Works on all devices including desktops, tablets and mobiles.
- **Flexible:** Can be repaired in-situ, without de-stressing the anchor.

Infrastructure Intelligence

Infrastructure Intelligence: The premier cloud-based sensor monitoring platform

Our Infrastructure Intelligence (II) platform allows management and monitoring of sensor data in real time.

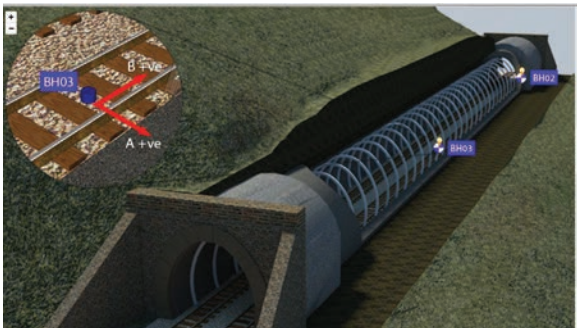
Designed for tracking a wide array of metrics including temperature, weather conditions, and environmental changes.

Infrastructure Intelligence proves particularly valuable in tunnel monitoring as it enables engineers and operators to monitor the structural integrity and safety of tunnels, providing data on factors such as air quality, humidity levels, and potential structural stresses.

By harnessing the power of Infrastructure Intelligence , issues can be swiftly identified before they escalate, ensuring safety for both the infrastructure and its users.

Key features

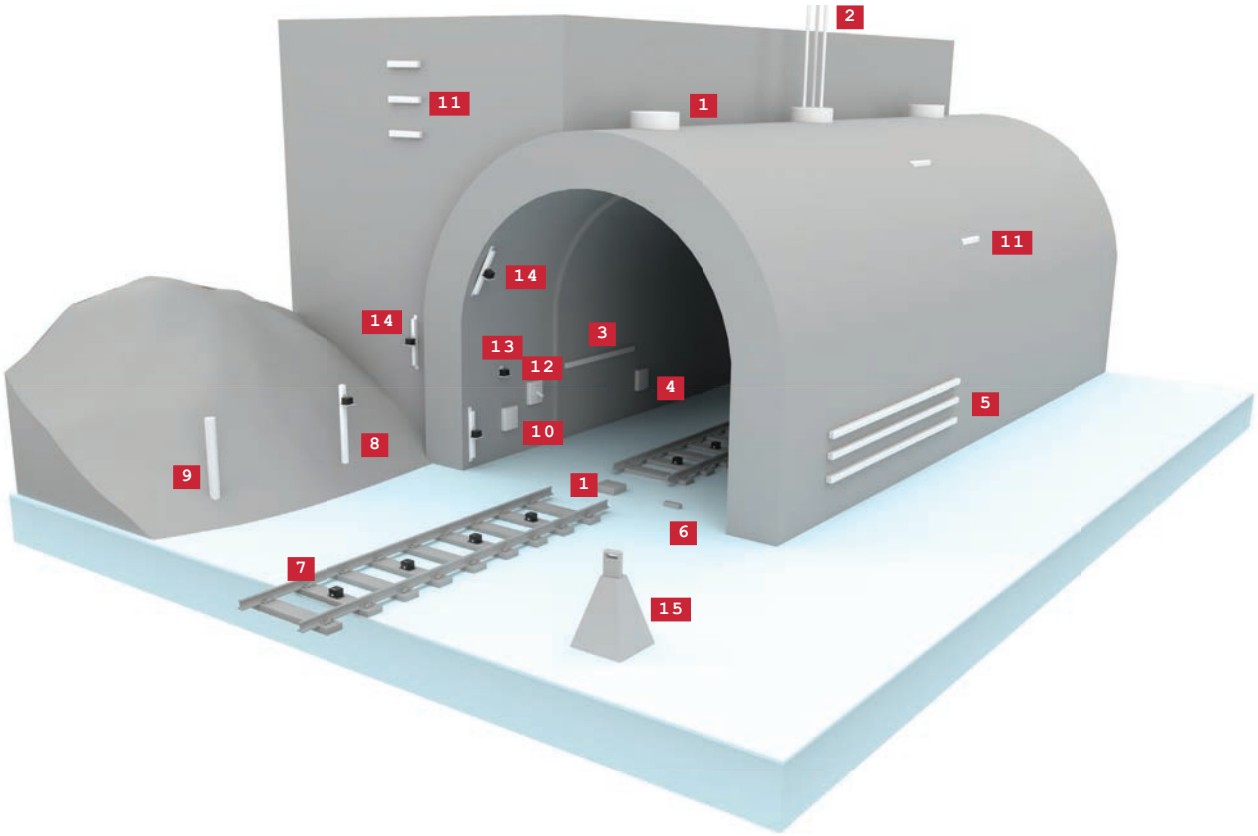
- Information can be shared via email and/or SMS alerts.
- Technology is secure and easily manageable from the Cloud.
- Delivers vital asset health data via plug-and-play sensors.
- 3D digital twin enables users to navigate the virtual site from their desks.
- Provides up-to-date digital representation of the site's environment using live telemetry updates. Charts (timed based and observation-over-depth) are available.
- Works on all devices including desktops, tablets and mobile phones using devices' native mobile browser.



Tunnelling monitoring and measurement solutions

DYWIDAG supplies an array of sensors and measurement equipment for the tunnelling sector as highlighted in the image and key below. Most of our portfolio can be represented on our Infrastructure Intelligence (II) platform.

Our solutions provide additional security to stakeholders and inform of potential ground movement, structural change and environmental conditions. Although are sensors benefit from our II data management platform, they are agnostic to the majority of digital data management platforms, vice versa, our II platform works with the major manufacturers of sensors.



1 Pressure Cells

2 Extensometers - Vertical in tunnel crown

3 Water Flow Meters

4 Vibration Sensors

5 Horizontal Inclinometers

6 Concrete Embedded Strain Gauges

7 Track Monitoring

8 Embankment Monitoring

9 Borehole Monitoring

10 Cast In Situ Data Loggers

11 Displacement Sensors

12 Smart Anchors

13 Temperature Sensors

14 Convergence Monitoring

15 Automatic Total Station Monitoring

DYWIDAG products and services

Structural health monitoring

Automated and manual monitoring including survey. Supply and installation of automated and manual monitoring and survey systems, this data can also be viewed on our infrastructure intelligence platform.

Concrete technologies

Permanent formwork systems and slab edge forms, form ties, reinforcement technologies - stop ends and starter packs, concrete accessories, sealing and chemical solutions.

Geotechnical

Specialist supplier of ground engineering products including ground anchors, tension piles, soil nails and mesh, rock bolts, smart anchors, marine tie bars and associated accessories.

Infrastructure Intelligence

Data acquisition platform, automated alarms and alerts, bespoke tailored system to suit your project.

Repair and refurbishment

Testing and repair of existing ground anchors, refurbishment of post-tensioning systems to existing structures, rope access and wrapping of stay cables.

Post-tensioning systems

Manufacture and installation of bonded and un-bonded post tensioning systems.

DYWIDAG

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