DYWIDAG

WE MAKE INFRASTRUCTURE
SAFER, STRONGER, AND SMARTER.

ROCK BOLTS AND MESHES

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REPUBLIC OF IRELAND ONLY

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About us

DYWIDAG-Systems International are a specialist geotechnical systems supplier with expert technical knowledge and long-standing experience in slope and rock face stabilisation.

Through our strategic partnership with specialist Swiss manufacturer GEOBRUGG we are able to offer complete slope and rock face stabilisation solutions including:

- Rock Bolts
- Resins & Grouts
- Wire Rope & Accessories
- High Tensile Strength Rock Netting

By providing a full suit of complimentary products, forming a comprehensive material package, DYWIDAG-Systems International are able to simplify our customers' supply chain, reduce delivery charges and mitigate the impact of truck movements on our environment.

Our approach allows us to provide customers with specific, technical advice, based on the performance on an entire system rather than an accumulation of individual components.

DYWIDAG-Systems International can provide advice and guidance on how changes can be made to increase the technical or economical efficiencies within the system.

DYWIDAG-Systems International UK was established in 1967 and has provided both products and technical advice to the UK's geotechnical drilling contractors and engineers ever since. By drawing on our experience, not only in rock face and slope stabilisation projects, but in our other application areas such as Soil Nailing, Micro Piling and Ground Anchoring,we have a reputation in line with our core values of:

- Technical Expertise & Advice
- High Quality Products
- Professional & Customer Focused Service
- Prompt & Efficient Deliveries

DYWIDAG-Systems International is a globally aligned organisation with the ability to draw on experience from around the world. We also understand the sensitivities and differing demands of local markets. Therefore, we always act in accordance with our motto:

Local Presence – Global Competence

Stabilization vs. Drapery

Passive Drapery Systems

Drapery systems are used to mitigate the effects of rockfall without preventing it. This system aims to control the descent of falling rock by limiting the velocity/energy gained during descent.

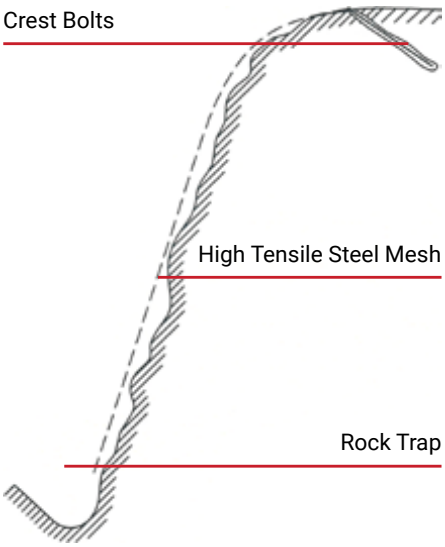
High Tensile Steel Mesh is used to provide a curtain, beyond which the falling rock cannot pass. Upon detachment from the face, the loose rock will impact on the mesh curtain and then rebound onto the rock face, each time dissipating energy and preventing large amounts of energy from accumulating.

Drapery systems utilise bolts at the crest and optionally at the toe of the rock face through which the load imparted onto the mesh, ensuring transferred back into the face. Wire ropes running along the crest and toe are used to hang the mesh ensuring loads are distributed over more than one anchorage point.

The primary installation focus of drapery systems is to ensure that the mesh remains as close to the face as possible, following the contours of the slope. Any area where the mesh comes away from the slope offers room for rock to free-fall and gain energy. Fast moving rock can deflect from the face and potentially punch through the mesh; drapery systems are best suited to even and relatively smooth faces.

Drops of drapery mesh should be terminated with an opening at the toe and a rock trap or ditch whenever possible, to allow for the failed material to be removed. In some cases, this will not be possible; therefore, the amount of strain in the mesh, when under load, is important to prevent encroachment into the site at the toe, e.g. lanes of traffic.

- Simple Installation
- Low Initial Cost
- Requires More Maintenance



Stabilisation Systems

Stabilisations systems are used in areas where rockfall or an accumulation of failed material can not be permitted. This approach uses rock bolts on the face to secure unstable masses of rock in position. The high tensile steel mesh is used to support the rock between the bolt positions.

By strategically placing the rock bolts in low points or depressions on the rock face, the mesh can be secured around outcrops of unstable material. Once a plate has been installed, load can be applied to the plate through torque applied to the nuts on the rock bolt. This process commonly known as pre loading reduces any available strain in the mesh locally around the plate and pulls the netting closer to the rock face. This, in turn, stretches the mesh over the high points. Removing the strain from the rock netting further reduces the space into which any failed material can move. Any failed material remains on the face, acting as a protective layer to the rock surface, preventing further weathering or erosion.

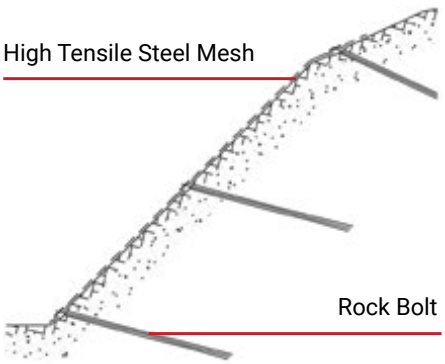
Mesh with low strain characteristics is desirable when forming a stabilisation system. In some instances, the dimension from the high points to the low on the rock face may only be 50-100mm, therefore, tension will not be established in an overly flexible netting formed from mild steel.

The location of rock bolts can be designed as a regular pattern, but the designer should be open to slight changes of position once work begins on site. To maximise the potential for pre-loading the system, bolts should be placed in the lowest points on the rock face in order to make the most of the topography. Due important for the mesh to have uniform properties throughout.

The strength and length of the rock bolts used will depend on the size and density of the unstable mass as well as the geotechnical characteristics of the rock in the stable zone, providing the geotechnical bond for the anchorage. An increase in design load or the presence of a weak rock in which to secure the bolt may result in a requirement for longer or larger diameter bolts.

Rock bolts can be used without a mesh facing. However it is likely that the incorporation of a high tensile steel mesh facing will reduce the number of rock bolts required. Weathered or fragmented rock is difficult to secure with rock bolts alone.

Stabilisation systems offer the ability to retain a rock mass on a slope; therefore, the strength and longevity of the materials used become even more important. These systems are placed under higher loads, and the consequences of failure are often greater compared to drapery solutions.



Rock Bolts

Basic Concept

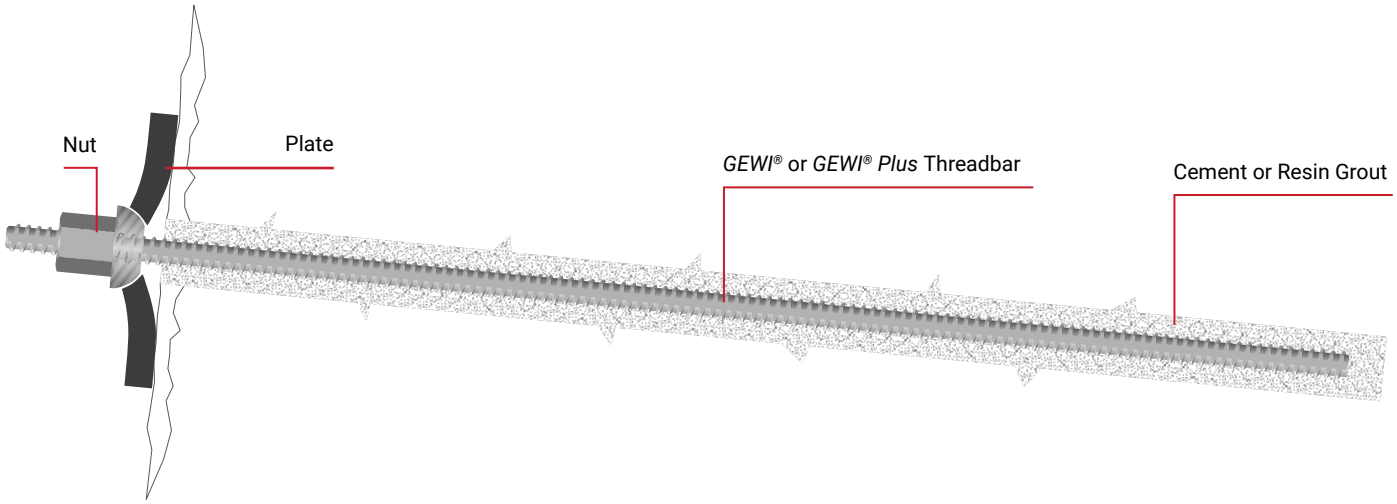
Rock Bolts are generally formed from solid threadbar systems, i.e. bar, nut, couplers and plates. The steel threadbar is used to bond unstable rock to stable sections, beyond the face, and requires both capacity for tensile and shear loads. Rock bolts are fully bonded and unlike ground anchors are passive installations.

Unless it has been severely weathered, rock will usually allow for an open hole to be drilled without any risk of collapse. Solid threadbars offer the most efficient means of transferring load and maintaining the smallest diameter borehole. Due to the higher bond strength offered by rock compared to soil, rock bolts can be installed into a much smaller hole than soil nails or ground anchors.

Smaller boreholes are desirable, as drilling through rock can be time consuming and expensive.

Fully threaded bar - can be cut and coupled at any point. They have a robust threadform that makes them ideal for construction site use:

- Coarse Pitch Threadform (d/2, except Ø 63.5mm which is d/3) with two flats – ensures thread is self cleaning
- Fully Galvanized Systems – galvanized threadbars and accessories also readily available



GEWI®

GEWI® Steel High Yield Threadbars are formed from a high tensile alloy steel. The bars are manufactured with a coarse left-hand thread over their full length. *GEWI®* couplers can provide a 100% load transfer between lengths of bar. The bar is also manufactured with flats on either side; these allow the self removal of dirt or debris as the bar is threaded into any female accessory, preventing cross threading and making it ideal for geotechnical applications.

GEWI® bar is manufactured in accordance with the German Certificate of Approval (Deutsches Institut für Bautechnik), the system also offers general conformance with BS 4449 : 2005 (Steel Reinforcement of Concrete).

The minimum specified characteristic yield strengths are:

- 500 N/mm^2 for bar diameters 16 - 50mm
- 555 N/mm^2 for bar diameters 57.5 - 63.5mm

16 - 50mm bars can be welded using appropriate industry practices relative to the carbon content of the steel. Welding of the higher grade 63.5mm diameter bar is also acceptable with additional measures.

The most common sizes of *GEWI®* bar used in rock-bolting applications are 25 - 32mm. The *GEWI®* product comes with a full range of accessories including eye-nuts, domed nuts & hemispherical washers, wedge bosses to increase head plate articulation and full strength couplers. Modulus of Elasticity:

- E = 205,000 N/mm^2 +/- 5%
- Stock Lengths
  - All bar diameters 12.0m. Tolerances +/- 100mm. Special lengths up to 18.0m are available to order.

All bar diameters can be cut to length to suit customer requirements or supplied bent to BS 8666 : 2000.

GEWI® Plus

DYWIDAG-Systems International has developed the *GEWI® Plus* system to meet the challenges driven by a need for higher load capacities in smaller structural cross sections.

GEWI® Plus offers an increase in strength compared to traditional *GEWI®* Threadbars. *GEWI® Plus* has a yield strength of 670 N/mm^2 – an increase of 34% and an ultimate strength of 800N/mm^2 – an increase of 45%.

In instances where construction tolerances within a concrete column, pre-cast segment or borehole are tight, the increased strength offered by *GEWI® Plus* can allow for bar sizes to be reduced subsequently, allowing for concrete cover requirements to be met or borehole sizes to become smaller.

Compared to *GEWI®*, *GEWI® Plus* can reduce the cross sectional area of steel required in a rock bolt, pile or ground anchor by up to 25% due to the increased strength.

Despite the high strength, *GEWI® Plus* is not sensitive to stress crack corrosion and hydrogen induced embitterment.

The robust *GEWI® Plus* thread is specially designed for rough site conditions The right-hand thread over the full length offers the possibility to fix and couple the bars at any point.

GEWI® Plus is fully integrated in the ISO 9001 quality assurance system of DYWIDAG-Systems International.

Rock Bolts

GEWI® Threadbar

Key Features

- Left Handed Thread
- Coarse Pitch Threadform (d/2), except 63.5mm
- Standard Load Range

Technical Data

Nominal Diameter	Steel Grade	Ultimate Strength	Yield Strength	70 % Ultimate Strength	Cross-Sectional Area	Diameter Over Threads	Thread Pitch	Weight
[mm]	[N/mm²]	[kN]	[kN]	[kN]	[mm²]	[mm]	[mm]	[kg/m]
16	500 / 600	121	101	85	201	18	8	1.58
20		188	157	132	314	23	10	2.47
25		295	246	206	491	28	12.5	3.85
28		370	308	259	616	32	14	4.83
32		482	402	337	804	36	16	6.31
36		612	510	428	1,020	40	18	7.99
40		754	629	528	1,257	45	20	9.86
50		1,178	982	825	1,963	55	26	15.41
57.5		1,818	1,441	1,273	2,597	63	20	20.38
63.5	555 / 700	2,217	1,758	1,552	3,167	69	21	24.66
75	500 / 600	2,651	2,209	1,655	4,418	82	24	34.68

Accessories

Nominal Diameter	Static Coupler		Lock Nut		Hexagonal Nut		Domed Nut		Eye Nut SWL 2t	
										
	Dia.	Length	AF	Length	AF	Length	AF	Length	Width	Height
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
16	32	90	32	30	32	40	27	33	62	87
20	36	105	32	40	36	45	36	42	66	96
25	40	115	41	40	41	50	41	45	71	106
28	45	125	41	45	46	55	41	54	76	112
32	52	140	50	50	55	60	46	57	95	135
36	60	150	55	55	60	65	N/A	N/A	100	140
40	65	160	65	70	65	70	60	70	105	155
50	80	200	80	85	80	85	80	85	120	185
57.5	102	230	90	80	90	100	90	100	130	230
63.5	102	260	100	115	100	115	100	115	140	235
75	108	240	100	80	100	100	100	120	140	250

Rock Bolts

GEWI® Plus Threadbar

Key Features

- Right Handed Thread
- Reduced Pitch Threadform (d3)
- Increased Load Range Capacity

Technical Data

Nominal Diameter	Steel Grade	Ultimate Strength	Yield Strength	70 % Ultimate Strength	Cross-Sectional Area	Diameter Over Threads	Thread Pitch	Weight
[mm]	[N/mm²]	[kN]	[kN]	[kN]	[mm²]	[mm]	[mm]	[kg/m]
18	670 / 800	203	170	142	254	21	8	2.00
22		304	255	213	380	25	8	2.98
25		393	329	275	491	28	10	3.85
28		493	413	345	616	32	11	4.83
30		566	474	396	707	34	11	5.55
35		770	645	539	962	40	14	7.55
43		1,162	973	813	1,452	48	17	11.40
50		1,570	1,315	1,099	1,963	56	18	15.40
57.5		2,078	1,740	1,455	2,597	63	20	20.38
63.5		2,534	2,122	1,774	3,167	69	21	24.86
75		3,534	2,960	2,474	4,418	82	24	34.68

Accessories

Nominal Diameter	Static Coupler		Lock Nut		Hexagonal Nut		Domed Nut		Eye Nut SWL 2t	
										
	Dia.	Length	AF	Length	AF	Length	AF	Length	Width	Height
[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]	[mm]
18	36	100			36	45	32	35	66	96
22	40	110			41	50	36	45	71	106
25	45	120			46	55	41	50	76	116
28	50	140	46	53	50	60	46	55	80	125
30	55	150	50	60	55	65	50	60	85	140
35	65	120	55	65	65	70	60	70	105	155
43	80	200	70	80	80	90	70	85	120	190
50	90	210	80	90	80	100	80	100	130	200
57.5	102	250	90	100	90	120	90	115	130	230
63.5	114	300	100	105	100	145	100	125	140	230
75	108	250	100	120	100	130	120	150	140	250

Accessories

Bearing Plates

Bearing plates have a dual purpose: as well as acting as a reaction surface to material moving against the head of the plate, and it secures and transfers load from any facing system into the rock bolts.

Size and thickness of the head plate need to be determined during the design phase as each project requires a different plate and it should not be assumed that they are standardized parts. However, for rock bolting, plates tend to be smaller but thicker as bearing failure below the plate is rarely an issue.

In order to transfer load from the rock bolt to the face efficiently, the plate should be secured tight to the face using a domed or hexagonal load nut. If a specific torque value is stated in the design, all nuts should be correctly tightened. If no load is stated, then a nominal figure of 10kN/m should be adopted to ensure that all nuts are tightened to a consistent amount.

Rock bolt/head plate articulation needs to be provided to ensure that the plate can be secured flush with the rock face. Articulation is the movement between the plate and the rock bolt; different plates can increase or decrease the amount of articulation. Insufficient articulation will cause the outside surface of the bar to clash with the inside edge of the bearing plate before the plate has come into contact with the rock face.

DYWIDAG-Systems International provide different plate types to provide increasing amounts of articulation. This range ensures that every project can be catered for.

Flat Plate	Formed Plate	Slotted Plate
up to 15°	up to 20°	up to 55°
		

Resins

Fasloc® Resin Cartridges offer quick installation for rock bolts and dowels used for the stabilisation of rock faces, cuttings and tunnels. The resin has a fast cure time, enabling the bolt to be loaded following installation. Resin cartridges are used with *GEWI®* Steel and GRP rock bolts, where the bolt can be spun into the resin to achieve a full bond. The fast cure time of Fasloc® resin cartridges offers installation benefits for roped access work, as well as for rail possessions or night closures.

For installation, the resin cartridges are placed in to a 38mm borehole, followed by the rock bolt, which is spun in using an air-powered spinning tool. This process ensures the two-part resin is fully mixed, and extruded within the borehole to fill the annulus and achieve cure. Typical installed bolt lengths range from 0.6m - 2.3m, using one to four resin cartridges.

Fasloc® Resin Cartridges offer:

- Fast installation and cure for rock bolts – roped access installation, rail possessions.
- Efficient mixing of two-part cartridge, with slight expansion on final cure - increased bond
- Increased permeability of borehole wall - for greater friction in rock.
- Ease of handling and installation – for consistent performance.
- Greater load performance, due to superior load transfer between the resin and the rock.
- Increased film shredding (to prevent “gloving”), due to larger filler aggregate.
- Improved mixing between the two resin components, through low resin to catalyst ratio.

Borehole Depth	Borehole Diameter	Rock Bolt Type	Bolt Diameter (Nom. / Over Threads)	No. of Resin Cartridges	Mix Speed / Duration	Ambient Temperature
[m]	[mm]		[mm]		[RPM / Sec]	[°C]
0.5	38	*GEWI®* or *GEWI® Plus*	25 / 28	1	150 / 20-30	15 - 20
1.0				2		
1.5				3		
2.0				4		

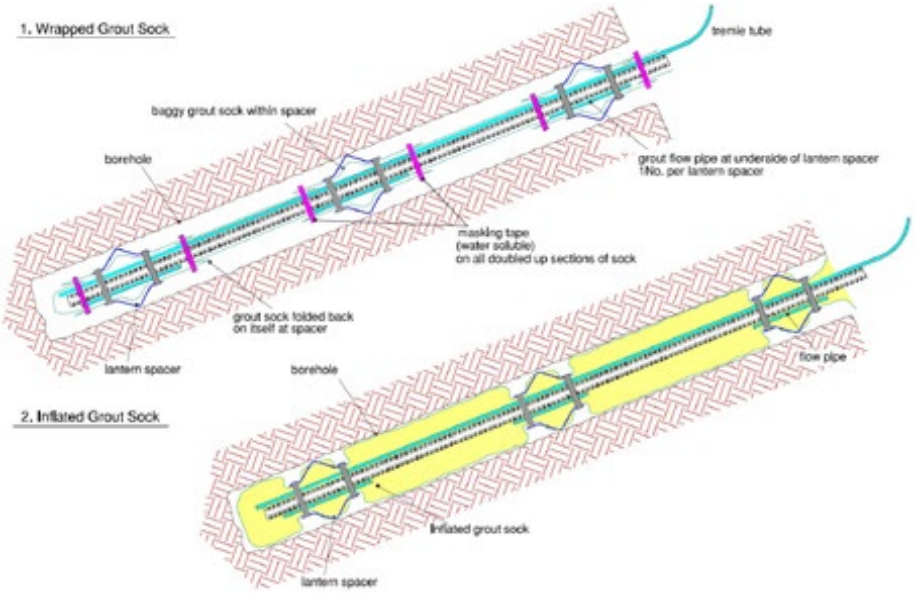
Accessories

Grout Sock

Grout socks are utilised in heavily fissured or fragmented rock. Rock bolts rely on the confinement of grout within a borehole in order to transfer the strength from the steel threadbar into the rock.

If fissures prevent the borehole from containing the grout, then the bar can be covered with a grout sock prior to placement in the hole. Grout socks are formed from a poly-cotton mix textile with high elasticity and strength but low permeability. As the grout fills the sock, the solid particles clog within the sock and fill the borehole. The cementitious water filtering through the grout sock or 'grout milk' then cements the mass to the inside surface of the borehole.

DYWIDAG Grout Socks can provide the same confinement in ground with fissures as would be expected in normal bolting conditions.



Care needs to be taken when placing the bolt within the grout sock to prevent tearing as this will reduce or negate the effectiveness of the sock. Care also needs to be taken when placing the bolt into the borehole as the rough surface left by drilling can cause damage to the material.

Expansion Shell Anchors / Rock Bolts with Expansion Shell

Key Features

- Extremely fast and easy installation
- Immediate load bearing capacity in the borehole
- Galvanized version available
- Retensionable
- Various angle compensation designs available
- Posterior grouting is possible – increased load bearing capacity and durability

Fields of Application

- Face bolts
- Ground support
- Roof support
- Medium hard to hard rock
- Potash and salt

Meshes

Basic Concept

DYWIDAG-Systems International through partnership with specialist Swiss Geo-hazards solution provider GEOBRUGG offer a range of high-tensile steel, flexible facing meshes.

GEOBRUGG have vast experience in reducing the impact of rock fall and developed their first Avalanche Protection Structure made of wire rope net in 1951. These avalanche prevention structures were exposed to rockfalls during snow-free periods, and they succeeded in holding these rocks.

Following the success of the Avalanche Barriers, GEOBRUGG developed the TECCO® SYSTEM³. The first mesh was made from High Tensile Strength Steel wire, This then evolved into more discrete, lighter meshes such as DELTAX® and more robust cable nets designed to resist large angular blocks known as SPIDER®.

The synergy between DYWIDAG-Systems International & GEOBRUGG allows the supply of an entire Rock Fall Protection System from one source.

Key Features

- High Tensile Steel Wire

Mild steel wire can vary in strength anywhere between 350-550N/mm². Geobrugg products utilize High Tensile Steel with wire with strengths no less than 1,770N/mm² for standard products and 1,650N/mm² for stainless steel meshes. Using higher strength wire allows for either a smaller diameter wire to be used in order to meet the same mesh strength as the mild steel alternative or for higher strength meshes to be produced from the same size wire.

- Low Strain Characteristics

Both the characteristics of the wire and the mesh geometry enable load to be carried by Geobrugg meshes with minimal strain/elongation under load. The reduced strain characteristics of Geobrugg meshes allow their facing systems to spread load between rock bolts or Soil Nails efficiently. Geobrugg meshes have characteristic strain values of between 6-7% at their UTS compared to mild steel meshes which strain anywhere between 12-20%.

- Low Weight

The additional strength offered by the high tensile strength steel allows meshes to contain less steel m² than the mild steel alternative.

DELTAX® 53kN/m

Roll Size - 3.9m x 30m = 79kg

Mild Steel Hex Mesh 50kN/m

Roll Size - 2m x 25m = 80kg

Corrosion Protection

Geobrugg High Tensile Steel Wire Mesh utilises advanced galvanizing alloys to achieve a high level of resistance to physical damage and corrosion. Both SUPERCOATING® and ULTRACOATING® treatments contain additional metals that improve the coatings performance compared to zinc alone.

SUPERCOATING® is applied to the 3mm and 4mm TECCO® products as well as the SPIDER® System. SUPERCOATING® is a 95% Zinc %5 Aluminium alloy. The addition of the Aluminium provides a smooth outer surface to the wire which reduces corrosion rates.

ULTRACOATING® provides corrosion protection for the 2mm TECCO® and the DELTAX® products. ULTRACOATING® combines Zinc & Aluminium with additional corrosion inhibitors.

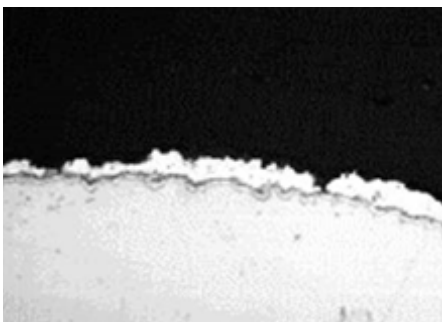
Both SUPERCOATING® & ULTRACOATING® can provide design lives of up to 120 years depending on the project specific environment.

Polymeric coatings such as PVC are not used on the standard High Tensile Steel Meshes due to their susceptibility to damage during storage, movement or installation. Polymeric coatings are prone to damage, through abrasion, at the key load transfer points, e.g. beneath bearing plates or when in contact with wire ropes.

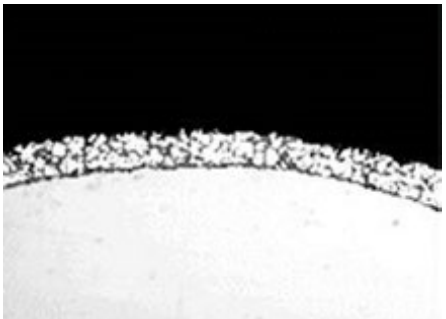
Both SUPERCOATING® and ULTRACOATING® have excellent self healing capabilities if damaged. When scratched, the zinc in the coating re-anodises filling any potential gaps in the coating.

The High Tensile Steel Wire used to produce the DELTAX®, TECCO® and SPIDER® systems are all double drawn. This process improves the uniformity and thickness of the galvanizing on the wire. By applying the corrosion protection to a larger diameter wire and then reducing the size by re-drawing without removing any of the coating, a more consistent and concentrated protection layer is established.

Double Drawing



Zinc coated wire



Double drawn ULTRACOATED Wire

Meshes

Accessories

The TECCO® SYSTEM³ has been designed to ensure that all the individual components work in harmony to transfer loads efficiently over the entire system. The relationship between the TECCO® Mesh, the Spike Plates and the TECCO® clip T2 & T3 provides a comprehensive facing solution. The TECCO® SYSTEM³ has been designed, tested and approved with the full details covered in the

Product	European Technical Approval
DELTAX® / GREENAX®	ETA 17/0116
TECCO® G45/2	ETA 17/0119
TECCO® G65/3	ETA 17/0118
TECCO® G65 Stainless Steel	ETA 17/0113
TECCO® G65/4	ETA 17/0117
SPIDER® S3-130	ETA 13/0477

Technical Data

	Roll Size	Roll Area	Tensile Strength	Punching Strength	Wire Diameter	Corrosion Protection	Weight per Roll
	[m]	[m²]	[kN/m]	[kN]*	[mm]		[kg]
DELTAX®	3.9 x 30	117	53	25.7 / 39 ***	2	ULTRACOATING®	76
TECCO® G45/2	3.5 x 30	105	85	80 / 110	2	ULTRACOATING®	121
TECCO® G65/3	3.9 x 30	117	150	180 / 240	3	SUPERCOATING®	193
TECCO® G65/4	3.5 x 20	70	250	280 / 370	4	SUPERCOATING®	231
SPIDER® S-130	3.5 x 20	70	220	230 /300 **	3 x 3 mm	SUPERCOATING®	182

* using Spike Plate P25/P33
** using Spike Plate P33/P66
*** using Square Plate 150 x 150 / 200 x 200

	Roll Size	Roll Area	Tensile Strength	Punching Strength	Wire Diameter	Corrosion Protection	Weight per Roll
	[m]	[m²]	[kN/m]	[kN]*	[mm]		[kg]
GREENAX®	3.9 x 30	117	53	25.7 / 39 *	2	ULTRACOATING®	123
TECCO® Green	3.9 x 25	97.5	150	180 / 240**	3	SUPERCOATING®	200

* using Square Plate 150 x 150 / 200 x 200
** using Spike Plate P33/P66

T2 clips - used to connect the mesh with the boundary wire rope

T3 clips - used to connect adjacent mesh panels together.

Geocomposites

Basic Concept

The Geobrugg mesh range includes two products that are specifically designed for weathered rock or soil retention. TECCO® GREEN (G65/3) and GREENAX® incorporate a three-dimensional polypropylene erosion control mat into the high-tensile steel wire mesh. The integrated, reinforced composite is suitable for temporary and permanent erosion control. These Geocomposite products can be used on slopes, embankments and cuttings where vegetation is to be encouraged. The three-dimensional erosion control mat provides an ideal environment for the vegetation to grow, even in difficult climatic conditions.

Both TECCO® GREEN and GREENAX® blend into nature and adapt to the topography of the slope. The three dimensional erosion control mat provides immediate protection from erosion, allowing vegetation to grow quickly. Seeding of the slope can be incorporated before or after installation. Both TECCO® GREEN and GREENAX® are supplied in Curry Green, in order to have minimal visual effect on the surrounding environment: it blends in with most landscapes. The integrated erosion control matting contains UV stabilisers wich increases the durability when left exposed.

Key Features

- Fast installation
  - Compared to installing a flexible facing mesh and a separate erosion control matting below, both TECCO® GREEN and GREENAX® offer time-saving on installation.
  - An individual erosion control matting would also require pinning to profile the matting to the slope; however, with a geocomposite, the weight of the steel within the product helps contour the matting to the slope.
- Minimal Visual Impact
  - The Curry Green polypropylene erosion matting provides the appearance of a vegetated slope following installation.
  - Compared to the traditional black product, when installed in large quantities, TECCO® GREEN and GREENAX® can provide a softer, more visually pleasing and unobtrusive solution whilst still providing a suitable face to accept hydro-seeding or topsoil.
- Increased Safety
  - Geocomposites allow an erosion control system and a structural facing to be installed simultaneously without setting foot on the slope. Secured to a border rope or anchor trench, the mesh can be rolled down from the top. In instances where profiling pins or rock bolts/soil nails are required, time spent installing mesh on the slope is reduced by at least 1/2 when using a geocomposite compared to a two layer approach.

TECCO® Green & GREENAX® Properties

Fibers	extruded mono-filaments
Thickness of single mono-filament	0.024 in
Material	Polypropylene (PP)
Melting point of polymer (ISO 306)	306 °F
UV resistance of polymer (ASTM D4355)	UV stabilized
Structure	irregular loopy structure
Color	curry green
Thickness (ASTM D5199)	0.55 in (+/- 10%)
Void ratio	> 90 %
Mass per [ft²] (ASTM D792)	0.88 lbs (+/- 10%)
Tensile strength	integrated in steel net

Technical Data

	Roll Size	Roll Area	Tensile Strength	Punching Strength	Wire Diameter	Corrosion Protection	Weight per Roll
	[m]	[m²]	[kN/m]	[kN]*	[mm]		[kg]
GREENAX®	3.9 x 30	117	53	25.7 / 39 *	2	ULTRACOATING®	123
TECCO® Green	3.9 x 25	97.5	150	180 / 240**	3	SUPERCOATING®	200

* using 150 x 150 / 200 x 200 square plate
** using P33/P66

TECCO® Green - Installation at Castle Eden Dene

T3 clips - used to connect adjacent mesh panels together.

GREENAX® – Installation in Edinburgh to stabilise the loose soil overburden at the crest of a rock face

GREENAX® – Installation adjacent to the M1 Motorway, Wakefield

DYWI® Mat

Basic Concept

DYWI® Mat is a cuspated, randomly extruded 3D matrix of polypropylene fibres. The fibres are extruded over a light weight biaxial geogrid which provides additional tensile strength, allowing the matting to be applied to steeper slopes. The aim of the product is to provide an artificial root structure to the layer of soil on the surface of a slope. DYWI® Mat products provide resistance to the removal of the upper layer of soil from pluvial and wind erosion.

DYWI® Mat is designed to be installed on slopes of up to 50°; however, when combined with DELTAX® slope protection mesh, it can be installed on faces of up to 70°. When used alone, DYWI® Mat is secured to the slope surface using pins driven in at regular spacings. Pin spacing will increase as the slope height or length increases. If intermediate pinning cannot be accommodated, anchor trenches at the top and bottom of the slopes can be used due to the increased tensile strength of the DYWI® Mat.

If possible, the DYWI® Mat will be dressed with topsoil and seeded following installation; however, on steep slopes this may not be possible. Where DYWI® Mat will be left exposed, the green colour reduces the visual impact on the surrounding environment compared to traditional black erosion mats. DYWI® Mat provides an ideal surface to accept hydro seeding following the installation if hand seeding is not practicable. Green erosion matting maintains a low temperature at the surface layer, protecting germinating vegetation.

Technical Data

	Description	
Type	Reinforced Cuspated 3D Polymeric Matrix	
Colour	Green	
Thickness	20mm	Nominal Thickness(± 5%)
Mass / m^2	550 g/m^2	EN ISO 9864
UTS	4.5 / 5 kN/m	EN ISO 10319
Elongation MD / CMD	25 / 25 %	+5% EN ISO 10319
Design Life	Up to 120 Years	
Void Ratio	95 %	
UV Resistance	Stabilised	Provides medium term protection to vegetation cover
Flow Velocity	4 (unvegetated) to 7 (vegetation)	m/sec
Roll Dimensions	2.5m Width	25m Length
Roll Diameter	0.7m	
Roll Weight	34 kg	
Overlap Requirements	125mm Horizontal	1.25 Vertically

1. The values given are indicative and correspond to nominal results obtained in our laboratories and testing institutes. In line with our policy of continuous improvement, the right is reserved to make changes without notice at any time. The thickness stated is the product thickness as manufactured; the product is compressed when rolled for delivery, and the extent of recovery will depend on time.
2. Final determination of the suitability of any information is the sole responsibility of the user. DYWIDAG-Systems International will be pleased to discuss the use of this or any other product, but responsibility for selection of a material and its application in any specific project remains with the user.
3. The standard product is intended to be sufficiently durable in European climates to allow new vegetative growth to develop through the open structure of the mat to provide the long term weathering protection.
4. Please refer to separate sheets for fixing instructions. A COSHH certificate is available on request.
5. Flow velocities are as quoted in CIRIA 116 figure 9 and shown in Allermoor Spillway flood monitoring data 2014.

Wire Rope

Basic Concept

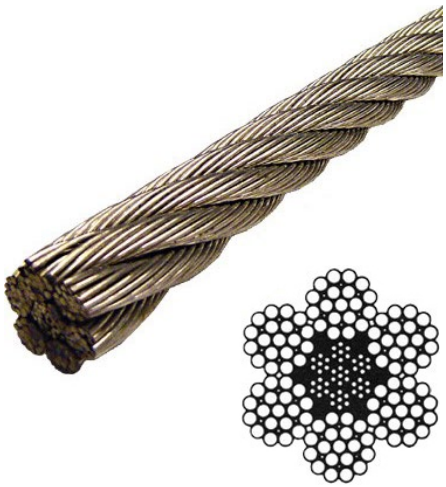
Wire ropes are commonly used to secure rockfall netting onto rock or slope faces. Both drapery and stabilisation systems utilise wire ropes to allow the load from meshes to be evenly distributed at the crest of a slope, spreading the load over multiple bolt/nail positions.

Wire ropes are also used in some instances to help contour mesh facings to the topography of the cliff/slope face.

DYWIDAG-Systems International supply a range of wire rope diameters to cater for the full range of applications. Wire ropes can be supplied with both fibre and steel cores and should provide an efficient combination of strength and flexibility. DYWIDAG-Systems International supply 6x19 fibre core wire ropes as standard; however, other specifications can be supplied upon request. 6x19 refers to the 6 bundles of 19 wire strands used to form the rope.

Galvanized wire ropes are provided in accordance with DIN 1142 and are formed from High Tensile Steel Strands.

DYWIDAG-Systems International also provide Stainless Steel wire ropes for marine or coastal environments.



Technical Data

Diameter	Weight	1770N/mm² MBF		1960/mm² MBF		1570/mm² (Stainless Steel) MBF	
[mm]	[kg/100m]	[kN]	[kg]	[kN]	[kg]	[kN]	[kg]
6	12.46	19.60	1,994	21.70	2,208	17.40	1,769
10	34.60	54.30	5,539	60.20	6,134	48.20	4,913
12	49.82	78.20	7,976	86.60	8,833	69.40	7,075
14	67.82	106.50	10,857	117.90	12,022	94.50	9,630
16	88.58	139.10	14,180	154.00	15,702	123.40	12,578
18	112.10	176.00	17,947	195.00	19,873	156.00	15,919

Minimum Breaking Force Factor – K = 0.307
Nominal Length Mass Factor – W = 0.346

DYWIDAG HCR Stainless Steel

Basic Concept

In coastal or aggressive environments, the use of traditional steel requires significant efforts to establish corrosion protection. For projects requiring product design lives in the region of 120 years, stainless steel provides an efficient solution.

Typical applications include: rock bolts, rock dowels, stitching bars and tie bars. DYWIDAG HCR Threadbars are also suitable for the fixing of stainless steel DELTAX® mesh, used for slope protection applications.

DYWIDAG HCR Threadbar is manufactured from stainless steel and is available in both 1,4301 (304) and 1,4401 (316) grades from stock. HCR Threadbar has been developed for permanent applications requiring higher levels of corrosion resistance than standard structural steel products. HCR Threadbar is a coarse pitch, fully threaded bar system, suitable for both geotechnical and structural applications. HCR Threadbar has a coarse pitch thread, running the full length of the bar, enabling the bar to be cut or coupled at any point, as well as a full load nut termination placed at the end, for load transfer to the face of a structure.

Bar Properties

Bar Diameter	Bar UTS	0.2% Proof Load	Weight	Yield Strength/ Tensile Strength	Thread Pitch	Thread Orientation
[mm]	[kN]	[kN]	[kg/m]	[MPA]	[mm]	
16	133	108	1.31	650 / 800	6	Right Hand
20	208	170	2.05			
24	302	245	2.98			
30	476	387	4.70			
36	698	567	6.84			

Duplex S HCR Threadbar is also available upon request; however, please note this grade is not held in stock as standard.
Contact DYWIDAG-Systems International for more information, including installation guides and fabrication drawings.

Accessories

Load Nut

Bar Diameter	A/F	Length
[mm]	[kN]	[kN]
16	133	108
20	208	170
24	302	245
30	476	387
36	698	567

Lock Nut

Bar Diameter	A/F	Length
[mm]	[kN]	[kN]
16	133	108
20	208	170
24	302	245
30	476	387
36	698	567

Coupler

Bar Diameter	Diameter	Length
[mm]	[kN]	[kN]
16	133	108
20	208	170
24	302	245
30	476	387
36	698	567

Plates*

Bar Diameter	Diameter	Length
[mm]	[kN]	[kN]
16	133	108
20	208	170
24	302	245
30	476	387
36	698	567

*Formed plates available up to 15mm thickness

Marine Rock Bolting – Marine Grade Meshes

Basic Concept

In coastal areas, the durability of galvanized steel is tested by the aggressive nature of the saline environment and may not satisfy the required design life of a project. In coastal areas, the use of polymeric coatings has long been approached with scepticism due to their soft nature and tendency for damage to occur to the coatings during transport, installation or following construction.

In order to achieve a solution to provide a design life of up to and in excess of 120 years, an entirely stainless steel solution is recommended.

The benefits of stainless steel mesh are widely accepted; however, the stabilisation system should be considered as a whole. The bar installed into the slope or cliff face provides the primary mechanism for stabilisation and therefore needs to have similar durability characteristics to the mesh on the surface. Although isolation between the rock bolts/soil nails, plates and mesh is possible, the potential for corrosion to occur between dissimilar metals needs to be considered.

By using Stainless Steel DELTAX® or TECCO® STAINLESS mesh alongside DYWIDAG HCR Stainless Bar, DYWIDAG-Systems International can provide a combined slope or rock face stabilisation system entirely from stainless steel, from one source.

Technical Data

	Roll Size	Roll Area	Tensile Strength	Punching Strength	Wire Diameter	Corrosion Protection	Weight per Roll
	[m]	[m^2]	[kN/m]	[kN]	[mm]		[kg]
Stainless Steel DELTAX®	3.9 x 55	214.5	45	60	2	INOX	76
TECCO® STAINLESS G65/3	3.5 x 30	105	140	170	3	INOX	175

* using Spike Plate P33 STAINLESS

TECCO® STAINLESS, Great Western Beach, Cornwall

Stainless Steel DELTAX®, Polperro, Cornwall

Slope Stabilisation with HCR Rock Bolts & TECCO® STAINLESS at the Cambrian Campaign, Wales, Great Britain

Owner Network Rail +++ **General Contractor** Alun Griffiths Rail Engineers Network Rail Infrastructure Design Group

Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Technical Advice, Material Supply and Stressing & Testing Services
Products 24mm & 30mm HCR Rock Bolts G65/3 TECCO® STAINLESS

TECCO® & *GEWI® Plus* Rock Bolts for the new Sewerage Treatment Works, Bellozanne, Jersey, Great Britain

Owner States of Jersey Department for Infrastructure +++ **General Contractor** CAN Geotechnical & Brenwal +++
Anchor Designer CAN Geotechnical

Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Material Supply
Products 30mm *GEWI® Plus* Rock Bolts, TECCO® G65/3, DELTAX® G80/2

Quarry Rockfall Protection with DELTAX® Drapery & TECCO® SYSTEM³, Cloud Hill, Ashby De La Zouch, Great Britain

Owner Breedon Aggregates Ltd +++ **General Contractor** Derbyshire Geotechnical +++ **Engineers** Key Geo Solutions Ltd

Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Technical Advice, Material Supply
Products 25mm *GEWI*® 32mm DYWI® Drill Hollow Bar, DELTAX® TECCO® G65/4 DYWI® & Mat Green

DELTAX® Stabilisation System with *GEWI*® Rock Bolts for a Railway Portal Slope Stabilisation in Brighton, Great Britain

Owner Network Rail +++ **General Contractor** BAM Ritchies +++ **Anchor Designer** Tony Gee Ltd

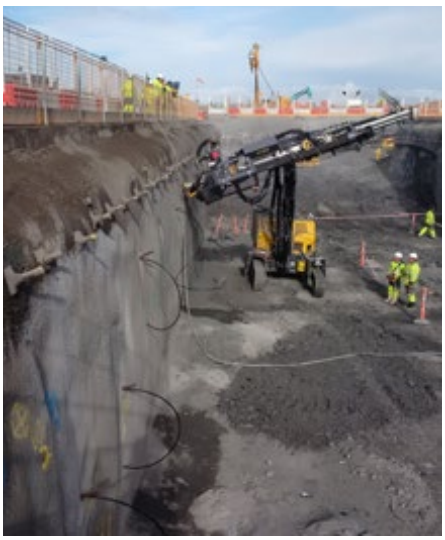
Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Material Supply
Products 25mm *GEWI*® Rock Bolts, DELTAX®

Rockfall Protection to Quarry Workings, Criggian Quarry Shropshire, Great Britain

Owner Aggregate Industries Ltd +++ **General Contractor** Derbyshire Geotechnical Ltd Key Geo Solutions Ltd

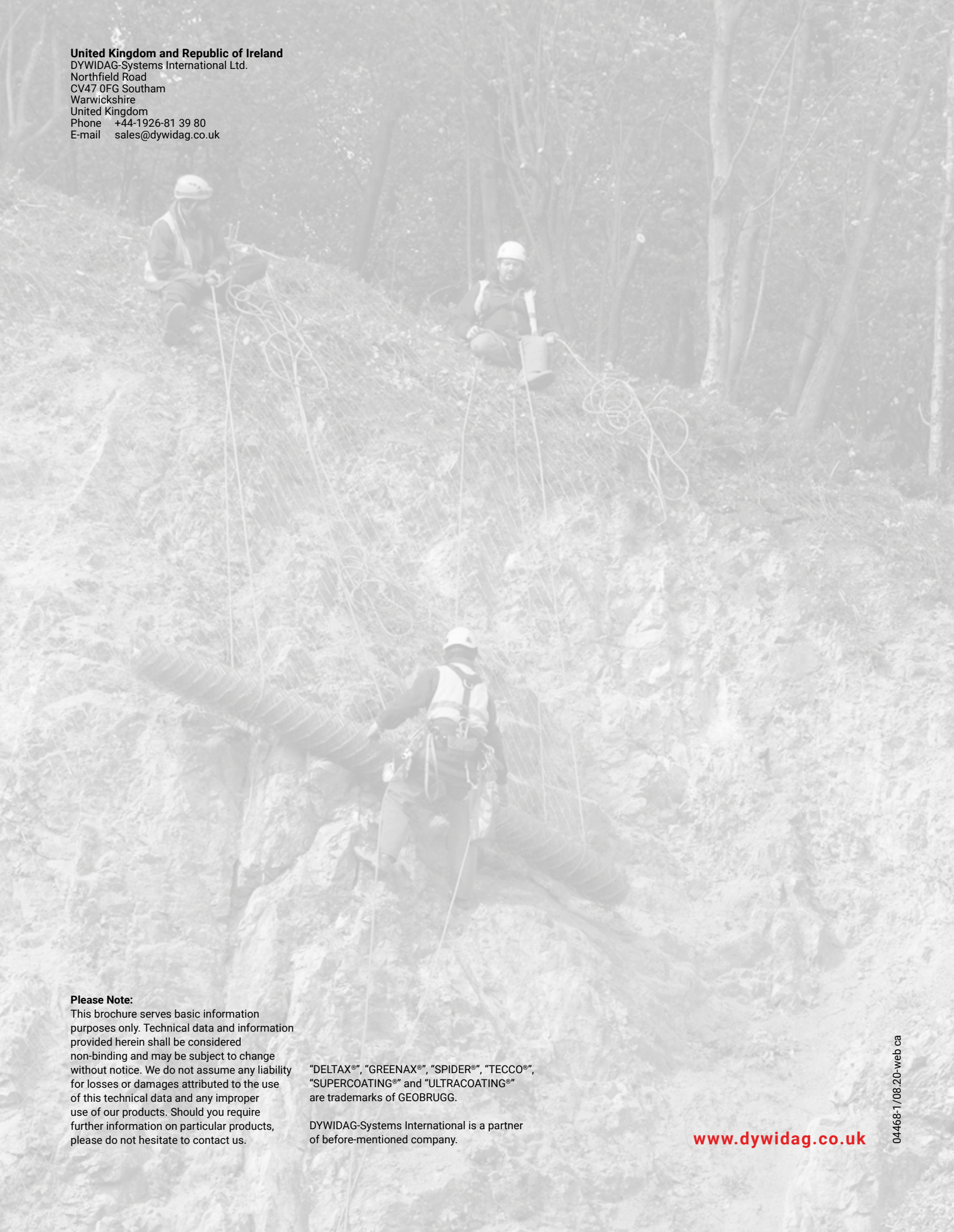
Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Material Supply
Products 25mm *GEWI*® Rock Bolts, DELTAX®

Power Station Galleries Ground Support Nails, Hinkley Point C, Great Britain



Owner EON +++ **General Contractor** Kier BAM JV +++ **Anchor Designer** Atkins Global

Unit DYWIDAG-Systems International Ltd., Great Britain
Scope Material Supply
Products 20mm, 25mm, 28mm 32mm & 40mm *GEWI*® and accessories, DYNA Force® Monitoring System



United Kingdom and Republic of Ireland
DYWIDAG-Systems International Ltd.
Northfield Road
CV47 0FG Southam
Warwickshire
United Kingdom
Phone +44-1926-81 39 80
E-mail sales@dywidag.co.uk

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DYWIDAG-Systems International is a partner of before-mentioned company.

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