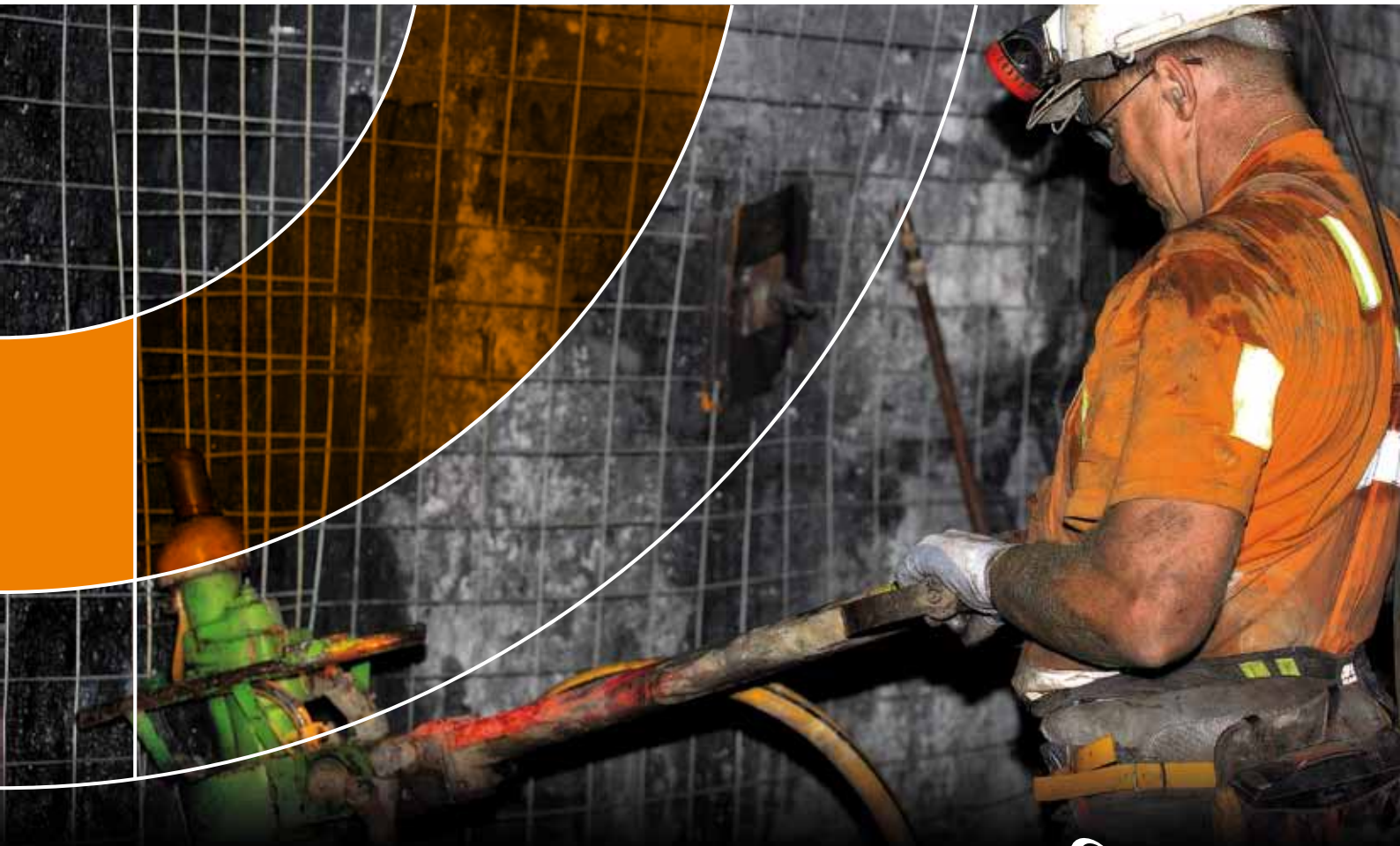




Product Data



Solutions from Materials Technology



A member of the Orica Group



History of the GRP Rockbolts

- 1985
WEIDMANN AG (Switzerland) developed GRP Rockbolts which were installed as permanent support.
- 2003
Rockbolt Systems AG founded and took over GRP Rockbolt Division from WEIDMANN AG and formed Beltec-Rockbolt Systems Group.
- 2008
FiReP® Group unified and new product concept «Durability for the future» started
- 2009
Minova becomes shareholder of FiReP Holding AG

FiReP® and Minova a successful partnership

In 1985 the development and manufacturing of GRP Rockbolts was started and these were used for the first time in a number of tunnelling projects in Switzerland. Today the **FiReP®** Group is one of the world's leading manufacturers of Fibre Reinforced Polymer products for mining, tunnelling and civil engineering with offices in Switzerland, Germany, China and Canada as well as manufacturing facilities in Slovenia and China.

As a consequence of a long-time global cooperation in mining and tunnelling projects, Minova became shareholder of FiReP Holding in 2009. This will strengthen the market positions of both Minova and FiReP. The alliance brings new products and technical expertise to the Minova portfolio and can be offered to Minova and FiReP customers around the world.

FiReP Holding AG is self-financed and successful SME lead by its owners, with headquarters in Rapperswil, situated near Lake Zürich, Switzerland. **FiReP®** develops, produces and distributes technically sophisticated FRP products for the mining, tunnelling and construction markets.

FiReP® is the brand name for Fibre Reinforced Polymer products. Many years of development resulted in the unique all-thread FRP rockbolt. It became standard in the FiReP Group for the whole range of products, which now includes:

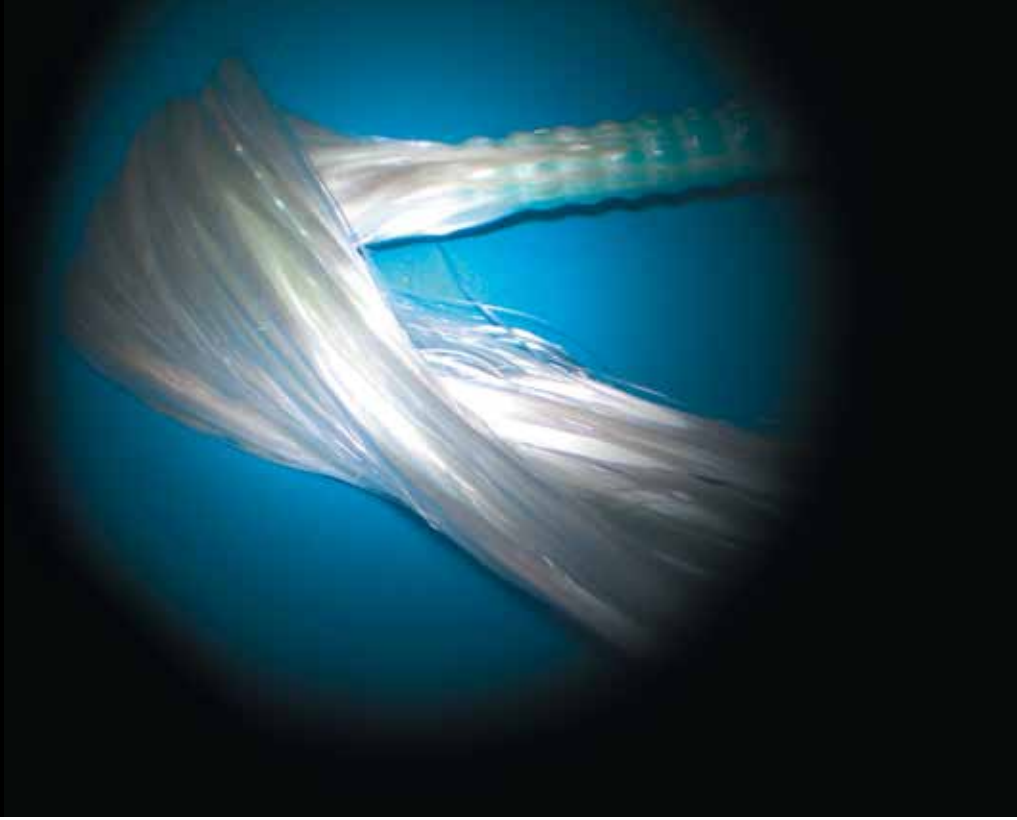
- POWERTHREAD FRP Rockbolts
- SPINMAX FRP Self Drilling Rockbolts
- CABLEX FRP Cable Bolts

The Minova International Group is part of Australian Orica Group, one of the world's leading mining service companies, and a leading supplier of underground mining and consumables in Europe, Russia, North America, South America, South Africa and Asia.

Together its companies have over fifty years of experience contributing towards safer and more productive mining in the fields of underground strata and ventilation control. The range of products includes resin capsules for roof bolting, high volume output grouts and specialised coatings for strata support, resin injection materials for strata support, consolidation and seal construction systems for ventilation control.

Benefits of FiReP® Rebar

- ❑ High corrosion resistance
- ❑ Excellent cuttability
- ❑ Continuous threaded profile
- ❑ High tensile strength
- ❑ Flexibility
- ❑ Low weight
- ❑ Anti-static conditioning optional
- ❑ Anti-magnetic
- ❑ High thermal isolation
- ❑ No electrical conductivity
- ❑ Wide range of various dimensions, diameters and profiles



General Information on FiReP Rebar Technology



FiReP® is the brand name for **Fibre Reinforced Polymer** products made and supplied by the **FiReP®** Group.

The special Fibre Reinforced Polymer is the answer and solution for your problem in many applications.

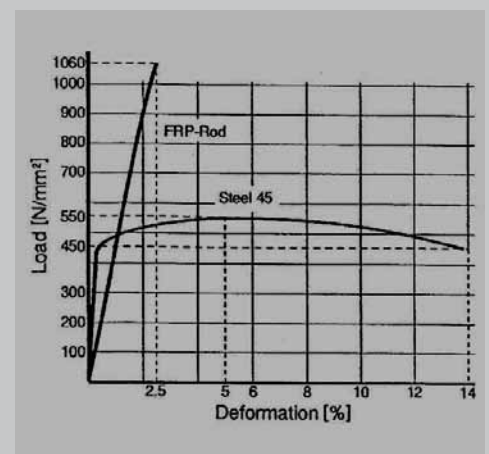
FiReP® has double the strength of standard steel, but only a quarter of the weight. It is corrosion resistant and just about any shape or form can be manufactured.

FiReP® profiles are produced in a pulltrusion process using high quality fibres, with a high fibre content of approximately 80%. The fibres are embedded in either a polyester or vinylester or epoxy resin matrix. This gives the rod a high tensile strength prominent in the longitudinal direction. The resin matrix fixes and protects the fibres.



The surface of **FiReP®** rod or tube is produced in the primary process with a wave shaped thread profile. The additional coating is a protection against mechanical and chemical damage.

	Unit	FiReP®	Steel	Aluminium
Specific Weight	kg/dm ³	2.2	7.8	2.7
Tensile Strength	N/mm ²	800 - 1,000	550 - 800	350
Tensile E-Modulus	N/mm ²	40,000 - 60,000	207,000	69,000
Ultimate Strain	%	2.5 - 3.5	> 15	> 10





Benefits of FiReP® FRP Rockbolts in Mining applica- tions

- High torsion strength
- Excellent cuttability
- Continuous threaded bar
- High tensile strength
- Low weight
- Anti-static coating
- Non-flammable

Mining

The use of **FiReP®** FRP rockbolts in mines continues to grow year on year and FRP rockbolting is becoming one of the most common support systems in the worldwide mining industry. Since the introduction of **FiReP®** FRP rockbolt systems, the choice of FRP rockbolts has increased and new applications have been made possible. At this time, the majority of FRP rockbolts are used in coal mines where they provide the necessary support but can easily be cut and do not impede the excavation of coal

CUTTABILITY IN MINING

Cuttable rockbolts and dowels have been used for a long time in the form of bongossi dowels, wood-FRP and steel-FRP combination or as injection moulded plastic dowels. With all these products there is a price to be paid for cuttability in the form of compromised strength, reduced availability of lengths and anchor head design. **FiReP®** GRP rockbolt systems offer a fully developed range of GRP rockbolts, with options available to support the varied requirements of modern extraction methods.

All system parts are made of polymer and designed to suit the needs of the user's cutting method without compromise. High tensile strength, ease of handling even under the most confined conditions, low weight and a bolt surface free of protruding and skin-irritating glass fibres translate into a product providing economy, security and user-friendliness.

ANTISTATIC COATING

FRP rockbolts can become charged with static electricity during transportation or handling, which can cause dangerous sparks. **FiReP®** GRP rockbolts are available with a special antistatic coating to prevent charge build up.

MORE ADVANTAGES

Since all parts of the **FiReP®** GRP rockbolt systems are manufactured from fibre glass reinforced plastics, the spoil material does not contain any metal parts which would otherwise have to be removed in expensive processes or can damage conveyors and removal systems.

FiReP® GRP rockbolt systems are corrosion resistant and can be used for permanent roadway support without the necessity of periodical replacement of corroded steel bolts. Even aggressive environments do not reduce the lifespan of FRP bolts.

FiReP® GRP rockbolts are only 25% of the weight of regular steel bolts, a fact that simplifies transport and handling saving significant cost.

Due to these characteristics and our high quality, **FiReP®** rockbolts were the first to be certified by German and British Coal Mines. The system is also used in large quantity in German Coal Mines and in several European mines for sole bolt support at the coal faces.

Benefits of FiReP® FRP Rockbolts in Tunnelling applications

- ▼ High corrosion resistance
- ▼ Permanent application
- ▼ Cuttability
- ▼ Continuous threaded bar
- ▼ High tensile strength
- ▼ High end loading
- ▼ Flexibility
- ▼ Low weight
- ▼ Easy handling



Tunnelling



FiReP® FRP rockbolt systems not only open up new design possibilities, but also offer consulting and project engineers a highly useful addition to the more commonly used steel rockbolt systems. They further increase the flexibility of rockbolting, creating a support system which can easily be adjusted to the prevailing rock conditions while excavating.

FiReP® FRP rockbolt systems are best suited in applications that require high tensile strength and the particular characteristics of fibreglass materials. Applied correctly they contribute substantially to the reduction of construction costs.

CORROSION RESISTANCE

FiReP® FRP rockbolt systems are corrosion resistant and therefore the only currently available rockbolt system which can be regarded as permanent, even under difficult conditions with aggressive water and rock deformations.

Corrosion is the most pressing material problem worldwide. With capital, downtime and material costs rising, corrosion prevention is high on many industries' list of priorities. Every minute, several tons of steel are lost to corrosion. The cost of corrosion protection is enormous. Even with protection the corrosion problem is only delayed but not solved. Correctly applied **FiReP®** FRP rockbolt systems support the construction over its entire life.

Because of its anti-corrosion concept, the **FiReP®** FRP rockbolt technology is used more and more increasingly for soil reinforcement and ground anchoring.

SINGLE-LINING SUPPORT SYSTEMS

Because of the durability of the materials, **FiReP®** FRP rockbolt systems can be utilised not only as a temporary support, as with regular steel rockbolts, but also integrated into the calculation for the final load-bearing structure. In-situ concrete shells can therefore be reduced or even eliminated.

This so-called **SINGLE-LINING** tunnel construction method is widely used in Europe in military and civil caverns. The final support consists solely of rockbolts and reinforced shotcrete. With the achieved improvements of those materials, single-lining tunnels will further increase in importance. The cost reductions, especially in the large scale Alpine cross tunnels are enormous. The construction costs of a railway tunnel for low speed or a highway tunnel with moderate traffic can be reduced by up to 50%.



POWERTHREAD FiReP® Rockbolt System

- ▼ Model K60
Solid Rods
- ▼ Model J64
Tubular Rods

POWERTHREAD FiReP® Rockbolt System

The **FiReP® POWERTHREAD** GRP Rockbolt was developed for strata support in mining and tunnelling as well as for slope and face stabilisation.

Due to its continuous thread the bolt can be trimmed if needed. The bolt has a high ultimate load and due to its profile it offers a maximum bond strength with all grouting materials. The cuttability protects machinery and equipment and prevents damage to machinery while drifting and enlarging tunnels. The bolt has a high corrosion resistance and is well suited for permanent support.

The high flexibility is well suited for application without couplings in confined locations. Due to its high tensile strength the bolt has a high and immediate load bearing capacity if applied with fast setting resin capsules. The low weight facilitates handling.



Benefits of FiReP® POWERTHREAD

- ▼ High corrosion resistance
- ▼ Permanent application
- ▼ Cuttability
- ▼ Continuous threaded bar
- ▼ High tensile strength
- ▼ High end loading
- ▼ Flexibility
- ▼ Low weight
- ▼ Easy handling



		Unit	Tubular Bolt		Solid Bolt						
			J64-25	J64-28	K60-20	K60-22	K60-25	K60-27	K60-30	K60-32	K60-38
Outer diameter	mm	25/12	28/12	20	22	25	27	30	32	38	
Tensile stress area	mm ²	250	357	200	250	346	400	510	580	830	
Ultimate load	kN	250	350	200	250	350	400	490	560	750	
Breaking load thread	Steel Nut	kN	150	200	80	100	180	200	200	320	--
	FRP Nut	kN	70	80	60	60	70	80	80	80	--
	POWER Nut	kN	150	180	80	100	180	180	--	--	--
Ultimate strength	N/mm ²	1,000	1,000	1,000	1,000	1,000	1,000	960	960	900	
Torsion resistance	Nm	100	110	60	70	120	130	180	230	--	
Shear resistance	N/mm ²	400	400	460	460	460	460	430	430	400	
Tensile E-Modulus	N/mm ²	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	
Strain at failure	%	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	
Weight	g/m	630	880	560	690	900	1,040	1,330	1,500	2,100	



**FiReP®
Spinset**

SPINSET Anti-Torsion Failure Rockbolt System

The purpose of the new **FiReP® SPINSET** system is to provide a quick and safe bolt installation for a two step application of GRP Rockbolts for underground mining and tunnelling applications. **SPINSET** ensures safe strata control and safe installation of tensioning the bolt with resin capsules. The rock bolt can be installed time and cost effectively, whilst not allowing the SPIN Bolt to be over spun.

SPINSET is composed by SPIN BOLT K61 and SPIN NUT, also SPIN PLATE.

FiReP® SPIN BOLT		
Outer Diameter [mm]	Torsion Strength [Nm]	
	K61	Standard GRP Rockbolt
18	80	50
20	100	60
22	130	80
23	150	100
25	180	120
27	200	130

FiReP® SPIN NUT			
Colour Code	Torsion Strength [Nm]		
	Torque level	Shear Pin	Shear Nep
White	40	35 - 45	--
Blue	60	46 - 65	60 - 70
Red	80	65 - 85	80 - 90
Grey	100	85 - 105	100 - 110
Black	120	105 - 125	120 - 130
Green	140	125 - 145	140 - 150
Yellow	160	--	160 - 170

**Benefits of SPINSET
FiReP® Rockbolt Setting System**

- ▼ High torsion GRP Rockbolt
- ▼ Anti over spin function
- ▼ Easy handling
- ▼ Continuous installation process
- ▼ Installation time saving



SPINSET Anti-Torsion Failure Rockbolt System



FiReP® SPIN PLATE			
Plate Diameter [mm]	Plastic		FRP*
	PP/Black	ABS/White	Natural
130	--	--	> 10 tons
200	6 - 8 tons	10 - 12 tons	> 10 tons
250	6 - 8 tons	10 - 12 tons	> 10 tons



Bolt Diameter	23 mm
Bolt Core Diameter	21 mm
Thread Pitch	10 mm
Effective Bolt Cross Section	368 mm ²
Bolt Weight	750 g/m
Tensile Strength	300 kN
Torsion Strength	150 Nm
Shear Strength	130 kN



SPINMAX FiReP® FRP Self-Drilling Bolt

- ▼ SPINMAX R32-Left hand thread (green)
- ▼ SPINMAX R32-Right hand thread (black)

SPINMAX FiReP® FRP Self-Drilling Bolt

FiReP® SPINMAX is a new generation of the **FiReP®** rockbolt series with considerably improved torque resistance and load bearing capacity of the thread profile for strong jointing with drill bits, nuts and couplers.

FiReP® SPINMAX FRP self-drilling rockbolts are used for:

- Face stabilisation
- Forepoling
- Slope stabilisation
- Ground support in soft rock
- Systematic rockbolting

In combination with injection work of surrounding rock **FiReP® SPINMAX** FRP self-drilling bolts are state of the art.

Due to its cuttability the **FiReP® SPINMAX** FRP self-drilling bolt is an economical alternative to steel and offers enormous advantages for modern rapid heading methods in tunnelling.

Furthermore, the cuttability protects the machinery and avoids obstructions while drifting or enlarging tunnels. The bolts have a high radial pressure resistance for injections with resin or grout and are corrosion resistant for permanent support.

The **FiReP® SPINMAX** offers a high tensile strength and can bear high loads. Its low weight with high torsion resistance makes the bolt well suited for works in loose rock up to a maximum hardness of 60 MPa.

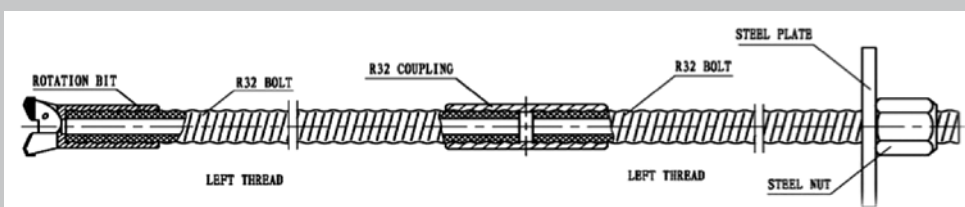



Benefits of FiReP® SPINMAX

- ▼ Super high torque resistance
- ▼ High corrosion resistance
- ▼ Permanent application
- ▼ Cuttability
- ▼ R32 standard thread profile
- ▼ High tensile strength
- ▼ High end loading
- ▼ Low weight
- ▼ Easy handling



	Unit	Standard Specification	
Ultimate load	kN	365	
Tensile stress area	mm ²	332	
Breaking load thread	Steel Nut	kN	120
	Coupling	kN	250
Ultimate strength	N/mm ²	1,100	
Shear resistance	N/mm ²	400	
Tensile E-Modulus	N/mm ²	45,000	
Strain at failure	%	2.5	
Fibre content	%	75	
Torsion resistance	Nm	400	
Weight	g/m	630	
Pitch	mm	12.7 ± 0.2	
Diameter thread (Da)	mm	31.3 ± 0.5	
Diameter core (Db)	mm	28.0 ± 0.5	
Diameter inside (Di)	mm	15.0 ± 0.3	





**HIPREX
FiReP® FRP High
Pressure Injection
Rockbolt**

HIPREX FiReP® FRP High Pressure Injection Bolt

The **FiReP® HIPREX** FRP high pressure injection and bolting system is a new development of a FRP high torque tube, valves and integrated packer for use in stabilising fractured rock and mineral by combining resin injecting and bolting. The high torsion hollow bar is fitted with an expansion packer and integrated non-return valve. Two additional valves are fitted to both ends of the tube, the top valve to burst when the packer is inflated, the bottom valve to prevent backflow after injection.

When starting the injection process the check valve will be opened and the medium will run through the hollow bar filling it and inflating the packer. The non-return valve opens but ensures that the medium will not flow backwards if the hydraulic pressure is reduced. After filling the bolt and packer to a certain pressure the disc will burst and allow rock injection. After injection is complete the non-return valve will close and prevent backflow of the resin. After the resin has cured the hollow bar will be fixed in the hole with a high bond strength.

The FRP system allows cutting during heading or mining of ore. Rapid heading will not be delayed. High corrosion resistance allows permanent application with high durability and the light weight makes handling easy, even in confined underground conditions.

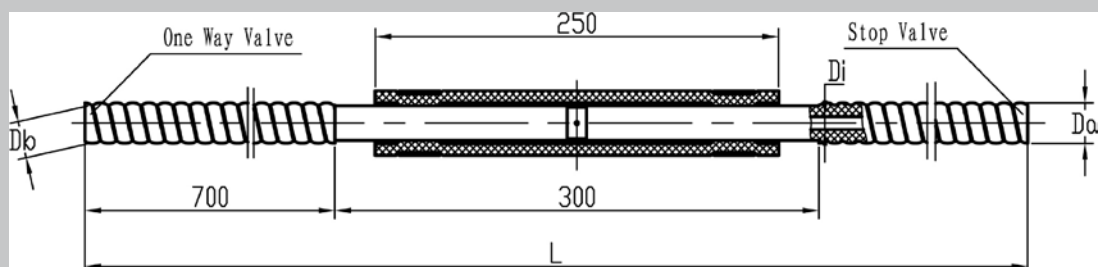


Benefits of FiReP® HIPREX

- ▣ High hydraulic burst pressure > 240 bars
- ▣ High corrosion resistance
- ▣ Permanent application
- ▣ Cuttability
- ▣ Continuous threaded bar
- ▣ High tensile strength
- ▣ High end loading
- ▣ Flexibility
- ▣ Low weight
- ▣ Easy handling
- ▣ Anti-static



	Unit	HIPREX 25/8	
Outer / Inner diameter	mm	28 / 8	
Tensile stress area	mm ²	350	
Ultimate load	kN	350	
Breaking load thread	Steel Nut	kN	180
	FRP Nut	kN	70
Ultimate strength	N/mm ²	1,000	
Tensile E-Modulus	N/mm ²	45,000	
Bending strength	N/mm ²	560	
Burst pressure	bars	240	
Strain at failure	%	2.5	
Weight	g/m	780	
Standard length	m	2.0 / 2.5	





**CABLEX
FiReP® Cable Bolt**

CABLEX FiReP® Cable Bolt

The **FiReP® CABLEX** Cable Bolt with its wide range of possibilities serves all applications that require long bolts e.g. long bolting of pilot tunnels, in confined space, or bolting set from a parallel tunnel. It can also be used for face stabilisation or slope protection.

The **FiReP® CABLEX** Cable Bolt can be assembled easily, either at the factory or directly on the job site, as there are no special tools or equipment required to do so (confined location, complicated transport).

The **FiReP® CABLEX** Cable Bolt has a high corrosion resistance for durable and permanent support. In spite of its low weight it has a high load bearing capacity.

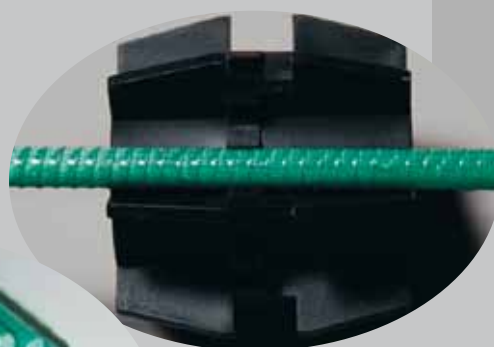
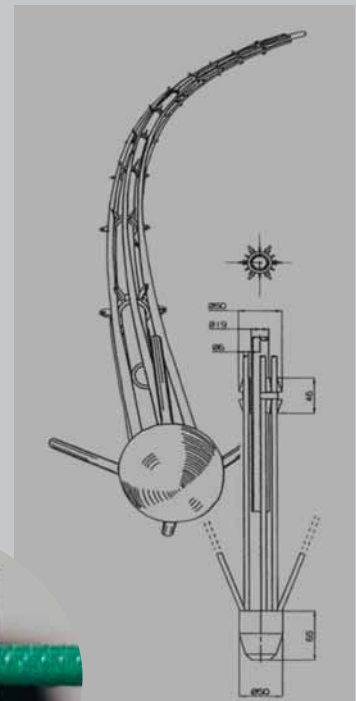


Benefits of FiReP® CABLEX

- ▣ High corrosion resistance
- ▣ Permanent application
- ▣ Cuttability
- ▣ High tensile strength
- ▣ Flexibility
- ▣ Low weight
- ▣ Easy handling
- ▣ Easy assembly on job site



Single Rod	
Diameter [mm]	6
Weight [g/m]	50
Breaking load [kN]	min. 35
Elongation at break [%]	2.5
Bending radius [m]	~ 0.3
Cable Bolt	
Number of rods	6 - 20
Breaking load 6 rods [kN]	210
Breaking load 12 rods [kN]	420
Breaking load 20 rods [kN]	700
Breaking load bolt head [kN]	70 - 200



POWERMESH
FiReP® FRP Mesh

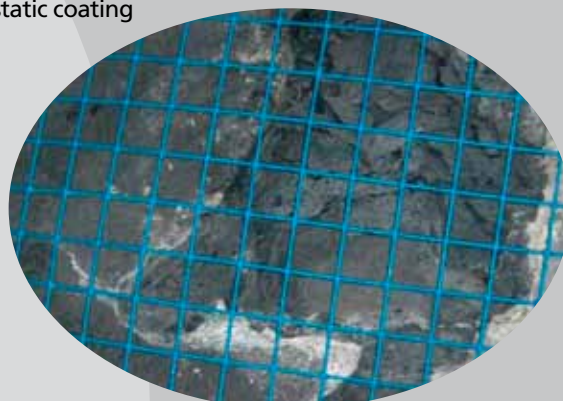
POWERMESH FiReP® FRP Mesh

FiReP® FRP POWERMESH was developed to comply with standard grid applications while providing the added benefits of durability or cuttability. The high load capacity at each joint, comparable to that of welded steel mesh, is unique and makes the design of FRP grid reinforced RC structures viable option for engineers and architects.

FiReP® POWERMESH		
	Unit	Standard 100 x 100 x 6 mm
Rod diameter	mm	6
Spacing	mm	100 x 100
Breaking load of 6 mm rod	kN	> 28.3
Ultimate strength of 6mm rod	N/mm ²	> 1,000
Tensile E-Modulus	N/mm ²	60,000
Load at knot	kN	> 3 and > 5
Overall dimensions	mm	2,000 x 800
Weight	g	1,800

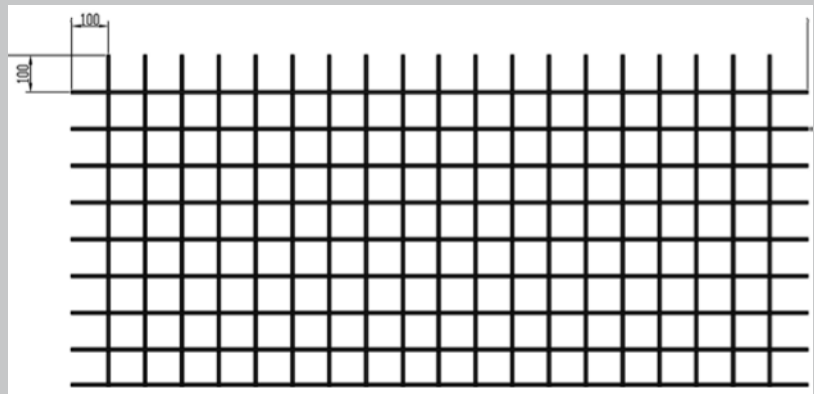
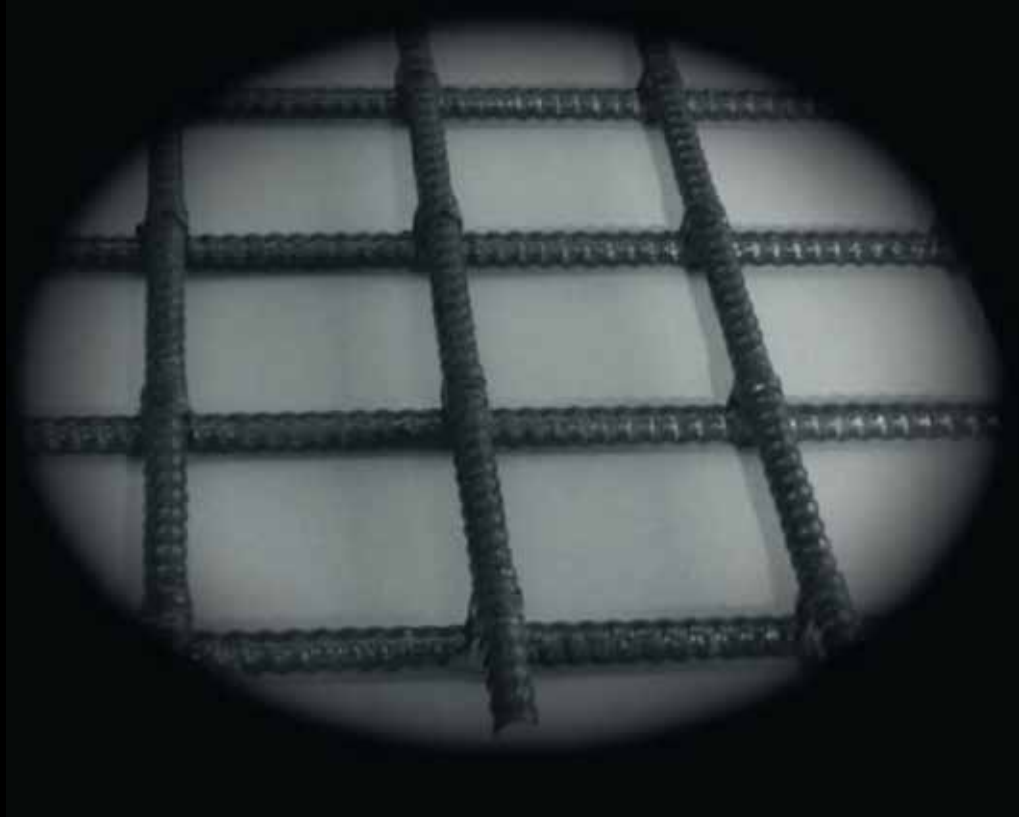
Options:

- Available rod size 3 mm - 12 mm
- Other mesh sizes available on request
- Polyester / Epoxy / Vinyl ester resin
- Non flammable
- Anti-static coating



Benefits of FiReP® POW-ERMESH

- ▣ High corrosion resistance
- ▣ Cuttability
- ▣ High tensile strength
- ▣ Flexibility
- ▣ Low weight
- ▣ Anti-static coating (optional)
- ▣ Anti-magnetic
- ▣ High thermal isolation
- ▣ No electrical conductivity
- ▣ Wide range of various meshes and spacing sizes





Minova Lokset resin capsules

available in different

- ▼ lengths
- ▼ diameters
- ▼ setting times

Minova resins and grouts used with FRP bolts

With **Lokset resin capsules**, **Carbothix** and **Geoflex** the Minova Group offers a range of capsules and dual component injection resins that are ideally suited for bonding FRP bolts.

A **Lokset resin capsule** is a dual component capsule available with various setting times. It contains resin and hardener in two separate chambers. The resin mortar contains unsaturated polyester filled with minerals and anti-settle additives. The hardener, which is colour-coded, contains organic peroxide. As standard, the cartridges are delivered with retainer caps which keep the inserted cartridges from sliding out of the borehole. The number and type of cartridges used can be varied depending on application. A bolt with an optional chisel tip is spun in with a roof bolting machine or with a hydraulic rig. While drilling, the bolt destroys the cartridges and mixes the resin components which immediately start reacting.



Carbothix is a instantly thickening, fast curing dual component silicate resin that can be used for injecting FRP bolts. The resin is CFC and halogen free. It can be used in both overhead and large diameter boreholes since it hardens very quickly after mixing. Once both components have been mixed, the resin instantly achieves a grease-like viscosity so that the mix stops flowing, even in large fissures, and requires pump pressure for displacement. The mix then cures to form a hard resin. The relatively low modulus of the cured resin, combined with its high strength, provides a uniform transfer of local rock stresses over the whole bolt length.



Geoflex is a non-expanding, semi flexible dual component resin having good adhesion even on moist surfaces. The resin is ideally suited for application in cracks of more than 0.25 mm width for grouting coal and adjacent strata, stabilising coal faces and for bolt injection. Geoflex is flexible and, under the stress of strata movement, capable of dissipating deformation energy. The mixture of the two components creates a tough, elastic, solid silicate resin (organic-mineral resin). Once the components have been thoroughly mixed, the viscous emulsion that results is immiscible with water and does not absorb any water (e.g. from the surrounding soil or rock strata). Due to

its density, it tends to sink in water. The cured resin is resistant against acids, alkali, brines and many solvents. Geoflex achieves its ultimate strength much faster than other resins. Just a few minutes after application, it already exceeds an adhesive strength of 1 N/mm² and thus is classified as "immediately load bearing".

FiReP® Special Application

FRP Solar Frame System for photovoltaic modules



FiReP® Special Applications

FRP Solar Frame System for photovoltaic modules



A special solution has been developed using a range of FiReP and Minova products to support photovoltaic (PV) modules for solar power stations in a cost efficient and durable manner.

We call it the Solar Frame system and it consists of UV resistant all-thread FiReP FRP (Fibre reinforced polymer) bars, FiReP FRP self-drilling SPINMAX anchor and Minova injection grouts.

The advantages of the so called FRP active frame concept are:

- Modern and progressive method of construction using durable FRP materials which can be adapted to various geotechnical and climatic conditions
- The active frame lowers consumption of load bearing material (up to 40% in comparison with a passive frame)
- The foundation and end frame is designed in accordance with international codes EN 1537, EN 14199 and EN 12715
- The frame is adaptable to variable terrains and is simple to adjust to the final linearity required for the rows
- The materials used for the foundations are resistant to chemical attack and natural degradation
- Machinery used for installation is widely available
- Speed of construction - anchoring and micro piling technologies can be accompanied by grouting with fast reacting PUR resins, which allows for the construction of the upper section to be completed within a tight time schedule
- No special treatment (e.g. decontamination or replacement) of subsoil necessary
- Allows for acceptable use of problematic and contaminated land with considerable economic advantages
- Acceptable use of brownfield sites will free uncontaminated regular building land (greenfield sites) for other use
- Easy removal of the structure at the end of the lifespan of the solar power plant





Product Service Support

Minova provides a full service support package to customers, including underground pull testing, operator awareness training, underground audits and stock control assistance. Each service package is developed to suit the individual customers requirements.

All aspects of Minova's product service support service is provided by experienced trained and qualified personnel.

Additional Information

For additional information relating to any aspect of this product specification data, including product performance, quality, testing, specification, range, availability etc. please contact your nearest Minova office, or email: technicalsupport@minovaint.com

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July 2010



A member of the Orica Group