



DESCRIPTION

The D-Bolt® is a rock reinforcement bolt comprised of a smooth steel bar with a number of deformed sections that act as anchor points along the bolt's length. The collar end of the D-Bolt® is threaded and is designed to be used in a system with a face plate, spherical washer and a nut that tightens the bolt to the rock face. The bolt is fully encapsulated in a borehole, only constrained to the resin or cement grout at the anchor points. This allows the smooth sections of the bolt, between the anchor points, to deform without constraints and absorb a high amount of energy as the rock mass dilates. The D-Bolt® is available in different lengths as per customer requirements, from approximately 1.5 to 6 meter. A D-Bolt® may also be coupled, where longer lengths are required. D-Bolt®s can be successfully installed using either cement or resin grout.

TYPICAL APPLICATIONS

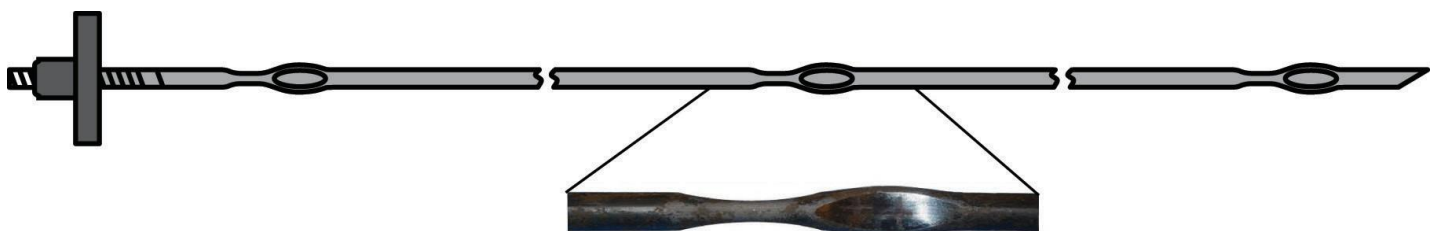
The D-Bolt is used as an effective rock reinforcement element in underground excavations. As a result of its unique ability to both withstand high static load and absorb dynamic energy, it is particularly suited in areas prone to large deformations in the rock mass, including rock burst and squeezing rock areas. The D-Bolt can be installed with standard mechanised bolting equipment, as well as manually, in conjunction with either cementitious grout or resin.

FUNCTIONALITY

The D-Bolt® reinforces the rock mass by constraining the dilation between the anchor points. When the rock mass dilates, the anchor points assume the load and the smooth sections between the anchor points stretch. The load on the smooth sections increases quickly with a small increase in the dilation, until the yield load is reached. Once the yield load is reached the smooth sections undergo plastic elongation until failure. The D-Bolt® absorbs the dilation energy by fully mobilising the strength and deformation capacities of the bolt material. The smooth sections of the D-Bolt® provide localised and independent reinforcement to the surrounding rock mass. This has the important advantage whereby failure of one section of the bolt would not affect the reinforcement function of other sections along the length of the bolt.

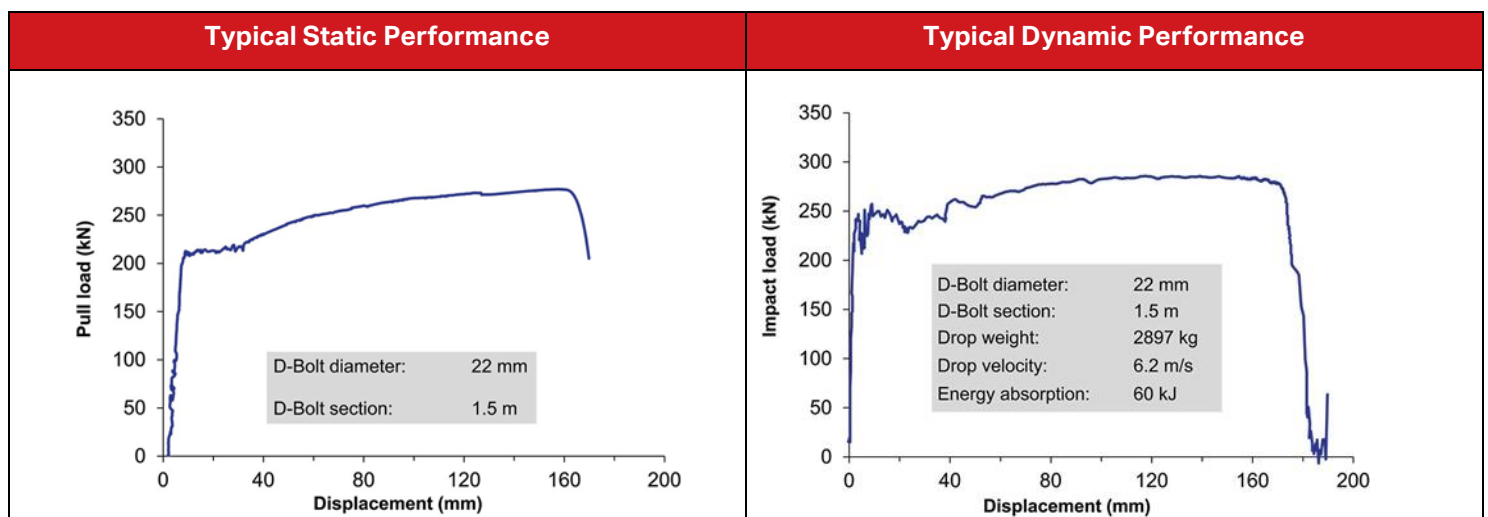
The anchor points are designed to mix two-component cartridge resins when the D-Bolt is spun into the borehole.

The D-Bolt® steel is manufactured using micro-alloyed, engineered carbon steel using specific properties that result in an optimal combination of yield strength, ultimate tensile strength and elongation. The D-Bolt® is also available with a hot dip galvanized (HDG) and/or powder coating that provides further resistance to corrosion.



TECHNICAL PERFORMANCE DATA

Description of Parameter	Ø 20 mm D-Bolt®	Ø 22 mm D-Bolt®
Material property HSLA steel	500 / 700 MPa	500 / 700 MPa
Bar Nominal Diameter	Ø20.3 mm ± 0.2 mm	Ø22.2 mm ± 0.2 mm
Cross Sectional Area	323.49 mm ²	386.88mm ²
Yield Load Theoretical	150 kN	190 kN
Yield Load Typical *)	164 kN ± 5 kN	215 kN ± 6 kN
Ultimate Load Theoretical	210 kN	250 kN
Ultimate Load Typical *)	228 kN ± 10 kN	277 kN ± 8 kN
Elongation at break A5 (A)	22%	22%
Displacement Capacity Static *)	138 mm ± 11 mm	153 mm ± 11 mm
Displacement Capacity Dynamic *)	195 mm ± 11 mm	227 mm ± 10 mm
Dynamic Energy Capacity *)	Min. 45 kJ	Min. 60 kJ
Charpy Test Impact Resistance KCU	Avg. 126 kJ/cm ²	Avg. 148 kJ/cm ²
Bolt Length **)	1.8 m; 2.1 m; 2.2 m; 2.25 m; 2.4 m; 2.7m; 3 m	
Thread Length **)	150 mm – 300 mm	
Thread Sizes ***)	M 22 x 2.5 CW/CWW	M24x3 CW/CWW
Installation – Recomm. Bore Hole Size	29 – 33 mm	31 – 36 mm
*) Canmet Test Results	Canmet MMSL report 10-043 (CR)	And Canmet MMSL Report 12-039(CR)
***) Other dimensions on request		
***) other thread types available on request	i.e. 7/8" UNC9 CCW	RD24.x4.5CCW



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DIMENSIONS / PACKING / THREADS

Diameter and length	
Bar / Anchor Diameter, metric:	20 / 27 mm 22 / 30 mm
Bar / Anchor Diameter, imperial (Americas)	0.8125" / 27 mm 7/8" / 30 mm
Standard Lengths: (Longer lengths and connectable D-Bolts available on request)	1700 to 4000 mm
Section length between anchor points: Standard (Section lengths can be adjusted to tailor individual rock mass conditions and bolt length)	500 – 1500 mm
Standard weight	
Diameter	Kg/m
20 mm	2.47
0.8125"	2.65
22 mm	2.98
7/8"	3.08

Standard Pack	
Bolts per back Bundled with steel bands	50 - 100

Threads	
Bar dia	Thread type, diameter and dir.
20 mm	M22x2.5 clock-wise (CW) M22x2.5 counter clock-wise (CCW) DIN405 R22
0.8125"	7/8" UNC9 CCW DIN405 Rd22 (CCW)
22 mm	M24 x 3.0 CW/CCW M24 x 3.0 CW/CCW R24 x 4.5 CW/CCW DIN405 Rd24 CW/CCW
7/8"	M24 x 3.0 CW/CCW R24 x 4.5 CW/CCW DIN405 Rd24 CW/CCW

Dynamic Rock Bolt

ACCESSORIES

Nuts

- › Standard hex nuts for M22x2.5 and M24x3.0 threads, DIN405 Rd22 and DIN405 Rd24 threads.

Driver Nuts	
Normet HEX driver nut for M22 x 2.5 thread	
Proof load	300 kN
W/ integrated Ø50 mm spherical seat	
Break-out torque (BOT) low	75 – 105 Nm
BOT medium	105 – 145 Nm
Normet HEX driver nut for M24 x 3.0 thread	
Proof load	300 kN
W/integrated Ø50 mm spherical seat	
BOT low	75 – 105 Nm
BOT medium	105 – 145 Nm
BOT high	160 – 200 Nm
F&J Dome nut, FJT-2	
BOT medium	105 – 145 Nm
F&J Square FSN nut with shear pin	
BOT low	75 – 105 Nm
BOT medium	105 – 145 Nm
BOT high	160 – 200 Nm

- › Flange nut HEX M24 for replating
- › F&J Flange nut square 7/8" UNC9 or M24x3.0 for replating
- › Nut threads can come in both CW and CCW directions

Spherical Washers

- › F&J FSW-1 Ø50 washer
- › Ø52 washer, hole Ø26, height 21 mm

Coupler

Dia. Ø33

Length 150 mm

Plates

- › D-Plate, Ø150x4 mm, hole 38, for Ø20 D-Bolt®
- › D-Plate, Ø150x6 mm, hole 38
- › D-Plate, Ø200x6.5 mm, hole 34
- › D-Plate, square 150 mm x 150 mm x 4.5 mm, hole Ø34
- › D-Plate, square 150 mm x 150 mm x 4.5 mm, hole Ø39

Standard Dome plate Ø200x6 mm, hole Ø38

- › Standard Dome plate, square 6" x 0.25", hole Ø34, for Ø20 (0.8125") D-Bolt®
- › Standard Dome plate, square 6" x 0.25", hole Ø34, for Ø22 (7/8") D-Bolt®
- › Standard Dome plate, square 8" x 0.25, hole Ø34, for Ø22 (7/8") D-Bolt®

The D-Bolt may also be used with other plates and spherical washers, with compatible designs and performance.

Wedge

- › Kiruna type wedge, Ø20x120 for immediate support in cement grout, load-bearing capacity approx. 30 kN

Drivers

North America

- › Socket size 36 mm/ 1"7/16, impact resistant 6 pt/12 pt driver, hex 25, 84 cm long for bolters
- › Socket size 36 mm/ 1"7/16, impact resistant 6 pt/12 pt driver, hex 22, 60 cm for hand held drills
- › Socket size 36 mm/ 1"7/16, impact resistant 6 pt/12 pt driver, hex 22, 36 cm for hand held drills

Australia:

- › Socket size 36AF hex T38 or R38 thread, 90 cm long. Other lengths can be obtained.

INSTRUCTION GUIDELINES FOR THE D-BOLT® USING RESIN GROUT

Recommended Borehole Diameter Range

D-Bolt® Ø20 / 0.8125":	Min. 29 mm Max. 33 mm
D-Bolt Ø22 / 7/8":	Min. 32 mm Max. 36mm

*Max. Ø39 mm with extra mixing paddle (Ø32)

Recommended Resin Cartridge Diameter

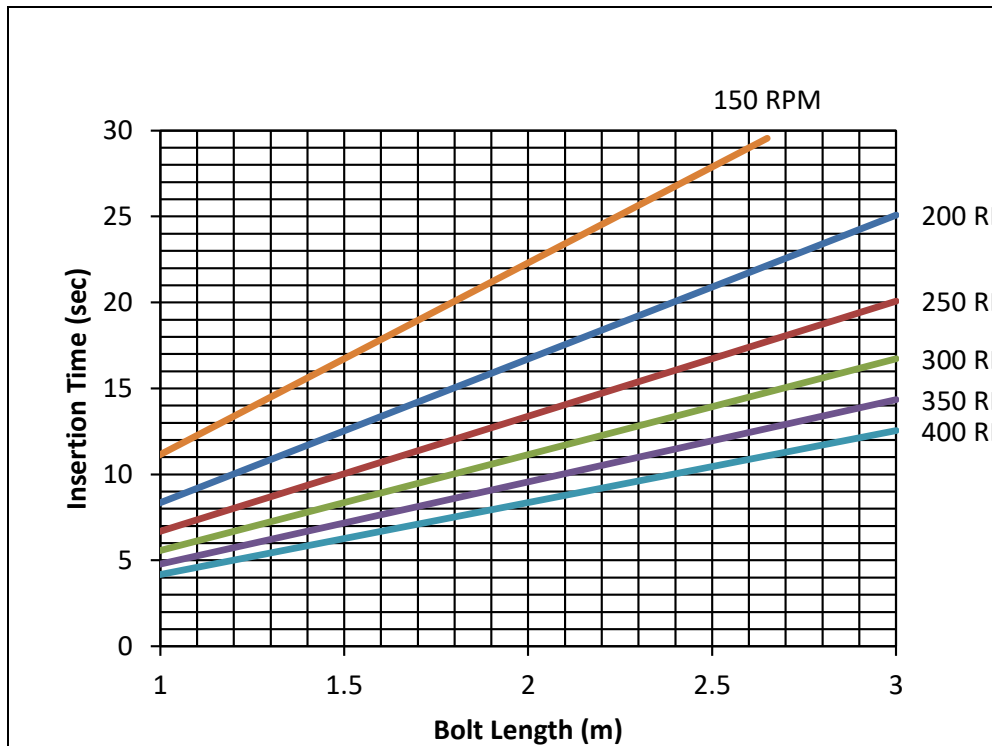
D-Bolt dia.	Bore hold dia.	Resin Cartridge dia.
Ø20 - 0.8125"	29 - 31 mm	22 - 24 mm
	31 - 33 mm	26 - 28 mm
Ø22 - 7/8"	32 - 34 mm	26 - 28 mm
	34 - 36 mm	29 - 31 mm

General Procedure

- › Bolt is inserted into the borehole following site specifics procedures and equipment.
- › For optimal performance, the angle between the bolt and the normal to the rock face should not exceed 15 degrees.
- › Bolt is spun into the borehole until the nut and plate are close to the rock surface/mesh, approximately 20 to 50 mm.
- › Bolt is spun for an additional 5-15 revolutions after stop of advance.
 - 1-3 seconds for mechanized bolters
 - 3-4 seconds for hand held equipment
- › Bolt anchor points must be fully encapsulated in the borehole for optimal D-Bolt® performance.
- › For optimal, long-term performance of the D-Bolt®, the resin should reach a min. UCS of 35 MPa when fully cured.

For detailed instructions of insertion and grouting process see page 6

D-Bolt® Spin Times as Function of rpm and Bolt Lengths¹

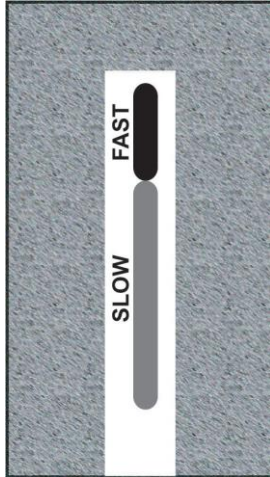


¹ May vary with temperature and other local conditions

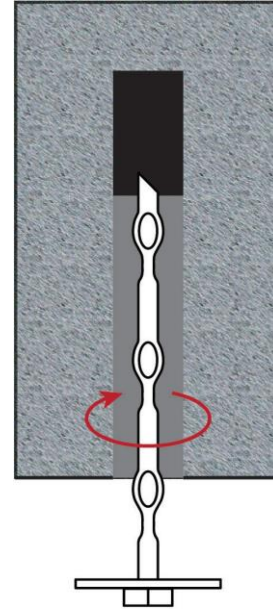
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INSTALLATION GUIDELINES FOR THE D-BOLT® USING RESIN CARTRIDGES

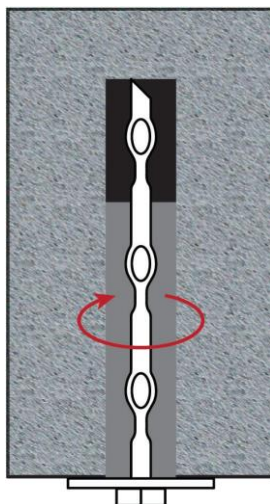
1. Insert one or two FAST cartridge(s) to the bottom of the hole and SLOW cartridges to the rest of the hole.



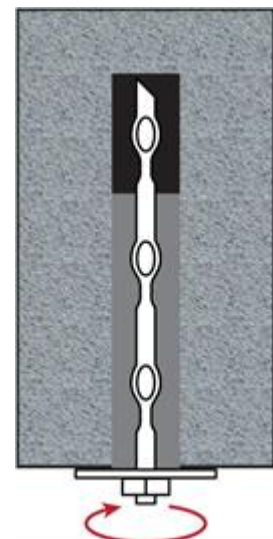
2. Push and spin the bolt into the hole. Find the proper insert time in the chart of insert time.



3. Continue to spin the bolt for at least 5-10 revolutions after the bolt reaches the bottom.



4. Stop rotation and hold the bolt until the FAST resin hardens and then rotate the nut to apply a small tension load.



INSTRUCTIONS FOR INSTALLING THE D-BOLT USING PUMABLE GROUT

Recommended Borehole Diameter Range

D-Bolt Ø20 / 0.8125":	Min. 29 mm Max. 35 mm
D-Bolt Ø22 / 7/8":	Min. 32 mm Max. 38mm

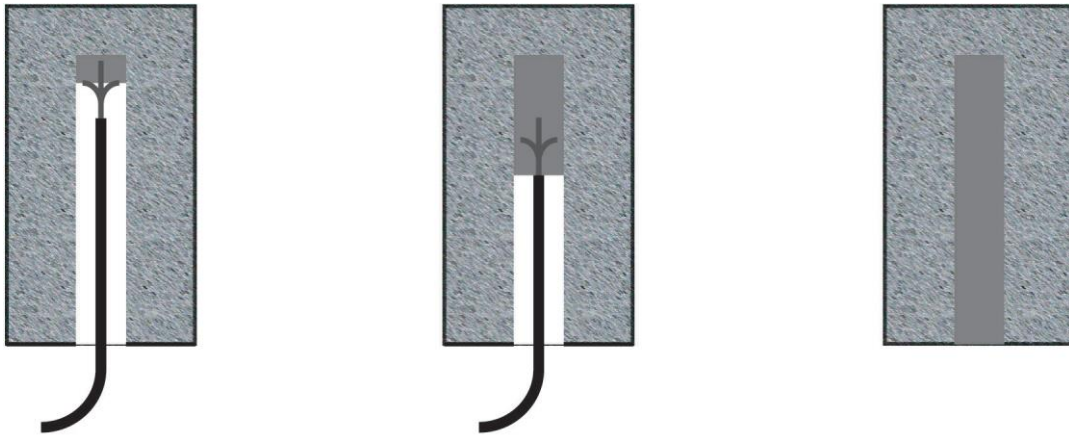
Recommended Borehole Diameter Range

Min. 0.35 – Max. 0.40

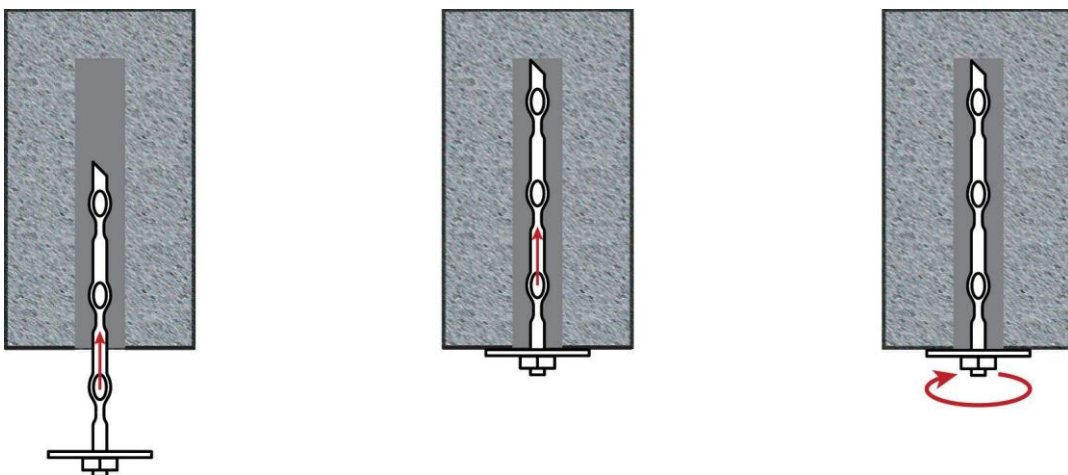
General Installation Procedure

- › Bolt is inserted into the borehole as needed, depending of equipment and dimensions of excavation, see illustrations below.
- › For optimal performance, the angle between the bolt and the normal to the rock face should not exceed 15 degrees.
- › Bolt must be fully encapsulated in the hole.
- › For optimal, long-term performance of the D-Bolt, the cement/resin grout should reach a min. UCS of 35 MPa after curing.

Visual Instructions for Cementitious Grouting of D-Bolt



1. Pump the cement grout with hose from bottom until the hole is completely filled.



2. Insert D-Bolt® up to the bottom of the borehole according to the installation procedure.

3. Wait the necessary time in order that the grout reaches the indicated resistance.

4. Tighten plate and nut with the indicated tension.

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