General description

The D-Bolt is a rock reinforcement element comprised of a smooth steel bar with a number of deformed sections that act as anchor points along its length. The collar end of the D-Bolt is threaded and is designed to be used with a face plate, spherical washer and a nut that fastens the bolt. The bolt is fully encapsulated in a borehole, but it is only constrained to the grout or resin along the anchor points. This allows the smooth sections of the bolt, between the anchor locations, to deform without constraints and absorb energy as the rock mass dilates.

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 dilution, 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. D-Bolt is also available with a hot dip galvanized (HDG) and/or powder coating that provides further resistance to corrosion.

Typical applications

The D-Bolt can be 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. D-Bolt can be installed with standard mechanized bolting equipment, as well as manually, in both cementitious grout and resin.
Technical performance data

<table>
<thead>
<tr>
<th>Mechanical properties</th>
<th>20 mm D-bolt</th>
<th>22 mm D-bolt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum *</td>
<td>Typical **</td>
</tr>
<tr>
<td>Yield load (kN)</td>
<td>140</td>
<td>150</td>
</tr>
<tr>
<td>Tensile load (kN)</td>
<td>190</td>
<td>210</td>
</tr>
<tr>
<td>Bolt’s elongation (%)</td>
<td>-</td>
<td>15%</td>
</tr>
<tr>
<td>Static energy absorption (kJ/m)</td>
<td>-</td>
<td>26</td>
</tr>
<tr>
<td>Dynamic energy absorption (kJ/m)</td>
<td>-</td>
<td>31</td>
</tr>
<tr>
<td>Shear load (kN)</td>
<td>-</td>
<td>180</td>
</tr>
<tr>
<td>Mass per meter bar (kg/m)</td>
<td>2.5</td>
<td>-</td>
</tr>
</tbody>
</table>

* Based on the steel specification
** Based on laboratory test results

Typical static performance

Typical dynamic performance

D-Bolt diameter: 22 mm
D-Bolt section: 1.5 m
## Dimensions, packing, threads

### Diameter and length

<table>
<thead>
<tr>
<th>Bar/anchor diameter, metric:</th>
<th>20/27 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>22/30 mm</td>
</tr>
<tr>
<td>Bar/anchor diameter, imperial:</td>
<td>0.8125&quot; /27 mm</td>
</tr>
<tr>
<td>(Americas)</td>
<td>7/8&quot; / 30 mm</td>
</tr>
</tbody>
</table>

**Standard lengths:**
1700 to 3000 mm
(Longer lengths and connectable D-Bolts available on request.)

**Section lengths between anchor points:**
- **Standard**: 500 - 1500 mm
- (Section lengths can be adjusted to tailor individual rock mass conditions and bolt length).

### Standard weight

<table>
<thead>
<tr>
<th>Diameter</th>
<th>kg/m</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mm</td>
<td>2.47</td>
</tr>
<tr>
<td>22 mm</td>
<td>2.98</td>
</tr>
<tr>
<td>0.8125&quot;</td>
<td>2.65</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>3.08</td>
</tr>
</tbody>
</table>

### Standard pack

- Bolts per back: 50 - 100
- Strapped with steel bands.

### Threads

<table>
<thead>
<tr>
<th>Bar dia</th>
<th>Thread type, diameter and dir.</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 mm</td>
<td>M22x2.5 clock-wise (CW)</td>
</tr>
<tr>
<td></td>
<td>M22x2.5 counter clock-wise (CCW)</td>
</tr>
<tr>
<td>0.8125&quot;</td>
<td>7/8&quot;UNC9 CCW</td>
</tr>
<tr>
<td>22 mm</td>
<td>M24x3.0 CW</td>
</tr>
<tr>
<td></td>
<td>M24x3.0 CCW</td>
</tr>
<tr>
<td></td>
<td>R24x4.5 CCW</td>
</tr>
<tr>
<td>7/8&quot;</td>
<td>M24x3.0 CCW</td>
</tr>
<tr>
<td></td>
<td>R24x4.5 CCW</td>
</tr>
</tbody>
</table>
Accessories

Nuts

- Standard hex nuts for M22x2.5 and M24x3.0 threads.
- Driver nuts:
  - Normet HEX driver nut for M22x2.5 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 M24x3.0 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
- 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.
- BJR Ø52 washer, hole Ø26, height 21 mm.

Plates

- EUR D-Plate, Ø150x4 mm, hole 38, for Ø20 D-Bolt.
- EUR D-Plate, Ø150x6 mm, hole 38, for Ø22 D-Bolt.
- NA D-Plate, square 150 mm x 150 mm x 4.5 mm, hole Ø34, for Ø20 (0.8125") D-Bolt.
- NA D-Plate, square 150 mm x 150 mm x 4.5 mm, hole Ø34, for Ø22 (7/8") D-Bolt.
- 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 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.

Normet reserves the right to change this specification without further notice.
Example instructions for installing the D-Bolt using resin grout

Recommended borehole diameter range

- **D-Bolt Ø20 / 0.8125"**:
  - min. 29 mm
  - max. 33 mm
- **D-Bolt Ø22**:  
  - min. 32 mm
  - max. 36 mm

Recommended resin cartridge diameter

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Ø20 - 0.8125&quot;</td>
<td>29 - 31 mm</td>
<td>22 - 24 mm</td>
</tr>
<tr>
<td>31 - 33 mm</td>
<td>26 - 28 mm</td>
<td></td>
</tr>
<tr>
<td>Ø22 - 7/8&quot;</td>
<td>32 - 34 mm</td>
<td>26 - 28 mm</td>
</tr>
<tr>
<td>34 - 36 mm</td>
<td>29 - 31 mm</td>
<td></td>
</tr>
</tbody>
</table>

General procedure

- Bolt is inserted into the borehole following site specifics procedures and equipment.
- 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 detailed instructions of insertion and grouting process see page 6.

Example of diagram of bolt spin times as function of rpm and bolt lengths

1. Example of diagram of bolt spin times as function of rpm and bolt lengths

   ![Example of diagram of bolt spin times as function of rpm and bolt lengths](image_url)

   1 May vary with temperature and other local conditions

Normet reserves the right to change this specification without further notice.

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info@normet.com
Instruction for resin grouting of D-Bolt (example with left hand thread)

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.
General instructions for installing the D-Bolt using cementitious 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. 38 mm

Recommended water/cement ratio

- 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.
- Bolt must be fully incapsulated in the hole.

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.