



Let's connect

# Pc-Bolt™

Combination bolt for rock support (tube bolt)  
Option: Pc-Packer



## Combination bolt

A combination bolt is installed for immediate support of rock, anchored by an expansion shell, to be fully grouted at a later stage, allowing it to be classified as permanent support. The advantage is that a single bolt is effective for immediate work protection at the face after torque tensioning, while later gaining additional corrosion protection by the grouting.

The combination bolt may be used for most ground conditions, but excluding ground subjected to strain bursting and very large contour convergence. The injected grout improves the corrosion protection provided by the Pc-Coat™. Such bolts are therefore highly attractive for very corrosive environments like subsea tunnels. The end-anchorage with tensioning of the tube bolt and the cementitious mortar embedment creates a very stiff system offering extended durability.

Any tunnel may cross zones of variable need of corrosion protection for bolts, but to classify the exposure level may be difficult.

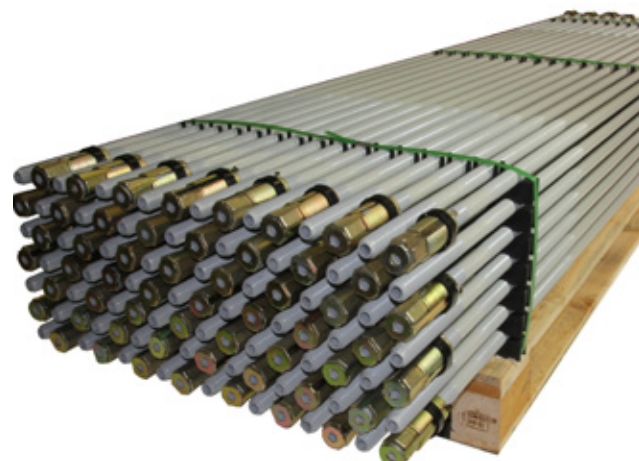
One mitigation strategy may be to use the well protected Combination Bolt along all of the tunnel length.

The Pc-Bolt™ may be used under most ground conditions, except when very high rock stresses may produce large radial deformations or strain bursting.

We produce two types of combination bolts - NC-Bolt (rebar bolt) and Pc-Bolt™(tube bolt). Product data sheets and brochures for both bolt types can be downloaded from [www.pretec.no](http://www.pretec.no)



Factory in Haining, Zhejiang, China.  
Total area: 22000 m2. Content: mechanical production,  
hot dip galvanizing and powder coating.



Pc-Bolt™ packed on pallet.



## Installation, equipment

Installation takes place in two steps:

- 1) Place the bolt in the hole and tension it by applying correct torque on the nut.
- 2) Grout injection for permanent anchoring and protection.



Immediate support by placement and tensioning at the tunnel face.



The grouting tool gets attached to the bolt end before start of the mortar pump. Two types of grouting tools are available.



Mortar gets pumped through the tube bolt from the bolt end.



Grouting through the tube ensures optimal result, filling the annular space from bottom of hole out to the circular bearing plate. A technique which reduces risk of air pockets along the bore hole.



In the bearing plate you can see the hole where grout will be squeezed out when the borehole is completely filled.

The pictures are freeze-frames from our animation film that can be found by searching for: "Pc-Bolt combination bolt" at [www.youtube.com](http://www.youtube.com) or our webpage [www.pretec.no](http://www.pretec.no)

## Technical information



Pc-Bolt™ ready for installation

### Specifications

Dimension	Material <sup>1)</sup>	Thread length	Weight	Borehole	
				Diameter, mm	Depth <sup>3)</sup>
M27/15	40Cr <sup>1)</sup>	2xM27x150mm	2,51kg/m	Ø45-48	L+150mm
R27/15	40Cr <sup>1)</sup>	R27 whole length	2,78kg/m	Ø45-48	L+150mm
R27/12	40Cr <sup>2)</sup>	R27 whole length	3,12kg/m	Ø45-48	L+150mm

### Mechanical properties

Dimension	Tension area $A_s$	Yield stress $R_{eh}$	Tensile stress $R_m$	Ductility $A_{gt}$
M27/15	314 mm <sup>2</sup>	Min. 500 N/mm <sup>2</sup>	Min. 600 N/mm <sup>2</sup>	Min. 8%
R27/15	319 mm <sup>2</sup>	Min. 500 N/mm <sup>2</sup>	Min. 600 N/mm <sup>2</sup>	Min. 8%
R27/12	382 mm <sup>2</sup>	Min. 660 N/mm <sup>2</sup>	Min. 830 N/mm <sup>2</sup>	Min. 12% <sup>4)</sup>

### Minimum load capacity

Dimension	End anchored		Fully grouted		Torque Nm	Pre-tension kN
	Yield kN	Failure kN <sup>5)</sup>	Yield kN	Failure kN		
M27/15	157	186	157	186	200-300	40-70
R27/15	159	191	159	191	200-400 <sup>6)</sup>	20-40
R27/12	246	270	246	270	200-400 <sup>6)</sup>	20-40

<sup>1)</sup> According to DIN EN 10083-3. Heat treated according to GB/T 16923

<sup>2)</sup> 8.8 according to ISO 898-1

<sup>3)</sup> L=bolt length

<sup>4)</sup> Elongation, A5

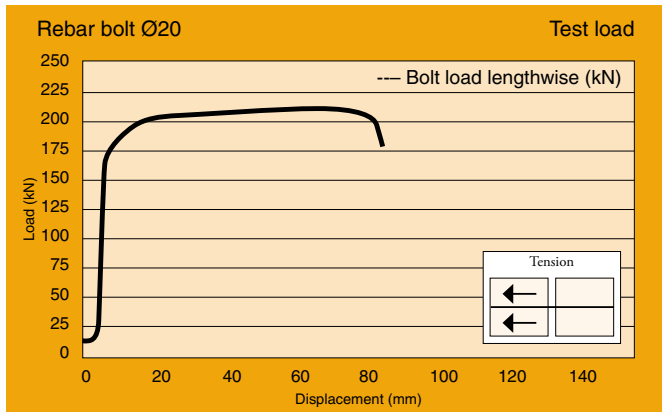
<sup>5)</sup> Poor and soft rock quality may give lower values. Test on site under actual conditions to correctly establish representative values.

<sup>6)</sup> Recommended torque with hexagon dome nut.

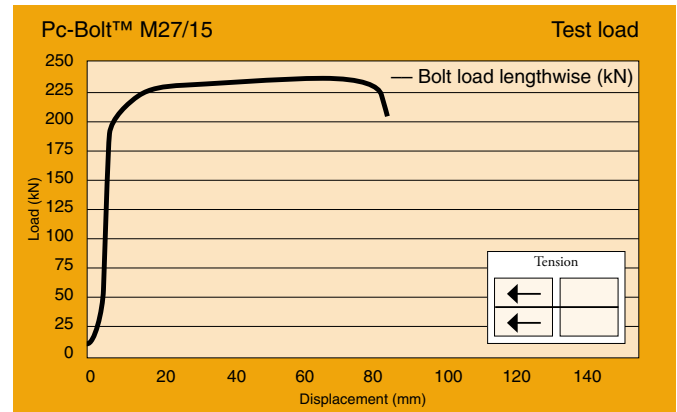
## Test results

A series of tests have been performed at SINTEF laboratories documenting the standard M27/15 Pc-Bolt™ capacity compared with Ø20 rebar.

Graphs 1 and 2 show a comparable load test of rebar Ø20 B500NC and M27/15 Pc-Bolt™

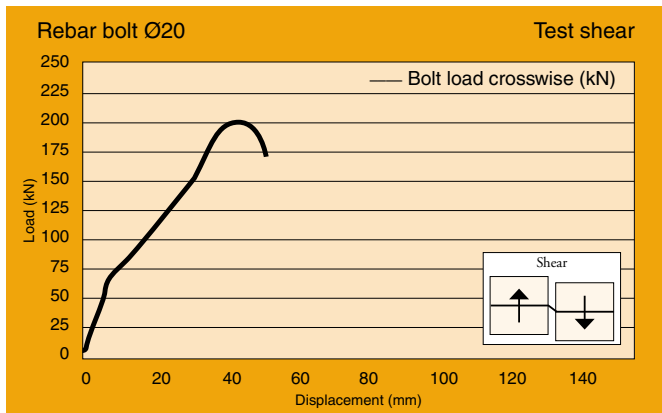


Graph 1 Load test rebar Ø20 B500NC

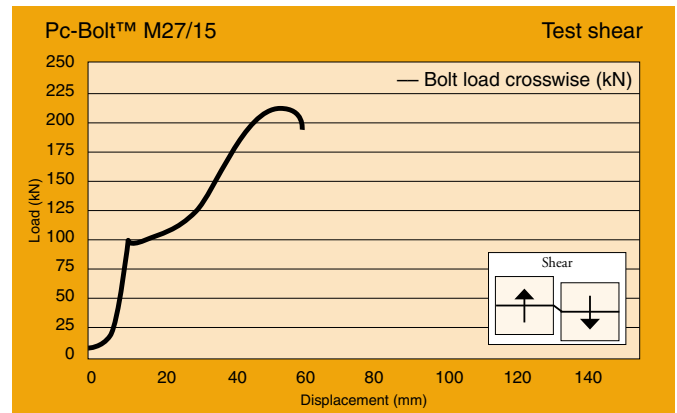


Graph 2 Load test M27/15 Pc-Bolt™

Graphs 3 and 4 show a comparable shear test of grouted rebar Ø20 B500NC and M27/15 Pc-Bolt™.



Graph 3 Shear test rebar Ø20 B500NC



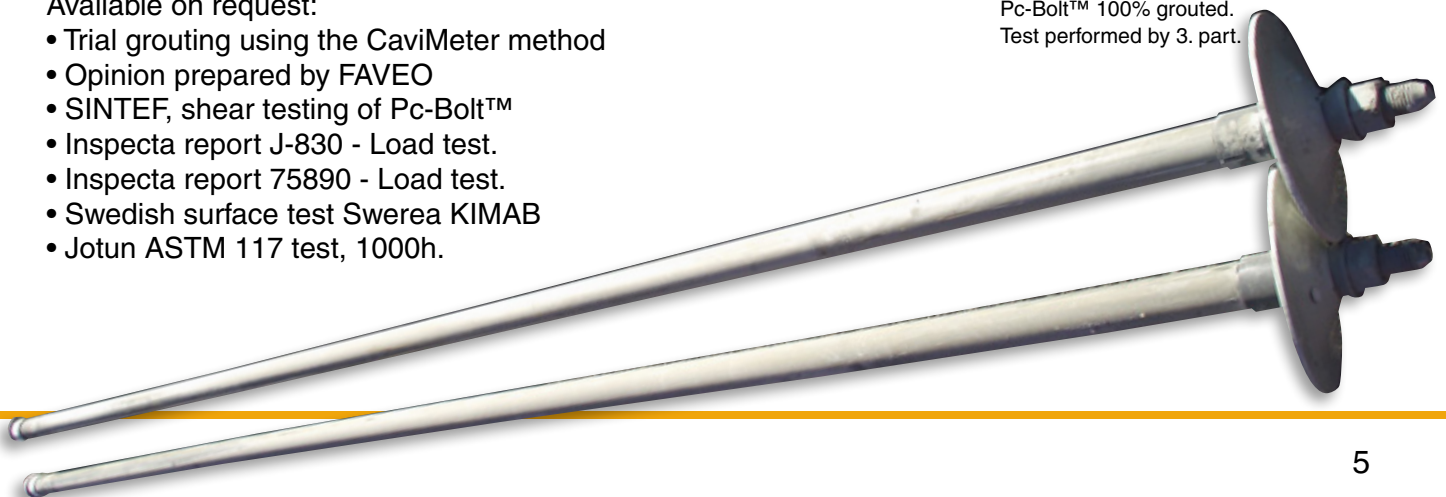
Graph 4 Shear test M27/15 Pc-Bolt™

## References & third party reports

Available on request:

- Trial grouting using the CaviMeter method
- Opinion prepared by FAVEO
- SINTEF, shear testing of Pc-Bolt™
- Inspecta report J-830 - Load test.
- Inspecta report 75890 - Load test.
- Swedish surface test Swerea KIMAB
- Jotun ASTM 117 test, 1000h.

Pc-Bolt™ 100% grouted.  
Test performed by 3. part.



## Stock program

Pc-Bolt™ is available in different types and lengths:  
M27/15 and R27/15 equivalent capacity to rebar Ø20 B500NC.  
R27/12 equivalent capacity to rebar Ø25 B500NC.  
All types are available in lengths from 1500mm to 6000mm.  
A connecting sleeve may be used to produce longer bolts.



Standard packing

### References & third party reports

Mix pure cement and water with a suitable water-reducing admixture.  
Typical water/cement-ratio is 0.3-0.4. Contact your cement admixture supplier for selection of admixture product.  
Carry out pre-construction testing on Site to establish correct mortar consistency. For more detailed information, please see own brochure "Grout recommendations" on [www.pretec.no](http://www.pretec.no)



Safe grouting tool



Quick grouting tool

To ensure proper and safe grouting, the safe Pretec grouting tool is recommended. Option for quick grouting is also available.

### Accessories

- Spherical bearing plate with hole for evacuation of air. Suitable for angle deviation up to 30° when used with dome nut or half ball compact.
- Ring clips ensures that the bolt is held in the center of the hole so grout embraces the entire bolt.
- Dome nut for R27/15 and R27/12 Pc-Bolt™. Fast and easy installation.
- Connecting sleeve for R27/15 and R27/12 Pc-Bolt™.
- Compact half ball and nut for M27/15 Pc-Bolt™. Recommended if you want highest possible pre-tension with low torque.
- Expansion shell for all types of Pc-Bolt™. Due to superior design, the expansion shell will provide immediate anchoring effect when the bolt has been installed and tensioned.



Expansion shell is mounted on the bolt from factory and is a part of the bolt.  
It is also available loose. Other accessories like bearing plate, must be ordered separately.

## Pc-Packer

The preferred solution used together with Pc-Bolt™ when you have water in the bore hole.

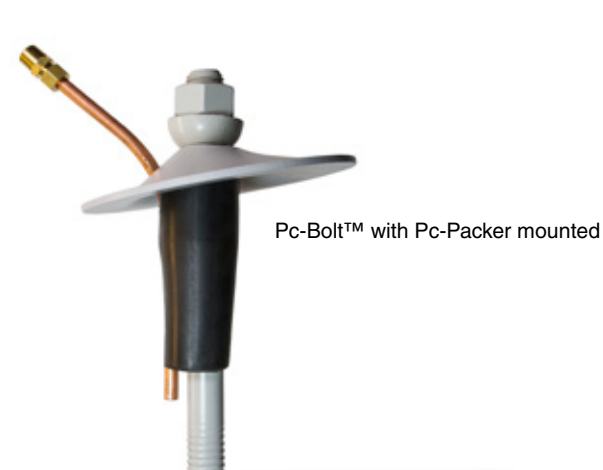


Pc-Bolt™ with Pc-Packer mounted, ready for installation

Put the Pc-Packer on to the Pc-Bolt™, and add the spherical plate and nut/halfball. The metall grouting pipe shall be put through the hole in the spherical plate. The Pc-Bolt™ and Pc-Packer is now ready for installation. During tensioning of the bolt the rubber packer is squeezed into the bore hole and seals it completely.

The bolt should be grouted through the metall pipe in the Pc-Packer using the interior hole in the bolt for evacuation of air and possible water. For grouting we recommend using the safe

grouting tool for Pc-Packer. When grout is coming out of the interior hole in the bolt end, it can be sealed using a cap nut with hose. The hose can be closed by bending or squeezing it flat with a plier. To prevent water and grout to be sprayed directly towards the operator, we recommend using our original cap nut with hose to steer the water and grout away to safe area. Pc-Packer is available for different bolt and bore hole diameters.



Pc-Bolt™ with Pc-Packer mounted



Safe grouting tool



Cap nut with hose



More information regarding grouting of Pc-Bolt™ with Pc-Packer can be found in our brochure "Grouting recommendations".



### 3-layer surface Pc-Coat™

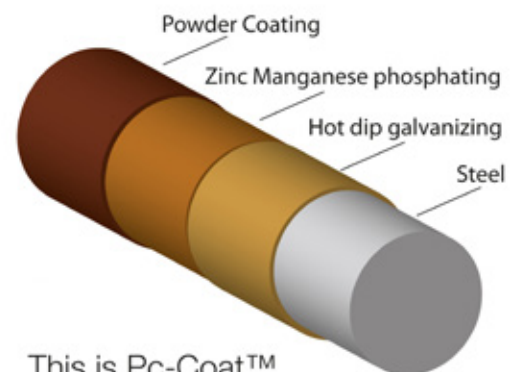
The hot dip galvanizing "fuses" with the steel. Ref. NS-EN ISO 1461.

Zinc & Manganese Phosphating provides a very strong bond with the hot dip galvanizing.

In addition, powder coating bonds extremely well to the phosphate. Ref. NS-EN 13438.

#### From steel to treatment-finished bolt

The image to the left shows the bolt's treatment in four stages, described in the graphic illustration below.



This is Pc-Coat™

Please refer to product technical data sheet for Pc-Coat and relevant management, operations and maintenance documentation and Pc-Coat™ brochure which may be downloaded at [www.pretec.no](http://www.pretec.no)





## Quality control

Our manufacturing plant Zhejiang Pretec Metal Products Co. Ltd. is certified according to ISO 9001 and EN 1090-1 with complete manufacturing control of all production steps. They are also environmentally certified according to ISO 14001.

Our CE product marking provides trace documentation from the steel mill to the final product, allowing Pretec to take full responsibility for providing the specified quality through the whole value chain.

We are continuously testing during manufacturing to ensure that our products will satisfy both the specifications and the expectations of the market, our customers and the construction site owner.

Certificates in compliance with EN 10204 3.1 are available for inspection. Pc-Bolt™ M27/15 and R27/15 are approved by the Norwegian Public Road Administration and Bane NOR (Norwegian Railway Authority).



Standard label marked with certificate number



Pretec China laboratory



Control of coating thickness

## Advantages: The Pc-Bolt

- Duplex corrosion protection: Hot dip galvanized and epoxy powder coated tube bolt and completely embedded in mortar, provides extended durability under all conditions.
- Highly efficient because it is suitable in most ground conditions and covers both immediate and permanent support in a single bolt.
- Same capacity whether it is temporarily end-anchored or fully embedded. Fully embedded provides an extra corrosion protection which ensures durability of the bolt.
- Bolts are delivered with zinc coated expansion shells mounted from the factory. This ensures proper function of the threads and the coating prevents corrosion until fully grouted. Less work on site saves time and there are fewer parts to handle for stock management.
- Bolts are clamped in groups and loaded on pallets. This prevents transport damage and simplifies managing number of bolts in stock.
- Easy and fast to grout. Also, the grouting process with Pc-Bolt is a minimal risk for the operators because the grouting tool is mounted directly on the bolt with threads.
- After mounting, the protruding part of the bolt is minimal which is important if a smooth sprayed concrete surface is needed for later installation of water proofing sheet membrane.
- The Pc-Bolt accessories allow grouting of the bolts also after application of sprayed concrete.
- Less sensitive regarding rough surface in bore hole walls, improper bore hole cleaning and long bore holes that are not straight.



Pc-Bolt™ with mounted expansion shell.

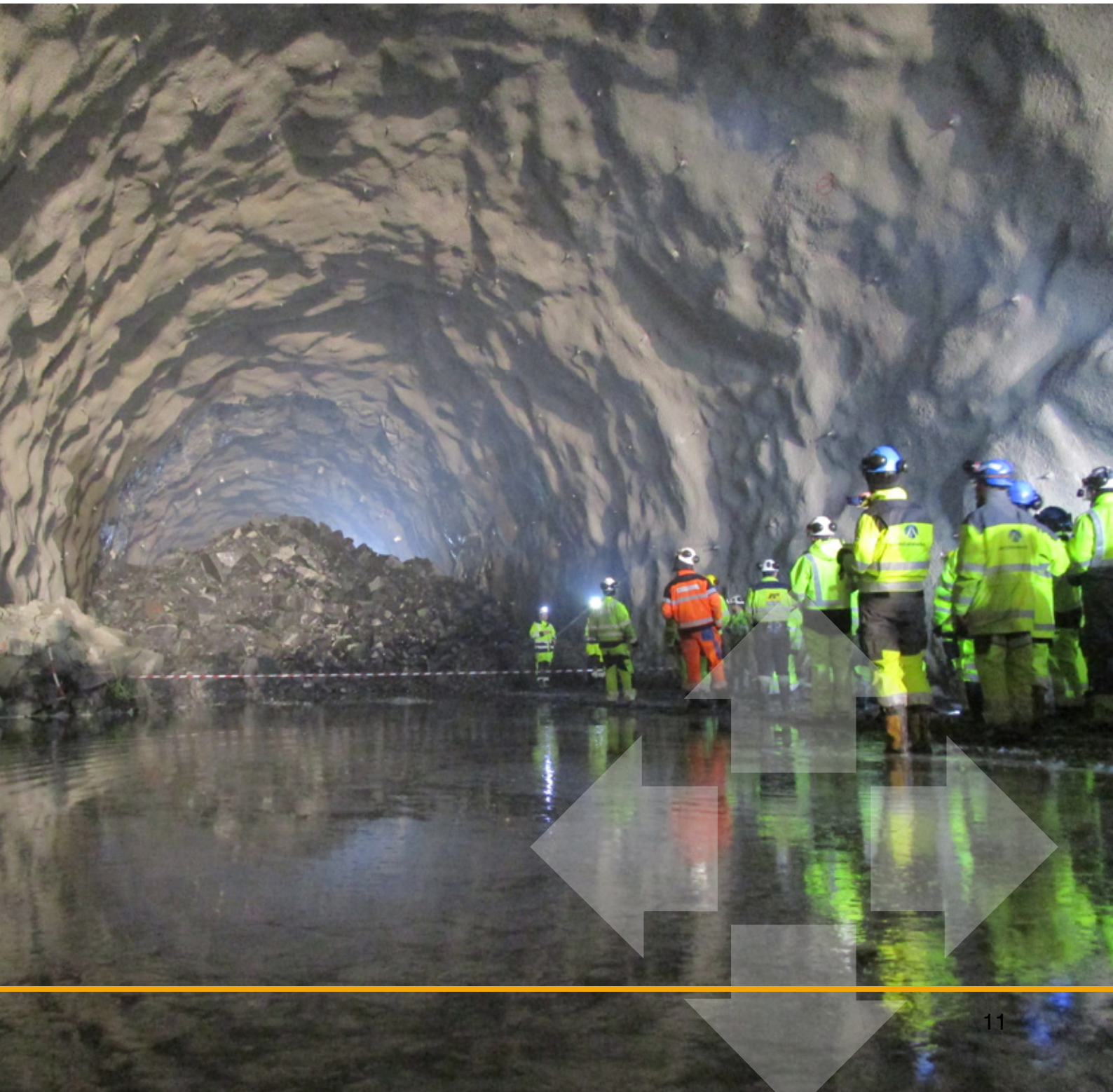


The logo for NTN, consisting of the letters "NTN" in a large, bold, white font, with "NORWEGIAN TUNNELLING NETWORK" in a smaller, white, sans-serif font below it, all set against a dark orange background with a faint map of Norway.

**NTN**  
NORWEGIAN  
TUNNELLING  
NETWORK

Norwegian Tunnelling Network (NTN) has issued a “Best Practice / the Norwegian way” document regarding installation of rock bolts:  
[www.norwegiantunnelling.com](http://www.norwegiantunnelling.com)

Look under “Elements of Norwegian tunneling” and “Temporary and permanent rock bolts”.





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