



BA - ANCHOR SYSTEM

Non-penetrative fastening technology for reinforcement of concrete inner shells and in-tunnel installations



BA-ANCHOR

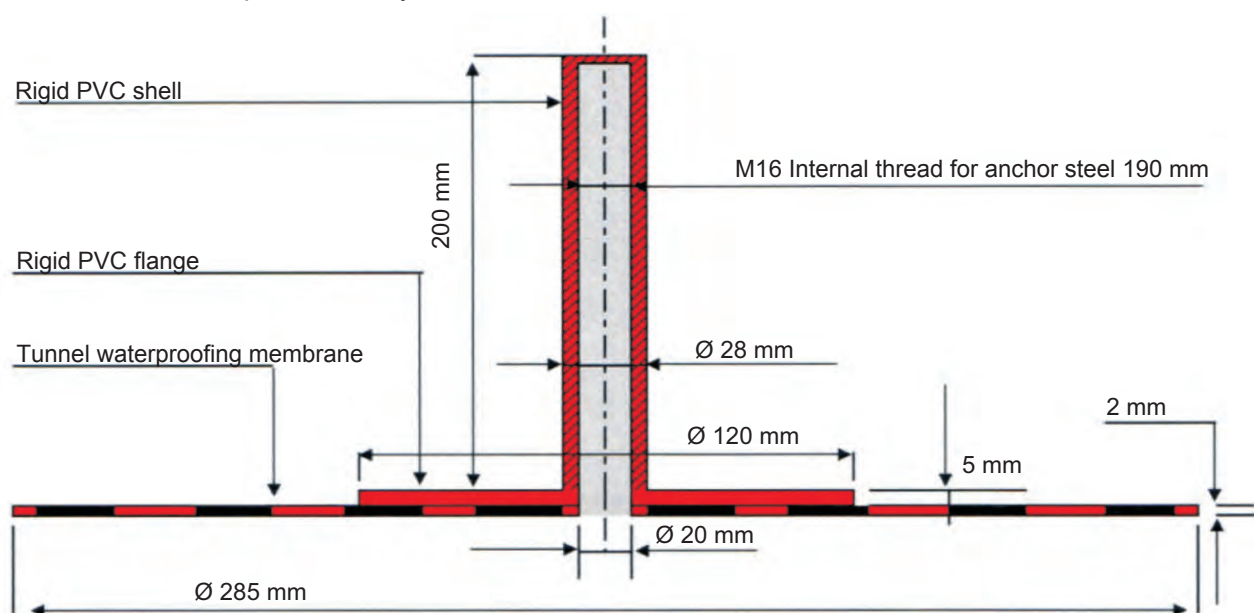
The patented BA-anchor is a rigid PVC shell with flange factory-welded onto a PVC tunnel waterproofing membrane, and allows connection to a non-penetrative flexible seal. The sealing layer is not penetrated by the anchor, but led around the anchor with the same material as the seal, thus maintaining the seal's tightness and integrity. To ensure that the BA-anchor meets the highest quality standards, it is tested in the laboratory and in various tunnels. The tensile and shear force transmissions of the anchor are optimal. Initially, the non-penetrative BA-anchor was deployed in the branch line and service bay in Kohlfirst tunnel N4, and has since been applied successfully in tunnel construction worldwide.

APPLICATIONS

The BA-Anchor system is used in tunnels and gallery construction wherever flawless sealing against groundwater is needed, even in instances of high water pressure. On the other hand, where the use of a formwork is not needed such as in rapid changes in cross sections, short tunnels, and in the production of drainage seals on excavation pits.

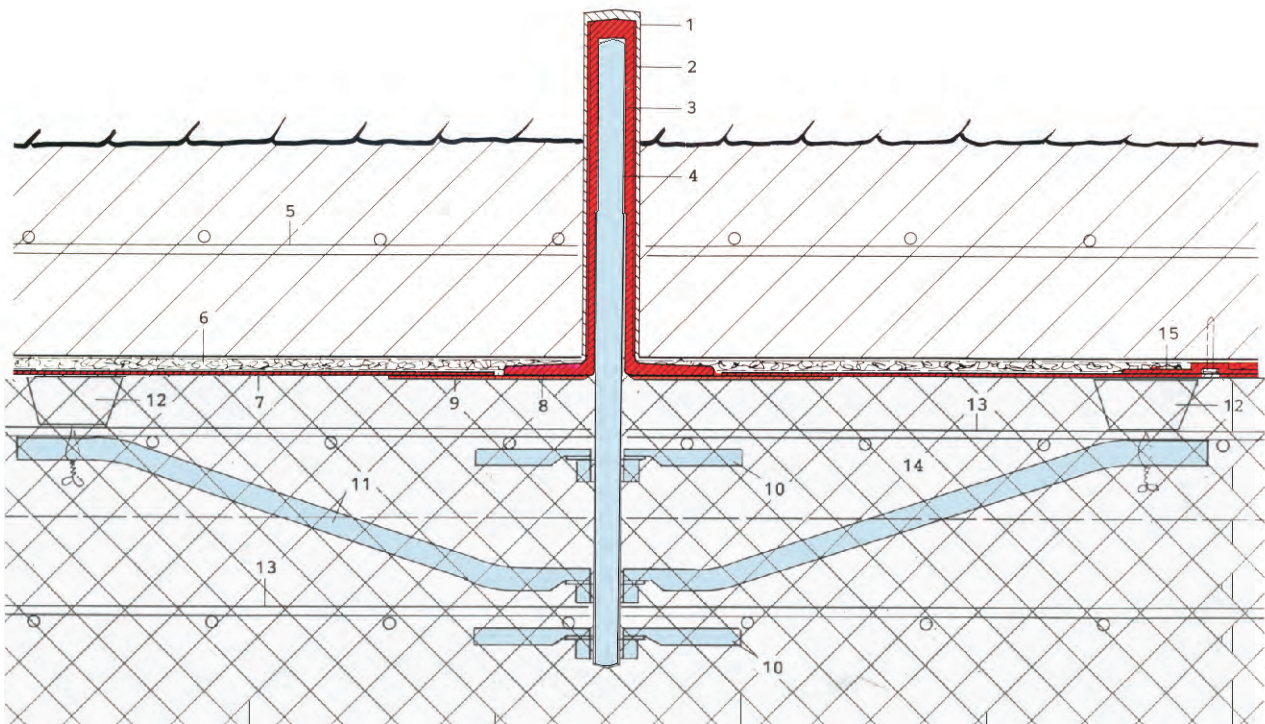
ADVANTAGES

- ° The BA-anchor system enables fast, safe installation of a single-sided reinforcement framework to protect shotcrete structures.
- ° The BA-anchor provides an excellent distribution of force through the rigid PVC shell.
- ° Because the sealing layer is not interrupted, as in a conventional anchor system, the anchor rod is protected against corrosion.
- ° The installation is quick and easy.





LAYER STRUCTURE IN BA-ANCHOR



- 1 Drill hole D=32 mm
- 2 Anchor grout (BA-anchor resin)
- 3 Anchor M16, rigid PVC
- 4 Anchor rod M16, St III
- 5 Shotcrete leveling layer
- 6 Drainage mat
- 7 Geomembrane PVC-soft

- 8 Link PVC-rigid/PVC-soft
- 9 Welding PVC-soft/PVC-soft
- 10 Fastening point D=12 mm perforated
- 11 Anchor spider D=14 mm perforated

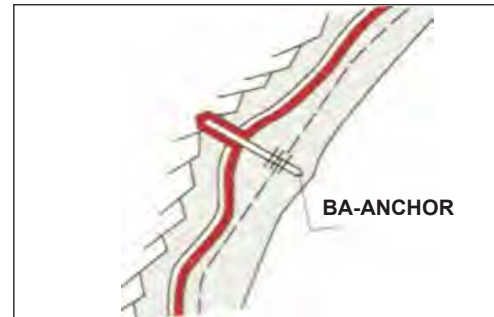
- 12 Spacer for e=30 mm
- 13 Reinforcement shotcrete
- 14 Shotcrete/in-situ concrete
- 15 Fastener for geomembrane



BA-ANCHOR SYSTEM IN PRACTICE

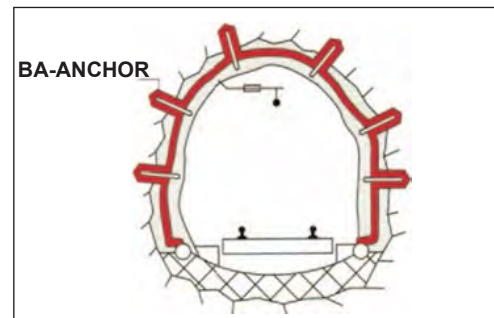
SHOTCRETE INNER SHELL

- Flexible, non-penetrative seal
- Safer shotcrete order
- High tensile strength of the anchor
- Perfect corrosion protection
- No perforation for sealing



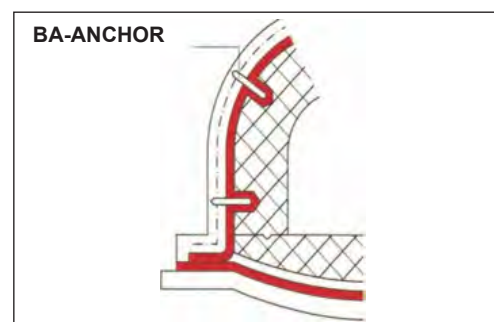
COMPOSITE ARCH

- Exterior and interior vaults are activated together against mountain, and if necessary against water pressure.
- Tensile- and shear-resistant connection exterior/interior vaults
- Flexible, durable sealing
- Corrosion-resistant anchor



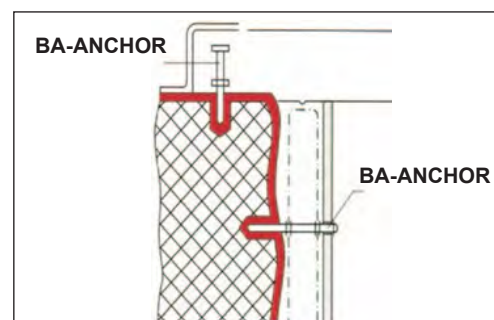
SHEAR PROTECTION

- Shear-safe connection of the protective layer at outer seals
- Reduction in the required thickness of the protective layer



FORMWORK ASSEMBLY

- Single-sided formwork assembly without support and without penetrating the seal
- Non-penetrative anchor assembly for lifting anchor

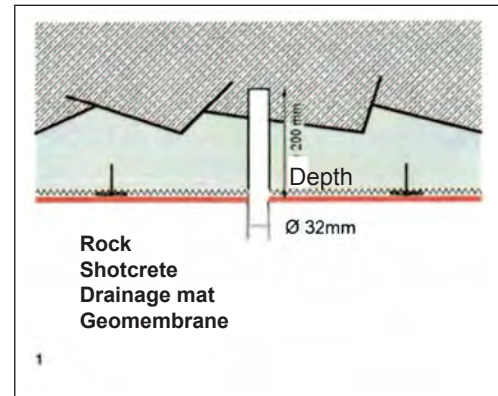




INSERT THE BA-ANCHOR

1. DRILL HOLE

- Drill hole according to anchor length for normal anchor M16/200: 32 mm L= 200 mm
- Inspect shotcrete and rock strength (drilling dust, sample anchor)

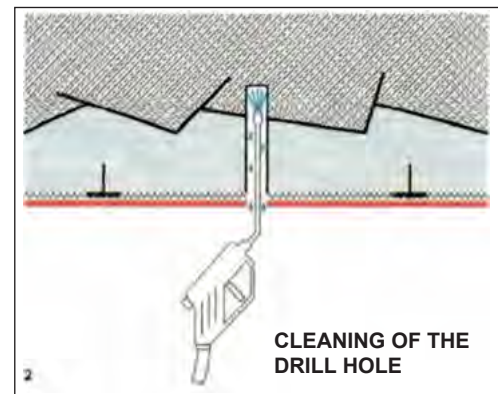


2. CLEANING OF DRILL HOLE

- Clean the drill hole first with pressurized water and compressed air.
- Check for water in the drill hole. Water must not be present in the drill hole. Moisture on the drill hole is not problematic.

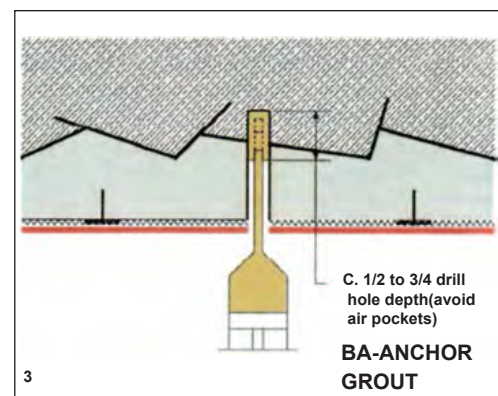
DRAIN

- Remove drilling dust.
- Rinse with high-pressure water.
- Blow out drill hole with compressed air.
- Remove standing water with compressed air.



3. BA-ANCHOR GROUT

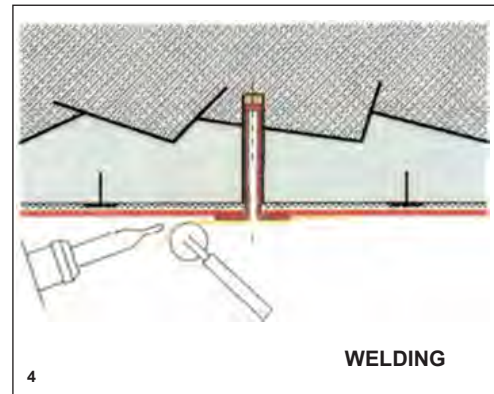
- Prior to injection ensure there is no water in the drill hole.
- Fill the drill hole to about 1/2 of the drill hole depth with BA-anchor grout.





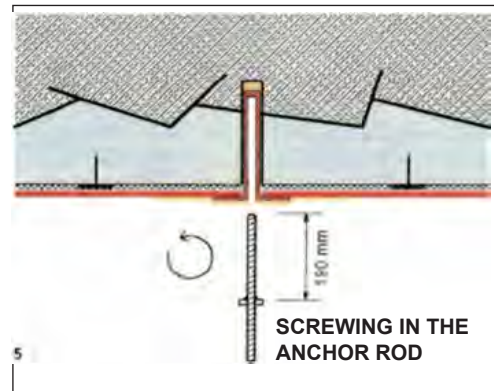
4. INSERTING THE BA-ANCHOR/WELDING

- Carefully screw in the BA-anchor prior to curing of the anchor grout until the flange rests on the threaded tunnel geomembrane (avoid air pockets).
- Clean the welded tunnel waterproofing membranes of sand, oil, grease, etc.
- **DRAINAGE**
- To displace the anchor shell
- Weld geomembrane.



5. SCREWING IN THE M16 THREADED ROD

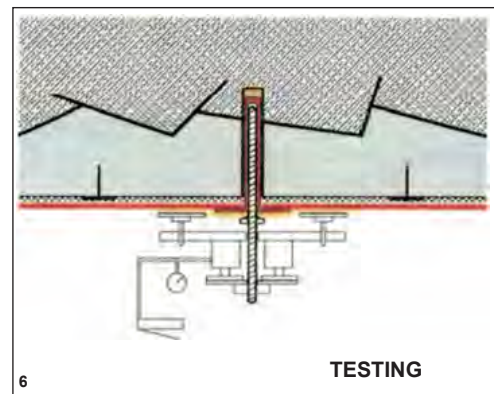
- The welded nut has a safety stop at 190 mm.
- Carefully hand-screw plastic thread.
- Insert with power assist into the pressure patch.



6. TESTING THE TRACTION

Test equipment:

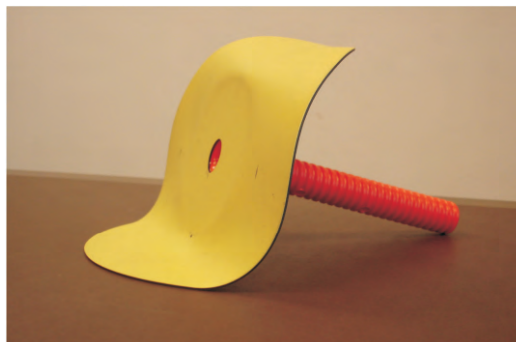
- Support plate
- Mount plate with screws
- Press with double cylinder
- Manometer
- Hand pump





SPECIFICATIONS OF STANDARD ANCHORS-BA 16/200 PVC

BA-anchor		M16
Anchor diameter	mm	16
Anchor length	mm	33
Shell diameter	mm	28
Shell length	mm	200
Drill hole diameter	mm	32
Steel quality		8.8
Working load	kN	20



Anchor shell with flange			
Material		PVC-U (PVC-rigid)	
Density	g/cm ³	1.37	DIN EN ISO 1183-1, Process A
Yield stress	Mpa	52	DIN EN ISO 527
Elongation at yield	%	3.5	DIN EN ISO 527
Breakdown voltage	Mpa	31	DIN EN ISO 527
Elongation at break	%	22	DIN EN ISO 527
Pull-E- module	Mpa	2,750	DIN EN ISO 527
Bend-E-module	Mpa	2,820	DIN EN ISO 178

Adhesive mortar epoxy			
Material		Epoxy resin	
Density	g/cm ³	1.65	DIN EN ISO 1183-1, Process A
Compressive strength	Mpa	60	DIN EN 196
Tensile strength	Mpa	15	DIN EN 527
Torsion strength	Mpa	30	DIN EN 196
Adhesion to concrete	Crushed concrete		
Pull-E-module	Mpa	5,000	DIN EN 524

Plastic cartridges for BA-anchor resin			
Material		Polyester resin	
Density	g/cm ³	2.0	DIN EN ISO 1183-1, Process A
Compressive strength	Mpa	70	DIN EN 196
Adhesion to concrete	Crushed concrete		
Dynamic-E-module	Mpa	15,000	DIN EN 524

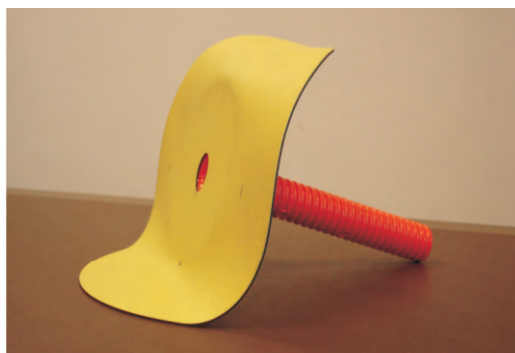
NOTE

The BA-anchor is also available in a version with FPO material.



STANDARD BA-ANCHOR 16/200 PVC AND MOUNTING ACCESSORIES

STANDARD ANCHOR BA 16/200 PVC



ANCHOR GROUT/ANCHOR RESIN



ANCHOR ROD



ANCHOR PLATES FIXING POINT



NOTE: Also available for all other dimensions



SPECIAL TYPES OF BA-ANCHORS

BA 10/75 PVC
Metric 10 mm thread for
light loads



BA 20/200 PVC
Metric 10 mm thread
for medium loads



BA 24/500 PVC
Metric 24 mm thread
for heavy loads



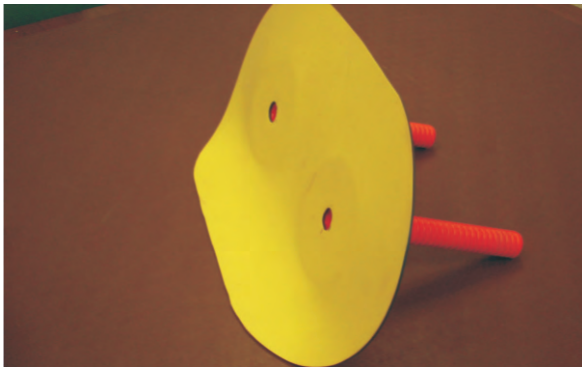
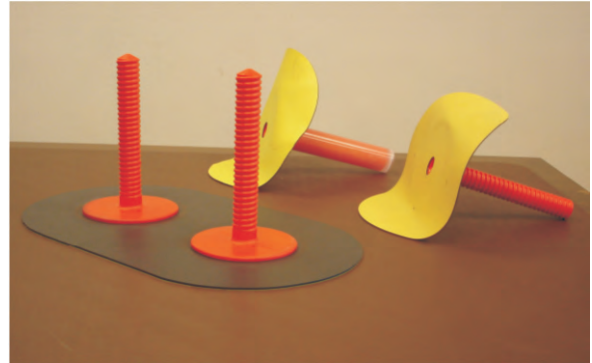
BA 30/500 PVC
Metric 30 mm thread
for very heavy loads



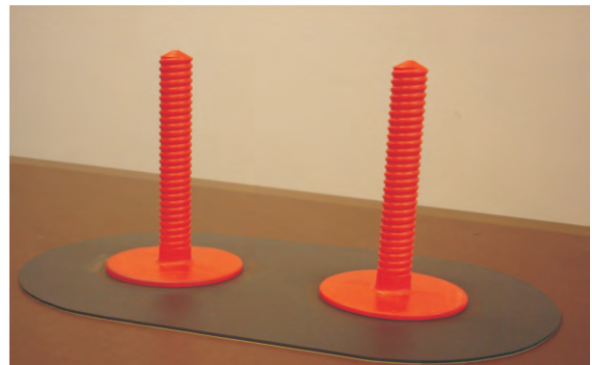


SPECIAL TYPES OF BA-ANCHORS

BA-anchor from left to right:
BA-twin anchor, BA 16/200 PVC
BA-anchor with viscous epoxy resin
BA-anchor 16/200 PVC (standard anchor)



BA 16/200 PVC twin-anchor
Special design for horizontal attitude of the sliding plane for TBM



BA 16/200 PVC twin-anchor

BA 16/200 PVC
Extended BA 16/500 PVC
Special construction due to geological conditions



NOTE:
BA-anchors can be produced in different countries, if necessary.
The delivery time for special productions is 6-8 weeks.



BENCHMARK TESTS

Pull-out test, performed on BA-anchors in non-reinforced shotcrete

1st Test		
BA-anchor with epoxy resin		
Embedment depth anchor steel: 190 mm		
Results:		
Pull-out strength after 8 days	110 kN	Until fracture of the shotcrete
Pull-out strength after 32 days	>120 kN	Until fracture of the shotcrete

2nd Test		
BA-anchor fixed anchor with fiber-reinforced mortar		
Embedment depth anchor steel: 190 mm		
Results:		
Pull-out strength after 8 days	65 kN	Until the breaking of rigid PVC shell
Pull-out strength after 32 days	95 kN	Until the breaking of rigid PVC shell



REMARKS:

These results originated from tests and cannot be viewed as maximum pull-out strength for other projects. The results serve as a rough guide. The theoretical stripping force was set at 30 kN/anchor. Each project requires pull-out tests under local conditions. It has proven effective to test every tenth anchor with 30 kN stripping forces.

The number of offsetting BA-anchors, depends on the requirement at 0.3-1 per piece/m². The rigidity of the reinforcement net as well as the flatness of the substrate determine this number. The stability of a self-supporting shotcrete inner shell is always the responsibility of the design engineer.



BENCHMARK TESTS

LOESCHBERG BASE TUNNEL

ALPTRANSIT

Test of HIGH LOAD ANCHOR



Engineers and Examiners at work



Anchor shell BA 30/300



Offset in rock anchor shell with anchor rod

Test equipment with hydraulic device
up to 700 bar



NOTE: Detailed documentation is available upon request.



APPLICATION: TUNNEL KOHLFIRST, FLURLINGEN (CH)

TUNNEL KOHLFIRST, FLURLINGEN

General view of the tunnel
Branch 5 gauge lines, vaulted with
shotcrete (self-supported)



BA-ANCHOR

Mounting with drill mount



BA-ANCHOR

Attached reinforcement spider
anchor is only necessary in
network sections shorter than
8 mm.



BA-ANCHOR mounted

Afterwards the shotcrete
layer gets applied with a
thickness of 30 cm.





APPLICATION: JUNGFRAU-RAILWAY



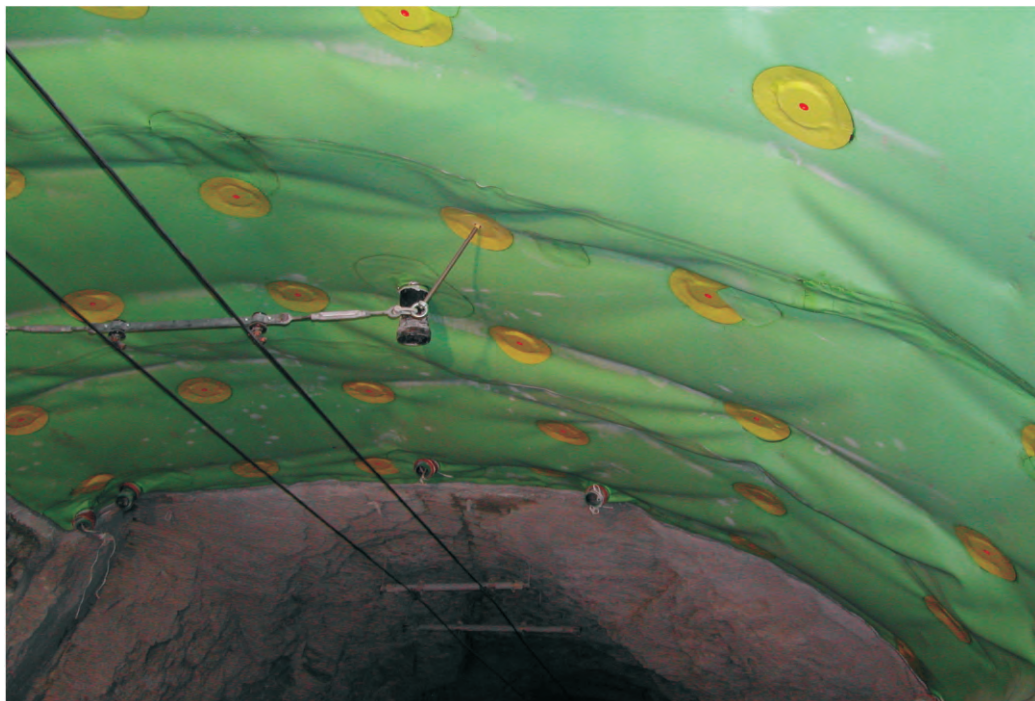
JUNFRAUJOCH STATION



JUNGFRAU-RAILWAY



**RAILROAD TRACKS
IN THE TUNNEL**



Vaults with BA-anchor for receiving the shotcrete. In the tunnel, the Jungfrau-Railway, the overhead line was mounted with BA-anchor.



APPLICATION: TUNNEL MROZOVKA; PRAGUE (CZ)

Installation of BA-anchor for assembly of the reinforcement and special anchor plates in the vaults

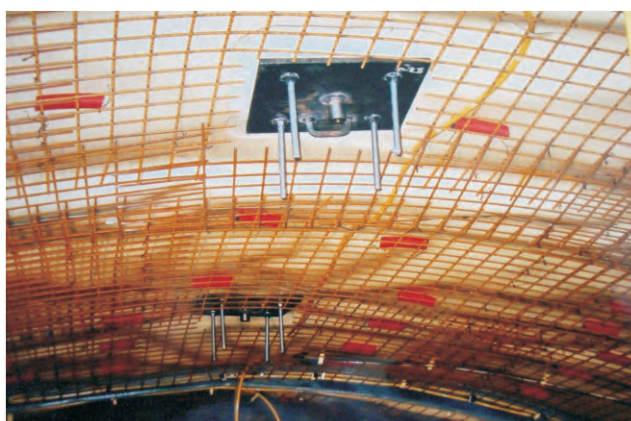
BA-anchor built-in
for installation of reinforcement
and anchor plate



Special anchor plate in the
vault mounted on anchor rods of
BA-anchor 20/300 FPO



Special anchor plates in the vault
4 pcs. BA-anchor 20/300 FPO
produced as a special grade,
according to the engineer





APPLICATIONS:

TUNNEL ZIMMERBERG-ZURICH, ZUGANSTOLLEN, ZERMATT, TUNNEL SCHOENBUHL-BERN (CH)

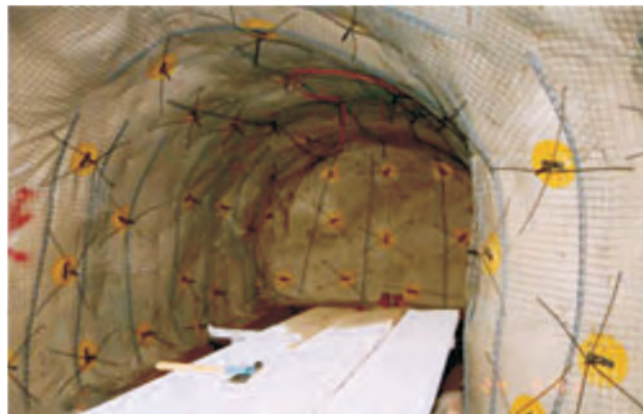
TUNNEL ZIMMERBERG LOS 101, ZUERICH

BA-anchor to accommodate the reinforcement in the upper wall area and as an additional support of the formwork



ZUGANGSTOLLEN, ZERMATT

Anchor assembly with spider for small network sections



TUNNEL SCHOENBUHL, BERN

Anchoring the ceiling support with BA-anchor 20/200 PVC





BA-ANCHOR TENDER SPECIFICATION

1. BA-anchor drilling and shifting

Deliver and offset BA-anchor type: _____ with internal thread and anchor rod M _____ steel III, including drilling the blind holes circa _____ cm deep in the outside vault. Deliver and press the anchor grout or the anchor resin brand type: _____ incl. Screw the BA-anchor into the blind hole. Connect the sealing membranes to the tunnel film by sealing technicians.

PC: _____ CHF: _____

2. BA-anchor connection to tunnel film

Weld the BA-anchor membrane with the tunnel foil using simple seam welding incl. of any cleaning work BA-anchor type: _____.

PC: _____ CHF: _____

3. BA-anchor drilling,

Moving and connection to the tunnel film

Deliver and move the BA-anchor type: _____ with internal thread anchor rod for M _____ steel III, incl. drilling blind holes circa _____ cm deep into the outer vaults. Deliver and press in the anchor grout or the anchor resin brand type: _____ incl. Screw in the BA-anchor in the blind hole and connect the sealing membrane by simple seam welding to the tunnel film.

PC: _____ CHF: _____

4. BA-anchor mounting assistant for reinforcement

4.1 Deliver the on-site mounting anchor rod to BA-anchor type: _____

PC: _____ CHF: _____

4.2 Deliver the on-site mounting spider anchor to BA-anchor type: _____

PC: _____ CHF: _____

4.3 Deliver the on-site mounting of net holders to BA-anchor type: _____

PC: _____ CHF: _____

5. Surcharges for Pro. 1-3

5.1 Surcharges for cutting the protective layer for the flange and welding with underlying sealing foil

PC: _____ CHF: _____

5.2 Closing and adding the protective layer in the flange of the anchor shell

PC: _____ CHF: _____
