TECHNICAL MANUAL

FATBAR®

Post-tensioned Anchoring System for Heavy Dynamic Loads

Version PEIKKO GROUP 04/2023

peikko®

FATBAR®

Post-Tensioned Anchor — Made for Heavy Dynamic Loads

Peikko is the European market leader in the development and supply of bolted connections. The FATBAR® post-tensioning system is intended to be used for the prestressing of structures and to perform under intense fatigue loads.

Peikko FATBAR® is a high strength steel bar with special threading at both or one end, supplied with steel anchor plates, spherical nuts, and conical washers, where all aforementioned components specifically developed and tested for fatigue loading and post-tensioned applications.

- High fatigue load resistance
- High load bearing capacity
- Increased structure life span
- Covered and verified by European Technical Assessment (ETA 10/0246)
- Variable length and diameter of the bolt according to customer specification
- Ordering via product code
- Quick deliveries directly from stock
- Various application possibilities
- Possible surface treatments
- Accessories and instructions for quick and easy installation and post-tensioning.

Peikko FATBAR® has a unique design that enables it to sustain greater fatigue loads, which increases the life span of concrete structures. FATBAR®'s excellent performance under fatigue loading has been demonstrated by tests in accordance with EAD 160004-00-0301.

FATBAR®s are post-tensioned against high dynamic stress and thus protect the structures from cracking even in harsh conditions. FATBAR® Post-Tensioned Anchors are assembled with washers and nuts (made of steel of property class 10) parametrically similar to those specified in standards DIN 6319 and DIN 6330 B. Bolt threads are cold-rolled with special threading developed for fatigue loading. The bolts are produced from steel of chemical composition that for the most part follows the requirements of EN 898-1 steel of property class 10.9, but with slight alteration in the recipe making it FATBAR® unique.

Hence, FATBAR®'s exact mechanical and physical properties linked to certain sizes of the bolt are declared further in this technical manual. FATBAR®s are offered in standardized models – available in lengths up to 11,900 mm and diameters between 36 mm and 98 mm. The bolts can be preassembled with anchor plate(s) and debonding sleeve according to the specification. Accessories like couplers and plastic protection caps for threads are available on request.

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About FATBAR®

1. Product properties

FATBAR® is a product intended to be used for prestressing applications in foundations and structures as bonded, unbonded, or external bar tendons.

Peikko FATBAR® is a high-strength steel bar with special threads at both ends. Thread profile known as FATBAR® thread is preassembled with spherical nut(s) and conical washer(s). The geometry of FATBAR® threads, nuts, and washers is designed for resisting fatigue loads. One FATBAR® end is called stressing anchorage, while the other is fixed anchorage.

For unbonded or external applications, both FATBAR® anchorage ends are formed in a similar way i.e. via load transfer accessory such as an anchor plate. For bonded applications, FATBAR® fixed anchorage instead has a special anchoring thread extending from the end to a specified length.

FATBAR® is available in a wide range of diameters and lengths, which allows different applications and loading conditions. Accessories such as steel anchor plates, debonding sleeve, protection caps, etc., are available. The kit supplied by Peikko comprises of FATBAR® and accessories as specified in order that meets requirements of intended use. Depending on accessory it might be preassembled on a FATBAR® or accompany it. Moreover, there shall be additional reinforcement in the anchorage zone and corrosion protection for steel bar and anchorage.

FATBAR® post-tensioning system consists of

- High-strength plain round bars with threads on both ends
- Spherical nuts and conical washers
- Steel anchor plates (optional)
- Connection tube (optional)
- Heat shrink tube as debonding sleeve (optional)
- PE duct (optional)
- Closed-cell foam tube (optional)
- Coupler nuts (optional)
- Plastic or metal, or concrete protection caps (optional)
- Installation templates (optional)
- Centralizers (optional).

FATBAR® is produced from the steel that in general follows EN 898-1 property class 10.9 material specification and is available in lengths up to 11,900 mm.

FATBAR® thread is cold-rolled and has a special geometry designed for fatigue loading. The maximum FATBAR® thread length is 500 mm and can be located on one or both ends of the bar, depending on the application.

FATBAR® is preassembled with conical washers and spherical nuts that are designed following the principles of DIN 6319 and DIN 6330 B and are property class 10.

FATBAR® can be ordered with debonding sleeve. In this case, Peikko treats the bolt's surface with grease and equips it with a heat shrink plastic tube, which covers the unthreaded length of the bar.

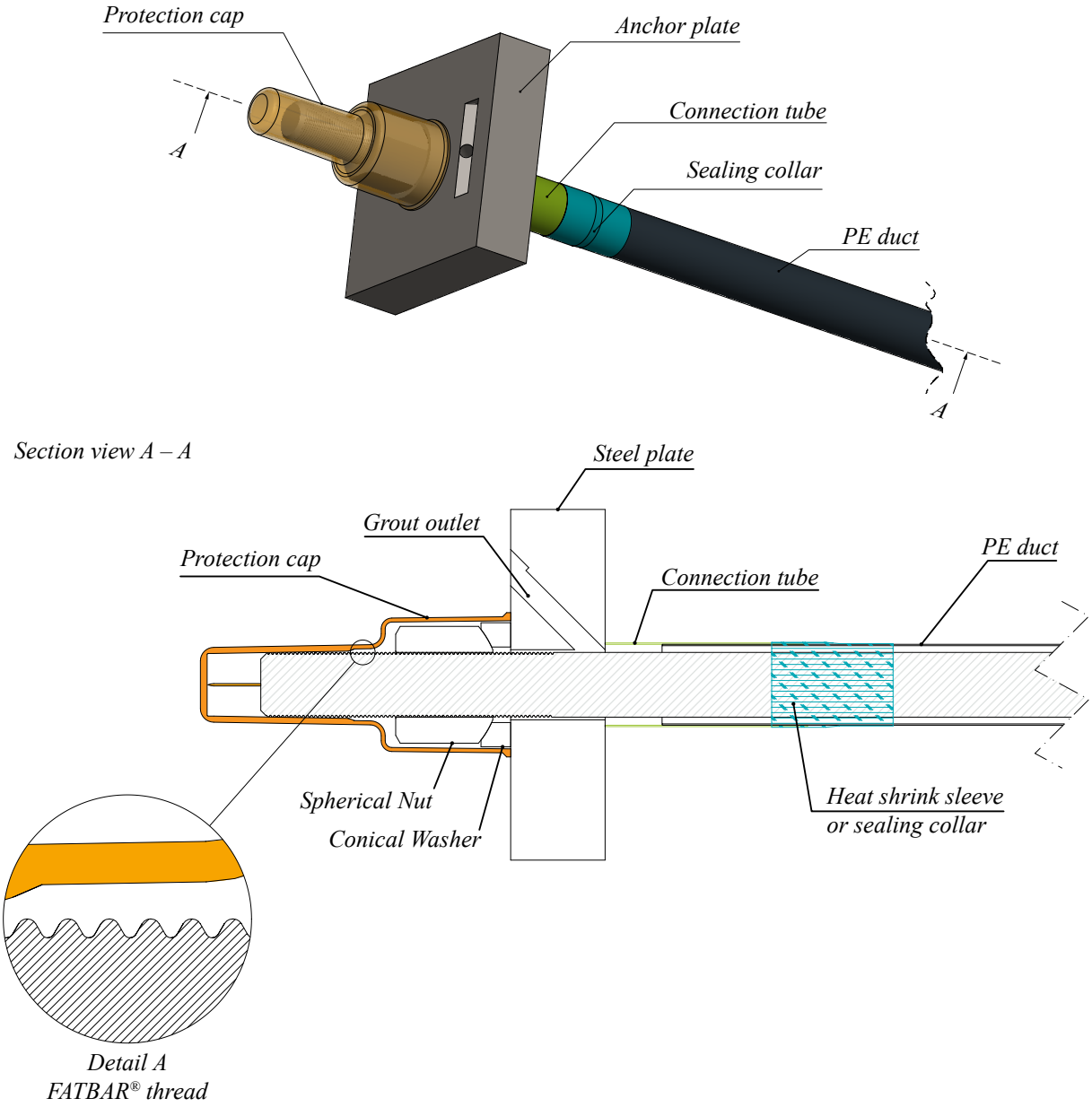


Figure 1. FATBAR® external tendon sectional view of stressing anchorage end.

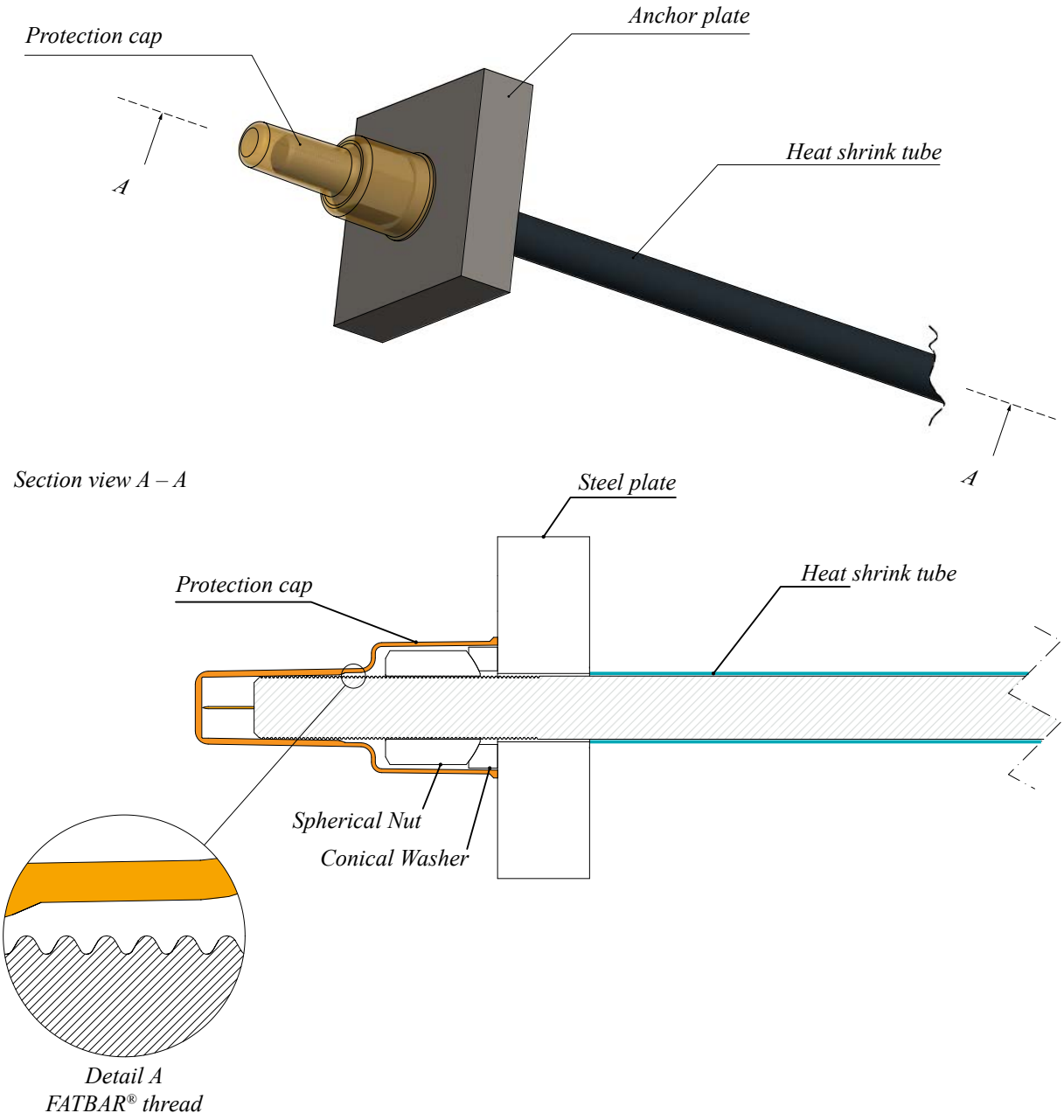


Figure 2. FATBAR® internal tendon sectional view of stressing anchorage end.

1.1 Structural behavior

FATBAR®s are intended to be used in post-tension application as internal bonded or unbonded bar tendons, or as external bar tendons. The post-tension load is applied to the active (stressing) anchoring end of the bolt with a hydraulic jack and is transferred to the structure either through the bonded length of the bolt or through the help of load transfer component assembled on the passive anchorage end of the bolt.

- Internal bar tendon
  In FATBAR® internal bar tendon applications, the preload is applied in the active anchoring end of the bolt and can be transferred to the concrete through the bonded length (bonded bar tendons) or through load transfer component on the passive anchoring end of the bolt (unbonded bar tendons).

- External bar tendon
  In FATBAR® external bar tendon applications, the length of the bolt is fully exposed (i.e., unbonded) and both ends are always fixed or connected to the structure, one end being the active anchoring end, where preload is applied, and the other being the passive anchoring end.

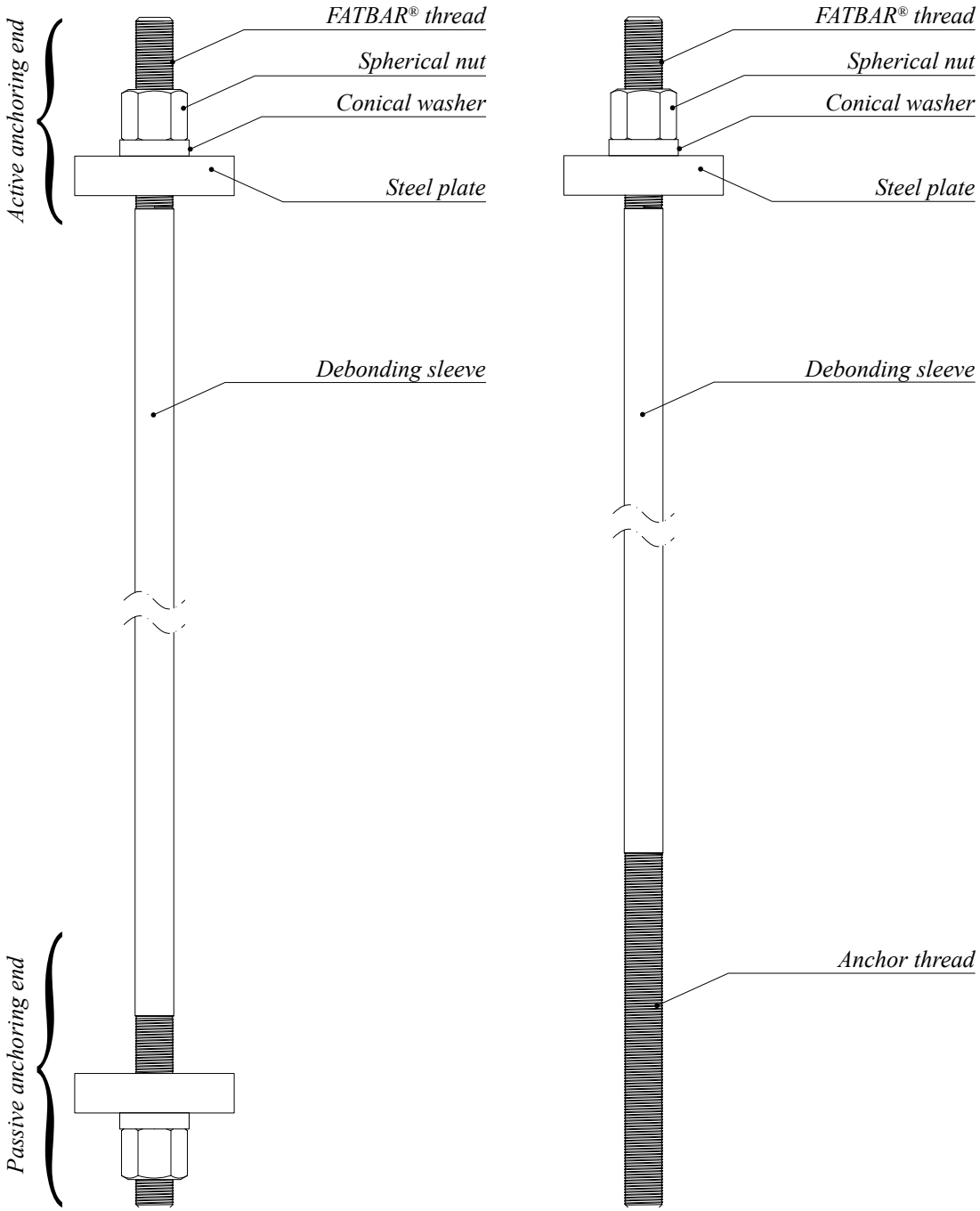


Figure 3. Unbonded and bonded FATBAR®.

1.2 Application conditions

1.2.1 Loading and environmental conditions

FATBAR® can be applied as internal or external bar tendon. Both applications require corrosion protection.

For internal bar tendon applications (Figure 5)

- FATBAR® active end

The top of the bar, a nut, and a washer are protected against corrosion with grease or grout. The plastic cap (see *Figure 4*) is filled with grease or grout. Grease complies with EAD 160027. Grout complies with EN 446 and EN 447. Metal or concrete cap also could be applied. If steel anchor plate is not embedded in concrete or covered by a cap it shall be galvanized with hot dipped zinc coating according to EN ISO 14713 and EN ISO 1461. In a case of hybrid anchor plates exposed steel components shall be galvanized. Other surface treatment methods also possible like metallization.

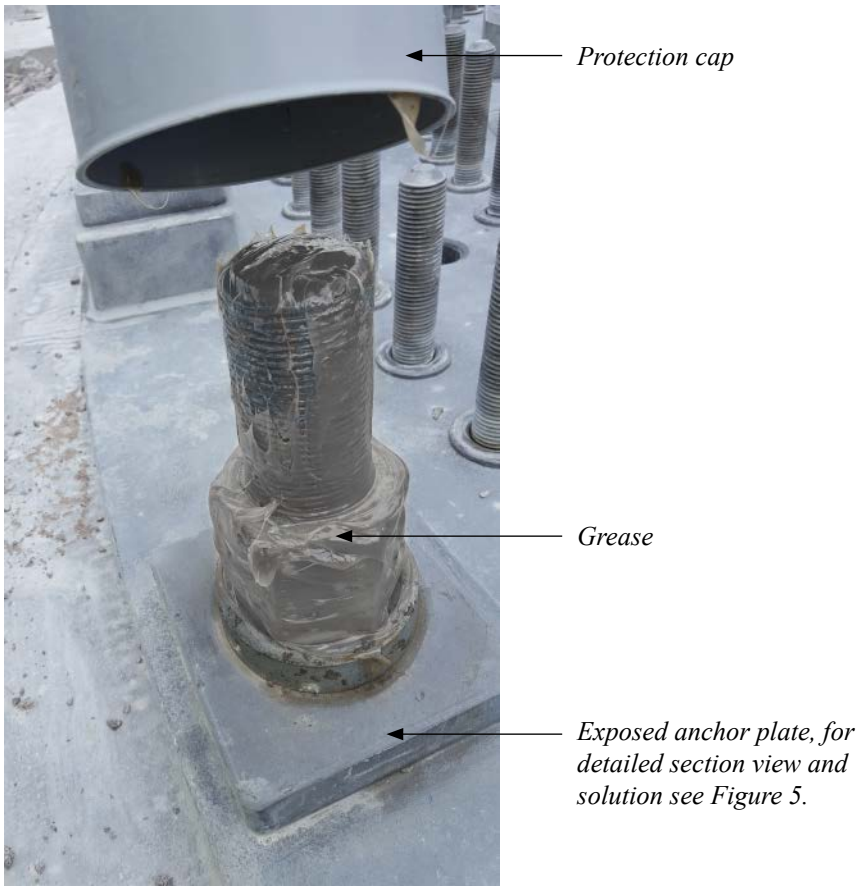


Figure 4. Corrosion protection of the FATBAR® active end.

If anchor plate is exposed, the heat shrink tube shall engage with hole in the anchor plate (as indicated in *Figure 5*, Detail B) to prevent thread's corrosion in the interface region and to stop water from migrating inside concrete along the surface of the bolt. Other solution is to apply hydro insulation along the perimeter of the anchor plate. This technique is specifically usable when hole clearance in anchor plate doesn't allow installation of heat shrink tube (sleeve) within the thickness of the anchor plate. However, hydro insulation is always recommended as shown in *Figure 5*.

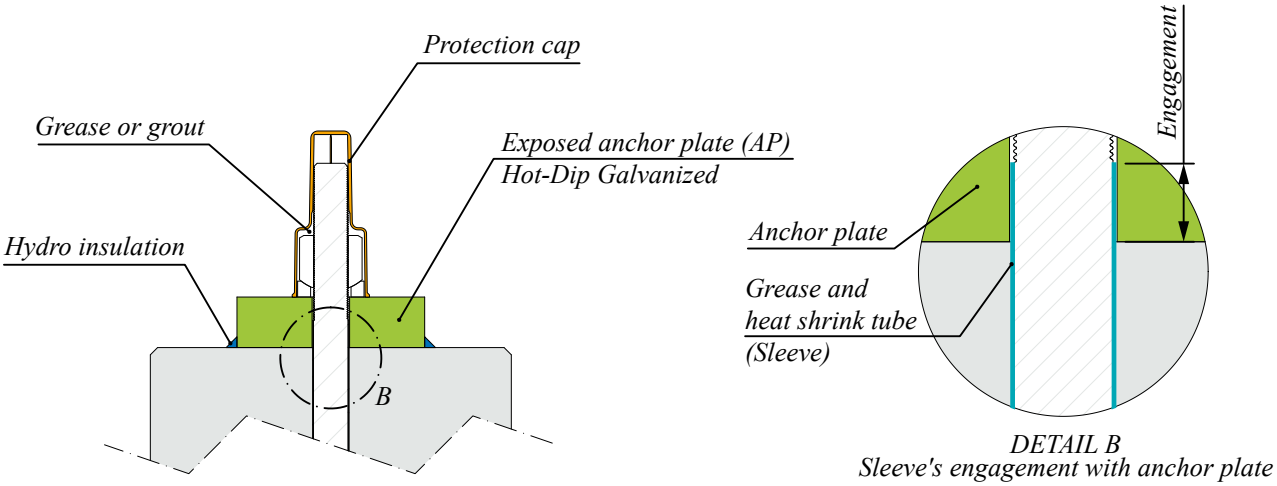
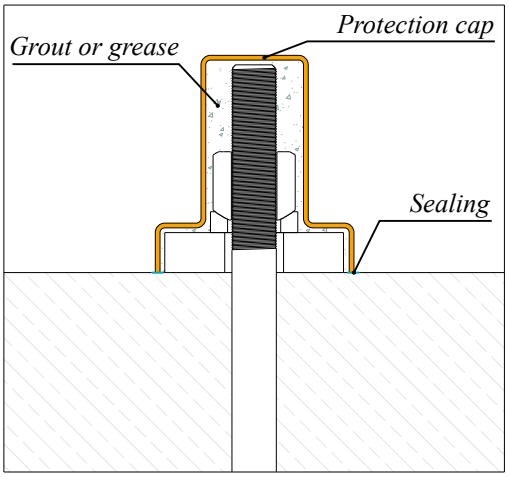


Figure 5. Corrosion protection of FATBAR® active end. Detail where anchor plate is exposed.

a) Protection cap houses all exposed components.



b) Active end fully embedded in concrete.

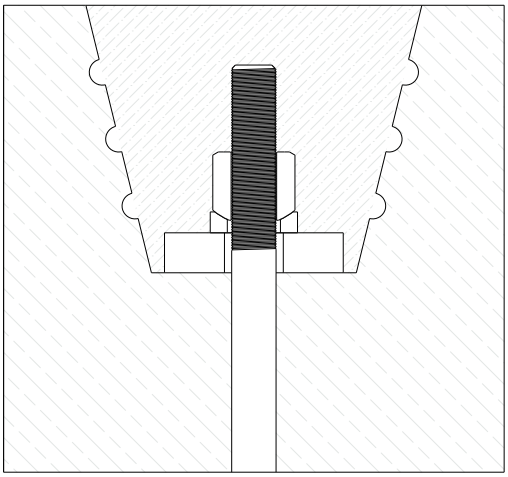


Figure 6. Protection of FATBAR® active end, alternative solutions.

- Bonded and Unbonded length of FATBAR®

Corrosion protection of bonded length is provided by concrete. For unbonded length, in addition to concrete cover, corrosion protection is enhanced with grease and the heat shrink tube. The grease and tube protect the bolt surface against corrosion and prevent water from infiltrating the concrete element from the interface.

- FATBAR® passive end (either fixed anchorage or bonded length of the bar, see *Figure 3*)

Passive end of the FATBAR® is surrounded by concrete which provide protection against corrosion.

For external bar tendon applications (*Figure 7*)

- FATBAR® active/passive end

In this application both ends are fully or partially open air, where standard method of protection for thread, washer, nut is protection cap filled with grease or grout. Instead of filling the cap entirely with grease, components can be simply covered by grease before cap is installed (see *Figure 4*). Exposed load transfer components like anchor plates, end plates, anchor traverse beams shall have protective coatings (e.g., galvanized with hot dipped zinc coating according to EN ISO 14713 and EN ISO 1461).

- FATBAR® length

The bar is sheathed with a PE duct. The gap between the bar and PE duct is filled with grout. The thickness of grouting shall be at least 5 mm. Grout and grouting shall fulfil the requirements of the standards EN 446 and EN 447. Tendon plates need to have a connection tube. The transition zone tube to PE duct shall be long enough to compensate for elastic elongation when stressing. Connection needs to be sealed with heat shrink sleeve.

Grouting is always done from a lower point of the FATBAR®. Hence one anchorage end has grout inlet and other grout outlet, or along the tendon utilizing an intermediate grout saddle. Grout inlet holes are threaded for proper connection with grouting equipment. Depending on the application, grouting of PE duct can be executed on-site or might be delivered premanufactured (i.e., PE duct is preinstalled on bar and grout is filled in the factory).

Please note that Peikko doesn't offer grouting as a service in the standard delivery package and grouting shall be outsourced separately from a company specializing in the grouting works.

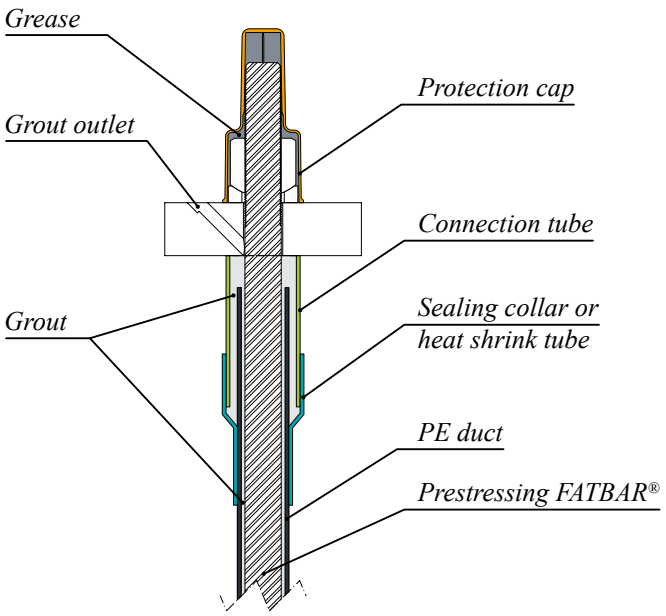


Figure 7. Corrosion protection detail of FATBAR® external tendon.

Bar structure coatings

For double protection of bar structure or as an alternative coating option for accessories, Peikko offers the following surface treatments:

- Epoxy powder coating

Epoxy powder coating is achieved by polymerizing a mixture of two compounds, resin and hardener, forming a thick, strongly bonded layer which protects the bolt's surface against abrasion, impact, corrosion, and extreme temperatures. Powder coating film thickness can be specified between maximum and minimum value (between 100 µm and 250 µm), considering a tolerance of ± 50 µm. Nominal film thickness of 150 µm fulfils corrosion class C3 for a lifetime of minimum 25 years. The maximum length of epoxy coating is 11.9 m and can be applied only in the unthreaded region of the bolt. Epoxy application in the bolt is preceded by sandblasting. Epoxy powder coating cannot be applied in threaded region where nuts are to be tightened.

- Xylan coating

Xylan is a fluoropolymer-based industrial coating used to provide reduced friction, wear resistance, heat resistance, corrosion protection, and non-stick properties to the bolt surface. Xylan is applied by spraying the bolt until a thin film is formed (25 ± 10 µm), which fulfils corrosion class C3 for a minimum lifetime of 25 years. The maximum length of Xylan coating is 11.9 m. The Xylan application is preceded by a pretreatment, which includes sandblasting, phosphating and heating the bolt, and is followed by a heat curing phase. Hot-dip galvanized nuts and hot-dip galvanized washers are supplied with Xylan-treated bolts. Xylan-coated threads do not require oversized nuts.

1.3 Other properties

FATBAR® is fabricated from round steel bars, grade: EN 10138-4 / Y1050H. FATBAR® as a product's key characteristics – mechanical and physical properties are given in this section.

Table 1. Tensile elements.

FATBAR® diameter	FB36	FB39	FB42	FB48	FB56	FB64	FB72	FB98
Nominal tensile strength f_{pk} (MPa)	1050				1000			960

Standard delivery for each bolt includes hexagonal nuts and washers:

Nuts	Property class 10	Partially DIN 6330 B with exact dimensions declared in ETA 10/0246
Washers	Property class 10	Partially DIN 6330 B with exact dimensions declared in ETA 10/0246

Peikko Group's production units are externally controlled and periodically audited based on production certifications and product approvals by various organizations.

Manufacturing method	
Length	Cutting
Thread	Cold-rolling

Manufacturing tolerances	
Length	± 10 mm
Thread length	+ 5,-0 mm
Thread root and crest diameter tolerance	± 0.168 mm

Table 2. Dimensions [mm] and weight [kg/m] of FATBAR®s.

FATBAR®		FB36	FB39	FB42	FB48	FB56	FB64	FB72	FB98
F (nominal size)		36	39	42	48	56	64	72	98
F_0 (major thread diameter)		37.708	40.008	43.458	49.420	57.550	65.500	72.795	98.380
Ø		35 – 36	38 – 40	42 – 45	48 – 50	56 – 58	65 – 67	73 – 75	98.7 – 101.3
Nominal cross section area A_p		1018	1195	1385	1810	2463	3217	4072	7543
l_{tot}	max	11900	11900	11900	11900	11900	11900	11900	11900
	min	1000	1000	1000	1000	1000	1000	1000	1000
l_{thr} (default values)		165	180	190	215	245	280	310	410
$l_{b,min}$	Active end	72	78	84	96	112	128	144	196
	Passive end	36	39	42	48	56	64	72	98
Weight		8	9.4	10.9	14.2	19.4	25.3	32	61.7

Table 3. Nuts and washers' dimensions [mm].

FATBAR®		FB36	FB39	FB42	FB48	FB56	FB64	FB72	FB98
Nuts	m	54	59	63	72	84	96	108	150
	s	55	60	65	75	85	95	105	135
Washers	d_2	42	44	48	55	64	72	79	109
	d_4	70	75	79	94	113	130	144	210
	d_5	66	70	71	87	99	113	117	168
	h_3	17	19	19	24	29	34	35	43

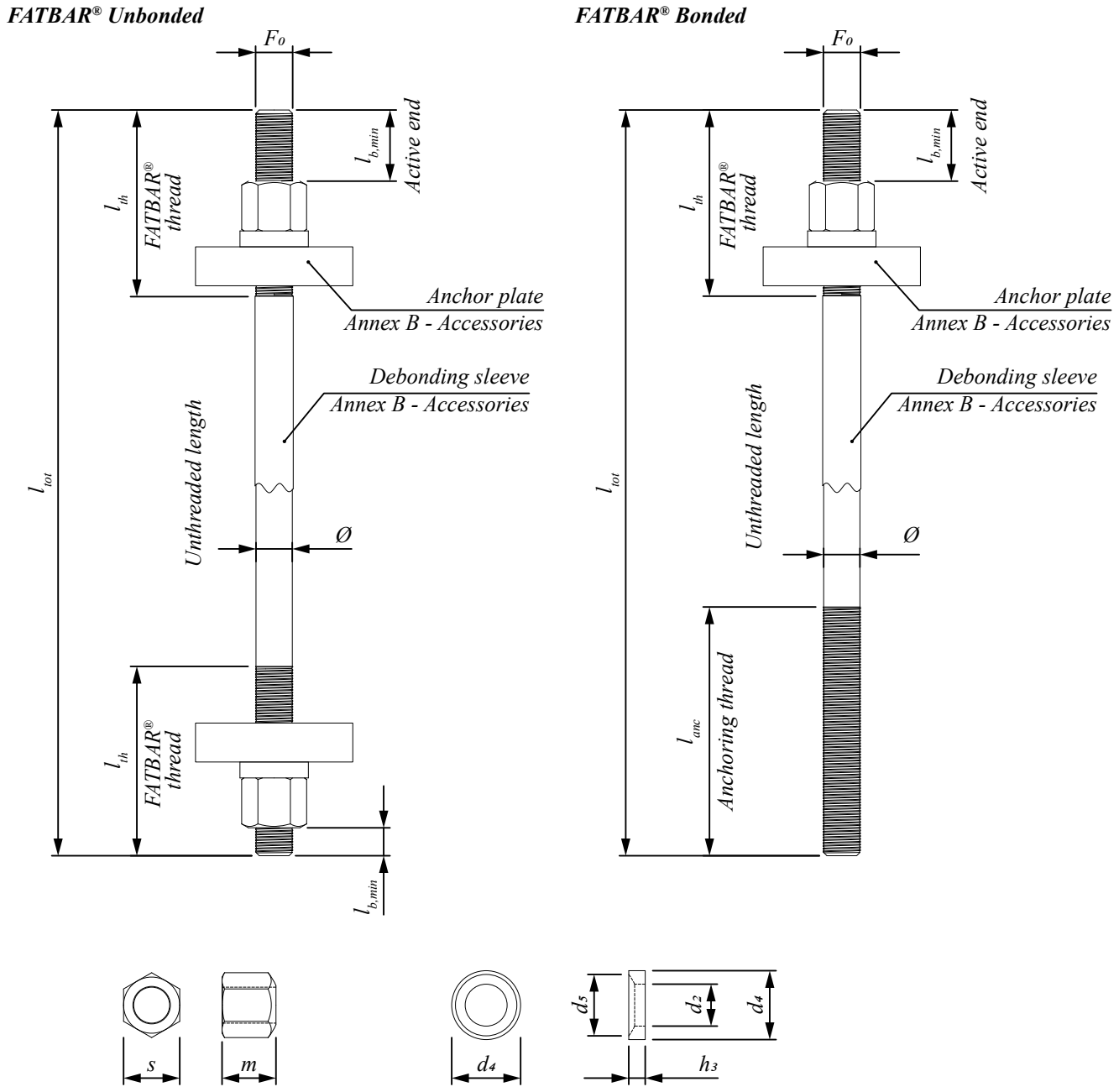


Figure 8. FATBAR® dimensions.

2. Resistances

2.1 Axial resistance

FATBARS®s are intended to be used in tension as post-tension bar tendons. FATBAR® post-tension system meets acceptance criteria of EAD 160004-00-0301 for resistance to static load and fatigue.

FATBAR® post-tension system is designed so that failure is controlled by fracture of the tensile element and not by failure of the anchorage components. Fatigue resistance has been tested with a constant upper load of 65 % of the characteristic force (F_{pk}) and with a stress variation of 80 N/mm^2 up to 2 × 10^6 load cycles.

Table 4 lists the maximum tension force in characteristic values for each tendon and gives maximum prestressing forces according to Eurocode 1992-1-1, cl. 5.10.2.1. Overstressing with $P_{max,0} = 0.95 \cdot F_{p0.1k}$ is permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the overstressing force.

Table 4. Characteristic values for tensile resistance of individual FATBAR®s (steel strength) and maximum prestressing forces.

FATBAR®		FB36	FB39	FB42	FB48	FB56	FB64	FB72	FB98
Nominal steel strength f_{pk}	MPa	1050	1050	1050	1050	1000	1000	1000	960
Nominal cross section area A_p	mm^2	1018	1195	1385	1810	2463	3217	4072	7543
Characteristic value of maximum force f_{pk}	kN	1069	1254	1455	1900	2463	3217	4072	7241
Maximum prestressing force $P_{max} = 0.8 \cdot f_{pk} \cdot A_p$	kN	855	1003	1164	1520	1970	2574	3258	5793
Maximum overstressing force $P_{max,0} = 0.95 \cdot A_p \cdot f_{p0.1k}$	kN	914	1072	1244	1625	2106	2752	3482	6115

where,
$f_{p0.1k}$ = characteristic 0.1 % proof-stress of prestressing steel.

NOTE: FATBAR® is a bar tendon for post-tension applications, therefore is primarily intended to work under tension. If FATBAR® is subjected to shear, contact Peikko for shear resistance and interaction verification.

2.2 Fire resistance

If the FATBAR® is cast in concrete as an anchor bolt or structural reinforcement, the concrete cover of the bolt should be at least equivalent to the concrete cover of the reinforcement of the concrete element to ensure adequate fire protection. If the fire resistance is judged to be insufficient, the concrete cover of the bolt must be increased. Fire resistance should be checked according to EN 1992-1-2. Other means to prolong structural integrity during a fire situation could be considered, such as fire-retardant coatings.

2.3 Selecting FATBAR®

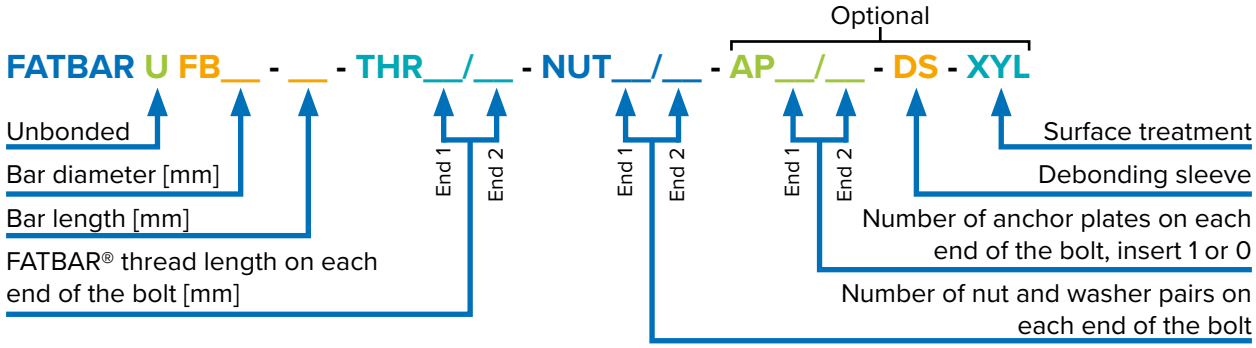
The following aspects must be considered when selecting the appropriate FATBAR® to be used in the project:

- Design values of loads and resistances of the bolt
- Geometry of the structure and length of the bolt
- Interaction with structure along the bolt's length
- Required accessories for intended use.

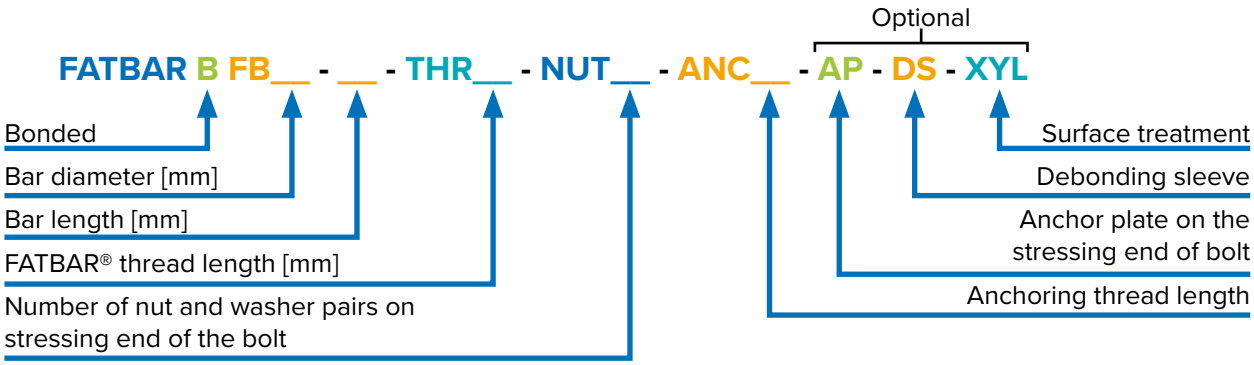
Product code

After selecting the FATBAR®, a product code describing the product may be defined according to the description below. Please use this code in drawings and when ordering the product from Peikko's Sales Service.

Product code for FATBAR® unbonded tendon:



Product code for FATBAR® bonded tendon:



NOTE 1: There are two standard FATBAR® assemblies, one for unbonded applications (U) and one for bonded applications (B). FATBAR® U has FATBAR® threads (THR) on both ends of the bar, FATBAR® B has FATBAR® thread (THR) on one end and anchoring thread (ANC) on the other end.

NOTE 2: Each FATBAR® diameter has a default thread length (THR). If left unspecified in product code, FATBAR® is fabricated with the default thread length. Maximum FATBAR® thread length is 500 mm.

NOTE 3: FATBAR® threads are preassembled with a spherical nut and conical washer.

NOTE 4: Anchoring thread length (ANC) in bonded applications shall be sufficient to resist the tension force in the bolt. See Annex D for methodology used to determine required length of anchoring thread.

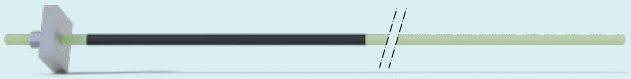
NOTE 5: If included in the product code, the debonding sleeve (DS) will extend through the entire unthreaded length of the bar.

NOTE 6: Special assemblies not covered by the two standard configurations of FATBAR® can be offered under special terms.

NOTE 7: If (AP) is left out from the product code, the FATBAR® won't be equipped with steel anchor plates.

NOTE 8: If (NUT) is left out from the product code, the bolt will be preassembled with one pair of spherical nut and conical washer on each FATBAR® thread end.

Table 5. Examples of product codes for different specifications.

Product code	Description
FATBAR U FB48 - 10000 – AP1/1 – DS 	• FATBAR® • Unbonded • Nominal diameter: FB48 • Total length of the bar: 10000 mm • FATBAR® thread length of 215 mm preassembled with a spherical nut and conical washer on each end (default) • Preassembled with a steel anchor plate on end 1 and end 2 • Debonding sleeve covering the unthreaded length • No additional surface treatment
FATBAR B FB39 - 5000 - ANC2500 – DS 	• FATBAR® • Bonded • Nominal diameter: FB39 • Total length of the bar: 5000 mm • FATBAR® thread length of 180 mm preassembled with a spherical nut and conical washer on one end (default) • Anchoring thread of 2500 mm extending from the other end • Without steel anchor plate • Debonding sleeve covering the unthreaded length • No additional surface treatment
FATBAR U FB42 - 2000 - THR500/500 – NUT2/1 – AP0/1 - DS – XYL 	• FATBAR® • Unbonded • Nominal diameter: FB42 • Total length of the bar: 2000 mm • FATBAR® thread length of 500 mm preassembled with two pairs of spherical nut and conical washer on end 1 and with one pair of spherical nut and conical washer on end 2 • Preassembled with steel anchor plate on end 2 • Debonding sleeve covering the unthreaded length • Surface treatment: Xylan Coating
FATBAR B FB36 - 8000 – THR300 - ANC4000 – AP - DS – EPX 	• FATBAR® • Bonded • Nominal diameter: FB36 • Total length of the bar: 8000 mm • FATBAR® thread length of 300 mm preassembled with a spherical nut and conical washer on one end • Anchoring thread of 4000 mm extending from the other end • Preassembled with steel anchor plate on end 1 • Debonding sleeve covering the unthreaded length • Surface treatment: Epoxy powder coating
FATBAR U FB64 - 11900 - THR400/300 	• FATBAR® • Unbonded • Nominal diameter: FB64 • Total length of the bar: 11900 mm • FATBAR® thread length of 400 mm on one end and 300 mm on the other end preassembled with a spherical nut and conical washer on each end • Without steel anchor plates • Without debonding sleeve • No additional surface treatment

Annex A – Product Applications

As a steel threaded bar with high tensile capacity, FATBAR® can have multiple applications in construction, such as:

1. Post-tensioned tie bar for repairing and strengthening existing structures.
2. Post-tension anchor for cable structures (e.g., cable-stayed bridges, masts, antennas).
3. Usable as longitudinal tendon. Strengthening structures with external post-tensioning bars. FATBAR® can be attached to a structural member and preloaded, closing possible cracks in the existing structure and increasing its tensile or bending strength.
4. High strength bolt for precast joints. FATBAR® can be used in heavy precast applications (e.g., infrastructure projects).
5. Usable as shear reinforcement. FATBAR® can be used for shear strengthening of existent structures or be applied in the structure's original layout in replacement of conventional rebars, typically in situations where heavy reinforcement is needed.
6. Post-tension anchor to connect structural steel to concrete elements (e.g., concrete foundations).
7. Applying normal force in a repairment joint to improve friction between old and new concrete. This is achieved by crossing FATBAR® through the joint and preloading them.
8. High strength ground/rock anchor bars for foundations and retaining walls.

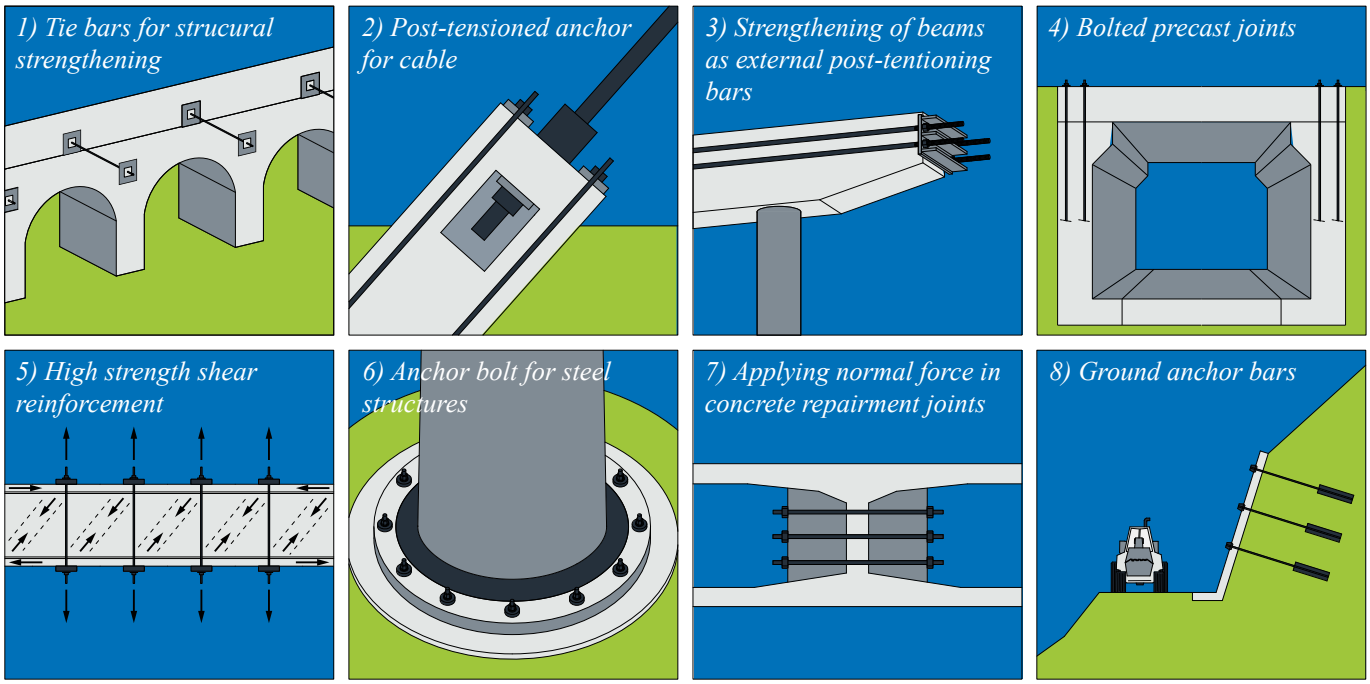


Figure 9. FATBAR® application examples.

Annex B – Accessories

Installation template

In cases where FATBAR®s are placed in a group, the correct position of the bolts, where feasible, can be secured using the PPL Installation Template. It enables groups of bolts to be centralized and the correct position to be assured in relation to the horizontal plate.

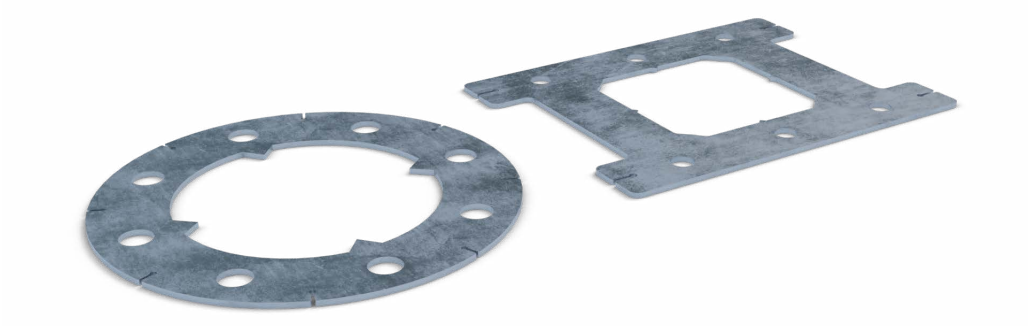


Figure 10. PPL installation templates for rectangular and circular configuration of bolts.

In some cases, integrated anchor plate might serve simultaneously as a template by locking individual bolts in the correct locations.

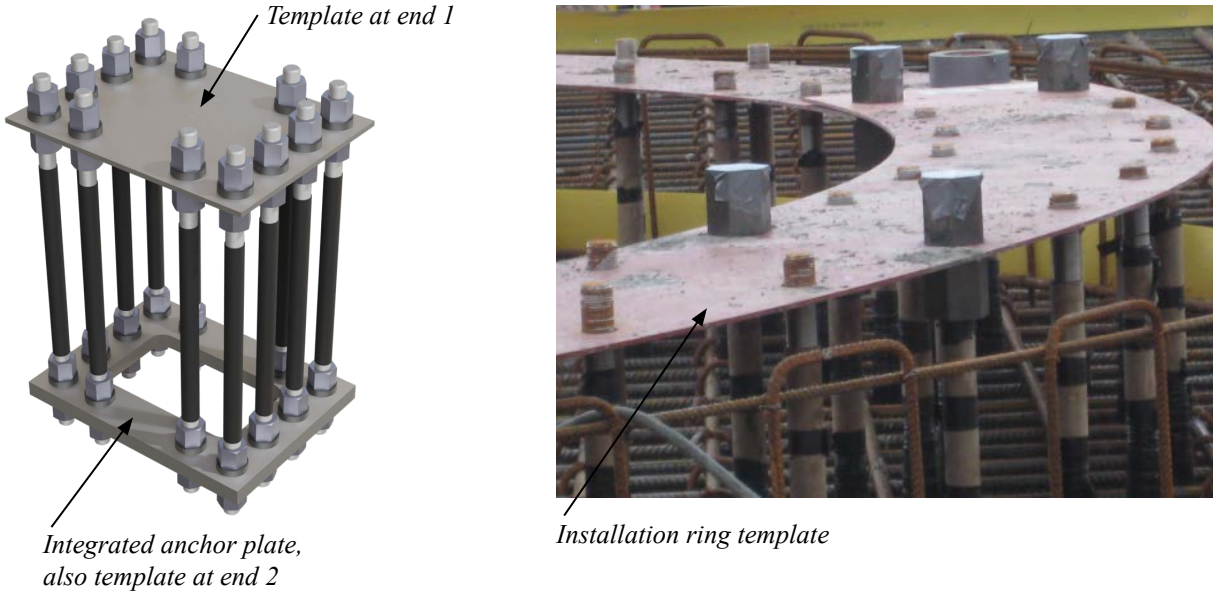


Figure 11. Installation template and integrated anchor plate.

Anchoring plate

The anchoring plates dimensions are presented in Table 6 and Figure 12. Anchoring plates can be provided by Peikko and preassembled on FATBAR®'s anchoring ends. The provided anchoring plates are approved in Peikko's concrete post-tensioning system ETA 10/0246 and are designed to meet the acceptance criteria of EAD 160004-00-0301 given in Clause 2.2.3 regarding load transfer to structure.

Peikko provides four pre-designed options of anchoring plates for each FATBAR® diameter: two size options of square anchoring plates and two size options of circular anchoring plates. Customer can pick the shape and the size of the anchoring plates according to the geometry. The selection of particular plate directly affects minimum edge distance, spacing and amount of supplementary reinforcement.

Table 6. Anchor plate geometry and minimum distances [mm].

FATBAR®				36	39	42	48	56	64	72
Square plate	Small size	Plate dimensions	S	160	175	185	210	245	280	315
			d	40	43	46	52	60	68	76
			t	40	45	45	55	60	70	80
		Center distance	K	320	350	370	420	490	560	630
		Edge distance	R	180	200	210	230	270	300	340
	Large size	Plate dimensions	S	195	210	230	260	305	345	390
			d	40	43	46	52	60	68	76
			t	50	55	60	70	80	90	105
		Center distance	K	260	280	300	340	400	450	510
		Edge distance	R	150	160	170	190	220	250	280
Circular plate	Small size	Plate dimensions	$Ø$	160	175	185	210	245	280	315
			d	40	43	46	52	60	68	76
			t	40	45	45	55	60	70	80
		Center distance	K	320	350	370	420	490	560	630
		Edge distance	R	180	200	210	230	270	300	340
	Large size	Plate dimensions	$Ø$	195	210	230	260	305	345	390
			d	40	43	46	52	60	68	76
			t	50	55	60	70	80	90	105
		Center distance	K	260	270	300	340	400	450	510
		Edge distance	R	150	160	170	190	220	250	280

NOTE: The anchoring plates are predesigned for a minimum concrete strength of $f_{cm,0,cyl}$ = 25 MPa.

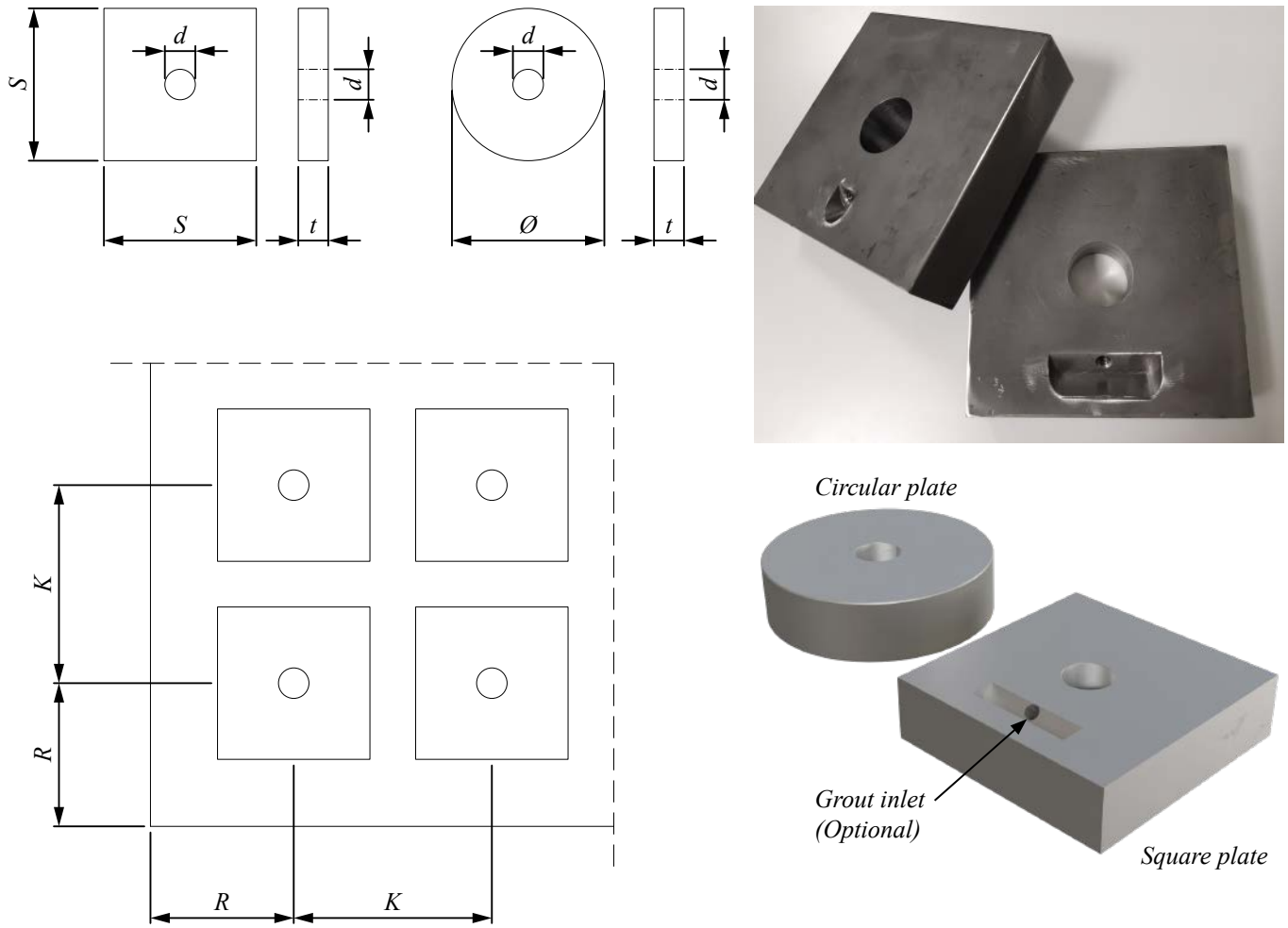


Figure 12. Geometric specifications for anchor plates.

Anchor plates can be manufactured with a grout inlet hole that is primarily included in the system for application: FATBAR® external tendon, where used to grout gap between bar and the PE duct. But there are also other applications that may require grout inlet hole e.g., for strengthening existing structures where after post-tensioning drilled channels shall be filled with the grout. Grout inlet/outlet holes can be manufactured with internal threads for easy and proper connection.

Other size anchoring plates can be used and supplied by Peikko, but custom plates require individual design according to Eurocode. For example, in cases where concrete class is higher, or edge distances are not fulfilled. FATBAR® is also suitable to work together with ultra-high performance concrete and composite anchor plates.

Anchor plates can also be wedge shaped if post tensioned structure's surface geometry requires that.

Figure 13. FATBAR® equipped with beveled anchor plates.

Debonding sleeve

For internal bar tendon applications, FATBAR® can be ordered with debonding sleeves. FATBAR®s with debonding sleeves are treated with grease and equipped with a heat shrink plastic tube along the unthreaded length.

Figure 14. FATBAR® and debonding sleeve.

PE duct and Connection tube

For external bar tendon applications, FATBAR®s can be ordered with PE duct. In this case anchor plat needs to have a connection tube made of steel or PE firmly connected to it (e.g., by welding if tube is made of steel). The transition zone tube to PE duct shall be long enough to compensate for elastic elongation when stressing. Connection needs to be sealed with heat shrink sleeve or Denso™ tape. Also note that in this application anchor plates must be manufactured with grout inlet holes.

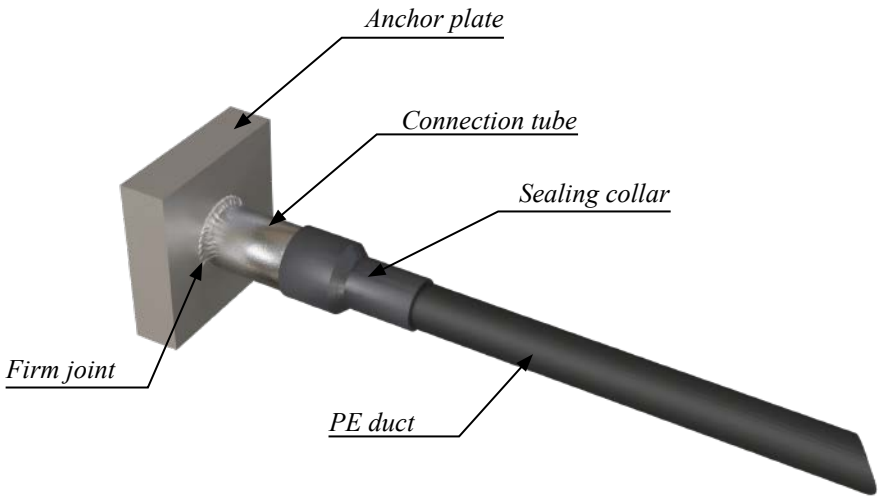


Figure 15. Connection tube and PE duct detail.

Ducts are made of smooth black plastic PE tubes. Ducts fulfil the requirements of EN 12201-1 and 2. Diameter of the ducts are so large that thickness of the corrosion protection grout is at least 5 mm. MOP shall be 1 MPa and tolerance grade shall be A.

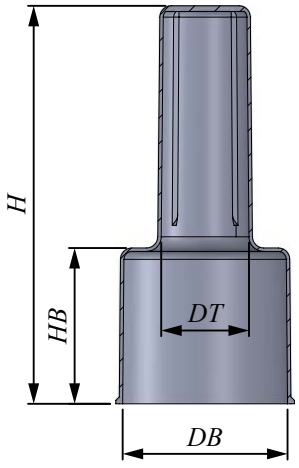
Protection caps

Protection caps provide cover to the bolt's exposed threaded end in anchor bolt applications. Protection caps, together with the grease that is applied to the bolt's surface, protects the bolt against corrosion and the main structure against water infiltration. Protection caps also prevent accidental damage to the bolt's threads. Protection caps geometry depends on the bolt's diameter and its protruding length bolt above the nut. Therefore, these dimensions must be specified so that the correct protection caps are provided.

Figure 16. Protection caps for FATBAR®.

Table 7. Peikko's protection caps dimensions [mm].

FATBAR®	*DB*	*DT*	*HB*	*H*
FB36	71.7	40.5	100	300
FB39	-	-	-	-
FB42	-	-	-	-
FB48	-	-	-	-
FB56	115	60.2	118	252
FB64	131.2	68.8	131	300
FB72	145	77.2	137	300
FB98	214	103.2	187	400



Closed-cell foam tube

FATBAR® can be equipped with closed-cell foam tube for anchor bolt applications. This accessory allows small perpendicular displacement or deflection of the FATBAR®'s external end by forming a clearance between the bolt and the surrounding concrete along a specified length/depth of the bar.

Figure 17. Closed-cell foam tube for FATBAR®.

Coupler nut

Coupler nuts enable FATBAR® to be spliced. It can be used to extend the bolt's length, to create connection, or for flexible transport length. Couplers can be either round or hexagonal shape.

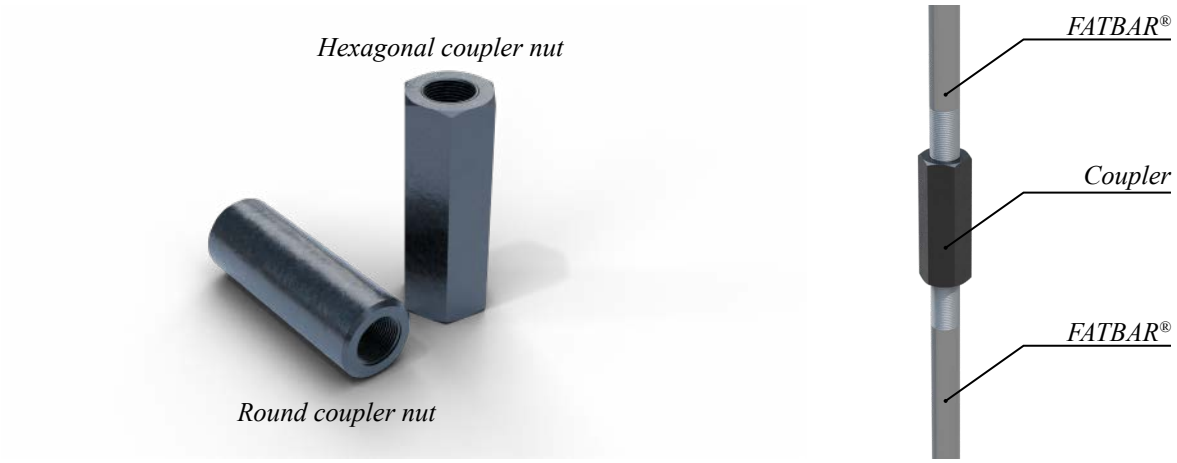


Figure 18. Coupler nuts for FATBAR®.

For post-tensioning systems where splicing happens inside concrete, special packaging for coupler shall be arranged – detail that will provide space for the movement.

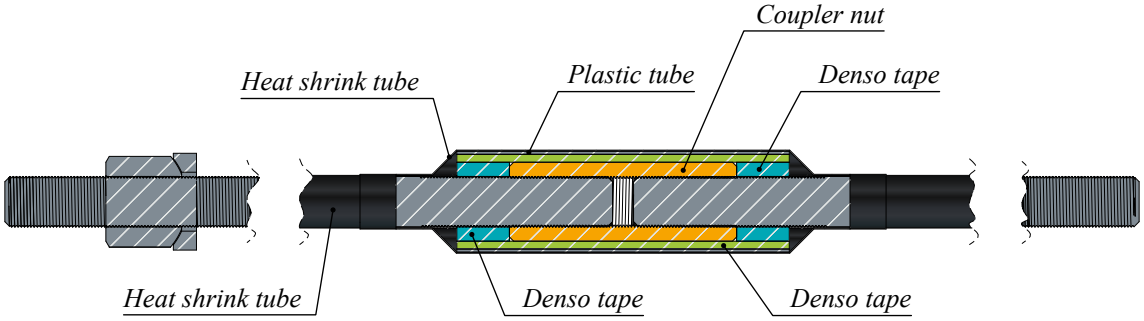


Figure 19. Movement enabling detail for coupler inside concrete.

Annex C – Additional reinforcement

Additional reinforcement is required for concrete post-tension applications of FATBAR®. Peikko provides pre-designed additional reinforcement details for each FATBAR® diameter as part of the post-tension system approved in ETA 10/0246. The additional reinforcement detail depends on the anchor plate choice (*Table 6*).

Table 8 and *Figure 20* presents the additional reinforcement that should accompany each anchor plate option.

Table 8. Additional reinforcement dimensions [mm].

Anchor plate specification			Additional reinforcement specification									
			Helix					Links				
Shape	Size	*FB*	Bar *Ø*	*A*	*B*	*OD*	N° turns	Bar *Ø*	*A*	*B*	*C*	N° of links
Square plate	Small size	36	12	20	60	260	6	12	20	60	200	6
		39	12	20	60	280	6	12	20	60	200	6
		42	14	20	60	310	6	14	20	60	220	6
		48	14	20	60	360	8	14	20	60	240	8
		56	16	20	60	400	8	16	20	60	270	8
		64	16	20	50	420	11	16	20	50	300	11
		72	16	20	50	430	14	16	20	50	340	14
	Large size	36	10	20	75	200	4	10	20	75	150	4
		39	10	20	75	210	4	10	20	75	150	4
		42	12	20	75	240	4	12	20	75	180	4
		48	12	20	60	280	6	12	20	60	210	6
		56	12	20	50	330	8	12	20	50	250	8
		64	14	20	60	380	8	14	20	60	300	8
		72	16	20	80	430	7	16	20	80	350	7
Circular plate	Small size	36	12	20	60	260	6	12	20	60	200	6
		39	12	20	60	280	6	12	20	60	200	6
		42	14	20	60	310	6	14	20	60	220	6
		48	14	20	60	360	8	14	20	60	240	8
		56	16	19	60	400	8	16	20	60	270	8
		64	16	20	50	420	11	16	20	50	300	11
		72	16	10	50	430	14	16	20	50	340	14
	Large size	36	10	20	75	200	4	10	20	75	150	4
		39	10	20	75	210	4	10	20	75	150	4
		42	12	20	75	240	4	12	20	75	180	4
		48	12	20	60	280	6	12	20	60	210	6
		56	12	20	50	330	8	12	20	50	250	8
		64	14	20	60	380	8	14	20	60	300	8
		72	16	20	80	430	7	16	20	80	350	7

NOTE: The additional reinforcements are predesigned for a minimum concrete strength of $f_{cm,0,cyl}$ = 25 MPa and a minimum rebar yielding strength of 500 MPa.

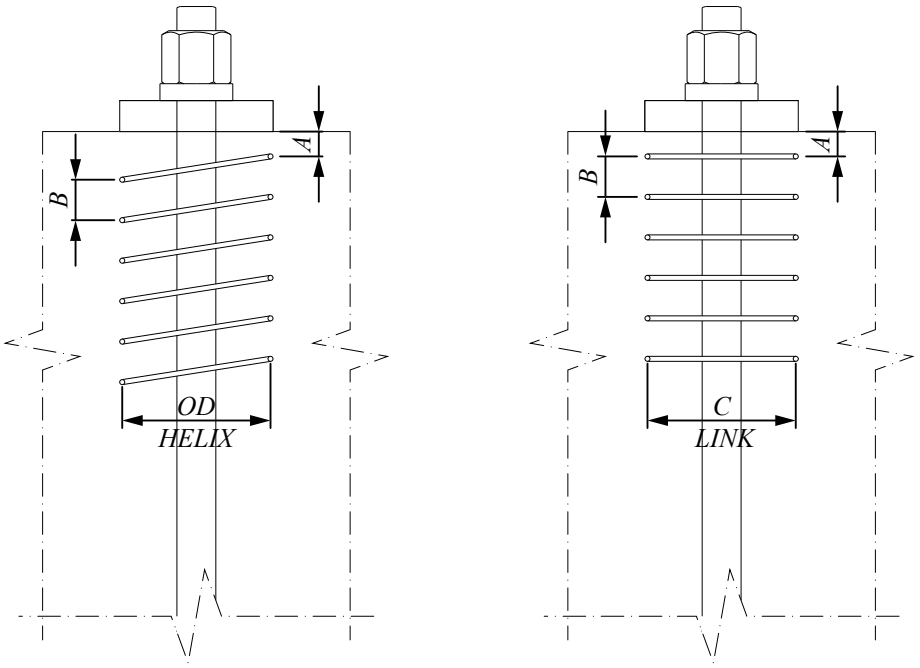


Figure 20. Additional reinforcement detail.

Reinforcement can also be designed according to the need together with anchor plate. The reinforcement specified in *Table 8* represents our standard solution those are default quantities that are tested and declared in ETA 10/0246.

Annex D – Ground anchor

Anchor thread length

FATBAR® bonded is mainly used for ground or rock anchor applications. In this kind of application, FATBAR® is supplied with an anchoring thread that transfers the tension load from the bar to the surrounding grout and then to the ground.

The load transfer occurs along the anchor thread length. Therefore, this length must provide enough bonding strength to resist the tension load in the bar. The bond length is calculated for two interfaces, bar-grout ($l_{b.1}$) and grout-rock ($l_{b.2}$). The anchor thread length is equal to the maximum of both bond length values.

$$l_{anc} = max(l_{b.1}; l_{b.2}) \qquad \text{Equation 1}$$

- Bond length for interface between bar and grout:

$$l_{b.1} = F_{p.max} / \pi F_0 f_{pbd} \qquad \text{Equation 2}$$

where,

$F_{p.max}$ = maximum tension force applied to the bar. Note that maximum force value might depend on application e.g., in rock anchors normally anchorage is designed for proof load. Because rock anchors are proof load tested where proof load is 1.2 to 1.5 times higher than post-tensioning load, and that shall be considered in the design.

F_0 = the diameter of the bar

f_{pbd} = the bond strength for anchorage according to EN 1992-1-1, Eq. (8.20) with the following coefficients:

η_{p2} = 1.4 coefficient determined by testing

η_1 = 1 for good bond conditions as defined in EN 1992-1-1, cl. 8.10.2.2(1)

= 0.7 otherwise

- Bond length for interface between grout and ground or rock:

$$l_{b.2} = F_{p.max} / \pi d_h \tau_w \gamma_a \qquad \text{Equation 3}$$

where,

d_h = the diameter of drill hole (chosen by designer), taking into account provisions of EN 1537 regarding minimum grout thickness

τ_w = bond strength between rock and grout, determined by investigation test, provided by geoengineer, or assumed by designer based on experience or literature e.g., manuals for specific works etc.

γ_a = the partial factor for anchorage resistance according to EN 1997-1 table A.16

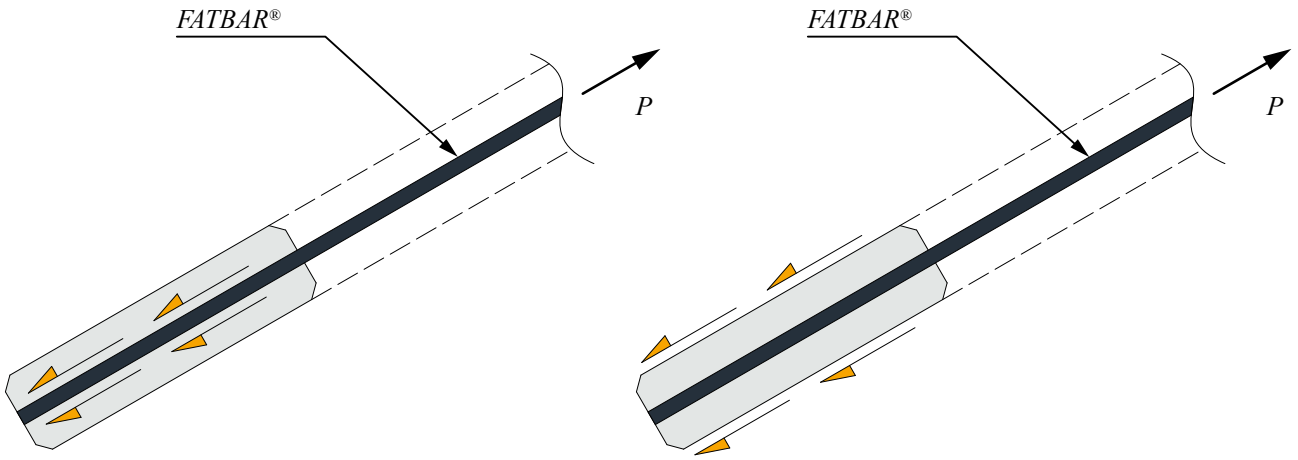


Figure 21. Shear resistance on interaction surfaces along anchoring length.

Tests on ground or rock anchors

During execution of anchors, two types of tests are performed on site: suitability tests and acceptance tests. Suitability tests are load tests to confirm that a particular anchor design will be adequate in a particular ground condition. Acceptance tests are performed after the rock anchors are installed and grouted and before they become operational to confirm that each anchorage meets the design requirements. Both of these tests must be performed according to EN ISO 22477-5. Prior to execution, an investigative test may also be performed.

Annex E – Post-tensioning FATBAR®

Prestressing forces

Prestressing and overstressing forces are specified in the respective standards and provisions valid at the place of use. *Table 9* lists the maximum values and the designation of the tendons. Regarding the Eurocode 1992-1-1, cl. 5.10.2.1, the maximum prestressing force applied to a bar tendon does not exceed $P_{max} = min(0.8F_{pk}; 0.9F_{p0.1k})$. Overstressing with $P_{max,0} = 0.95F_{p0.1k}$ is only permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the overstressing force.

Initial prestressing force, P_{m0}, immediately after stressing and anchoring does not exceed the forces as specified in Eurocode 2.

Table 9. Maximum prestressing and overstressing forces [kN]

		FB36	FB39	FB42	FB48	FB56	FB64	FB72	FB98
Maximum prestressing force	kN	855	1003	1164	1520	1970	2574	3258	5793
Maximum overstressing force	kN	914	1072	1244	1625	2106	2752	3482	6115

Loss of prestressing forces

The initial post-tensioning force applied to the active anchorage (P_0) is transmitted along the tendon but decreases as a consequence of instantaneous and long-term losses. The effective post-tensioning force at each tendon point x (P_x) can be determined based on Eurocode 2, EN 1992:1-1 as follows:

$$P_x = P_0 - \Delta P_i - \Delta P_{lt} \qquad \text{Equation 4}$$

P_x (kN) = prestressing force at a point x away from the anchorage
P_0 (kN) = prestressing force or initial prestressing force at the anchorage, $x = 0$
ΔP_i (kN) = instantaneous losses, $\Delta P_i = \Delta P_{i,1} + \Delta P_{i,2} + \Delta P_{i,3}$
$\Delta P_{i,1}$ (kN) = loss in prestressing force due to friction at a distance x away from the active anchorage along the tendon, calculated according to Equation 5
$\Delta P_{i,2}$ (kN) = loss in prestressing force due to anchorage slippage, determined according to *Table 10*
$\Delta P_{i,3}$ (kN) = loss in prestressing force due to instantaneous deformation of the concrete, see EN 1992:1-1
ΔP_{lt} (kN) = long-term losses, see EN 1992:1-1

Friction losses

In FATBAR® post-tensioned system, frictional losses can occur due to contact between the steel and the sides of the debonding sleeve by means of (*i*) intentional variation in tendon profile and (*ii*) unintentional deviation for tendon (wobble).

FATBAR® is a straight element which cannot be bent, as such there is no frictional loss due to intentional curvature of the tendon. Therefore, the only frictional loss that may be considered is due wobble which can be estimated based on Eurocode 2, EN 1992:1-1 as described below:

$$\Delta P_{i,l} = \Delta P_{\mu}(x) = P_{max}\,(1 - e^{-\mu(\theta + kx)}) \qquad \text{Equation 5}$$

where,

$\Delta P_{\mu}(x)$	(kN)	=	frictional loss
P_{max}	(kN)	=	force at the active end during tensioning at the distance $x = 0\ m$
k	(rad/m)	=	coefficient of unintentional angular displacement or wobble factor. EN 1992-1-1 recommends $0.005 < k < 0.01$ (rad/m)
μ		=	friction coefficient between bar and duct must be taken into account regarding *Table 5.1* of EN 1992-1-1
Θ	(rad)	=	sum of the angular deviations over a distance x, irrespective of direction or sign

Slip at anchorages

Slip at anchorages is considered in design of the structure and for determination of tendon elongation. *Table 10* specifies the slip values considered for determining prestressing force and tendon elongation. These values are defined to obtain loss in prestressing force due to this phenomenon.

Table 10. Slip at anchorage [mm]

FATBAR	Anchor plate	Anchorage slippage
FB36 **FB39**	Solid plate, square	0.5
	Solid plate, circular	
FB42 **FB48** **FB56**	Solid plate, square	0.7
	Solid plate, circular	
FB64 **FB72** **FB98**	Solid plate, square	0.9
	Solid plate, circular	

Installation of FATBAR®

Identification of the product

FATBAR® is available in two standard models, FATBAR® U for unbonded applications and FATBAR® B for bonded applications. FATBAR® can be identified by the name in the label on the product. The product code contains all information regarding the geometry of the bar (diameter, length, and thread lengths) and surface treatments.

Forming a bolt group

When FATBAR®s are applied as anchor bolts, they can be collected into bolt groups using the PPL Installation Template or integrated anchor plate. The installation template enables bolt groups to be centralized on the horizontal plane in exactly the right place and easily adjusted to the correct casting level.

Ordering PPL Installation Templates

When PPL Installation Templates are ordered the thread diameter of bolts, the number of bolts and the center to center dimensions must be specified.

Examples of installation plates:

1. **PPL42-4** 360×360: 4 pieces FB42 bolts in square form..
2. **PPL39-4** 500×400: 4 pieces FB39 bolts in rectangular form.
3. **PPL60-6** 280×(190+190): 6 pieces FB64 bolts rectangular form.
4. **PPL36-8** (190+190)×(190+190): 8 pieces FB36 bolts in the form of a square.
5. **PPL52-3** 300×300: 3 pieces FB56 bolts in the form of rectangular triangles.
6. **PPL30-8** D400: 8 pieces FB36 bolts in the form of circles with diameter of 400 mm.

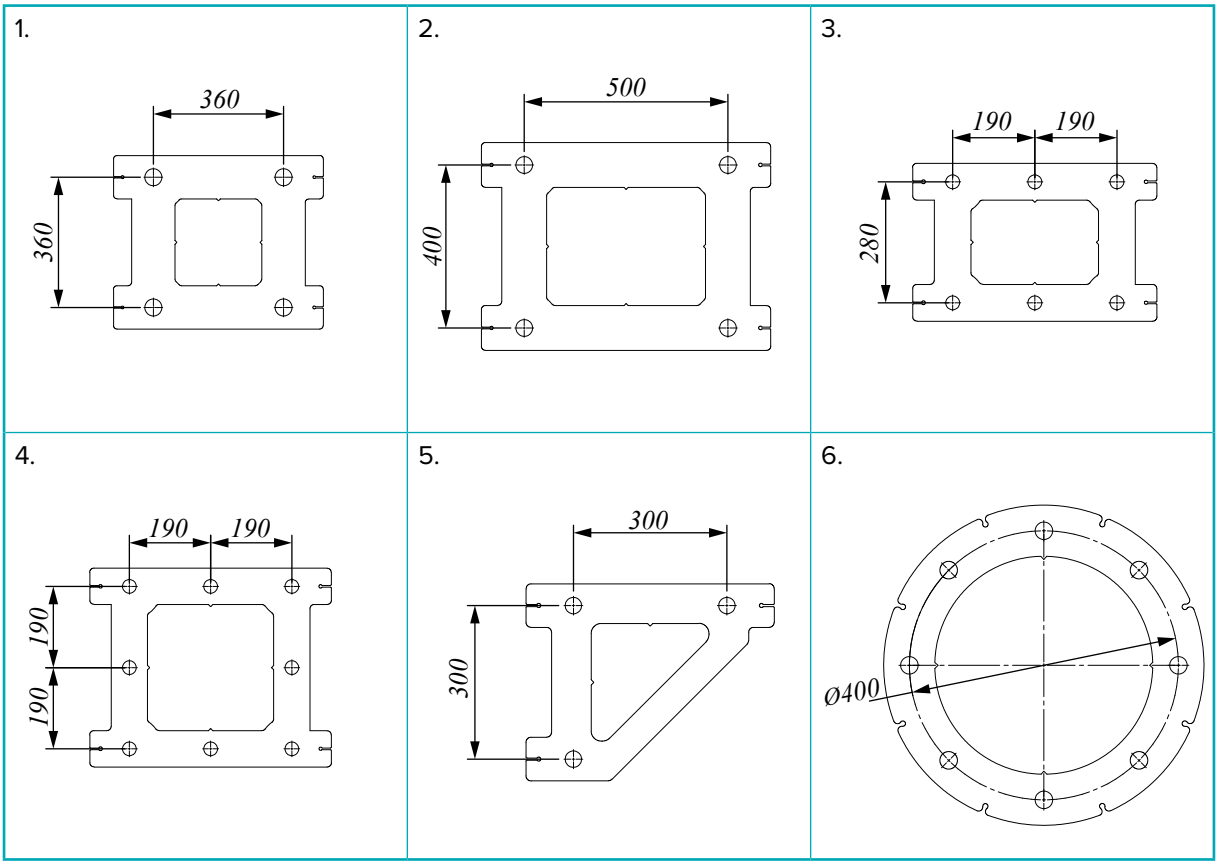


Figure 22. PPL Installation Templates – examples.

PPL Installation Templates can also be manufactured according to drawings that present the location of the bolts and thread diameters.

Bending the bolts

FATBAR® are intended to work always in straight position and cannot be bent.

Welding the bolts

FATBAR®'s steel grade is not weldable.

Post-tensioning the bolts

Proper post-tensioning force should be applied according to Annex E.

Tensioning can be carried out by a method which measures force and elongation. Total required strain at the stressing end can be obtained by utilizing Peikko's calculation procedure for prestressing design of anchor bolts or by consulting with Peikko's customer engineering service.

Figure 23. Measuring required elongation during tensioning process.

Hydraulic jack shall be used to achieve elongation in the FATBAR® that corresponds to the selected tensioning force. Tensioning by wrench key is not allowed due to risks of thread damage and inaccuracy.

Hydraulic jack kit includes adapter (i.e., puller), jack, stressing bridge, tightening wrench. Adapter's inner thread profile shall match FATBAR® thread shape and diameter, hence Peikko can provide drawing for the needed part to the contractor.

Once required elongation in the FATBAR® is reached, and before releasing the jack the nut of the bolt is tightened against the anchor plate through the cavity in the stressing bridge. If stressing bridge doesn't have opening to reach nut with the wrench, then, alternatively, it has inner built-in spanner that encloses the nut and is operated from the outside.

Post-tensioning can also be done without adapter/puller but that requires an extra top plate and longer protruding thread.

Peikko doesn't offer post-tensioning as a service but provides necessary technical specifications and drawings for the site.

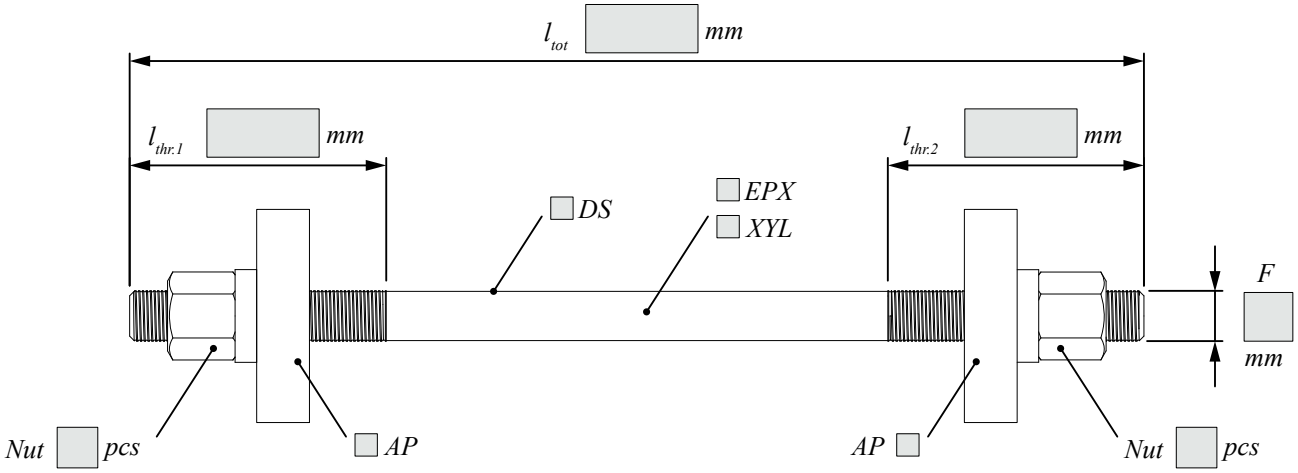
a) Adapter/puller *b) Hydraulic jack* *c) Stressing bridge*

Figure 24. Components of hydraulic post-tensioning kit.

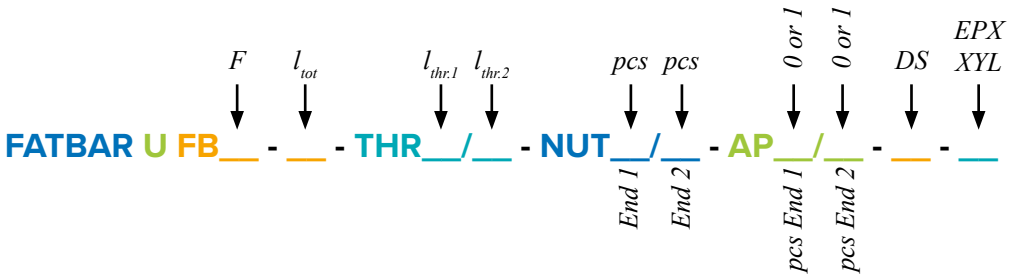
Figure 25. Assembled post-tensioning tool.

FATBAR® Specification template

FATBAR® Unbonded internal tendon

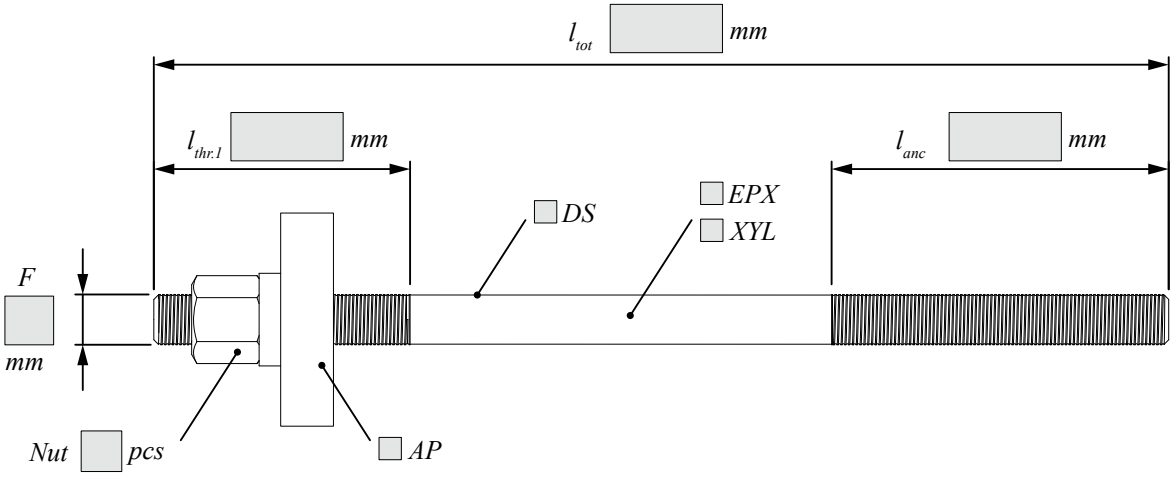


Accordingly, reflection in product code:

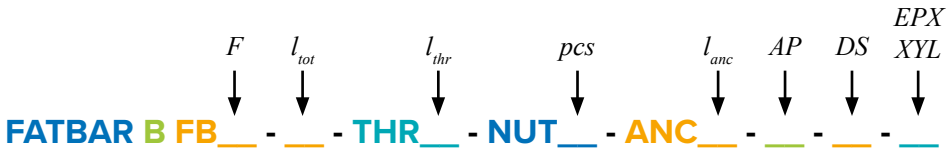


See also section Selecting of FATBAR® for product code breakdown.

FATBAR® Bonded internal tendon



Accordingly, reflection in product code:



See also section Selecting of FATBAR® for product code breakdown.

Revision History

Version: PEIKKO GROUP 042023. Revision: 001

- First publication.

Resources

DESIGN TOOLS

Use our powerful software every day to make your work faster, easier, and more reliable. Peikko design tools include design software, 3D components for modeling programs, installation instructions, technical manuals, and product approvals of Peikko's products.

peikko.com/design-tools

TECHNICAL SUPPORT

Our technical support teams around the world are available to assist you with all of your questions regarding design, installation etc.

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APPROVALS

Approvals, certificates, and documents related to CE-marking (DoP, DoC) can be found on our websites under each products' product page.

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EPDS AND MANAGEMENT SYSTEM CERTIFICATES

Environmental Product Declarations and management system certificates can be found at the quality section of our websites.

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