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per la valutazione tecnica**
Italian Technical Assessment Body

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European Technical Assessment **ETA 15/0321 of 30/12/2025**

GENERAL PART

Trade name of the construction product

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product family to which the construction product belongs

PAC 16: Reinforcing and prestressing steel for concrete (and ancillaries). Post tensioning kits.

Manufacturer

**TTM tension technology S.r.l.
Via Oger Martin, 21
03024 Ceprano (FR) - Italy**

Manufacturing plant

**TTM tension technology S.r.l.
Via Alberto da Giussano, 9
20011 Corbetta (MI) - Italy**

This European Technical Assessment contains:

34 pages, including 25 annexes which form an integral part of this assessment

This European Technical Assessment is issued in accordance with Regulation (EU) n° 305/2011, on the basis of

EAD 160004-00-0301 – Post-tensioning kits for prestressing of structures

This version replaces

ETA 15/0321 (version 02) of 05/05/2016

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SPECIFIC PARTS

1. TECHNICAL DESCRIPTION OF THE PRODUCT

1.1 Definition of the product

The **TTM tension technology - Bonded and unbonded monostrand post-tensioning system** consists of:

- tendon:
 - bonded and unbonded tendons with one tensile elements;
- tensile elements:
 - 7-wire prestressing steel strand having the characteristics indicated in Table 1; the wire can be equipped with a protective sheathing against corrosion:

Table 1: Tensile elements

Strands type	Nominal diameter [mm]	Nominal cross section [mm ²]	Characteristic tensile strength [MPa]
Normal – T15	15.2	139	1860
Super – T15S	15.7	150	1860
Compact T15C	15.2	165	1860

- anchor head:

Anchor head	Active	Passive	Number of strand
			1
Anchorage E – ED	X	X	X
Anchorage EX – EXD	X	X	X
Coupler GX	-	-	X

- “E” series active and passive anchorages are designed for traditional post-tensioning application;
- “ED” worked series active and passive anchorages are designed for traditional post-tensioning application, and are composed by anchor head 1E15 *filettata* and 1E15 *tornita*– foro Ø 20mm;
- “EX” series active and passive anchorages are made of the same elements as the “E” series ones, but they are designed for post-tensioning applications in aggressive environment: the anchorage is completely encapsulated in polyethylene;
- “EXD” series active and passive anchorages are made of the same elements as the “E” series ones, but they are designed for post-tensioning applications in aggressive environment: the anchorage is completely encapsulated in polyethylene and the plastic coating is worked to make a connection with the protection cap EXD;
- “GX” series connection on single strand cables is carried out by using a coupler that allows to guarantee the strand connection. The polyethylene covering is guaranteed on its whole length allowing the connection to slide due to the elongation.

- bursting reinforcement (helix and stirrups);
- sheathing (ducts);
- corrosion protection for all tensile elements and anchor heads.

The product description, with reference to its components, is given in Annex A.

1.2 Components

The components correspond to the drawings and provisions given in this European Technical Assessment including the Annexes.

The characteristic material values, dimensions and tolerances of the components not indicated in the Annexes or in the following paragraphs correspond to the respective values laid down in the technical documentation of this European Technical Assessment.

1.2.1 Strands

As long as prEN 10138 remains a pre-standard, 7-wire strands in accordance with national provisions are used. The corresponding characteristics are given in Table 2:

Table 2: Dimensions and properties of 7-wire strands

Designation	Symbol	Unit	Value		
Characteristic tensile strength	f_{ptk}	MPa	1860	1860	1860
Nominal diameter	D	mm	15.2	15.7	15.2
Nominal cross section	A_p	mm ²	139	150	165
Nominal mass	M	g/m	1093	1172	1289

To avoid any possible confusions, only strands with one nominal diameter shall be used on one site. Further characteristic values of the strands are reported in Annex A17.

1.2.2 Wedges

Wedges type T15 are made of case hardening steel 16NiCrS4Pb according to EN 10277-4. The wedges are made in 3 or 2 segments, hold together by a spring ring, they are 43 mm long and have 60°-tooth. Further characteristic values of the wedges are explained in the Annex 1. The 3 segments wedges are used on active and passive anchorages and they are signed by T15. The 2 segments wedges are used on pre blocked and through anchorages and they are signed by T15-2S.

The pre-blocking force applied is 1.3 times the ordinary force so to avoid draw-in.

1.2.3 Anchor heads

Anchor head 1E15, 1E15 *filettata* and 1E15 *tornita*– foro Ø 20 mm are realized by closed die forging, are made by steel C40-45 according to EN 10083-2.

- Anchor head 1E15 *filettata*:
The anchorage active and passive is provided with a threaded closing tip in order to guarantee a stronger closure to contain grease. The application allows to install unbonded/bonded single strand.
- Anchor head 1E15 *tornita*– foro Ø 20 mm:
The application allows to install unbonded/bonded single strand anchorages with through strand. The application is typical of industrial floors, diaphragms or continuous grouting slabs, where on a continuous cable several anchorages are installed in series.

Further characteristic values are reported in the Annex A1. Anchor head 1EX15 and 1EXD15 are coated by H.D.P.E. in order to improve the corrosion protection.

1.2.4 Coupler

The Coupling sleeve type 1G15 are made by steel 39NiCrMo3 according to EN 10083-3 and completely encapsulated in polyethylene (1GX15). They are made up by two elements joined together through a threaded bolt. They are equipped of two wedges type T15 in order to ensure the extension of the wire (see Annex A15 and A16).

1.2.5 Helix and stirrups

The steel grades and dimensions of the helix and of the stirrups shall comply with the values given in the Annexes. The helix shall be placed exactly in the tendon axis. The helix dimensions shall comply with the values specified in Annex A4.

If required for a specific project design, the reinforcement given in the Annex A4 may be modified in accordance with the respective regulations in force at the place of use as well as with the eventual relevant approval of the local authority and of the manufacturer to provide equivalent performance.

1.2.6 Tubes and trumpets

Tubes and trumpets (see Annex A2) are positioned between the sheath and the anchorage and guarantee proper protection to the strand where the sheath is removed. They are made of H.D.P.E. and they are able to keep stability when high temperatures are reached during the injection process. In the area where it is necessary to remove the PE-coat a proper HDPE coupler is applied in order to avoid any void.

1.2.7 Permanent corrosion protection

All components or materials have to be selected according to the standards and regulations in force at the place of use. In absence of such standards or regulations, components and materials in accordance with EAD 160004-00-0301 are deemed as acceptable.

Application of corrosion protection in the anchorage zone shall comply with the assembly instructions specified in Annex B1 and B2. The void in the anchorage zone shall be completely filled with a corrosion protective grease.

1.3 Design of the PT kit

1.3.1 Maximum prestressing forces

Prestressing and over-tensioning forces have to be specified in accordance with national provisions. For more details see Annex A19.

1.3.2 Friction losses

For the calculation of loss of prestressing force due to friction Coulomb's law applies. Due to the grease filling of the HDPE – sheathing of the individual mono-strands, the friction coefficient μ is very low for unbounded applications. The calculation of the friction losses is given by the equation:

$$F_x = F_0 \cdot e^{-\mu(\alpha+kx)}$$

with:

- F_x [kN]: prestressing force at a distance x along the tendon
- F_0 [kN]: prestressing force at $x = 0$ m
- μ [rad^{-1}]: friction coefficient
- k [rad/m]: wobble coefficient
- α [rad]: sum of the angular displacements over the distance x , irrespective of direction or sign
- x [m]: distance along the tendon from the point where the prestressing force is equal to F_0 .

Friction losses in anchorages are low and do not have to be taken into consideration in design and execution.

Values of μ and k values are specified in Table 4 and are the values provided by the European standard EN 1992-1-1 (Table 7.2).

Table 4: Friction and wobble coefficients for strands according to EN 1992-1-1 (Table 7.2).

Friction coefficient μ [rad ⁻¹]				Wobble coefficient k [rad/m]
Internal tendons		Greased and sheathed strand	External tendons	0.05-0.01
Metal duct	Polymer duct	PE duct	PE duct	
0.19	0.14	0.05	0.12	

1.3.3 Support of tendons (valid only for unbonded)

Monostrands have to be secured in their position. Spacing of tendon supports is:

- normally: 1.00 – 1.30 m
- free tendon layout (Annex B2) in max. 45 cm thick slabs

In the transition zone between:

- a) high tendon position and anchorage (e.g. cantilever): 1.50 m;
- b) low and high tendon position or low tendon position and anchorage: 3.00 m.

In the region of the high or low tendon position, the tendons shall be connected in an appropriate way to the reinforcement mesh at the least two points at least, with a spacing of 0.3 to 1.3 m. The reinforcement mesh shall be fixed in its position; special spacers for tendons are therefore not required. For details see Annex B2.

Prestressing forces due to free tendon layout may be considered for the evidence of Serviceability Limit States. The evidence of Ultimate Limit States shall be carried out without consideration of prestressing forces due to this kind of prestressing.

1.3.4 Radii of curvature of internal tendons

The minimum radius of curvature R_{min} of internal tendon with strands of nominal diameter of 15.2 (normal) is 2.5 m, for strands of nominal diameter of 15.7 (super) is 2.6 m and for strands of nominal diameter of 15.2 (compact) is 5.0 m. If these radii are adhered to, the verification of prestressing steel outer fibre stresses in curved sections is not required.

1.3.5 Concrete strength

Concrete according to EN 206-1 has to be used. For more details see Annex A19.

1.3.6 Centre and edge distances of the tendon anchorages, concrete cover

Spacing and distances shall not be less than the values given in Annex A5.

The anchorages E, ED, EX, EXD always should be embedded in the concrete in such a way that the long sides of the anchorages are parallel to the long centre or edge distances (see Annex A10).

1.4 Installation

The information about installation is provided with the technical documentation from the manufacturer and it is assumed that the product will be installed according to it or (in absence of such instructions) according to the usual practice of the building professionals.

Installation instructions are reported in Annex B1 and Annex B2.

2. SPECIFICATION OF THE INTENDED USE IN ACCORDANCE WITH EUROPEAN ASSESSMENT DOCUMENT N° 160004-00-0301 (hereinafter EAD)

2.1 Intended use

The **TTM tension technology - Bonded and unbonded monostrand post-tensioning system** is intended to be used for the prestressing of structures of normal weight concrete as:

- Internal bonded tendon for concrete and composite structure (with anchors placed in concrete);
- Internal unbonded tendon for concrete and composite structures (with anchors placed in concrete).

The structural members used to be designed in accordance with national laws.

2.2 Packaging, transport and storage

Concerning product packaging, transport and storage it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on the transport and storage, as he considers necessary in order to reach the declared performances.

The components and the tendons shall be protected against moisture and staining, taking all necessary measures to avoid conditions for rust and chemical, mechanical and electrochemical damages to components.

Tensile elements shall be kept separate from areas where welding operations are carried out.

2.3 Use, maintenance, repair

Manufacturer's installation instructions have to comply with. In any case respective standards and regulations in force at the place of use should be observed.

It is highly recommended to apply EN 17678-1:2022 — "Installation of post-tensioning kits for prestressing of structures — Part 1: Competence of personnel for the installation"

2.4 Assumed working life

The performances assessed in this European Technical Assessment, according to the applicable EAD, are based on an assumed intended working life of 100 years, provided that the conditions for packaging, transport, storage, installation as well as appropriate use, maintenance and repair are met. The indications given on the working life cannot be interpreted as a guarantee given by the manufacturer but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3. PERFORMANCE OF THE PRODUCT AND REFERENCES TO THE METHODS USED FOR ITS ASSESSMENT

The tests for performance assessment of **TTM tension technology - Bonded and unbonded monostrand post-tensioning system** were carried out in compliance with EAD 160004-00-0301 according to the test methods reported herein, as well for what concerns sampling, conditioning and testing provisions.

The numbering (#) in the following tables corresponds to the numbering of Table 1 of EAD 160004-00-0301.

3.1 MECHANICAL RESISTANCE AND STABILITY (BWR 1)

#	Essential characteristic	Performance
1	Resistance to static load – Clause 2.2.1	See Annex C1
2	Resistance to fatigue – Clause 2.2.2	See Annex C2
3	Load transfer to the structure – Clause 2.2.3	See Annex C3
4	Friction coefficient – Clause 2.2.4	According to EN 1992-1-1 Table 7.2 See Clause 1.3.2
5	Deviation/deflection (limits) for internal bonded and internal unbonded tendon - Clause 2.2.5	The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.5. See Clause 1.3.4.
6	Deviation/deflection (limits) for external tendon - -- Clause 2.2.6	The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.6. See Clause 1.3.4.
7	Assessment of assembly - Clause 2.2.7	The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.7. See Annex B1 and B2, Clause 1.3.3.
8	Resistance to static load under cryogenic conditions for applications with anchorage/coupling outside the possible cryogenic zone - Clause 2.2.8	Not applicable
9	Resistance to static load under cryogenic conditions for applications with anchorage/coupling inside the possible cryogenic zone – Clause 2.2.9	Not applicable
10	Material properties, component performance, system performance of plastic duct – Clause 2.2.10	No performance assessed
11	Material properties, component performance, system performance of plastic duct to provide an encapsulated tendon – Clause 2.2.11	No performance assessed
12	Material properties, component performance, system performance of plastic duct to provide an electrically isolated tendon – Clause 2.2.12	No performance assessed

#	Essential characteristic	Performance
13	Corrosion protection – Clause 2.2.13	The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.13. See Clause 1.2.7
Monostrand, sheathing base material		
14	Melt index – Clause 2.2.14	No performance assessed
15	Density – Clause 2.2.15	No performance assessed
16	Carbon black – Clause 2.2.16	No performance assessed
17	Tensile strength – Clause 2.2.17	No performance assessed
18	Elongation – Clause 2.2.18	No performance assessed
19	Thermal stability – Clause 2.2.19	No performance assessed
Monostrand, manufactured sheathing		
20	Tensile strength – Clause 2.2.20	No performance assessed
21	Elongation – Clause 2.2.21	No performance assessed
22	Surface of sheathing - Clause 2.2.22	No performance assessed
23	Environmental stress cracking - Clause 2.2.23	No performance assessed
24	Temperature resistance - Clause 2.2.24	No performance assessed
25	Resistance to externally applied agents - Clause 2.2.25	No performance assessed
26	Sheathing minimum thickness - Clause 2.2.26	No performance assessed
Monostrand, manufactured monostrand		
27	External diameter of sheathing - Clause 2.2.27	No performance assessed
28	Mass of sheathing per metre - Clause 2.2.28	No performance assessed
29	Mass of filling material per metre - Clause 2.2.29	No performance assessed
30	Alteration of dropping point caused by monostrand manufacturing - Clause 2.2.30	No performance assessed
31	Alteration of oil separation caused by monostrand manufacturing - Clause 2.2.31	No performance assessed
32	Impact resistance - Clause 2.2.32	No performance assessed
33	Friction between sheathing and strand - Clause 2.2.33	No performance assessed
34	Leak tightness - Clause 2.2.34	No performance assessed

3.2 SAFETY IN CASE OF FIRE (BWR 2)

#	Essential characteristic	Performance
35	Reaction to fire	No performance assessed

3.3 HYGIENE, HEALTH AND THE ENVIRONMENT (BWR 3)

#	Essential characteristic	Performance
36	Content, emission and/or release of dangerous substances – Clause 2.2.36	PT system does not contain and release any dangerous substances; it does not cause harmful emission of toxic gases, dangerous particles or radiation to the indoor environment nor contamination of the outdoor environment (air, soil, water).

4. ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE (AVCP) SYSTEM APPLIED, WITH REFERENCE TO ITS LEGAL BASE

In accordance with the European Assessment Document EAD No. 160004-00-0301 the applicable European legal act is: **Commission Decision 98/456/EC**.

The system of assessment and verification of constancy of performance (AVCP) is 1+.

5. TECHNICAL DETAILS NECESSARY FOR THE IMPLEMENTATION OF THE AVCP SYSTEM, AS PROVIDED FOR IN EAD 160004-00-0301

Technical details necessary for the implementation of the AVCP system are laid down in the Control Plan deposited at ITAB/ITC-CNR.

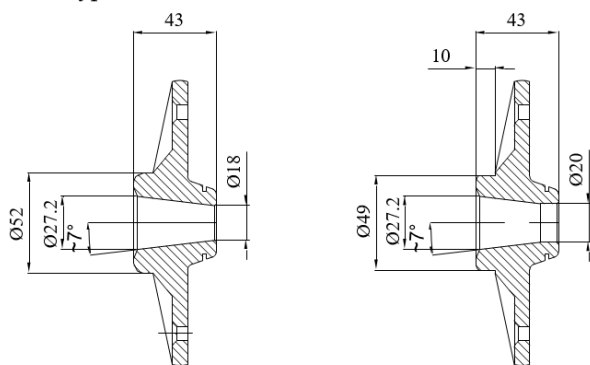
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Coordinator of ITAB Technical Committee
Annalisa Franco, PhD

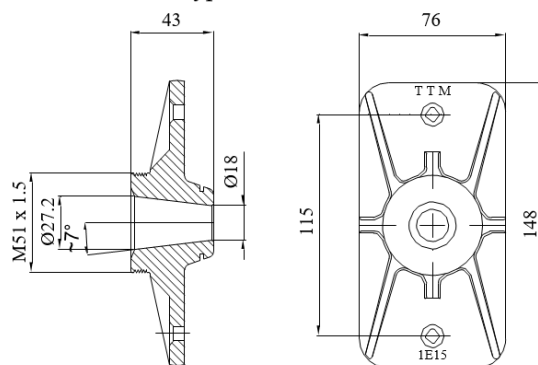
Director of ITAB
Mr. Antonio Occhuzzi

President of ITAB
Mr. Massimo Sessa

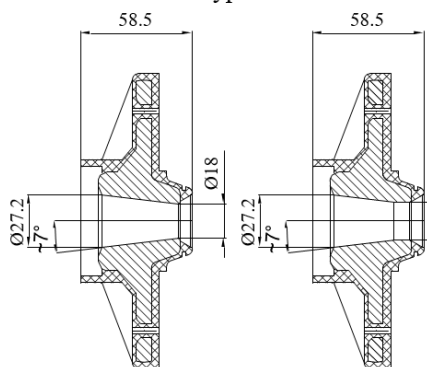
Anchor type 1E15
Type 1E15 tornita – foro Ø20



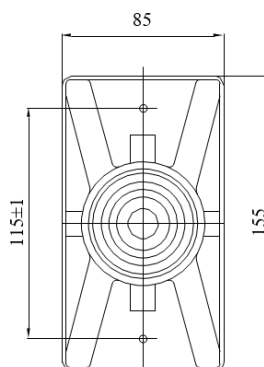
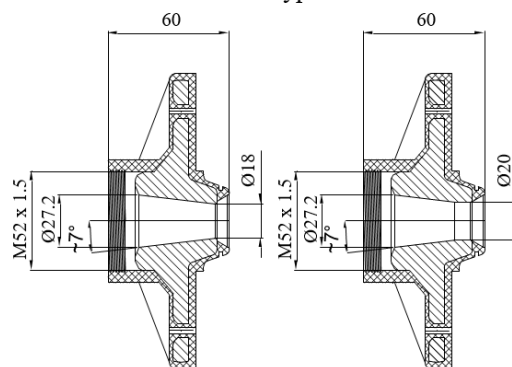
Anchor type 1ED15
Type 1E15 filettata



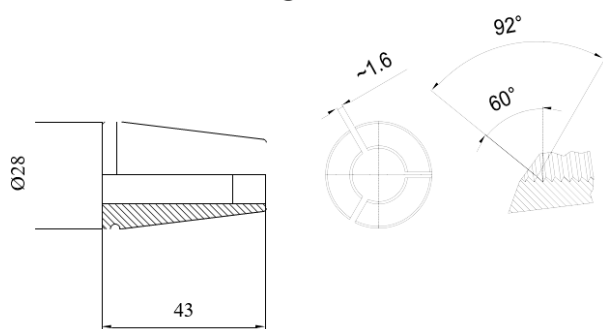
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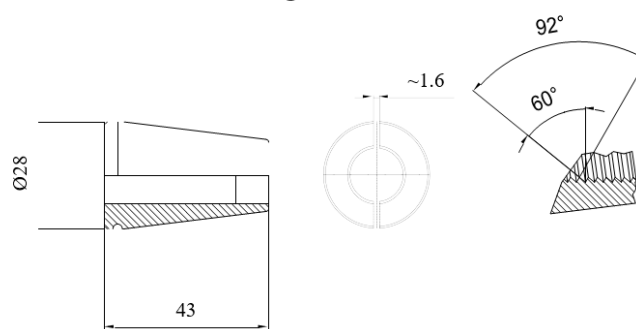
Anchor type 1EXD15



Wedge T15



Wedge T15 – 2S

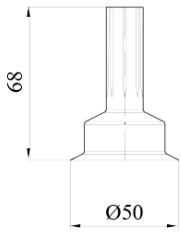


TTM tension technology - Bonded and unbonded monostrand post-tensioning system

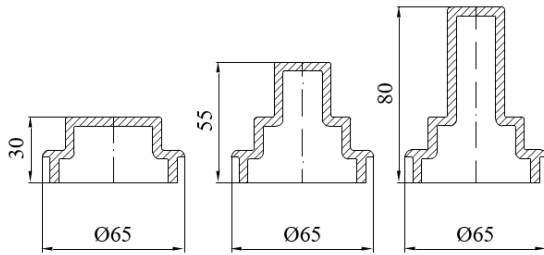
Product Description – Anchorage

Annex A1
of ETA N° 15/0321

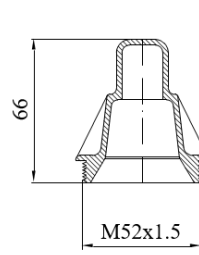
Protection cap E



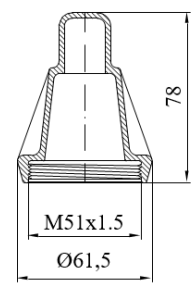
Protection cap EX



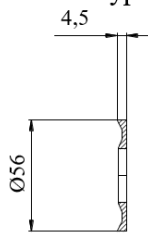
Protection cap XD



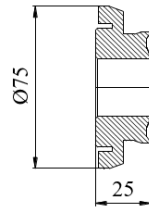
Protection cap ED



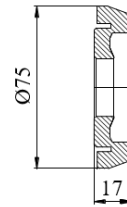
Rubber sealing series E - EX
Type DD7025



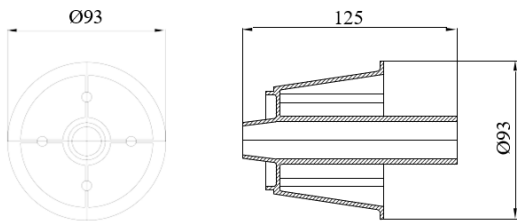
Rubber sealing series EXD
Type DD1096GK



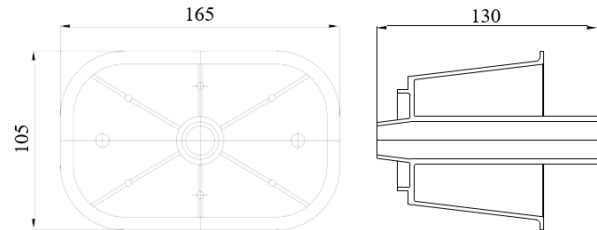
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Type DD1095GK



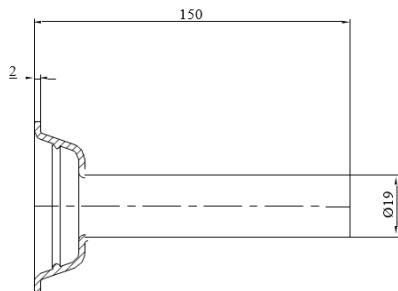
Pocket former type DD7099B



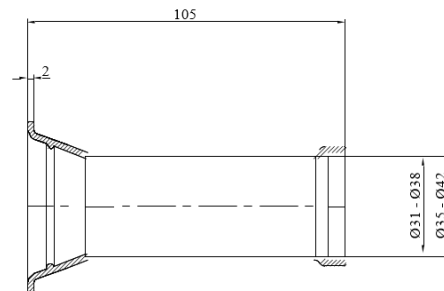
Pocket former type o DD1097A



Plastic trumpet unbonded



Plastic trumpet bonded

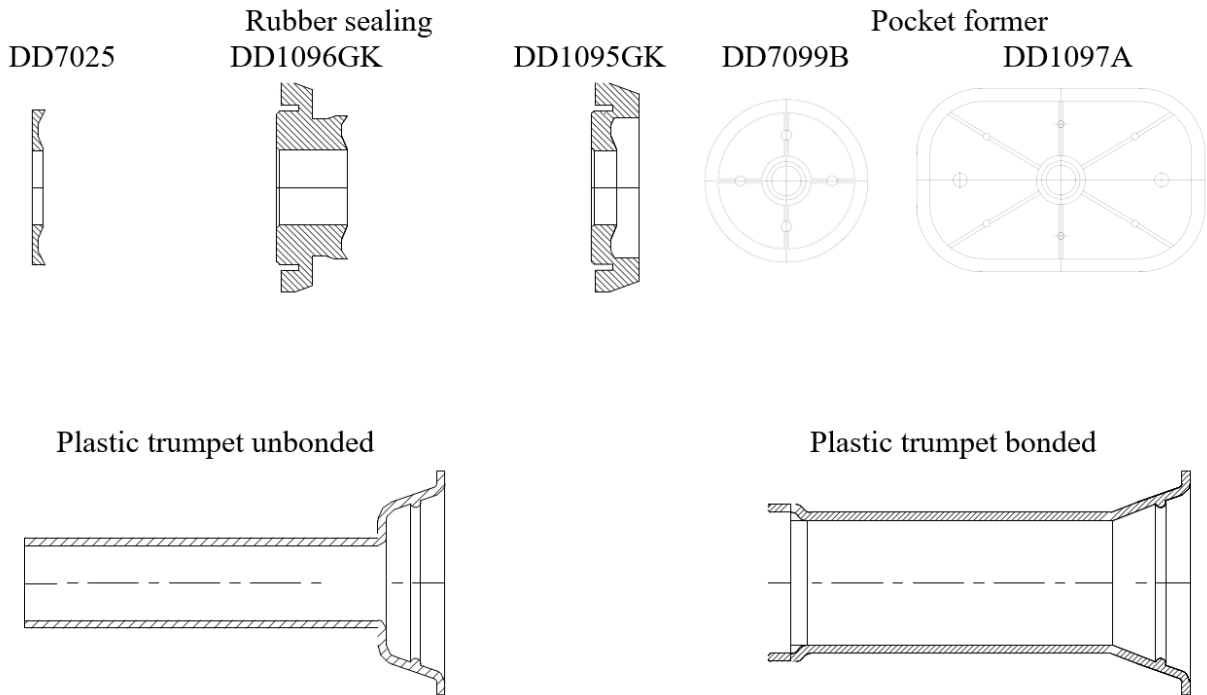


TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Accessories

**Annex A2
of ETA N° 15/0321**

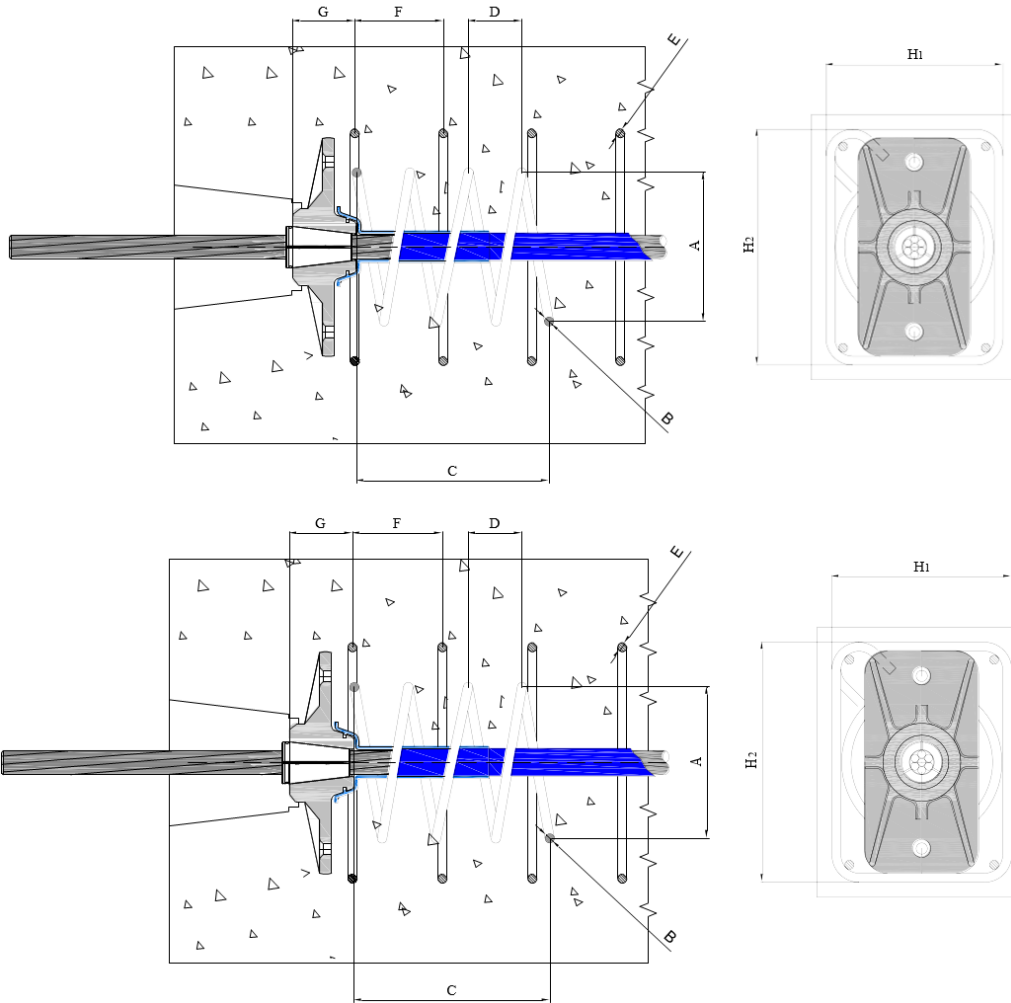
Anchor	Type	Pocket former	Rubber sealing	Plastic trumpet
1E15	A1	DD-1097A	DD-7025	Unbonded
		DD-7099B	DD-7025	Unbonded
	A5	DD-1097A	DD-7025	Bonded
		DD-7099B	DD-7025	Aderente
1ED15	A4	DD-7099B	DD-7025	Unbonded
		DD-1097A	DD-1095GK	Unbonded
	A14	DD-7099B	DD-7025	Bonded
		DD-1097A	DD-1095GK	Bonded
1EX15	A2	DD-1097A	DD-7025	Unbonded
		DD-7099B	DD-7025	Unbonded
	A8	DD-1097A	DD-7025	Unbonded
	A9	DD-1097A	DD-7025	Unbonded
	A13	DD-1097A	DD-7025	Bonded
		DD-7099B	DD-7025	Bonded
	A15	DD-1097A	DD-7025	Bonded
A16	DD-1097A	DD-7025	Bonded	
1EXD15	A3	DD-1097A	DD-1996GK	Unbonded
	A12	DD-1097A	DD-1996GK	Bonded



TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Accessories

Annex A3
of ETA N° 15/0321

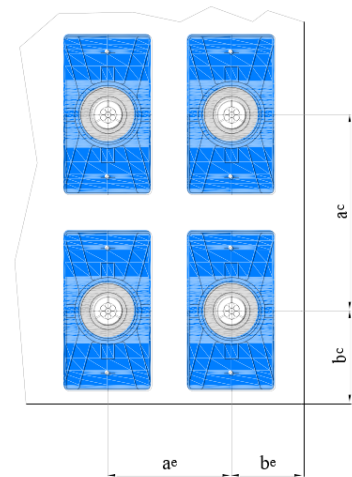
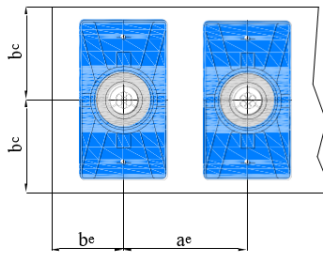
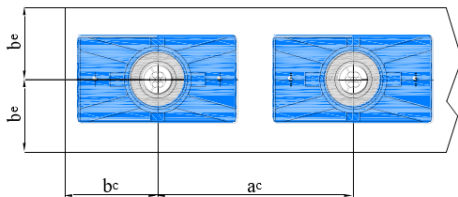
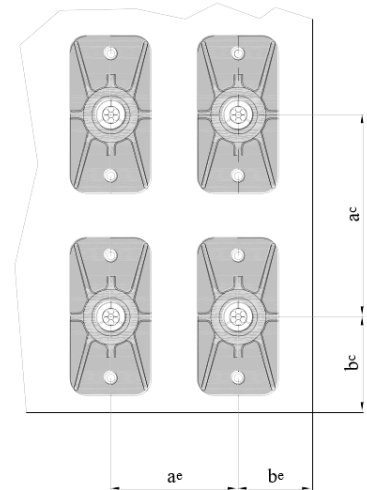
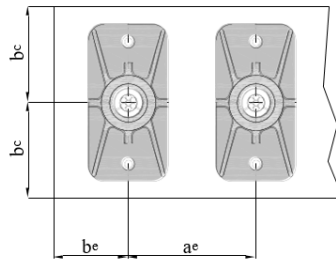
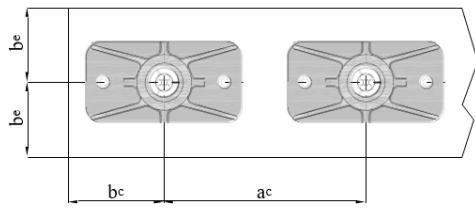


Concrete strength $f_{cmj,cube}$ [MPa]	35	45
Strand [mm ²]	165	165
f_{ptk} [MPa]	1860	1860
Helix		
Outer diameter [mm] A	110	110
Bar diameter [mm] B	6	6
Length [mm] C	131	131
Pitch [mm] D	40	40
Number pitches	3	3
Additional reinforcement		
Number of stirrups	5	5
Bar diameter [mm] E	6	6
Spacing [mm] F	60	60
Distance from anchor head G	40	40
Outer diameter H ₁ [mm]	120	120
Outer diameter H ₂ [mm]	160	160

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Dimensions of anchorages, helix and additional reinforcement

**Annex A4
of ETA N° 15/0321**



	Unit	Value	
$f_{cmj,cube}$	MPa	35	45
a_c	mm	180	180
b_c	mm	95	95
a_e	mm	140	140
b_e	mm	70	70

Where:

- a_c e a_e : minimum centre distance
- b_c e b_e : minimum centre and edge distances

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Distance from the edges monostrand anchorage

Annex A5
of ETA N° 15/0321

Product Description – Anchorages

Anchorages are available in the following versions:

1E15 anchor head

1ED15 worked anchor head (tornita – foro Ø 20 / filettata)

1EX15 anchor head completely encapsulated in polyethylene or polypropylene

1EXD15 worked anchor head completely encapsulated in polyethylene or polypropylene

1GX15 Coupler

can be used in the following applications

- **A** Active anchorage
- **B** through anchorage
- **C** Coupler
- **D** Passive anchorage

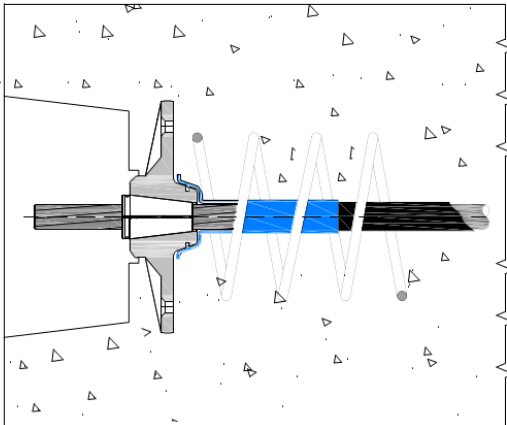
Type	Anchor type									
	1E15		1ED15		1EX15		1EXD15		1GX15	
A	A1 A5	Unbonded Bonded	A4 A14	Unbonded Bonded	A2 A8 A9 A13 A15 A16	Unbonded Unbonded Unbonded Bonded Bonded Bonded	A3 A12	Unbonded Bonded	-	
B	-		B1 B2	Unbonded Bonded	-		B4 B6	Bonded Unbonded	-	
C	-		-		-		-		C1 C2 C4 C5	Unbonded Unbonded Bonded Bonded
D	D1 D5	Unbonded Bonded	D4 D14	Unbonded Bonded	D2 D8 D9 D13 D15 D16	Unbonded Unbonded Unbonded Bonded Bonded Bonded	D3 D12	Unbonded Bonded	-	

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

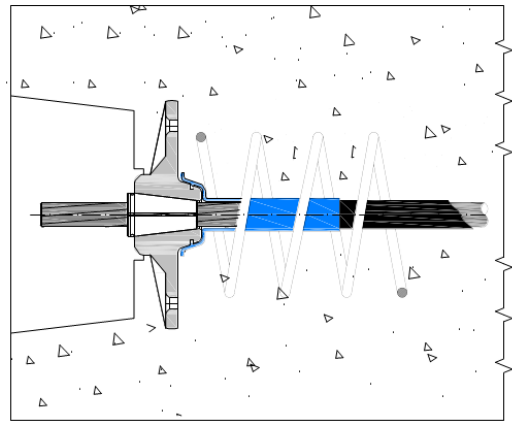
Product Description – Anchorages

Annex A6
of ETA N° 15/0321

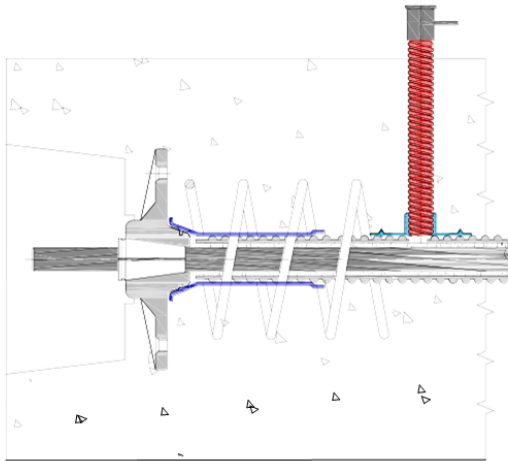
Anchor 1E15



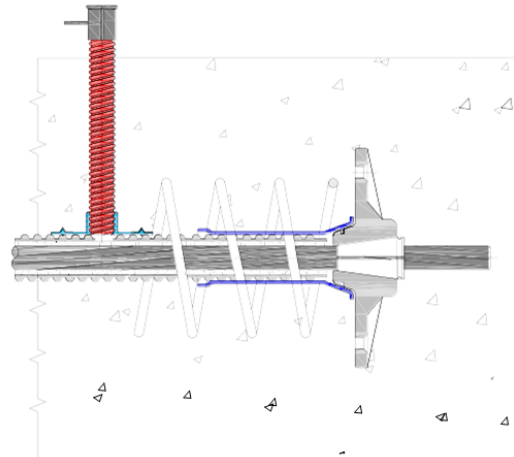
1E15-A1 active unbonded



1E15-D1 passive unbonded and preblocked or to lock on site



1E15-A5 active bonded



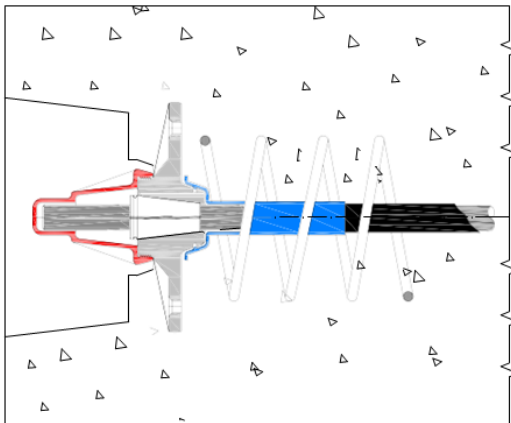
1E15-D5 passive bonded and preblocked or to lock on site

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

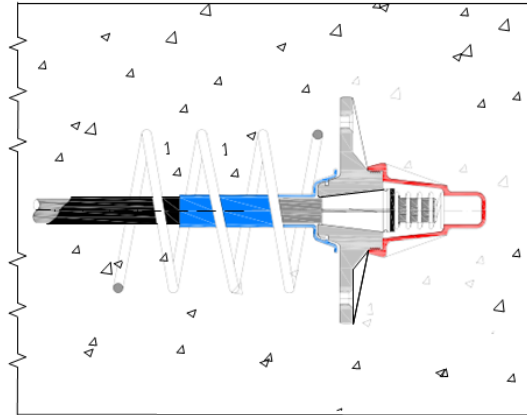
Product Description – Anchor 1E15

**Annex A7
of ETA N° 15/0321**

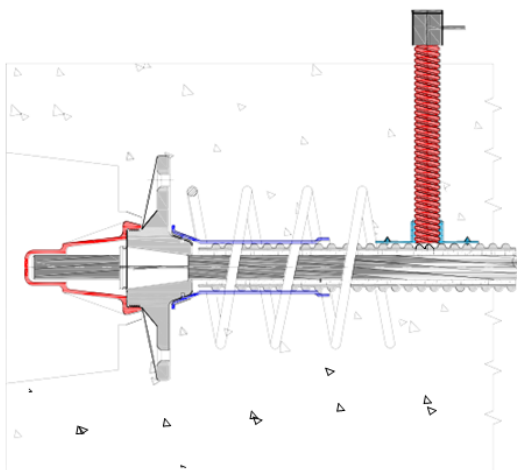
Anchor 1ED15



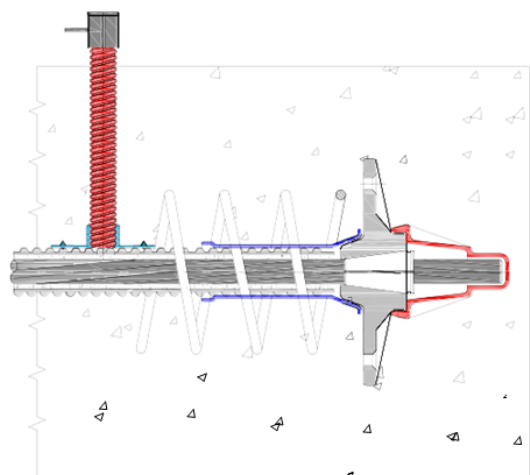
1ED15-A4 active unbonded provided of anchor head 1E15 filettata and protection cap ED



1ED15-D4 passive unbonded pre-assembled and pre-lubricated anchorages, provided of anchor head 1E15 filettata locking spring and protection cap ED



1ED15-A14 active, bonded provided of anchor head 1E15 filettata and protection cap ED



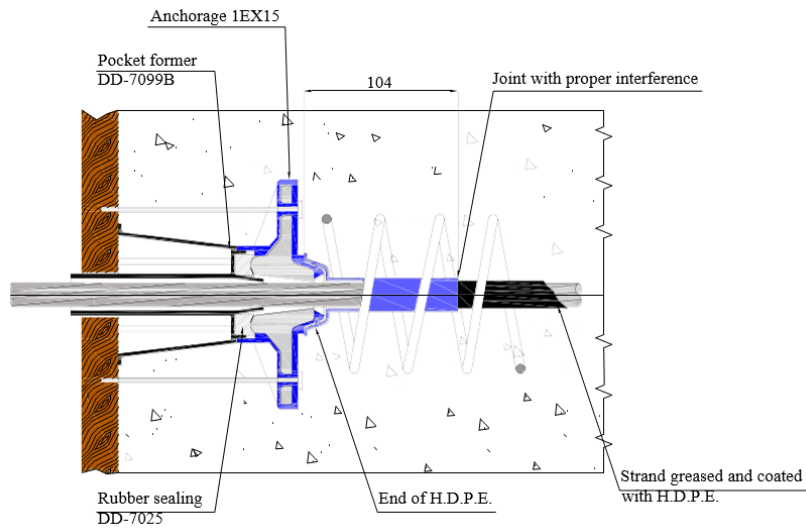
1ED15-D14 passive bonded pre-assembled and pre-lubricated anchorages, provided of anchor head 1E15 filettata locking spring and protection cap ED

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Anchor 1ED15

Annex A8
of ETA N° 15/0321

Anchor 1EX15

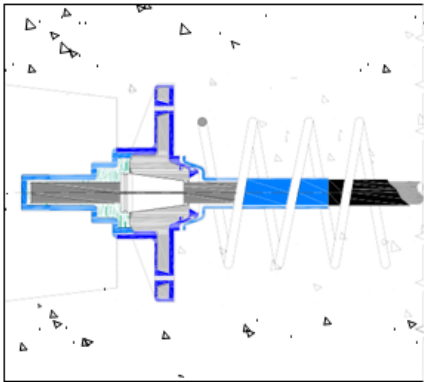


TTM tension technology - Bonded and unbonded monostrand post-tensioning system

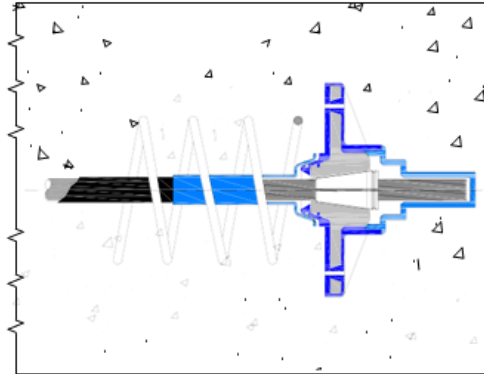
Product Description – Anchor 1EX15

Annex A9
of ETA N° 15/0321

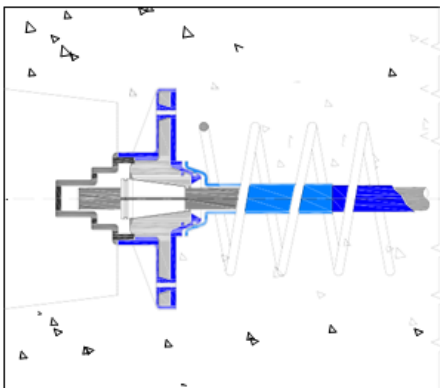
Anchor 1EX15 encapsulated



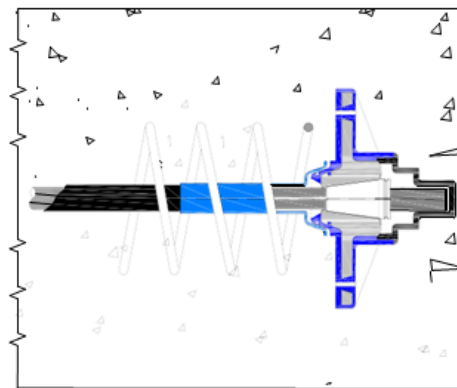
1EX15-A2 active unbonded, provided of long protection cap EX



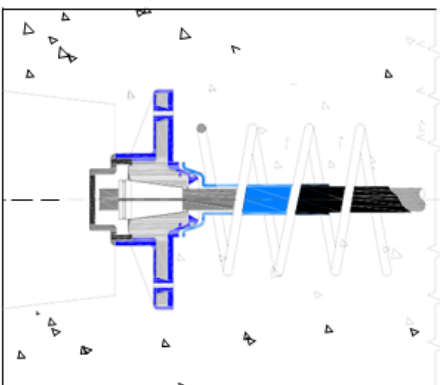
1EX15-D2 passive unbonded, preblocked or to lock on site provided of long protection cap EX



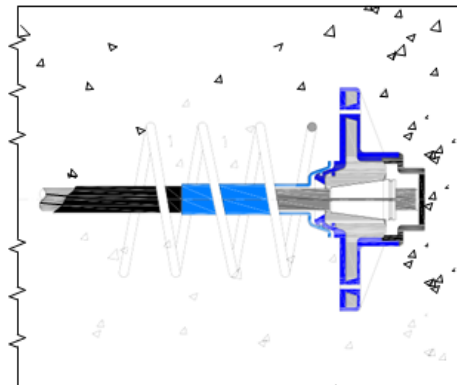
1EX15-A8 active unbonded, provided of medium protection cap EX



1EX15-D8 passive unbonded, preblocked or to lock on site provided of medium protection cap EX



1EX15-A9 active unbonded, provided of short protection cap EX



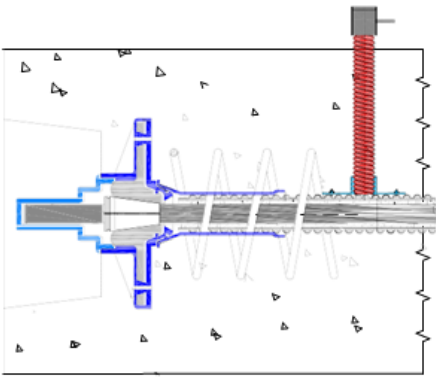
1EX15-D9 passive unbonded, preblocked or to lock on site provided of short protection cap EX

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

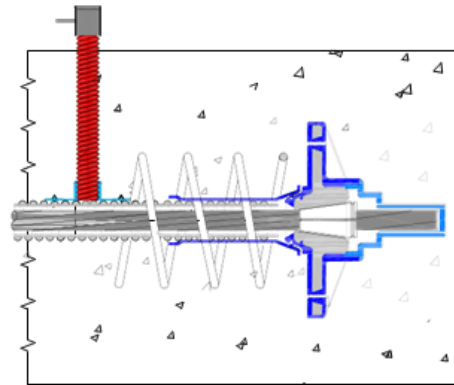
Product Description – Anchor 1EX15 encapsulated

Annex A10
of ETA N° 15/0321

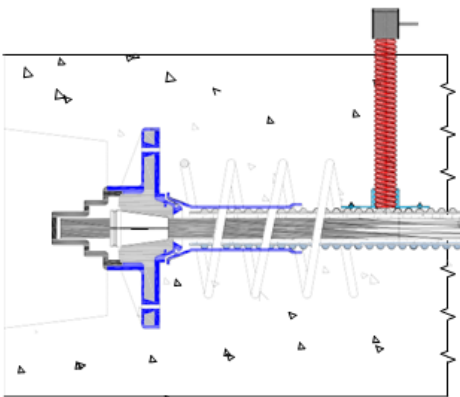
Anchor 1EX15 encapsulated



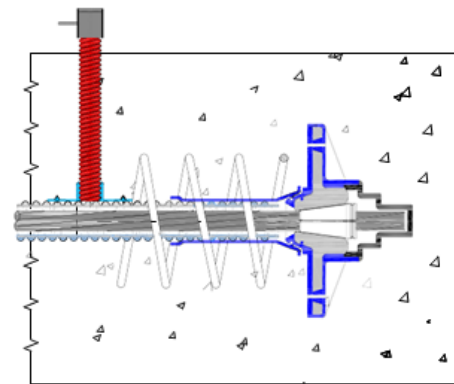
1EX15-A13 active, bonded, provided of long protection cap EX



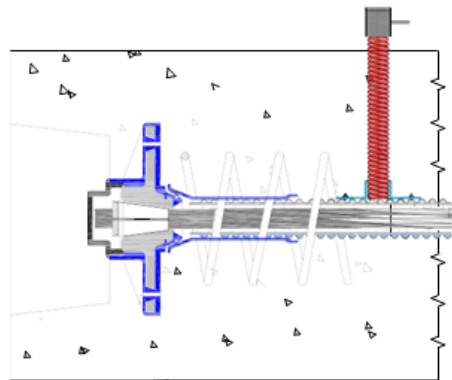
1EX15-D13 passive, bonded, preblocked or to lock on site provided of long protection cap EX



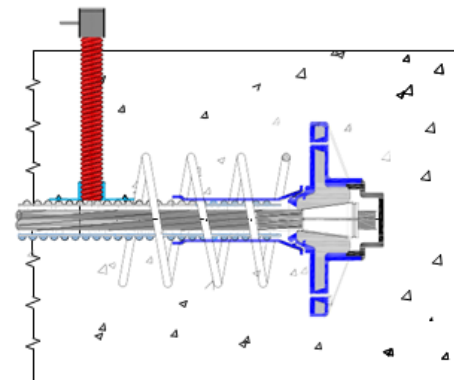
1EX15-A15 active, bonded, provided of medium protection cap EX



1EX15-D15 passive, bonded, preblocked or to lock on site provided of medium protection cap EX



1EX15-A16 active, bonded, provided of short protection cap EX



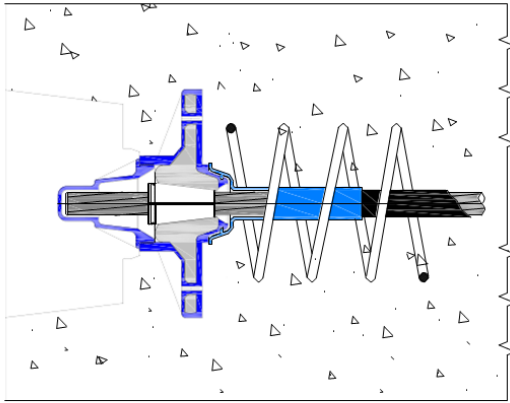
1EX15-D16 passive, bonded, preblocked or to lock on site provided of short protection cap EX

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

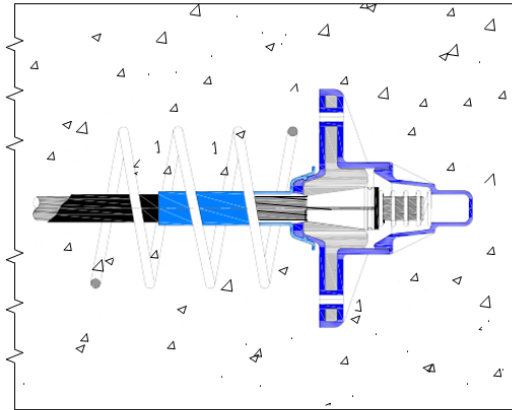
Product Description –anchor 1EX15 encapsulated

Annex A11
of ETA N° 15/0321

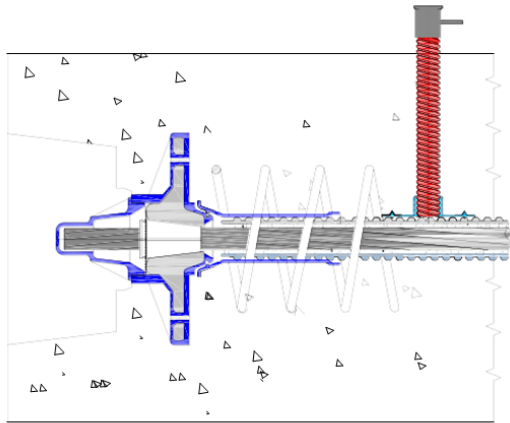
Anchor 1EXD15 encapsulated



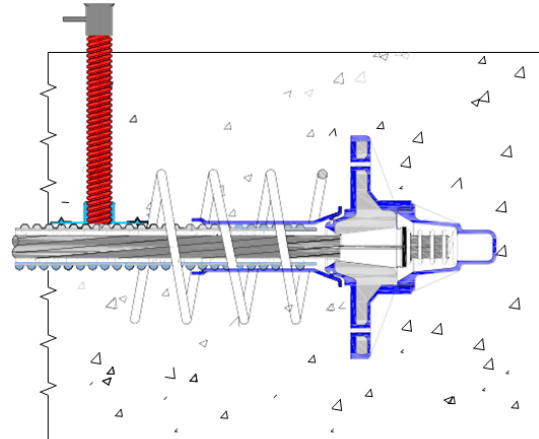
1EXD15-A3 active, unbonded provided of protection cap EXD



1EXD15-D3 passive unbonded, pre-assembled and pre-lubricated anchorage provided of locking spring and protection cap EXD



1EXD15-A12 active bonded, provided of protection cap EXD



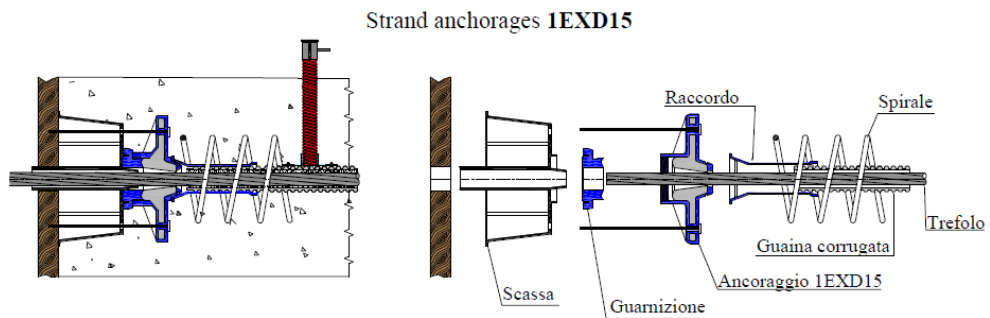
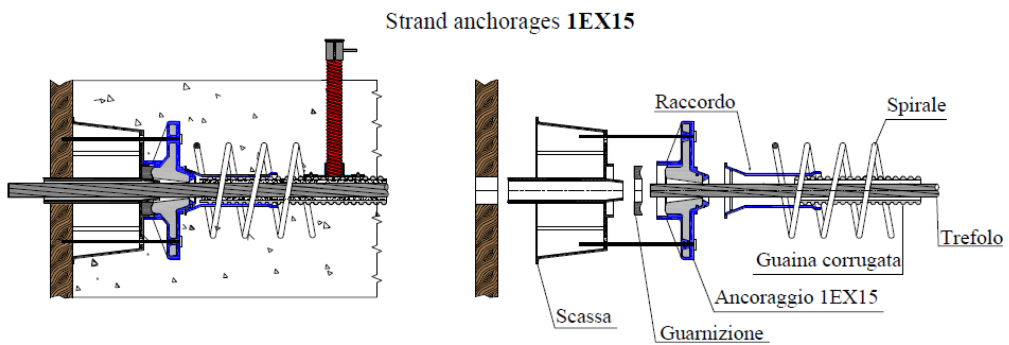
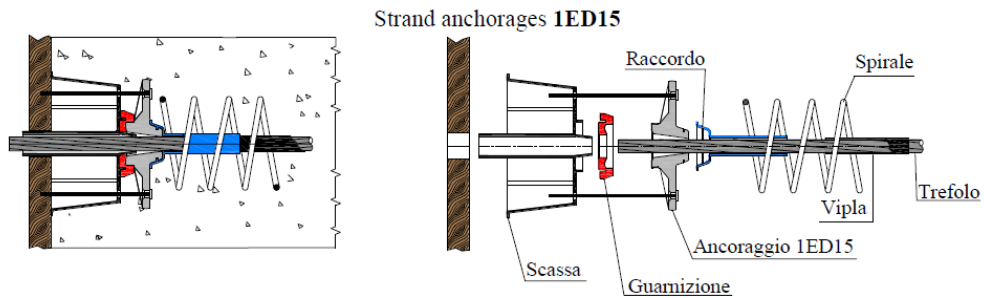
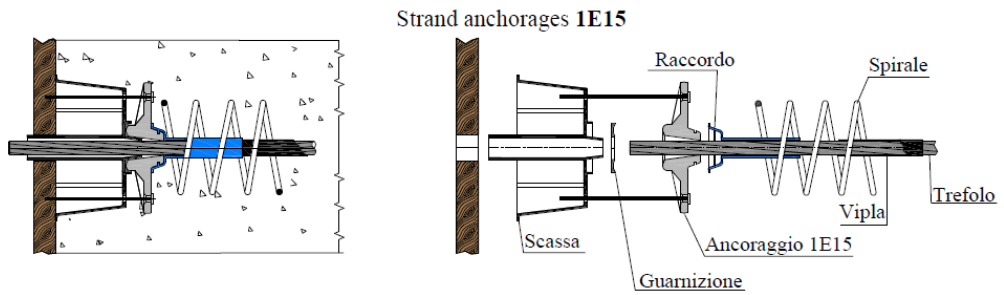
1EXD15-D12 passive bonded, pre-assembled and pre-lubricated anchorage provided of locking spring and protection cap EXD

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Anchor 1EXD15 encapsulated

Annex A12
of ETA N° 15/0321

Construction stages

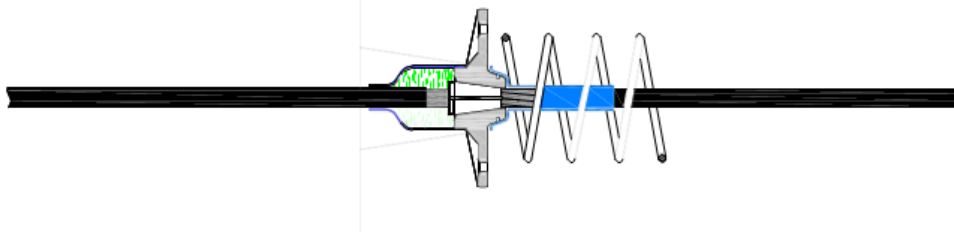


TTM tension technology - Bonded and unbonded monostrand post-tensioning system

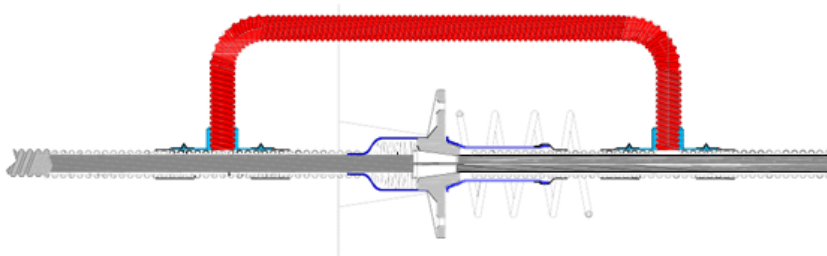
Product Description – Construction stages

**Annex A13
of ETA N° 15/0321**

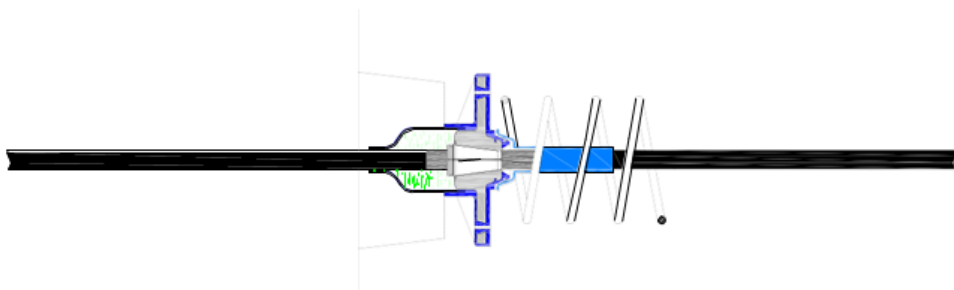
Passing anchorages



11ED15-B1 through, unbonded provided of anchor head 1E15 tornita– foro $\varnothing 20$ and protection cap.



1ED15-B2 through, bonded provided of anchor head 1E15 tornita– foro $\varnothing 20$, protection cap.



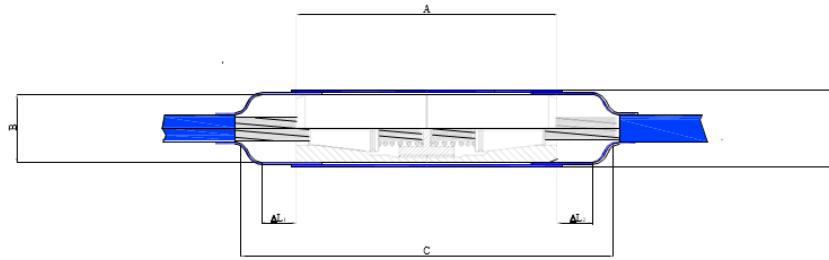
1EXD15-B6: through, unbonded provided of anchor head 1EXD15, protection cap.

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

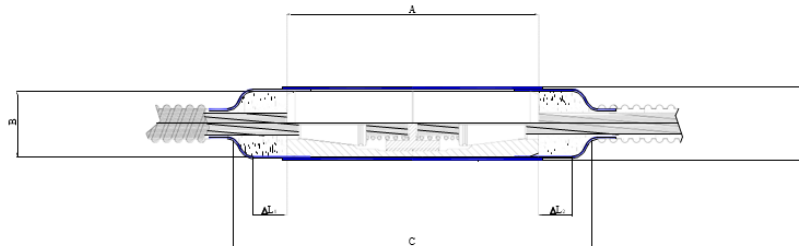
Product Description – Passing anchorages

Annex A14
of ETA N° 15/0321

Coupler **1GX15** unbonded



Coupler **1GX15** bonded

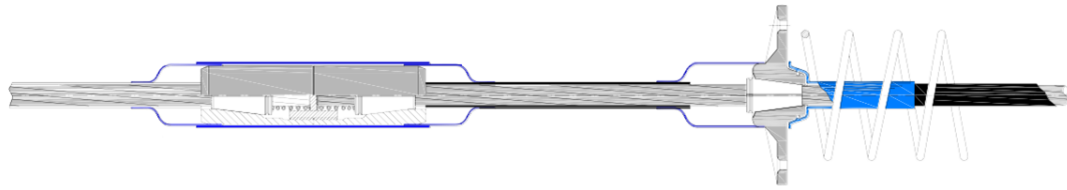


Type	A	B	C	ΔL_1	ΔL_2	D
1GX15	180 ± 0.6	$48 \pm 0,5$	Variable	Variable	Variable	60 ± 0.5

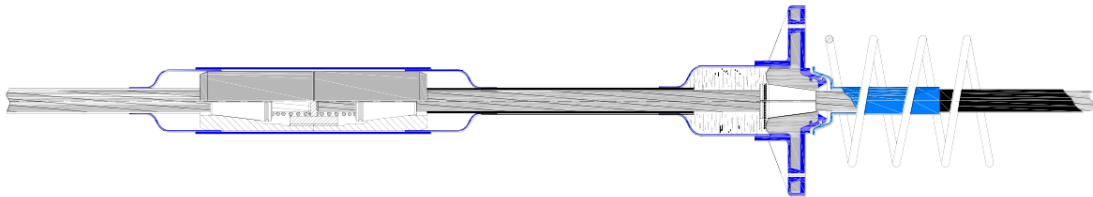
TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Connections 1GX15

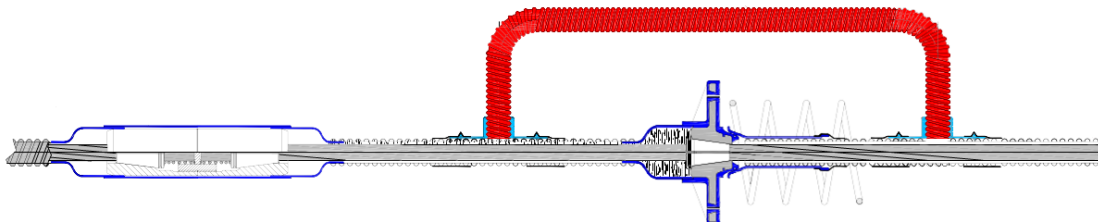
Annex A15
of ETA N° 15/0321



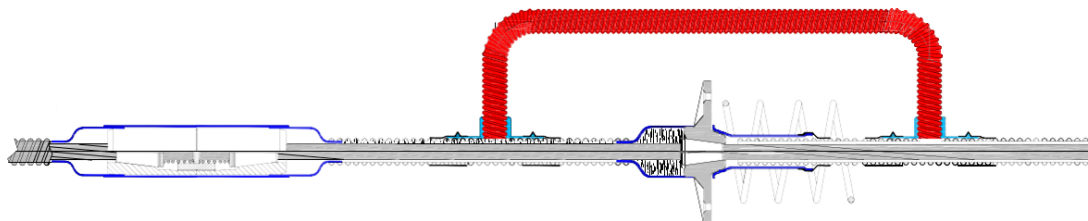
1GX15-C1 unbonded, provided of anchor head 1E15 tornita– foro Ø 20 and protection cap



1GX15-C2 unbonded, provided of anchor head 1EXD15 and protection cap



1GX15-C4 bonded, provided of anchor head 1EXD15, steel sheath and protection cap



1GX15-C5 bonded, provided of anchor head 1E15 tornita– foro Ø 20, steel sheath and protection cap

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Connections 1GX15

**Annex A16
of ETA N° 15/0321**

Strands



Tensile strength	$f_{p(1)k}$	MPa	1670		
Tensile strength	f_{ptk}	MPa	1860		
	Strand		T15	T15S	T15C
Nominal diameter	D	mm	15.2	15.7	15.2
Nominal cross section	A_p	mm ²	139	150	165
Nominal mass	M	g/m	1093	1172	1289
Characteristic value maximum force	F_m	kN	259	279	307
Characteristic value of 0.1% proof force	$F_{p(0,1)}$	kN	228	246	270
	Coated and Greased Strands				
External diameter	Diam.	mm	18,00	18,50	18,00
Nominal diameter	D	mm	15.2	15.7	15.2
Nominal cross section	A_p	mm ²	139	150	165
Nominal mass	M	g/m	1210	1290	1400
Characteristic value maximum force	F_m	kN	259	279	307
Characteristic value of 0.1% proof force	$F_{p(0,1)}$	kN	228	246	270
	Relaxation after 1000 h				
At 0.7 Rm		%	2.5	2.5	2.5
At 0.8 Rm		%	4.5	4.5	4.5
Modulus of elasticity	E	kN/mm ²	196		

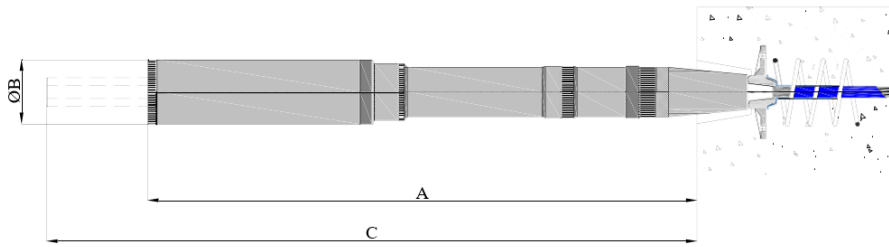
TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Strands

**Annex A17
of ETA N° 15/0321**

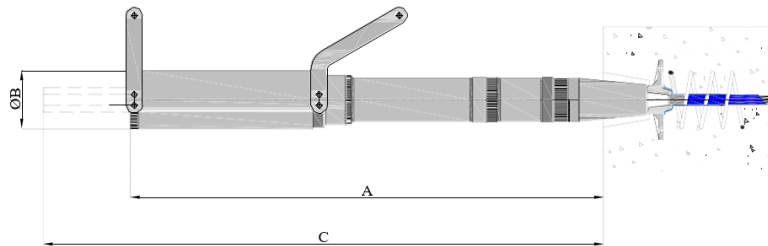
Jacks TTM Series

TTM250KN



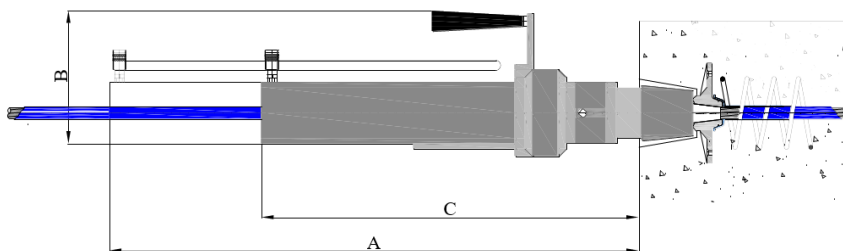
Jack type	Tensioning Extension	Stroke	Stressing Section	Weight	A	B	C
TTM250KN-40	80-100	40	47.2 cm ²	16.5 Kg	280	100	
TTM250KN-60	350	60	47.2 cm ²	19.2 Kg	570	100	
TTM250KN-100	350	100	47.2 cm ²	21.5 Kg	670	100	
TTM250KN-200	350	200	47.2 cm ²	26.0 Kg	880	100	1080

TTM300KN



Jack type	Tensioning Extension	Stroke	Stressing Section	Weight	A	B	C
TTM300KN-100	350	100	68.8 cm ²	24 Kg	670	110	
TTM300KN-200	350	200	68.8 cm ²	28 Kg	880	110	1080

TTM280KN-200



Jack type	Tensioning Extension	Stroke	Stressing Section	Weight	Width	A	B	C
TTM280KN-200	300	200	51.3 cm ²	28 Kg	260	690	180	490

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Jacks

**Annex A18
of ETA N° 15/0321**

Design

Prestressing and over-tensioning forces have to be set as follows:

- the maximum force P_0 applied to a tendon shall not exceed the force $P_{0,max} = A_p \min \{0,8 f_{pk}; 0,9 f_{p0,1k}\}$ laid down in Table A1 ($A_p=139 \text{ mm}^2$), in Table A2 ($A_p=150 \text{ mm}^2$) or in Table A3 ($A_p=165 \text{ mm}^2$).
- the value of the initial prestressing force P_{m0} immediately after tensioning and anchoring shall not exceed the force $P_{m0,max} = A_p \min \{0,75 f_{pk}; 0,85 f_{p0,1k}\}$ laid down in Table A1 ($A_p=139 \text{ mm}^2$), in Table A2 ($A_p=150 \text{ mm}^2$) or in Table A3 ($A_p=165 \text{ mm}^2$).

$$f_{p0,1k} = 0,88 \cdot f_{ptk} = 0,88 \cdot 1860 = 1636,8 \text{ MPa}$$

Table A1: Maximal prestressing forces for tendons with $A_p=139 \text{ mm}^2$

Tendon designation	Number of strands	Cross section A_p [mm ²]	Prestressing force $f_{p0,1k}=1636.8 \text{ MPa}$	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
1E15 – 1ED15	1	139	193	205
1EX15 – 1EXD15	1	139	193	205
1GX15	1	139	193	205

Table A2: Maximal prestressing forces for tendons with $A_p=150 \text{ mm}^2$

Tendon designation	Number of strands	Cross section A_p [mm ²]	Prestressing force $f_{p0,1k}=1636.8 \text{ MPa}$	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
1E15 – 1ED15	1	150	209	221
1EX15 – 1EXD15	1	150	209	221
1GX15	1	150	209	221

Table A3: Maximal prestressing forces for tendons with $A_p=165 \text{ mm}^2$

Tendon designation	Number of strands	Cross section A_p [mm ²]	Prestressing force $f_{p0,1k}=1636.8 \text{ MPa}$	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
1E15 – 1ED15	1	165	230	243
1EX15 – 1EXD15	1	165	230	243
1GX15	1	165	230	243

For prestressing, the mean compressive strength of concrete shall be at least $f_{cmj,cube}$ or $f_{cmj,cyl}$ according to Table A4.

Table A4: Necessary mean concrete strength, f_{cmj}

Mean concrete strength	Unit	Value	
Cube strength, $f_{cmj,cube}$	MPa	35	45
Cylindric strength, $f_{cmj,cyl}$	MPa	29	37

For partial prestressing with 30% of the full prestressing force the actual mean value of the concrete compressive strength to be proved $0.5 \cdot f_{cmj,cube}$ or $0.5 \cdot f_{cmj,cyl}$; intermediate values can be interpolated linearly.

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Product Description – Design: Maximum prestressing forces and minimum concrete strength

Annex A19
of ETA N° 15/0321

SPECIFICATION OF INTENDED USE

➤ INSTALLATION INSTRUCTIONS

1. General

Tendons may be manufactured on site or in the manufacturing plant. Assembly and installation of tendons shall only be performed by qualified post-tensioning specialist companies with the required resources in the use of the TTM post-tensioning system. The respective standards and regulations in force at the place of use shall be complied with.

2. De-sheathing of monostrands

The length of the PE sleeves and the tube connections of the protective tubes as well as the length along which the monostrand sheathing has to be removed have to be determined depending on the variations in temperature to be expect between installation and concreting (see Annex A6). The monostrand sheathing shall overlap the PE sleeve, the tube connections of the protective tubes or the transition tube by at least 150 mm and shall not press against the anchorage. This has to be checked by the application of markings before concreting.

3. Examination of tendons and possible repairs of the corrosion protection system

Careful handling of tendons during installation has to be ensured. Before concreting the post tensioning site manager shall carry out a final examination of the installed tendons. Damage to PE sheathings which causes or may cause leaking of corrosion-protective grease to be repaired. Repair measures shall comply with valid standards. Repairs shall be in accordance with the respective load requirements and be suitable for operating temperatures of up to 30°C.

4. Stressing

Prestressing requires free space directly behind the anchorages. The manufacturer shall keep information on prestressing jacks and appropriate clearance behind the anchorage.

With a mean concrete compressive strength in the anchorage zone, $f_{cm,0}$, complying with the values laid down in Annexes full prestressing may be applied.

Elongations and prestressing forces shall be checked continuously during the stressing operation. The results of the stressing operation shall be recorded for each tendon and the measured elongations shall be compared with the previously calculated values.

Information on the prestressing equipment have been submitted to ITAB. The safety-at-work and health protection regulations shall be complied with.

5. Restressing

Restressing of tendons in combination with the release and reuse of wedges is permitted, whereby the wedges shall bite into at least 15 mm of virgin strand surface and no wedge bites shall remain inside the final length of the tendon between anchorages.

6. Welding

Welding is not intended and it is not permitted to weld on built-in components of post-tensioning system. In the case of welding operations near tendons or anchorages precautionary measures are required to avoid damage to the corrosion protection system.

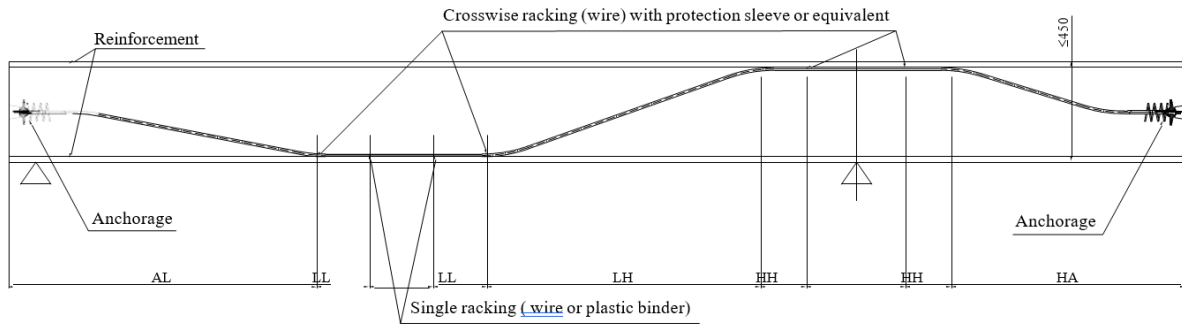
TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Intended Use – Installation instructions

Annex B1
of ETA N° 15/0321

Free tendon layout

(for slab thickness ≤ 450 mm)



Sections		max. distances of fixing points (mm)
AL	Anchorage to Low point	3000
LL	Low point to Low point	1000 - 1300
LH	Low point to High point	3000
HH	High point to High point	300 - 1000
HA	High point to Anchorage	1500

1. Installing the tendon anchorages (fasting onto the framework)
2. Installing the reinforcement (bottom layer) on spacers (and the spacers for tendon top layer)
3. Placing the tendons on the lower reinforcement (and on the spacers for tendon top layer)
4. Cutting the PE-sheathing to the required length
5. Inserting the tendons through the anchorages
6. Temporary protection of the strand protrusion with the cut PE-sheathings
7. Connecting the tendons with the lower reinforcement
8. Installing the upper reinforcement
9. Lifting up and connecting the tendons to the upper reinforcement, if no spacers for tendons are installed
10. Supervising the correct seat of the anchors and of the PE-sleeves before concreting

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Intended Use – Installation instructions: free tendon layout

Annex B2
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Material and standard references

Component	Material	Standard / Specification
Anchor head	C40 - C45	EN 10083-
Coupler	39NiCrMo3	EN 10083-
Wedge	16NiCrS4Pb	EN 10277-
Helix and additional reinforcements (stirrups)	$R_e \geq 500$ MPa	Ribbed reinforcement steel B450 C Italian D.M. 17.01.18 EN 10080:2005
Steel strip sheaths	Steel	EN 523
PE caps, PE transition tube, PE sleeve	HDPE	EN ISO 1872-1
	Concrete	EN 206-1
Grouting	Grout	EN 445 – EN 446 – EN 447 pr EN 10138
Tendon	Strand	Italian D.M. 17.01.18

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Intended Use – Installation instructions: Material and standard references

**Annex B3
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Table C1: Results of Static tests

Strand	Element	Maximum load F_{max} [kN]	Percentage of the tensile elements ultimate strength [%]	Elongation ε_{Tu} [%]
T15C	anchor head 1E15	298.0	96.5	2.34
T15C		300.9	97.4	2.72
T15C		301.7	97.7	2.62
T15C		301.9	97.8	2.91
T15C		301.7	97.7	3.03
T15S	anchor head 1ED15	284.9	98.2	5.60
T15S		283.6	97.8	5.25
T15S		284.2	98.0	5.78
T15C		300.6	97.1	4.97
T15C		299.7	96.8	4.91
T15C		300.3	97.0	4.93
T15S	1GX15 coupler	277.9	95.8	4.07
T15S		281.2	97.0	4.66
T15C		301.2	97.3	4.70
T15C		302.0	97.5	4.80
T15C		304.8	98.4	5.30

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.1 of EAD.

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Performances – Static Tests

**Annex C1
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Table C2: Results of fatigue tests for anchor head 1E15

Strand	n° of broken wires
T15C	0
T15C	0
T15C	0
T15C	0

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.2 of EAD.

Table C3: Results of fatigue tests for anchor head 1ED15

Strand	n° of broken wires
T15C	0
T15C	0
T15C	0
T15C	0

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.2 of EAD.

Table C4: Results of fatigue tests for anchor head 1GX15 coupler

Strand	n° of broken wires
T15C	0
T15C	0
T15C	0
T15C	0

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.2 of EAD.

TTM tension technology - Bonded and unbonded monostrand post-tensioning system

Performances – Fatigue tests

**Annex C2
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Table C5: Results of test for assess the load transfer to structure for anchor head 1E15 – $f_{cm,cube} = 35$ MPa

Strand	$f_{cm,0}$ [MPa]	$f_{cm,e}$ [MPa]	$f_{cm,e}/f_{cm,0}$ [-]	$F_{p,k}$ [kN]	Required load F_{max} [kN]	Ultimate load F_u [kN]	F_u/F_{max} [-]	Max crack width [mm]
T15C	35	37.37	1.07	306.9	360.5	460.0	1.28	0.08
T15C	35	37.37	1.07	306.9	360.5	520.0	1.44	0.04
T15C	35	37.38	1.07	306.9	360.5	480.0	1.33	0.04
T15C	35	33.63	0.96	306.9	324.4	445.0	1.37	0.04

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.3 of EAD.

Table C6: Results of test for assess the load transfer to structure for anchor head 1E15 – $f_{cm,cube} = 45$ MPa

Strand	$f_{cm,0}$ [MPa]	$f_{cm,e}$ [MPa]	$f_{cm,e}/f_{cm,0}$ [-]	$F_{p,k}$ [kN]	Required load F_{max} [kN]	Ultimate load F_u [kN]	F_u/F_{max} [-]	Max crack width [mm]
T15C	45	44.64	0.99	306.9	334.9	505.0	1.51	0.06
T15C	45	44.64	0.99	306.9	334.9	515.0	1.54	0.03
T15C	45	46.63	1.04	306.9	349.8	420.0	1.20	0.05
T15C	45	46.63	1.04	306.9	349.8	465.0	1.33	0.06

All the results of the performed tests satisfy the acceptance criteria defined in clause 2.2.3 of EAD.

**TTM tension technology - Bonded and unbonded
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Performances - Load transfer to structure

**Annex C3
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