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European Technical Assessment

**ETA 16/0472
of 06/11/2019**

General Part

Technical Assessment Body issuing the ETA:	Technical and Test Institution for Construction Prague
Trade name of the construction product	TTM Bonded and unbonded slab system
Product family to which the construction product belongs	Post Tensioning kits - slab system for 3 to 5 strands
Manufacturer	Tension Technology Martin S.r.l. Via Oger Martin, 21 – 03024 Ceprano (FR), Italy www.ttmsrl.it info@ttmsrl.it
Manufacturing plant(s)	Via Alberto da Giussano, 9 – 20011 Corbetta (MI), Italy
This European Technical Assessment contains	44 pages including 30 Annexes which form an integral part of this assessment. Annexes contain confidential information and are not included in the European Technical Assessment when that assessment is publicly disseminated.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	European Assessment Document 160004-00-0301
This version replaces	ETA 16/0472 issued on 31/05/2017

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Specific part

1 Technical description of the product

1.1 General

This European Technical Assessment (ETA) applies to a kit, the PT system

TTM - Bonded and unbonded slab system

Including the following components:

- **Tendon:**
Bonded and unbonded tendons with 3 to 5 tensile elements;
- **Tensile elements:**
7-wire prestressing steel strand with nominal diameter and nominal tensile strength as given in Table 1.

Table 1: Tensile elements

Type of strands	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 and coupler:**

Table 2: Anchor and coupler

Anchor head	Strand type	Active	Passive	Number of strand
Type N	T15, T15S, T15C	N	ND	3 to 5
Type L	T15, T15S	L-LX	LD-LDX	3 to 5
Coupler NG-NGX	T15, T15S, T15C	-	-	1

“N” series anchorages are designed for the application to plate or slabs. They are available in sizes from 3 to 5 strands.

- “N” series: active anchorages designed for slab and post-tensioning application;
- “ND” series: passive anchorages designed for slab and post-tensioning application;

“L” series anchorages are designed for the application to plate or slabs. The main characteristic of this anchorage is its dimensions, where the shorter side is suitable for limited thickness plates. The anchorage type “L” is defined with only one type of the anchor head. This type of the anchor head allows to install 3 till 5 strands.

- “**L**” series: active bonded and unbonded anchorages designed for slab and post-tensioning application; the anchorage is installed completely embedded in the concrete and allows the use of plastic or steel strip sheath.
- “**LX**” series: active bonded and unbonded anchorages designed for slab and post-tensioning application; it keeps the main characteristics of the L type and in addition is provided completely encapsulated with a plastic cover.
- “**LD**” series: passive bonded and unbonded anchorages designed for slab and post-tensioning application; the anchorage is provided with a steel cover and it is installed completely embedded in the concrete and allows the use of plastic or steel strip sheath.
- “**LDX**” series: passive bonded and unbonded anchorages designed for slab and post-tensioning application; it keeps the main characteristics of the LD type and in addition is provided completely encapsulated with a plastic cover.

Coupler:

- “**NG**” system (bonded application): the connection on single strand cables is carried out by using a coupler (1G15) that allows guaranteeing the strand connection.
 - “**NGX**” system (unbonded application): the connection on single strand cables is carried out by using a coupler (1GX15) that allows guaranteeing 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.

1.2 Designation

1.2.1 General

This European Technical Assessment for the TTM bonded and unbonded slab systems issued on the basis of agreed data, deposited at the Technical and Test Institute for Construction Prague, which identifies the TTM bonded and unbonded slab systems that has been assessed and judged.

Each type of anchorage is defined in Annexes.

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

The arrangement of the tendons, the design of the anchorage zones, the anchorage components and the diameters of the ducts shall correspond to the attached description and drawings; the dimensions and materials shall comply with the values given therein.

Changes to the production process of the TTM bonded and unbonded slab systems, which could result in this deposited data being incorrect, should be notified to the Technical and Test Institute for Construction Prague before the changes are introduced. The Technical and Test Institute for Construction Prague will decide whether or not such changes affect this ETA and consequently the validity of the CE marking on the basis of this ETA and, if so, whether further assessment or alterations to this ETA are considered necessary.

1.3 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.

1.3.1 Anchor heads

Anchor head N and ND are realized by closed die forging, are made by steel C40-45 according to EN 10083-2, and have a conical hole drilled in circular arrangement to accommodate strands and wedges. Additionally, passive anchorages have threaded holes to fix the retaining plate and cylindrical seating for retaining springs. For further characteristic values of the anchor heads see Annexes 1.

Anchor head L-LX-LD and LDX are realized by closed die forging, are made by steel C40-45 according to EN 10083-2, and have a conical hole drilled in circular arrangement to accommodate strands and wedges. The anchorage is made of a polyethylene support which offers protection to the steel anchor plate. Additionally, passive anchorages have threaded holes to fix the retaining plate and cylindrical seating for retaining springs. For further characteristic values of the anchor heads see Annexes 18.

1.3.2 Coupling

The Coupling systems NG and NGX, respectively for bonded and unbonded application, allow making joint on tendons installed. The NG system use the coupling type 1G15 which is made by steel 39NiCrMo3 according to EN 10083-3; the NGX system use the same coupling but 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 Annexes 16 and 17).

The coupling 1G15 and 1GX15 are covered by ETA 15-0321.

1.3.3 Strands

Only 7-wire strands shall be used in accordance with nationally provisions with the characteristics given in Table 3:

Table 3: Dimensions and properties of 7-wire strands

Designation	Symbol	Unit	Value		
Characteristic tensile strength	f_{pk}	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 confusion, only strands with one nominal diameter shall be used on one site. Further characteristic values of the strands are reported in Annex 27.

1.3.4 Wedges

Wedges type T15 are made of case hardening steel 16NiCrS4Pb according to EN 10277-4. The wedges are made in 3 and 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.

1.3.5 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 Annexes from 3 to 8 (anchorage N) and Annexes from 19 to 22 (anchorage L).

If required for a specific project design, the reinforcement given in the Annexes 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 ETA holder to provide equivalent performance.

1.3.6 Sheath

The steel strip sheaths are corrugated to guarantee a mechanical bond with the concrete. The steel strip sheaths are made of cold-formed and welded along the edges or locked together by crimping. The metallic sheath is purchased in accordance to EN 523.

System can also be used with plastic ducts for internal bonded tendons and these must comply with EAD 160004-00-0301, Annex D.

1.3.7 Grout

Grout shall be used in accordance with EN 447. In case of use of a special grout or grease, this must comply with EAD 160027-00-0301. Standards and regulations for grouts and grouting valid in place of use shall be considered. In restressable tendons grout may not be considered in case of use of plastic coated strands.

1.3.8 Permanent corrosion protection

The corrosion protection materials used are specified according to EAD 160027-00-0301, or with a corrosion protection system consisting of a corrosion protection filling material grout shall be used according to EN 447:1996.

1.3.8.1 Corrosion protection of the strand

The strand for unbounded applications is provided in the factory with corrosion protection consisting of corrosion protective grease and extruded PE sheathing which shall be in accordance to EAD 160027-00-0301 "Individually greased and sheathed monostrands".

1.3.8.2 Corrosion protection in anchorage

Application of corrosion protection in the anchorage zone shall comply with the assembly instructions specified in clause 1.5. The void in the anchorage zone shall be completely filled with corrosion protective grease.

1.4 Design

1.4.1 Maximum prestressing forces

Prestressing and over-tensioning forces are specified in the respective national provisions: the maximum force P_0 applied to a tendon shall not exceed the force

$P_{0,max} = A_p \cdot \min \{0,8 f_{pk}; 0,9 f_{p0,1k}\}$ laid down in Table 4 ($A_p=139 \text{ mm}^2$), in Table 5 ($A_p=150 \text{ mm}^2$) or in Table 6 ($A_p=165 \text{ mm}^2$). The value of the initial prestressing force P_{m0} immediately after tensioning and anchoring shall not exceed the force

$P_{m0,max} = A_p \cdot \min \{0,75 f_{pk}; 0,85 f_{p0,1k}\}$ laid down in Table 4 ($A_p=139 \text{ mm}^2$), in Table 5 ($A_p=150 \text{ mm}^2$) or in Table 6 ($A_p=165 \text{ mm}^2$).

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

Table 4: 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 <small>$f_{p0,ik} = 1636,8 \text{ MPa}$</small>	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
N-ND-L-LX-LD-LDX	1	139	193	205

Table 5: 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 <small>$f_{p0,ik} = 1636,8 \text{ MPa}$</small>	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
N-ND-L-LX-LD-LDX	1	150	209	221

Table 6: 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 <small>$f_{p0,ik} = 1636,8 \text{ MPa}$</small>	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
N-ND	1	165	230	243

1.4.2 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 strand, the friction coefficient μ is very low for unbounded applications. The calculation of the friction losses is given by the equation:

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

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; μ and k values are specified in Table 7.

Table 7: Friction and wobble coefficients

Tendon designation	Friction coefficient μ [rad ⁻¹]	Wobble coefficient k [rad/m]
N-ND-L-LX-LD-LDX (Bonded)	0,19	0,007 – 0,009
N-ND-L-LX-LD-LDX (Unbonded)	0,06	0,009

1.4.3 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.

1.4.4 Concrete strength at time of stressing

Concrete according to EN 206-1 has to be used. For prestressing the mean compressive strength of concrete shall be at least $f_{\text{cmo,cube}}$ or $f_{\text{cmo,cyl}}$ according to Table 8.

Table 8: Necessary mean concrete strength, f_{cmo}

Tendon designation	Mean concrete strength	
	Cube strength $f_{\text{cmo,cube}}$ [MPa]	Cylindric strength $f_{\text{cmo,cyl}}$ [MPa]
N,ND	35	29
N,ND, L-LX-LD-LDX	45	37

For partial prestressing with 30% of the full prestressing force the actual mean value of the concrete compressive strength to be proved

$$0,5 \cdot f_{\text{cmj,cube}} \text{ or } 0,5 \cdot f_{\text{cmj,cyl}}$$

intermediate values can be interpolated linearly.

1.4.5 Centre and edge distances, concrete cover

Spacing and distances shall not be less than values given in the Annexes 9 and 10 (anchorage type N) and Annex 23 (anchorage type L).

1.4.6 Slip at anchorages

Anchorage slippage shall be taken consideration in calculation of tendon elongation and prestressing force in tendon. The slippage is 6 mm at active and passive anchorage, 4 mm at active anchorage stressed with a prestressing jack.

1.5 Installation

1.5.1 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, see EAD 160004-00-0301. The respective standards and regulations in force at the place of use shall be complied with.

1.5.2 De-sheathing of strands

The length of the PE sleeves and the tube connections of the protective tubes as well as the length along which the strand sheathing has to be removed have to be determined depending on the variations in temperature to be expect between installation and concreting. The strand 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.

1.5.3 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 of PE sheathings, which causes or may cause leaking of corrosion-protective grease have 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.

1.5.4 Stressing

Prestressing requires free space directly behind the anchorages. The ETA holder 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 shall have been submitted to the Technical and Test Institute for Construction Prague.

The safety-at-work and health protection regulations shall be complied with.

1.5.5 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.

1.5.6 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.

2 Specification of the intended use(s) in accordance with the applicable European Assessment Document (hereinafter EAD)

2.1 Intended use

The Bonded and Unbonded Slab TTM systems are assumed to be used for:

The prestressing of structures of normal-weight concrete in concrete and composite structures with:

- internal bonded strands
- internal unbonded strands

The Post-Tensioning system is assumed to be used for the prestressing of structures of normal weight concrete with internal bonded and unbonded tendons, also subjected to dynamic loads. Fatigue tests have been performed according to EAD 160004-00-0301.

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

The post tensioning system unbonded covered by this ETA does not included the possibility of the replacements of the tendons.

The provisions made in this European Technical Approval are based on an assumed working life of the Post-Tensioning System of 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the kit manufacturer or the Approval Body, but are to be regarded only as a means for selecting the appropriate product in relation to the expected, economically reasonable working life of the works.

2.2 Recommendations for the manufacturer

2.2.1 Recommendations on packaging, transport and storage

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.

2.2.2 Recommendations on use, maintenance, repair

Manufacturer's installation instructions have to comply with, according to EAD 160004-00-0301. In any case respective standards and regulations in force at the place of use should be observed.

It is highly recommended to apply CWA 14646:2003.

3 Performance of the product and references to the methods used for its assessment

This European Technical Assessment for the slab system part of this document is issued on the basis of agreed data, deposited at the Technical and Test Institute for Construction Prague which identifies the post-tensioning system that has been assessed and judged.

Assessment of the performance of the post-tensioning system part of this document for the intended use in the sense of basic requirement for construction work 1 (mechanical resistance and stability) and for basic requirement for construction work 3 (hygiene, health and environment) has been made in accordance with the EAD 160004-00-0301, European Technical Assessment document of post-tensioning kits for prestressing of structures based on the provisions for all systems.

Table 9: Performance of the system BWR 1

Product-type: Slab Kit		Intended use: For the prestressing of structures
Basic requirement for construction work	Essential characteristic	Performance
1 Mechanical resistance and stability	Resistance to static load	Satisfaction of acceptance criteria given in Clause 2.2.1 of EAD 160004-00-0301
	Resistance to fatigue	Satisfaction of acceptance criteria given in Clause 2.2.2 of EAD 160004-00-0301
	Load transfer to the structure	Satisfaction of acceptance criteria given in Clause 2.2.3 of EAD 160004-00-0301

Table 10: Performance of the system BWR 3

Product-type: Slab Kit		Intended use: For the prestressing of structures
Basic requirement for construction work	Essential characteristic	Performance
3 Hygiene, health and environment	Release of dangerous substances	Slab system 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)

BWRs 2, 4, 5, 6 and 7 are not relevant according to EAD 160004-00-0301.

4 Assessment and verification of constancy of performance (hereinafter AVCP) system applied, with reference to its legal base

According to the decision 98/456/EC of the European Commission² the system 1+ of assessment and verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table applies.

Table 11: System of assessment and verification of constancy of performances

Product(s)	Intended use(s)	Level(s) or class(es)	System(s)
Slab Kits	For the prestressing structures	-	1+

This AVCP system is defined as follows:

System 1+: Declaration of the performance of the essential characteristics of the construction product by the manufacturer on the basis of the following items:

(a) Tasks of the manufacturer

- (1) Factory production control;
- (2) Further testing of samples taken at the factory by the manufacturer in accordance with a prescribed test plan;

(b) Tasks for the notified body

- (3) Determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product;
- (4) Initial inspection of factory and of factory production control;
- (5) Continuous surveillance, assessment and approval of factory production control;
- (6) Audit testing of samples taken at the factory

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

5.1 Tasks of the manufacturer

5.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical assessment.

The manufacturer may only use initial material stated in the technical documentation of this European technical assessment.

The factory production control shall be in accordance with the "TTM Control Plan" relating to this European Technical Assessment which is part of the technical documentation of this European Technical Assessment.

The "TTM Control Plan" is laid down in the context of the factory production control system operated by the manufacturer and deposited at the Technical and Test Institute for Construction Prague.

The prescribed test plan defined in Annex 18 gives the type and frequency of checks and tests conducted during production and on the final product as part of the continuous internal production control.

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the "TTM Control Plan".

The records contain at least the following information:

- designation of the product or basic materials and the components;
- type of control or testing;
- date of manufacture and of testing of product or components and of basic materials or components;
- results of controls and tests and, where relevant, comparison with the requirements;
- signature of person responsible for the factory production control.

If the test results are unsatisfactory, the manufacturer shall immediately implement measures to eliminate defects. Construction products or components which are not in compliance with the requirements shall be handled such that they cannot be mistaken for products complying with the requirements. After elimination of the defects the relevant tests shall be immediately repeated as far as is technically possible and necessary for verifying the deficiency elimination.

5.1.2 Other tasks

The manufacturer shall, on the basis of a contract, involve a notified body which is approved for the tasks referred to in section 5.2 in the field of TTM post-tensioning system in order to undertake the actions lay down in section 5.2. For this purpose, the "TTM Control Plan" referred to in section 5.1.1 shall be handed over by the manufacturer to the notified body or bodies involved.

The manufacturer shall make a declaration of performance, stating that the construction product is in conformity with the provisions of this European Technical Assessment.

At least once a year, each components manufacturer shall be audited by the kit manufacturer.

5.2 Tasks of the Notified body

5.2.1 General

The notified body (bodies) shall perform the:

- determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product,
- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control,
- audit-testing of samples taken at the factory

in accordance with the provisions laid down in the "Control Plan" relating to this European Technical Assessment.

The notified body (bodies) shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The main production center is checked at least once a year by the notified body. Each component producer is checked at least once every five years by the notified body.

The notified body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European Technical Assessment. In cases where the provisions of the European Technical Assessment and its "TTM Control Plan" are no longer fulfilled the notified body shall withdraw the certificate of conformity and inform the Technical and Test Institute for Construction Prague without delay.

5.2.2 Determination of the product-type on the basis of type testing (including sampling), type calculation, tabulated values or descriptive documentation of the product

For initial type testing the results of the tests performed as part of the assessment of the European technical assessment may be used unless there are changes in production procedure or factory plant. In such cases, the necessary initial type testing shall be agreed between the Technical and Test Institute for Construction Prague and the Notified body involved.

5.2.3 Initial inspection of factory and of factory production control

The notified body shall ascertain that, in accordance with the prescribed test plan, the manufacturing plant, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous orderly manufacturing of the system according to the specifications given in the Annexes of this European Technical Assessment.

5.2.4 Surveillance, assessment and approval of factory production control

The kit manufacturer shall be inspected at least once a year. Each component manufacturer shall be inspected at least once in five years. It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking into account the prescribed test plan.

5.2.5 Audit testing of samples taken at the kit manufacturer

During surveillance inspection, the notified body shall take samples at the factory of components of the system or of individual components for which this European technical assessment has been granted, for independent testing.

For the most important components Annex 29, complying with EAD 160004-00-0301, Clause 3.3, summarizes the minimum procedures.

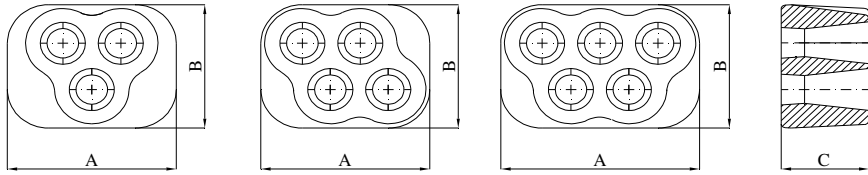
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Annexes

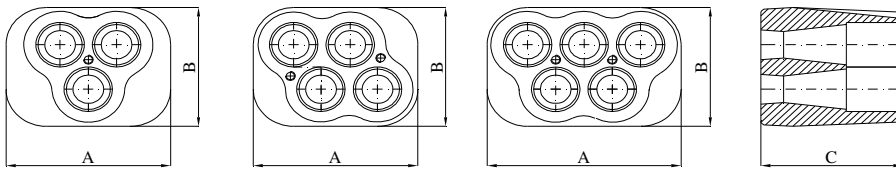
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ACTIVE ANCHORAGE



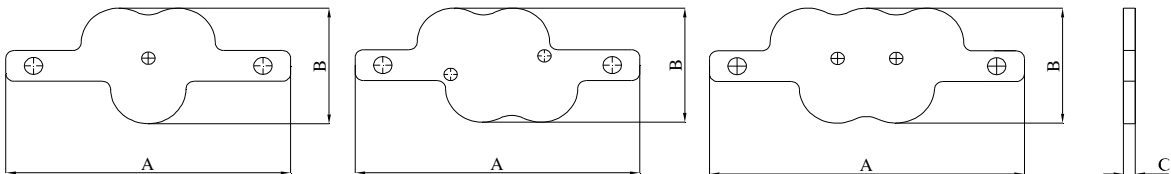
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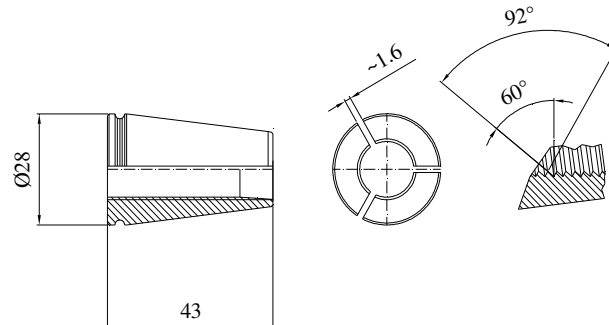
CONE

COVER



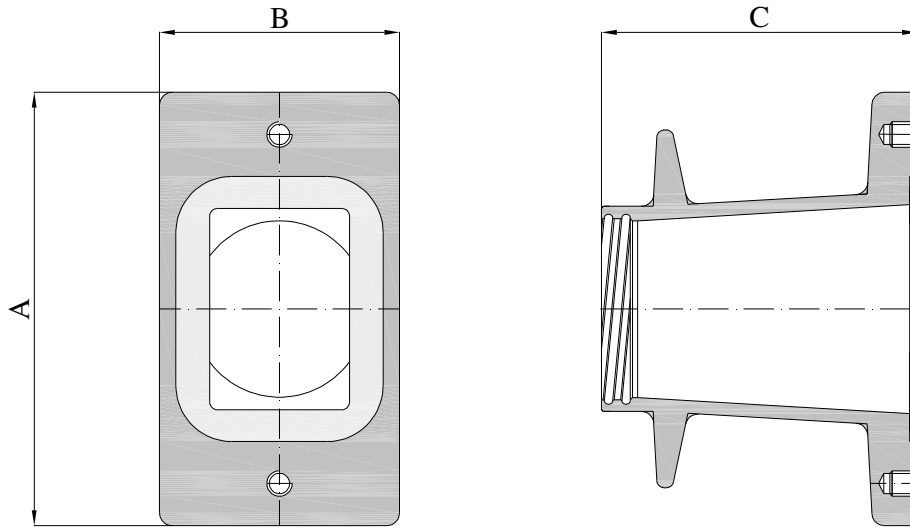
ACTIVE ANCHORAGE				PASSIVE ANCHORAGE				COVER			
Strand	3	4	5	Strand	3	4	5	Strand	3	4	5
A (mm)	102	102	120	A (mm)	102	102	120	A (mm)	170	170	188
B (mm)	80	80	80	B (mm)	80	80	80	B (mm)	75	75	75
C (mm)	53	53	53	C (mm)	88	88	88	C (mm)	7	7	7

WEDGE T15



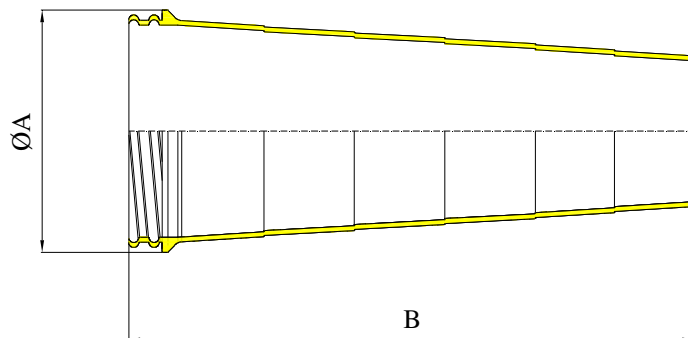
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Anchorage dimensions	
ETA 16/0472 - of 06/11/2019 – page 15 of 44	Annex 1

BEARING PLATE TYPE "N"



Number of strand	3	4	5
A (mm)	170	170	235
B (mm)	95	95	99.5
C (mm)	125	125	125

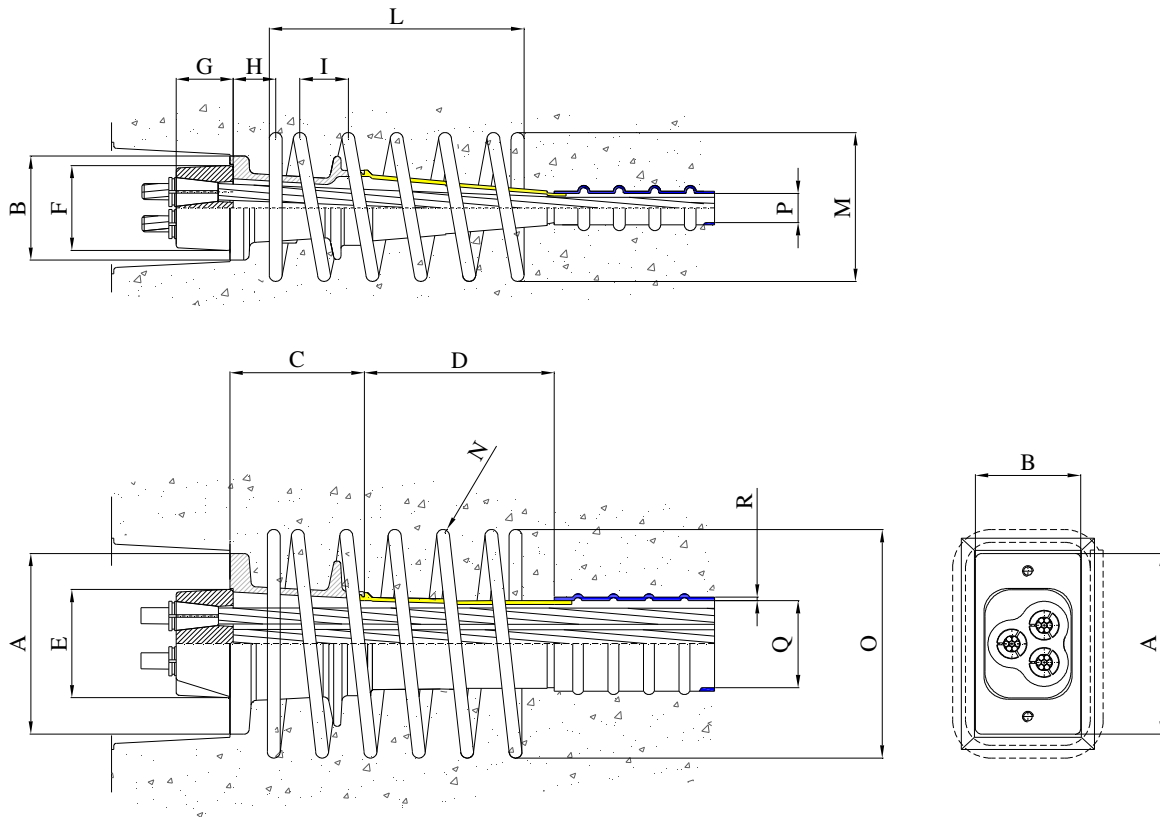
TRANSITION PIPE



Numero di trefoli	3	4	5
ØA (mm)	80	80	96
B (mm)	200	200	200

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Bearing plate type N - Trumpet	
ETA 16/0472 - of 06/11/2019 – page 16 of 44	Annex 2

ACTIVE ANCHORAGE TYPE "3N15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
3N15	170	95	125	200	102	80	53	41	45	237	150	12	245	25	76	2,5

All dimensions are in mm

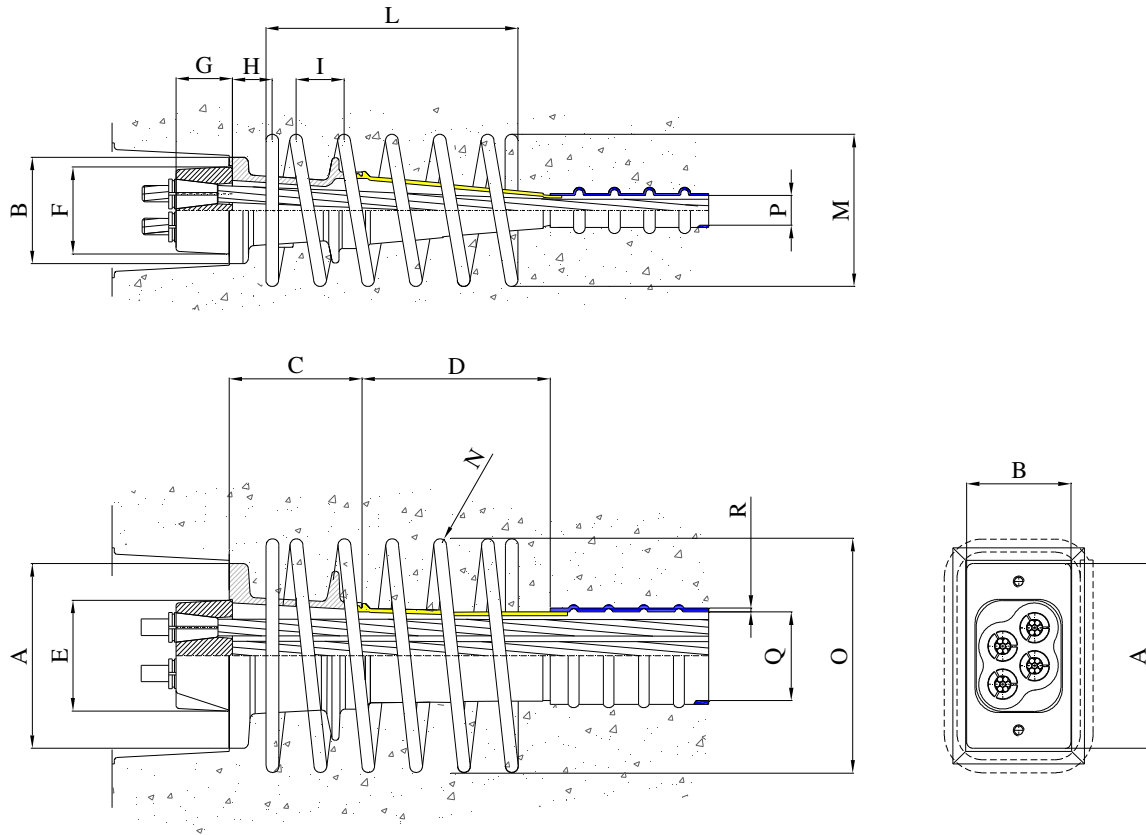
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
3N15	170	95	125	200	102	80	53	41	45	237	140	12	215	25	76	2,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
3N15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 17 of 44	Annex 3

ACTIVE ANCHORAGE TYPE "4N15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
4N15	170	95	125	200	102	80	53	41	45	237	150	12	245	25	76	2,5

All dimensions are in mm

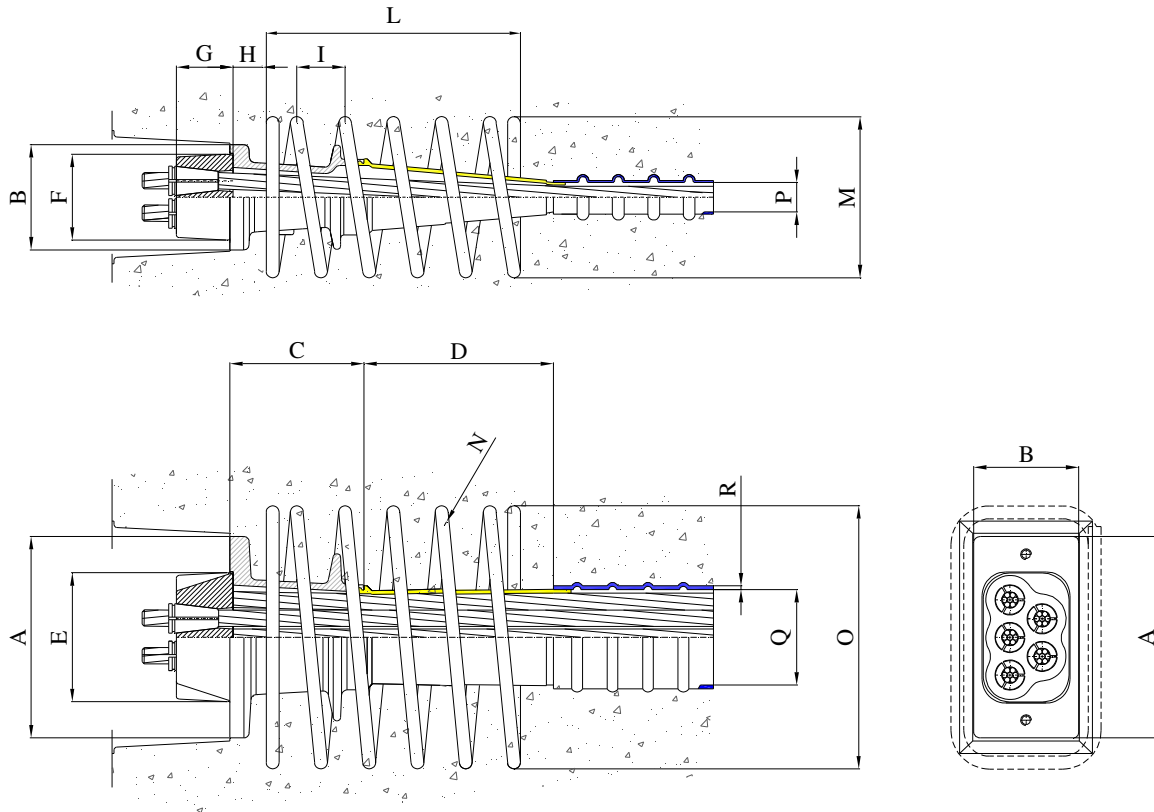
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
4N15	170	95	125	200	102	80	53	41	45	237	140	12	215	25	76	2,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
4N15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 18 of 44	Annex 4

ACTIVE ANCHORAGE TYPE "5N15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
5N15	188	100	125	185	120	80	53	40	45	259.5	170	12	265	20	90	2,5

All dimensions are in mm

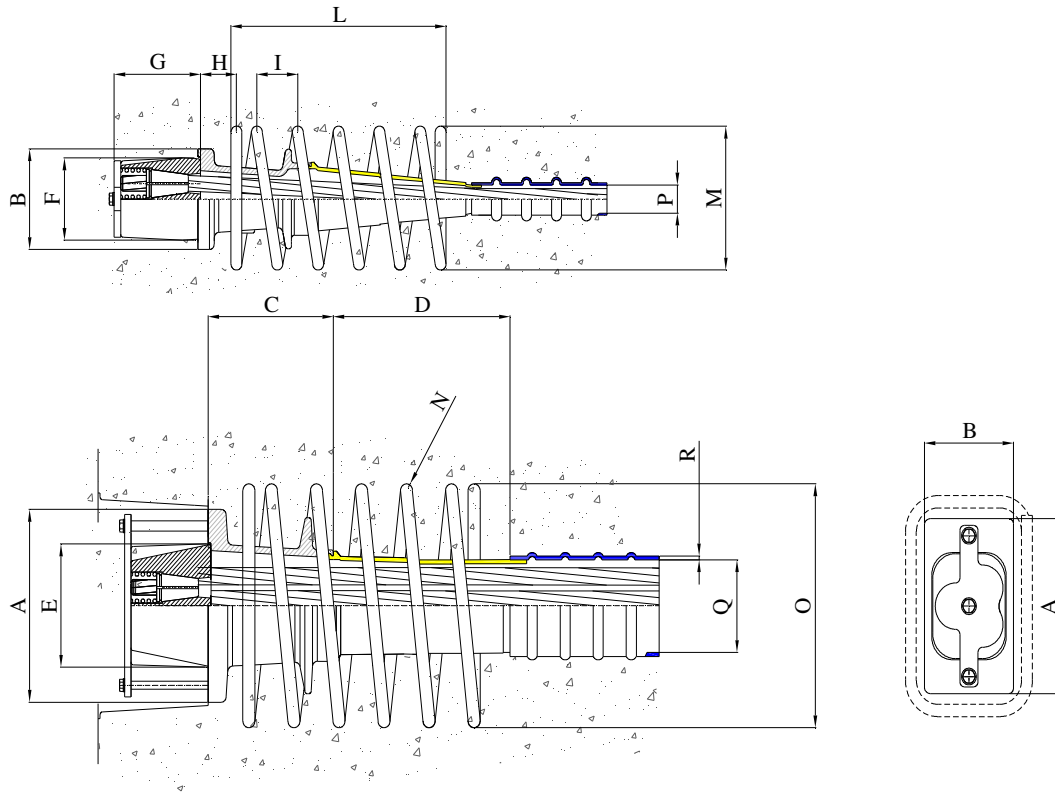
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
5N15	188	100	125	185	120	80	53	40	45	237	150	12	245	20	90	2,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5N15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 19 of 44	Annex 5

PASSIVE ANCHORAGE TYPE "3ND15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
3ND15	170	95	125	200	102	80	88	41	45	237	150	12	245	25	76	2,5

All dimensions are in mm

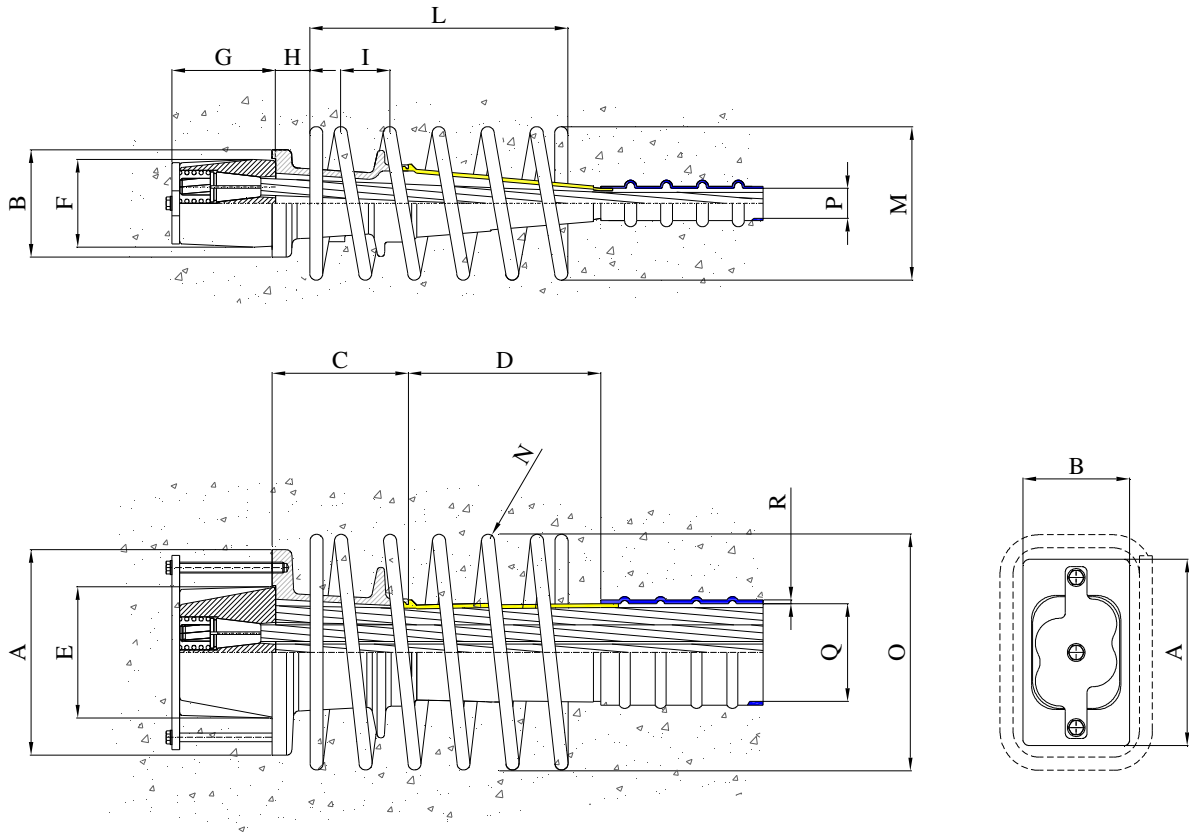
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
3ND15	170	95	125	200	102	80	88	41	45	237	140	12	215	25	76	2,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
3ND15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 20 of 44	Annex 6

PASSIVE ANCHORAGE TYPE "4ND15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
4ND15	170	95	125	200	102	80	88	41	45	237	150	12	245	25	76	2,5

All dimensions are in mm

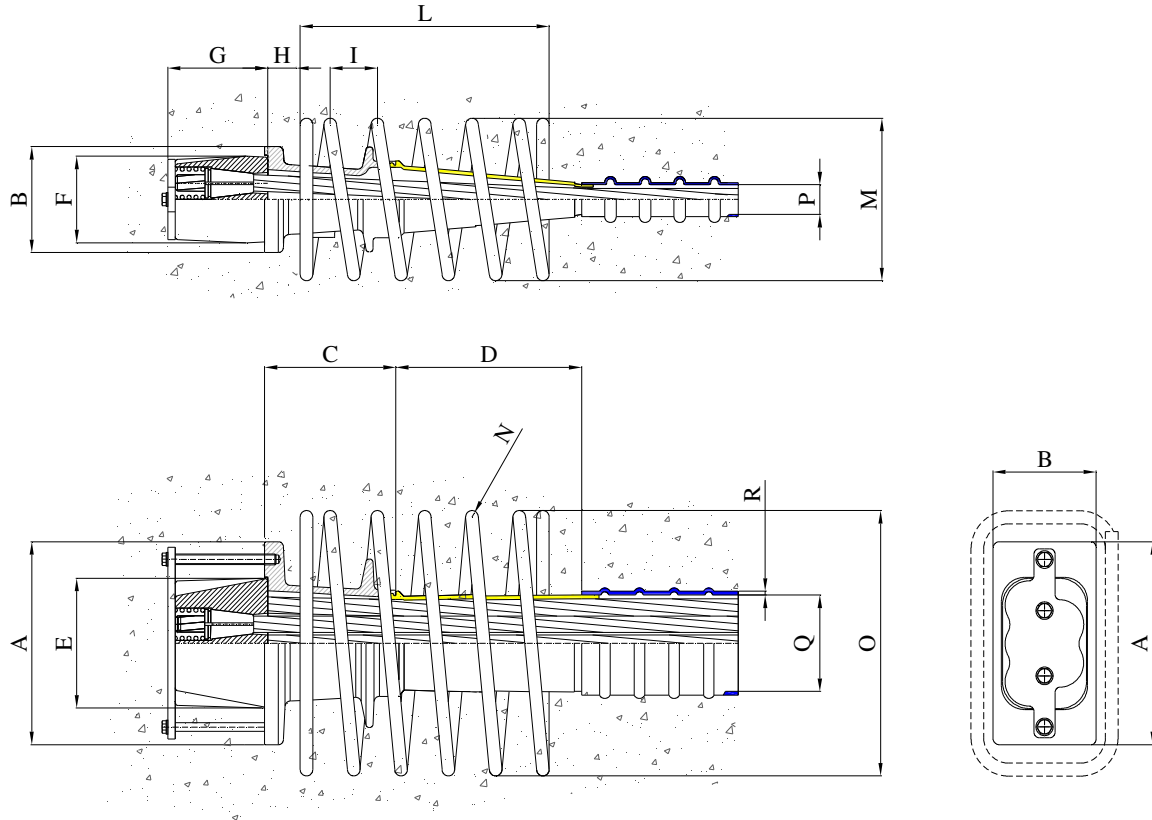
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
4ND15	170	95	125	200	102	80	88	41	45	237	140	12	215	25	76	2,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering post tensioning applications bonded and unbonded
4ND15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 21 of 44	Annex 7

PASSIVE ANCHORAGE TYPE "5ND15"



Concrete strength 35MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
5ND15	188	100	125	185	120	80	88	40	45	259.5	170	12	265	20	90	2,5

All dimensions are in mm

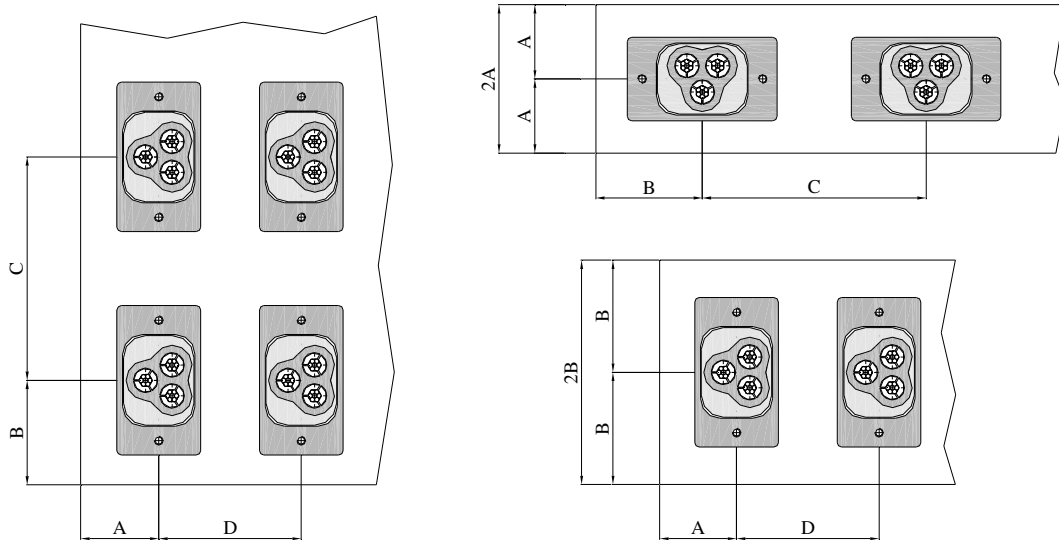
Concrete strength 45MPa

Type	A	B	C	D	E	F	G	H	I	L	M	N	O	P	Q	R
5ND15	188	100	125	185	120	80	88	40	45	237	150	12	245	20	90	2,5

All dimensions are in mm

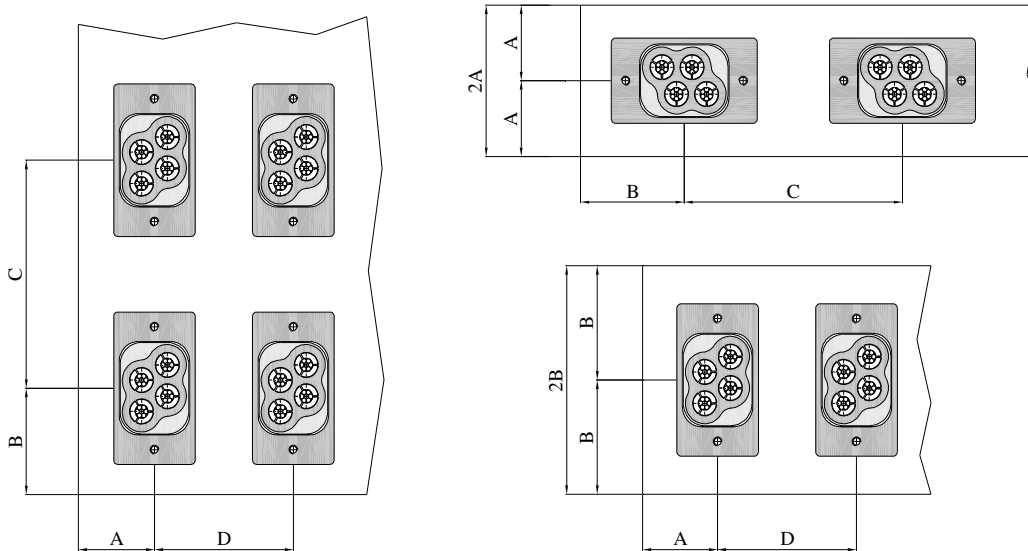
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5ND15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 22 of 44	Annex 8

DISTANCE FROM EDGES FOR ANCHORAGES TYPE "3N15"



	Type	A (mm)	B (mm)	C (mm)	D (mm)
Concrete strength 45MPa	3N15	95	135	260	180
Concrete strength 35MPa	3N15	100	150	290	190

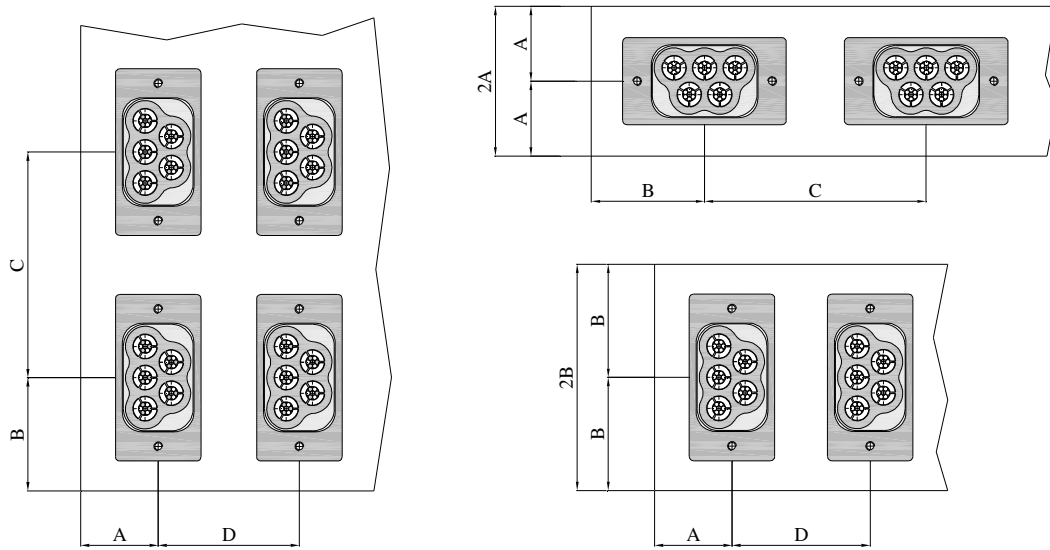
DISTANCE FROM EDGES FOR ANCHORAGES TYPE "4N15"



	Type	A (mm)	B (mm)	C (mm)	D (mm)
Concrete strength 45MPa	4N15	95	135	260	180
Concrete strength 35MPa	4N15	100	150	290	190

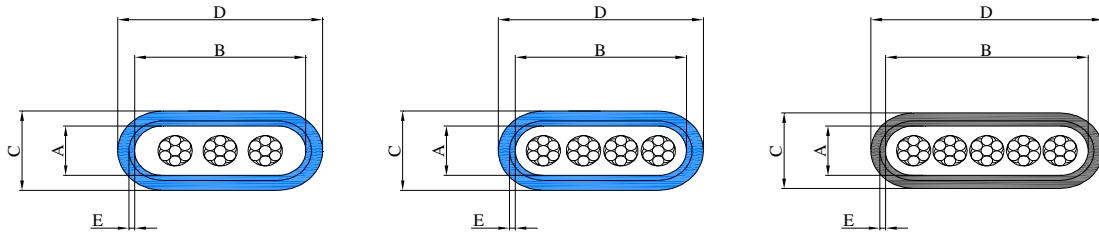
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Distance from edges	
ETA 16/0472 - of 06/11/2019 – page 23 of 44	Annex 9

DISTANCE FROM EDGES FOR ANCHORAGES TYPE "5N15"

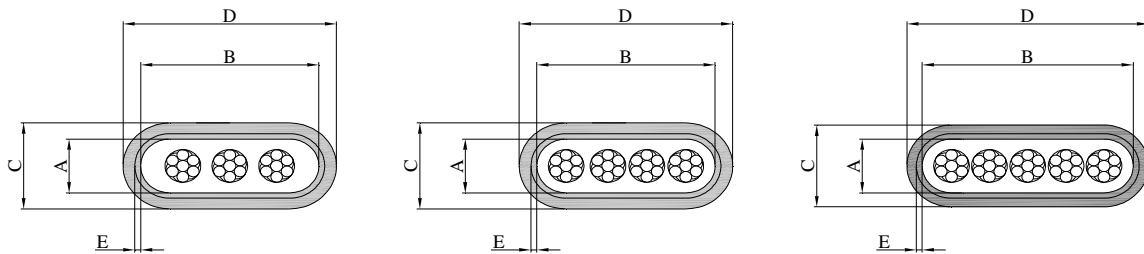


	Type	A (mm)	B (mm)	C (mm)	D (mm)
Concrete strength 45MPa	5N15	100	150	290	190
Concrete strength 35MPa	5N15	110	155	310	210

CORRUGATED DUCT FOR TYPE “N – ND” BONDED APPLICATION

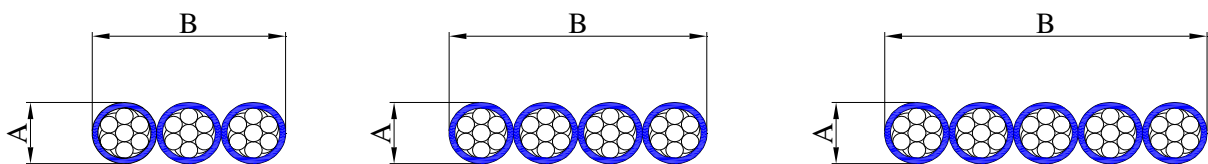


Type anchorages	Type ducts	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
3N15 / 3ND15	SPE90x42x3	25	76	40	90	2,5
4N15 / 4ND15	SPE90x42x3	25	76	40	90	2,5
5N15 / 5ND15	SPE105x38x2	25	90	38	104	2



Type anchorages	Type ducts	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
3N15 / 3ND15	SL-78x25	25	78	35	88	0,3
4N15 / 4ND15	SL-78x25	25	78	35	88	0,3
5N15 / 5ND15	SL-105x25	25	105	33	115	0,3

OVERALL DIMENSIONS STRANDS UNBONDED APPLICATION

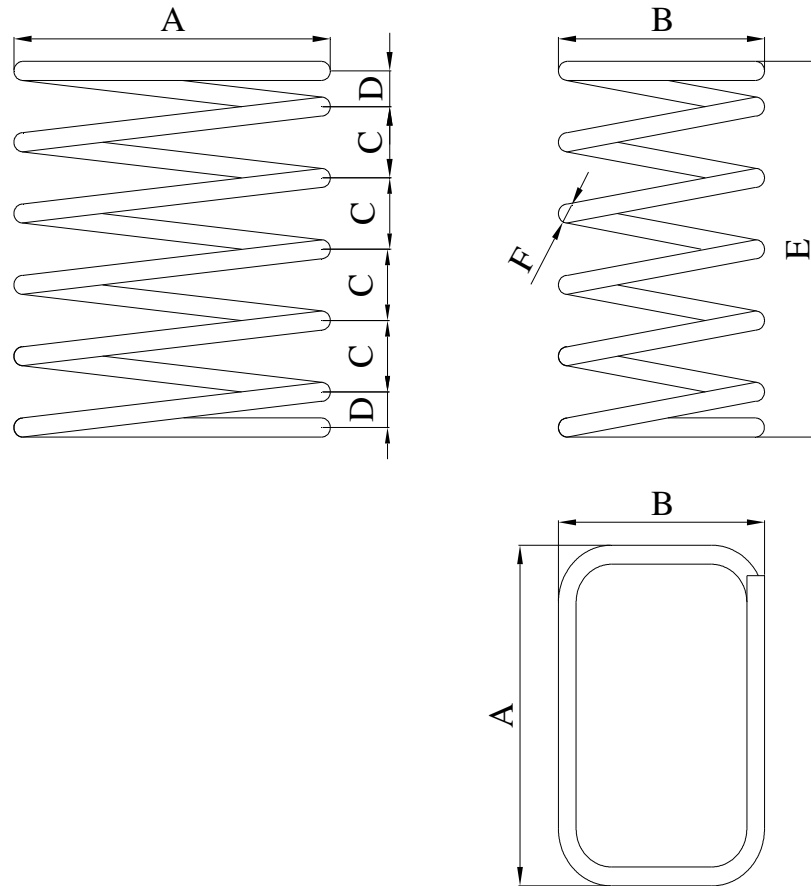


Strands	T15	T15S	T15C
A	18,5	19	18,5
B (3 strands)	55,5	57	55,5
B (4 strands)	74	76	74
B (5 strands)	92,5	95	92,5

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Corrugated duct – Strands unbonded application	
ETA 16/0472 - of 06/11/2019 – page 25 of 44	Annex 11

REINFORCEMENT BARS FOR ANCHORAGES TYPE "N - ND"



Concrete strength 35MPa

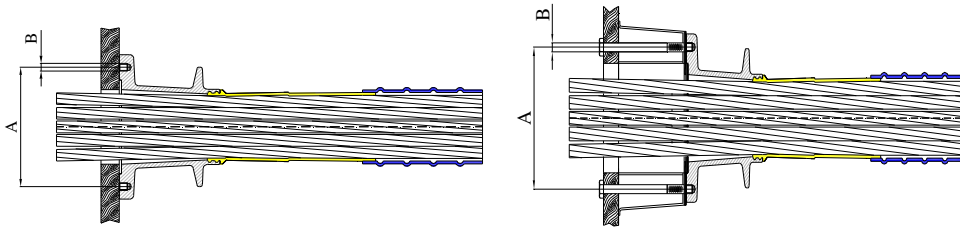
Type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)
3N15 / 3ND15	245	150	45	22.5	237	12
4N15 / 4ND15	245	150	45	22.5	237	12
5N15 / 5ND15	265	170	45	22.5	259.5	12

Concrete strength 45MPa

Type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)
3N15 / 3ND15	215	140	45	22.5	237	12
4N15 / 4ND15	215	140	45	22.5	237	12
5N15 / 5ND15	245	150	45	22.5	237	12

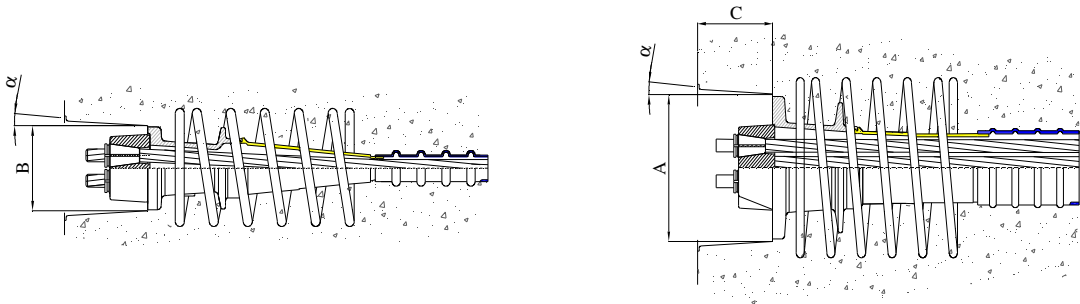
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Reinforcement bar for anchorage "N" and "ND"	
ETA 16/0472 - of 06/11/2019 – page 26 of 44	Annex 12

CONNECTION TO THE FORMWORK FOR ANCHORAGE TYPE “N”



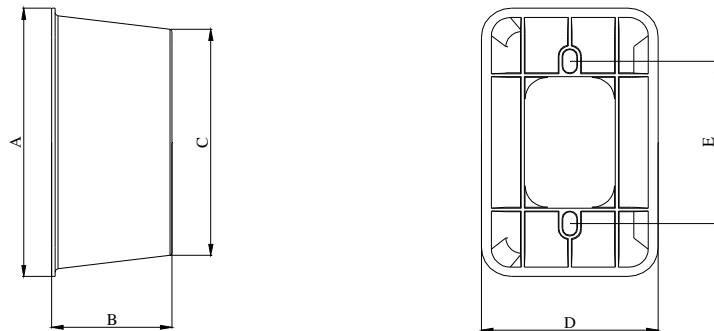
Type anchorages	A (mm)	B (mm)
3N15	152	M10
4N15	152	M10
5N15	155	M10

RECESSES FOR ANCHORAGES TYPE “N”



Type anchorages	A (mm)	B (mm)	C (mm)	α (mm)
3N15	200	110	120	5°
4N15	200	110	120	5°
5N15	200	110	120	5°

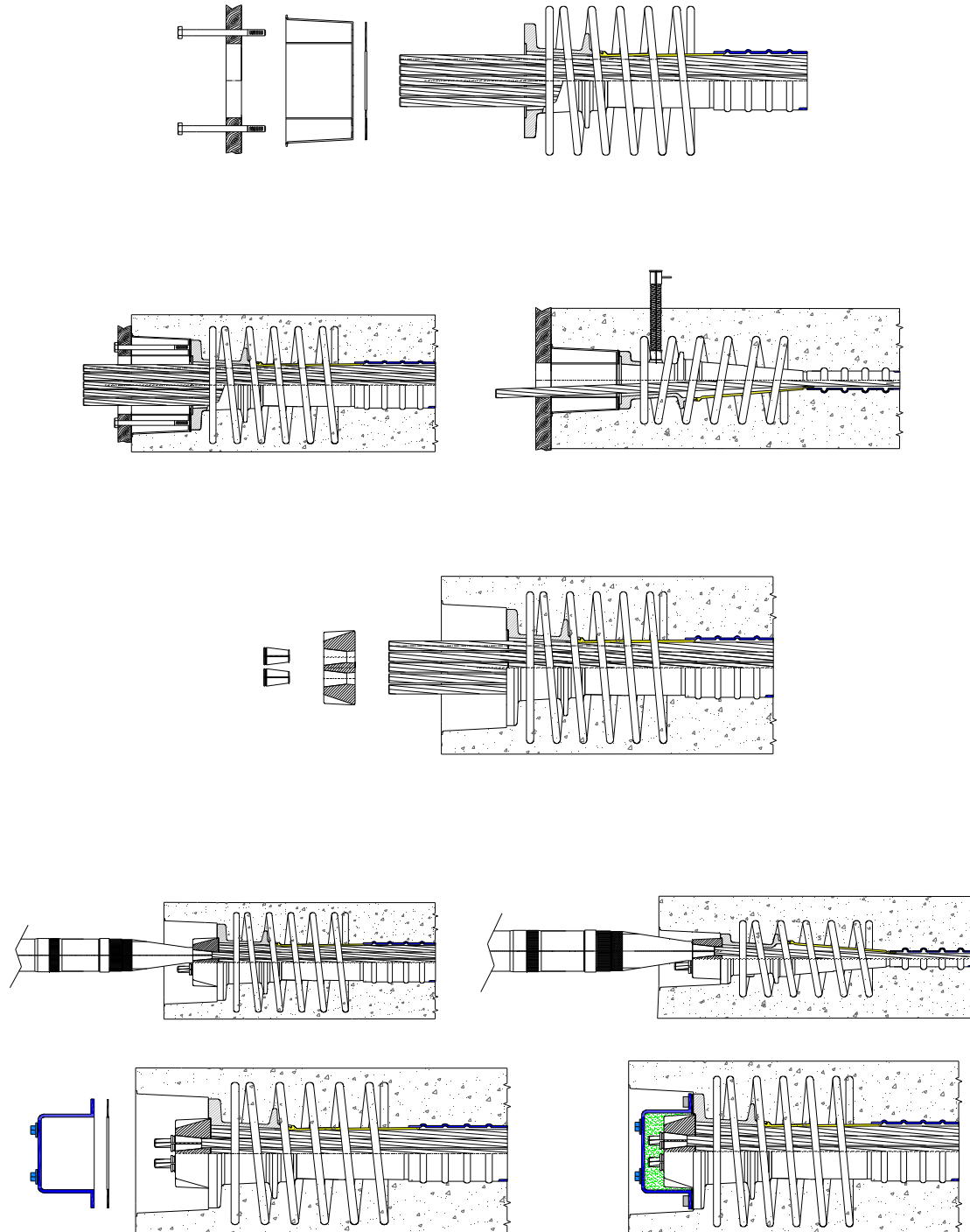
POCKET FORMER



Type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
Pocket former	241,5	103,5	203,5	152	146,1

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Connection to the formwork	
ETA 16/0472 - of 06/11/2019 – page 27 of 44	Annex 13

RE USABLE POCKET FORMER



Bonded and Unbonded slab system

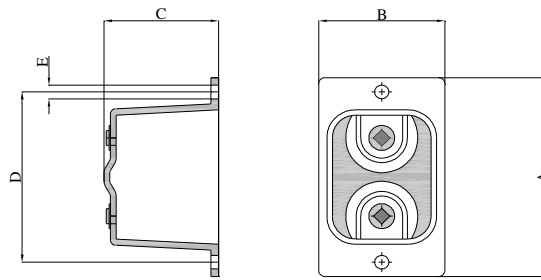
Pocket former

ETA 16/0472 - of 06/11/2019 – page 28 of 44

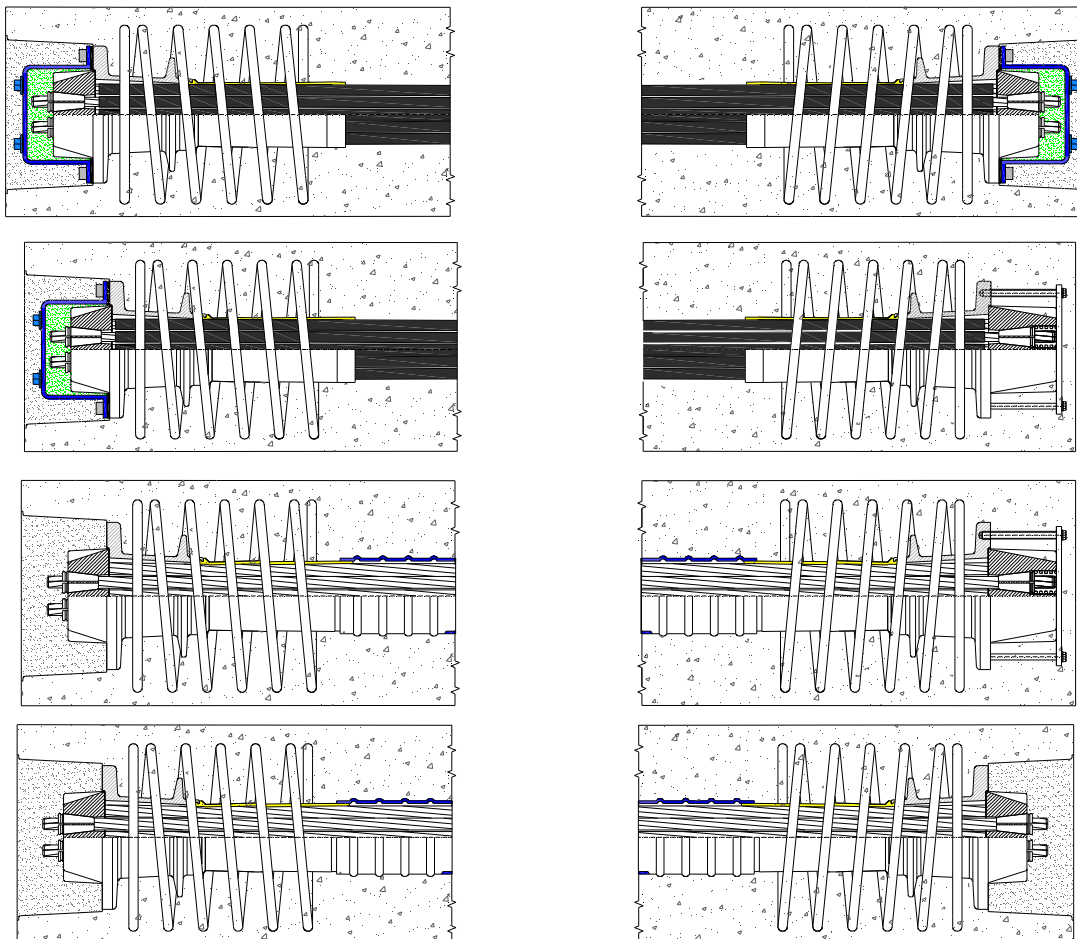
Tension Technology Martin s.r.l.
Engineering slab applications
bonded and unbonded

Annex 14

PROTECTION CAP

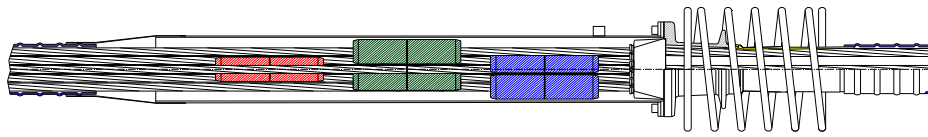


Type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
Protection cap	180	100	90	155	11

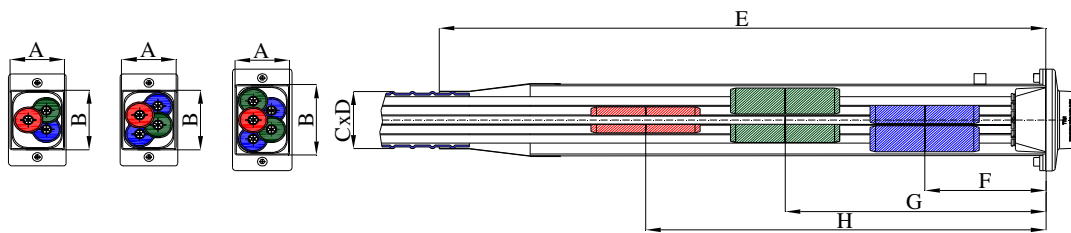
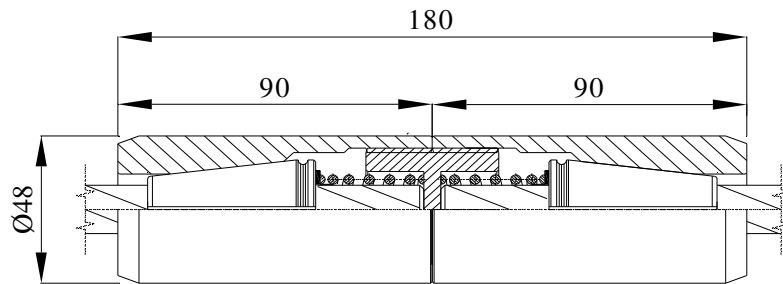


COUPLING NG SYSTEM (bonded application)

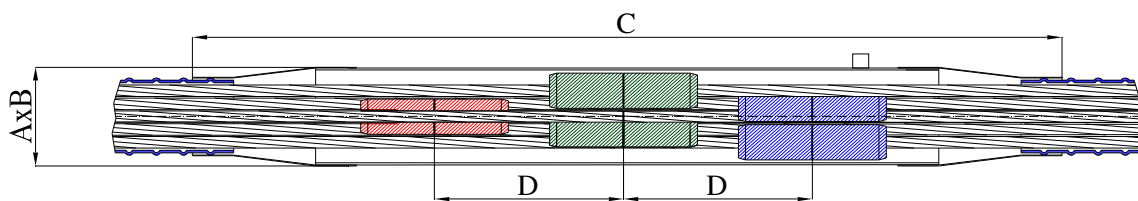
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Protection cap	
ETA 16/0472 - of 06/11/2019 – page 29 of 44	Annex 15



Coupling type 1G15



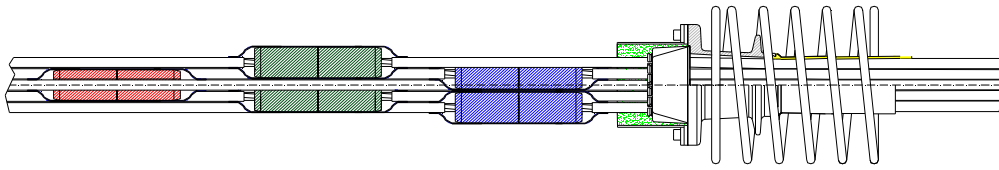
Application type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)	G (mm)	H (mm)
3NG15	90	110	90	40	1000	200	430	660
4NG15	90	110	90	40	1000	200	430	660
5NG15	90	130	105	38	1000	200	430	660



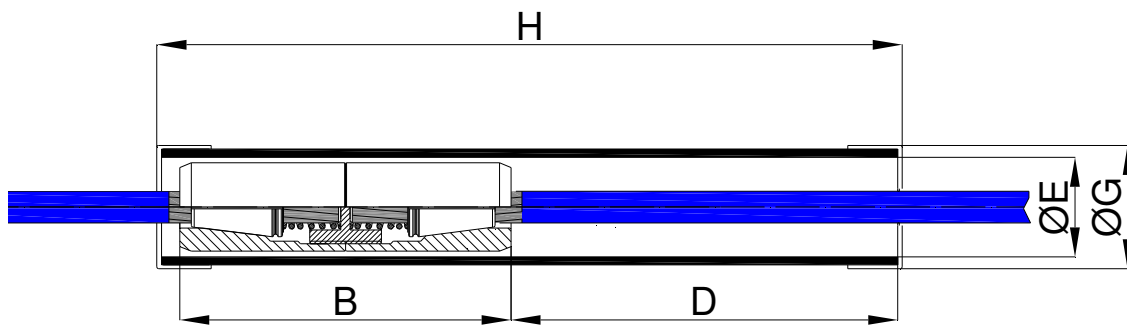
Application type	A (mm)	B (mm)	C (mm)	D (mm)
3NG15	90	110	1000	230
4NG15	90	110	1000	230
5NG15	90	130	1000	230

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Coupling NG	
ETA 16/0472 - of 06/11/2019 – page 30 of 44	Annex 16

COUPLING NGX SYSTEM (unbonded application)

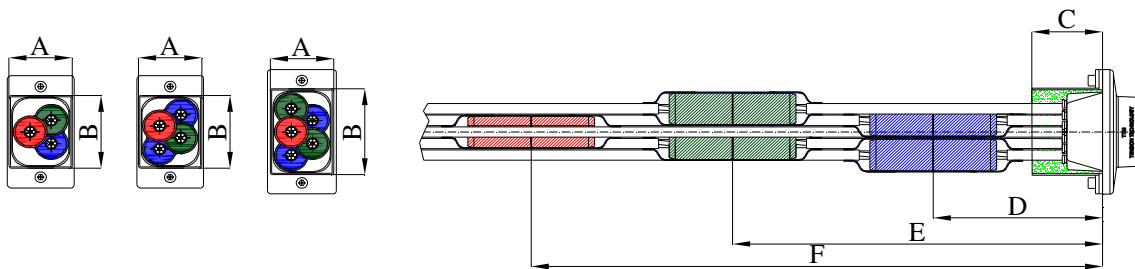


Coupling type 1GX15



Type	B (mm)	D (mm)	E (mm)	G (mm)	H (mm)
1GX15	180	210	54	67	405

Indicative dimensions



Application type	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)	F (mm)
3NGX15	90	110	100	230	500	710
4NGX15	90	110	100	230	500	710
5NGX15	90	130	100	230	500	710

Bonded and Unbonded slab system

Coupling NGX

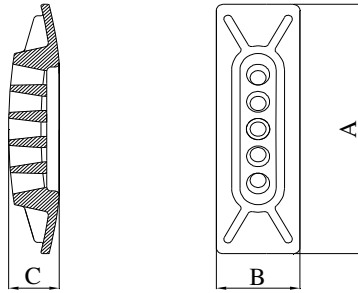
ETA 16/0472 - of 06/11/2019 – page 31 of 44

Tension Technology Martin s.r.l.
Engineering slab applications
bonded and unbonded

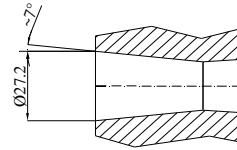
Annex 17

ACTIVE ANCHORAGE TYPE "L"

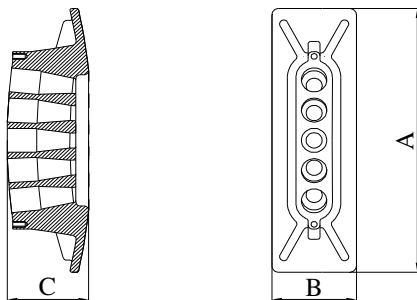
ACTIVE ANCHORAGE



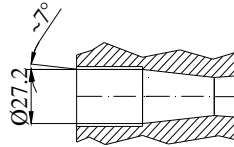
CONE



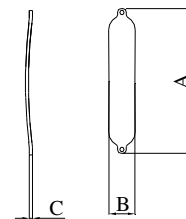
PASSIVE ANCHORAGE



CONE

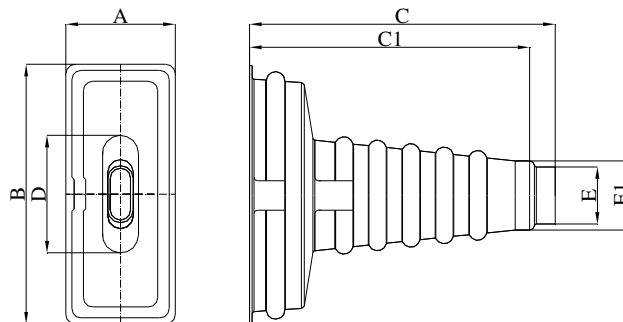


COVER



ACTIVE ANCHORAGE		PASSIVE ANCHORAGE		COVER	
A (mm)	330	A (mm)	330	A (mm)	230
B (mm)	100	B (mm)	100	B (mm)	45
C (mm)	60	C (mm)	95	C (mm)	5

TRANSITION PIPE



A (mm)	B (mm)	C (mm)	C1 (mm)	D (mm)	E (mm)	E1 (mm)
163	391	455	415	177	86	105

Bonded and Unbonded slab system

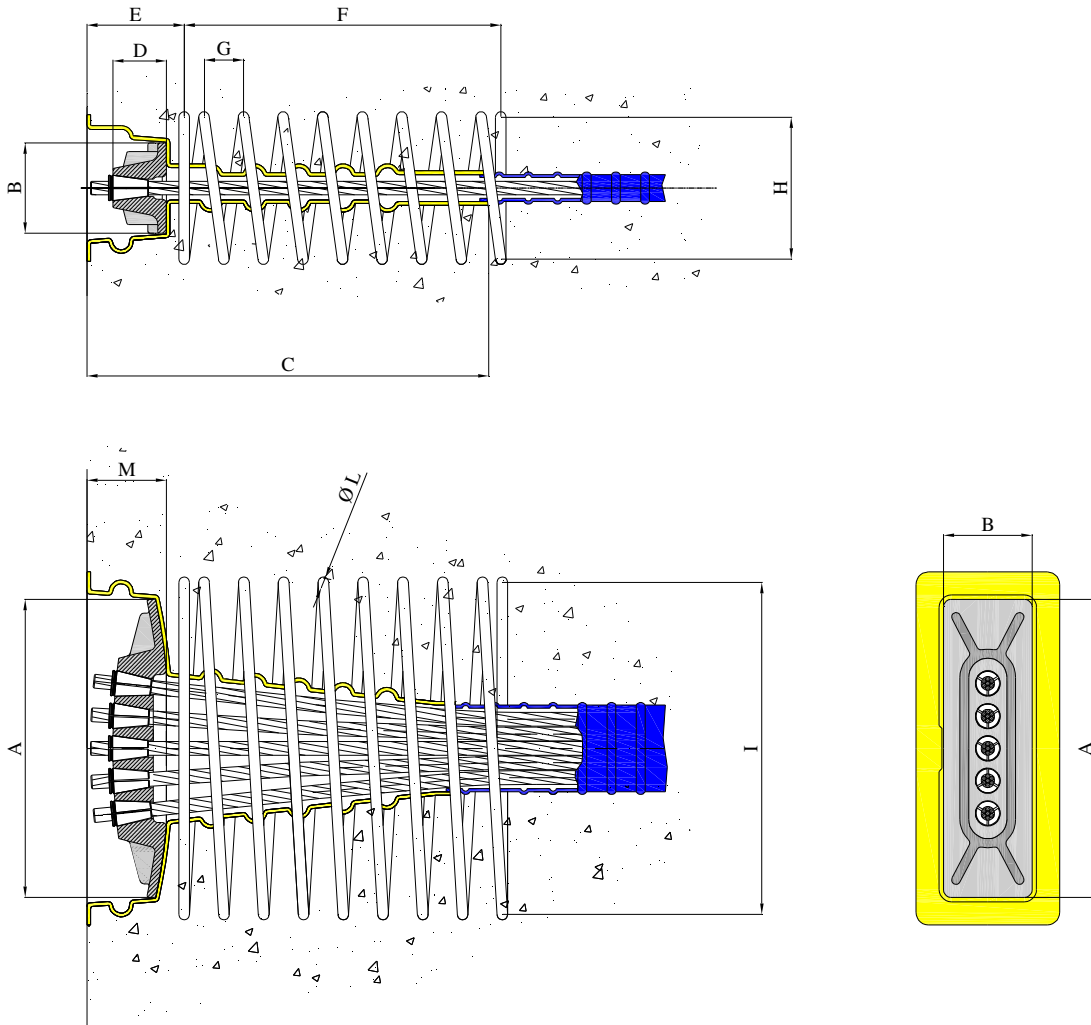
Anchorage dimensions – Transition pipe

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Tension Technology Martin s.r.l.
Engineering slab applications
bonded and unbonded

Annex 18

ACTIVE ANCHORAGE TYPE "5L15"



Concrete strength 45MPa

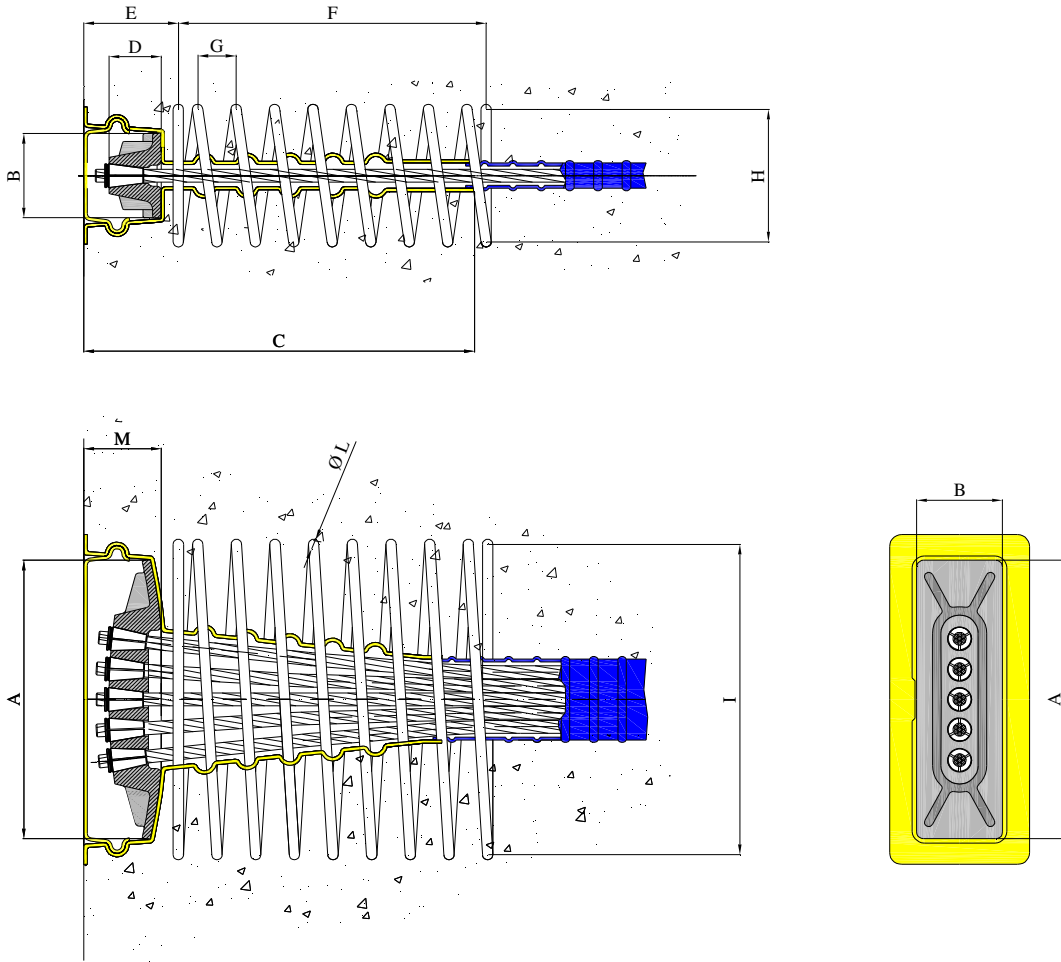
Type	A	B	C	D	E	F	G	H	I	L	M
5L15	330	100	400	60	110	350	45	150	360	12	90

All dimensions are in mm

The dimensions can be applied also to the anchorage with 3 or 4 strands.

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5L15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 33 of 44	Annex 19

ACTIVE ANCHORAGE TYPE "5LX15"



Concrete strength 45MPa

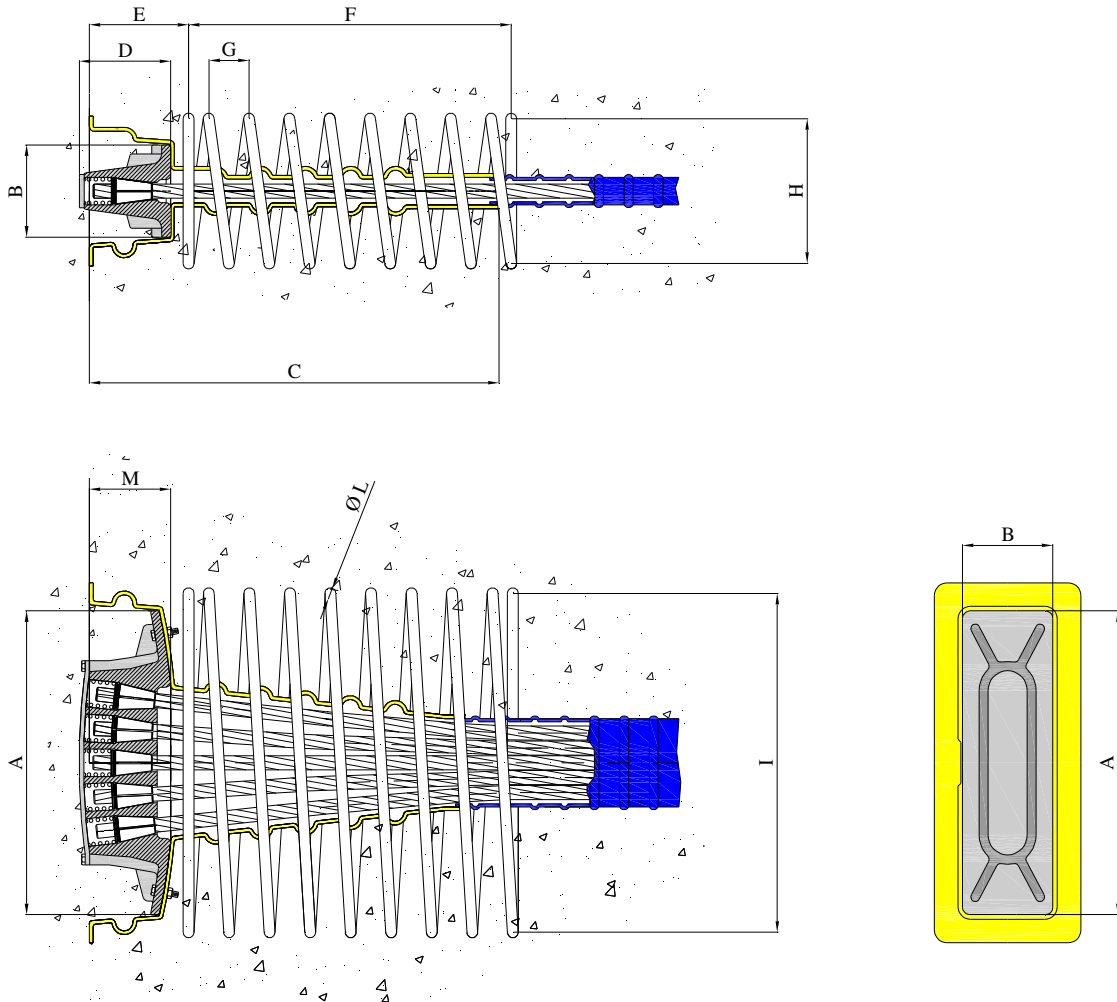
Type	A	B	C	D	E	F	G	H	I	L	M
5LX15	330	100	400	60	110	350	45	150	360	12	90

All dimensions are in mm

The dimensions can be applied also to the anchorage with 3 or 4 strands.

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5LX15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 34 of 44	Annex 20

PASSIVE ANCHORAGE TYPE "5LD15"



Concrete strength 45MPa

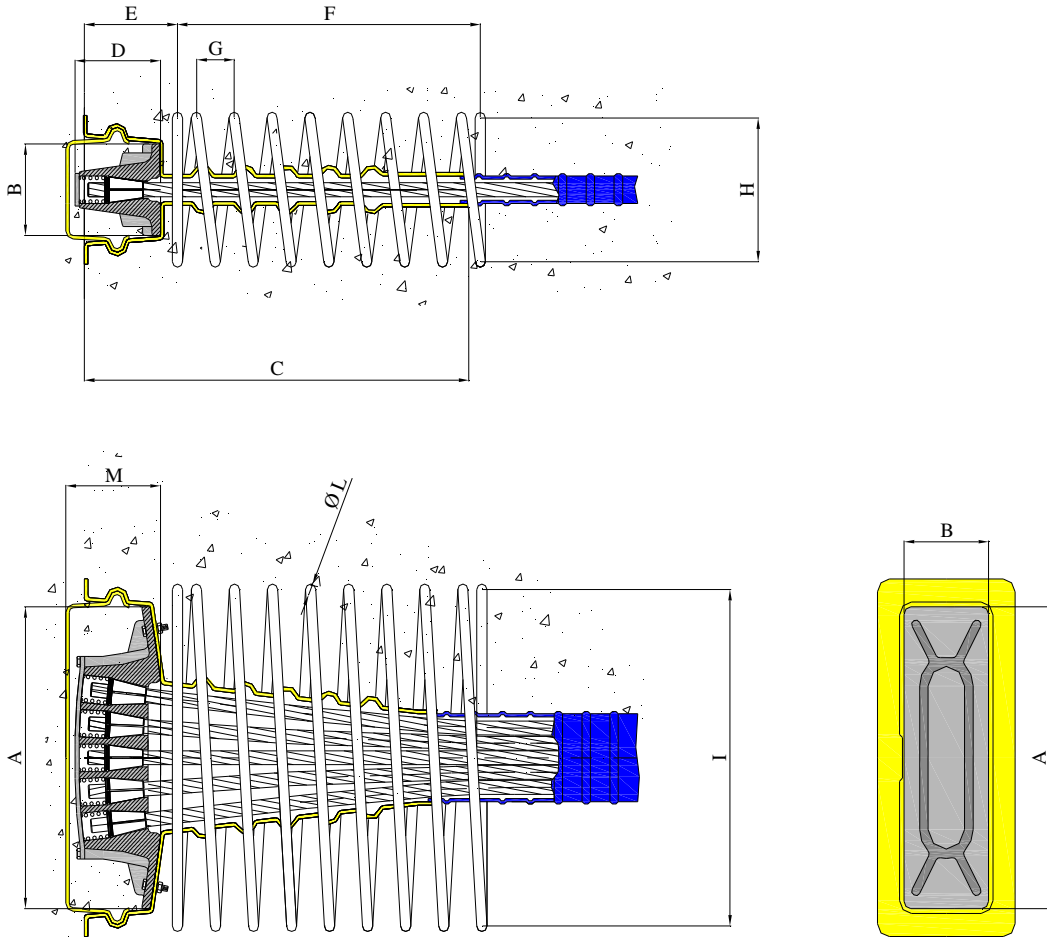
Type	A	B	C	D	E	F	G	H	I	L	M
5LD15	330	100	400	100	110	350	45	150	360	12	90

All dimensions are in mm

The dimensions can be applied also to the anchorage with 3 or 4 strands.

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5LD15 Anchorage recess	
ETA 16/0472 - of 06/11/2019 – page 35 of 44	Annex 21

PASSIVE ANCHORAGE TYPE "5LDX15"



Concrete strength 45MPa

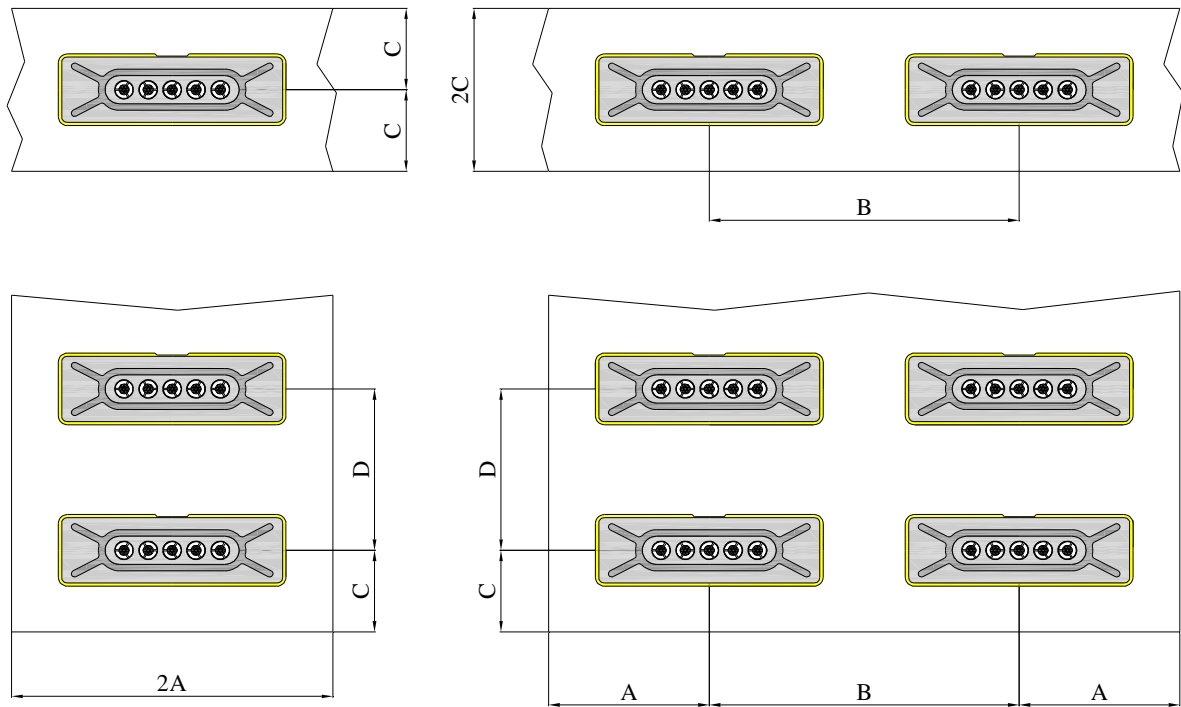
Type	A	B	C	D	E	F	G	H	I	L	M
5LDX15	330	100	400	100	110	350	45	150	360	12	115

All dimensions are in mm

The dimensions can be applied also to the anchorage with 3 or 4 strands.

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
5LDX15 Anchorage recess	
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DISTANCE FROM EDGES ANCHORAGES TYPE “L”

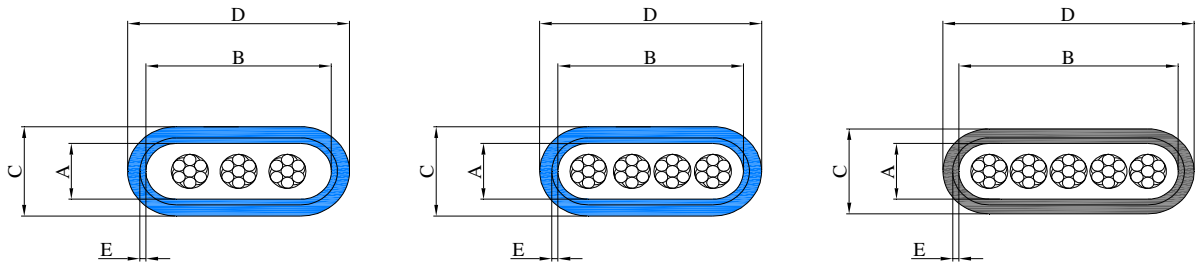


	Type	A	B	C	D
Concrete strength 45MPa	3-4-5 strands	225	440	110	210

All dimensions are in mm

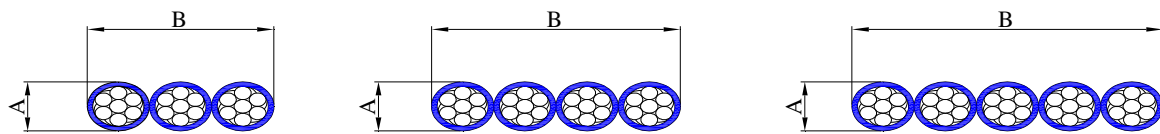
Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Distance from edge	
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CORRUGATED DUCT FOR ANCHORAGE "L" - BONDED APPLICATION



Type	Type ducts	A (mm)	B (mm)	C (mm)	D (mm)	E (mm)
3-4 strands	SPE90x42x3	25	76	40	90	2,5
5 strands	SPE105x38x2	25	90	38	104	2

OVERALL DIMENSIONS STRANDS UNBONDED APPLICATION

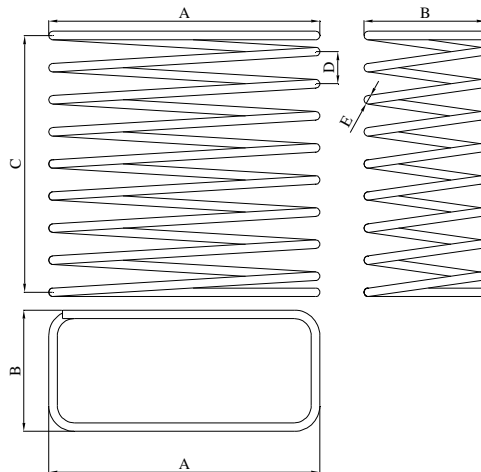


Strands	T15	T15S
A	18,5	19
B (3 strands)	55,5	57
B (4 strands)	74	76
B (5 strands)	92,5	95

All dimensions are in mm

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Corrugated duct – Strands unbonded application	
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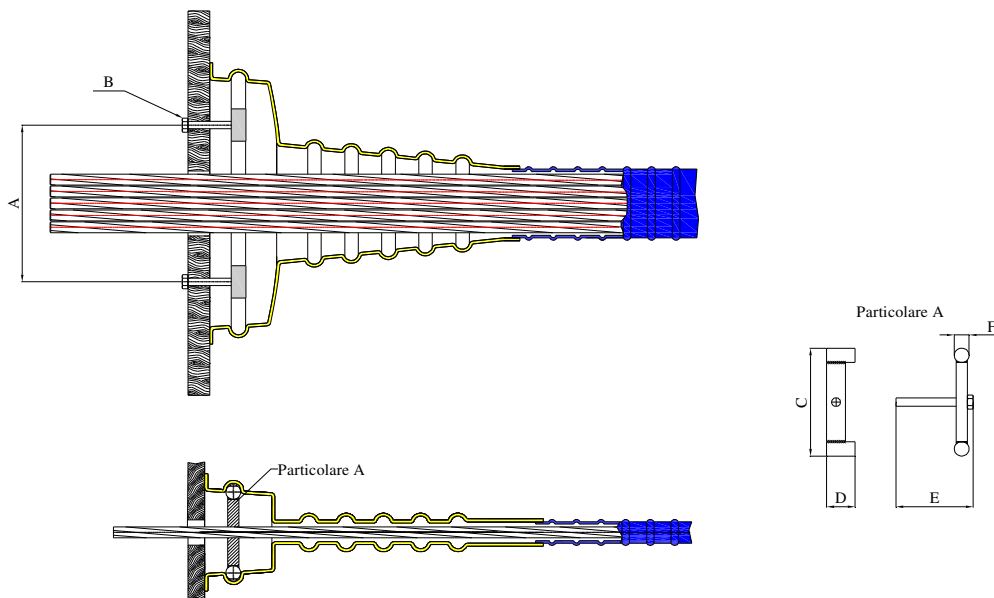
REINFORCEMENT BARS FOR ANCHORAGES TYPE “L”



Concrete strength 45MPa

Type	A	B	C	D	E
L	360	150	350	45	12

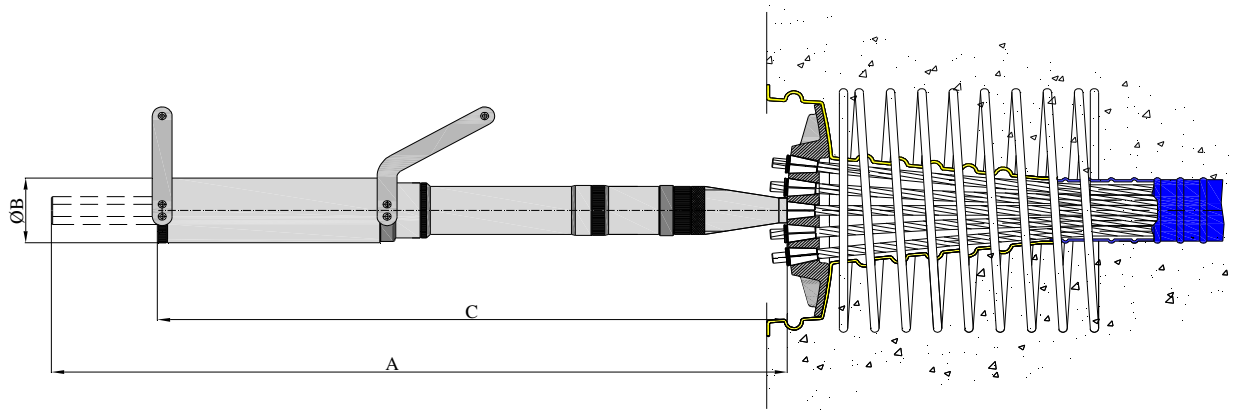
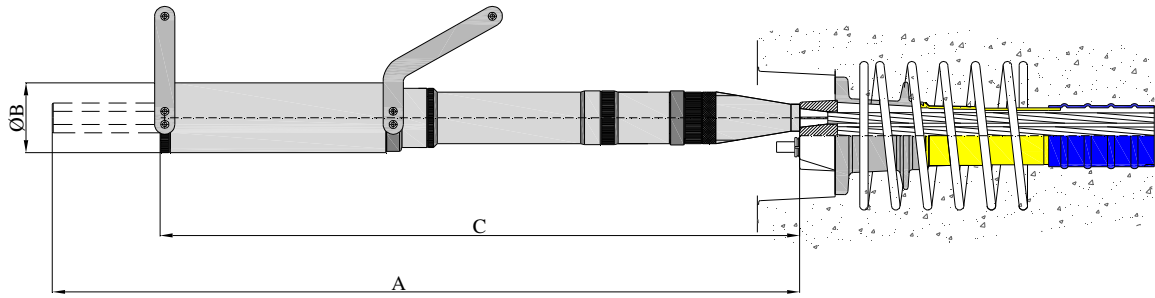
CONNECTION TO THE FORMWORK FOR ANCHORAGE TYPE “L”



Type	A	B	C	D	E	F
L	230	M10x100	150	38	Variable	20

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Reinforcement – Connection to the formwork	
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MONO STRAND JACK



JACK TYPE	Stressing Section	Weight	Stroke	Tensioning Extension	A	B	C
	cm ²	kg	mm	mm	mm	mm	mm
TTM250KN-100	47.2	21.5	100	350	740	100	740
TTM250KN-200	47.2	26	200	350	1050	100	950
TTM300KN-100	68.8	24	100	350	740	110	740
TTM300KN-200	68.8	28	200	350	1050	100	950

Bonded and Unbonded slab system

Jack

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Tension Technology Martin s.r.l.
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STRAND FOR POST TENSIONING

Strand diameter	mm	15,2	15,7	15,2
Standard		prEN 10138	prEN 10138	prEN 10138
Strand type		Normal	Super	Compact
Identification		T15	T15S	T15C
Nominal cross-sectional area A_p	mm ²	139,00	150,00	165,00
Characteristic tensile strength f_{pk}	N/mm ²	1.860	1.860	1.860
Characteristic 0,1 % - proof stress $f_{p0,1k}$	N/mm ²	1.670	1.670	1.670
Mass	g/m	1.093	1.172	1.289
Characteristic ultimate force F_{pk}	kN	260	279	307
Characteristic yield force $F_{p0,1k}$	kN	234	251	270
Elastic limit 0,1% (Pt0,1k)	kN	230	248	264
Relaxation after 1.000 h.0,7 f_{pt}	%	2,5	2,5	2,5
Relaxation after 1.000 h.0,8 f_{pt}	%	4,5	4,5	4,5
Elastic modulus	kN/mm ²	196 +/- 10	196 +/- 10	196 +/- 10
External diameter of strand greased and coated	mm	18,00	18,50	18,00
Weight of grease for metre of strand	g/m	75	78	70
Weight of strand greased and coated	g/m	1.210	1.290	1.400

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Strand	
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Prescribed test-plan

Component	Item ⁽¹⁾	Test / Check	Traceability ⁽²⁾	Minimum frequency	Documentation
Anchor head	material	check	full	100 %	“3.1” ⁽³⁾
	detailed dimensions	test		5 % ≥ 2 specimen	yes
	visual inspection	check		100 %	no
Coupler	material	check	full	100 %	“3.1” ⁽³⁾
	detailed dimensions	test		5 % ≥ 2 specimen	Yes
	visual inspection	check		100 %	No
Wedge	Material	check	full	100 %	“3.1” ⁽³⁾
	treatment, hardness	test		0,5 % ≥ 2 specimen	Yes
	detailed dimensions	test		5 % ≥ 2 specimen	Yes
	visual inspection	check		100 %	No
Duct	material	check	full	100 %	Yes
	visual inspection	check		100 %	No
Tensile element (strand)	material	check	full	100 %	Yes
	diameter	test		each coil/bundle	No
	visual inspection	check		each coil/bundle	no
Constituents of filling material as per EN 447	cement	check	full	100 %	yes
	admixtures, additions, ...	check	full	100 %	yes
Helix	material	check	full	100 %	yes
	visual inspection	check		100 %	no
Stirrups	material	check	full	100 %	yes
	visual inspection	check		100 %	no
Steel Duct	material	check	full	100 %	CE
	visual inspection	check		100 %	no

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering slab applications bonded and unbonded
Prescribed test plan	
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Audit-testing

Component	Item (1)	Test / Check (2)	Sampling – Number of components per visit
Anchor head	material according to specification	check, test	1
	detailed dimensions	test	
	visual inspection ⁽¹⁾	check	
Coupler	material according to specification	check, test	1
	detailed dimensions	test	
	visual inspection ⁽¹⁾	check	
Wedge	material according to specification	check, test	2
	Treatment	test	2
	detailed dimensions	test	1
	main dimensions, surface hardness	test	5
	visual inspection ⁽¹⁾	check	5
Single tensile element test	EAD 160004-00-0301 Annex C.7	test	1 series
Other important components	Fixed from approved Body		

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering post tensioning applications bonded and unbonded
Prescribed test plan	
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OVERVIEW VERSIONS AND APPLICATIONS

SERIES	TYPE	STRAND TYPE			APPLICATION		
		T15	T15S	T15C		BONDED	UNBONDED
N	3N15	X	X	X	ACTIVE	X	X
	4N15	X	X	X	ACTIVE	X	X
	5N15	X	X	X	ACTIVE	X	X
	3ND15	X	X	X	PASSIVE	X	X
	4ND15	X	X	X	PASSIVE	X	X
	5ND15	X	X	X	PASSIVE	X	X
L	5L15	X	X	-	ACTIVE	X	X
	5LX15	X	X	-	ACTIVE	X	X
	5LD15	X	X	-	PASSIVE	X	X
	5LDX15	X	X	-	PASSIVE	X	X
COUPLER	NG	X	X	X	-	X	-
	NGX	X	X	X	-	-	X

Bonded and Unbonded slab system	Tension Technology Martin s.r.l. Engineering post tensioning applications bonded and unbonded
Overview versions and applications	
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