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**MEMBER OF EOTA**

## European Technical Approval ETA-09/0169

*Original version in English*

Trade name:	FREYSSIBAR
Holder of approval:	SOLETANCHE FREYSSINET 1 bis, rue du Petit Clamart F-78140 VELIZY (France)
Generic type and use of construction product:	Post-tensioning kit for prestressing of structures with bars
Valid from:	30 June 2013
to:	29 June 2018
Kit manufacturer	SOLETANCHE FREYSSINET 1 bis, rue du Petit Clamart F-78140 VELIZY (France)
This European Technical Approval contains:	34 pages including 18 pages of drawings which form an integral part of the document



European Organisation for Technical Approvals

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## **I. LEGAL BASES AND GENERAL CONDITIONS**

1. This European Technical Approval is issued by UK Certification Authority for Reinforcing Steels in accordance with the

- Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products (89/106/EEC) amended by Council Directive 93/68/EEC of 22 July 1993.(1)
- UK implementation of the Construction Products Directive, 89/106/EEC: Statutory Instrument 1991, No 1620 "Building and Buildings, The Construction Products Regulations 1991" — made 15 July 1991, laid before Parliament 22 July 1991, coming into force 27 December 1991, and amended by the Construction Products (Amendment) Regulations 1994 (Statutory Instrument 1994, No 3051).
- Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals (2).
- Guideline for European Technical Approval of Post-tensioning Kits for Prestressing of Structures. ETAG013 Edition June 2002.

2. The UK Certification Authority for Reinforcing Steels is authorised to check whether the provisions of this European Technical Approval are met. Checking may take place in the manufacturing plant(s). Nevertheless, the responsibility for the conformity of the products to the European Technical Approval and for their fitness for intended use remains with the holder of the European Technical Approval.

3. This European Technical Approval is not to be transferred to other manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European Technical Approval.

4. This European Technical Approval may be withdrawn by UK Certification Authority for Reinforcing Steels according to Article 5 of the Council Directive 89/106/EEC.

5. Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of UK Certification Authority for Reinforcing Steels. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.

6. The European Technical Approval is issued by the approval body in its official language(s). These versions should correspond fully to the version used by EOTA for circulation. Translations into other languages have to be designated as such.

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### References:

- (1) Official Journal of the European Communities No L40, 11.02, 1989, page 12.
- (2) Official Journal of the European Communities No L17, 20.01, 1994, page 34.

## **II. SPECIFIC CONDITIONS OF THIS EUROPEAN TECHNICAL APPROVAL**

### **1 DEFINITION OF PRODUCT AND INTENDED USE**

#### **1.1 PRODUCT DEFINITION**

The Freyssinet bar prestressing system is designed for both bonded and unbonded internal and external prestressing.

The PT system comprises:

- the tensile element  
Tendons are ribbed bars made of prestressing steel, hot rolled, threaded by cold deformation, with diameters: 26.5, 32, 36, 40 and 50mm, and a 1030MPa tensile strength complying with prEN 10138-4-Y-1030-H-26,5/50,0-R.
- Stressing and fixed anchorages with anchor plates, washers and nuts
- Fixed and movable couplers
- Ducts\*  
Steel strip ducts complying with EN 523,  
Corrugated plastic duct complying with ETAG 013 Clause C.3.
- Bursting steel reinforcement\*  
Additional reinforcement placed in the anchorage zone complying with EN 10080.
- Filling materials\*  
Grout complying with EN 447  
Grease complying with ETAG 013 Clause C.4.1  
Wax complying with ETAG 013 Clause C.4.2.

**\* Not included with the kit by the ETA holder but may supplied separately.**

## **1.2 CATEGORIES OF USE**

The prestressing kit described in this ETA can be used for new structures, for repair and reinforcement of existing structures with following tendon types:

- Internal bonded tendon
- Internal unbonded tendon
- External tendon for structures with a tendon path situated outside the cross-section of the structure or member but inside its envelope.

The prestressing kit described in this ETA can be used in any type of structure and is used more frequently in:

- bridges
- buildings
- nuclear containment structures
- offshore structures
- floating installations and platforms
- retaining walls

## **1.3 ASSUMED SERVICE LIFE OF THE KIT**

Measures taken in this ETA assume an intended service life of 100 years for prestressing kits.

Indications mentioned on the service life of a construction product cannot be interpreted as a guarantee given neither by the manufacturer nor the approval body. They only serve as a means to select components and appropriate materials to meet the economically reasonable expected life-time of structures.

## **2 CHARACTERISTICS OF THE PT SYSTEM**

### **2.1 STRESSING ANCHORAGES**

The stressing anchorage consists of an anchor plate, a washer and a nut. For injection purposes, the bearing plate may be fitted with a grout slot and threaded holes to attach the grouting cap.

The stressing anchorage can be used as a fixed anchorage.

### **2.2 FIXED ANCHORAGES**

The fixed anchorage consists of an anchor plate with or without grout slots, a washer and a nut. The nut is tack welded onto the anchor plate at the factory.

### 2.3 COUPLERS

The same coupler is used for mobile and fixed configurations. It connects two bars together by means of a sleeve.

The fixed coupler enables the direct connection to the stressing anchorage of an already stressed tendon.

### 2.4 TENSILE ELEMENT

Initial prestressing and oversteering forces are specified in the respective standards and provisions valid at the place of use. The table 1 lists informative maximum values of the tendons.

Table 1: Initial prestressing and oversteering forces according to Eurocode 2 and prEN 10138-4:2009

Nominal bar diameter	Nominal cross sectional area	Maximum prestressing force	Maximum oversteering force <sup>(1)</sup>
d	Sn	0.90 Sn Fp0.1k	0.95 Sn Fp0.1k
mm	mm <sup>2</sup>	kN	kN
26.5	552	414	437
32	804	604	638
36	1018	765	807
40	1257	944	996
50	1964	1475	1557
<sup>(1)</sup> The fulfillment of the stabilization criteria and requirements for crack widths in the load transfer tests were verified at 0.80 Sn Fpk ( Fp0.1k = 835 MPa; Fpk = 1030 MPa )			

In any case, the stressing force has to satisfy regulations in the place of use.

### 2.5 FRICTION IN TENDONS

The coefficients of friction ( $\mu$ ) and of wobble ( $k$ ), as defined in European standard pr EN1992-1-1 to obtain the prestressing force with the equation  $P(x) = P_{\max} e^{-\mu(\theta+kx)}$ , vary in accordance with the type of bars.

The coefficients in the table 2 are the values provided by the above European standard.

Table 2 :

2.5.1.1.1 Type of bars	k (rad/m)	$\mu$ (rad <sup>-1</sup> )
Ribbed bars	$0.005 \leq k \leq 0,01$	0,65

Friction losses in the anchorages and couplers are low and need not to be taken into consideration in design and execution.

## **2.6 RADII OF CURVATURE**

Straight bars only are used.

## **2.7 SLIP AT ANCHORAGES AND COUPLERS**

Table 3 specifies the slip values to be taken into consideration in design and for determining tendon elongation.

In the case of a single tensioning operation:

Table 3: slip values at anchorages

Nominal bar diameter (mm)	26,5 - 32 - 36	40 –50
Slip at stressing anchorage (mm)	1,5	2,0
Slip at fixed anchorage (mm)	0,15	
Slip at sleeve (mm)	0,30	

A smaller draw-in value is reached at the stressing anchorage by carrying out three jacking operations to the maximum load followed each time by a transfer of the force to the anchorage. Resulting draw-in values are given in the table 4. Such procedure is recommended for short bars (i.e. less than 4 meters).

Table 4: special slip values at anchorages

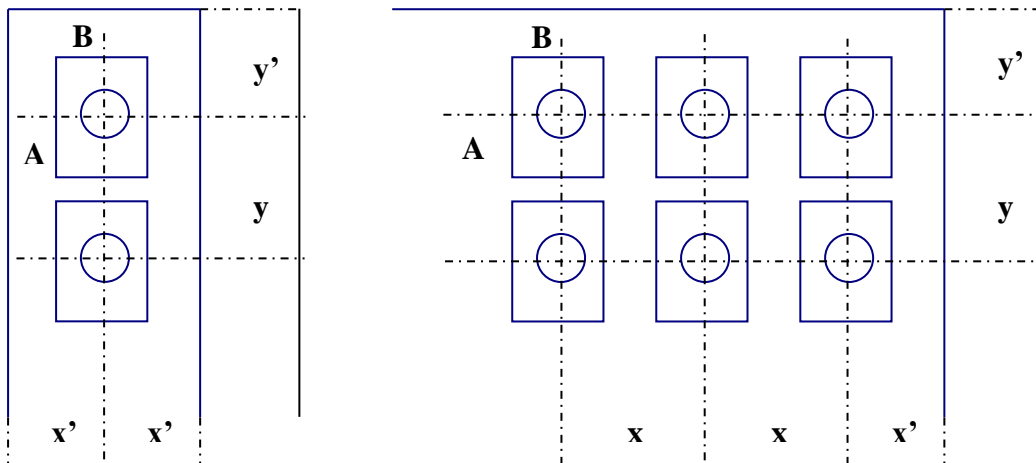
Nominal bar diameter (mm)	26,5 - 32 - 36	40 –50
Slip at stressing anchorage (mm)	0,5	0,7

## **2.8 LATERAL COVER AND DISTANCES IN PRESTRESSED CONCRETE STRUCTURES**

In what follows, it is considered that anchorages are positioned relative to two orthogonal directions x and y.

Notations:

- A, B: plane dimensions of the trumplate ( $A \geq B$ ),
- a, b: side lengths of test specimen ( $a \geq b$ ),
- x, y: minimum centre distance between two anchorages in the structure in x- and y-directions,
- x', y': minimum edge distance between anchorages and the closest external surface in x- and y-directions,
- $f_{cm,0}$ : mean compressive strength measured on cylinder required before tensioning.



Dimensions  $x$  and  $y$  shall satisfy the following conditions:

- $x \geq B+30$  (mm)
- $y \geq A+30$  (mm)
- $x \cdot y \geq a \cdot b$
- $x \geq 0.85 a$
- $y \geq 0.85 b$
- $x' \geq 0.5 x + \text{cover} - 10$  (mm)
- $y \geq 0.5 y + \text{cover} - 10$  (mm)

The values of  $a$  and  $b$  are given in the table 5 for a concrete strengths  $f_{cm,o}$  of 30 MPa.

Table 5 : Side length of prisms

Nominal bar diameter	$f_{cm,o} = 30$ MPa
(mm)	$a \times b$ (mm)
26.5	190 x 190
32	220 x 220
36	245 x 245
40	270 x 270
50	340 x 340

## 2.9 BURSTING REINFORCEMENT IN PRESTRESSED CONCRETE STRUCTURES

Bursting reinforcement consists in:

- Surface reinforcement,
- Anchorage bursting reinforcement,
- General reinforcement to balance mechanically the concerned piece within the structure, the dimensions of which result from the design rules of reinforced concrete.

Anchorage bursting reinforcement as defined in annex P results from load transfer testing. If required the local zone reinforcement specified in the ETA may be modified for a specific project design in



accordance with national regulations and relevant approval of the local authorities and of the ETA holder to provide equivalent performance.

## **2.10 STRENGTH OF CONCRETE**

Concrete according to EN 206-1 shall be used. The actual mean compressive strength of concrete measured on cylinders at time of stressing  $f_{cm,o}$  shall be at least 30 MPa.

## **2.11 CLEARANCE BEHIND ANCHORAGES**

Behind each anchorage a clearance must be reserved to allow for:

- Installation of nuts,
- Placing of stressing jack,
- Sufficient protection cover of cable end after cutting-off of bar overlengths,
- Installation of temporary or permanent cap, if necessary.

Table 6: Minimum bar overlength for stressing (mm, from the bearing plate)

Bar diameter	26.5	32	36	40	50
Jack directly connected to the bar	185	190	195	260	260
Jack using a traction tie rod	116	125	145	170	215

For external fixed anchorages a minimal clearance of 200 mm allows the installation of the washer, and nut on the protruding bar.

For special purposes this given clearance might be reduced after consulting the ETA holder.

## **2.12 MEASUREMENT OF FRICTION COEFFICIENT AND LOAD TRANSFER PERCENTAGE FROM STRESSING END TO THE OTHER**

This operation is possible whenever access to both ends is possible.

## **2.13 ADJUSTMENT OF PRESTRESSING LOAD**

In the case of prestressing tendons injected with a flexible filling product, it is possible to adjust the prestressing load at any time during service life if tendon overlengths have been maintained. The overlengths are protected by an adequately long protection cap.

## **2.14 POSSIBILITY OF DETENSIONING**

In the case of prestressing tendons injected with a flexible filling product, it is possible to detension the tendon.

**2.15 TEMPORARY OR PERMANENT CAPS**

Caps are available. Caps can be plastic or steel. If steel, they are protected against corrosion by hot-dip galvanising in accordance with standard EN ISO 1461, or are delivered uncoated and are painted on site.

**2.16 VERIFICATION METHODS**

The assessment of the suitability of the kit for the intended use, in relation to the requirements for mechanical resistance and stability in the sense of the Essential Requirement 1 has been made in compliance with the Guideline for European Technical Approval (ETAG 013) of “Post-Tensioning Kits for Prestressing of Structures”. Performances examined in conformity to the ETAG satisfy the pertinent essential requirements. These are mainly performances related to static load, transfer on concrete and resistance to fatigue. Methods for check, evaluation and assessment of aptitude for use and test procedures conforms those detailed in the ETAG.

**3 CHARACTERISTICS OF COMPONENTS****3.1 BARS**

The thread is a special high quality and of high accuracy thread obtained by cold rolling. Nominal diameters of the ribbed bars are 26.5, 32, 36, 40 and 50mm.

The tendons consist of plain and ribbed high tensile bars complying with prEN 10138-4-Y-1030-H-R and have the following properties:

Diameter mm	26.5	32	36	40	50
Characteristic value of maximum force kN	568	828	1048	1294	2022

**3.2 ANCHORAGES AND COUPLERS**

Anchor plates, nuts, washers and sleeves are defined in the annex I to K

The standard nut and washer of the fixed anchorage can be tack-welded onto the anchor plate at the factory.

**3.3 LUBRICATION, TEMPORARY PROTECTION, CONDITIONING**

Bar anchorages and couplers are delivered slightly oiled.

Temporary protection of tensile elements is obtained by soluble oil. Following products may be used:

- Shell Dromus B Oil,
- Caltex soluble RGBF Oil,
- Mobiloil Solvag 1533 Oil,
- Rustban 310 Oil.

### **3.4 DANGEROUS SUBSTANCES**

The ETA holder declares that no dangerous substances are present in the components of the PT kit.

In addition to the specific clauses relating to dangerous substances contained in the ETA, there may be other requirements, applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In conformity with the provisions of the European directive 89/106/EEC, these requirements must also be complied with wherever they apply.

## **4 EVALUATION OF CONFORMITY AND CE MARKING**

### **4.1 ATTESTATION OF CONFORMITY SYSTEM**

The system of attestation of conformity specified by the European Commission in mandate 98/456/EC is system 1+, with audit testing of samples, described in Council Directive (89/106/EEC) Annex III and is detailed as follows:

a) Tasks for 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 Approved Body:

- (1) Initial type testing of the product.
- (2) Initial inspection of factory and of factory production control (FPC).
- (3) Continuous surveillance, assessment and approval of factory production control (FPC).
- (4) Audit testing of samples.

### **4.2 RESPONSIBILITIES**

#### **4.2.1 Tasks of the Manufacturer**

##### **4.2.1.1. Factory Production Control**

In accordance with ETAG013 clause 8.2.1.2.1, the manufacturer shall implement a quality management system complying with EN ISO 9001: 2000, including a quality plan that addresses the FPC requirements of ETAG013.

The quality plan shall specifically ensure that purchased product conforms to specified purchase requirements. The type and extent of control applied to the supplier and the purchased product shall

be dependent upon the effect of the purchased product on subsequent product realization or the final product.

The manufacturer shall evaluate and select suppliers based on their ability to supply product in accordance with the manufacturer's requirements. Criteria for selection, evaluation and re-evaluation shall be established. Records of the results of evaluations and any necessary actions arising from the evaluation shall be maintained.

In accordance with EN ISO9001: 2000, the manufacturer shall monitor and measure the characteristics of the product to verify that product requirements have been met. This shall be carried out at appropriate stages of the product realization process in accordance with the following test plan (Table 7).

Evidence of conformity with the test plan shall be maintained and shall indicate the person(s) authorizing release of product.

Product release and service delivery shall not proceed until the planned arrangements have been satisfactorily completed.

All records of relevant results concerning the ETA and the audit reports concerning the components manufactures shall be made available for at least 10 years.

Table 7 : Prescribed test plan

Component	Item	Test/ Check	Traceability <sup>3</sup>	Minimum Frequency <sup>2</sup>	Documen-tation
Nut, sleeve	material <sup>5</sup>	Check	full	100%	EN10204:3.1
	detailed dimensions <sup>4</sup>	Test		5% ≥ 5 specimen	Yes
	strength (Hardness test)	Test		0.5% ≥ 2 specimen per batch	Yes
	visual inspection <sup>1</sup>	Check		100 %	No
Plate	material <sup>5</sup>	Check	full	100 %	EN10204:2.2
	detailed dimensions <sup>4</sup>	Test		3% ≥ 2 specimen	Yes
	visual inspection <sup>1</sup>	Check		100 %	No
Steel strip ducts	material <sup>5</sup>	check	"CE"	100 %	"CE"
	visual inspection	check		100 %	no
Smooth steel pipes	material <sup>5</sup>	check	"CE"	100 %	"CE"
	visual inspection	check		100 %	No
Bars tendons	material <sup>5</sup>	check	full	100 %	EN10204:3.1
	diameter	test		Each coil/bundle	No
	visual inspection	check		Each coil/bundle	No
Single tensile element	1 series			Once per year	ETAG 013 E.3

- 1 visual inspection relates to thread gauge testing, correctness of marking or tag, adequate performing, surface aspect, absence of burrs or faults, absence of cavities, corrosion etc. as indicated in the testing plan.
- 2 all samples taken at random and clearly identified
- 3 full: full traceability of each component to its raw material.  
bulk: traceability of each delivery of components to a defined point.
- 4 detailed dimensions mean measuring of all dimensions and angles according to the specification as given in the prescribed test plan
- 5 material checks are included for information only as these are not part of the prescribed test plan.

## 4.2.2 Tasks of Approved Body

### 4.2.2.1 Initial Type-testing of the Product

The results of the tests performed as part of the initial assessment for this European Technical Approval may be used unless there are changes in the manufacturing process or plant. In such cases, the necessary initial type-testing shall be agreed between and UK Certification Authority for Reinforcing Steels and the approved body involved.

### 4.2.2.2 Initial Inspection of Factory and of Factory Production Control

The approved body shall audit the manufacturer's factory production control system including the prescribed test plan (Table 7) to ensure that the PT system complies with this ETA.

#### **4.2.2.3 Continuous Surveillance**

The approved body shall audit the manufacturer's factory production control system including the prescribed test plan (Table 7) at least once a year to ensure that the PT system continues to comply with this ETA. The approved body checks each component producer at least once every five years.

#### **4.2.2.4 Audit Testing of Samples**

The approved body shall select component samples during surveillance audits and check for compliance with the above test plan (Table 7).

#### **4.2.2.5 Certification**

The approved body shall issue a certificate of product conformity as evidence of compliance with this ETA.

### **4.3 CE MARKING**

The CE marking shall be affixed to the delivery note.

The CE mark shall be accompanied by the following information:

- Name or identifying mark of the producer and plant.
- The last two digits of the year in which the marking was affixed.
- The numbers of the certificates of conformity.
- The ETA number.
- The use categories.
- The number of the approved body involved.
- The product identity (commercial name).

## **5 ASSUMPTIONS UNDER WHICH THE FITNESS OF THE PRODUCT(S) FOR THE INTENDED USE WAS FAVOURABLY ASSESSED**

### **5.1 MANUFACTURING**

The Freyssinet Post-tensioning bar system shall be manufactured in accordance with this European Technical Approval and the production shall be covered by a current product conformity certificate in accordance with ETAG013.

### **5.2 INSTALLATION**

The Freyssinet post-tensioning bar system shall be installed by an experienced specialist PT contractor in accordance with the installation instructions (Freyssinet installation manual PB1030 SPA 001) using the ETA holders specified equipment and procedures.

Post-tensioning design shall comply with the recommendations given in this ETA and the anchorage shall be detailed in accordance with the bursting reinforcement requirements given in Annex P of this ETA.

Stressing shall not be undertaken until the minimum specified concrete transfer strength has been achieved.

Components supplied by third parties that are included in this ETA (and not supplied by the ETA holder) shall comply with the requirements of this European Technical Approval.

All necessary information to enable satisfactory installation shall be supplied by the ETA holder with the PT kit.

## **6 RECOMMENDATIONS FOR THE MANUFACTURER.**

### **6.1 RECOMMENDATIONS ON PACKAGING, TRANSPORT AND STORAGE**

The ETA holder shall package the PT kit components to prevent corrosion, chemical change and mechanical damage during transportation to the end user.

The ETA holder shall give instructions for suitable storage on site to prevent corrosion, chemical change and mechanical damage.

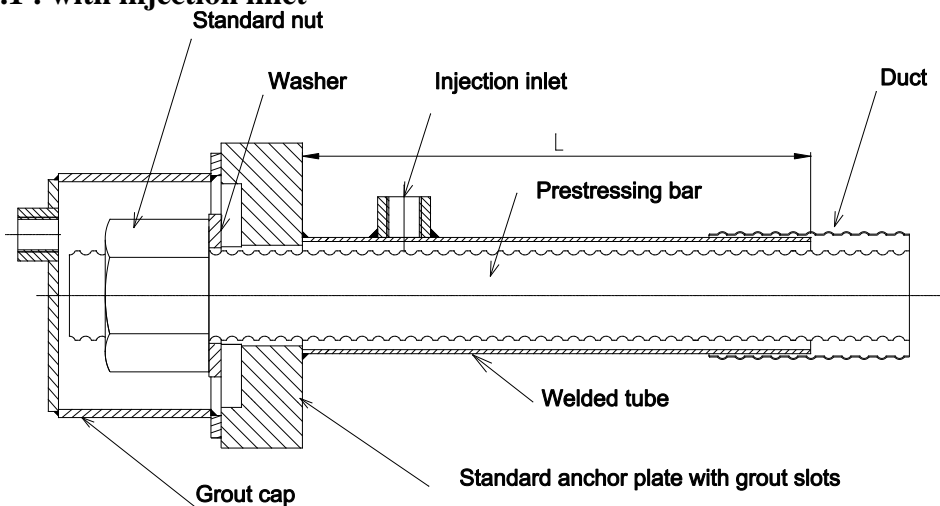
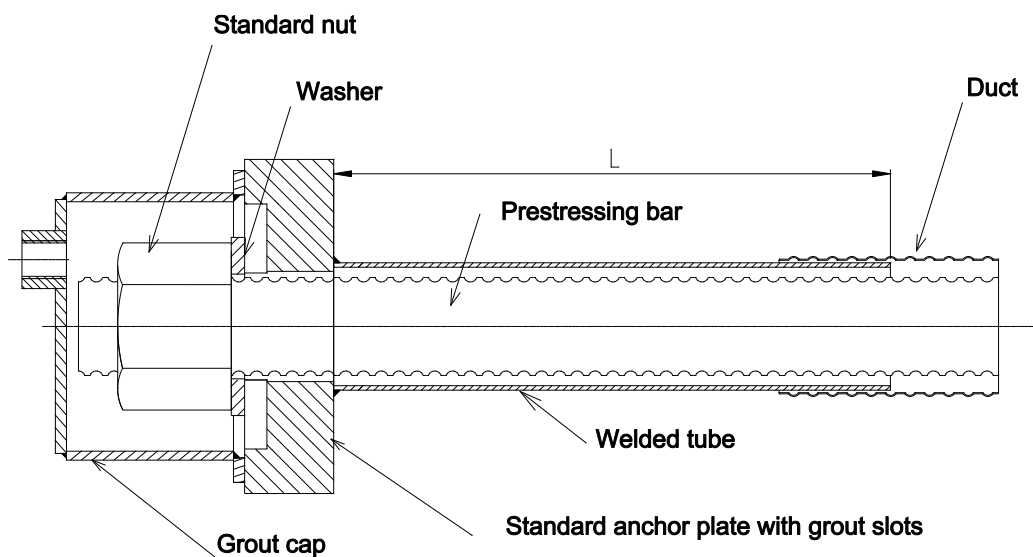
### **6.2 RECOMMENDATIONS ON USE, MAINTENANCE, REPAIR**

The Freyssinet Post-tensioning bar system requires no maintenance provided that it is protected from mechanical damage and corrosion. Protection may also be required against fire damage.

Occasionally, there may be a requirement to reassess the tensile load in a tendon, some time after installation and stressing. Provided that access can be gained to one end, where a nut and bearing plate exist and that the thread beyond the nut is of sufficient length and not corroded, a jack can be reattached and the load in the tendon assessed.

Signed on Behalf of UK CARES

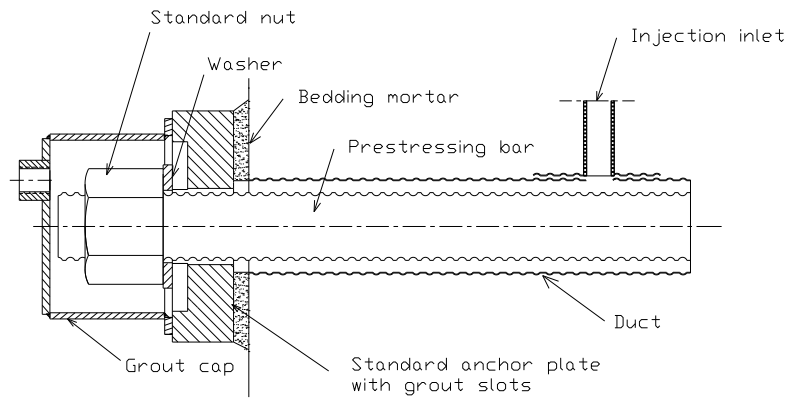


**Diagram A1.1 : with injection inlet****Diagram A1.2: without injection inlet**

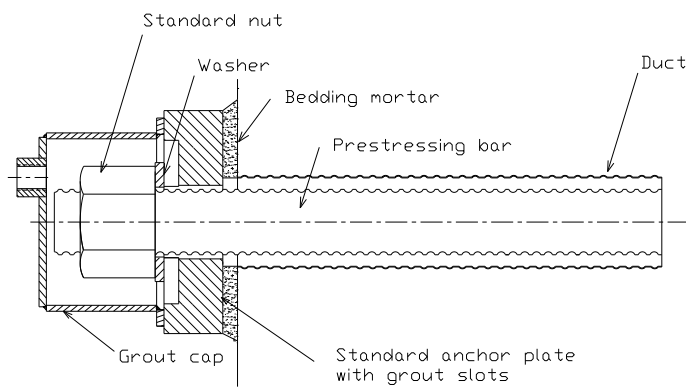
Nominal diameter	$\phi_{\text{tube}}$ (outer diameter)	$E_{\text{tube}}$ (thickness)	L
mm	mm	mm	mm
26.5	42.9	2	200
32	48.5	2	200
36	50.8	2	200
40	57.2	2	250
50	76.2	2	250

	<p>FREYSSINET- PT bar tendon</p> <p><b>Anchor plate installed before concreting</b></p> <p>FIXED &amp; STRESSING ANCHORAGE</p>	Annex A1
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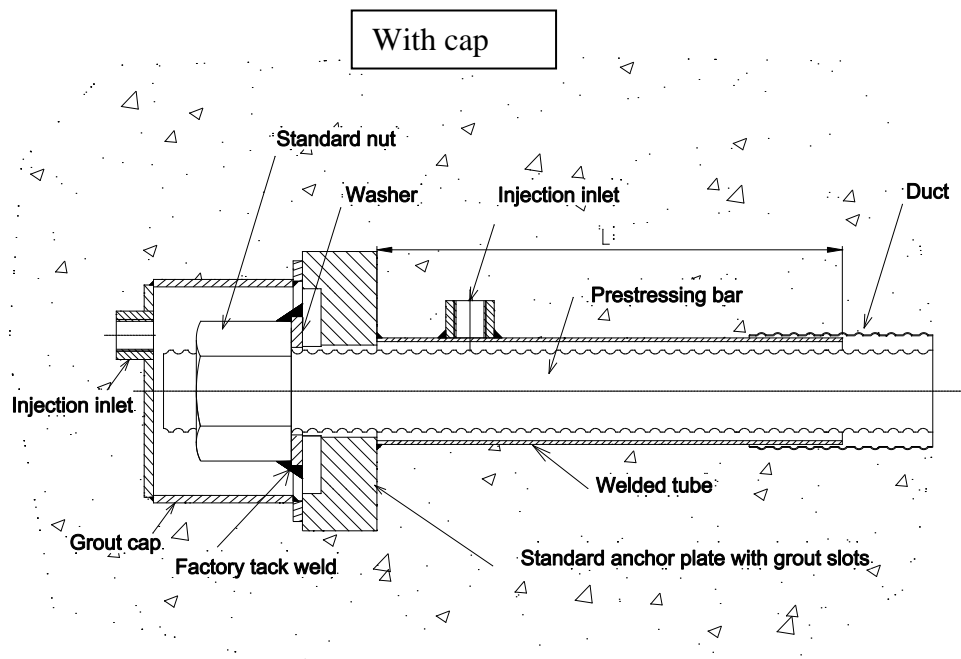
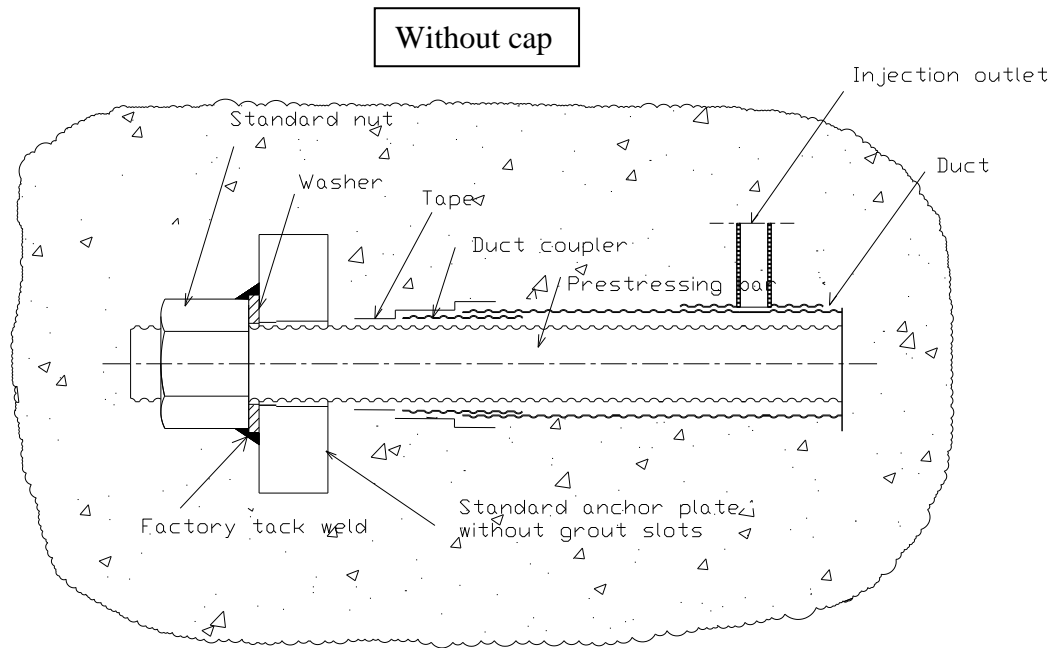
**Diagram A2.1: with injection inlet**



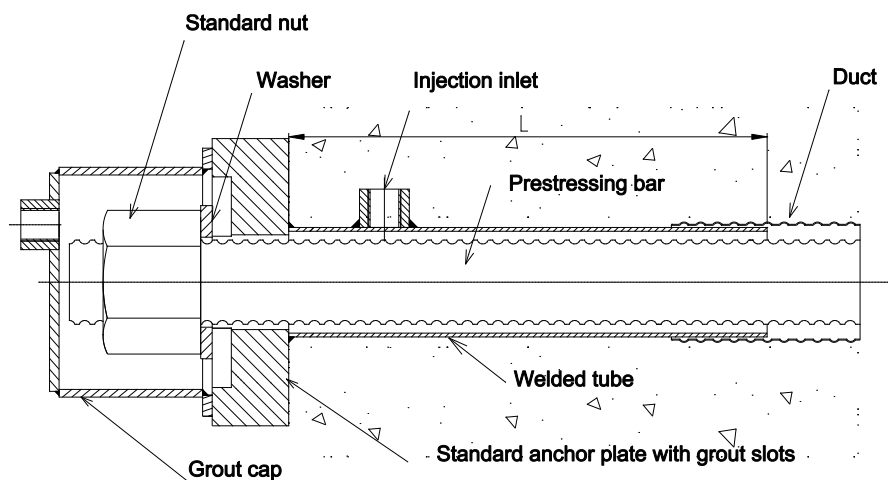
**Diagram A2.1: without injection inlet**



	<p>FREYSSINET- PT bar tendon  <b>Anchor plate installed after concreting</b></p> <p><b>FIXED &amp; STRESSING ANCHORAGE</b></p>	<p><b>Annex A2</b></p>
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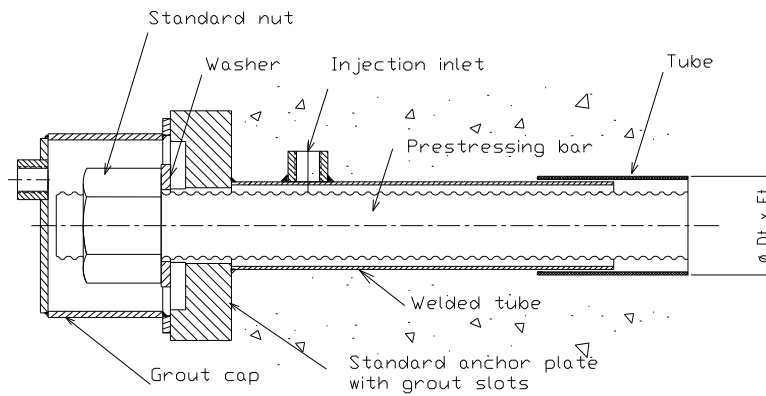


	<p>FREYSSINET- PT bar tendon</p> <p><b>Internal prestressing - Bonded tendon</b></p> <p><b>Cement grout injection</b></p> <p>EMBEDDED FIXED ANCHORAGE</p>	Annex A3
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Nominal diameter	$\phi_{\text{duct}}$ (inner diameter)	$E_{\text{duct}}$ (thickness)	L
mm	mm	mm	mm
26.5	45	0.45	200
32	50	0.45	200
36	55	0.45	200
40	60	0.45	250
50	75	0.50	250

	<p>FREYSSINET- PT bar tendon</p> <p><b>Internal prestressing - Bonded tendon</b></p> <p><b>Cement grout injection</b></p> <p>STANDARD ANCHORAGES</p>	Annex <b>B</b>
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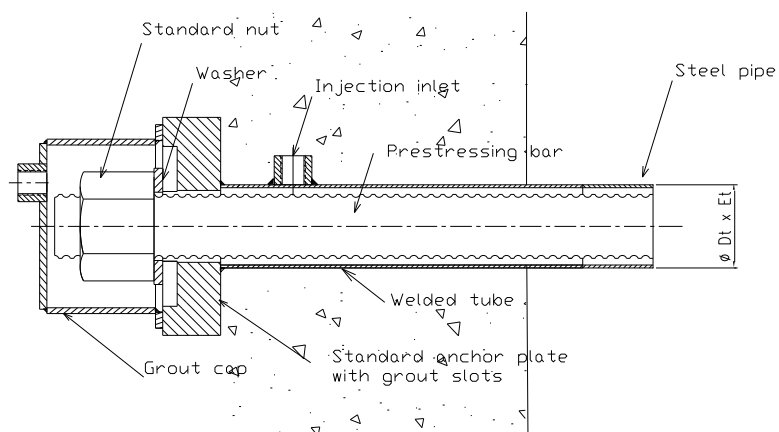
Nominal diameter	$\phi_{\text{tube}}^{**} \times E_{\text{tube}}^{***}$ steel (*)	$\phi_{\text{tube}}^{**} \times E_{\text{tube}}^{***}$ PE tube
mm	mm	mm
26.5	42.9 x 2	63 x 5.8
32	48.5 x 2	63 x 5.8
36	50.8 x 2	75 x 6.8
40	57.2 x 2	75 x 6.8
50	76.2 x 2	90 x 8.2

\* for a steel ducting, tube dimensions are given assuming a butt welding of the pipe to the formwork tube welded to the anchor plate

\*\* outer diameter

\*\*\* thickness

	<p>FREYSSINET- PT bar tendon</p> <p><b>Internal prestressing - Unbonded tendon</b></p> <p><b>grease or wax injection</b></p>	Annex C
	STANDARD ANCHORAGES	



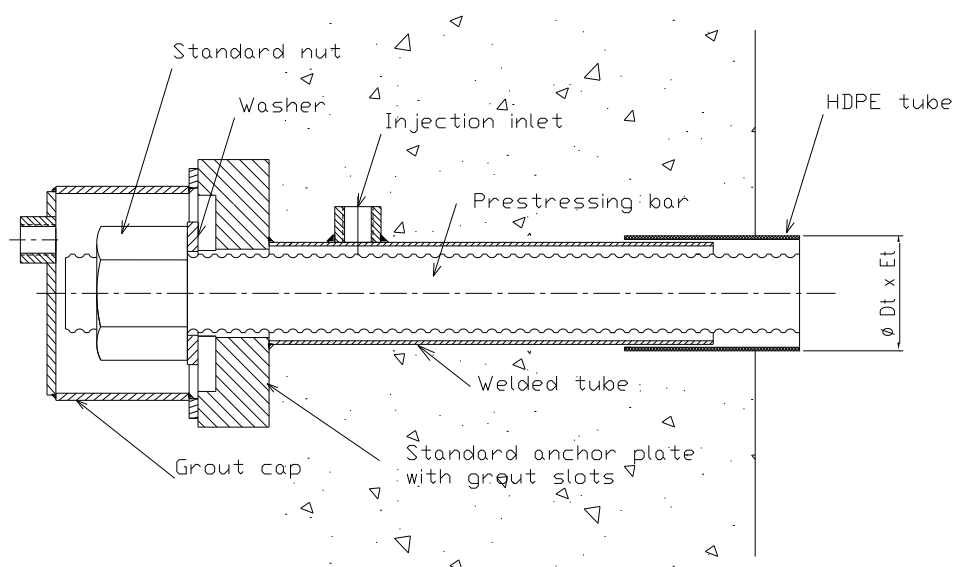
Nominal diameter	$\phi_{\text{tube}}^{**} \times E_{\text{tube}}^{***}$ steel
mm	mm
26.5	42.9 x 2
32	48.5 x 2
36	50.8 x 2
40	57.2 x 2
50	70 x 2

\*\* outer diameter

\*\*\* thickness

	<b>FREYSSINET- PT bar tendon</b> <b>External tendon with steel pipe</b> <b>Cement grout or grease or wax injection</b>	<b>Annex D</b>
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	<b>STANDARD ANCHORAGES</b>	
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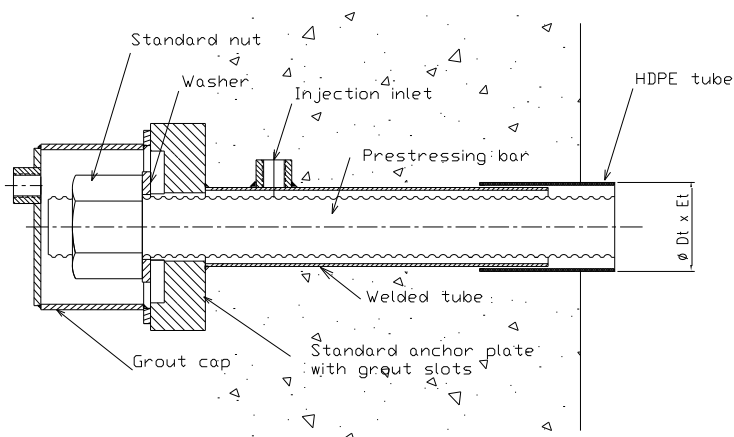


Nominal diameter	$\phi_{\text{tube}}^{**} \times E_{\text{tube}}^{***}$ PE tube
mm	mm
26.5	63 x 3.8
32	63 x 3.8
36	75 x 4.5
40	75 x 4.5
50	90 x 5.4

\*\* outer diameter

\*\*\* thickness

	<b>FREYSSINET- PT bar tendon External tendon with HDPE tube cement or grease injection</b>	<b>Annex E</b>
	<b>STANDARD ANCHORAGES</b>	



Nominal diameter	$\phi_{\text{tube}}^{**} \times E_{\text{tube}}^{***}$ PE tube
mm	mm
26.5	63 x 5.8
32	63 x 5.8
36	75 x 6.8
40	75 x 6.8
50	90 x 8.2

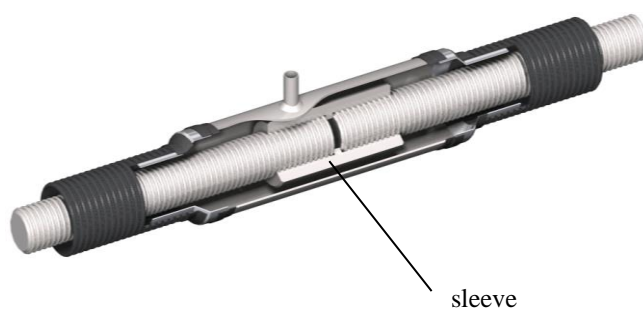
\*\* outer diameter

\*\*\* thickness

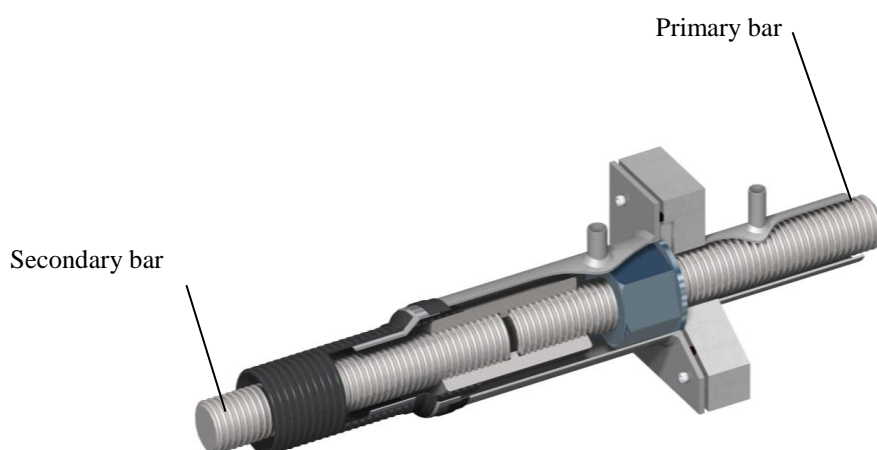
	<p>FREYSSINET- PT bar tendon  <b>External tendon with HDPE tube  wax injection</b></p> <p>STANDARD ANCHORAGES</p>	Annex F
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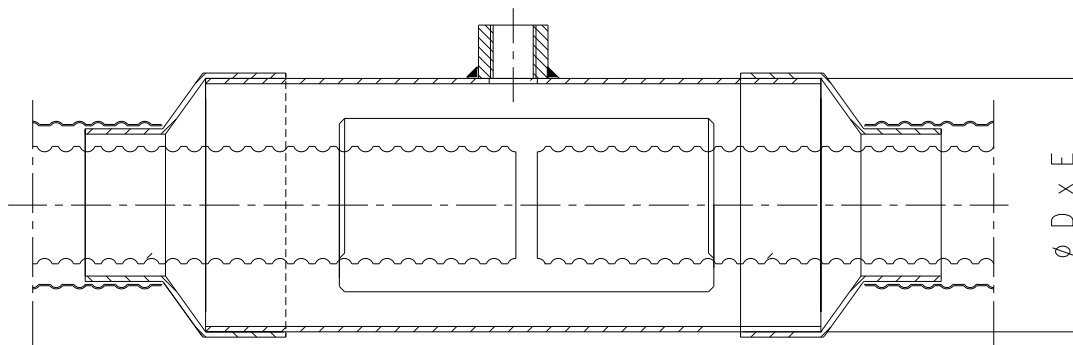
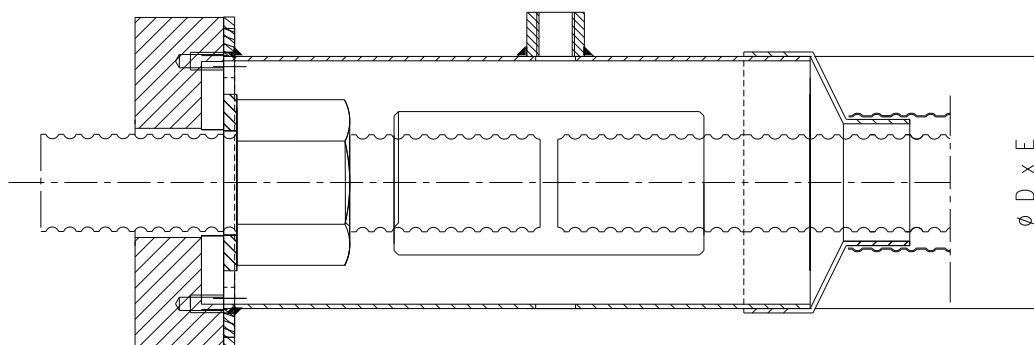
**Diagram G1 : movable coupler**



**Diagram G2 : fixed coupler**



	<p>FREYSSINET- PT bar tendon</p> <p><b>Bonded tendons</b></p> <p>MOVABLE AND FIXED COUPLEURS</p>	<p><b>Annex G</b></p>
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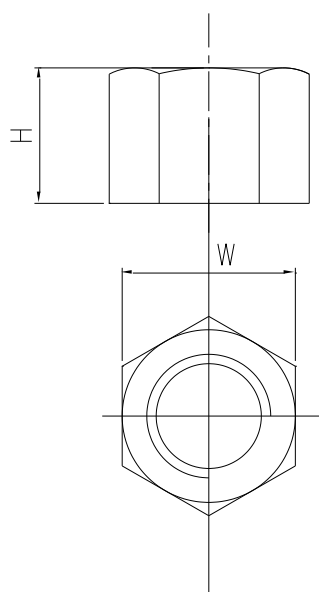
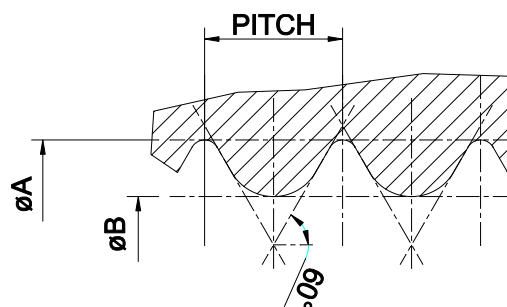
**Diagram G.1: movable coupler****Diagram G.2: fixed coupler**

Nominal diameter	$\phi D^* \times E^{**}$ movable coupler	$\phi D^* \times E^{**}$ Fixed coupler
mm	mm	mm
26.5	70 x 2	88.9 x 2
32	76.2 x 2	88.9 x 2
36	88.9 x 2	101.6 x 2
40	95 x 2	114.3 x 2
50	114.3 x 2	152.4 x 2

\*  $\phi D$  : outer diameter

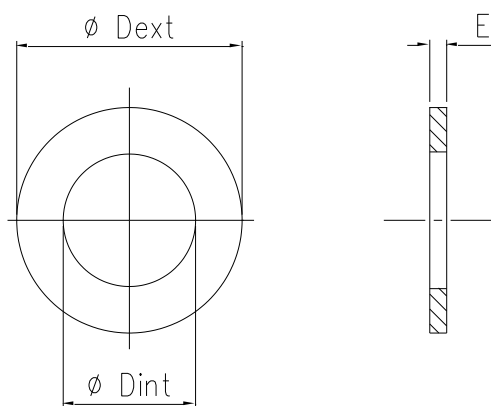
\*\* E : thickness

	<p>FREYSSINET- PT bar tendon</p> <p><b>Bonded tendons</b></p> <p>CAP DIMENSIONS FOR</p> <p>MOVABLE AND FIXED COUPLEURS</p>	Annex <b>H</b>
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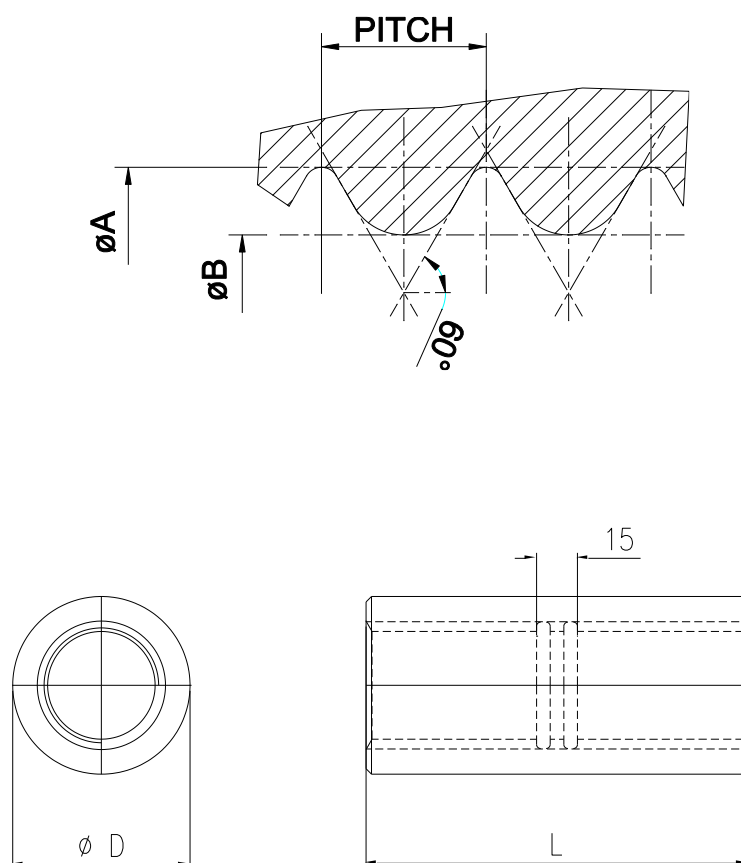
Nominal diameter	W	H	ØA	ØB	PITCH
mm	mm	mm	mm	mm	mm
26.5	50	37	30.8	25.9	6
32	56	41	36.5	31.6	6
36	62	46	40.7	35.8	6
40	65	55	46.2	39.5	8
50	90	71	55.9	49.25	8

	<p>FREYSSINET- PT bar tendon  <b>Bonded, unbonded and external tendons</b></p> <p>ANCHORAGE  NUT</p>	Annex I
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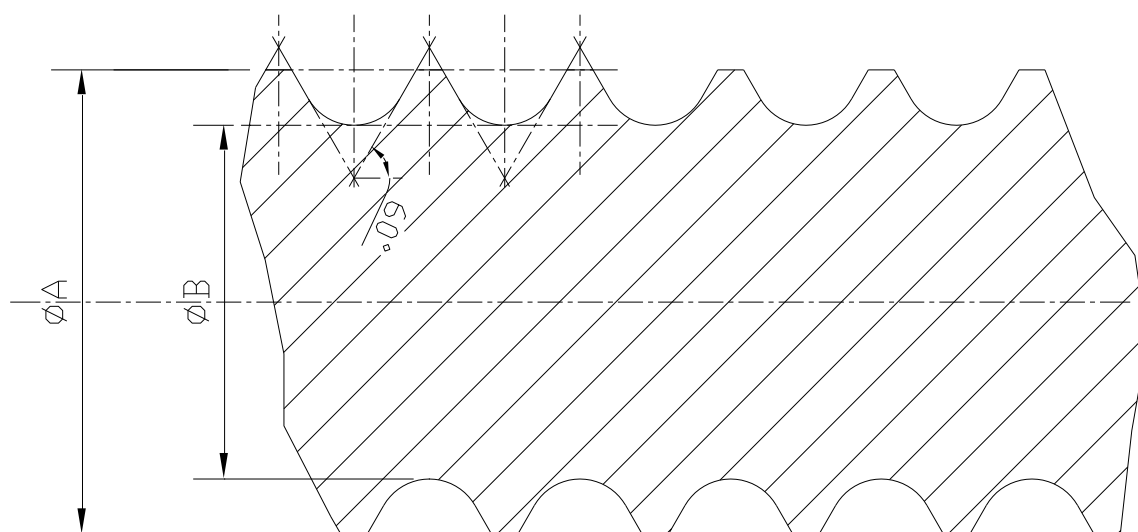
Nominal diameter	E	ø Dext	ø Dint
mm	mm	mm	mm
26.5	6	65	32.5
32	6	70	38.5
36	6	75	42.5
40	6	80	48.5
50	6	105	58

	<p>FREYSSINET- PT bar tendon  <b>Bonded, unbonded and external tendons</b></p> <p>ANCHORAGE  WASHER</p>	Annex <b>J</b>
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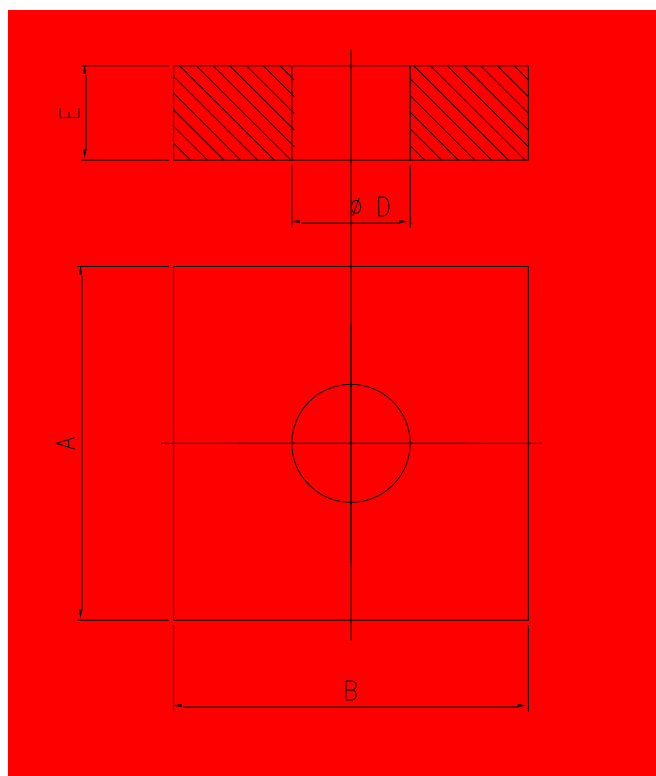
Nominal diameter	$\phi D$	L	$\phi A$	$\phi B$	PITCH
mm	mm	mm	mm	mm	mm
26.5	45	90	30.8	25.9	6
32	50	115	36.5	31.6	6
36	60	130	40.7	35.8	6
40	65	140	46.2	39.5	8
50	76	170	55.9	49.25	8

	<p>FREYSSINET- PT bar tendon  <b>Bonded, unbonded and external tendons</b></p> <p>COUPLING DEVICE  SLEEVE</p>	Annex <b>K</b>
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Nominal diameter	ØA	ØB	PITCH
mm	mm	mm	mm
26.5	28.8	25.2	6
32	34.5	30.8	6
36	38.6	35.0	6
40	43.4	38.6	8
50	53.2	48.2	8

	<p>FREYSSINET- PT bar tendon</p> <p><b>Bonded, unbonded and external tendons</b></p> <p>BAR DIMENSIONS</p>	Annex <b>L</b>
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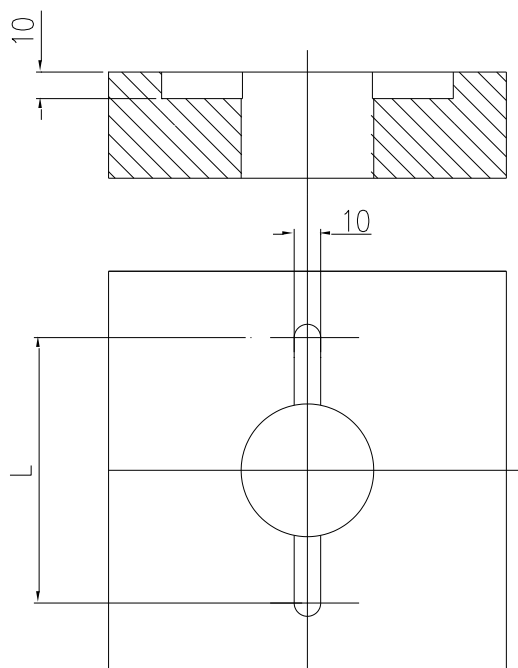
Standard manufactured dimensions

Nominal diameter	A	B	E	$\phi$ D
mm	mm	mm	mm	mm
26.5	125	110	35	34
32	125	125	35	40
36	160	140	40	44
40	160	160	40	50
50	200	200	45	60

Minimum dimensions – Available on special demand

Nominal diameter	A	B	E	$\phi$ D
mm	mm	mm	mm	mm
26.5	110	110	30	34
32	125	125	35	40
36	140	140	40	44
40	160	160	40	50
50	200	200	45	60

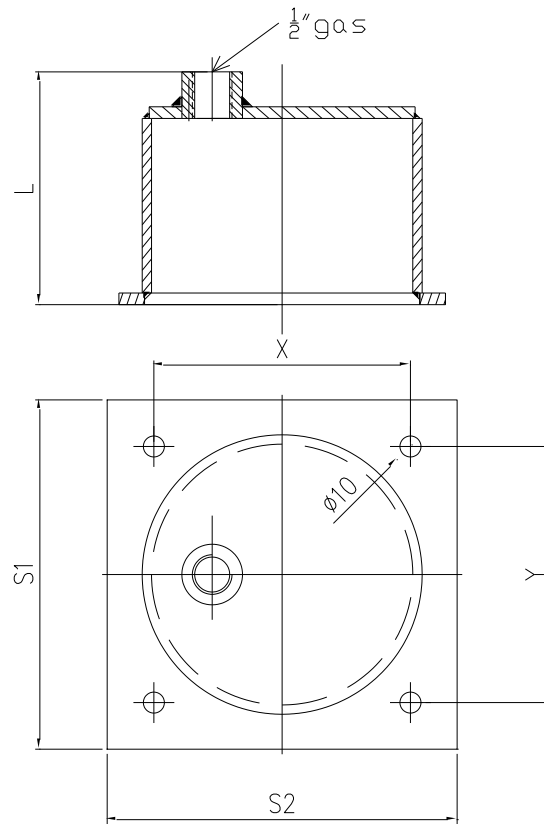
	<p>FREYSSINET- PT bar tendon</p> <p><b>Bonded, unbonded and external tendons</b></p>	Annex <b>M</b>
	ANCHOR PLATE	



Nominal diameter	L
mm	mm
26.5	80
32	85
36	100
40	100
50	130

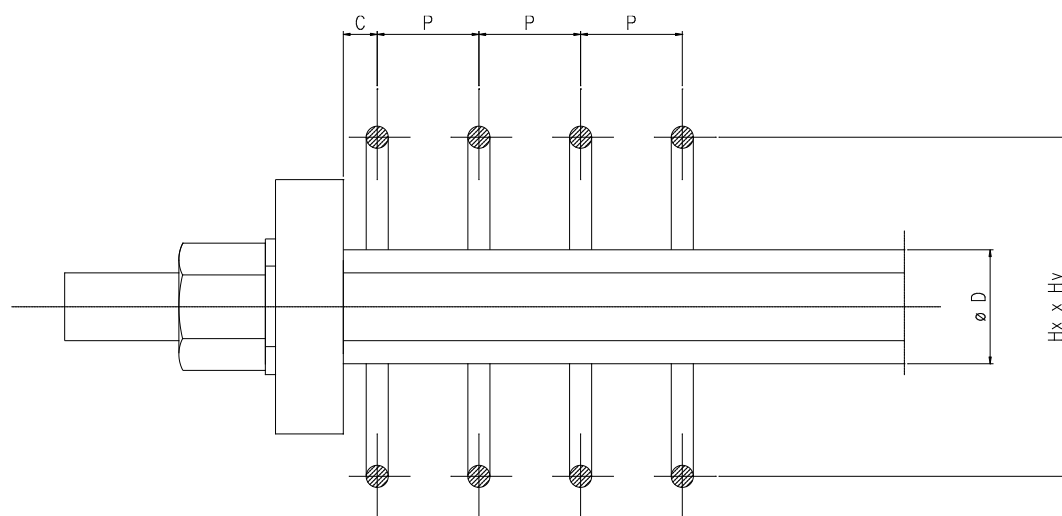
	<p>FREYSSINET- PT bar tendon</p> <p><b>Bonded, unbonded and external tendons</b></p> <p>ANCHOR PLATE WITH GROUT SLOTS</p>	Annex N
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Nominal diameter	S1 x S2	X x Y	L standard	L for keeping stressing overlength
mm	mm	mm	mm	mm
26.5	110 x 110	90 x 90	95	210
32	125 x 125	95 x 95	100	220
36	140 x 140	105 x 105	120	220
40	150 x 150	110 x 110	120	220
50	185 x 185	142 x 142	150	280

	<p>FREYSSINET- PT bar tendon  <b>Bonded, unbonded and external tendons</b></p> <p>PERMANENT CAP</p>	Annex <b>O</b>
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All reinforcement according to EN 10800:2005  
 $f_y = 500 \text{ MPa}$

BURSTING REINFORCEMENT						
Nominal bar diameter	Rebar diameter	Number of frames	C	P	$\phi \text{ Dmax}$	Hx x Hy
(mm)	(mm)		(mm)	(mm)	mm	(mm x mm)
26.5	10	5	20	40	42.9	160 x 160
32	12	4	20	50	48.5	185 x 185
36	12	5	20	50	50.8	210 x 210
40	12	6	20	60	57.2	240 x 240
50	14	6	20	60	70	310 x 310

	FREYSSINET- PT bar tendon Bonded, unbonded and external tendons	Annex <b>P</b>
	BURSTING REINFORCEMENT	