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European Technical Assessment

ETA 10/0107 of 2021-12-16

Technical Assessment Body issuing the ETA:	Cerema Direction technique infrastructures de transport et matériaux
Trade name of the construction product	CCL ‘XF’ & ‘XU’ Multistrand and Monostrand Bonded/Unbonded Systems
Product family to which the construction product belongs	16. Reinforcing and prestressing steel for concrete (and ancillaries). Post tensioning kits.
Manufacturer	CCL Stressing International Ltd Unit 8 Park 2000 Millennium Drive Leeds England LS11 5BP
Manufacturing plant(s)	CCL Stressing Systems Ltd Unit 8 Park 2000 Millennium Drive Leeds England LS11 5BP
This European Technical Assessment contains	46 pages including 26 Annexes (26 pages) which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of	EAD 160004-00-0301, edition September 2016 Post-tensioning systems for prestressing of structures
This ETA replaces (conversion+corrigendum)	ETA 10/0107 v1 issued on 2015-07-02

1. Technical description of the products

1.1. Definition of the product

This European Technical Assessment applies to:

- **CCL 'XF' Multistrand Bonded Flat Slab Post-Tensioning System**

  Consisting of the following components:
  - Tendon: Bonded multistrand tendons with 2-6 tensile elements
  - Tensile Elements: 7-wire prestressing steel strand with nominal tensile strengths of 1770 MPa/1860 MPa and nominal diameters of 12.5 mm / 12.9 mm / 13.0 mm / 15.2 mm / 15.3 mm / 15.7 mm
  - Anchorages: Live End and Dead End anchorages with 2-6 strands
  - Reinforcement: Local anchorage zone reinforcement in Helix or Link layouts
  - Corrosion Protection: Grout and sealing around the anchorage zone & duct

- **CCL 'XU' Monostrand Unbonded Post-Tensioning System**

  Consisting of the following components:
  - Tendon: Unbonded monostrand tendons with single tensile elements
  - Tensile Elements: 7-wire prestressing steel strand with nominal tensile strengths of 1770 MPa/1860 MPa and nominal diameters of 12.5 mm / 12.9 mm / 13.0 mm / 15.2 mm / 15.3 mm / 15.7 mm
  - Anchorages: Live End and Dead End anchorages with single strands
  - Reinforcement: Local anchorage zone reinforcement in Helix or Link layouts
  - Corrosion Protection: Plastic coated strand with sealing around the anchorage zone

1.2. Components and design

1.2.1. Range and Designation of Anchorages

The type of anchorage is designated depending on its function in the structure in the following order:

- The first letters signify the System Type;
- The next numbers signify the size of the Force Transfer Unit;
- The next numbers signify the maximum number of strands in the tendon;
- The next numbers signify the nominal diameter of the strands in the tendon;
- The next letter shows the type of anchorage;
- The optional last letter (only for XF system) signifies whether the system is encapsulated.

Examples:

XF-20-5-12.9-L-E – Encapsulated Live End flat slab anchorage with a size 20 Force Transfer Unit having 5 strands of Ø12.9 mm.

XU-15.2-D – Dead End monostrand anchorage having 1 strand of Ø15.2 mm.

The various types of anchorage are specified in Tables 1, 2 and 3.

Table 1 CCL 'XF' Anchorages for 13 mm Systems

Anchorage	No. of Strands	Strand Ø
XF-10-3-13	3	12.5/12.9/13.0
XF-20-5-13	5	12.5/12.9/13.0
XF-30-6-13	6	12.5/12.9/13.0

Table 2 CCL 'XF' Anchorages for 15 mm Systems

Anchorage	No. of Strands	Strand Ø
XF-10-2-15	2	15.2/15.3/15.7
XF-20-4-15	4	15.2/15.3/15.7
XF-30-5-15	5	15.2/15.3/15.7

Table 3 CCL 'XU' Anchorages

Anchorage	No. of Strands	Strand Ø
XU-13	1	12.5/12.9/13.0
XU-15	1	15.2/15.3/15.7

1.2.1.1 XF Live End Anchorages

CCL 'XF' Live End (LE) Anchorages are rectangular in section multistrand anchorages shown in Annex 02. The anchorage comprises:

- Steel Wedges
- SG Iron or Cast Steel Anchor Head (AH)
- Cast Iron Force Transfer Unit (FTU)
- Plastic Deviation Cone (DC)

The strands of the anchorage are singularly stressed by a Jack bearing on the AH by means of a stressing nose (SN).

The prestressing force is applied to the strands and locked in place by the wedges into the AH which is supported on the FTU cast into the concrete. This FTU ensures the transmission of the prestressing force into the concrete.

The FTU and the DC ensure the correct deviation of the strands from the AH to the Duct.

LE anchorages can be used as Active or Passive anchorages.

1.2.1.2 XU Live End Anchorages

CCL 'XU' Live End (LE) Anchorages are circular/rectangular in section monostrand anchorages shown in Annex 13. The anchorage comprises:

- Steel Wedges
- SG Iron Force Transfer Unit (FTU)
- Plastic Concrete Excluder (CE)
- Plastic Sealing Cap (SC)

The strands of the anchorage are singularly stressed by a Jack bearing on the FTU by means of a stressing nose (SN).

The prestressing force is applied to the strands and locked in place by the wedges into the FTU which is cast into the concrete. This FTU ensures the transmission of the prestressing force into the concrete.

There is no deviation of the strands from the FTU.

LE anchorages can be used as Active or Passive anchorages.

1.2.1.3 **CCL ‘XF’ Encapsulated Live End Anchorages**

CCL ‘XF’ Encapsulated Live End (ELE) Anchorages are rectangular in section multistrand anchorages shown in Annex 03. The anchorage comprises:

- Steel Wedges
- SG Iron or Cast Steel Anchor Head (AH)
- Cast Iron Force Transfer Unit (FTU)
- Plastic Deviation Cone (DC)
- Plastic Sealing Cap (SC)
- Connecting Accessories

The strands of the anchorage are singularly stressed by a Jack bearing on the AH by means of a stressing nose (SN).

The prestressing force is applied to the strands and locked in place by the wedges into the AH which is supported on the FTU cast into the concrete. This FTU ensures the transmission of the prestressing force into the concrete.

The FTU and the DC ensure the correct deviation of the strands from the AH to the Duct.

LE anchorages can be used as Active or Passive anchorages.

1.2.1.4 **XU Dead End Anchorages**

CCL ‘XU’ Dead End (DE) Anchorages are circular/rectangular in section monostrand anchorages shown in Annex 14. The anchorage comprises:

- Steel Wedges
- SG Iron Force Transfer Unit (FTU)
- Plastic Concrete Excluder (CE)
- Plastic Sealing Cap (SC) and Spring

The wedges are locked in place with a spring which is held in place by the SC while the prestressing force is applied to the opposite (live) end of the tendon. The prestressing force in the strands is locked by the wedges into the FTU which is cast into the concrete. This FTU ensures the transmission of the prestressing force to the concrete.

There is no deviation of the strands from the FTU.

DE anchorages can be used as buried passive anchorages. It is recommended in this case the wedges are preloaded onto the strand to ensure correct and efficient seating after concreting.

1.2.2. Anchorage Components

1.2.2.1 **Wedges Type ‘X’**

CCL Type ‘X’ wedges are manufactured from a suitable case-hardening steel to European Standard EN 10084.

The wedges are machined from bar stock according to the dimensions provided in Annex 08. Wedges are roll marked on their cylindrical face for identification purposes.
The wedges are then heat treated to a specific process to obtain the necessary hardness and ductility.

1.2.2.2 **XF Anchor Heads**

CCL ‘XF’ AHs are manufactured from a suitable SG cast iron to European Standard EN 1563 or Cast Steel to European Standard EN 10293.

The AHs are cast according to the dimensions provided in Annex 05. The AHs are marked with the CCL Logo, Part Number and Traceability Reference for identification purposes.

1.2.2.3 XF Force Transfer Units

CCL 'XF' FTUs are manufactured from a suitable cast iron to European Standard EN 1561.

The FTUs are cast as per the dimensions provided in Annex 04; then holes tapped for connection of the FTU to the Slab Shuttering. FTUs are marked with the CCL Logo, Part Number and Traceability Reference for identification purposes.

CCL 'XF' FTUs have a Rectangular bearing face (which supports the Rectangular face of the AH) and multiple surfaces of load transfer for transmission of prestressing force from the tendon to the reinforced concrete that surrounds them. Filling material entry is through a tapered hole in the upper section of the casting body. Venting may also take place through this connection when required. The opposite end of the casting is internally slotted for connection of the DC.

1.2.2.4 XU Force Transfer Units

CCL 'XU' FTUs are manufactured from a suitable SG cast iron to European Standard EN 1563.

The FTUs are cast according to the dimensions provided in Annex 15. The FTUs are marked with the CCL Logo, Part Number and Traceability Reference for identification purposes.

1.2.2.5 Deviation Cones, 'XF' Sealing Caps and Ducts

CCL 'XF' DCs are moulded plastic cones slotted into CCL 'XF' FTU's. For Encapsulated tendons, the joint between the FTU and DC is sealed using a heat shrink sleeve. These cones provide the deviation point for the strands in the tendon. The duct is connected to the DC via location lugs on the cone.

CCL 'XF' SCs are moulded plastic caps fitted with a Gasket to CCL 'XF' FTUs. These caps completely encapsulate the anchor head and provide an air-tight seal.

DCs and 'XF' SCs can be manufactured from HDPE or Polypropylene according to the dimensions provided in Annexes 06 and 07 and supplied in any colour. The DCs and 'XF' SCs are marked with the CCL Logo, Part Number and Traceability Reference for identification purposes.

Ducts used with the DC of the present ETA should comply with the following standards:

- Metal ducts – EN 523
- Plastic ducts for internal tendons – EAD 160004-00-0301

Bond length of the plastic ducts shall be at least 40 ducts transverse diameters.

1.2.2.6 XU Spring Retaining Caps

CCL 'XU' SCs are manufactured from plastic to the dimensions provided in Annex 16 and have lugs to lock into the FTU's.

1.2.2.7 Bursting Reinforcement

Bursting reinforcement material designation is in accordance with European Standard EN 10080:2005 with characteristic yield strength (f_{yk}) 500 MPa. For each unit of the CCL 'XF' and 'XU' PT System two types of reinforcement can be employed:

- Links
- Helices

The minimum bursting reinforcement dimensions are shown in Annexes 10, 12, 19 and 21.

As the bursting reinforcement cannot compensate for a local defect of filling of the concrete behind the anchorage, the designer of the structure will have to ensure that the density and the distribution of the reinforcement in the vicinity of the anchorages allows pouring and adequate compaction of the concrete whilst maintaining containment of the bursting forces.

If stated in the ETA, the local zone reinforcement specified in the ETA and confirmed in the load transfer test, may be modified for a specific project design if required in accordance with regulations at the place of use and relevant approval of the local authority and of the ETA holder to provide equivalent performance.

The local anchorage zone bursting reinforcement design rules for the CCL 'XF' and 'XU' PT System are based on a modified version of the equation proposed by Roberts[1].

1.2.3. Tendons

1.2.3.1 Standard Notation

Table 4 lists the standard notation and its intended meaning used within this ETA.

Table 4 Standard Notation

Notation	Definition
d	Nominal Diameter of an individual strand / mm
f_{pk}	Characteristic Tensile Strength of the strand / MPa
n	Number of individual strands in the tendon
A_p	Nominal Cross-Sectional Area of the tendon / mm^2
A_s	Nominal Cross-Sectional Area of an individual strand / mm^2
F_{pk}	Characteristic Ultimate Resisting Force of the tendon / kN ($F_{pk} = A_p$ x f_{pk})
$F_{p0.1k}$	Characteristic 0.1 % Proof Force of the tendon / kN ($F_{p0.1k} = A_p$ x $f_{p0.1k}$)
F_{pks}	Characteristic Ultimate Resisting Force of an individual strand / kN ($F_{pks} = A_s$ x f_{pk})
$F_{p0.1ks}$	Characteristic 0.1 % Proof Force of an individual strand / kN
F_0	Min ($k_1 F_{pk}$; $k_2 F_{p0.1k}$) / kN
F_{0s}	Min ($k_1 F_{pks}$; $k_2 F_{p0.1ks}$) / kN
M_p	Nominal Mass per Metre of the tendon / kg/m
M_s	Nominal Mass per Metre of an individual strand / g/m

The maximum allowable stressing force that can be applied to the tendon immediately prior to lock-off must be determined in accordance with EN 1992-1.1, with values given in the relevant national annex for k_1 and k_2. Values given in the tables below are indicative values respecting recommended values by EN 1992-1.1 for k_1 and k_2. Overstressing is permitted if the force in the jack can be measured to an accuracy of ± 5 % of the final value of the prestressing force. In such cases the maximum prestressing force P_{max} may be increased to $k_3 F_{p0,1ks}$ with $k_3 = 0.95$.

1.2.3.2 Strand Designation

Strand designation is in accordance with European Standard White Draft prEN 10138-3:2006 "Prestressing Steels - Part 3: Strand". For example, prestressing steel strand with a nominal tensile strength of 1860 MPa, 7 wires and a nominal diameter of 15.7 mm is designated as "EN10138-3-

[1] Roberts C. , Behavior and Design of the Local Anchorage Zone in Post-Tensioned Concrete. M.S. Thesis, University of Texas at Austin, May 1990

Y1860S7-15.7". Prestressing steel strand with a nominal tensile strength of 1770 MPa, 7 wires and a nominal diameter of 12.9 mm is designated as "EN10138-3-Y1770S7-12.9". In the interest of simplicity and for the purpose of this document, the various classes of strand will be referred to as Y(nominal tensile strength)-(nominal diameter), e.g. Y1770-15.2, as the standard prEN 10138-3:2006 and number of wires in the strand remain constant.

1.2.3.3 Strand Characteristics

The tendons consist of 1-6 7-wire prestressing steel strands, factory-provided with a corrosion protection system with characteristics in accordance with prEN 10138-3:2006. Some typical characteristics are provided in Table 5 and Annex 01. For details of sheath thickness for strands used with the CCL 'XU' system refer to FIP Report "Corrosion protection of prestressing steels: 1996" - section 2.2.3.

In the absence of European standards for prestressing steel, strands complying with national provisions and with the characteristics given in Table 5 and Annex 01 shall be used.

Table 5 Strand Characteristics

Designation	d mm	A_s mm²	M_s g/m	f_{pk} MPa	F_{pks} kN	$F_{p0.1ks}$ kN	F_{0s} kN
Y1770-12.5	12.5	93	726	1770	165	145	131
Y1860-12.5	12.5	93	726	1860	173	152	137
Y1770-12.9	12.9	100	781	1770	177	156	140
Y1860-12.9	12.9	100	781	1860	186	164	148
Y1860-13.0	13.0	102	797	1860	190	167	150
Y1770-15.2	15.2	139	1086	1770	246	216	194
Y1860-15.2	15.2	139	1086	1860	259	228	205
Y1770-15.3	15.3	140	1093	1770	248	218	196
Y1860-15.3	15.3	140	1093	1860	260	229	206
Y1770-15.7	15.7	150	1172	1770	266	234	211
Y1860-15.7	15.7	150	1172	1860	279	246	221

1.2.3.4 Prestressing Forces

Tables 6 to 11 list the maximum allowable prestressing forces for all tendons specified in this ETA as a guide only in accordance with Eurocode 2, 5.10.2.1. For certain countries where national provisions are more restrictive, lower prestressing forces than specified below shall be applied. Allowable prestressing forces must be checked against relevant local standards.

Table 6 Maximum Allowable Stressing Force of Tendons with Ø12.5 mm Strand

				Y1770-12.5		Y1860-12.5	
Anchorage	N	A_p mm²	M_p kg/m	F_{pk} kN	F_0 kN	F_{pk} kN	F_0 kN
XU-13	1	93	0.73	165	131	173	137
XF-10	3	279	2.18	494	392	519	410
XF-20	5	465	3.63	823	653	865	684
XF-30	6	558	4.36	988	783	1038	821

Table 7 Maximum Allowable Stressing Force of Tendons with Ø12.9 mm Strand

Anchorage	N	A_p mm²	M_p kg/m	Y1770-12.9 F_{pk} kN	Y1770-12.9 F_0 kN	Y1860-12.9 F_{pk} kN	Y1860-12.9 F_0 kN
XU-13	1	100	0.78	177	140	186	148
XF-10	3	300	2.34	531	421	558	443
XF-20	5	500	3.91	885	702	930	738
XF-30	6	600	4.69	1062	842	1116	886

Table 8 Maximum Allowable Stressing Force of Tendons with Ø13.0 mm Strand

Anchorage	n	A_p mm²	M_p kg/m	Y1860-13.0 F_{pk} kN	Y1860-13.0 F_0 kN
XU-13	1	102	0.80	190	150
XF-10	3	306	2.39	569	451
XF-20	5	510	3.98	949	752
XF-30	6	612	4.78	1138	902

Table 9 Maximum Allowable Stressing Force of Tendons with Ø15.2 mm Strand

Anchorage	N	A_p mm²	M_p kg/m	Y1770-15.2 F_{pk} kN	Y1770-15.2 F_0 kN	Y1860-15.2 F_{pk} kN	Y1860-15.2 F_0 kN
XU-15	1	139	1.09	246	194	259	205
XF-10	2	278	2.17	492	389	517	410
XF-20	4	556	4.34	984	778	1034	821
XF-30	5	695	5.43	1230	972	1293	1026

Table 10 Maximum Allowable Stressing Force of Tendons with Ø15.3 mm Strand

Anchorage	N	A_p mm²	M_p kg/m	Y1770-15.3 F_{pk} kN	Y1770-15.3 F_0 kN	Y1860-15.3 F_{pk} kN	Y1860-15.3 F_0 kN
XU-15	1	140	1.09	248	196	260	206
XF-10	2	280	2.19	496	392	521	412
XF-20	4	560	4.37	991	785	1042	824
XF-30	5	700	5.47	1239	981	1302	1031

Table 11 Maximum Allowable Stressing Force of Tendons with Ø15.7 mm Strand

Anchorage	N	A_p mm²	M_p kg/m	Y1770-15.7 F_{pk} kN	Y1770-15.7 F_0 kN	Y1860-15.7 F_{pk} kN	Y1860-15.7 F_0 KN
XU-15	1	150	1.17	266	211	279	221
XF-10	2	300	2.34	531	421	558	443
XF-20	4	600	4.69	1062	842	1116	886
XF-30	5	750	5.86	1328	1053	1395	1107

1.2.4. CCL Stressing Jacks

The CCL Jacks used for the CCL 'XF' and 'XU' System have the following features:

- Automatic gripping of the wedges on the strands.
- Single strand stressing of strands of the tendon.
- Swivel Noses to suit the anchorage
- Partial stressing of the tendons with later recovery up to the final values of the prestressing force, overlapping wedge bites to the strand must be avoided.
- The stressing by successive loadings of the Jack when the final extension is greater than the full extension of the CCL Jack.

Other different Jacks may be used by the CCL Specialist PT Distribution/Licence Company, provided their suitability to the CCL 'XF' and 'XU' Anchorage are approved by CCL before use.

Manuals and procedures are available for each CCL Stressing Jack from CCL or the CCL website.

Various dimensions and characteristics of CCL Stressing Jacks are given in Annexes 22 and 23. CCL Jacks are marked with their Serial Numbers for identification purposes.

Different Jack noses are required for each system type as table 12.

Table 12 Jacks identification codes for relevant anchorages

Jack	XU13	*XU15*	XF13	*XF15*
160kN Jack Short Stroke (Including Nose Assembly Plunger)	106420	-	106421	-
160kN Jack Long Stroke (Including Nose Assembly Plunger)	106430	-	106431	-
300kN Jack Short Stroke (Including Nose Assembly Plunger)	-	107420	-	107421
300kN Jack Long Stroke (Including Nose Assembly Plunger)	-	107430	-	107431
250kN PT Jack (Including Nose Assembly Plunger)	103026	103029	103020	103023

1.2.5. Friction Losses

With Post-Tensioned steel the effect of friction may be the single greatest factor causing loss of prestress. There are three main causes of friction loss in the Post-Tensioned tendon:

- Friction due to the deviation of the tendon through the anchorage.
- Friction between the tendon and the duct due to unintentional lack of alignment (or wobble) of the duct.
- Friction due to the curvature of the duct.

Friction Loss in CCL 'XF' anchorages determined from testing is 2-3 %.

Friction Loss in CCL 'XU' anchorages determined from testing is 0 %.

Friction Loss in the duct for Post-Tensioned tendons can be estimated from:

$$\Delta P_{\mu}(x) = P_{max}(1 - e^{-\mu(\theta + kx)})$$

Where:

$\Delta P_{\mu}(x)$ = losses due to friction
$P_{\max}$ = force at the active end during tensioning
θ = sum of the angular displacements over a distance x (irrespective of direction or sign)
μ = coefficient of friction between the tendon and its duct
k = unintentional angular displacement (radian per unit length)
x = distance along the tendon from the point where the prestressing force is equal to $P_{\max}$

The values for the coefficient of friction, μ, and unintentional angular displacement, k, should be in line with EN 1992 Eurocode 2: Design of Concrete Structures and previous experience from site measurements, as shown in Table 13. Values for the coefficient of friction may differ in local codes and can change due to the condition of strand and duct. The user should check local codes for compliance.

Table 13 Coefficients of Friction and Unintentional Angular Displacement

Application	Duct Type	μ		k	
		Non Lubricated	Lubricated	Minimum	Maximum
Bonded Prestressing	Corrugated Metal	0.19	0.17	0.005	0.01
	HDPE	0.15	0.13	0.0013	0.0033
	Smooth Metal	0.20	0.10	0.005	0.01
Unbonded Prestressing	HDPE Sheathing	0.07 to 0.10		0.010	0.025

When the tendon to be controlled has 2 Active/LE anchorages, i.e. with the tendon being able to be stressed with the Jack at both ends, the measurement on site of the friction loss of the tendon is possible by comparing the load applied by one Jack to the load measured on the other Jack.

1.2.6. Anchorage Wedge Set

CCL 'X' Range Jacks are equipped with a hydraulic lock-off system ensuring even seating of the wedges in the AH before removal of the Jack. After the transfer of load from the Jack to the anchorage, the strand and wedges draw a little further into the AH. This further movement is known as wedge set. The wedge set leads to a loss of tension in the strand, which must be taken into account in the load loss/elongation calculations.

The values for wedge set to be used in the calculations for all tendons are:

For active anchorages with Jacks with hydraulic lock-off:

- Wedge Set, g = 6 mm ± 2 mm

For active anchorages with Jacks without hydraulic lock-off:

- Wedge Set, g = 8 mm ± 2 mm

For passive anchorages with spring-loaded retaining plates:

- Wedge Set, g = 8 mm ± 2 mm

1.2.7. Tendon Elongation

The force in the tendon during stressing is measured with a hydraulic pressure gauge. Elastic elongation of the tendon can also be used to monitor this force. The designer specifies an expected elongation (including acceptable tolerance). The following formula can be used to estimate the elongation:

$$\delta = \frac{PL_t}{(A_p E_p)}$$

Where:

δ = elongation of the tendon

P = average force in a tendon

L_t = tendon length between anchorages

A_p = nominal cross-sectional area of a tendon

E_p = modulus of elasticity of the tendon steel

Flat duct multistrand and monostrand tendons usually have very little slack in the system before stressing and therefore should not require an initial stressing operation to provide a reference zero point against which to measure extensions.

1.2.8. Spacing of the Supports

For tendons in steel ducts, the maximum spacing of the supports will be 1.0 m for straight sections or sections with large radius of curvature, or 0.5 m for sections with small radius of curvature. For tendons in plastic ducts, the maximum spacing of the supports will be 0.75 m for straight sections or sections with large radius of curvature, or 0.5 m for sections with small radius of curvature. For tendons in smooth steel tubes, spacing could be increased according to the rigidity of the tube and its slope, but cannot exceed 3.0 m.

The supports carrying the ducting should be sufficiently strong to carry the weight of the duct and the strands passing through it when threaded prior to concreting, as well as the forces occurring during and after concreting, including compaction of the concrete.

1.2.9. Radius of Curvature

Generally radius of curvature depend on duct type; minimum radius of curvature must comply with national regulations.

1.2.10. Compressive Strength of Concrete

The mean compressive strength of concrete at which full prestressing is permitted, $f_{cm,0}$, specified by the designer of the structure must be greater than or equal to 25 MPa cube strength. In the case of partial stressing of a standard anchorage to 50 % of F_{pk}, the minimum mean compressive strength of concrete could be reduced by 30 %.

1.2.11. Anchorage Spacing and Concrete Cover

Taking into account the tested values of mean compressive concrete strength, $f_{cm,0}$, (25 MPa and 45 MPa cube strength for XF system and 25 MPa for XU system); the test specimen side lengths of the end block (*a* and *b*) are provided in Annexes 09 and 11 for three levels of mean compressive concrete strength, Annexes 18 and 20 for one level of mean compressive concrete strength.

For XF system, values of $f_{cm,0}$ between 25 MPa and 45 MPa cube strength, a and b can be determined by straight line interpolation, as is the case for values quoted for $f_{cm,0}$ on cube = 35 MPa.

The minimum concrete cover from the reinforcement to the edge of the structure, c_{min}, should be established according to EN 1992 Eurocode 2: Design of Concrete Structures and must be taken into account when determining the minimum distances from the axis of an anchorage to the edge of the structure (e_x and e_y).

Given the test specimen side lengths *a* and *b*, the minimum distances between two axes of anchorages (*x* and *y*) result from the following formulae:

- $A_c = x\,.\,y \geq a\,.\,b$
- $x \geq 0.85\;a$
- $y \geq 0.85\;b$
- $e_x = \frac{x}{2} - 10\text{ mm} + c_{min}$
- $e_y = \frac{y}{2} - 10\text{ mm} + c_{min}$

Note:
The reduction in the centre spacing of tendon anchorages shall not be less than the outside dimensions of the reinforcement.

1.3. Installation

The CCL 'XF' and 'XU' anchorages are fit for use in suitably designed structures. The designer of the structure is assumed to respect the relevant specifications set by applicable standards and to adapt their design in accordance with these standards and the advice of the ETA holder.

1.3.1. 'XF' Installation

1.3.1.1 **Anchorages**

The void (pocket) former and FTU are fixed to the formwork, then the DC is slotted into the FTU and sealed, in the case of the encapsulated system, the joint between the FTU and DC is sealed using a heat shrink sleeve. The local bursting reinforcement is attached with the general reinforcement.

The ducting is connected, and the sealing of the connection between the duct and the anchorage is carried out, either by an adhesive sealing tape, or by a heat-shrink sleeve, in the case of the encapsulated system, a heat-shrink sleeve is used at each duct connection.

The void former provides sufficient room for the installation of the AH, wedges, sealing cap and jacking operations. Once the jacking process is completed for non-encapsulated anchorages, the excess strand is cut, the exposed anchorage components painted and the void filled with a dry mixture of sand and cement grout. For encapsulated anchorages, the excess strand is cut and the sealing cap / gasket fitted to the FTU.

Setting out dimensions of the anchorage and space reserved behind each anchorage are to be checked before concreting.

The taper holes (conical drills) of the AHs shall be clean and corrosion free.

AHs and wedges are assembled immediately prior to stressing of the tendon in order to avoid corrosion.

Active Anchorages

Sufficient space must be reserved behind the anchorage for the installation and operation of the stressing Jack.

Stressing must only be carried out when the concrete has cured to the required minimum compressive strength.

The cut length of the strands, calculated from exposed face of the FTU must be sufficient to allow installation of the AH and wedges, the threading of the stressing Jack and insertion of the Jack wedges. These lengths should be checked with the local agent to ensure the suitability to the particular stressing Jack to be used.

1.3.1.2 **Pre-Sealing and Grouting of Anchorages**

After stressing CCL 'XF' anchorages, the tendon shall be cut back into the void, the exposed anchorage components painted and the void filled with a dry mixture of sand and cement grout (see section 1.3.1.3) in the ratio 3:1 respectively prior to grouting the tendon.

1.3.1.3 **Corrosion Protection**

After stressing of the tendon, the free volume between the duct and the strands is filled to protect the tendon from corrosion. CCL 'XF' anchorages shall be injected with a corrosion protection substance in accordance with the local regulations and with the specifications of implementation laid out by CCL.

Corrosion protection is usually carried out in internal prestressing in concrete by a cement grout which ensures a mechanical connection between the reinforcement and the concrete structure. Grouts must comply with requirements of EN 445, EN 446, EN 447 or with EAD 160027-00-0301, and must be pre-bagged, reducing the variability due to site batching and the inherently variable properties of bagged cement. Common grout to be used should have been subject to and have results of the inclined tube test as laid out in EAD 160027-00-0301.

Grouting procedures should conform to EN 447 and fib Bulletin No. 20 "Grouting of tendons in prestressed concrete". Manufacture and the placement of a cement grout must respect the local specifications and the guidelines laid out in EAD 160027-00-0301.

An up to date list of corrosion protection products that can be used with the CCL 'XF' System is available from CCL.

1.3.2. 'XU' Installation

1.3.2.1 **Anchorages**

The plastic coated strand is fitted into the FTU and the sheathing cut flush with the back face of the FTU (see Annexes 13 and 14) it is then sealed by means of a plastic concrete excluder. The pocket former and FTU are fixed to the formwork by means of a rubber sealing washer, plastic bayonet fitting and a slotted plastic nut.

The local bursting reinforcement is attached with the general reinforcement.

To facilitate the installation of the FTU and the wedge a sufficient open space must be reserved behind each anchorage. This open space must also allow for the implementation of the sealing cap and stressing.

Setting out dimensions of the anchorage and space reserved behind each anchorage are to be checked before concreting. Wedges are assembled immediately prior to stressing of the tendon in order to avoid corrosion.

Active Anchorages

Sufficient space must be reserved behind the anchorage for the installation and operation of the stressing Jack. Stressing must only be carried out when the concrete has cured to the required minimum compressive strength.

The cut length of the strands, calculated from exposed face of the FTU must be sufficient to allow installation of the FTU and wedge, the threading of the stressing Jack and insertion of the Jack wedge. These lengths should be checked with the local agent to ensure the suitability to the particular stressing Jack to be used.

Passive Anchorages

For tendons where the tension is applied at one end only, a dead end anchorage can be used. The wedge is pre-seated in the anchor head by a seating jack. The prestressing force for pre-seating of the wedge should be equal to the values of $\boldsymbol{F_{0s}}$ shown in table 5 The retaining spring is then located within the sealing cap which is filled with grease. This will hold the wedges in place with sufficient force to help prevent wedge-stepping. Finally the exposed FTU face is painted and the void filled with a dry mixture of sand and cement grout.

The cut length of the strands, calculated from exposed face of the FTU must be sufficient to allow installation of the sealing cap and spring but not too long to interfere with the fitting of the cap.

1.3.2.2 **Corrosion Protection**

After stressing, grease filled caps are fitted onto the FTU to protect the open end of the tendon, the exposed FTU face is painted and the void filled with a dry mixture of sand and cement grout. See 1.2.3.3 for details of strand sheath.

2. Specifications of the intended use in accordance with the applicable European Assessment Document

2.1. Intended use

Basic categories of use are:

- Internal bonded tendon for concrete and composite structures
- Internal unbonded tendon for concrete and composite structures

Optional categories of use for CCL XF System are:

- Internal bonded tendon with plastic duct
- Encapsulated tendon

The design of the load introduction zone supporting the PT anchorage system must comply with relevant Eurocodes and regulations in force at the place of use.

2.2. Working life

The provisions made in this ETA are based on an assumed intended working life of the CCL ‘XF’ and ‘XU’ PT Systems of 100 years (provided that the conditions laid down for packaging / transport / storage / installation / use / maintenance / repair are met). The indications given on the working life cannot be interpreted as a guarantee given by the producer or the assessment body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3. Performance of the products and methods used for its assessment

This European Technical Assessment for the post-tensioning system part of this document is issued on the basis of agreed data, deposited at Cerema, 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 Works Requirement 1 (mechanical resistance and stability) has been made in accordance with the EAD 160004-00-0301, European Assessment Document for post-tensioning kits for prestressing of structures based on the provisions for all systems.

Product type: Post-Tensioning kit		**Intended use:** Prestressing of structures
N°	**Essential characteristic** (acc. to EAD 160004-00-0301)	**Product Performance**
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load	≥ 95 % of Actual Ultimate Tensile Strength – AUTS (acceptance criteria given in clause 2.2.1 of EAD 160004-00-0301)
2	Resistance to fatigue	No fatigue failure in anchorage and not more than 5 % loss on cross section after 2 million cycles (acceptance criteria given in in clause 2.2.2 of EAD 160004-00-0301)
3	Load transfer to the structure	Stabilization of crack width under cyclic load and ultimate resistance ≥ 110 % characteristic load (acceptance criteria given in clause 2.2.3 of EAD 160004-00-0301)
4	Friction coefficient	See Clause 1.2.5 (acceptance criteria given in clause 2.2.4 of EAD 160004-00-0301)
5	Deviation / deflection for internal unbonded tendon	See Clause 1.2.9 (acceptance criteria given in clause 2.2.5 of EAD 160004-00-0301)
6	Deviation / deflection for external unbonded tendon	See Clause 1.2.9 (acceptance criteria given in clause 2.2.6 of EAD 160004-00-0301)
7	Assessment of assembly	Installation of strands, duct filling
Aspects of durability		
13	Corrosion protection	See Clause 1.3.1.3 and 1.3.2.2 (acceptance criteria given in clause 2.2.13 of EAD 160004-00-0301)

4. Assessment and verification of constancy of performance system applied, with reference to its legal base

In accordance with the decision 98/456/EC[2] of the European Commission, the system 1+ of assessment and verification of constancy of performances (see Annex V to Regulation (EU) No 305/2011), given in the following table applies:

Product(s)	Intended use(s)	Level(s) or class(es)	System(s)
Post-tensioning Kits	For the prestressing of 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.

[2] Official Journal of the European communities L201/112 of 3 July 1998

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

5.1. Tasks for 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 or results performed. This production control system shall insure that the product is in conformity with this European Technical Assessment.

The manufacturer shall only use initial / raw / constituent materials (as relevant) stated in the technical documentation of this European Technical Assessment.

The factory production control shall be in accordance with the "CCL Control Plan" relating to this European Technical Assessment which is part of the technical documentation of this European Technical Assessment. The "Control Plan" is laid down in the context of the factory production control system operated by the manufacturer and deposited at Cerema.

The prescribed test plan defined in Annex 24 and 25 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 "CCL Control Plan" relating to this European Technical Assessment.

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.

The kit manufacturer is responsible for the manufacture and the quality of each component that is manufactured or supplied by a subcontractor.

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.

The records shall be kept for at least ten years and submitted to the notified body. On request they shall be presented to Cerema.

5.1.2. Other tasks

The manufacturer shall, on the basis of a contract, involve a body (bodies) which is (are) notified for the tasks referred to in section 5.2 in the field of CCL post-tensioning system in order to undertake the actions laid down in section 5.2. For this purpose, the "CCL Control Plan" referred to in sections 5.1 and 5.2 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.

At least once a year specimens shall be taken from at least one job site and one series of single tensile element test shall be performed according to EAD 160004-00-0301, Annex C.7 (see annex 26). The results of these test series shall be made available to the notified body.

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 "CCL 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 centre 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 certification body involved by the manufacturer shall issue a certificate of constancy of performance 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 “Control Plan” are no longer fulfilled the certification body shall withdraw the certificate of constancy of performances and inform Cerema 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 Cerema 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 post-tensioning system according to the specifications given in 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 PT system or of individual components for which this European Technical Assessment has been granted, for independent testing. For the most important components Annex 26, complying with EAD 160004-00-0301 Table 4, summarises the minimum procedures which have to be performed by the certification body.

Issued in Sourdun on 16 December 2021

By
Centre d'étude et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema)
Direction technique Infrastructures de transport et matériaux (DTecITM)

MOULINE Eric

Signature numérique de MOULINE Eric
Date : 2021.12.16 12:14:47 +01'00'

Éric MOULINE (deputy director of Cerema ITM), ETA manager

Designation of tendon

Prestressing steel:

-	Type:		Strand according to prEN 10183-3
-	Strength:	f_{pk}	1860 MPa or 1770 MPa
-	Nominal cross section:	A_s	See 1.2.3.3 Strand Characteristics
-	Relaxation at 0.70f_{pk} after 1000 hours:		2.5 %
-	Modulus of elasticity:	E_p	195 GPa

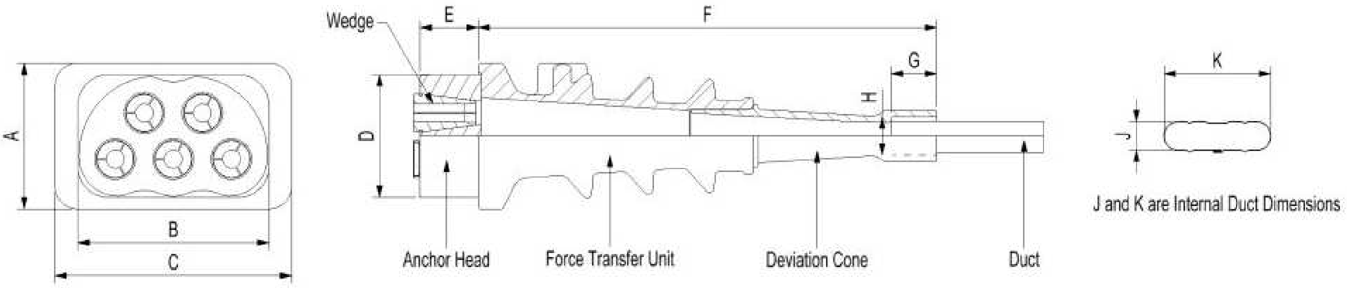
Tendon:

-	Type:		Internal/Unbonded
-	Use category:		Concrete
-	Corrosion protection:		Grout, Grease, Wax according to section 1.3.1.3 of the present ETA
-	Weight of tendon:	M_p	See 1.2.3.4 Prestressing Forces
-	Force at 1.00f_{pk}:	F_{pk}	See 1.2.3.4 Prestressing Forces
-	Friction coefficient:	μ	See 1.2.5 Friction Losses
-	Unintentional deviation/ Wobble coefficient:	k	See 1.2.5 Friction Losses
-	Minimum radius of curvature:	R_{min}	See 1.2.9 Radius of Curvature
-	Maximum spacing of duct supports:	s_{max}	See 1.2.8 Spacing of the Supports

Anchorages:

-	Type:		See 1.2.1 – 1.2.2 & Annexes 02 – 21
-	Minimum centre spacing:	x, y	See Annex 09, 11, 18, 20 and 1.2.11 Anchorage Spacing and Concrete Cover
-	Minimum edge distance:	e_x, e_y	See Annex 09, 11, 18, 20 and 1.2.11 Anchorage Spacing and Concrete Cover
-	Anchorage seating:	g	See 1.2.6 Anchorage Wedge Set

Live End Anchorage



Live End Anchorage Ø12.5/12.9/13.0 mm Strand

Anchorage	Strands	A	B	C	D	E	F	G	H	J	K
XF-10	3	80	91	108	66	39	242	30	25	18	42
XF-20	5	95	126	155	80	39	300	30	25	18	69
XF-30	6	95	151	190	80	39	332	30	25	18	86

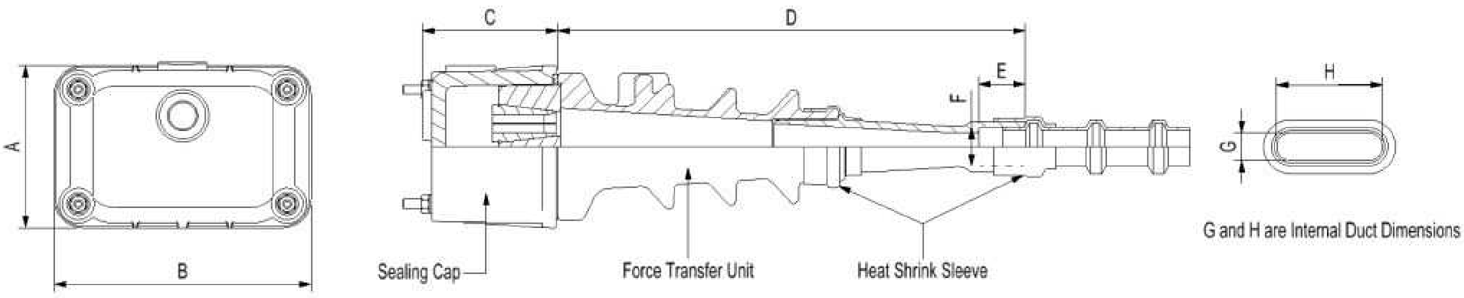
Live End Anchorage Ø15.2/15.3/15.7 mm Strand

Anchorage	Strands	A	B	C	D	E	F	G	H	J	K
XF-10	2	80	91	108	66	44	242	30	25	18	42
XF-20	4	95	126	155	80	44	300	30	25	18	69
XF-30	5	95	151	190	80	44	332	30	25	18	86

CCL 'XF' System
Live End Anchorage

Annex 02
of ETA-10/0107

Encapsulated Anchorage



Encapsulated Anchorage Ø12.5/12.9/13.0 mm Strand

Anchorage	Strands	A	B	C	D	E	F	G	H
XF-10	3	118	90	86	242	30	25	21	38
XF-20	5	105	165	86	300	30	25	21	71
XF-30	6	105	200	86	332	30	25	21	90

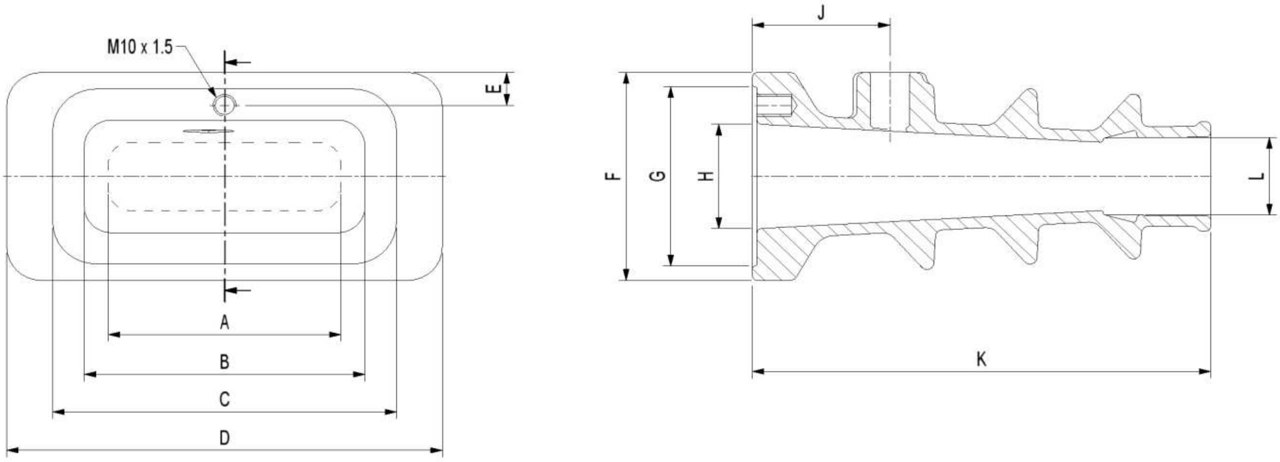
Live End Anchorage Ø15.2/15.3/15.7 mm Strand

Anchorage	Strands	A	B	C	D	E	F	G	H
XF-10	2	118	90	86	242	30	25	21	38
XF-20	4	105	165	86	300	30	25	21	71
XF-30	5	105	200	86	332	30	25	21	90

CCL ‘XF’ System
Encapsulated Anchorage

Annex 03
of ETA-10/0107

Force Transfer Unit

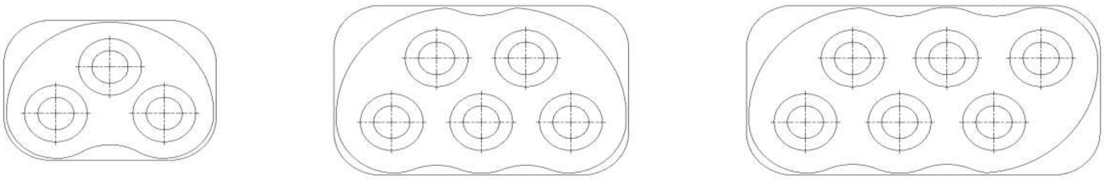


Anchorage	A	B	C	D	E	F	G	H	J	K	L
XF-10	56	64	93	108	13	80	68	40	50	140	33
XF-20	85	94	128	155	15	95	82	48	55	180	36
XF-30	106	119	152	190	15	95	82	48	60	200	36

	CCL ‘XF’ System Force Transfer Unit	**Annex 04** of ETA-10/0107

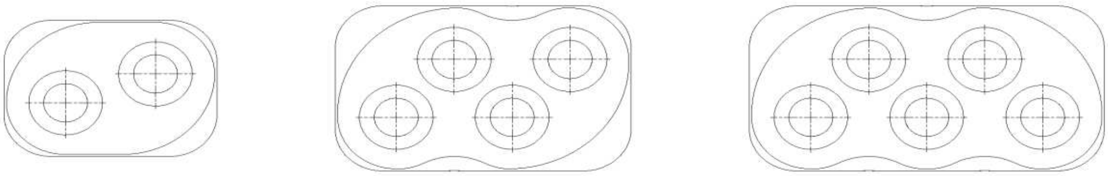
Anchor Head

XF Anchor Heads Ø12.5/12.9/13.0 mm Strand



Anchorage	*n*	Layout
XF-10	3	A
XF-20	5	B
XF-30	6	C

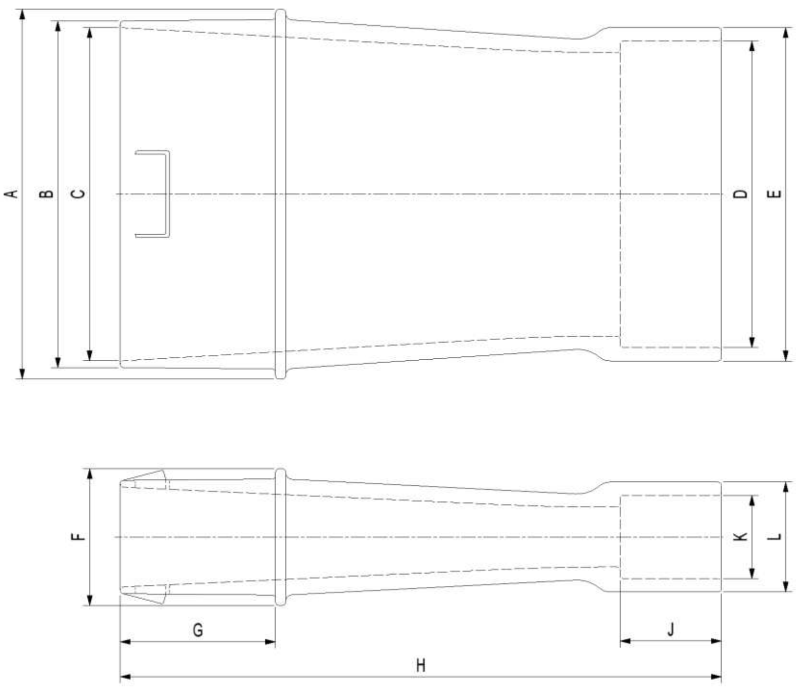
XF Anchor Heads Ø15.2/15.3/15.7 mm Strand



Anchorage	*n*	Layout
XF-10	2	A
XF-20	4	B
XF-30	5	C

	CCL 'XF' System Anchor Head	**Annex 05** of ETA-10/0107

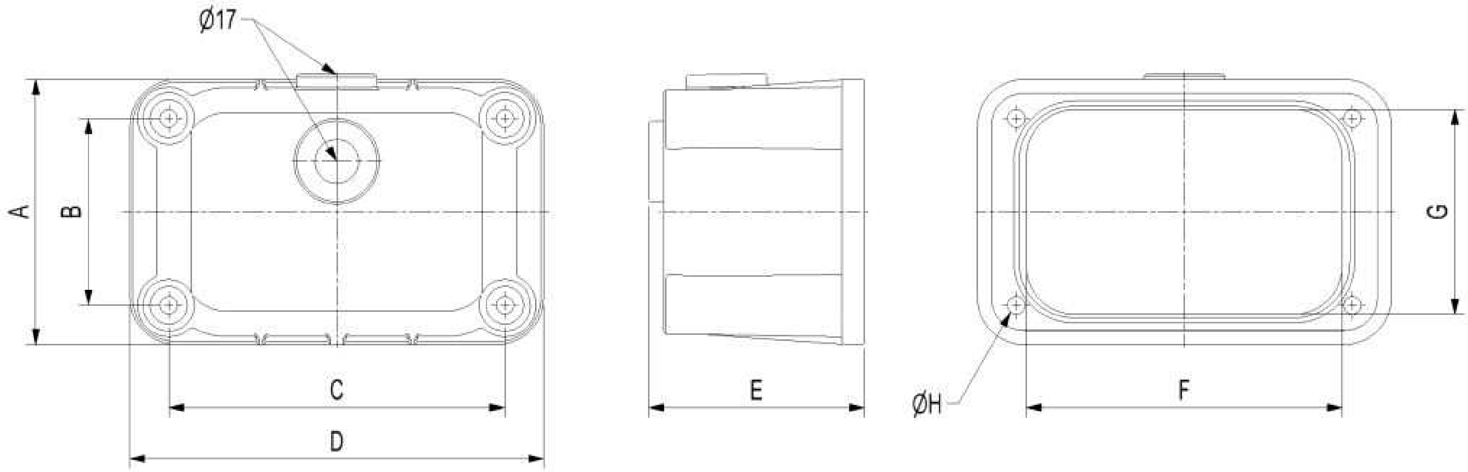
Deviation Cone



Anchorage	A	B	C	D	E	F	G	H	J	K	L
XF-10	61	54	50	48	56	38	41	143	30	25	33
XF-20	90	83	79	75	83	41	41	161	30	25	33
XF-30	111	104	100	92	100	41	46	178	30	25	33

ccl®	CCL 'XF' System Deviation Cone	**Annex 06** of ETA-10/0107

Sealing Cap

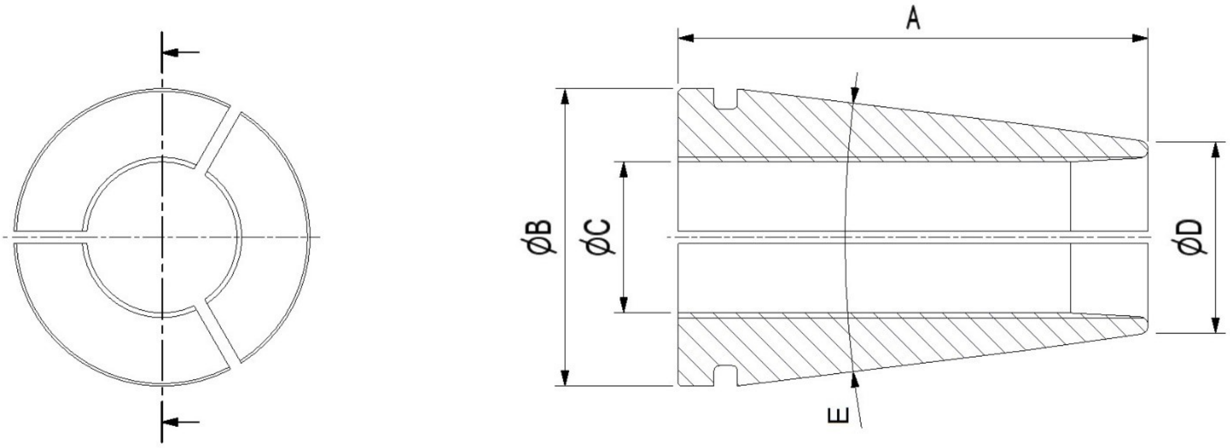


Anchorage	A	B	C	D	E	F	G	H
XF-10	90	62	94	118	86	93	68	6
XF-20	105	74	134	165	86	128	82	7
XF-30	105	74	169	200	86	152	82	7

CCL 'XF' System
Sealing Cap

Annex 07
of ETA-10/0107

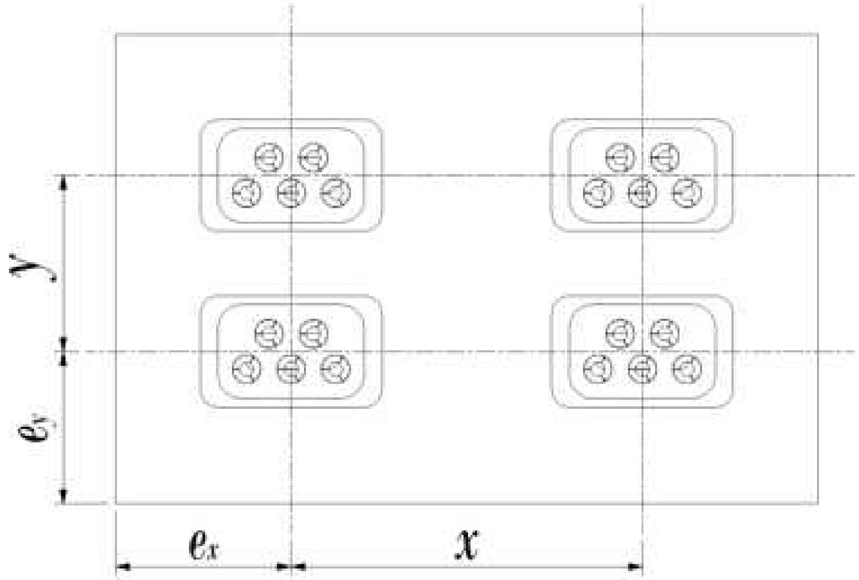
Wedge Type ‘X’



Wedge	A	ØB	ØC	ØD	E
X13.0	41	25	11.9	16	14°
X15.3	46	29	14.5	19	14°
X15.7	46	29	14.8	19	14°

	CCL ‘XF’ System Wedge Type ‘X’	**Annex 08** of ETA-10/0107

Anchorage Spacing and Edge Distances for Links Type Bursting Reinforcement



$$A_c = x\,.\,y \geq a\,.\,b \quad ; \quad x \geq 0.85\,a \quad ; \quad y \geq 0.85\,b \quad ; \quad e_x = \frac{x}{2} - 10\text{ mm} + c_{min} \quad ; \quad e_y = \frac{y}{2} - 10\text{ mm} + c_{min}$$

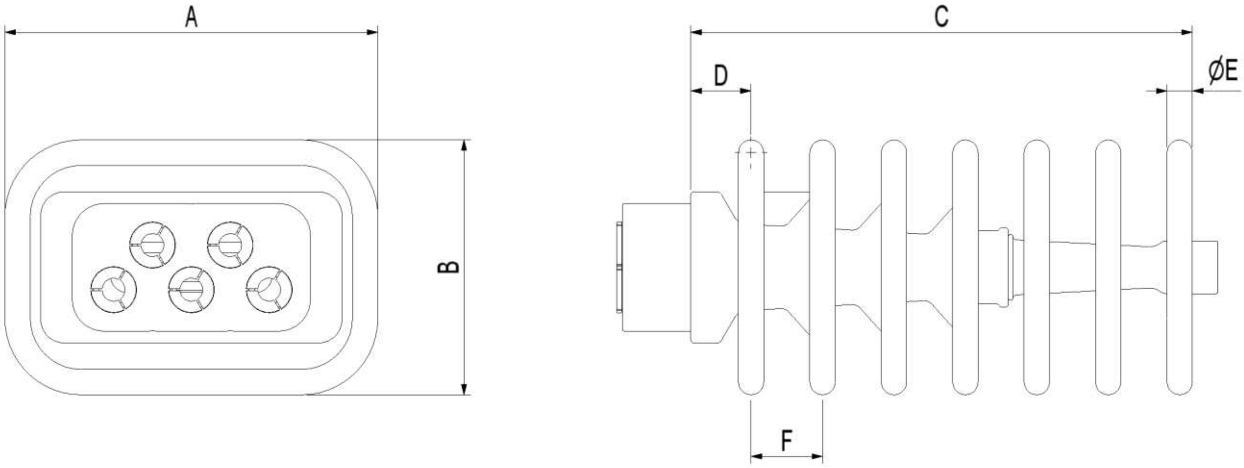
Where c_{min} is the minimum concrete cover
Values of x, y, e_x, e_y shall be rounded up to the nearest 5 mm.

	$f_{cm,0}$ on cube					
	25 MPa		**35 MPa**		**45 MPa**	
Anchorage	**a**	**b**	**a**	**b**	**a**	**b**
XF-10	220	155	195	150	170	145
XF-20	335	205	285	195	235	185
XF-30	375	225	330	205	285	185

CCL 'XF' System
Anchorage Spacing and Edge Distances
for Links Type Bursting Reinforcement

Annex 09
of ETA-10/0107

Bursting Reinforcement Sizes for Links (f_{yk} = 500 MPa)



	$f_{cm,0}$ on cube 25 MPa						
Anchorage	**A**	**B**	**C**	**D**	**ØE**	**F**	**N**
XF-10	190	125	221	25	12	38	6
XF-20	305	175	332	30	16	49	7
XF-30	345	195	367	30	16	47	8

	$f_{cm,0}$ on cube 35 MPa						
Anchorage	**A**	**B**	**C**	**D**	**ØE**	**F**	**N**
XF-10	165	120	216	25	12	37	6
XF-20	205	155	308	30	16	45	7
XF-30	255	155	346	30	16	44	8

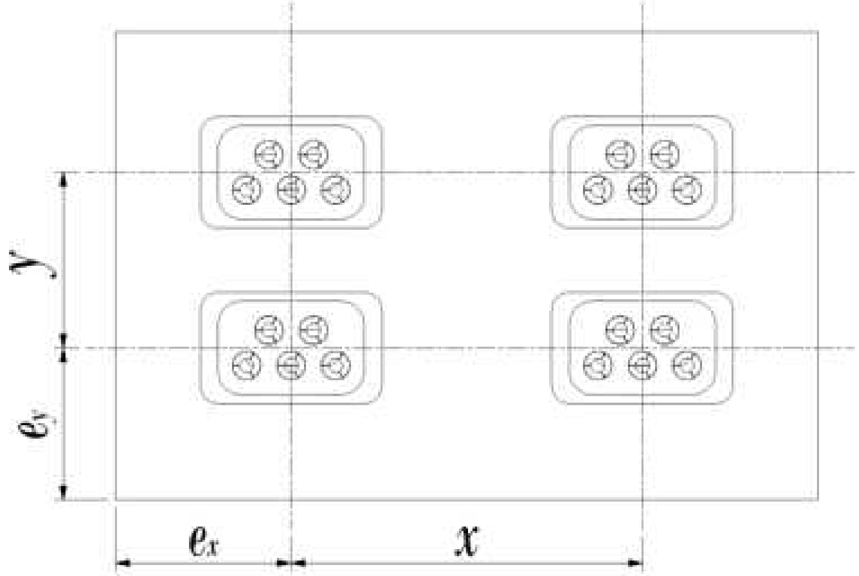
	$f_{cm,0}$ on cube 45 MPa						
Anchorage	**A**	**B**	**C**	**D**	**ØE**	**F**	**N**
XF-10	140	115	174	25	10	36	5
XF-20	205	155	243	30	16	41	6
XF-30	255	155	290	30	16	42	7

N = Number of Links
Each Link Shall be Closed by Overlapping or Welding

CCL 'XF' System
Bursting Reinforcement Sizes
for Links (f_{yk} = 500 MPa)

Annex 10
of ETA-10/0107

Anchorage Spacing and Edge Distances for Helices Type Bursting Reinforcement



$$A_c = x \,.\, y \geq a \,.\, b \quad ; \quad x \geq 0.85\, a \quad ; \quad y \geq 0.85\, b \quad ; \quad e_x = \frac{x}{2} - 10\text{ mm} + c_{min} \quad ; \quad e_y = \frac{y}{2} - 10\text{ mm} + c_{min}$$

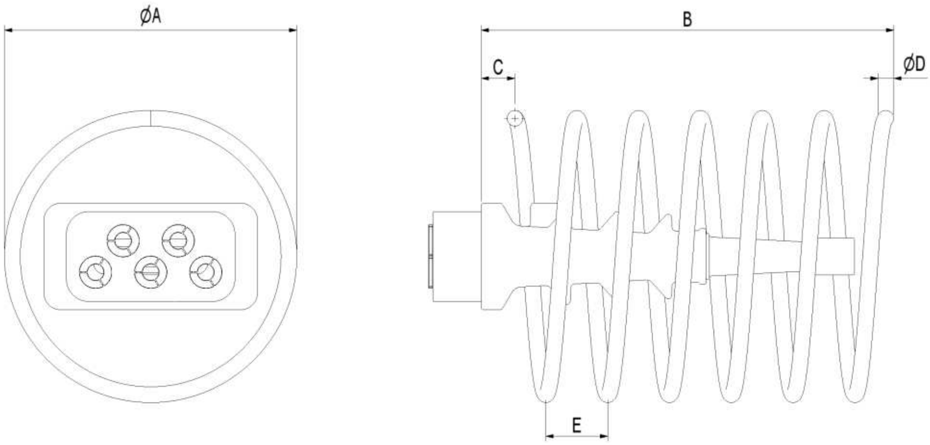
Where c_{min} is the minimum concrete cover
Values of x, y, e_x, e_y shall be rounded up to the nearest 5 mm.

	$f_{cm,0}$ on cube					
	25 MPa		35 MPa		45 MPa	
Anchorage	**a**	**b**	**a**	**b**	**a**	**b**
XF-10	220	180	195	170	170	160
XF-20	335	250	285	235	235	215
XF-30	375	280	330	260	285	240

CCL 'XF' System
Anchorage Spacing and Edge Distances
for Helices Type Bursting Reinforcement

Annex 11
of ETA-10/0107

Bursting Reinforcement Sizes for Helices (f_{yk} = 500 MPa)



	$f_{cm,0}$ on cube 25 MPa					
Anchorage	**ØA**	**B**	**C**	**ØD**	**E**	**N**
XF-10	160	228	25	10	36	5.5
XF-20	230	348	30	12	52	6
XF-30	260	366	30	12	55	6

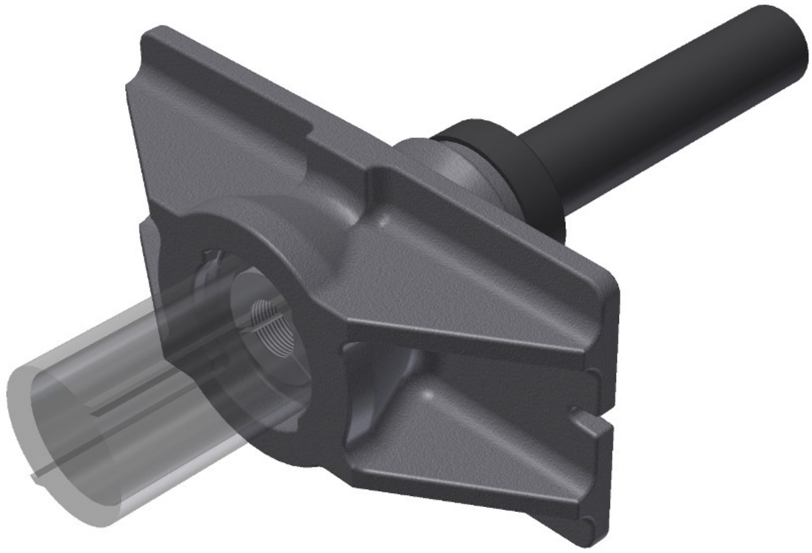
	$f_{cm,0}$ on cube 35 MPa					
Anchorage	**ØA**	**B**	**C**	**ØD**	**E**	**N**
XF-10	150	210	25	10	40	4.5
XF-20	215	311	30	12	55	5
XF-30	240	331	30	12	59	5

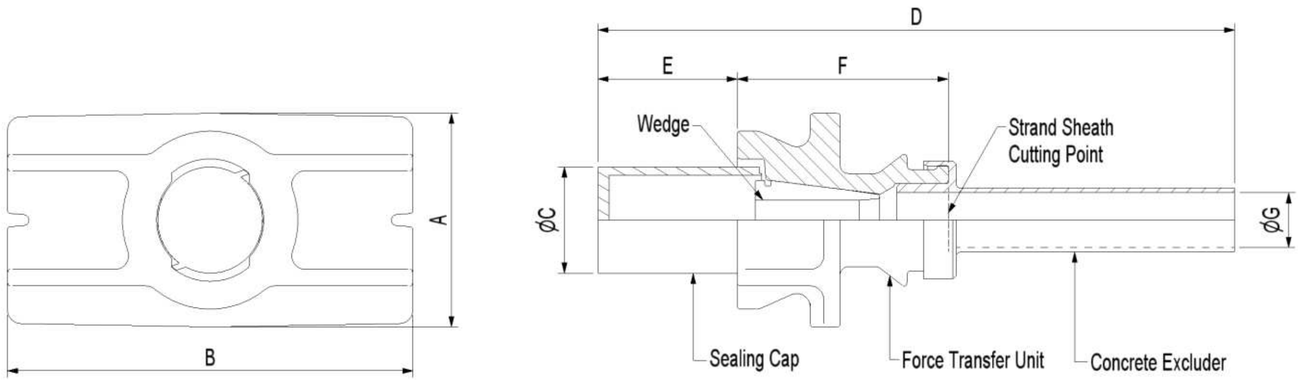
	$f_{cm,0}$ on cube 45 MPa					
Anchorage	**ØA**	**B**	**C**	**ØD**	**E**	**N**
XF-10	140	184	25	10	44	3.5
XF-20	195	247	30	10	47	4.5
XF-30	220	297	30	12	58	4.5

N = Number of Revolutions

	CCL 'XF' System Bursting Reinforcement Sizes for Helices (f_{yk} = 500 MPa)	**Annex 12** of ETA-10/0107

Live end Anchorage

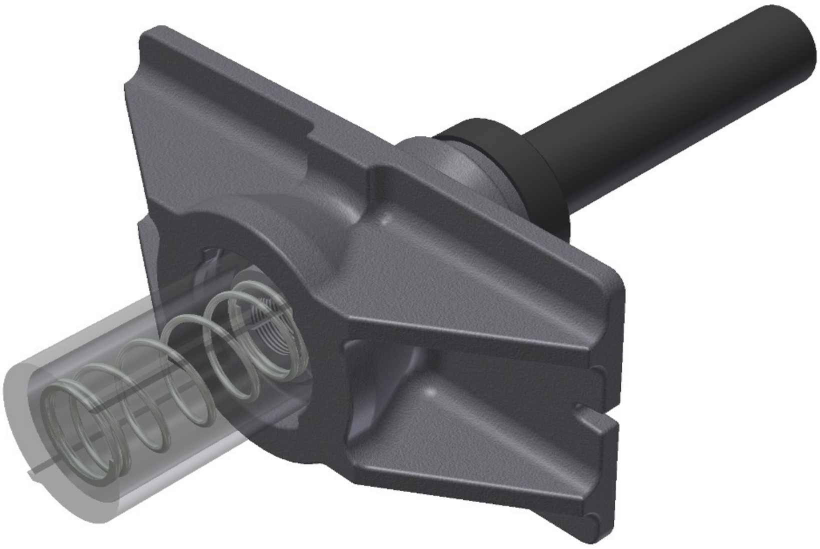


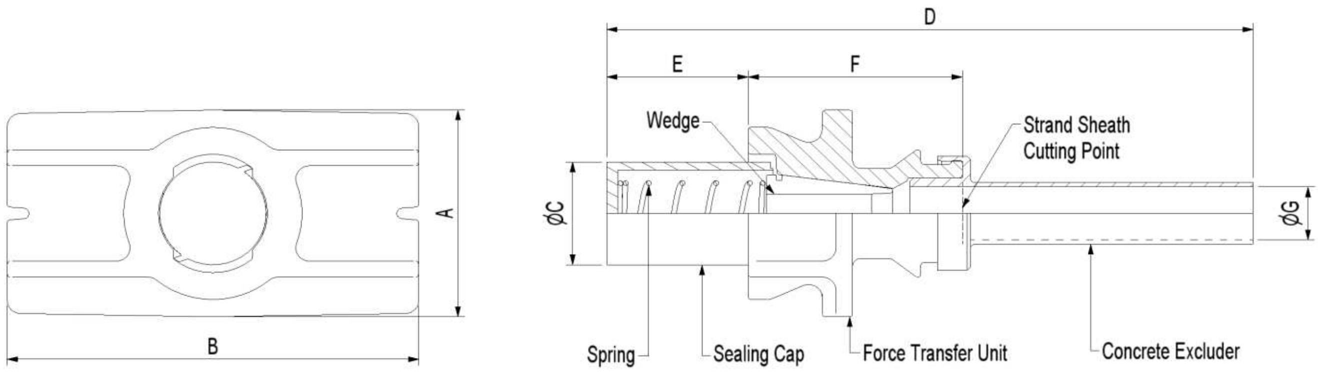


Anchorage	A	B	ØC	D	E	F	ØG
XU-13	63	110	39	205	52	70	18
XU-15	78	150	39	236	52	78	20

	CCL 'XU' System Live end Anchorage	**Annex 13** of ETA-10/0107

Dead end Anchorage

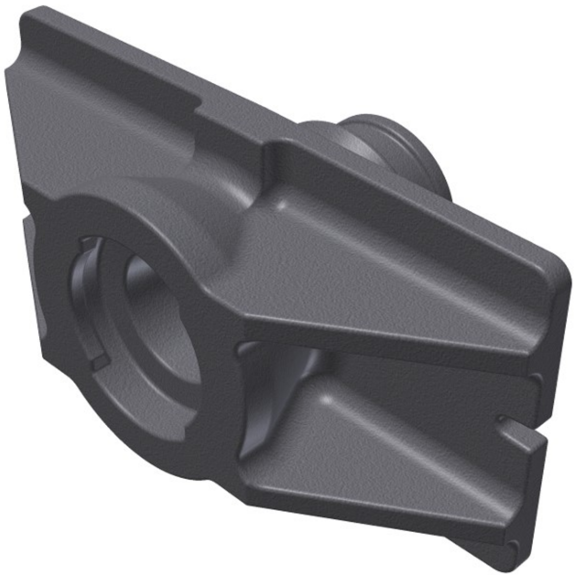


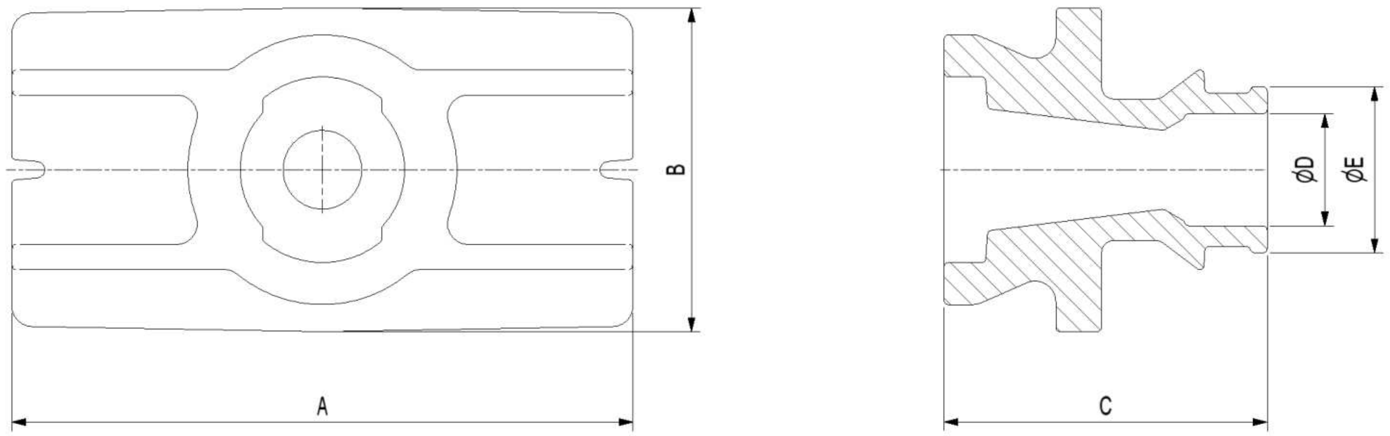


Anchorage	A	B	ØC	D	E	F	ØG
XU-13	63	110	39	205	52	70	18
XU-15	78	150	39	236	52	78	20

	CCL 'XU' System Dead end Anchorage	**Annex 14** of ETA-10/0107

Force Transfer Unit



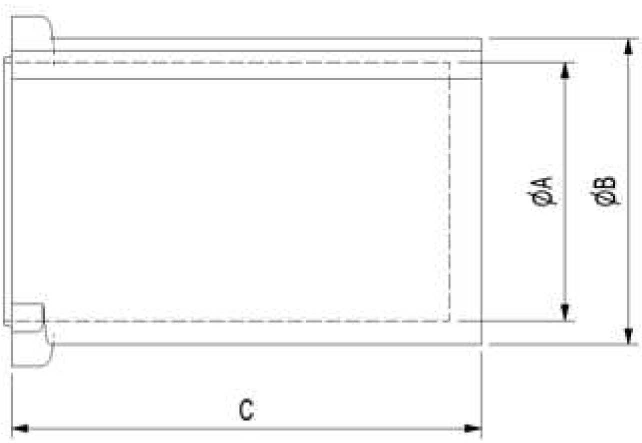


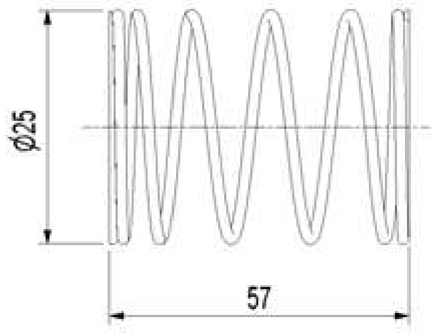
Anchorage	A	B	C	ØD	ØE
XU-13	110	63	70	22	34
XU-15	150	78	78	27	40

CCL ‘XU’ System
Force Transfer Unit

Annex 15
of ETA-10/0107

Sealing Cap & Spring



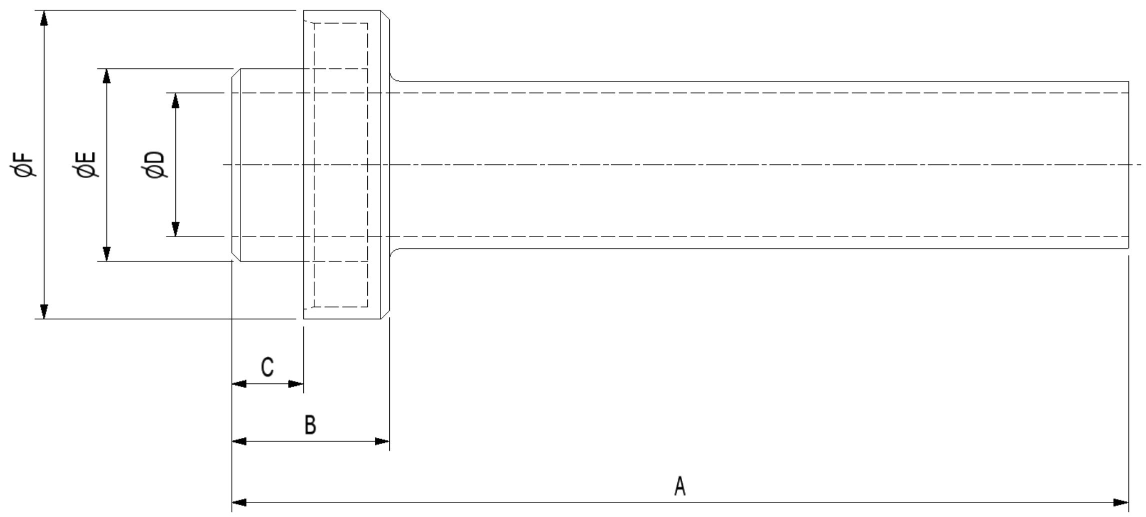


Anchorage	ØA	ØB	C
XU-13	33	39	60
XU-15	33	39	60

CCL 'XU' System
Sealing Cap & Spring

Annex 16
of ETA-10/0107

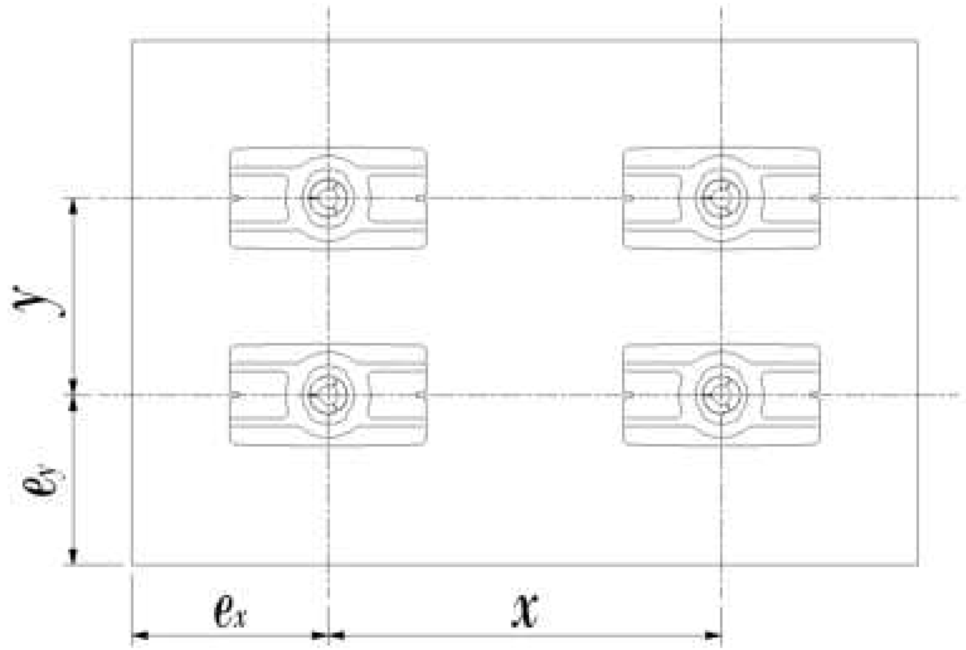
Concrete Excluder



Anchorage	A	B	C	ØD	ØE	ØF
XU-13	100	20	8	18	22	37
XU-15	125	22	10	20	27	43

ccl®	CCL 'XU' System Concrete Excluder	**Annex 17** of ETA-10/0107

Anchorage Spacing and Edge Distances for Links Type Bursting Reinforcement

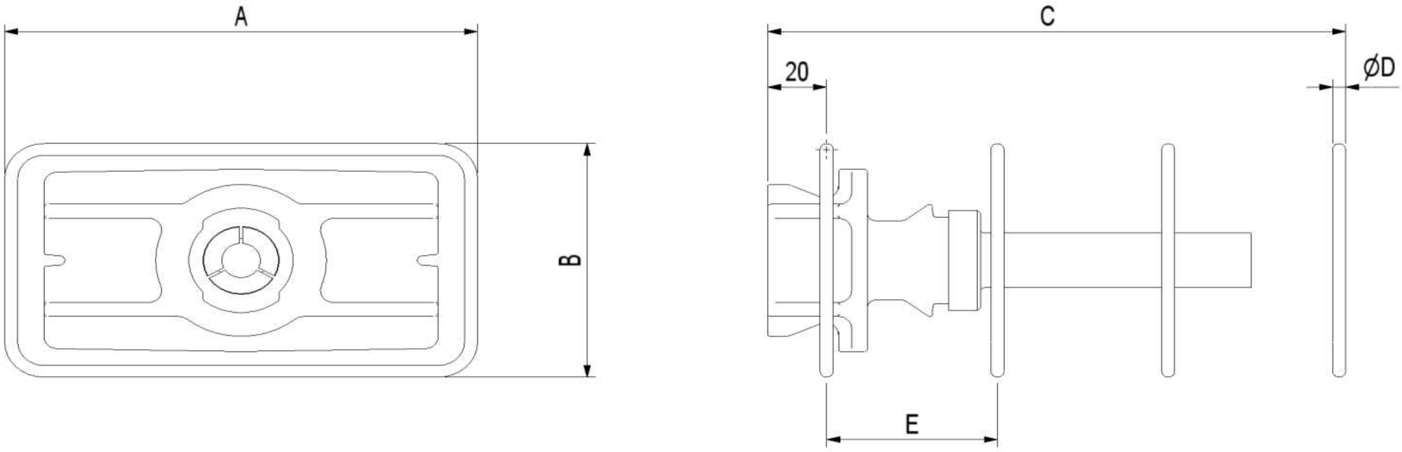


$$A_c = x \,.\, y \geq a \,.\, b \quad ; \quad x \geq 0.85\, a \quad ; \quad y \geq 0.85\, b \quad ; \quad e_x = \frac{x}{2} - 10\text{ mm} + c_{min} \quad ; \quad e_y = \frac{y}{2} - 10\text{ mm} + c_{min}$$

Where c_{min} is the minimum concrete cover
Values of x, y, e_x, e_y shall be rounded up to the nearest 5 mm.

	$f_{cm,0}$ on cube	
	25 MPa	
Anchorage	**a**	**b**
XU-13	170	120
XU-15	200	120

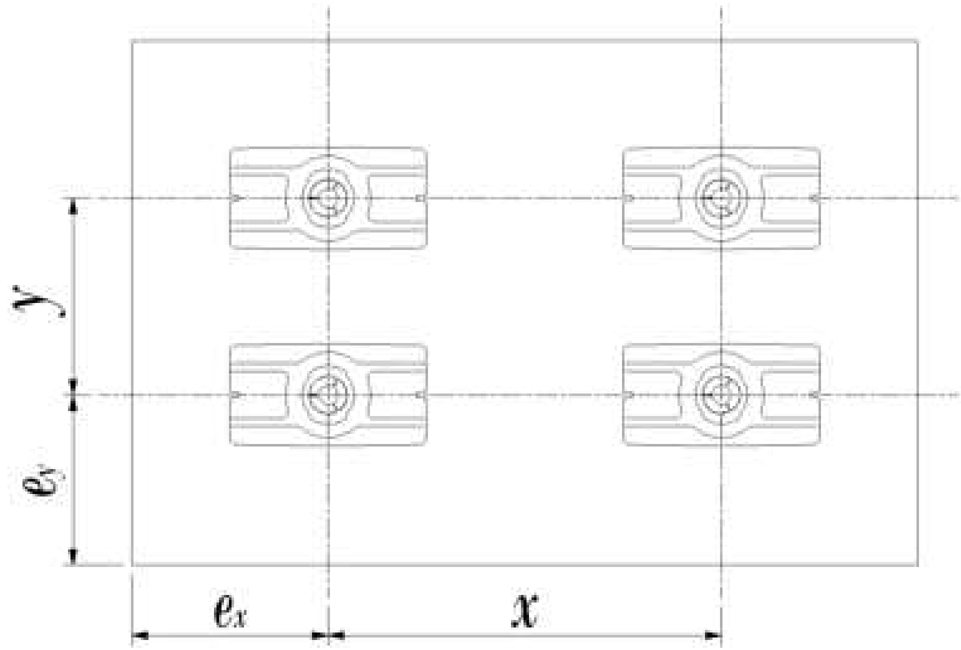
Bursting Reinforcement Sizes for Links (f_{yk} = 500 MPa)



	$f_{cm,0}$ on cube					
	25 MPa					
Anchorage	**A**	**B**	**C**	**ØD**	**E**	**N**
XU-13	150	100	323	5	75	5
XU-15	180	100	383	5	72	6

N = Number of Links
Each Link Shall be Closed by Overlapping or Welding

Anchorage Spacing and Edge Distances for Helices Type Bursting Reinforcement



$$A_c = x\,.\,y \geq a\,.\,b \quad ; \quad x \geq 0.85\,a \quad ; \quad y \geq 0.85\,b \quad ; \quad e_x = \frac{x}{2} - 10\text{ mm} + c_{min} \quad ; \quad e_y = \frac{y}{2} - 10\text{ mm} + c_{min}$$

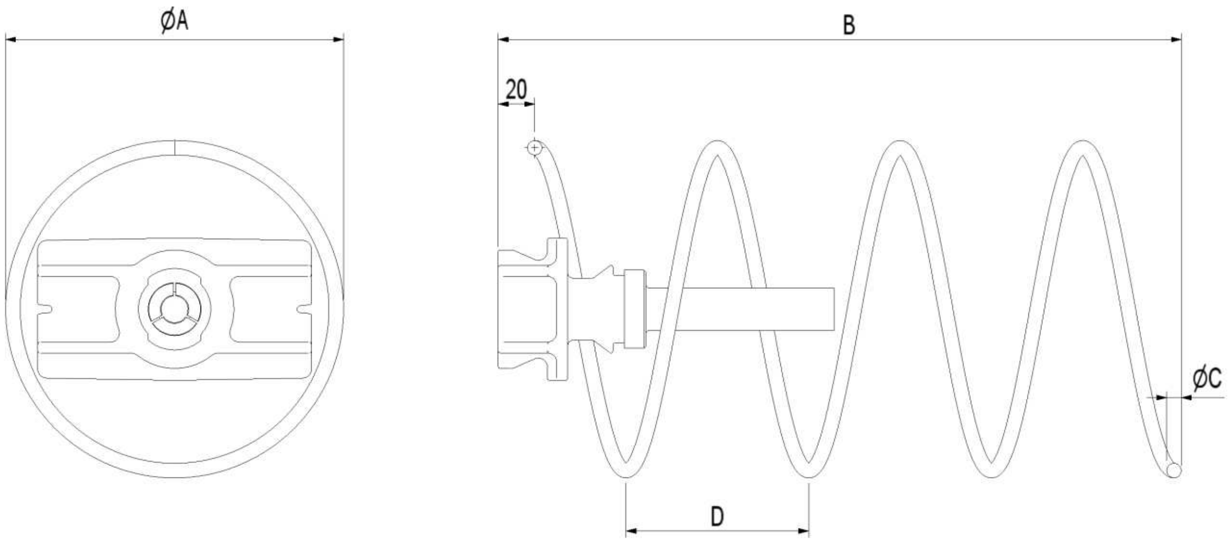
Where c_{min} is the minimum concrete cover
Values of x, y, e_x, e_y shall be rounded up to the nearest 5 mm.

	$f_{cm,0}$ on cube	
	25 MPa	
Anchorage	**a**	**b**
XU-13	170	160
XU-15	205	205

CCL 'XU' System
Anchorage Spacing and Edge Distances
for Helices Type Bursting Reinforcement

Annex 20
of ETA-10/0107

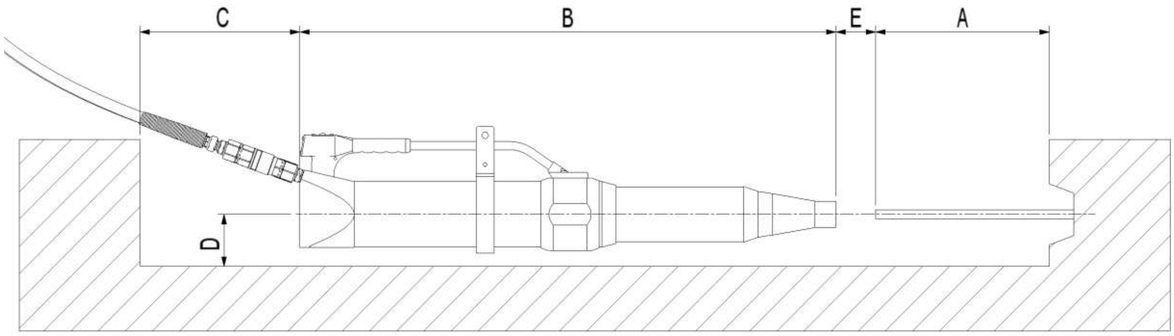
Bursting Reinforcement Sizes for Helices (f_{yk} = 500 MPa)



	$f_{cm,0}$ on cube				
	25 MPa				
Anchorage	**A**	**B**	**ØC**	**D**	**N**
XU-13	140	324	8	100	3
XU-15	185	374	8	100	3.5

N = Number of Revolutions

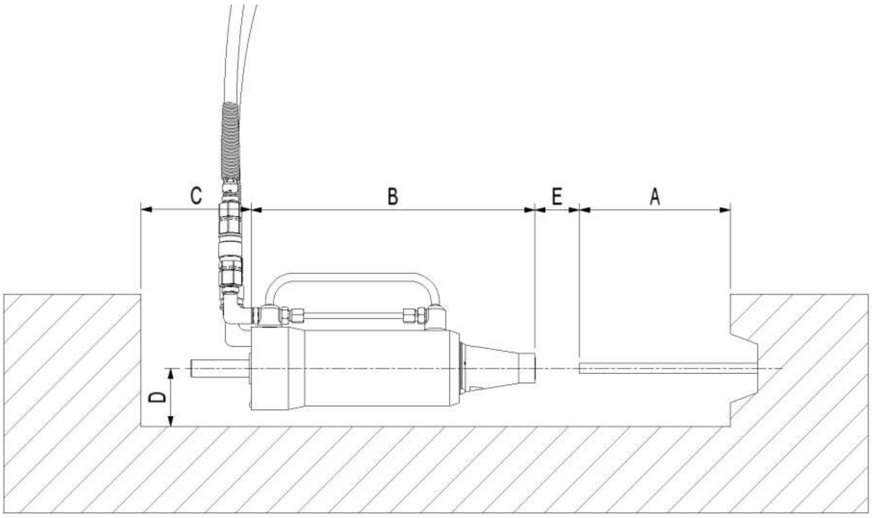
Stressomatic Jack



Jack	Strand	A	B	C	D	E (Extension)
160 kN Short stroke	13	225	755	200	60	205
160 kN Long stroke	13	225	1085	200	60	535
300 kN Short stroke	13 / 15	350	860	200	70	205
300 kN Long stroke	13 / 15	350	1070	200	70	410

	CCL ‘XF’ / ‘XU’ Systems Stressomatic Jack	**Annex 22** of ETA-10/0107

250 kN PT Jack



Jack	Anchorage	Strand	A	B	C	D	E (Extension)
250kN	**XF**	13	220	415	100	70	190
250kN	**XF**	15	220	415	100	70	190
250kN	**XU**	13	175	370	100	70	190
250kN	**XU**	15	175	370	100	70	190

CCL ‘XF’ / ‘XU’ Systems
250kN PT Jack

Annex 23
of ETA-10/0107

Prescribed Test Plan

1	2	3	4	5	6
Component	**Item**	**Test/ Check**	**Traceability[4]**	**Minimum Frequency**	**Documen-tation**
Wedge	Material	Check	Full	100 %	3.1[1]
	Treatment, Hardness[5]	Test		0.5 % ≥ 2 Specimens	Yes
	Detailed Dimensions[2]	Test		5 % ≥ 2 Specimens[7]	Yes
	Visual Inspection[3,6]	Check		100 %	□o
XF Anchor Head	Material	Check	Full	100 %	3.1[1]
	Detailed Dimensions[2]	Test		5 % ≥ 2 Specimens	Yes
	Visual Inspection[3]	Check		100 %	No
XF FTU	Material	Check	Bulk	100 %	3.1[1]
	Detailed Dimensions[2]	Test		3 % ≥ 2 Specimens	Yes
	Visual Inspection[3]	Check		100 %	No
XU FTU	Material	Check	Bulk	100 %	3.1[1]
	Detailed Dimensions[2]	Test		5 % ≥ 2 Specimens	Yes
	Visual Inspection[3]	Check		100 %	No
Duct, Sheathing	Material	Check	Full	100 %	3.1[1]
	Visual Inspection[3]	Check		100 %	No
Corrugated plastic ducts	Material	Check	Full	100 %	3.11
	Visual Inspection[3]	Check		100 %	No
Tensile Element Strand	Material	Check	CE	100 %	CE
	Diameter	Test		Each Coil / Bundle	No
	Visual Inspection[3]	Check		Each Coil / Bundle	No
Constituents of Filling Material as per EN 447	Cement	Check	Bulk	100 %	Yes
	Admixtures, Additions	Check		100 %	Yes
'XF' Plastic Sealing Cap and Plastic Deviation Cone	Material	Check	Bulk	100 %	3.1[1]
	Visual Inspection[3]	Check		0.1 % ≥ 2 Specimens	No
Spring (XU System)	Material	Check	"CE" [1]	100 %	3.1[1]
	Visual Inspection[3]	Check		0.1 % ≥ 2 Specimens	No
Bursting Reinforcement (Links, Helices)	Material	Check	Full	100 %	Yes
	Visual Inspection[3]	Check		100 %	No

CCL 'XF' / 'XU' Systems
Prescribed Test Plan

Annex 24
of ETA-10/0107

Prescribed Test Plan

All samples shall be randomly selected and clearly identified.

1.
Inspection certificate type "3.1" according to EN 10204. If the basis of "CE"-marking is not available, the prescribed test plan has to include appropriate measures, only for the time until the harmonised technical specification is available.

2.
Measurement of all dimensions and angles as stated in the Control Plan and Process Control Record Sheet.

3.
Visual inspection covers main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface finish, fins, kinks, smoothness, corrosion, coating etc. as detailed in the Control Plan.

4.
Full: Full traceability of each component to its raw material.
Bulk: Traceability of each delivery of components to a defined point.

5.
Surface hardness.

6.
Wedge teeth.

7.
Test quantities are assumed as wedge segments.

	CCL 'XF' / 'XU' Systems Prescribed Test Plan	**Annex 25** of ETA-10/0107

Audit Testing

1	2	3	4
Component	**Item**	**Test/ Check**	**Sampling – No. of Components Per Visit**
Wedge	Material According to Specification	Check, Test	2
	Treatment	Test	2
	Detailed Dimensions	Test	1
	Main Dimensions, Surface Hardness	Test	5
	Visual Inspection	Check	5
XF Anchor Head	Material According to Specification	Check, Test	1
	Detailed Dimensions	Test	
	Visual Inspection	Check	
XF/XU FTU	Material According to Specification	Check, Test	1
	Detailed Dimensions	Test	
	Visual Inspection	Check	
Single Tensile Element Test	EAD 160004-00-0301 Annex C.7	Test	1 Series

All Samples shall be randomly selected and clearly identified

	CCL 'XF' / 'XU' Systems Audit Testing	**Annex 26** of ETA-10/0107