POST-TENSIONING

SUSPA - Wire EX
External Post-Tensioning Kit for Prestressing of Structures with 30 to 84 prestressing steel wires

ETA-07/0186

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DYWIDAG

European Organisation for Technical Approvals
Europäische Organisation für Technische Zulassungen
Organisation Européenne pour l'Agrément Technique

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General part

Technical Assessment Body issuing the European Technical Assessment	Österreichisches Institut für Bautechnik (OIB) Austrian Institute of Construction Engineering
Trade name of the construction product	SUSPA – Wire EX
Product family to which the construction product belongs	External post-tensioning kit for prestressing of structures with 30 to 84 prestressing steel wires
Manufacturer	DYWIDAG-Systems International GmbH Neuhofweg 5 85716 Unterschleissheim Germany
Manufacturing plants	DYWIDAG-Systems International GmbH Max-Planck-Ring 1 40764 Langenfeld Germany DYWIDAG-Systems International GmbH ul. Hallera 78 41-709 Ruda Śląska Poland
This European Technical Assessment contains	46 pages including Annexes 1 to 23, which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of	European Assessment Document (EAD) 160004-00-0301 – Post-Tensioning Kits for Prestressing of Structures.
This European Technical Assessment replaces	European Technical Assessment ETA-07/0186 of 30.05.2016.

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Remarks

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment[1] – ETA – applies to a kit, the PT system

SUSPA – Wire EX,

comprising the following components, see Annex 1 and Annex 2.

– Tendon

  External, pre-assembled tendon with 30 to 84 tensile elements, wound up on barrels for delivery on site.

– Tensile element

  Circular, plain prestressing steel wire with nominal diameter and nominal tensile strengths as defined in Table 1

Table 1 Tensile elements

Nominal diameter	Designation according to prEN 10138-2[2]	Nominal tensile strength
mm	—	N/mm^2
7.0	Y1670C	1 670
7.0	Y1770C	1 770

NOTE 1 N/mm^2 = 1 MPa

– Anchor and coupler, see Table 2

  The prestressing steel wires are anchored via cold-upset heads (button heads).

  Stressing anchor C with bearing plate or multi plane anchor body for tendons with 30 to 84 prestressing steel wires

  Fixed anchor D with bearing plate or multi plane anchor body for tendons with 30 to 84 prestressing steel wires

  Fixed anchor E with bearing plate for tendons with 30 to 84 prestressing steel wires

[1] ETA-07/0186 was firstly issued in 2007 as European technical approval with validity from 12.11.2007, extended in 2012 with validity from 12.11.2012, amended in 2013 with validity from 28.06.2013, amended and converted 2015 to European Technical Assessment ETA-07/0186 of 19.10.2015, amended 2016 to ETA-07/0186 of 30.05.2016, and 2020 to ETA-07/0186 of 16.11.2020.

[2] Standards and other documents referred to in the European Technical Assessment are listed in Annex 23.

Fixed anchor F with bearing plate for tendons with 30 to 84 prestressing steel wires

Fixed coupler C-K with bearing plate or multi plane anchor body for tendons with 30 to 66 prestressing steel wires

Movable coupler K-K for tendons with 30 to 66 prestressing steel wires

– Helix and additional reinforcement or only additional reinforcement without helix in the anchorage zone

– Permanent corrosion protection for tensile elements, anchors and couplers

PT system

1.2 Designation and range of the anchorages and couplers

1.2.1 Designation

The designation of the anchor or coupler unit is by its function in the structure and by the number of prestressing steel wires. The prefix "EX" before the number of the prestressing steel wires refers to the external arrangement of the tendons, i.e., outside the concrete cross section.

The various anchors and couplers are shown in Annex 1 and Annex 2.

1.2.2 Anchors and couplers

1.2.2.1 General

The tendon is pre-assembled at the manufacturing plant. It is wound up on a barrel for delivery on site.

The prestressing steel wires are anchored via cold-upset heads (button heads) in basic bodies or in anchor bodies E. The basic bodies or anchor bodies E provide cylindrical boreholes for 30 to 84 prestressing steel wires. An external thread is machined on the basic body. Button heads and boreholes in basic body and anchor body E are identical for all anchors and couplers, and hence the same principle of anchoring the prestressing steel wires applies from the smallest to the largest anchor. The available tendon sizes are listed in Table 2.

Table 2 Anchorages and Couplers

Component	Number of prestressing steel wires [1]									
Anchor										
Stressing anchor C with bearing plate	30	36	42	48	54	60	66	72	78	84
Stressing anchor C with multi plane anchor body	30	36	42	48	54	60	66	72	78	84
Fixed anchor D with bearing plate	30	36	42	48	54	60	66	72	78	84
Fixed anchor D with multi plane anchor body	30	36	42	48	54	60	66	72	78	84
Fixes anchor E with bearing plate	30	36	42	48	54	60	66	72	78	84
Fixed anchor F with bearing plate	30	36	42	48	54	60	66	72	78	84
Coupler										
Fixed coupler C-K with bearing plate	30	36	42	48	54	60	66			
Fixed coupler C-K with multi plane anchor body	30	36	42	48	54	60	66			
Movable coupler K-K	30	36	42	48	54	60	66			

[1] One or more prestressing steel wires may be omitted to install tendons with numbers of prestressing steel wires between the numbers given.

Anchor and coupler may be provided with less prestressing steel wires than the maximum number, resulting in a continuous tendon row. Thereby the prestressing steel wires are omitted as much as possible radial symmetrically. For all omitted prestressing steel wires, the respective bores in basic body or anchor body E do not need to be drilled. Anchors and couplers with omitted prestressing steel wires are in any case installed with unchanged dimensions and unchanged reinforcement compared to anchorages and couplers with complete number of prestressing steel wires.

1.2.2.2 Stressing anchor C

Stressing anchor C comprises a basic body with an external thread, a tensioning sleeve with an external and internal thread, a bearing nut C with an internal thread, and a bearing plate or a multi plane anchor body. The internal thread of the tensioning sleeve is threaded onto the basic body and the bearing nut C is threaded onto the external thread of the tensioning sleeve. Bearing nut C is supported on the bearing plate or multi plane anchor body.

Within the structure

– adjacent to the bearing plate helix and additional reinforcement are arranged centrically aligned with regard to the bearing plate or

– adjacent to the multi plane anchor body additional reinforcement is arranged centrically aligned with regard to the multi plane anchor body.

The pre-assembled tendon is passed through a recess tube and the bearing plate or multi plane anchor body. For details regarding the stressing anchor C, see Annex 5, Annex 6, Annex 7, Annex 8, Annex 11, and Annex 15.

For stressing the tensioning spindle, which transfers the force from the prestressing jack to the tendon, is screwed into the tensioning sleeve. Subsequently the bearing nut C is screwed up to the bearing plate or multi plane anchor body. After stressing, the force is transferred to the structure by the tensile elements via basic body, tensioning sleeve, bearing nut C, and bearing plate or multi plane anchor body.

1.2.2.3 Fixed anchor D

The fixed anchor D comprises a basic body with an external thread, a bearing nut D with an internal thread, and a bearing plate or a multi plane anchor body. The bearing nut D, which is screwed on the basic body, is supported on the bearing plate or multi plane anchor body.

Same as to the stressing anchor C within the structure

– adjacent to the bearing plate helix and additional reinforcement are arranged centrically aligned with regard to the bearing plate or

– adjacent to the multi plane anchor body additional reinforcement is arranged centrically aligned with regard to the multi plane anchor body.

The pre-assembled tendon is passed through a recess tube and the bearing plate or multi plane anchor body. For details regarding the fixed anchor D, see Annex 5, Annex 6, Annex 7, Annex 8, Annex 11, and Annex 15.

After stressing, the force is transferred to the structure by the tensile elements via the basic body, the bearing nut D, and the bearing plate or multi plane anchor body.

1.2.2.4 Fixed anchor E

The fixed anchor E comprises an anchor body E and a bearing plate. The anchor body E is supported on the bearing plate. Same as to fixed anchor D within the structure, adjacent to the bearing plate helix and additional reinforcement are arranged centrically aligned with regard to the bearing plate.

The pre-assembled tendon is passed from the anchorage through bearing plate and recess tube. For details regarding the fixed anchor E, see Annex 5, Annex 9, Annex 11, and Annex 15.

After stressing, the force is transferred to the structure by the tensile elements via anchor body E and the bearing plate.

1.2.2.5 Fixed anchor F

The fixed anchor F comprises a basic body with an external thread, a bearing nut F with an internal thread, and a bearing plate. The bearing nut F, which is screwed on the basic body, is supported on the bearing plate. Same as to fixed anchor D within the structure, adjacent to the bearing plate helix and additional reinforcement are arranged centrically aligned with regard to the bearing plate.

The pre-assembled tendon is passed through a recess tube and the bearing plate. For details regarding the fixed anchor F, see Annex 5, Annex 10, Annex 11, and Annex 15.

After stressing, the force is transferred to the structure by the tensile elements via the basic body, the bearing nut F, and the bearing plate.

1.2.2.6 Fixed coupler C–K

For the fixed coupler C–K a coupling sleeve and a coupling spindle are employed. The fixed coupler C–K connects a second tendon, second construction stage, with a first tendon previously stressed on stressing anchor C, first construction stage.

Coupling is achieved by the coupling spindle that is screwed into the tensioning sleeve of the previously stressed tendon. The basic body of the second tendon is connected to the coupling spindle via the coupling sleeve. For details regarding the fixed coupler C–K, see Annex 5, Annex 7, Annex 11, Annex 12, and Annex 18.

1.2.2.7 Movable coupler K–K

For the movable coupler K–K two coupling sleeves and a coupling spindle are employed. The movable coupler K–K connects two tendons prior to stressing.

Coupling sleeves are screwed each on the basic bodies of both tendons to be coupled. Coupling is achieved by a coupling spindle that is screwed into the two coupling sleeves. For details regarding the movable coupler K–K, see Annex 12 and Annex 18.

1.3 Designation and range of the tendons

1.3.1 Designation

The tendon is designated by “SUSPA – Wire EX”, followed by a hyphen and the number of prestressing steel wires, extending up to 84 prestressing steel wires.

1.3.2 Prestressing steel wire

Only circular, plain prestressing steel wire with a nominal diameter of 7.0 mm and a nominal tensile strength of 1 670 or 1 770 N/mm^2 may be used. The dimensions and specifications of the prestressing steel wire are given in Annex 19.

1.3.3 Maximum stressing forces

The prestressing and overstressing forces are specified in the respective standards and regulations in force at the place of use. Annex 4 lists the maximum prestressing and overstressing forces of the tendons according to Eurocode 2. Overstressing is only permitted, if the force in the prestressing jack can be measured with an accuracy of ± 5 % of the final overstressing force.

Intermediate tendon sizes may be developed from the basic sizes by reducing the number of prestressing steel wires. Thereby the prestressing steel wires are arranged in the best possible radially symmetric way, see Clause 1.2.2.1. The maximum prestressing forces are reduced proportionately to the number of prestressing steel wires.

1.4 Centre spacing and edge distances, concrete cover

Depending on the actual mean compressive strength of concrete at the time of stressing, $f_{cm, 0}$, the centre and edge distances of the anchor are given in Annex 7 and Annex 11. However, the centre and edge distances of anchors may be reduced in one direction by up to 15 %, but not smaller than the outer diameter of the helix and the bearing plate or multi plane anchor body dimensions and placing of additional reinforcement remains still possible. In case of reduction of the distances in one direction, the centre and edge distances in the perpendicular direction are increased by the same percentage in order to keep an equal concrete area in the anchorage zone.

Standards and regulations on concrete cover in force at the place of use are observed.

1.5 Concrete strength at time of stressing

Normal concrete according to EN 206 is used.

At the time full prestressing force is transmitted to the concrete structure, the actual mean cube compressive strength of concrete, $f_{cm, 0, cube}$, is at least as given in Annex 7 and Annex 11, i.e., $f_{cm, 0, cube}$ = 33 N/mm^2 or 40 N/mm^2. The actual mean compressive strength, $f_{cm, 0, cube}$, is verified by at least three specimens, cube of size 150 mm, that are cured under the same conditions as the structure.

For partial prestressing with 30 % of the full prestressing force the actual mean concrete compressive strength is at least $0.5 \cdot f_{cm, 0, cube}$. Intermediate values may be interpolated linearly according to Eurocode 2.

1.6 Slip at anchorages and couplers

The impact of slip at anchor and coupler is taken into account for the calculation and determination of the elongation at stressing. The slip per tendon end does not exceed 1 mm.

1.7 Deflection

1.7.1 Deviators

The deviators are designed in accordance with Annex 13 and Annex 14. The deflection half shells are trumpet-shaped at their ends. The trumpet-shaped extension allows compensating angular tolerances. Grease is applied on the contact surface between PE duct and deflection half shells.

Deviators may be open or closed. Where a tendon is placed on a member or passing through a member of the structure, deviator or aperture have such dimensions as to avoid any unintended contact of tendon and structure. In detailing the construction tolerances are taken into account.

1.7.2 Minimum radii of curvature

Depending on the tendon size, the minimum radii of curvature are given in Annex 14.

If these radii are observed, prestressing steel edge stresses in the area of curvature do not need to be verified.

1.8 Friction losses

For calculation of loss of prestressing force due to friction Coulomb's law applies. Calculation of friction loss is by the equation

$$F_x = F_0 \cdot e^{-\mu \cdot \alpha}$$

Where

F_x ....kN ....prestressing force at a distance x along the tendon

F_0 ....kN ....prestressing force at x = 0 m

μ .... rad^{-1}............friction coefficient, see Table 3

α .... rad .... sum of the angular displacements over distance x, irrespective of direction or sign

x .... m .... distance along the tendon from the point where prestressing force is equal to F_0

NOTE 1 1 rad = 1 m/m = 1

NOTE 2 Wobble effect can be neglected for external tendons

Table 3 Friction coefficient μ

PE duct		
μ	rad^{-1}	0.06

1.9 Reinforcement in the anchorage zone

Steel grades and dimensions of helix and additional reinforcement specified in Annex 7, Annex 11, and Annex 20 are conformed to in any case. Centric position of the helix, if present, is secured by welding the end ring onto the bearing plate or by tying to the reinforcement.

If required for a specific project design, the reinforcement given in Annex 7 and Annex 11 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and DYWIDAG-Systems International GmbH in order to provide equivalent performance.

Components

1.10 Prestressing steel wire

The prestressing steel wire is suitable for cold-upsetting of button heads. In the course of preparing the European Technical Assessment no characteristic has been assessed for the prestressing steel wires. In execution, a suitable prestressing steel wire that conforms to Annex 19 and is according to the standards and regulations in force at the place of use is applied.

1.11 Anchorages and couplers

1.11.1 General

The anchor and coupler components conform to the specifications given in the Annexes and in the technical file[3] of the European Technical Assessment. The technical file specifies dimensions, materials, information regarding the material identification of the components including tolerances and the materials used in the corrosion protection system.

1.11.2 Basic body

The basic body serves for all anchors and couplers, except for fixed anchor E, to transfer the prestressing force from the prestressing steel wires to the anchor or coupler, see Annex 1, Annex 2, and Annex 3. An external thread is provided on the basic body to screw on tensioning sleeve, bearing nut D, bearing nut F, or coupling sleeve.

1.11.3 Tensioning sleeve

The tensioning sleeve provides both an external and an internal thread. It serves to transfer the prestressing force from basic body to bearing nut C in stressing anchor C, see Annex 1, Annex 2, Annex 5, Annex 6, Annex 8. Furthermore, the sleeve receives the tensioning spindle during stressing. As regards fixed couplers C-K, see Annex 2 and Annex 12, the coupling spindle is screwed into the tensioning sleeve to couple the tendons.

[3] The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

1.11.4 Bearing nuts C, D, and F

The principal layout of these bearing nuts is identical.

Bearing nut C is used for the stressing anchor C and fixed coupler C-K. The internal thread of bearing nut C is screwed on the external thread of the tensioning sleeve, see Annex 1, Annex 2, Annex 5, Annex 6, and Annex 8. During stressing, bearing nut C on the tensioning sleeve is screwed up to the bearing plate or multi plane anchor body.

Bearing nut D, which is screwed on the basic body of the fixed anchor, directly transfers the prestressing force from basic body to bearing plate or multi plane anchor body, see Annex 1, Annex 5, Annex 6, and Annex 8.

Bearing nut F, which is screwed on the basic body of the fixed anchor, directly transfers the prestressing force from basic body to bearing plate, see Annex 1, Annex 5, and Annex 10.

1.11.5 Anchor body E

Anchor body E is for fixed anchors only. It transfers the prestressing force from the prestressing steel wires directly to the bearing plate, see Annex 1, Annex 5, and Annex 9.

1.11.6 Coupling sleeve

The coupling sleeve is used to connect the basic bodies with the coupling spindle in fixed and movable couplers, see Annex 2 and Annex 12. Compared to the tensioning sleeve, the coupling sleeve provides no external thread.

1.11.7 Coupling spindle

In case of fixed coupler C–K, the coupling spindle serves to connect the second tendon to the previously stressed first tendon and, in case of the movable coupler K–K, to connect the two tendons. The coupling spindle has external threads on both ends, which for the fixed coupler C-K are screwed into the tensioning sleeve and into the coupling sleeve and for the movable coupler K–K are screwed into both coupling sleeves, see Annex 2 and Annex 12.

1.11.8 Bearing plate

The bearing plate, which is of circular shape, has a central hole to pass through the tendon.

The bearing plate is used together with stressing anchor C, fixed anchor D, fixed anchor E, fixed anchor F, and at the side of the first tendon, first construction stage, of fixed coupler C–K, see Annex 1, Annex 2, Annex 8, Annex 9, Annex 10, Annex 11, and Annex 12.

1.11.9 Multi plane anchor body

The multi plane anchor body is of circular shape with a central aperture for the tendon and transfers the tendon force by two load transfer planes into the concrete, see Annex 1, Annex 2, Annex 6, and Annex 7.

The multi plane anchor is used together with stressing anchor C, fixed anchor D, and at the side of the first tendon, first construction stage, of fixed coupler C–K, see Annex 1, Annex 2, Annex 6, Annex 7, and Annex 12.

1.11.10 Button heads of the prestressing steel wires

From prestressing steel wire to basic body and anchor body E the force is transferred by button heads. The button heads may only be cold-upset on suitable prestressing steel wires by means of a special equipment. Diameters and heights of the button heads conforms to the technical file.

1.11.11 Head retaining disc

The head retaining disc is installed on all basic bodies and anchor bodies E of stressing and fixed anchors as well as of couplers.

1.12 Permanent corrosion protection

1.12.1 General

In the course of preparing the European Technical Assessment, no characteristic has been assessed for components and materials of the corrosion protection system referred to in the Clauses 1.12.2 to 1.12.4. In execution, all components or materials are selected according to the standards and regulations in force at the place of use. In the absent of such standards or regulations, components and materials in accordance with EAD 160004-00-0301 are deemed as acceptable. Österreichisches Institut für Bautechnik has been notified about such materials.

1.12.2 Corrosion protecting filling materials

The prestressing steel wires are coated with corrosion protecting filling materials at the factory and subsequently the duct is filled with the same filling material.

The technical specifications of the corrosion protecting filling materials are deposited with Österreichisches Institut für Bautechnik.

1.12.3 Corrosion protection for anchors and couplers

Corrosion protection is applied in accordance with Annex 15 to Annex 18. If installed in an area protected from UV radiation also PE anchor caps according to Annex 16 may be used for stressing anchors C, and fixed anchors D, fixed anchors E, or fixed anchors F. If installed in a non-UV protected area, steel anchor caps are installed, see Annex 17.

Where the couplers are not installed in a closed hollow box girder or protected against UV radiation by different means, a second shrinkable sleeve is shrunk over each first shrinkable sleeve of the couplers as protection to UV radiation.

1.12.4 Corrosion protection of exposed steel parts

Surfaces of all steel parts not protected by a sufficiently thick cover of concrete or by corrosion protecting filling material and PE duct are protected against corrosion by one of the protection systems in accordance with EN ISO 12944-5, unless they consist of stainless steel.

The surface is prepared in accordance with EN ISO 12944-4. EN ISO 12944-7 is observed for the execution of the corrosion protection. If other corrosion protection systems are used, these correspond to those stated above as far as their efficiency is concerned.

1.13 Material specifications of the components

Material specifications of the components are given in Annex 20.

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

2.1 Intended use

The PT system is intended to be used for the prestressing of structures. The specific intended use is

– External tendon for concrete and composite structures with a tendon path situated outside the cross section of the structure member but inside the envelope.

2.2 Assumptions

2.2.1 General

Concerning product packaging, transport, storage, maintenance, replacement, and repair it is the responsibility of the manufacturer to undertake the appropriate measures and to advise his clients on transport, storage, maintenance, replacement, and repair of the product as he considers necessary.

2.2.2 Packaging, transport and storage

Tendons with anchors are assembled at the factory, i.e., pre-assembled tendons.

Advice on packaging, transport, and storage includes.

- During transport of the tendons a minimum radius of curvature of 0.90 m is observed.
- Temporary protection of prestressing steel and components in order to prevent corrosion during transportation from the production site to the job site
- Transportation, storage, and handling of the prestressing steel and other components in a manner as to avoid damage by mechanical or chemical impact
- Protection of tensile elements and other components from moisture
- Keeping tensile elements separate from areas where welding operations are performed

2.2.3 Design

2.2.3.1 General

Advice on design includes the following items.

Design of the structure permits correct installation and stressing of tendons, and design and reinforcement of the anchorage zone permits correct placing and compacting of concrete.

Verification of transfer of prestressing forces to structural concrete is not required if centre and edge distances of the tendons as well as grade and dimensions of helix and additional reinforcement, see Annex 7, Annex 11, and Clause 1.4, are conformed to. Forces outside the area of helix and additional reinforcement are verified and, if required, covered by appropriate reinforcement. In general, reinforcement of the structure may not be taken into consideration as additional reinforcement. Reinforcement exceeding the required reinforcement of the structure may be used as additional reinforcement, if adequate placing is possible.

If required for a specific project design, the reinforcement given in Annex 7 and Annex 11 may be modified in accordance with the respective regulations in force at the place of use as well as with the relevant approval of the local authority and DYWIDAG-Systems International GmbH in order to provide equivalent performance.

The initial prestressing force applied to the stressing anchor will decrease especially as a result of friction along the tendon and of the elastic shortening of the structure and in the course of time as a result of creep and shrinkage of concrete and of relaxation of prestressing steel. Advice is provided by stressing instructions prepared by DYWIDAG-Systems International GmbH.

The design of the structure should consider protection of the external tendons against damage by e.g., impact of vehicles, vibrations, etc.

2.2.3.2 Helix and additional reinforcement

The centric position of the helix is secured by welding the end ring to the bearing plate or by fastening to the reinforcement.

Additional reinforcement is installed according to Annex 7 or Annex 11 adjacent to bearing plate or multi plane anchor body.

2.2.3.3 Fixed couplers C-K

Under all possible load combinations, the prestressing force at the second construction stage is at no time greater than at the first construction stage, neither during construction nor in the final state.

2.2.3.4 Tendons in steel structures

Post-tensioning kits are primarily used in structures made of concrete. They can, however, be used with other structural materials, e.g., in steel structures. However, there is no particular assessment in EAD 160004-00-0301 for these applications. Hence, load transfer of stressing force from the anchorage to the steel structure is via steel members, designed according to Eurocode 3.

The steel members have such dimensions as to permit a force of 1.1 · F_{pk} being transferred into the steel structure. The verification is performed according to Eurocode 3 as well as to the respective standards and regulations in force at the place of use.

2.2.4 Installation

2.2.4.1 General

It is assumed that the product will be installed according to the manufacturer's instructions or – in absence of such instructions – according to the usual practice of the building professionals.

Assembly and installation of tendons are only carried out by qualified PT specialist companies with the required resources and experience in the use of external multi-wire post-tensioning systems, see CWA 14646. The company's PT site manager has a certificate, stating that she or he has been trained by DYWIDAG-Systems International GmbH and that she or he possesses the necessary qualification and experience with the external prestressing system, "SUSPA – Wire EX".

Anchor plate and anchor body are placed perpendicular to the tendon's axis. At the anchorages the tendon layout continues with a straight length. Couplers are only placed in straight tendon sections.

The respective standards and regulations in force at the place of use are considered.

2.2.4.2 Anchors

2.2.4.2.1 Stressing anchor C

Installation on site includes the following working steps.

- Installation of the tendon through the aperture, the recess tube, and the bearing plate or multi plane anchor body.
- Screwing the tensioning sleeve on the basic body.
- Place bearing nut C accordingly, to screw it on the tensioning sleeve during stressing.
- Stressing the tendon by means of a tensioning spindle screwed into the tensioning sleeve.
- Applying the prestressing force and screwing bearing nut C to bearing plate or multi plane anchor body.
- Providing the steel parts of the anchor with corrosion protection, see Annex 15.

The minimum engagement depths of the threaded parts in accordance with Annex 5 are observed.

2.2.4.2.2 Fixed anchor D

Installation on site includes the following working steps.

- Installation of the tendon through the aperture, the recess tube, and the bearing plate or multi plane anchor body.
- Screwing the bearing nut D on the basic body.
- Providing the steel parts of the anchor with corrosion protection after stressing, see Annex 15.

The minimum engagement depths of the threaded parts in accordance with Annex 5 are observed.

2.2.4.2.3 Fixed anchor E

Installation on site includes the following working steps.

- Installation of the tendon through the bearing plate, the aperture, and the recess tube.
- Anchor body E is pre-assembled on the tendon. The tendon is threaded from the anchorage through bearing plate, recess tube, and aperture.
- Providing the steel parts of the anchor with corrosion protection after stressing, see Annex 15.

2.2.4.2.4 Fixed anchor F

Installation on site includes the following working steps.

- Installation of the tendon through the aperture, the recess tube, and the bearing plate.
- Screwing the bearing nut F on the basic body.
- Providing the steel parts of the anchor with corrosion protection after stressing, see Annex 15.

The minimum engagement depths of the threaded parts in accordance with Annex 5 are observed.

2.2.4.3 Couplers

2.2.4.3.1 Fixed coupler C-K

The fixed coupler C-K connects a second tendon with a previously stressed first tendon.

The anchor at the fixed coupler C-K in the already stressed first construction stage is equivalent to the stressing anchor C with bearing plate or multi plane anchor body. The anchor of first construction stage is installed perpendicular to the tendon's axis of the first construction stage with the same procedure as the stressing anchor C. The layout of tendon axis first construction stage coincides with tendons axis of the second construction stage.

Installation of the second construction stage on site includes the following working steps.

- Screwing the coupling spindle into the tensioning sleeve of the previously stressed first tendon.
- Screwing the coupling sleeve on the basic body of the tendon to be attached and on the coupling spindle.
- Providing the steel parts of the fixed coupler C-K with corrosion protection in accordance with Annex 18 after stressing of the second construction stage.

The minimum engagement depths of the threaded parts in accordance with Annex 5 and Annex 12 are observed.

2.2.4.3.2 Movable coupler K-K

The movable coupler K-K connects two tendons prior to stressing. The installation on site includes the following working steps.

- Screwing coupling sleeves on the basic bodies of the tendons to be coupled.
- Screwing the coupling spindle into the coupling sleeve screwed on the first basic body.
- Screwing the coupling sleeve of the second tendon on the coupling spindle.
- Providing the steel parts of the movable coupler K-K with corrosion protection in accordance with Annex 18 before or after stressing.

The minimum engagement depths of the threaded parts in accordance with Annex 12 are observed.

2.2.4.4 Checking of tendons

During installation, careful handling of the tendons is ensured. Prior to the stressing operation, the person responsible performs a final check on the installed tendons.

2.2.4.5 Exchanging tendons

Exchange of tendons is permitted. The specifications for exchangeable tendons are defined during the design phase. Stressing and fixed anchorages are accessible and adequate space is provided behind the anchorages.

2.2.4.6 Stressing and stressing records

2.2.4.6.1 Stressing

With a mean concrete compressive strength in the anchorage zone conforming to the specifications in Annex 7, Annex 11, and Clause 1.5 full prestressing may be applied.

The prestressing forces are applied in accordance with a specified stressing schedule. This schedule includes the required mean compressive strength of the concrete, time and sequence of the tendons to be stressed, the various prestressing levels, and the elongations calculated for the tendons, as well as time, and way of lowering and removal of the formwork. Any possible spring back forces of the formwork are taken into account.

2.2.4.6.2 Restressing

Restressing or relaxing the prestressing force is possible at any time. The minimum engagement depths of the threaded parts are observed.

2.2.4.6.3 Stressing records

In particular prestressing forces applied and elongation measured, and any important observations made during the stressing operation are documented in the stressing records.

2.2.4.6.4 Stressing equipment, space requirements, and safety-at-work

For stressing, hydraulic jacks are used. Information about the stressing equipment has been submitted to Österreichisches Institut für Bautechnik.

Clearance is considered directly behind the anchors to stress the tendons. DYWIDAG-Systems International GmbH keeps for reference more detailed information on the prestressing jacks used and the required clearance for handling and stressing.

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

2.2.4.7 Welding on anchor

Welding on anchors is permitted on the following parts only.

– Welding the helix end turn to a closed ring.

– Fastening the helix to the bearing plate.

Welding of the helix end turn may be omitted, if the helix is extended by 1.5 additional turns, see Annex 11.

After the tendons have been installed, welding operations shall not be conducted any more. In case of welding operation close to tendons precautionary measures are required to avoid any damage.

Plastic material may be welded after installation of the tendons.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the PT system of 100 years, provided that the PT system is subject to appropriate installation, use, and maintenance, see the Clause 2.2. These provisions are based upon the current state of the art and the available knowledge and experience.

In normal use conditions, the real working life may be considerably longer without major degradation affecting the basic requirements for construction works[4].

The indications given as to the working life of the construction product cannot be interpreted as a guarantee, neither given by the product manufacturer or his representative nor by EOTA nor by the Technical Assessment Body, but are regarded only as a means for expressing the expected economically reasonable working life of the product.

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

3.1 Essential characteristics

The performances of the PT system for the essential characteristics are given in Table 4.

Table 4 Essential characteristics and performances of the product

№	Essential characteristic	Product performance
Basic requirement for construction works 1: Mechanical resistance and stability		
1	Resistance to static load	See Clause 3.2.1.1.
2	Resistance to fatigue	See Clause 3.2.1.2.
3	Load transfer to structure	See Clause 3.2.1.3.
4	Friction coefficient	See Clause 3.2.1.4.
5	Deviation, deflection (limits) for external tendon	See Clause 3.2.1.5.
6	Assessment of assembly	See Clause 3.2.1.6.
7	Corrosion protection	See Clause 3.2.1.7.
Basic requirement for construction works 2: Safety in case of fire		
8	Reaction to fire	See Clause 3.2.2.1.
Basic requirement for construction works 3: Hygiene, health, and the environment		
9	Content, emission, and/or release of dangerous substances	See Clause 3.2.3.1.
Basic requirement for construction works 4: Safety and accessibility in use		
—	Not relevant. No characteristic assessed.	—

[4] The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works are subject, as well as on the particular conditions of design, execution, use, and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the assumed working life.

№	Essential characteristic	Product performance
Basic requirement for construction works 5: Protection against noise		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 6: Energy economy and heat retention		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 7: Sustainable use of natural resources		
—	No characteristic assessed.	—

3.2 Product performance

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.1. The characteristic values of maximum force, F_{pk}, of the tendon with prestressing steel wires according to Annex 19 are listed in Annex 19.

3.2.1.2 Resistance to fatigue

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.2. The characteristic values of maximum force, F_{pk}, of the tendon with prestressing steel wires according to Annex 19 are listed in Annex 19.

Fatigue resistance of anchors and couplers was tested and verified with an upper force of $0.65 \cdot F_{pk}$, a fatigue stress range of 80 N/mm^2, and $2 \cdot 10^6$ load cycles.

3.2.1.3 Load transfer to structure

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.3. The characteristic values of maximum force, F_{pk}, of the tendon with prestressing steel wires according to Annex 19 are listed in Annex 19.

Conformity with the stabilisation and crack width criteria specified for the load transfer test was verified to a force level of $0.80 \cdot F_{pk}$.

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.8.

3.2.1.5 Deviation, deflection (limits) for external tendon

For minimum radii of curvature see Clause 1.7.2.

3.2.1.6 Assessment of assembly

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.7.

3.2.1.7 Corrosion protection

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.13.

3.2.2 Safety in case of fire

3.2.2.1 Reaction to fire

The performance of components made of steel or cast iron is Class A1 without testing.

The performance of components of other materials has not been assessed.

3.2.3 Hygiene, health, and the environment

3.2.3.1 Content, emission and/or release of dangerous substances

According to the manufacturer's declaration, the PT system does not contain dangerous substances.

– SVOC and VOC

  The performance of components made of steel or cast iron that are free of coating with organic material is no emission of SVOC and VOC.

  The performance of components of other materials has not been assessed.

– Leachable substances

  The product is not intended to be in direct contact to soil, ground water, and surface water.

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the PT system for the intended use, and in relation to the requirements for mechanical resistance and stability, safety in case of fire, and for hygiene, health and the environment, in the sense of the basic requirements for construction works № 1, 2, and 3 of Regulation (EU) № 305/2011, has been made in accordance with Annex A of EAD 160004-00-0301, Post-tensioning kits for prestressing of structures, for

– Item 5, External tendon.

3.4 Identification

The European Technical Assessment for the PT system is issued on the basis of agreed data that identify the assessed product[5]. Changes to materials, to composition, or to characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

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

4.1 System of assessment and verification of constancy of performance

According to Commission Decision 98/456/EC the system of assessment and verification of constancy of performance to be applied to the PT system is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1, and provides for the following items.

(a) The manufacturer shall carry out

  (i) factory production control;

  (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan[6].

[5] The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

[6] The prescribed test plan has been deposited with Österreichisches Institut für Bautechnik and is handed over only to the notified product certification body involved in the procedure for the assessment and verification of constancy of performance. The prescribed test plan is also referred to as control plan.

(b) The notified product certification body shall decide on the issuing, restriction, suspension or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body

(i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values or descriptive documentation of the product;

(ii) initial inspection of the manufacturing plant and of factory production control;

(iii) continuing surveillance, assessment, and evaluation of factory production control;

(iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

4.2 AVCP for construction products for which a European Technical Assessment has been issued

Notified bodies undertaking tasks under System 1+ shall consider the European Technical Assessment issued for the construction product in question as the assessment of the performance of that product. Notified bodies shall therefore not undertake the tasks referred to in Clause 4.1, point (b) (i).

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 kit manufacturer exercises permanent internal control of the production. All the elements, procedures, and specifications adopted by the kit manufacturer are documented in a systematic manner in the form of written policies and procedures.

– Control of the incoming materials

  The manufacturer checks the incoming materials to establish conformity with their specifications.

– Inspection and testing

  Kind and frequency of inspections, tests, and checks, conducted during production and on the final product normally include.

  – Definition of the number of samples taken by the kit manufacturer
  – Material properties e.g., tensile strength, hardness, surface finish, chemical composition, etc.
  – Determination of the dimensions of components
  – Check correct assembly
  – Documentation of tests and test results

All tests are performed according to written procedures with suitable calibrated measuring devices. All results of inspections, tests, and checks are recorded in a consistent and systematic way. The basic elements of the prescribed test plan are given in Annex 21, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the "SUSPA – Wire EX".

The results of inspections, tests, and checks are evaluated for conformity. Shortcomings request the manufacturer to immediately implement measures to eliminate the defects.

– Control of non-conforming products

  Products, which are considered as not conforming to the prescribed test plan, are immediately marked and separated from such products that do conform. Factory production control addresses control of non-conforming products.

– Complaints

  Factory production control includes procedures to keep records of all complaints about the PT system.

The records are presented to the notified product certification body involved in continuous surveillance and are kept at least for ten years after the product has been placed on the market. On request, the records are presented to Österreichisches Institut für Bautechnik.

At least once a year the manufacturer audits the manufacturers of the components given in Annex 22.

5.1.2 Declaration of performance

The manufacturer is responsible for preparing the declaration of performance. When all the criteria of the assessment and verification of constancy of performance are met, including the certificate of constancy of performance issued by the notified product certification body, the manufacturer draws up the declaration of performance. Essential characteristics to be included in the declaration of performance for the corresponding intended use are given in Table 4.

5.2 Tasks for the notified product certification body

5.2.1 Initial inspection of the manufacturing plant and of factory production control

The notified product certification body establishes 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 manufacturing of the PT system according to the given technical specifications. For the most important activities, EAD 160004-00-0301, Table 4 summarises the minimum procedure.

5.2.2 Continuing surveillance, assessment, and evaluation of factory production control

The activities are conducted by the notified product certification body and include surveillance inspections. The kit manufacturer is inspected at least once a year. Factory production control is inspected and samples are taken for independent single tensile element tests.

For the most important activities, the control plan according to EAD 160004-00-0301, Table 4 summarises the minimum procedure. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the control plan.

Each manufacturer of the components given in Annex 22 is audited at least once in five years. It is verified that the system of factory production control and the specified manufacturing process are maintained, taking account of the prescribed test plan.

The results of continuous surveillance are made available on demand by the notified product certification body to Österreichisches Institut für Bautechnik. When the provisions of the European Technical Assessment and the prescribed test plan are no longer fulfilled, the certificate of constancy of performance is withdrawn by the notified product certification body.

5.2.3 Audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer’s storage facilities

During surveillance inspections, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components Annex 22 summarises the minimum procedures. Annex 22 conforms to EAD 160004-00-0301, Table 4. In particular, at least once a year, the notified product certification body also carries out one single tensile element test series according to EAD 160004-00-0301, Annex C.7 and Clause 3.3.4 on specimens taken from the manufacturing plant or at the manufacturer's storage facility.

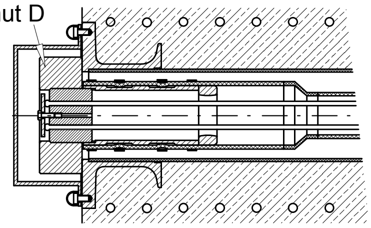
Issued in Vienna on 16 November 2020
by Österreichisches Institut für Bautechnik

The original document is signed by

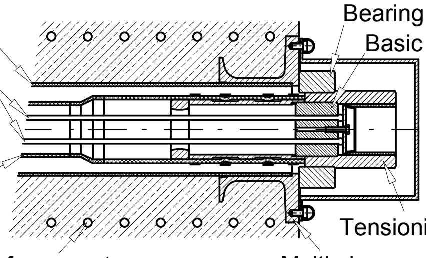
Rainer Mikulits
Managing Director

Bearing plate anchorage

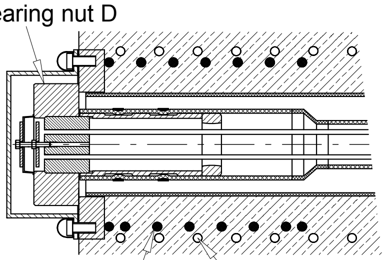
Fixed anchor D



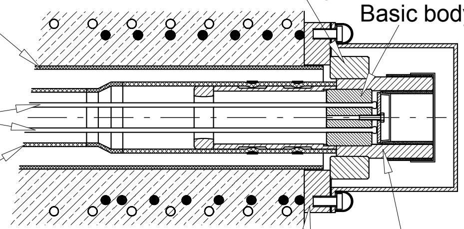
Stressing anchor C



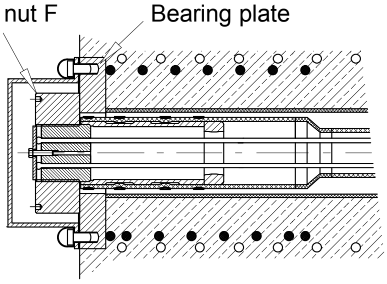
Fixed anchor D



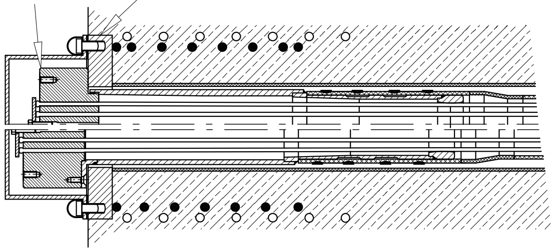
Stressing anchor C



Fixed anchor F



Fixed anchor E with thread or flange connection



Multi plane anchor body

Overview on tendons and anchorage assemblies, and maximum prestressing forces

Tendon SUSPA – Wire		EX-30	EX-36	EX-42	EX-48	EX-54	EX-60	EX-66	EX-72	EX-78	EX-84
Maximum prestressing force for Y1670C at 0.90 · $F_{p0.1}$	kN	1 528	1 834	2 139	2 445	2 751	3 056	3 362	3 668	3 973	4 279
Maximum prestressing force for Y1770C at 0.90 · $F_{p0.1}$	kN	1 617	1 941	2 264	2 588	2 911	3 235	3 558	3 882	4 205	4 528
Stressing anchor C	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fixed anchor D, E, and F	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Multi plane anchorage C and D	—	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Key
✓ ..... Available

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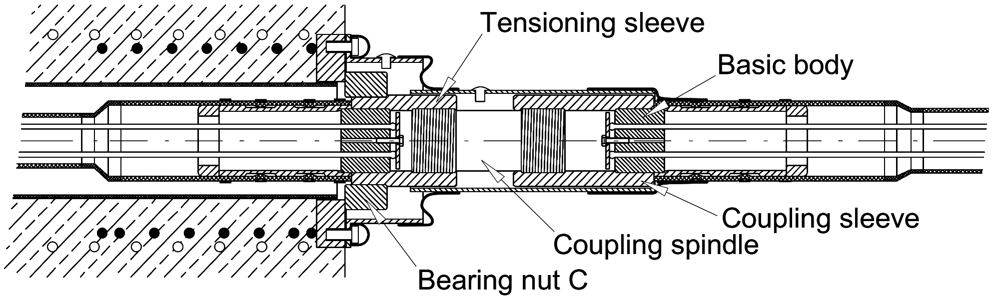
External prestressing system
SUSPA – Wire EX

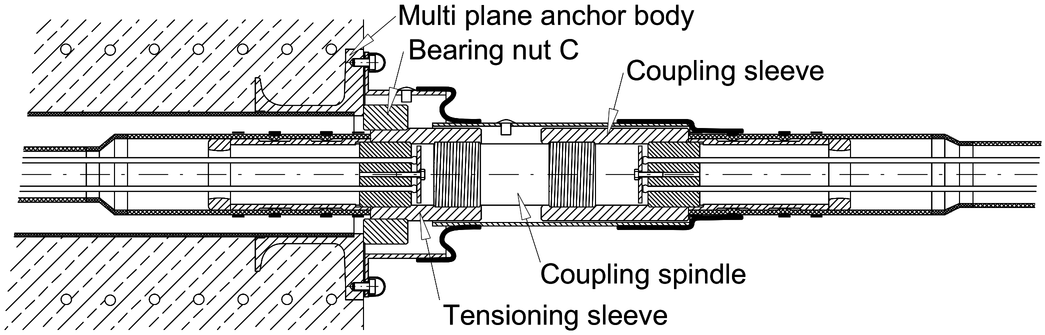
Anchorage assemblies – Overview

Annex 1
of European Technical Assessment
ETA-07/0186 of 16.11.2020

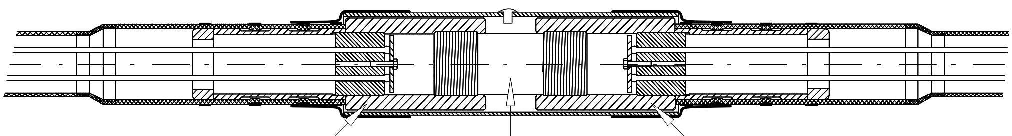
Fixed coupler C–K
with bearing plate anchorage



Fixed coupler C–K
with multi plane anchor body



Movable coupler K–K



Overview on tendons and coupler assemblies, and maximum prestressing forces

Tendon SUSPA – Wire		EX-30	EX-36	EX-42	EX-48	EX-54	EX-60	EX-66	EX-72	EX-78	EX-84
Maximum prestressing force for Y1670C at 0.90 · $F_{p0.1}$	kN	1 528	1 834	2 139	2 445	2 751	3 056	3 362	3 668	3 973	4 279
Maximum prestressing force for Y1770C at 0.90 · $F_{p0.1}$	kN	1 617	1 941	2 264	2 588	2 911	3 235	3 558	3 882	4 205	4 528
Fixed coupler C–K	—	✓	✓	✓	✓	✓	✓	✓	—	—	—
Movable coupler K–K	—	✓	✓	✓	✓	✓	✓	✓	—	—	—

Key
✓..... Available
—.... Not available

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External prestressing system
SUSPA – Wire EX

Coupler assemblies – Overview

Annex 2
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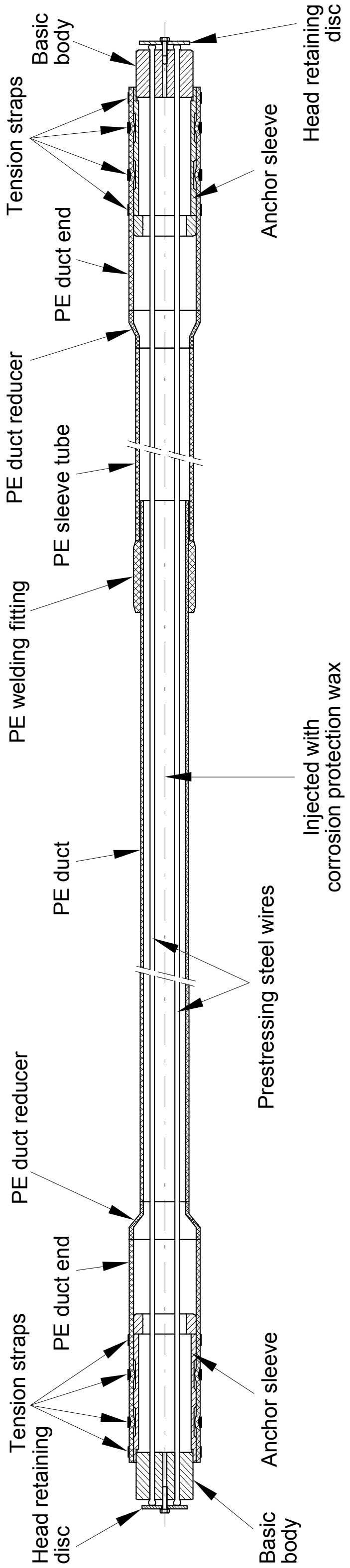
Tendon including sheathing scheme
Tendon after prefabrication



DYWIDAG DYWIDAG-Systems International GmbH Phone: +49/89/309050-100 E-Mail: dsihv@dywidag-systems.com	**External prestressing system** **SUSPA – Wire EX** Sheathing scheme	**Annex 3** of European Technical Assessment **ETA-07/0186** of 16.11.2020

Number of wires	Wire mass	Cross-sectional area of wires	f_{pk} = 1 670 N/mm²		f_{pk} = 1 770 N/mm²	
			Maximum prestressing force	Maximum overstressing force	Maximum prestressing force	Maximum overstressing force
		A_p	$A_p \cdot 0.90 \cdot f_{p0.1}$	$A_p \cdot 0.95 \cdot f_{p0.1}$	$A_p \cdot 0.90 \cdot f_{p0.1}$	$A_p \cdot 0.95 \cdot f_{p0.1}$
—	kg/m	mm²	kN	kN	kN	kN
30	9.0	1 155	1 528	1 613	1 617	1 707
36	10.8	1 386	1 834	1 936	1 941	2 049
42	12.6	1 617	2 139	2 258	2 264	2 390
48	14.4	1 848	2 445	2 581	2 588	2 731
54	16.2	2 079	2 751	2 904	2 911	3 073
60	18.0	2 310	3 056	3 226	3 235	3 414
66	19.8	2 541	3 362	3 549	3 558	3 756
72	21.7	2 772	3 668	3 871	3 882	4 097
78	23.5	3 003	3 973	4 194	4 205	4 439
84	25.3	3 234	4 279	4 517	4 528	4 780

Notes

$A_p \cdot 0.90 \cdot f_{p0.1} = 0.90 \cdot F_{p0.1}$ ....Maximum prestressing force

$A_p \cdot 0.95 \cdot f_{p0.1} = 0.95 \cdot F_{p0.1}$ ....Maximum overstressing force

For $F_{p0.1} = A_p \cdot f_{p0.1}$ see Annex 19.

By omitting wires in anchorages and couplers in a radially symmetrical way, also tendons with numbers of wires lying between the numbers given above can be installed. Any unnecessary hole remains undrilled.

With regard to dimensions and reinforcement, anchorages and couplers with omitted wires remain unchanged compared to anchorages and couplers with a full number of wires.

Each omitted wire reduces mass, cross-sectional area, and prestressing force of the tendon by the figures given in the following table.

Number of wires	Wire mass	Cross-sectional area of wires	f_{pk} = 1 670 N/mm²		f_{pk} = 1 770 N/mm²	
			Maximum prestressing force	Maximum overstressing force	Maximum prestressing force	Maximum overstressing force
		A_p	$A_p \cdot 0.90 \cdot f_{p0.1}$	$A_p \cdot 0.95 \cdot f_{p0.1}$	$A_p \cdot 0.90 \cdot f_{p0.1}$	$A_p \cdot 0.95 \cdot f_{p0.1}$
—	kg/m	mm²	kN	kN	kN	kN
1	0.300	38.5	50.9	53.8	53.9	56.9

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External prestressing system

SUSPA – Wire EX

Maximum prestressing and overstressing forces

Annex 4

of European Technical Assessment
ETA-07/0186 of 16.11.2020

Technical data for tendons EX-30 to EX-84

Tendon	SUSPA – Wire Preferred sizes X	EX-30	EX-36 X	EX-42	EX-48	EX-54 X	EX-60	EX-66 X	EX-72	EX-78	EX-84 X
Pipes											
PE recess tube C and D	Ø d_{a1} × s	140 × 4.3	160 × 4.9	180 × 5.5	180 × 5.5	180 × 5.5	200 × 6.2	200 × 6.2	200 × 6.2	200 × 4.9	200 × 4.9
Steel recess tube E and F	Ø d_{a1} × s	139.7 × 4	1159 × 5	177.8 × 5	177.8 × 5	177.8 × 5	203 × 5.6	203 × 5.6	203 × 5.6	203 × 5.6	203 × 5.6
Recess tube E	Ø d_{a1}	114.3	121	127	133	133	146	152.4	152.4	159	159
Duct type 1	Ø d_{a2} × s	63 × 3.8	63 × 3.8	75 × 4.3	75 × 4.3	75 × 4.3	83 × 4.7	83 × 4.7	87 × 5.0	90 × 5.1	90 × 5.1
Duct type 2	Ø d_{a2} × s	75 × 4.3	75 × 4.3	90 × 5.1	90 × 5.1	90 × 5.1	90 × 5.1	90 × 5.1	90 × 5.1	—	—
Characteristic friction coefficient	μ	0.06									
Anchoring components with thread C, D, and F											
Basic body											
Outer diameter of basic body	Ø G	80	88	95	98	98	108	117	117	121	121
Minimum engagement depth	D_v	46	50	60	60	76	70	78	86	90	96
Length of tensioning sleeve	L_z	140	150	170	170	200	190	200	220	235	250
Ext. thread of tensioning sleeve	Ø C_t	118	128	140	144	148	160	173	173	178	178
Bearing nut C	Ø M	170	190	210	215	222	242	245	249	253	257
Height	C_h	56	63	70	72	75	80	80	85	90	95
Minimum engagement depth	C_v	40	45	47	50	53	60	65	71	75	80
Bearing nut D	Ø M	170	190	210	215	222	242	245	249	253	257
Bearing nut F	Ø F	138	147	158	167	177	188	198	203	213	218
Height	D_h, F_h	62	70	75	78	83	88	90	95	100	105
Minimum engagement depth	D_v, F_v	46	50	60	60	76	70	78	86	90	96
Anchoring components fixed anchor E – Fixed anchor E is provided with duct type 1 or only for sizes EX-60, EX-66, and EX-72 with duct type 2											
Outer diameter	Ø E	138	147	158	167	177	188	198	203	213	218
Height overall	G_h	70	73	80	80	95	90	100	105	110	115
Height over bearing plate, thread connection	E_h	52	57	60	63	76	71	80	86	90	96
Thread diameter	Ø G	80	88	95	98	98	108	117	117	121	121
Height over bearing plate, flange connection	E_g	74	77	84	84	99	94	104	109	114	119

Dimensions in mm

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External prestressing system

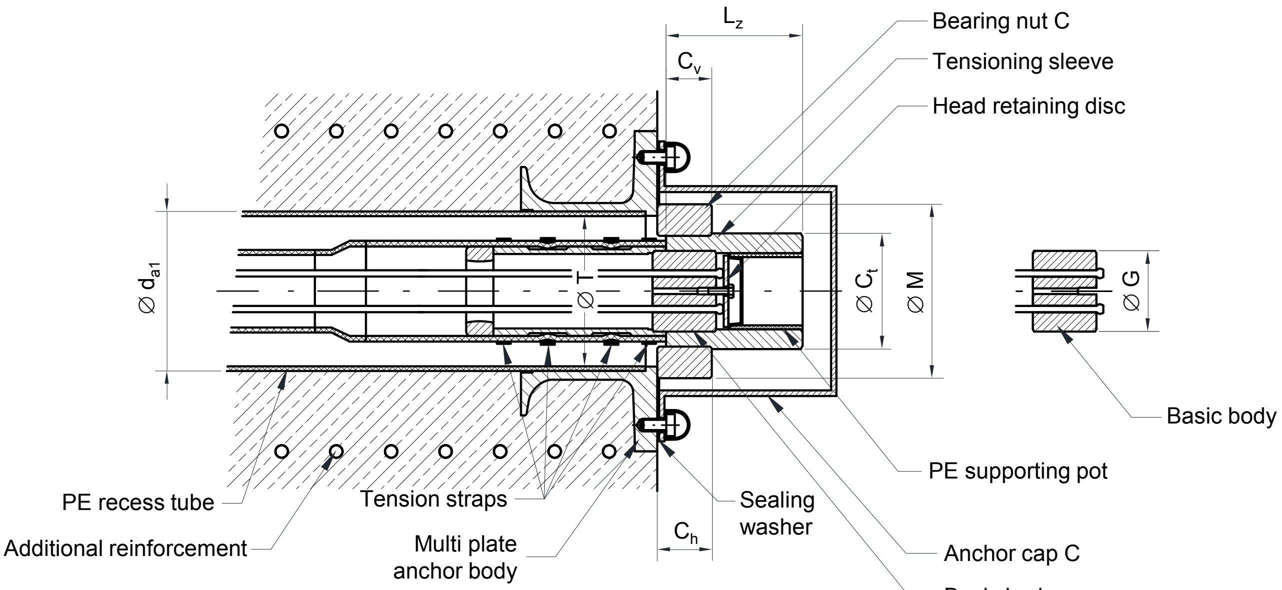
SUSPA – Wire EX

Technical data for anchorages C, D, E, and F – EX-30 to EX-84

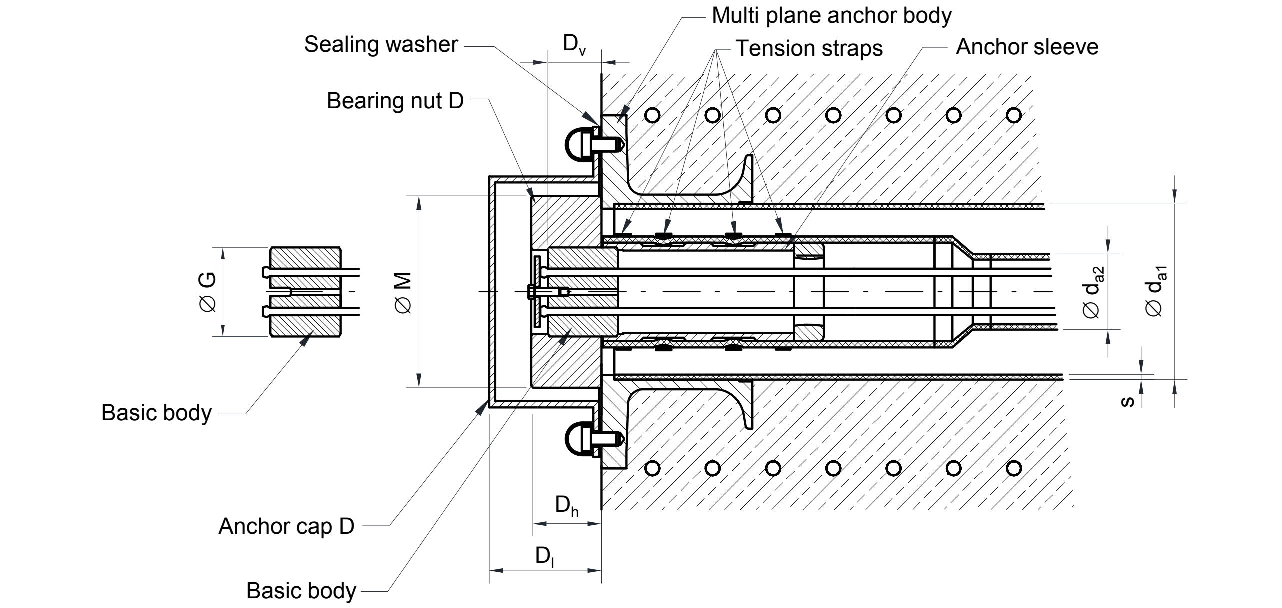
Annex 5
of European Technical Assessment
ETA-07/0186 of 16.11.2020

OiB Member of EOTA

Stressing anchor C



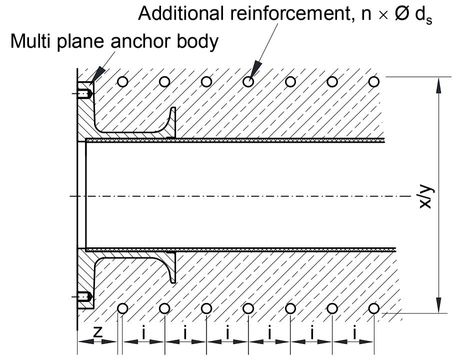
Fixed anchor D

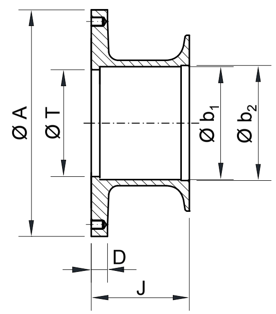


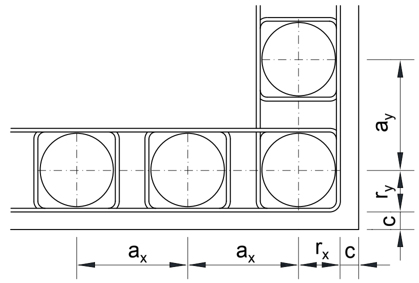
Above representations without corrosion protection, see Annex 15

DYWIDAG DYWIDAG-Systems International GmbH Phone: +49/89/309050-100 E-Mail: dsihv@dywidag-systems.com	**External prestressing system** **SUSPA – Wire EX** Stressing anchor C and fixed anchor D with multi plane anchor body Anchorage layout	**Annex 6** of European Technical Assessment **ETA-07/0186** of 16.11.2020

Multi plane anchor body
Stressing anchor C and fixed anchor D







Reinforcement as schematic example

Tendon SUSPA – Wire		EX-30 [1]	EX-36	EX-42	EX-48	EX-54	EX-60	EX-66	EX-72	EX-78	EX-84
Concrete strength $f_{cm, 0, cube 150}$ during prestressing	N/mm²	33	33	33	33	33	33	33	33	33	33
Multi plane anchor body											
Outer diameter	Ø A	276	276	322	322	322	367	367	367	387	387
Aperture	Ø T	152	152	172	172	172	192	192	192	193	193
Inner diameter	Ø b_1	163	163	183	183	183	203	203	203	203	203
Inner diameter notch	Ø b_2	171	171	197	197	197	207	207	207	207	207
Thickness	D	24	24	24	24	24	29	29	29	33	33
Height	J	132	132	154	154	154	175	175	175	185	185
Minimum anchor distances											
Edge distance (plus c) [2]	r_x/r_y	155	170	185	195	205	215	225	235	245	250
Centre distance	a_x/a_y	330	355	385	405	425	450	470	490	505	520
Additional reinforcement, ribbed reinforcing steel, $R_e \geq$ 500 N/mm²											
Bar diameter	Ø d_s	20	20	20	20	20	20	20	20	20	20
Edge distance	z	35	35	35	35	35	40	40	40	50	50
Distance	i	50	50	50	50	50	50	50	50	50	50
Number	n	5	5	6	7	7	7	7	8	8	8
External dimensions [3]	x/y	300	310	320	340	360	370	380	395	410	430

[1] Anchor EX-36 equipped with 30 prestressing steel wires only
[2] c … concrete cover
[3] The external dimensions x, y have to be met exactly.

Dimensions in mm

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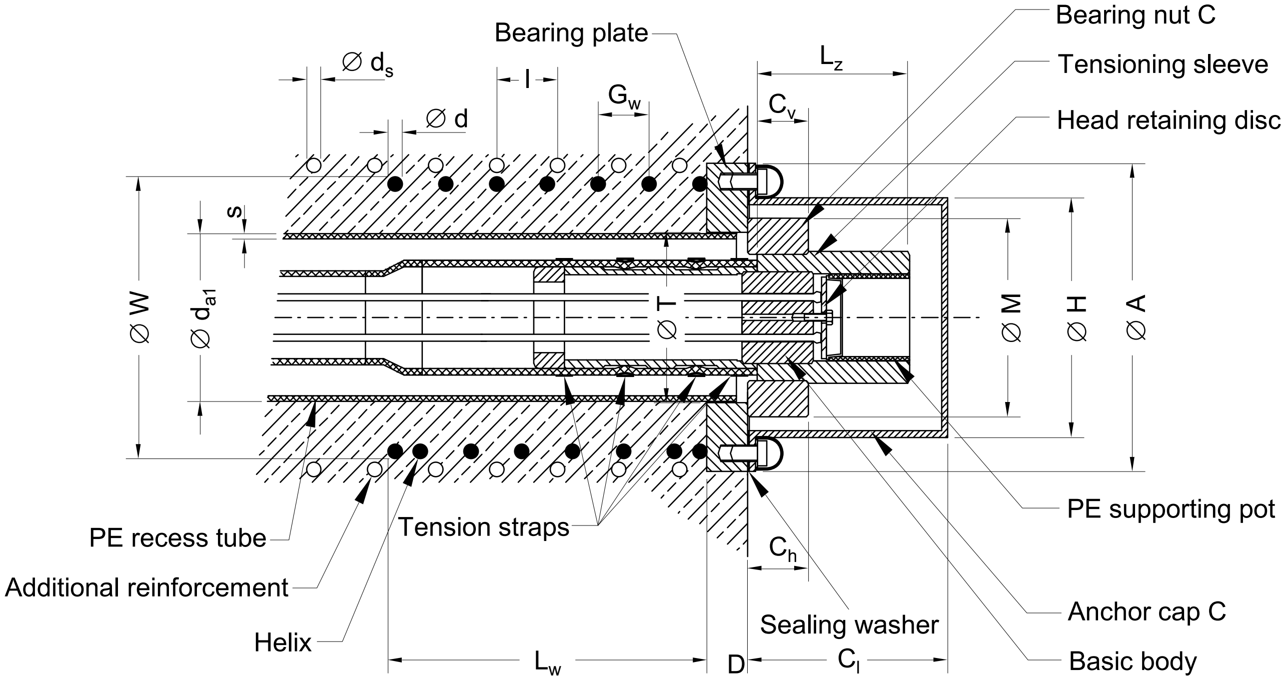
External prestressing system
SUSPA – Wire EX
Anchorage with multi plane anchor body
Centre and edge distances,
additional reinforcement
Stressing anchor C, fixed anchor D

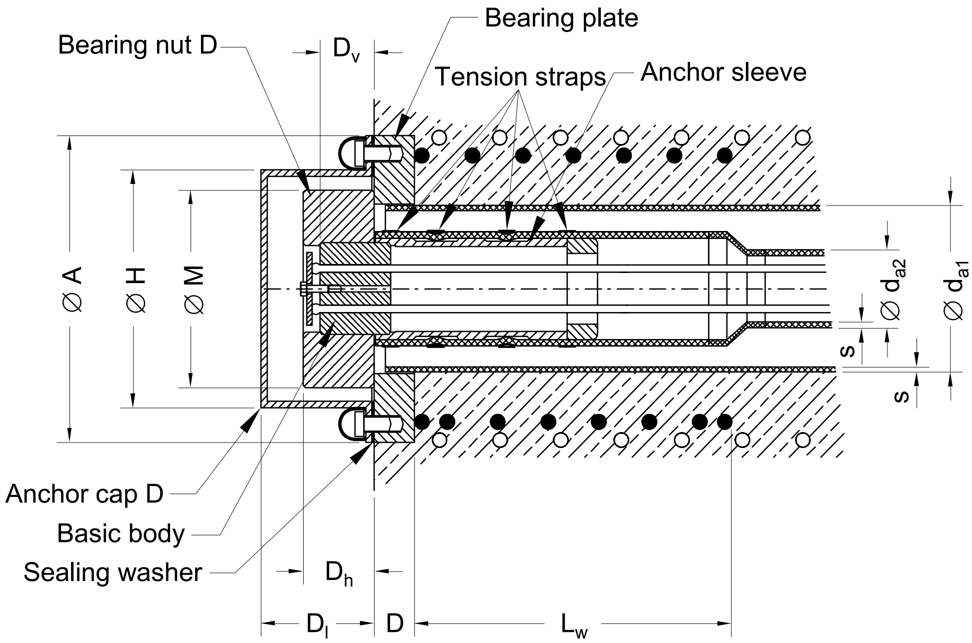
Annex 7
of European Technical Assessment
ETA-07/0186 of 16.11.2020

OIB Member of EOTA

Stressing anchor C



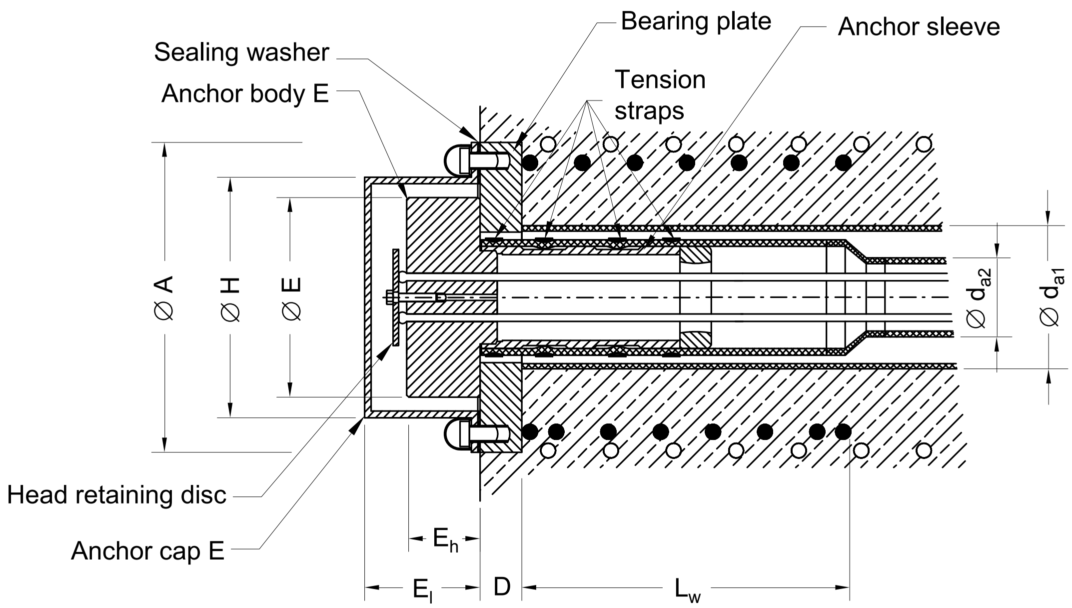
Fixed anchor D



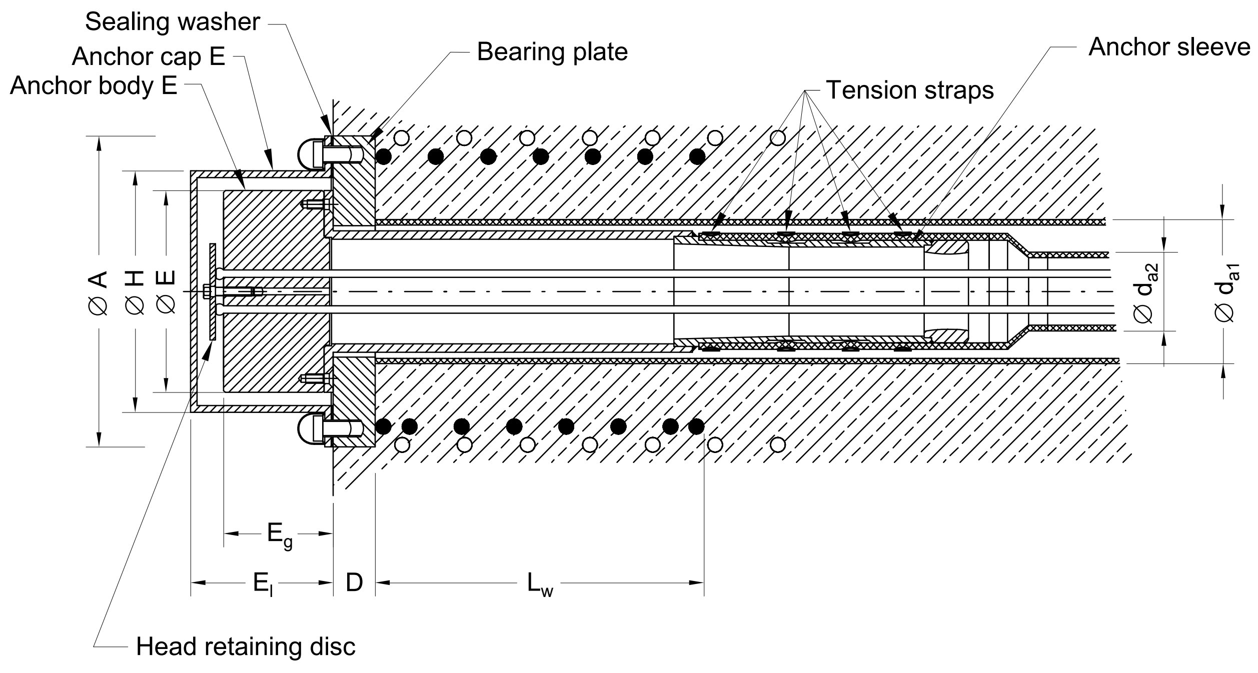
Above representations without corrosion protection, see Annex 15

DYWIDAG DYWIDAG-Systems International GmbH Phone: +49/89/309050-100 E-Mail: dsihv@dywidag-systems.com	**External prestressing system** **SUSPA – Wire EX** Stressing anchor C and fixed anchor D with bearing plate – Anchorage layout	**Annex 8** of European Technical Assessment **ETA-07/0186** of 16.11.2020

Fixed anchor E with thread connection



Fixed anchor E with flange connection



Fixed anchor E is applicable with bearing plate only.
Above representations without corrosion protection, see Annex 15
Applications with fixed anchor E shall be agreed with DYWIDAG-Systems International GmbH.

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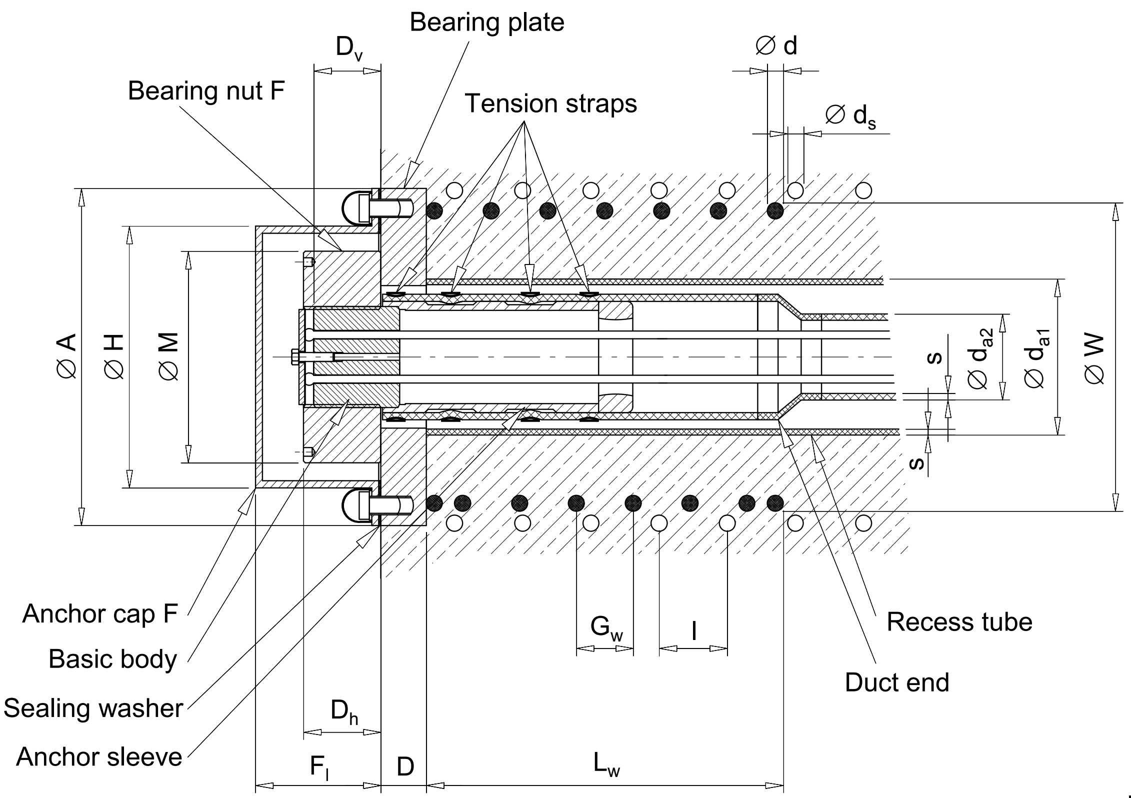
Fixed anchor F



Fixed anchor F is applicable with bearing plate only.
Above representations without corrosion protection, see Annex 15
Applications with fixed anchor F shall be agreed with DYWIDAG-Systems International GmbH.

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External prestressing system

SUSPA – Wire EX

Fixed anchor F with bearing plate
Anchorage layout

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of European Technical Assessment
ETA-07/0186 of 16.11.2020

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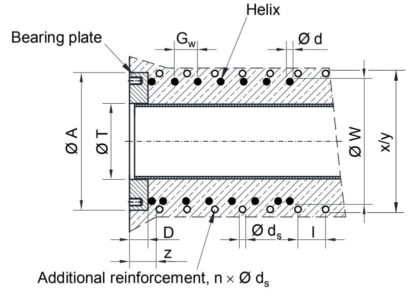
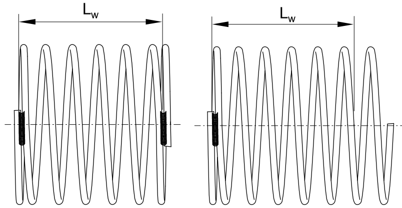
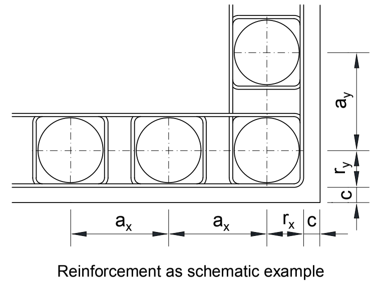
Bearing plate anchorage
Stressing anchor C and fixed anchor D, E and F







Tendon	SUSPA – Wire Preferred sizes X	EX-30		EX-36 X		EX-42		EX-48		EX-54 X		EX-60		EX-66 X		EX-72		EX-78		EX-84 X	
Bearing plates and helixes																					
Concrete strength $f_{cm, 0, cube 150}$ during prestressing	N/mm²	33	40	33	40	33	40	33	40	33	40	33	40	33	40	33	40	33	40	33	40
Bearing plate	Ø A	320		340		360		360		370		405		405		415	405	425	405	430	405
Aperture anchors C and D	max Ø T	143		163		183		183		183		203		203		203		203		203	
Aperture anchors E and F	max Ø T	101		109		118		121		122		133		141		141		148		148	
Thickness	D	50		55		60		60		60		55		55		60	55	60	55	60	55
Helix outer diameter	Ø W	300		330		330		350		360		410		410		420	410	430	410	440	410
Maximum pitch	G_w	50		50		50		50		50		50		50		50		50		50	
Minimum length	L_w	262		314		316		366		368		416		416		416		416		416	
Minimum wire diameter	Ø d	12		14		16		16		18		16		16		16		16		16	
Minimum anchor distances																					
Edge distance (plus c) [1]	r_x/r_y	165	155	180	170	185	175	200	180	210	185	230	215	240	225	250	230	255	235	265	240
Centre distance	a_x/a_y	350	330	380	360	385	360	415	375	440	390	480	450	500	470	520	480	530	490	545	500
Additional reinforcement, ribbed reinforcing steel, $R_e \geq$ 500 N/mm²																					
Bar diameter	Ø d_s	10	10	10	10	10	10	12	12	12	12	14	14	14	14	16	16	16	16	16	16
Edge distance	z	115	115	120	120	130	130	130	130	130	130	125	125	125	125	110	100	110	100	110	100
Distance	l	50	50	50	50	50	50	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Number	n	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	7
External dimensions [2]	x/y	330	310	360	340	365	340	395	355	420	370	460	430	480	450	500	460	510	470	525	480

Dimensions in mm

[1] c … Concrete cover
[2] The external dimensions x, y have to be met exactly.

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External prestressing system
SUSPA – Wire EX
Anchorage with bearing plate – Centre and edge distances, additional reinforcement – Stressing anchor C, fixed anchor D, E, and F

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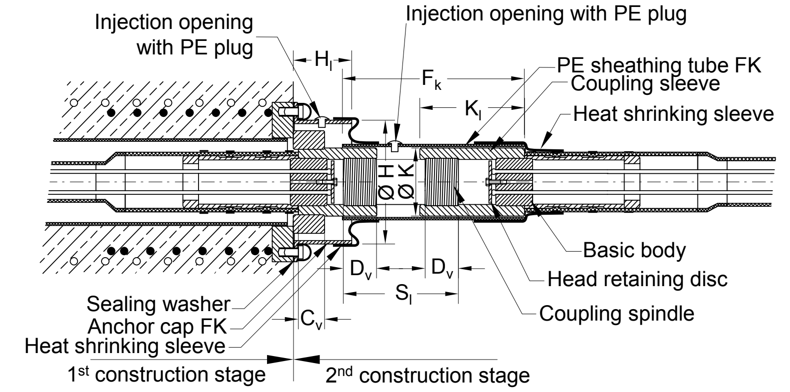
of European Technical Assessment
ETA-07/0186 of 16.11.2020

Fixed coupler C–K
Bearing plate

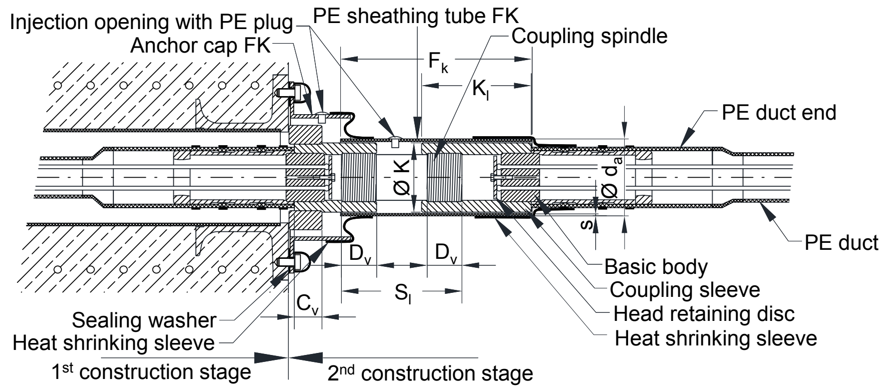
Stressing anchor C



Coupler K

Fixed coupler C–K
Multi plate anchor body

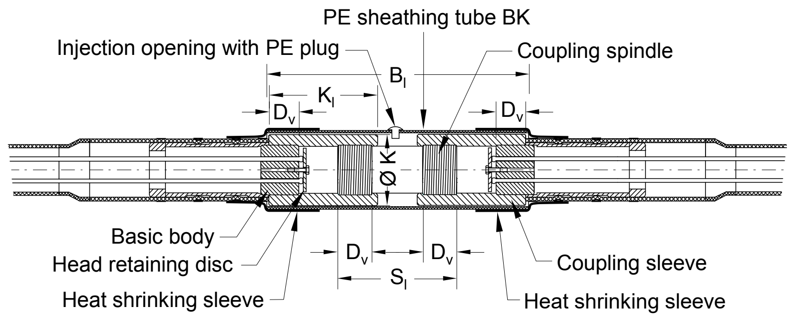
Stressing anchor C



Coupler K

Movable coupler K–K

Coupler K



Coupler K

Representations without corrosion protection, see Annex 18

Tendon	**SUSPA – Wire**	**EX-30**	**EX-36**	**EX-42**	**EX-48**	**EX-54**	**EX-60**	**EX-66**
Anchor cap FK (steel)	Ø H	229	254	279	279	279	298.5	298.5
min. length	H_l	100	100	110	110	110	120	120
PE sheath tubes								
min. length FK	F_k	400	430	510	510	620	640	700
min. length BK	B_l	500	530	630	630	670	700	750
external diameter	Ø d_a	140	160	160	180	180	200	200
Components with thread								
Coupling sleeve								
min. engagement depth	D_v	46	50	60	60	76	70	78
min. engagement depth	C_v	40	45	47	50	53	60	65
Outer diameter	Ø K	118	128	140	144	148	160	173
Length	K_l	180	200	240	240	300	305	335
Coupling spindle min. length	S_l	220	230	270	270	320	330	360

Dimensions in mm

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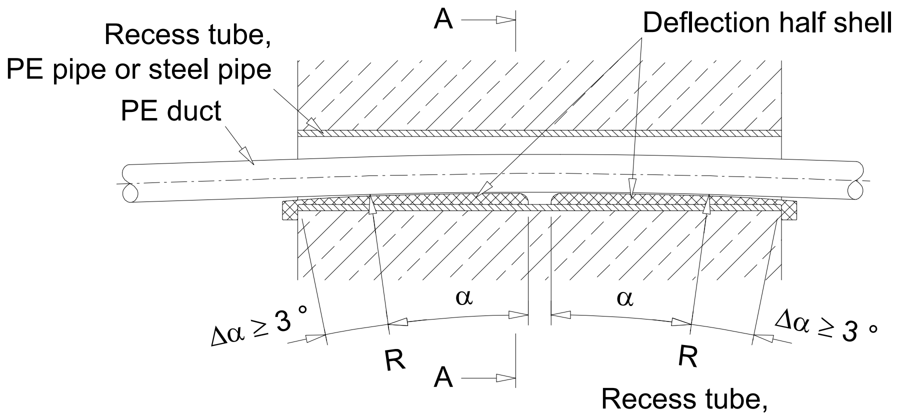
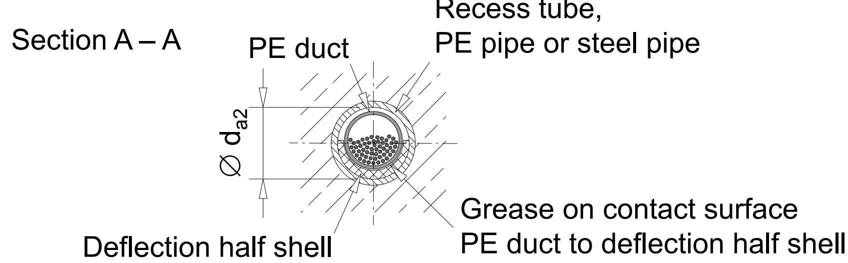
Standard tendon deflection by means of deflection half shells

With recess tube – Standard



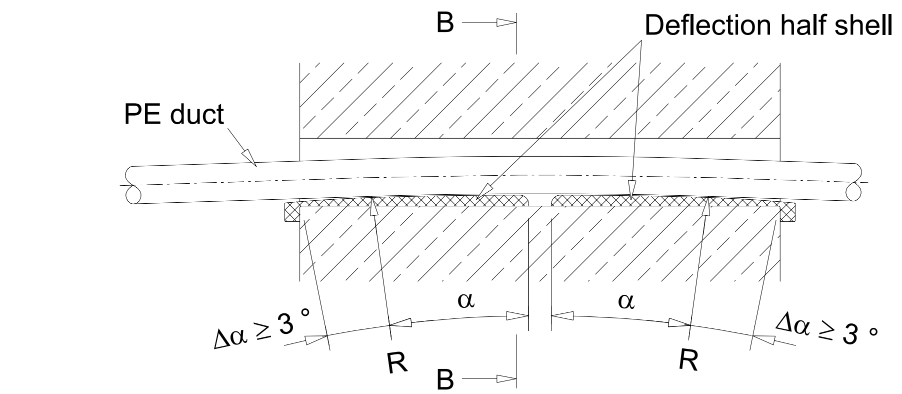
No offset between deflection half shells in the aperture permitted.

All edges of the deflection half shells are radiused.



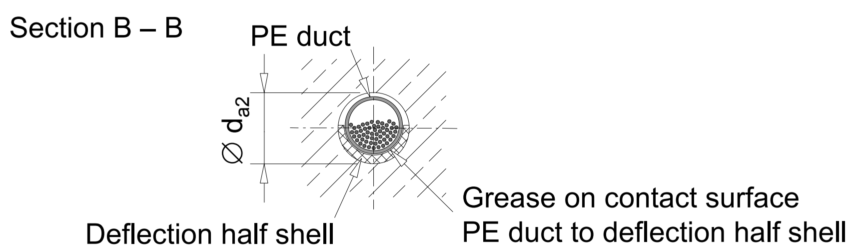
The deviator is commonly installed inside an aperture, passing through a member. It may also be arranged in open position, i.e., with deflection half shells resting on a member. The open arrangement shall be coordinated with DYWIDAG-Systems International GmbH.

Without recess tube



No offset between deflection half shells in the aperture permitted.

All edges of the deflection half shells are radiused.



DYWIDAG DYWIDAG-Systems International GmbH Phone: +49/89/309050-100 E-Mail: dsihv@dywidag-systems.com	**External prestressing system** **SUSPA – Wire EX** Tendon deflection by means of deflection half shells	**Annex 13** of European Technical Assessment **ETA-07/0186** of 16.11.2020

Standard tendon deflection with deflection half shells

Standard deflection half shells are provided for a variety of deflection radii and deflection angles. As a preferred standard, the deflection radius is 5 000 mm. Details shall be inquired at and co-ordinated with DYWIDAG-Systems International GmbH.

Special sizes of deflection half shells for minimum deflection radii

Special sizes of deflection half shells are an option but, in most cases, have to be manufactured to order. Therefore, special sizes shall be agreed with DYWIDAG-Systems International GmbH as early as in the design phase.

Minimum deflection radii R for standard duct size – Optimised deflection radius											
Tendon	**SUSPA – Wire**	**EX-30**	**EX-36**	**EX-42**	**EX-48**	**EX-54**	**EX-60**	**EX-66**	**EX-72**	**EX-78**	**EX-84**
PE duct	∅ d_{a2}	75	75	90	90	90	90	90	90	90	90
Wire Y1670C	R	2 700	2 700	2 700	2 700	2 700	2 700	2 900	3 200	3 500	3 700
Wire Y1770C	R	2 500	2 500	2 500	2 500	2 600	2 800	3 100	3 400	3 700	4 000
Minimum deflection radii R for smaller duct size – Optimised duct diameter											
Tendon	**SUSPA – Wire**	**EX-30**	**EX-36**	**EX-42**	**EX-48**	**EX-54**	**EX-60**	**EX-66**	**EX-72**	—	
PE duct	∅ d_{a2}	63	63	75	75	75	83	83	87		
Wire Y1670C	R	2 700	2 800	2 700	2 900	3 200	2 800	3 100	3 300		
Wire Y1770C	R	2 500	2 900	2 700	3 000	3 400	3 000	3 300	3 500		

Dimensions in mm

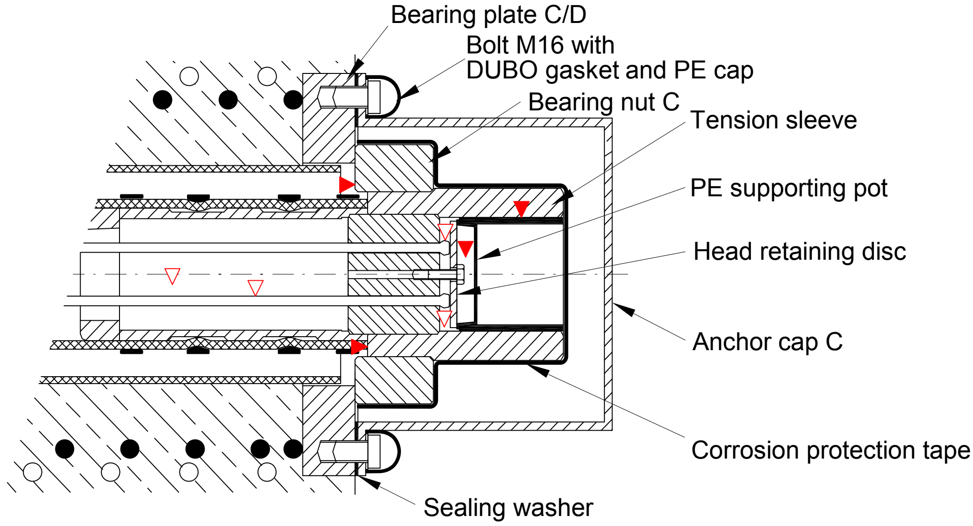
Deflection devices for particular applications

For deflection of Wire EX tendons also bent pipes can be used. Bent pipes are in plastic or steel. The pipe bending radii are in accordance with the above tables. The ends of the pipes are fitted with trumpets of increasing inner diameter.

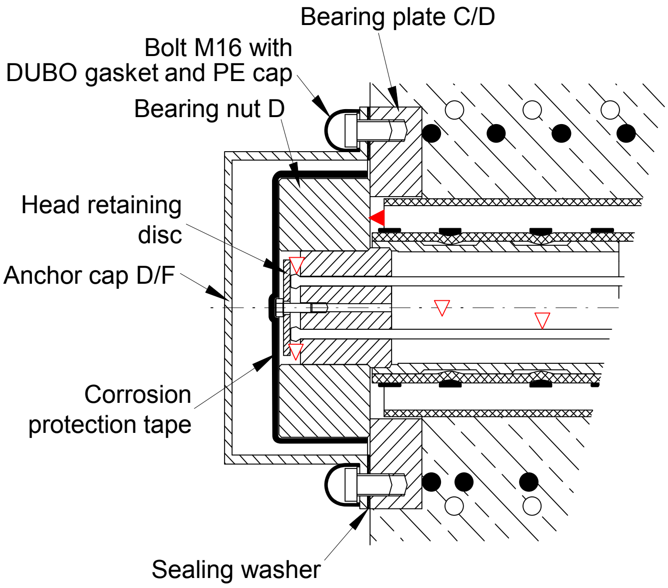
The use of concrete parts for deflection of Wire EX tendons is possible. The deflection radii are the same as in the tables above. The concrete surface is plastic coated on the rounded side.

It is essential to coordinate design and installation of these particular deflection devices with DYWIDAG-Systems International GmbH as early as in the design phase.

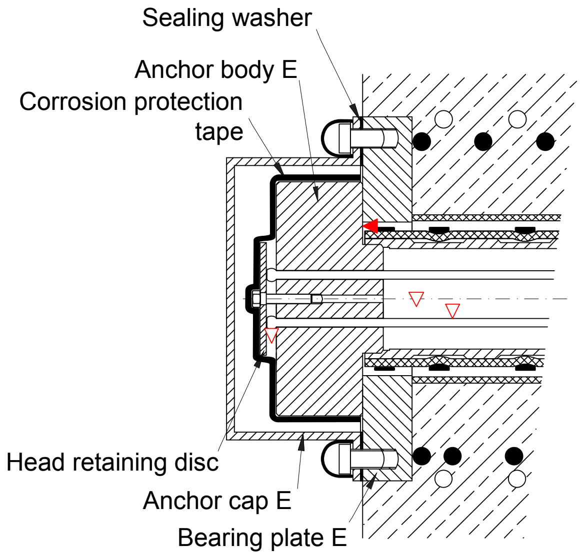
Stressing anchor C



Fixed anchor D/F



Fixed anchor E



Corrosion protection of exposed surfaces of bearing plates according to Clause 1.12.4

Key for corrosion protection

▽ ....Corrosion protection wax

▼ ....Corrosion protection wax or grease

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External prestressing system

SUSPA – Wire EX

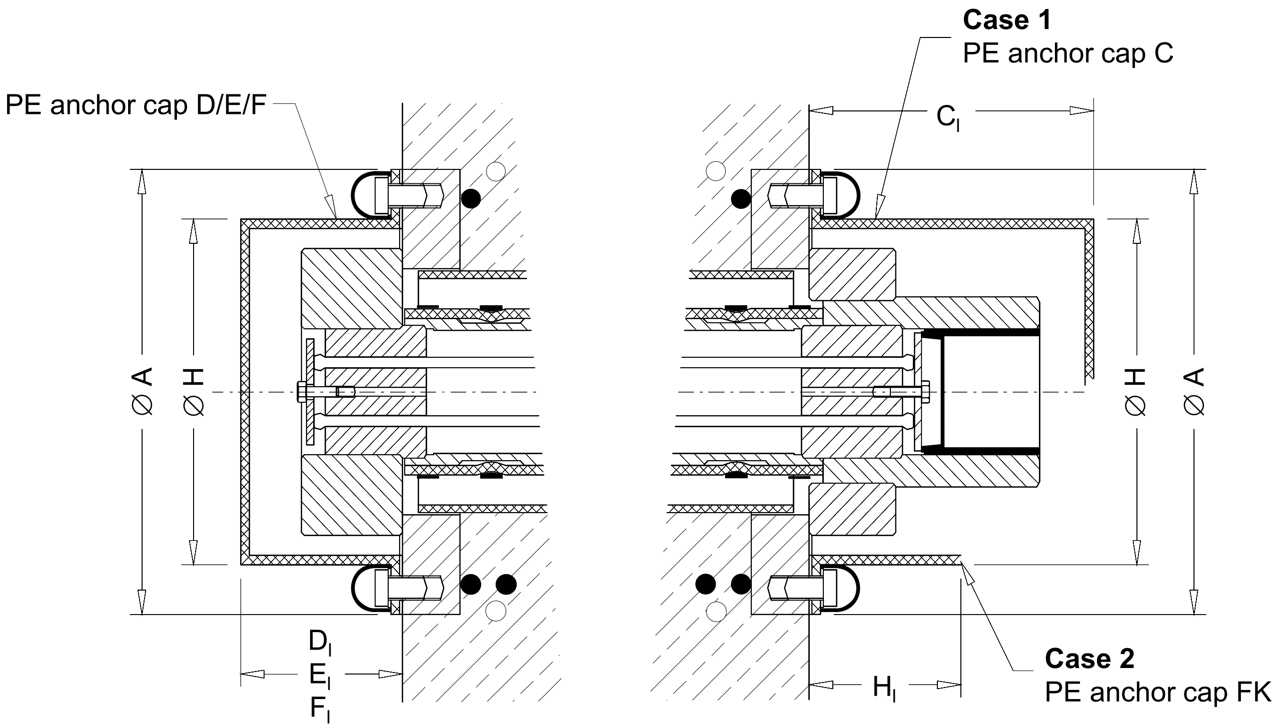
Corrosion protection for anchorages

Annex 15

of European Technical Assessment

ETA-07/0186 of 16.11.2020

Fixed anchor D/E/F **Stressing anchor C**



NOTE Above fixed anchor D is shown.

Above representations without corrosion protection, see Annex 15

Tendon SUSPA – Wire		EX-30	EX-36	EX-42 EX-48	EX-54	EX-60 EX-66	EX-72	EX-78	EX-84
PE anchor cap	Ø A	320	340	360	370	405	405	405	405
	Ø H	225	250	250	280	315	315	315	315
min. length									
Anchor cap C	C_l	170	180	200	230	240	260	280	290
Anchor cap D/E/F	$D_l/E_l/F_l$	100	110	110	120	160	165	170	175
Anchor cap FK	H_l	100	100	100	110	110	—	—	—

Dimensions in mm

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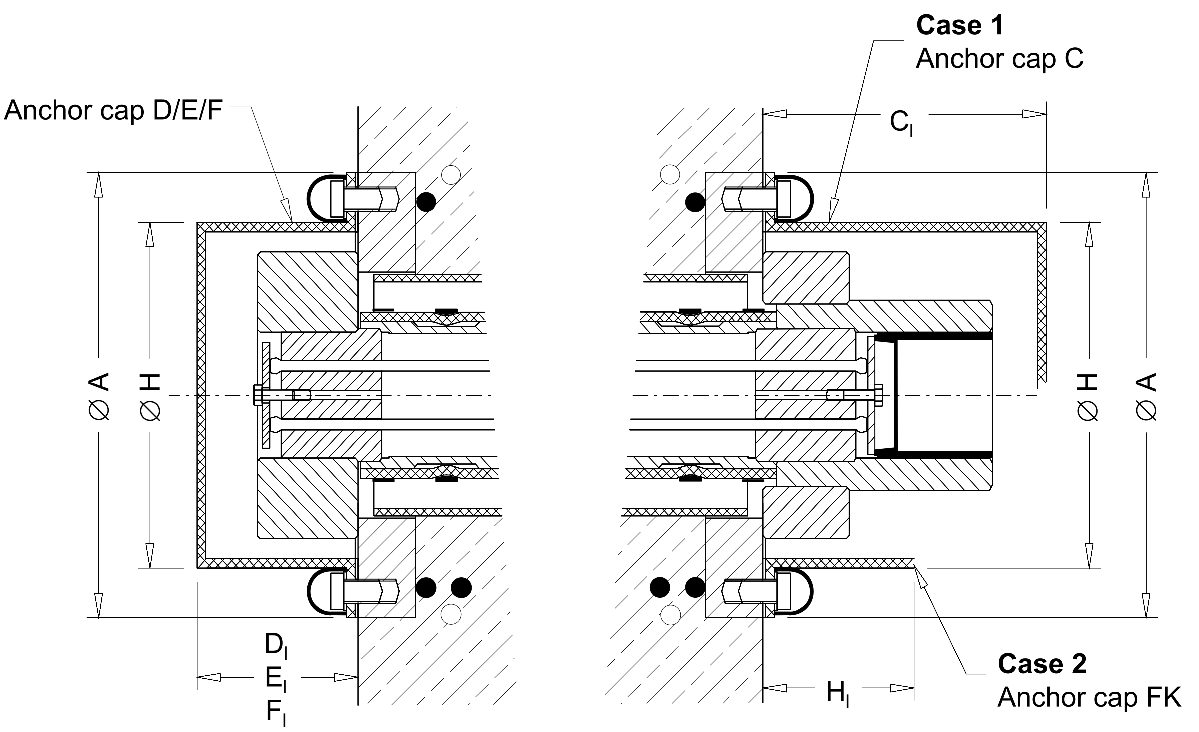
External prestressing system
SUSPA – Wire EX
Dimensions of PE anchor caps

Fixed anchor D/E/F **Stressing anchor C**



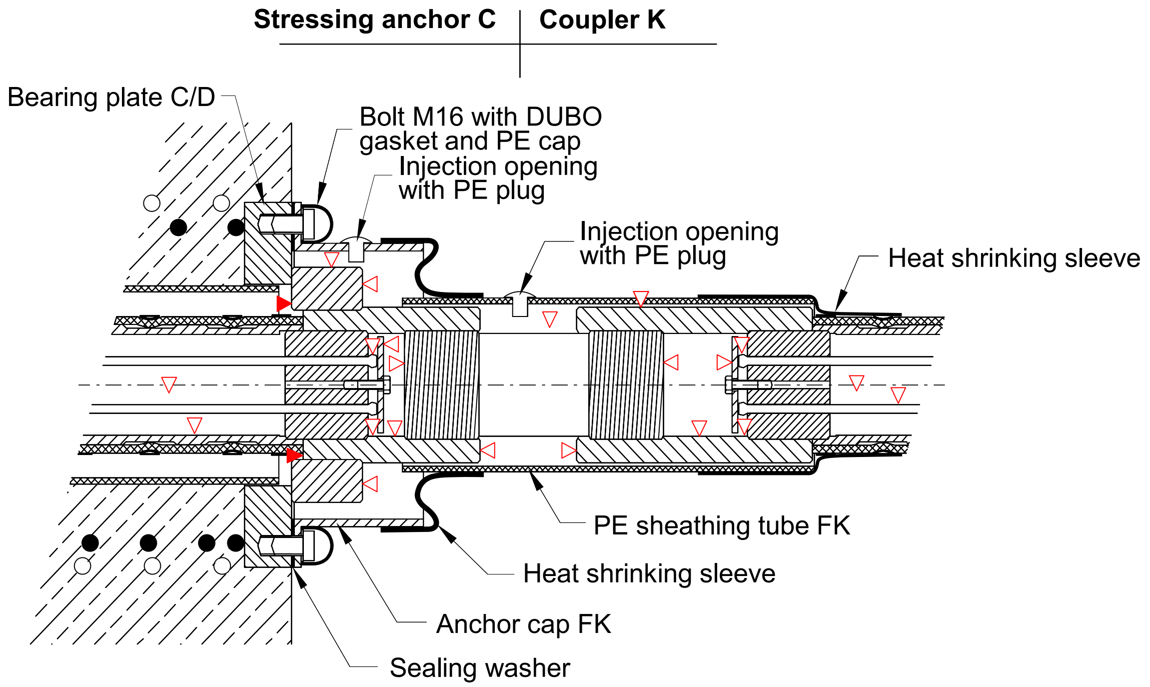
NOTE Above fixed anchor D is shown.

Above representations without corrosion protection, see Annex 15

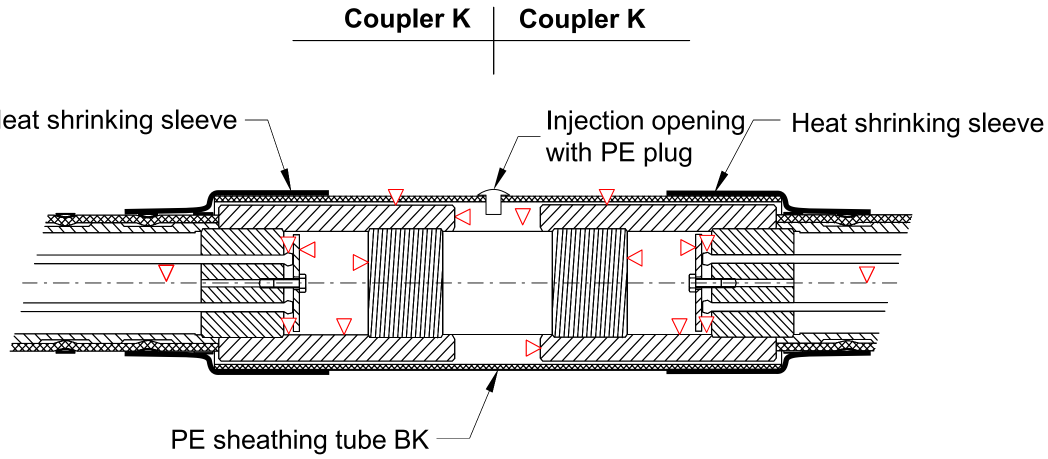
Tendon	**SUSPA – Wire**	**EX-30**	**EX-36**	**EX-42 EX-48**	**EX-54**	**EX-60 EX-66**	**EX-72**	**EX-78**	**EX-84**
Anchor cap	Ø A	320	340	360	370	405	405	405	405
	Ø H	229	254	279	279	298.5	298.5	305	318
min. length									
Anchor cap C	C_l	180	193	243	243	235	255	275	285
Anchor cap D/E/F	$D_l/E_l/F_l$	110	123	133	133	155	160	165	170
Anchor cap FK	H_l	100	100	110	110	120	—	—	—

Dimensions in mm

Fixed Coupler C–K



Movable coupler K–K



A second heat shrinking sleeve protects the first heat shrinking sleeve if the coupler is not installed in a UV protected area.

Corrosion protection of exposed surfaces of bearing plates according to Clause 1.12.4

Key for corrosion protection
▽ ....Corrosion protection wax
▼ ....Corrosion protection wax or grease

Characteristic		Unit	Value	
Designation according to prEN 10138-2		—	Y1670C	Y1770C
Nominal tensile strength	R_m, f_{pk}	N/mm²	1 670	1 770
Nominal diameter	d	mm	7.0	
Nominal cross-sectional area	A_p	mm²	38.5	
Nominal mass	M	g/m	300.7	
Cross-sectional shape		—	circular	
Surface		—	plain	
Characteristic value of maximum force	F_{pk}	kN	64.3	68.1
Maximum value of maximum force	$F_{p,max}$	kN	73.9	78.3
Characteristic value of 0.1 % proof force	$F_{p0.1}$	kN	56.6	59.9
Minimum elongation at maximum force, $L_0 \geq 100$ mm	A_{gt}	%	3.5	
Modulus of elasticity	E	N/mm²	205 000 [1)]	

1) Standard value

Number of wires	n	—	30	36	42	48	54	60	66	72	78	84
Nominal cross-sectional area of prestressing steel	A_p	mm²	1 155	1 386	1 617	1 848	2 079	2 310	2 541	2 772	3 003	3 234
Characteristic tensile strength f_{pk} = 1 670												
Characteristic value of maximum force of tendon	F_{pk}	kN	1 929	2 315	2 701	3 086	3 472	3 858	4 244	4 630	5 015	5 401
Characteristic tensile strength f_{pk} = 1 770												
Characteristic value of maximum force of tendon	F_{pk}	kN	2 043	2 452	2 860	3 269	3 677	4 086	4 495	4 903	5 312	5 720

By omitting wires in the anchorages and couplers in a radially symmetrical way, also tendons with numbers of wires lying between the numbers given above can be installed. Any unnecessary hole remains undrilled. With regard to dimensions and reinforcement, anchorages and couplers with omitted wires remain unchanged compared to anchorages and couplers with full number of wires.

Each omitted wire reduces the nominal cross-sectional area by 38.5 mm² and the characteristic value of maximum force of tendon by 64.3 kN and 68.1 kN respectively.

Designation	Standard	Material [1)]
Basic body Anchor body E	EN ISO 683-1, EN ISO 683-2	Steel
Bearing nut C Bearing nut D Bearing nut F	EN ISO 683-1, EN ISO 683-2	Steel
Tensioning sleeve	EN ISO 683-1, EN ISO 683-2	Steel
Coupling sleeve	EN ISO 683-1, EN ISO 683-2	Steel
Coupling spindle	EN ISO 683-1, EN ISO 683-2	Steel
Bearing plate	EN 10025-2+AC	Steel
Multi plane anchor body	EN 1563	Cast iron
Helix	EN 10025-2+AC	Steel
Additional reinforcement	—	Ribbed reinforcing steel, $R_e \geq 500$ N/mm²
PE duct	EN ISO 17855-1	PE-HD
PE recess tube	EN ISO 17855-1	PE-HD
PE anchor cap	EN ISO 17855-1	PE-HD
PE duct end	EN ISO 17855-1	PE-HD
Steel anchor cap	EN 10025-2+AC	Steel
Head retaining disc	EN 10025-2+AC	Steel
Anchor sleeve	EN 10025-2+AC EN 1563	Steel Cast iron
Sealing washer	—	Perbunan

[1)] Detailed material data is deposited with Österreichisches Institut für Bautechnik.

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Bearing plate	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	3 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Basic body, Anchor body E, Bearing nut C, Bearing nut D, Bearing nut F, Tensioning sleeve, Coupling sleeve, Coupling spindle, Multi plane anchor body Button heads	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	5 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
Prestressing steel wire	Material	Checking	[2], [4]	100 %	continuous
	Diameter	Testing	[2]	1 sample	each coil or every 7 tons [5]
	Visual inspection	Checking	[2]	1 sample	
PE ducts	Material	Checking	[2], [4]	100 %	continuous
	Traceability	full			
Additional reinforcement (Helix)	Material	Checking [6]	[2]	100 %	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	full			
PE-recess tube	Material	Checking [1]	[2]	100 %	continuous
	Detailed dimensions	Testing	[2]	1 %, ≥ 2 specimens	continuous
	Visual inspection [3]	Checking	[2]	100 %	continuous
	Traceability	bulk			
Caps (PE / Metal)	Visual inspection [3]	Checking [7]	[2]	100 %	continuous
	Traceability	full			
Materials of corrosion protection systems	Material	Checking [7]	[2]	100 %	continuous
	Traceability	full			

[1] Checking by means of an inspection report 3.1 according to EN 10204.
[2] Conformity with the specifications of the components
[3] Successful visual inspection does not need to be documented.
[4] Checking of relevant certificate, as long as the basis of "CE"-marking is not available.
[5] Maximum between a coil and 7 tons is taken into account.
[6] Checking by means of at least a test report 2.2 according to EN 10204.
[7] Checking of relevant certificate, CE marking and declaration of performance or, if basis for CE marking is not available, certificate of supplier

Traceability	full	Full traceability of each component to its raw material.
	bulk	Traceability of each delivery of components to a defined point.
Material		Defined according to technical specification deposited by the supplier
Detailed dimension		Measuring of all the dimensions and angles according to the specification given in the test plan
Visual inspection		Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.

Subject / type of control		Test or control method	Criteria, if any	Minimum number of samples [1]	Minimum frequency of control
Bearing plate	Material	Checking and testing, hardness and chemical [2]	[3]	1	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Visual inspection	Checking	[3]	1	1/year
Basic body, Anchor body E, Bearing nut C, Bearing nut D, Bearing nut F, Tensioning sleeve, Coupling sleeve, Coupling spindle, Multi plane anchor body Button heads	Material	Checking and testing, hardness and chemical [2]	[3]	1	1/year
	Detailed dimensions	Testing	[3]	1	1/year
	Visual inspection	Checking	[3]	1	1/year
Single tensile element test		According to EAD 160004-00-0301, Annex C.7		9	1/year

[1] If the kits comprise different kinds of anchor heads e.g., with different materials, different shape, different wedges, etc., then the number of samples is understood as per kind.

[2] Testing of hardness and checking of chemical composition by means of an inspection report 3.1 according to EN 10204.

[3] Conformity with the specifications of the components

Material	Defined according to technical specification deposited by DYWIDAG-Systems International GmbH at the Notified body
Detailed dimension	Measuring of all the dimensions and angles according to the specification given in the test plan
Visual inspection	Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.

European Assessment Documents

EAD 160004-00-0301	Post-Tensioning Kits for Prestressing of Structures

Eurocodes

Eurocode 2	Eurocode 2 – Design of concrete structures
Eurocode 3	Eurocode 3 – Design of steel structures

Standards

EN 206+A1, 11.2016	Concrete – Specification, performance, production and conformity
EN 1563, 08.2018	Founding – Spheroidal graphite cast irons
EN 10025-2, 08.2019	Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels
EN 10204, 10.2004	Metallic products – Types of inspection documents
EN ISO 683-1, 06.2018	Heat-treatable steels, alloy steels and free-cutting steels – Part 1: Non-alloy steels for quenching and tempering
EN ISO 683-2, 06.2018	Heat-treatable steels, alloy steels and free-cutting steels – Part 2: Alloy steels for quenching and tempering
EN ISO 12944-4, 12.2017	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation
EN ISO 12944-5, 10.2019	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems
EN ISO 12944-7, 12.2017	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 7: Execution and supervision of paint work
EN ISO 17855-1, 10.2014	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
prEN 10138-2, 08.2009	Prestressing steels – Part 2: Wires
CWA 14646, 01.2003	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel

Other documents

98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards posttensioning kits for the prestressing of structures, Official Journal of the European Communities L 201 of 17 July 1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 88 of 4 April 2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76, Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41, and Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019, OJ L 169 of 15.06.2019, p. 1
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27.05.2014, p. 76

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