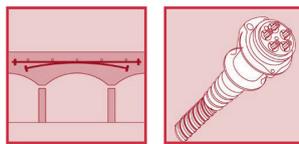


**DYWIDAG** 



European Organisation for Technical Approvals  
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## POST-TENSIONING

**Multistrand PT System for  
Bonded Application  
with 1 to 22 strands**

**ETA-13/0839**

11 June 2024



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# European Technical Assessment

**ETA-13/0839**  
of 11.06.2024

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 Strand DW

**Product family to which the construction product belongs**

Bonded post-tensioning kit for prestressing of structures with 1 to 22 strands

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**This European Technical Assessment contains**

82 pages including Annexes 1 to 47, which form an integral part of this assessment.

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**This European Technical Assessment replaces**

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Specific parts

## 1 Technical description of the product

### 1.1 General

The European Technical Assessment<sup>1</sup> – ETA – applies to a kit, the bonded PT system

### SUSPA Strand DW,

comprising the following components

- Tendon  
Bonded tendon with 1 to 22 tensile elements
- Tensile element  
7-wire prestressing steel strand with nominal diameter and nominal tensile strengths as given in Table 1

Table 1: Tensile elements

Nominal diameter		Designation according to prEN 10138-3 <sup>2</sup>	Nominal tensile strength
mm	inch		
15.7	0.62	Y1770S7	1 770
15.7	0.62	Y1860S7	1 860

NOTE 1 MPa = 1 N/mm<sup>2</sup>

- Anchorage  
Prestressing steel strand anchored by either 3-piece wedge, compression fitting, or bond head  
Stressing (active) and fixed (passive) anchor with wedges, anchor head E, and multi-plane anchor body MA for tendons with 5 to 22 prestressing steel strands  
Stressing (active) and fixed (passive) anchor with wedges, anchor head E, and multi-plane anchor body MA for encapsulated and electrically isolated tendons with 5 to 22 prestressing steel strands  
Stressing (active) and fixed (passive) anchor with wedges, anchor head E, and anchor plate E for tendons with 3 to 22 prestressing steel strands  
Stressing (active) and fixed (passive) anchor with wedges, anchor head E, and anchor plate E for encapsulated and electrically isolated tendons with 3 to 22 prestressing steel strands  
Fixed (passive) anchor with compression fittings, anchor head EP, and multi-plane anchor body MA for tendons with 5 to 22 prestressing steel strands

<sup>1</sup> ETA-13/0839 was firstly issued in 2013 as European technical approval with validity from 25.06.2013, converted 2017 to European Technical Assessment ETA-13/0839 of 11.12.2017, amended 2021 to European Technical Assessment ETA-13/0839 of 30.03.2021, and amended 2024 to European Technical Assessment ETA-13/0839 of 11.06.2024.

<sup>2</sup> Standards and other documents referred to in the European Technical Assessment are listed in Annex 46 and Annex 47.

Fixed (passive) anchor with compression fittings, anchor head EP, and anchor plate E for tendons with 3 to 22 prestressing steel strands

Fixed (passive) anchor with bond anchorage H for tendons with 3 to 22 prestressing steel strands

Stressing (active) and fixed (passive) anchor with wedges, and anchor SK6 for tendons with one single prestressing steel strand

– Coupler

Prestressing steel strand anchored by either 3-piece wedge or compression fitting

Fixed coupler with wedges, compression fittings, coupler head K, and multi-plane anchor body MA for tendons with 5 to 22 prestressing steel strands

Fixed coupler with wedges, compression fittings, coupler head K, and multi-plane anchor body MA for encapsulated and electrically isolated tendons with 5 to 22 prestressing steel strands

Fixed coupler with wedges, compression fittings, coupler head K, and anchor plate E for tendons with 3 to 22 prestressing steel strands

Fixed coupler with wedges, compression fittings, coupler head K – EI, and anchor plate K – EI for encapsulated and electrically isolated tendons with 3 to 22 prestressing steel strands

Movable coupler with compression fittings and coupler head V for tendons with 3 to 22 prestressing steel strands

Movable coupler with compression fittings and coupler head V for encapsulated and electrically isolated tendons with 3 to 22 prestressing steel strands

Movable coupler with wedges and 2 coupler barrels K6 for tendons with one single prestressing steel strand

- Floating block anchorage Z with wedges and anchor head Z for tendons with 2 to 8 prestressing steel strands
- Helix and additional reinforcement or only additional reinforcement without helix in the anchorage zone
- Ducts
- Permanent corrosion protection for tensile elements, anchorages, and couplers

## PT system

### 1.2 Designation and range of anchorages and couplers

#### 1.2.1 Designation

Anchorage and couplers are designated by their function in the structure, the nominal diameter of the prestressing steel strands and the maximum number of prestressing steel strands. The first number indicates the nominal diameter of the prestressing steel strand, “6” = 15.7 mm (0.62”), followed by the maximum number of prestressing steel strands per unit “n”, 6-n. The available anchorages and couplers are shown in Annex 1 and Annex 2 and are listed in Table 2.

Table 2: Anchorages and Couplers – Combinations of components for different use categories

Components	Steel duct PL1	Plastic duct PL1	Plastic duct PL2 encapsulated	Plastic duct PL3 electrically isolated	Number of strands <sup>1)</sup>			
	1	4	5	6	—			
Use category according to Table 6	1	4	5	6	—			
<b>Anchorage</b>								
Stressing and fixed anchor MA with wedge	+	+	+	—	5	7	9	12 15 19 22
Stressing and fixed anchor MA-EI with wedge	•	•	•	+	5	7	9	12 15 19 22
Fixed anchor MP with compression fitting	+	+	—	—	5	7	9	12 15 19 22
Stressing and fixed anchor E with wedge	+	+	+	+	3 4 5	7	9	12 15 19 22
Fixed anchor EP with compression fitting	+	+	—	—	3 4 5	7	9	12 15 19 22
Fixed anchor with bond anchorage HL/HR	+	+	—	—	3 4 5	7	9	12 15 19 22
Stressing and fixed anchor SK with wedge	+	+	—	—	1			
<b>Coupler</b>								
Fixed coupler with coupler head K and anchor body MA	+	+	+	—	5	7	9	12 15 19 22
Fixed coupler with coupler head K and anchor body MA-EI	•	•	•	+	5	7	9	12 15 19 22
Fixed coupler with coupler head K and anchor plate E	+	+	—	—	3 4 5	7	9	12 15 19 22
Fixed coupler with coupler head K-EI and anchor plate K-EI	•	•	+	+	3 4 5	7	9	12 15 19 22
Movable coupler with coupler head V	+	+	+	+	3 4 5	7	9	12 15 19 22
Movable coupler K6-K6	+	+	—	—	1			
Floating block anchorage with anchor head Z	+	+	—	—	2	4	6	8
<b>KEY</b> + .....applicable — .....not applicable • .....applicable but not recommended <b>NOTES</b> <sup>1)</sup> Except for floating block anchorage one or more prestressing steel strands may be omitted to install tendons with numbers of prestressing steel strands between the numbers given. “Multi-plane anchor body MA” and “anchor body MA” are synonyms.								

## 1.2.2 Tendon range

The available tendons sizes are listed in Table 2. The characteristic values of maximum force of tendons are given in Annex 5 and Annex 6.

Anchorage and coupler may be provided with less prestressing steel strands than the maximum number, resulting in a continuous tendon row. Therefore, the prestressing steel strands are omitted as much as possible radially symmetrically. For all omitted prestressing steel strands, the respective bores in anchor head or coupler head do not need to be drilled. Alternatively, at anchor head E and coupler head K a short length of prestressing steel strand with a wedge is pressed in. The respective bores in anchor head EP and coupler head V may be left void. For coupler heads K and V, the slots of the projecting ring collar may be equally redistributed. However, overall dimensions of anchor head and coupler head are unchanged in any case.

Moreover, each anchor and coupler may be installed with virtually any meaningful number of prestressing steel strands smaller or equal to the complete number of prestressing steel strands for the respective size. However, the resulting prestressing force is exactly axial with regard to anchor and coupler. This is obtained by an appropriate arrangement of the prestressing steel strands in anchor head and coupler head.

Anchorage and couplers with omitted strands are in any case installed with unchanged dimensions and unchanged reinforcement compared to anchorages and couplers with complete number of strands.

Omitting of prestressing steel strands in a tendon with floating block anchorage Z is impossible.

As indicated in Table 2, particular anchorages and couplers can be provided as part of encapsulated tendons (PL2) or electrically isolated tendons (PL3) with plastic ducts. However, tendons with all anchorages and couplers can be installed with plastic ducts, even without encapsulation or electrical isolation (PL1).

## 1.2.3 Anchorage

### 1.2.3.1 General

The stressing anchor arranges the prestressing steel strands for the stressing operation and subsequently anchors the stressed prestressing steel strands by means of wedges. Each prestressing steel strand is individually anchored within a conical bore of the anchor head E or anchor head EI or anchor SK6 by means of a 3-piece wedge. All prestressing steel strands of the bundle tendon are stressed at the same time.

In the fixed anchor, the prestressing steel strands are anchored by means of wedges in anchor head E, anchor head EI, and anchor SK6, or by means of compression fittings in anchor head EP, or by bond and bond heads within bond anchorage H.

The same principles of anchorage apply from the smallest to the largest tendon.

### 1.2.3.2 Stressing and fixed anchor with anchor head E

The stressing anchor comprises wedges, an anchor head E or an anchor head EI, and an anchor body MA, an anchor body MA-EI, or an anchor plate E, see Annex 1, Annex 15, Annex 16, Annex 17, Annex 18, Annex 19, Annex 30, Annex 32, Annex 33, and Annex 34. The trumpet is arranged between anchor body MA or anchor plate E and the duct, or in case of anchor body MA-EI also inside the anchor body MA-EI, and in general is surrounded by a helix. The helix, if present, is centrally aligned to anchor body MA or anchor body MA-EI or anchor plate E and fastened in its position. If required, the free end of the helix is fastened to the additional reinforcement. Anchor with anchor body MA can be installed without or with helix, while anchor with anchor body MA-EI or anchor plate E is always with helix. The duct is inserted into the trumpet or screwed thereon. The anchor head E or anchor head EI is slipped over the prestressing steel strands before stressing.

Up to a maximum number of 5 strands, anchor with anchor body MA and anchor with anchor plate E can be both installed with flat duct, see Annex 7 and Annex 13.

The stressing anchor can also be used as a fixed anchor. In that case, access is given to the fixed anchor during stressing.

For electrically isolated anchorages, an isolation plate is installed between anchor head EI and anchor body MA-EI or anchor plate E, in case of anchor plate E accompanied by a load distributing steel plate, see Annex 18 and Annex 34.

#### 1.2.3.3 Fixed anchor with anchor head EP

The fixed anchor comprises compression fittings, a retainer plate, an anchor head EP and an anchor body MA or an anchor plate E, see Annex 1, Annex 15, and Annex 30. The assembly corresponds to the stressing anchor with anchor head E but instead of wedges, the prestressing steel strands are anchored by compression fittings. The compression fittings are locked by means of a retainer plate. For this anchorage, access does not need to be provided during stressing, therefore, it can be embedded in concrete.

Same as for the stressing anchor, the fixed anchor with anchor body MA can be installed without or with helix and fixed anchor with anchor plate E is always with helix.

For anchorages in encapsulated and electrically isolated tendons, only a stressing anchor according to Clause 1.2.3.2 is installed as fixed anchor. The fixed anchor with anchor head EP and compression fittings may not be installed as anchorage in encapsulated or electrically isolated tendons.

#### 1.2.3.4 Anchorage with anchor body MA

Anchor body MA transfers the tendon force by several load transfer planes – multi-plane anchor body MA – into the structural concrete, see, Annex 1, Annex 2, Annex 3, Annex 15, Annex 16, Annex 17, and Annex 20.

The anchor heads E and EP and the coupler head K with corresponding wedges and compression fittings can be used with anchor body MA. The anchor body MA is used within a stressing anchor as well as a fixed anchor. Anchorage with multi-plane anchor body MA can be installed even without helix, see Annex 16.

Anchorage with anchor body MA can be installed as parts of an encapsulated tendon.

#### 1.2.3.5 Anchorage with anchor body MA-EI

Anchor body MA-EI transfers the tendon force by several load transfer planes – multi-plane anchor body MA-EI – into the structural concrete, see Annex 3, Annex 15, Annex 18, Annex 19, and Annex 21.

Anchor head EI and coupler head K-EI with corresponding wedges and compression fittings can be used with anchor body MA-EI. The anchor body MA-EI is used within a stressing anchor as well as a fixed anchor. Anchorage with multi-plane anchor body MA-EI is always installed with helix, see Annex 19.

Anchorage and fixed coupler with anchor body MA-EI can be installed as parts of an encapsulated or an electrically isolated tendon.

#### 1.2.3.6 Anchorage with anchor plate E

Different to anchor body MA there is only one single load transfer plane with anchor plate E. Anchor plate E always is accompanied by a helix, see Annex 1, Annex 4, Annex 30, Annex 32, Annex 33, Annex 34, and Annex 35. Applications with anchor plate E require preceding consultations of the ETA holder to confirm availability.

Anchor heads E and EP and coupler head K with corresponding wedges and compression fittings can be used with anchor plate E. Anchor plate E is used within a stressing anchor as well as a fixed anchor.

Anchorage and fixed coupler with anchor plate E and anchor plate K-EI can be installed as parts of an encapsulated or an electrically isolated tendon.

#### 1.2.3.7 Bond anchorages H – HL and HR

The bond anchorage H anchors the prestressing steel strands by bond of the prestressing steel strands and in particular with bond heads to the structural concrete. Therefore, it can only be used as a fixed anchor, embedded in concrete. Beside bond heads it comprises a ring, a helix, and spacers for creating the intended strand layout, see Annex 1 and Annex 22. The prestressing steel strands used in this anchorage do not receive any surface treatment, including no temporary corrosion protection, neither from the manufacturing plant nor on site.

#### 1.2.3.8 Stressing and fixed single prestressing steel strand anchor SK6

The single prestressing steel strand anchor SK6 comprises a wedge and anchor SK6, see Annex 1, Annex 26, Annex 27, and Annex 28. With this anchorage only one single prestressing steel strand is anchored. The stressing anchor is fastened to the formwork on site and connected to the prestressing steel strand. The fixed anchor does not need access during stressing, therefore it can be embedded in concrete. In this case it is installed with a spring and locked by a venting cap to secure the wedge seating. A PE-sleeve connects the anchor to the duct. The additional reinforcement is aligned and fastened centrally to anchor SK6, PE-sleeve and duct.

Anchor SK6 serves for both in one piece, anchoring the prestressing steel strand and load transfer to the structural concrete.

#### 1.2.4 Coupler

##### 1.2.4.1 General

The fixed coupler connects a 2<sup>nd</sup> tendon with an already stressed 1<sup>st</sup> tendon and the movable coupler connects two unstressed tendons prior to stressing both tendons at once. A 100 mm long and at least 4 mm thick PE-HD insert should be installed at the deviating point at the end of the trumpet, if the coupler may be subjected to significant fatigue actions. The insert is not required for plastic trumpet, where the duct is screwed on an external thread of the plastic trumpet.

##### 1.2.4.2 Fixed coupler

The fixed coupler comprises wedges, compression fittings, coupler head K or coupler head K-EI, anchor body MA, anchor body MA-EI, anchor plate E, or anchor plate K-EI, and a ring, see Annex 2, Annex 20, Annex 21, and Annex 35. The fixed coupler connects a 2<sup>nd</sup> tendon with an already stressed 1<sup>st</sup> tendon. The already stressed 1<sup>st</sup> tendon is anchored in the same way as with an anchor head E of a stressing anchor. In addition, coupler head K or coupler head K-EI provide a projecting ring collar with slots. The prestressing steel strands of the 2<sup>nd</sup> tendon to be joined, provided with compression fittings, are placed in the slots, and secured with a tensioning belt.

Fixed coupler with coupler head K-EI and anchor body MA-EI or anchor plate K-EI can be installed as parts of an encapsulated or an electrically isolated tendon.

##### 1.2.4.3 Movable coupler with coupler head V

The movable coupler comprises compression fittings, retainer plates, coupler head V, and a ring, see Annex 2, Annex 20, Annex 21, and Annex 35. The movable coupler connects two tendons prior to stressing. The prestressing steel strands of both tendons are anchored by means of compression fittings. The compression fittings of tendon 1 are secured by a retainer plate and the compression fittings of tendon 2 are locked by a retainer ring plate and a tensioning belt. The coupling principle is identical to the one of the fixed coupler with coupler head K.

Movable coupler with coupler head V can be installed as part of encapsulated or electrically isolated tendon.

Prior to final assembly of the coupler tube, and according to the stressing direction, the correct position of the coupler in the coupler tube is checked.

#### 1.2.4.4 Movable coupler K6-K6

The movable coupler comprises wedges and 2 coupler barrels K6, connected by the coupler bushing, see Annex 2 and Annex 29. With this coupler only one single prestressing steel strand is coupled. The prestressing steel strands of both tendons are anchored by means of wedges. A locking pin inside the coupler bushing prevents the prestressing steel strands from being pushed too far into the coupler bushing. Springs between wedges and coupler bushing secure the wedge positions in the cones.

Prior to final assembly of the protective tube, and according to the stressing direction, the correct position of the coupler in the protective tube is checked.

#### 1.2.5 Floating block anchorage Z

The floating block anchorage Z comprises wedges, an anchor head Z, retainer plates, and two rings, see Annex 2 and Annex 36. Floating block anchorage Z is normally used to stress a ring tendon, e.g. in storage facilities or tanks. Both tendon ends, end 1 and end 2, of the ring tendon overlap in the floating block anchorage Z.

For stressing, the strand protrusion of tendon end 1 is guided out of the stressing recess by means of a deviation chair. To compensate the strand friction within the deviation chair, a higher force is applied by the prestressing jack for stressing.

The floating block anchorage Z can also be applied as intermediate stressing anchor between two fixed anchors, e.g. if these anchors are not accessible for prestressing jacks.

During stressing, the anchor head Z is displaced by the value E, where E is 50 % of the sum of elongation and a slip of 6 mm of tendon end 2. When the prestressing force is transferred from prestressing jack to anchorage, the prestressing steel strands of tendon end 1 slip by approximately 6 mm. As a result of the slip, the force within the tendon at the end of stressing is lower than during stressing.

After stressing, the stressing recess is concreted and subsequently the tendon injected with cement grout.

#### 1.2.6 Centre and edge distances, concrete cover

All centre and edge distances have been determined with regard to requirements on load-bearing capacity, depending on the actual mean compressive strength of concrete at time of stressing,  $f_{cm,0}$ . Distance of tendon anchorages conforms to the values specified in Annex 16, Annex 17, Annex 19, Annex 22, Annex 24, Annex 25, Annex 28, Annex 32 and Annex 33. Fixed coupler with anchor plate K-EI may require to adapted minimum centre and edge distances according to Annex 32 and Annex 33 to the dimensions of anchor plate K-EI, see Annex 35. However, these values for centre distance between anchorages may be reduced in one direction by 15 %, but not smaller than to the outside diameter of the helix and the dimensions of anchor body MA, anchor body MA-EI, anchor plate E, or anchor plate K-EI. In case of a 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.

The concrete cover of tendons is neither smaller than 20 mm nor smaller than the concrete cover of reinforcement installed in the same cross section. Concrete cover at the anchorage is at least 20 mm on the protection caps and venting caps. Standards and regulations on concrete cover in force at the place of use are observed.

#### 1.2.7 Strength of concrete

Concrete according to EN 206 is used.

At the time of transmission of the prestressing force to the structural concrete, the actual mean cube compressive strength of concrete,  $f_{cm,0,cube}$ , or the actual mean cylinder compressive strength of concrete,  $f_{cm,0,cyl}$ , is at least as given in Annex 16, Annex 17, Annex 19, Annex 24, Annex 25, Annex 28, Annex 32 and Annex 33. The actual mean compressive strength,  $f_{cm,0,cube}$  or  $f_{cm,0,cyl}$ , is verified by means of at least three specimens, cube of size 150 mm or cylinder with

diameter of 150 mm and height of 300 mm, which 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  $0.5 \cdot f_{cm, 0, cube}$  or  $0.5 \cdot f_{cm, 0, cyl}$ . Intermediate values may be interpolated linearly according to Eurocode 2.

#### 1.2.8 Reinforcement in the anchorage zone

In any case, steel grades and dimensions of helix and additional reinforcement specified in the Annex 15, Annex 16, Annex 17, Annex 19, Annex 23, Annex 24, Annex 25, Annex 28, Annex 31, Annex 32 are conformed to.

The centric position of the helix is secured by welding the end ring onto the anchor plate or onto the multi-plane anchor body or by means of holding devices that are braced against the tendon.

If required for a specific project design, the reinforcement given in Annex 15, Annex 16, Annex 17, Annex 19, Annex 23, Annex 24, Annex 25, Annex 28, Annex 31, Annex 32, and Annex 33 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 of the ETA holder to provide equivalent performance.

### 1.3 Designation and range of tendons

#### 1.3.1 Designation

The tendon is designated by the nominal diameter of the prestressing steel strand and the number of prestressing steel strands with 6-n. The first number indicates the nominal diameter of the prestressing steel strand  $6 = 15.7 \text{ mm}$  (0.62"), followed by the number "n" of prestressing steel strands.

#### 1.3.2 Range of tendons

The PT system includes tendons, see Table 2, with 1 to 22 prestressing steel strands. Only 7-wire prestressing steel strands with a nominal diameter of 15.7 mm and tensile strengths of  $1770 \text{ N/mm}^2$  or  $1860 \text{ N/mm}^2$  are used. The dimensions and specifications of the prestressing steel strands are given in Table 1 and Annex 42.

Characteristic values of maximum force of the tendons are listed in Annex 5 and Annex 6.

#### 1.3.3 Maximum stressing forces

Prestressing and overstressing forces are specified in the respective standards and regulations in force at the place of use. Annex 5 and Annex 6 lists the maximum prestressing and overstressing forces of the tendons according to Eurocode 2. I.e. the maximum prestressing force applied to a tendon is not exceeding  $0.90 \cdot A_p \cdot f_{p0.1}$ . Overstressing with up to  $0.95 \cdot A_p \cdot f_{p0.1}$  is only permitted if the force in the prestressing jack can be measured to an accuracy of  $\pm 5 \%$  of the final value of the overstressing force.

Initial prestressing force,  $P_{m0}$ , immediately after stressing and anchoring does not exceed the forces as specified in Eurocode 2.

Where

$A_p$  .....  $\text{mm}^2$  .... Cross-sectional area of prestressing steel of tendon, i.e.  $A_p = n \cdot S_0$

$f_{p0.1}$  ..  $\text{N/mm}^2$ ... Characteristic 0.1 % proof stress of prestressing steel, i.e.  $F_{p0.1} = f_{p0.1} \cdot S_0$

n..... — ..... Number of prestressing steel strands, i.e.  $n = 1$  to 22

$S_0$  .....  $\text{mm}^2$  .... Nominal cross-sectional area of one single prestressing steel strand, see Annex 42

$F_{p0.1}$  ..... kN..... Characteristic value of 0.1 % proof force of one single prestressing steel strand, see Annex 42

$P_{m0}$  ..... kN..... Initial prestressing force immediately after stressing and anchoring

## 1.4 Slip at anchorage and coupler

Slip at anchorage and coupler is taken into consideration in design and for determining tendon elongation. In Table 3 slip and the required locking measure of wedges and compression fittings are specified.

Table 3: Slip values and locking of wedges and compression fittings

Anchorage or coupler		Slip	Locking measures
—		mm	—
Stressing anchor	E6-n	6 <sup>1), 2)</sup>	—
	SK6	5 <sup>1)</sup>	—
Fixed coupler – 1 <sup>st</sup> construction stage	K6-n	6 <sup>1), 2)</sup>	—
Fixed anchor	E6-n	6	— <sup>3)</sup>
	EP6-n	0	Retainer plate
	SK6	5	Spring, Venting cap
Bond anchorage	H6-n	0	—
Fixed coupler – 2 <sup>nd</sup> construction stage	K6-n	0	Tensioning belt
Movable coupler	V6-n	0	Retainer plate, Retainer ring plate, Tensioning belt
Movable coupler	K6-K6	10	Spring
Floating block anchorage Z	Z6-n	6 <sup>4)</sup>	Retainer plate

### NOTES

- 1) Slip occurs by transfer of prestressing force from jack to anchorage.
- 2) Slip is 3 mm with power-seating of ~ 20 kN per strand. This requires a special prestressing jack, its availability is to be coordinated with the ETA holder.
- 3) Anchor is accessible during stressing.
- 4) See Clause 1.2.5.

## 1.5 Friction losses

The tendon layout should not feature abrupt changes of the tendon axis since this may lead to significant additional friction losses. For calculation of losses of prestressing forces due to friction, Coulomb's friction law applies. Calculation of friction loss is by the equation

$$P_x = P_0 \cdot e^{-\mu \cdot (\alpha + k \cdot x)}$$

Where

$P_x$  .....kN ..... Prestressing force at distance x from the stressing anchor along the tendon

$P_0$  .....kN ..... Prestressing force at the distance x = 0 m

$\mu$  ..... rad<sup>-1</sup> ..... Friction coefficient, see Table 4 and Table 5

$\alpha$  ..... rad ..... Sum of angular deviations over a distance x, irrespective of direction or sign

k ..... rad/m ..... Wobble coefficient, see Table 4 and Table 5

x ..... m ..... Distance along the tendon from the point where the prestressing force is equal to  $P_0$

NOTE 1 rad = 1 m/m = 1

Table 4: Friction coefficient  $\mu$  and wobble coefficient  $k$  of metal strip sheath

—		Circular metal duct		Flat metal duct	
		Duct I	Duct II	Vertical axis	Horizontal axis
$\mu$	rad <sup>-1</sup>	0.20	0.19	0.15	0.23 – 0.32
$k$	rad/m	0.005	0.005	0.014	
	°/m	(0.3) <sup>1)</sup>	(0.3) <sup>1)</sup>	(0.8) <sup>1)</sup>	

NOTE

<sup>1)</sup> For information only

Table 5: Friction coefficient  $\mu$  and wobble coefficient  $k$  of plastic duct

—		Circular plastic duct	Flat plastic duct	
			Vertical axis	Horizontal axis
$\mu$	rad <sup>-1</sup>	0.10–0.14	0.10–0.14	0.14–0.25
$k$	rad/m	0.005	0.008	
	°/m	(0.3) <sup>1)</sup>	(0.5) <sup>1)</sup>	

NOTE

<sup>1)</sup> For information only

Information on friction losses in anchorages and couplers is included in Annex 7, Annex 20, Annex 21, Annex 28, Annex 29, and Annex 36.

## 1.6 Support of ducts

Tendons are installed with high accuracy. This is achieved by installation of duct supports exactly levelled with regard to their designated position. The supports are secured in their position and the ducts fastened thereto. Distance between duct supports for tendons with steel strip sheaths does not exceed 1.8 m. In sections with maximum tendon curvature the distance between duct supports is reduced to 0.60 to 0.75 m.

If the prestressing steel strands are installed after concreting (duct II), special attention is applied that the duct will not displace. For that, the duct is additionally fastened between the supports, e.g. to the reinforcement of the structure. If tendons are installed in several layers, only the lowest layer can be firmly connected with the duct support. All other tendon layers are placed and fastened on subsequently installed supports.

For corrugated plastic ducts, spacing of supports should be 0.6 m to 0.75 m, see Annex 12 and Annex 13. Half shells are recommended for PL1 and PL2 and shall be applied for PL3 see Clause 1.11.2.

## 1.7 Radii of curvature

The minimum radii of curvature of tendons are specified for standard sizes of circular ducts in Annex 8, Annex 9, Annex 10, and Annex 11. They correspond to

- A maximum prestressing force of the tendon of  $P_{m0} = 0.85 \cdot F_{p0.1}$
- A nominal diameter of the prestressing steel strand of  $d = 15.7$  mm
- Prestressing steel strand with a maximum nominal tensile strength of 1 860 N/mm<sup>2</sup>

- A maximum pressure under the prestressing steel strands of  $p_{R, \max} = 140 \text{ kN/m}$ ,  $170 \text{ kN/m}$ ,  $200 \text{ kN/m}$ , or  $230 \text{ kN/m}$
- A minimum concrete compressive strength of  $f_{cm, 0, \text{cube}} = 25 \text{ N/mm}^2$

In case of different tendon parameters or a different pressure under the prestressing steel strands, the calculation of the minimum radius of curvature can be carried out by the equation

$$R_{\min} = \frac{2 \cdot P_{m0} \cdot d}{d_i \cdot p_{R, \max}} \geq 2.0 \text{ m for } \geq 5 \text{ prestressing steel strands}$$

Where

$R_{\min}$ ..... m ..... Minimum radius of curvature

$P_{m0}$  ..... kN ..... Prestressing force of the tendon

$d$ .....mm..... Nominal diameter of the prestressing steel strand

$d_i$ .....mm..... Inner duct diameter

$p_{R, \max}$ .... kN/m ..... Maximum pressure under the prestressing steel strands

The minimum radius of curvature should not be less than 2.0 m. For a reduction of the minimum radius of curvature, the effects of the radial deviation forces on the concrete and stresses resulting from the curvature in the prestressing steel require verification, or the stressing force is reduced accordingly. Standards and regulations on minimum radius of curvature or on the maximum pressure under the prestressing steel strands in force in the place of use are observed.

## Components

### 1.8 Specification of prestressing steel strand

7-wire prestressing steel strand with plain surfaces of the individual wires, a nominal diameter of 15.7 mm and tensile strengths of  $1770 \text{ N/mm}^2$  or  $1860 \text{ N/mm}^2$  are used. Dimensions and specifications of the prestressing steel strand are according to prEN 10138-3 and are given in Clause 1.1, Table 1, and Annex 42.

In the course of preparing the European Technical Assessment, no characteristic has been assessed for the prestressing steel strand. In execution, a suitable prestressing steel strand that conforms to Annex 42 and is according to the standards and regulations in force at the place of use is taken.

### 1.9 Anchorage and coupling components

#### 1.9.1 General

Specifications of anchorage and coupler components are given in the Annexes and the technical file<sup>3</sup> of the European Technical Assessment. Therein the components' dimensions, materials, material identification data with tolerances and the materials used in corrosion protection are specified.

For prestressing steel strands with nominal tensile strength of  $1860 \text{ N/mm}^2$  as well as  $1770 \text{ N/mm}^2$  the same anchorages and couplers are used.

#### 1.9.2 Anchor head

The anchor heads E, EI, and EP are made of steel with a pattern of regular arranged bores for anchoring the prestressing steel strands, see Annex 16, Annex 17, Annex 19, Annex 32, and Annex 33. Anchor heads E and EP are available without a step, see Annex 32 and Annex 33, or with a step, see Annex 16 and Annex 17. For the stressing anchor Anchor heads E and EI provides cylindrical bores with conical ends at one side for bearing wedges. Anchor head EP for

<sup>3</sup> The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

the fixed anchor provides only cylindrical bores for bearing compression fittings. All bores are countersunk and deburred. See Annex 14 for details on the conical and cylindrical bores.

The single prestressing steel strand anchor SK6, see Annex 26, is made of cast iron, and contains a conical hole to bear one wedge. It is used with a wedge as stressing anchor as well as fixed anchor.

For installation, the bores and cones are clean and free of damage or rust and are provided with corrosion protection oil.

### 1.9.3 Coupler head

Coupler heads K, K-EI, V, and K6 are made of steel with patterns of regular arranged bores and slots for anchoring the prestressing steel strands. In the inner part of coupler heads K, K-EI, and V the bore patterns are identical to the anchor heads E, EI, and EP. In addition, the projecting ring collar of the coupler heads provides slots for anchoring prestressing steel strands by means of compression fittings.

Coupler heads K and K-EI, see Annex 20, Annex 21, and Annex 35, for fixed coupler provide in the inner part cylindrical bores with conical ends for stressing and bearing the wedges of the 1<sup>st</sup> construction stage like anchor heads E and EI. On the projecting ring collar, the prestressing steel strands of 2<sup>nd</sup> construction stage are anchored in slots by means of compression fittings.

The coupler head V see Annex 20, Annex 21, and Annex 35, for movable coupler provides in the inner part cylindrical bores for bearing the compression fittings of the 1<sup>st</sup> tendon like anchor head EP. On the projecting ring collar the prestressing steel strands of the 2<sup>nd</sup> tendon are anchored in slots by means of compression fittings.

The coupler K6-K6, see Annex 29, for movable single prestressing steel strand coupler comprises 2 coupler barrels K6 with cones and threads that are connected by a steel bushing.

For installation, the bores and cones are clean and free of damage or rust and are provided with corrosion protection oil.

### 1.9.4 Anchor body MA and anchor plate E

Anchor body MA and MA-EI, see Annex 16, Annex 17, and Annex 19, and anchor plate E and anchor plate K-EI, see Annex 32, Annex 33, and Annex 35, are used together with anchor heads E, EI, and EP of the stressing and fixed anchor and with coupler heads K and K-EI of the fixed coupler.

Applications with anchor plate E require preceding consultations of the ETA holder to confirm availability.

Cast iron anchor bodies MA and MA-EI are of circular shape and provide several load transfer planes for load transfer to the structural concrete. There are three anchor bodies MA

- Anchor body MA
- Anchor body MA for plastic cap
- Anchor body MA-EI

Steel anchor plates E and K-EI are of circular shape as well, but with only one load transfer plane. Anchor bodies MA and anchor plates E and K-EI feature a centric circular hole for passing through the tendon.

### 1.9.5 Bond head

The bulb shaped bond head at the end of the prestressing steel strand, see Annex 22, for bond anchorage H is made by means of a special jack.

### 1.9.6 Anchor head Z

The anchor head Z, see Annex 36, is made of steel, of rectangular shape, and with two patterns of regular arranged bore for anchoring the prestressing steel strands. Anchor head Z is stressing and fixed anchor in one piece. All prestressing steel strands are anchored by means

of wedges. The bores and cones for the stressing end are located in the centre of the anchor head Z. The bores for the fixed end are split. One half each is located adjacent to the centre holes on the outside ends of the anchor head Z, with cones arranged on the opposite side to the ones of the stressing end.

All cylindrical bores are countersunk and deburred. For installation, the bores and cones are clean and free of damage or rust and are provided with corrosion protection oil.

#### 1.9.7 Ring

Steel rings are used for bond anchorage H, see Annex 1, Annex 22, Annex 24, and Annex 25, fixed coupler with coupler heads K and K-EI, see Annex 2, Annex 20, Annex 21, and Annex 35, for movable coupler with coupler head V, see Annex 2, Annex 20, Annex 21, and Annex 35, and as well for floating block anchorage Z, see Annex 2 and Annex 36.

#### 1.9.8 Wedge and compression fitting

Only 3-piece wedge and compression fitting according to Annex 14 are used.

Three wedges that are similar in geometry and are made of different material are used

- Two wedges with 30 ° tooth geometry according to Annex 14 are made of two different materials
- One wedge with 45 ° tooth geometry according to Annex 14 is made of one material. This wedge shall be used for cryogenic applications

Within one anchorage and one coupler, only one of these three wedges is installed.

#### 1.9.9 Retainer plate

Retainer plate and retainer ring plate are used for fixed anchor with anchor head EP, see Annex 15, Annex 30, and Annex 31, for movable coupler with coupler head V, see Annex 20, Annex 21, and Annex 35, as well as for floating block anchorage Z, see Annex 36.

### 1.10 Helix and additional reinforcement

Steel grades and dimensions of helix and additional reinforcement conform to the specifications given in the Annexes and the technical file of the European Technical Assessment. Helix for anchorage with anchor bodies MA or MA-EI or anchor plate E can be made of plain round steel wire or ribbed reinforcing steel. Helix for bond anchorage H is made of ribbed reinforcing steel.

Generally, both ends of each helix are welded to closed rings. Welding of one end, the inner end, may be omitted. Details on welding of helix are given in Annex 17, Annex 19, Annex 32 and Annex 33.

### 1.11 Duct

#### 1.11.1 Steel strip sheath

Usually, a corrugated duct made of steel strips is used. As a general rule, ducts with a smaller inner diameter, duct I, are used for prefabricated tendons. Longer tendons are transported to the job site in coils or oblong loops. The minimum transport bending diameter D for tendons up to 6-12 is 1.50 m and for larger tendons 1.80 m.

For on-site fabrication of tendons, the prestressing steel strands are inserted into the ducts either before or after placing the concrete. In general, ducts with a larger inner diameter, duct II, are used for that purpose. Either one or several prestressing steel strands are consecutively pushed or pulled into the respective duct or the entire tendon all at once.

Generally, ducts with circular cross section – so called “round” duct – and for tendons 6-3 to 6-5 ducts with oval cross sections – so called “flat” duct – are available. The ends of the ducts are connected with sockets. For length compensation, a short duct piece may be installed between duct and trumpet of an anchorage as a telescopic duct.

The circular duct conforms to EN 523. For the flat duct EN 523 applies analogously.

### 1.11.2 Plastic duct

The corrugated plastic duct conforms to Annex 12 and Annex 13. The plastic duct is made of polypropylene according to Annex 38 with circular or oval cross section and toroidal corrugations. The main dimensions of the plastic duct are given in Annex 12 and Annex 13.

Couplers to joint sections of plastic ducts and connections to trumpets of anchorages, see Annex 12 and Annex 13 are made with heat shrinking sleeves. For supporting the plastic ducts during installation, in general no specific stiffeners are required.

The plastic ducts have been tested according to *fib* bulletin 75 within a temperature range of  $-20\text{ °C}$  to  $+50\text{ °C}$ .

The plastic duct can be applied for all optional use categories, see Table 6, in internal bonded tendons with plastic ducts and Protection Level 1 (PL1), in encapsulated tendons with plastic duct and Protection Level 2 (PL2), and in electrically isolated tendons with plastic duct and Protection Level 3 (PL3).

For small and in particular minimum radii of curvature, half shells are inserted between plastic duct and supports. The half shells are provided in shapes compatible with the corrugation of the plastic duct. Half shells are recommended for PL1 and PL2 and shall be applied for PL3.

Alternatively, other corrugated plastic ducts may be used as well, if permitted at the place of use.

## 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. In execution, all components and materials are selected according to the standards and regulations in force at the place of use.

Corrosion protection of tendon, anchorage, and coupler is provided by grout according to EN 447, special grout according to EAD 160027-00-0301, or ready-mixed grout with an adequate composition according to standards and regulations in force at the place of use.

### 1.12.2 Encapsulated tendon

As an additional measure for corrosion protection, encapsulated tendons with plastic trumpets and plastic ducts are used (PL2). The tendon, including anchorages and fixed and movable coupler is encased by isolation material between the anchors. The anchors' front sides are completely covered by plastic caps, see Annex 3, Annex 4, Annex 15, Annex 21, Annex 30, Annex 34, and Annex 35.

### 1.12.3 Electrically isolated tendon

As an additional measure for corrosion protection, electrically isolated tendons with plastic trumpets and plastic ducts are used (PL3). In addition to sheathing design of encapsulated tendon the plastic trumpets do also line out the inside of anchor body MA-EI or anchor plate E. Adjacent to the trumpet lining and between anchor head EI and anchor body MA-EI or anchor plate E, and coupler anchor head K-EI and anchor plate K-EI, an isolation plate is installed, in case of anchor plate E or K-EI with a load distributing steel plate, see Annex 3, Annex 4, Annex 15, Annex 18, Annex 21, Annex 34 and Annex 35. Therefore, the tendon, including anchorages and fixed and movable coupler is completely encased by isolation material. Its integrity can be verified by measuring the electrical resistance between tendon and surrounding structure.

### 1.13 Welding

Welding is only permitted for the following components

- Welding the helix end turn to a closed ring
- Welding the helix end ring to anchor body MA or to anchor body MA-EI or to anchor plate E to secure the centric position of the helix

During welding it is ensured that there is no contact to duct and to prestressing steel strand.

After assembly of the tendons, no welding operations are carried out anymore. Welding operations close to tendons require precautionary measures to avoid damage.

Plastic components may be welded even after installation of the tendons.

### 1.14 Material specifications of the components

Material specifications of the components are given in Annex 37.

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

### 2.1 Intended uses

The PT system SUSPA Strand DW is intended to be used for the prestressing of structures. The specific intended uses are listed in Table 6.

Table 6: Intended uses

Line No	Use category
Use categories according to tendon configuration and material of structure	
1	Internal bonded tendon for concrete and composite structures
Optional use categories	
2	Internal tendon for cryogenic applications with anchorage outside the possible cryogenic zone
3	Internal tendon for cryogenic applications with anchorage inside the possible cryogenic zone
4	Internal bonded tendon with corrugated plastic duct made of HDPE or PP
5	Encapsulated tendon
6	Electrically isolated tendon

### 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.



bond head the decrease of the tendon force can be assumed to be linear and zero at the beginning of the bond head.

#### 2.2.3.3 Increased losses of prestressing forces at fixed coupler

For verification of the limitation of crack widths and for verification of the stress range increased losses of prestressing forces at fixed couplers due to creep and shrinkage of the concrete are taken into consideration. The determined losses of prestressing forces of tendons without the influence of couplers are multiplied by the factor 1.5 in the areas of fixed couplers.

For movable couplers, increased losses of prestressing forces need not to be taken into consideration.

#### 2.2.3.4 Fixed and movable coupler

Under all possible load combinations, the prestressing force at the 2<sup>nd</sup> construction stage of the fixed coupler is at no time higher than at the 1<sup>st</sup> construction stage, neither during construction nor in the final state.

The length of the coupler tube or the protective tube and its position relative to the coupler ensures unimpeded movement of the coupler in the protective tube along a length of minimum  $1.15 \cdot \Delta l + 30$  mm, where  $\Delta l$  in mm is the expected displacement of the coupler during stressing, see Annex 20, Annex 21, and Annex 35.

#### 2.2.3.5 Tendons in masonry structures

Post-tensioning kits are primarily used in structures made of concrete. They can, however, be used with other structural materials, e.g. in masonry structures. However, there is no particular assessment in EAD 160004-00-0301 for these applications. Hence, load transfer of stressing force from anchorage to masonry structure is via concrete or steel member, designed according to the European Technical Assessment, especially according to Clause 1.2.6, Clause 1.2.7, and Clause 1.2.8, or Eurocode 3, respectively.

The concrete or steel members have such dimensions as to permit a force of  $1.1 \cdot F_{pk}$  being transferred into the masonry. The verification is performed according to Eurocode 6 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 bonded multi-strand post-tensioning systems, see CWA 14646. The company's PT site manager has a certificate, stating that she or he has been trained by the ETA holder and that she or he possesses the necessary qualification and experience with the PT system SUSPA Strand DW.

#### 2.2.4.2 Anchorage

##### 2.2.4.2.1 General

Stressing and fixed anchor and fixed coupler with anchor head E, EI, EP, and coupler head K or K-EI can be installed with either an anchor body MA or an anchor body MA-EI or an anchor plate E or an anchor plate K-EI. In all that cases, the same installation procedure applies, see Annex 31. Stressing and fixed anchor and fixed coupler with anchor body MA or MA-EI or anchor plate E or K-EI and anchor head or coupler head are installed perpendicular to the tendon's axis. Adjacent to the trumpet, the tendon continues with a straight section over a length of at least 250 mm.

Centric position of helix is secured by welding the end ring to anchor body or anchor plate or by means of spacers braced against the tendon. The additional reinforcement is fastened centrally to the trumpet by tying or by means of spacers.

When installing an electrically isolated tendon, an isolation plate is placed between anchor head EI and anchor body MA-EI or anchor plate E, or between coupler head K-EI and anchor body MA-EI or anchor plate K-EI, see Annex 18, Annex 19, Annex 21, Annex 34, and Annex 35. Additionally, in case of anchor plate E or anchor plate K-EI a load distributing steel plate is placed between isolation plate and anchor head EI or coupler head K-EI, see Annex 34 and Annex 35. For fixed coupler K-EI with anchor body MA-EI, an adapter plate is placed on anchor body MA-EI. On the adapter plate follows isolation plate, load distribution plate, and coupler head K, see Annex 21.

#### 2.2.4.2.2 Stressing anchor

Site assembly comprises the following working steps, see Annex 26 and Annex 31

- Fastening anchor body MA, anchor body MA-EI, anchor plate E, anchor plate K-EI, or anchor SK6 to the formwork
- Installation of trumpet between anchor body MA, anchor body MA-EI, anchor plate E, or anchor plate K-EI and duct, or installation of the PE-sleeve between anchor SK6 and duct
- If the helix is not already welded onto anchor body MA or MA-EI or anchor plate E in the manufacturing plant, the helix is placed, centred to the tendon axis, and fastened to the reinforcement
- Pushing the duct into trumpet or PE-sleeve to approximately a length of  $d$ , where  $d$  is the duct diameter, or, in the case of appropriately shaped polyethylene trumpets, screwing the duct onto the trumpet
- Sealing the joint between trumpet or PE-sleeve and duct
- Pushing the anchor head E or EI over the prestressing steel strands just before stressing
- Tightening the prestressing steel strands with 3-piece wedges

The anchor head E can be provided with an external thread, on which a protection cap can be screwed on for grouting, see Annex 3, Annex 4, and Annex 31.

#### 2.2.4.2.3 Fixed anchor

Anchor head E or EI can also be used in a fixed anchor. In that case, the fixed anchor remains accessible during stressing of the tendon. Installation is the same as for stressing anchor according to Clause 2.2.4.2.2 using anchor body MA or anchor plate E. Encapsulated and electrically isolated tendons are only installed with fixed anchors using anchor head E or EI.

Fixed anchor EP can be either prefabricated or assembled at the construction site. Due to the geometrical equivalence, this anchor is installed similarly to the stressing anchor. Instead of wedges, compression fittings are used for anchoring the prestressing steel strands. The compression fittings are secured by a retaining plate. For fixed anchor EP, access does not need to be provided during stressing, therefore, it can be embedded in concrete.

#### 2.2.4.2.4 Bond anchorage H – HL or HR

Before shaping the bond heads, ring, helix, and spacers are placed on the tendon. The bond heads are shaped in the manufacturing plant or on site by cold forming and all bond heads are arranged by means of spacers according to their designated position.

#### 2.2.4.2.5 Floating block anchorage Z

Floating block anchorage Z is in general used for ring tendons, e.g. in storage facilities or tanks. Both ends, end 1 and end 2, of the ring tendon overlap in the floating block anchor head Z.

Site assembly comprises the following steps

- Pushing the anchor head Z over the prestressing steel strands just before stressing, first on stressing end or end 1, respectively, and subsequently on passive end or end 2,

respectively, whereas end 1 of the tendon is inserted into the inner bores and end 2 of the tendon into the outer bores of anchor head Z

- Alignment of anchor head Z by anticipating its displacement during stressing
- Anchoring the prestressing steel strands of end 2 with 3-piece wedges and securing the wedges with retainer plates
- Stressing is carried out at end 1 of the tendon by means of a special deviation chair

Floating block anchorage Z may also be applied as intermediate stressing anchor between two fixed anchors. In this case the two tendon ends overlap in the anchor head Z. Installation steps are the same as for ring tendons.

#### 2.2.4.3 Coupler

##### 2.2.4.3.1 Fixed coupler with coupler head K

The fixed coupler joints a 2<sup>nd</sup> tendon with an already stressed 1<sup>st</sup> tendon. The anchorage of the prestressing steel strands in the already stressed 1<sup>st</sup> tendon in coupler head K or K-EI is equivalent to the stressing anchor with anchor head E or EI. The coupler with coupler head K or K-EI and anchor body MA or MA-EI or anchor plate E or K-EI is installed perpendicular to the tendon's axis with the same procedure as the stressing anchor E or EI. Adjacent to the trumpet the tendon continues with a straight section over a length of at least 250 mm.

Site assembly of the 2<sup>nd</sup> tendon comprises the following working steps

- Jointing the 2<sup>nd</sup> tendon with the 1<sup>st</sup> tendon by inserting the prestressing steel strands, provided with compression fittings, into the slots of the projecting ring collar of coupler head K. The compression fittings are held in place by a tensioning belt
- Installing the coupler trumpet
- Arranging a vent pipe for grouting

##### 2.2.4.3.2 Movable coupler with coupler head V and movable coupler K6-K6

The movable coupler joints two tendons prior to stressing.

With the movable coupler with coupler head V, the prestressing steel strands of both tendons are anchored by means of compression fittings. The anchorage of the prestressing steel strands of the 1<sup>st</sup> tendon in coupler head V is equivalent to the fixed anchor with anchor head EP.

Site assembly of movable coupler with coupler head V comprises the following steps

- Connecting tendon 2 by inserting the prestressing steel strands, provided with compression fittings, into the slots of the projecting ring collar of coupler head V. The compression fittings of tendon 1, already installed prior to tendon 1, are held in place by a retainer plate and those of tendon 2 by a retainer ring plate and a tensioning belt
- Placing the coupler head V into the coupler tube
- The correct position of coupler head V in the coupler tube with regard to direction and displacement during stressing is checked prior to final assembly of the coupler tube
- Arranging a vent pipe behind coupler head V facing the grouting direction. If the coupler, in grouting direction, is placed in a downwards position, a vent pipe is also arranged in front of coupler head V

Movable coupler K6-K6 is installed analogously.

#### 2.2.4.4 Ducts and tendon placement

Tendons are installed with high accuracy on supports, see Clause 1.6. During installation careful handling of tendons is ensured.

Prior to concreting, the PT site manager carries out a final examination of the installed tendons. Damages to duct or tendons are either repaired immediately or reported to the responsible person.

#### 2.2.4.5 Encapsulated tendon

Installation of encapsulated tendons requires special care with regard to completely encase the tendon with an impermeable envelope. Checks are made by the responsible person, in particular at the following working steps

- After installation of tendon with regard to geometry of tendon, integrity of the duct especially at joints, and deformation of the duct especially at supports to avoid unintended kinks and too small radii with a risk of penetration of the prestressing steel strands during stressing
- Half shells are recommended for support of plastic duct in an encapsulated tendon, see Clause 1.11.2
- Before concreting with special attention to integrity of duct especially at contact points to reinforcing steel and the joint trumpet to anchor body MA or anchor plate E
- Before stressing with regard to the joint trumpet to anchor body MA or anchor plate E
- After stressing with regard to correct position of anchor head E or coupler head K
- Before grouting with regard to clean and undamaged sealing surfaces, and correct and tight position of protection caps
- After grouting with regard to correct and tight position of protection caps and penetration of grout out of the encased tendon

All shortcomings are rectified immediately. Major damages are immediately reported to the person responsible for the construction site for further actions. For each tendon, the checks performed with all relevant findings and corrective measures are systematically recorded.

#### 2.2.4.6 Electrically isolated tendon

Installation of electrically isolated tendons requires special care with regard to completely encase the tendon with electrically isolation material. Checks are made by the responsible person, in particular at the following working steps

- After installation of tendon with regard to geometry of tendon, integrity of the duct especially at joints, and deformation of the duct especially at supports to avoid unintended kinks and too small radii with a risk of penetration of the prestressing steel strands during stressing
- Half shells shall be applied for support of plastic duct in an electrically isolated tendon, see Clause 1.11.2
- Before concreting with special attention to integrity of duct especially at contact points to reinforcing steel and the joint trumpet to anchor body MA-EI or anchor plate E or anchor plate K-EI
- Before stressing with regard to the joint trumpet to anchor body MA-EI or anchor plate E or anchor plate K-EI and to a complete and correct installation of the isolation plate at the anchor
- After stressing with regard to correct position of anchor head EI or coupler head K-EI on the isolation plate
- Before grouting with regard to clean and undamaged sealing surfaces, and correct and tight position of protection caps
- After grouting with regard to correct and tight position of protection caps and penetration of grout out of the encased tendon

All shortcomings are rectified immediately. Major damages are immediately reported to the person responsible for the construction site for further actions. For each tendon, the checks



To establish a complete corrosion protection of the tendon, stressing and anchor recesses are concreted once stressing and grouting are completed.

### 2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the SUSPA Strand DW of 100 years, provided that the SUSPA Strand DW is subject to appropriate installation, use, and maintenance, see 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<sup>4</sup>.

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 Performance of the product

Table 7: Performance of the product in relation to the essential characteristics

Essential characteristic	Method of assessment	Performance
Basic requirement for construction works 1: Mechanical resistance and stability		
Resistance to static load	EAD 160004-00-0301, Clause 2.2.1	Clause 3.1.1
Resistance to fatigue	EAD 160004-00-0301, Clause 2.2.2	Clause 3.1.2
Load transfer to the structure	EAD 160004-00-0301, Clause 2.2.3	Clause 3.1.3
Friction coefficient	Clause 1.5	Clause 3.1.4
Deviation, deflection (limits)	Clause 1.7	Clause 3.1.5
Assessment of assembly	EAD 160004-00-0301, Clause 2.2.7	Clause 3.1.6
Resistance to static load under cryogenic conditions for applications with anchorage / coupling outside the possible cryogenic zone	EAD 160004-00-0301, Clause 2.2.8	Clause 3.1.7
Resistance to static load under cryogenic conditions for applications with anchorage / coupling inside the possible cryogenic zone	EAD 160004-00-0301, Clause 2.2.9	Clause 3.1.8

<sup>4</sup> 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	Method of assessment	Performance
Material properties, component performance, system performance of plastic duct (PL1)	EAD 160004-00-0301, Clause 2.2.10	Clause 3.1.9
Material properties, component performance, system performance of plastic duct to provide an encapsulated tendon (PL2)	EAD 160004-00-0301, Clause 2.2.11	Clause 3.1.10
Material properties, component performance, system performance of plastic duct to provide an electrically isolated tendon (PL3)	EAD 160004-00-0301, Clause 2.2.12	Clause 3.1.11
Corrosion protection	EAD 160004-00-0301, Clause 2.2.13	Clause 3.1.12
Basic requirement for construction works 2: Safety in case of fire		
Reaction to fire	Clause 3.1.13	Clause 3.1.13
Basic requirement for construction works 3: Hygiene, health and environment		
Content, emission, and/or release, of dangerous substances	Clause 3.1.14	Clause 3.1.14
Basic requirement for construction works 4: Safety and accessibility in use		
Not relevant. No characteristic assessed.	—	—
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.	—	—

### 3.1.1 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 tendon with prestressing steel strands according to Annex 42 are listed in Annex 5 and Annex 6.

### 3.1.2 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 tendon with prestressing steel strands according to Annex 42 are listed in Annex 5 and Annex 6.

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  $80 \text{ N/mm}^2$ , and  $2 \cdot 10^6$  load cycles.

### 3.1.3 Load transfer to the 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 tendons with prestressing steel strands according to Annex 42 are listed in Annex 5 and Annex 6.

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

3.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.5.

3.1.5 Deviation, deflection (limits)

For minimum radii of curvature see Clause 1.7.

3.1.6 Assessment of assembly

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

3.1.7 Resistance to static load under cryogenic conditions for applications with anchorage / coupling outside the possible cryogenic zone

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.8 for

- The anchorages with anchor head E or EI
- The wedges as given in Clause 1.9.8 for cryogenic applications

3.1.8 Resistance to static load under cryogenic conditions for applications with anchorage / coupling inside the possible cryogenic zone

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.9 for

- Sizes up to 22 prestressing steel strands
- The anchorages with anchor head E or EI
- The wedges as given in Clause 1.9.8 for cryogenic applications
- The assessment with one anchorage under cryogenic conditions

3.1.9 Material properties, component performance, system performance of plastic duct (PL1)

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.10. For the characteristic values of material properties and component performance see Annex 38 and Annex 39 and for system performance see Annex 40 and Annex 41.

3.1.10 Material properties, component performance, system performance of plastic duct to provide an encapsulated tendon (PL2)

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.11. For the characteristic values of material properties and component performance see Annex 38 and Annex 39 and for system performance see Annex 40 and Annex 41.

3.1.11 Material properties, component performance, system performance of plastic duct to provide an electrically isolated tendon (PL3)

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.12. For the characteristic values of material properties and component performance see Annex 38 and Annex 39 and for system performance see Annex 40 and Annex 41.

3.1.12 Corrosion protection

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

3.1.13 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.

### 3.1.14 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.

## 3.2 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the PT system, for the intended uses, 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 1, Internal bonded tendon
- Item 8, Optional use category: Internal tendon – Cryogenic applications with anchorage / coupling outside the possible cryogenic zone
- Item 9, Optional use category: Internal tendon – Cryogenic applications with anchorage / coupling outside the possible cryogenic zone
- Item 10, Optional use category: Internal tendon – Cryogenic applications with anchorage / coupling inside the possible cryogenic zone
- Item 11, Optional use category: Internal tendon – Cryogenic applications with anchorage / coupling inside the possible cryogenic zone
- Item 12, Optional use category: Internal bonded tendon with plastic (polymer duct)
- Item 13, Optional use category: Encapsulated (bonded) tendon
- Item 14, Optional use category: Electrically isolated (bonded) tendon

## 3.3 Identification

The European Technical Assessment for the PT system SUSPA Strand DW is issued on the basis of agreed data<sup>5</sup> that identify the assessed product. Changes to materials, to composition, 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 the decision 98/456/EC of the European Commission, as amended, the system of assessment and verification of constancy of performance (see Annex V of Regulation (EU) № 305/2011) 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.

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<sup>5</sup> The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

- (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<sup>6</sup>.
- (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**

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited by the Technical Assessment Body Österreichisches Institut für Bautechnik.

The notified product certification body shall visit the factory at least once a year for surveillance of the manufacturer.

##### **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.

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<sup>6</sup> 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.

- Determination of the dimensions of components
- Check correct assembly
- Documentation of tests and test results

At least once a year the manufacturer audits the manufacturers of the components given in Annex 44. 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 43, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the SUSPA Strand DW.

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.

#### 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 7. In Annex 45 the combinations of essential characteristics and corresponding intended uses are listed.

## 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 verifies the ability of the manufacturer for a continuous and orderly manufacturing of the SUSPA Strand DW according to the European Technical Assessment. In particular, the following items are appropriately considered

- Personnel and equipment
- Suitability of the factory production control established by the manufacturer
- Full implementation of the prescribed test plan

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

The notified product certification body visits the factory at least once a year for routine inspection. In particular, the following items are appropriately considered

- Manufacturing process including personnel and equipment
- Factory production control
- Implementation of the prescribed test plan

Each manufacturer of the components given in Annex 44 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 SUSPA Strand DW for independent testing. For the most important components, Annex 44 summarises the minimum procedures performed by the notified product certification body.

Issued in Vienna on 11 June 2024  
by Österreichisches Institut für Bautechnik

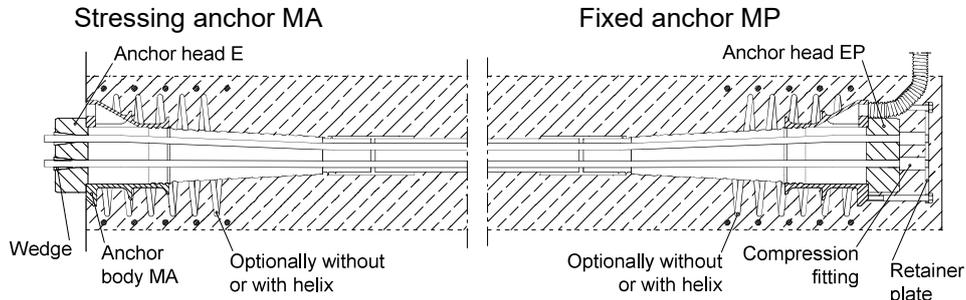
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Thomas Rockenschaub  
Deputy Managing Director

## Anchorages

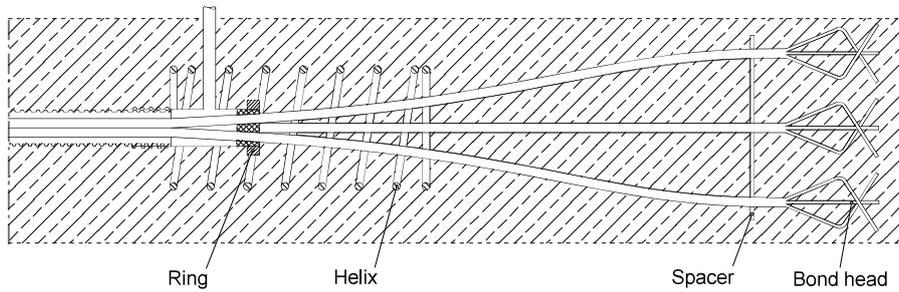
### Multi-plane anchorage MA

PL1/2/3



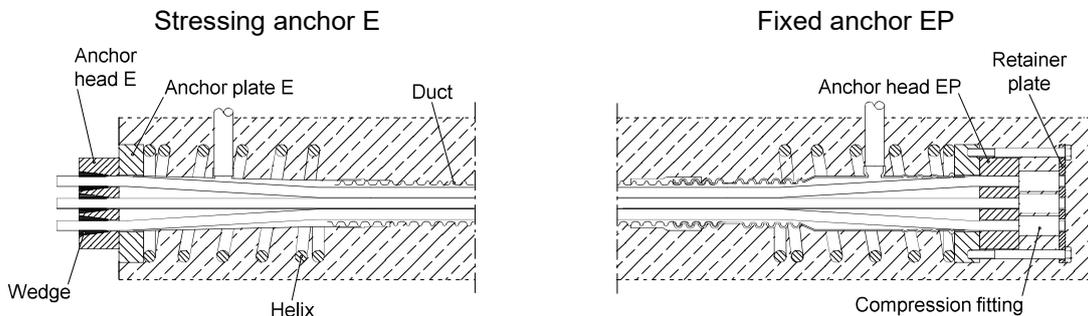
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PL1



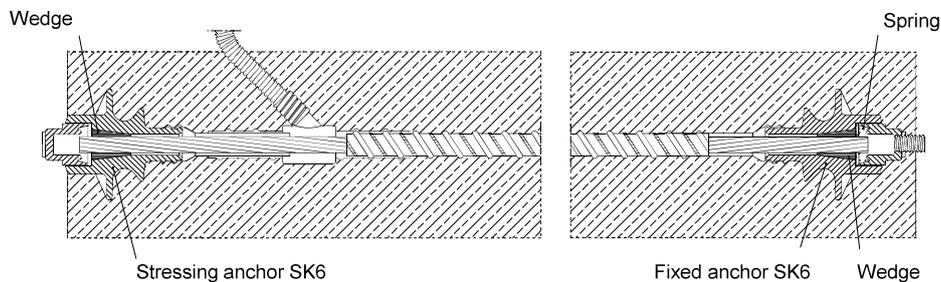
### Plate anchorage E

PL1/2/3



### Single strand anchorage SK6

PL1



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**Bonded prestressing system  
 SUSPA Strand DW  
 Overview on anchorages**

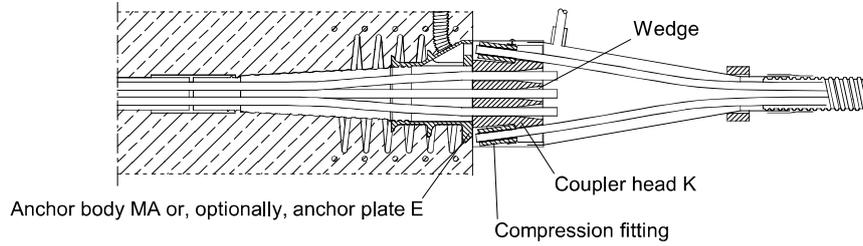
**Annex 1  
 of ETA-13/0839** of 11.06.2024

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### Couplers

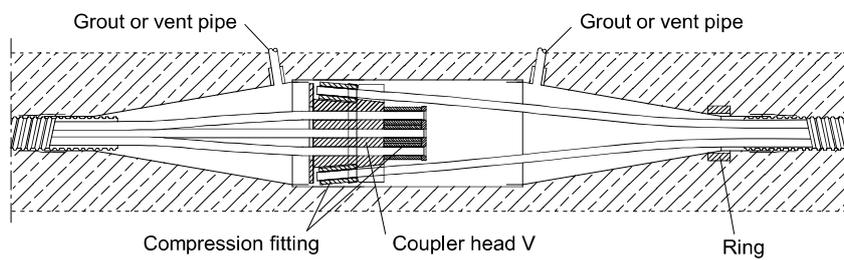
Fixed coupler K

PL1/2/3



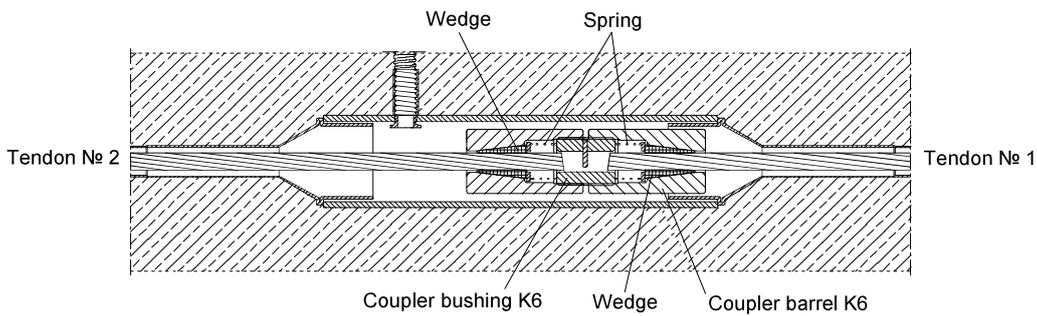
Movable coupler V

PL1/2/3



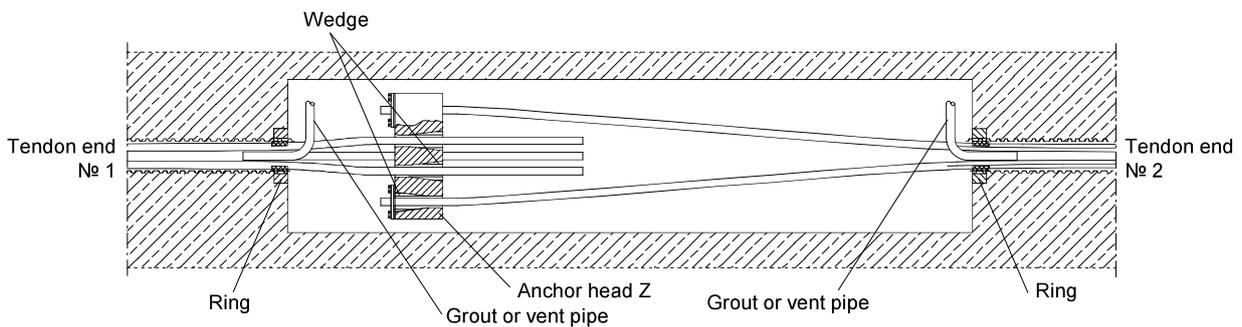
Movable coupler K6-K6

PL1



Floating block anchorage Z

PL1



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#### Bonded prestressing system SUSPA Strand DW

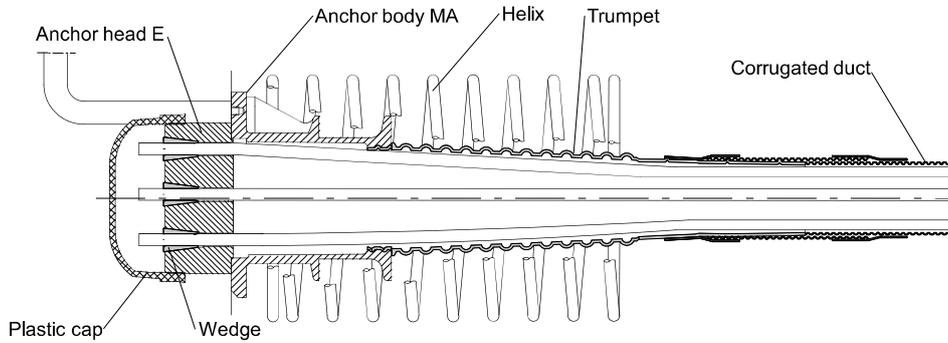
Overview on couplers and  
 Floating block anchorage Z

Annex 2  
 of ETA-13/0839 of 11.06.2024

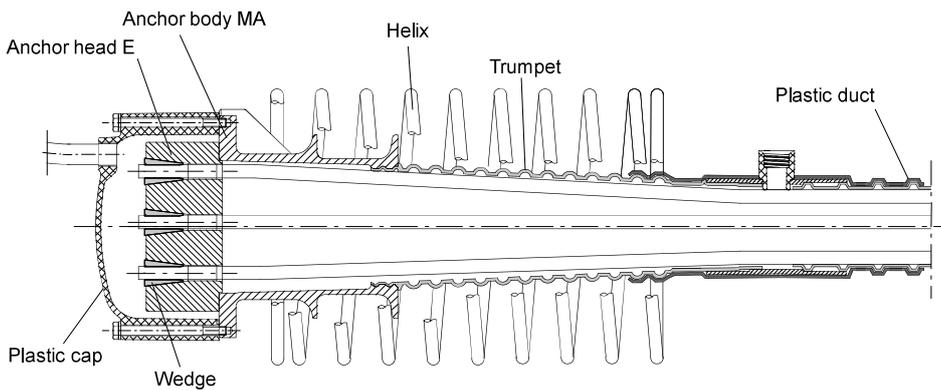
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**Protection levels of tendons with anchor body MA according to fib bulletin 33 “durability of post-tensioning tendons”**

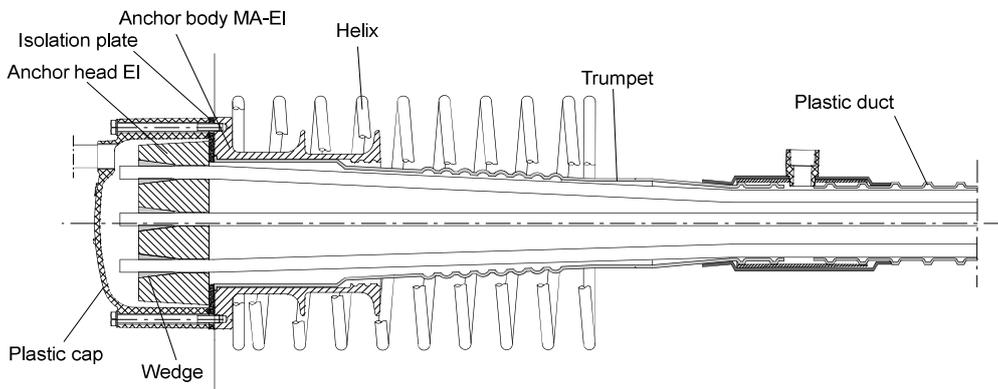
**PL1: Duct with filling material providing durable corrosion protection – Bonded strand PT tendon with corrugated steel strip sheath or corrugated plastic duct**



**PL2: PL1 plus an envelope, enclosing the PT tendon over its entire length, providing a permanent leak tight barrier – Anchorage with leak tight plastic cap, plastic trumpet, and plastic duct**



**PL3: PL2 plus integrity of tendon and encapsulation to be monitorable and inspectable at any time – Completely isolated anchorage with plastic trumpet also inside anchor body MA-EI, jointed with isolation plate, with leak tight plastic cap, and plastic duct – Electrically isolated tendon (EIT)**



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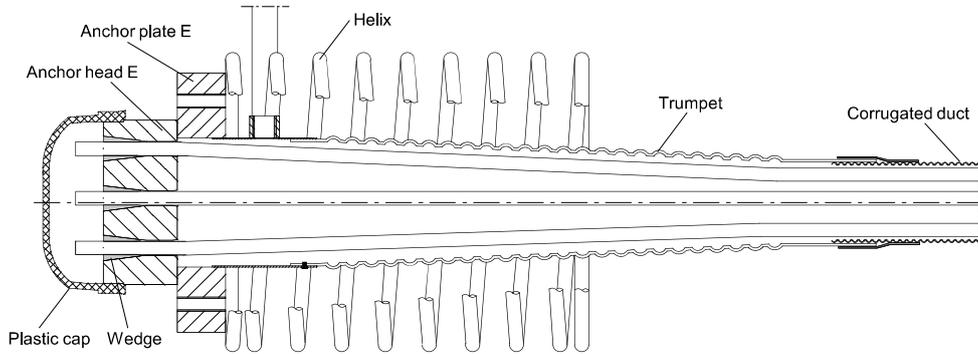
**Bonded prestressing system  
 SUSPA Strand DW**  
 Protection levels of tendons  
 with anchor body MA

**Annex 3  
 of ETA-13/0839 of 11.06.2024**

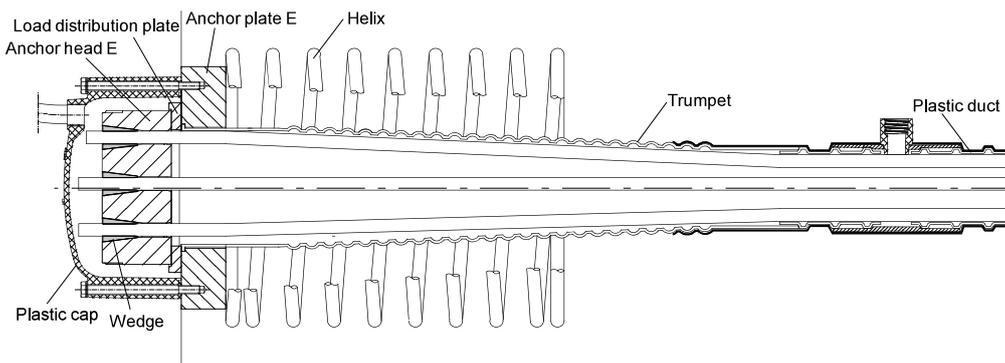
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**Protection levels of tendons with anchor plate according to fib bulletin 33 “durability of post-tensioning tendons”**

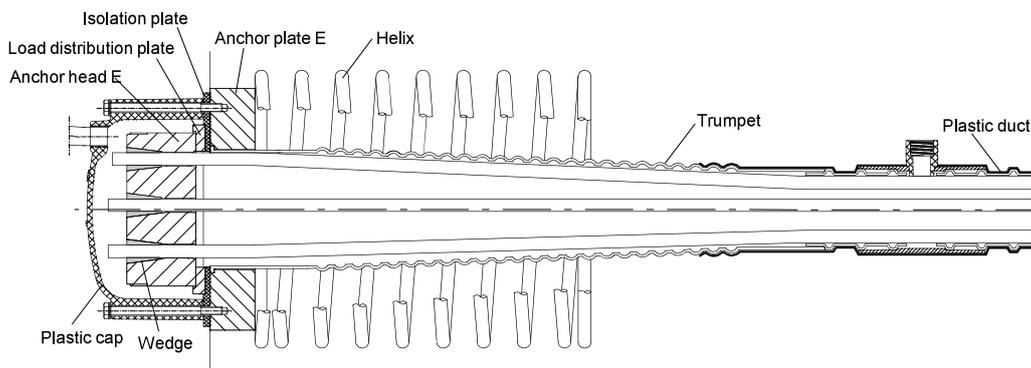
**PL1: Duct with filling material providing durable corrosion protection – Bonded strand PT tendon with corrugated steel strip sheath or corrugated plastic duct**



**PL2: PL1 plus an envelope, enclosing the PT tendon over its entire length, providing a permanent leak tight barrier – Anchorage with leak tight plastic cap, plastic trumpet, and plastic duct**



**PL3: PL2 plus integrity of tendon and encapsulation to be monitorable and inspectable at any time – Completely isolated anchorage with plastic trumpet also inside anchor plate, jointed with isolation plate, with leak tight plastic cap, and plastic duct – Electrically isolated tendon (EIT)**



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**Bonded prestressing system  
 SUSPA Strand DW**  
 Protection levels of tendons  
 with anchor plate E

**Annex 4**  
 of **ETA-13/0839** of 11.06.2024

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Tendon range – Strand Y1770S7 15.7 –  $f_{pk} = 1\,770\text{ N/mm}^2$

Number of strands	Mass of strands	Nominal cross-sectional area	Maximum prestressing force <sup>1), 3)</sup>	Maximum overstressing force <sup>1), 2), 3)</sup>	Characteristic value of maximum force
		$A_p$	$0.90 \cdot F_{p0.1}$	$0.95 \cdot F_{p0.1}$	$F_{pk}$
—	kg/m	mm <sup>2</sup>	kN	kN	kN
1	1.17	150	211	222	266
2	2.34	300	421	445	532
3	3.52	450	632	667	798
4	4.69	600	842	889	1 064
5	5.86	750	1 053	1 112	1 330
6	7.03	900	1 264	1 334	1 596
7	8.20	1 050	1 474	1 556	1 862
8	9.38	1 200	1 685	1 778	2 128
9	10.55	1 350	1 895	2 001	2 394
10	11.72	1 500	2 106	2 223	2 660
11	12.89	1 650	2 317	2 445	2 926
12	14.06	1 800	2 527	2 668	3 192
13	15.24	1 950	2 738	2 890	3 458
14	16.41	2 100	2 948	3 112	3 724
15	17.58	2 250	3 159	3 335	3 990
16	18.75	2 400	3 370	3 557	4 256
17	19.92	2 550	3 580	3 779	4 522
18	21.10	2 700	3 791	4 001	4 788
19	22.27	2 850	4 001	4 224	5 054
20	23.44	3 000	4 212	4 446	5 320
21	24.61	3 150	4 423	4 668	5 586
22	25.78	3 300	4 633	4 891	5 852

- 1) The given values are maximum values according to Eurocode 2. The actual values are taken from the standards and regulations in force at the place of use.
- 2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of  $\pm 5\%$  of the final value of the overstressing force.
- 3) For strands according to prEN 10138-3, 09.2000, the values are multiplied by 0.98.

Where

- $f_{pk}$  ..... Characteristic tensile strength of prestressing steel strand
- $F_{pk}$  ..... Characteristic value of maximum force of tendon
- $F_{p0.1}$  ..... Characteristic value of 0.1 % proof force of tendon,  $F_{p0.1} = A_p \cdot f_{p0.1}$   
For  $F_{p0.1}$  of one single strand see Annex 42.
- $A_p$  ..... Nominal cross-sectional area of tendon



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**Bonded prestressing system  
SUSPA Strand DW**

Tendon range – Strand Y1770S7 15.7  
Maximum prestressing and overstressing force  
Characteristic values of maximum force of tendon

**Annex 5**  
of **ETA-13/0839** of 11.06.2024

Tendon range – Strand Y1860S7 15.7 –  $f_{pk} = 1\,860\text{ N/mm}^2$

Number of strands	Mass of strands	Nominal cross-sectional area	Maximum prestressing force <sup>1), 3)</sup>	Maximum overstressing force <sup>1), 2), 3)</sup>	Characteristic value of maximum force
		$A_p$	$0.90 \cdot F_{p0.1}$	$0.95 \cdot F_{p0.1}$	$F_{pk}$
—	kg/m	mm <sup>2</sup>	kN	kN	kN
1	1.17	150	221	234	279
2	2.34	300	443	467	558
3	3.52	450	664	701	837
4	4.69	600	886	935	1 116
5	5.86	750	1 107	1 169	1 395
6	7.03	900	1 328	1 402	1 674
7	8.20	1 050	1 550	1 636	1 953
8	9.38	1 200	1 771	1 870	2 232
9	10.55	1 350	1 993	2 103	2 511
10	11.72	1 500	2 214	2 337	2 790
11	12.89	1 650	2 435	2 571	3 069
12	14.06	1 800	2 657	2 804	3 348
13	15.24	1 950	2 878	3 038	3 627
14	16.41	2 100	3 100	3 272	3 906
15	17.58	2 250	3 321	3 506	4 185
16	18.75	2 400	3 542	3 739	4 464
17	19.92	2 550	3 764	3 973	4 743
18	21.10	2 700	3 985	4 207	5 022
19	22.27	2 850	4 207	4 440	5 301
20	23.44	3 000	4 428	4 674	5 580
21	24.61	3 150	4 649	4 908	5 859
22	25.78	3 300	4 871	5 141	6 138

- 1) The given values are maximum values according to Eurocode 2. The actual values are taken from the standards and regulations in force at the place of use.
- 2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of  $\pm 5\%$  of the final value of the overstressing force.
- 3) For strands according to prEN 10138-3, 09.2000, the values are multiplied by 0.98.

Where

- $f_{pk}$  ..... Characteristic tensile strength of prestressing steel strand
- $F_{pk}$  ..... Characteristic value of maximum force of tendon
- $F_{p0.1}$  ..... Characteristic value of 0.1 % proof force of tendon,  $F_{p0.1} = A_p \cdot f_{p0.1}$   
For  $F_{p0.1}$  of one single strand see Annex 42.
- $A_p$  ..... Nominal cross-sectional area of tendon



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**Bonded prestressing system  
SUSPA Strand DW**

Tendon range – Strand Y1860S7 15.7  
Maximum prestressing and overstressing force  
Characteristic values of maximum force of tendon

**Annex 6**  
of **ETA-13/0839** of 11.06.2024

Technical data for tendons 6-1 to 6-22 with circular steel strip sheath  
strand Y1770S7 15.7 and strand Y1860S7 15.7

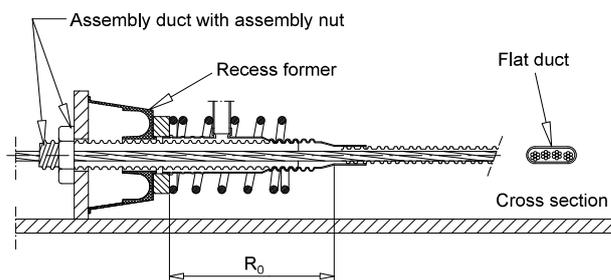
Tendon	6-1	6-3	6-4	6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands $\varnothing$ 15.7 mm	1	3	4	5	7	9	12	15	19	22
Nominal cross-sectional area of prestressing steel mm <sup>2</sup>	150	450	600	750	1 050	1 350	1 800	2 250	2 850	3 300
Nominal mass of prestressing steel kg/m	1.17	3.52	4.69	5.86	8.20	10.55	14.06	17.58	22.27	25.78
Modulus of elasticity N/mm <sup>2</sup>	195 000 (standard value)									
Circular steel strip sheath										
Wobble coefficient k	0.005 rad/m $\triangleq$ 0.30 °/m									
Duct I $\varnothing$ d <sub>i</sub> / d <sub>a</sub> mm	20/27	40/47	45/52	50/57	55/62	65/72	75/82	80/87	90/97	95/102
Eccentricity mm	3	6	7	7	6	9	10	10	10	10
Friction coefficient $\mu$ rad <sup>-1</sup>	0.20									
Distance of tendon support m	0.60–1.80									
Duct II $\varnothing$ d <sub>i</sub> / d <sub>a</sub> mm	25/32	45/52	50/57	55/62	60/67	70/77	80/87	85/92	95/102	105/112
Eccentricity mm	5	9	10	11	9	12	14	13	14	18
Friction coefficient $\mu$ rad <sup>-1</sup>	0.19									
Distance of tendon support m	0.60–1.80 m with stiffening, e.g. with PE tube or prefabricated tendon with strands 0.60–1.00 m with strengthened duct In a tendon section with minimum radius of curvature 0.60–0.75 m applies.									
Friction loss in stressing anchorages SK6, MA, and E %	— <sup>1)</sup>	1.0	1.3	1.2	1.0	0.7	0.8	0.8	0.7	0.6
Friction loss in movable couplers K6-K6 and V %	— <sup>1)</sup>	1.8	2.0	1.8	1.8	1.7	1.7	1.7	1.7	1.6

<sup>1)</sup> Friction losses are low and do not have to be considered in design and execution.

Technical data for tendons 6-3 to 6-5 with flat steel strip sheath  
strand Y1770S7 15.7 and strand Y1860S7 15.7

Tendon	6-3	6-4	6-5	
Number of strands $\varnothing$ 15.7 mm	3	4	5	
Trumpet length R <sub>0</sub> m	370	325	535	
Flat steel strip sheath				
Dimensions	d <sub>i</sub> mm	55 × 21	70 × 21	85 × 21
	d <sub>a</sub> mm	60 × 25	75 × 25	90 × 25
Distance of tendon support M	0.50–1.00			
Wobble coefficient k	0.014 rad/m $\triangleq$ 0.80 °/m			
Bending around weak axis, Minimum radius of curvature R M	2.5			
Friction coefficient $\mu$ rad <sup>-1</sup>	0.15			
Bending around strong axis, Minimum radius of curvature R m	5.0			
Friction coefficient $\mu$ rad <sup>-1</sup>	0.23	0.26	0.32	

Stressing anchor E  
Assembly condition



NOTE Flat ducts can be installed with anchor body MA and with anchor plate E.



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**Bonded prestressing system  
SUSPA Strand DW**

Technical data  
Tendons 6-1 to 6-22 with circular steel strip sheath  
Tendons 6-3 to 6-5 with flat steel strip sheath

**Annex 7**  
of **ETA-13/0839** of 11.06.2024

Minimum radii of curvature for circular duct –  $p_{R, \max} = 140 \text{ kN/m}$

Strand Y1860S7,  $f_{pk} = 1\,860 \text{ N/mm}^2$

Number of strands	Duct I, inner diameter	Minimum radius of curvature	Duct II, inner diameter	Minimum radius of curvature	Duct III, inner diameter	Minimum radius of curvature
n	$\varnothing d_i$	$R_{\min}$	$\varnothing d_i$	$R_{\min}$	$\varnothing d_i$	$R_{\min}$
—	mm	m	mm	m	mm	m
1	20	2.0	25	2.0	23	2.0
2	40	2.0	45	2.0	48	2.0
3	40	4.0	45	3.2	48	3.0
4	45	4.1	50	3.9	48	3.9
5	50	4.7	55	4.3	48	4.9
6	55	5.1	60	4.7	59	4.8
7	55	6.0	60	5.5	59	5.6
8	65	5.8	70	5.4	76	4.9
9	65	6.5	70	6.0	76	5.6
10	75	6.3	80	5.9	76	6.2
11	75	6.9	80	6.4	76	6.8
12	75	7.5	80	7.0	76	7.4
13	80	7.6	85	7.2	85	7.2
14	80	8.2	85	7.7	85	7.7
15	80	8.8	85	8.3	85	8.3
16	90	8.3	95	7.9	100	7.5
17	90	8.9	95	8.4	100	8.0
18	90	9.4	95	8.9	100	8.4
19	90	9.9	95	9.4	100	8.9
20	95	9.9	105	8.9	115	8.2
21	95	10.4	105	9.4	115	8.6
22	95	10.9	105	9.8	115	9.0

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**Bonded prestressing system  
SUSPA Strand DW**  
Minimum radii of curvature for circular duct  
 $p_R = 140 \text{ kN/m}$

**Annex 8**  
of **ETA-13/0839** of 11.06.2024

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Minimum radii of curvature for circular duct –  $p_{R, max} = 170 \text{ kN/m}$

Strand Y1860S7,  $f_{pk} = 1860 \text{ N/mm}^2$

Number of strands	Duct I, inner diameter	Minimum radius of curvature	Duct II, inner diameter	Minimum radius of curvature	Duct III, inner diameter	Minimum radius of curvature
n	$\varnothing d_i$	$R_{min}$	$\varnothing d_i$	$R_{min}$	$\varnothing d_i$	$R_{min}$
—	mm	m	mm	m	mm	m
1	20	2.0	25	2.0	23	2.0
2	40	2.0	45	2.0	48	2.0
3	40	3.2	45	2.6	48	2.3
4	45	3.2	50	3.2	48	3.2
5	50	3.9	55	3.5	48	4.0
6	55	4.2	60	3.9	59	3.9
7	55	4.9	60	4.5	59	4.6
8	65	4.8	70	4.4	76	4.1
9	65	5.3	70	5.0	76	4.6
10	75	5.1	80	4.8	76	5.1
11	75	5.7	80	5.3	76	5.6
12	75	6.2	80	5.8	76	6.1
13	80	6.3	85	5.9	85	5.9
14	80	6.8	85	6.4	85	6.4
15	80	7.2	85	6.8	85	6.8
16	90	6.9	95	6.5	100	6.2
17	90	7.3	95	6.9	100	6.6
18	90	7.7	95	7.3	100	7.0
19	90	8.2	95	7.7	100	7.3
20	95	8.1	105	7.4	115	6.7
21	95	8.5	105	7.7	115	7.1
22	95	8.9	105	8.1	115	7.4



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**Bonded prestressing system  
SUSPA Strand DW**  
Minimum radii of curvature for circular duct  
 $p_R = 170 \text{ kN/m}$

**Annex 9**  
of **ETA-13/0839** of 11.06.2024

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Minimum radii of curvature for circular duct –  $p_{R, \max} = 200 \text{ kN/m}$

Strand Y1860S7,  $f_{pk} = 1\,860 \text{ N/mm}^2$

Number of strands	Duct I, inner diameter	Minimum radius of curvature	Duct II, inner diameter	Minimum radius of curvature	Duct III, inner diameter	Minimum radius of curvature
n	$\varnothing d_i$	$R_{\min}$	$\varnothing d_i$	$R_{\min}$	$\varnothing d_i$	$R_{\min}$
—	mm	m	mm	m	mm	m
1	20	2.0	25	2.0	23	2.0
2	40	2.0	45	2.0	48	2.0
3	40	2.8	45	2.2	48	2.0
4	45	2.7	50	2.7	48	2.7
5	50	3.3	55	3.0	48	3.4
6	55	3.6	60	3.3	59	3.3
7	55	4.2	60	3.8	59	3.9
8	65	4.0	70	3.8	76	3.5
9	65	4.5	70	4.2	76	3.9
10	75	4.4	80	4.1	76	4.3
11	75	4.8	80	4.5	76	4.8
12	75	5.3	80	4.9	76	5.2
13	80	5.3	85	5.0	85	5.0
14	80	5.7	85	5.4	85	5.4
15	80	6.2	85	5.8	85	5.8
16	90	5.8	95	5.5	100	5.3
17	90	6.2	95	5.9	100	5.6
18	90	6.6	95	6.2	100	5.9
19	90	6.9	95	6.6	100	6.2
20	95	6.9	105	6.3	115	5.7
21	95	7.3	105	6.6	115	6.0
22	95	7.6	105	6.9	115	6.3

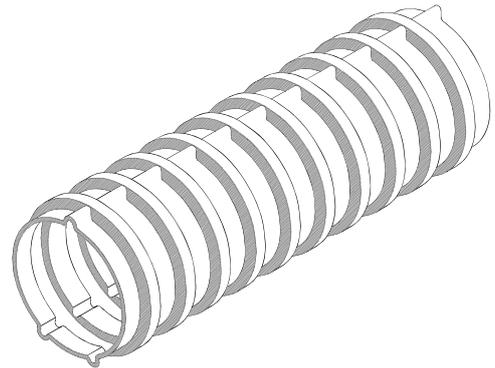
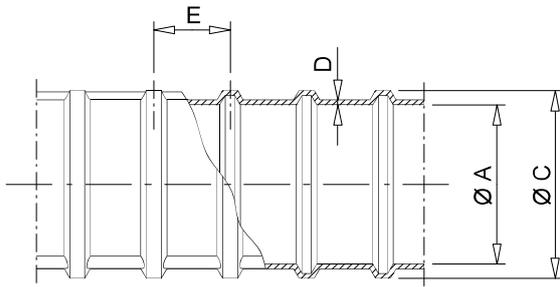
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**Bonded prestressing system  
 SUSPA Strand DW**  
 Minimum radii of curvature for circular duct  
 $p_R = 200 \text{ kN/m}$

**Annex 10**  
 of **ETA-13/0839** of 11.06.2024

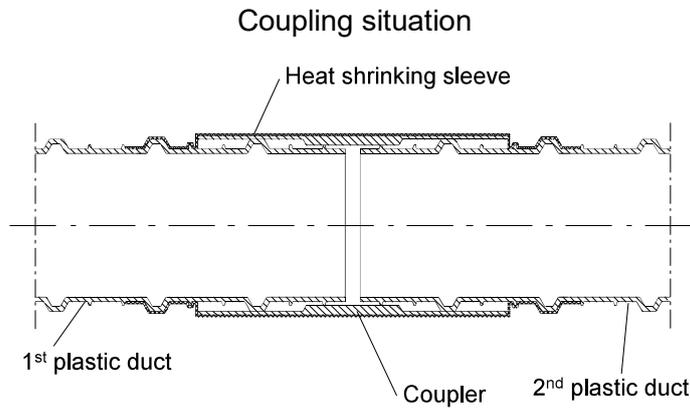
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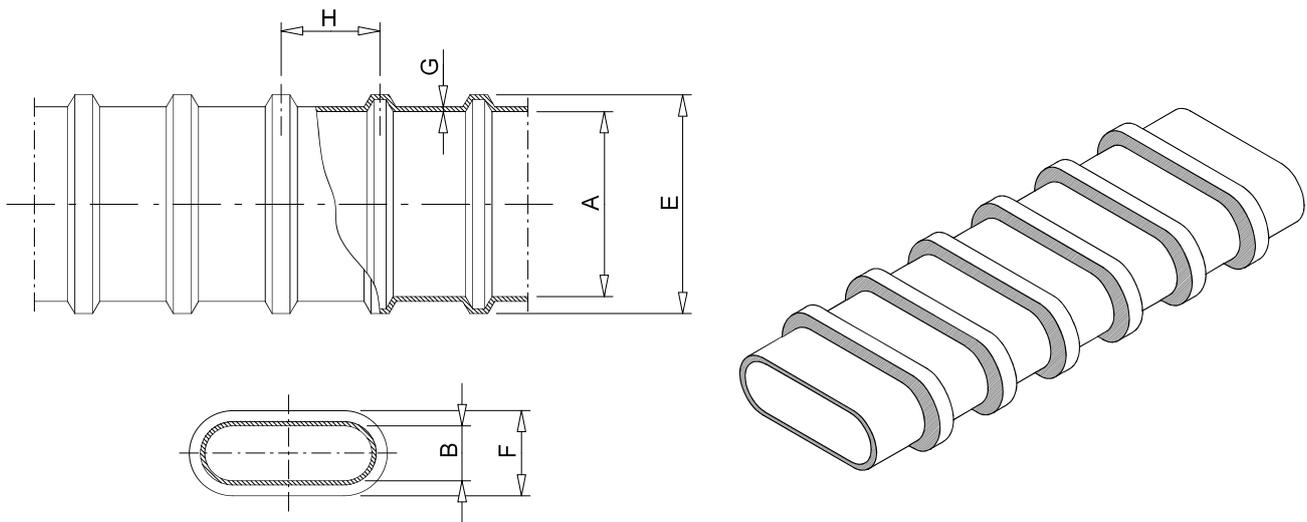


Circular plastic duct			23	48	59	76	85	100	115
Number of strands $\varnothing$ 15.7 mm			1	3, 4, 5	7	9, 12	15	19	22
Dimensions									
inner	$\varnothing$ A	mm	23.0	48.0	58.5	76.0	85.5	100.0	115.0
ribs	$\varnothing$ C	mm	37.0	59.0	72.5	91.0	100.5	116.0	131.0
Wall thickness	D	mm	2.0	2.0	2.0	2.5	2.5	3.0	3.5
Rib distance	E	mm	39.5	28.0	42.0	52.5	39.5	39.5	60.0
Distance of supports		m	0.5	0.6–0.7					
Wobble coefficient	k	rad/m	0.005						
Friction coefficient	$\mu$	rad <sup>-1</sup>	0.10–0.14						

NOTE Dimensions rounded to the nearest 0.5 mm.

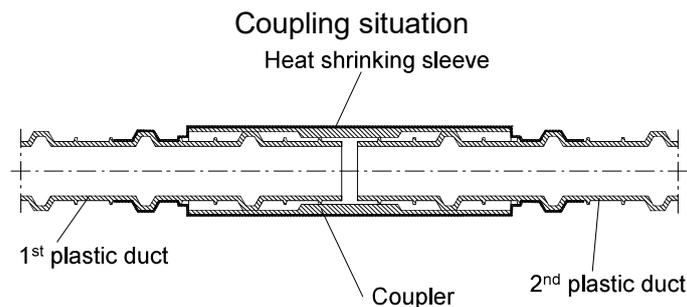


Dimensions in mm



Flat plastic duct			38 × 22	52 × 21	72 × 21	76 × 25	91 × 22
Number of strands $\varnothing$ 15.7 mm			2	3	3	4	5
Dimensions of cross section							
inner	A	mm	37.5	67.5	71.0	75.5	91.0
	B	mm	21.5	35.5	21.0	25.0	22.0
ribs	E	mm	52.5	71.5	85.5	90.0	105.0
	F	mm	36.5	39.5	36.0	40.0	40.0
Wall thickness	G	mm	2.0	2.0	2.0	2.0	2.0
Rib distance	H	mm	40.0	40.0	40.0	40.0	40.0
Distance of supports		m	0.5				
Wobble coefficient	k	rad/m	0.008				
Friction coefficient	$\mu$	rad <sup>-1</sup>	0.10–0.14				

NOTE Dimensions rounded to the nearest 0.5 mm.



Dimensions in mm

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**Bonded prestressing system  
SUSPA Strand DW**

Flat plastic duct  
Data sheet

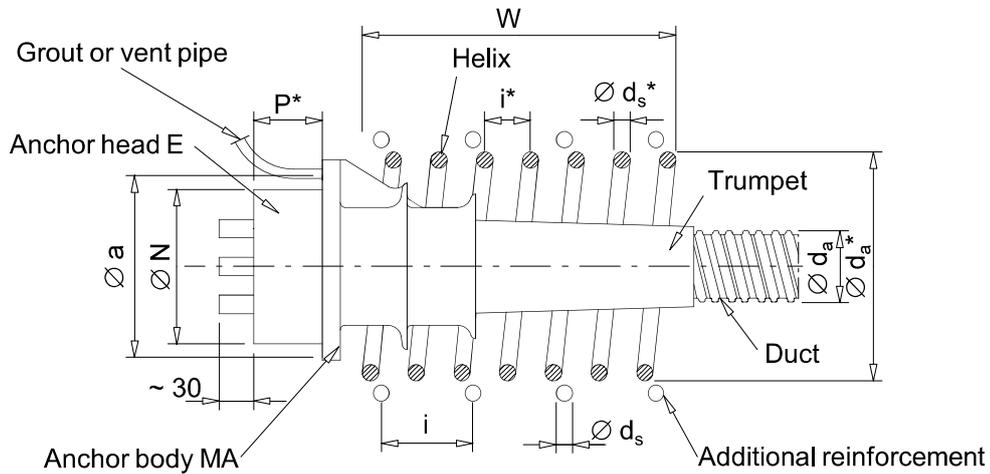
**Annex 13**  
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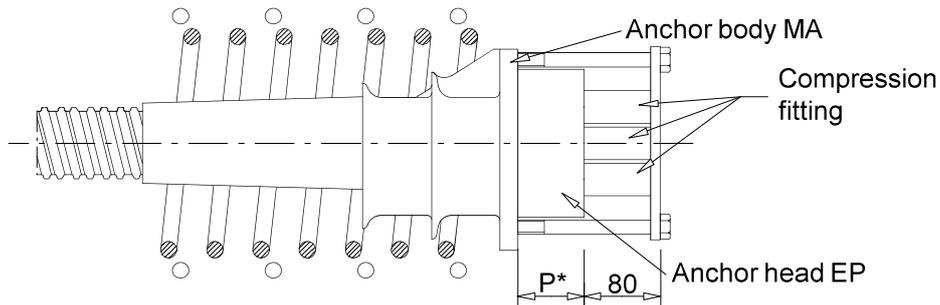
Stressing anchor MA with anchor body MA and anchor head E – PL1 and PL2

For PL2 the tendon is installed with

- Sealing and protection cap
- Plastic duct
- Assembly of stressing anchor MA is applied also as fixed anchor.

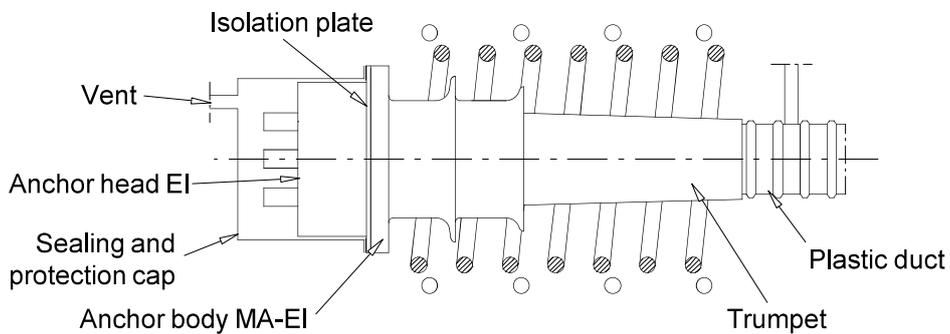


Fixed anchor MP with anchor body MA and anchor head EP – PL1



Further dimensions as per stressing anchor MA

Stressing and fixed anchor with anchor body MA-EI and anchor head EI – PL3



Dimensions in mm



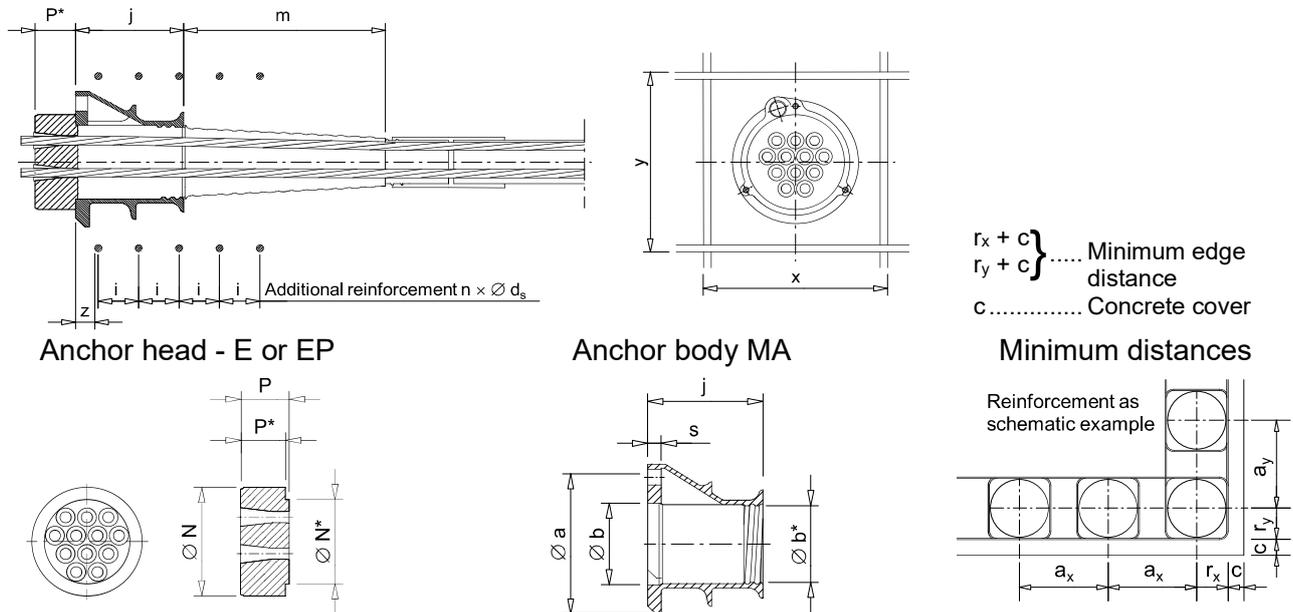
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**Bonded prestressing system  
 SUSPA Strand DW**  
 Stressing and fixed anchor with anchor  
 body MA

**Annex 15**  
 of **ETA-13/0839** of 11.06.2024

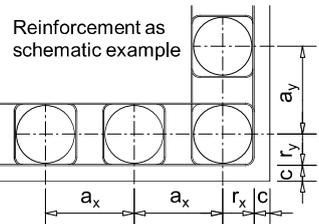
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Anchorage with multi-plane anchor body MA with additional reinforcement and without helix, tendons 6-5 to 6-22, strand Y1770S7 15.7 and strand Y1860S7 15.7 – PL1 and PL2



$r_x + c$   
 $r_y + c$  } Minimum edge distance  
c ..... Concrete cover

Minimum distances



Tendon		6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands		5	7	9	12	15	19	22
Strand arrangement								
Anchor head	Ø N	135	135	155	170	190	200	220
	Ø N*	88	96	112	128	148	159	176
	thickness P	60	60	65	75	85	95	100
	depth P*	56.5	56.5	61.5	71.5	81.5	91.5	96.5
Anchor body MA	Ø a	150	170	190	220	250	280	305
	Ø b	90	98	114	130	150	162	179
	Ø b*	80	90	100	120	130	145	161
	height j	90	100	125	180	200	220	220
	thickness s	18	18	15	17	19	23	26.5
Trumpet length	m	240	210	280	350	390	430	550
<b>Minimum concrete compressive strength at time of stressing</b>								
$f_{cm, 0, cube}$ N/mm <sup>2</sup>		34 44 54	34 44 54	34 44 54	34 44 54	34 44 54	34 44 54	34 44 54
$f_{cm, 0, cyl}$ N/mm <sup>2</sup>		28 35 43	28 35 43	28 35 43	28 35 43	28 35 43	28 35 43	28 35 43
Centre distance <sup>1)</sup> $a_x, a_y$		255 225 205	300 265 240	335 300 275	380 340 310	425 375 345	475 420 385	510 450 410
Edge distance (plus c) <sup>1), 2)</sup> $r_x, r_y$		120 105 95	140 125 110	160 140 130	180 160 145	205 180 165	230 200 185	245 215 195
<b>Additional reinforcement, ribbed reinforcing steel <math>R_e \geq 500</math> N/mm<sup>2</sup></b>								
Minimum numbers of layers n		5 5 5	6 5 6	6 6 6	8 8 7	8 8 8	8 8 9	10 9 8
Minimum bar diameter Ø $d_s$		16 16 16	16 16 16	16 16 16	16 16 16	20 16 16	20 20 20	20 20 20
Maximum spacing z		40 40 40	40 40 40	40 40 40	40 40 40	40 40 40	40 40 40	40 40 40
Maximum spacing i		50 50 50	50 50 50	50 50 50	45 50 50	55 45 45	55 55 50	50 50 50
External dimensions <sup>3)</sup> x, y		240 205 175	280 235 195	305 260 225	320 295 260	380 335 300	410 370 350	430 390 360

<sup>1)</sup> Minimum dimensions      <sup>2)</sup> c ... concrete cover  
<sup>3)</sup> The external dimensions x, y have to be met exactly.

Dimensions in mm



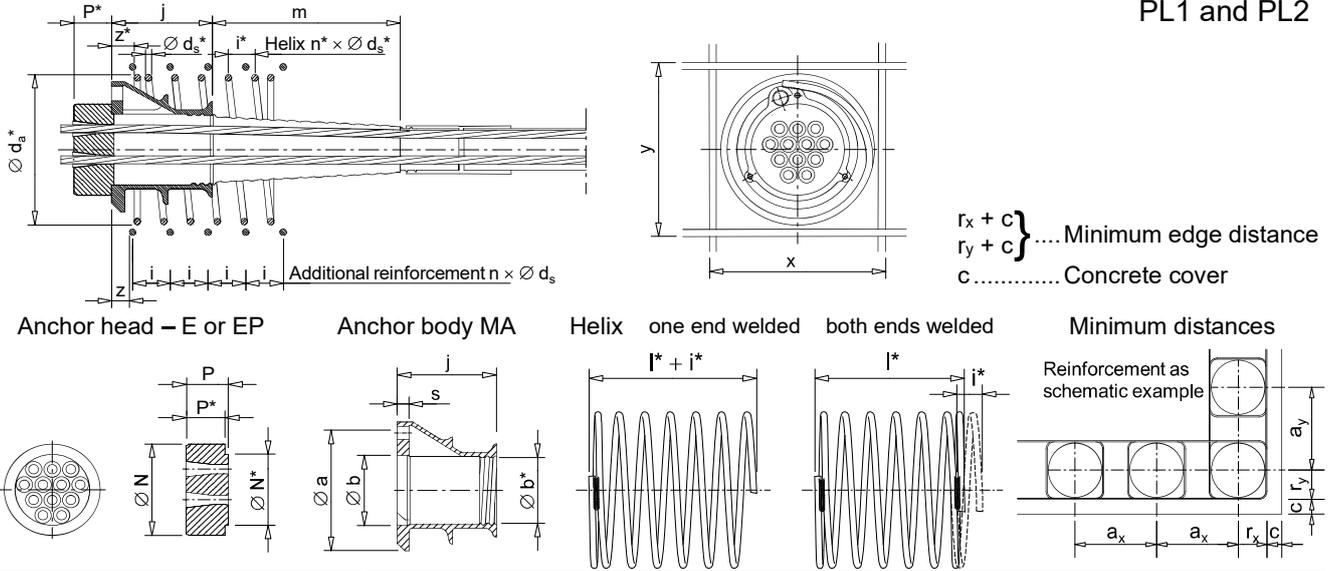
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**Bonded prestressing system  
SUSPA Strand DW**

Anchorage with multi-plane anchor body MA  
with additional reinforcement and without helix  
Data sheet for tendons 6-5 to 6-22

**Annex 16**  
of **ETA-13/0839** of 11.06.2024

**Anchorage with multi-plane anchor body MA with additional reinforcement and with helix and with minimum centre distances, tendons 6-5 to 6-22, strand Y1770S7 15.7 and strand Y1860S7 15.7 PL1 and PL2**



Tendon		6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands		5	7	9	12	15	19	22
Strand arrangement								
Anchor head	$\varnothing N$	135	135	155	170	190	200	220
	$\varnothing N^*$	88	96	112	128	148	159	176
	thickness P	60	60	65	75	85	95	100
	depth $P^*$	56.5	56.5	61.5	71.5	81.5	91.5	96.5
Anchor body MA	$\varnothing a$	150	170	190	220	250	280	305
	$\varnothing b$	90	98	114	130	150	162	179
	$\varnothing b^*$	80	90	100	120	130	145	161
	height j	90	100	125	180	200	220	220
thickness s	18	18	15	17	19	23	26.5	
Trumpet length m		240	210	280	350	390	430	550

Minimum concrete compressive strength at time of stressing												
$f_{cm, 0, \text{cube}}$ N/mm <sup>2</sup>	25	34	45	25	34	45	25	34	45	25	34	45
$f_{cm, 0, \text{cyl}}$ N/mm <sup>2</sup>	20	28	36	20	28	36	20	28	36	20	28	36
Centre distance <sup>1)</sup> $a_x, a_y$	270	235	220	320	280	245	345	305	270	400	350	310
Edge distance (plus c) <sup>1), 2)</sup> $r_x, r_y$	125	110	100	150	130	115	165	145	125	190	165	145

Helix												
Minimum number of turns $n^*$	5.5	5	5	5	5	5	6.5	6	6	6	7	7
Minimum wire diameter $\varnothing d_s^*$	12	12	12	14	14	14	14	14	14	14	16	14
Maximum distance $z^*$	40	40	40	40	40	40	40	40	40	45	45	45
Min. external diameter $\varnothing d_a^*$	205	185	180	240	220	200	270	250	220	320	265	255
max. $i^*$	45	40	50	50	50	50	50	50	50	50	50	50
min. $l^*$	235	195	235	240	240	240	315	290	290	290	340	340

Additional reinforcement, ribbed reinforcing steel $R_e \geq 500$ N/mm <sup>2</sup>												
Minimum numbers of layers n	5	5	5	6	6	6	7	7	7	7	8	8
Minimum bar diameter $\varnothing d_s$	12	12	12	12	12	12	14	14	14	14	14	14
Maximum distance z	35	35	35	35	35	35	35	35	35	40	40	40
Maximum spacing i	50	45	50	55	50	50	55	55	55	55	50	55
External dimensions x, y	250	215	200	300	260	225	325	285	250	380	330	290

<sup>1)</sup> Minimum dimensions      <sup>2)</sup> c ... concrete cover      Dimensions in mm

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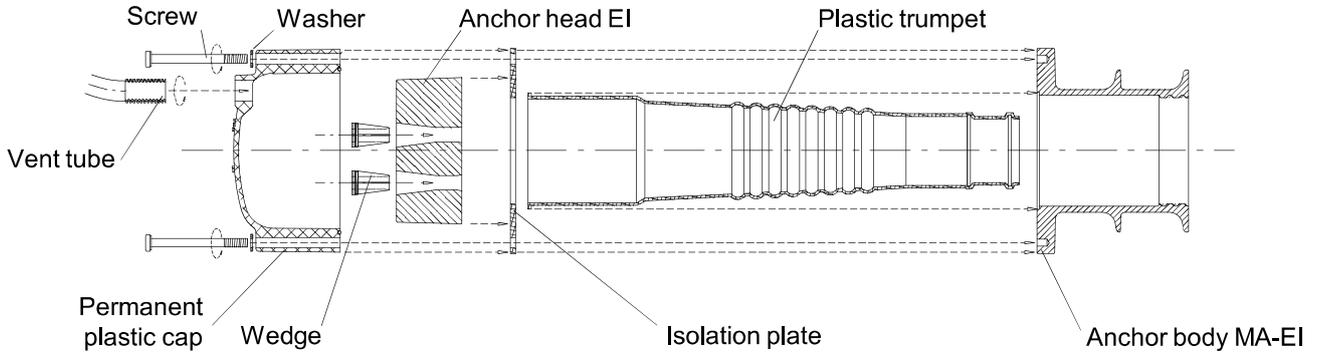
**Bonded prestressing system  
SUSPA Strand DW**

Anchorage with multi-plane anchor body MA  
with additional reinforcement and with helix  
Data sheet for tendons 6-5 to 6-22

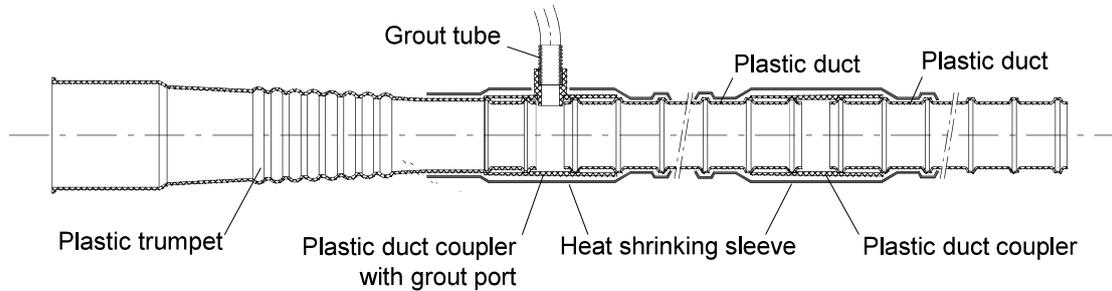
**Annex 17  
of ETA-13/0839 of 11.06.2024**

Stressing and fixed anchor MA with anchor body MA-EI and anchor head EI – PL3

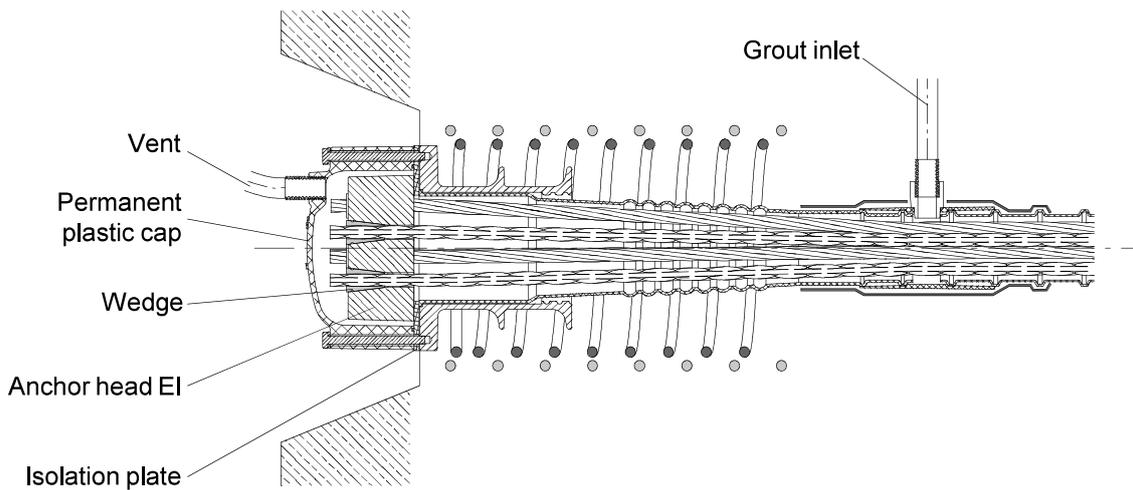
Assembly of MA-EI anchorage components



Assembly of MA-EI anchorage components



Assembly of MA-EI anchorage components



Dimensions in mm



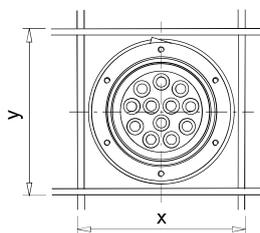
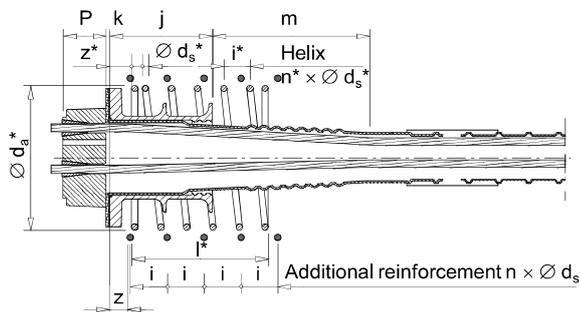
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**Bonded prestressing system  
 SUSPA Strand DW**  
 Stressing and fixed anchor with anchor  
 body MA-EI – Electrically isolated

**Annex 18**  
 of **ETA-13/0839** of 11.06.2024

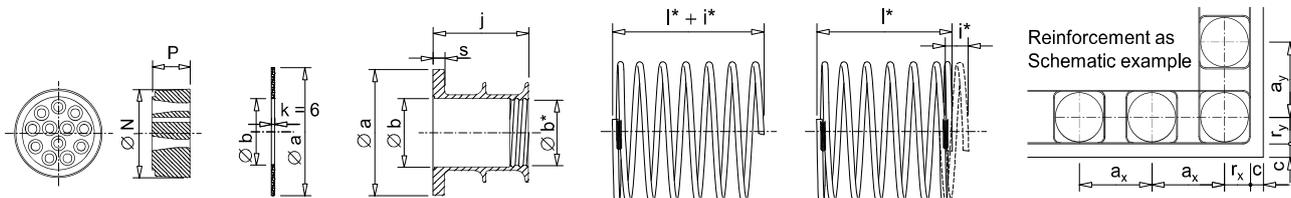
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Anchorage with multi-plane anchor body MA-EI, with additional reinforcement, with helix and with minimum centre distances, tendons 6-5 to 6-22, strand Y1770S7 15.7 and strand Y1860S7 – PL3



$r_x + c$  } ..... Minimum edge distance  
 $r_y + c$  }  
 c ..... Concrete cover

Anchor head EI    Isolation plate    Anchor body MA-EI    Helix    one end welded    both ends welded    Minimum distances



Tendon		6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands		5	7	9	12	15	19	22
Strand arrangement								
Anchor head EI	Ø N	135	135	155	175	200	215	234
thickness	P	60	60	65	75	85	95	100
Anchor body MA-EI	Ø a	160	186	220	245	258	280	313
	Ø b	88	98	114	133	157	165	183
	Ø b*	92	102	115	127	148	158	177
height	j	90	100	125	180	200	220	220
thickness	s	18	18	22	22	22	23	26.5
Trumpet length	m	235	250	290	355	425	365	560
<b>Minimum concrete compressive strength at time of stressing</b>								
$f_{cm, 0, cube}$ N/mm <sup>2</sup>		25 34 45	25 34 45	25 34 45	25 34 45	25 34 45	25 34 45	25 34 45
$f_{cm, 0, cyl}$ N/mm <sup>2</sup>		20 28 36	20 28 36	20 28 36	20 28 36	20 28 36	20 28 36	20 28 36
Centre distance <sup>1)</sup>	$a_x, a_y$	275 245 225	330 290 255	355 315 280	405 360 315	455 400 350	510 445 390	550 480 415
Edge distance (plus c) <sup>1), 2)</sup>	$r_x, r_y$	130 115 105	155 135 120	170 150 130	195 170 150	220 190 165	245 215 185	265 230 200
<b>Helix</b>								
Minimum number of turns	$n^*$	5.5 5 5	5 5 5	6.5 6 6	6 7 7	8 8 7	8.5 8 7.5	9 8.5 8
Minimum wire diameter	Ø $d_s^*$	12 12 12	14 14 14	14 14 14	14 14 14	16 14 14	16 16 16	16 16 16
Maximum distance	$z^*$	40 40 40	40 40 40	40 40 40	45 45 45	50 50 50	50 50 50	55 55 55
Min. external diameter	Ø $d_{a^*}$	205 185 180	240 220 200	270 250 220	320 265 255	345 310 285	420 375 310	465 370 340
	max. $i^*$	45 40 50	50 50 50	50 50 50	50 50 50	50 50 50	50 50 50	50 50 50
	min. $l^*$	235 195 235	240 240 240	315 290 290	290 340 340	395 390 340	420 395 370	445 420 395
<b>Additional reinforcement, ribbed reinforcing steel <math>R_e \geq 500</math> N/mm<sup>2</sup></b>								
Minimum numbers of layers	$n$	5 5 5	6 6 6	7 7 7	7 8 8	8 8 8	8 8 8	8 8 8
Minimum bar diameter	Ø $d_s$	12 12 12	12 12 12	14 14 14	14 14 14	16 16 16	16 16 16	16 16 16
Maximum distance	$z$	35 35 35	35 35 35	35 35 35	40 40 40	40 40 40	40 40 40	45 45 45
Maximum spacing	$i$	50 45 50	55 50 50	55 55 55	55 50 55	65 60 60	65 65 65	60 55 55
External dimensions	$x, y$	255 225 205	310 270 235	335 295 260	385 340 295	435 380 330	490 425 370	530 460 395

<sup>1)</sup> Minimum dimensions

<sup>2)</sup> c ... concrete cover

Dimensions in mm



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**Bonded prestressing system  
 SUSPA Strand DW**

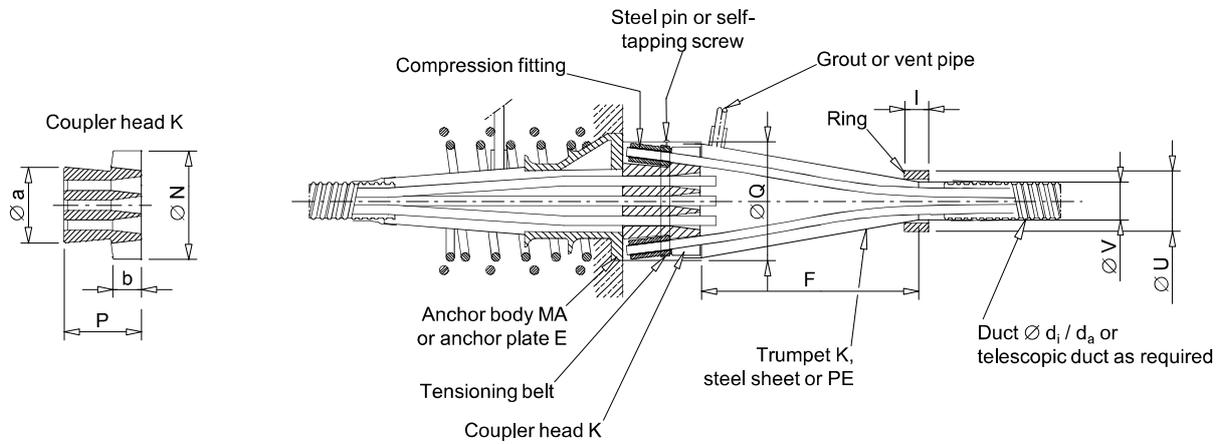
Anchorage with multi-plane anchor body MA  
 with additional reinforcement and with helix  
 Data sheet for tendons 6-5 to 6-22

**Annex 19  
 of ETA-13/0839** of 11.06.2024

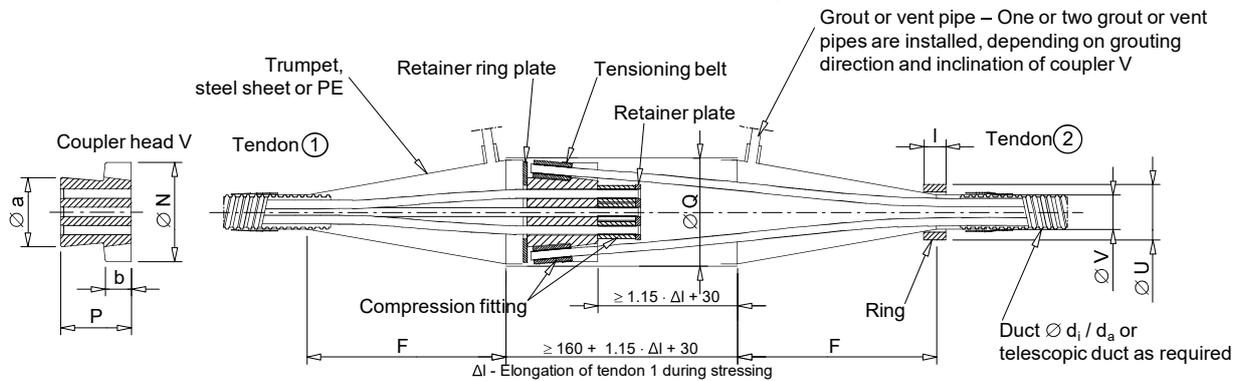
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**Coupler K and V 6-3 to 6-22 – Strand Y1770S7 15.7 and strand Y1860S7 15.7**

**Fixed coupler K – Tendons 6-5 to 6-22 with anchor body MA and 6-3 to 6-22 with anchor plate – PL1**



**Movable coupler V – Tendons 6-3 to 6-22 – Position of coupler head V prior to stressing – PL1**



Tendon		6-3	6-4	6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands		3	4	5	7	9	12	15	19	22
Strand arrangement										
Coupler head K, V	$\varnothing N$	140	150	180	180	210	220	260	260	290
	$\varnothing a$	86	96	126	126	156	166	206	206	236
	P	128	128	128	128	128	128	128	128	128
	b	50	50	50	50	50	50	50	50	50
Friction loss in movable coupler V		1.8 %	2.0 %	1.8 %	1.8 %	1.7 %	1.7 %	1.7 %	1.7 %	1.6 %
Trumpet	F	250	280	370	370	410	460	570	570	640
	$\varnothing Q$	150	160	190	190	230	240	280	280	310
Ring	$\varnothing V$	55	60	73	73	82	92	97	109	122
	I	30	30	40	40	40	40	50	50	50
	$\varnothing U$	70	80	101	101	110	127	140	159	171
Duct	Duct I $\varnothing d_i / d_a$	40/47	45/52	50/57	55/62	65/72	75/82	80/87	90/97	95/102
	Duct II $\varnothing d_i / d_a$	45/52	50/57	55/62	60/67	70/77	80/87	85/92	95/102	105/112

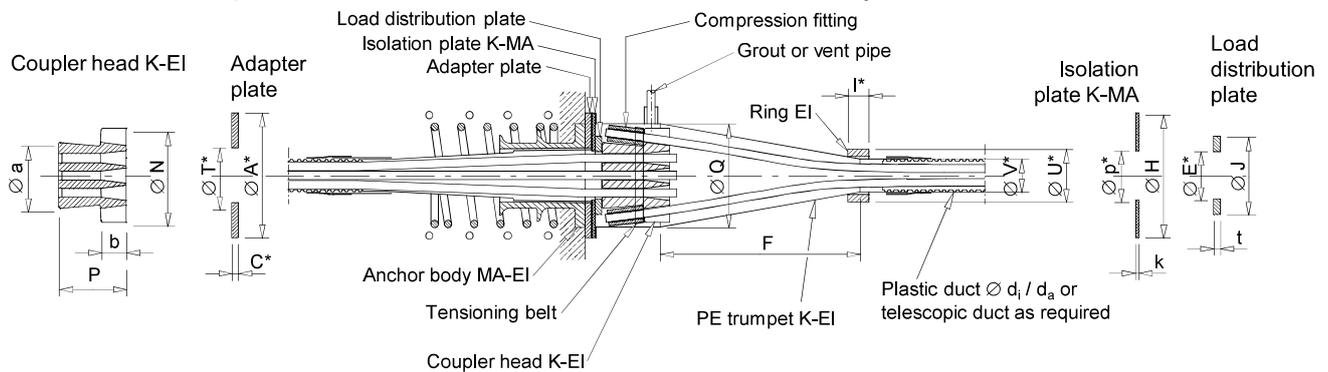
Dimensions in mm

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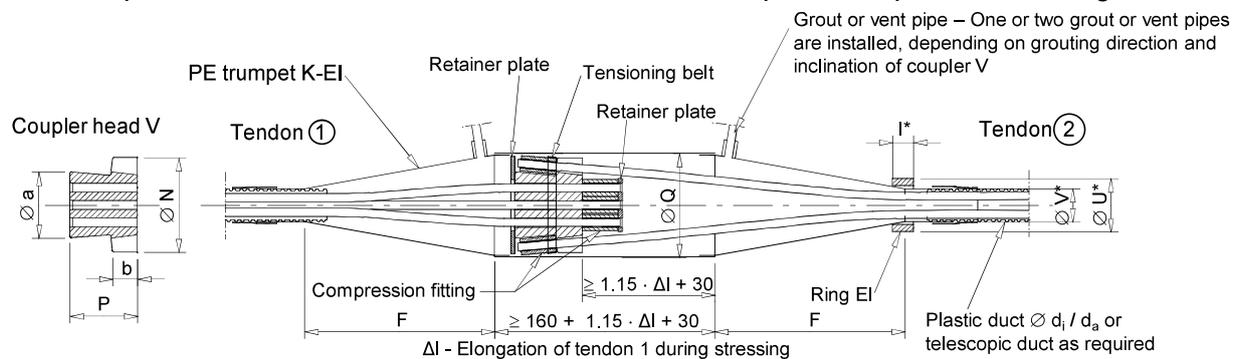
**Bonded prestressing system  
SUSPA Strand DW**  
Coupler K and V  
Data sheet for tendons 6-3 to 6-22

**Annex 20**  
of **ETA-13/0839** of 11.06.2024

**Coupler K and V 6-3 to 6-22 – Strand Y1770S7 15.7 and strand Y1860S7 15.7**  
**Fixed coupler K-EI – Tendons 6-5 to 6-22 with anchor body MA or MA-EI – PL2 / PL3**



**Movable coupler V-EI – Tendons 6-3 to 6-22 – Position of coupler head prior to stressing – PL2 / PL3**



Tendon		6-3	6-4	6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands <sup>1)</sup>		3	4	5	7	9	12	15	19	22
Coupler head K-EI <sup>1)</sup>	∅ N	140	150	180	180	210	220	260	260	290
	∅ a	86	96	126	126	156	166	190	200	220
	P	128	128	128	128	128	128	128	128	128
	b	50	50	50	50	50	50	50	50	50
Friction loss in movable coupler V		1.8 %	2.0 %	1.8 %	1.8 %	1.7 %	1.7 %	1.7 %	1.7 %	1.6 %
PE Trumpet K-EI	F	300	300	480	410	545	545	670	670	780
	∅ Q	180	180	200	205	250	250	285	285	315
Load distribution plate	∅ J	—	—	145	145	160	185	210	225	250
	t	—	—	15	15	15	15	15	20	25
	∅ E*	—	—	83	93	109	128	151	159	177
Isolation plate K-MA	∅ H	—	—	250	260	300	300	340	340	370
	k	—	—	6	6	6	6	6	6	6
	∅ p*	—	—	83	93	109	128	150	159	177
Adapter plate	∅ A*	—	—	250	260	300	300	340	340	370
	C*	—	—	12	12	12	12	12	12	12
	∅ T*	—	—	92	98	114	133	157	165	183
Ring EI	∅ U*	102	102	102	127	152	152	178	178	193
	I*	40	40	40	40	40	40	50	50	50
	∅ V*	82	82	82	98	117	117	131	131	143

<sup>1)</sup> For strand arrangements and dimensions of coupler head V see Annex 20.

Dimensions in mm

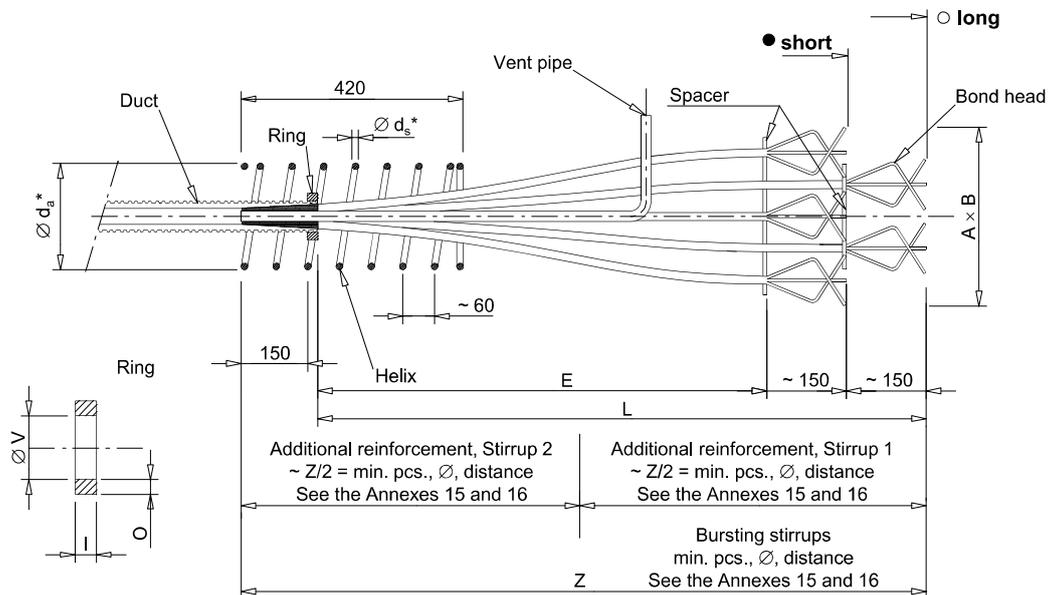


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**Bonded prestressing system**  
**SUSPA Strand DW**  
Coupler K and V  
Encapsulated and electrically isolated  
Data sheet for tendons 6-3 to 6-22

**Annex 21**  
of **ETA-13/0839** of 11.06.2024

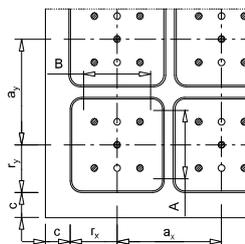
**Bond anchorage H 6-3 to 6-22**  
for  $f_{cm, 0, \text{cube}} \geq 34 \text{ N/mm}^2$  or  $f_{cm, 0, \text{cyl}} \geq 28 \text{ N/mm}^2$  – PL1



Tendon	6-3		6-4		6-5		6-7		6-9	
Format	HL	HR								
Elevation anchorage										

Tendon	6-12		6-15		6-19		6-22	
Format	HL	HR	HL	HR	HL	HR	HL	HR
Elevation anchorage								

- Key**
- ..... Position long
  - ..... Position short
  - ⊙ ..... 3<sup>rd</sup> position 1)
  - $r_x + c$  } ..... Minimum edge distance
  - $r_y + c$  }
  - c ..... Concrete cover



1) 3<sup>rd</sup> position see Annex 23.

Reinforcement as schematic example

Dimensions in mm



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**Bonded prestressing system**  
**SUSPA Strand DW**  
Bond anchorage H  
Strand arrangement – Helix

**Annex 22**  
of **ETA-13/0839** of 11.06.2024



Bond anchorage H 6-3 to 6-9 for  $f_{cm,0,cube} \geq 34 \text{ N/mm}^2$  or  $f_{cm,0,cyl} \geq 28 \text{ N/mm}^2$  – PL1  
strand Y1770S7 15.7 and strand Y1860S7 15.7

For layout see the Annex 22 und Annex 23.

Tendon		6-3		6-4		6-5		6-7		6-9	
Number of strands		3		4		5		7		9	
Format		HL	HL	HR	HL	HR	HL	HR	HL	HR	
Dimensions	A	290	390	210	330	210	450	250	390	290	
	B	90	90	190	90	210	90	250	210	290	
	Z	1400	1400	1400	1400	1400	1400	1400	1400	1400	
	E	950	950	950	950	950	950	950	950	950	
	L	1250	1250	1250	1250	1250	1250	1250	1250	1250	
Helix	$\varnothing d_a^*$	—	—	—	160	160	180	180	230	230	
	$\varnothing d_s^*$	—	—	—	12	12	12	12	14	14	
Ring	$\varnothing V$	Duct outer diameter + ~ 3 mm									
	O	11	14	14	14	14	14	14	14	14	
	I	20	20	20	20	20	30	30	30	30	
Centre distance <sup>1)</sup>	$a_x$	180	190	285	210	305	230	340	280	375	
	$a_y$	380	430	285	440	305	500	340	500	375	
Edge distance (plus c) <sup>1), 2)</sup>	$r_x$	80	85	135	95	145	105	160	130	180	
	$r_y$	180	205	135	210	145	240	160	240	180	
Bursting stirrups <sup>3)</sup>	a	100	100	—	100	—	100	—	100	100	
	b	80	80	—	80	—	83	—	90	100	
	$n_0$	6	6	—	6	—	6	—	6	5	
	$\varnothing$	10	10	—	10	—	10	—	12	14	
	Width	160	170	—	190	—	210	—	260	355	
Stirrup 1	c	115	115	115	115	105	115	105	120	120	
	d	80	80	80	80	80	83	85	90	100	
	$n_1$	8	8	7	8	7	8	7	8	6	
	$\varnothing$	12	12	12	12	12	12	12	14	14	
	Width	160	170	265	190	285	210	320	260	355	
Stirrup 2	e	850	850	785	850	785	850	785	900	810	
	f	166	166	170	166	170	166	170	200	185	
	$n_2$	5	5	5	5	5	5	5	4	5	
	$\varnothing$	12	12	12	12	12	12	12	14	14	
	Width	160	170	265	190	285	210	320	260	355	
Height		360	410	265	420	285	480	320	480	355	

<sup>1)</sup> Minimum dimension

<sup>2)</sup> c ... concrete cover

<sup>3)</sup> Crosswise installation of bursting reinforcement for fixed anchor HR according to Annex 23

Dimensions in mm



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**Bonded prestressing system  
SUSPA Strand DW**  
Bond anchorage H  
Data sheet for tendons 6-3 to 6-9

**Annex 24**  
of **ETA-13/0839** of 11.06.2024

Bond anchorage H 6-12 to 6-22 for  $f_{cm, 0, cube} \geq 34 \text{ N/mm}^2$  or  $f_{cm, 0, cyl} \geq 28 \text{ N/mm}^2$  – PL1  
strand Y1770S7 15.7 and strand Y1860S7 15.7

For layout see the Annex 22 und Annex 23.

Tendon		6-12		6-15		6-19		6-22	
Number of strands		12		15		19		22	
Format		HL	HR	HL	HR	HL	HR	HL	HR
Dimensions	A	480	390	480	410	610	490	730	490
	B	250	330	250	350	250	390	250	450
	Z	1 400	1 400	1 400	1 400	1 400	1 400	1 400	1 400
	E	950	950	950	950	950	950	800 <sup>1)</sup>	950
	L	1 250	1 250	1 250	1 250	1 250	1 250	1 250	1 250
Helix	$\varnothing d_a^*$	250	250	295	295	330	330	360	360
	$\varnothing d_s^*$	14	14	16	16	16	16	16	16
Ring	$\varnothing V$	Duct outer diameter + ~ 3 mm							
	O	20	20	20	20	20	20	20	20
	I	30	30	30	30	30	30	30	30
Centre distance <sup>2)</sup>	$a_x$	300	390	350	460	390	525	410	570
	$a_y$	570	440	630	475	715	525	780	560
Edge distance (plus c) <sup>2), 3)</sup>	$r_x$	140	185	165	220	185	255	195	275
	$r_y$	275	210	305	230	350	255	380	270
Bursting stirrups <sup>4)</sup>	a	100	100	100	100	110	110	110	120
	b	100	100	100	100	110	110	110	120
	$n_0$	6	5	6	6	6	5	6	5
	$\varnothing$	12	12	14	14	14	14	14	14
	Width Height	280 200	420 150	330 220	455 230	370 220	505 230	390 260	550 280
Stirrup 1	c	120	120	120	120	130	130	130	140
	d	100	100	100	100	110	110	110	120
	$n_1$	8	6	8	6	7	6	6	5
	$\varnothing$	14	14	14	14	14	14	14	14
	Width Height	280 550	370 420	330 610	440 455	370 695	505 505	390 760	550 540
Stirrup 2	e	1 020	820	1 020	900	1 120	1 000	1 120	1 060
	f	200	200	150	150	110	120	110	120
	$n_2$	3	4	5	5	5	6	5	6
	$\varnothing$	14	14	14	14	14	14	14	14
	Width Height	280 550	370 420	330 610	440 455	370 695	505 505	390 760	550 540

1) Bond head in 3<sup>rd</sup> position, see Annex 23

2) Minimum dimension

3) c ... concrete cover

4) Crosswise installation of bursting reinforcement for fixed anchor HR according to Annex 23

Dimensions in mm



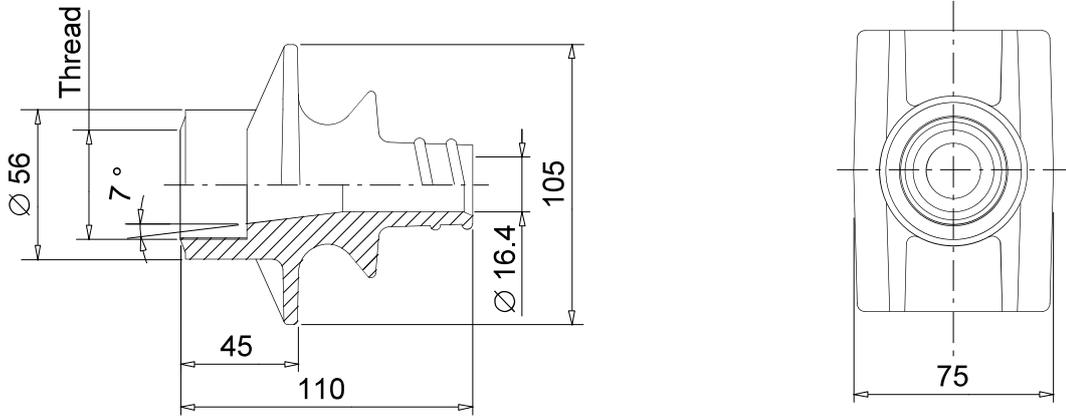
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**Bonded prestressing system  
SUSPA Strand DW**  
Bond anchorage H  
Data sheet for tendons 6-12 to 6-22

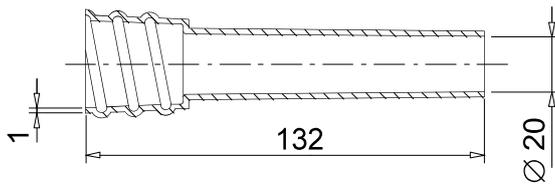
**Annex 25**  
of **ETA-13/0839** of 11.06.2024

Single strand anchorage SK6 – PL1

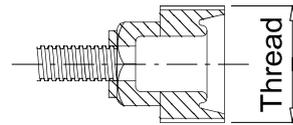
Anchor SK6



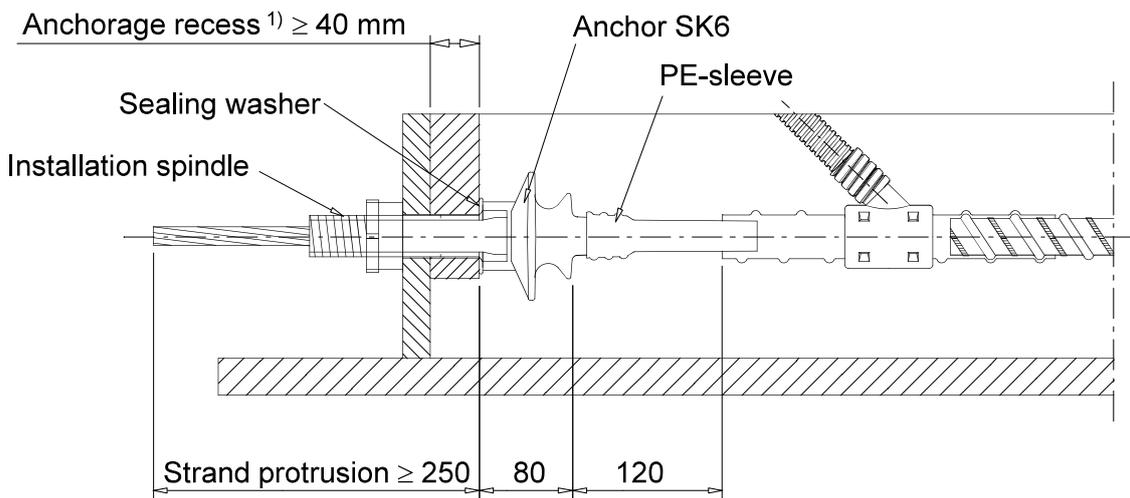
PE-sleeve



Venting cap



Stressing anchor SK6 – Assembly state



1) Concrete cover on venting cap  $\geq 25$  mm

Dimensions in mm

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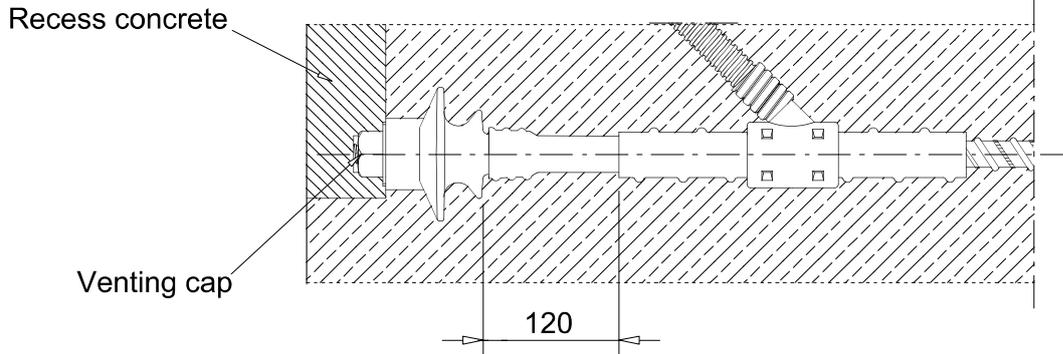
**Bonded prestressing system  
 SUSPA Strand DW**  
 Single strand anchorage SK6  
 Basic components and assembly

**Annex 26**  
 of **ETA-13/0839** of 11.06.2024

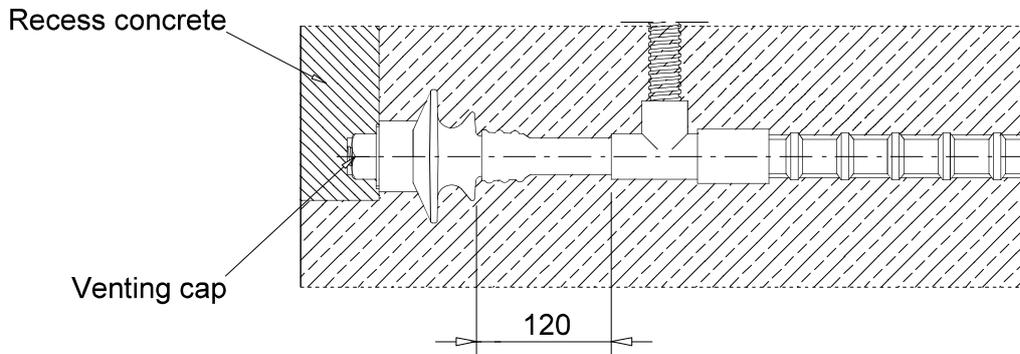
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### Single strand anchorage SK6 – PL1

#### Stressing anchor SK6 after prestressing – Steel strip duct



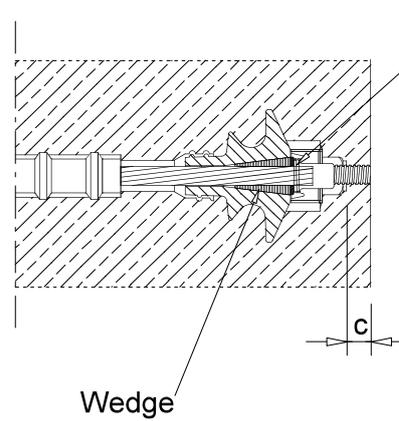
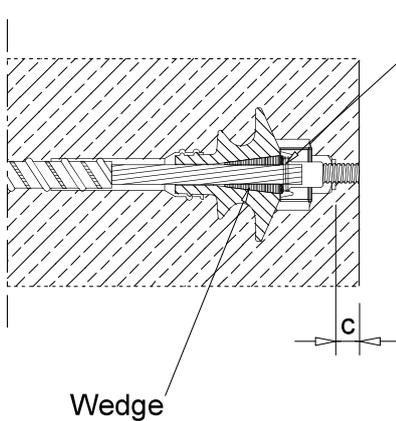
#### Stressing anchor SK6 after prestressing – Plastic duct Sealing of joints to duct with heat shrinking sleeves



#### Fixed anchor SK6 grouted

##### Steel strip duct

##### Plastic duct



c..... Concrete cover on venting cap  $\geq 25$  mm

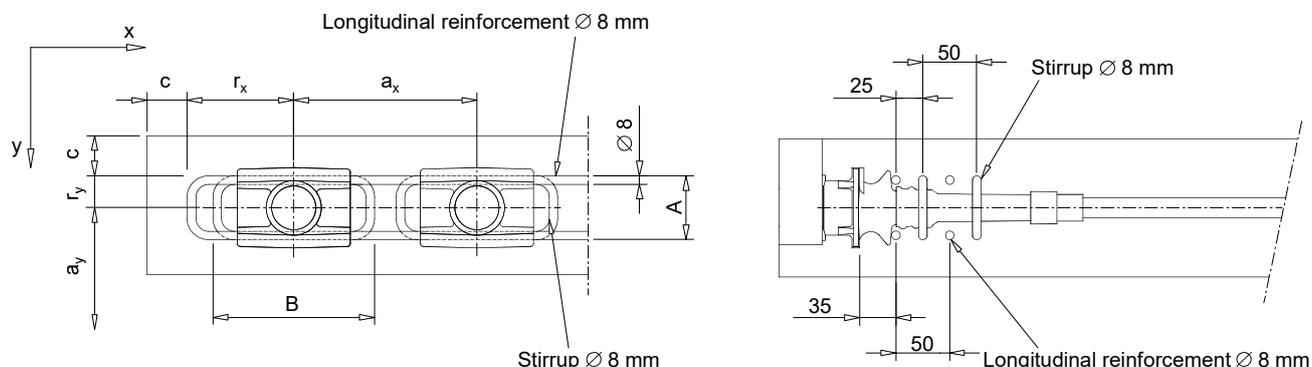
Dimensions in mm

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**Bonded prestressing system  
 SUSPA Strand DW**  
 Single strand anchorage SK6  
 Stressing and fixed anchor

**Annex 27**  
 of **ETA-13/0839** of 11.06.2024

Single strand anchorage SK6 – PL1  
strand Y1770S7 15.7 and strand Y1860S7 15.7  
minimum centre and edge distances



$a_x$  } ..... Minimum centre distance  
 $a_y$  }  
 $r_x + c$  } ..... Minimum edge distance  
 $r_y + c$  }  
 $c$  ..... Concrete cover

Minimum concrete strength at time of stressing	$f_{cm, 0, cube}$ N/mm <sup>2</sup>	20	28	36
	$f_{cm, 0, cyl}$ N/mm <sup>2</sup>	16	23	29
Minimum centre distance	$a_x$	210	190	170
	$a_y$	120	105	90
Minimum edge distance (plus c)	$r_x$	120	110	100
	$r_y$	50	45	35
Additional reinforcement, ribbed reinforcing steel, $R_e \geq 500$ N/mm <sup>2</sup>				
Minimum number of longitudinal reinforcement, $\varnothing 8$ mm, per side		2	2	2
Minimum number of stirrups $\varnothing 8$ mm		2	2	2
Minimum height	A	100	85	70
Minimum width	B	190	170	150
Friction loss in stressing anchor is low and does not have to be considered in design and execution.				

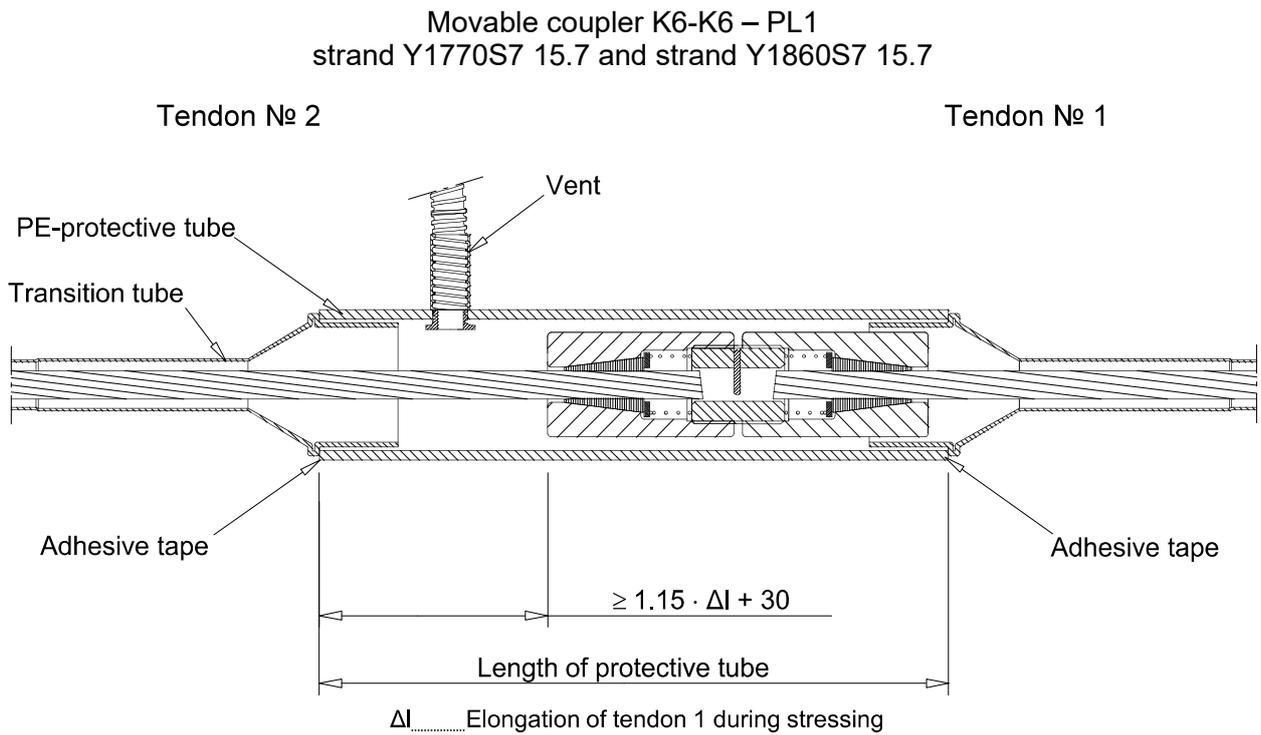
Dimensions in mm

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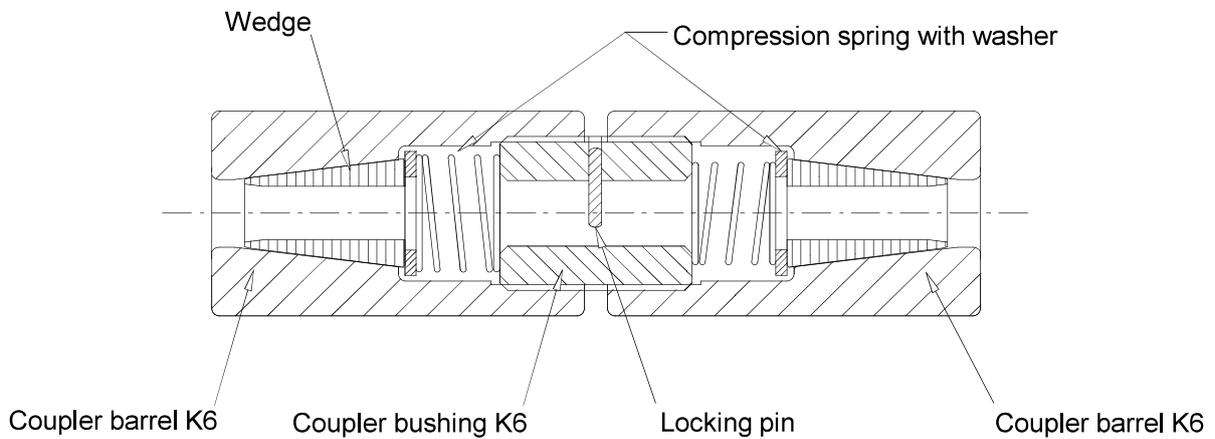
**Bonded prestressing system  
SUSPA Strand DW**  
Single strand anchorage SK6  
Data sheet

**Annex 28**  
of **ETA-13/0839** of 11.06.2024



Minimum engagement length of coupler bushing: 20 mm on both sides

**Coupler K6-K6 – Condition as delivered**



Friction losses in movable coupler K6-K6 during stressing are low and do not have to be considered in design and execution.

Dimensions in mm



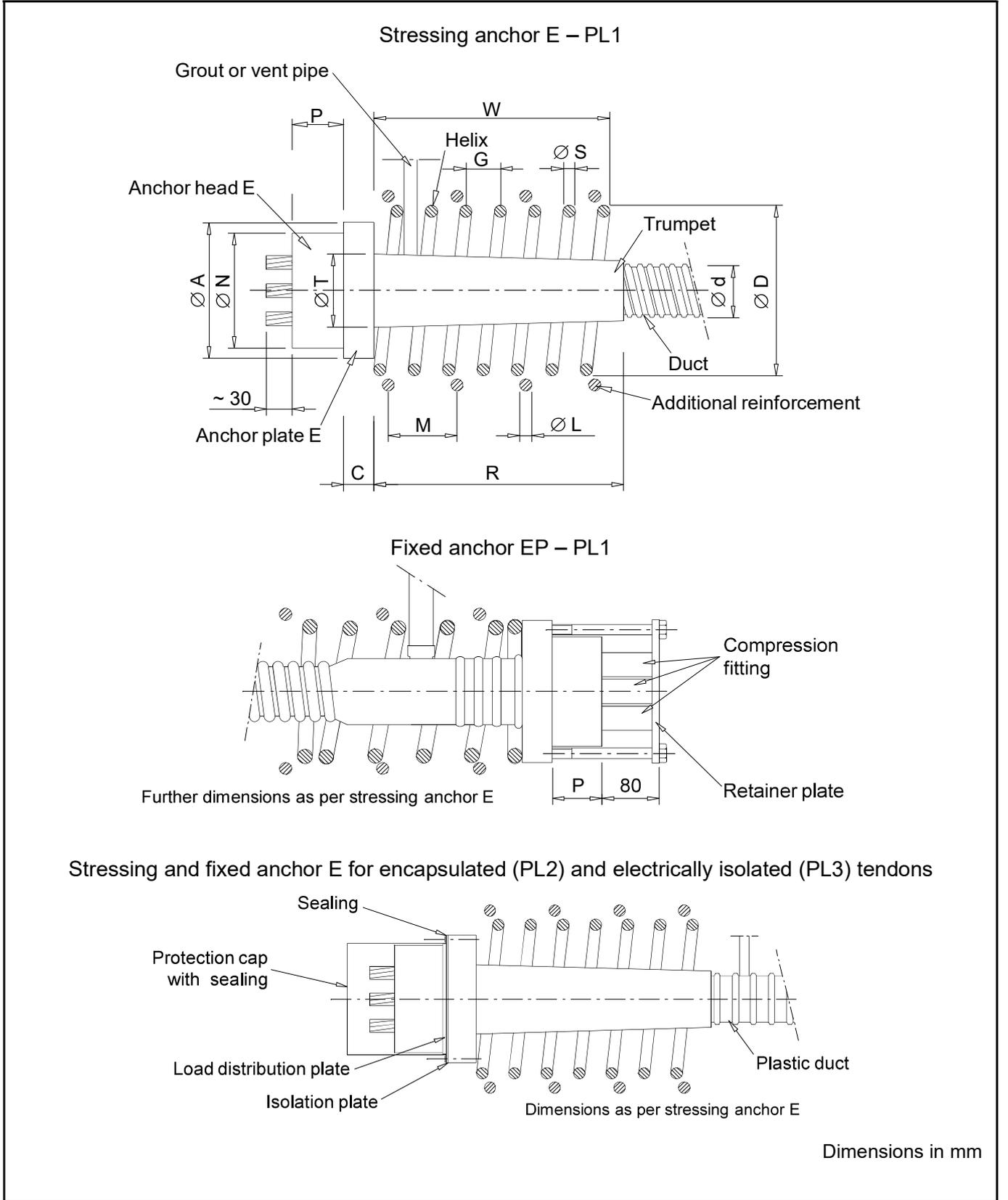
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**Bonded prestressing system**  
**SUSPA Strand DW**  
 Single strand coupler K6-K6

**Annex 29**  
 of **ETA-13/0839** of 11.06.2024

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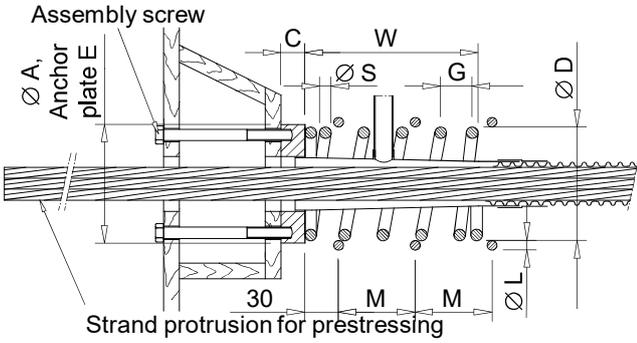
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**Bonded prestressing system  
 SUSPA Strand DW**  
 Anchor E and EP  
 Electrically isolated stressing and fixed  
 anchor E

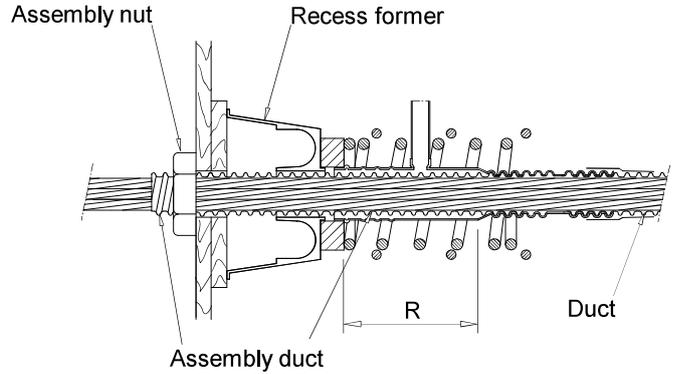
**Annex 30**  
 of **ETA-13/0839** of 11.06.2024

**Assembly overview  
 Stressing anchor E**

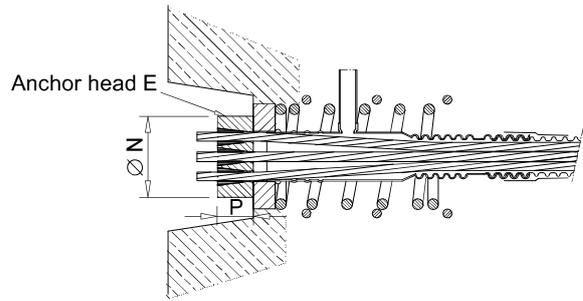
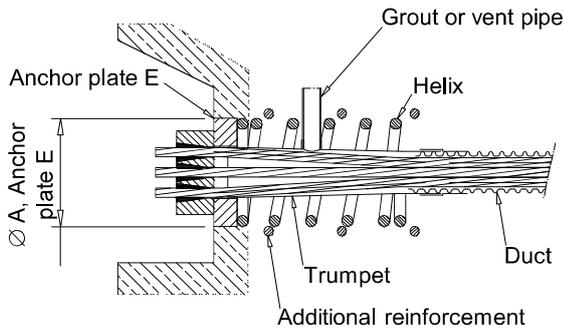
(a) Fastening the anchor plate with assembly screws  
 Assembly condition



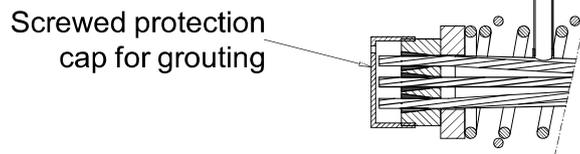
(b) Fastening the anchor plate with assembly duct and recess former  
 Assembly condition 6-3 to 6-5



(a) and (b) after stressing

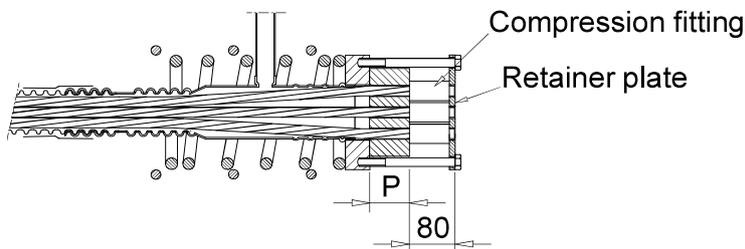


(a) and (b) with screwed on protection cap



**Fixed anchor EP**

With compression fittings  
 Assembly and after stressing



Further dimensions as per stressing anchor E

Dimensions in mm

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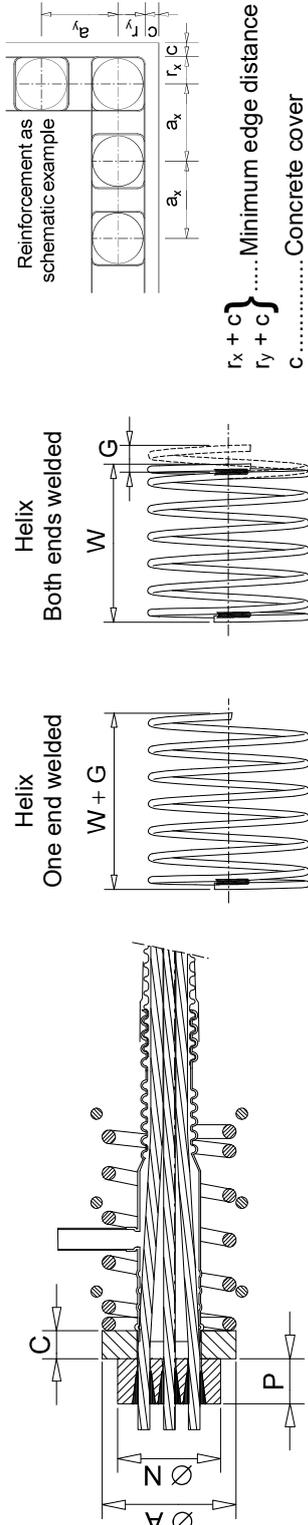
**Bonded prestressing system  
 SUSPA Strand DW  
 Assembly – Overview**

**Annex 31  
 of ETA-13/0839 of 11.06.2024**

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Stressing anchor E 6-3 to E 6-22 and fixed anchor EP 6-3 to 6-22 – PL1 / PL2 / PL3  
Strand Y1770S7 15.7



Tendon	6-3	6-4	6-5	6-7	6-9	6-12	6-15	6-19	6-22	
Number of strands	3	4	5	7	9	12	15	19	22	
Strand arrangement										
Anchor head diameter	Ø N	110	135	135	155	170	190	200	220	
Thickness	P	55	60	60	65	75	85	95	100	
Trumpet length	R	170	290	290	460	460	650	650	750	
Duct I	Ø d <sub>I</sub> / d <sub>a</sub>	40/47	50/57	55/62	65/72	75/82	80/87	90/97	95/102	
Duct II	Ø d <sub>II</sub> / d <sub>a</sub>	45/52	50/57	55/62	60/67	70/77	80/87	85/92	95/102	
For strand Y1770S7, nominal diameter 15.7 mm										
<b>Minimum concrete compressive strength at time of stressing</b>										
f <sub>cm, 0, cube</sub>	N/mm <sup>2</sup>	25	35	45	25	35	45	25	35	45
f <sub>cm, 0, cyl</sub>	N/mm <sup>2</sup>	20	28	36	20	28	36	20	28	36
Minimum centre distance	a <sub>x</sub> , a <sub>y</sub>	215	195	—	245	220	205	270	245	225
Min. edge distance (plus c)	r <sub>x</sub> , r <sub>y</sub>	100	90	—	115	100	95	125	115	105
<b>Anchor plate E</b>										
Diameter	Ø A	150	130	—	170	150	170	230	200	200
Thickness	C	25	20	—	30	25	25	35	30	30
Hole diameter	Ø T	58	58	—	72	72	72	86	86	86
<b>Helix</b>										
Minimum external diameter	Ø D	150	150	—	180	160	160	240	200	200
Minimum wire diameter	Ø S	12	12	—	14	14	14	14	14	14
Maximum pitch	G	50	50	—	50	50	50	50	50	50
Minimum length	W	235	235	—	290	285	240	340	290	290
Minimum number of turns	H	5	5	—	6	6	5	7	6	6
<b>Additional reinforcement, ribbed reinforcing steel, R<sub>e</sub> ≥ 500 N/mm<sup>2</sup></b>										
Minimum number of layers	K	4	4	—	5	4	4	5	4	4
Minimum bar diameter	Ø L	10	10	—	10	12	10	12	10	12
Maximum spacing	M	70	60	—	60	60	60	80	70	80

Dimensions in mm

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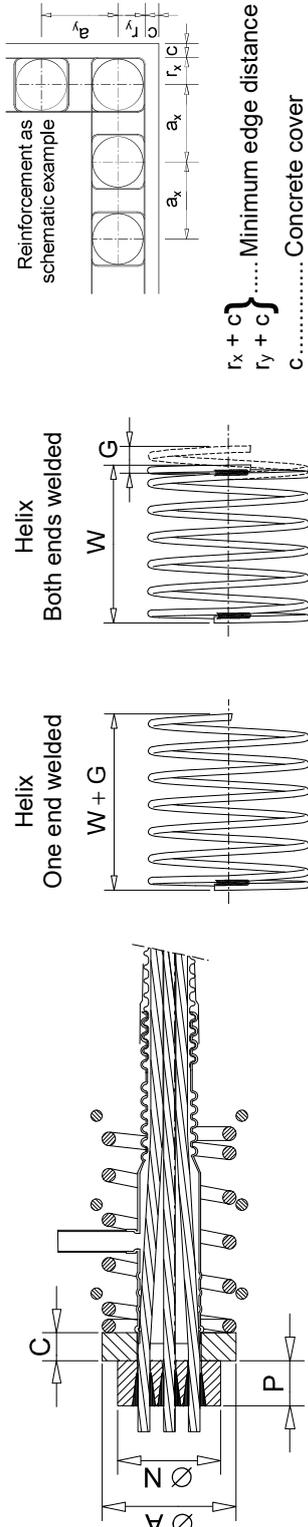
**Bonded prestressing system  
SUSPA Strand DW**

Stressing anchor E and fixed anchor EP  
Prestressing steel strand Y1770S7, 15.7 mm  
Data sheet for tendons 6-3 to 6-22

**Annex 32**  
of **ETA-13/0839** of 11.06.2024

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Stressing anchor E 6-3 to E 6-22 and fixed anchor EP 6-3 to 6-22 – PL1 / PL2 / PL3  
Strand Y1860S7 15.7



Tendon	6-3		6-4		6-5		6-7		6-9		6-12		6-15		6-19		6-22	
	3		4		5		7		9		12		15		19		22	
Number of strands	3		4		5		7		9		12		15		19		22	
Strand arrangement																		
Anchor head diameter	Ø N	95	110	135	135	135	135	135	155	155	170	170	190	190	200	200	220	220
Thickness	P	50	55	60	60	60	60	60	65	65	75	75	85	85	95	95	100	100
Trumpet length	R	160	170	290	290	290	290	290	460	460	460	460	650	650	650	650	750	750
Duct	Ø d <sub>i</sub> / d <sub>a</sub>	40/47	45/52	50/57	50/57	50/57	50/57	50/57	65/72	65/72	75/82	75/82	80/87	80/87	80/87	80/87	95/102	95/102
Duct	Ø d <sub>i</sub> / d <sub>a</sub>	45/52	50/57	55/62	55/62	55/62	55/62	60/67	70/77	70/77	80/87	80/87	85/92	85/92	85/92	85/92	105/112	105/112
For strand Y1860S7, nominal diameter 15.7 mm																		
<b>Minimum concrete compressive strength at time of stressing</b>																		
	25		35		45		25		35		45		25		35		45	
$f_{cm, 0, cube}$	N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>		N/mm <sup>2</sup>	
$f_{cm, 0, cyl}$	20		28		36		20		28		36		20		28		36	
Minimum centre distance	$a_x, a_y$	225	205	185	250	230	210	275	255	235	320	295	270	365	335	305	415	385
Min. edge distance (plus c)	$r_x, r_y$	105	95	85	115	105	95	130	120	110	150	140	125	175	160	145	200	185
<b>Anchor plate E</b>																		
Diameter	Ø A	155	155	175	165	165	200	185	185	235	205	205	260	230	230	295	265	265
Thickness	C	25	25	30	30	30	30	30	30	40	40	40	45	40	40	50	50	50
Hole diameter	Ø T	58	58	58	72	72	72	86	86	86	86	86	86	112	112	112	120	120
<b>Helix</b>																		
Minimum external diameter	Ø D	160	150	140	180	170	160	200	190	180	245	230	220	280	255	240	330	305
Minimum wire diameter	Ø S	12	12	12	12	12	12	12	12	14	14	14	14	14	14	14	16	16
Maximum pitch	G	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Minimum length	W	235	235	235	285	235	240	285	285	240	390	290	340	390	340	340	395	345
Minimum number of turns	H	5	5	5	6	5	5	6	6	5	8	6	7	8	7	7	8	7
<b>Additional reinforcement, ribbed reinforcing steel, <math>R_{s} \geq 500</math> N/mm<sup>2</sup></b>																		
Minimum number of layers	K	4	4	4	5	4	4	4	4	5	5	5	6	5	5	6	6	6
Minimum bar diameter	Ø L	10	10	12	10	12	10	12	12	12	14	14	14	14	14	14	16	16
Maximum spacing	M	70	60	60	60	60	60	60	60	60	70	70	70	70	70	70	70	70
Dimensions in mm																		

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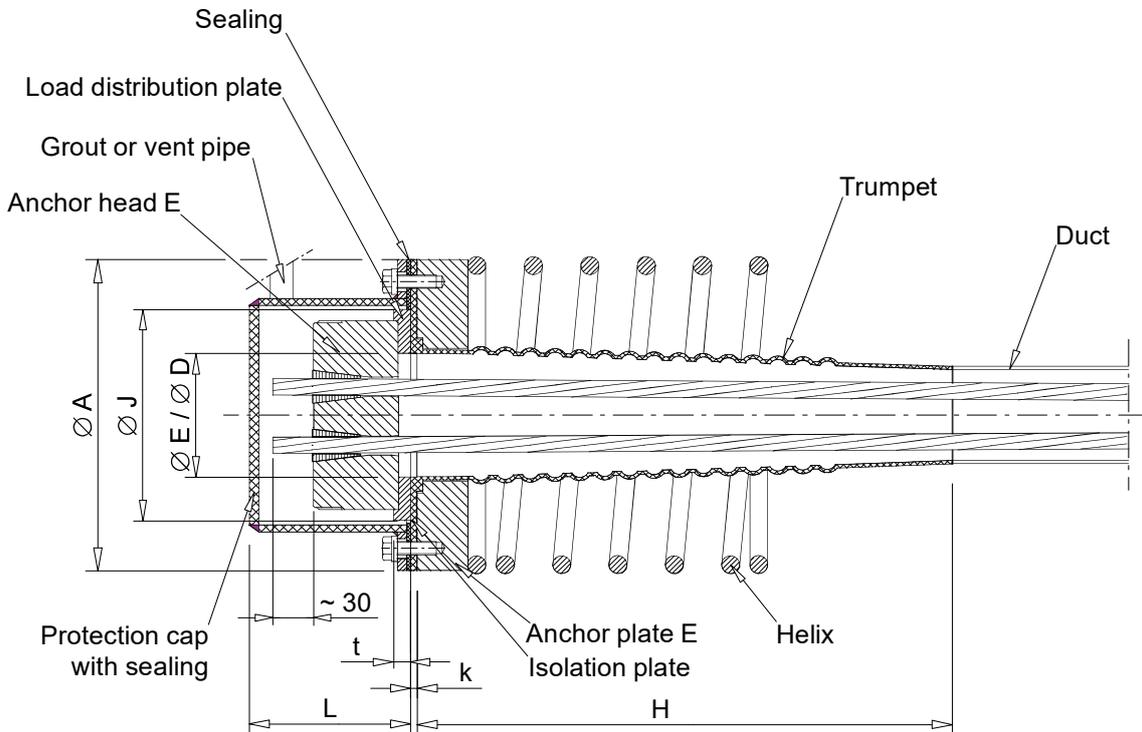
**Bonded prestressing system  
SUSPA Strand DW**

Stressing anchor E and fixed anchor EP  
Prestressing steel strand Y1860S7, 15.7 mm  
Data sheet for tendons 6-3 to 6-22

**Annex 33**  
of **ETA-13/0839** of 11.06.2024

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Encapsulated (PL2) and electrically isolated (PL3) anchorage E, 6-3 to 6-22  
 Strand Y1770S7 15.7 and strand Y1860S7 15.7



The encapsulated (PL2) anchorage is installed without isolation plate.

Helix and additional reinforcement according to Annex 32 and Annex 33.

Tendon		6-3	6-4	6-5	6-7	6-9	6-12	6-15	6-19	6-22
Number of strands		3	4	5	7	9	12	15	19	22
Strand arrangement										
Load distribution plate										
Diameter	Ø J	100	110	145	145	160	185	210	225	250
Thickness	t	15	15	15	15	15	15	15	20	25
Hole diameter	Ø E	59	66	83	83	112	115	144	150	170
Trumpet length	H	170	185	298	300	470	470	660	660	760
For strand Y1770S7 15.7 and strand Y1860S7 15.7										
Isolation plate										
Diameter	Ø A	130	150	170	200	230	265	290	330	360
Thickness	k	6	6	6	6	6	6	6	6	6
Hole diameter	Ø D	59	66	83	83	112	115	144	150	170

Dimensions in mm



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**Bonded prestressing system  
 SUSPA Strand DW**

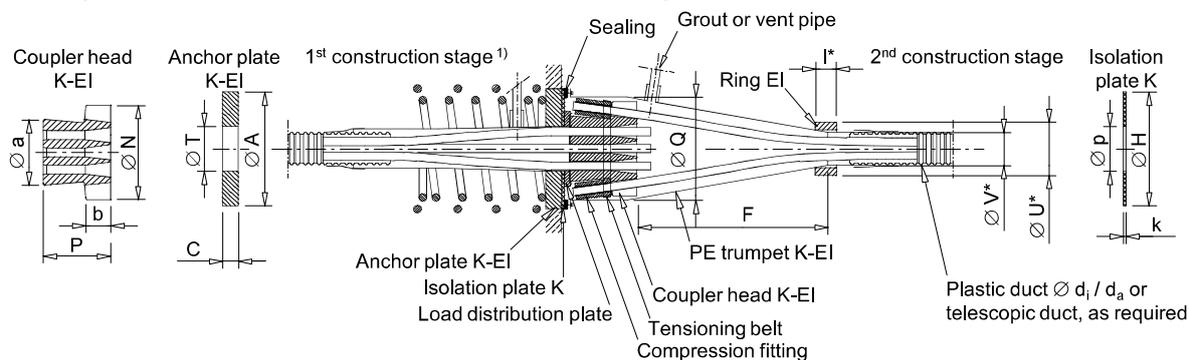
Encapsulated and electrically isolated  
 anchorage E – Prestressing steel strand  
 Y1770S7, 15.7 mm and Y1860S7, 15.7 mm  
 Data sheet for tendons 6-3 to 6-22

**Annex 34**  
 of **ETA-13/0839** of 11.06.2024

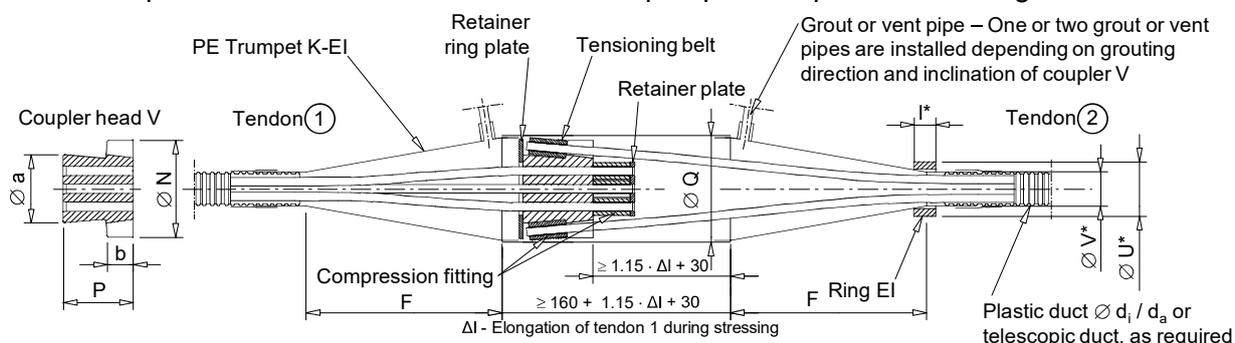
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### Coupler K-EI and V-EI – Strand Y1770S7 15.7 and strand Y1860S7 15.7

#### Fixed coupler K-EI – Tendons 6-3 to 6-22 with anchor plate EI – PL2 / PL3



#### Movable coupler V-EI – Tendons 6-3 to 6-22 – Coupler position prior to stressing – PL2 / PL3



Tendon		6-3 <sup>2)</sup>	6-4 <sup>2)</sup>	6-5 <sup>2)</sup>	6-7	6-9	6-12	6-15	6-19	6-22															
Number of strands <sup>3)</sup>		3	4	5	7	9	12	15	19	22															
Coupler head K-EI <sup>3)</sup>	Diameter Ø N	140	150	180	180	210	220	260	260	290															
	Diameter Ø a	86	96	126	126	156	166	190	200	220															
	Height P	128	128	128	128	128	128	128	128	128															
	Thickness b	50	50	50	50	50	50	50	50	50															
PE Trumpet K-EI	Ø Q	300	300	480	410	545	545	670	670	780															
	Ø F	180	180	200	205	250	250	285	285	315															
<b>Minimum concrete compressive strength at time of stressing</b>																									
$f_{cm, 0, cube}$ N/mm <sup>2</sup>		25	34	45	25	34	45	25	34	45	25	34	45	25	34	45	25	34	45	25	34	45			
$f_{cm, 0, cyl}$ N/mm <sup>2</sup>		20	28	36	20	28	36	20	28	36	20	28	36	20	28	36	20	28	36	20	28	36	20	28	36
Anchor plate K-EI	Diameter Ø A	230	230	230	230	230	230	250	250	250	260	260	260	300	300	300	300	300	300	300	300	300	300	300	300
	Thickness C	25	25	25	30	30	30	40	40	40	40	40	40	45	40	40	50	50	50	60	55	50	65	60	55
	Hole diameter Ø T	58	58	58	72	72	72	86	86	86	86	86	86	112	112	112	120	120	120	152	152	152	152	152	152
Isolation plate K	Diameter Ø H	230	230	250	260	300	300	340	340	340	380	340	340	420	370	370									
	Thickness k	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6									
	Hole diameter Ø p	55	69	83	83	112	115	150	150	150	152	152	152	174	174	174									
Ring EI	Diameter Ø U*	102	102	102	127	152	152	178	178	193															
	Thickness I*	40	40	40	40	40	40	50	50	50															
	Hole diameter Ø V*	82	82	82	98	117	117	131	131	143															

- Fixed coupler, 1<sup>st</sup> construction stage, corresponds to electrically isolated stressing anchor E, see Annex 32, Dimensions in mm Annex 33, and Annex 34.
- These tendon sizes may require the minimum centre and edge distances according to Annex 32 and Annex 33 to be adapted to the dimensions of anchor plate K-EI.
- For strand arrangement and dimensions of coupler head V see Annex 20.

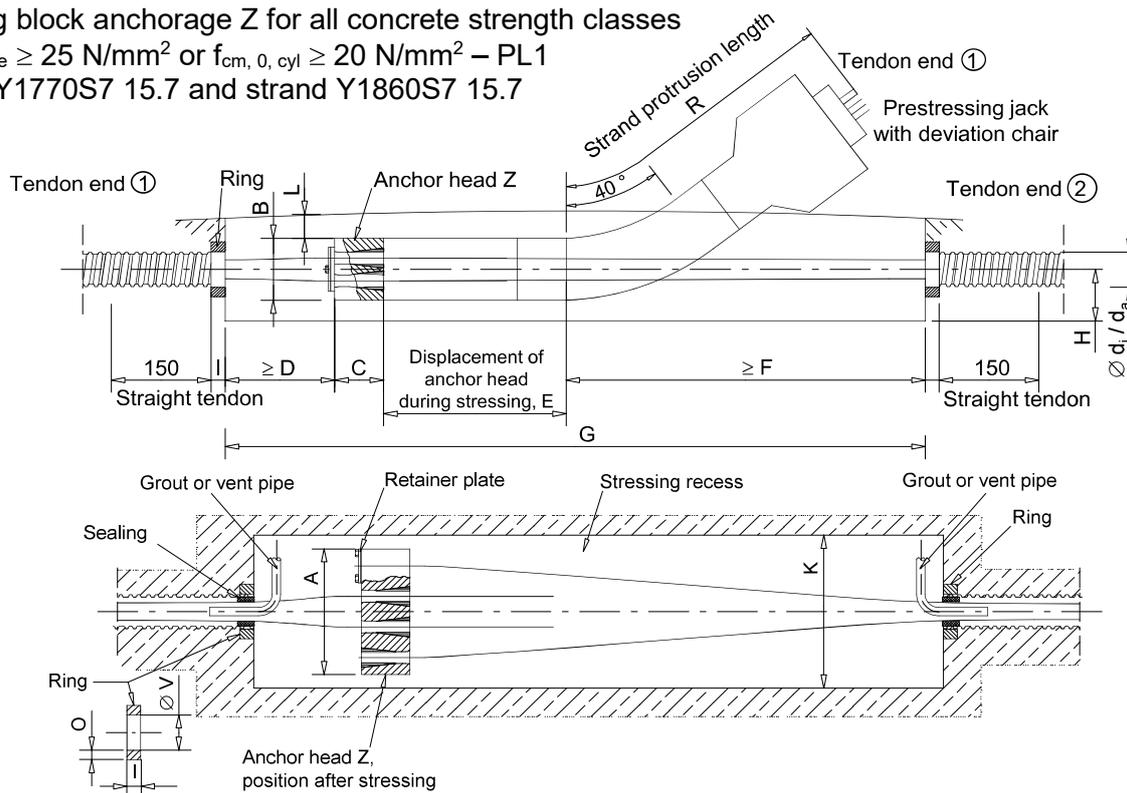
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**Bonded prestressing system  
SUSPA Strand DW**  
Electrically isolated  
couplers K-EI and V-EI  
Data sheet for tendons 6-3 to 6-22

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**Floating block anchorage Z for all concrete strength classes**

$f_{cm, 0, cube} \geq 25 \text{ N/mm}^2$  or  $f_{cm, 0, cyl} \geq 20 \text{ N/mm}^2$  – PL 1  
strand Y1770S7 15.7 and strand Y1860S7 15.7



Over stressing with subsequent release of stressing force is impossible.

Tendon		Z 6-2	Z 6-4	Z 6-6	Z 6-8
Number of strands		2	4	6	8
Strand arrangement					
Anchor head	Length	A	140	170	210
	Width	B	90	100	140
	Thickness	C	70	80	100
Strand protrusion	Length	R	850	1 000	1 200
	Duct I	$\varnothing d_i / d_a$	40/47	45/52	55/62
Duct	Duct II	$\varnothing d_i / d_a$	45/52	50/57	60/67
	Ring	$\varnothing V$	Duct outer diameter + ~ 3 mm		
Stressing recess	min. O	I	11	14	14
		I	20	20	30
	D		100	200	300
	E		Elongation of tendon end 2		
	F		550	800	1 000
	G		720 + E	1 080 + E	1 400 + E
	H		65	70	90
	K		180	210	250
L		Concrete cover required			
Friction loss in floating block anchorage Z, including loss in deviation chair			13 %	13 %	13 %
					16 %

Dimensions in mm

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**Bonded prestressing system  
SUSPA Strand DW**  
Floating block anchorage Z  
Data sheet for tendons Z 6-2 to Z 6-8

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**Material properties of plastic duct for PL1, PL2, and PL3**

Essential characteristic	Testing	Product performance
Oxidation Induction Time (OIT) at 200 °C	Duct, ASTM D 3895	≥ 25 minutes
Slow-Crack-Growth Resistance	Duct, ASTM F 2136	≥ 25 hours
Notched impact 23 °C 0 °C	Compound, ASTM D 256	≥ 300 J/m ≥ 50 J/m
Melt Flow Rate (MFR) at 230 °C	Compound, Duct, ASTM D 1238	0.3–10 g/10 min
Density	Duct, ASTM D 1505	0.89–0.91 g/cm <sup>3</sup>
Flexural Modulus	Compound, ASTM D 790	≥ 750 MPa
Tensile Yield Strength	Compound, ASTM D 638	≥ 20 MPa
Elongation at yield and at break	Compound, ASTM D 638	≥ 5.0 % ≥ 50 %
Thermal expansion coefficient	Compound, ASTM D 696	≤ 125 · 10 <sup>-6</sup>

NOTE For ASTM standards see *fib* bulletin 75.

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**Bonded prestressing system  
SUSPA Strand DW**  
Plastic duct  
Specifications of polypropylene

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<b>Component performance of plastic duct for PL1, PL2, and PL3</b>					
Essential characteristic		Product performance			
Dimensional requirements		See Annex 12 and Annex 13 Dimensional tolerances according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Stiffness of duct		See Annex 41			
Longitudinal load resistance of duct system		≥ 10 minutes			
Lateral load resistance of duct		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Flexibility of duct system		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Leak tightness of duct system		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Concrete pressure test on duct		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Wear resistance of duct		The residual wall thickness after testing is PL1 ≥ 1.0 mm PL2, PL3 ≥ 1.5 mm			
Wear resistance of duct under sustained load		The residual wall thickness after testing is PL1 ≥ 0.5 mm PL2, PL3 ≥ 1.0 mm			
Bond behaviour of duct		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met for			
		Designation	Number of strands Ø 15.7 mm	Designation	Number of strands Ø 15.7 mm
		38 × 22	02	48	03, 04, 05
		52 × 21	03	59	07
		72 × 21	04	76	09, 12
		76 × 25	04	85	15
		91 × 22	05	100	19
Precast segmental duct coupler system where applicable		Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.10, 2.2.11, and 2.2.12 are met.			
Fracture resistance of duct system		Characteristic not assessed.			

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**System performance of plastic duct for PL1, PL2, and PL3**

Essential characteristic	Product performance
Leak tightness of anchorage-duct assembly	No leakage with positive and negative pressure for 30 minutes
Full scale duct assembly	Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.11 and 2.2.12 are met.
Leak tightness of assembled duct system	Acceptance criteria according to EAD 160004-00-0301, Clauses 2.2.11 and 2.2.12 are met.
EIT performance of the duct system	Electrical resistance <sup>1)</sup> Duct designation 76, 85, 100, and 115 Duct $\geq 2\,000\text{ k}\Omega$ Duct with coupler $\geq 2\,000\text{ k}\Omega$ Duct with coupler and vent $\geq 2\,000\text{ k}\Omega$  Capacitance <sup>1)</sup> $\leq 3.5\text{ nF}$  Loss factor <sup>1)</sup> $\leq 0.03$
EIT performance of anchorage-duct assembly	$\geq 15\text{ k}\Omega$

<sup>1)</sup> Length of duct immersed in water 1.0 m

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**Bonded prestressing system  
 SUSPA Strand DW**  
 Plastic duct  
 Performance of plastic duct

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**Stiffness of plastic duct**

Plastic Duct Designation	$(E \cdot I)_{\text{eff}}$ in Nm <sup>2</sup>	
	at 23 °C	at 45 °C
38 × 22	3.8	2.9
52 × 21	5.0	3.3
72 × 21	4.6	3.3
76 × 25	10.0	8.8
90 × 21	11.7	13.3
23	5.0	5.0
50	54.4	47.7
60	29.6	25.4
75	105	81.3
85	116	98.5
100	348	300
115	339	296

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**Bonded prestressing system  
 SUSPA Strand DW**  
 Plastic duct  
 Stiffness of plastic duct

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Strand			Y1770S7	Y1860S7
Characteristic tensile strength	$R_m$	N/mm <sup>2</sup>	1 770	1 860
Nominal diameter of strand	D	mm	15.7	
Nominal diameter of outer wire	$d_o$	mm	5.2	
Diameter of core wire d	$d'$	mm	$\geq 1.03 \cdot d_o$	
Nominal mass per metre	M	g/m	1 172	
Nominal cross-sectional area	$A_p$	mm <sup>2</sup>	150	
Characteristic value of maximum force	$F_m$	kN	266	279
Maximum value of maximum force	$F_{m, max}$	kN	306	321
Characteristic value of 0.1 % proof force <sup>1)</sup>	$F_{p0.1}$	kN	234	246
Minimum elongation at maximum force, $L_0 \geq 500$ mm	$A_{gt}$	%	3.5	
Modulus of elasticity	E	N/mm <sup>2</sup>	195 000 <sup>2)</sup>	
Relaxation after 1 000 h, for an initial force of				
– $0.70 \cdot F_{ma}$	—	%	$\leq 2.5$	
– $0.80 \cdot F_{ma}$	—	%	$\leq 4.5$	

1) For strands according to prEN 10138-3, 09.2000, the value is multiplied by 0.98

2) Standard value



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**Bonded prestressing system  
SUSPA Strand DW**  
Specification of the  
7-wire prestressing steel strand

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Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Anchor head E, EI, EP, Anchor head Z, Single strand anchor SK6, Coupler head K, K-EI, Coupler head V, Coupler barrel K6, Coupler bushing K6, Anchor body MA, MA-EI	Material	Checking <sup>1)</sup>	<sup>2)</sup>	100 %	continuous
	Detailed dimensions	Testing	<sup>2)</sup>	5 %, $\geq 2$ specimens	continuous
	Visual inspection <sup>3)</sup>	Checking	<sup>2)</sup>	100 %	continuous
	Traceability	full			
Anchor plate E, K-EI	Material	Checking <sup>3)</sup>	<sup>2)</sup>	100 %	continuous
	Detailed dimensions	Testing	<sup>2)</sup>	3 %, $\geq 2$ specimens	continuous
	Visual inspection <sup>3)</sup>	Checking	<sup>2)</sup>	100 %	continuous
	Traceability	bulk			
Wedge, Compression fitting	Material	Checking <sup>1)</sup>	<sup>2)</sup>	100 %	continuous
	Treatment, hardness	Testing	<sup>2)</sup>	0.5 %, $\geq 2$ specimens	continuous
	Detailed dimensions	Testing	<sup>2)</sup>	5 %, $\geq 2$ specimens	continuous
	Visual inspection <sup>4)</sup>	Checking	<sup>2)</sup>	100 %	continuous
	Traceability	full			
Prestressing steel strand	Material	Checking <sup>5)</sup>	<sup>2)</sup>	100 %	continuous
	Diameter	Testing	<sup>2)</sup>	1 sample	each coil or every 7 tons <sup>6)</sup>
	Visual inspection <sup>4)</sup>	Checking	<sup>2)</sup>	1 sample	
Helix in plain round steel, EN 10025	Material	Checking <sup>3)</sup>	<sup>2)</sup>	100 %	continuous
	Visual inspection <sup>4)</sup>	Checking	<sup>2)</sup>	100 %	continuous
	Traceability	full			
Steel strip sheath	Material	Checking <sup>7)</sup>	<sup>2)</sup>	100 %	continuous
	Dimension	Testing	<sup>2)</sup>	3 %, $\geq 2$ specimens	continuous
	Traceability	full			
Protective tube	Material	Checking <sup>7)</sup>	<sup>2)</sup>	100 %	continuous
	Visual inspection <sup>5)</sup>	Checking	<sup>2)</sup>	100 %	continuous
	Traceability	full			
Cement, Admixtures, Additions of filling materials as per EN 447	Material	Checking <sup>7)</sup>	<sup>2)</sup>	100 %	continuous
	Traceability	Full			
Plastic duct	According to <i>fib</i> Bulletin				

- 1) Checking of relevant certificate, the certificate is an inspection certificate 3.1 according to EN 10204.
  - 2) Conformity with the specifications of the component
  - 3) Checking by means of at least a test report 2.2 according to EN 10204.
  - 4) Successful visual inspection does not need to be documented.
  - 5) Checking of relevant certificate as long as the basis of "CE"-marking is not available.
  - 6) Maximum between a coil and 7 tons has to be taken into account.
  - 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  
 Traceability bulk Traceability of each delivery of components to a defined point  
 Material Defined according to the technical specification deposited by the manufacturer  
 Detailed dimensions Measuring of all dimensions and angles according to the specification given in the test plan  
 Visual inspection Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.  
 Treatment, hardness Surface hardness, core hardness and treatment depth



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**Bonded prestressing system  
 SUSPA Strand DW**  
 Contents of the prescribed test plan

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Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
Anchor head E, EI, EP, Anchor head Z, Single strand anchorage SK6, Coupler head K, K-EI Coupler head V, Coupler barrel K6, Coupler bushing K6, Anchor body MA, MA-EI Anchor plate E, K-EI	Material	Checking and testing, hardness and chemical <sup>2)</sup>	<sup>3)</sup>	1	1/year
	Detailed dimensions	Testing	<sup>3)</sup>	1	1/year
	Visual inspection	Checking	<sup>3)</sup>	1	1/year
Wedge, Compression fitting	Material	Checking and testing, hardness and chemical <sup>2)</sup>	<sup>3)</sup>	2	1/year
	Treatment, hardness	Checking and testing, hardness profile	<sup>3)</sup>	2	1/year
	Detailed dimensions	Testing	<sup>3)</sup>	1	1/year
	Main dimensions, surface hardness	Testing	<sup>3)</sup>	5	1/year
	Visual inspection	Checking	<sup>3)</sup>	5	1/year
Single tensile element test		According to EAD 160004-00-0301, Annex C.7		9	1/year
Plastic duct		According to <i>fib</i> Bulletin			

<sup>1)</sup> If the kit comprises different kinds of anchor bodies and heads, e.g. with different materials, different shape, different wedges, etc., then the number of samples are understood as per kind of anchor bodies and heads.

<sup>2)</sup> Testing of hardness and checking of chemical composition by means of an inspection certificate 3.1 according to EN 10204.

<sup>3)</sup> Conformity with the specifications of the component

Material Defined according to the technical specification deposited by the ETA holder at the Notified body

Detailed dimensions Measuring of all dimensions and angles according to the specification given in the test plan

Visual inspection Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.

Treatment, hardness Surface hardness, core hardness, and treatment depth



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**Bonded prestressing system  
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Audit testing

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Essential Characteristic	Clause	Intended use Line № according to Clause 2.1, Table 6					
		1	2	3	4	5	6
Resistance to static load	3.1.1	+	+	+	+	+	+
Resistance to fatigue	3.1.2	+	+	+	+	+	+
Load transfer to the structure	3.1.3	+	+	+	+	+	+
Friction coefficient	3.1.4	+	+	+	+	+	+
Deviation, deflection (limits)	3.1.5	+	+	+	+	+	+
Assessment of assembly	3.1.6	+	+	+	+	+	+
Resistance to static load under cryogenic conditions for applications with anchorage / coupling outside the possible cryogenic zone	3.1.7	—	+	—	—	—	—
Resistance to static load under cryogenic conditions for applications with anchorage / coupling inside the possible cryogenic zone	3.1.8	—	—	+	—	—	—
Material properties, component performance, system performance of plastic duct (PL1)	3.1.9	—	— <sup>1)</sup>	— <sup>1)</sup>	+	—	—
Material properties, component performance, system performance of plastic duct to provide an encapsulated tendon (PL2)	3.1.10	—	— <sup>1)</sup>	— <sup>1)</sup>	—	+	—
Material properties, component performance, system performance of plastic duct to provide an electrically isolated tendon (PL3)	3.1.11	—	— <sup>1)</sup>	— <sup>1)</sup>	—	—	+
Corrosion protection	3.1.12	+	+	+	+	+	+
Reaction to fire	3.1.13	+	+	+	+	+	+
Content, emission, and/or release of dangerous substances	3.1.14	+	+	+	+	+	+

**Key**

+ ..... Essential characteristic relevant for the intended use

— ..... Essential characteristic not relevant for the intended use

<sup>1)</sup> ..... Essential characteristic relevant for cryogenic applications where plastic ducts are used

For combinations of intended uses the essential characteristics of all intended uses composing the combination are relevant.



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**Bonded prestressing system  
SUSPA Strand DW**  
Essential characteristics  
for the intended use

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## Reference documents

### European Assessment Documents

EAD 160004-00-0301	Post-Tensioning Kits for Prestressing of Structures
EAD 160027-00-0301	Special filling products for post-tensioning kits

### Eurocodes

Eurocode 2	Eurocode 2: Design of concrete structures
Eurocode 3	Eurocode 3: Design of steel structures
Eurocode 6	Eurocode 6: Design of masonry structures

### Standards

EN 206+A2, 03.2021	Concrete – Specification, performance, production and conformity
EN 446, 10.2007	Grout for prestressing tendons – Grouting procedures
EN 447, 10.2007	Grout for prestressing tendons – Basic requirements
EN 523, 08.2003	Steel strip sheaths for prestressing tendons – Terminology, requirements, quality control
EN 1562, 03.2019	Founding – Malleable cast irons
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 10130, 12.2006	Cold-rolled low carbon steel flat products for cold forming – Technical delivery conditions
EN 10204, 10.2004	Metallic products – Types of inspection documents
EN 10277, 06.2018	Bright steel products – Technical delivery conditions
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 17855-1, 10.2014	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
prEN 10138-3, 09.2000	Prestressing steels – Part 3: Strand
prEN 10138-3, 08.2009	Prestressing steels – Part 3: Strand
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

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**Bonded prestressing system  
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**Other documents**

<i>fib</i> bulletin 33, 12.2005	Durability of post-tensioning tendons
<i>fib</i> bulletin 75, 12.2014	Polymer-duct systems for internal bonded post-tensioning
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, OJ L 201 of 17.07.1998, 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 088 of 04.04.2011, 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 25.06.2019, 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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**Bonded prestressing system  
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