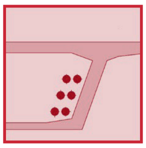 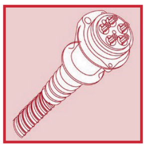

POST-TENSIONING

DYWIDAG External and Internal Unbonded Strand Post-Tensioning System

ETA-13/0979

06 September 2023

DYWIDAG

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

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European Technical Assessment — ETA 13/0979 of 06/09/2023

General Part

Technical Assessment Body issuing the ETA: Cerema	
Trade name of the construction product	DYWIDAG external and internal unbonded strand post-tensioning system
Product family to which the construction product belongs	16 - Post-tensioning kit for prestressing of structures
Manufacturer	DYWIDAG – Systems International GmbH Neuhofweg 5 85716 Unterschleissheim Germany
Manufacturing plant	DYWIDAG Sp. z o.o. ul. Hallera 78 41-709 Ruda Śląska Poland
This European Technical Assessment contains	49 pages including 24 annexes which form an integral part of this assessment.
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 160004-00-0301. Edition September 2016, Post-Tensioning Kits for Prestressing of Structures
This ETA replaces	ETA 13/0979, issued on 30/05/2018

Content

APPENDICES

Specific parts

1 Technical description of the product

1.1 Definition of the product

This European Technical Assessment applies to:

DYWIDAG external and internal unbonded strand post-tensioning system.

Consisting of 3 to 55 strands.

The prestressing tendon consists of a bundle of 7-wire strands, anchorages, deviators, sheathing/duct and corrosion protective compounds.

Strands

7-wire prestressing steel strand with diameter and tensile strengths as given in Table 1.1, according to the prEN 10138-3: "Prestressing steels – Strand". As long as EN 10138 is not implemented, 7-wire strands in accordance with national provisions shall be used.

Table 1.1: Dimensions and properties of 7-wire strands

Nominal diameter		Designation according to prEN 10138-3	Nominal tensile strength
mm	inch	-	N/mm^2
15.3	0.60	Y1770S7	1770
15.3	0.60	Y1860S7	1860
15.7	0.62	Y1770S7	1770
15.7	0.62	Y1860S7	1860

Anchorages:

Stressing (active) and fixed (passive) anchor:

- o Multiplane anchorage MA for tendons with 5 to 55 strands:
  - Anchor body MA
  - Wedge plate MA
  - PE Trumpet
- o Plate anchorage for tendons with 3 to 55 strands:
  - Anchor Plate,
  - Wedge Plate,
  - Steel trumpet with PE insert
  - PE-insert

Deviators:

For external PT-systems, deviators are specific elements at given locations in the structure along the tendon. These are generally made of steel tubes (straight or pre-bent) placed inside the concrete structure or construction steel saddles applied to the structure
Deviators shall be designed according to this ETA, unless a national regulation in the place of use is stricter.

Reinforcements:

Helix and additional reinforcement (stirrups) in the anchorage zone for the concrete confinement at anchorages to ensure local prestressing force transfer into the concrete structure.

Sheaths and ducts:

Sheaths and plastic ducts. Sheathings for external and internal unbonded tendons are made of plastic (polyethylene, HDPE).

Corrosion protection:

Permanent corrosion protection for tensile elements, and anchorages can be a cement based grout (in accordance with EN 447 or EAD 160027-00-0301) for rigid injection or for flexible injection grease or wax based compound (in accordance with EAD 160027-00-0301).

Plastic tubes, ducts, the ordinary reinforcement for bursting reinforcement and grouting products are covered by European or national provisions thus they are not described in this ETA. However, they can be used for the prestressing kits.

1.2 Components and design

The components correspond to the drawings and provisions given in this European Technical Assessment including the Annexes. The characteristic material values, dimensions and tolerances of the components not indicated in the Annexes shall correspond to the respective values laid down in the technical documentation of this European Technical Assessment. Arrangement of the tendons, the design of the anchorage zones, the anchorage components and the diameters of the sheathings shall correspond to the attached description and drawings; the dimensions and materials shall comply with the values given therein.

1.2.1 Range and designation of anchorages

The first digit of the designation of components of anchorages (6) identifies the nominal strand diameter in tenfold of inches (0.60”/0.62”), the second digit is an internal code and the last two digits refer to the number of strands in the tendon (size of tendon). The components (except helix and additional reinforcement) fit for tendons with both strand strengths.

1.2.2 Strands

7-wire prestressing steel strands with a nominal diameter of 15.3 mm or 15.7 mm and tensile strengths of 1 770 N/mm² or 1 860 N/mm² shall be used, in accordance with national provisions with the characteristics given in Annex 19.

To avoid confusions only strands with one nominal diameter and tensile strength shall be used at one site.

Only strands stranded in the same direction shall be used in a tendon.

1.2.3 Wedges

Wedges (see Annex 2) are approved with 30°-tooth or 45°-tooth. The segments of the wedges for strands Ø 15.3 mm are 42 mm long and the segments of the wedges for strands Ø 15.7 mm are 45 mm long. The wedge dimension does not depend on the strands’ strength.

Wedges of one supplier only may be used at one construction site.

1.2.4 Wedge plates

The conical drills of the wedge plates (see Annex 2) shall be clean, stainless and provided with a corrosion protection.

1.2.5 Anchor plates

The 3 to 55 strands anchor plates (see Annexes 3, 4 and 5) are made of plain steel and are used together with wedge plates as stressing of fixed anchors.

In case of external prestressing, a circular anchor plate with recess tube welded watertight to it shall be used, see Annexes 1 and 3 to 5.

In case of internal prestressing an anchor plate with steel trumpet and tension ring, welded watertight to each other shall be used, see Annexes 1 and 3 to 5

1.2.6 Cast-iron anchor bodies

The 5 to 55 strands anchor bodies MA (see Annexes 9 and 10) are made of cast iron and are used together with wedge plates as stressing or fixed anchor, for external and internal prestressing.

They are circular in shape and provide several load transfer planes for load transfer to concrete and feature a centric circular hole for passing through the tendon.

1.2.7 Steel trumpet with PE-insert (for external tendon)

Steel trumpets are applicable for both internal and external prestressing.

As a part of the steel trumpet the tension ring is welded to the steel tube with the flange. The PE-insert is fixed to the tension ring through a gasket with a retaining ring and screws, see Annex 1. A piece of plastic sheathing with relevant diameter is mirror welded to the PE-insert. Its length is determined in order to protrude out from the concrete body around the anchorage zone.

1.2.8 Helix and additional reinforcement

The steel grades and dimensions of the helixes and additional reinforcement shall be in conformity with the specifications given in the Annexes 6 to 8, and Annexes 11 to 15 and the technical documentation of the ETA. The central position in the structural concrete member on site shall be ensured according to Clause 1.3.3.

Helixes for anchorages with anchor bodies MA can be made of plain round steel wire or ribbed reinforcing steel. The end turn of the helix shall be welded the anchor plate or the anchor body MA or to a closed ring. Welding of the helix end turn may be omitted if the helix is extended by 1.5 additional turns.

1.2.9 Sheathings, tubes and trumpets

Sheathings made of polyethylene shall comply with EN 12201 and Annex D of EAD 160004-00-0301. The dimensions of the sheathings shall comply with values given in Annex 2. The connections and seals between the sections of sheathing are effected either with mirror welding or electro-welding couplers.

The recess tubes and steel tubes (respectively welded to anchor plate and flange), see Annexes 3 to 5, are manufactured from at least 3.2 mm thick steel sheath material (see Annex 18).

The trumpets at the stressing and fixed anchorages (see Annexes 9 and 10) are manufactured from 3.0 mm thick PE material (see Annex 18). The connections and seals between a section of sheathing and a trumpet are effected with mirror welding.

1.2.10 Grout

Grout according to EN 447 shall be used.

1.2.11 Wax and grease

Wax and grease as defined in EAD 160027-00-0301 or according to national regulations valid in place of use shall be used.

1.2.12 Protective caps

Caps serve as closing the anchorage to enable grouting/injection and its protection. The caps are made of steel. Regularly they cover the wedge plate and are left in place after injection. Elongated caps may be used for sufficient strand over-length for later prestressing force adjustment or detensioning (if applicable).

1.3 Design

1.3.1 General

Design of the structure shall permit correct installation, stressing and grouting of the tendon and the design and reinforcement of the anchorage zone shall permit a correct placing of reinforcement and compacting of the concrete.

Tendons arranged one on top of each other should be separated by an appropriately thick concrete layer, as in case of tendon curvatures there is a risk of the inner ducts to be crushed by the outer tendons, as a result of deviation forces resulting from the prestressing tendons.

The initial prestressing force applied to the stressing anchor will decrease especially as a result of friction along the tendon and of the elastic shortening of the structure and in the course of time because of relaxation of the prestressing steel, and creep and shrinkage of the concrete. The stressing instructions prepared by the ETA holder shall be consulted.

1.3.2 Concrete strength

Concrete according to EN 206 shall be used.

At the time of transmission of the full prestressing force to the concrete member the mean concrete strength in the anchorage zone shall be at least $f_{cm,0,cube}$ or $f_{cm,0,cyl}$ according to Table 1.3.2.1. The mean concrete strength ($f_{cm,0,cube}$ or $f_{cm,0,cyl}$) shall be verified by means of at least three specimens (cube with the edge length of 150 mm or cylinder with diameter of at least 150 mm and height of at least two times the diameter), which shall be stored under the same conditions as the concrete member, with the individual values of specimens not differ more than 5 %.

For partial prestressing with 30 % of the full prestressing force the actual mean value of the concrete compressive strength to be proved is 0.5 $f_{cm,0,cube}$ or 0.5 $f_{cm,0,cyl}$; intermediate values may be interpolated linearly according to EN 1992-1-1.

Table 1.3.2.1: Required minimum mean concrete strength $f_{cm,0}$ of the specimens at time of prestressing

	$f_{cm,0,cube}$ [N/mm²]	$f_{cm,0,cyl}$ [N/mm²]
Plate Anchorage	25	20
	45	36
	60	50
MA with helix	25	20
	34	28
	45	36
MA without helix	34	27
	45	35
	54	43

1.3.3 Welding

Welding at the anchorages is only permitted at the following points:

a) Welding the end turn of the helix to a closed ring.
b) Welding the helix end ring turn to the anchor body MA or its connection tube or by means of spacers braced against the tendon to secure the centric position of the helix.

During welding it shall be ensured that there is no contact between duct and prestressing steel strand.

After mounting the tendons no more welding shall be performed at the anchorages and in the immediate vicinity of the tendons.

1.3.4 Friction losses

At calculation the losses of the prestressing force due to the friction coefficient μ = 0.12 – 0.14 shall be considered. This value is for information only. The exact friction coefficient must be adapted to each project and also in case of restressing.

For internal unbonded tendons the wobble coefficient k = 0.005 rad/m (unintentional deviation) shall be considered.

At external tendons, no wobble coefficient k need to be taken into account.

For the determination of strains and forces of prestressing steel friction losses in the active anchorage zone, $\Delta P_{\mu A}$ in the active anchorage zone shall be taken into account as follows:

- For tendons sizes from 6803 to 6805 : $\Delta P_{\mu A}$ = 1.0 %,
- For tendons sizes from 6807 to 6855 : $\Delta P_{\mu A}$ = 0.5 %

1.3.5 Radius of curvature of the tendons at deviations and geometry of deviators

The smallest admissible radius of curvature of the tendons as defined in the Table 2 of EAD 160004-00-0301 Clause 2.2.6 and the required dimensions of the bent steel deviation tubes are given in Table 1.3.5.1 (also see Annex 17). All values that differ from the Table 2 of EAD 160004-00-0301 were calculated by linear extrapolation.

Table 1.3.5.1: Smallest radius of curvature – PE-Tube

Tendon	Min. radius of curvature (m)	Tendon	Min. radius of curvature (m)	Tendon	Min. radius of curvature (m)
6803	2.50	**6812**	2.50	**6831**	3.75
6804	2.50	**6815**	2.75	**6837**	4.00
6805	2.50	**6819**	3.00	**6843**	4.80
6807	2.50	**6822**	3.25	**6849**	5.40
6809	2.50	**6827**	3.50	**6855**	5.40

The minimum values of radius of curvature given in Table 1.3.5.1 shall be respected, unless a national regulation is stricter.

A straight length of the tendon behind the anchorage according to Table 1.3.5.2 and Table 1.3.5.3 is required.

Behind the anchor plate a straight length of the tendon (measured from the top of the anchor plate) according to Table 1.3.5.2 is required.

Table 1.3.5.2: Required straight length of the tendon in the anchorage zone by using anchor plates (measured from the top of the anchor plate)

Tendon	Straight length of the tendon (m)	Tendon	Straight length of the tendon (m)	Tendon	Straight length of the tendon (m)
6803	0.70	**6812**	1.10	**6831**	1.60
6804	0.80	**6815**	1.20	**6837**	1.60
6805	0.85	**6819**	1.30	**6843**	1.80
6807	0.90	**6822**	1.40	**6849**	1.70
6809	1.00	**6827**	1.50	**6855**	1.70

By using anchor bodies type MA, a straight length of the tendon behind the anchorage (measured from the top of the anchor body) according to Table 1.3.5.3 is required.

Table 1.3.5.3: Required straight length of the tendon in the anchorage zone by using anchor bodies (measured from the top of the anchor body)

Tendon	Straight length of the tendon (m)	Tendon	Straight length of the tendon (m)
6805	0.85	**6827**	1.30
6807	0.75	**6831**	1.45
6809	1.00	**6837**	1.45
6812	1.05	**6843**	1.60
6815	1.05	**6849**	1.70
6819	1.20	**6855**	1.70
6822	1.20	**-**	-

In case of an external exchangeable tendon with cement grout, no curved tendon layout is allowed within the concrete body around the anchorage zone.

In case of a curved tendon layout in the anchorage zone of an external tendon with wax, the smallest admissible radius of curvature is given Table 1.3.5.4.

Table 1.3.5.2, Table 1.3.5.3 and Table 1.3.5.4 give conservative values.

Table 1.3.5.4: Minimum radius of curvature in the anchorage area

Tendon	Min. radius of curvature in the anchorage area (m)	Tendon	Min. radius of curvature in the anchorage area (m)	Tendon	Min. radius of curvature in the anchorage area (m)
6803	3.00	**6812**	3.50	**6831**	4.75
6804	3.00	**6815**	3.75	**6837**	5.00
6805	3.00	**6819**	4.00	**6843**	5.80
6807	3.00	**6822**	4.25	**6849**	6.40
6809	3.25	**6827**	4.50	**6855**	6.40

The minimum values of radius of curvature given in Table 1.3.5.4 shall be respected unless a national regulation is stricter.

1.3.6 Centre and edge distances of the tendon anchorages, concrete cover

The centre and edge distances of the tendon anchorages shall be the values given in the Annexes 6 to 8 and Annexes 11 to 15 depending on the actual mean concrete strength at time of stressing, $f_{cm,0}$ (Annexes 6 to 8 and 11 to 15).

These are valid for both strand sizes (Ø)15.7 mm and (Ø)15.3 mm.

The values of the centre or edge distances of the anchorages given in the Annexes may be reduced in one direction up to 15 %, however, in the other direction these values shall be increased for keeping the same concrete area in the anchorage zone. By reducing these values, a minimal centre and edge distance has to be considered:

- MA-Anchorages without helix (see Annexes 14 and 15): External dimension of the stirrup reinforcement plus 20 mm.
- Plate and MA-Anchorages with helix (see Annexes 6 to 8, and Annexes 11 and 12): External diameter of the helix plus 20 mm.

The dimensions of the additional reinforcement shall be fitted accordingly.

All centre and edge distances have only been specified in conjunction with load transfer to the structure; therefore, the concrete cover given in national standards and provisions shall be taken into account additionally.

The concrete cover may under no circumstance be less than 20 mm or smaller than the concrete cover of the reinforcement installed in the same cross section. The concrete cover of the anchorage should be at least 20 mm. Standards and regulations on concrete cover valid in place of use shall be considered.

1.3.7 Reinforcement in the anchorage zone

The anchorages (including reinforcement) for the transfer of the prestressing forces to the structural concrete were verified by means of tests. The resistance to the forces occurring in the structural concrete in the anchorage zone outside the helix and the additional reinforcement shall be verified. An adequate transverse reinforcement shall be provided here in particular for the occurring transverse tensile forces (not shown in the attached drawings).

The steel grades and dimensions of the additional reinforcement (stirrups) shall follow the values given in the Annexes 6 to 8, and Annexes 11 to 15. From the given amount of additional reinforcement 50 kg reinforcement steel/m³ concrete may be taken into account as part of the structurally required reinforcement. Existing reinforcement in a corresponding position more than the reinforcement required by design may be taken into account for the additional reinforcement. The additional reinforcement shall be of closed stirrups (stirrups closed by means of bends or hooks or an equivalent method) or of orthogonal reinforcement properly anchored. The stirrups locks (bends or hooks) shall be placed staggered.

In the anchorage zone, vertically led gaps shall be provided for proper concreting.

If required for a specific project design, the reinforcement given in the Annexes can be modified in accordance with the respective regulations in force at the place of use as well as with relevant approval of the local authority and of the ETA holder to provide equivalent performance. If in exceptional cases – due to an increased amount of reinforcement – the helix or the concrete cannot be properly placed, the helix can be replaced by different equivalent reinforcement.

1.3.8 Support of ducts

Tendons shall be installed with high accuracy. This is achieved by installing duct supports exactly levelled with regard to their planned position. The supports shall be secured in their position and the ducts fixed thereto. Distance between duct supports shall not exceed 1.8 m. In sections with maximum tendon curvature, the distance between the duct supports is reduced and shall be of 0.60 m to 1.20 m.

If the strands are installed after concreting (duct type II), attention shall be paid that the duct will not displace. For this purpose, the duct shall be additionally fixed between the supports e.g. to the reinforcement of the structure. If tendons are installed in several layers, only the lowest layer can be rigidly connected with the duct support. All other tendon layers shall be fixed on subsequently placed supports.

For corrugated plastic ducts, spacing of supports should be 0.60 m to 1.0 m for sizes ranging from 50 mm to 85 mm, and from 0.60 m or 0.75 m as stated above, to 1.4 m for the sizes ranging from 100 mm to 130 mm.

1.3.9 Resistance to fatigue at anchorages

With the fatigue tests carried out in accordance with EAD 160004-00-0301, the stress range of 80 MPa of the anchorages at the maximum load of 0.65 f_{pk} at $2x10^6$ load cycles was demonstrated.

1.4 Installation

1.4.1 Installation of the tendon

The central position of the helix and stirrups shall be ensured by tack-welding to the anchor plate or other appropriate mountings. The anchor plate or the anchor body respectively, shall be in direction perpendicular to the axis of the straight tendon in the vicinity of the anchorage.

The tendon shall be placed straightforward behind the anchorage according to Table 1.3.5.2 and Table 1.3.5.3. During installation, careful handling of the tendon shall be ensured. Prior to placing the concrete, the person responsible shall perform a final check on the installed tendons.

1.4.2 Wedging force, slip at anchorages, wedge securing and corrosion protection compound

If the calculated prestressing force is less than 0.7 $P_{m0,max}$ the wedges of non-accessible fixed anchorages shall be pre-wedged with $P_{0,max}$ (see Clause 1.4.3.5).

The draw-in at the anchorage to be taken into account for the determination of the elongations and at load transfer from the jack onto the anchorage shall be taken from Table 1.4.2.1.

The wedges of all anchorages (fixed anchorages) which are no more accessible during tensioning shall be secured by means of wedge keeper plates and bolts.

Table 1.4.2.1: Draw-in values for calculation of elongation [mm]

	Draw-in at stressing anchorage (mm)		Draw-in at fixed anchorage (mm)
	Draw-in to be considered for calculation of elongation	Draw-in at load transfer from the jack onto the anchorage	Draw-in to be considered for calculation of elongation
Without pre-wedging or power-seating	1	8	6
With power-seating 20 kN per strand at stressing anchorage	1	4	-
With pre-wedging $P_{0,max}$ at fixed anchorage	-	-	1

At installation of the wedges into the conical borings of the not accessible fixed anchorages the gaps shall be filled with corrosion protection compound.

Before pouring of concrete, the wedge plates of the not-accessible fixed anchorages shall be sealed with a grout cap.

1.4.3 Stressing and stressing records

1.4.3.1 Stressing

At time of stressing the minimum mean concrete strength shall comply with the values given in Clause 1.3.2. Near the anchorages the concrete must be especially homogeneous.

The minimum straight length for tensioning behind the anchorages (strand protrusion) depends on the jack which is used on site (see Annex 23). All strands of a tendon shall be stressed simultaneously. This can be done by centrally controlled individual jacks or by a bundle jack.

The prestressing forces are applied in accordance with a prescribed stressing plan. Such schedule includes time and sequence of the various prestressing levels and the elongations calculated for the tendons, the required mean cube or cylinder compressive strength of the concrete as well as time and kind of shuttering lowering and removal. Any possible spring back forces of the falsework shall be taken into account.

1.4.3.2 Restressing

Restressing of tendons in combination with release and reuse of wedges is permitted. After restressing the wedges shall bite into at least 15 mm of virgin strand surface and no wedge marks shall remain of the tendon between the anchorages.

1.4.3.3 Stressing record

All stressing operations shall be recorded for each tendon. In general, the required prestressing force shall be achieved. The elongation is measured and compared with the calculated value.

1.4.3.4 Prestressing jacks and space requirements, safety-at-work

For stressing hydraulic jacks are used. Information about the stressing equipment is shown in Annex 23. To facilitate jack placement and stressing the tendons, clearance according to Annex 23 shall be considered directly behind the anchorages.

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

1.4.3.5 Stressing forces

The maximum prestressing and over-tensioning force to be applied on the tendon is specified in the national standards and regulations in force in the place of use.

Table 1.4.3.5.1: Maximum prestressing forces[1] for tendons with Ap = 140 mm²

Tendon Designation	Number of strands	Cross section A_p [mm²]	Prestressing force Y1770S7 $F_{p0.1k}$ = 218 kN		Prestressing force Y1860S7 $F_{p0.1k}$ = 229 kN	
			$P_{m0,\,max}$ [kN]	$P_{0,\,max}$ [kN]	$P_{m0,\,max}$ [kN]	$P_{0,\,max}$ [kN]
6803	3	420	**556**	**589**	**584**	**618**
6804	4	560	**741**	**785**	**779**	**824**
6805	5	700	**927**	**981**	**974**	**1031**
6807	7	980	**1297**	**1373**	**1363**	**1443**
6809	9	1260	**1668**	**1766**	**1752**	**1855**
6812	12	1680	**2224**	**2354**	**2336**	**2473**
6815	15	2100	**2780**	**2943**	**2920**	**3092**
6819	19	2660	**3521**	**3728**	**3698**	**3916**
6822	22	3080	**4077**	**4316**	**4282**	**4534**
6827	27	3780	**5003**	**5297**	**5256**	**5565**
6831	31	4340	**5744**	**6082**	**6034**	**6389**
6837	37	5180	**6856**	**7259**	**7202**	**7626**
6843	43	6020	**7968**	**8436**	**8370**	**8863**
6849	49	6860	**9080**	**9613**	**9538**	**10099**
6855	55	7700	**10191**	**10790**	**10706**	**11336**

The maximum force $P_{0,max}$ defined according to EN 1992-1-1 Clause 5.10.2 (with recommended values for k_1 and k_2), and according to prEN 10138, shall not exceed the values laid down in Table 1.4.3.5.1 (140 mm²) or in Table 1.4.3.5.2 (150 mm²).

Maximum prestressing force $P_{0,max}$ = min (0.8 F_{pk} ; 0.9 $F_{p0.1k}$) where $F_{pk} = A_p\, f_{pk}$ is the characteristic tensile force of tensile elements of tendons and $F_{p0.1k} = A_p\, f_{p0.1k}$ the characteristic tensile yield force of tensile elements of tendon (0.1 % proof load).

The initial prestressing force P_{m0} immediately after tensioning and anchoring shall not exceed the values laid down in Table 1.4.3.5.1 (140 mm²) or in Table 1.4.3.5.2 (150 mm²), see also Annex 1.

Initial prestressing force P_{m0} = min (0.75 F_{pk} ; 0.85 $F_{p0.1k}$)

[1] The forces $P_{0,\,max}$ and P_{m0} are given as recommended values. The actual values are to be found in national regulations valid on place of use. Compliance with the stabilisation and crack width criteria in the load transfer test was verified to a load level of 0.80 F_{pk}.

Table 1.4.3.5.2: Maximum prestressing forces[2] for tendons with Ap = 150 mm²

Tendon Designation	Number of strands	Cross section A_p [mm²]	Prestressing force Y1770S7 $F_{p0.1k}$ = 234 kN		Prestressing force Y1860S7 $F_{p0.1k}$ = 246 kN	
			$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]	$P_{m0,max}$ [kN]	$P_{0,max}$ [kN]
6803	3	450	**597**	**632**	**627**	**664**
6804	4	600	**796**	**842**	**836**	**886**
6805	5	750	**995**	**1053**	**1046**	**1107**
6807	7	1050	**1392**	**1474**	**1464**	**1550**
6809	9	1350	**1790**	**1895**	**1882**	**1993**
6812	12	1800	**2387**	**2527**	**2509**	**2657**
6815	15	2250	**2984**	**3159**	**3137**	**3321**
6819	19	2850	**3779**	**4001**	**3973**	**4207**
6822	22	3300	**4376**	**4633**	**4600**	**4871**
6827	27	4050	**5370**	**5686**	**5646**	**5978**
6831	31	4650	**6166**	**6529**	**6482**	**6863**
6837	37	5550	**7359**	**7792**	**7737**	**8192**
6843	43	6450	**8553**	**9056**	**8991**	**9520**
6849	49	7350	**9746**	**10319**	**10246**	**10849**
6855	55	8250	**10940**	**11583**	**11501**	**12177**

The number of strands in a tendon may be reduced by leaving out strands lying radial-symmetrically in the wedge plate. The provisions for tendons with completely filled wedge plates (basic types) also apply to tendons with only partly filled wedge plates. Into the not filled cones short pieces of strands with wedges have to be pressed to assure a sufficient bending stiffness of the wedge plate. For such tendons wedge plates machined without the not required conical borings can be applied, too.

The prestressing force is reduced per strand left out as shown in Table 1.4.3.5.3.

Table 1.4.3.5.3: Reduction of the prestressing force per strand

A_p [mm²]	Y1770S7		Y1860S7	
	ΔP_{m0} [kN]	ΔP_0 [kN]	ΔP_{m0} [kN]	ΔP_0 [kN]
140	**185.3**	**196.2**	**194.7**	**206.1**
150	**198.9**	**210.6**	**209.1**	**221.4**

1.4.4 Grouting

1.4.4.1 Grout and grouting procedures

Grout according to Clause 1.2.11 shall be used. Grouting procedures shall be carried out in accordance with EN 446. Local standards and national regulations valid in place of use shall be considered.

1.4.4.2 Water rinse

Normally, sheathing shall not be rinsed with water. Local standards and national regulations valid in place of use shall be considered.

[2] The forces $P_{0,max}$ and P_{m0} are given as recommended values. The actual values are to be found in national regulations valid on place of use. Compliance with the stabilisation and crack width criteria in the load transfer test was verified to a load level of 0.80 F_{pk}.

1.4.4.3 Grouting speed

The grouting speed shall be in the range between 3 m/min and 12 m/min.

1.4.4.4 Grouted section and re-grouting

After completion of the prestressing operation and acceptance of the stressing records, the tendons are grouted as soon as possible. If the tendons remain ungrouted for a longer time, appropriate corrosion protection measures shall be implemented after acceptance of the ETA holder.

The maximum length of a grouted section depends on the capacity of the grouting equipment and shall be determined before the grouting procedure. When exceeding these tendon lengths, additional grouting openings shall be provided. Where the tendon is led via distinct high points, re-groutings shall be performed in order to avoid voids. For re-groutings, appropriate measures shall be taken into account already in design.

Vents on the ducts shall be provided at both ends and at the points of the tendon where air or water may accumulate. In case of ducts of considerable length, vents or inlets may be required at intermediate positions. Local standards and national regulations valid in place of use shall be considered. If plastic ducts are used, the relevant notes in the technical documentation of the plastic duct system shall be observed.

1.4.4.5 Surveillance

Surveillance according to EN 446 shall be carried out.

1.4.5 Wax and grease injection

Wax and grease according Clause 1.2.12 shall be used. Injection shall be carried out according to DSI special instructions. Injection equipment is normally composed of melting device (heater), stirrer and pump.

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

2.1 Intended use

DYWIDAG External and internal strand, unbonded post tensioning system

The DYWIDAG external and internal unbonded strand post-tensioning systems (in the following PT systems) have been developed to be used for:

- New structures,
- Repair and strengthening of existing structures exposed to effects from gravity and live loads, climate exposures, imposed sets of deformations.

These PT systems are meant for concrete structures/members with a tendon path situated:

- Outside their cross section but inside their envelope (external tendon),
- Inside their cross section (internal unbonded tendon).

They may also be employed in structures made of other materials, e.g. masonry, steel, cast iron, timber or combination of several materials. In case of use with other materials than concrete, dimensions and prestressing force transfer shall be designed according to the relevant Eurocodes or national regulations valid in place of use.

The following optional use categories for the external and unbonded internal (wax injected) tendons are possible:

- restressable tendon;
- exchangeable tendon;
- encapsulated tendon.

2.2 Working life

The provisions made in this European Technical Assessment are based on an assumed working life of the PT system of 100 years. These provisions are based upon the current state of the art and the available knowledge and experience. The indications given on the working life cannot be interpreted as a guarantee given by the kit manufacturer or the Assessment Body, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

The relevant Eurocodes are the following:

EN 1990 “Eurocode 0”: Basis of structural design
EN 1991 “Eurocode 1”: Actions on structures
EN 1992 “Eurocode 2”: Design of concrete structures
EN 1993 “Eurocode 3”: Design of steel structures
EN 1994 “Eurocode 4”: Design of composite steel and concrete structures
EN 1995 “Eurocode 5”: Design of timber structures
EN 1996 “Eurocode 6”: Design of masonry structures

The PT system is supposed to be subject to appropriate use and maintenance (see Clause 1.2.2 of EAD 160004-00-0301).

3 Performance of the product and methods used for its assessment

This European Technical Assessment for the post-tensioning systems part of this document is issued on the basis of agreed data, deposited at Cerema, which identifies the post-tensioning systems that have been assessed and judged.

Assessment of the performance of the post-tensioning system part of this document for the intended use in the sense of basic requirement for construction work 1 (mechanical resistance and stability) has been made in accordance with the EAD 160004-00-0301 Post-Tensioning Kits for Prestressing of Structures based on the provisions for all systems.

Table 3.1 : Essential characteristics and performances of the product

Product type: post-tensioning kit for prestressing of structure		Intended uses: all described in Clause 2.1
Basic work requirement	**Essential characteristic**	**Product performance**
BWR 1 Mechanical resistance and stability	Resistance to static load	≥ 95 % of Actual Ultimate Tensile Strength – AUTS (acceptance criteria given in Clause 2.2.1 of EAD 160004-00-0301)
	Resistance to fatigue	No fatigue failure in anchorage and not more than 5 % loss on cross section after 2 million cycles (acceptance criteria given in Clause 2.2.2 of EAD 160004-00-0301)
	Load transfer to the structure	Stabilization of crack width under cyclic load and ultimate resistance ≥ 110 % characteristic load (acceptance criteria given in Clause 2.2.3 EAD 160004-00-0301)
	Friction coefficient	See Clause 1.3.4
	Deviation/deflection (limits) for external and internal unbonded tendon	Minimum radii of external and internal unbonded tendon (acceptance criteria in Clauses 2.2.5 and 2.2.6 of EAD 160004-00-0301)
	Assessment of assembly	Installation of strands, duct filling (acceptance criteria given in Clause 2.2.7 of EAD 160004-00-0301)
	Entries 8 to 34 of Table 1 of EAD 160004-00-0301	No performances assessed
BWR 2 Safety in case of fire	Reaction to fire	No performance assessed
BWR 3 Hygiene, health and the environment	Content, emission and/or Release of dangerous substances	No performance assessed

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

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

Table 4.1: AVCP system of the product

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

This AVCP system is defined as follows:

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

(a) Tasks of the manufacturer

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

(b) Tasks for the notified body

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

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

5.1 Tasks for the manufacturer

5.1.1 Factory production control

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

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

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

The prescribed test plan defined in Annexes 20.a and 20.b gives the type and frequency of checks and tests conducted during production and on the final product as part of the continuous internal production control.

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

The records contain at least the following information:

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

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

5.1.2 Other tasks

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in Clause 5.2 in the field of Dywidag post-tensioning system in order to undertake the actions laid down in Clause 5.2. For this purpose, the "control plan" referred to in Clause 5.1.1 shall be handed over by the manufacturer to the Notified Body or bodies involved.

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

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

5.2 Tasks of the Notified Body

5.2.1 General

The Notified Body (bodies) shall perform the:

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

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

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

The main production centre is checked at least once a year by the Notified Body. Each component producer is checked at least once every five years by the Notified Body.

The Notified Body involved by the manufacturer shall issue a certificate of constancy of performance of the product stating the conformity with the provisions of this European Technical Assessment.

In cases where the provisions of the European Technical Assessment and its “Control Plan” are no longer fulfilled the Notified Body shall withdraw the certificate of constancy of performance and inform Cerema ITM without delay.

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

For initial type testing the results of the tests performed as part of the assessment of the European Technical Assessment may be used unless there are changes in production procedure or factory plant. In such cases, the necessary initial type testing shall be agreed between Cerema ITM and the Notified Body involved.

5.2.3 Initial inspection of factory and of factory production control

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

5.2.4 Surveillance, assessment and approval of factory production control

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

5.2.5 Audit testing of samples taken at the manufacturer

During surveillance inspection, the Notified Body shall take samples at the factory of components of the PT system or of individual components for which this European Technical Assessment has been granted, for independent testing.

For the most important components Annex 21 summarises the minimum procedures.

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By

Centre d'étude et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement (Cerema)

Direction technique Infrastructures de transport et matériaux (DTecITM)

Le Directeur Adjoint du Cerema ITM

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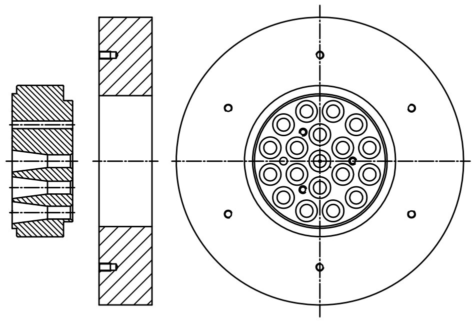
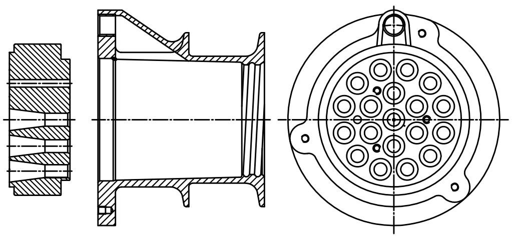
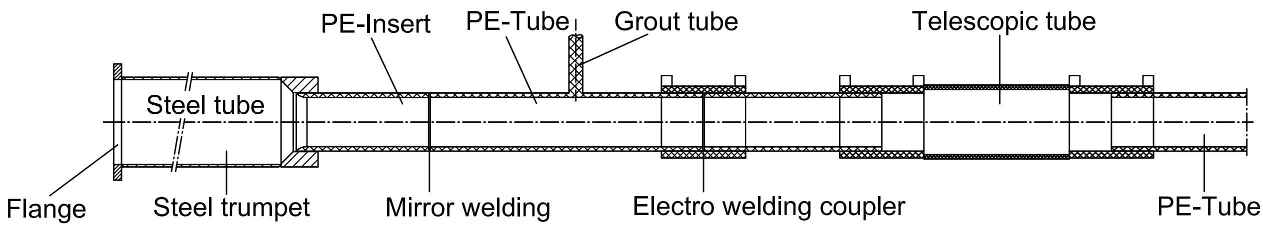
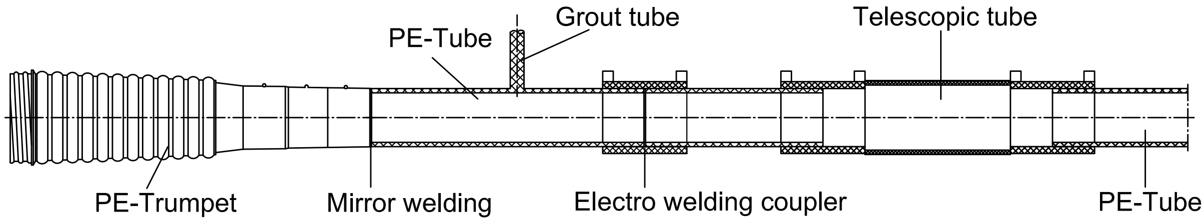
Éric MOULINE, Deputy Director of Cerema ITM

Designation	Figure	Tendon Size	Initial prestressing force Y18607S $P_{m0, max}$ [kN] Strand 140 mm²	Strand 150 mm²
Plate anchorage 6803 - 6855 Annex 3-8, 21		68 03	584	627
		68 04	779	836
		68 05	974	1046
		68 07	1363	1464
		68 09	1752	1882
		68 12	2336	2509
		68 15	2921	3137
		68 19	3699	3973
Multiplane anchorage MA 6805 - 6855 Annex 9-14, 21		68 22	4283	4600
		68 27	5257	5646
		68 31	6036	6482
		68 37	7204	7737
		68 43	8372	8991
		68 49	9540	10246
		68 55	10709	11501

Sheathing - Plate anchorage:



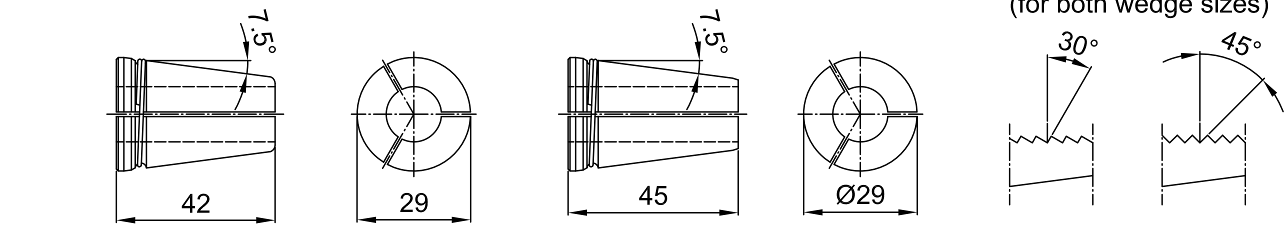
Sheathing - Multiplane anchorage MA:



DYWIDAG DYWIDAG-Systems International GmbH www.dywidag.com	DYWIDAG - PT external strand tendon **Anchorage range** **Components - Sheathing**	Annex 1 of European Technical Assessment ETA-13/0979

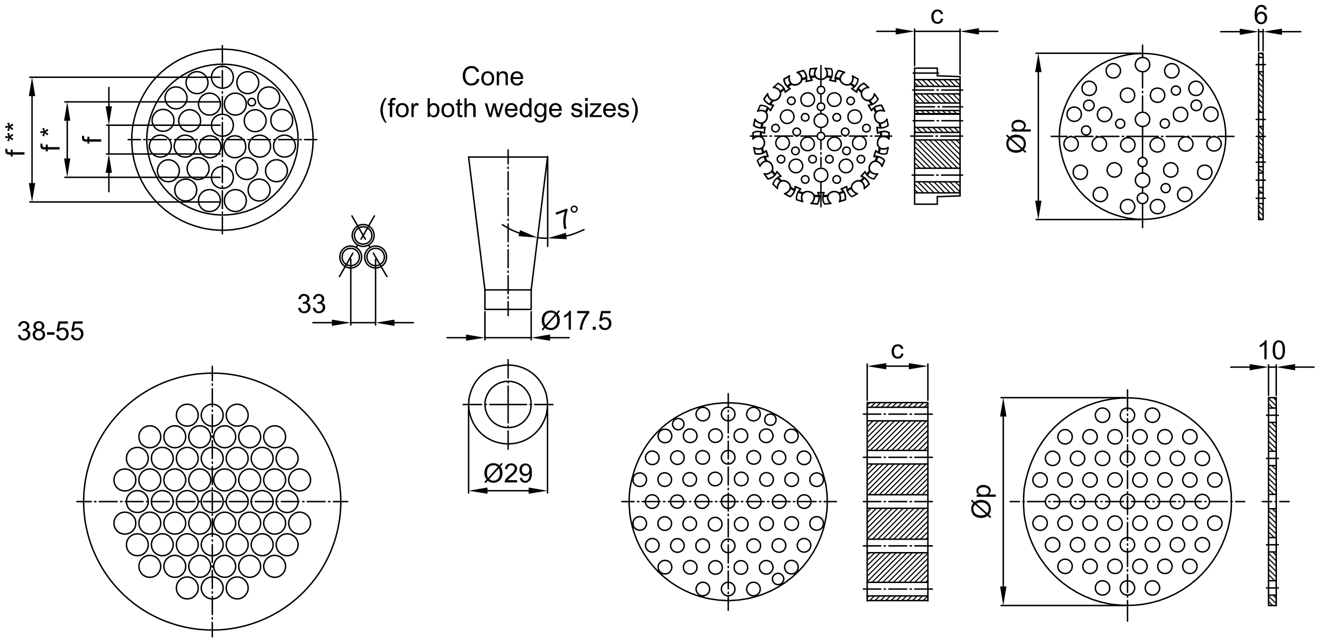
Wedge:

Strand 140 mm² (0,6") | Strand 150 mm² (0.62") | Wedge tooth geometries (for both wedge sizes)



Pitch circles:

03-37 Wedge plate | Spacer | Wedge keeper plate



Dimensions in mm

Tendon size		6803	6804	6805	6807	6809	6812	6815	6819	6822	6827	6831	6837	6843	6849	6855
No. of strands		03	04	05	07	09	12	15	19	22	27	31	37	43	49	55
Spacer	c	–	–	40	40	40	40	40	60	60	60	60	60	75	75	80
Wedge keeper plate	Øp	80	80	90	100	115	135	155	170	185	195	215	215	275	275	275
Pitch circles		–	–	–	0	0	–	–	0	–	–	0	0	0	0	0
	f	44	50	60	70	86	40	60	70	86	38	–	65	66	66	66
	f *	–	–	–	–	–	105	125	136	152	100	126	126	132	132	132
	f **	–	–	–	–	–	–	–	–	–	165	190	190	198	198	198
	f ***	–	–	–	–	–	–	–	–	–	–	–	–	231	264	264
Duct (min. values): Outer diameter		50	50	63	75	75	90	110	110	125	125	140	140	160	160	180
PE80, PN6 (cement gr. injection): min. wall thickness		2.4	2.4	3.0	3.6	3.6	4.3	5.3	5.3	6.0	6.0	6.7	6.7	7.7	7.7	8.6
PE100, PN10 (wax or cement gr. inj.): min. wall thickness		3.0	3.0	3.8	4.5	4.5	5.4	6.6	6.6	7.4	7.4	8.3	8.3	9.5	9.5	10.7

DYWIDAG

DYWIDAG-Systems International GmbH

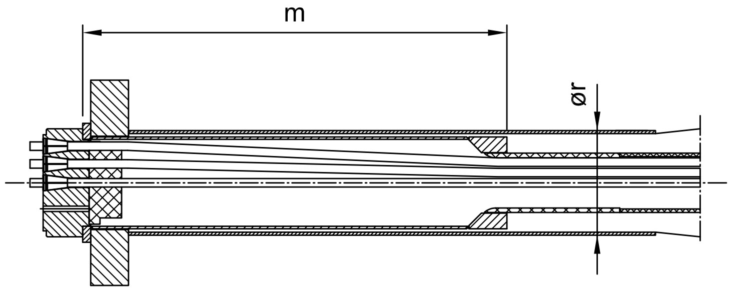
www.dywidag.com

DYWIDAG - PT external strand tendon

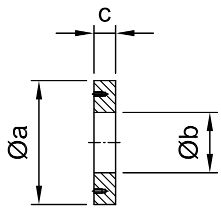
Details: Wedge, Cone, Hole pattern, Duct dimensions

Annex 2 of European Technical Assessment

ETA-13/0979

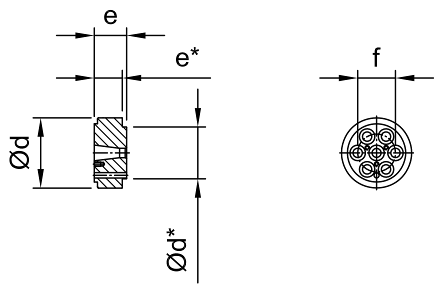


Anchor plate

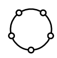
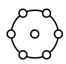
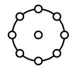


Wedge plate

(f acc. to Annex 2)



Dimensions in mm

Tendon size	6803			6804			6805			6807			6809		
No. of strands	03			04			05			07			09		
Cone pattern and position															
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	45	60	25	45	60	25	45	60	25	45	60	25	45	60
Anchor plate Ø a	170	170	165	190	175	165	220	200	185	250	230	210	275	265	240
Type 2353/2354/2355 Ø b	86			86			105			112			125		
c	25	25	25	30	30	30	40	35	35	45	40	40	50	50	45
Wedge plate Type 1350 for 6803, 6804 Type 1362 for 6805, 6807 Ø d	110			110			117			130			145		
Ø d *	71			71			88			96			112		
e	55			55			55			60			60		
e *	47			47			47			52			52		
Trumpet Length mm	250			320			350			350			530		
Recess tube Ø r	95.0			95.0			114.3			127.0			139.7		

DYWIDAG

DYWIDAG-Systems International GmbH

www.dywidag.com

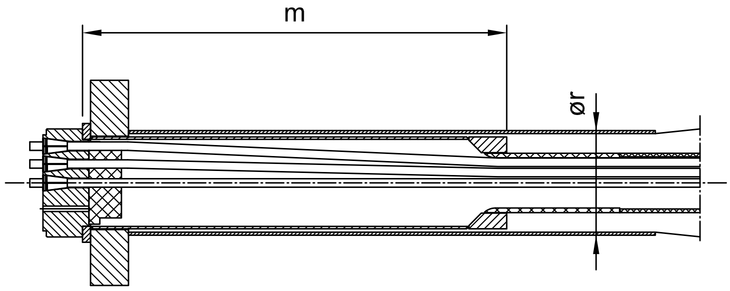
DYWIDAG - PT external strand tendon

Plate Anchorage

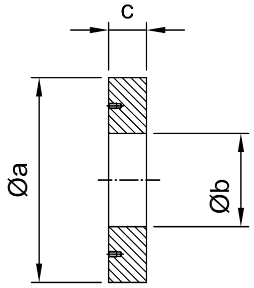
Dimensions of components for 6803 - 6809

Annex 3
of European Technical Assessment

ETA-13/0979

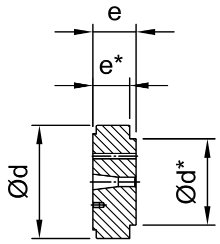


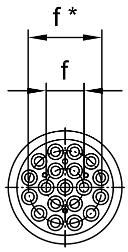
Anchor plate



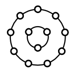
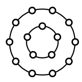
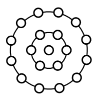
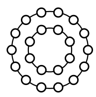
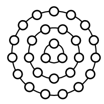
Wedge plate

(f, f *, f** acc. to Annex 2)

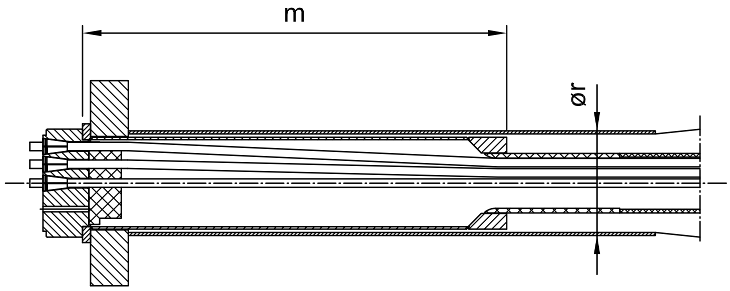




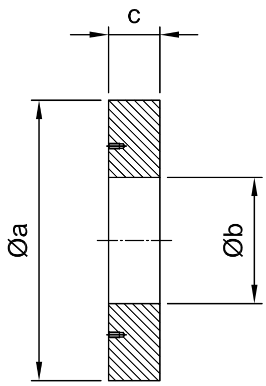
Dimensions in mm

Tendon size		6812			6815			6819			6822			6827		
No. of strands		12			15			19			22			27		
Cone pattern and position																
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]		25	45	60	25	45	60	25	45	60	25	45	60	25	45	60
Anchor plate	Ø a	315	300	270	355	335	305	405	380	340	450	410	365	-	455	405
Type 2353/2354/2355	Ø b	144			163			173			199			208		
	c	55	55	50	60	60	55	70	70	60	80	75	65	-	85	75
Wedge plate	Ø d	170			190			210			220			240		
Type 1362	Ø d *	128			148			159			176			188		
	e	65			70			80			85			95		
	e *	55			60			68			73			80		
Trumpet Length	mm	600			630			785			815			960		
Recess tube	Ø r	159.0			177.8			193.7			219.1			244.5		

DYWIDAG DYWIDAG-Systems International GmbH www.dywidag.com	DYWIDAG - PT external strand tendon **Plate Anchorage** Dimensions of components for 6812 - 6827	Annex 4 of European Technical Assessment ETA-13/0979

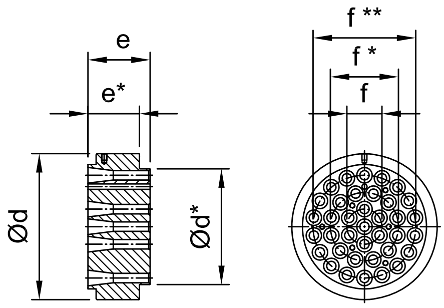


Anchor plate



Wedge plate

(f, f *, f **, f*** acc. to Annex 2)



Dimensions in mm

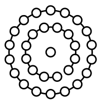
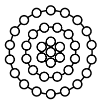
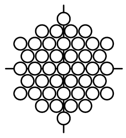
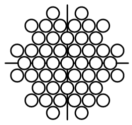
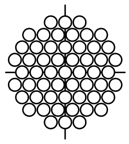
Tendon size		6831			6837			6843	6849	6855
No. of strands		31			37			43	49	55
Cone pattern and position										
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]		25	45	60	25	45	60	47	47	47
Anchor plate	Ø a	-	490	440	-	520	470	560	590	610
Type 2353/2354/2355	Ø b	234			234			262	277	277
	c	-	90	80	-	95	90	95	95	100
Wedge plate	Ø d	270			270			320	340	340
Type 1362	Ø d *	214			214			251	262	262
	e	100			115			130	140	140
	e *	80			95			110	120	120
Trumpet Length	mm	1105			1105			1495	1235	1235
Recess tube	Ø r	273.0			273.0			273.0	298.5	298.5

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Plate Anchorage

Dimensions of components for 6831 - 6855

Annex 5
of European Technical Assessment

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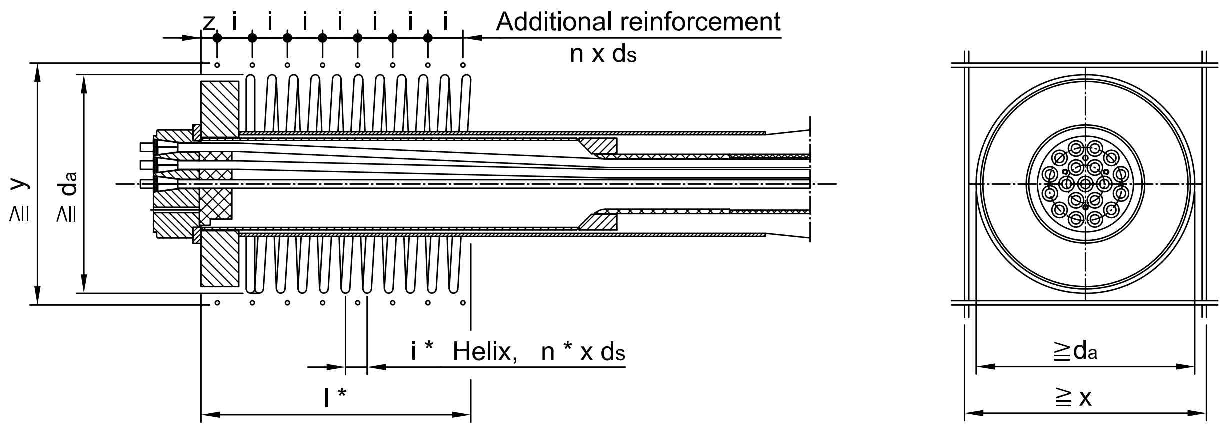

Dimensions in mm

For z the concrete cover has to be considered!

Tendon size	6803			6804			6805			6807			6809		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279.0kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265.5kN)														
No. of strands	03			04			05			07			09		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	45	60	25	45	60	25	45	60	25	45	60	25	45	60
Centre distance A	225	195	180	255	220	205	285	245	225	335	285	265	370	320	300
Edge distance R	0.5 x Centre distance + Concrete cover - 10mm														
Additional reinforcement (Material see Annex 18)															
No. n	–	–	4	–	–	6	–	–	5	–	–	6	–	–	5
Ø d_s	–	–	8	–	–	8	–	–	10	–	–	10	–	–	12
z	–	–	40	–	–	40	–	–	40	–	–	40	–	–	40
i	–	–	60	–	–	50	–	–	50	–	–	50	–	–	60
x / y	–	–	160	–	–	185	–	–	205	–	–	245	–	–	280
Helix (Material see Annex 18)															
Turns n *	6	5	–	6.5	6	–	7	6.5	–	8	7.5	–	10	8	–
Ø d_s	14	14	–	14	14	–	14	14	–	14	14	–	14	14	–
Ø d_a	175	150	–	200	165	–	235	200	–	285	240	–	320	270	–
i *	40	45	–	45	40	–	45	40	–	45	40	–	40	40	–
min l *	240	220	–	295	245	–	325	270	–	375	315	–	425	345	–

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Plate Anchorage

Centre and edge distances of tendon sizes 6803 - 6809 for strand Y1860S7 15.3 and 15.7 and for strand Y1770S7 15.3 and 15.7

Annex 6 of European Technical Assessment

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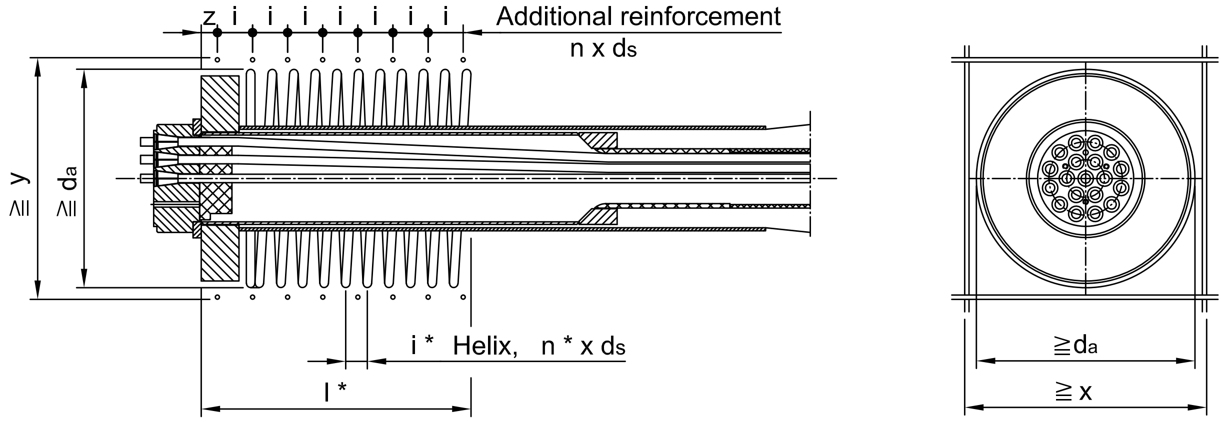

Dimensions in mm — For z the concrete cover has to be considered!

Tendon size	6812			6815			6819			6822			6827		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279.0kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265.5kN)														
No. of strands	12			15			19			22			27		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	45	60	25	45	60	25	45	60	25	45	60	25	45	60
Centre distance A	425	370	340	470	415	375	530	465	420	570	500	450	–	555	500
Edge distance R	0.5 x Centre distance + Concrete cover - 10mm														
Additional reinforcement (Material see Annex 18)															
No. n	–	–	7	–	–	8	–	–	8	–	–	9	–	10	10
Ø d_s	–	–	14	–	–	14	–	–	16	–	–	16	–	12	16
z	–	–	40	–	–	40	–	–	50	–	–	50	–	40	50
i	–	–	60	–	–	50	–	–	55	–	–	60	–	60	60
x / y	–	–	320	–	–	355	–	–	400	–	–	430	–	535	480
Helix (Material see Annex 18)															
Turns n *	10	8.5	–	9	8	–	9.5	9	–	10	10	9	–	11	9
Ø d_s	16	16	–	20	20	–	20	20	–	20	20	14	–	20	16
Ø d_a	370	315	–	420	360	–	475	405	–	520	450	370	–	495	425
i *	45	45	–	55	55	–	55	55	–	55	50	45	–	50	50
min l *	480	410	–	520	465	–	560	530	–	595	545	440	–	605	495

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Plate Anchorage

Centre and edge distances of tendon sizes 6812 - 6827
for strand Y1860S7 15.3 and 15.7 and
for strand Y1770S7 15.3 and 15.7

Annex 7
of European Technical Assessment

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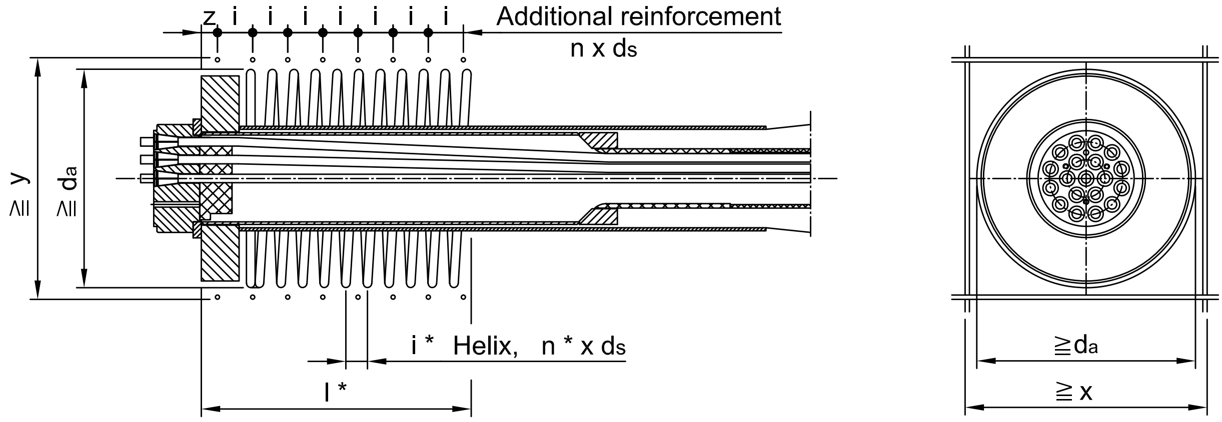

Dimensions in mm

For z the concrete cover has to be considered!

Tendon size	6831			6837			6843	6849	6855
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279.0kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265.5kN)								
No. of strands	31			37			43	49	55
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	45	60	25	45	60	47	47	47
Centre distance A	–	595	535	–	650	580	680	710	760
Edge distance R	0.5 x Centre distance + Concrete cover - 10mm								
Additional reinforcement (Material see Annex 18)									
No. n	–	11	11	–	11	10	13	12	13
Ø d s	–	14	16	–	16	16	16	20	20
z	–	40	50	–	50	50	50	60	60
i	–	60	50	–	60	60	50	50	60
x / y	–	575	515	–	630	560	660	690	740
Helix (Material see Annex 18)									
Turns n *	–	12	9.5	–	12.5	10	12.5	11	11
Ø d s	–	20	16	–	20	16	20	20	20
Ø d a	–	535	465	–	580	510	620	620	680
i *	–	45	50	–	45	50	45	55	60
min l *	–	605	525	–	635	560	632	665	720

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Plate Anchorage

Centre and edge distances of tendon sizes 6831 - 6855 for strand Y1860S7 15.3 and 15.7 and for strand Y1770S7 15.3 and 15.7

Annex 8 of European Technical Assessment

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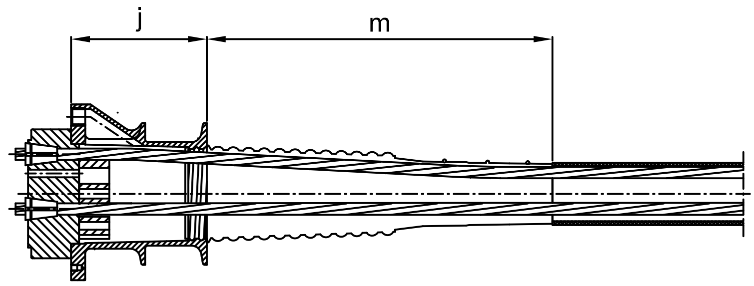
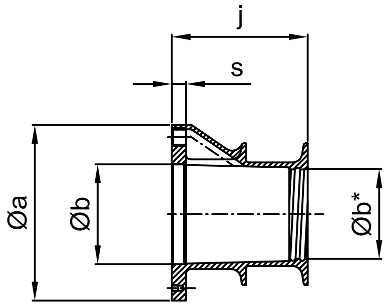
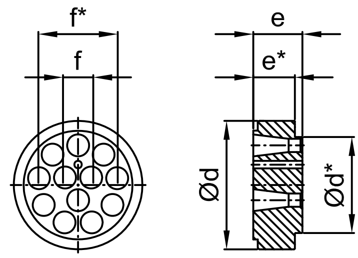


Anchor body MA

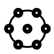
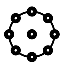
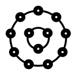
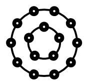
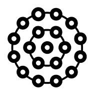
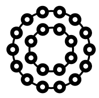


Wedge plate MA

(f, f* acc. to Annex 2)



Dimensions in mm

Tendon size		6805	6807	6809	6812	6815	6819	6822
No. of strands		05	07	09	12	15	19	22
Cone pattern and position								
Anchor body MA Type 2311	Ø a Ø b Ø b* j s	150 90 80 90 18	170 98 90 100 18	190 114 100 125 15	220 130 120 180 17	250 150 130 200 19	280 162 145 220 23	305 179 161 220 26.5
Wedge plate Type 1362	Ø d Ø d* e e*	117 88 55 47	130 96 60 52	145 112 60 52	170 128 65 55	190 148 70 60	210 159 80 68	220 176 85 73
Trumpet Length	mm	235	150	340	345	305	420	455

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Multiplane anchorage MA

Dimensions of components for 6805 - 6822

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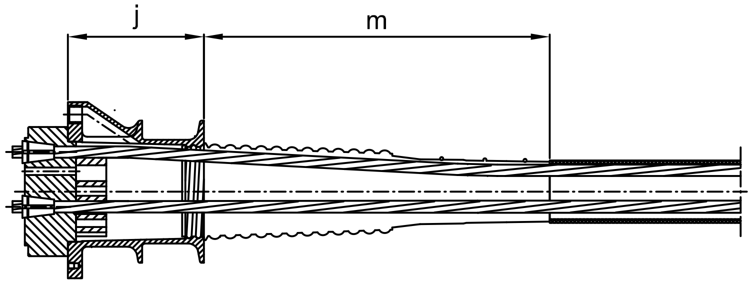
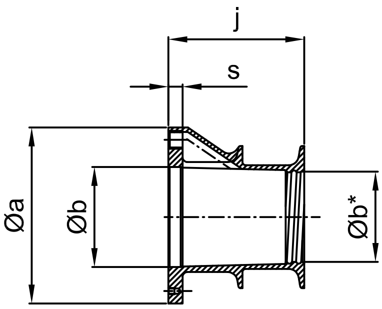
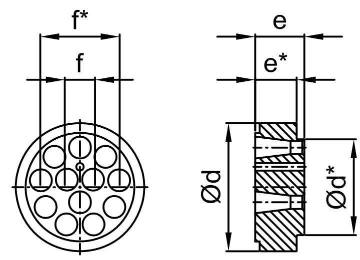


Anchor body MA

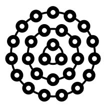
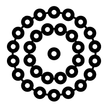
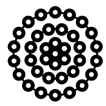
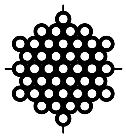
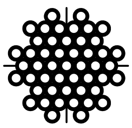
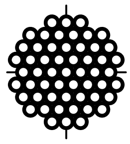


Wedge plate MA

(f, f*, f**, f*** acc. to Annex 2)



Dimensions in mm

Tendon size		6827	6831	6837	6843	6849	6855
No. of strands		27	31	37	43	49	55
Cone pattern and position							
Anchor body MA Type 2311	Ø a Ø b Ø b* j s	330 190 161 240 30	385 217 195 350 40	420 217 195 350 50	465 254 252 380 50	510 266 252 420 50	510 266 252 420 50
Wedge plate Type 1362	Ø d Ø d* e e*	240 188 95 80	270 214 100 80	270 214 115 95	320 251 130 95	340 262 140 110	340 262 140 120
Trumpet Length	mm	535	600	600	950	780	780

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Multiplane anchorage MA

Dimensions of components for 6827 - 6855

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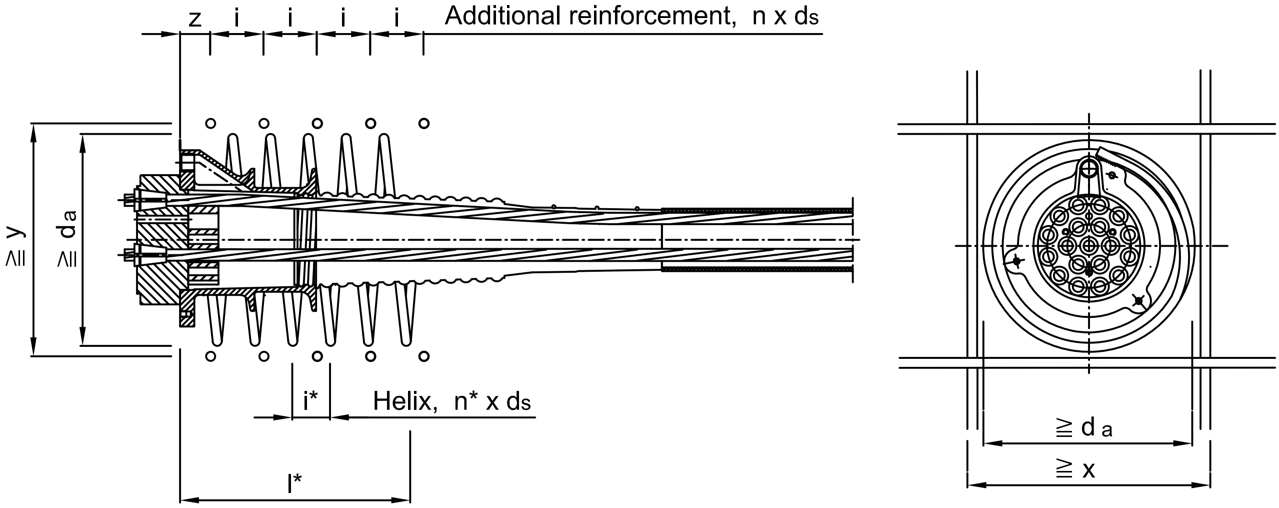

Dimensions in mm

Tendon size	6805			6807			6809			6812			6815		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265,5kN)														
No. of strands	05			07			09			12			15		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	34	45	25	34	45	25	34	45	25	34	45	25	34	45
Center distance A	275	240	220	325	280	250	345	305	270	400	350	310	450	390	350
Edge distance R	0.5 x Center distance + Concrete cover - 10 mm														
Additional reinforcement (Material see Annex 18)															
No. n	5	5	5	6	6	6	7	7	7	7	8	8	8	8	8
Ø d s	12	12	12	12	12	12	14	14	14	14	14	14	16	16	16
z	40	40	40	40	40	40	40	40	40	45	45	45	50	50	50
i	50	45	50	55	50	50	55	55	55	55	50	55	65	60	60
x/y	255	220	200	305	260	230	325	285	250	380	330	290	430	370	330
Helix (Material see Annex 18)															
Turns n*	4,5	4	4	4	4	4	5,5	5	5	6	7	7	8	8	7
Ø d s	12	12	12	14	14	14	14	14	14	14	14	14	16	14	14
Ø d a	205	185	180	240	220	200	270	250	220	320	265	255	345	310	285
i*	45	40	50	50	50	50	50	50	50	50	50	50	50	50	50
min l*	240	200	240	245	245	245	315	290	290	345	395	395	450	445	395

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Multiplane anchorage MA with Helix

Centre and edge distances of tendon sizes 6805 - 6815
for strand Y1860S7 15.3 and 15.7 and
for strand Y1770S7 15.3 and 15.7

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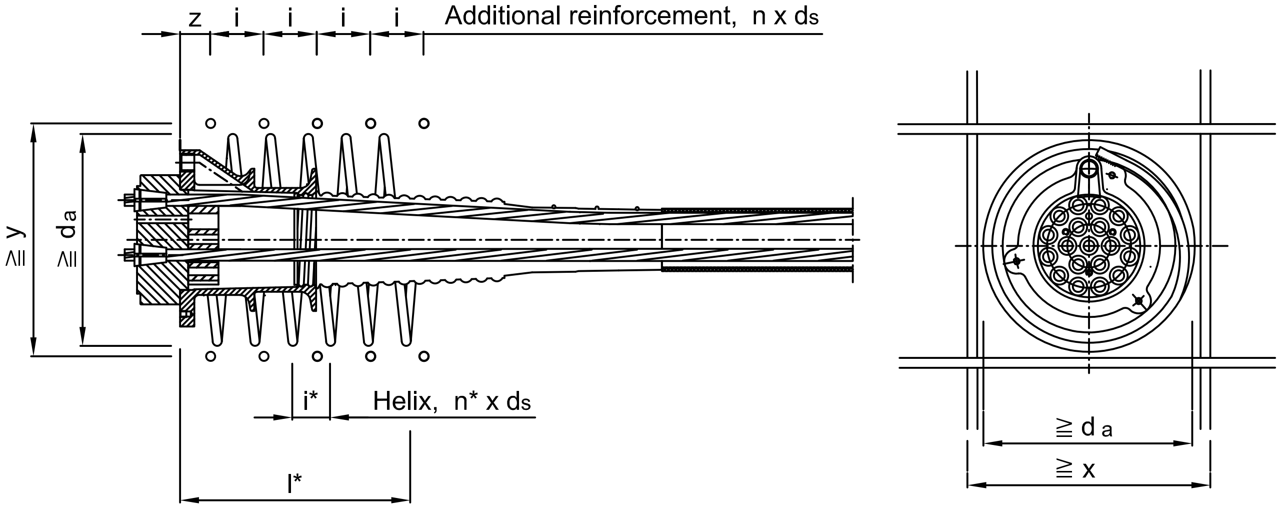

Dimensions in mm

Tendon size	6819			6822			6827			6831			6837		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265,5kN)														
No. of strands	19			22			27			31			37		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	25	34	45	25	34	45	25	34	45	34	45	52	34	45	52
Center distance A	505	435	385	545	470	415	605	525	465	640	570	540	700	630	600
Edge distance R	0.5 x Center distance + Concrete cover - 10 mm														
Additional reinforcement (Material see Annex 18)															
No. n	8	8	8	8	8	8	10	10	10	9	8	8	10	9	8
Ø d s	16	16	16	16	16	16	20	20	20	20	20	20	20	20	20
z	50	50	50	55	55	55	55	55	55	40	40	40	40	40	40
i	65	65	65	60	55	55	65	60	60	75	80	80	75	75	85
x/y	485	415	365	525	450	395	585	505	445	620	550	520	680	610	580
Helix (Material see Annex 18)															
Turns n*	8,5	8	7,5	9	8,5	8	10	9	8,5	10	9	8	11	9	8
Ø d s	16	16	16	16	16	16	16	16	16	20	20	20	20	20	20
Ø d a	420	375	310	465	370	340	510	430	370	560	500	480	620	550	520
i*	50	50	50	50	50	50	50	50	50	55	60	65	50	60	65
min l*	480	455	430	505	480	455	560	510	485	630	620	600	640	630	610

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Multiplane anchorage MA with Helix

Centre and edge distances of tendon sizes 6819 - 6837 for strand Y1860S7 15.3 and 15.7 and for strand Y1770S7 15.3 and 15.7

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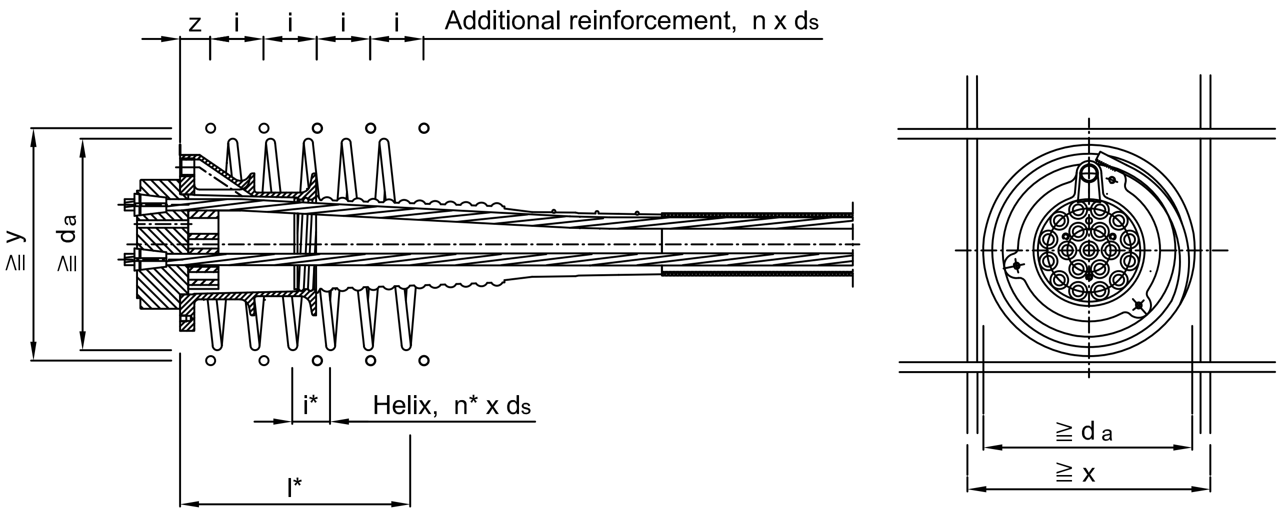

Dimensions in mm

Tendon size	6843	6849	6855
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265,5kN)		
No. of strands	43	49	55
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	53	53	53
Center distance A	640	680	710
Edge distance R	0.5 x Center distance + Concrete cover - 10 mm		
Additional reinforcement (Material see Annex 18)			
No. n	10	13	14
Ø d s	20	20	20
z	50	50	50
i	70	60	55
x/y	620	660	690
Helix (Material see Annex 18)			
Turns n*	10	10	11
Ø d s	20	20	20
Ø d a	530	550	580
i*	55	60	55
min l*	640	690	695

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Multiplane anchorage MA with Helix

Centre and edge distances of tendon sizes 6843 - 6855
for strand Y1860S7 15.3 and 15.7 and
for strand Y1770S7 15.3 and 15.7

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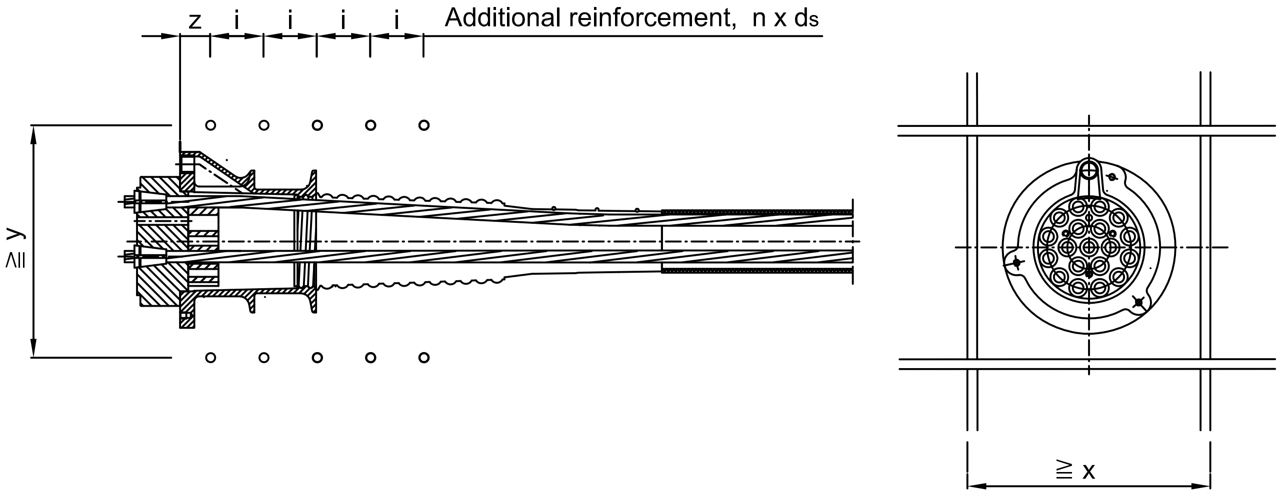

Dimensions in mm

Tendon size	6805			6807			6809			6812		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265,5kN)											
No. of strands	05			07			09			12		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	34	45	54	34	45	54	34	45	54	34	45	54
Center distance A	260	225	210	305	265	245	335	300	275	385	340	315
Edge distance R	0.5 x Center distance + Concrete cover - 10 mm											
Additional reinforcement (Material see Annex 18)												
No. n	5	5	5	6	5	6	6	6	6	8	8	7
Ø d_s	16	16	16	16	16	16	16	16	16	16	16	16
z	40	40	40	40	40	40	40	40	40	40	40	40
i	50	50	50	50	50	50	50	50	50	45	50	50
x/y[1]	240	205	175	280	235	195	305	260	225	320	295	260

[1] The distances x/y must be strictly adhered to.

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DYWIDAG - PT external strand tendon

Multiplane anchorage MA without Helix

Centre and edge distances of tendon sizes 6805 - 6812
for strand Y1860S7 15.3 and 15.7 and
for strand Y1770S7 15.3 and 15.7

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of European Technical Assessment

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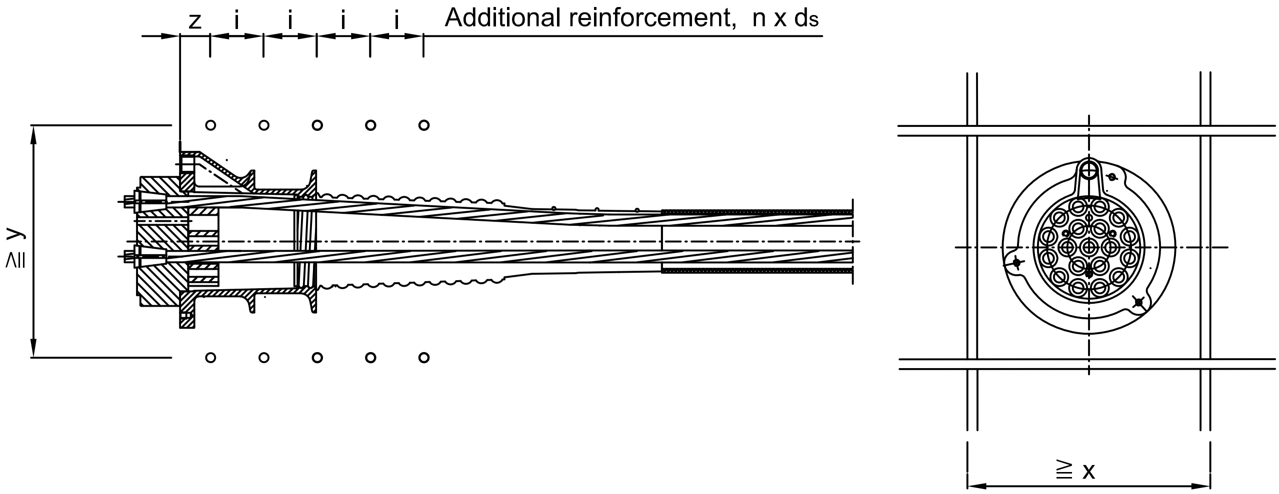

Dimensions in mm

Tendon size	6815			6819			6822		
Strand	150mm², f_{pk}=1860N/mm² (F_{pk}=279kN) and 150mm², f_{pk}=1770N/mm² (F_{pk}=265,5kN)								
No. of strands	15			19			22		
Minimum actual concrete strength at stressing $f_{cm,0,cube}$ [N/mm²]	34	45	54	34	45	54	34	45	54
Center distance A	430	380	350	480	420	390	515	450	415
Edge distance R	0.5 x Center distance + Concrete cover - 10 mm								
Additional reinforcement (Material see Annex 18)									
No. n	8	8	8	8	8	9	10	9	8
Ø d_s	20	16	16	20	20	20	20	20	20
z	40	40	40	40	40	40	40	40	40
i	55	50	45	55	55	50	50	50	50
x/y[1]	380	335	300	410	370	350	430	390	360

[1] The distances x/y must be strictly adhered to.

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Multiplane anchorage MA without Helix

Centre and edge distances of tendon sizes 6815 - 6822
for strand Y1860S7 15.3 and 15.7 and
for strand Y1770S7 15.3 and 15.7

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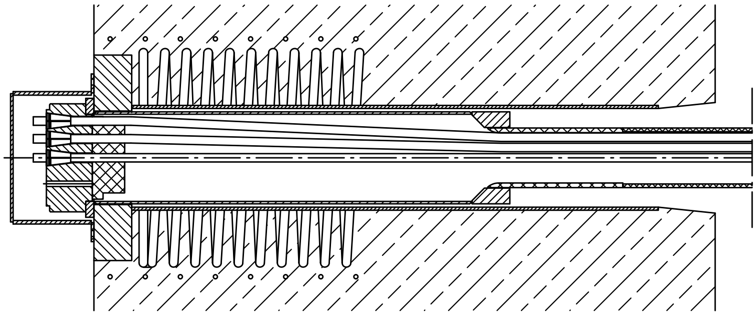
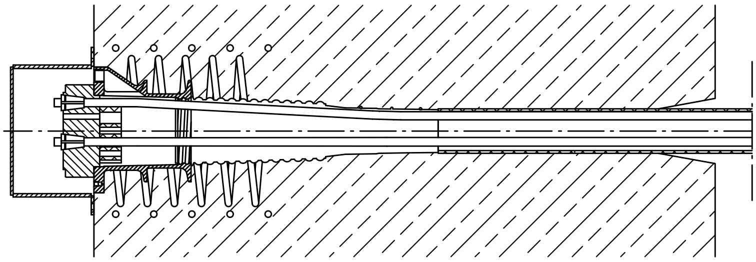
External application

Plate anchorage

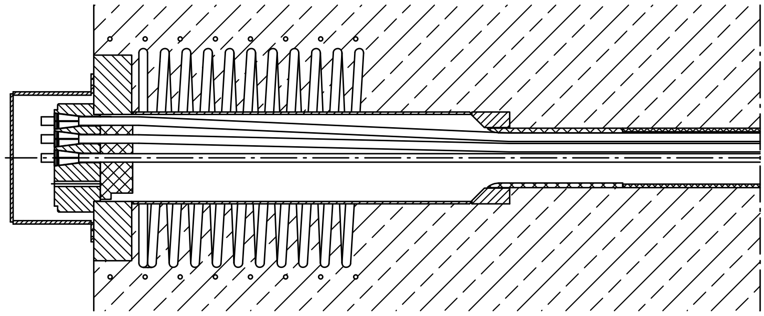


Multiplane anchorage MA

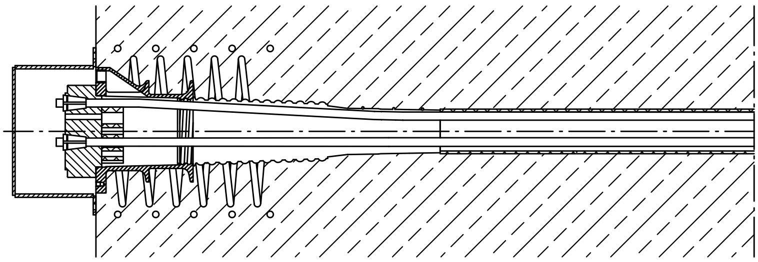


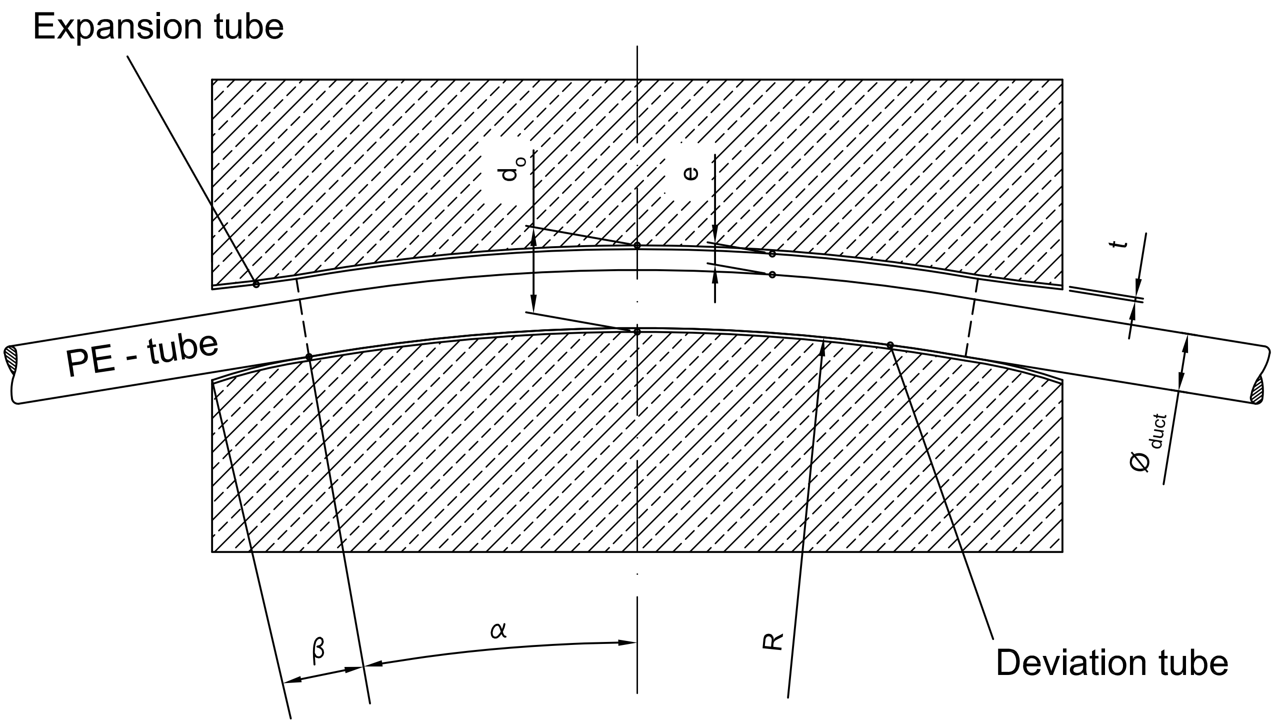
Internal application

Plate anchotage



Multiplane anchorage MA





α = Designed deviation angle
β = Deviation angle in reserve
β ≥ 3° at each end in all directions required, R ≥ R_{min}

Tendon size	6803	6804	6805	6807	6809	6812	6815	6819	6822	6827	6831	6837	6843	6849	6855
R_{min} * [m]	2.50	2.50	2.50	2.50	2.50	2.50	2.75	3.00	3.25	3.50	3.75	4.00	4.80	5.40	5.40
$ø_{duct}$ ** [mm]	50	50	63	75	75	90	110	110	125	125	140	140	160	160	180
d_o ** [mm]	70.0	70.0	82.5	95.0	95.0	108.0	133.0	133.0	152.4	152.4	168.3	168.3	193.7	193.7	219.1
t [mm]	3.6	3.6	3.6	3.6	3.6	3.6	4.0	4.0	4.5	4.5	5.0	5.0	5.4	5.4	5.9
e [mm]	12.8	12.8	12.3	12.8	12.8	10.8	15.0	15.0	18.4	18.4	18.3	18.3	22.9	22.9	27.3

* the minimum values of radius of curvature shall be respected, unless a national regulation is stricter

** minimum values

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Deviator - Geometrical requirements for circular steel tubes

Annex 17 of European Technical Assessment

ETA-13/0979

Designation	Material	Standard
Wedge	Case hardened steel *	EN 10277-2: 2018 EN 10083-2: 2006
Wedge plate	Quenched and tempered steel *	EN ISO 683-1: 2018
Anchor plate	Structural steel *	EN 10025-2: 2019
Multiplane anchor body Type MA	Cast ductile iron *	EN 1563: 2018 ASTM A536: 2019
Steel tube for anchor plate	Structural steel *	EN 10216-1: 2013 EN 10217-1: 2019
Spacer	Polyethylene (PE)	EN ISO 1872-1: 1999
Flange	Structural steel *	EN 10025-2: 2019
Steel tube for steel trumpet	Structural steel *	EN 10216-1: 2013 EN 10217-1: 2019
Tension ring	Structural steel *	EN 10025-2: 2019
PE - Insert	Polyethylene (PE)	EN ISO 1872-1: 1999
Retaining ring	Structural steel *	EN 10025-2: 2019
Helix	S 235 JR Reinf. steel $R_e \geqq 500$ MPa	EN 10025-2: 2019 EN 10080: 2005 **
Additional reinforcement	$R_e \geqq 500$ MPa	EN 10080: 2005 **
PE - Tube	Polyethylene (PE)	EN 12201-2: 2011
PE - Trumpet	Polyethylene (PE)	EN ISO 1872-1: 1999

* Exact material properties and definitions deposited at CEREMA.

** As long as EN 10080 does not exist harmonized, national standards shall be considered.

DIMENSIONS AND PROPERTIES OF 7-WIRE STRANDS

Designation	Symbol	Unit	Value	
Tensile strength	R_m/F_{pk}	MPa	1770 or 1860	
Strand				
Nominal diameter	D	mm	15.3	15.7
Nominal cross section	A_p	mm²	140	150
Nominal mass	M	g/m	1093	1172
Surface configuration	–	–	plain	
Force of Single Strand at 0.1 %				
Y 1770	$F_{p0.1k}$	kN	218	234
Y 1860	$F_{p0.1k}$	kN	229	246
Modulus of elasticity	E	MPa	~195 000	
Individual wires				
External wire diameter	d	mm	5.0 ± 0.04	5.2 ± 0.04
Core wire diameter	d'	mm	1.02 to 1.04 d	

As long as EN 10138 does not exist 7-wire strands in accordance with national provisions and with the characteristics given in the table above shall be used.

CONTENT OF CONTROL PLAN

Component	Item	Test/Check	Traceability [5]	Minimum frequency	Documentation
Anchor plate	material	check	bulk	100 %	"2.2" [1]
	detailed dimensions [6]	test		3 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
Cast-iron anchor body	material	check	full	100 %	"3.1" [2]
	detailed dimensions [6]	test		3 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
Wedge plate	material	check	full	100 %	"3.1" [2]
	detailed dimensions [6]	test		5 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
Steel trumpet	material	check	bulk	100 %	"2.1" [3]
	detailed dimensions [6]	test		3 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
PE-insert	material	check	bulk	100 %	"2.1" [3]
	detailed dimensions [6]	test		3 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
Wedge	material	check	full	100 %	"3.1" [2]
	treatment, hardness	test		0.5 % ≥ 2 specimens	yes
	detailed dimensions [6]	test		5 % ≥ 2 specimens	yes
	visual inspection [4]	check		100 %	no
Sheathing	material	check	"CE"	100 %	"CE"
	visual inspection [4]	check		100 %	no

Continuation of Control Plan and footnotes see Annex 20b

CONTENT OF CONTROL PLAN - CONTINUED -

Component	Item	Test/Check	Traceability [5]	Minimum frequency	Documentation
Tensile element strand	material [7]	check	full	100 %	yes
	diameter	test		each coil/bundle	no
	visual inspection [4]	check		each coil/bundle	no
Helix	material	check	full	100 %	yes
	visual inspection [4]	check		100 %	no
Stirrups	material	check	full	100 %	yes
	visual inspection [4]	check		100 %	no
Constituents of filling material as per EN 447	cement	check	full	100 %	yes
	admixtures, additives	check	full	100 %	yes
Wax	material [8]	check	full	100 %	”2.2“ [1]

All samples shall be randomly selected and clearly identified.

1 ”2.2“: Test report type ”2.2“, according to EN 10204
2 ”3.1“: Inspection certificate type ”3.1“, according to EN 10204
3 ”2.1“: Declaration of compliance with the order type ”2.1“, according to EN 10204
4 Visual inspection means e.g.: Main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, coating, etc., as given in the Inspection sheet
5 Full: Full traceability of each component to its raw material
Bulk: Traceability of each delivery of components to a defined point
6 Detailed dimensions means measuring of all dimensions and angles according to the specification as given in the Inspection sheet
7 Characteristic material properties see Annex 18
8 Characteristic material properties shall comply with EAD 160027-00-0301, Clauses 2.2.13 to 2.2.26.

Component	Item	Test/Check [1]	Sampling – Number of components per audit
Wedge plate	material according to specification	check, test	1
	detailed dimensions	test	
	visual inspection [2]	check	
Cast-iron anchor body	material according to specification	check, test	1
	detailed dimensions	test	
	visual inspection [2]	check	
Wedge	material according to specification	check, test	2
	treatment	test	2
	detailed dimensions	test	1
	main dimensions, surface hardness	test	5
	visual inspection [2]	check	5
Single tensile element test	EAD 160004-00-0301, Annex C, Clause C.7	test	1 series
Inclined Tube test	EAD 160027-00-0301, Clause 2.2.27	test	1 test

1 All samples shall be randomly selected and clearly identified.

2 Visual inspection means e.g.: main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, coating, etc., as given in the inspection sheet.

1 Manufacture

The setup of the DYWIDAG external strand post-tensioning tendon with deviations can be manufactured in structure itself. At pushing of the strands and during stressing the sheathing should be fixed against movement.
In case of straight tendons partly prefabrication is possible. In this case the sheathing with the trumpet of one anchorage can be preassembled in shop or on site. If also the strands are preassembled then they must be prewedged and secured with a wedge keeper plate during transport. For the proper diameter of coil during transport must be considered.

2 Strands used

The strands made of high-strength prestressing steel composing the tendons are defined in the draft European Standard “prEN 10138-3: Prestressing steels – Part 3: Strand” or in national approvals.
The primary characteristics are given in **Annex 19**.

3 Sheathing

The sheathing is assembled from PE-tubes as characterized in **Annexes 1 and 2**. The sheathing produced must be mechanically resistant, continuous in shape, ensure continuity of the seal, and UV-resistant, if required in the project’s specification.
The fitting between the sheathing segments is produced by means of mirror welding or electro-welding couplers. The sheathing can be prefabricated to its complete length or manufactured in the structure.

Plate anchorage:
The sheathing is connected to the PE-insert (or its proper extension) of the anchorage by means of mirror welding or electro-welding coupler.

Multiplane anchorage MA:
The sheathing is connected to the PE-trumpet of the anchorage by means of mirror welding.

To compensate differences between the planned and the actual length of a tendon and to compensate unexpected or not avoidable sliding of the sheathing when stressing the tendon at least one telescopic tube should be assembled along the free length near to the stressing anchorage.

4 Inlets, bleed vents and outlets

Grouting with cement grout presupposes the possibility of intervening along the tendon path in order to adjust the filling and bleed any air, water, etc. that may be within the sheathing. In this aim, accessories (electro-welding collars or welded pipes) for reinjection, venting and bleeding are installed in proper positions on the sheathing. In case of wax injection proper accessories as inlets and for venting shall be applied at proper positions.
In case of an injection or vent tube in the region of a deviator this required space has to be considered when planning/dimensioning and manufacturing the deviators, for example made of prebent steel tubes.

5 Anchorages

Anchorages depending on the tendon sizes are identical for both strand steel grades.

The plate anchorage consists of

- anchor plate with a steel recess tube welded watertight on it,
- steel trumpet, consisting of a steel flange, a steel tube and a steel tension ring welded to its two opposite ends and a PE-insert fixed to the tension ring with a retaining ring through a gasket and screws. If necessary, a piece of PE-sheathing of proper length is mirror-welded to the PE-insert in order to overhang the concrete member backside the anchorage and make a connection with the ordinary sheathing possible,
- spacer within the steel trumpet which puts the strands in order and guarantees a proper fatigue strength and improves the wedge plate placing,
- wedge plate,
- wedges, each consisting of three segments.

The anchor plate can be concrete-encased or placed onto the structure whereas the continuous and uniform support of the anchor plate must be guaranteed.

The multiplane anchorage MA consists of

- concrete-encased cast-iron anchor body,
- PE-trumpet with a piece of PE-sheathing of proper length mirror-welded to it in order to overhang the concrete member backside the anchorage and make a connection with the ordinary sheathing possible,
- spacer within the PE-trumpet which puts the strands in order and guarantees a proper fatigue strength and improves the wedge plate placing,
- wedge plate,
- wedges, each consisting of three segments.

These two types of anchorage can likewise be used as stressing and accessible fixed (passive) anchorage – and with a wedge keeper plate as not accessible. The wedges of the embedded passive anchorage have to be sealed.
Stressing anchorages can be restressed. In order to unload the tendon before grouting and to restress after grouting, shims divided into two halves shall be positioned between flange and anchor plate. Altogether four sets of shims can be applied at one anchorage. The cuts between the two half-shims shall be staggered by turning 90°.
The bursting forces caused by the prestressing force transfer to the concrete member shall be carried by a helix made of plain steel wire or reinforcement steel. Additional reinforcement such as straight bars or stirrups is also required

In any case the tendon layout in the back of the anchorage shall be straight at least as long as mentioned in **Table 1.3.5.2** and **Table 1.3.5.3**. If the steel trumpet with PE-insert and onwelded first part of PE-sheathing is installed before concreting of the structure then even a part of the onwelded piece of PE-sheathing can be curved, whereas the required straight part according to **Table 1.3.5.2** and **Table 1.3.5.3** and the minimum admissible radius of curvature according to **Table 1.3.5.4** shall be obeyed. The requirements of mirror-welding shall be considered. Important is that the curved parts of the PE-sheathing must be completely and properly supported by the concrete structure and the deviation tube in the anchorage zone in order to minimize the bending action effects in the sheathing!

6 Wedges

The wedges are manufactured of alloyed steel for cementation then saw cut into three parts and then treated. Three segments are attached by means of a retaining ring. The dimensions of wedges can be found in **Annex 2**.

7 Deviators

Normally, deviators are made of smooth steel tubes bent in the planned form. Other deviation saddle designs like a curved concrete surface are also possible as long as the limits of geometry according to **Table 1.3.5.1** and **Annex 17** are obeyed.

8 Protective caps

In order to enable grouting/injection corrosion protective compound and for final protection of the anchorage a permanent metallic cap fixed onto the anchor plate shall be used. The length of the cap shall be determined depending on, whether the tendon is restressable or not.

9 Stressing

A hydraulic pump unit and a centre hole jack are used for stressing the prestressing steel. During stressing all pertinent safety rules and recommendations must be fully known and obeyed. The force targets along with the corresponding values of elongation; moreover, tolerances must be known. Furthermore, the order in which the post-tensioning tendons are to be stressed must be specified. The required/specified strength of concrete of both the structure and anchorage zone undergoing stressing must be verified.

The strands pass through the jack and are anchored in the tension disk with clamping jaws. All strands of a tendon are stressed simultaneously. Strands of straight tendons can be stressed one-by-one with monojacks.

The prestressing force is checked with the aid of a pressure gauge. Furthermore, the elongation of the prestressing steel serves as control of the prestressing force. Long tendons for which the jack stroke is insufficient can be stressed in stages.

Stressing in load steps and resetting of the jack is easily done. At stressing, a wedge slip according to **Table 1.4.2.1** remains after wedge seating procedure with or without power seating device.

10 Grouting with cement mortar

After stressing cement grout can be injected – if specified by the designer – into the void between prestressing steel and sheathing thus serving as corrosion protection of the strands.

Before grouting it shall be controlled that the stressed tendon does not kink at the ends of the deviations.

The grout is injected through the properly placed grout inlets (mostly at the deepest points of the sheathing).

The sheathing is vented at the ends of the tendon by means of venting pipes or grouting caps.

Intermediate venting points at high points are necessary in case of long tendons.

The DSI grouting equipment is composed of mixer and pump. For some applications, vacuum pumps that allows for certain rate of depressurisation inside the sheathing, hence facilitating progression of the grouting (vacuum supported grouting).

Grouting shall be executed in accordance with EN 445, EN 446 and EN 447 and national regulations, if applicable. The climatic conditions and temperature of the structure must satisfy use conditions of the injection product.

In case of restressable tendons the strands projecting ends in the cap shall be covered just after grout has been set the grout shall be removed between and on the projecting ends of the strands and singular tubes filled with corrosion protecting compound shall be slid on. Before the surfaces of wedge plate and wedges shall be covered with corrosion protective tape. The ends of the tubes shall be tightened at the wedge plate with tape. The wedge plate shall be covered with tape. At the other end of the singular tubes these shall be closed with small caps.

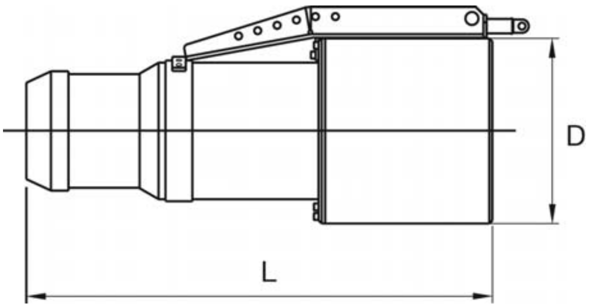
Just after grouting the completeness of the filling grade shall be controlled with strokes of a hammer.

11 Injection

Injection products with a wax base as defined in Clauses 2.2.13 to 2.2.26 of the EAD 160027-00-0301 shall be used.

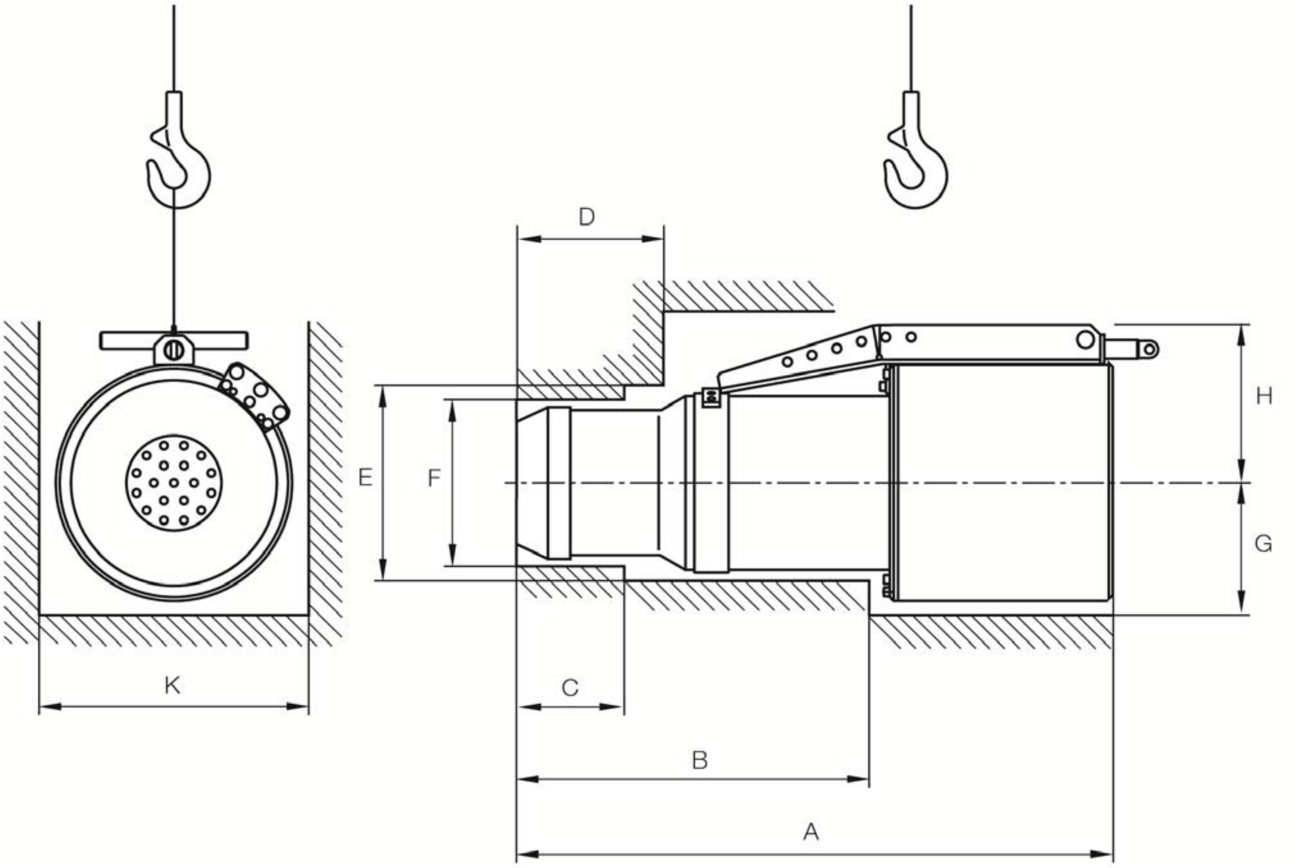
Before and during injection the relevant prescriptions and requirements of DSI must be obeyed.

Jack type	Usage of jacks for tendons 68 ..																			
	01	02	03	04	05	06	07	08	09	10	12	15	19	22	27	31	37	43	49	55
SM 240	●																			
HoZ 950/100		●	●	●																
HoZ 1700/150					●	●	●													
HoZ 3000/250								●	●	●	●									
HoZ 5400/250												●	●	●						
6800														●	●					
9750																●	●			
15000																		●	●	●



Jack type [1]	Length L [mm]	Diameter D [mm]	Stroke [mm]	Piston area [cm²]	Capacity [2] [kN]	Weight [kg]
SM 240	842	98	200	47.13	240	19
HoZ 950/100	621	203	100	161.98	972	65
HoZ 1700/150	803	280	150	298.45	1745	160
HoZ 3000/250	1137	385	250	508.94	3054	400
HoZ 5400/250	1271	482	250	894.57	5367	600
6800	1150	560	300	1237.01	6803	1185
9750	1170	680	300	1772.45	9748	1770
15000	1610	980	500	2695.29	15632	5500

1 Power seating incl.
2 Without friction



BLOCK-OUT-DIMENSIONS [mm]

Jack type	A	B	C	D	E	F	G	H	K	L [2]
SM 240	880 [1]	370	-	80	100	75	50	120	100	230/270
HoZ 950/100	621	350	150	-	220	200	130	190	260	300/400
HoZ 1700/150	803	490	180	-	270	230	170	220	340	450/600
HoZ 3000/250	1130	650	220	300	360	320	220	310	440	350/600
HoZ 5400/250	1235	740	220	300	420	360	270	320	540	450/800
6800	1421 [1]	-	80	-	-	330	310	410	620	- /1200
9750	1470 [1]	-	120	-	-	380	390	550	740	- /1200
15000	2190 [1]	-	100	-	-	560	520	765	1040	- /1700

1 Stroke incl.
2 Neccessary Strand protrusion (without/with power seating device)

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