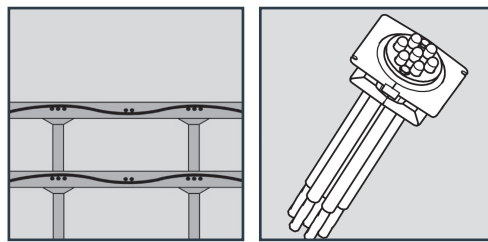


European Technical Assessment Post-Tensioning Systems

DYWIDAG SYSTEMS



**DSI monostrand prestressing
system L1-L7 with cast iron
anchors**

**Unbonded post-tensioning kits for
prestressing of structures with 1 to 7
monostrands**

ETA-19/0077

09. April 2019



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European Technical Assessment

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

DSI monostrand prestressing system L1–L7 with cast iron anchors

Product family to which the construction product belongs

Unbonded post-tensioning kits for prestressing of structures with 1 to 7 monostrands

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This European Technical Assessment contains

39 pages including Annexes 1 to 16, which form an integral part of this assessment.

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Remarks

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Specific parts

1 Technical description of the product

1.1 General

The European Technical Assessment – ETA – applies to a kit, the unbonded PT system

DSI monostrand prestressing system L1–L7 with cast iron anchors,

comprising the following components.

– Tendon

Unbonded tendon with 1 to 7 monostrands as tensile elements

– Tensile element

7-wire prestressing steel strand with nominal diameter and nominal tensile strengths as given in Table 1, factory provided with a corrosion protection system comprising a corrosion protection filling material and a PE-sheathing – Monostrand

Table 1 Tensile elements

| Nominal diameter of prestressing steel strand | | Designation according to prEN 10138-3 ¹ | Nominal tensile strength |
|---|------|--|--------------------------|
| mm | inch | — | N/mm ² |
| 15.7 | 0.62 | Y1770S7 | 1 770 |
| 15.7 | 0.62 | Y1860S7 | 1 860 |

NOTE 1 N/mm² = 1 MPa

– Anchorage and coupling

The Monostrands are anchored by 3-piece wedges.

Stressing (active) and fixed (passive) anchor with wedges and anchor body SKM, SFM, or MGS for a tendon with $n = 1$ to 7 monostrands

Fixed coupling FKM with wedges, anchor body SKM, coupling head FKM, coupling sleeve FKM, and ancillary components for one single monostrand

Movable coupling BK with wedges, coupling heads BK, coupling sleeve BK, and ancillary components for one single monostrand

¹ Standards and other documents referred to in the European Technical Assessment are listed in Annex 16.

- Additional reinforcement in the anchorage zone for anchorage and fixed coupling
- Permanent corrosion protection system for tensile elements, anchorages, and couplings

PT system

1.2 Designation and range of anchorages and couplings

1.2.1 Designation

The designation of anchorage or coupling is by its function in the structure and the number of monostrands. The first number indicates the nominal diameter of the prestressing steel strand, "68" = 15.7 mm (0.62"), followed by the maximum number of monostrands per unit "n", 68 0n. E.g. 6807 as the designation for an anchorage with maximum 7 monostrands. Function within the structure is expressed as follows.

- SFM as fixed anchor for one single monostrand
- SKM as stressing anchor for one single monostrand
- MGF as fixed anchor for 2 to 7 monostrands
- MGS as stressing anchor for 2 to 7 monostrands
- FKM as fixed coupling for one single monostrand
- BK as movable coupling for one single monostrand

The available anchorages and couplings are shown in Annex 1.

1.2.2 Anchorage and coupling

1.2.2.1 General

The prestressing steel strands are anchored with ring wedges in conical holes of cast iron anchor bodies or steel coupling heads, see Annex 3, Annex 4, Annex 5, Annex 6, and Annex 10. The same principle of anchoring the prestressing steel strands applies to all sizes of anchorages and all couplings.

1.2.2.2 Stressing and fixed anchor

Stressing and fixed anchor comprise 1-piece cast iron anchor body with 3-piece wedges and PE-sleeves or transition tubes, see Annex 3, Annex 4, and Annex 10. The cast iron anchor body serves for both, anchoring the prestressing steel strands and load transfer to the structural concrete via two load transfer planes.

The PE-sleeve or transition tubes are attached to the anchor body and the prestressing steel strands are threaded into the anchor body through the PE-sleeve or transition tubes. An overlap between monostrand sheathing and PE-sleeve or transition tube is observed and the joint monostrand to PE-sleeve or transition tube is sealed with adhesive tape or sealing sleeve, see Annex 3 and Annex 4. After inserting the wedge, the anchor body is filled with corrosion protection filling material.

The fixed anchor can be assembled either on the construction site same as the stressing anchor or preassembled with the monostrand in the factory. For fixed anchor

- SFM for one single monostrand, with washer, compression spring, and protective cap attached to secure the wedge seating, see Annex 3.
- MGF for 2 to 7 monostrands, with PE-caps placed over the ends of the prestressing steel strands and locking plate with gasket attached to secure the wedges, see Annex 4.

Fixed anchors do not require access during stressing and can be embedded in concrete, observing a cover of concrete on the caps of at least 20 mm.

For stressing anchors, once stressing is completed, the prestressing steel strands are cut, the anchor bodies filled with corrosion protection filling material and on anchor body

- SKM for one single monostrand a protective cap is screwed in, see Annex 3 and Annex 10.
- MGS for 2 to 7 monostrands PE-caps are placed over the ends of the prestressing steel strands and locking plate with gasket is attached, see Annex 4 and Annex 10.

The additional reinforcement is placed and secured exactly centrally with regard to the anchor body, see Annex 7 and Annex 8.

1.2.2.3 Centre and edge distances of anchorages, concrete cover

The minimum centre and edge distances of tendon anchorages and the actual mean compressive strength of concrete at time of stressing, $f_{cm,0}$, are given in Annex 7 and Annex 8. However, centre and edge distances of anchorages may be reduced in one direction by up to 15 %, but not smaller than the outer dimensions of the anchor body and placing of additional reinforcement remains still possible. 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.

Under no circumstances concrete cover of the tendon falls below 20 mm nor below the concrete cover of the reinforcement installed in the same cross section. At the anchorage a concrete cover of at least 20 mm remains on the caps. Standards and regulations on concrete cover in force in the place of use are observed.

1.2.2.4 Strength of concrete

Concrete according to EN 206 is used.

At the time of transmission of the full prestressing force to the concrete structure the actual mean compressive strength of concrete, $f_{cm,0,cube}$ or $f_{cm,0,cyl}$, is at least as given in Annex 7 and Annex 8, see Table 2. The actual mean compressive strength 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 value of the 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.

Table 2 Compressive strength of concrete

| Concrete compressive strength | | Compressive strength in N/mm ² | | | |
|-------------------------------|-----------------|---|----|----|----|
| Cube, 150 mm | $f_{cm,0,cube}$ | 23 | 27 | 30 | 35 |
| Cylinder, Ø 150 mm | $f_{cm,0,cyl}$ | 19 | 22 | 25 | 28 |

1.2.2.5 Reinforcement in the anchorage zone

Grade and dimensions of the additional reinforcement, are given in Annex 7, Annex 8, and Annex 12. Additional reinforcement is of closed stirrups or properly anchored orthogonal reinforcement. The reinforcement of the structure is not employed as additional reinforcement. Reinforcement exceeding the required reinforcement of the structure may be used as additional reinforcement if appropriate placing is possible.

If required for a specific project design, the reinforcement given in Annex 7 and Annex 8 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.

1.2.2.6 Fixed coupling

The fixed coupling FKM is for one single monostrand only. It comprises stressing anchor SKM, coupling sleeve FKM, coupling head FKM, compression spring, washer, wedges, and PE sleeves.

The fixed coupling FKM connects a second tendon, second construction stage, with a first tendon previously stressed on stressing anchor SKM, first construction stage.

Coupling is achieved by the coupling sleeve FKM that is screwed into the anchor body SKM of the previously stressed tendon. The coupling head FKM of the second tendon is screwed onto the coupling sleeve FKM. For details regarding the fixed coupling FKM see Annex 5.

1.2.2.7 Movable coupling

The movable coupling BK is for one single monostrand only. It comprises two coupling heads BK that are connected with a coupling sleeve BK, wedges, compression springs and washers.

The movable coupling BK connects two tendons prior to stressing.

Coupling is achieved by the coupling sleeve BK that is screwed into both coupling heads BK. For details regarding the movable coupling BK, see Annex 6.

1.3 Designation and range of tendons

1.3.1 Designation

The tendon designation is by nominal diameter and number of the monostrands. The first number indicates the nominal diameter of the prestressing steel strand, "68" = 15.7 mm (0.62"), followed by the number of monostrands "n", 68 0n, e.g. 6807 for a tendon with 7 monostrands.

1.3.2 Range of tendons

The PT system includes tendons with 1, 2, 3, 4, 5, 6, and 7 monostrands according to Clause 1.1 and Annex 11. The monostrands of each tendon are anchored in stressing and fixed anchors according to Clause 1.1.

Characteristic values of maximum force of the tendons are listed in Annex 11.

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 9 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 jack can be measured to an accuracy of $\pm 5\%$ of the final value of the prestressing force.

Where

A_p mm² Nominal cross-sectional area of prestressing steel, i.e. $A_p = n \cdot S_0$

$f_{p0.1}$ N/mm² 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 7

S_0 mm² Nominal cross-sectional area of one single prestressing steel strand, see Annex 11

$F_{p0.1}$ kN Characteristic value of 0.1 % proof force, see Annex 11

1.4 Slip at anchorages and couplings

Slip at anchorages and couplings is taken into consideration in design and for determining tendon elongation. In Table 3 the slip, taken into account for determining elongation during stressing and of the prestressing force, and the required locking measures of wedges are specified. While the slip at the fixed anchor is considered for calculation of elongation only, the slip at the stressing end

occurs at force transfer from jack to anchorage and is considered for calculation of the prestressing force.

Table 3 Slip values and locking of wedges

| Anchorage, coupling | | Slip | Locking measures |
|------------------------------------|-----------------------|------|--|
| — | | mm | — |
| Stressing anchor ^{1), 2)} | SKM | 6 | — |
| | MGS | 6 | — |
| Fixed anchor | SFM | 6 | Protective cap, compression spring, and washer |
| | MGF | 6 | Gasket and locking plate |
| Fixed coupling | SKM ^{1), 2)} | 6 | — |
| | FKM | 5 | Washer and compression spring |
| Movable coupling | BK | 10 | Washers and compression springs |

NOTE

¹⁾ Slip at transfer of prestressing force from jack to anchorage.

²⁾ Slip is 3 mm with power-seating of ~ 20 kN per strand

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 along a tendon Coulomb's friction law applies. Due to corrosion protection filling material and PE sheathing of the monostrand friction is very low. The calculation of friction losses is carried out by the equation

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

Where

P_xkNPrestressing force at distance x along the tendon

P_0kNPrestressing force at the distance $x = 0$ m

μ rad^{-1} Friction coefficient, $\mu = 0.06 \text{ rad}^{-1}$

α rad.....Sum of the angular deviations over a distance x , irrespective of their direction or sign

k rad/mWobble coefficient, $k = 0.9 \cdot 10^{-2} \text{ rad/m} (= 0.5 \text{ }^\circ/\text{m})$

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

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

1.6 Support of monostrands

The monostrands are installed with high accuracy and are secured in their position. Spacing of tendon support is

- 1 Normally ≤ 1.00 m

For radius of curvature in normal cases see Clause 1.7.

- 2 Free tendon layout, see Annex 13, in maximum 450 mm thick slabs

In the transition zone between

- a) high tendon position and anchorage (e.g. cantilever) ≤ 1.50 m

- b) low and high tendon position or low tendon position and anchorage ≤ 3.00 m

At high and low tendon position, the tendons are connected in an appropriate way to the rebar mesh, at least at two points with spacing of 0.3 m to 1.0 m. The rebar mesh is fastened in its position. Special spacers for tendons are therefore not required. For details see Annex 13.

1.7 Radii of curvature of internal tendons

The minimum allowable radius of curvature for internal tendons with prestressing steel strands of nominal diameter of 15.7 mm is 2.5 m. If this radius is adhered to, verification of prestressing steel outer fibre stresses in curvatures is not required. The minimum allowable radius of curvature for deviation of a tendon with multistrand anchorages in the anchorage zone outside PE-sleeve or PE-transition tube is 3.5 m.

Components

1.8 Monostrand

1.8.1 Specification of prestressing steel strand

7-wire prestressing steel strands with plain surfaces of the individual wires, a nominal diameter of 15.7 mm, and tensile strengths of 1 770 N/mm² or 1 860 N/mm² are used. Dimensions and specifications of the prestressing steel strands are according to prEN 10138-3 and are given in Clause 1.1, Table 1, Table 4, and Annex 11.

1.8.2 Specification of monostrand

The monostrands are 7-wire prestressing steel strands according to Clause 1.8.1, factory provided with a corrosion protection system comprising corrosion protection filling material and PE-sheathing, see Table 4.

Table 4 Monostrand

| | | | |
|---|-------------------|-----------------------|-----------------------|
| 7-wire prestressing steel strand | — | Y1770S7 ¹⁾ | Y1860S7 ¹⁾ |
| Nominal diameter of prestressing steel strand | mm | 15.7 ²⁾ | 15.7 ²⁾ |
| Nominal cross-sectional area | mm ² | 150 | 150 |
| Characteristic tensile strength | N/mm ² | 1 770 | 1 860 |
| Mass of prestressing steel | kg/m | 1.17 | 1.17 |
| Monostrand | | | |
| External diameter of monostrand | mm | ≥ 20 | ≥ 20 |
| Mass of monostrand | kg/m | 1.30 | 1.30 |

¹⁾ Designation according to prEN 10138-3

²⁾ Corresponding to 0.62 inches

In the course of preparing the European Technical Assessment no characteristic has been assessed for the monostrand. In execution, a suitable monostrand that conforms to Annex 11 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 coupling components are given in the Annexes and the technical file² of the European Technical Assessment. Therein the components' dimensions, materials, material identification data with tolerances and the materials used in corrosion protection are specified.

1.9.2 Anchor body

The anchor body is made of cast iron and provides holes for anchoring the prestressing steel strands, see Annex 2 and Annex 10. At one end the holes are conical to accommodate prestressing steel strands and wedges. The anchor body is employed as stressing and fixed anchor.

All conical holes are countersunk and deburred. See Annex 10 for details on the conical holes. For installation the holes and cones are clean and free of damage or rust and are provided with corrosion protection oil.

1.9.3 Wedge

The PT-system includes two wedges that are in three pieces, 68 00 0037 and 68 00 0040, see Annex 10.

- Wedge 68 00 0037 is for fixed coupling FKM, 2nd construction stage, and for movable coupling BK. Coupling head FKM and coupling unit BK are delivered with preassembled wedges to the construction site.
- Wedge 68 00 0040 is for fixed and stressing anchors SFM, SKM, MGF, and MGS, and for the 1st construction stage of the fixed coupling FKM.

1.9.4 PE-sleeve and transition tube

PE-sleeve and transition tube are of HD PE, see Annex 10.

- The PE-sleeve is screwed on the anchor body SKM and the coupling head FKM.
- The transition tube is inserted into the anchor body MGS.

PE-sleeve and transition tube overlap the monostrand at anchorage and fixed coupling to facilitate the transition monostrand to anchorage.

1.9.5 Coupling head

The coupling heads FKM and BK are in steel, see Annex 5 and Annex 6. Conical bores are provided to accommodate prestressing steel strand and wedge. At one end of the coupling head there is a cylindrical extension with an internal thread to screw onto the coupling sleeve.

All conical and cylindrical bores are countersunk and deburred. See Annex 10 for details on the conical bores. For installation the bores and cones are clean and free of damage or rust and are provided with corrosion protection oil.

² The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

1.9.6 Coupling sleeve

The coupling sleeves FKM and BK are in steel, see Annex 5 and Annex 6. The coupling sleeves are cylindrical parts with a centre bore and an external thread. They are screwed into

- Stressing anchor SKM and coupling head FKM to establish the connection at the fixed coupling with coupling sleeve FKM.
- Both coupling heads BK to establish the connection at the movable coupling with coupling sleeve BK.

1.9.7 Protective cap, PE-cap

The protective cap is made of plastic, see Annex 10, encases the corrosion protection filling material and seals the tendon end at the anchorages SKM and SFM.

At the fixed anchor SFM, the protective cap together with a compression spring and a washer hold the wedge in place, see Annex 1, Annex 3, and Annex 10.

The PE-cap is made of HD PE, see Annex 10, encases the corrosion protection filling material and seals the protruding end of the prestressing steel strand at the anchorages MGS and MGF.

1.9.8 Ancillary components for anchorage and coupling

Compression spring and washer at the fixed anchor SFM, at the fixed coupling FKM, and at the movable coupling BK hold the wedge in place. Compression spring and washer are made of steel.

PE-caps, gasket, and locking plate secure the wedges at the fixed anchor MGF and seal the anchorage at the fixed and stressing anchor MGF and MGS. The locking plate is made of steel.

1.10 Permanent corrosion protection

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 or materials are selected according to the standards and regulations in force at the place of use.

The prestressing steel strand is provided in the factory with corrosion protection consisting of corrosion protective filling material and extruded PE-sheathing – Monostrand.

Application of corrosion protection in the anchorage zone is described in the assembly instructions in Clause 2.2.4. The de-sheathed prestressing steel strand is completely covered by PE-sleeve or transition tube. In the final stage the PE-sleeve or transition tube overlaps the PE-sheathing of the monostrand by at least 80 mm. The transition joint monostrand to PE-sleeve or transition tube is sealed and the void in the anchorage zone is completely filled with a corrosion protection filling material.

1.11 Material specifications of the components

Material specifications of the components are given in Annex 12.

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

2.1 Intended use

The PT system DSI monostrand prestressing system L1–L7 with cast iron anchors is intended to be used for the prestressing of structures.

Use category according to tendon configuration and material of structure is

- Internal unbonded tendon for concrete and composite structures

2.2 Assumptions

2.2.1 General

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

2.2.2 Packaging, transport and storage

Tendons and anchorages may be assembled on site or at the factory, i.e. pre-assembled tendons. During transport, the tendons may be wind to a coil with a minimum internal diameter of 1.5 m or as specified by the manufacturer of the monostrand.

Advice on packaging, transport, and storage includes.

- Temporary protection of prestressing steel and components in order to prevent corrosion during transportation from production site to construction site
- Transportation, storage, and handling of prestressing steel and other components in a manner as to avoid damage by mechanical or chemical impact
- Protection of tensile elements and other components from moisture
- Keeping tensile elements away from zones where welding operations are performed

2.2.3 Design

Advice on design includes.

- Design of the structure permits correct installation and stressing of tendons and design and reinforcement of the anchorage zone permits correct placing and compacting of concrete.
- Verification of transfer of stressing forces to the structural concrete is not required, if centre and edge distances of the tendons, strength of concrete, as well as grade and dimensions of additional reinforcement, see Clause 1.2.2.3, Clause 1.2.2.4, Clause 1.2.2.5, Annex 7, and Annex 8 are conformed to. The forces outside the area of additional reinforcement are verified and, if necessary, covered by appropriate, in general transverse reinforcement. The reinforcement of the structure is not employed as additional reinforcement. Reinforcement exceeding the required reinforcement of the structure may be used as additional reinforcement if appropriate placing is possible.
- The anchor recess is designed as to ensure a concrete cover of at least 20 mm at the caps in the final state.
- Bursting out of prestressing steels in case of failure is prevented. Sufficient protection is provided by e.g. a cover of reinforced concrete.
- The initial prestressing force applied to the stressing anchor will decrease especially as a result of slip, see Clause 1.4, friction along the tendon, see Clause 1.5, 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 concrete. The stressing instructions prepared by the ETA holder should be consulted.
- In the fixed coupling, the prestressing force at the 2nd construction stage is not greater than at the 1st construction stage, neither during construction, nor in the final state, nor due to any load combination.

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 unbonded 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 internal unbonded prestressing system DSI monostrand prestressing system L1–L7 with cast iron anchors.

Anchor bodies are placed perpendicular to the tendon's axis. At the anchorages the tendon layout continues with a straight length of at least 125 mm. Couplings are placed in straight tendon sections only. The centric position of the additional reinforcement is secured by tying or by means of spacers braced against the tendon.

In the final stage the voids in anchorages, couplings, and PE-sleeves or transition tubes are completely filled with corrosion protection filling material. The PE-sleeve or transition tube overlaps the monostrand sheathing by at least 80 mm and the monostrand sheathing does not press against the anchorage. This is checked by applied markings before concreting.

2.2.4.2 De-sheathing of monostrands

The length along which the monostrand sheathing is removed at the stressing anchor depends on the variations in temperature to be expected between installation and concreting. PE-sleeve or transition tube overlaps the monostrand sheathing, but the monostrand sheathing does not press against the anchorage. This is checked prior to concreting by applied markings.

2.2.4.3 Examination of tendons and possible repairs of the corrosion protection system

During installation careful handling of tendons is ensured. Before concreting the PT site manager carries out a final examination of the installed tendons. Damages to PE sheathings, which cause or may cause leaking of corrosion protection filling material, are repaired. Repair is in accordance with the respective load requirements and suitable for operating temperatures up to 30 °C.

2.2.4.4 Fixed anchor

The fixed anchor is either prefabricated or assembled at the construction site. In case of inaccessible fixed anchor SFM the protective cap together with compression spring and washer is screwed on before or at tendon installation to secure the wedge, see Annex 3. For fixed anchor MGF the wedges are secured with PE-caps, gasket, and locking plate, see Annex 4.

In general, the fixed anchor is factory assembled. Factory assembly comprises the following steps.

- Screw PE-sleeve onto the anchor body or attach PE-transition tubes to the anchor body.
- Place the wedges into the conical holes of the anchor body.
- Fill in a measured quantity of corrosion protection filling material.
- For anchorage SFM screw on the protection cap filled with corrosion protection filling material together with compression spring and washer.
- Remove PE sheathing from the monostrand over a length of 50 to 60 mm.
- Insert the de-sheathed monostrand through the PE-sleeve or transition tube, observing the overlap length PE-sleeve or transition tube to monostrand.
- Attach PE-caps with gasket and locking plate on anchorage MGF.
- Wipe off corrosion protection filling material that has leaked out and seal the joint monostrand to PE-sleeve or transition tube.
- Cut the monostrand from the coil, observing the required tendon length.

2.2.4.5 Stressing anchor

The anchor body is fastened to the formwork on site and connected to the monostrand. It can also be used as an accessible fixed anchor.

Site assembly comprises the following steps, see Annex 3 and Annex 4.

- Fastening the anchor body with assembled PE-sleeve or transition tube and with recess form onto the formwork. For stressing anchor SKM an installation spindle with sealing and nut is used. Stressing anchor MGS is installed with a sealing ring towards the formwork.
- Hold the monostrand towards the anchorage to mark cutting point and overlapping length on the PE sheathing.
- Cut and pull off the PE sheathing from the monostrand.
- Insert the monostrand through PE-sleeve or transition tube and anchor body.
- Check overlapping length between monostrand and PE-sleeve or transition tube.
- Fill PE-sleeves or transition tube with corrosion protection filling material and seal joint monostrand to PE-sleeve or transition tube.
- Place the previously removed PE sheathing onto the end of the prestressing steel strand in order to protect the strand protrusion until stressing.

For prefabricated tendons the first step is done later on site. The other steps are carried out in identical order and the prefabricated tendons are prepared, e.g. coiled, for transport.

2.2.4.6 Fixed coupling FKM

The anchorage of the 1st construction stage is installed and stressed same as the stressing anchor SKM.

Site assembly of the 2nd construction stage comprises the following steps, see Annex 5.

- Screw the pre-assembled coupling head FKM and coupling sleeve FKM into the internal thread of the stressing anchor SKM.
- Fill a sufficient quantity of corrosion protection filling material into the expanded section of the PE-sleeve and slip the PE-sleeve onto the monostrand.
- Remove approximately 120 mm of the monostrand PE-sheathing.
- Apply a coloured marking on the monostrand.
- Push the de-sheathed strand into the coupling head FKM. The wedge pushed forward by the compression spring retains the prestressing steel strand.
- Check the insertion depth by means of the coloured marking.
- Seal the joint monostrand to PE-sleeve with sealing sleeve or adhesive tape.

2.2.4.7 Movable coupling BK

Site assembly comprises the following steps, see Annex 6.

Tendon № 1

- Remove approximately 120 mm of the monostrand PE-sheathing.
- Apply a coloured marking on the monostrand.
- Place the PE-protective tube section 1 onto the monostrand.
- Fill a sufficient quantity of corrosion protection filling material into the expanded section of the PE-protective tube section 1.

Tendon № 2

- Remove the PE-sheathing of the monostrand along a length equal to that of the protective tube minus 100 mm.
- Apply a coloured marking on the monostrand.
- Place the PE-protective tube section 2 with the sealing sleeve onto the monostrand.

Coupling

- Place the pre-assembled coupling unit with coupling heads BK, coupling sleeve BK, wedges, springs, washers, and filled with corrosion protection filling material onto the de-sheathed prestressing steel strand of tendon № 1 up to the locking steel pin.
- Insert the de-sheathed prestressing steel strand of tendon № 2 into the coupling up to the locking steel pin.
- The wedges pushed forwards by the compression springs retain both prestressing steel strands.
- Check insertion depths of the monostrands by means of the coloured markings on both sides of the coupling.

Corrosion protection

- Push forward the PE-protective tube over the coupling and ensure corrosion protection filling material leaks out between protective tube and PE-sheathing of the monostrand of tendon № 1.
- Press the securing pin into the PE-protective tube section 1 to secure the position of the coupling. Ensure sufficient clearance within PE-protective tube section 2 to allow for unimpeded displacement of the coupling during stressing.
- Push forward the PE-protective tube section 2 to approximately 20 mm before the end of the expanded section of the PE-protective tube 1.
- Seal the joint of monostrand № 2 to PE-protective tube section 2 with sealing sleeve or adhesive tape.
- Inject corrosion protection filling material through the injection nipple of the PE-protective tube section 2 until the corrosion protection filling material begins to spill out at the annular gap between PE-protective tube section 1 and PE-protective tube section 2.
- Clean the PE-components from the excess corrosion protection filling material and seal the joint PE-protective tube section 1 to PE-protective tube section 2 with adhesive tape.
- Seal the joint monostrand № 1 to PE-protective tube section 1 with sealing sleeve or adhesive tape.

2.2.4.8 Welding at the anchorage

Welding operations are not intended to be performed on components of the DSI monostrand prestressing system L1–L7 with cast iron anchors. After the tendons have been prefabricated or installed, welding operations are not conducted any more. In case of welding operation close to tendons precautionary measures are required to avoid any damage.

2.2.4.9 Checking of tendons

The tendons are carefully handled during installation. Prior to placing the concrete, the responsible person performs a final check on the installed tendons, see Clause 2.2.4.3.

2.2.4.10 Stressing and stressing records

2.2.4.10.1 General

The geometrical properties of anchor bodies, centre and edge distances and additional reinforcement of tendon anchorages are specified in Annex 2, Annex 7, and Annex 8.

2.2.4.10.2 Stressing

With a mean concrete compressive strength in the anchorage zone according to Annex 7 and Annex 8 full prestressing may be applied. The prestressing forces are applied in accordance with a prescribed stressing schedule. Said schedule includes time and sequence of the various prestressing levels and the elongations calculated for the tendons, the required mean cube compressive strength of the concrete as well as time and kind of formwork lowering and removal. Any possible spring back forces of the falsework are taken into account.

Prestressing comprises the following steps

- Remove the PE protective sheathing from the strand protrusion.
- Fill the void in the anchorage with corrosion protection filling material using a thin injection lance.
- Place the wedges into the conical holes of the stressing anchor.
- Stress with prestressing jack.
- Measure tendon elongation during stressing.
- Cut off the strand protrusion with a cutting disk or cutting tool.
- Screw on the protective cap on anchorage SKM or attach PE-caps, gasket, and locking plate on anchorage MGS. The caps are filled with corrosion protection filling material.
- Fill the anchor recess with concrete.

2.2.4.10.3 Restressing

Restressing of tendons before final cutting of strand protrusions in combination with release and reuse of wedges is permitted. After restressing, the wedges bite into at least 15 mm of virgin strand surface and no wedge bite remains on the tendon between the anchorages.

2.2.4.10.4 Stressing records

Any important observations made during the stressing operation, in particular prestressing forces applied and elongation measured, are recorded in a stressing record for each tendon.

2.2.4.10.5 Stressing equipment, clearance requirements and safety-at-work

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

To stress the tendons, clearance of approximately 1 m directly behind the anchorage is required. The ETA holder keeps available more detailed information on the jacks used and the required space for handling and stressing.

The safety-at-work and health protection regulations are observed.

2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of the DSI monostrand prestressing system L1–L7 with cast iron anchors of 100 years, provided that the DSI monostrand prestressing system L1–L7 with cast iron anchors 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 works³.

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 Performances of the product and references to the methods used for its assessment

3.1 Essential characteristics

The performances of the DSI monostrand prestressing system L1–L7 with cast iron anchors for the essential characteristics are given in Table 5.

Table 5 Essential characteristics and performances of the product

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

³ The real working life of a product incorporated in a specific works depends on the environmental conditions to which that works are subject, as well as on the particular conditions of design, execution, use, and maintenance of that works. Therefore, it cannot be excluded that in certain cases the real working life of the product may also be shorter than the assumed working life.

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

3.2 Product performance

3.2.1 Mechanical resistance and stability

3.2.1.1 Resistance to static load

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.1. The characteristic value of maximum force, F_{pk} , of the tendon with prestressing steel strands according to Annex 11 is given in Annex 11.

3.2.1.2 Resistance to fatigue

The PT system as described in the ETA meets the acceptance criteria of EAD 160004-00-0301, Clause 2.2.2. The characteristic value of maximum force, F_{pk} , of the tendon with prestressing steel strands according to Annex 11 is given in Annex 11.

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

3.2.1.3 Load transfer to 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 the tendon with prestressing steel strands according to Annex 11 is given in Annex 11.

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

3.2.1.4 Friction coefficient

For friction losses including friction coefficient see Clause 1.5.

3.2.1.5 Deviation, deflection (limits) for internal and unbonded tendon

For minimum radius of curvature of internal tendons see Clause 1.7.

3.2.1.6 Assessment of assembly

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

3.2.1.7 Corrosion protection

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

3.2.2 Safety in case of fire

3.2.2.1 Reaction to fire

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

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

3.2.3 Hygiene, health, and the environment

3.2.3.1 Content, emission, and/or release of dangerous substances

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

- SVOC and VOC

The performance of components made of steel or cast iron that are free of coating with organic material is no emission of SVOC and VOC. The performance of components of other materials has not been assessed.

- Leachable substances

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

3.3 Assessment methods

The assessment of the essential characteristics in Clause 3.1 of the DSI monostrand prestressing system L1–L7 with cast iron anchors, for the intended use, and in relation to the requirements for mechanical resistance and stability, safety in case of fire, and for hygiene, health, and the environment in the sense of the basic requirements for construction works № 1, 2, and 3 of Regulation (EU) № 305/2011, has been made in accordance with Annex A of EAD 160004-00-0301, Post-Tensioning kits for prestressing of structures, for item 2, Internal unbonded PT systems.

3.4 Identification

The European Technical Assessment for the DSI monostrand prestressing system L1–L7 with cast iron anchors is issued on the basis of agreed data that identify the assessed product⁴. Changes to materials, to composition, or to characteristics of the product, or to the production process could result in these deposited data being incorrect. Österreichisches Institut für Bautechnik should be notified before the changes are introduced, as an amendment of the European Technical Assessment is possibly necessary.

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

4.1 System of assessment and verification of constancy of performance

According to Commission Decision 98/456/EC the system of assessment and verification of constancy of performance to be applied to the DSI monostrand prestressing system L1–L7 with cast iron anchors is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1, and provides for the following items.

(a) The manufacturer shall carry out

- (i) factory production control;

⁴ The technical file of the European Technical Assessment is deposited at Österreichisches Institut für Bautechnik.

- (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan⁵.
- (b) The notified product certification body shall decide on the issuing, restriction, suspension, or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body
 - (i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values, or descriptive documentation of the product;
 - (ii) initial inspection of the manufacturing plant and of factory production control;
 - (iii) continuing surveillance, assessment, and evaluation of factory production control;
 - (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

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

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

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

5.1 Tasks for the manufacturer

5.1.1 Factory production control

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

- Control of the incoming materials

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

- Inspection and testing

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

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

All tests are performed according to written procedures with suitable calibrated measuring devices. All results of inspections, tests, and checks are recorded in a consistent and systematic way. The basic elements of the prescribed test plan are given in Annex 14, conform to

⁵ 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.

EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the DSI monostrand prestressing system L1–L7 with cast iron anchors.

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 conform. Factory production control addresses control of non-conforming products.

– Complaints

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

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

At least once a year the manufacturer audits the manufacturers of the components given in Annex 15.

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 5.

5.2 Tasks for the notified product certification body

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

The notified product certification body establishes that, in accordance with the prescribed test plan, the manufacturing plant, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous manufacturing of the PT system according to the given technical specifications. For the most important activities, EAD 160004-00-0301, Table 4 summarises the minimum procedure.

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

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

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

Each manufacturer of the components given in Annex 15 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 inspection, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components, Annex 15 summarises the minimum procedures. Annex 15 conforms to EAD 160004-00-0301, Table 4. In particular, at least once a year, the notified product certification body also carries out one single tensile element test series according to EAD 160004-00-0301, Annex C.7 and Clause 3.3.4 on specimens taken from the manufacturing plant or at the manufacturer's storage facility.

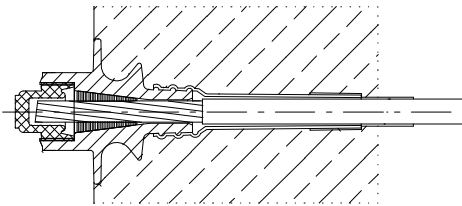
Issued in Vienna on 09 April 2019
by Österreichisches Institut für Bautechnik

The original document is signed by

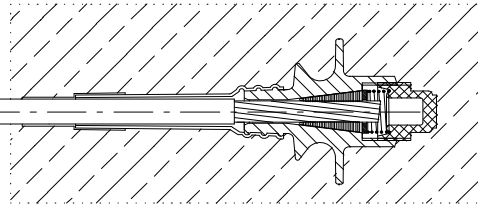
Rainer Mikulits
Managing Director

Overview on anchorages and couplings

Stressing anchor SKM



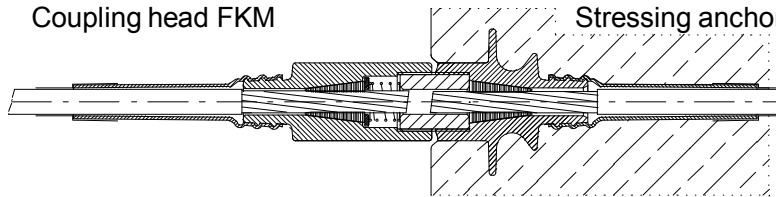
Fixed anchor SFM



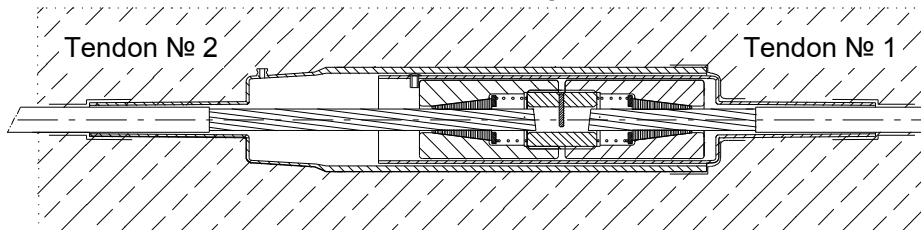
Fixed coupling FKM

2nd construction stage
Coupling head FKM

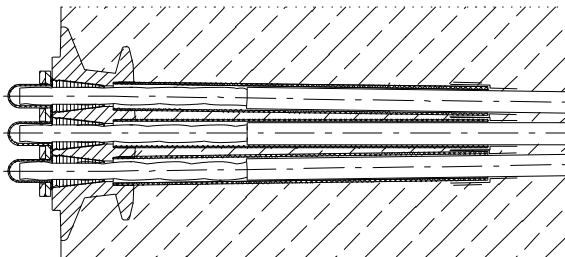
1st construction stage
Stressing anchor SKM



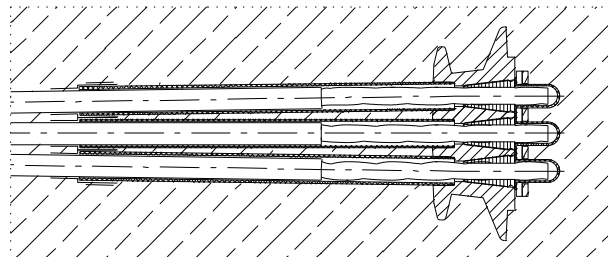
Movable coupling BK



Stressing anchor MGS



Fixed anchor MGF



Maximum prestressing force

| Tendon | — | 6801 | 6802 | 6803 | 6804 | 6805 | 6806 | 6807 |
|--|----|------|------|------|------|-------|-------|-------|
| Maximum prestressing force for prestressing steel strand Y1770S7 at $0.9 \cdot F_{p0.1}$ | kN | 211 | 421 | 632 | 842 | 1 053 | 1 264 | 1 474 |
| Maximum prestressing force for prestressing steel strand Y1860S7 at $0.9 \cdot F_{p0.1}$ | kN | 221 | 443 | 664 | 886 | 1 107 | 1 328 | 1 550 |



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DSI Unbonded Monostrand System

Anchorage and coupling – Overview
Maximum prestressing force

Annex 1

of European Technical Assessment
ETA-19/0077 of 09.04.2019

| | | |
|---|--|--|
| 68 01 1435 | | |
| 68 02 1435 | | |
| 68 03 1435 | | |
| 68 04 1435 | | |
| 68 05 1435 | | |
| <p>68 06 1435 Same as 68 07 1435 with omitted central prestressing steel strand</p> | | |
| 68 07 1435 | | |

Dimensions in mm

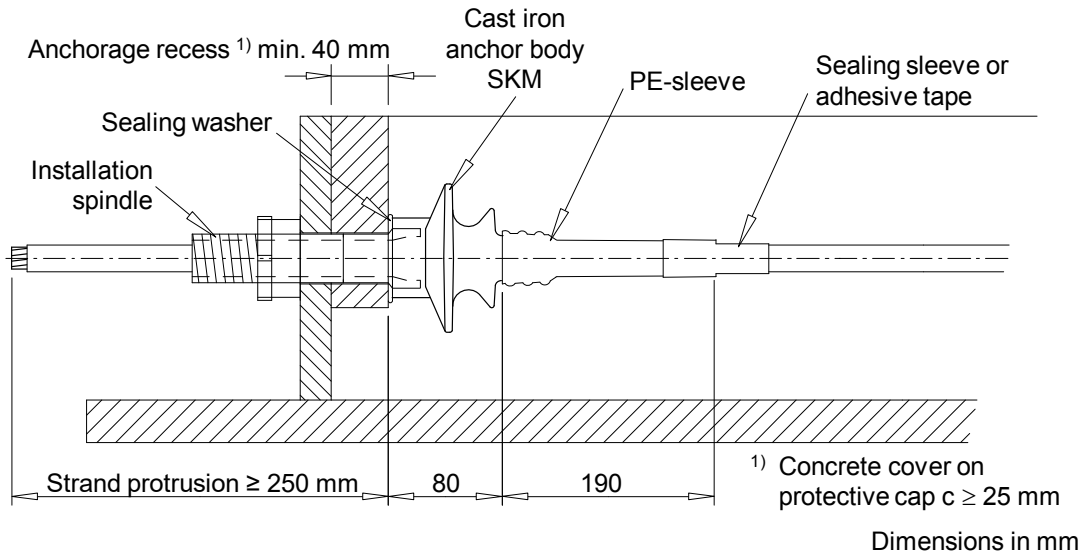


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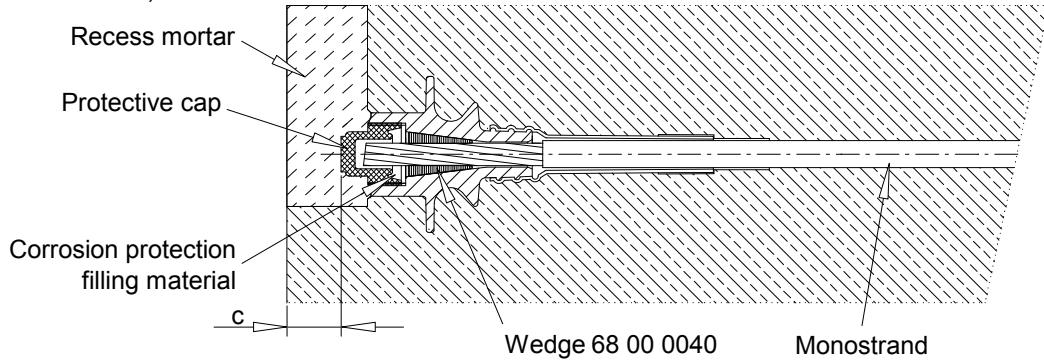
DSI Unbonded Monostrand System
Anchor bodies

Annex 2
of European Technical Assessment
ETA-19/0077 of 09.04.2019

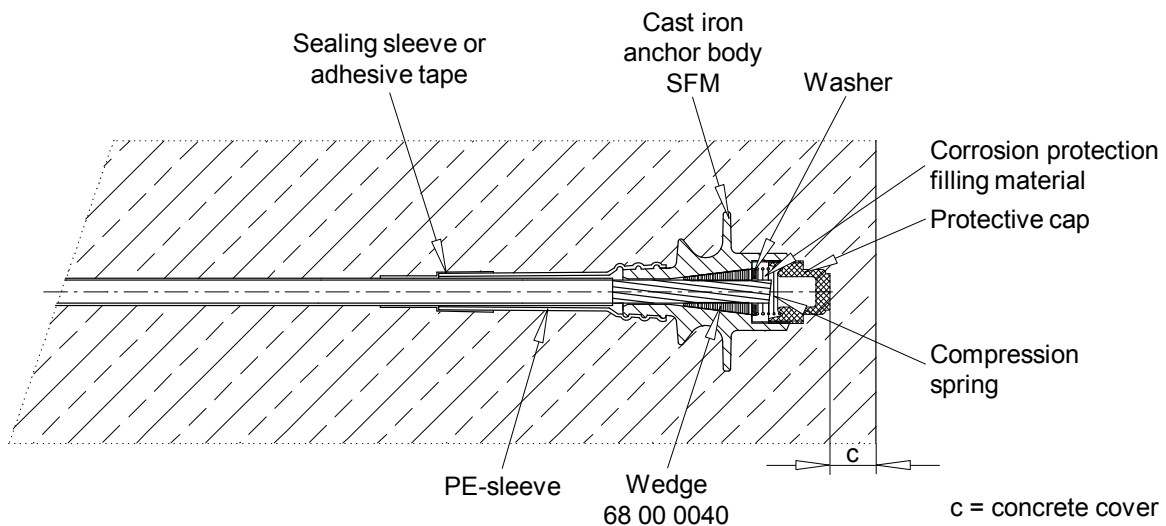
Assembly state of anchorage SKM



Stressing anchor SKM, final state



Fixed anchor SFM, final state



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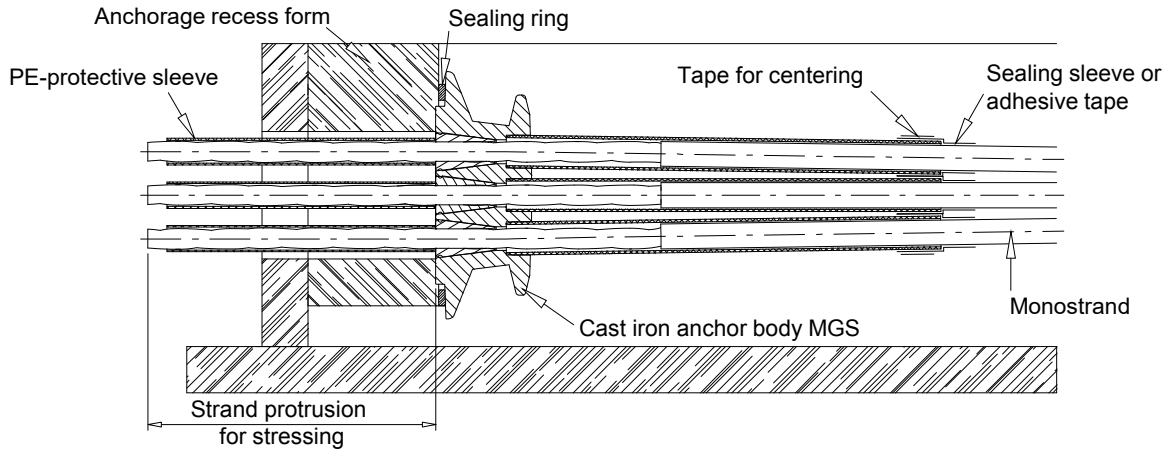
DSI Unbonded Monostrand System

Stressing anchor SKM and
Fixed anchor SFM

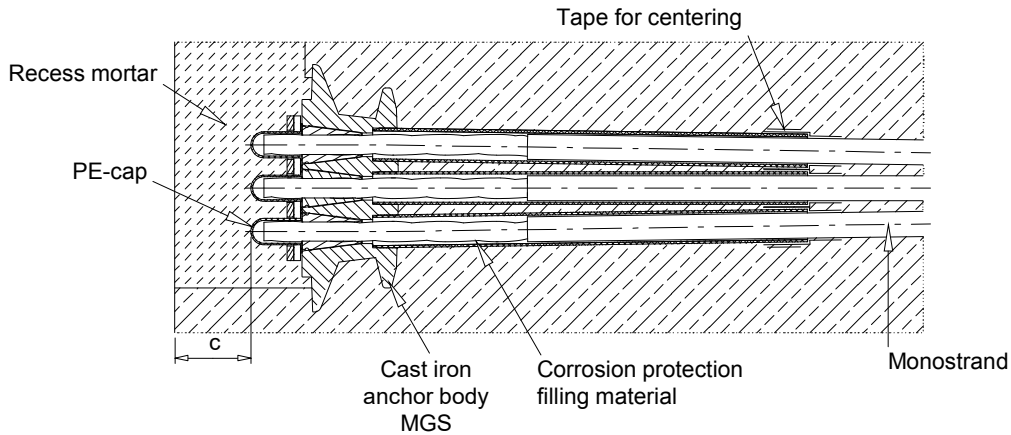
Annex 3

of European Technical Assessment
ETA-19/0077 of 09.04.2019

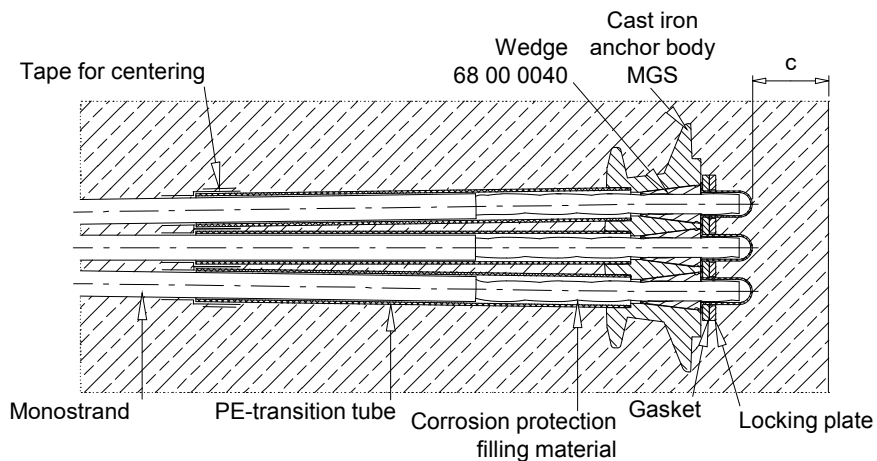
Assembly state of anchorage MGS



Stressing anchor MGS, final state



Fixed anchor MGF, final state



c = concrete cover



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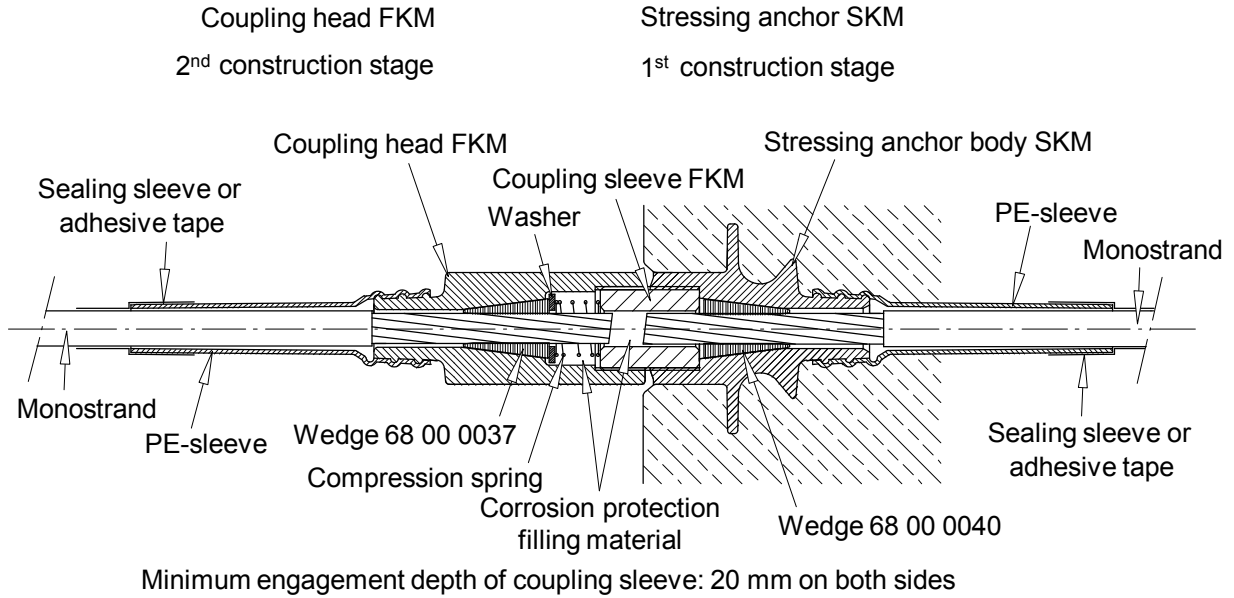
DSI Unbonded Monostrand System

Stressing anchor MGS and
Fixed anchor MGF

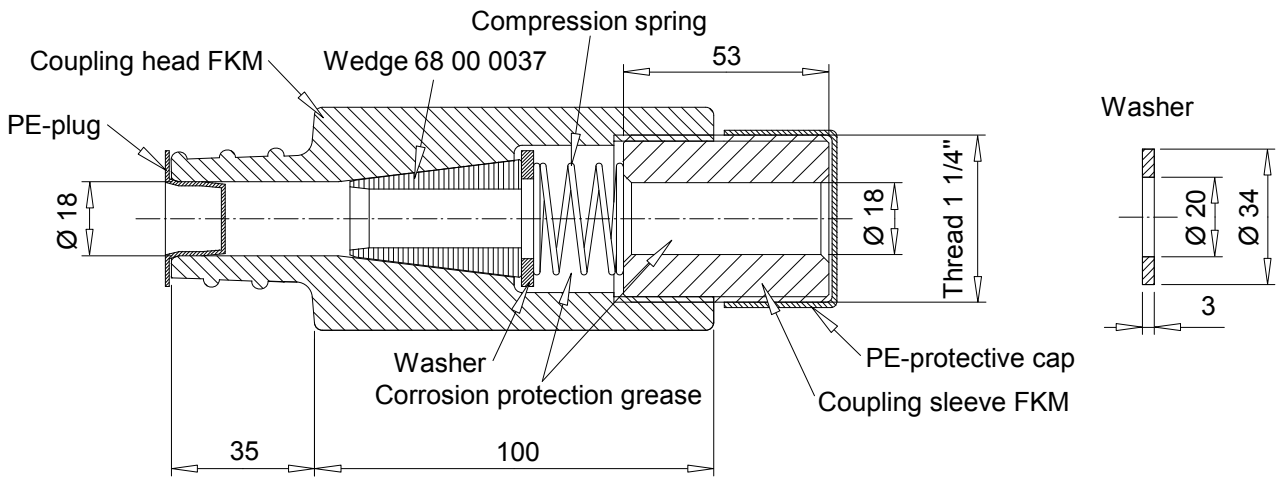
Annex 4

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Fixed coupling FKM



Coupling unit FKM – Condition as delivered



Dimensions in mm



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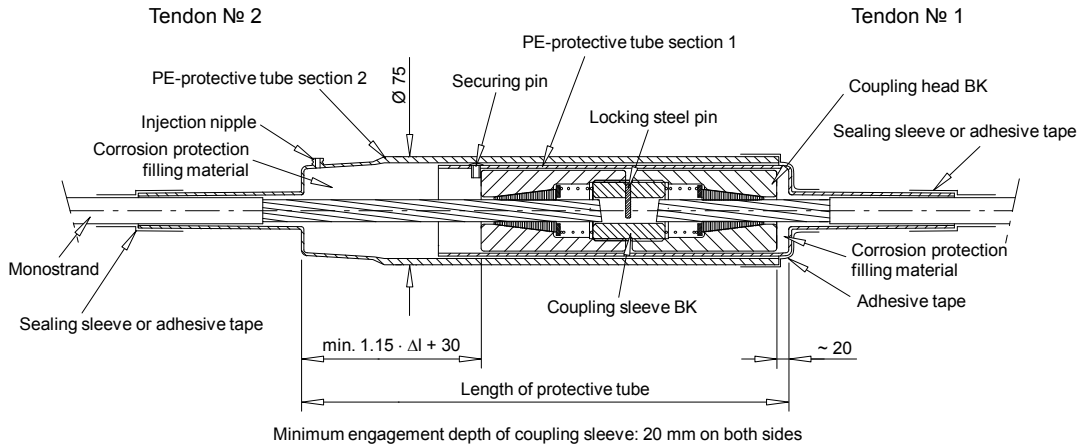
DSI Unbonded Monostrand System

Fixed coupling FKM

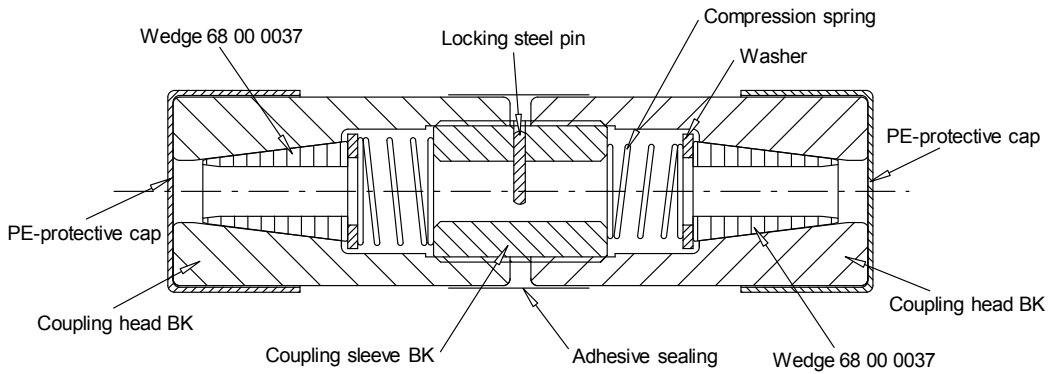
Annex 5

of European Technical Assessment
ETA-19/0077 of 09.04.2019

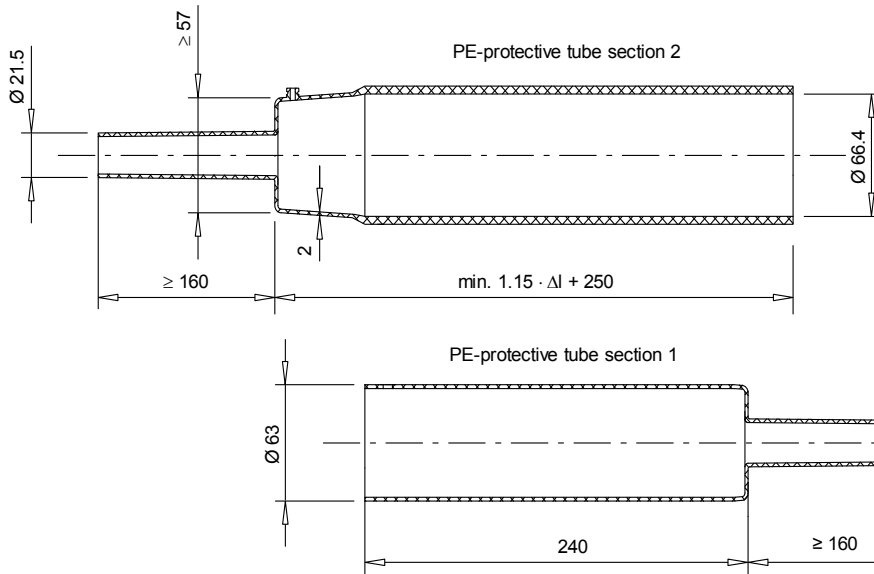
Movable coupling BK



Coupling unit BK – Condition as delivered



PE-protective tube



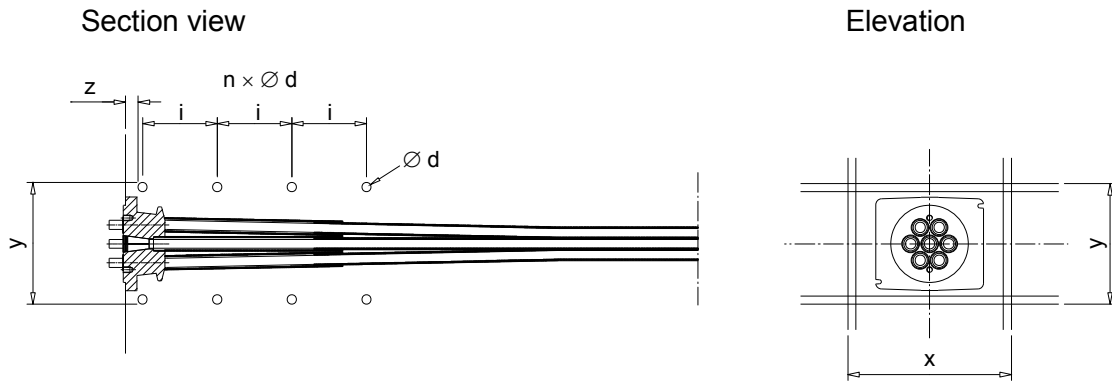
Dimensions in mm



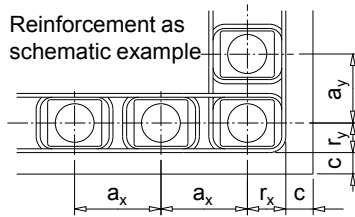
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Movable coupling BK

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Minimum distances



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

| Tendon size | 6801 | | | | 6802 | | | | 6803 | | | | 6804 | | | |
|--|---|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|
| Prestressing steel strand | 150 mm ² , $f_{pk} = 1770$ N/mm ² ($F_{pk} = 266$ kN) and $f_{pk} = 1860$ N/mm ² ($F_{pk} = 279$ kN) | | | | | | | | | | | | | | | |
| Number of strands | 01 | | | | 02 | | | | 03 | | | | 04 | | | |
| Minimum concrete strength at stressing in N/mm ² $f_{cm, 0, cube}$ | 23 | 27 | 30 | 35 | 23 | 27 | 30 | 35 | 23 | 27 | 30 | 35 | 23 | 27 | 30 | 35 |
| Centre distance a_x | 190 | 175 | 170 | 170 | 205 | 205 | 205 | 195 | 245 | 245 | 240 | 225 | 290 | 270 | 260 | 240 |
| a_y | 105 | 100 | 90 | 90 | 145 | 145 | 145 | 140 | 175 | 175 | 170 | 160 | 205 | 190 | 185 | 170 |
| Edge distance, plus c ¹⁾ r_x | 110 | 105 | 100 | 100 | 95 | 95 | 95 | 90 | 115 | 115 | 110 | 105 | 135 | 125 | 120 | 110 |
| r_y | 45 | 40 | 35 | 35 | 65 | 65 | 65 | 60 | 80 | 80 | 75 | 70 | 95 | 85 | 85 | 75 |
| Additional reinforcement, n | 4 | 4 | 4 | 3 | 5 | 5 | 4 | 4 | 5 | 5 | 5 | 5 | 6 | 5 | 5 | 5 |
| steel according to $\varnothing d$ | 8 | 8 | 8 | 8 | 10 | 10 | 10 | 8 | 12 | 10 | 10 | 8 | 14 | 14 | 14 | 12 |
| Annex 12 z | 35 | 35 | 35 | 35 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| i | 25 | 25 | 25 | 25 | 45 | 50 | 55 | 60 | 50 | 45 | 55 | 45 | 50 | 50 | 55 | 45 |
| x ²⁾ | 170 | 155 | 150 | 150 | 170 | 170 | 170 | 160 | 210 | 210 | 205 | 190 | 250 | 230 | 225 | 200 |
| y | 85 | 80 | 70 | 70 | 125 | 125 | 125 | 120 | 155 | 155 | 150 | 140 | 185 | 170 | 165 | 150 |

1) c = Concrete cover

2) At the edge of tendon size 6801, 2 stirrups with $x = 195, 185, 175,$ and 175 mm

Dimensions in mm



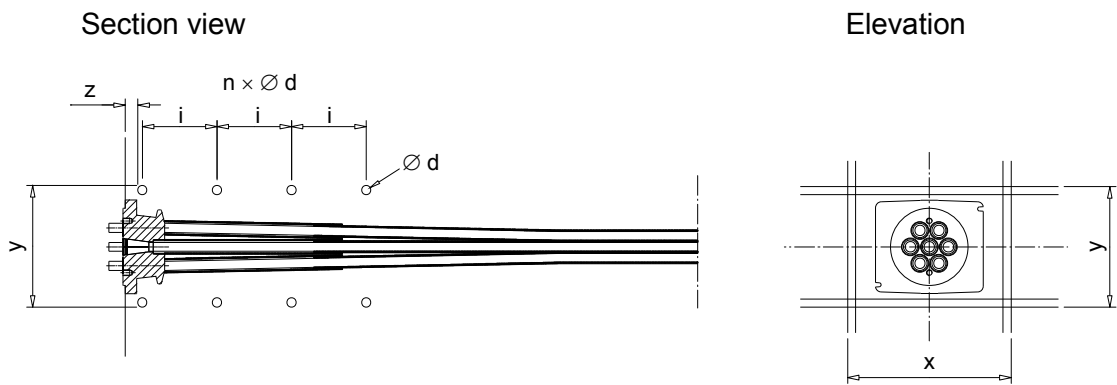
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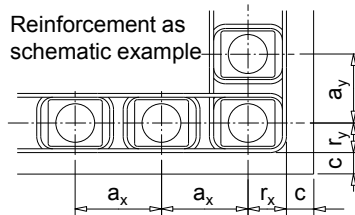
Additional reinforcement
Centre and edge distances

Annex 7

of European Technical Assessment
ETA-19/0077 of 09.04.2019



Minimum distances



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

| Tendon size | 6805 | | | | 6806 | | | | 6807 | | | | |
|--|---|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|-----|
| Prestressing steel strand | 150 mm ² , $f_{pk} = 1\,770$ N/mm ² ($F_{pk} = 266$ kN) and $f_{pk} = 1\,860$ N/mm ² ($F_{pk} = 279$ kN) | | | | | | | | | | | | |
| Number of strands | 05 | | | | 06 | | | | 07 | | | | |
| Minimum concrete strength at stressing in N/mm ² $f_{cm, 0, cube}$ | 23 | 27 | 30 | 35 | 23 | 27 | 30 | 35 | 23 | 27 | 30 | 35 | |
| Centre distance | a_x | 335 | 315 | 295 | 275 | 380 | 350 | 325 | 305 | 415 | 380 | 350 | 320 |
| | a_y | 240 | 225 | 210 | 195 | 270 | 250 | 230 | 215 | 295 | 270 | 250 | 230 |
| Edge distance, plus c ¹⁾ | r_x | 160 | 150 | 140 | 130 | 180 | 165 | 155 | 145 | 200 | 180 | 165 | 150 |
| | r_y | 110 | 105 | 95 | 90 | 125 | 115 | 105 | 100 | 140 | 125 | 115 | 105 |
| Additional reinforcement, steel according to Annex 12 | n | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 6 | 6 | 6 |
| | $\varnothing d$ | 16 | 16 | 14 | 14 | 16 | 16 | 14 | 14 | 16 | 16 | 16 | 14 |
| | z | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 | 40 |
| | i | 55 | 60 | 50 | 55 | 55 | 60 | 50 | 60 | 50 | 50 | 55 | 45 |
| | x | 295 | 270 | 265 | 235 | 335 | 310 | 285 | 260 | 375 | 330 | 310 | 285 |
| y | 220 | 205 | 190 | 175 | 245 | 230 | 210 | 195 | 275 | 250 | 230 | 210 | |

1) c = Concrete cover

Dimensions in mm



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Additional reinforcement
Centre and edge distances

Annex 8

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| Tendon size | Number of strands | Mass of strands | Cross-sectional area of strands | $f_{pk} = 1\,770\text{ N/mm}^2$ | | $f_{pk} = 1\,860\text{ N/mm}^2$ | |
|-------------|-------------------|-----------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| | | | | Maximum prestressing force | Maximum overstressing force | Maximum prestressing force | Maximum overstressing force |
| — | — | — | A_p | $A_p \cdot 0.90 \cdot f_{p0.1}$ | $A_p \cdot 0.95 \cdot f_{p0.1}$ | $A_p \cdot 0.90 \cdot f_{p0.1}$ | $A_p \cdot 0.95 \cdot f_{p0.1}$ |
| — | — | kg/m | mm ² | kN | kN | kN | kN |
| 6801 | 01 | 1.30 | 150 | 211 | 222 | 221 | 234 |
| 6802 | 02 | 2.60 | 300 | 421 | 445 | 443 | 467 |
| 6803 | 03 | 3.90 | 450 | 632 | 667 | 664 | 701 |
| 6804 | 04 | 5.20 | 600 | 842 | 889 | 886 | 935 |
| 6805 | 05 | 6.50 | 750 | 1 053 | 1 112 | 1 107 | 1 169 |
| 6806 | 06 | 7.80 | 900 | 1 264 | 1 334 | 1 328 | 1 402 |
| 6807 | 07 | 9.10 | 1 050 | 1 474 | 1 556 | 1 550 | 1 636 |

Notes

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

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

For $F_{p0.1} = A_p \cdot f_{p0.1}$ see Annex 11.

Overstressing with up to $A_p \cdot 0.95 \cdot f_{p0.1}$ 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.



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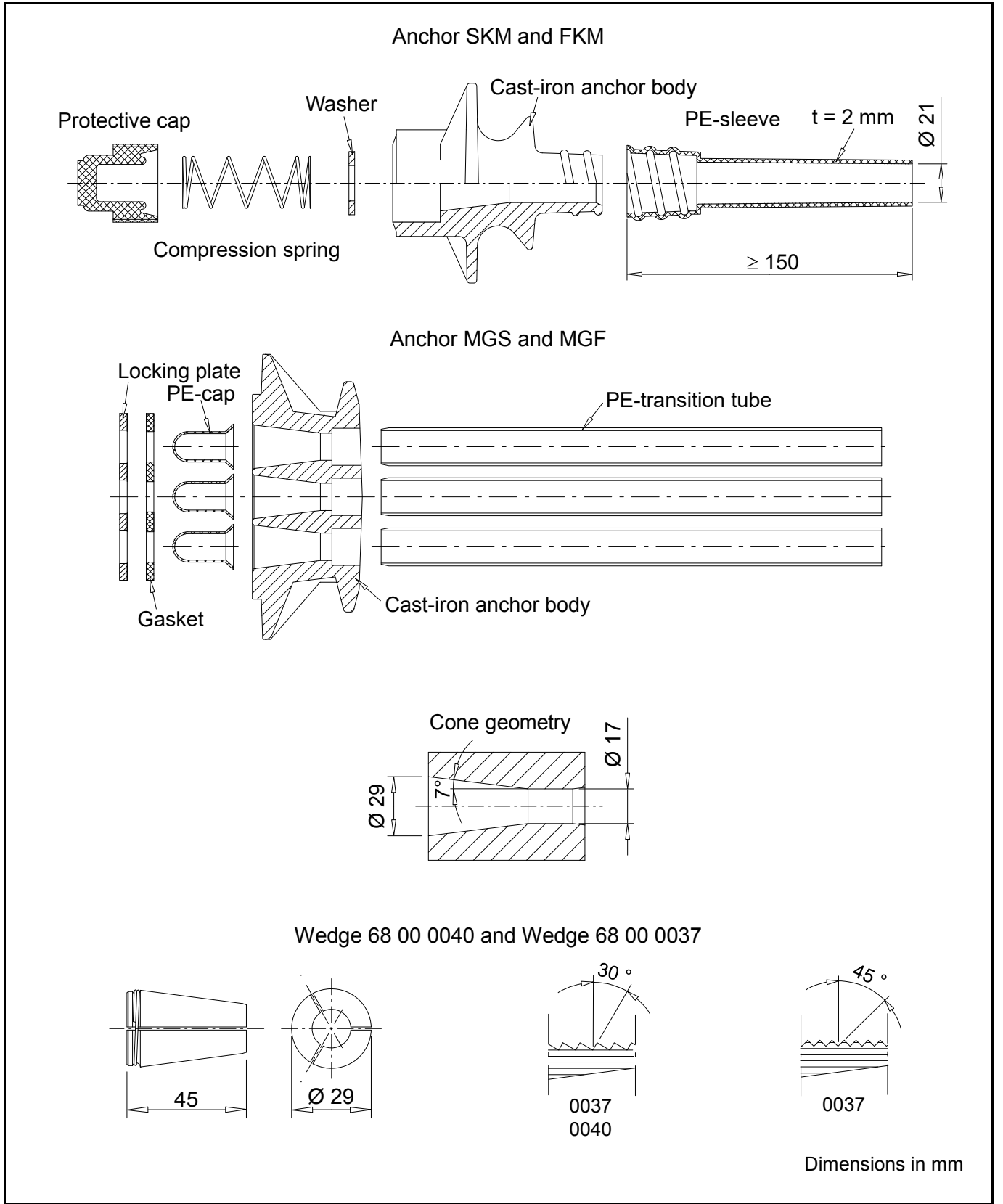
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Maximum prestressing and overstressing forces

Annex 9

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ETA-19/0077 of 09.04.2019




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DSI Unbonded Monostrand System
Basic components of anchorages

Annex 10
of European Technical Assessment
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Prestressing steel strand specification

| Characteristic | Symbol | Unit | Y1770S7 | Y1860S7 |
|--|---------------|-------------------|-----------------------|---------|
| Characteristic tensile strength | R_m, f_{pk} | N/mm ² | 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' | mm | $\geq 1.03 \cdot d_o$ | |
| Nominal mass per metre of prestressing steel | M | g/m | 1 172 | |
| Nominal mass per metre of monostrand | M | g/m | 1 300 | |
| Nominal cross-sectional area | S_0 | mm ² | 150 | |
| Characteristic value of maximum force | F_{pk} | kN | 266 | 279 |
| Maximum value of maximum force | $F_{m, max}$ | kN | 306 | 321 |
| Characteristic value of 0.1 % proof force | $F_{p0.1}$ | kN | 234 | 246 |
| Minimum elongation at maximum force, $L_0 \geq 500$ mm | A_{gt} | % | 3.5 | |
| Modulus of elasticity | E | N/mm ² | 195 000 ¹⁾ | |
| Maximum relaxation after 1 000 h, for an initial force of $0.70 \cdot F_{ma}$ | — | % | ≤ 2.5 | |
| $0.80 \cdot F_{ma}$ | — | % | ≤ 4.5 | |

1) Standard value

Characteristic maximum force of tendon

| Number of strands | n | — | 01 | 02 | 03 | 04 | 05 | 06 | 07 |
|--|----------|-----------------|-----|-----|-----|-------|-------|-------|-------|
| Nominal cross-sectional area of prestressing steel | A_p | mm ² | 150 | 300 | 450 | 600 | 750 | 900 | 1 050 |
| Characteristic tensile strength $f_{pk} = 1 770$ N/mm ² | | | | | | | | | |
| Characteristic value of maximum force of tendon | F_{pk} | kN | 266 | 532 | 798 | 1 064 | 1 330 | 1 596 | 1 862 |
| Characteristic tensile strength $f_{pk} = 1 860$ N/mm ² | | | | | | | | | |
| Characteristic value of maximum force of tendon | F_{pk} | kN | 279 | 558 | 837 | 1 116 | 1 395 | 1 674 | 1 953 |



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DSI Unbonded Monostrand System
Prestressing steel strands
Characteristic maximum force of tendon

Annex 11
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| Designation | Standard | Material ¹⁾ |
|---|--------------------------|---|
| Anchor body | EN 1563 | Ductile cast iron |
| Coupling heads | EN 10083-2 | Steel |
| Coupling sleeves | EN 10025-2 | Steel |
| Wedge 68 00 0037 | EN 10277-2 EN 10083-2 | Steel |
| Wedge 68 00 0040 | EN 10084 | Steel |
| Washer | EN ISO 7089 | Steel |
| Locking plate | EN 10025 | Steel |
| Additional reinforcement | — | Ribbed reinforcing steel, $R_e \geq 500 \text{ N/mm}^2$ |
| Compression spring | DIN 2098-1 | Steel |
| Protective cap | — | PP |
| PE-cap PE-sleeve PE-transition tube PE-protective tube | EN ISO 17855-1 | PE |
| Sealing | — | Synthetic caoutchouc |

¹⁾ Detailed material specifications are deposited at Österreichisches Institut für Bautechnik

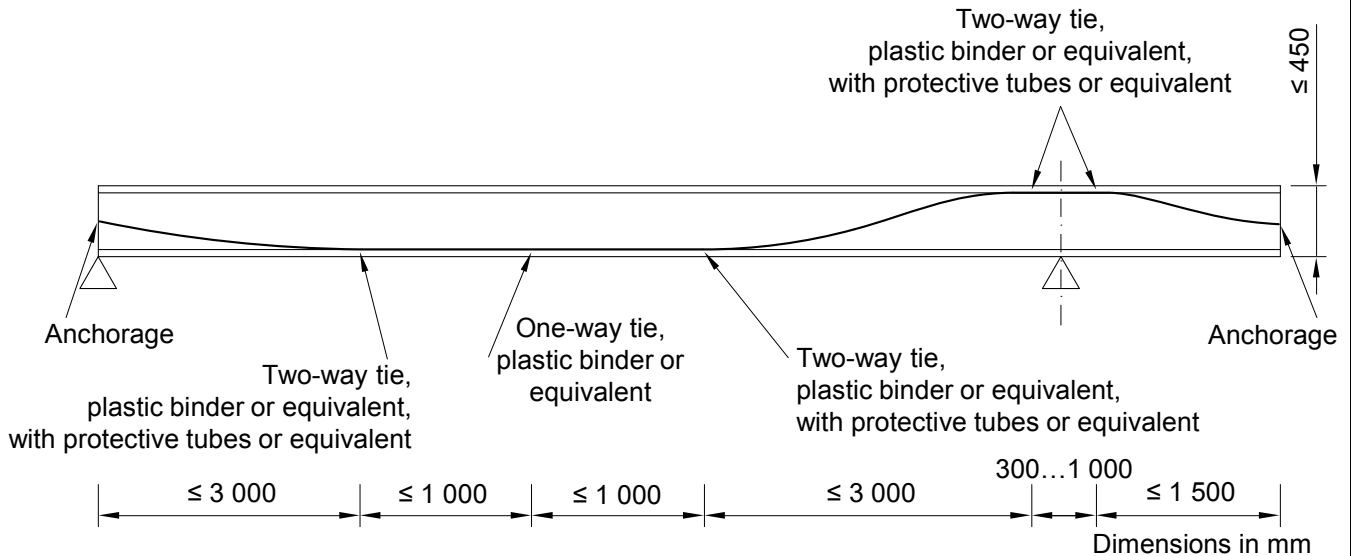


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DSI Unbonded Monostrand System
Material specifications

Annex 12
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Free tendon layout, plate thickness ≤ 450 mm



- 1 Installing the bottom layer of reinforcement on spacers
- 2 Installing the spacers for the top layer of reinforcement taking account of tendon installation
- 3 Installing the tendon anchorages, fastening onto the framework
- 4 Placing the tendons on the lower reinforcement and on the spacers for tendon top layer
- 5 Cutting the PE-sheathing to the required length
- 6 Inserting the tendons through the anchorages
- 7 Placing protective tubes (e.g. cut PE-sheathings) in the region of the connections with the reinforcement for protection of the tendons
- 8 Installing the upper reinforcement
- 9 Lifting up and connecting the tendons to the upper reinforcement
- 10 Connecting the tendons with the lower reinforcement
- 11 Connecting and proofing the tendons with tape at the PE-sleeves of the anchors
- 12 Supervising the correct seat of the anchors and of the PE-sleeves before concreting



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DSI Unbonded Monostrand System

Tendon installation instructions
Free tendon layout

Annex 13

of European Technical Assessment
ETA-19/0077 of 09.04.2019

| Subject / type of control | | Test of control method | Criteria, if any | Minimum number of samples | Minimum frequency of control | |
|--|---------------------------------|---|------------------|---------------------------|---|--|
| Anchor body, Coupling head BK, Coupling head FKM, Coupling sleeve BK, Coupling sleeve FKM | Material | Checking ¹⁾ | ²⁾ | 100 % | continuous | |
| | Detailed dimensions | Testing | ²⁾ | 5 %, ≥ 2 specimens | continuous | |
| | Visual inspection ³⁾ | Checking | ²⁾ | 100 % | continuous | |
| | Traceability | full | | | | |
| Wedge 68 00 0037, Wedge 68 00 0040 | Material | Checking ¹⁾ | ²⁾ | 100 % | continuous | |
| | Treatment, hardness | Testing | ²⁾ | 0.5 %, ≥ 2 specimens | continuous | |
| | Detailed dimensions | Testing | ²⁾ | 5 %, ≥ 2 specimens | continuous | |
| | Visual inspection ³⁾ | Checking | ²⁾ | 100 % | continuous | |
| | Traceability | full | | | | |
| Monostrand | Material | Checking ⁴⁾ | ²⁾ | 100 % | continuous | |
| | Diameter | Testing | ²⁾ | 1 sample | each coil or every 7 tons ⁵⁾ | |
| | Visual inspection ³⁾ | Checking | ²⁾ | 1 sample | | |
| ¹⁾ Checking of relevant certificate, the certificate is an inspection report 3.1 according to EN 10204. ²⁾ Conformity with the specifications of the components ³⁾ Successful visual inspection does not need to be documented. ⁴⁾ Checking of relevant certificate (CE) as long as the basis of "CE"-marking is not available. ⁵⁾ Maximum between a coil and 7 tons has to be taken into account Traceability full Full traceability of each component to its raw material. Material Defined according to the technical specification deposited by the supplier Detailed dimension Measuring of all the dimensions and angles according to the specification given in the test plan Visual inspection Main dimensions, correct marking and labelling, surface, corrosion, coating, etc. Treatment, hardness Surface hardness, core hardness and treatment depth | | | | | | |
|  DYWIDAG-Systems International GmbH www.dywidag-systems.com | | DSI Unbonded Monostrand System Contents of the prescribed test plan | | | Annex 14 of European Technical Assessment ETA-19/0077 of 09.04.2019 | |

| Subject / type of control | | Test of control method | Criteria, if any | Minimum number of samples ¹⁾ | Minimum frequency of control |
|--|-----------------------------------|--|------------------|---|------------------------------|
| Anchor body, Coupling head BK, Coupling head FKM, Coupling sleeve BK, Coupling sleeve FKM | Material | Checking and testing, hardness and chemical ²⁾ | ³⁾ | 1 | 1/year |
| | Detailed dimensions | Testing | ³⁾ | 1 | 1/year |
| | Visual inspection | Testing | ³⁾ | 1 | 1/year |
| Wedge 68 00 0037, Wedge 68 00 0040 | Material | Checking and testing, hardness and chemical ²⁾ | ³⁾ | 2 | 1/year |
| | Treatment, hardness | Checking and testing, hardness profile | ³⁾ | 2 | 1/year |
| | Detailed dimensions | Testing | ³⁾ | 1 | 1/year |
| | Main dimensions, surface hardness | Testing | ³⁾ | 5 | 1/year |
| | Visual inspection | Checking | ³⁾ | 5 | 1/year |
| Single tensile element test | | According to EAD 160004-00-0301, Annex C.7 | | 9 | 1/year |
| <p>¹⁾ 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.</p> <p>²⁾ Testing of hardness and checking of chemical composition by means of an inspection report 3.1 according to EN 10204.</p> <p>³⁾ Conformity with the specifications of the components</p> <p>Material Defined according to the technical specification deposited by the ETA holder at the Notified body</p> <p>Detailed dimension Measuring of all the dimensions and angles according to the specification given in the test plan</p> <p>Visual inspection Main dimensions, correct marking and labelling, surface, corrosion, coating, etc.</p> <p>Treatment, hardness Surface hardness, core hardness, and treatment depth</p> | | | | | |
|  DYWIDAG-Systems International GmbH www.dywidadg-systems.com | | DSI Unbonded Monostrand System Audit testing | | Annex 15 of European Technical Assessment ETA-19/0077 of 09.04.2019 | |

European Assessment Document

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

Standards

| | |
|--------------------------|--|
| Eurocode 2 | Eurocode 2 – Design of concrete structures |
| EN 206+A1 (11.2016) | Concrete – Specification, performance, production and conformity |
| EN 1563 (08.2018) | Founding – Spheroidal graphite cast irons |
| EN 10025-2+AC (06.2005) | Hot rolled products of structural steels – Part 2: Technical delivery conditions for non-alloy structural steels |
| EN 10083-2+A1 (08.2006) | Steels for quenching and tempering – Part 2: Technical delivery conditions for non-alloy steels |
| EN 10084 (04.2008) | Case hardening steels – Technical delivery conditions |
| EN 10204 (10.2004) | Metallic products – Types of inspection documents |
| EN 10277-2 (03.2008) | Bright steel products – Technical delivery conditions – Part 2: Steels for general engineering purposes |
| EN ISO 7089 (06.2000) | Plain washers – Normal series, Product grade A |
| EN ISO 17855-1 (11.2014) | Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications |
| 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 |
| DIN 2098-1 (10.1968) | Helical springs made from round wire – Cold coiled compression springs above and including 0.5 mm wire diameter |

Other documents

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

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