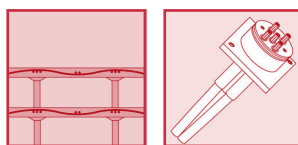




European Organisation for Technical Approvals  
Europäische Organisation für Technische Zulassungen  
Organisation Européenne pour l'Agrément Technique



## POST-TENSIONING

**SUSPA/DYWIDAG –  
Unbonded Monostrand System  
with 1 to 5 Monostrands**

**ETA-03/0036**

29 January 2021



Austrian Institute of Construction Engineering  
Schenkenstrasse 4 | T+43 1 533 65 50  
1010 Vienna | Austria | F+43 1 533 64 23  
www.oib.or.at | mail@oib.or.at



## European Technical Assessment

**ETA-03/0036**  
of 29.01.2021

### General part

#### Technical Assessment Body issuing the European Technical Assessment

Österreichisches Institut für Bautechnik (OIB)  
Austrian Institute of Construction Engineering

#### Trade name of the construction product

SUSPA/DSI – Unbonded Monostrand System  
with 1 to 5 Monostrands

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

Unbonded post-tensioning kits for prestressing of  
structures with monostrands

#### Manufacturer

DYWIDAG-Systems International GmbH  
Neuhofweg 5  
85716 Unterschleissheim  
Germany

#### Manufacturing plants

DYWIDAG-Systems International GmbH  
Max-Planck-Ring 1  
40764 Langenfeld  
Germany

DYWIDAG-Systems International GmbH  
ul. Hallera 78  
41-709 Ruda Śląska  
Poland

#### This European Technical Assessment contains

38 pages including Annexes 1 to 15, which form  
an integral part of this assessment.

#### This European Technical Assessment is issued in accordance with Regulation (EU) № 305/2011, on the basis of

European Assessment Document  
(EAD) 160004-00-0301 – Post-Tensioning Kits  
for Prestressing of Structures.

#### This European Technical Assessment replaces

European Technical Assessment ETA-03/0036 of  
15.06.2018.

## Table of contents

<b>EUROPEAN TECHNICAL ASSESSMENT    ETA-03/0036 OF 29.01.2021 .....</b>	<b>1</b>
GENERAL PART.....	1
TABLE OF CONTENTS.....	2
REMARKS .....	6
SPECIFIC PARTS.....	6
<b>1     TECHNICAL DESCRIPTION OF THE PRODUCT.....</b>	<b>6</b>
1.1    General .....	6
PT SYSTEM.....	7
1.2    Designation and range of anchorages and couplings .....	7
1.2.1    Designation .....	7
1.2.2    Single anchorages SK6 and SF6 and couplings KS6-SK6 and K6-K6.....	7
1.2.2.1    General.....	7
1.2.2.2    Stressing anchor SK6 .....	7
1.2.2.3    Fixed anchor SF6.....	7
1.2.2.4    Fixed coupling KS6-SK6 .....	7
1.2.2.5    Movable coupling K6-K6 .....	7
1.2.3    Multistrand anchorages MER6 and MEF6 .....	7
1.2.3.1    Stressing anchor MER6 .....	7
1.2.3.2    Fixed anchor MEF6.....	8
1.2.4    Centre and edge distances of anchorages, concrete cover .....	8
1.2.5    Strength of concrete .....	8
1.2.6    Reinforcement in the anchorage zone.....	8
1.3    Designation and range of tendons.....	8
1.3.1    Designation .....	8
1.3.2    Range of tendons.....	9
1.3.3    Maximum stressing forces.....	9
1.4    Slip at anchorages.....	9
1.5    Friction losses .....	10
1.6    Support of monostrands .....	10
1.7    Radii of curvature of internal tendons .....	10
COMPONENTS.....	11
1.8    Monostrand .....	11
1.8.1    Specification of prestressing steel strand .....	11
1.8.2    Specification of monostrand .....	11

1.9	Anchorage components.....	11
1.9.1	General .....	11
1.9.2	Anchor and coupling heads .....	11
1.9.3	Wedges.....	12
1.9.4	Helix .....	12
1.10	Permanent corrosion protection.....	12
1.11	Material specifications of the components .....	12
<b>2</b>	<b>SPECIFICATION OF THE INTENDED USE IN ACCORDANCE WITH THE APPLICABLE EUROPEAN ASSESSMENT DOCUMENT (HEREINAFTER EAD).....</b>	<b>12</b>
2.1	Intended use .....	12
2.2	Assumptions.....	12
2.2.1	General .....	12
2.2.2	Packaging, transport and storage.....	12
2.2.3	Design.....	13
2.2.4	Installation.....	13
2.2.4.1	General.....	13
2.2.4.2	De-sheathing of monostrands .....	13
2.2.4.3	Examination of tendons and possible repairs of the corrosion protection system .....	14
2.2.4.4	Stressing anchor SK6 .....	14
2.2.4.5	Fixed anchor SF6.....	14
2.2.4.6	Fixed coupling KS6-SK6 .....	15
2.2.4.7	Movable coupling K6-K6 .....	15
2.2.4.8	Stressing anchor MER6 .....	16
2.2.4.9	Fixed anchor MEF6.....	17
2.2.4.10	Checking of tendons .....	17
2.2.4.11	Stressing and stressing records .....	17
2.2.4.11.1	General .....	17
2.2.4.11.2	Stressing .....	17
2.2.4.11.3	Restressing .....	18
2.2.4.11.4	Stressing records .....	18
2.2.4.11.5	Stressing equipment, clearance requirements, and safety-at-work.....	18
2.2.4.12	Welding at anchorages .....	18
2.3	Assumed working life .....	18
<b>3</b>	<b>PERFORMANCE OF THE PRODUCT AND REFERENCES TO THE METHODS USED FOR ITS ASSESSMENT ....</b>	<b>19</b>
3.1	Essential characteristics .....	19
3.2	Product performance.....	20
3.2.1	Mechanical resistance and stability .....	20
3.2.1.1	Resistance to static load .....	20
3.2.1.2	Resistance to fatigue .....	20

3.2.1.3	Load transfer to the structure .....	20
3.2.1.4	Friction coefficient .....	20
3.2.1.5	Deviation, deflection (limits) for internal bonded and unbonded tendon .....	20
3.2.1.6	Assessment of assembly .....	20
3.2.1.7	Corrosion protection .....	20
3.2.2	Safety in case of fire .....	20
3.2.2.1	Reaction to fire .....	20
3.2.3	Hygiene, health, and the environment .....	20
3.2.3.1	Content, emission and/or release of dangerous substances .....	20
3.3	Assessment methods .....	21
3.4	Identification .....	21
<b>4</b>	<b>ASSESSMENT AND VERIFICATION OF CONSTANCY OF PERFORMANCE (HEREINAFTER AVCP) SYSTEM APPLIED, WITH REFERENCE TO ITS LEGAL BASE .....</b>	<b>21</b>
4.1	System of assessment and verification of constancy of performance .....	21
4.2	AVCP for construction products for which a European Technical Assessment has been issued .....	22
<b>5</b>	<b>TECHNICAL DETAILS NECESSARY FOR THE IMPLEMENTATION OF THE AVCP SYSTEM, AS PROVIDED FOR IN THE APPLICABLE EAD .....</b>	<b>22</b>
5.1	Tasks for the manufacturer .....	22
5.1.1	Factory production control .....	22
5.1.2	Declaration of performance .....	23
5.2	Tasks for the notified product certification body .....	23
5.2.1	Initial inspection of the manufacturing plant and of factory production control .....	23
5.2.2	Continuing surveillance, assessment and evaluation of factory production control .....	23
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 .....	23
<b>ANNEXES</b>	<b>.....</b>	<b>24</b>
ANNEX 1	ANCHORAGES AND COUPLINGS – OVERVIEW .....	24
ANNEX 2	BASIC COMPONENTS OF ANCHORAGES – CAST-IRON ANCHORS SK6 AND SF6 .....	25
ANNEX 3	STRESSING ANCHOR SK6 AND FIXED ANCHOR SF6 .....	26
ANNEX 4	STRESSING ANCHOR SK6 AND FIXED ANCHOR SF6 – MINIMUM CENTRE AND EDGE DISTANCES .....	27
ANNEX 5	FIXED COUPLING KS6-SK6 .....	28
ANNEX 6	MOVABLE COUPLING K6-K6 .....	29
ANNEX 7	STRESSING ANCHOR MER6 AND FIXED ANCHOR MEF6 .....	30
ANNEX 8	STRESSING ANCHOR MER6 AND FIXED ANCHOR MEF6 – SIZE 6-2 TO 6-5 .....	31

ANNEX 9	TENDON INSTALLATION INSTRUCTIONS – FREE TENDON LAYOUT .....	32
ANNEX 10	MAXIMUM PRESTRESSING AND OVERSTRESSING FORCES .....	33
ANNEX 11	PRESTRESSING STEEL STRANDS – CHARACTERISTIC MAXIMUM FORCE OF TENDON .....	34
ANNEX 12	MATERIAL SPECIFICATIONS.....	35
ANNEX 13	CONTENTS OF THE PRESCRIBED TEST PLAN.....	36
ANNEX 14	AUDIT TESTING .....	37
ANNEX 15	REFERENCE DOCUMENTS.....	38

## Remarks

Translations of the European Technical Assessment in other languages shall fully correspond to the original issued document and should be identified as such.

Communication of the European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may be made with the written consent of Österreichisches Institut für Bautechnik. Any partial reproduction has to be identified as such.

## Specific parts

### 1 Technical description of the product

#### 1.1 General

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

#### **SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands,**

comprising the following components.

- Tendon

Unbonded monostrand tendon with one to five 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 corrosion protection filling material and PE-sheathing

**Table 1** Tensile elements

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

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

- Anchorage and coupling

Monostrand anchored by 2-piece wedge

Stressing and fixed anchors SK6 and SF6 for tendons with one single monostrand

Fixed coupling KS6-SK6 and movable coupling K6-K6 for tendons with one single monostrand

Stressing and fixed anchors MER6 and MEF6 for tendons with 2 to 5 monostrands

<sup>1</sup> ETA-03/0036 was firstly issued in 2004 as European technical approval with validity from 01.04.2004, amended in 2009 with validity from 01.04.2009 and 2013 with validity from 30.06.2013, converted 2018 to European Technical Assessment ETA-03/0036 of 15.06.2018 and amended in 2021 to European Technical Assessment ETA-03/0036 of 29.01.2021.

<sup>2</sup> Standards and other documents referred to in the European Technical Assessment are listed in Annex 15.

For monostrands with a nominal tensile strength of either 1 860 N/mm<sup>2</sup> or 1 770 N/mm<sup>2</sup>, the same anchorages and couplings are used.

- Helix and additional reinforcement in the anchorage zone
- Corrosion protection for tensile elements, anchorages, and couplings

## PT system

### 1.2 Designation and range of anchorages and couplings

#### 1.2.1 Designation

Anchorage and coupling are designated according to their function in the structure, by the nominal diameter of the prestressing steel strand, and the number of required prestressing steel strands with 6-n. The first number indicates the nominal diameter of prestressing steel strand (6 = 15.7 mm (0.62 ")), followed by the maximum number n of prestressing steel strands per anchorage or coupling. The available anchorages and couplings are shown in Annex 1.

#### 1.2.2 Single anchorages SK6 and SF6 and couplings KS6-SK6 and K6-K6

##### 1.2.2.1 General

With these anchorages and couplings only one single monostrand is anchored or coupled. If installed with additional reinforcement, the minimum centre and edge distances can be attained with these anchorages, see Annex 4.

##### 1.2.2.2 Stressing anchor SK6

The stressing anchor SK6, see Annex 2, is fastened to the formwork on site and connected to the monostrand, see Annex 3. A PE-sleeve covers the transition from monostrand to anchorage and completes the corrosion protection. The stressing anchor can also be used as a fixed anchor. In that case, access is given to the fixed anchor during stressing.

The stressing anchor SK6 is designed to allow, after stressing, the anchor to be connected to the coupling head KS6 to form a fixed coupling, see Annex 5.

##### 1.2.2.3 Fixed anchor SF6

The outward appearance of the fixed anchor SF6, see Annex 2, is identical to the stressing anchor SK6. In the factory, the fixed anchor is attached to the monostrand, which is cut to the required length. The wedges of the fixed anchor are secured by spring and protective cap, see Annex 3. A PE-sleeve covers the transition from monostrand to anchorage and completes the corrosion protection.

##### 1.2.2.4 Fixed coupling KS6-SK6

This coupling allows the joining of a second tendon with an already stressed first tendon, see Annex 5. This is achieved by screwing coupling head KS6 with coupling sleeve S into the already stressed stressing anchor SK6. Subsequently, the monostrand is inserted into the self-acting anchorage of the coupling head KS6. A PE-sleeve covers the transition from monostrand to coupling head KS6 and completes the corrosion protection.

##### 1.2.2.5 Movable coupling K6-K6

The movable coupling is used to join two monostrands, which subsequently are stressed at the same time, see Annex 6. The corrosion protection is completed by two overlapping PE-protective tubes, filled with corrosion protection filling material.

#### 1.2.3 Multistrand anchorages MER6 and MEF6

##### 1.2.3.1 Stressing anchor MER6

2 to 5 monostrands are anchored in one anchorage, with bore hole distances of 33 mm. A rectangular bearing plate is used, see Annex 7 and Annex 8, to which PE-transition tubes have already been attached in the factory. The bearing plate is fastened to the formwork on site and

connected to the monostrands. PE-transition tubes cover the transition from monostrands to anchorage and complete the corrosion protection. The stressing anchor can also be used as a fixed anchor. In that case, access is given to the fixed anchor during stressing.

#### 1.2.3.2 Fixed anchor MEF6

In the factory, the anchor head is tack welded to the bearing plate and the PE-transition tubes are attached to the bearing plate, see Annex 7. The anchorage can be connected to the monostrands either in the factory or on site. PE-transition tubes cover the transition from monostrands to anchorage and complete the corrosion protection.

#### 1.2.4 Centre and edge distances of anchorages, concrete cover

All centre and edge distances have been determined with regard to requirements on load-bearing capacity. Centre and edge distances of anchorages conform to the values specified in Annex 4 and Annex 8. However, the values specified in Annex 4 and Annex 8 for centre distance between anchorages may be reduced in one direction by 15 % but are not lower than the outside diameter of the helix. In case of a reduction of the distances in one direction, the centre and edge distances in the perpendicular direction are increased by the same percentage in order to keep an equal concrete area in the anchorage zone.

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

#### 1.2.5 Strength of concrete

Concrete according to EN 206 is used.

For stressing, the mean compressive strength of concrete is at least  $f_{cm,0}$  as given in Annex 4 and Annex 8. The actual mean compressive strength,  $f_{cm,0,cube}$  or  $f_{cm,0,cyl}$ , is verified by means of at least three specimens, cube of size 150 mm or cylinder with diameter of 150 mm and height of 300 mm, which are cured under the same conditions as the structure.

For partial prestressing with 30 % of the full prestressing force, the actual mean 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.

#### 1.2.6 Reinforcement in the anchorage zone

In any case, steel grades and dimensions of helix and additional reinforcement specified in Annex 4 and Annex 8 are conformed to.

The centric position of the helix is secured by welding the end ring onto the bearing plate or by means of holding devices braced against the tendon.

If required for a specific project design, the reinforcement given in Annex 4 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.

### 1.3 Designation and range of tendons

#### 1.3.1 Designation

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

### 1.3.2 Range of tendons

SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands includes tendons with 1, 2, 3, 4, and 5 monostrands according to Clause 1.1 and Annex 11. The monostrands of each tendon are anchored in stressing and fixed anchors according to Clause 1.2.2 and 1.2.3.

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 10 lists the maximum prestressing and overstressing forces of the tendons according to Eurocode 2. I.e., the maximum prestressing force applied to a tendon does not exceed  $0.90 \cdot A_p \cdot f_{p0.1k}$ . 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 overstressing force.

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

Where

$A_p$  .....mm<sup>2</sup> ..... Cross-sectional area of prestressing steel, i.e.  $A_p = n \cdot S_0$

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

$n$  ..... — ..... Number of prestressing steel strands, i.e.  $n = 1$  to  $5$

$S_0$  .....mm<sup>2</sup> ..... 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

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

## 1.4 Slip at anchorages

Slip at anchorages is taken into consideration in design and for determining tendon elongation. Table 2 specifies the slip values that are taken into consideration in calculations of tendon elongation and tendon force, as well as the required locking measures of wedges at anchorages and couplings that are passive during stressing.

**Table 2** Slip values and wedge locking for anchorages and couplings

Anchorage, coupling	Slip	Wedge locking
—	mm	—
Stressing anchor <sup>1)</sup> SK6	5	Protective cap
Stressing anchor <sup>1)</sup> MER6	6	Locking plate
Fixed anchor SF6	5	Washer, compression spring, protective cap
Fixed anchor MEF6	5	Locking plate
Fixed coupling 2 <sup>nd</sup> tendon KS6-SK6	5	Washer, compression spring
Movable coupling K6-K6, total	10	Washer, compression spring

NOTE

<sup>1)</sup> Slip at transfer of prestressing force from jack to anchorage.

## 1.5 Friction losses

The tendon layout should not feature abrupt changes of the tendon axis, since this may lead to significant additional friction losses. For calculation of losses of prestressing forces due to friction, Coulomb's friction law applies. Due to the corrosion protection filling material within the PE-sheathing of monostrands, the friction coefficient  $\mu$  is very low. Calculation of friction loss is by the equation

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

Where

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

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

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

$\alpha$  .....  $\text{rad}$ .....Sum of angular deviations over a distance  $x$ , irrespective of direction and sign

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

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

NOTE 1  $\text{rad} = 1 \text{ m/m} = 1$

Friction losses in the anchorages are low and are not taken into consideration in design and execution.

## 1.6 Support of monostrands

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

- 1 Normally ..... 1.00–1.30 m

For radius of curvature in normal cases see Clause 1.7.

- 2 Free tendon layout, see Annex 9, in maximum 45 cm 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 a spacing of 0.3 m to 1.0 m. The rebar mesh is fixed in its position. Therefore, special spacers for tendons are not required. For details see Annex 9.

## 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 anchors 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 strand with plain surfaces of the individual wires, a nominal diameter of 15.7 mm and tensile strengths of 1 770 N/mm<sup>2</sup> or 1 860 N/mm<sup>2</sup> is used. Dimensions and specifications of prestressing steel strand are according to prEN 10138-3 and are given in Clause 1.1, Table 1, and Annex 11.

#### 1.8.2 Specification of monostrand

The monostrand is a 7-wire prestressing steel strand according to Clause 1.8.1, factory provided with a corrosion protection system comprising corrosion protection filling material and PE-sheathing, see Table 3.

Within one structure, prestressing steel strands with one characteristic tensile strength should be used. If tendons with prestressing steel strands of different tensile strengths are to be installed, appropriate measures to prevent confusion are implemented.

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.

**Table 3** Monostrand

7-wire prestressing steel strand	—	Y1770S7 <sup>1)</sup>	Y1860S7 <sup>1)</sup>
Nominal diameter	mm	15.7 <sup>2)</sup>	15.7 <sup>2)</sup>
Nominal cross-sectional area	mm <sup>2</sup>	150	150
Characteristic tensile strength	N/mm <sup>2</sup>	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

<sup>1)</sup> Designation according to prEN 10138-3

<sup>2)</sup> Corresponding to 0.62 inches

### 1.9 Anchorage components

#### 1.9.1 General

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

For prestressing steel strands with nominal tensile strength of 1 860 N/mm<sup>2</sup> as well as 1 770 N/mm<sup>2</sup> the same anchorages and couplings are used.

#### 1.9.2 Anchor and coupling heads

The exits of the conical bores of anchor and coupling heads are countersunk and deburred. For installation, they are clean, free from rust, and provided with corrosion protection oil.

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

### 1.9.3 Wedges

Only wedges as specified in Annex 2 are used. The wedges feature an annular groove.

### 1.9.4 Helix

Steel grades and dimensions of helixes conform to the values specified in Annex 8 and Annex 12.

In general, both ends of each helix are welded to closed rings. Welding of one end, the inner end, may be omitted. Details on welding of helix are given in Annex 8.

## 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 and 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 comprising corrosion protection 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 void in the anchorage zone is completely filled with a corrosion protection filling material.

If PE-protective tubes with a length of more than 1.5 m are installed with the movable couplings K6-K6, handling tests for injection of the corrosion protection filling material are performed prior to injection.

## 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 SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands is intended to be used for the prestressing of structures. The 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 wound 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 steels and components in order to prevent corrosion during transportation from the production site to the job 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 tendon 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 helix and additional reinforcement, see Clause 1.2.4, Clause 1.2.5, Clause 1.2.6, Annex 4, and Annex 8 are conformed to. The forces outside the area of helix and 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 anchorage recess is designed as to ensure a concrete cover of at least 25 mm at the caps in the final stage.
- 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 stressing 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.
- Under all possible load combinations, the stressing force at the 2<sup>nd</sup> construction stage of the fixed coupler is at no time higher than at the 1<sup>st</sup> construction stage, neither during construction nor in the final stage.
- The length of the PE-protective tube and its position relative to the coupler ensures unimpeded movement of the coupler in the PE-protective tube along a length of minimum  $1.15 \cdot \Delta l + 30$  mm, where  $\Delta l$  in mm as the expected displacement of the coupler during stressing.

### 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 the SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands, 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 SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands.

The centric position of the additional reinforcement is secured by tying or by means of spacers braced against the tendon.

#### 2.2.4.2 De-sheathing of monostrands

The length of the PE-sleeves, see Annex 2, and the tube connections of the PE-protective tubes, see Annex 6, as well as the length along which the monostrand sheathing is removed are

determined by the PT specialist company depending on the expected variations in temperature between installation and concreting. The monostrand sheathing overlaps the PE-sleeve, the tube connections of the PE-protective tubes, or the PE-transition tube by at least 150 mm and does not press against the anchorage. This is checked by application of markings before concreting.

#### 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.

The fixed anchor MEF6, see Annex 7, is only installed if all tack welding seams between the bearing plate and anchor head are intact, ensuring a safe and joint free connection between bearing plate and anchor head.

#### 2.2.4.4 Stressing anchor SK6

The stressing anchor SK6 is designed that, after stressing, it can be connected to the coupling head KS6 to form a fixed coupling, see Annex 5.

The anchor SK6 is fastened to the formwork on site and connected to the monostrand. It can also be used as a fixed anchor. In that case, access is given to the fixed anchor during stressing.

Site assembly comprises the following working steps, see Annex 3.

- Fastening the cast-iron anchor using the sealing washer and installation spindle that is pushed through the hole in the formwork.
- Placing PE-sleeve and sealing sleeve onto the monostrand.
- Placing the monostrand against the anchorage to mark the cutting point on the PE-sheathing.
- Cutting and pulling off the PE-sheathing in the anchorage zone of the prestressing steel strand.
- Inserting the monostrand through the cast-iron anchor.
- Filling corrosion protection filling material into the expanded section of the PE-sleeve and screwing the PE-sleeve onto the cast-iron anchor.
- Sealing the transition zone PE-sleeve to monostrand with the sealing sleeve. The two parts overlap by at least 3 cm.

Alternatively, the transition zone PE-sleeve to monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.

- Place the previously removed PE sheathing onto the prestressing steel strand ends in order to protect the prestressing steel strand protrusions.

#### 2.2.4.5 Fixed anchor SF6

As a rule, this anchorage is factory-assembled. Factory assembly comprises the following working steps.

- Filling a sufficient quantity of corrosion protection filling material into the expanded section of the PE-sleeve.
- Screwing PE-sleeve and sealing sleeve onto the cast-iron anchor.
- Placing the wedge into the conical bore.
- Mounting compression spring and washer.

- Filling in a measured quantity of corrosion protection filling material.
  - Screwing on the protective cap.
  - Removing a 5 to 6 cm long piece of the PE-sheathing from the monostrand.
  - Applying a marking on the sheathing of the monostrand.
  - Inserting the de-sheathed monostrand through the PE-sleeve until it pushes against the protective cap of the cast-iron anchor.
  - Checking the insertion depth by means of the marking on the monostrand sheathing.
  - Wiping off corrosion protection filling material that has leaked from the PE-sleeve.
  - Sealing the transition zone PE-sleeve to monostrand with the sealing sleeve. The two parts overlap by at least 3 cm.
- Alternatively, the transition zone PE-sleeve to monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.
- Cut the monostrand from the coil.

#### 2.2.4.6 Fixed coupling KS6-SK6

Fixed coupling is used for joining non-stressed tendon to already stressed tendon by means of a factory-prepared coupling head KS6, see Annex 5.

Site assembly comprises the following working steps.

- Removing the protective cap from the stressing anchor SK6.
  - Removing the PE-cap and the PE-plug from the coupling head KS6 and screwing the coupling head KS6 into the internal thread of the stressing anchor SK6.
  - Fill a sufficient quantity of corrosion protection filling material into the expanded section of the PE-sleeve.
  - Pushing PE-sleeve and sealing sleeve onto the monostrand.
  - Removing approximately 12 cm of the monostrand PE-sheathing.
  - Apply a coloured marking on the monostrand.
  - Placing the de-sheathed prestressing steel strand into the coupling head KS6. The wedge pushed forwards by the compression spring secure the position of the monostrands.
  - Check the insertion depth by means of the coloured marking.
  - Sealing the transition zone PE-sleeve to monostrand by the sealing sleeve. The two parts overlap by at least 3 cm.
- Alternatively, the transition zone PE-sleeve to monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.

#### 2.2.4.7 Movable coupling K6-K6

The movable coupling is used for joining two tendons that are subsequently stressed at the same time, see Annex 6.

Site assembly comprises the following working steps.

Tendon № 1

- Removing approximately 12 cm of the monostrand PE-sheathing.
- Applying a coloured marking on the monostrand.
- Placing PE-protective tube section 1 and sealing sleeve onto the monostrand.
- Filling a sufficient quantity of corrosion protection filling material into the expanded section of the PE-protective tube section 1.

#### Tendon № 2

- Removing the PE-sheathing of the monostrand along a length equal to that of the PE-protective tube minus 10 cm.
- Applying a coloured marking on the monostrand.
- Placing the PE-protective tube section 2 with the sealing sleeve onto the monostrand.

#### Coupling

- Removing the PE-protective caps from the prefabricated coupling filled with corrosion protection filling material.
- Placing the coupling onto the de-sheathed prestressing steel strand of tendon № 1 up to the steel locking pin.
- Inserting the de-sheathed prestressing steel strand of tendon № 2 into the coupling up to the steel locking pin.
- Check the insertion depth of the monostrands by means of the coloured marking 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 PE-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.
- Push forward the PE-protective tube section 2 to approximately 2 cm before the end of the expanded section of the PE-protective tube section 1.
- Sealing the transition zone of PE-protective tube section 2 to tendon № 2 with the sealing sleeve with an overlap of at least 3 cm.

Alternatively, the transition zone PE-protective tube to monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.

- 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.
- Sealing the transition zone PE-protective tube section 1 to PE-protective tube section 2 with adhesive tape and sealing of the transition zone PE-protective tube section 1 to tendon № 1 with the sealing sleeve with an overlap of at least 3 cm.

Alternatively, the transition zone PE-protective tube to monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.

#### 2.2.4.8 Stressing anchor MER6

2 to 5 monostrands are anchored in one anchorage. Rectangular bearing plates are used, see Annex 7 and Annex 8, which have already been provided with PE-transition tubes in the factory. The bearing plate is fastened to the formwork on site and connected to the monostrands. The stressing anchor can also be used as a fixed anchor. In that case, access is given to the fixed anchor during stressing.

Site assembly comprises the following working steps.

- Fastening the bearing plate to the formwork with screws.
- Placing the monostrands against the anchor to mark the cutting point on the PE-sheathings.
- Cutting the PE-sheathings.

- Inserting the monostrand through PE-transition tube and bearing plate.

Stressing comprises the following working steps.

- Removing the PE-sheathing from the prestressing steel strand protrusion.
- Placing the anchor head onto the prestressing steel strand protrusions.
- Filling the void in the anchorage with corrosion protection filling material using a thin injection lance and inserting the wedges in the conical bore.
- Stressing with prestressing jack.
- Cutting the prestressing steel strand protrusion with a cutting disk or cutting tool.
- Placing the PE-caps filled with corrosion protection filling material onto the projecting prestressing steel strand ends.
- Placing the locking plate onto the PE-caps and screwing the locking plate onto the anchor head. It secures the position of the PE-caps and prevents bursting out of prestressing steel strands in case of failure.
- Filling the anchorage recess with concrete.

#### 2.2.4.9 Fixed anchor MEF6

The anchor head is tack welded in the factory and the PE-transition tubes are fastened onto the bearing plate in the factory. The anchorage may be assembled in the factory or on site.

Assembly comprises the following working steps.

- Removing the sheathing from the monostrands along a length of 9 to 12 cm.
- Inserting the de-sheathed monostrands through PE-transition tube, bearing plate, and anchor head until the ends of the prestressing steel strands protrude from the anchor head by approximately 2 to 3 cm.
- Filling the void in the anchorage with corrosion protection filling material using a thin injection lance and inserting the wedges in the conical bores.
- Placing the PE-caps filled with corrosion protection filling material onto the prestressing steel strand ends.
- Placing the locking plate with sealing onto the PE-caps and screwing the locking plate onto the anchor head.

#### 2.2.4.10 Checking of tendons

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

#### 2.2.4.11 Stressing and stressing records

##### 2.2.4.11.1 General

The geometrical properties of anchor heads, centre and edge distances and additional reinforcement of tendons are specified in Annex 4 and Annex 8.

##### 2.2.4.11.2 Stressing

With a mean concrete compressive strength in the anchorage zone of  $f_{cm,0}$  according to the specifications in Annex 4 and Annex 8, full stressing may be applied.

Stressing comprises the following working steps.

- Removing the PE protective sheathing from the prestressing steel strand protrusion.
- Filling the void in the anchorage with corrosion protection filling material using a thin injection lance.

- Inserting the wedges into the conical bore of the stressing anchor.
- Stressing with prestressing jack.
- Measure tendon elongation during stressing.
- Cutting off the prestressing steel strand protrusion with a cutting disk or cutting tool.
- Screwing on the cap filled with corrosion protection filling material.
- Filling the anchorage recess with concrete.

#### 2.2.4.11.3 Restressing

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

#### 2.2.4.11.4 Stressing records

All stressing operations are recorded for each tendon. Primarily, stressing is performed up to the required force. For control, the elongation is measured and compared with the prior calculated value.

#### 2.2.4.11.5 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.

Stressing of single and multistrand anchorages requires approximately 1 m of free space directly behind the anchorages. 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.

#### 2.2.4.12 Welding at anchorages

Welding is not permitted at anchorages, except welding the end turns of the helix and welding the helix and tack welding the anchor head onto the bearing plate.

In case of welding operations near tendons, precautionary measures are required to avoid damage to the corrosion protection system.

### 2.3 Assumed working life

The European Technical Assessment is based on an assumed working life of SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands of 100 years, provided that SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands is subject to appropriate installation, use, and maintenance, see Clause 2.2.

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

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

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

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

#### 3.1 Essential characteristics

The performances of SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands for the essential characteristics are given in Table 4.

**Table 4** 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.	—
Basic requirement for construction works 6: Energy economy and heat retention		
—	Not relevant. No characteristic assessed.	—
Basic requirement for construction works 7: Sustainable use of natural resources		
—	No characteristic assessed.	—

## 3.2 Product performance

### 3.2.1 Mechanical resistance and stability

#### 3.2.1.1 Resistance to static load

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

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  $80 \text{ N/mm}^2$  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 are listed 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 bonded and unbonded tendon

For minimum radii of curvature 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 SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands, 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 tendon.

### 3.4 Identification

The European Technical Assessment for SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands is issued on the basis of agreed data that identify the assessed product<sup>5</sup>. 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 SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands is System 1+. System 1+ is detailed in Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, Annex, point 1.1., and provides for the following items.

- (a) The manufacturer shall carry out
  - (i) factory production control;
  - (ii) further testing of samples taken at the manufacturing plant by the manufacturer in accordance with the prescribed test plan<sup>6</sup>.
- (b) The notified product certification body shall decide on the issuing, restriction, suspension or withdrawal of the certificate of constancy of performance of the construction product on the basis of the outcome of the following assessments and verifications carried out by that body
  - (i) an assessment of the performance of the construction product carried out on the basis of testing (including sampling), calculation, tabulated values or descriptive documentation of the product;
  - (ii) initial inspection of the manufacturing plant and of factory production control;
  - (iii) continuing surveillance, assessment, and evaluation of factory production control;
  - (iv) audit-testing of samples taken by the notified product certification body at the manufacturing plant or at the manufacturer's storage facilities.

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

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

## **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 13, conform to EAD 160004-00-0301, Table 3, and are specified in the quality management plan of the SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands.

The results of inspections, tests, and checks are evaluated for conformity. Shortcomings request the manufacturer to immediately implements 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 14.

### 5.1.2 Declaration of performance

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

## 5.2 Tasks for the notified product certification body

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

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

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

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

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

Each manufacturer of the components given in Annex 14 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 request 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

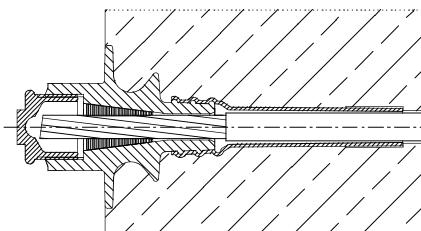
During surveillance inspection, the notified product certification body takes samples of components of the PT system for independent testing. Audit-testing is conducted at least once a year by the notified product certification body. For the most important components, Annex 14 summarises the minimum procedures. Annex 14 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 29 January 2021  
by Österreichisches Institut für Bautechnik

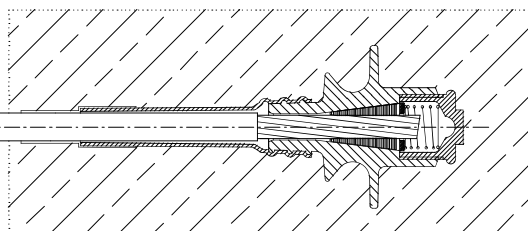
The original document is signed by

Rainer Mikulits  
Managing Director

Stressing anchor SK6

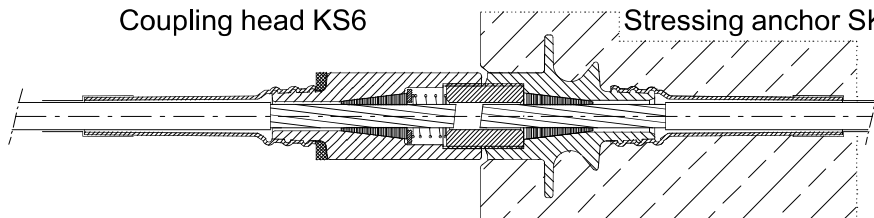


Fixed anchor SF6



Fixed coupling KS6-SK6

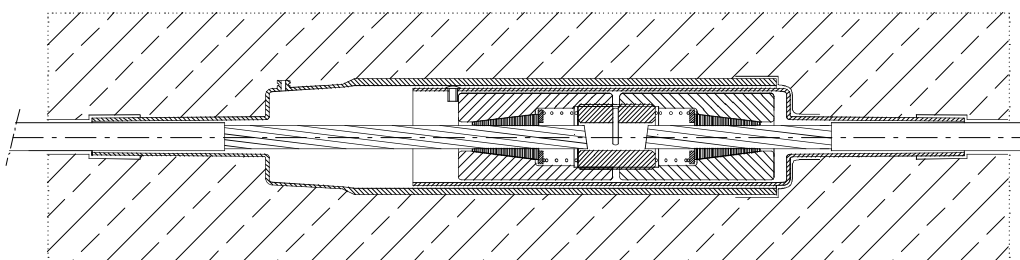
Coupling head KS6



Stressing anchor SK6

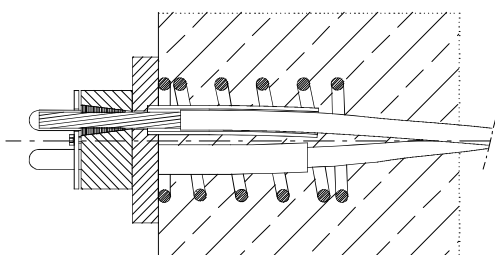
Movable coupling K6-K6

Tendon № 1

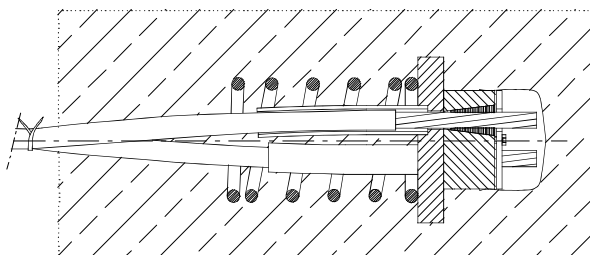


Tendon № 2

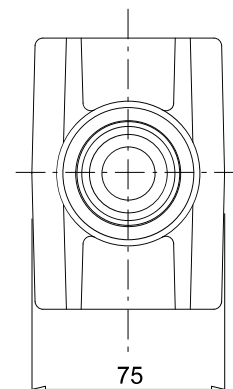
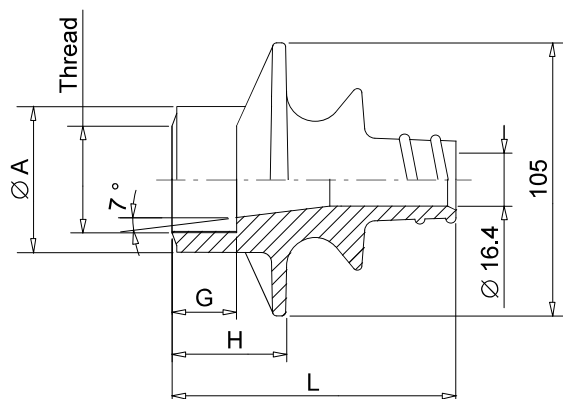
Stressing anchor MER6



Fixed anchor MEF6

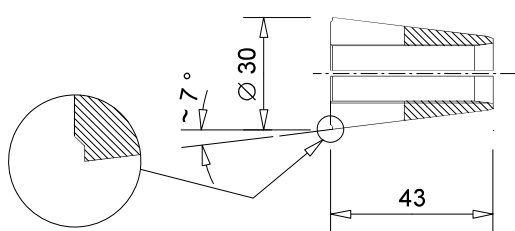


### Cast iron anchor SK6 and SF6



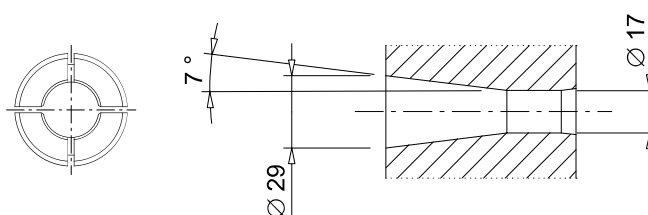
Anchor	Ø A	G	H	L
—	mm	mm	mm	mm
SK6	56	25	45	110
SF6	51	10	30	95

### Wedge

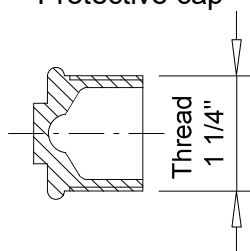


Wedges for prestressing steel strands with nominal diameter 15.7 mm feature an annular groove on the front face.

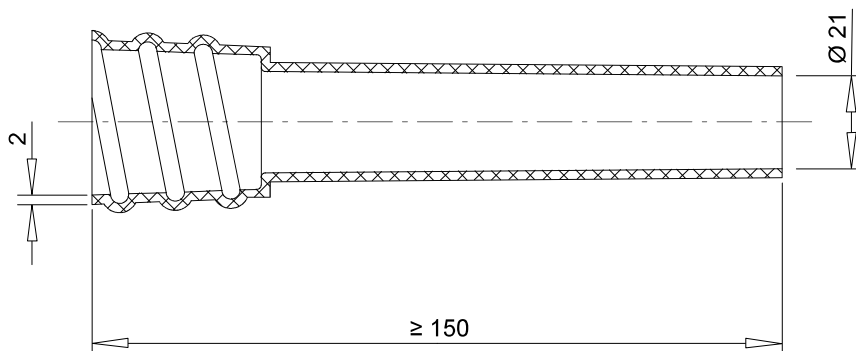
### Hole geometry



### Protective cap



### PE-sleeve



Dimensions in mm

**DYWIDAG**

DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

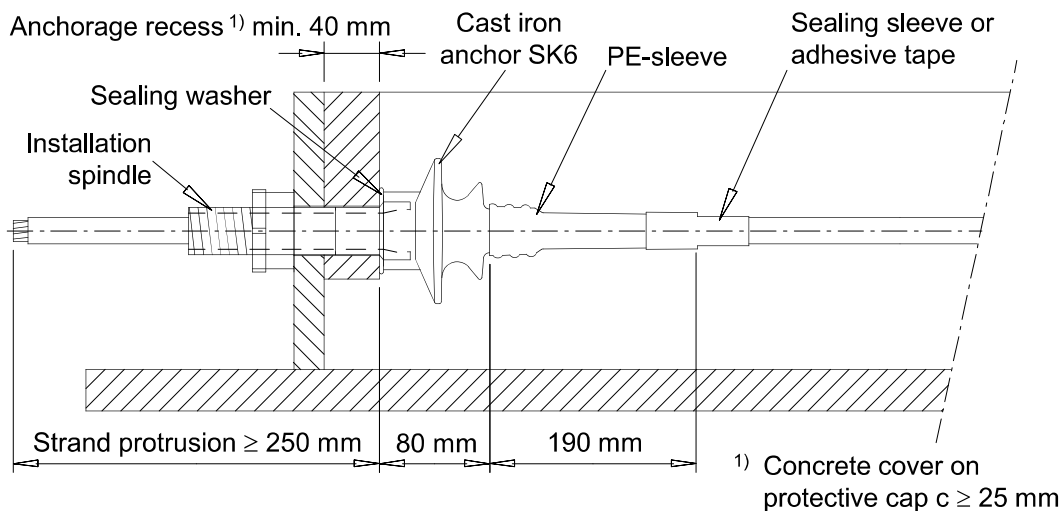
**SUSPA/DSI**  
**Unbonded Monostrand System**

Basic components of anchorages  
Cast-iron anchors SK6 and SF6

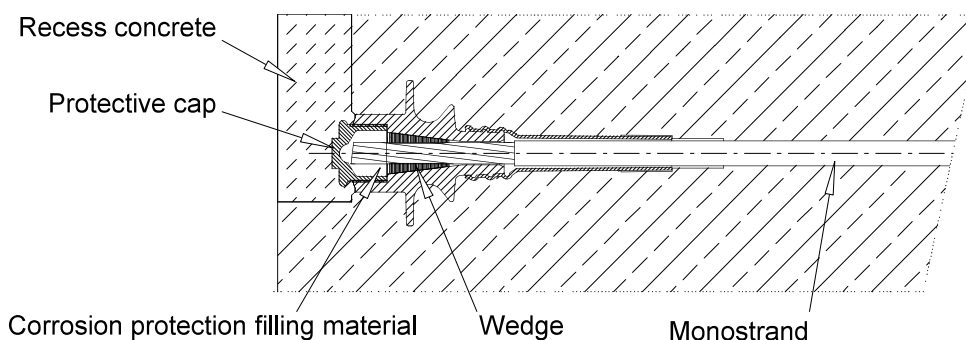
**Annex 2**

of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

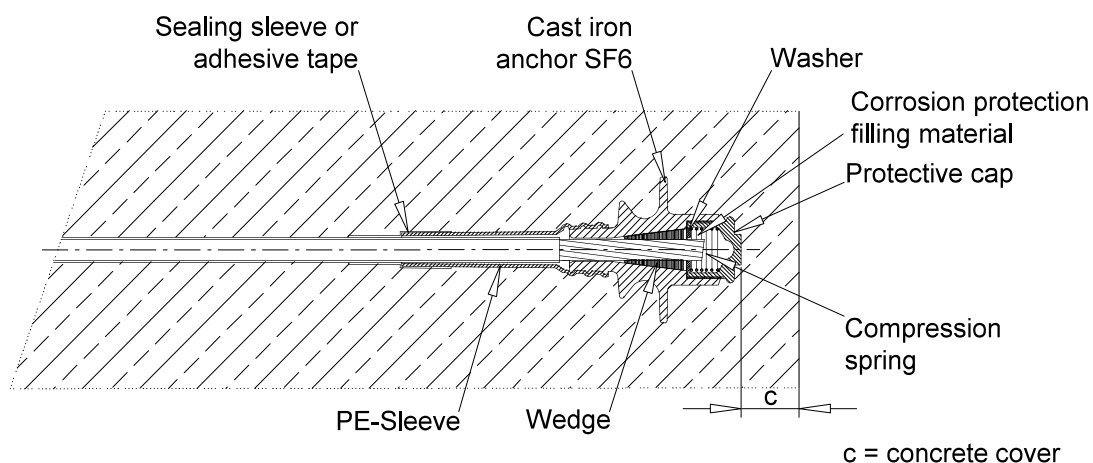
### Assembly state of stressing anchor SK6



### Stressing anchor SK6, final state



### Fixed anchor SF6, final state



**DYWIDAG**

DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

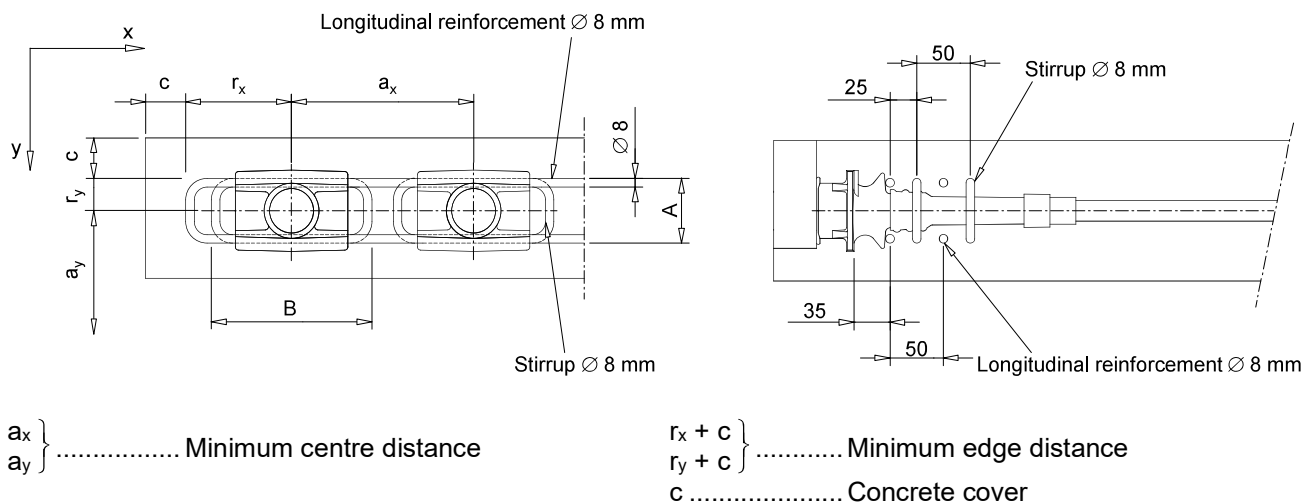
**SUSPA/DSI**  
**Unbonded Monostrand System**

Stressing anchor SK6 and  
fixed anchor SF6

**Annex 3**  
of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

# Stressing anchor SK6 and fixed anchor SF6 Minimum centre and edge distances

## With additional reinforcement



Concrete strength at time of stressing	$f_{cm, 0, \text{cube } 150}$	20 N/mm <sup>2</sup>	28 N/mm <sup>2</sup>	36 N/mm <sup>2</sup>
	$f_{cm, 0, \text{cyl}}$	16 N/mm <sup>2</sup>	23 N/mm <sup>2</sup>	29 N/mm <sup>2</sup>
Minimum centre distance	$a_x$	210	190	170
	$a_y$	120	105	90
Minimum edge distance, plus c	$r_x$	120	110	100
	$r_y$	50	45	35
Additional reinforcement	$R_e \geq 500$ N/mm <sup>2</sup>			
Number of longitudinal reinforcement	$\varnothing 8$ mm per side	2	2	2
Number of stirrups	$\varnothing 8$ mm	2	2	1
Length min. A		100	85	70
Width min. B		190	170	150

## Without additional reinforcement

Concrete strength at time of stressing	$f_{cm, 0, \text{cube } 150}$	20 N/mm <sup>2</sup>	28 N/mm <sup>2</sup>	36 N/mm <sup>2</sup>
	$f_{cm, 0, \text{cyl}}$	16 N/mm <sup>2</sup>	23 N/mm <sup>2</sup>	29 N/mm <sup>2</sup>
Minimum centre distance	$a_x$	260	240	220
	$a_y$	170	150	130
Minimum edge distance, plus c <sup>1)</sup>	$r_x$	120	110	100
	$r_y$	75	65	55

<sup>1)</sup> c as concrete cover of reinforcement in the same cross section, at least 20 mm

Dimensions in mm



DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

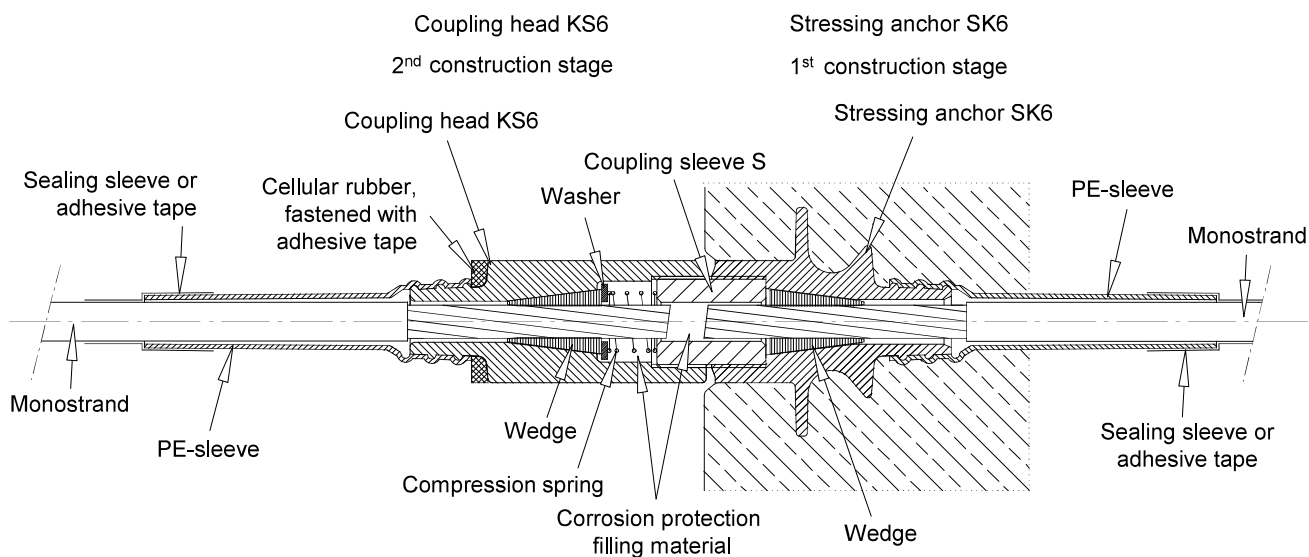
## SUSPA/DSI Unbonded Monostrand System

Stressing anchor SK6 and  
fixed anchor SF6  
Minimum centre and edge distances

## Annex 4

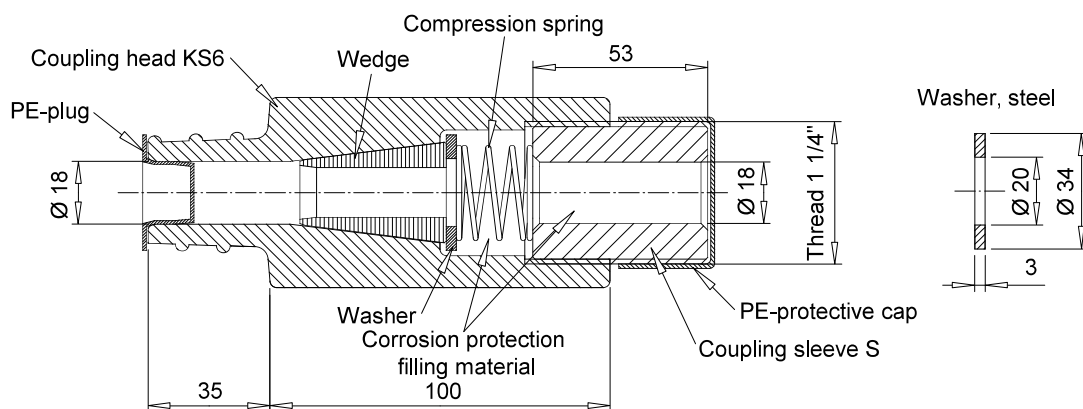
of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

### Fixed coupling KS6-SK6



Minimum engagement depth of coupling sleeve: 20 mm on both sides

### Coupling element KS6 – Condition as delivered



Dimensions in mm

**DYWIDAG**

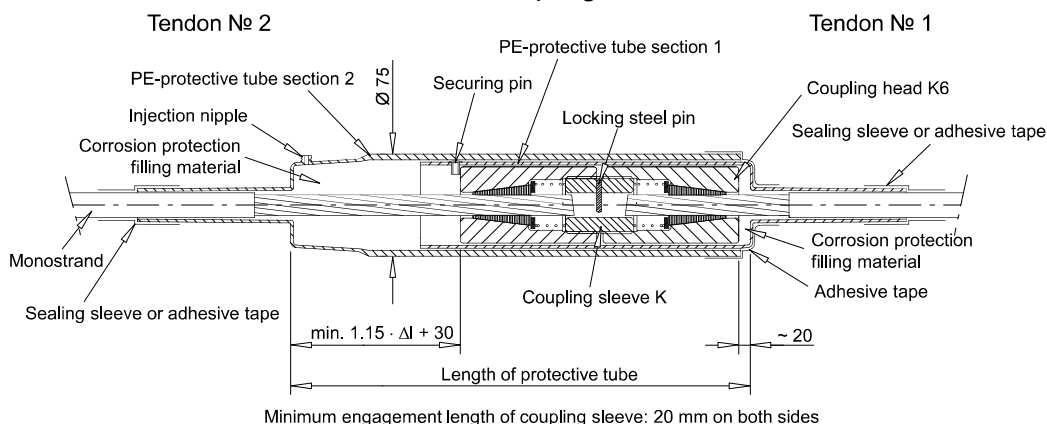
DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

**SUSPA/DSI**  
**Unbonded Monostrand System**

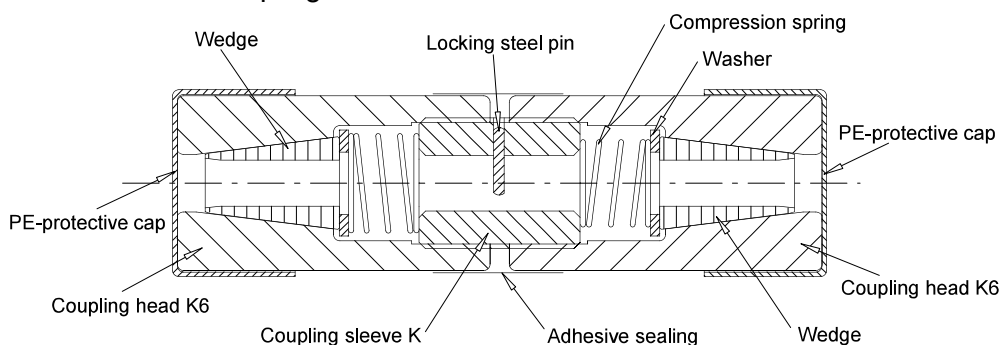
Fixed coupling KS6-SK6

**Annex 5**  
of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

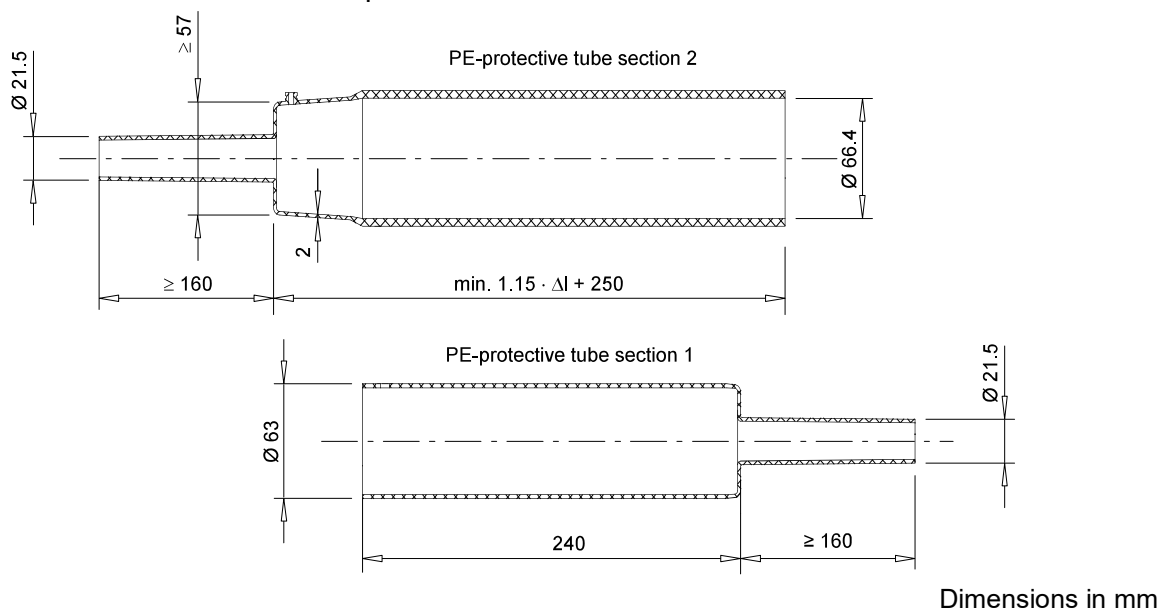
### Movable coupling K6-K6



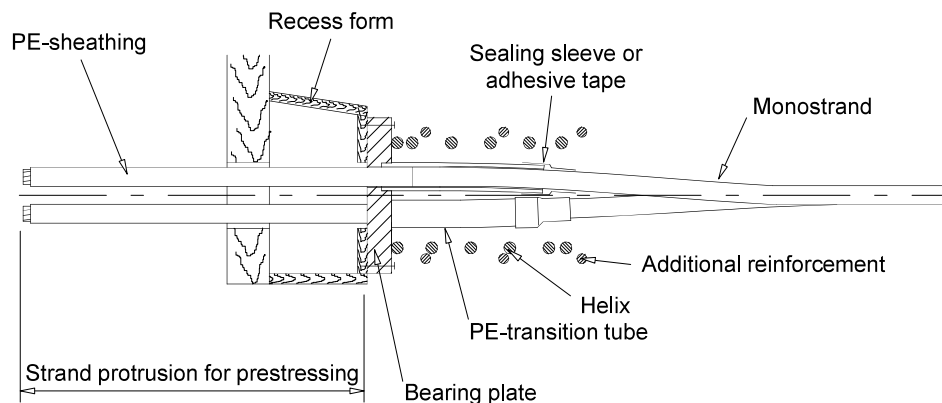
### Coupling element K6 – Condition as delivered



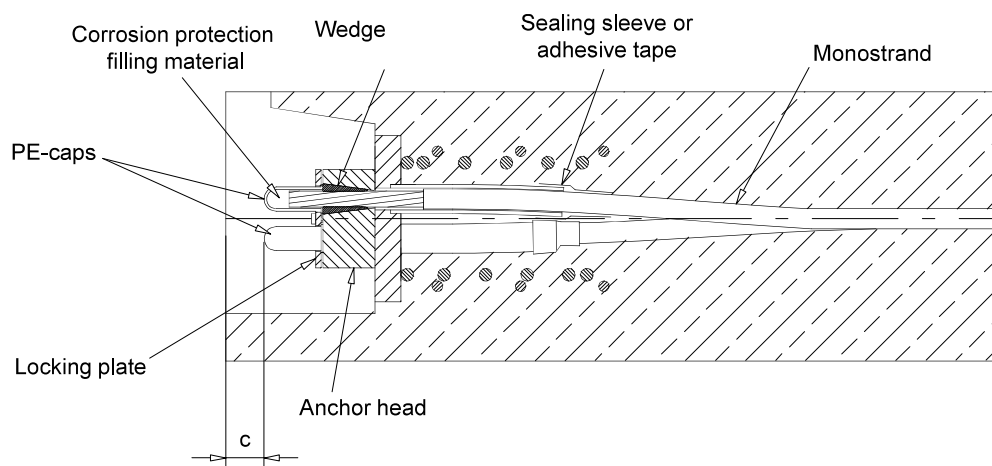
### PE-protective tubes – Sections



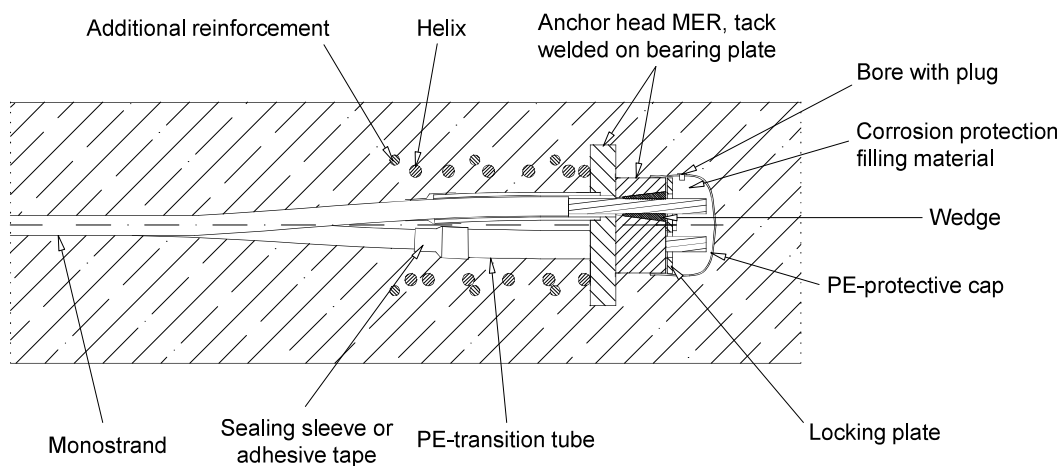
### Assembly state of stressing anchor MER6



### Stressing anchor MER6 after stressing



### Fixed anchor MEF6, final state



c = concrete cover

**DYWIDAG**

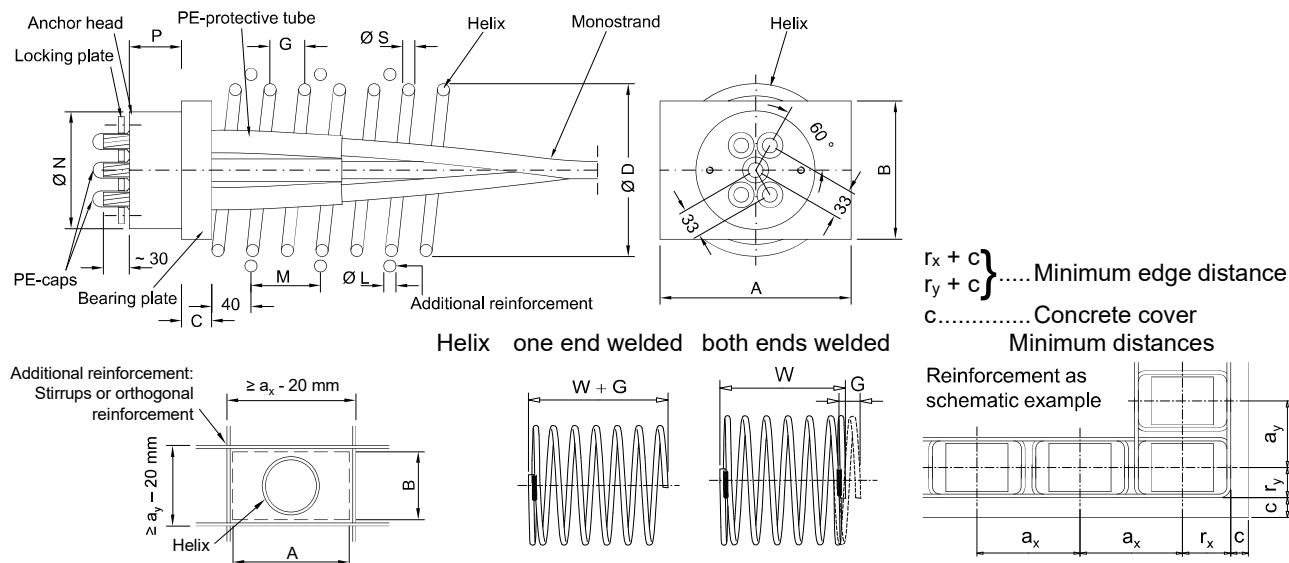
DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

**SUSPA/DSI**  
**Unbonded Monostrand System**

Stressing anchor MER6 and  
Fixed anchor MEF6

**Annex 7**  
of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

### Stressing anchor MER6 and fixed anchor MEF6 with rectangular bearing plate



Concrete strength $f_{cm, 0}$ , cube 150 at time of stressing		20 N/mm <sup>2</sup>				28 N/mm <sup>2</sup>				36 N/mm <sup>2</sup>			
Designation		6-2	6-3	6-4	6-5	6-2	6-3	6-4	6-5	6-2	6-3	6-4	6-5
Number of strands		2	3	4	5	2	3	4	5	2	3	4	5
Strand arrangement													
Anchor head	$\varnothing N$	90	95	110	135	90	95	110	135	90	95	110	135
	P	50	50	55	60	50	50	55	60	50	50	55	60
Bearing plate	A	125	150	180	200	125	150	180	200	125	150	180	200
	B	100	115	135	155	100	115	135	155	100	115	135	155
	C	25	30	35	35	25	30	35	35	25	30	35	35
Helix	Min. external diameter $\varnothing D$	110	140	160	180	100	120	120	140	75	90	110	130
	Min. wire diameter $\varnothing S$	12	12	12	12	12	12	12	12	10	12	12	12
	Maximum pitch G	40	50	50	60	40	40	40	40	40	45	45	60
	Minimum length W	195	285	285	335	195	235	235	235	190	215	215	275
	Min. number of turns n	5	6	6	6	5	6	6	6	5	5	5	5
Minimum centre distance	$a_x$	220	280	335	380	200	250	290	330	180	215	250	280
	$a_y$	170	195	215	245	145	170	190	215	120	140	165	190
Minimum edge distance, plus c	$r_x$	100	130	160	180	90	115	135	155	80	100	115	130
	$r_y$	75	90	100	115	65	75	85	100	50	60	75	85
Additional reinforcement, $R_e \geq 500$ N/mm <sup>2</sup>	No of layers K	3	3	4	5	3	3	4	4	3	3	4	4
	Bar $\varnothing L$	10	12	12	12	10	10	10	12	10	10	10	12
	Spacing M	60	70	75	70	60	70	70	75	55	70	55	75

Dimensions in mm

**DYWIDAG**

DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

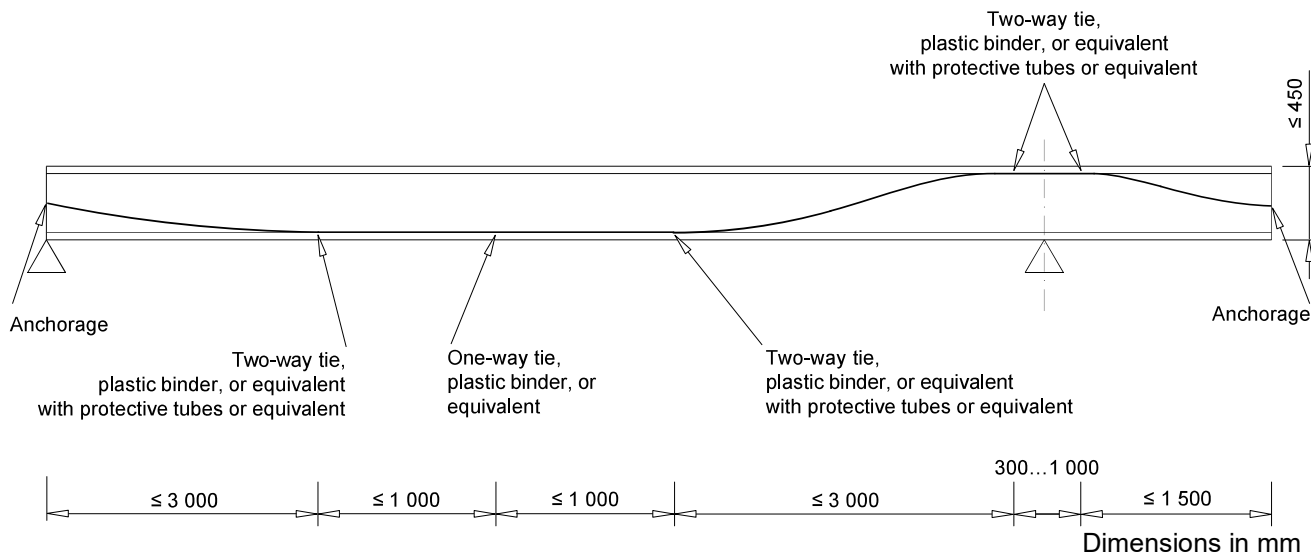
**SUSPA/DSI**  
**Unbonded Monostrand System**

Stressing anchor MER6 and  
Fixed anchor MEF6  
Size 6-2 to 6-5

**Annex 8**

of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

### Free tendon layout, plate thickness $\leq 450$ 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 sealing the tendons with tape at the PE-sleeves of the anchors
- 12 Checking correct seat of anchors and of PE-sleeves before concreting

Maximum prestressing and overstressing force

Designation	Number of strands	Mass of mono-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
—	—	kg/m	$A_p$ mm <sup>2</sup>	$0.90 \cdot A_p \cdot f_{p0.1}$ kN	$0.95 \cdot A_p \cdot f_{p0.1}$ kN	$0.90 \cdot A_p \cdot f_{p0.1}$ kN	$0.95 \cdot A_p \cdot f_{p0.1}$ kN
6-1	1	1.30	150	211	222	221	234
6-2	2	2.60	300	421	445	443	467
6-3	3	3.90	450	632	667	664	701
6-4	4	5.20	600	842	889	886	935
6-5	5	6.50	750	1 053	1 112	1 107	1 169

NOTES

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

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

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



DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

**SUSPA/DSI**  
**Unbonded Monostrand System**

Maximum prestressing and  
overstressing forces

**Annex 10**

of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

Prestressing steel strand

Characteristic	Symbol	Unit	Y1770S7 15.7	Y1860S7 15.7
Tensile strength	$R_m, f_{pk}$	N/mm <sup>2</sup>	1 770	1 860
Nominal diameter of strand	d	mm	15.7 (0.62 ")	
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	kg/m	1.172	
Allowable deviation from nominal mass	—	%	$\pm 2$	
Nominal cross-sectional area	$S_0$	mm <sup>2</sup>	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 <sup>2</sup>	195 000 <sup>1)</sup>	
Relaxation after 1 000 h, for an initial force of $0.70 \cdot F_{ma}$ $0.80 \cdot F_{ma}$	—	%	$\leq 2.5$	
	—	%	$\leq 4.5$	

<sup>1)</sup> Standard value

Characteristic maximum force of tendon

Number of strands	n	—	01	02	03	04	05
Nominal cross-sectional area of prestressing steel	$A_p$	mm <sup>2</sup>	150	300	450	600	750
Characteristic tensile strength $f_{pk} = 1\,770$ N/mm <sup>2</sup>							
Characteristic value of maximum force of tendon	$F_{pk}$	kN	266	532	798	1 064	1 330
Characteristic tensile strength $f_{pk} = 1\,860$ N/mm <sup>2</sup>							
Characteristic value of maximum force of tendon	$F_{pk}$	kN	279	558	837	1 116	1 395

Designation	Standard	Material <sup>1)</sup>
Anchor SK6, SF6	EN 1562 EN 1563	Ductile cast iron
Anchor head	EN ISO 683-1 EN ISO 683-2	Steel
Coupling heads	EN ISO 683-1 EN ISO 683-2	Steel
Bearing plate	EN 10025-2	Steel
Coupling sleeves	EN 10025-2	Steel
Wedge	EN 10277	Steel
Washer	EN ISO 7089	Steel
Locking plate	EN 10025-2	Steel
Helix	EN 10025-2 —	Steel Ribbed reinforcing steel, $R_e \geq 500 \text{ N/mm}^2$
Stirrup and additional reinforcement	Ribbed reinforcing steel, $R_e \geq 500 \text{ N/mm}^2$	
Compression spring	DIN 2098-2	Steel
Protective cap	EN 1562	Cast iron
PE-cap and PE-protective cap PE-plug PE-transition tube PE-installation spindle and PE-nut PE-sleeve PE-protective tube sections 1 and 2	EN ISO 17855-1	PE
Sealing sleeve	Synthetic rubber	

<sup>1)</sup> Detailed material specifications are deposited at Österreichisches Institut für Bautechnik

Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples	Minimum frequency of control
Bearing plate MER6, MEF6	Material	Checking <sup>1)</sup>	2)	100 %	continuous
	Detailed dimensions	Testing	2)	3 %, ≥ 2 specimens	continuous
	Visual inspection <sup>3)</sup>	Checking	2)	100 %	continuous
	Traceability	bulk			
Anchor head SK6, SF6, MER6, MEF6 Coupling head KS6, K6 Coupling sleeve S, K	Material	Checking <sup>4)</sup>	2)	100 %	continuous
	Detailed dimensions	Testing	2)	5 %, ≥ 2 specimens	continuous
	Visual inspection <sup>3)</sup>	Checking	2)	100 %	continuous
	Traceability	full			
Wedge	Material	Checking <sup>4)</sup>	2)	100 %	continuous
	Treatment, hardness	Testing	2)	0.5 %, ≥ 2 specimens	continuous
	Detailed dimensions	Testing	2)	5 %, ≥ 2 specimens	continuous
	Visual inspection <sup>3)</sup>	Checking	2)	100 %	continuous
	Traceability	full			
Monostrand	Material	Checking	2), 5)	100 %	continuous
	Diameter	Testing	2), 5)	1 sample	each coil or every 7 tons <sup>6)</sup>
	Visual inspection	Checking	2), 5)	1 sample	
Helix in plain round steel EN 10025	Material	Checking <sup>1)</sup>	2)	100 %	continuous
	Visual inspection <sup>3)</sup>	Checking	2)	100 %	continuous
	Traceability	full			

<sup>1)</sup> Checking by means of at least a test report 2.2 according to EN 10204.

<sup>2)</sup> Conformity with the specifications of the component

<sup>3)</sup> Successful visual inspection does not need to be documented.

<sup>4)</sup> Checking by means of an inspection certificate 3.1 according to EN 10204.

<sup>5)</sup> Checking of relevant certificate as long as the basis of "CE"-marking is not available.

<sup>6)</sup> Maximum between a coil and 7 tons has to be taken into account

Traceability full Full traceability of each component to its raw material

bulk Traceability of each delivery of components to a defined point

Material Defined according to technical specification deposited by the supplier

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

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

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



DYWIDAG-Systems International GmbH  
Phone: +49/89/309050-100  
E-Mail: dsihv@dywidag-systems.com

**SUSPA/DSI**  
**Unbonded Monostrand System**

Contents of the prescribed test plan

**Annex 13**  
of European Technical Assessment  
**ETA-03/0036** of 29.01.2021

Subject / type of control		Test of control method	Criteria, if any	Minimum number of samples <sup>1)</sup>	Minimum frequency of control
Bearing plate MER6, MEF6	Material	Checking and testing, hardness and chemical <sup>2)</sup>	<sup>3)</sup>	1	1/year
	Detailed dimensions	Testing	<sup>3)</sup>	1	1/year
	Visual inspection	Checking	<sup>3)</sup>	1	1/year
Anchor head SK6, SF6, MER6, MEF6 Coupling head KS6, K6 Coupling sleeve S, K	Material	Checking and testing, hardness and chemical <sup>2)</sup>	<sup>3)</sup>	1	1/year
	Detailed dimensions	Testing	<sup>3)</sup>	1	1/year
	Visual inspection	Checking	<sup>3)</sup>	1	1/year
Wedge	Material	Checking and testing, hardness and chemical <sup>2)</sup>	<sup>3)</sup>	2	1/year
	Treatment, hardness	Checking and testing, hardness profile	<sup>3)</sup>	2	1/year
	Detailed dimensions	Testing	<sup>3)</sup>	1	1/year
	Main dimensions, surface hardness	Testing	<sup>3)</sup>	5	1/year
	Visual inspection	Checking	<sup>3)</sup>	5	1/year
Single tensile element test		According to EAD 160004-00-0301, Annex C.7		9	1/year

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

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

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

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

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

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

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

<b>DYWIDAG</b>  DYWIDAG-Systems International GmbH Phone: +49/89/309050-100 E-Mail: dsihv@dywidag-systems.com	<b>SUSPA/DSI</b> <b>Unbonded Monostrand System</b>  Audit testing	<b>Annex 14</b> of European Technical Assessment <b>ETA-03/0036</b> of 29.01.2021
---	--	---

## 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 1562 (03.2019)	Founding - Malleable cast irons
EN 1563 (08.2018)	Founding - Spheroidal graphite cast irons
EN 10025-2 (08.2019)	Hot rolled products of structural steels - Part 2: Technical delivery conditions for non-alloy structural steels
EN 10204 (10.2004)	Metallic products – Types of inspection documents
EN 10277 (06.2018)	Bright steel products - Technical delivery conditions
prEN 10138-3 (08.2009)	Prestressing steels – Part 3: Strands
EN ISO 683-1 (06.2018)	Heat-treatable steels, alloy steels and free-cutting steels - Part 1: Non-alloy steels for quenching and tempering
EN ISO 683-2 (06.2018)	Heat-treatable steels, alloy steels and free-cutting steels - Part 2: Alloy steels for quenching and tempering
EN ISO 7089 (06.2000)	Plain washers – Normal series, Product grade A
EN ISO 17855-1 (10.2014)	Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specifications
DIN 2098-2 (08.1970)	Helical springs made of round wire – Dimensions for cold-coiled compression springs of less than 0.5 mm wire diameter
CWA 14646 (01.2003)	Requirements for the installation of post-tensioning kits for prestressing of structures and qualification of the specialist company and its personnel

### Other documents

98/456/EC	Commission decision 98/456/EC of 3 July 1998 on the procedure for attesting the conformity of construction products pursuant to Article 20 (2) of Council Directive 89/106/EEC as regards posttensioning kits for the prestressing of structures, OJ L 201 of 17.07.1998, p. 112
305/2011	Regulation (EU) № 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC, OJ L 088 of 04.04.2011, p. 5, amended by Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014, OJ L 157 of 27.05.2014, p. 76, Commission Delegated Regulation (EU) № 574/2014 of 21 February 2014, OJ L 159 of 28.05.2014, p. 41, and Regulation (EU) 2019/1020 of the European Parliament and of the Council of 20 June 2019, OJ L 169 of 25.06.2019, p. 1
568/2014	Commission Delegated Regulation (EU) № 568/2014 of 18 February 2014 amending Annex V to Regulation (EU) № 305/2011 of the European Parliament and of the Council as regards the assessment and verification of constancy of performance of construction products, OJ L 157 of 27.05.2014, p. 76

**DYWIDAG-SYSTEMS  
INTERNATIONAL GMBH  
POST-TENSIONING**

**NAUEN**

Tel +49 3321 4418-0  
E-mail [sales.de@dywidag.com](mailto:sales.de@dywidag.com)

**KÖNIGSBRUNN**

Tel +49 8231 9607-0  
E-mail [sales.de@dywidag.com](mailto:sales.de@dywidag.com)

**LANGENFELD**

Tel +49 2173 7902-0  
E-mail [sales.de@dywidag.com](mailto:sales.de@dywidag.com)



[www.dywidag.com](http://www.dywidag.com)