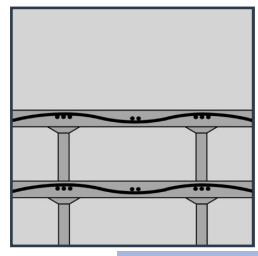
DYWIDAG-SYSTEMS INTERNATIONAL

European Technical Approval SUSPA-DSI Post-Tensioning

SUSPA-Systems



Post-Tensioning Kit for Prestressing of Structures with Unbonded Monostrands for Concrete (1 to 5 Monostrands)

ETA-03/0036

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Authorised and notified according to Article 10 of the Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products

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European Technical Approval ETA-03/0036

English translation, the original version is in German

Handelsbezeichnung *Trade name*	**SUSPA/DSI – Monolitzenspannverfahren ohne Verbund mit 1 bis 5 Monolitzen** *SUSPA/DSI – Unbonded Monostrand System with 1 to 5 Monostrands*
Zulassungsinhaber *Holder of Approval*	**DYWIDAG-Systems International GmbH** **Dywidagstraße 1** **85609 Aschheim** **Deutschland**
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	**Spannsystem für das Vorspannen von Tragwerken mit Monolitzen ohne Verbund für Beton** *Post-tensioning kit for prestressing of structures with unbonded monostrands for concrete*
Geltungsdauer vom *Validity from* bis zum *to*	**01.04.2009** **31.03.2014**
Herstellwerk *Manufacturing plant*	**DYWIDAG-Systems International GmbH** **Niederlassung Langenfeld** **Max-Planck-Ring 1** **40764 Langenfeld** **Deutschland**
Diese Europäische Technische Zulassung umfasst *This European Technical Approval contains*	**36 Seiten, einschließlich 14 Anhängen** *36 pages, including 14 Annexes*
Diese Europäische Technische Zulassung ersetzt *This European Technical Approval replaces*	**ETA-03/0036 mit Geltungsdauer vom 01.04.2004 bis zum 31.03.2009.** *ETA-03/0036 with validity from 01.04.2004 to 31.03.2009.*

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I LEGAL BASES AND GENERAL CONDITIONS

1 This European Technical Approval is issued by Österreichisches Institut für Bautechnik in accordance with:

1. Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1], modified by the Council Directive 93/68/EEC of 22 July 1993[2];
2. *dem Salzburger Bauproduktegesetz, LGBl. Nr. 11/1995, in der Fassung LGBl. Nr. 47/1995, LGBl. Nr. 63/1995, LGBl. Nr. 123/1995, LGBl. Nr. 46/2001, LGBl. Nr. 73/2001 und LGBl. Nr. 99/2001;*

   the Salzburg Construction Products Regulation, LGBl. № 11/1995, amended by LGBl. № 47/1995, LGBl. № 63/1995, LGBl. № 123/1995, LGBl. № 46/2001, LGBl. № 73/2001 and LGBl. № 99/2001;
3. Common Procedural Rules for Requesting, Preparing and the Granting of European Technical Approvals set out in the Annex of Commission Decision 94/23/EC[3];
4. Guideline for European Technical Approval of "Post-Tensioning Kits for Prestressing of Structures", ETAG 013, Edition June 2002.

2 Österreichisches Institut für Bautechnik is authorised to check whether the provisions of this European Technical Approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European Technical Approval and for their fitness for the intended use remains with the holder of the European Technical Approval.

3 This European Technical Approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European Technical Approval.

4 This European Technical Approval may be withdrawn by Österreichisches Institut für Bautechnik, in particular after information by the Commission on the basis of Article 5 (1) of Council Directive 89/106/EEC.

5 Reproduction of this European Technical Approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Österreichisches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European Technical Approval.

6 The European Technical Approval is issued by the Approval Body in its official language. This version corresponds to the version circulated within EOTA. Translations into other languages have to be designated as such.

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1 Official Journal of the European Communities № L 40, 11.02.1989, page 12
2 Official Journal of the European Communities № L 220, 30.08.1993, page 1
3 Official Journal of the European Communities № L 17, 20.01.1994, page 34

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II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of products and intended use

1.1 Definition of products

This European Technical Approval (ETA) applies to a kit, the PT system

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

comprising the following components.

- Tendon

  Unbonded monostrand tendons with one to five tensile elements.

- Tensile elements

  7-wire prestressing steel strands with a nominal diameter of 15.7 mm (0.62 ") and a nominal tensile strength of either 1,860 MPa or 1,770 MPa, factory-provided with a corrosion protection system consisting of corrosion-protective grease and PE-sheathing.

- Anchorages and couplings
  - stressing and fixed anchors SK6 and SF6 for tendons with one monostrand;
  - fixed coupling KS6-SK6 and movable coupling K6-K6 for tendons with one monostrand;
  - stressing and fixed anchors MER6 and MEF6 for tendons with 2 to 5 monostrands.

  For monostrands with a nominal tensile strength of either 1,860 MPa or 1,770 MPa the same anchorages and couplings are used.

- Helix and additional reinforcement in the anchorage zone.

- Corrosion protection system in the couplings and the anchorage zone.

NOTE 1 MPa = 1 N/mm^2

1.2 Intended use

The PT-system is intended to be used for prestressing of structures.

Use category according to type of tendon and material of structure:

- Internal unbonded tendon for concrete and composite structures.

The provisions made in this European Technical Approval are based on an assumed intended working life of the PT system of 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the manufacturer or the Approval Body, but are to be regarded only as a means for choosing appropriate product in relation to the expected economically reasonable working life of the construction works.

2 Characteristics of products and methods of verification

PT SYSTEM

2.1 Range and designation of anchorages and couplings

The type or the unit of anchorages and couplings is designated, depending on their function in the structure, by the nominal diameter of strand and the number of required strands with 6-n. The first number indicates the nominal diameter of strand (6 = 15.7 mm (0.62 ")), followed by

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the maximum number n of strands per unit. The various types of anchorages are specified in Annex 1.

2.1.1 Single anchorages SK6 and SF6 and couplings KS6-SK6 and K6-K6 (Annexes 2, 3, 4, 5 and 6)

With this type of anchorages and couplings only one monostrand is anchored or coupled. If installed with additional reinforcements, the lowest centre and edge distances can be attained (Annex 4) with this anchorages.

Stressing anchor SK6

The stressing anchor SK6 is fastened to the formwork on site and connected to the monostrand (Annex 3). The stressing anchor can also be used as a fixed anchor.

The stressing anchor SK6 is designed to allow, after prestressing, the anchor to be connected to the coupling element KS6 to form a fixed coupling (Annex 5).

Fixed anchor SF6

The outward appearance of the fixed anchor SF6 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 a spring and a protective cap (Annex 3).

Fixed coupling KS6-KS6

This coupling allows the joining of a new tendon with an already stressed tendon. This is done by screwing together the coupling element KS6 and the already stressed stressing anchor SK6 by a coupling sleeve. Subsequently, the monostrand is inserted into the self-acting anchorage of the coupling head. A PE sleeve completes the corrosion protection (Annex 5).

Moveable coupling K6-K6

The movable coupling is used to join two monostrands which subsequently are stressed at the same time (Annex 6). The corrosion protection is completed by two overlapping PE-sheathings, filled with corrosion-protective grease.

2.1.2 Multistrand anchorages MER6 and MEF6

Stressing anchor MER6 (Annex 8)

2 to 5 monostrands are anchored in one anchorage, with bore hole distances of 33 mm. Rectangular bearing plates are used (Annex 7), to which PE transition tubes have already been applied 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.

Fixed anchor MEF6

In the factory the anchor head is tack welded to the bearing plate and the PE transition tubes have also already been fastened to the bearing plate (Annex 7). The anchor can be connected to the monostrands either in the factory or on site.

2.2 Range and designation of tendons

Prestressing and overtensioning forces are specified in the respective standards and regulations in force at the place of use. Table 1 lists the prestressing forces according to EN 1992-1-1 and prEN 10138-3.

The tendons are 1 to 5 monostrands with 7-wire prestressing steel strands, factory-provided with a corrosion protection system consisting of a corrosion-protective grease and a PE-sheathing.

7-wire prestressing steel strand, see Annex 11

Nominal diameter ..... 15.7 mm (0.62 ")

Nominal cross sectional area ..... 150 mm^2

Characteristic tensile strength ..... 1,860 MPa or 1,770 MPa

0.1 % proof force ..... 246 kN or 234 kN

Mass of prestressing steel..... 1.17 kg/m

Monostrand (Annexes 12 and 13)

Mass of monostrand..... 1.30 kg/m

External diameter of monostrand ..... ≥ 20 mm

Table 1: Prestressing forces: Prestressing and overstressing forces

Designation	Number of strands	Characteristic ultimate resisting force of tendon	Maximum prestressing force [1)]	Maximum overstressing force [1), 2)]	Nominal mass of tendon	Steel cross-sectional area
—	n	$A_p \cdot f_{pk}$	$0.9 \cdot F_{p0.1k}$	$0.95 \cdot F_{p0.1k}$	m	A_p
—	—	kN	kN	kN	kg/m	mm^2
Characteristic tensile strength f_{pk} = 1,860 MPa						
6-1	1	279	221	234	1.3	150
6-2	2	558	443	467	2.6	300
6-3	3	837	664	701	3.9	450
6-4	4	1,116	886	935	5.2	600
6-5	5	1,395	1,107	1,169	6.5	750
Characteristic tensile strength f_{pk} = 1,770 MPa						
6-1	1	266	211	222	1.3	150
6-2	2	532	421	445	2.6	300
6-3	3	798	632	667	3.9	450
6-4	4	1,064	842	889	5.2	600
6-5	5	1,330	1,053	1,112	6.5	750

Notes

1) The given values are according to EN 1992-1-1 and prEN 10138-3, i.e. $\min(k_1 \cdot f_{pk}, k_2 \cdot f_{p0.1k})$ applies. The fulfilment of the stabilisation criteria and the requirements for crack widths in the load transfer tests were verified at $0.8 \cdot F_{pk}$.
$F_{pk} = A_p \cdot f_{pk}$
$F_{p0.1k} = A_p \cdot f_{p0.1k}$

2) Overstressing is permitted if the force in the prestressing jack can be measured to an accuracy of ± 5 % of the final value of the prestressing force.

Fatigue resistance of the tendons has been tested with a maximum force of $0.65 \cdot F_{pk}$ and a stress variation of 80 N/mm^2 up to $2.0 \cdot 10^6$ load cycles.

2.3 Friction losses

For calculation of losses of prestressing forces due to friction, Coulomb's friction law applies. Due to the grease filling within the PE sheathing of strands, the friction coefficient μ is very low. Calculation of friction loss is by the equation

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

Where:

P_x..... kN ..... prestressing force at the distance x along the tendon

P_0..... kN ..... prestressing force at x = 0 m

μ ..... rad^{-1}..... friction coefficient, μ = 0.06 rad^{-1}

k..... m^{-1}..... wobble coefficient, $k = 0.9 \cdot 10^{-2}$ m^{-1} (= 0.5 °/m)

θ..... rad..... sum of angular displacements over a distance x (irrespective of direction or sign)

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

2.4 Support of tendons

Monostrands have to be secured in their position. Spacing of tendon support is.

1 Normally ..... 1.00 - 1.30 m

2 Free tendon layout (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.

In the region of the high or low tendon position, the tendons shall be 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 has to be fixed in its position. Special spacers for tendons are therefore not required. For details see Annex 9.

2.5 Slip at anchorages

Slip at anchorages has to be taken into consideration in design and for determining tendon elongation.

Table 2 specifies the slip values which have to be taken into consideration in calculations of tendon elongation or tendon loads, as well as the required wedge blocking of anchorages which are passive during tensioning.

Table 2: Slip values and wedge blocking of anchorages

Anchorage		Slip	Wedge Blocking
Stressing anchor	SK6	5 mm [1)]	Protective cap
	MER6	6 mm [1)]	Locking plate
Fixed anchor	SF6	5 mm	Washer, compression spring, protective cap
	MEF6	5 mm	Locking plate
Fixed coupling 2nd tendon	KS6-SK6	5 mm	Washer, compression spring
Moveable coupling total	K6-K6	10 mm	Washer, compression spring
Note 1) Slip at load transfer to anchorage			

2.6 Spacing of tendon anchorages, concrete cover

All centre and edge spacing have been determined with regard to static requirements. Spacing of tendon anchorages shall conform to the values specified in the Annexes 4 and 8. However, the values specified in the Annexes 4 and 8 for centre spacing between anchorages may be reduced in one direction by 15 %, but shall not be lower than the outside diameter of the helix. In this case, the centre spacing perpendicular to the direction which has been decreased shall be increased by the same percentage.

The steel grades and dimensions of additional reinforcements specified in the Annexes shall be conformed to in any case.

The centric position of the helix has to be secured by welding the end rings onto the bearing plate or by means of holding devices which are supported against the tendon.

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

Verification of load transfer to the structural concrete is not required. Resistance to loads occurring in the structural concrete outside the zone of the helix shall be verified. In particular, bursting forces shall be covered by appropriate transverse reinforcements.

The concrete cover of tendons shall neither be smaller than 2 cm nor smaller than the concrete cover of reinforcements installed in the same cross-section. The anchorage should have a concrete cover of at least 2 cm. Standards and regulations on concrete cover in force at the place of use shall be observed.

2.7 Radii of curvature of internal tendons

The minimum allowable radius of curvature for internal tendons with 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 the PE-sleeve is 3.5 m.

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2.8 Strength of concrete

Concrete according to EN 206-1[4] has to be used. For prestressing, the mean compressive strength of concrete shall be at least $f_{cm,\,0}$ as given in the Annexes 4 and 8.

For partial prestressing with 30 % of the full prestressing force the actual mean value of the concrete compressive strength shall be at least $0.5 \cdot f_{cm,\,0,\,cube}$. Intermediate values may be interpolated linearly according to EN 1992-1-1.

2.9 Dangerous substances

The release of dangerous substances is determined according to ETAG 013, clause 5.3.1. The PT system conforms to the provisions of Guidance Paper H[5] about dangerous substances.

A declaration of conformity in this respect was made by the manufacturer.

In addition to the specific clauses relating to dangerous substances contained in this European Technical Approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the EU Construction Products Directive, these requirements need also to be met, when and where they apply.

COMPONENTS

2.10 Monostrand

The monostrand is a 7-wire prestressing steel strand, factory-provided with a corrosion protection system consisting of corrosion-protective grease and PE-sheathing.

Only the following 7-wire prestressing steel strands (Annex 11) shall be used

Nominal diameter ..... 15.7 mm (0,62 ")

Nominal cross sectional area ..... 150 $mm^2 \pm 2$ %

Mass of prestressing steel..... 1.17 kg/m $\pm$ 2 %

Characteristic tensile strength ..... 1,860 MPa or 1,770 MPa

Single wire

Surface ..... plain

External wire diameter d ..... 5.2 $\pm$ 0.04 mm

Core wire diameter d' ..... 1.02 to 1.04 · d

Monostrand

Nominal mass..... 1.30 kg/m

Outside diameter ..... $\geq$ 20 mm

The corrosion protection system of the monostrand is as specified in ETAG 013, Annex C.1 (Annexes 12 and 13).

2.11 Anchorage components

The components of anchorages shall be in conformity to the specifications given in the Annexes and the technical documentation[6]. In these the components' dimensions, materials and material

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4 Standards and Guidelines and other documents referred to in the European Technical Approval are listed in Annex 14.

5 Guidance Paper H: A harmonized approach relating to Dangerous substances under the construction products directive, Rev. September 2003

identification data with allowable tolerances and the materials used in corrosion protection are listed.

2.11.1 Anchor and coupling heads

The exits of the conical bores of anchor and coupling heads are countersunk and deburred. For installation, they shall be clean, free from rust, and coated with corrosion-protective grease. Welding is not permitted at anchorages, except welding of the end turns of the helix and welding of the helix and tack welding of anchor head onto the bearing plate.

2.11.2 Wedges

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

2.11.3 Helix

The steel grades and dimensions of helixes have to conform to the values specified in Annex 8.

Each helix end shall be welded to form a closed ring. Welding of the helix's final turns can be omitted on the inner ends, if the helix is extended by 1.5 additional turns.

2.11.4 Materials

Table 3: Materials

Components	Standard/Specification
Anchor head	EN 10083-2 EN 10083-3
Coupling sleeve K/S	EN 10025
Cast-iron anchor SF and SK	EN 1562 EN 1563
Coupling head F	EN 10083-2
Bearing plate	EN 10025
Locking plate	EN 10025
Washer	EN ISO 7089
Wedge	EN 10277-2
Helix	EN 10025
Stirrup and additional reinforcement	Ribbed reinforcing steel, $R_e \geq 500$ MPa
Compression spring	DIN 2098-2
Protective cap	EN 1562
Corrosion protection grease	Specification according to ETAG 013
Sealing sleeve	Synthetic rubber

[6] The technical documentation of the European Technical Approval is deposited at Österreichisches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

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Components	Standard/Specification
PE caps PE plug PE transition tube PE installation and nut PE sleeve PE protective tube, section 1+2	EN ISO 1872-1
Note Detailed material data is deposited with Österreichisches Institut für Bautechnik.	

PERMANENT CORROSION PROTECTION

2.12 Corrosion protection of the monostrand

The strand is provided in the factory with corrosion protection consisting of corrosion-protective grease and extruded PE sheathing which shall be in accordance to ETAG 013, Annex C.1 (Annexes 12 and 13).

2.13 Corrosion protection in anchorage and coupling zones

Application of corrosion protection in the anchorage zone shall conform to the assembly instructions specified in clause 4.3. The void in the anchorage zone shall be completely filled with a corrosion-protective grease.

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

METHODS OF VERIFICATION

2.14 Methods of verification

The assessment of the fitness of the SUSPA/DSI – Unbonded Monostrand System for the intended use in relation to the requirements for mechanical resistance and stability in the sense of Essential Requirement 1 of the Council Directive 89/106/EEC has been made in according to the Guideline for European Technical Approvals of "Post-Tensioning Kits for Prestressing of Structures", ETAG 013, based on the provisions for all systems.

IDENTIFICATION

2.15 Identification

The European Technical Approval for the SUSPA/DSI – Unbonded Monostrand System is issued on the basis of agreed data deposited with Österreichisches Institut für Bautechnik, which identifies SUSPA/DSI – Unbonded Monostrand System that has been assessed and judged. Changes to SUSPA/DSI – Unbonded Monostrand System's production process, which could result in this deposited data being incorrect, should be notified to Österreichisches Institut für Bautechnik before the changes are introduced. Österreichisches Institut für Bautechnik will decide whether or not such changes affect the European Technical Approval and consequently the validity of the CE marking on the basis of the European Technical Approval and, if so,

whether further assessment or alterations of the European Technical Approval are considered necessary.

3 Evaluation of conformity and CE marking

3.1 Attestation of conformity system

The system of attestation of conformity assigned by the European Commission to this product in accordance with Council Directive 89/106/EEC of 21 December 1988, Annex III, Section 2, Clause i), referred to as System 1+, provides for

Certification of the conformity of the product by an approved certification body on the basis of

(a) Tasks for the manufacturer

(1) Factory production control;

(2) Further testing of samples taken at the factory by the manufacturer in accordance with the prescribed test plan[7];

(b) Tasks for the approved body

(3) Initial type-testing of the products;

(4) Initial inspection of factory and of factory production control;

(5) Continuous surveillance, assessment and approval of factory production control in accordance with the prescribed test plan[7];

(6) Audit testing of samples taken at the factory.

3.2 Responsibilities

3.2.1 Tasks for the manufacturer – Factory production control

At the manufacturing plant, the manufacturer has to implement and continuously maintains a factory production control system. All the elements, requirements and provisions adopted by the manufacturer are documented systematically in the form of written operating and process instructions. This production control system ensures that the product is in conformity with the European Technical Approval.

Within the framework of factory production control, the manufacturer carries out tests and checks. Details of the extent, nature and frequency of tests and checks to be performed within the framework of the factory production control correspond to the prescribed test plan[7], which is part of the technical documentation of the European Technical Approval.

The results of factory production control are recorded and evaluated. The records include at a minimum the following information.

- Designation of the products and of the basic materials,
- Type of check or testing,
- Date of manufacture of the products and date of testing of the products or basic materials or components,
- Result of check or testing and, if appropriate, comparison with requirements,
- Name and signature of person responsible for the factory production control.

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7 The prescribed test plan has been deposited at Österreichisches Institut für Bautechnik and is handed over only to the approved bodies involved in the conformity attestation procedure.

On request, the records shall be presented to Österreichisches Institut für Bautechnik.

If test results are unsatisfactory, the manufacturer shall immediately take measures to eliminate the defects. Construction products or components which are not in conformity to the requirements shall be removed. After elimination of the defects the respective test shall be repeated immediately if such verification is technically required.

The basic elements of the prescribed test plan[7] conforms to ETAG 013, Annex E.1 and are specified in the quality management plan of the unbonded SUSPA/DSI – Monostrand System.

Table 4: Content of the prescribed test plan for SUSPA/DSI – Monostrand System

Component	Item	Test / check	Traceability	Minimum frequency [1]	Documentation
Anchor SK6, SF6, Coupling element KS6, Coupling K6-K6, Anchor head MER6, MEF6	material	check	full [2]	100 %	3.1 [3]
	detailed dimensions [4]	test		5 % ≥ 2 specimen	yes
	visual inspection [5], [6]	check		100 %	no
Bearing plate MER6, MEF6	material	check	bulk [7]	100 %	2.2 [8]
	detailed dimensions [9]	test		3 % ≥ 2 specimen	yes
	visual inspection [5]	check		100 %	no
Wedge	material	check	full [2]	100 %	3.1 [3]
	treatment, hardness [9], [10]	test		0.5 % ≥ 2 specimen	yes
	detailed dimensions [9]	test		5 % ≥ 2 specimen	yes
	visual inspection [5], [11]	check		100 %	no
Monostrand	prestressing steel [12]	check	full [2]	100 %	yes
	diameter of strand	test		each coil	no
	material [13], [14]	test		ETAG 013, Annex C.1.4	yes
	visual inspection [5]	check		each coil	no
PE protective and transition tubes	material [13]	check	full [2]	100 %	yes
Corrosion-protective grease	material [13]	check	full [2]	100 %	yes

[1] All samples shall be randomly selected and clearly identified.

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[2] full: Full traceability of each component to its raw material.

[3] "3.1": Inspection certificate "3.1" according to EN 10204

[4] Other dimensions than [6]

[5] Visual inspection: E.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion, coating, etc., as detailed in the prescribed test plan[7]

[6] Dimensions: Conical bores regarding angle, diameter and surface condition, thread dimensions of all anchors and couplings.

[7] bulk: Traceability of each delivery of components to a defined point.

[8] "2.2": Test report "2.2" according to EN 10204

[9] Geometrical properties

[10] Surface hardness

[11] Teeth, cone surface

[12] Suppliers certificate

[13] As long as the basis for CE-marking of prestressing steel is not available, an approval or certificate according to the respective rules in force at the place of use shall accompany each delivery.

[14] According to ETAG 013, Annex C.1.4

3.2.2 Tasks for the approved body

3.2.2.1 Initial type-testing of product

For initial type-testing the results of the tests performed as part of the assessment for the European Technical Approval may be used unless there are changes in the manufacturing process or factory plant. In the case of changes, the necessary initial type-testing shall be agreed between Österreichisches Institut für Bautechnik and the approved body involved.

3.2.2.2 Initial inspection of factory and of factory production control

The approved body shall ascertain that in accordance with the prescribed test plan[7] the manufacturing plant, in particular personnel and equipment, and the factory production control are suitable to ensure a continuous orderly manufacturing of the PT system according to the specifications given in Section II as well as in the Annexes of this European Technical Approval.

3.2.2.3 Continuous surveillance

The kit manufacturer shall be inspected at least once a year. Each component manufacturer of the components listed in Table 5 shall be inspected at least once every five years. It shall be verified that the system of factory production control and the specified manufacturing process are maintained taking account of the prescribed test plan[7].

The results of product certification and continuous surveillance shall be made available on demand by the approved body to Österreichisches Institut für Bautechnik. The results of product certification and continuous surveillance should be filed for at least ten years. If the provisions of the European Technical Approval and the prescribed test plan[7] are no longer fulfilled, the certificate of conformity shall be withdrawn and Österreichisches Institut für Bautechnik informed immediately.

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3.2.2.4 Audit testing of samples taken at the factory

During surveillance inspection, the approved body shall take random samples at the manufacturing plant of components of the PT system or of individual components, for which this European Technical Approval has been granted, for independent testing. For the most important components, Table 5 given below summarises the minimum procedures, to be implemented by the approved body.

Table 5: Audit testing

Audit Testing – Minimum Procedures to be Performed			
Component	Item	Test / check	Sampling[1)] – Number of components per visit
Anchor head	material according to specification	check, test	1
	detailed dimensions	test	
	visual inspection [2)]	check	
Wedge	material according to specification	check, test	2
	treatment	test	2
	detailed dimensions	test	1
	main dimensions, surface hardness	test	5
	visual inspection [2)]	check	5
Single tensile element test	single tensile element test according to ETAG 013, Annex E.3	test	1 series

Notes
1) All samples shall be randomly selected and clearly identified.
2) Visual inspection: E.g. main dimensions, gauge testing, correct marking or labelling, appropriate performance, surface, fins, kinks, smoothness, corrosion protection, corrosion, coating etc., as laid down in the prescribed test plan[7].

3.3 CE marking

The delivery note of the components of the PT system shall contain the CE marking. The symbol "CE" shall be followed by the identification number of the certification body and shall be accompanied by the following information.

- Name or identifying mark and address of the manufacturer;
- The last two digits of the year in which the CE marking was affixed;
- Number of the European Technical Approval;
- Number of the certificate of conformity;
- Information on identification of the product (trade name).

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4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

The SUSPA/DSI – Unbonded Monostrand System is manufactured in accordance with the provisions of the European Technical Approval. Composition and manufacturing process are deposited with Österreichisches Institut für Bautechnik.

4.2 Design

4.2.1 General

Design of the structure shall permit correct installation and stressing of tendon. Reinforcement in the anchorage zone shall permit correct placing and compacting of concrete.

4.2.2 Anchor recess and safeguard against bursting out of prestressing steel

The anchor recess shall be designed as to ensure a concrete cover of at least 20 mm at protective caps or locking plates in the final state.

Prevention of bursting out of prestressing steels in case of failure shall be ensured. Sufficient protection is provided by e.g. a cover of reinforced concrete.

4.2.3 Fixed coupling (Annex 5)

Under the possible load combinations, the prestressing force acting on the couplings KS6-SK6 in the second installation stage may at no time be greater than the prestressing force acting on the coupler in the first installation stage, either during installation or in the final state.

4.2.4 Movable coupling (Annex 6)

The PE protective tube, Section 2 shall be installed with sufficient length and in an appropriate position relative to the coupler so as to ensure unimpeded movement along $1.15 \cdot \Delta l + 30$ mm.

4.2.5 Bundled monostrands

If required, factory-bundled monostrands can be supplied and installed. Installation of groups comprising 2, 3, 4 or max. 5 monostrands is possible. If the bundles are provided with the fixed anchor SF6 on one side, they are normally factory-connected in the vertical position.

4.3 Installation

4.3.1 General

Assembly and installation of tendons shall only be carried out by qualified PT specialist companies with the required resources and experience in the use of the SUSPA/DSI – Unbonded Monostrand System, see ETAG 013, Annex D.1. The respective standards and regulations in force at the place of use shall be considered. The company's PT site manager shall have a certificate from the ETA holder, stating that she or he has been trained by the ETA holder and that she or he possesses the necessary qualifications and experiences with the SUSPA/DSI – Unbonded Monostrand System.

4.3.2 De-sheathing of monostrands

The length of the PE sleeves (Annex 2) and the tube connections of the protective tubes (Annex 6) as well as the length along which the monostrand sheathing has to be removed have to be determined by the company depending on the variations in temperature to be expected between installation and concreting. The monostrand sheathing shall overlap the PE sleeve, the tube connections of the protective tubes or the transition tube by at least 150 mm and shall not press against the anchorage. This has to be checked by the application of markings before concreting.

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

Careful handling of tendons during installation has to be ensured. Before concreting the PT site manager shall carry out a final examination of the installed tendons. Damage to PE sheathings which causes or may cause leaking of corrosion-protective grease have to be repaired. Repair measures shall be in accordance to valid standards. Repairs shall be in accordance with the respective load requirements and be suitable for operating temperatures of up to 30 °C.

The fixed anchor MEF6 (Annex 7) shall only be 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.

4.3.4 Single anchorages SK6 and SF6

4.3.4.1 Stressing anchor SK6

The stressing anchor SK6 is designed that, after prestressing, it can be connected to the coupling element KS6 to form a fixed coupling (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 anchorage.

Site assembly comprises the following steps:

- Fastening the cast-iron anchor using the sealing washer and installation spindle which is pushed through the hole in the formwork.
- Placing the PE sleeve (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 strand.
- Inserting the monostrand through the cast-iron anchor.
- Filling corrosion-protective grease into the expanded section of the PE sleeve and screwing the PE sleeve onto the cast-iron anchor.
- Sealing the transition zone PE sleeve/monostrand with the sealing sleeve; the two parts shall overlap by at least 3 cm.

  Alternatively, the transition zone PE sleeve/monostrand may be sealed by means of an adhesive tape with an overlap of at least 5 cm.
- Placing the previously removed PE sheathing onto the prestressing strand ends in order to protect the strand protrusion.

Prestressing comprises the following step:

- Removing the PE protective sheathing from the strand protrusion.
- Filling the void in the anchorage with corrosion-protective grease using a thin injection lance.
- Placing the wedges into the conical bore of the stressing anchor.
- Stressing with prestressing jack.
- Cutting off the strand protrusion with a cutting disk or cutting tool.
- Screwing on the protective cap filled with corrosion-protective grease.
- Filling the anchor recess with concrete.

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4.3.4.2 Fixed Anchor SF6

This anchor is factory assembled. Factory-assembly comprises the following steps:

- Filling a sufficient quantity of corrosion-protective grease into the expanded section of the PE sleeve.
- Screwing the PE sleeve (sealing sleeve) onto the cast-iron anchor.
- Placing the wedges into the conical bore.
- Mounting the compression spring and washer.
- Filling in a measured quantity of corrosion-protective grease.
- Screwing on the protective cap.
- Removing a 5 to 6 cm 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.
- Placing the previously removed PE sheathing onto the strand ends in order to protect the strand protrusion.
- Wiping off the corrosion-protective grease that has leaked from the PE sleeve.
- Sealing the transition zone PE sleeve/monostrand with the sealing sleeve; the two parts shall overlap by at least 3 cm.

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

4.3.4.3 Fixed coupling KS6-SK6

Fixed couplings are used for joining non-stressed tendons to stressed tendons by means of a factory-prepared coupling element (Annex 5).

Site assembly comprises the following steps:

- Removing the protective cap from the stressing anchor SK6.
- Removing the PE cap and the PE plug from the coupling element KS6 and screwing the KS6 coupling element into the internal thread of the SK6 stressing anchor.
- Filling a sufficient quantity of corrosion-protective grease into the expanded section of the PE sleeve.
- Pushing the PE sleeve (sealing sleeve) onto the monostrand.
- Removing approximately 12 cm of the monostrand PE sheathing.
- Applying a coloured marking on the monostrand.
- Placing the de-sheathed strand into the coupling element KS6. The wedges pushed forwards by the compression spring secure the position of the monostrands.
- Checking the insertion depth by means of the coloured marking.

- Sealing the transition zone PE sleeve/monostrand by the sealing sleeve; the 2 parts shall overlap by at least 3 cm.

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

4.3.4.4 Movable coupling K6-K6

The movable coupling is used for joining two tendons which are subsequently stressed at the same time (Annex 6).

Site assembly comprises the following steps:

Tendon No. 1

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

Tendon No. 2

- Removing the PE sheathing of the monostrand along a length equal to that of the protective tube less 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-protective grease.
- Placing the coupling onto the de-sheathed strand of tendon No. 1 up to the steel locking pin.
- Inserting the de-sheathed strand of tendon No. 2 into the coupling up to the locking pin.
- Checking the insertion depth of the monostrands by means of the coloured marking on both sides of the coupling.

Corrosion protection

- Pushing forward the PE protective tube over the coupling, whereby corrosion-protective grease will leak out between protective tube and PE sheathing of the monostrand of tendon No. 1.
- Pressing the securing pin into the PE protective tube section 1 (securing the position of the coupling).
- Pushing forward the PE protective tube section 2 to approximately 2 cm before the end of the expanded section of the PE protective tube 1.
- Sealing the transition zone of PE protective tube section 2 / tendon No. 2 with the sealing sleeve with an overlap of at least 3 cm.
- Injecting corrosion-protective grease through the injection nipple of the PE protective tube section 2 until the grease begins to spill out at the annular gap between PE protective tube section 1 and PE protective tube section 2.

- Cleaning the PE components from the excess corrosion-protective grease.
- Sealing the transition zone PE protective tube 1/PE protective tube section 2 with adhesive tape and sealing of the transition zone PE protective tube 1/tendon 1 with the sealing sleeve with an overlap of at least 3 cm.

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

4.3.4.5 Multistrand anchorages MER6 and MEF6

Stressing anchor MER6

2 to 5 monostrands are anchored in one anchorage. Rectangular bearing plates are used (Annex 7) 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.

Site assembly comprises the following 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 the PE transition tube and the bearing plate.

Stressing comprises the following steps:

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

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 steps:

- Removing the sheathing from the monostrands along a length of 9 to 12 cm.
- Inserting the de-sheathed monostrands through the PE transition tube, bearing plate and anchor head until the ends of the strands protrude from the anchor head by approximately 2 to 3 cm.

- Filling the void in the anchorage with corrosion-protective grease using a thin injection lance and installing the wedges in the conical bore.
- Placing the PE caps filled with corrosion-protective grease onto the strand ends.
- Placing the locking plate with sealing onto the PE caps and screwing the locking plate onto the anchor head.

4.4 Stressing and stressing record

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

4.4.1 Stressing

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

Restressing of tendons before final cutting of strand protrusions in combination with release and reuse of wedges is allowed. After restressing and anchoring, wedge marks on the strand, resulting from the preceding stressing operation, shall be located at least 15 mm from the wedges in the outward direction.

4.4.2 Stressing records

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

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

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

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

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

5 Recommendations for the manufacturer

5.1 Recommendations regarding packaging, transport and storage

During transport, the tendons may be wind to a coil with am minimum internal diameter of 1.5 m or as specified by the manufacturer of the monostrand.

The ETA holder shall have instructions related to

- 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 the tensile elements and of other components in order to avoid any mechanical, chemical or electrochemical changes.
- Protection of tensile elements and other components from moisture.
- Segregation of tensile elements from zones where welding operations are performed.

5.2 Recommendations on installation

The installation guidelines of the ETA holder shall be followed, see ETAG 013, Annex D.3. The respective standards and regulations in force at the place of use should be observed.

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5.3 Accompanying information

It is the responsibility of the ETA holder to ensure that all necessary information on design and installation is submitted to those responsible for design and execution of the works constructed with the SUSPA/DSI – Unbonded Monostrand System.

On behalf of Österreichisches Institut für Bautechnik

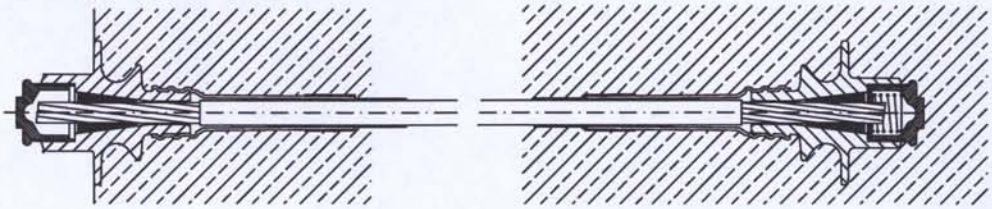
Rainer Mikulits

Managing Director

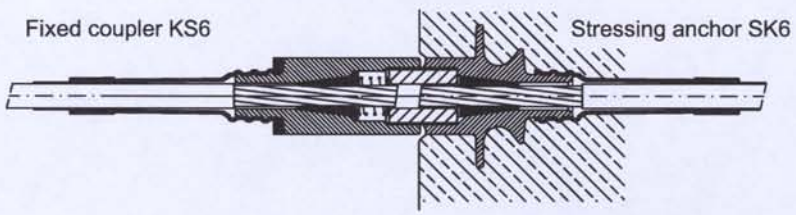
Member of EOTA

Stressing anchor SK6

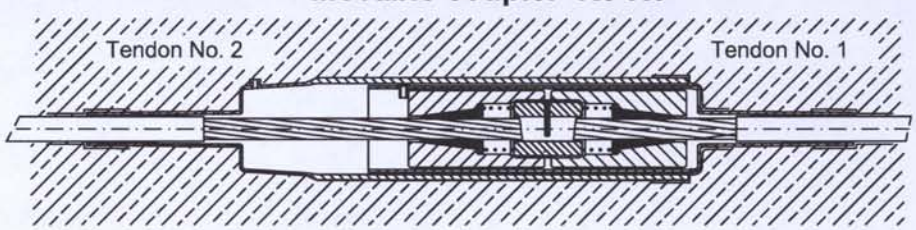
Fixed anchor SF6



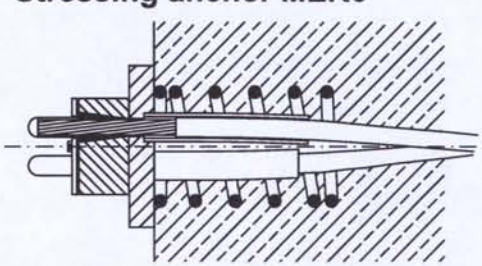
Fixed coupler KS6-SK6



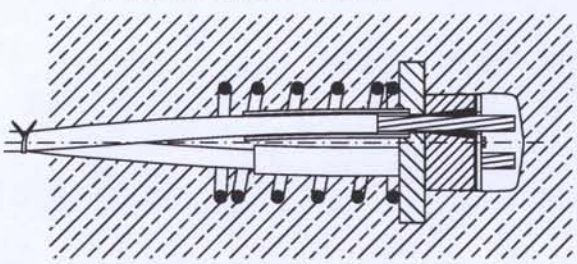
Movable coupler K6-K6



Stressing anchor MER6



Fixed anchor MEF6



DSI
DYWIDAG-Systems International GmbH
www.dywidag-systems.com

SUSPA / DSI - Unbonded Monostrand System

Anchoring Systems

Annex 01

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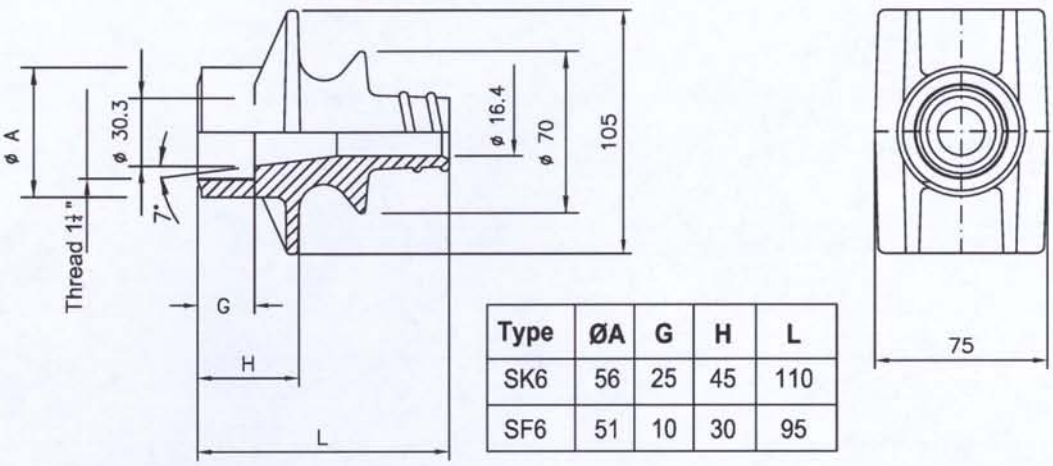
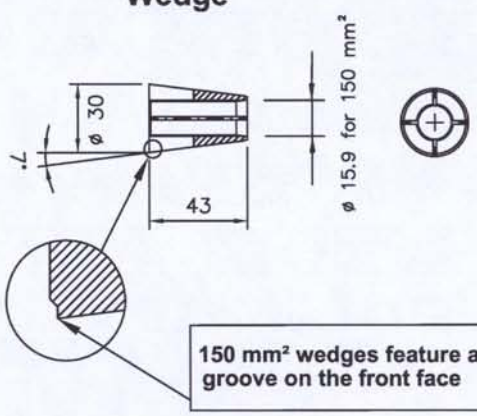
Cast-iron anchor SK6 and SF6

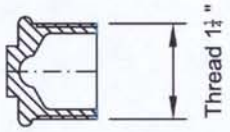


Type	ØA	G	H	L
SK6	56	25	45	110
SF6	51	10	30	95

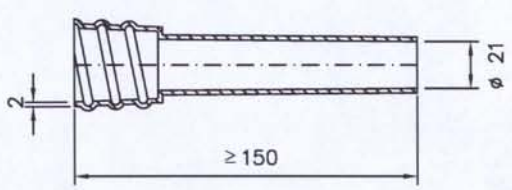
Wedge



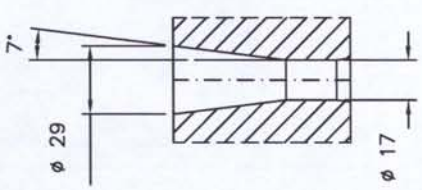
Protective cap



PE-sleeve



Bore geometry



Dimensions in mm

DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Basic Components of Anchors / Cast-iron Anchors SK6 and SF6	Annex 02

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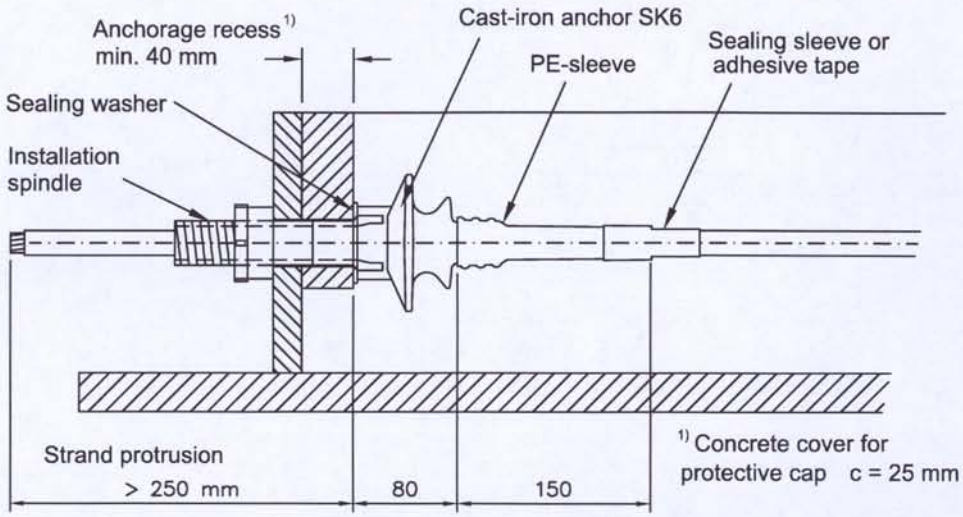
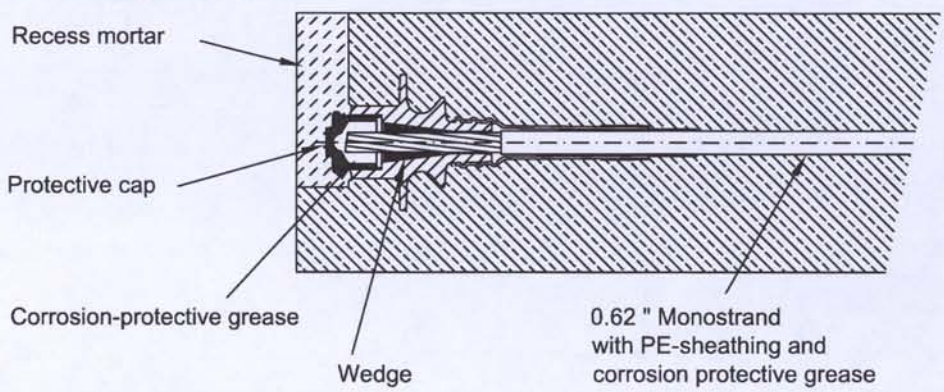
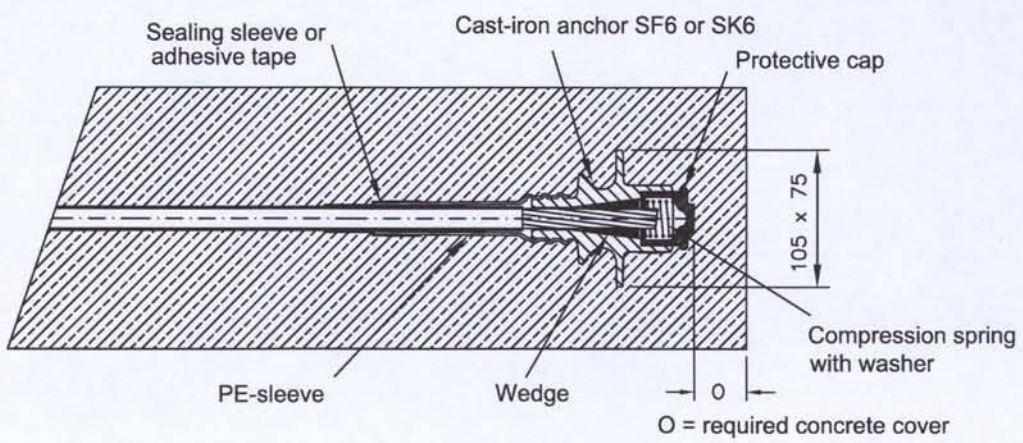
Stressing anchor SK6: Assembly state



Stressing anchor SK6: Prestressed condition



Fixed anchor SF6



Dimensions in mm

DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Stessing anchor SK6 and Fixed anchor SF6	Annex 03

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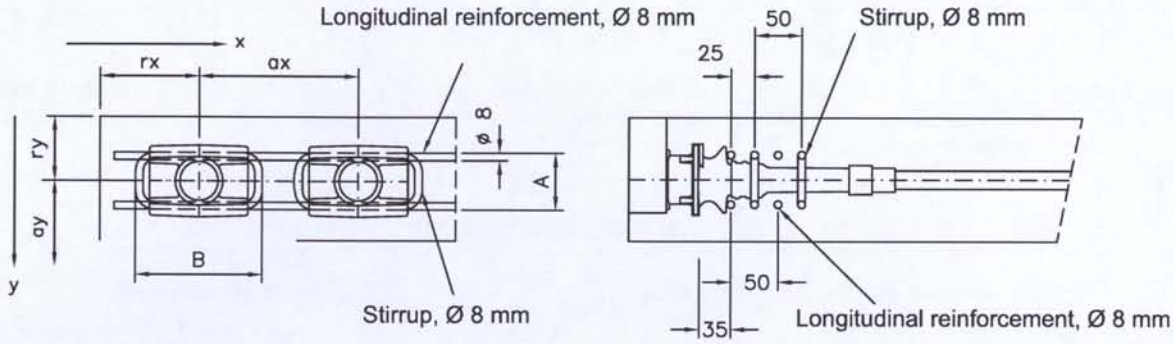
Stressing anchor SK6 and Fixed anchor SF6
Minimum Center and Edge Distances

A.) With additional reinforcement



Concrete strength $f_{cm,0}$ at the time of stressing (cube 150)		20 N/mm²	28 N/mm²	36 N/mm²
Min. center distance	a_x	210	190	170
	a_y	120	105	90
Min. center and edge distances	r_x / r_y	0.5 · min. center distance + concrete cover - 10 mm		
Additional reinforcement	$R_e \geq$ 500 MPa			
Number of longitudinal reinforcements	Ø 8 mm per side	2	2	2
Number of stirrups	Ø 8 mm	2	2	1
	Length min. A	100	85	70
	Width min. B	190	170	150

B.) Without additional reinforcement

Concrete strength $f_{cm,0}$ at the time of stressing (cube 150)		20 N/mm²	28 N/mm²	36 N/mm²
Min. center distance	a_x	260	240	220
	a_y	170	150	130
Min. center and edge distances	r_x / r_y	0.5 · min. center distance + concrete cover - 10 mm		

Dimensions in mm

DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Stressing anchor SK6 and Fixed anchor SF6 Minimum Center and Edge Distances	Annex 04

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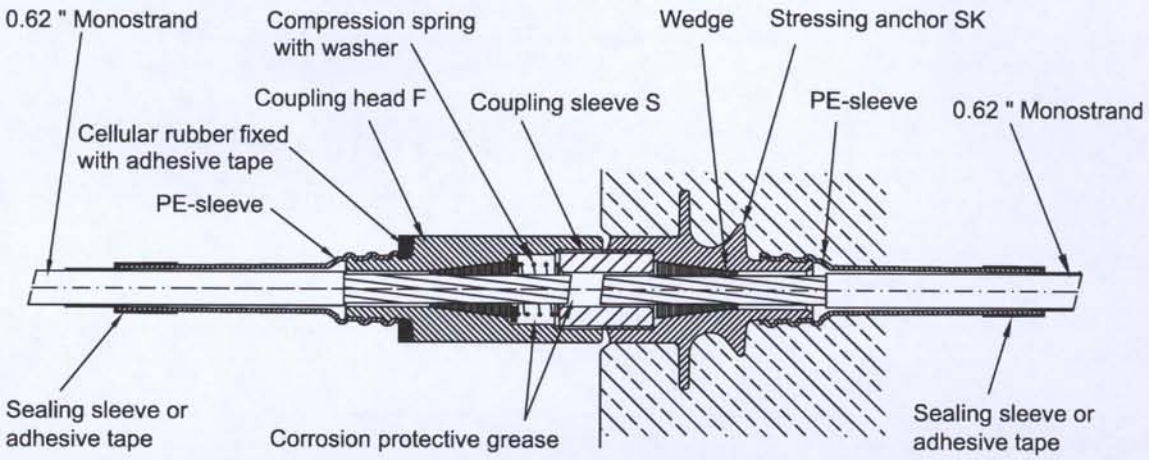
Fixed Coupling KS6-SK6

Coupling element KS6

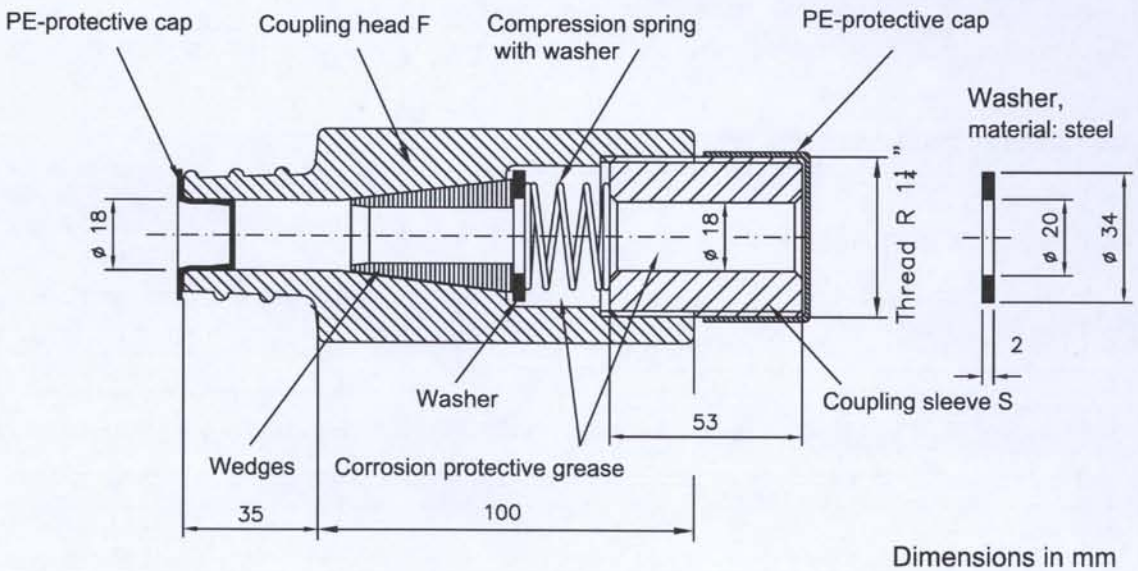
Stressing anchor SK6



Min. engagement lenght of coupling sleeve: 20 mm on both sides

2nd construction stage | 1st construction stage

Coupling element KS6-condition as delivered

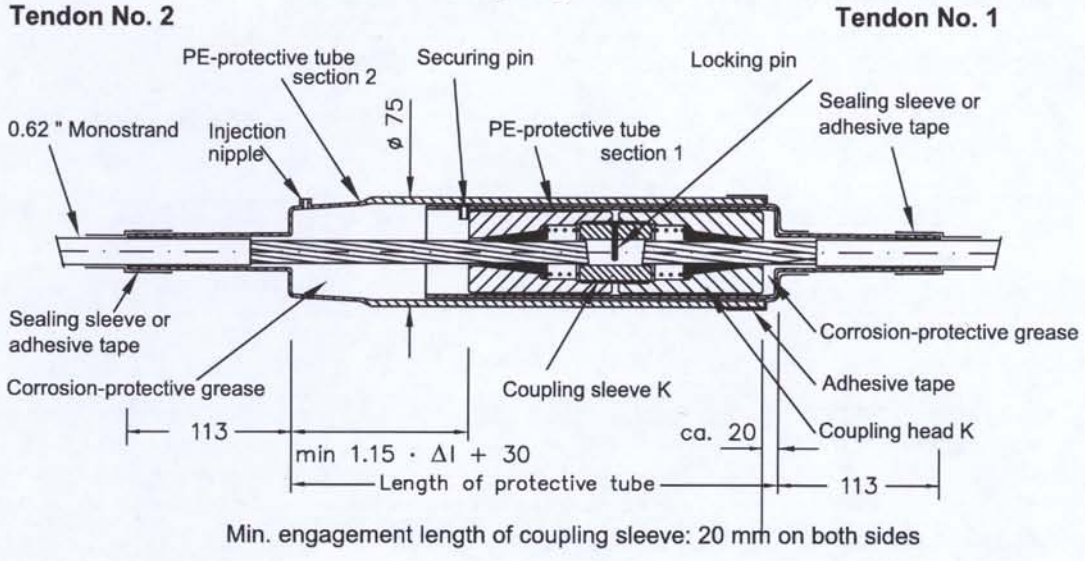


Dimensions in mm

DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Fixed Coupling KS6-SK6	Annex 05

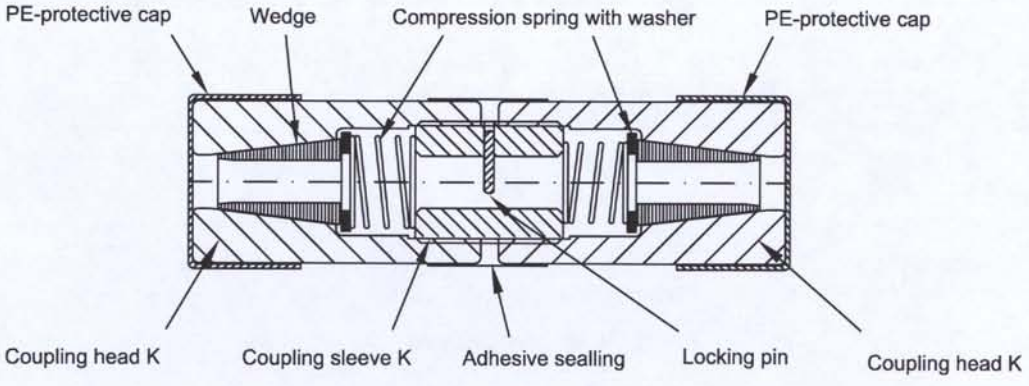
Member of EOTA

Movable Coupling K6-K6

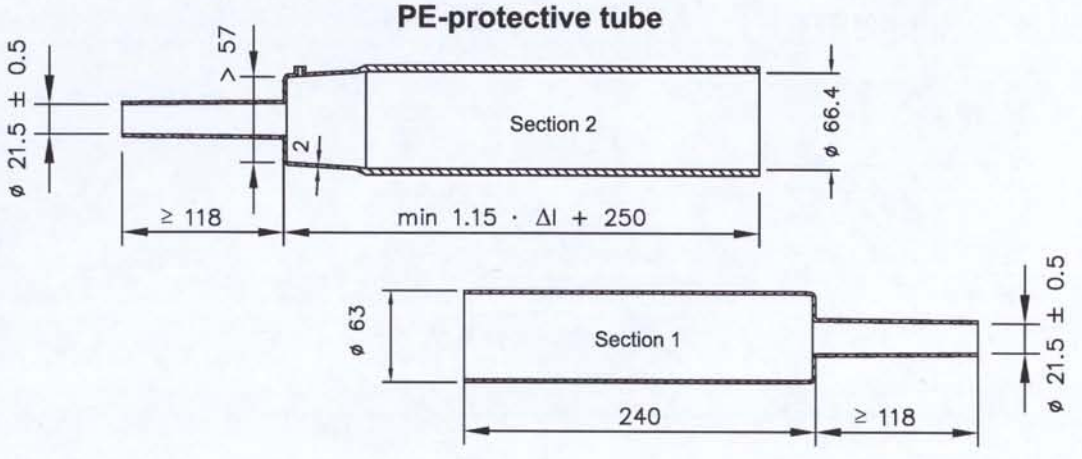


Min. engagement length of coupling sleeve: 20 mm on both sides

Coupling K6-K6 - condition as delivered



PE-protective tube

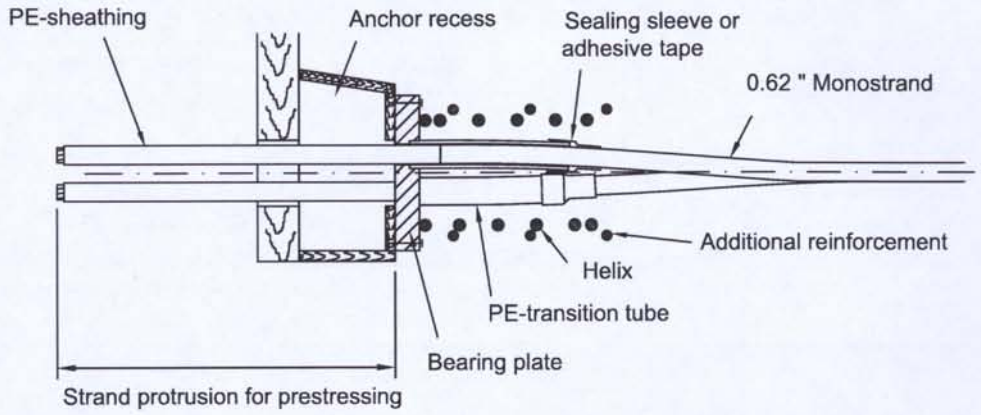


Dimensions in mm

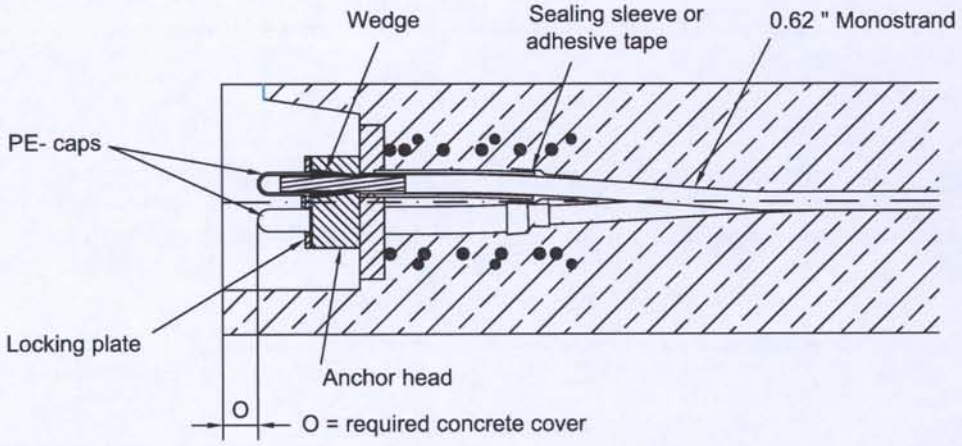
DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Movable Coupling K6-K6	Annex 06

Member of EOTA

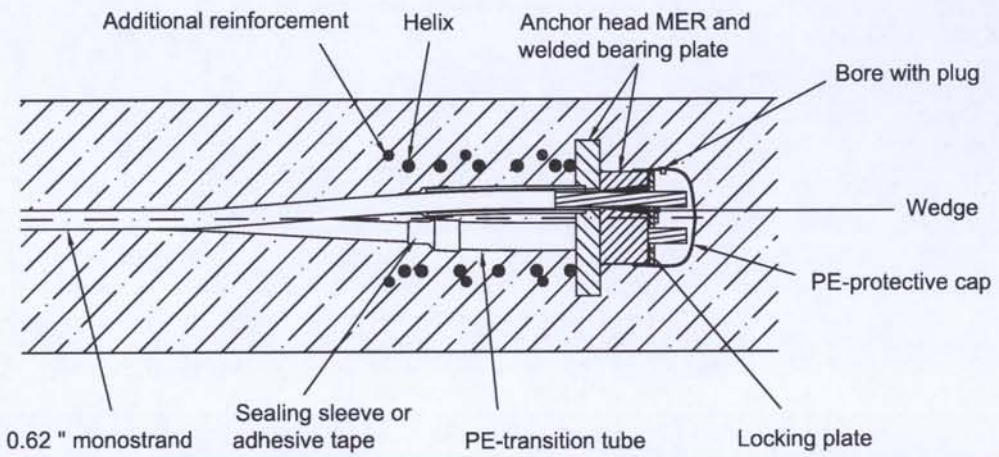
Stressing anchor MER6: Assembly state



Stressing anchor MER6: Prestressed state



Fixed anchor MEF6



DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Stressing anchor MER6 and Fixed anchor MEF6	Annex 07

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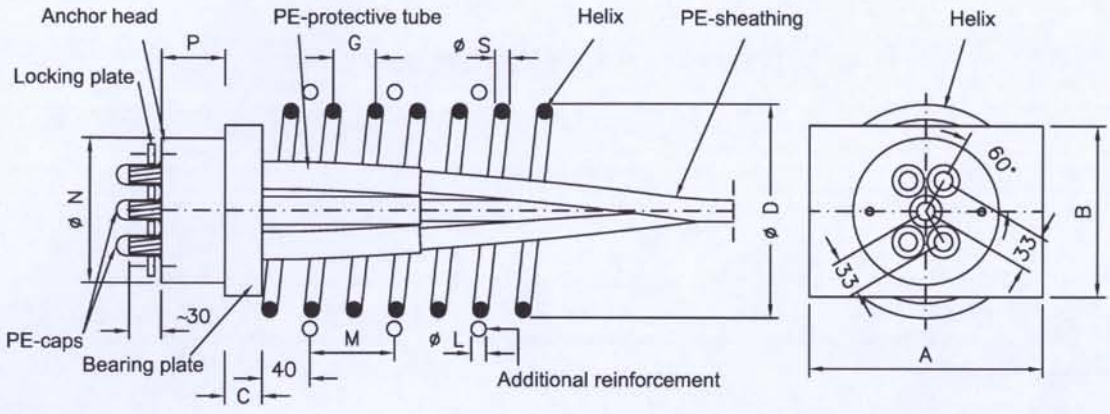
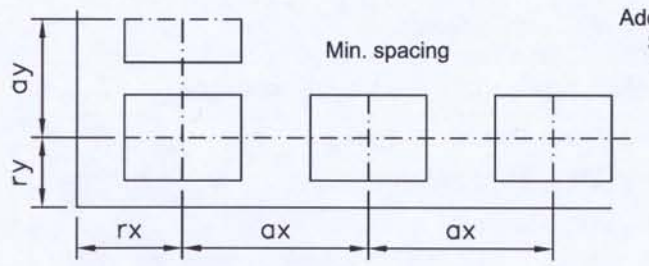
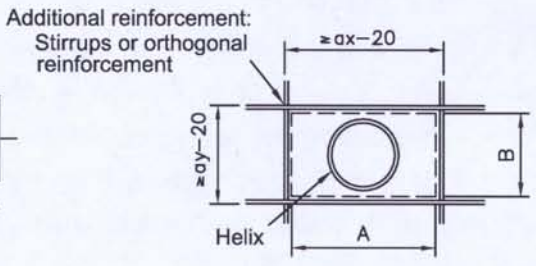
Stressing anchor MER6 / fixed anchor MEF6 with rectangular bearing plate



Concrete strength $f_{cm,0}$ at the time of stressing (cube 150)		20 N/mm²				28 N/mm²				36 N/mm²			
Tendon type		6-2	6-3	6-4	6-5	6-2	6-3	6-4	6-5	6-2	6-3	6-4	6-5
View of anchor heads													
Anchor head	Ø 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	Ø D	110	140	160	180	100	120	120	140	75	90	110	130
	Ø S	12	12	12	12	12	12	12	12	10	12	12	12
Max. pitch	G	40	50	50	60	40	40	40	40	40	45	45	60
No. of turns	n	4	5	5	5	4	5	5	5	4	4	4	4
Min. center distance	ax	220	280	335	380	200	250	290	330	180	215	250	280
	ay	170	195	215	245	145	170	190	215	120	140	165	190
Min. edge distances	rx / ry	0,5 · min. center distance + concrete cover - 10 mm											
Additional reinforcement $R_e \geq 500$ MPa													
No. of layers	K	3	3	4	5	3	3	4	4	3	3	4	4
Bar	Ø 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

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SUSPA / DSI - Unbonded Monostrand System

Stressing anchor MER6 and Fixed anchor MEF6 / Type 6-2 to 6-5

Annex 08

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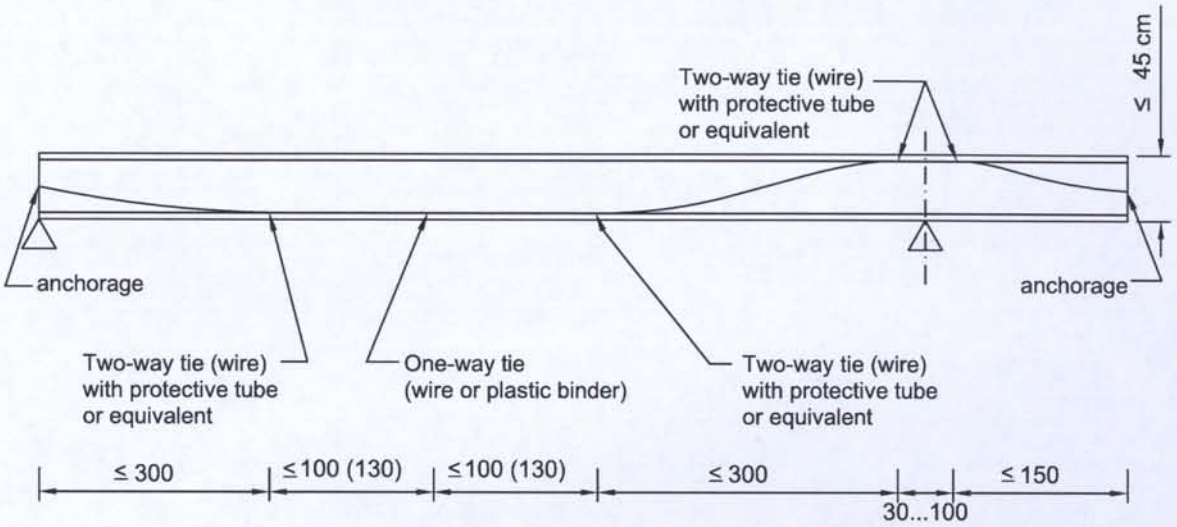
Unbonded Post -Tensioning

Free tendon layout, plate thickness ≤ 45 cm

Tendon installation instructions



Dimensions in cm

1. Installing the reinforcement (bottom layer) on spacers
2. Installing the tendon anchorages (fasting onto the formwork) and transition tubes
3. Placing the tendons on the lower reinforcement
4. Cutting the PE sheathing to the required length
5. Inserting the tendons through the anchorages
6. Installing the spacers for the reinforcement (top layer)
7. Placing protective tubes (e.g. cutting lengths of sheathing) in the region of the twistings (connections with 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 adhesive tape or such like at anchorages-transition tubes

DSI DYWIDAG-Systems International GmbH www.dywidag-systems.com	SUSPA / DSI - Unbonded Monostrand System Anchoring Systems	Annex 09

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Designation of Tendon

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

Prestressing steel

– Type		Strand according to prEN 10138-3
– Strength	R_m	1,860 MPa or 1,770 MPa
– Nominal cross sectional area	S_0	150 mm^2
– Relaxation at 0.7 R_m after 1000 hours		2.5 %
– Modulus of elasticity:		195 GPa

Tendon

– Type		internal, unbonded
– Use category		concrete
– Corrosion protection		greased and sheathed
– Mass of tendon		depending on no. of strands **n**; Prestressing steel n · 1.17 kg/m Monostrand n · 1.30 kg/m
– Force at 1.0 F_{pk}		depending on no. of strands **n**; f_{pk} = 1,860 MPa, n · 246 kN f_{pk} = 1,770 MPa, n · 234 kN
– Friction coefficient		0.06 rad^{-1}
– Wobble coefficient	k	0.9 · 10^{-2} m^{-1} (0.5 °/m)
– Minimum radius of curvature	R_{min}	2.5 m

Anchorages

– Types of anchorages	see Annex 1
– Live end anchorage SK6 Dead end anchorage SF6	see Annexes 2, 3 and 4
– Fixed coupling KS6-SK6	see Annex 5
– Moveable coupling K6-K6	see Annex 6
– Live end anchorage MER6 Dead end anchorage MEF6	see Annexes 7 and 8

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Strand 0.62 " – 150 mm², 1,860 MPa or 1,770 MPa according to prEN 10138-3

Type		**Y 1860S7 15.7**	**Y 1770S7 15.7**
Tensile strength R_m	MPa	1,860	1,770
Strand			
Nominal diameter d	mm	15.7 (0.62 ")	
Nominal cross sectional area S_0	mm^2	150 ± 2 %	
Individual wires			
External wire diameter d	mm	5.2 ± 0.04	
Core wire diameter d'	mm	1.02 to 1.04 · d	
Mass m	kg/m	1.17	
Allowable deviation from nominal mass	%	± 2	
Characteristic value of maximum force F_m	kN	279	266
Maximum value of max. force $F_{m,\,max}$	kN	329	314
Characteristic force at 0.1 % elongation $F_{p0.1}$	kN	246	234
Minimum elongation at maximum force, $l_0 \geq 500$ mm A_{gt}	%	3.5	

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Strand Specification

Annex 11

Sheating Base Material Specification

Characteristics	Test method / Standard	Acceptance criteria
Melt index	ISO 1133 (10 minutes at 2.16 kg)	≤ 0.25 g
Density	DIN 53479	≥ 0.95 g/cm^3
Carbon black – Content – Dispersion – Distribution	 ISO 6964 ISO 4437 ISO 4437	 2.3 ± 0.3 % Index max: C2 Index max: 3
Tensile strength (23 °C)	EN ISO 527-2	≥ 22 MPa
Elongation – at 23 °C – at –20 °C	 EN ISO 527-2 EN ISO 527-2	 > 600 % > 350 %
Thermal stability	ISO/TR 10837	≥ 20 minutes at 210 °C in O_2 without degradation (oxygen induction time)

Properties after Monostrand Manufacturing

Characteristics	Test method / Standard	Acceptance criteria
Tensile strength at 23 °C	EN ISO 527-2	≥ 18 MPa
Elongation – at 23 °C – at -20 °C	 EN ISO 527-2 EN ISO 527-2	 ≥ 450 % ≥ 250 %
Surface of sheathing		No visual damage No bubbles No traces of filling material visible
Environmental stress cracking	NF C 32-060	No cracking after 72 hours in a tensio-active liquid at 50 °C
Temperature resistance – Variation of tensile strength at 23 °C after conditioning for 3 days at 100 °C – Variation of elongation at 23 °C after conditioning for 3 days at 100 °C	 EN ISO 527-2 EN ISO 527-2	 ≤ 25 % ≤ 25 %
Resistance to externally applied agents – Mineral oil – Acids – Bases – Solvents – Salt spray	EN ISO 175	Variation of tensile strength ≤ 25 % Variation of elongation ≤ 25 % Variation of volume ≤ 5 %
Sheathing minimum thickness	EN 496	≥ 1.0 mm

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Monostrand Specification

Characteristics	Test method / ETAG 013	Acceptance criteria
Impact resistance	Clause C.1.3.2.1	No tear or penetration of sheathing
Friction between sheathing and strand	Clause C.1.3.2.2	≤ 60 N/m
Squeezing – Transverse deformation under load – Residual transverse deformation after removal of load	Clause C.1.3.2.3	 ≤ 3 % ≤ 2.5 %
Leak tightness	Clause C.1.3.2.4	No water leaking through specimen

Grease Properties after Monostrand Manufacturing

Characteristics	Test method / Standard	Acceptance criteria
Dropping point – Variation during monostrand manufacturing	ISO 2176	 ≤ 10 %
Oil separation – Variation during monostrand manufacturing	DIN 51808	 After 72 hours: ≤ 3 %, After 7 days: ≤ 5 %

Grease Specification

Characteristics	Test method / Standard	Acceptance criteria
Cone penetration, 60 impacts (1/10 mm)	ISO 2137	250 - 300
Dropping point	ISO 2176	≥ 150 °C
Oil separation at 40 °C	DIN 51817	After 72 hours: ≤ 2.5 %, After 7 days: ≤ 4.5 %
Oxidation stability	DIN 51808	100 hours at 100 °C: ≤ 0.06 MPa 1000 hours at 100 °C: ≤ 0.2 MPa
Corrosion protection – 168 hours at 35 °C – 168 hours at 35 °C	 NFX 41-002 (salt spray) NFX 41-002 (distilled water spray)	 Pass No corrosion
Corrosion test	DIN 51802	Grade: 0
Content of aggressive elements – Cl^-, S^{2-}, NO_3^- – SO_4^{2-}	 NFM 07-023 NFM 07-023	 50 ppm (0.005 %) 100 ppm (0.010 %)

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Guideline for European Technical Approval

ETAG 013 (06.2002)	Guideline for European Technical Approval of Post-Tensioning Kits for Prestressing of Structures

Standards

EN 206-1+A1+A2 (06.2005)	Concrete - Part 1: Specification, performance, production and conformity
EN 1562+A1 (06.2006)	Founding - Malleable cast irons
EN 1563+A1+A2 (07.2005)	Founding - Spheroidal graphite cast irons
EN 1992-1-1 (12.2004)	Eurocode 2: Design of concrete structures - Part 1-1: General rules and rules for buildings
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 (08.2006)	Steels for quenching and tempering - Part 2: Technical delivery conditions for non alloy steels
EN 10083-3+AC (10.2008)	Steels for quenching and tempering - Part 3: Technical delivery conditions for alloy steels
EN 10204 (10.2004)	Metallic products - Types of inspection documents
EN 10277-2+AC (03.2008)	Bright steel products - Technical delivery conditions - Part 2: Steels for general engineering purposes
prEN 496 (05.1991)	Plastics piping systems; plastics pipes and fittings; measurements of dimensions and visual inspection of surfaces
prEN 10138-3 (05.2006)	Prestressing steels - Part 3: Strands
EN ISO 175 (03.2000)	Plastics - Methods of test for the determination of the effects of immersion in liquid chemicals (ISO 175:1999)
EN ISO 527-2 (05.1996)	Plastics - Determination of tensile properties - Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Corr 1:1994)
EN ISO 1872-1 (05.1999)	Plastics - Polyethylene (PE) moulding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 1872-1:1993)
EN ISO 7089 (06.2000)	Plain washers - Normal series - Product grade A
ISO 1133 (06.2005)	Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

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ISO 2137 (12.2007)	Petroleum products and lubricants - Determination of cone penetration of lubricating greases and petrolatum
ISO 2176 (06.2001)	Petroleum products - Lubricating grease - Determination of dropping point ; Technical Corrigendum 1
ISO 6964 (12.1986)	Polyolefin pipes and fittings; Determination of carbon black content by calcination and pyrolysis; Test method and basic specification
ISO 4437 (06.2007)	Buried polyethylene (PE) pipes for the supply of gaseous fuels - Metric series - Specifications
ISO/TR 10837 (07.1991)	Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings (withdrawn 10.2008)
NF C32-060 (05.1996)	Polyethylen for insulation and sheath for telecommunication cables (withdrawn 06.2008)
NF M07-023 (02.1969)	Liquid fuels - Determination of chlorides in crude petroleum and petroleum products
NF X41-002 (08.1975)	Protection against physical, chemical and biological agents - Salt spray test (withdrawn 01.2003)
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
DIN 51802 (04.1990)	Testing lubricating greases for their corrosion-inhibiting properties by the SKF Emcor method
DIN 51808 (01.1978)	Testing of lubricants; determination of oxidation stability of greases, oxygen method
DIN 51817 (04.1998)	Testing of lubricants - Determination of oil separation from greases under static conditions
DIN 53479 (10.1991)	Testing of plastics and elastomers – determination of density

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