

GEOTECHNICAL SYSTEMS

**DYWIDAG Permanent Anchors (Single Bar Anchors) for Soil and Rock with Steel Tendons made of: Grade St 950/1050
Ø26.5mm, Ø32mm, Ø36mm and Ø40mm**

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General Construction Supervisory Authority Approval/
General Design-Type Approval
No. Z-20.1-17 from November 15, 2018

Deutsches Institut für Bautechnik DIBt
(German Institute for Building Technology)

General Construction Supervisory Authority Approval/General Design-Type Approval

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Applicant:
**DYWIDAG-Systems
International GmbH**
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80796 München

Subject of approval:
**DYWIDAG Permanent Anchors (Single Bar Anchors) for Soil and Rock
with Steel Tendons made of:
Grade St 950/1050 26.5mm dia., 32.0mm dia., 36.0mm dia. and 40.0mm dia.**

The above-mentioned subject matter is hereby granted general construction supervisory authority accreditation/approval.
This notice comprises 18 pages and 7 annexes.

The subject matter was granted a general construction supervisory authority approval on April 1, 1989 for the first time.

Important note

This general construction supervisory authority approval/general design-type approval is the translation of a document originally prepared in the German language which has not been verified and officially authorized by "Deutsches Institut für Bautechnik" (DIBt; German Institute for Civil Engineering). In case of doubt in respect to the wording and interpretation of this notice, the original German version hereof shall prevail exclusively. Therefore, no liability is assumed for translation errors or inaccuracies.

I GENERAL PROVISIONS

- 1 This notice verifies the applicability or fitness for the intended purpose of the subject matter of approval within the meaning of the *Land* building codes [*Landesbauordnungen*].
- 2 This notice does not replace the permissions, approvals and certificates required by law for the realization of building projects.
- 3 This notice is issued without prejudice to the rights of third parties, especially private property rights.
- 4 Copies of this notice must be made available to the user or installer of the subject matter of approval without prejudice to more detailed provisions under “Special Provisions”. In addition, it must be pointed out to the user or installer of the subject of approval that this notice must be available at the site of use or installation. Copies hereof must also be made available to the authorities involved on request.
- 5 This notice may only be reproduced in its entirety. A publication of excerpts is subject to the approval of DIBt. Texts and drawings included in promotional material may not contradict this notice, and translations must include the note “Translation of the German original version not verified by DIBt”.
- 6 This notice is issued subject to revocation. The provisions herein can be subsequently amended or modified, especially if the latest technical findings give reason for this.
- 7 This notice refers to the information and documents provided by the applicant. Any amendment of such information and documents is not covered by this notice and must be promptly disclosed to DIBt.
- 8 The general design-type approval covered by this notice is deemed to be a general construction supervisory authority approval of the design at the same time.

II SPECIAL PROVISIONS

1 Subject matter of approval and applicability

1.1 Subject matter of approval

(1) Subject matter of this general construction supervisory authority approval are the ground anchors DYWIDAG permanent anchors (single bar anchors) for soil and rock of DYWIDAG-Systems International GmbH with steel tendons according to Table 1:

Table 1: Steel tendon

Type	Steel grade	Nominal bar diameter [mm]			
Prestressing steel bar (Threadbar)	Prestressing steel, grade St 950/1050	26.5	32.0	36.0	40.0

(2) Design variants according to Table 2 are differentiated, which differ due to the corrosion protection system in the area of the tendon free length L_{tf} :

Table 2: Design variants

Design variant	Corrosion protection system in the area of the	
	tendon free length L_{tf}	tendon bond length L_{tb}
DYWIDAG permanent anchor with a corrugated duct (see Annex 1):	<ul style="list-style-type: none"> • Steel tendon within a corrugated duct and factory filled with inner cement grout • Corrugated duct with smooth sheathing, factory coated 	<ul style="list-style-type: none"> • Steel tendon within a corrugated duct and factory filled with inner
DYWIDAG permanent anchor with a heat shrink sleeve (see Annex 2):	<ul style="list-style-type: none"> • Steel tendon with corrosion protection heat shrink sleeve, factory coated • Smooth sheathing over the corrosion protection heat shrink sleeve, factory fitted 	

1.2 Applicability

(1) The ground anchors may be used as permanent anchors.

(2) The use is limited to those cases where the entire load transfer length of the anchor is located either in non-cohesive or cohesive soils or in rock (cf. DIN EN 1997-1¹ in conjunction with DIN EN 1997-1/NA² and DIN 1054³, Section 3.1). Deviating cases may only be realized subject to the consent of an expert in geotechnical engineering.

(3) DIN EN 1537⁴, Section 5, applies to the soil investigation requirements.

¹	DIN EN 1997-1:2009-09	Eurocode 7: Geotechnical design - Part 1: General rules; German version EN 1997-1:2004 + AC:2009
²	DIN EN 1997-1/NA:2010-12	National Annex - Nationally determined parameters - Eurocode 7: Geotechnical design - Part 1: General rules
³	DIN 1054:2010-12	Subsoil - Verification of the safety of earthworks and foundations - Supplementary rules to DIN EN 1997-1
⁴	DIN EN 1537:2001-01 DIN EN 1537 Ber. 1:2011-12	Execution of special geotechnical works - Ground anchors Correction to DIN EN 1537:2001-01

2 Provisions covering the construction product

2.1 Properties and composition

2.1.1 Steel tendon

(1) The ground anchors must be realized as single bar anchors with steel tendons made from ribbed prestressing steel bars (threadbar).

(2) The material to be used for the steel tendon may only be prestressing steel bars with rolled-on thread ribs on both sides, grade St 950/1050, 26.5mm, 32mm, 36mm and 40mm diameter, based on the general design-type approval No. Z-13.73-50123⁵ in conjunction with the European Technical Assessment ETA-05/0123⁶.

2.1.2 Coupling / Splice formation

(1) For the coupling of the grade St 950/1050 steel, couplers as defined by the general design-type approval No. Z-13.73-50123 in conjunction with the European Technical Assessment ETA-05/0123 must be used (see also Annexes 3 and 4). The couplers are provided with boreholes to secure them against unscrewing (fixing) by means of threaded pins, the diameter and position of which are indicated on the construction drawings deposited (see also Annex 7).

(2) For the corrosion protection system in the area of the splice formation, the coupler splice variants according to Table 3 are available in accordance with the design variants according to Table 2.

Table 3: Coupler splice variants

Design variant	Coupler splice in the area of the	
	tendon free length L_{fr}	tendon bond length L_{tb}
DYWIDAG permanent anchor with a corrugated duct (see Annex 1):	<ul style="list-style-type: none"> • Type A: anti-corrosion compound across the coupler within the coupler pipe (Annex 3) • Type B: corrosion protection heat shrink sleeve over the coupler with connection to the corrugated duct within the coupler pipe (Annex 3) 	<ul style="list-style-type: none"> • double heat shrink sleeve layer across the coupler with connection to the corrugated duct (Annex 3)
DYWIDAG permanent anchor with a heat shrink sleeve (see Annex 2):	<ul style="list-style-type: none"> • corrosion protection heat shrink sleeve over the coupler with connection to the heat shrink sleeve within the coupler pipe (Annex 4) 	

(3) The coupler pipe consists of PVC-U in accordance with DIN EN ISO 1163-1⁷ or PE-HD in line with DIN EN ISO 17855-1⁸. The dimensions can be taken from Annexes 3 and 4.

⁵ Z-13.73-50123 DYWIDAG-System International GmbH; Destouchesstrasse 68; 80796 München, Germany; Application rules for the bar post-tensioning system according to ETA-05/0123 of 06/27/2018 for the external prestressing of load-bearing structures

⁶ ETA-05/0123 DYWIDAG-System International GmbH; Destouchesstrasse 68; 80796 München, Germany; Bonded, unbonded, and external post-tensioning kits for prestressing of structures with bars, diameter 17.5 to 47mm; 06/27/2018

⁷ DIN EN ISO 1163-1:1999-10 Plastics - Unplasticized poly(vinyl chloride) (PVC-U) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 1163-1:1995) - German version EN ISO 1163-1:1999

⁸ DIN EN ISO 17855-1:2015-02 Plastics - Polyethylene (PE) moulding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 17855-1:2014) - German version EN ISO 17855-1:2014

(4) In the area of the tendon free length L_{tf} , elongation values as defined by Annexes 3 and 4 are to be observed at the couplings. These values must for all sections in a building project be selected equal to or greater than the maximum elongation value occurring there.

(5) Maximally one coupler splice may be arranged in the area of the tendon bond length L_{tb} , with a coupler splice at the transition from the tendon free length L_{tf} to the tendon bond length L_{tb} not being deemed to be a coupler splice in L_{tb} . A coupler splice at the transition from the tendon free length L_{tf} to the tendon bond length L_{tb} must be executed as a coupler splice in L_{tb} (see Annex 3).

2.1.3 Anchor head

(1) The anchor head must be executed according to Annex 5; for this purpose, the pipe socket must be connected to the anchor plate in the course of the prefabrication in the plant (see Section 2.2.1.3).

(2) For the anchoring of the grade St 950/1050 steel, 26.5mm, 32mm, 36mm and 40mm diameter, domed nuts and square anchor plates must be used in accordance with the general design-type approval No. Z-13.73-50123 in conjunction with the European Technical Assessment ETA-05/0123.

(3) The pipe sockets (S235JR) must have the dimensions stated in Annex 5, dependent on the bar diameter of the steel tendon used. At the air-side end, the pipe sockets are connected to the anchor plate, while two sealing rings are installed at the earth-side end during the assembly of the anchor head on the construction site. The sealing rings must conform to the dimensions of the pipe sockets and of the smooth and corrugated ducts; these are, dependent on the bar diameter of the tendon used, deposited at DIBt.

(4) The anchor plates are provided with boreholes to fasten the anchor cap and inject the pipe socket with an anti-corrosion compound, the diameter and position of which must be indicated on the construction drawings deposited at DIBt (see also Annex 7).

(5) The tendon must be anchored perpendicular to its axis in each direction.

2.1.4 Anchor cap

(1) The anchor caps, as shown in Annexes 1 and 2, are made from steel (S235JR, minimum thickness 3.0mm). These are screwed onto the anchor plate with an inserted sealing ring (nitrile rubber).

(2) If the anchor cap is not exposed to mechanical loads (e.g. is subsequently cast in concrete), then it can be made from PE-HD.

2.1.5 Plastic sheathings

(1) Only such pipes may be used as plastic sheathings for encasing the tendon free length or the tendon bond length, which consist of PVC-U pursuant to DIN EN ISO 1163-1, of polyethylene with a molding compound ISO 17855-PE-HD,,E,44-T022 in accordance with DIN EN ISO 17855-1 or of polypropylene with the molding compounds ISO 19069-PP-B,,EAGC,10-16-003 or ISO 19069-PP-H,,E,06-35-012/022 pursuant to DIN EN ISO 19069-1⁹. The pipes must be straight and may not show any trapped bubbles, and their pigmentation must be uniform.

⁹

DIN EN ISO 19069-1:2015-06

Plastics - Polypropylene (PP) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 19069-1:2015) - German version EN ISO 19069-1:2015

(2) Pipes in straight length and pipes in coils may be used. Any individual segments of the PVC-U sheathings possibly required must be screwed together and carefully glued with a specific PVC adhesive or carefully sealed by wrapping them with a specific PVC tape. Unspliced pipes must be used as the PE or PP sheathings.

(3) The basic dimensions of the plastic pipes (ribbed and smooth pipes) must correspond to the information provided in Annexes 1 and 2, and the required wall strengths are set forth in Section 2.2.1.2.

2.1.6 Heat shrink sleeves

(1) Corrosion protection heat shrink sleeves or fix heat shrink sleeves must be used as the heat shrink sleeves.

(2) Corrosion protection heat shrink sleeves pursuant to DIN EN 12068¹⁰ with the classification "sheathing EN 12068-C30" (e.g. SATM, CPSM) made from radiated cross-linked polyethylene must be used, which, on the inside, are coated with a butyl rubber based adhesive with corrosion inhibitors; a minimum of 700g/m² adhesive must be applied (mean value of 1.100g/m², nominal thickness of 0.95mm).

(3) Fix heat shrink sleeves (e.g. MWTM, SRH2) consist of polyethylene; the sealing adhesive compound within the heat shrink sleeve must be a hot melt type adhesive.

(4) The heat shrink sleeves must be shrunk on with hot air, infrared radiation, or the soft flame of a gas burner; the wall thickness in shrunk condition must be ≥ 1.5mm.

2.1.7 Anti-corrosion compound

(1) Anti-corrosion compounds are used for the splice formation of the tendon and at the anchor head. Denso-Cord, Denso-Jet, Denso-Fill, Petro-Plast or Nontribos MP-2 must be used as the anti-corrosion compound. These anti-corrosion compounds must each correspond to the formula deposited at DIBt by the manufacturer of the particular compound.

(2) If Nontribos MP-2 is used as the anti-corrosion compound, and if direct contact to cement stone surfaces is given, then these surfaces must be sealed with SikaCor-277 beforehand.

2.1.8 Anti-corrosion coating

(1) If not cast in concrete completely (concrete cover of at least 5cm), exposed steel parts of the prefabricated anchor head construction (anchor plate with pipe sockets and anchor cap) must be provided with a corrosion protection system as required by DIN EN ISO 12944-5¹¹ dependent on the determined corrosivity category of the environment and with the period of protection "high (H)". The surface must be prepared as specified by DIN EN ISO 12944-4¹². DIN EN ISO 12944-7¹³ must be observed for the execution of the coating work.

10	DIN EN 12068:1999-03	Cathodic protection - External organic coatings for the corrosion protection of buried or immersed steel pipelines used in conjunction with cathodic protection - Tapes and shrinkable materials; German version EN 12068:1998
11	DIN EN ISO 12944-5:2008-01	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems (ISO 12944-5:2007); German version EN ISO 12944-5:2007
12	DIN EN ISO 12944-4:1998-07	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 4: Types of surface and surface preparation (ISO 12944-4:1998); German version EN ISO 12944-4:1998
13	DIN EN ISO 12944-7:1998-07	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work (ISO 12944-7:1998) - German version EN ISO 12944-7:1998

(2) Alternatively, the prefabricated anchor head construction and exposed areas of the anchor caps can, in the case of a corrosivity category of the environment of C1 to C4 inclusive, be provided with a corrosion protection using hot-dip galvanizing according to DIN EN 14713-1¹⁴ dependent on the determined corrosivity category of the environment and with the period of protection "high (H)". The surfaces must be prepared and finished in accordance with DIN EN ISO 1461¹⁵. DAST Guideline 022¹⁶ must be observed.

2.1.9 Inner cement grout

(1) Inner cement grout as defined by DIN EN 447¹⁷ must be used. In addition, DIN EN 445¹⁸ and DIN EN 446¹⁹ must be observed.

(2) For the injection of the corrugated duct with inner cement grout in the plant, the prepared anchor must be positioned on an inclined plane, so that injection from the lowest point (injection cap) and ventilation at the highest point (ventilation cap) are ensured. The injection must continue until bubble-free inner cement grout exits from the ventilation cap.

2.1.10 Additional components

(1) The spacers must correspond to the specifications of Annexes 1 to 2 and to the specifications deposited at DIBt.

(2) To maintain a distance of ≥ 5 mm between the tendon and the corrugated duct, the tendon must be provided with internal spacers every 1.0m, or a 6mm dia. polyethylene helix with a pitch of 0.5m must be placed between them. The material thickness of the internal spacers in the area of their star spikes or webs is > 5 mm.

2.2 Manufacture, packaging, transport, storage and marking

2.2.1 Manufacture of prefabricated anchors for installation and grouting

2.2.1.1 Steel tendon

(1) Prior to its installation, the steel tendon must be treated in accordance with the approval provisions for the particular steel. For the production of the anchor the steel tendon must be clean and free of damaging rust.

(2) Steel with a slight rust film may be used. The term "slight rust film" is defined as the uniform beginning of rust formation which has not yet led to the formation of corrosion pits visible with the naked eye and which, in general, may be removed by wiping with a dry rag. However, rust should not be removed in this manner, except in those areas which are to be protected from corrosion by means of heat shrink sleeves; such areas must be free of rust and also of rust films.

2.2.1.2 Prefabricated anchor construction

(1) The manufacture of the prefabricated anchors and the corrosion protection measures must be carried out in the plant for every tendon or every tendon section in accordance with the work instructions deposited at DIBt.

14	DIN EN ISO 14713-1:2010-05	Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance (ISO 14713-1:2009); German version EN ISO 14713-1:2009
15	DIN EN ISO 1461:2009-10	Zinc coatings applied on steel by hot-dip galvanizing (galvanization of pieces) – requirements and tests (ISO 1461:2009); German version EN ISO 1461:2009
16	DAST Guideline 022:2016-06	Guideline for hot-dip-zinc-coating of prefabricated structural steel components, Deutscher Ausschuss für Stahlbau DAST, Sohnstr. 65, 40237 Düsseldorf
17	DIN EN 447:1996-07	Grout for prestressing tendons - Specification for common grout - German version EN 447:1996
18	DIN EN 445:1996-07	Grout for prestressing tendons - Test methods - German version EN 445:1996
19	DIN EN 446:1996-07	Grout for prestressing tendons - Grouting procedures; German version EN 446:1996

(2) In the case of the DYWIDAG permanent anchor with a corrugated duct according to Table 2 (Annex 1), the following must be, in particular, observed during the manufacture in the plant:

The steel tendon must be inserted into a corrugated sheathing (corrugated duct) made from plastic according to Section 2.1.5 over approximately the entire length (cf. Annex 1). Care must be taken to ensure that only straight pipes, which have also been delivered in such a condition, are used. The corrugated duct must have a uniform wall thickness of $\geq 1.0\text{mm}$. To maintain the distance between the tendon and the corrugated duct, internal spacers as per Section 2.1.10 must be used.

The ends of the ribbed pipe must be connected to caps (injection and ventilation caps) made from PE-HD on both sides and glued. The annular void between the tendon and the ribbed pipe must be injected with inner cement grout in accordance with Section 2.1.9. Following the grouting operation, the opening of the injection cap is to be closed with a corrosion protection heat shrink sleeve as required by Section 2.1.6 at the earth-side end of the bond length of the ground anchor, or, alternatively, an injection cap with a ball valve must be mounted (see Annexes 1 and 2).

A smooth pipe made from plastic according to Section 2.1.5 with a wall thickness of $>1.5\text{mm}$ is pulled over the corrugated duct in the area of the tendon free length L_{tf} . The inner diameter of the smooth pipe may be at most 2mm greater than the outer diameter of the corrugated duct. The smooth pipe must be fixed in its position with an adhesive tape suited for the particular plastic used (cf. Annex 1). Sections 4 and 3.2.3.1 must be observed with regard to the corrosion protection in the area of the couplings.

(3) In the case of the DYWIDAG permanent anchor with a heat shrink sleeve according to Table 2 (Annex 2), the following must be, in particular, observed during the manufacture in the plant:

In the area of the tendon bond length L_{tb} , the corrosion protection must be produced with a corrugated duct in accordance with the DWIDAG permanent anchor.

Instead of the ribbed pipe, corrosion protection heat shrink sleeves according to Section 2.1.6 may be arranged throughout the entire tendon free length L_{tf} . These must, at the transition from the tendon free length L_{tf} to the tendon bond length L_{tb} , be embedded or overlap for at least 10cm in the anti-corrosion compound of the tendon bond length L_{tb} . The corrosion protection heat shrink sleeves must overlap for a minimum of 5cm at any joints in the area of the tendon free length L_{tf} .

A smooth sheathing as defined in Section 2.1.5 and with the dimensions stated in Annex 2 is to be arranged over the corrosion protection heat shrink sleeve in the tendon free length L_{tf} . The sheathing is to be sealed using fix heat shrink sleeves as per Section 2.1.6 at the air and earth-side ends. Sections 4 and 3.2.3.1 must be observed with regard to the corrosion protection in the area of the couplings.

(4) The tendon sections to be coupled must be prepared in the plant dependent on the design variants in accordance with paragraphs (2) and (3). The projecting steel at the tendons to be coupled must be embedded in the Denso-Jet or Petroplast anti-corrosion compound.

2.2.1.3 Design and corrosion protection of the anchor head

(1) The construction design of the anchor head is shown in Annexes 1, 2 and 5. The assembly of the anchor head on the construction site must be performed in accordance with the work instructions deposited at DIBt. The following prefabrication measures of the anchor head construction must be conducted in the plant:

The anchor plate must be circumferentially welded to the pipe socket. The welding operations may only be carried out by companies, which have a welding certificate for the execution class EXC 1 as required by DIN EN 1090-1²⁰.

After the welding operations, the prefabricated anchor head construction and exposed surfaces of the protection caps according to Section 2.1.8 must be protected from corrosion.

(2) If considered necessary by the notified product certification body, samples must be deposited at such a body. DIN EN ISO 12944-7, Section 6, applies to coating materials covered by DIN EN ISO 12944-5.

2.2.2 Packaging, transport and storage

(1) The integrity of the corrosion protection components must be ensured. Special care must be taken during storage, transport and installation of the readily assembled permanent anchors so that the sheathings are not damaged as a result of improper handling.

(2) Depending on the temperatures, the anchors may not be removed from the assembly bench earlier than one day after the injection of the inner cement grout has taken place in the plant.

(3) The further transport and the installation may only be carried out three days after the inner cement grout has been injected in the plant.

(4) The anchors may not be stored on the ground; contamination and soiling of, most notably, the corrugated ducts must be avoided. If the anchors are supported at intervals only, the support points may not be sharp-edged, but must be flat.

(5) If anchors are piled up, they must lie on top of one another in a parallel manner. If supported in intervals by square timbers or adequate spacers, then the weight of the anchors on top may only be carried via the timbers or spacers.

(6) In no case may the anchors be thrown or dropped. They must be transported in such a manner (e.g. by hand on the shoulders or by means of carrying straps) that in particular the corrugated ducts cannot be damaged. If transported by a crane hook, the anchor must be carried at its stressing end directly on the steel or with carrying straps or must be placed in ducts.

2.2.3 Marking

(1) The delivery note for the prefabricated anchor must be marked by the manufacturer with the mark of conformity (Ü-Zeichen) in accordance with the conformity mark regulations issued by the German Länder. The marking may only be performed if the requirements pursuant to Section 2.3 have been met.

(2) The delivery note must, among other things, state for which ground anchors the components are designated and in which plant they have been manufactured. Only components for one design variant to be specified may be delivered on a delivery note.

2.3 Certificate of conformity

2.3.1 General

(1) The conformity of the anchor components and of the anchor construction prefabricated for installation and grouting with the provisions of the general construction supervisory authority approval covered by this notice must be confirmed for every manufacturing plant with a declaration of conformity issued by the manufacturer based on its internal production control system and on a certificate of conformity issued by a notified product certification body, as well as regular external monitoring by a recognized external surveillance authority in accordance with the following provisions: The manufacturer of the anchor components and of the prefabricated anchor construction must commission a notified product certification body and an external surveillance authority to issue the certificate of conformity and perform the external monitoring, including the product inspection/testing to be carried out in this process.

(2) The manufacturer must issue the declaration of conformity by marking the building product with the mark of conformity (Ü-Zeichen), indicating the intended purpose of use.

(3) The certification body must forward a copy of the certificate of conformity issued to DIBt for information.

(4) In addition, DIBt must be provided with a copy of the report on the first inspection for information.

2.3.2 Factory production control

(1) Every manufacturing plant must establish and implement its own factory production control system. A factory production control system is defined as the continuous monitoring of the production to be performed by the manufacturer who thus ensures that the building products manufactured meet the requirements covered by this general construction supervisory authority approval.

(2) The factory production control system should at least include the measures listed in Annex 7 regarding the incoming goods inspection and the control during the production.

(3) The results of the internal production control must be recorded and evaluated. The records must at least contain the following information:

- The description of the construction product or of the basic material and of its components,
- the type of the control or inspection,
- the date of manufacture and the date of inspection of the construction product or of the basic material or of its components,
- the results of the controls and inspections and, if applicable, a comparison with the relevant requirements,
- the signature of the person in charge of the internal production control system.

(4) The records must be kept for a minimum of five years and submitted to the notified product certification body involved in continuous surveillance. They must be submitted to DIBt and to the competent highest construction supervisory authority on request.

(5) If the test results are unsatisfactory, the manufacturer must immediately take the measures necessary to eliminate the identified deficiency. Construction products which do not meet the requirements must be handled in such a manner that they cannot be mistaken for conforming products. Once the deficiency has been eliminated, the test in question must be immediately repeated, provided that this is technically feasible and also required to verify the elimination of the deficiency.

2.3.3 External surveillance

(1) The facilities and the internal factory production control system in all manufacturing plants must be reviewed by a notified product certification body on a regular basis, but at least twice a year.

(2) An initial inspection must be carried out as part of the external surveillance. As part of the external surveillance, samples are to be taken for sample checks, and the testing tools are to be checked. Both sampling and testing are incumbent on the notified product certification body involved in continuous surveillance.

(3) The results of the certification and of the external surveillance must be kept for a minimum of five years. They must be presented to DIBt and to the competent highest construction supervisory authority by the notified product certification body on request.

3 Provisions for planning, design and installation

3.1 Planning and design

(1) Unless stated otherwise in the text below, DIN EN 1997-1 in conjunction with DIN EN 1997-1/NA and DIN 1054 apply to the planning and design of structures using ground anchors.

(2) The limitation of the stipulated prestressing loads in accordance with the general design-type approval No. Z-13.73-50123 must be observed. It must be verified that the prestressing loads $P_{m0}(x)$ are not exceeded in accordance with Section 2.2.2 of approval No. Z-13.73-50123.

(3) It must be verified that the change of load (characteristic value) in the steel tendon due to frequently repetitive live loads (including wind) is not greater than 20% of the characteristic load E_k .

(4) Based on the fatigue tests carried out within the scope of the European Technical Assessment ETA-05/0123, a fatigue stress range of 80N/mm^2 for $2 \cdot 10^6$ load cycles was verified for a maximum stress of $0.65F_{pk}$. It must be verified that the fatigue stress range on the air-side anchorage and at the possible sites of coupling does not exceed 0.7 times that value. Load cycle figures exceeding $2 \cdot 10^6$ are not verified by the European Technical Assessment ETA-05/0123. Verification will only be required if the dynamic load is not covered by the prestressing.

3.1.1 Air-side anchorage via steel and reinforced concrete structures

(1) For the anchorage of reinforced concrete structures, the additional reinforcement and the minimum distances of the anchorage for the plate anchorage (Annex 5) dependent on the concrete strength class in accordance with the general design-type approval No. Z-13.73-50123, Section 2.2.6, in conjunction with the European Technical Assessment ETA-05/0123 must be observed.

(2) When supported on steel structures, the static behavior of the bearing plates and transition structures must be verified in each individual case. Both are not the subject matter of this general construction supervisory authority approval.

3.1.2 Air-side anchorage via rock

(1) The overall safety of the anchored rock mass is the subject matter of rock mechanical verifications of stability; the anchor forces required for stability must be determined by an expert²¹.

(2) For anchorages via rock, the design values of the rock pressure (resistance) must be established on a case-to-case basis by an expert, taking into consideration a possible structural breakdown in the immediate vicinity of the borehole. Any necessary adapters must be designed in accordance with the relevant standards, taking into account the design values of the rock pressure (resistance).

3.2 Installation

3.2.1 General

(1) The requirements of DIN EN 1537 in conjunction with DIN SPEC 18537²² and DIN EN 1997-1 in conjunction with DIN EN 1997-1/NA and DIN 1054 must be observed for the installation (in-situ manufacture) and verification, provided that nothing to the contrary is stated in the text below.

(2) The assembly and installation of ground anchors may only be performed under the responsible technical supervision of DYWIDAG-Systems International GmbH. The work must be carried out in accordance with the work instructions deposited at DIBt.

(3) The ground anchors may also be assembled and installed by companies which can present a certificate issued by DYWIDAG-Systems International GmbH that they have been trained in the assembly of the ground anchors in accordance with this general construction supervisory authority approval.

(4) The work instructions regarding the assembly of the anchors on the construction site and the assembly of the anchor head must be available on the construction site. A copy of the instructions must be made available to the notified product certification body (see Section 3.2.6); the same also applies to the construction drawings of the anchor head.

(5) DYWIDAG-Systems International GmbH must keep a list of structures secured with permanent anchors, indicating the structure anchored, the type of anchor (design variant), and the number of anchors.

3.2.2 Drilling the boreholes

3.2.2.1 Borehole diameter

The borehole diameter must be chosen in such a manner that an anchor with the external spacers (Annexes 1 and 2) can be inserted without any problems. DIN EN 1537 in conjunction with DIN SPEC 18537, Section 8.1, applies.

3.2.2.2 Boreholes in soil

(1) In general, boreholes must be cased.

(2) Boreholes may be uncased or partly cased in cohesive soil if it is proven within the scope of a suitability test that there is solid ground over the total length of the uncased part of the borehole, that the drill rods used are sufficiently rigid to ensure straight drilling, and that the borehole can be thoroughly cleaned.

²¹ Experts in geotechnical engineering must be consulted for the determination of static and structural requirements, as well as of characteristic loads.

²² DIN SPEC 18537:2012-02 Supplementary provisions to DIN EN 1537:2001-01, Execution of special geotechnical works - Ground anchors

3.2.2.3 Boreholes in rock

(1) The drilling method must be matched with the specific rock properties.

(2) It must be verified that in the area of the free bond length perpendicular to the borehole axis:

- no joint displacements are anticipated if the load transfer length has not been limited (see Section 3.2.4.4), or
- the joint displacements to be anticipated are smaller than the difference between the smooth sheathing and the borehole diameter if the load transfer length has been limited.

(3) The free passage of the boreholes must be verified, for example, by means of a gage.

3.2.3 Installation into the borehole

(1) In the area of the bond length, elastic spacers or segment spacers in accordance with Annexes 1 and 2 must be positioned at least every 1.5m on a continuous basis, beginning with the first spacer at the anchor base. The first spacer must be arranged maximally 0.75m from the anchor base-side end. When installing a ground anchor using a casing, the arrangement of spacers can be omitted if the wall thickness of the starting pipe or the material thickness at the nipple passages is > 10mm.

(2) If a lost drill or ram bit is used, it must be knocked off with a steel rod prior to the installation of the anchor. If in the case of a cased borehole, the projecting end of the drill set has an edged internal thread or a sharp-edged pipe end, the anchors prepared in accordance with Section 2.2.1 may only be inserted into the borehole if an edge-free inserting trumpet or a pipe nipple fully covering the internal thread of the casing has been placed onto the projecting end of the drill set. When inserting the anchor, attention must be paid that the corrosion protection is not damaged. If the coupling of individual tendon sections is required, please proceed according to Section 3.2.3.1.

3.2.3.1 Coupler splices

(1) The general requirements of Section 2.1.2 apply to the splice formation of the steel tendon.

(2) The coupler splice can be produced on the construction site prior to or directly during the anchor installation. For the production prior to the installation of the anchor, the anchor must be stored on a straight plane; Section 2.2.2 must be observed.

(3) Tendon sections prefabricated in the plant as per Section 2.2.1.2 must be used. The projecting steel at the tendon sections to be coupled must be embedded in the Denso-Jet or Petroplast anti-corrosion compound; however, temporary protection measures must be removed beforehand. The coupler, when assembling the tendon sections, is screwed onto the tendon until the ventilation cap is tightly clamped. Thereafter, the coupler is secured by threaded pins against unscrewing on this side. The second tendon section is screwed into the coupler, and the unscrewing device is enabled on this side.

(4) For the design of the coupler splice variants according to Table 3, the following must be observed for the assembly:

Coupler splice for the DYWIDAG permanent anchor with a corrugated duct

- Coupler splice in the tendon free length L_{tf} - variant A:
 The coupler is embedded in an anti-corrosion compound before the coupler pipe is slipped over. Thereupon, the coupler pipe is slipped over and connected on both sides to the smooth pipe, using an appropriate plastic or tissue adhesive (as a stopper) and fix heat shrink sleeves (cf. Annex 3).

- Coupler splice in the tendon free length L_{tf} - variant B:
A corrosion protection heat shrink sleeve is shrunk onto the coupler, and the overlap length to the corrosion protection of the tendon sections (corrugated duct with injection or ventilation cap) corresponds at least to the diameter of the corrugated ducts. The slipped over coupler pipe is, similar to variant A, connected on both sides to the smooth pipe (cf. Annex 3).
- Coupler splice in the tendon bond length L_{tb} :
A splice in L_{tb} must be made as described in Annex 3. In this process, the coupling socket is covered by heat shrink sleeves in two layers (inside: corrosion protection heat shrink sleeve, outside: fix heat shrink sleeve; cf. Section 2.1.6), wherein the outer layer covers the inner layer or is at least of the same length. The overlap length to the corrosion protection of the tendon sections (corrugated duct with injection or ventilation cap) corresponds at least to the diameter of the corrugated ducts.

Coupler splice for the DYWIDAG permanent anchor with a heat shrink sleeve

- Coupler splice in the tendon free length L_{tf} :
For a splice in L_{tf} see Annex 4. The overlap length of the heat shrink sleeve over the coupler with the heat shrink sleeve of the tendon sections must at least correspond to the diameter of the tendon. Similar to the DYWIDAG permanent anchor with a corrugated duct, variant A, the slipped over coupler pipe is connected on both sides to the smooth pipe.
- Coupler splice in the tendon bond length L_{tb} :
Similar to the DYWIDAG permanent anchor with a corrugated duct, a splice in L_{tb} is to be made as described in Annex 3.

(5) When applying the adhesive tapes or heat shrink sleeves, the surfaces of the plastic pipes to be wrapped must be clean and dry.

3.2.4 Production of the ground anchor

3.2.4.1 Cement grout

(1) The basic materials to be used for the cement grout are cements with particular properties in accordance with DIN 1164-10²³ and cements in line with DIN EN 197-1²⁴ - taking into consideration the applicable exposure classes as defined by DIN EN 206-1²⁵ in conjunction with DIN 1045-2²⁶ (Tables 1, F.3.1, and F.3.2) -, water as stipulated by DIN EN 1008²⁷ and, where required, additives in accordance with DIN EN 934-2²⁸ in conjunction with DIN EN 206-1/DIN 1045-2 or subject to a general construction supervisory authority approval, and natural aggregates for concrete with a maximum grain diameter of 4mm in compliance with DIN EN 12620²⁹, taking into consideration DIN EN 206-1/DIN 1045-2.

(2) The water/cement ratio must be between 0.35 and 0.70 and should be chosen as low as possible especially in cohesive soil and in rock. The cement grout must be mixed mechanically, and may not segregate or lump before its injection. In the case of an alternative use of inner cement grout, the water/cement ratio must be limited to a maximum of 0.44 pursuant to DIN EN 447.

3.2.4.2 Production of the grout body in soil

(1) In the instance of a cased borehole, the pipes are pulled slowly and incrementally after the borehole has been filled with cement grout and the anchor has been installed and, where required, a grout cap has been put on, while the necessary grouting pressure is maintained. Grouting must at least be performed up to the transition point from the tendon bond length L_{tb} to the tendon free length L_{tf} .

(2) The injection for the production of the grout body must always be carried out from the lowest point of the grout body, while venting, if required, must always be performed from the highest point. In the case of ascending anchors, a packer mounted outside on the corrugated duct at the transition from the tendon bond length L_{tb} to the tendon free length L_{tf} must be activated prior to the beginning of the grouting operations.

(3) The grouting operation may only be terminated if bubble-free cement grout exits from the ventilation tube as added through the filling or grouting tube. In the case of downwardly inclined (descending) anchors, the ventilation tube may be omitted if the borehole is injected from the bottom until cement grout exits at the borehole top without any bubbles.

23	DIN 1164-10:2004-08	Special cement - Part 10: Composition, requirements and conformity evaluation for special common cement
	DIN 1164-10 Ber. 1:2005-01	Corrections to DIN 1164-10:2004-08
24	DIN EN 197-1:2004-08	Cement - Part 1: Composition, specifications and conformity criteria for common cements: German version EN 197-1:2000 + A1:2004
	DIN EN 197-1 Ber. 1:2004-11	Corrections to DIN EN 197-1:2004-08
	DIN EN 197-1/A3:2007-09	Cement - Part 1: Composition, specifications and conformity criteria of common cements; German version EN 197-1:2000/A3:2007
25	DIN EN 206-1:2001-07	Concrete - Part 1: Specification, performance, production and conformity
	DIN EN 206-1/A1:2004-10	Concrete - Part 1: Specification, performance, production and conformity; German version EN 206-1/A1:2004
	DIN EN 206-1/A2:2005-09	Concrete - Part 1: Specification, performance, production and conformity; German version EN 206-1:2000/A2:2005
26	DIN 1045-2:2008-08	Concrete, reinforced and prestressed concrete structures - Part 2: Concrete - Specification, properties, production and conformity - Application rules for DIN EN 206-1
27	DIN EN 1008:2002-10	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete; German version EN 1008:2002
28	DIN EN 934-2:2009-09	Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling; German version EN 934-2:2009
29	DIN EN 12620:2008-07	Aggregates for concrete; German version EN 12620:2002+A1:2008

3.2.4.3 Production of the grout body in rock

(1) The rock must be sufficiently compact so that a faultless production of the grout body is ensured. This must be verified by special examinations (e.g. visual borehole inspection, gage measurement of the grout level, geohydraulic test) to the extent required.

(2) The mortar formula, the grouting pressure and the grouting operation must be determined on a case-by-case basis by the field engineer in consultation with an expert²¹ and the designing engineer based on the results of the rock explorations, water injection tests and the findings after the drilling of the boreholes. The designated grouting method must be explored within the scope of a suitability test. The amount of cement grout required for an anchor, its composition and the grouting pressure must be measured and recorded, e.g. by using the production record according to Annex H.1 of DIN SPEC 18537.

3.2.4.4 Limitation of the load transfer length

(1) The load transfer length must be limited by one of the following methods:

- a) by flushing out excess cement grout by means of a flushing tube firmly mounted on the sheathing. The flushing tube must be arranged in such a manner that the first discharge openings are 50cm above the transition point between the tendon free length and the tendon bond length. The verification of this value must be confirmed in the drilling record. The flushing pressure applied must be approx. 4bar.
- b) by flushing out excess cement grout by means of a flushing lance. The flushing lance closed at the bottom and provided with lateral openings must be inserted up to approx. 1.0m above the L_{tb}/L_{tf} transition point. The flushing pressure applied must be approx. 4bar.
- c) by blocking the load transfer length by means of a packer. The suitability of the packer must be proven within the scope of a suitability test.

In the case of downwardly inclined (descending) ground anchors, method a), b) or c) may be applied. For upwardly inclined (ascending) ground anchors, method c) must be applied.

(2) Limitation of the load transfer length may be omitted if the conditions stated therefor in DIN EN 1537 in conjunction with DIN SPEC 18537, Section 8.3.6, are met.

3.2.4.5 Post-grouting

(1) Once the cement grout of the initial grouting operation has set or fully hardened, further injections of cement grout can be made in the area of the grout body. For this purpose, valve tubes provided with collars or grout tubes with valves must be used in the area of the tendon bond length L_{tb} . The grout body can be burst using water; grouting with grout cement must be performed in accordance with DIN EN 1537 in conjunction with DIN SPEC 185372, Section 8.3.6.

(2) Subsequently, if the load transfer length must be limited, the free bond length must be flushed free again.

3.2.5 Anchor head assembly, corrosion protection measures on the construction site

(1) The provisions of the general design-type approval No. Z-13.73-50123, in particular, Section 2.3.3, apply to the assembly of the anchor head and the preparation of the stressing operations.

(2) The individual steps of the assembly of the anchor head on the construction site inclusive of the corrosion protection measures must be carried out in accordance with the work instructions deposited at DIBt.

(3) The free steel end must be coated with a thick layer of an anti-corrosion compound as defined by Section 2.1.7 until the time when the anchor head construction is mounted.

(4) The prefabricated anchor head construction (anchor plate with pipe socket, Section 2.2.1.3) is slipped on via the free steel end and the end of the corrugated or smooth duct. The transition from the pipe socket to the corrugated or smooth duct must be sealed with

two sealing rings in accordance with the design variant according to Table 2 (see Annexes 1 and 2), and the correct position must be finally checked.

(5) The cavity between the steel tendon and the anchor plate/pipe socket must be injected with an anti-corrosion compound in accordance with Section 2.1.7.

(6) If any anti-corrosion compound is removed during the stressing operation, it must be replaced.

(7) After the anchor has been stressed, the domed nut and the steel projection must be protected with a cap in accordance with Section 2.1.4, and the space between the nut and the cap must be injected with an anti-corrosion compound as per Section 2.1.7.

(8) If the anchors must be retensioned due to monitoring inspections, care must be taken that any anti-corrosion compound removed during the tensioning operation is replaced.

3.2.6 Suitability and acceptance tests, supervision of the installation

(1) Suitability and acceptance tests must be carried out on every construction site in accordance with DIN EN 1537 in conjunction with DIN SPEC 18537.

(2) The suitability tests must be supervised by a monitoring body for monitoring the installation of ground anchors included in the list of inspection, monitoring and certification bodies in accordance with the *Land* building codes, Part V, as amended from time to time³⁰.

(3) Within the scope of the monitoring activities related to suitability and acceptance tests, the monitoring body commissioned must monitor - at least randomly - the assembly of the permanent anchors on the construction site, especially the corrosion protection measures to be carried out on site, e.g. the complete injection of the anchor head area with an anti-corrosion compound.

(4) The beginning of the anchor operations must be reported to the competent building supervision authority. The monitoring body must report to the competent building supervision authority if facilities and personnel on site do not warrant proper installation.

3.2.7 Declaration of conformity regarding the execution

(1) The executing company must issue a declaration of conformity pursuant to Section 16a(5), Section 21(2) MBO³¹ that the ground anchors assembled are in agreement with this general design-type approval.

(2) The declaration of conformity of the executing company must be prepared in accordance with DIN EN 1537, Section 10, supplemented by DIN SPEC 18537, Section 3.6. In addition, the approval number of this general construction supervisory authority approval/general design-type approval must be stated.

(3) The declaration of conformity must be handed over to the client for incorporation into the construction file and presented to DIBt and to the competent highest construction supervisory authority on request.

³⁰ Most recent: List of inspection, monitoring and certification bodies based on the *Land* building codes [*"LBO"*] as of May 2017 - DIBt - Mitteilungen, Deutsches Institut für Bautechnik, 2017 edition of May 26, 2017

³¹ Musterbauordnung (MBO), Version of November 2002, last amended by the resolution adopted by the conference of the German Model Building Code) ministers of construction of 05/13/2016

4 Provisions for usage, support and maintenance

4.1 Verification

(1) DIN EN 1537, Section 9.10, supplemented by DIN SPEC 18537, Section 3.5.9, applies.

(2) If required, verification should be performed by the monitoring body which has already been assigned with the suitability tests.

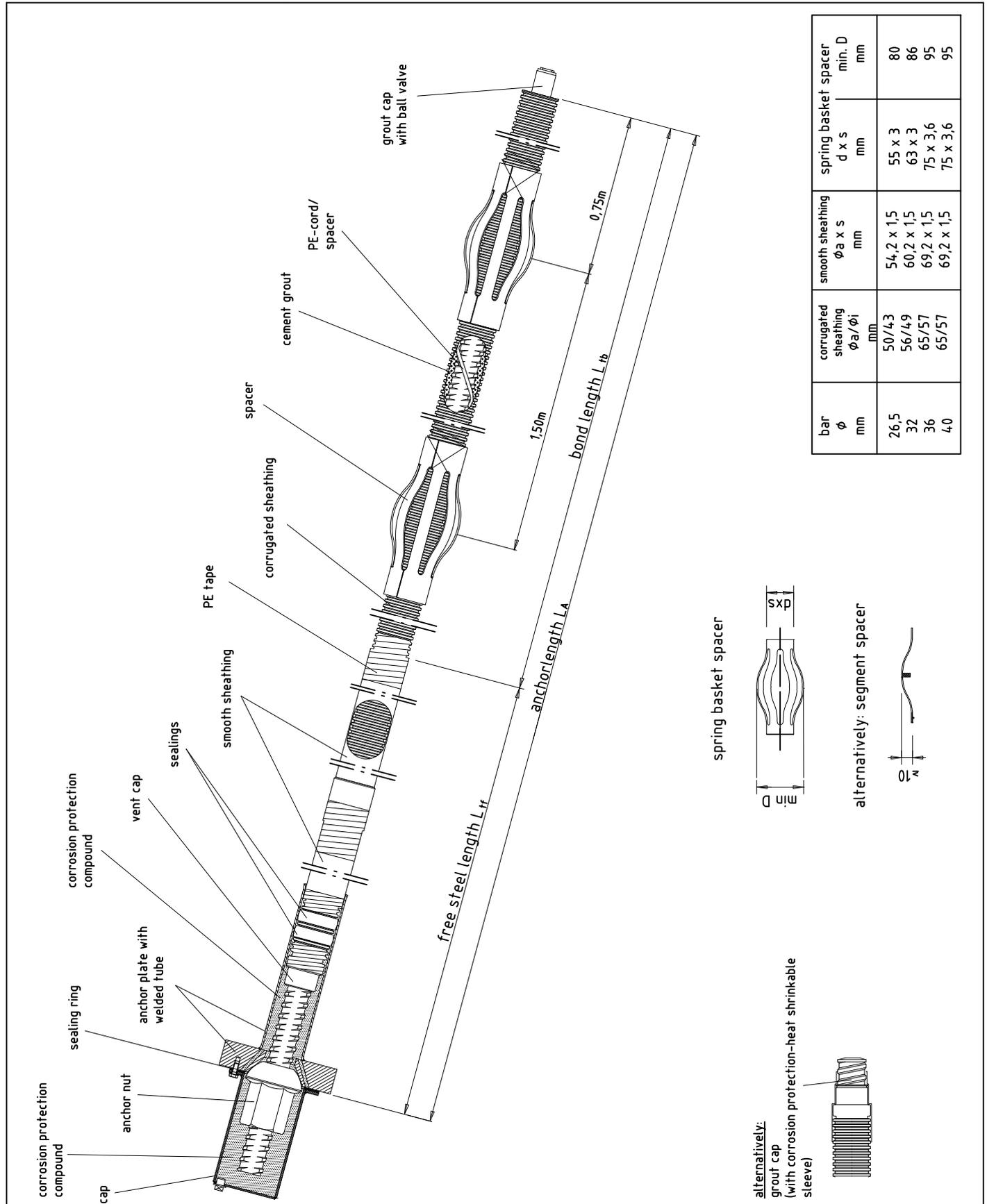
Bettina Hemme
Section Head

Certified

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Deutsches Institut
für Bautechnik
11

General Construction Supervisory Authority Approval/
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 No. Z-20.1-17 from November 15, 2018



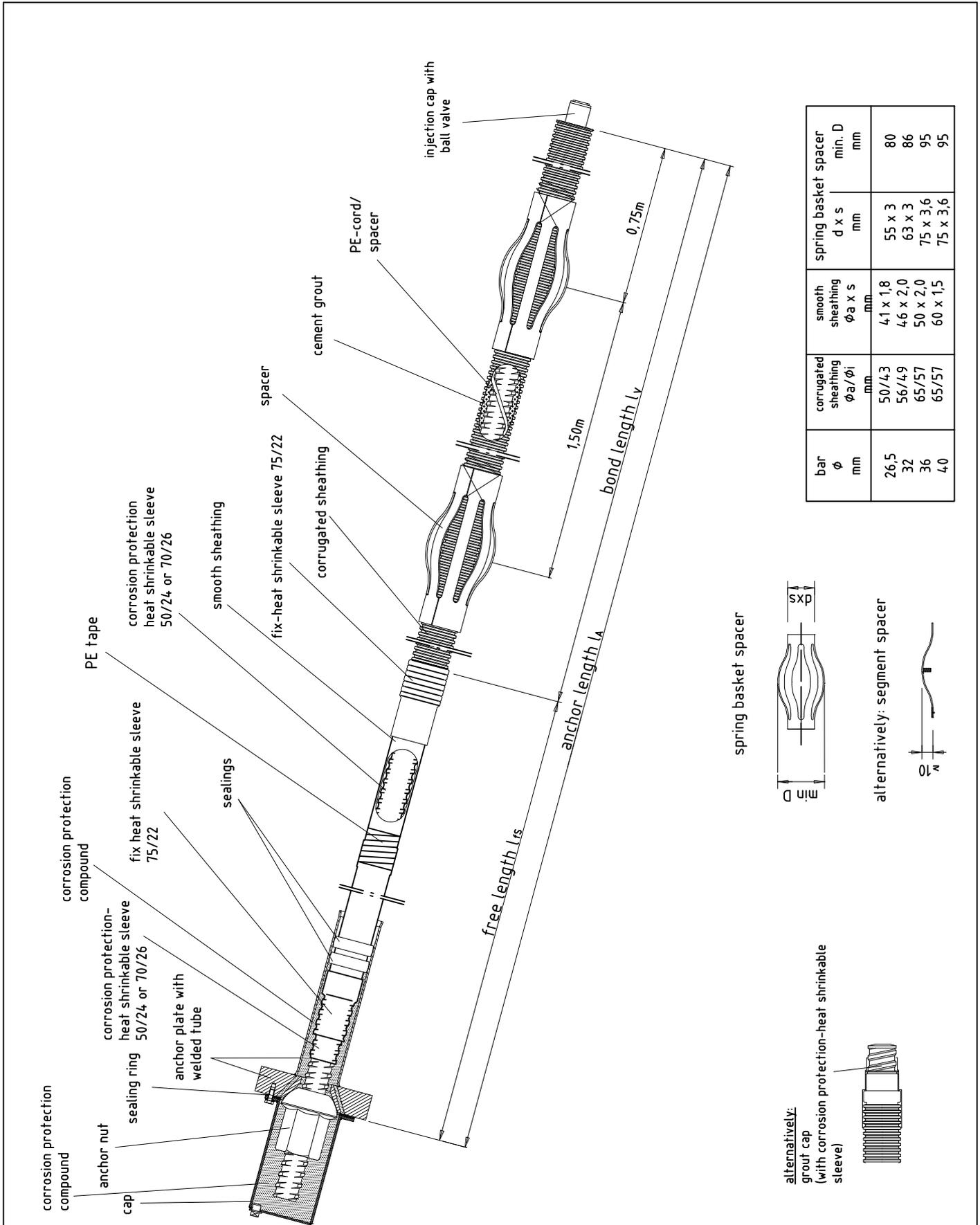
bar φ mm	corrugated sheathing φ _a /φ _i mm	smooth sheathing φ _a x s mm	spring basket spacer d x s mm	min. D mm
26,5	50/43	54,2 x 1,5	55 x 3	80
32	56/49	60,2 x 1,5	63 x 3	86
36	65/57	69,2 x 1,5	75 x 3,6	95
40	65/57	69,2 x 1,5	75 x 3,6	95

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

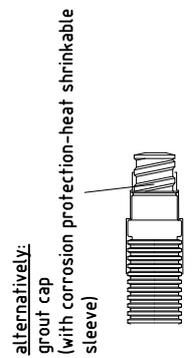
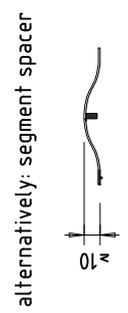
Overview Permanent DYWIDAG Anchors
 with corrugated sheathing

Annex 1

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bar φ mm	corrugated sheathing φa/φi mm	smooth sheathing φa x s mm	spring basket spacer	
			d x s mm	min. D mm
26,5	50/43	4,1 x 1,8	55 x 3	80
32	56/49	4,6 x 2,0	63 x 3	86
36	65/57	5,0 x 2,0	75 x 3,6	95
40	65/57	6,0 x 1,5	75 x 3,6	95

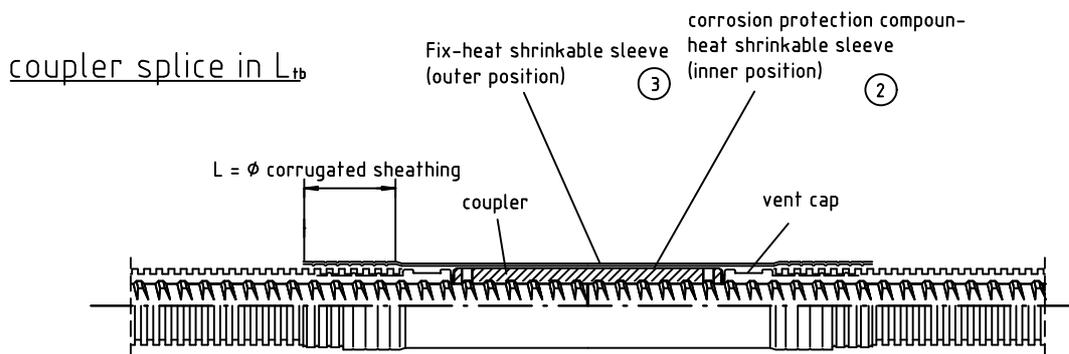
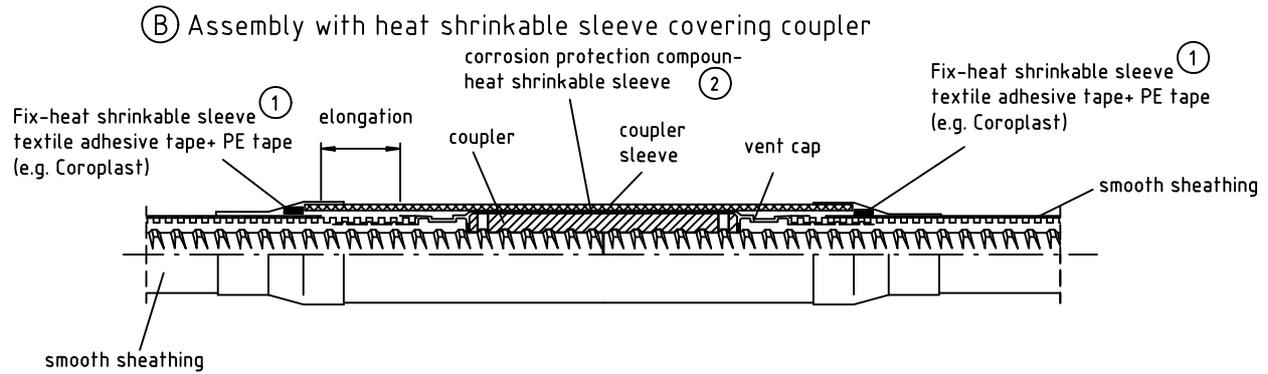
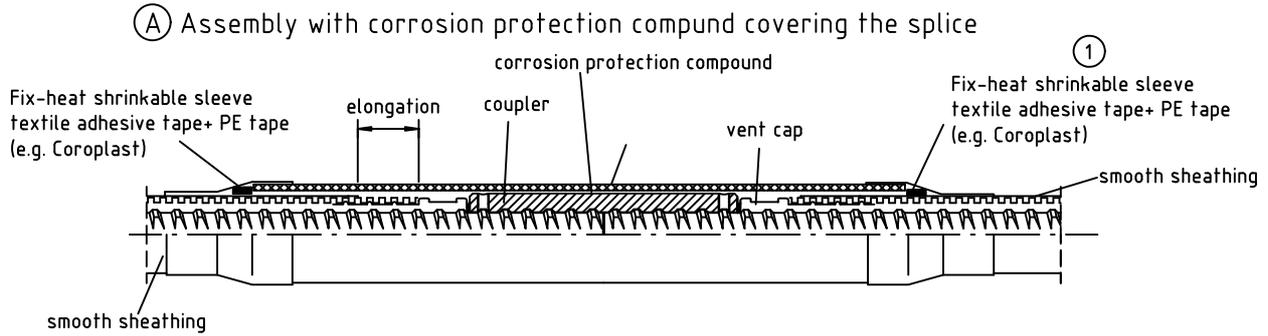


Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Overview Permanent DYWIDAG Anchors with heat shrinkable sleeve in free length

Annex 2

coupler splice for anchors with corrugated sheathing in L_{ff}



bar ϕ mm	coupler	heat shrinkable sleeve			coupler sleeve 1)			
		① mm	② mm	③ mm	Typ (A)		Typ (B)	
					diameter mm	thickness mm	diameter mm	thickness mm
26,5	in accordance with ETA 05/0123 and Z-13.71-50123	95/29	70/26	75/22	63	3,0	75	3,6
32		95/29	70/26	75/22	75	5,6	75	3,6
36		115/34	90/36	95/29	80	4,4	90	4,3
40		115/34	90/36	95/29	80	4,4	90	4,3

rotary protection of all couplers by threaded pins

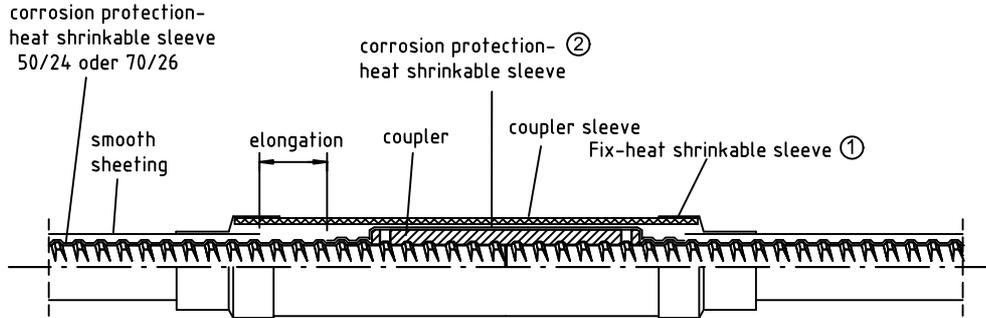
1) PVC-coupler sleeve, up to 15 bar of grouting pressure

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 ϕ 26,5mm, ϕ 32,0 mm, ϕ 36,0 mm und ϕ 40 mm

Coupler splice
 Permanent single bar anchor with corrugated sheathing

Annex 3

Coupler splice for anchors with shrink sleeve in l_{fs}



bar ϕ mm	coupler	heat shrinkable sleeve		coupler sleeve ¹⁾	
		① mm	② mm	diameter mm	thickness mm
26,5	in accordance with ETA 05/0123 and Z-13.71-50123	95/29	70/26	75	3,6
32		95/29	70/26	75	3,6
36		115/34	90/36	90	4,3
40		115/34	90/36	90	4,3

rotary protection of all couplers by threaded pins

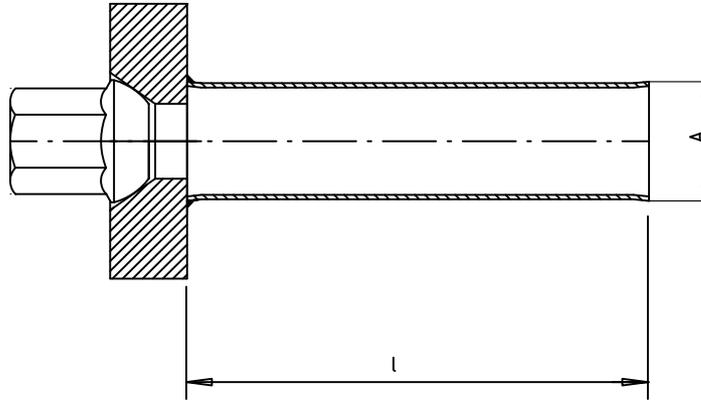
¹⁾PVC-coupler sleeve, up to 15 bar of grouting pressure

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Coupler splice
 Permanent single bar anchor with heat shrinkable sleeve

Annex 4

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Minimum concrete grade: C20/25

Exposition classes according to DIN EN 1992-1-1/NA:2013-04,
 tabel E.1DE have to be take into account

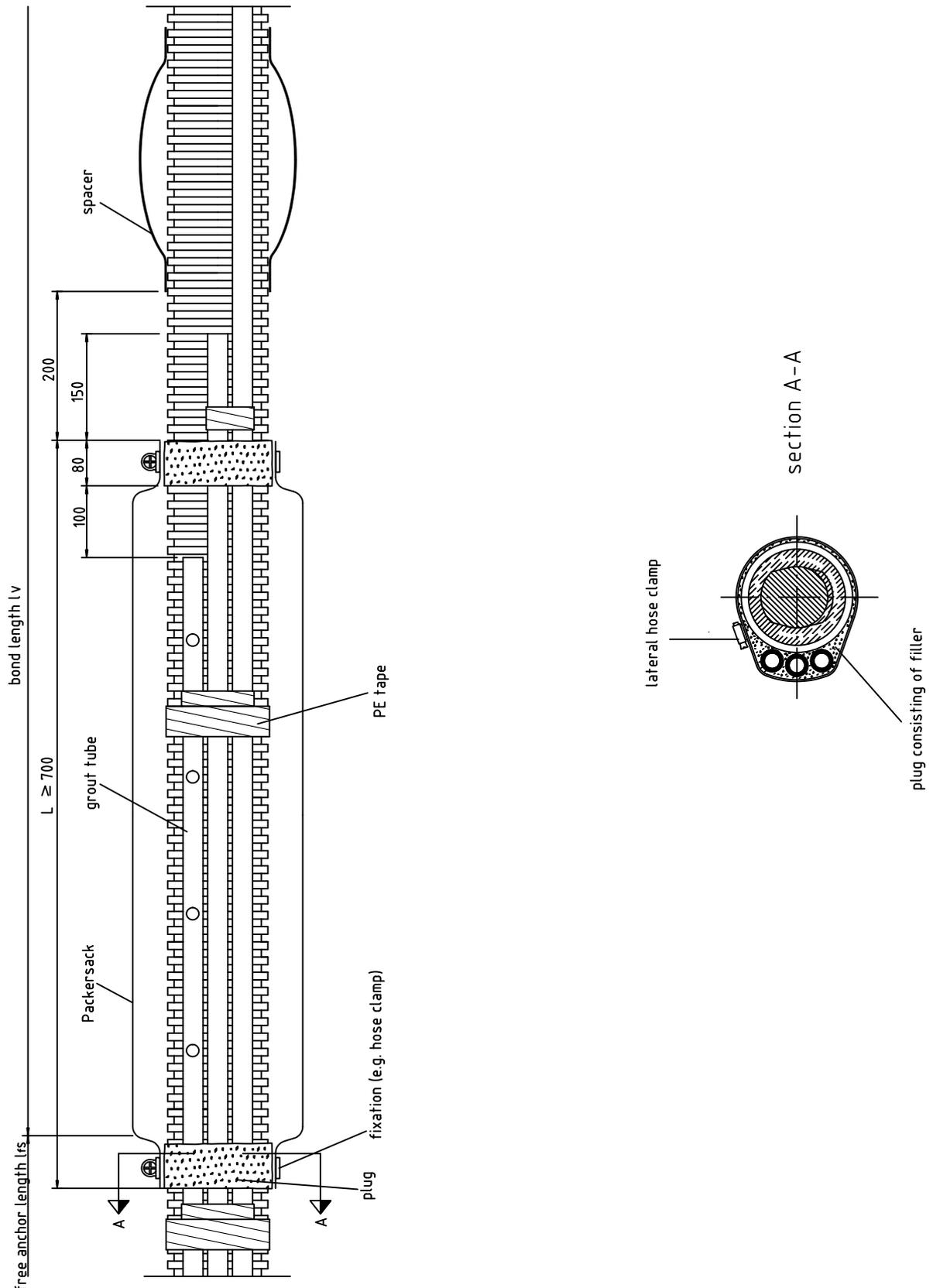
bar φ mm	solid plate	pipe socket			material	anchor nut	min. axis distance mm	min. edge distance mm
		tube φ x s mm	A mm	l mm				
26,5	acc. ETA 05/0123 and Z-13.71-50123	63,5x3,2	~67	≥ 300	S235JR (1.0038) DIN EN 10025-2	acc. ETA 05/0123 and Z-13.71-50123	acc. ETA 05/0123 and Z-13.71-50123	
32		70,0x3,2	~74					
36		76,1x2,9	~80					
40		76,1x2,9	~80					

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Permanent single bar anchor
 anchorage with solid plate and anchor nut

Annex 5

General Construction Supervisory Authority Approval/
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Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Permanent single bar anchor
 Injection packer

Annex 6

General Construction Supervisory Authority Approval/
 General Design-Type Approval
 No. Z-20.1-17 from November 15, 2018

Inspection	Inspection method	FPCS ¹	IP/EM ²	Value	
1. Incoming goods inspection					
1.1	Steel bar with threaded ribs	Delivery note	every delivery	X	Mark of conformity acc. to the GCSA approval
1.2	Anchor nuts	Delivery note	every delivery	X	Performance declaration acc. to ETA-05/0123
1.3	Coupling sleeves	Delivery note	every delivery	X	Performance declaration acc. to ETA-05/0123
	Rotary protection: Diameter and position of the holes	Measurement	at least 5% of each delivery	X	Shop drawings
1.4	Anchor plates	Delivery note	every delivery	X	Performance declaration acc. to ETA-05/0123
	Borholes for anchor caps and backfill: Diameter and position of the holes	Measurement	at least 5% of each delivery	X	Shop drawings
Plastic pipes (smooth pipes, corrugated ducts, coupler pipes), press-in and vent caps					
1.5	Molding compound			X	Inspection certificate "2.1"
	Wall thickness (by corrugated duct wall thickness at inner and outer rib and at the flank)	Measurement	1 per 100 pcs.	X*	Annex 1 and 2 and shop drawings
	Pipe diameter inside and outside	Measurement	1 per 100 pcs.	X*	Annex 1 and 2 and shop drawings
Sealing rings					
1.6	Molding compound	DIN EN 10204	every delivery	X	Inspection certificate "2.1"
	Inner and outer diameter	Measurement	1% of each delivery, min. 5 pcs	X*	Shop drawings
Pipe socket					
1.7	Steel grade	DIN EN 10204	every delivery	X	Inspection certificate "2.1"
	Diameter, widening A, wall thickness, length	Measurement	1 per 100 pcs.	X*	Shop drawings

to be continued on Annex 7, Page 2

* Inspection plan:

If each individual measured value equals or exceeds the minimum value stipulated, the batch must be accepted. Otherwise, additional samples can be taken. The same measurements as those on the first sample must be carried out on these additional samples. The measuring results must be merged with the previous measurements. The mean value \bar{x} and the standard deviation s must be derived from all values. If the test value (numerical value)

$$z = \frac{\bar{x} - x_{min}}{s} \geq 1.64$$

derived therefrom equals or exceeds the minimum value required, the batch must be accepted, otherwise rejected.

¹ Factory Production Control System

² Initial testing/external monitoring (twice a year)

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Minimum Requirements for the Internal Production Control System

Annex 7
Page 1 of 2

continuation of Annex 7, Page 1

Inspection		Inspection method	FPCS ¹	IP/EM ²	Value
1.8	Heat shrink sleeves				
	Molding compound	DIN EN 10204	every delivery	X	Inspection certificate "2.1"
	Corrosion protection shrink tubing: - Classification - Glue applying	EN 12068 Measurement	1 per 100 pcs. 1 per 100 pcs.	X X*	C30 >700 g/m ² (Average: 1100 g/m ² , Nom. thickness: 0,95 mm)
1.9	Corrosion protection coatings, materials and corrosion protection systems				
	Material properties and layer thickness	DIN EN 10204	5% of the quantity produced	X	Inspection certificate "3.1"
2. Control during manufacture					
2.1	heat shrink sleeves- wall thickness in the shrunk condition	Specimen and measurement	1 per anchor type per delivery	X*	>1,5 mm
2.2	heat shrink sleeve - nonporosity on the steel tension member	Apply a voltage of 10 kV	every steel tension bar	X	Yes/no- test
2.3	Cement grout	DIN EN 445	DIN EN 446	X	DIN EN 447
2.4	Assembly of the prefabricated anchors	visual	every working day	X	Z-20.1-17, Section 2.2.1
2.5	Sealing rings for pipe socket / corrugated or smooth tube	Funktionalität, fit accuracy	1 per 100 pcs.	X	Yes/no- test

* Inspection plan:

If each individual measured value equals or exceeds the minimum value stipulated, the batch must be accepted. Otherwise, additional samples can be taken. The same measurements as those on the first sample must be carried out on these additional samples. The measuring results must be merged with the previous measurements. The mean value \bar{x} and the standard deviation s must be derived from all values. If the test value (numerical value)

$$z = \frac{\bar{x} - \text{min. value}}{s} \geq 1.64$$

derived therefrom equals or exceeds the minimum value required, the batch must be accepted, otherwise rejected.

¹ Internal Production Control System

² Initial testing/external monitoring (twice a year)

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: St 950/1050 Ø26,5mm, Ø32,0 mm, Ø36,0 mm und Ø40 mm

Minimum Requirements for the Internal Production Control System

Annex 7
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