DYWIDAG

GEOTECHNICAL SYSTEMS

DYWIDAG Permanent Anchors (Single Bar Anchors) for Soil and Rock with Steel Tendons made of: Grade St 950/1050 Ø 26.5mm, Ø 32mm, Ø 36mm and Ø 40mm

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General Construction Supervisory Authority Approval/ General Design-Type Approval

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Applicant:
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Subject of Approval:
DYWIDAG permanent anchors (single bar anchors) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm

The above mentioned subject is hereby granted general construction supervisory authority accreditation/approval.
This approval includes 18 pages and eight Annexes with nine pages.
The item was granted a general construction supervisory authority approval on 1 April 1989 for the first time.

Important note
This general construction supervisory authority approval/general design-type approval is the translation of a document originally prepare in the German language which has not been verified and officially authorized by "Deutsches Institut für Bautechnik" (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

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2 This Approval does not replace any permits, approvals or certificates required by law for the implementation of construction projects.

3 This Approval is issued without prejudice to any third party rights, including, but not limited to private property rights.

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7 This Approval refers to the information made available and documents provided by the applicant on the subject of approval. Any change to these materials is not covered by this Approval and must be immediately reported to the German Institute for Building Technology.

II SPECIAL PROVISIONS

1 Subject of the regulation and scope of use or application

1.1 Subject of approval and scope of use

(1) The subject of the approval are “DYWIDAG permanent anchors (single bar anchors) for soil and rock” from DYWIDAG Systems International GmbH, further referred to as DYWIDAG single bar anchors, consisting of:

- steel tendons made of ribbed prestressing steel bars in accordance with the general construction supervisory authority approval,
- steel anchor nuts, anchor plates and couplers in accordance with the European Technical Assessment,
- steel pipe sockets;
- plastic or steel anchor caps;
- other components of the corrosion protection system consist of plastic sheathing, corrosion protection compounds and inner cement grout.

(2) DYWIDAG single bar anchors may be used for permanent installation. For this purpose, they must be protected with a corrosion protection system according to the installation versions DYWIDAG Permanent Anchor with Corrugated Tube and DYWIDAG Permanent Anchor with Heat Shrink Sleeve (see Annex 1 or Annex 2 and Table 1). The corrosion protection system is to be applied at the plant.

(3) The DYWIDAG single bar anchor may be used as ground anchor per DIN EN 1537 in conjunction with DIN/TS 18537

1.2 Subject of approval and scope of use

(1) The subject of approval are the planning, design and installation of ground anchors according to DIN EN 1537 in conjunction with DIN/TS 18537.

(2) The ground anchors are to be manufactured in accordance with Annexes 1 to 2 with DYWIDAG single bar anchor and cement grout.

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

2 Provisions for the construction product

2.1 Properties and composition

There are different installation versions according to Table 1, which differ in their corrosion protection system in the area of the steel section L_{tf} (see also Annexes 1 and 2):

Table 1: Installation versions

Installation version	Corrosion protection system in the area of	
	tendon free length L_{tf}	tendon bond length L_{tb}
DYWIDAG-permanent anchor with corrugated tube (see Annex 1)	• Steel tendon in corrugated tube and filled with inner cement grout • Smooth tube over corrugated tube	• Steel tendon in corrugated tube and filled with inner cement grout
DYWIDAG-permanent anchor with shrink sleeve (see Annex 2)	• Steel tendon with corrosion protection heat shrink sleeve • Smooth sheathing over corrosion protection heat shrink sleeve	

2.1.1 Steel tendon

(1) Only general construction supervisory authority-approved ribbed prestressing bars with rolled-on thread ribs on both sides according to Table 2 may be used as material for the steel tendon.

Table 2: Steel tendon

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

(2) For the coupling of the threadbars according to Table 2, couplers shall be used in accordance with the parameters declared in the declaration of performance according to ETA-05/0123[1] (see also Annex 3). The couplers are provided with threaded holes to secure the screwed connection (fixing) by means of grubscrews, the diameter and position of which are indicated on the design drawings submitted.

2.1.2 Anchor head

(1) For anchoring of the threadbars according to Table 2, the stressing anchor, consisting of a domed nut with/without grooves and a square solid plate (anchor plate), shall be used with the dimensions specified in the declaration of performance according to ETA-05/0123[1]. The main geometric dimensions and material specifications for the domed nuts and the square solid plates are given in Annex 3.

(2) The anchor plates for fixing the anchor cap and for filling the pipe socket with corrosion protection compound, which deviate from the specifications provided in ETA-05/0123[1], shall be provided with holes, the diameter and position of which are indicated on the filed corrosion protection design drawings.

2.1.3 Anchor caps, pipe sockets and corrosion protection coating

2.1.3.1 Anchor caps

The anchor caps according to Annex 1, 2 and 6 shall be made of steel (S235JR) with a wall thicknesses ≥3.0 mm or PE-HD with a wall thicknesses ≥4.0 mm and shall have dimensions according to the workshop drawings deposited with DIBt. Sealing against the anchor plate is achieved with a nitrile rubber sealing ring placed underneath.

2.1.3.2 Pipe sockets

(1) The pipe sockets must be made of steel (S235JR) and have dimensions corresponding to the threadbar diameter according to Annex 6. At the open-air end they should be connected to the anchor plate, at the earth end they overlap with the smooth or corrugated sheathing.

(2) Within the overlap length, sealing rings are arranged on site in accordance with the installation version (Table 1) when installing the anchor head as follows:

- DYWIDAG permanent anchor with corrugated tube:

2 profile rings made of neoprene (CR) on the corrugated tube (see Annex 1 and 6)

- DYWIDAG permanent anchor with shrink sleeve:

1 sponge rubber ring on the smooth tube and 1 piece of sponge rubber ring on the corrosion protection heat shrink sleeve (see Annex 2 and 6)

The sealing rings must be matched to the dimensions of the pipe sockets and the installation version of the corrosion protection system. These are deposited with DIBt depending on the bar diameter of the threadbars used, see also Annex 6.

[1] ETA-05/0123 of 23.06.2023 Bonded, unbonded an external post-tensioning kits for prestressing of structures with bars

2.1.3.3 Corrosion protection coating

(1) If not cast completely in concrete (at least 5 cm coverage thickness), the anchor plate must be provided with a corrosion protection system as defined by DIN EN ISO 12944-5 depending on the determined corrosivity category of the environment and with the protection period “very high (VH)”. The surface must be prepared as specified by DIN EN ISO 12944-4. DIN EN ISO 12944-7 must be observed for the execution of the coating work.

(2) The exposed surfaces of the pipe socket and of the steel anchor cap must also be provided with one of the corrosion protection systems mentioned under item (1).

(3) Alternatively, the anchor plate and surfaces of steel parts that are exposed or not sufficiently covered with concrete, e.g. pipe socket and steel anchor cap, where the environment corrosivity category is between C1 and C4 inclusive, must be provided with corrosion protection using hot-dip zinc coating according to DIN EN 14713-1 depending on the determined corrosivity category of the environment with the protection period “very high (VH)”. Surfaces must be prepared and treated as prescribed by DIN EN ISO 1461. DASt Guideline 022 [2]must be observed.

2.1.4 Corrosion protection system components

2.1.4.1 Plastic sheathings

(1) Only plastic sheathings may be used for encasing the free steel section or the anchoring section which are made of PVC-U as per DIN EN ISO 21306-1, polyethylene with molding compound as per ISO 17855-PE-HD, E, 44-T022 as per DIN EN ISO 17855-1 or of polypropylene with molding compounds ISO 19069-PP-B, EAGC, 10-16-003 or ISO 19069-PP-H, E, 06-35-012/022 as per DIN EN ISO 19069-1. The sheathing must not contain bubbles and pigment distribution must be even.

(2) The basic dimensions of the smooth and corrugated tubes must correspond to the data provided in Annexes 1 and 2. For the DYWIDAG permanent anchor with corrugated tube, the inside diameter of the smooth tubes must not be more than 2.0 mm larger than the outside diameter of the corrugated tubes. The minimum wall thickness of the corrugated tubes is 1.0 mm and of the smooth tubes 1.5 mm for all installation versions.

(3) To maintain a distance of ≥5 mm between the threadbar and the corrugated tube, arrange internal spacers at a distance of 1.0 m from each other on the threadbar. The material thickness of the inner spacers is >5 mm in the star spikes area. Alternatively, a Ø 6 mm polyethylene helix with a pitch of 0.5 m can be used.

(4) PE caps with a wall thickness of ≥1 mm are to be used as end caps or injection caps at the ends of the corrugated tubes.

(5) If couplings are required for the threadbars, the coupler connections shall be protected by means of a coupler tube made of the molding compounds according to (1) and with the dimensions according to Annex 4.

2.1.4.2 Heat shrink sleeves

(1) Use corrosion protection heat shrink sleeves or fixing heat shrink sleeves as heat shrink sleeves.

(2) Use corrosion protection heat shrink sleeves as per DIN EN 12068 with the classification Coating EN 12068-C30 (e.g. SATM, CPSM) of radiation-crosslinked polyethylene, which is lined on the inside with a butyl rubber based adhesive with corrosion inhibitors; the amount of adhesive must be at least 700 g/m^2.

(3) Fixing heat shrink sleeves (e.g. MWTM, SRH2) are made of polyethylene; the sealing adhesive mass must be a hot melt adhesive.

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

[2] DASt Guideline 022:2016-06 Guideline for hot-dip-zinc-coating of prefabricated structural steel structures; Deutscher Ausschuss für Stahlbau DASt, Sohnstr. 65, 40237 Düsseldorf

2.1.4.3 Corrosion protection compounds

Corrosion protection compounds are used for the butt formation on the threadbars and at the anchor head. Denso-Cord, Denso-Jet, Denso-Fill, Petro-Plast or Nontribos MP-2 must be used as corrosion protection compounds. These corrosion protection compounds must each comply with the technical data sheets deposited with DIBt.

2.1.4.4 Inner cement grout

Inner cement grout as per DIN EN 447 should be used. In addition, DIN EN 445 and DIN EN 446 must be observed.

2.2 Production, packaging, transport, storage and marking

2.2.1 Manufacture and corrosion protection of the prefabricated DYWIDAG single bar anchor for installation and grouting

(1) The following works should be carried out at the plant.

(2) The DYWIDAG single bar anchors are assembled and the corrosion protection system arranged in accordance with the work instructions corresponding to the installation versions as per Table 1, submitted to DIBt. For this purpose, the steel tendon (threadbar) must be treated in accordance with the approval requirements for steel before use. The threadbar must be clean and free of damaging rust. Threadbars with a slight rust film may be used. The term “slight rust film” is defined as the uniform initial phase of rust formation which has not yet led to the formation of corrosion pits visible to the naked eye and which in general may be removed by wiping with a dry rag.

2.2.1.1 Prefabrication of the corrosion protection system in the free steel section L_{tf} and the anchoring section L_{tb}

(1) Plastic tubes in accordance with Section 2.1.4.1 (smooth and corrugated plastic tubes) shall be used to encase the threadbar; their basic dimensions shall be in accordance with the specifications on Annex 1 and 2. Bars and coils may be used. The individual sections of the PVC-U sheathing pipes made of PVC-U that may be required must be screwed together and sealed with an adhesive suitable PVC or by wrapping with adhesive tape suitable for PVC. Care must be taken to ensure that only straight pipes, which have also been delivered in such a condition, are used. As PE or PP sheathing, continuous pipes should be used.

(2) In the case of the DYWIDAG permanent anchor with corrugated tube, the threadbar must be routed in a plastic corrugated tube over approximately the entire length (see Annex 1), in the case of the DYWIDAG permanent anchor with shrink sleeve over the anchoring section L_{tb} (see Annex 2). To maintain the distance between the threadbar and the corrugated tube, use internal spacers according to Section 2.1.4.1 (3). The ends of the corrugated tube shall be closed and bonded on both sides with caps (injection cap and/or end cap) according to Section 2.1.4.1 (4). At the ground end of the anchor, the corrugated tube must be closed with an injection cap with ball valve; alternatively, an injection cap with corrosion protection heat shrink sleeve can be arranged. If the threadbar is coupled and assembled from individual threadbars at the installation site, the free steel projections required for the coupling must be taken into account when installing the corrugated tubes/caps.

(3) The ring space between the threadbar and the corrugated tube must be filled with inner cement grout according to Section 2.1.4.4. For this purpose, the previously prepared threadbar must be positioned on an inclined plane so that backfilling is ensured from the lowest point (injection cap or end cap) and venting at the highest point (end cap). Backfilling must be carried out until bubble-free inner cement grout emerges from the highest end cap.

(4) In the case of the DYWIDAG permanent anchor with shrink sleeve, corrosion protection heat shrink sleeves are arranged in the free steel section L_{tf} over the entire length in accordance with Section 2.1.4.2 (2) instead of the corrugated tube (see Annex 2). At the transition point from the free steel section L_{tf} to the anchoring section L_{tb}, the anchoring section L_{tb} must incorporate or overlap the corrosion protection of the anchoring section L_{tb} by at least 10 cm. The corrosion protection heat shrink sleeves must overlap for a minimum of 5 cm at any joints in the area of the free steel section L_{tf}.

Above the corrosion protection heat shrink sleeve in the free steel section L_{tf}, a smooth tube made of plastic shall be arranged according to the above requirements and the dimensions given in Annex 2. This must be sealed on the air and ground side by means of fixing heat shrink sleeve in accordance with Section 2.1.4.2 (3).

(5) In the case of the DYWIDAG permanent anchor with corrugated tube, a smooth plastic tube must be arranged concentrically over the corrugated tube in the area of the free steel section L_{tf} in accordance with the requirements of Section 2.1.4.1 (2). The smooth tube must be fixed in position by means of an adhesive tape suitable for plastic. At the transition point from the free steel section L_{tf} to the anchoring section L_{tb}, the smooth tube must be fixed to the corrugated tube with a fixing heat shrink sleeve (see Annex 1).

(6) If the threadbar is coupled and assembled from individual threaded sections at the installation site, individual expansion paths at the coupling points (see Annex 4) must be observed for both installation versions with regard to the fixation of the smooth tubes. Threaded sections to be coupled shall be prepared at the factory in accordance with the installation version according to items (1) to (5). The protruding steel on the threaded sections to be coupled must be temporarily protected against corrosion. For covering the coupling points, coupler tubes according to Section 2.1.4.1 (5) shall be used and included in the delivery.

2.2.1.2 Prefabrication and corrosion protection of the anchor head

The construction design of the anchor head is shown in Annexes 1, 2 and 6. The following prefabrication measures must be taken at the factory for the anchor head construction:

- Anchor plates and pipe sockets in accordance with Sections 2.1.2 and 2.1.3.2 shall be circumferentially welded to each other. Anchor plates welding contractors must have a welding certificate for the execution class EXC 1 as required by DIN EN 1090-1.
- After joining, the pipe socket (inside and outside) as well as exposed anchor plates shall be provided with a corrosion protection coating according to Section 2.1.3.3.

2.2.2 Transport and storage

(1) The effectiveness of the corrosion protection of DYWIDAG single bar anchors depends on the integrity of the corrosion protection system. Therefore, care must be taken during the storage, transport and installation of the prefabricated DYWIDAG single bar anchors to ensure that the corrosion protection system, in particular the corrugated plastic sheathing, is not damaged through improper handling.

(2) Depending on the temperature, the DYWIDAG single bar anchor may be removed from the assembly bench at the earliest one day (24 h) after grouting with inner cement grout at the plant. Further transport and installation is allowed not earlier than 3 days after injection with inner cement grout at the plant.

(3) The prefabricated DYWIDAG single bar anchors may not be stored on the ground; contamination and soiling – mainly of the corrugated pipes – must be avoided. If the prefabricated DYWIDAG single bar anchors are supported at intervals only, the support points may not be sharp-edged, but must be flat. If prefabricated DYWIDAG single bar anchors are piled up, they must lie on top of each other in a parallel manner. If supported at intervals by square timber or adequate spacers, then the weight of the anchors on top may only be carried via the timber or spacers.

(4) In no case may the prefabricated DYWIDAG single bar 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 especially the corrugated sheathing will not be damaged. If transported by a crane hook, the anchor must be carried at its stressing end or with carrying straps or placed in ducts.

2.2.3 Marking

(1) The prefabricated or pre-assembled DYWIDAG single bar anchors and the delivery note for the DYWIDAG single bar anchors must be marked by the manufacturer with the conformity mark (Ü-Zeichen) in accordance with the conformity mark regulations issued by the German Länder. Such marking is allowed only if the requirements as per Section 2.3 are met.

(2) In particular, the delivery note must include the use for which the DYWIDAG single bar anchors are intended and the plant in which they were manufactured. One delivery note should only list anchoring components for one installation version; the assignment of the “DYWIDAG single bar anchors” anchoring components must clearly result from the delivery note.

2.3 Conformity confirmation

2.3.1 General

(1) The confirmation of conformity of the anchor components and the DYWIDAG single bar anchors prefabricated for installation and grouting with the provisions of the general construction supervisory authority approval covered by the Approval must be provided for each manufacturing plant with a declaration of conformity from the manufacturer based on a plant production control and a certificate of conformity from a recognized certification body and regular external monitoring by a recognized monitoring body in accordance with the following provisions.

(2) Issuing a certificate of conformity and external monitoring, including the product tests to be carried out, require from the manufacturer of the anchor components and the prefabricated DYWIDAG single bar anchor to engage a recognized certification body and a recognized monitoring body.

(3) The manufacturer submits the declaration of conformity by marking the construction products with a conformity mark with reference to the intended use.

(4) The certification body must provide the German Institute for Building Technology with a copy of the certificate of conformity they have issued.

(5) Additionally, a copy of the initial test report must be submitted to the German Institute for Building Technology.

2.3.2 Plant production control

(1) A plant production control must be set up and carried out at every manufacturing plant. The plant production control is understood as a continuous monitoring of production carried out by the manufacturer, by means of which the manufacturer ensures that the construction products they manufacture meet the provisions of the general construction supervisory authority approval granted under this Approval.

(2) The plant production control shall include at least the measures listed in Annex 8 regarding incoming goods control and control during manufacturing.

(3) Results of the plant production control must be recorded and evaluated. Such records must contain at least the following information:

- Designation of the construction product or the initial material and its components;
- Nature of the control or inspection;
- Date of manufacturing and inspection of the construction product or the initial material or its components;

- Results of the controls and inspections and, if applicable, a comparison with the relevant requirements,
- Signature of the person responsible for the plant production control.

(4) Such records must be retained for at least five years and presented to the monitoring body responsible for external monitoring. They must be presented to the German Institute for Building Technology and to the competent highest construction supervisory authority on request.

(5) If the inspection result is unsatisfactory, the manufacturer must immediately take the necessary measures to remove the defect. Construction products that do not met the requirements must be handled in such a way so as to exclude confusion with the conforming ones. When the defect is removed, the respective inspection must be repeated immediately – insofar as it is technically possible and necessary to prove that the defect has been removed.

2.3.3 External monitoring

(1) At every manufacturing plant, the plant itself and the plant production control must be controlled through external monitoring on a regular basis, in any case at least twice a year.

(2) As part of external monitoring, an initial test in accordance with Annex 8 must be carried out. Samples are to be taken for spot checks and also the testing tools are to be controlled. The sampling and inspections are the responsibility of the recognized monitoring body.

(3) The results of the certification and external monitoring must be retained for at least five years. They must be presented by the certification body or the monitoring body to the German Institute for Building Technology and to the competent highest construction supervisory authority on request.

3 Provisions for planning, design and installation

3.1 General

(1) The ground anchors must be planned, designed and executed in accordance with technical building specifications, unless otherwise specified below.

(2) For the planning, execution and inspections (suitability and acceptance tests) of ground anchors, the specifications in DIN EN 1537 in conjunction with DIN/TS 18537 must be observed. Dimensioning is based on DIN EN 1997-1 in conjunction with DIN EN 1997-1/NA and DIN 1054, unless otherwise specified below.

(3) The application is limited to the cases where the total load transfer length of the anchor, either in cohesive or non-cohesive soils is in rock (see DIN EN 1997-1 in conjunction with DIN EN 1997-1/NA and DIN 1054, Section 3.1). Any deviating cases may only be carried out upon the consent of geotechnical experts.

(4) The requirements for the subsoil investigations are covered by DIN EN 1537, Section 5.

(5) The execution planning documentation must include all information resulting from the details implementation planning. This pertains among others to the measures for preparing the prefabricated DYWIDAG single bar anchor for installation, grout composition and grout body production, as well as the construction details of any required coupler splices and anchor head design/anchor head.

3.2 Planning

3.2.1 Drillhole

(1) The borehole diameter must be selected in such a way that the anchor with spacers can be inserted without problems and the minimum coverage with grout can be maintained. In the head area, the diameter of the pipe socket must also be taken into account. The provisions of DIN EN 1537 in conjunction with DIN/TS 18537, Section 8.1, shall apply.

(2) In the case of rock anchors, it must be verified that in the area of the free anchor section perpendicular to the borehole axis:

- no fracture displacements is expected if the load transfer length is not limited;
- the expected fracture displacements are smaller than the difference between the sheathing and the borehole diameter if the load transfer length is limited through an appropriate process (see Section 3.2.4 (4)).

3.2.2 Anchor preparation

(1) Spacers (spring cage or segment spacers) must be placed on the prefabricated DYWIDAG single bar anchors in the area of the anchoring section according to Annexes 1 and 2. The spacers must be arranged starting from the anchor foot at maximum distance of 1.50 m on the corrugated sheathing in the anchoring section so that they are secured against displacement. The first spacer must be positioned at a maximum of 0.75 m from the anchor foot end. When installing the ground anchor as protection for a casing, the arrangement of the spacers can be omitted if the wall thickness of the initial pipe or the material thickness at the nipple passages is >10 mm.

(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 effected from the highest point. For this purpose, ascending ground anchors must have a packer with the appropriate grouting and vent tube arranged (see Annex 7).

(3) If postgrouting of the grout body is planned, valve hoses or pipes with grouting hoses with sleeves should be used, which must be taken into account during planning and attached before the anchors are installed.

3.2.3 Coupler splices

If couplings are required for the DYWIDAG single bar anchors, they must be installed according to Section 2.1.1 (2) using couplers (see Annex 3). To complete the corrosion protection system above the joints, the following measures must be planned depending on the location of the joints and specified in the execution planning documentation.

3.2.3.1 Coupling in the free steel section L_{tf}:

(1) In the area of the free steel section L_{tf}, expansion paths must be provided at the coupling points. For all sections in a construction project, these values must be selected equal to or greater than the maximum elongation value occurring there.

(2) Couplings in the free steel section L_{tf} can be designed in two variants, see Annex 4:

Variant A: Design with corrosion protection compound over the coupler

- A coupler tube according to Section 2.1.4.1 (5) shall be placed above the coupler connection. The coupler tube shall be connected to the respective smooth tubes of the threaded sections to be coupled by means of fixing heat shrink sleeve according to Section 2.1.4.2 (3). The gap between the coupling and the coupler tube must be filled with corrosion protection compound according to Section 2.1.4.3.
- Variant A is applicable for the installation version DYWIDAG permanent anchor with corrugated tube according to Table 1.

Variant B: Version with heat shrink sleeve over the coupler

- A corrosion protection heat shrink sleeve is shrunk over the coupling sleeve in accordance with Section 2.1.4.2 (2) and connected to the corrosion protection of the threaded sections on both sides. The overlapping lengths of the corrosion protection heat shrink sleeve on the corrosion protection of the threaded sections are as follows for the installation versions

- DYWIDAG permanent anchor with corrugated tube: ≥outer diameter of the plastic corrugated tube,
- DYWIDAG permanent anchor with shrink sleeve: ≥ outer diameter of the threadbar.
- A coupler tube shall be arranged over the entire coupler connection as in the case of variant A and connected to the respective smooth tubes of the tendon sections to be coupled.

3.2.3.2 Coupling in the anchoring section L_{tb} and at the transition point to the free steel section L_{tf}

(1) In the case of a coupling in the anchoring section L_{tb}, two layers of heat shrink sleeves shall be arranged over the coupler connection, the first layer being a corrosion protection heat shrink sleeve and the second (outer) layer being a fixing heat shrink sleeve in accordance with Section 2.1.4.2. The overlap lengths for corrosion protection of the tendon sections (corrugated tube with end cap) are at least equal to the diameter of the corrugated tubes, see Annex 5.

(2) A maximum of one coupler may be arranged in the anchoring section L_{tb}. The coupling at the transition point from the free steel section L_{tf} to the anchoring section L_{tb} shall be designed same as the coupling in the anchoring section, but it shall not be considered as a coupling in the anchoring section.

3.2.4 Grout and grout body

(1) For the manufacturing of the grout body, cement grout should be used.

(2) The starting materials for the cement grout are cements with special properties according to DIN 1164–10 and cements according to EN 197-1 – taking into account the existing exposure classes as per DIN EN 206-1 in conjunction with DIN 1045-2 (Tables 1, F.3.1 and F.3.2), water as per DIN EN 1008 and, if necessary, additives as per EN 934-2 in conjunction with DIN EN 206-1/ DIN 1045-2 or with general construction supervisory authority approval and natural aggregates for concrete with up to 4 mm grain diameter as per EN 12620 – taking into account DIN EN 206-1/DIN 1045-2, Appendix U to be applied.

(3) 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.

(4) The load transfer length of the grout body is to be limited by one of the following methods:

a) by flushing out excess cement grout using a flushing hose permanently mounted on the plastic tubing. The flushing hose must be arranged in such a manner that the first lateral discharge openings lie 50 cm above the transition point between the free steel section L_{tf} and the anchoring section L_{tb} of the tendon. Verification of this value must be confirmed in the record. The flushing pressure applied must be approx. 4 bar.

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. 1.0 m above the transition point L_{tb}/L_{tf}. The flushing pressure applied must be approx. 4 bar.

c) by blocking the load transfer length by means of a packer. The suitability of the packer must be verified within the scope of a suitability test.

In the case of downward-inclined (descending) ground anchors, methods a), b), or c) may be applied. For upward-inclined (ascending) ground anchors, method c) must be applied. This procedure must be included in the execution planning documentation.

(5) Limitation of the load transfer length may be omitted if the respective conditions stated in DIN EN 1537 in conjunction with DIN SPEC 18537, Section 8.3.4, are fulfilled.

(6) Post-grouting operations with cement suspension may be carried out in accordance with DIN EN 1537 in conjunction with DIN/TS 18537, Section 8.3.5. The grout body can be burst using water. After post-grouting, if the load transfer length must be limited, the free anchor length must be flushed again.

3.2.5 Anchor head

(1) The anchor head as per Section 2.1.2, other components of the anchor head as per Section 2.1.3 and the prefabrication of the anchor head structure at the plant as per Section 2.2.1.2 must be planned accordingly and specified in the execution planning documentation.

(2) The threadbar must be anchored in each direction perpendicular to its axis.

(3) To seal the transition point between the pipe socket and the corrosion protection of the threadbar, profile rings/sponge rubber rings must be provided in accordance with Section 2.1.3.2 (2) and arranged within the overlap length, see also Annexes 1, 2 and 6.

(4) Gaps between the steel tendon and anchor cap/anchor plate/pipe socket shall be filled with corrosion protection compounds according to Section 2.1.4.3.

(5) Provided that the anchor cap is not exposed to mechanical stresses and is subsequently cast in concrete, it can be made of PE-HD (see Section 2.1.3.1).

(6) When the anchor heads are supported on concrete, the minimum center distances and minimum edge distances stated in Annex 6 shall apply. Concrete in accordance with DIN EN 206-1 in conjunction with DIN 1045-2 shall be used. At the time of application of the full prestressing force, the normal weight concrete in the anchoring area must have a minimum compressive strength class C20/25. The strength shall be verified based on at least three test specimens (test cylinders or cubes with an edge length of 150 mm), which shall be stored under the same conditions as the component of the support, as compressive strength mean value, whereby the three individual values shall not deviate from each other by more than 5%. Unless more precisely demonstrated, the characteristic strength of the concrete at time t_j of application of the prestressing force $f_{ck,tj}$, may be calculated based on the value of the cylindrical compressive strength of the specimen $f_{cmj,cyl}$ as follows:

$$f_{ck,tj} = f_{cmj,cyl} - 8$$

(7) The axis and edge distances given in Annex 6 assume that in the anchoring area of the concrete support (reference specimen: A x A x A) at least 50 kg/m³ of reinforcement is already provided and this is evenly distributed over the height A. If this does not apply, additional reinforcement must be provided in accordance with the missing amount of reinforcement and subsequent requirements:

- Ribbed reinforcing steel B500A or B500B according to DIN 488-1 or according to the general construction supervisory authority approval must be used as additional reinforcement.
- The additional reinforcement consists of closed stirrups (plug-in stirrups, stirrups according to DIN EN 1992-1-1/NA, Figure NA.8.5 e or g) or similar reinforcement according to DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA, Section 8.4.
- When using closed stirrups, the stirrup locks must be arranged in an offset manner.
- The leg lengths of the arranged stirrups or the lengths of the crosswise straight reinforcing bars used as additional reinforcement (minus the anchoring sections on both sides) for the anchoring without additional reinforcement are 20 mm smaller than the center distances of the respective anchoring.

Absorption of forces occurring in the structural concrete must be verified outside the specified anchoring areas.

(8) All the axial and edge distances specified in Annex 6 and ETA-05/0123[1] have been provided only with regard to the static requirements; therefore, the concrete coverings of the reinforcing steel or steel core reinforcement specified in other standards and guidelines - in particular in DIN EN 1992-1-1 in conjunction with DIN EN 1992-1-1/NA or DIN EN 1992-2 in conjunction with DIN EN 1992-2/NA - must also be taken into account.

3.3 Design

3.3.1 Limitation of prestressing forces and further proof

(1) According to DIN EN 1992-1-1, Section 5.10.2.1 (1), the applied

maximum force P_{max} must not exceed the force $P_{max} = 0.80\ A_p \cdot f_{pk}$ listed in Table 3.

The mean value of the prestressing force $P_{m0}(x)$ immediately after the prestressing force has been applied to the anchoring must not exceed the force $P_{m0}(x) = 0.75\ A_p\ f_{pk}$ listed in Table 3 at any point according to DIN EN 1992-1-1, Section 5.10.3 (2).

Table 3: Prestressing forces for prestressing steel bars St 950/1050 (threadbars)

Description	Nominal bar diameter d_s [mm]	P_{max} [kN] 0.80 $A_p\ f_{pk}$	$P_{m0}(x)$ [kN] 0.75 $A_p\ f_{pk}$
26 WR	26.5	464	434
32 WR	32	676	633
36 WR	36	856	802
40 WR	40	1056	990

(2) It must be proven that the changes of forces (characteristic value) in the steel tendon frequently repeated specified load (including wind) is not greater than 20% of the characteristic load E_k.

(3) Fatigue tests carried out within the scope of ETA-05/0123[1] demonstrated a fatigue range of 80 N/mm^2 with $2 \cdot 10^6$ load cycles with a top stress of 0.65 f_{pk}. It must be proven 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 cycles above $2 \cdot 10^6$ are not verified by ETA-05/0123. The verification is only needed if the pulsating load is not covered by the prestressing.

3.3.2 Airside anchoring over reinforced concrete, steel structures and rock

(1) When anchoring reinforced concrete structures, the minimum axis and edge distances according to Annex 6 shall apply. In addition, the design principles according to Section 3.2.5 (6) to (8) shall be observed with regard to the minimum concrete compressive strength and any additional reinforcement required. The transmission of forces in the structure (e.g. splitting forces) must be verified in each individual case.

(2) In the case of anchoring or support on steel structures, sufficient load-bearing capacity and corrosion protection must be demonstrated or specified for the bearing plates and the transition structures in each case.

(3) In the case of rock anchors, the overall safety of the anchored rock body is the subject of the rock mechanical stability surveys; the anchoring forces required for stability are to be determined by an expert[3]. For anchoring through rock, the design values of the rock pressure (resistance) must be determined by an expert in each individual case, taking into consideration possible structural disturbance directly at the borehole. Necessary intermediate components are to be dimensioned according to relevant standards, taking into consideration the design values of the rock pressure (resistance).

[3] In order to determine the static and structural requirements, as well as the characteristic load, experts in geotechnics must be consulted.

3.4 Installation

3.4.1 General

(1) Prefabricated or pre-assembled DYWIDAG single bar anchor for installation and grouting are to be checked for completeness of all the mandatory components by the contractor on the basis of the execution planning documentation and delivery note.

(2) Works must be carried out in accordance with the work instructions from DYWIDAG-Systems International GmbH submitted to the German Institute for Building Technology. The work instructions concerning anchor manufacturing at the construction site and the installation of the anchor heads must be available at the construction site.

3.4.2 Installation into the borehole

(1) The minimum borehole diameter must be selected in accordance with the execution planning documentation. Before the installation of the DYWIDAG single bar anchor, the boreholes in rock should be tested for any blockages, e.g. with a template.

(2) If transported by a crane hook, the anchor must be carried at its stressing end or with carrying straps or placed in ducts. In the area of the anchoring section, a spacer in accordance with the execution planning documentation should be arranged.

(3) If, during the installation of the DYWIDAG single bar anchor protected in a casing, the projecting end of the drill set has an edged inner thread or a sharp-edged pipe end, the prepared “DYWIDAG single bar anchor” may not be inserted into the casing until an edge-free inserting trumpet or a pipe nipple which fully covers the inner thread of the casing has been put onto the projecting end of the drill set. It must be ensured that the corrosion protection is not damaged when the DYWIDAG single bar anchor is inserted.

3.4.3 Couplings with coupler splices

(1) The necessary couplings are to be made with couplers and may be executed in accordance with the execution planning documentation. The coupler splice can be fabricated on site before anchor installation or directly during anchor installation. For fabrication before anchor installation, the anchor must be supported on a straight plane.

(2) Threaded sections prefabricated at the factory are to be used. The protruding steel on the threadbars to be coupled must be filled with Denso-Jet or Petroplast corrosion protection compound; temporary protective measures must be removed beforehand. When assembling the threaded sections, the coupler is screwed onto the threadbar to such an extent that it fits tightly against the prefabricated corrosion protection (end cap with corrugated tube or heat shrink sleeve, depending on the position and installation version). Thereafter, the coupler is secured on this side by an unscrew protection. The second threaded section is screwed into the coupler up to its prefabricated corrosion protection, then the unscrew protection is to be activated on this side.

(3) Depending on the variant and installation position of the coupling, the following activities are required to complete the corrosion protection system:

- Coupler splice in the free steel section L_{tf} - variant A:
  Before pushing over the coupler tube, the coupler is filled with corrosion protection compound so that the space between the coupler connection and the coupler tube is filled with corrosion protection compound. The coupler tube is then pushed over and connected to the smooth tube on both sides with fixing heat shrink sleeve (see Annex 4).

- Coupler splice in the free steel section L_{tf} - variant B:
  A corrosion protection heat shrink sleeve with overlap lengths for corrosion protection of the threaded sections is shrunk on over the coupler in accordance with the execution planning documentation. The coupler tube, which is then pushed over, is connected to the smooth tube on both sides as in type A (see Annex 4).

- Coupler splice in the anchoring section L_{tb}:
  Heat shrink sleeves in 2 layers (inner: corrosion protection heat shrink sleeve, outer: fixing heat shrink sleeve) with overlap lengths for corrosion protection of the threaded sections must be shrunk on over the coupling sleeve in accordance with the execution planning documentation, with the outer layer covering the inner layer or being at least the same length (see Annex 5).

When applying the heat shrink sleeves, the surfaces must be dry and clean.

3.4.4 Grout body production

(1) For the production of the grout body, grout (cement grout) in accordance with the execution planning documentation must be used. The cement grout must be machine-mixed. Before grouting, no demixing or formation of lumps may occur.

(2) The amount of grout, its composition and the grouting pressure for a ground anchor must be measured and recorded, e.g. using the manufacturing protocol in accordance with DIN/TS 18537, Annex F, Fig. F.1.

(3) For cased boreholes, after filling the borehole with grout and installing the DYWIDAG single bar anchor and, if applicable, after putting on the grout cap, the pipe should be pulled out slowly and step by step while maintaining the required grouting pressure. Grouting must at least be performed up to the transition point from the anchoring section of the tendon L_{tb} to the free steel section L_{tf}.

(4) For ascending anchors, a packer attached to the outside of the corrugated plastic sheathing at the transition point from the anchoring section of the tendon L_{tb} to the free steel section L_{tf} must be activated before the beginning of the grouting works (see also Annex 7). The grouting process may only be ended when the grout without bubbles comes out from the vent tube as provided on the filling or grouting tube.

(5) If the force transmission length of the grout body is limited according to the execution planning documentation, the free anchor section is to be flushed using an appropriate method.

(6) The grout body produced in rock must be tight enough to ensure flawless production of the grout body. This should be verified to the required extent using special investigations (e.g. optical borehole inspection, mortar level measurement, water pressure test). The grout composition, injection pressure and the grouting procedure should be determined individually based on the results of the rock probing and water pressure tests, as well as the findings after drilling the boreholes by the executing engineer in collaboration with the expert[3] and with the designing engineer. The planned grouting method must be verified by way of a suitability test.

3.4.5 Anchor head installation and corrosion protection measures at the construction site

(1) The head-side free end of the steel tendon shall be coated thickly with corrosion protection compound in accordance with the execution planning documentation until the anchor head structure is in place.

(2) The prefabricated anchor head construction (anchor plate with pipe socket) is pushed on over the free end of the threadbar. Sealing at the transition point from the pipe socket to the corrosion protection of the threadbar (profile rings/sponge rubber rings) must undergo a final inspection for proper seating. The gap between the threadbar and the anchor plate/pipe socket must be filled with corrosion protection compound. The corrosion protection compound removed during tensioning must be reintroduced.

(3) Before screwing on the anchoring nut, visually inspect the thread of the threadbar, as well as the anchoring nut for damage and replace if necessary. Before setting up the rod tensioning jack and starting the tensioning process, make sure that the system consisting of rod, anchor plate and domed nut is centrally aligned, so that the nut can be inserted into the cone without being forced. If the ratchet of the tensioning press produces unexpected resistance before the anchor nut is tightened, the system must be checked and, if necessary, realigned or replaced.

(4) After tensioning the ground anchor, the domed nut and the projection of the threadbar must be covered with corrosion protection compound and anchor cap according to the execution planning documentation and sealed against the anchor plate.

3.4.6 Suitability and acceptance tests, supervision of the installation

(1) The suitability tests must be supervised by a surveillance agency for monitoring the installation of ground anchors which is included in the list of inspection, surveillance and certification agencies in keeping with the regional building codes, Part V, as amended from time to time[4]. All necessary documents (installation instructions, design drawings, etc.) must be made available to the monitoring body; this also includes the design drawings of the anchor head.

(2) As part of the monitoring activity for the suitability and acceptance tests, the monitoring body involved must monitor the assembly of permanent anchors at the construction site, in particular the corrosion protection measures carried out at the construction site, e.g. the complete filling of the anchor head area with corrosion protection compound, at least randomly.

(3) The monitoring body must report to the competent construction supervisory authority, if the facilities and personnel at the construction site do not ensure proper installation. The competent construction supervisory authority must be informed about the beginning of such works.

3.4.7 Declaration of conformity of the installation

(1) A declaration of conformity in accordance with paragraph 16a section 5 in conjunction with paragraph 21 section 2 of the MBO[5] must be submitted by the contractor to confirm the conformity of the type of construction with the general design-type approval.

(2) The executing company's declaration of conformity must be drafted in accordance with DIN EN 1537, Section 10 in conjunction with DIN/TS 18537. Additionally, the Approval number must be provided.

(3) Copies of the records must be handed over to the client for incorporation into the construction file and presented to the German Institute for Building Technology and to the competent highest construction supervisory authority on request.

4 Provisions for use, maintenance, and service

(1) For re-inspections, DIN EN 1537, Section 9.10 applies, supplemented by DIN/TS 18537.

(2) If necessary, the re-inspection should be carried out by the same monitoring body that was already involved in the suitability tests.

(3) If, as a result of the monitoring tests, the anchors have to be retensioned, it must be ensured that the corrosion protection compound removed during tensioning is reintroduced.

List of standards

EN 197-1:2011-11	Cement – Part 1: Composition, specifications and conformity criteria of common cements; (in Germany replaced with DIN EN 197-1:2011-11)
DIN EN 206-1:2001-07	Concrete – Part 1: Specification, performance, production and conformity; German version EN 206-1:2000
DIN EN 206-1/A1:2004-10	Concrete – Part 1: Specification, performance, production and conformity; German version EN 206-1:2000

[4] recently: List of inspection, surveillance and certification agencies in accordance with the regional building codes, edition 2023, Status as of: 1 January 2023 – Notifications regarding DIBt information, department P4, Recognition and Notification of Third Parties

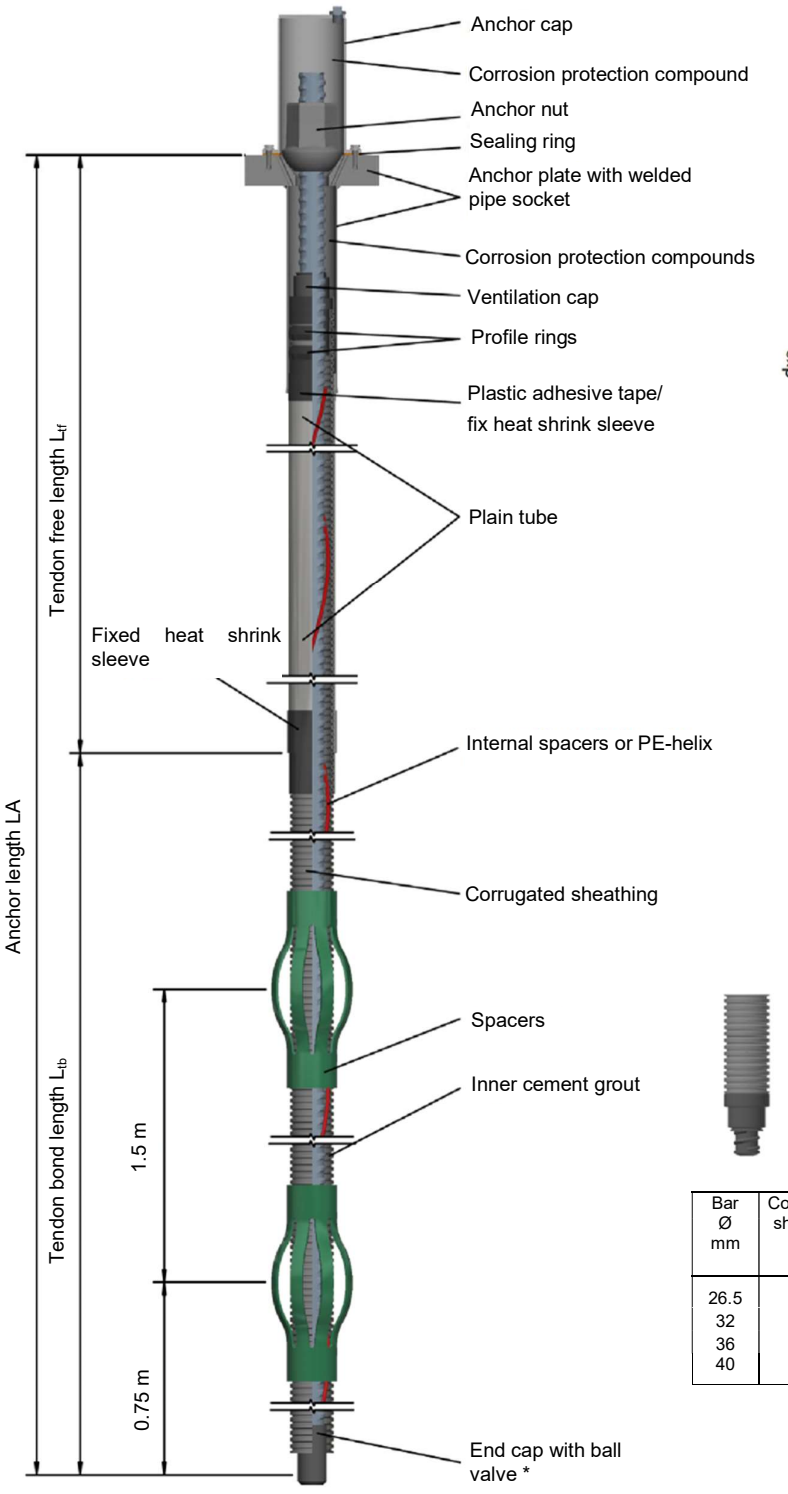
[5] Model Building Code (Musterbauordnung, MBO) version of November 2002, last amended by means of the decision of the Conference of the Minister of Construction of 25 September 2020

DIN EN 206-1/A2:2005-09	Concrete – Part 1: Specification, performance, production and conformity; German version EN 206-1:2000/A2:2005
DIN EN 445:1996-07	Grout for prestressing tendons - Test methods; German version EN 445:1996
DIN EN 446:1996-07	Grout for prestressing tendons - Grouting procedures; German version EN 446:1996
DIN EN 447:1996-07	Grout for prestressing tendons - Specification for common grout; German version EN 447:1996
DIN 488-1:2009-08	Reinforcing steel - Part 1: Varieties, properties, characteristics
EN 934-2:2009+A1:2012	Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labelling; (in Germany replaced with DIN EN 934-2:2012-08)
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
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
DIN 1054:2021-04	Subsoil - Verification of the safety of earthworks and foundations - Supplementary rules to DIN EN 1997-1
DIN EN 1090-1:2012-02	Design of steel structures and aluminum structures – Part 1: Verification of compliance of structural components; German version EN 1090-1:2009+A1:2011
DIN 1164-10:2013-03	Special cement – Part 10: Composition, requirements and conformity evaluation for cement with low effective alkali content
DIN EN ISO 1461:2009-10	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:2009); German version EN ISO 1461:2009
DIN EN 1537:2014-07	Execution of special geotechnical works – Ground anchors; German version EN 1537:2013
DIN EN 1992-1-1:2011-01	Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, German version EN 1992-1-1:2004+AC:2010
DIN EN 1992-1-1/NA:2013-04	National Annex – Nationally determined parameters – Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings
DIN EN 1992-2:2010-12	Eurocode 2: Design of concrete structures – Part 2: Concrete bridges - Design and detailing rules; German version EN 1992-2:2005 + AC:2008
DIN EN 1992-2/NA:2013-04	National Annex – Nationally determined parameters – Eurocode 2: Design of concrete structures – Part 2: Concrete bridges - Design and detailing rules;
DIN EN 1997-1:2009-09	Eurocode 7: Geotechnical design - Part 1: General rules; German version EN 1997-1:2004 + AC:2009

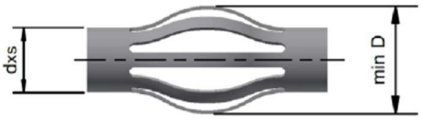
DIN EN 1997-1/NA:2010-12	National Annex – Nationally determined parameters – Eurocode 7: Geotechnical design - Part 1: General rules
DIN EN 10204:2005-01	Metallic products - Types of inspection documents, German version EN 10204:2004
DIN EN 12068:1999-03	Cathodic protection – External organic coatings 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
DIN EN 12620:2008-07	Aggregates for concrete; German version EN 12620:2002+A1:2008
DIN EN ISO 12944-4:2018-04	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 4: Types of surface and surface preparation (ISO 12944-4:2017); German version EN ISO 12944-4:2017
DIN EN ISO 12944-5:2020-03	EN ISO 12944-5:2019 Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems (ISO 12944-5:2019); German version
DIN EN ISO 12944-7:2018-04	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 7: Execution and supervision of paint work (ISO 12944-7:2017); – German version EN ISO 12944-7:2017
DIN EN ISO 14713-1:2017-08	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 14713-1:2017); German version EN ISO 14713-1:2017
DIN EN ISO 17855-1:2015-02	Plastics - Polyethylene (PE) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 17855-1:2014) - German version EN ISO 17855-1:2014
DIN/TS 18537:2021-05	Supplementary specifications to DIN EN 1537:2014–07, Execution of special geotechnical works – Ground anchors
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
DIN EN ISO 21306-1:2019-07	Plastics - Unplasticized Poly(Vinyl Chloride) (PVC-U) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 21306-1:2019); German Version EN ISO 21306-1:2019

Bettina Hemme
Office Supervisor

Certified
Jendryschik



Spring basket spacer

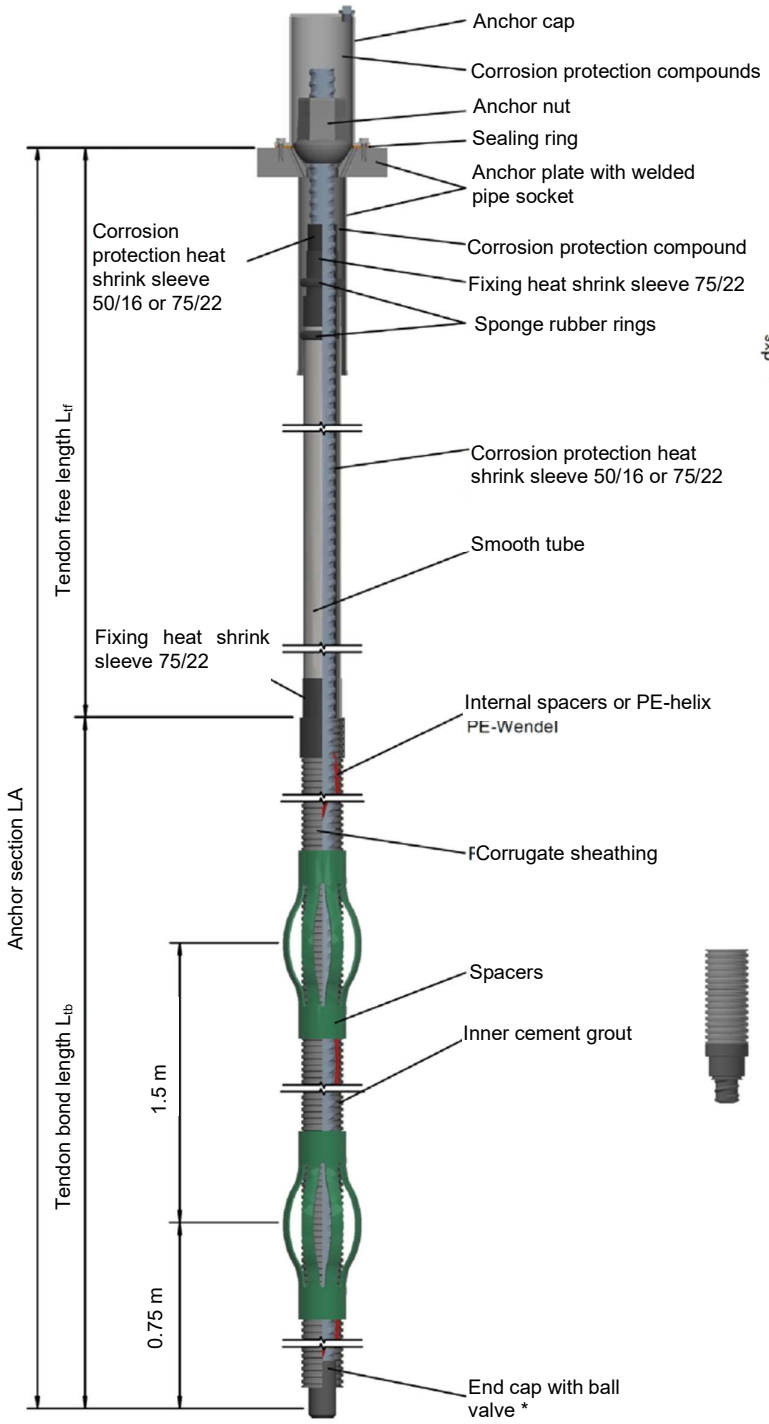


alternatively: Segment spacer

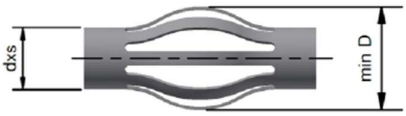
* alternatively:
Injection cap (with corrosion protection heat shrink sleeve)

Bar Ø mm	Corrugated sheathing Øa/Øi mm	Plain tube Øa x s mm	Spring basket spacer d x s mm	Spring basket spacer min. D mm
26.5	50/43	54.2 x 1,5	55 x 3	80
32	56/49	60.1 x 1.5	63 x 3	86
36	65/57	69.8 x 1.5	75 x 3.6	95
40	65/57	69.8 x 1.5	75 x 3.6	95

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 1
Overview of installation version DYWIDAG permanent anchor with corrugated tube	



Spring basket spacer

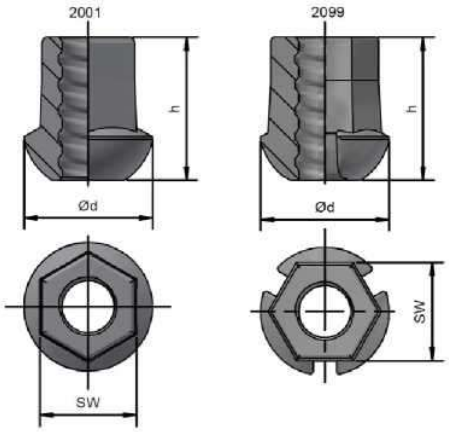


alternatively: Segment spacer

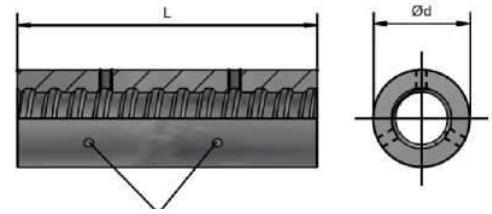
* alternatively:
Injection cap (with corrosion protection heat shrink sleeve)

Bar Ø mm	Corrugated sheathing Øa/Øi mm	Plain tube Ø a x s mm	Spring basket spacer d x s mm	min. D mm
26.5	50/43	44 x 2.0	55 x 3	80
32	56/49	46 x 2.0	63 x 3	86
36	65/57	52 x 2.0	75 x 3.6	95
40	65/57	63 x 2.0	75 x 3.6	95

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 2
Overview of installation version DYWIDAG permanent anchor with heat shrink sleeve	

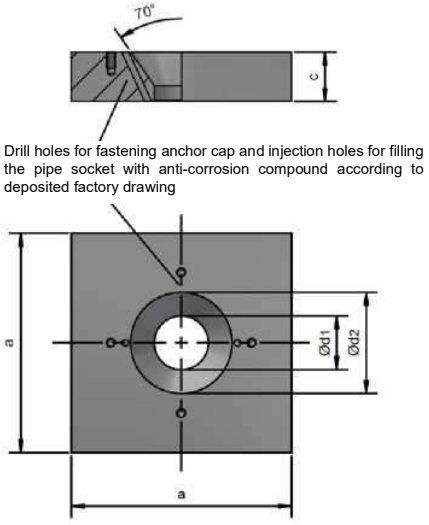


Domed nut (domed nut with grouting slots 2099 according to ETA 05/0123)				
Nominal diameter	Material	SW	Ø d	h
mm	-	mm	mm	mm
Ø 26.5	DIN EN 10025-2 - S355J2 / E295	50	72	75
Ø 32	DIN EN 10025-2 - S355J2 / E295	60	80	90
Ø 36	DIN EN 10025-2 - S355J2 / E295	65	90	100
Ø 40	DIN EN 10293 — G34CrMo4	70	100	115



Anti-rotation device according to deposited factory drawing

Coupler (coupler 3003 according to ETA 05/0123)			
Nominal diameter	Material	Ø d	L
mm	-	mm	mm
Ø 26.5	DIN EN ISO 683-1-C45	50	170
Ø 32	DIN EN ISO 683-1-C45	60	200
Ø 36	DIN EN ISO 683-1-C45	68	210
Ø 40	DIN EN 10220-20MnVS6	70	245



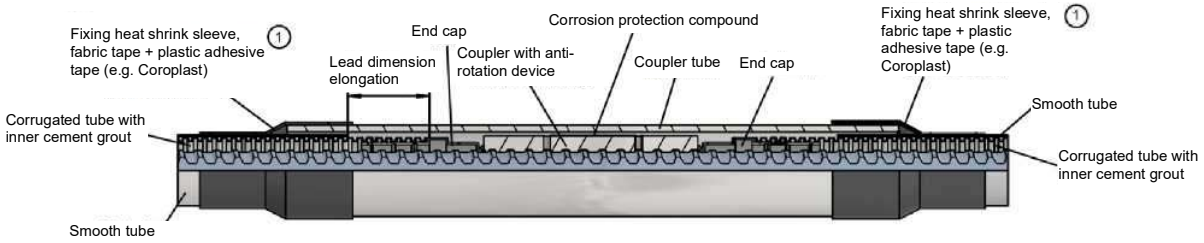
Drill holes for fastening anchor cap and injection holes for filling the pipe socket with anti-corrosion compound according to deposited factory drawing

Anchor plate (Square solid plate 2011 according to ETA 05/0123)					
Nominal diameter	Material	a	C	Ø d1	Ø d2
mm	-	mm	mm	mm	mm
Ø 26.5	DIN EN 10025-2 -S235JR	150	35	39	72
Ø 32	DIN EN 10025-2-S235JR	180	40	45	82
Ø 36	DIN EN 10025-2-S235JR	200	45	49	92
Ø 40	DIN EN 10025-2-S235JR	220	45	54	100

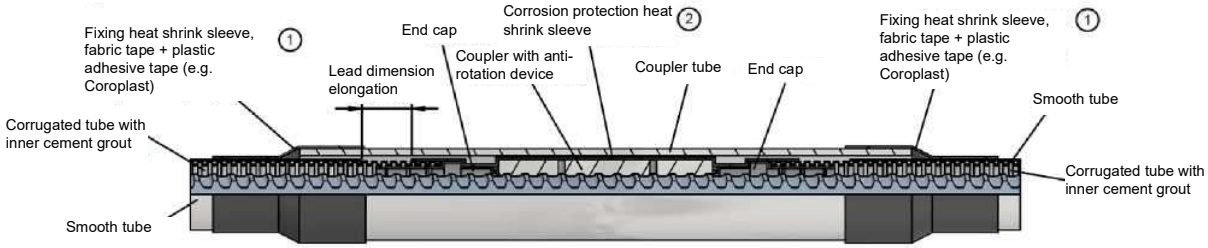
DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 3
Components according to ETA-05/0123: Stressing anchor (anchor plate, domed nut) and coupler	

Coupler splice for anchor with corrugated tube in L_{tf}

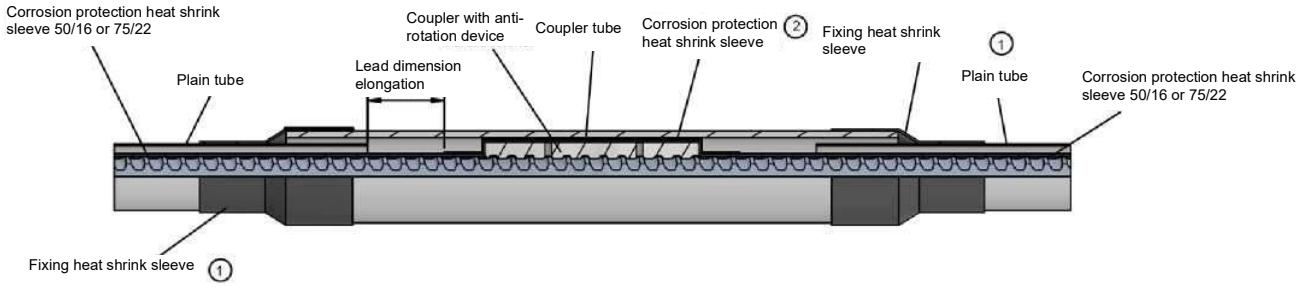
Variant (A) Version with corrosion protection compound at the coupler



Variant (B) Version with heat shrink sleeve over the coupler



Coupler splice for anchor with heat shrink sleeve in L_{tf}



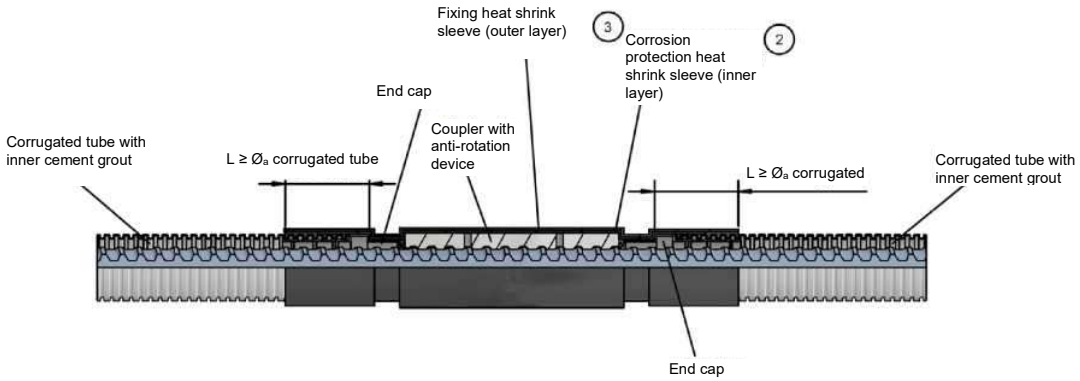
Bar Ø mm	Coupler	Heat shrink		Coupler tube[1]					
		① mm	② mm	Variant (A)		Variant (B)		Free steel section with heat shrink	
				Diameter mm	Wall thickness mm	Diameter mm	Wall thickness mm	Diameter mm	Wall thickness mm
26.5	see Annex 3	95/29	75/22	63	3.0	75	3.6	75	3.6
32		95/29	75/22	75	3.6	75	3.6	75	3.6
36		115/34	95/29	80	4.4	90	4.3	90	4.3
40		115/34	95/29	80	4.4	90	4.3	90	4.3

Anti-rotation for all couplers using grub screws

[1] PVC coupler tube up to 15 bar grouting pressure

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 4
Coupling variants in the free steel section L_{tf}	

Coupler splice in Lfb

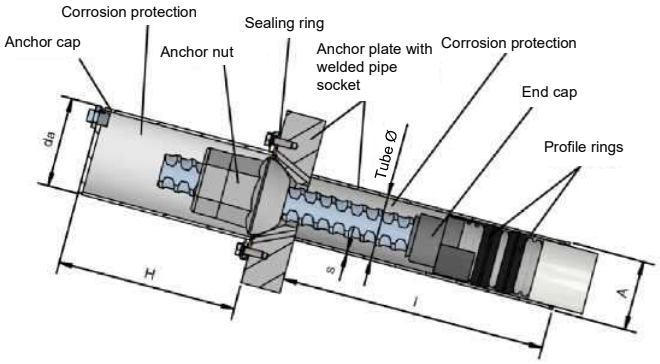


Bar Ø mm	Coupler	Heat shrink	
		② mm	③ mm
26.5	see Annex 3	75/22	75/22
32		75/22	75/22
36		95/29	95/29
40		95/29	95/29

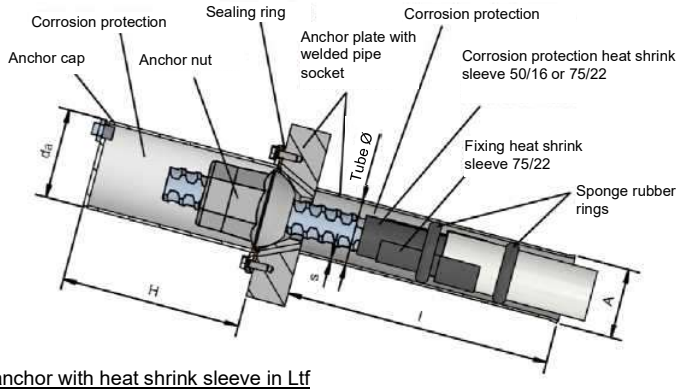
Anti-rotation for all couplers using grubscrews

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 5
Coupler splice in the anchoring section Ltb	

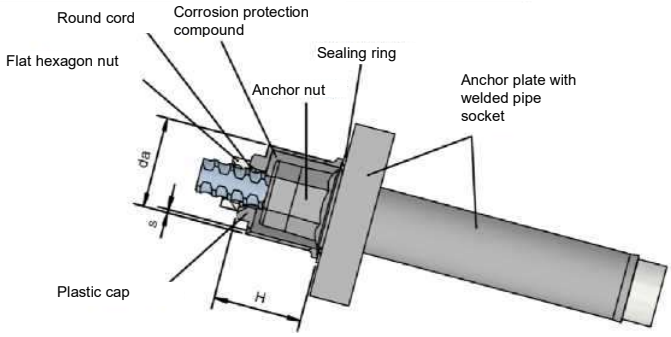
Anchor head with anchor cap (steel) for anchor head with corrugated tube in Ltf



Anchor head with anchor cap (steel) for anchor head with heat shrink sleeve in Ltf



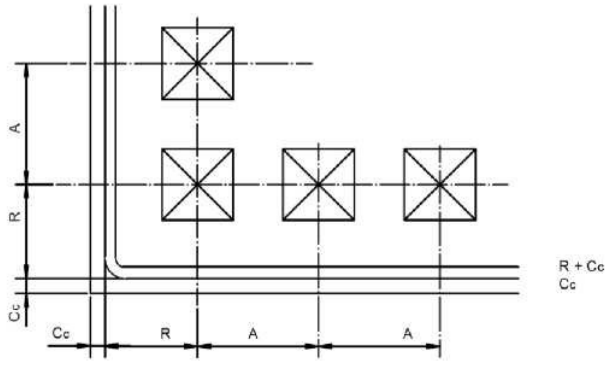
Anchor head with plastic cap for anchor head with corrugated tube and anchor with heat shrink sleeve in Ltf



Minimum concrete class C20/25

With regard to concrete quality, exposure classes according to DIN EN 1992-1-1/NA:2013-04, Table E.1DE must be observed

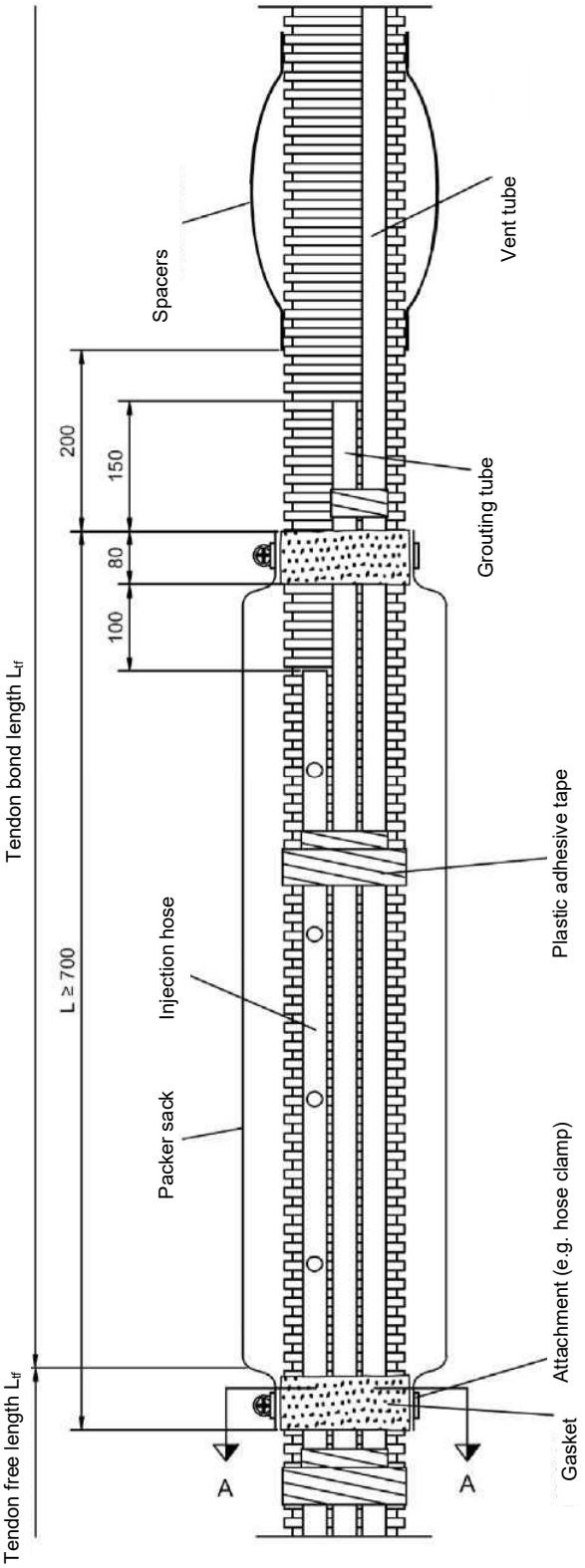
Bar Ø mm	Anchor nut and anchor plate	Pipe sockets			Anchor cap (steel) (DIN EN 10025-2 - S235)		Plastic cap		Sponge rubber ring		Profile ring	
		Tube Ø x s mm	A mm	l mm	Tube d_a x s mm	H mm	d_a x s mm	H mm	Ø i mm	Ø a mm	Ø i mm	Ø a mm
26.5	see Annex 3	63.5 x 3.2	~67	>300	88.9 x 3.2	200	83 x 4	95	41 30	61 60	49.5	58.8
32		70.0 x 2.9	~74		95 x 3,6	200	93 x 4	95	40 36	70 66	55	65
36		76.1 x 2.9	- 80		101.6 x 3.6	200	103 x 4	100	47 40	77 70	64	71.5
40		76.1 x 2.9	~80		114.3 x 3.2	250	115 x 4	115	47 40	77 70	64	71.5

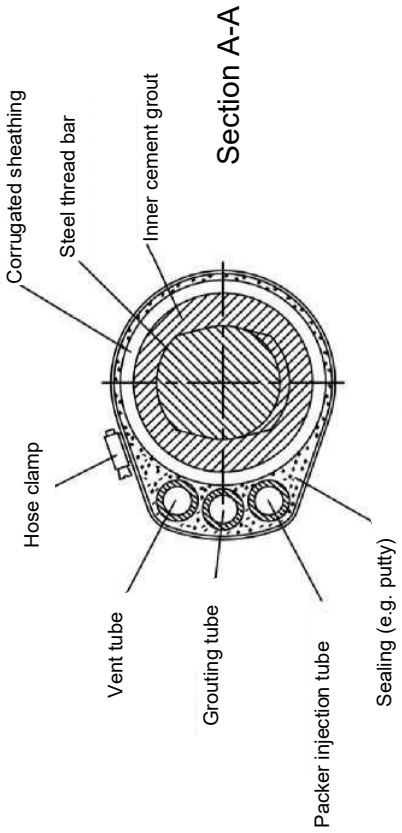


min. axis distance	min. edge distance
A mm	R mm
280	130
340	160
380	180
420	200

Minimum edge distance
Concrete cover of the reinforcement in the same cross-section, at least 20 mm

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 6
Anchor head design; minimum axis and edge distances according to ETA-05/0123	





DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm and Ø 40.0 mm	Annex 7
Injection sealer for DYWIDAG permanent anchor	

Inspection		Inspection method	FPCS[1]	EP/ FÜ[2]	Value
1. Incoming goods control:					
1.1 Steel tendon		conformity mark, delivery note	every shipment	X	according to general construction supervisory authority approval
Stressing anchor (domed nut WR 2001/2099; square anchor plate WR 2011; coupler WR 3003)		CE mark in connection with declaration of performance according to ETA-05/0123 dated 23.06.2023, delivery note	every shipment	X	Annex 3
1.2	Unscrew protection coupler: - diameter and position of the holes	Measurement*	at least 5% of each delivery	X	Plant drawings
	Holes on the anchor plate for anchor cap and backfilling pipe socket: diameter and position of the holes	Measurement*	at least 5% of each delivery	X	Plant drawings
	Pipe sockets and anchor caps				
1.3	Steel grade/Molding compound	DIN EN 10204	every shipment	X	Plant certificate 2.1
	Diameter, wall thickness, length	Measurement*	1 every 100 pcs	X	Works drawings and Annex 6
	Profile rings/Sponge rubber rings for pipe sockets; sealing washers for anchor caps				
1.4	Molding compound	DIN EN 10204	every shipment	X	Plant certificate 2.1
	Width, outer and inner diameter	Measurement*	1% of each delivery, at least 5 pieces	X	Works drawings and Annex 6
	Plastic tubes (smooth tubes, corrugated tubes, coupler tubes), end caps and injection caps				
1.5	Molding compound	DIN EN 10204	every shipment	X	Plant certificate 2.1
	Wall thickness (for corrugated tubes at inner and outer rib and at the side)	Measurement*	1 every 100 pcs	X	DIN EN 1537; Annex 1, 2, 4 and works drawings
	Tube outer and inner diameter	Measurement*	1 every 100 pcs	X	Annex 1, 2, 4 and working drawings
	Heat shrink sleeves (fixing heat shrink sleeves [1] and corrosion protection heat shrink sleeves [2])				
1.6	Molding compound ([1] and [2])	DIN EN 10204	every shipment	X	Plant certificate 2.1
	- Classification [2] - Amount of adhesive [2]	EN 12068 Measurement*	1 per 100 pcs 1 per 100 pcs	X X	C30 > 700 g/m²
	Corrosion protection coatings				
1.7	Material properties and coating thickness	DIN EN 10204	5% of the produced amount	X	Certificate of conformity 3.1

1 Plant production control
2 Initial inspection / external monitoring (2 x annually)

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: St 950/1050 Ø 26.5 mm, Ø 32.0 mm, Ø 36.0 mm und Ø 40.0 mm	Annex 8, Page 1 of 2
DYWIDAG permanent anchors - minimum WPK and FÜ requirements	

Inspection		Inspection method	FPCS[1]	EP/ FÜ[2]	Value
2. Control during manufacturing					
2.1	Inner cement grout	DIN EN 445	DIN EN 446	X	DIN EN 447
Heat shrink sleeves (fixing heat shrink sleeves [1] and corrosion protection heat shrink sleeves [2])					
2.2	[2]: Free of pores at the steel tendon in L_{tf} (for installation version DYWIDAG permanent anchor with shrink sleeve)	Applying a voltage of 10 kV	every load-carrying element	X	Yes/No test
	[1] and [2]: Wall thickness in shrunk state	Sample and measurement*	1 per anchor type per delivery lot	X	≥1,5 mm
2.3	Function acceptance Profile rings/ sponge rubber rings for sealing pipe sockets	Visual, sample	1 % per delivery lot	X	Yes/No test
2.4	Connection of anchor plate and pipe socket: circumferential weld seam, continuous without defects	Visual inspection	1 per anchor type per delivery lot	X	Yes/No test
2.5	All of the plant-applied corrosion protection measures	Visual inspection	every load-carrying element	X	Documented procedures
2.6	Packaging of the components	Visual inspection	every shipment	X	Planning or execution documents

* Inspection plan:
If each individual measured value is equal to or greater than the required minimum value, L_{os} shall be assumed.
Otherwise, additional samples can be taken. The same measurements as in the first sample are to be carried out on these samples. The measurement results shall be summarized with the previous measurements. The mean value x and the standard deviation s must be formed from all measured values. If the test parameter (numerical value)

$$z = x - 1.64\ s$$

to be formed therefrom is equal to or greater than the required minimum value, the value L_{os} is to be rejected.

1 Plant production control
2 Initial inspection / external monitoring (2 x annually)

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