

GEOTECHNICAL SYSTEMS

DYWIDAG Permanent Anchors (Single Bar Anchors) for Soil and Rock with Steel Tendons made of: B500B - GEWI Ø 40mm and Ø 50mm and S 555/700 - GEWI Ø 63.5mm

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German Länder

**Approval Body for Building Products and
Building Methods**

**General Construction Supervisory Authority Approval/
General Design-Type Approval**

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Ordering party
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Subject of Approval:

**DYWIDAG permanent anchors (single bar anchors) for soil and rock with steel
tendons made of: B500B-GEWI Ø40 mm and Ø50 mm and S 555/700-GEWI Ø63.5 mm**

The above-mentioned regulated item matter is hereby granted general construction supervisory authority accreditation/approval. This Approval consists of 17 pages and five Annexes. The subject was first approved on 30 March 1994 by the construction authorities.

Important Notice

This general construction supervisory authority approval is the translation of a document originally prepared in the German language which has not been verified and officially authorized by the "Deutsches Institut für Bautechnik" (German Institute for Civil Engineering). In case of doubt in respect to the wording and interpretation of this approval, the original German version of this document 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 the rights of third parties, especially private property rights.
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II SPECIAL PROVISIONS

1 Subject matter of approval and use or application scope

1.1 Subject of approval and scope of use

(1) The subject of the approval are the “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 steel bars with threaded ribs in accordance with general building authority approval/general type approval;
- anchor nuts, anchor plates and couplers made of steel and in accordance with general building authority approval/general type approval;
- 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 factory corrosion protection system (Annex 1).

(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 is planning, design and installation of DYWIDAG single bar anchors as ground anchors according to DIN EN 1537 in conjunction with DIN/TS 18537.

(2) The ground anchors are to be manufactured in accordance with Annex 1 - DYWIDAG permanent anchor – overview.

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

2 Provisions for the construction product

2.1 Properties and composition

In the area of the free steel length L_{fr} and the anchoring length L_{tb} the following corrosion protection system must be arranged and provided by the plant:

- free steel length L_{fr} :
Steel tendon in ribbed tube and filled with inner cement grout, ribbed tube additionally covered with a smooth tube
- anchoring section L_{tb} :
Steel tendon in ribbed tube and filled with inner cement grout

2.1.1 Steel tendon

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

Table 1: Steel tendon

Type	Description	Steel grade	Diameter
Reinforcing steel bar with thread ribs	B500B-GEWI	B500B	40 and 50 mm
Steel bar with thread ribs	S 555/700-GEWI	S 555/700	63.5 mm

(2) Couplers in accordance with the approval¹ Z-1.5-149 (B500B-GEWI) and Z-1.5-2 (S 555/700-GEWI) are to be used for coupling the steel bars according to Table 1 (see also Annex 2). The couplers are provided with threaded holes to secure the screwed connection (fixing) by means of grubscrews (6 per coupler), the diameter and position of which are indicated on the design drawings submitted.

2.1.2 Anchor head

(1) Straight anchor nuts in accordance with Annex 3 and the approval¹ Z-1.5-149 (B500B, type T 2002) or Z-1.5-2 (S 555/700, 63 T 2002) must be used for anchoring the steel bars. For the S 555/700 (d = 63.5 mm), domed nuts (63 T 2044) are also permitted in accordance with Z-1.5-2.

(2) Square anchor plates made of steel in accordance with Annex 3 or the approval¹ Z-1.5-2, anchor plate 63 T 2139, must be used to transfer the force from the anchor nut to the concrete component to be anchored. If domed nuts are used for the S 555/700 (d = 63.5 mm), anchor plates 63 T 2011 with cone in accordance with Z-1.5-2 must be used. The anchor plates for fixing the anchor cap and for filling the pipe socket with corrosion protection compound 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 cap

The anchor cap with the dimensions according to Annex 3 is made of steel (S235JR) with a wall thicknesses ≥ 3.0 mm. In the case of B500B-GEWI, d=40 and 50 mm, anchor caps made of PE-HD with a wall thicknesses ≥ 4.0 mm can also be used. Sealing against the anchor plate is achieved with a nitrile rubber sealing ring placed underneath.

2.1.3.2 Pipe sockets

The pipe sockets must be made of steel (S235JR) and have dimensions corresponding to the steel bar diameter according to Annex 3. At the open-air end they should be connected to the anchor plate, at the earth end they overlap with the smooth or ribbed tube. Two profile rings (Neoprene (CR)) are placed on the ribbed tube within the overlap length when the anchor head is installed. Profile rings must be matched to the dimensions of the pipe sockets and ribbed tubes; these are specified by the German Institute for Building Technology depending on the steel bar diameter used, see also Annex 3.

2.1.3.3 Corrosion protection coating

(1) If not completely cast in concrete (at least 5 cm cover 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 0222 must be observed.

¹ General Construction Supervisory Authority Approval/ General Design-Type Approval in the currently valid version
² DAST Guideline 022:2016-06 Guideline for hot-dip-zinc-coating of prefabricated structural steel structures;
Deutscher Ausschuss für Stahlbau

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 ribbed tubes must correspond to the data provided in Annex 1. The inside diameter of the smooth tubes must not be more than 4.0 mm larger than the outside diameter of the ribbed tubes. The ribbed tube must have a uniform wall thickness of ≥ 1.0 mm (steel tendon $\varnothing 40$ mm and 50 mm) or ≥ 1.5 mm (steel tendon $\varnothing 63.5$ mm).

(3) A polyethylene spiral with a diameter of $\varnothing 6$ mm (steel bar $\varnothing 40$ and 50 mm) or $\varnothing 8$ mm (steel bar $\varnothing 63.5$ mm), pitch 0.5 m, must be arranged to maintain the distance of 5 mm between the steel bar and the ribbed tube. Alternatively, internal spacers can also be arranged on the steel bar at intervals of 1.0 m. The material thickness of the inner spacers is > 5 mm in the star spikes or webs area.

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

(5) If couplings are required for the steel tendon, the coupler connection must be protected using a coupler tube made of PVC-U according to DIN EN ISO 21306-1 and the dimensions according to Annex 2.

2.1.4.2 Heat shrink sleeves

(1) Use corrosion protection heat shrink sleeves and 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/m².

(3) Fixing heat shrink sleeves (e.g. MWTM, RDK) 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.

2.1.4.3 Corrosion protection compounds

Corrosion protection compounds are used for the splice 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 is applied in accordance with the work instructions submitted to the German Institute for Building Technology. For this purpose, the steel tendon (threadbar) must be treated in accordance with the approval requirements for steel before use. The steel tendon must be clean and free of damaging rust. Steel tendons 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 ribbed tubes) are to be used to encase the steel tendons. Straight sections or 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) The steel tendon must be routed in a ribbed tube over almost its entire length (see Annex 1). To maintain the distance between the steel tendon and the ribbed tube, use internal spacers according to Section 2.1.4.1 (3). The ends of the ribbed tube shall be closed and bonded on both sides with caps (injection end cap) according to Section 2.1.4.1 (4). If the steel tendon is connected and assembled from individual steel tendon sections at the installation site, the free steel projections required for the coupling must be taken into account when installing the plastic ribbed tubes and end caps.

(3) The ring space between the steel tendon and the ribbed tube must be filled with inner cement grout according to Section 2.1.4.4. For this purpose, the previously prepared steel tendon must be positioned on an inclined plane so that backfilling is ensured from the lowest point and venting at the highest point (tube of the injection end cap). Backfilling must be carried out until bubble-free inner cement grout emerges from the highest injection end cap. In the case of steel tendon sections that are arranged at the ground end of the anchoring length L_{tb} of the ground anchor (anchor foot), the opening of the injection end cap must be covered and sealed with a corrosion protection heat shrink sleeve in accordance with Section 2.1.4.2 (2) after completion of the grouting work or alternatively an injection cap with ball valve must be arranged, see also Annex 1.

(4) A smooth plastic tube must be arranged concentrically over the ribbed 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 ribbed tube with a fixing heat shrink sleeve (see Annex 1).

(5) If the steel tendon is coupled and assembled from individual steel tendon sections at the installation site, individual elongations at the coupling points (see Annex 2) must be observed with regard to the fixation of the smooth tubes. Steel tendon sections to be coupled shall be prepared at the factory according to items (1) to (4). The protruding steel on the steel tendon 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 and 3. 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 no sooner than one day (24 h) after grouting with inner cement grout at the plant. Further transport and installation is allowed not earlier than 2 days (48h) after injection with inner cement grout at the plant. The anchors may be installed at a time when the inner cement grout has not yet fully hardened.

(3) The prefabricated DYWIDAG single bar anchors may not be stored on the ground; contamination and soiling – mainly of the ribbed tubes – 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) In addition, DIBt must be provided with a copy of the report on the first testing for information.

2.3.2 Factory production control system

(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 5 regarding incoming goods control and control during manufacturing.

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

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

(4) 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 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 meet the requirements must be handled in such a way so as to exclude confusion with the conforming ones. 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 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 5 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 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 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 DYWIDAG single bar 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 basket or segment spacers) must be placed on the prefabricated DYWIDAG single bar anchors in the area of the anchoring section according to Annex 1. The spacers must be arranged starting from the anchor foot at maximum distance of 1.50 m on the ribbed tube 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 DYWIDAG single bar anchor in protective pipe, the arrangement of the spacers can be omitted if the wall thickness of the 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 done from the lowest point of the grout body, while venting, if required, must always be carried out from the highest point. For this purpose, ascending ground anchors must have a packer with the appropriate grouting and vent tube arranged (see Annex 4).

(3) If post-grouting of the grout body is planned, valve hoses or pipes with injection valves 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, these must be made using couplers. 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_{fr} :

(1) In the area of the free steel section L_{fr} , 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_{fr} can be designed in two variants (see Annex 2):

Variant A

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 tendon 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 (B)

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 tendon sections (ribbed pipe filled with grout). The overlap length on the ribbed tube of the tendon sections is $L \geq$ ribbed tube outer diameter on both sides.

A coupler tube shall be arranged over the entire coupler connection as in the case of Type 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_{fr}

(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 length on the ribbed tube of the tendon sections is $L \geq$ ribbed tube outer diameter on both sides, see also Annex 2.

(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_{fr} 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 DIN EN 197-1 – taking into account the existing exposure classes as per DIN EN 1045-2 (Tables 1, F.3 and F.4), water as per DIN EN 1008 and, if necessary, additives as per EN 934-2 in conjunction with DIN 1045-2 or with general construction supervisory authority approval and natural aggregates for concrete with up to 4mm grain diameter as per DIN EN 12620 – taking into account DIN 1045-2 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 tube. 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. Provided that the anchor cap is not exposed to mechanical stresses (e.g. is subsequently cast in concrete), it can be made of PE-HD for the B500B-GEWI, $d = 40$ and 50mm (see Section 2.1.3.1 and Annex 3). In all other cases, steel anchor caps must be used.

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

(3) To seal the transition point of the pipe sockets and the smooth or ribbed tube, two profile rings should be provided in accordance with Annex 3 and arranged within the overlapping length on the ribbed tube. 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.

(4) For anchoring over reinforced concrete structures, a minimum concrete compressive strength of the support $\geq C20/25$ must be observed; DIN EN 1992-1-1/NA, Table E.1DE, must also be observed.

3.3 Design

3.3.1 Maximum values of prestressing forces and further proof

(1) It must be verified that the prestressing force (lock-off load) $P_{0,max}$ do not exceed the following condition:

$$P_{0,max} = 0.6 \cdot A_s \cdot f_{t0,2k}$$

A_s = cross-sectional area of the steel tendon

$f_{t0,2k}$ = characteristic stress value of the steel tendon at 0.2 % permanent elongation

(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) 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 the verified vibration amplitude of the respective valid approval¹ No. Z-1.5-149 or No. Z-1.5-2. Load cycle above $2 \cdot 10^6$ are not verified by the approvals¹ No. Z-1.5-149 or No. Z-1.5-2. 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, anchor plates and anchor nuts must be used in accordance with Annex 3 (see also Section 2.1.2). The additional reinforcement and the minimum distances of the anchoring for the slab anchoring (center and edge distances) must be observed depending on the concrete strength class in accordance with Annex 3. The minimum concrete strength class must be $\geq C20/25$. 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.

(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 (e.g. angle compensation tube) 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 expert³. 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 strength (resistance).

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

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) Tendon section prefabricated at the factory are to be used. The protruding steel on the tendons to be coupled must be filled with Denso-Jet or Petroplast corrosion protection compound; temporary protective measures must be removed beforehand. When assembling the tendon sections, the coupler is screwed onto the tendon to such an extent that it fits tightly against the prefabricated corrosion protection (injection end cap with ribbed tube). Thereafter, the coupler is secured on this side by an unscrew protection. The second tendon 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 2).
- 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 tendon 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 2).
- 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 tendon sections must be shrunk on over the coupler in accordance with the execution planning documentation, with the outer layer covering the inner layer or being at least the same length (see Annex 2).

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 4). 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 experts 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 steel tendon and the smooth or ribbed tube. Sealing at the transition point from the pipe socket to the smooth or ribbed tube (2x profile rings) must undergo a final inspection for proper seating. The gap between the steel tendon and the anchor plate/pipe socket must be filled with corrosion protection compound. The corrosion protection compound removed during tensioning must be reintroduced.

(3) After tensioning the ground anchor, the anchor nut and the projection of the steel tendon 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 time⁴. 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.

⁴ recently: List of inspection, surveillance and certification agencies in accordance with the regional building codes, edition 2025, Status as of: 1 January 2025 - Notifications regarding DIBt information, department P4, Recognition and Notification of Third Parties

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 MBO⁵ 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.

The following technical specifications have been referenced:

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 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: Steel grades, properties, marking
DIN EN 934-2:2012-08	Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling; German version EN 934-2:2009+A1:2012
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 1045-2:2023-08	Concrete, reinforced and prestressed concrete structures – Part 2: Concrete
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 edition EN 1090-1:2009+A1:2011

⁵ Model Building Code (Musterbauordnung, MBO) version of November 2002, last changed by the decision of the conference of the minister of construction of 25 September 2020

DIN 1164-10:2023-02	Special cement – Part 10: Cement with low effective alkali content – Composition and requirements
DIN EN ISO 1461:2022-12	Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:2022); German edition EN ISO 1461:2022
DIN EN 1537:2014-07	Execution of special geotechnical works – Ground anchors; German edition 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/A1:2015-03	Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, German version EN 1992-1-1:2004/A1:2014
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 1992-1-1/NA/A1:2015-12	National Annex – Nationally determined parameters – Eurocode 2: Design of concrete structures – Part 1-1: General rules and rules for buildings, amendment A1
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 12068:1999-03	Cathodic corrosion 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 edition EN ISO 12944-4:2017
DIN EN ISO 12944-5:2020-03	Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 5: Protective paint systems (ISO 12944-5:2019); German version EN ISO 12944-5:2019
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

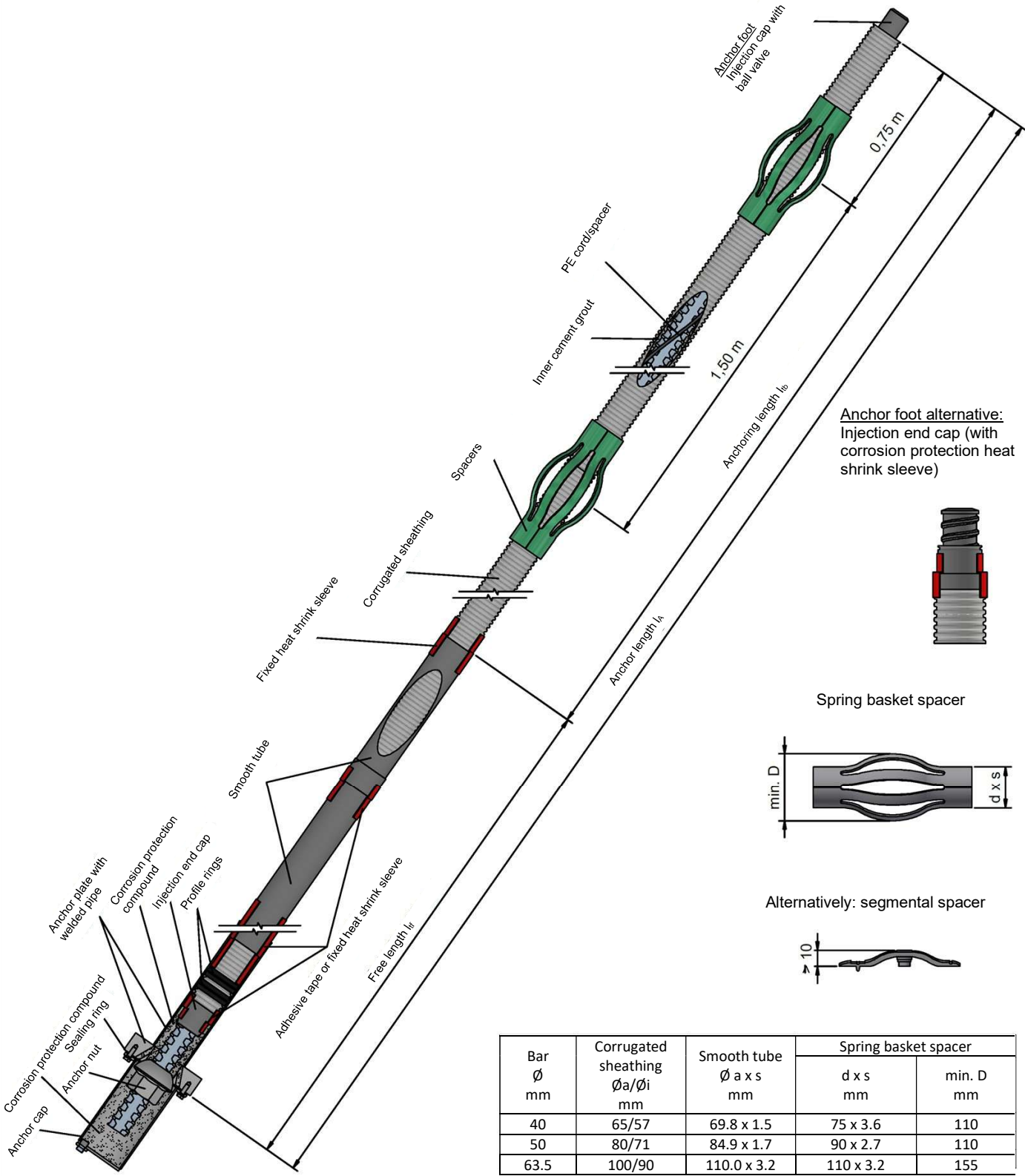
Plastics - Polyethylene (PE) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 17855-1:2014) - German version EN ISO 17855-1:2014

DIN/TS 18537:2021-05

Supplementary specifications to DIN EN 1537:2014–07, Execution of special geotechnical works – Ground anchors

Bettina
Hemme Office
Supervisor

Certified
Jendryschik



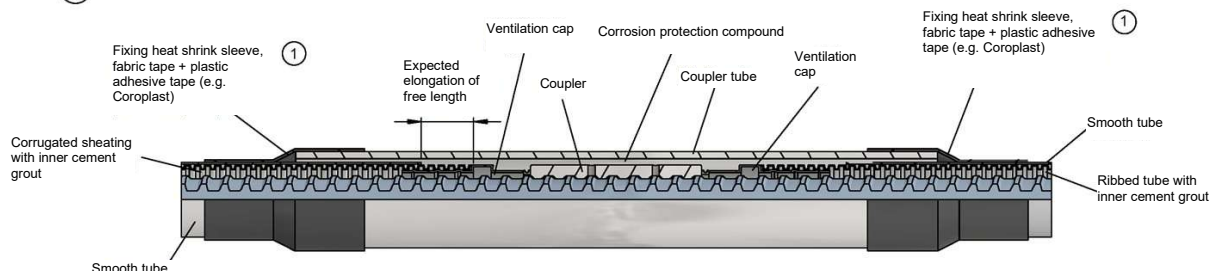
DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons
made of: B500B-GEWI $\varnothing$ 40 mm and $\varnothing$ 50 mm and S 555/700-GEWI $\varnothing$ 63.5 mm

DYWIDAG permanent anchor - overview

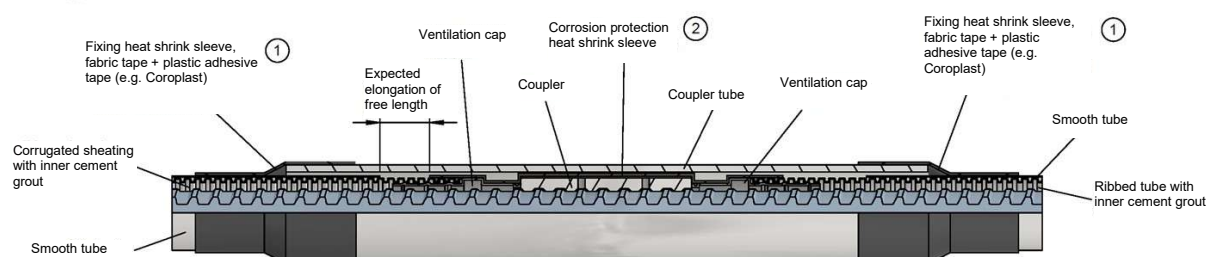
Annex 1

Coupler splice in L_{tr}

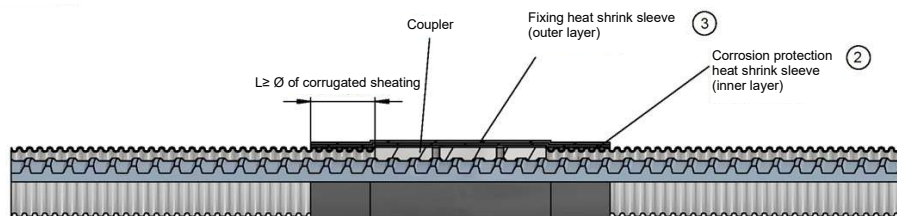
(A) Design with corrosion protection compound over the coupler



(B) Version with heat shrink sleeve over the coupler



Coupler splice in L_{tb}



Secure all couplers against rotation using grub screws or alternatively glue one end of the bar with synthetic resin adhesive.

Bar Ø mm	Coupler	Heat shrink sleeve			Coupler tube ¹⁾			
		①	②	③	Type (A)		Type (B)	
					d mm	s mm	d mm	s mm
40	as per Z-1.5-149	115/34	95/29	95/29	80	4.4	90	6.7
50		115/34	140/42	115/34	110	5.3	110	5.3
65.5	as per Z-1.5-2	140/42	140/42	115/34	125	3.7	125	3.7

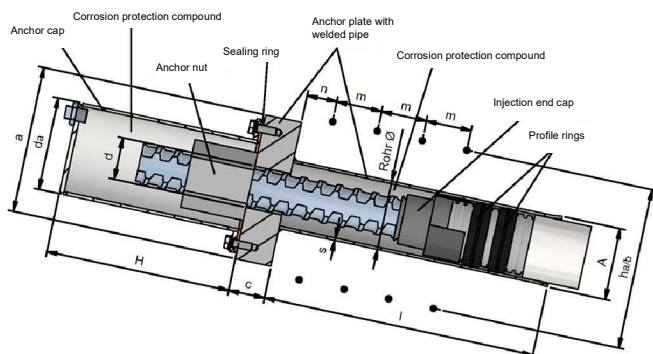
1) PVC coupler tube up to 15 bar grouting pressure

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons
made of: B500B-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

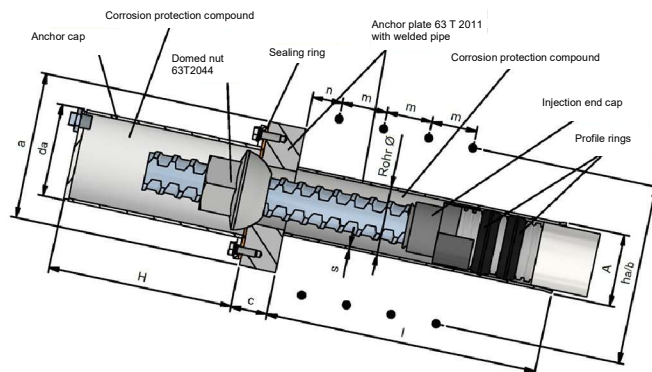
DYWIDAG permanent anchors - coupler splice

Annex 2

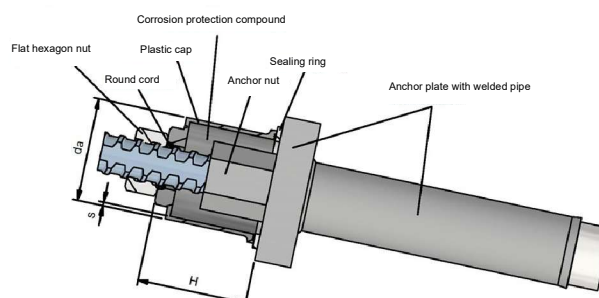
Anchor head with anchor cap (steel) and anchor nut for Ø40, Ø50 and Ø63.5 mm



Anchor head with anchor cap (steel) and domed nut for Ø63.5 mm



Anchor head with plastic cap and anchor nut embedded in concrete for Ø 40 and Ø 50 mm



Minimum concrete class: C20/25

Exposure classes according to:
DIN EN 1992-1-1/NA:2013-04, Table E.1DE, must be observed with regard to the concrete grades

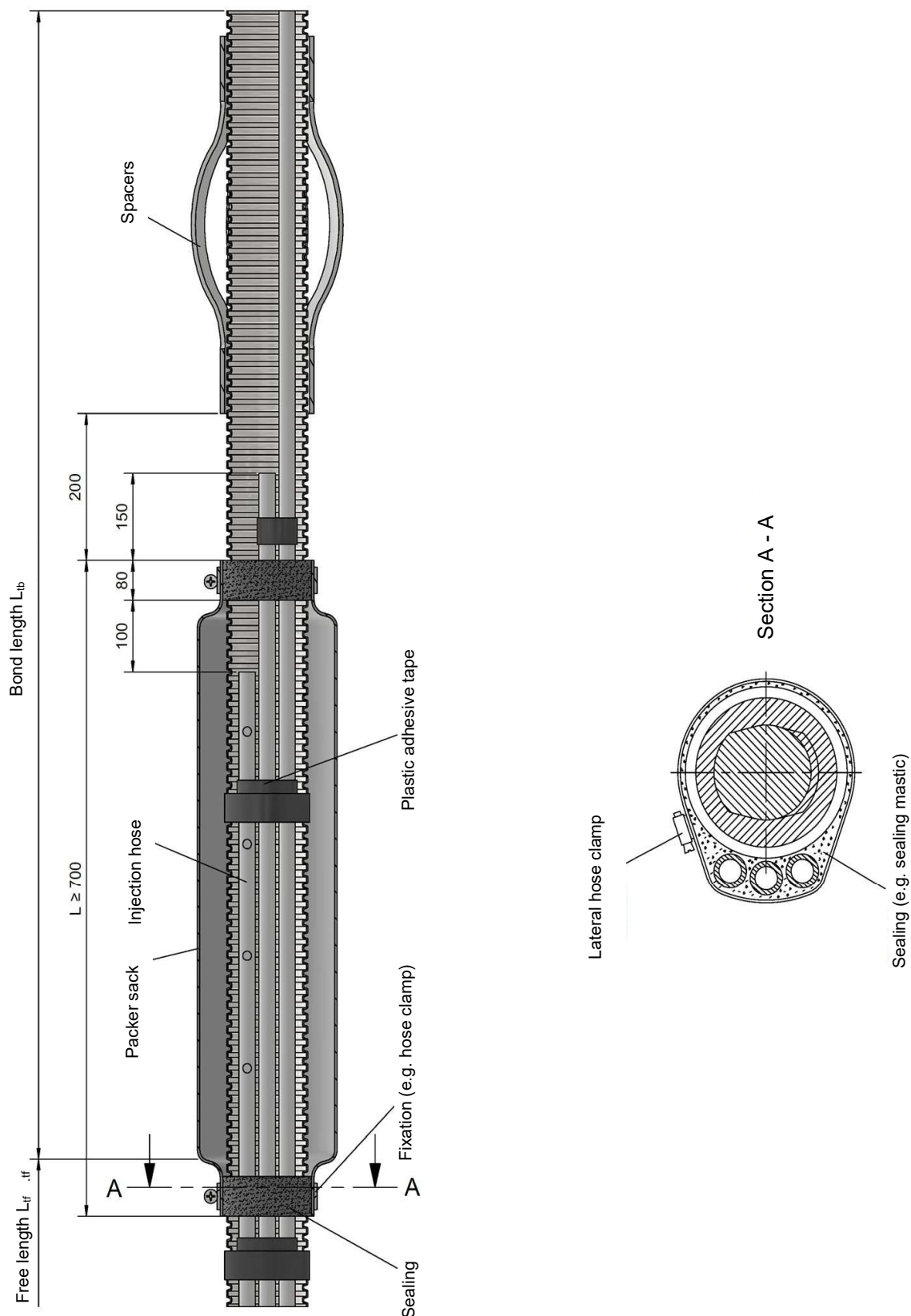
Applicable approvals for the GEWI process (Z-1.5-149 and Z-1.5-2) must be observed

Bar Ø mm	Square anchor plate			Pipe sockets			Material	(1) Domed/ (2) Anchor nut	Additional reinforcement				Min. center distance mm	Min. edge distance mm	Anchor cap (steel) (DIN EN 10025-2 - S235)		Plastic cap		Profile ring	
	a/b mm	c mm	d mm	Tube Ø x s mm	A mm	l mm			h _{a/b} mm	n mm	m mm	Ribbed reinforcing steel acc. DIN 488			Tube d _a x s mm	H mm	d _a x s mm	H mm	Ø mm	Ø mm
40	160	40	46	76.1 x 2.9	~80		S235JR (1.0028) DIN EN 10025 2	(2) T 2002 acc. Z-1.5-149	210	20	50	3 Ø 12 mm	240	140	101.6 x 3.6	200	113 x 4	115	64	71.5
50	200	45	58	101.6 x 3.6	~106				300	25	60	4 Ø 12 mm	330	190	127 x 4	300	123 x 4	135	79	96
63.5	T 2139 or T 2011 acc. Z-1.5-2			127 x 4	~130	>300		(2) T 2002 or (1) T 2044 acc. Z- 1.5-2	350	25	70	4 Ø 16 mm	380	230	168.3 x 4	300	-	-	97.5	121

DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons
made of: B500B-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

DYWIDAG permanent anchor - anchor head, anchoring via reinforced concrete
structures

Annex 3



DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons
made of: B500B-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

DYWIDAG permanent anchor - injection packer

Annex 4

Audit		Inspection method	FPCS ¹	EP/FÜ ²	Value
1. Incoming goods inspection:					
1.1	Steel tendon B500B-GEWI or S 555/700-GEWI	conformity mark, delivery note	every shipment	X	General building authority approval
1.2	Hex anchor nut (T2002)	conformity mark, delivery note	every shipment	X	Z-1.5-149 or Z-1.5-2
	Domed nut (T2044) for Ø 63.5 mm	conformity mark, delivery note	every shipment	X	Conformity mark as per Z-1.5-2
1.3	Coupler (T3003)				
	Material, dimensions, thread geometry	conformity mark, delivery note	every shipment	X	Z-1.5-149 or Z-1.5-2
	Unscrew protection: Diameter and position of the threaded holes; grubscrews	measurement*	at least 5% of each delivery	X	Plant drawing
1.4	Anchor plate				
	Flat anchor plate (T2139) and with cone (T2011) for Ø 63.5 mm	conformity mark, delivery note	every shipment	X	Z-1.5-2
	Flat anchor plate for Ø 40 mm and Ø 50 mm: - Material -Geometry	DIN EN 10204, Measurement*	every shipment	X X	Certificate 2.2, Annex 3 and plant drawings
	Drill holes for anchor cap and injection: Diameter and position of the holes	measurement*	at least 5% of each delivery	X	Plant drawing
1.5	Plastic tubes (smooth tubes, ribbed tubes, coupler tubes), injection end caps				
	Molding compound	DIN EN 10204	every shipment	X	Plant certificate 2.1
	Wall thickness (for corrugated tubes, wall thickness on the inner and outer ribs and the side)	measurement*	1 every 100 pcs	X	Annex 1, 2 and plant drawings
	Tube outer and inner diameter	measurement*	1 every 100 pcs	X	Annex 1, 2 and plant drawings
1.6	Profile rings (sealing of the pipe socket)				
	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	Annex 3 and plant drawings
¹ Internal Production Control System ² Initial testing/external monitoring (twice a year)					
DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: B500B-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm					Annex 5, Page 1 of 2
DYWIDAG permanent anchors - minimum WPK and FÜ requirements					

Audit		Inspection method	FPCS ¹	EP/FÜ ²	Value
1. Incoming goods inspection:					
1.7 Pipe sockets and anchor caps					
	Steel grade/Molding compound	DIN EN 10204	every shipment	X	Plant certificate 2.1
	Diameter, wall thickness, length/height	measurement*	1 every 100 pcs	X	Annex 3 and plant drawings
Heat shrink sleeves (fixing heat shrink sleeves [1] and corrosion protection heat shrink sleeves [2])					
1.8	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 every 100 pcs 1 every 100 pcs	X X	C30 > 700 g/m ₂
Corrosion protection coatings					
1.9	Material properties and coating thickness	DIN EN 10204	5% of the produced amount	X	Certificate of conformity 3.1
2. Control during/after manufacture					
2.1	Heat shrink sleeves – wall thickness in shrunk state	sample and measurement*	1 per anchor type per delivery lot	X	≥ 1.5 mm
2.2	Inner cement grout	DIN EN 445	DIN EN 446	X	DIN EN 447
2.3	Functional takeover of the profile rings for pipe sockets/ribbed tubes	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-bearing 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, the batch must be accepted. Otherwise, additional samples can be taken. The same measurements as those on the first sample are to be carried out on these samples. The measurement results shall be merged with the previous measurements. The mean value x and the standard deviation s must be derived from all measured values. If the test parameter (numerical value) $z = x - 1.64 s$ derived therefrom is equal to or greater than the required minimum value, the batch must be accepted, otherwise rejected.					
¹ Internal Production Control System ² Initial testing/external monitoring (twice a year)					
DYWIDAG permanent anchor (single bar anchor) for soil and rock with steel tendons made of: B500B-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm					Annex 5, Page 2 of 2
DYWIDAG permanent anchors - minimum WPK and FÜ requirements					

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