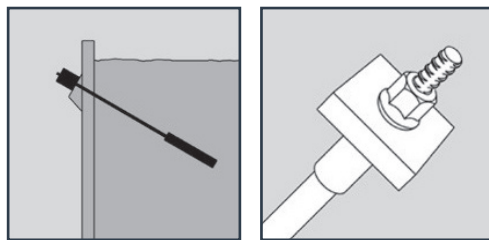


DYWIDAG Geotechnical Systems

DYWIDAG Permanent Bar Anchors



**Permanent DYWIDAG Anchors
(Single Bar Anchors) for Soil
and Rock with steel tendons
made of:**

**BSSt 500 S-GEWI® Ø 40 mm and
Ø 50 mm and
S 555/700-GEWI® Ø 63.5 mm**

**Approval Number
Z-34.11-225**

Validity
11 April 2010 - 11 April 2015

DEUTSCHES INSTITUT FÜR BAUTECHNIK

German Institute for Civil Engineering

Statutory Body

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Testing office for structural engineering

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APPROVAL CERTIFICATE

Approval Number:

Z-34.11-225

Valid from:

April 11, 2010

to:

April 11, 2015

Applicant:

DYWIDAG-Systems International GmbH
Destouchesstraße 68, 80796 München

Object of Approval:

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and
Rock with steel tendons made of:
BSt 500 S-GEWI Ø 40 mm and Ø 50 mm and
S 555/700-GEWI Ø 63,5 mm

The aforementioned object of approval is herewith generally approved by the construction supervision authority. This approval certificate comprises 15 pages and four appendices. The object was first granted general technical approval on March 30, 1994.

Important Notice

The approval in hand is the translation of a document originally prepared in 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 wording and/or 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 REGULATIONS

- 1 This General Approval verifies the suitability (fitness for the intended purpose) of the subject of the approval in keeping with the state construction ordinances.
- 2 If requirements with regards to special expert knowledge and experience of the people who are responsible for assembling construction products and for different kinds of construction are made in the approval certificate in accordance with country specific regulations corresponding to § 17 section 5 of the Model Building Regulation, it has to be noted that this expert knowledge and experience can also be proven by equivalent certificates of other member states of the European Union. This also applies to equivalent certificates that are presented within the framework of the agreement about the European Economic Area [EEA] or other bilateral agreements.
- 3 The General Approval does not replace the permissions, agreements and certifications required by law for a construction project to be carried out.
- 4 The General Approval is granted without prejudicing the rights of third parties, especially private protection rights.
- 5 Manufacturers and sellers of the subject of the approval must submit copies of the General Approval to the user of the subject of the approval, notwithstanding any rulings to the contrary in the "Special regulations", and must point out that the General Approval must be available where the subject of the approval is used. Copies of the General Approval must be made available to involved authorities on request.
- 6 The General Approval may only be copied completely. The publication of extracts is subject to approval by the DIBt. Texts and drawings of advertising material may not contradict the General Approval. Translations of the General Approval must contain the note "Translation of the German original which has not been checked by the DIBt".
- 7 The General Approval is granted, but is revocable. The regulations in the General Approval can be subsequently supplemented or changed, especially if the latest technical findings give reason for this.

If the anchor plate is not fully concreted, it must be protected against corrosion by a corrosion protection systems in accordance with DIN EN ISO 12944-5³ depending on the determined category of corrosivity of the environment and provided with the protection duration "high (H)".

Surface preparation is carried out in accordance with DIN EN ISO 12944-4⁴. When carrying out the galvanization work, DIN EN ISO 12944-7⁵ must be observed.

All of the surfaces of metal parts, e.g. of the pipe socket and the steel protection cap, that are bare or not sufficiently protected by a concrete cover (minimum 5 cm), must also be provided with one of these corrosion protection systems.

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

To ensure that the anchor head will be positioned vertically to the steel tendon, angular deviations are to be compensated (e.g. through a mortar bed).

2.1.3.2 Air-Side Anchorage via Rock

For rock anchorages, the rated values of rock pressure are to be established on a case-to-case basis by an expert⁶, taking into consideration a possible structural fault in the immediate vicinity of the borehole. In case adapters are required, they are to be designed pursuant to relevant norms, taking into account the rated values of rock pressure.

2.1.3.3 Air-Side Anchorage via Steel and Reinforced Concrete Structures

For the design of structural elements to be anchored, DIN 1054² and DIN 4125¹ apply.

For the anchorage of reinforced concrete structures, the additional reinforcement and the minimum distances of the anchorage for the plate anchorage pursuant to Appendix 3 as well as the General Technical Approvals of the GEWI system (Z-1.5-149, Z-1.5-2) must be observed.

For supports on steel structures, sufficient bearing capacity and corrosion protection must be proven and determined for the anchor plates and transition structures (e.g. pipe for angular alignment). Neither of them is subject of the present General Approval.

2.1.4 Plastic Sheathings

For the sheathing of the tendon's free length and the bond length, only plastic sheathings may be used which consist of PVC-U as specified by DIN EN ISO 1163-1⁷, polyethylene with a moulding compound as specified by DIN EN ISO 1872-1⁸ - PE, E, 45 - T 022 - or polypropylene with a moulding compound as specified by DIN 1873-1⁹ - PP - B, EAGC, 10-16-003 or DIN EN ISO 1873-1⁹ - PP - H, E, 06-35-012/022.

The tubes must be straight and without trapped bubbles; they must have a uniform pigmentation.

If individual sections of the PVC-U ducts are required, they must be screwed together and thoroughly sealed using glue that is suitable for PVC or wrapped with an adhesive tape that is suitable for PVC. In the case of PE or PP ducts, continuous ducts are to be used.

³ DIN EN ISO 12944-5:2008-01 Coating materials – corrosion protection of steel structures by coating systems – part 5: coating systems (ISO 12944-5:2007); German version EN ISO 12944-5:2007

⁴ DIN EN ISO 12944-4:1998-07 Coating materials – corrosion protection of steel structures by coating systems – part 4: surface types and surface preparation (ISO 12944-4:1998); German version EN ISO 12944-4:1998

⁵ DIN EN ISO 12944-7:1998-07 Coating materials – corrosion protection of steel structures by coating systems – part 7: execution and supervision of coating work (ISO 12944-7:1998); German version EN ISO 12944-7:1998

⁶ Geotechnical experts have to be consulted for determining statical and constructional requirements as well as characteristic stress

⁷ DIN EN ISO 1163-1:1999-10 Plastics – unplasticized polyvinyl chloride (PVC-U) molding compounds – part 1: designation system and basis for specifications (ISO 1163-1:1995); German version EN ISO 1163-1:1999

⁸ DIN EN ISO 1872-1:1999-10 Plastics – polyethylene (PE) molding compounds – part 1: designation system and basis for specifications (ISO 1872-1:1993); German version EN ISO 1872-1:1999

⁹ DIN EN ISO 1873-1:1995-12 Plastics – polypropylene (PP) molding compounds – part 1: designation system and basis for specifications (ISO 1873-1:1995); German version EN ISO 1873-1:1995

2.2 Manufacture, Storage, Transport and Marking

2.2.1 Corrosion Protection and Manufacture of Prefabricated Anchors for Installation and Grouting

2.2.1.1 General

Dimensions and materials of the components used as well as the design must correspond to the specifications and work instructions deposited at the German Institute for Civil Engineering.

The effectiveness of the corrosion protection depends on the integrity of the corrosion protection components. Therefore, special care is to be taken during transport and installation of the readily assembled permanent anchors so that sheathings will not be damaged as a result of improper handling.

Prior to its installation, the steel tendon must be treated as required by the approval provisions for the respective steel. For the fabrication of the anchor, the steel tendon must be clean and free of damaging rust.

2.2.1.2 Preassembled Anchor Design

2.2.1.2.1 Steel Tendon

The steel tendon is to be protected approximately along the whole length (cf Appendix 1) by a corrugated tube (corrugated sheathing) consisting of plastic as specified in section 2.1.4. The corrugated sheathing must have a uniform wall thickness $> 1\text{mm}$. The dimensions of the corrugated sheathings are specified in Appendix 1.

Bar sections that must remain screwable for anchoring our coupling are not encased, but puttied with viscous corrosion protection compound.

The corrugated tube must be closed with caps on both ends and sealed.

The annulus between the threadbar and sheathing of angular inclined anchors is to be grouted bottom-up with cement mortar specified in DIN EN 447¹⁰, taking into account the alterations in accordance with the valid Building Rules List A part 1 or in accordance with the General Technical Approval. The space compliance of $\geq 5\text{ mm}$ between tendon and corrugated sheathing is to be ascertained by spacers that are positioned at a distance of 1.0 m to each other or by a polyethylene helix, $\varnothing 6\text{ mm}$; gradient 0.5 m. Full grouting must be ensured by suitable measures.

At the tendon free length, a smooth plastic tube according to section 2.1.4 with a wall thickness of $> 1.5\text{ mm}$ is slipped over the corrugated sheathing. The basic dimensions of the smooth plastic tubes are mentioned in Appendix 1. The distance between the corrugated sheathing and the smooth plastic tube may only amount to a maximum of 2 mm. The smooth tube must be affixed at its position with a suitable adhesive tape or a fixed heat shrinkable sleeve (with an interior adhesive coating such as MWTM, cf. Appendix 1). Section 2.2.1.3.2 is to be observed regarding corrosion protection around the couplers.

2.2.1.2.2 Connection of the anchor plate with the pipe socket

Between the anchor plate and the upper rim of the duct, a steel pipe is to be assembled that must be welded to the anchor plate. The welding work in order to seal the pipe socket to the anchor plate is to be executed in the factory. A class A assembly qualification according to DIN 18800-7¹¹ is compulsory for the welding of the anchor plates.

In accordance with section 2.1.3.1, bare anchor plates and steel pipes are to be provided with a coating in accordance with DIN EN ISO 12944-5³ in the factory. This coating must provide a durable corrosion protection, taking into account the actual environment conditions.

¹⁰ DIN EN 447:1996-07

Cement grout for tendons – requirements for common grout – German version EN 447:1996

¹¹ DIN 18800-7:2008-11

Steel structures – part 7: realization and construction qualification

2.2.1.3 Couplers

2.2.1.3.1 General Requirements

The steel tendons BSt 500 S-GEWI and S 555/700-GEWI can be spliced using a coupler in accordance with the General Technical Approval of the GEWI System (Z-1.5-149, Z-1.5-2, please also cf. Appendix 2).

The tendon sections that are to be coupled must be prepared at the factory according to section 2.2.1.2.1. The surmounting steel of the coupled tendons must be puttied with Denso-Jet or Petroplast corrosion protection mass.

A maximum of one splice may be applied in the anchoring area. Leading expansion distances according to Appendix 2 are to be selected equal or longer than the expected expansion distance for all building projects. The below mentioned types of splices are permissible subject to the overall corrosion protection system (cf. sections 2.2.1.2.1).

2.2.1.3.2 Splices

Two alternatives are available for a splice in the tendon free length l_{fs} (cf. Appendix 2).

Alternative A: The coupler connection is protected by corrosion protection compound inside the coupler tube. Then the coupler tube is arrested on both sides either with a plastic and texture adhesive tape or with fixed heat shrinkable sleeves (with interior adhesive coating).

Alternative B: The coupler connection is protected by a corrosion protection heat shrinkable sleeve inside the coupler tube. The slipped on coupler tube is arrested as in A (cf Appendix 2).

Material properties and dimensions must correspond to the specifications deposited at the German Institute for Civil Engineering.

The heat shrinkable sleeves must be shrunk by hot air, infrared rays or the low flame of a gas burner. The heat shrinkable sleeves must have a minimum wall thickness of 1.5 mm when shrunk.

The joint tube (cf. Appendix 2) consists of PVC-U complying with DIN EN ISO 1163-1⁷. The surface of the plastic pipes to be wrapped must be clean and dry before applying the adhesive tape or heat shrinkable sleeves.

A splice in l_v is to be applied as described in Appendix 2. The coupler is to be wrapped in two layers of heat shrinkable sleeves (inside: corrosion protection heat shrinkable sleeve, outside: fixed heat shrinkable sleeve).

2.2.2 Storage

Depending on the temperatures, the anchors may not be removed from the assembly platform at the factory for 24 hours after the grouting operation has taken place. Transportation and installation may only be carried out 3 days after grouting has taken place in the factory.

The readily assembled anchors may not be stored on the ground. If the anchors are supported in intervals only, the support points may not be sharp-edged, but flat. If anchors are piled up, they must lie on top of each other in a parallel manner. If they are supported by square timbers or suitable spacers in intervals, the weight of the anchors on top may only be transferred via the timbers or the spacers.

2.2.3 Transport

The anchors may neither be thrown nor dropped. They are to be carried such (e.g. by hand, on the shoulders or by means of carrying straps) that corrugated sheathings in particular will not be damaged. If transported by a crane hook, the anchor is to be carried at its stressing end, directly at the steel, or with carrying straps, or it must be placed in ducts.

2.2.4 Marking

The delivery note for the prefabricated anchor must be marked by the manufacturer with the agreement mark (U-mark) according to the agreement ordinance of the German States. The marking may only be carried out if the requirements according to Section 2.3 have been met.

Among other things, the delivery note must indicate for which pressure-grouted anchors the components (e.g. anchor plates chosen in relation to the intermediate structure) are determined and in which factory they have been produced. The delivery note must clearly indicate to which type of pressure-grouted anchor the components are assigned.

2.3 Verification of Agreement**2.3.1 General**

Each manufacturing plant must confirm that the anchor components and the prefabricated anchors for installation and grouting comply with the regulations in this General Approval by means of an agreement certificate based on the plant's own manufacturing control and regular external surveillance, including initial inspection / testing in accordance with the following regulations.

The manufacturer of the anchor components and of the prefabricated anchors must organize a recognized certification authority and a recognized external surveillance authority for the issuing of an agreement certificate and for the external surveillance, including product inspection / testing, that has to be carried out.

The manufacturer has to provide a declaration that an agreement certificate has been granted by marking the construction products with the agreement mark (U-mark), including a note of the designated use.

The certification authority must send a copy of the agreement it issues to the DIBt.

In addition, a copy of the report on the initial inspection is to be forwarded to the DIBt for information.

2.3.2 In-house Manufacturing Control**2.3.2.1 General**

Each plant must set up and also carry out its own manufacturing control. In-house manufacturing control is understood to be the continuous monitoring of production by the manufacturer who thus ensures that the construction products manufactured by him meet the requirements of this General Approval.

The results of the in-house production surveillance must be recorded and evaluated.

The records must contain at least the following information:

- Designation / description of the construction product and / or the outset, material and the components,
- Kind of surveillance or inspection,
- Date of manufacture and inspection/testing of the construction product and the outset material or the components,
- Results of surveillance and inspection and, if applicable, a comparison with requirements,
- A signature of the person responsible for in-house production surveillance.

The records must be filed for at least five years and presented to the external instance assigned with surveillance. On request, they must be submitted to the DIBt and the highest construction supervisory authority responsible.

If the inspection results are unsatisfactory, the manufacturer must immediately take the action necessary for elimination of the problem. Construction products which do not meet requirements must be treated in such a way that they cannot be mixed with conforming products. Once the problem has been eliminated, the original inspection must be repeated immediately, provided that this is technically possible and also required, to verify elimination of the problem.

The in-house manufacture control must include at least the measures detailed below.

- 2.3.2.2 Steel Tendons**
Only steel tendons may be used for which an agreement certificate has been produced in compliance with the provisions of the relevant General Approval.
- 2.3.2.3 Anchor Nuts**
Only anchor nuts may be used for which a certificate of conformity has been produced within the scope of the General Technical Approval for the DYWIDAG GEWI System (Z-1.5-149, Z-1.5-2).
- 2.3.2.4 Plastic Sheathing**
The composition of the moulding compound is to be attested with the agreement certificate "2.1" as per DIN EN 10204¹². The wall thicknesses and diameters of the plastic sheathings must be measured. In case of corrugated sheathings, one sheathing is to be taken from each batch (100 tubes) to measure the wall thickness at an internal and external rib each and on the flank of the tubes as well as the diameter of the tubes. The dimensions must correspond to the drawings deposited at the German Institute for Civil Engineering. The decision of whether a batch is accepted or rejected must be made in accordance with section 2.3.2.11.
- 2.3.2.5 Couplers, coupler sleeves**
Only couplers may be used for which a certificate of conformity has been produced within the scope of the General Technical Approval for the DYWIDAG GEWI System (Z-1.5-149, Z-1.5-2).
One sheathing is to be taken from each batch (100 tubes) to measure the wall thickness as well as the diameter of the tubes. The dimensions must correspond to the drawings deposited at the German Institute for Civil Engineering. The decision of whether a batch is accepted or rejected must be made in accordance with section 2.3.2.11.
- 2.3.2.6 Vent Caps and Sealing Elements**
The material properties and dimensions must comply with the information filed with the DIBt. The values are to be attested by the agreement certificate "2.1" in keeping with DIN EN 10204¹².
At least 1% of the pipes sockets have to be tested in the factory to ensure that the sealing rings or the bead of the vent cap are tightly attached to the matching corrugated tube.
The wall thicknesses and diameters or the widths and thicknesses respectively of the sealing rings are to be tested on 1 % or at least 5 pieces of each furnished batch.
The decision of whether a batch is accepted or rejected must be made in accordance with section 2.3.2.11.
- 2.3.2.7 Heat shrinkable Sleeves**
The material properties of the heat shrinkable sleeves and of the bonding agent are to be attested by the agreement certificate "2.1" in keeping with DIN EN 10204¹². For each batch (100 pieces), the wall thickness of the basic material is to be measured and the bonding job determined.
The thickness of the heat shrinkable sleeves must be measured after shrinkage. To achieve this, a heat shrinkable sleeve has to be shrunk on a piece of sheathing parallel to the manufacture of an anchor type.
The decision of whether a batch is accepted or rejected must be made in accordance with section 2.3.2.11.
- 2.3.2.8 Anchor Plates**

¹² DIN EN 10204:2005-01

Only anchor plates may be used for which a certificate of conformity has been produced within the scope of the General Technical Approval No. Z-1.5-2.

If anchor plates according to Appendix 3 are used or statically proven in isolated cases, the compliance with material properties must be proven by a factory certification "2.2" in accordance with DIN EN 10204¹². Furthermore, each anchor plate must be tested with regards to dimensions and major deficits by means of a Yes/No test (these tests do not have to be recorded).

2.3.2.9 Corrosion protection coating, corrosion protection system materials

The correct thickness of the corrosion protection coating of anchor plate, pipe socket and steel protection cap has to be checked on 5% of the corresponding number of produced parts in the factory.

Proof of the material properties of all materials used for corrosion protection must be provided by an inspection certificate "3.1" of the producing factory according to DIN EN 10204¹². Above all, this inspection certificate must state that the requirements determined in the description and the technical delivery conditions are met. DIN EN ISO 12944-7⁵, section 6, applies to coating products pursuant to DIN EN ISO 12944-5³.

2.3.2.10 Assembly and Corrosion Protection

Checking on the cement grout is to be carried out pursuant to the "Guideline for the surveillance of the production and injection of cement grout in tension channels"¹³.

The corrosion protection measures to be carried out at the factory pursuant to section 2.2.1 are to be verified by visual inspection on each anchor (statistical evaluation is not required).

2.3.2.11 Inspection Plan

If each individual test value is equal to or higher than the required minimum value, the batch is to be accepted. Otherwise, additional samples can be taken. The same measurements have to be carried out on these samples as on the first samples. The measurement results must be summarized with previous measurements. An average value "x" and "a", standard deviation "s" have to be determined from all values. If the resulting test value (numerical value) $z = x - 1.64 s$ is equal to or larger than the required minimum value, the batch must be accepted. Otherwise, it has to be rejected.

2.3.3 External Surveillance

In each production plant, external surveillance must be set up and carried out regularly, but at least twice a year, to check the plant's own manufacturing control.

During external surveillance, initial testing inspection of the anchors must be carried out and samples taken. Sampling and inspection are the responsibility of the recognized surveillance authority in each case.

The results of certification and external surveillance must be filed for at least five years. On request, they must be presented to the DIBt and to the highest construction supervisory authority by the certifying body and the surveillance authority.

3 Regulations for Drafting and Design

3.1 General

Unless stated otherwise below, DIN 1054² applies to the planning and design of structures that incorporate ground anchors.

3.2 Additional Proof

3.2.1 Maximum Values of Tensioning Loads

Evidence must be provided that the permissible tensioning loads $P_{0,max}$ do not exceed the following constraint:

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

A_s = cross-section area of the steel tendon

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

3.2.2 Change of Load in the Steel Tendon due to Frequently Repetitive Live Loads

Evidence must be provided that the change of load (characteristic value) in the steel tendon due to frequently repetitive live loads (including wind) is not larger than 20% of the characteristic stress E_k .

Evidence must be provided that the change in load at the air-side anchorage and possible couplers does not exceed the 0.7 fold of the proven load range of the valid General Technical Approval No. Z-1.5-149 or No.Z-1.5-2 respectively. Load cycle values exceeding $2 \cdot 10^6$ have not been proven by General Technical Approval No. Z-1.5-149 or No. Z-1.5-2 respectively

Evidence is only necessary if the swelling load is not covered by tensioning.

3.3 Rock Anchors

The overall safety of the rock mass anchored is the subject of rock mechanical stability evidences; the anchor forces required for stability are to be determined by an expert⁶.

4 Regulations for Work Execution

4.1 General

Assembly and installation of the ground anchors may only be carried out under the technical guidance of the company DYWIDAG-Systems International GmbH. Work has to be carried out in accordance with the job instructions deposited at the German Institute for Civil Engineering.

The company DYWIDAG-Systems International GmbH must maintain a list of structures secured with permanent anchors pursuant to this General Approval indicating the structure anchored and the number of anchors installed.

4.2 Drilling the Boreholes

4.2.1 Borehole Diameter

The minimum borehole diameter has to be chosen in such a fashion that the anchor can be properly inserted with the spacers. For minimum borehole diameters, DIN 4125¹, section 7.1, applies.

4.2.2 Boreholes in the Ground

As a general rule, the borehole drillings are to be cased.

The borehole may be drilled uncased or partly cased in cohesive soils, if evidence is produced within the scope of the suitability test that there is solid ground on the total length of the uncased part of the drilling, that the drill rods used are sufficiently rigid to assure a straight drilling and that the borehole can be properly cleaned.

4.2.3 Drilling of the Boreholes in Rock

The drilling method will be defined by the specific rock properties.

Evidence must be provided that in the area of the free anchor length perpendicular to the borehole axis

- No joint movements will be anticipated, if the load transfer length has not been limited (see section 4.4.3), or
- Joint movements to be expected will be smaller than the difference between the smooth sheathing and the borehole diameter, if the load transfer length has been limited.

Checking of the free passage of the boreholes by means of a template is recommended.

4.3 Installation into the Borehole

According to Appendix 1, spring basket spacers are to be positioned at least every 1.5 m in the area of the bond length. In non-cohesive soils, the positioning of spacers may be abandoned if the wall thickness of the starting tube or the material thickness at the nipple passages is > 10 mm.

If a lost drill or ram bit is used, it must be knocked off with a steel rod prior to the anchor installation. If in the case of a cased borehole, the projecting end of the drilling outfit features an edged internal thread or a sharp-edged pipe end, anchors prepared in accordance with section 2.2.1 may not be inserted into the borehole until an edge-free inserting trumpet or a pipe nipple which covers the internal thread of the sheathing completely has been placed onto the projecting end of the drill outfit. It must be made sure that the corrosion protection is not damaged when inserting the anchor.

After filling the borehole with cement grout according to section 4.4.2 and after placing the grout cap, it must be injected at least up to the transition point from bond length l_v to tendon free length l_{fs} while pulling out the casings step-by-step.

4.4 Production of the Ground Anchor

4.4.1 Composition of the Cement Grout

Cements with special characteristics according to DIN 1164-10¹⁴ and cements according to DIN EN 197-1¹⁵ – taking into account the present exposition class according to DIN EN 206-1¹⁶ in conjunction with DIN 1045-2¹⁷ (Tables 1, F.3.1 and F.3.2) – , water according to DIN EN 1008¹⁸ as well as, if applicable, admixtures according to DIN EN 934-2¹⁹ in conjunction with DIN EN 206-1¹⁶/DIN 1045-2¹⁷ or with general technical approval and aggregates for concrete with a maximum grain diameter of 4 mm according to DIN EN 12620²⁰ - taking into account DIN EN 206-1¹⁶/DIN 1045-2¹⁷ - have to be used as source material for cement grout.

14	DIN 1164-10:2004-08 DIN 1164-10 Ber. 1: 2005-01	Cement with special characteristics – part 10: composition, requirements and compliance certificate of normal cement with special characteristics Amendment for DIN 1164-10:2004-08
15	DIN EN 197-1:2004-08 DIN EN 197-1 Ber. 1:2004-11 DIN EN 197-1/A3:2007-09	Cement- part 1: composition, requirements and criteria of conformity of normal cement; German version EN 197-1:2000 + A1:2004 Amendment for DIN EN 197-1:2004-08 Cement- part 1: composition, requirements and criteria of conformity of normal cement; German version EN 197-1:2000/A3:2007
16	DIN EN 206-1:2001-07 DIN EN 206-1/A1:2004-10 DIN EN 206-1/A2:2005-09	Cement- part 1: determination, characteristics, manufacturing and conformity Cement- part 1: determination, characteristics, manufacturing and conformity; German version EN 206-1/A1:2004 Cement- part 1: determination, characteristics, manufacturing and conformity; German version EN 206-1: 2000/A2:2005
17	DIN 1045-2:2008-08	Bearing structures consisting of concrete, reinforced concrete and post-tensioned concrete – part 2: concrete – determination, characteristics, manufacturing and conformity – application guide for DIN EN 206-1
18	DIN EN 1008:2002-10	Water for concrete – determination for sample-taking, testing and evaluation of the suitability of water, including water accumulating during concrete production, as an additive for concrete; German version EN 1008:2002
19	DIN EN 934-2:2009-09	Additives for concrete, mortar and cement mortar – part 2: Concrete additives – definitions, requirements, conformity, marking and labeling; German version EN 934-2:2009
20	DIN EN 12620:2008-07	Granularity for concrete; German version EN 12620:2002+A1:2008

The water-cement value must be between 0.35 and 0.7 and should be chosen as low as possible, especially in cohesive soils and in rock. The cement mortar must be mixed mechanically. Until grouting, neither demixing nor lumping may occur.

4.4.2 Fabrication of the Grout Body

4.4.2.1 Fabrication of the Grout Body in Soil

DIN 4125¹, section 7.3.3. applies for uncased boreholes.

In case of a cased borehole, the pipes will be drawn slowly and step by step after filling the sheathing with cement grout while maintaining the necessary grouting pressure. Injection for the production of the grout body must always be carried out from the deepest point of the grout body, the venting from the highest point. The grouting operation may not be stopped until cement grout emerges through the vent tube without any bubbles. In case of downwardly inclined anchors, the vent tube may be dispensed with, if the borehole is filled from the bottom until cement grout escapes at the top.

4.4.2.2 Fabrication of the Grout Body in Rock

The rock must be so compact that a perfect fabrication of the grout body can be assured. Checking will be made in the necessary extent by special investigations (e.g. visual borehole inspection, gauge measurement of the grout level, Lugeon test).

In each individual case, the mortar formula, grouting pressure and grouting operation is to be established by the field engineer in consultation with the expert⁶ and the engineer based on the results of the rock explorations, water injection tests and the findings after the drilling of the boreholes.

The proposed grouting technique is to be investigated within the scope of the suitability test. The amount of cement grout needed for one anchor, its composition and the grouting pressure are to be measured and recorded. The use of form Appendix A DIN 4125¹ is recommended.

4.4.3 Limitation of the Load Transfer Length

In general, the load transfer length is to be limited by the following methods:

- a) by flushing out excess cement grout by means of a flushing hose mounted on the sheathing. The flushing hose is to be arranged such that the first discharge openings are positioned 50 cm above the transition point between the tendon free length and the bond length. The verification of this value is to be confirmed in the drilling protocol. The flushing pressure applied is to be approximately 4 bar.
- b) by flushing out excess cement grout by means of a lance. The flushing lance that is closed at the bottom and provided with lateral openings is to be inserted up to approx. 1.0 m above the transition point l_v/l_{fs} . The flushing pressure applied is to be approximately 4 bar.
- c) by blocking the load transfer length by means of a packer (see Appendix 4).

The suitability of the packer is to be evidenced within the scope of the suitability test.

Methods a) and b) are to be applied for downwardly inclined ground anchors in soil and may also be used for downwardly inclined ground anchors in rock.

Method c) is to be applied for upwardly inclined ground anchors and may also be used for downwardly inclined anchors.

For rock anchors, the force transfer length may not be limited, if relations correspond to DIN 4125¹, section 7.5.

4.4.4 Post-Grouting

Once the initial grouting has set or fully hardened, further injections of cement grout may be made in the area of the ground anchor. For this purpose, valve tubes or valve pipes with collars, or grout tubes with post-grouting valves are to be used. The grout body may

be burst open using water; however, grouting is to be carried out as required by DIN 4125¹, section 7.4.

In case the force transfer length l_0 must be limited (see section 4.4.3), the free load transfer length must subsequently be flushed again. To avoid leakages during postgrouting, $l_0 = l_v + 2 \text{ m}$ may apply; however, $l_0 - l_v$ may not be greater than $0.3 \cdot l_{fs}$. To this end, the required limitation of the grout body must be effected via a flushing lance which will be inserted up to 2.0 m before the beginning of l_v .

4.5 Protective Measures against Corrosion on Site

Individual steps of anchor head assembly on site, including corrosion protection measures, have to be carried out according to the working instruction of the company DYWIDAG-Systems International GmbH deposited at the German Institute for Civil Engineering.

Before applying the anchor head structure, the free steel end is to be protected from corrosion (coating with a viscous corrosion protection compound in accordance with deposit).

The area between the anchor plate and the corrosion protection sheathing of the anchor must be protected by a steel pipe (pipe socket) that is closely welded to the anchor plate. The pipe socket must be sealed off from the corrugated tube by rubber sealing rings or the bead of the vent cap.

The void between the steel tendon and the anchor plate/ steel pipe must be injected with a corrosion protection compound. Denso-Cord, Denso-Jet, Denso-Fill, Petro-Plast or Nontribos MP-2 must be used as corrosion protection compounds.

The cement grout surface of the corrugated tube must be previously sealed with Icosit 277, if the corrosion protection material Nontribos MP-2 is applied and if it is not protected by the vent cap.

Corrosion protection compound that has been removed during tensioning must be replaced.

After stressing the anchor, the anchor nut and the steel protrusion must be protected by a cap, and the space between nut and cap must also be filled with the corrosion protection material described above. If the cap is not subject to mechanical load (e.g. subsequently embedded), it may consist of HDPE.

In all other cases, a minimum 3 mm thick DIN EN ISO 1461²¹ hot-dip galvanized steel cap coated according to DIN EN ISO 1461-t Zn or a steel cap that is endowed with a corrosion protection system according to section 2.1.3.1 and that is screwed onto the anchor plate with an underlying nitrile rubber sealing washer must be applied.

If anchors, due to maintenance inspection, must be subsequently tightened, then care must be taken that the removed corrosion protection material be refilled again.

4.6 Suitability and Acceptance Tests and Supervision of the Installation

Suitability and acceptance tests are to be carried out on every construction site in compliance with DIN 4125¹.

The suitability tests for permanent anchors are to be supervised by a surveillance agency for the supervision of installing ground anchors being registered with the inspection, surveillance and certification authorities complying with the prevailing state building code, part V, in the valid version²².

In the course of their surveillance activities for the suitability and acceptance tests, the commissioned surveillance agency must supervise at least randomly the assembly and installation of the permanent anchors at the construction site, especially the corrosion protection measures e.g. seeing to that the anchor head is completely filled.

²¹ DIN EN ISO 1461:2009-10

Zinc coatings applied on steel by hot-dip galvanizing (galvanization of pieces) – requirements and tests (ISO 1461:2009); German version EN ISO 1461:2009

²²

Latest issue: register of inspection, surveillance and certification authorities complying with state building codes – version: June 2010 – DIBt – notifications, German Institute for Civil Engineering 41 (2010), special booklet No. 40

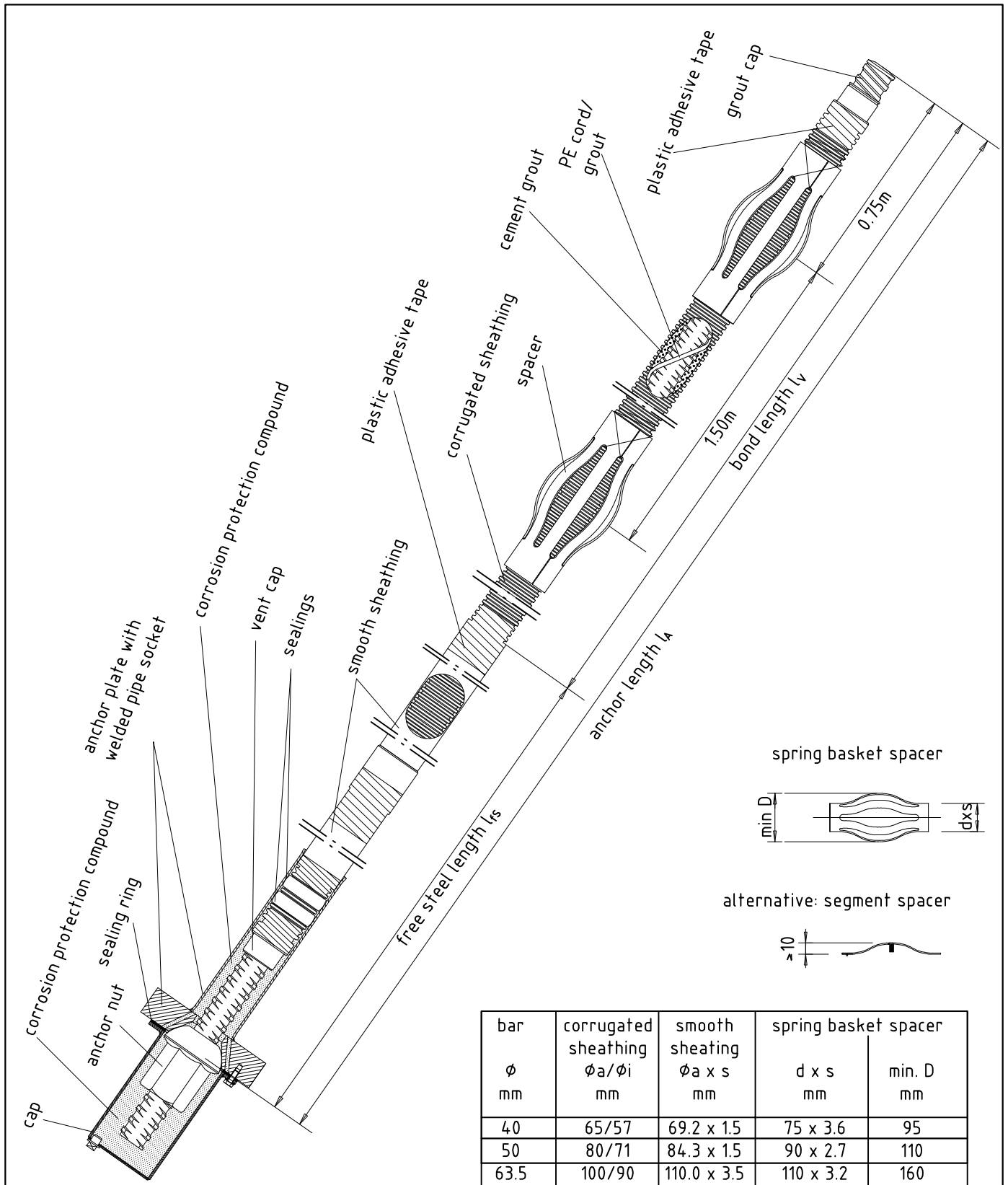
The surveillance agency must report to the building supervision authority concerned whenever facilities and the personnel on site do not assure proper installation. The beginning of such work is to be reported to the building supervision authority concerned.

5 Provisions for Usage, Maintenance and Service

5.1 Verification

DIN 4125¹, section 13, applies.

If required, verification is to be made by the surveillance agency which has already performed the suitability tests.

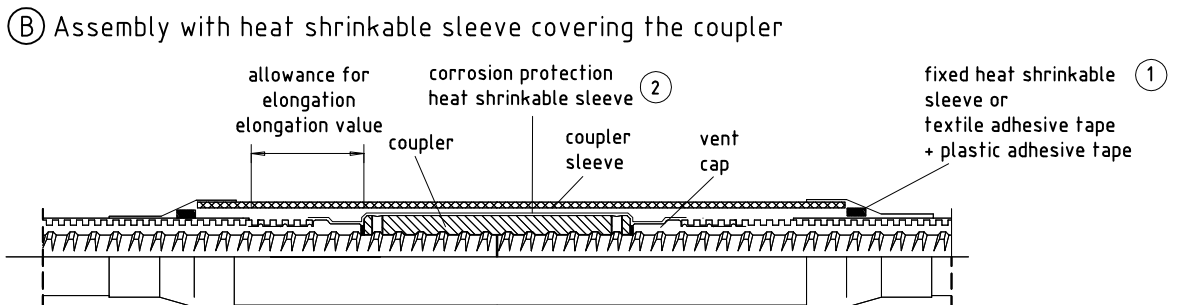
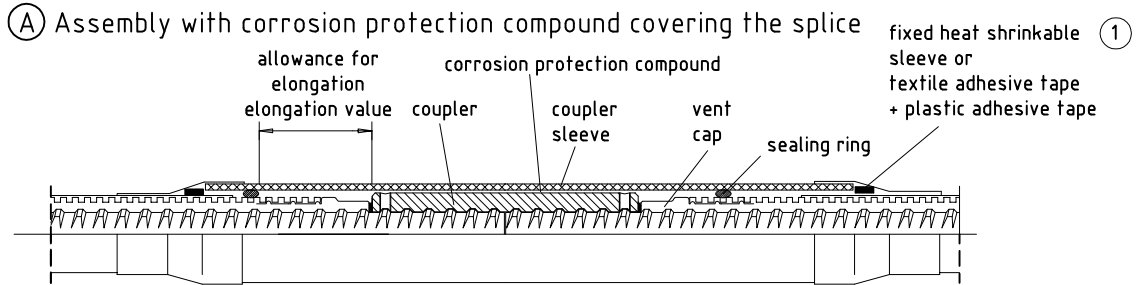


Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons
 made of: BSt 500 S-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

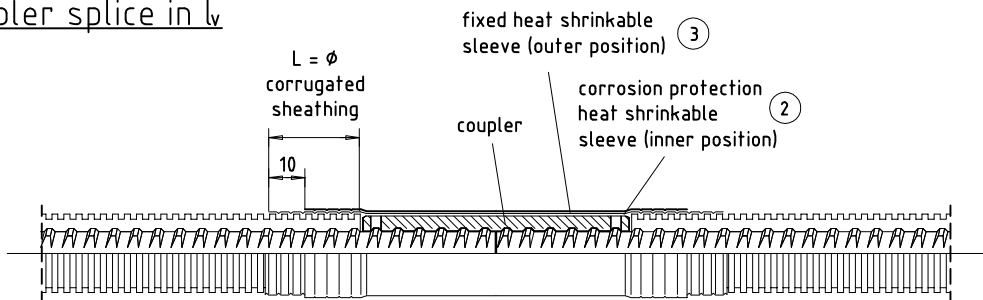
Overview DYWIDAG permanent bar anchor with GEWI steel

Appendix 1

coupler splice in l_{fs}



coupler splice in l_v



Rotary protection of all couplers by threaded pins.
Alternatively, glue in one bar end using resin adhesive.

bar ø mm	coupler	heat shrinkable sleeve			coupler sleeve ¹⁾			
		①	②	③	Type (A)		Type (B)	
		d	s	d	s	d	s	
40	acc. Z-1.5-149	115/34 or 120/34	90/36	95/29 or 95/26	80	4.4	90	6.7
50		115/34 or 120/34	120/54	115/34 or 120/34	110	5.3	110	5.3
63,5	acc. Z-1.5-2	140/42	120/54	115/34 or 120/34	125	3.7	125	3.7

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

Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: BSt 500 S-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

coupler splice assembly

Appendix 2

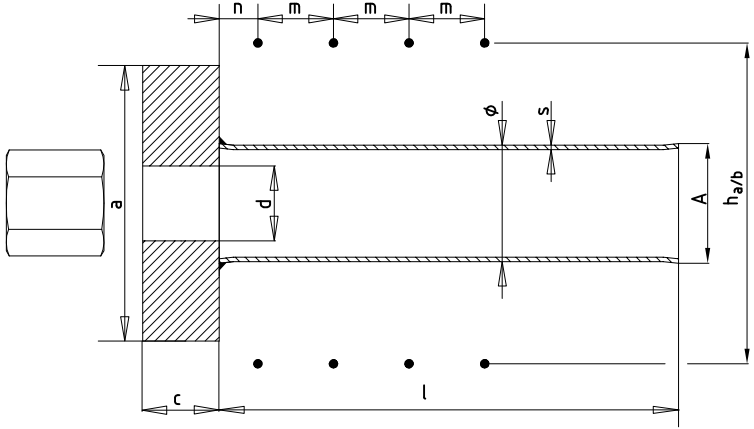
Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons
 made of: BSf 500 S-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

anchor assembly

Permanent DYWIDAG bar anchor Ø40, Ø50

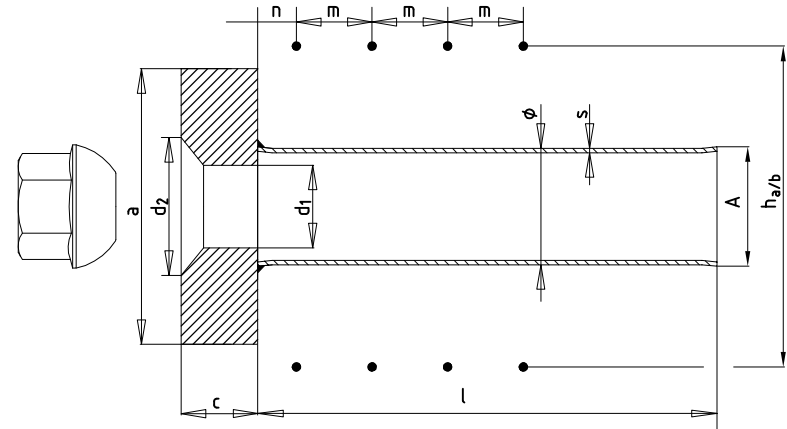
and Ø63,5mm GEWI

anchor nut
 anchor plate



Permanent DYWIDAG bar anchor Ø63,5mm GEWI

domed anchor nut
 anchor plate with cone



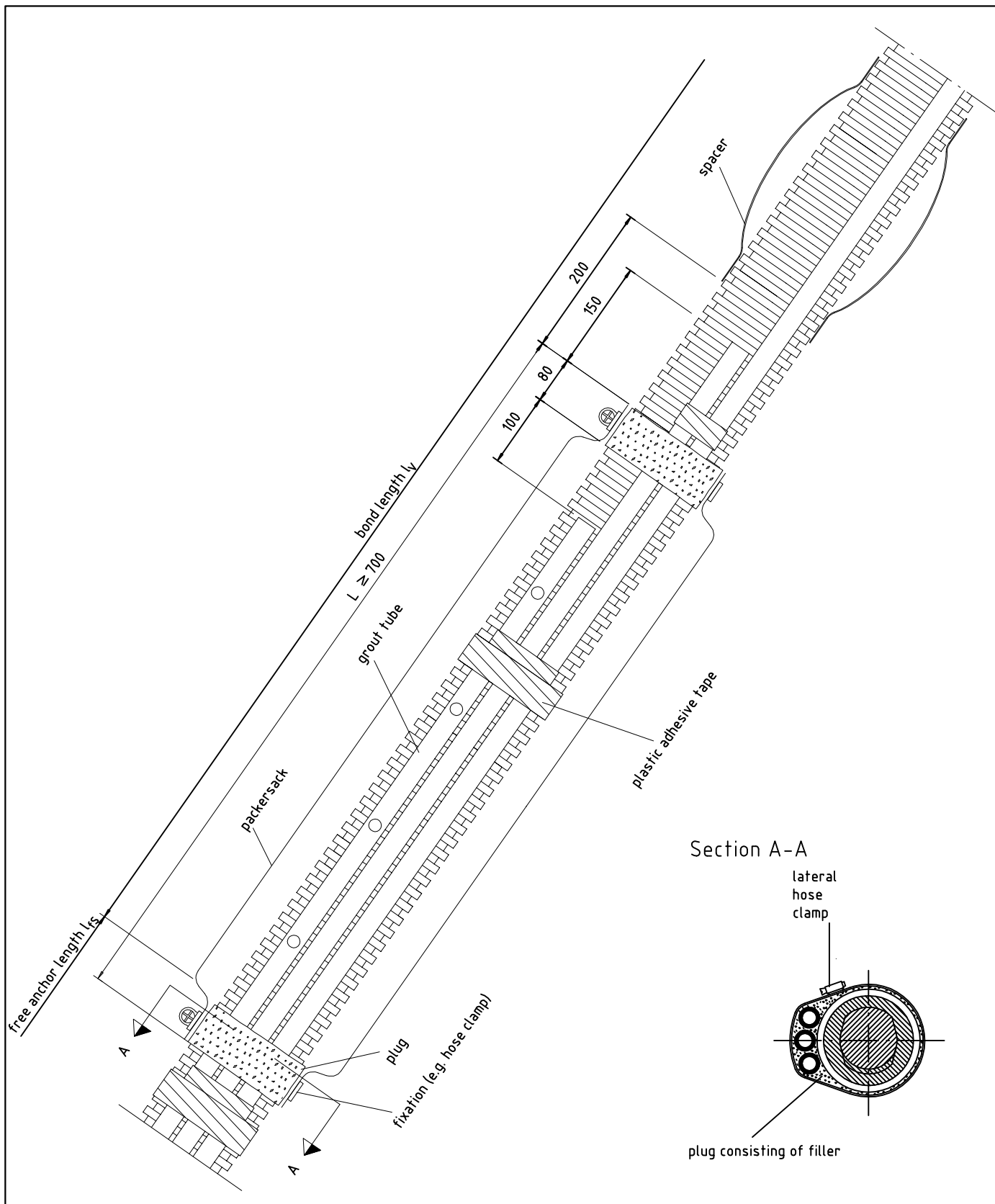
Minimum concrete grade: C20/25

Exposition classes according to DIN 1045-1 (2008-08) section 6.2 (table 3) have to be taken into account.

bar φ mm	square anchor plate				pipe socket			Material	domed - / anchor nut	additional reinforcement			min. axis distance mm	min. edge distance mm	
	a mm	c mm	d mm	d1/d2 mm	tube φ x s mm	A mm	l mm			h _{a/b} mm	n mm	m mm			corrugated reinforcing steel acc. DIN 488
40	160	40	46	-	76.1x2.9	~80	≥ 300	S235JR (1.0038) DIN EN 10025-2	acc. Z-1.5-149	210	20	50	3 φ 12mm	240	140
50	200	45	58	-	101.6x3.6	~106				300	25	60	4 φ 12mm	330	190
63.5	acc. Z-1.5-2				127x4	~130			acc. Z-1.5-2	acc. Z-1.5-2					

The valid approvals for the GEWI system (Z-1.5-149 und Z-1.5-2) must be observed.

Appendix 3



Permanent DYWIDAG Anchors (Single Bar Anchors) for Soil and Rock with steel tendons made of: BSt 500 S-GEWI Ø 40 mm and Ø 50 mm and S 555/700-GEWI Ø 63.5 mm

injection packer

Appendix 4

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