DYWIDAG

GEOTECHNICAL SYSTEMS

DYWIDAG GEWI Piles (Micropiles) with Load-Bearing Elements made of Reinforcing Steel Bar with Thread Ribs B500B, Ø20mm, Ø25mm, Ø28mm, Ø32mm, Ø40mm and Ø50mm

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Applicant:
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Subject of approval:
DYWIDAG GEWI Piles (Micropiles) with Load-Bearing Elements made of Reinforcing Steel Bar with Thread Ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm und Ø 50 mm

The above-mentioned regulated item matter is hereby granted general construction supervisory authority accreditation/approval.
This approval includes 14 pages and eight Annexes with nine pages.
The item was granted a general construction supervisory authority approval on 28 August 1992 for the first time.

I GENERAL PROVISIONS

1 This approval confirms the usability or applicability of the regulated item within the context of the state construction codes.

2 This approval does not replace the permissions, approvals and certificates required by law for the execution of construction projects.

3 This approval is issued without prejudice to the rights of third parties, especially private property rights.

4 Copies of this approval must be made available to the user or installer of the regulated item without prejudice to more detailed provisions under “Special Provisions”. In addition, it must be pointed out to the user or installer of the regulated item that this approval must be available at the site of use or installation. Copies hereof must also be made available to the authorities involved on the request.

5 This approval may only be reproduced in its entirety. A publication of excerpts is subject to the approval of DIBt. Texts and drawings included in promotional materials may not contradict this approval and translations must include the note “Translation of the German original version not verified by DIBt”.

6 This approval is issued subject to revocation. The provisions herein can be subsequently amended or modified, especially if the latest technical findings give reason for this.

7 This approval refers to the information and documents provided by the applicant. Any amendment of such information and documents is not covered by this approval and must be promptly disclosed to DIBt.

II SPECIAL PROVISIONS

1 Subject matter of approval and use or application scope

1.1 Subject matter of approval and use scope

(1) The subject matter of this approval are DYWIDAG GEWI piles from DYWIDAG-Systems International GmbH that comprise:

- load-bearing elements made of reinforcing steel bar with thread ribs and a nominal diameter of 20 mm, 25 mm, 28 mm, 32 mm, 40 mm and 50 mm,
- couplers and anchoring elements made of steel, as well as
- additional components.

(2) DYWIDAG GEWI piles may be used for permanent installation. For such applications, the steel load-bearing elements may be provided with a corrosion protection system that consists of corrugated plastic sheathing injected with inner cement grout (see Annex 2).

(3) DYWIDAG GEWI piles may be used as composite piles (micro piles) according to DIN EN 14199 in combination with DIN SPEC 18539.

1.2 Subject of approval and scope of application

(1) This approval covers the planning, measurements and execution of composite piles (micropiles) according to DIN EN 14199 in combination with DIN SPEC 18539, unless otherwise stated below.

(2) Micro piles are to be executed according to Annexes 1, 2 and 3, using DYWIDAG GEWI piles and cement grout (injection grout).

(3) The micropiles may be used as tension piles or compression piles and are designed for loading by axial loads only.

2 Regulations covering the construction product

2.1 Properties and composition

2.1.1 Steel load-bearing elements

(1) Only B500B reinforcing steel bars with thread ribs according to Table 1 may be used.

Table 1: Nominal diameter and steel grade

Nominal diameter [mm]	B500B reinforcing steel bar acc. to approval no.[1]		
	Z-1.1-58	Z-1.1-59	Z-1.1-167
20	X		X
25	X		X
28	X		X
32	X		X
40	X	X	
50	X	X	

(2) When using DYWIDAG GEWI piles as single-bar piles, the steel load-bearing elements are to be made of a reinforcing steel bar (see Annexes 1 and 2). The steel load-bearing elements of the single-bar piles may be provided with a corrosion protection system that consists of corrugated plastic sheathing injected with inner cement grout.

[1] General Construction Supervisory Authority Approval, General Construction Supervisory Authority Approval/ General Design-Type Approval or General Design-Type Approval

(3) When using DYWIDAG GEWI piles as multi-bar piles (see Annex 3), the steel load-bearing elements may be made using a combination of reinforcing steel bars with thread ribs and nominal diameters as follows:

- 2 Ø 40 mm
- 2 Ø 50 mm
- 3 Ø 32 mm
- 3 Ø 40 mm
- 3 Ø 50 mm
- 1 Ø 40 mm, 1 Ø 50 mm
- 2 Ø 40 mm, 1 Ø 50 mm
- 1 Ø 40 mm, 2 Ø 50 mm

(4) The steel load-bearing element of the DYWIDAG GEWI piles may be spliced using couplers according to Table 2 (see Annex 7).

Table 2: Connecting and anchoring means

Nominal diameter [mm]	Coupler connections and anchorages according to the approval no.[3]		
	Z-1.5-76*	Z-1.5-149*	Z-1.5-174*
20	X		X
25	X		X
28	X		X
32	X		X
40		X	X
50		X	X

* A combination of couplers or anchorage elements from the approvals provided is not allowed. To reduce mistakes, depending on the construction site, only anchoring and connecting means according to the same approval may be used, as follows: for Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm according to the approval no. Z-1.5-76 or no. Z-1.5-174, for Ø 40 mm, Ø 50 mm according to the approval no. Z-1.5-149 or no. Z-1.5-174.

(5) The pile connection in the foundation body may be completed using anchoring means for end anchorage (anchor pieces, anchor nuts, lock nuts) according to Table 2. In the case of Ø 32 mm, Ø 40 mm and Ø 50 mm steel load-bearing elements anchoring may also be made using locked plate anchorage. For this purpose, use a plate according to Annex 4 to this approval with the geometric dimensions and material specifications provided.

(6) In the case of single-bar pile acc. to Annex 1, structural protection of the pile neck must be ensured in the transition area from the pile shaft to the foundation body. The ribbed PE or PVC sheathing with at least 1 mm thickness must maintain a distance of ≥5 mm from the steel load-bearing element and may be prepared in advance at the shop.

(7) In the case of single-bar piles according to Annex 2 pile neck protection is to be provided by the corrugated plastic sheathing already in place and injected with inner cement grout.

2.1.2 Corrosion protection system elements in case of permanent installation

(1) The corrugated plastic sheathing to be used as part of the corrosion protection system must be made either of PVC-U according to DIN EN ISO 21306-1, of polyethylene with a molding compound ISO 17855-PE-HD,,E,44-T022 according to DIN EN ISO 17855-1 or polypropylene with the molding compounds ISO 19069-PP-B,,EAGC,10-16-003 or ISO 19069-PP-H,,E,06-35-012/022 according to DIN EN ISO 19069-1. It must be ensured that only straight ducts are installed. The corrugated plastic sheathing must have a uniform wall thickness of ≥1 mm; only sheathing without evidence of any trapped bubbles and with uniform pigmentation may be installed.

(2) To maintain a distance of ≥5 mm between the steel load-bearing element and the corrugated plastic sheathing, the steel load-bearing element must be provided with plastic spacers arranged at every 1 m or wound with a Ø 6 mm polyethylene helix with a 0.5 m pitch.

(3) Inner cement grout as prescribed by DIN EN 447 must be used for filling the empty ring space between the steel load-bearing element and the corrugated plastic sheathing. The provisions of DIN EN 445 and DIN EN 446 must also be observed.

(4) To ensure complete corrosion protection and cover coupling elements at the impact sites, corrosion protection heat shrink sleeves (e.g. CPSM) according to DIN EN 12068 classified as "EN 12068 - C30 coating", made of radiation crosslinked polyethylene should be used, covered with an adhesive made of butyl and natural rubber with the addition of corrosion inhibitors on the inner side; at least 700 g/m^2 of the adhesive must be used. The heat shrink sleeves must be shrunk on with hot air, infrared radiation, or gas burner soft flame; the wall thickness in the shrunk condition must be ≥1.5 mm.

2.2 Manufacture, packaging, transport, storage and marking

2.2.1 Manufacture and corrosion protection of the prefabricated DYWIDAG GEWI piles for installation and grouting

(1) The following work must be carried out at the plant.

(2) DYWIDAG GEWI piles must be assembled for the relevant application, i.e. steel load-bearing elements must be assembled with the proper reinforcing steel bars, coupling and anchoring elements.

(3) In the case of DYWIDAG GEWI piles according to Annex 1 (single-bar piles) the pile neck protection (section 2.1.1 (6)) may be completed at the shop. The distance of ≥5 mm between the corrugated plastic sheathing and the steel load-bearing element may be secured by using spacers according to section 2.1.2 (2) and injected with inner cement grout according to (5) to fill the gap entirely.

(4) The steel load-bearing element of the DYWIDAG GEWI piles may be embedded in the case of single-bar piles, except for any possible joints, in a corrugated plastic sheathing injected with inner cement grout over its entire length (see Annex 2). To maintain a distance of ≥5 mm between the steel load-bearing element and the corrugated plastic sheathing, spacers as defined in Section 2.1.2 (2) must be arranged. An end cap (injection cap, see Annex 2), made of the same material as the corrugated plastic sheathing (plastic or molding compound according to section 2.1.2 (1)), should be placed at the earth-side end of a DYWIDAG GEWI pile. Connect the end cap with the corrugated plastic sheathing using cams and adhesive. The air-side end is closed with a ventilation cap made of PE, which must be sealed using the appropriate adhesive band. If the steel load-bearing element is spliced, injection or ventilation caps made of PE must be placed at the ends of the corrugated plastic sheathing, observing the amount of free space necessary for connection at the bar ends, and then sealed with the appropriate adhesive band. In the case of corrugated plastic sheathing made of PE the injection or ventilation caps made of PE may be connected to the corrugated plastic sheathing using an adhesive, which removes the need to seal the connection by means of the appropriate adhesive band. The possibly required individual segments of the corrugated plastic sheathing made of PVC-U must be screwed together and carefully glued with a specific PVC adhesive. Unspliced ducts must be used as the PE or PP ribbed sheathing.

(5) The ring space between the steel load-bearing element and the corrugated plastic sheathing must be injected with inner cement grout as set out in Section 2.1.2 (3) from the bottom to the top, while the load-bearing element is stored on an inclined plane. For this purpose, the prepared steel load-bearing element must be positioned on an inclined plane, so that injection from the lowest point (end cap or injection cap) and ventilation at the highest point (ventilation cap) are ensured. To ensure complete injection, the ventilation cap must be connected to a 0.5 m long filling tube or to a grout cone.

2.2.2 Packaging, transport and storage

(1) The effectiveness of the corrosion protection depends on the integrity of the corrosion protection components. Therefore, special care must be taken during the transport, storage and installation of the DYWIDAG GEWI pile to ensure that the corrosion protection components, in particular the corrugated plastic sheathing, are not damaged due to improper handling. Storage must be above the ground; contamination of the steel load-bearing elements or corrugated plastic sheathing must be excluded.

(2) Depending on the temperatures, the DYWIDAG GEWI piles may not be removed from the assembly bench earlier than one day after the injection of the inner cement grout has taken place at the plant. The further transport and the installation may only be carried out 2 days (48 hrs) after the inner cement grout has been injected in the plant.

2.2.3 Marking

(1) The prefabricated or pre-assembled DYWIDAG GEWI piles and the delivery note for the DYWIDAG GEWI piles must be marked by the manufacturer with the conformity mark (Ü-Zeichen) in accordance with the conformity mark regulations issued by the German federal states. The marking may only be performed if the requirements pursuant to Section 2.3 have been met.

(2) The delivery note must, among other things, state for which piles the DYWIDAG GEWI piles are designated and in which plant they have been manufactured. Only components for one micropile type to be specified may be delivered on a delivery note.

2.3 Certificate of conformity

2.3.1 General

Conformity of the pile components and of the DYWIDAG GEWI piles prefabricated for installation and grouting with the provisions of the general construction supervisory authority approval covered by this approval must be confirmed for every manufacturing plant with a declaration of conformity issued by the manufacturer based on their factory production control system and on a approval of conformity issued by a notified product certification body, as well as regular external surveillance by a external surveillance agency in accordance with the following provisions:

The manufacturer of the pile components and of the DYWIDAG GEWI piles must commission a notified product certification body and a external surveillance authority to issue the certificate of conformity and perform the external surveillance, including the product testing to be carried out in this process.

The manufacturer shall show that a certificate of compliance has been issued by marking the construction products with the compliance mark (Ü- Zeichen) including a reference to the designated use.

The notified product certification body must send a copy of the certificate of conformity issued to the DIBt.

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) Each manufacturer and each supplier must set up and also carry out their own factory production control. Factory production control is understood to be the continuous monitoring of production by the manufacturer or supplier who thus ensures that the construction products manufactured meet the requirements of this general construction supervisory authority approval.

(2) The internal production control system should at least include the measures listed in Annex 8 regarding the incoming goods inspection and the control during the production.

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

- 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 submitted to DIBt and to the competent highest construction supervisory authority on request.

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

2.3.3 External monitoring

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

(2) An initial test must be carried out as part of external monitoring. In this process, samples must be taken for sample checks, and testing tools must be inspected. Both sampling and testing are incumbent on the external surveillance authority.

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

3 Regulations for planning, design and execution

3.1 Planning

3.1.1 General

(1) Micropiles must be planned in accordance with the requirements of DIN EN 14199 in conjunction with DIN SPEC 18539, unless otherwise stated in the text below.

(2) An expert in geotechnical engineering must be consulted if the soil contains elements which may weaken the corrosion protection in case they intrude into the grout body (e.g. organic substances).

(3) The micropiles may not be installed if the subsoil contains ground water or seepage water from waste heaps and/or landfills, so that a high corrosion probability for shallow pitting and pitting corrosion of the steel according to DIN 50929-3, Table 8, with $W_0 < -8$, can be expected unless the load-bearing steel element is protected by a corrugated plastic sheathing injected with inner cement grout over its entire length.

(4) Implementation planning must contain the information resulting from the planning with regard to the implementation of the details. This includes, but is not limited to information on the manufacturing of any required coupling points by means of couplers, cement mortar composition, cement mortar coverage and centering of the steel load-bearing elements, as well as pile head embedding by means of anchoring or bonding.

3.1.2 Coupler splices

(1) Coupling must be made in accordance with Section 2.1.1 (4).

(2) For tensile loads, the couplers must be locked with nuts. In the case of non-dynamic actions, the lock nuts can be omitted if a fixed or corrosion protection heat shrink sleeve (see Section 2.1.2 (4)) is arranged in accordance with Annex 7, taking into account the overlap lengths on the steel load-bearing elements or corrugated plastic sheathing included there. Fixed heat shrink sleeves (e.g. MWTM) are made of polyethylene, while the sealing adhesive mass in the heat shrink sleeve must be a
hot melt adhesive.

(3) Irrespective of the specifications in section (2), locking with nuts is always required in the case of alternating loads and dynamic actions in accordance with DIN EN 1991-1-1, Section 2.2 in conjunction with DIN EN 1991-1-1/NA (see Annex 7).

(4) The distance between the joints in the longitudinal direction of a reinforcing steel bar with thread ribs must be ≥1 m. Clear spacing of the couplers in a multi-bar pile must be at least 50 mm.

(5) In the case of DYWIDAG GEWI piles according to Annex 2 (single-bar piles), where the steel load-bearing elements are embedded in corrugated plastic sheathing injected with inner cement grout, the site of coupling must be protected with a corrosion-protection heat shrink sleeve (see Section 2.1.2 (4)) in accordance with Annex 7, subject to the overlap lengths provided there. The hollow space between the grout column or injection cap/ventilation cap and the splice must, as required by DIN 30672, be completely filled with the plastic sealing tape "Densoplast Petrolatum" on both sides of the splice, before the heat shrink sleeve is shrunk on.

3.1.3 Pile shaft

3.1.3.1 Cement grout

The basic materials for the cement grout are cements with particular properties in accordance with DIN 1164-10 and cements in line with DIN EN 197-1, taking into consideration the present exposition classes as defined by DIN EN 206-1 in conjunction with DIN 1045-2. (Tables 1, F.3.1 and F.3.2), water as stipulated by DIN EN 1008 and, where required, additives in accordance with DIN EN 934-2 in conjunction with DIN EN 206-1/DIN 1045-2 or subject to a general construction supervisory authority approval, and natural aggregates for concrete in compliance with DIN EN 12620, taking into account DIN EN 206-1/DIN 1045-2.

3.1.3.2 Centering and covering of the steel load-bearing element

(1) The load-bearing steel element must be centered within the borehole in such a manner that an adequate cement stone covering is provided at all sites, including over the couplers. For DYWIDAG GEWI piles with steel load-bearing elements in accordance with Annex 1 and 3, which are not embedded in corrugated plastic sheathings injected with inner cement grout, the minimum dimensions of the covering pursuant to DIN SPEC 18539, A Annex C, apply.

(2) DYWIDAG GEWI piles with steel load-bearing elements embedded in corrugated plastic sheathing injected with inner cement grout as per Annex 2 must have a cement stone covering of at least 10 mm over the corrugated plastic sheathing.

(3) The cement stone covering must be secured by means of spring basket spacers or segment spacers (see Annexes 1 to 3), also in combination with a post-grouting system, solely by means of the sheathing (only in the case of non-cohesive soils) or in combination with the aforementioned spacers. The measures to be taken depend on the soil and the inclination of the piles (see also Table 3). Segment spacers may only be used for steel load-bearing elements which are embedded in corrugated plastic sheathings injected with inner cement grout as per Annex 2.

(4) The distances between the spacers depend on the particular inclination; distances from the first spacer on the pile base are continuously indicated in Table 3 and in the Annexes 1 to 3. The first spacer on the pile base must be arranged depending on the inclination ≤1.50 m from the earth-side end of the steel load-bearing element.

Table 3: Inclination of the piles and distance between the spacers

Spacer	Steel load-bearing element	Inclination of the piles	Distance between the spacers[1]	Remarks
Spring basket or segment spacer[2]	1 Ø 20 mm 1 Ø 25 mm 1 Ø 28 mm 1 Ø 32 mm 1 Ø 40 mm 1 Ø 50 mm	0° (vertical) to 15°	≤ 3.0 m	Dimensions of the spacers, see Annexes 1 and 2
		16° - 45°	≤ 2.6 m	
		46° - 80°	≤ 2.2 m	
Spring basket spacer[2]	Multi-bar piles in accordance with Section 2.1.1 (3)	see Annex 3		Dimensions of the spacers, see Annex 3

1 a minimum of 3 spacers in each case

2 If the wall thickness of the starter pipe of the casing equals or exceeds the cement stone covering c, then spacers may be omitted in non-cohesive soils in accordance with DIN EN 1997-1 in conjunction with DIN EN 1997-1/NA and DIN 1054, Section 3.1.

3.1.3.3 Post-grouting

Post-grouting is to be performed by means of the optional use of the post-grouting system dedicated for DYWIDAG GEWI piles. Piles subject to load may not be post-grouted.

3.1.4 Pile connection in the foundation body and pile neck

DYWIDAG GEWI piles may be connected or anchored to the structure according to section 2.1.1 (5) or using couplers (single-bar piles) according to the approvals in Table 1.

3.1.4.1 Single-bar piles

(1) Additional reinforcement or the optional surface reinforcement in the pile head, as well as the necessary anchoring length must be made or observed as per the approvals provided in Table 1 and 2. When using plate anchorage for Ø 32 mm, Ø 40 mm and Ø 50 mm, the provisions of Annex 4 shall also apply.

(2) If this has not been done in the shop, in the case of DYWIDAG GEWI piles as per Annex 1, in the transition area from the pile shaft to the foundation body, a protection of the pile neck must be ensured in accordance with section 2.1.1 (6). The pile neck sheathing must be placed on the pile neck according to the dimensions t_{1R} and t_2 and must be surrounded by at least 10 mm cement stone.

(3) In the case of DYWIDAG GEWI piles according to Annex 1, as an alternative to the corrugated plastic sheathing at the pile neck, additional reinforcement made of N 94 welded steel mesh (or a reinforcement cage of an equivalent cross-section and the same spacing between the wires) can be provided around the steel load-bearing element at the pile neck with external longitudinal wires and overlapping length in the direction of the bar circumference ≥180° or spiral reinforcement with external longitudinal bars according to Annex 1 and 5. The additional reinforcement must be located in the cross section as far to the outside as possible, while the longitudinal wires/longitudinal bars must be covered with cement stone in accordance with DIN SPEC 18539, A Annex C. The inner diameter of the longitudinal wires/longitudinal bars of the additional reinforcement must be at least the Ø of the load-bearing steel element + 25 mm. The reinforcing steel mesh or spiral reinforcement with longitudinal bars shall be positioned concentrically to the steel load-bearing element to meet the above conditions and centered within the borehole by suitable spacers. When arranging the additional reinforcement in the pile neck, the embedment lengths $t_{1B/1W}$ and t_2 according to Annex 1 must be observed. Additional information regarding geometric dimensions can be found in Annex 5.

(4) In the case of steel load-bearing elements already embedded in corrugated plastic sheathing injected with inner cement grout (see Annex 2), an additional corrugated plastic sheathing is not required.
As pile neck protection, the existing corrugated plastic sheathing with the bond length t_1 must be integrated in the entire structure (see Annex 2).

3.1.4.2 Multi-bar piles

(1) In the case of DYWIDAG GEWI piles, which consist of 2 or 3 reinforcing steel bars with thread ribs, the force must always be transmitted from the steel load-bearing element into the foundation body by means of anchorages in accordance with section 2.1.1. (5) or approvals according to Table 2. The additional reinforcement in the pile head must be arranged as shown in Annex 6. The minimum bar bonding in the rising structure is t_1 + 50 mm (Annex 6) in the pile axis.

(2) In the t_2 area of the pile neck (Annex 6), a spiral reinforcement is to be arranged and its ends are to be welded. The dimensions and the arrangement of the spiral reinforcement can be taken from Annex 6. The cement grout covering the spiral reinforcement must at least conform to the values of DIN SPEC 18539, A Annex C.

3.2 Design

3.2.1 General

(1) Unless otherwise stated in the following text, the technical construction standards, in particular, DIN EN 1997-1, DIN EN 1997-1/NA and DIN 1054, shall apply.

(2) In the case of dynamic actions according to DIN EN 1991-1-1, Section 2.2, in conjunction with DIN EN 1991-1-1/NA, it must be verified that the fatigue strengths of the steel load-bearing element or of the coupler splices and the anchorages are not exceeded. These fatigue strength values can be found in the corresponding approvals according to Table 1 and 2.

(3) γ_M= 1.15 must be used in the design situations BS-P, BS-T and BS-A as the partial safety factor γ_M for the material resistance of the steel load-bearing element.

3.2.2 Tensile piles

For piles as described in the Annexes 1 and 3, the steel load-bearing element that is not embedded in corrugated plastic sheathing injected with inner cement grout, it must be verified that the tensile stresses or marginal stresses do not exceed the value of 230 N/mm² in the case of unintended bending stresses in steel based on the design values of impacts in the design situation BS-P.

3.2.3 Proof of the transfer length (force transmission length) in soil

(1) It must be ensured that the force transmission length into the soil is greater than the required transfer length from the steel load-bearing element to the cement stone.

(2) To verify the transfer length, the design value of the bond strength must be determined in accordance with DIN EN 1992-1-1, Section 8.4.2, in conjunction with DIN EN 1992-1-1/NA. This also applies in the same way to the proof of anchorage by bonding. For multi-bar piles, the reduction factor for determining the values f_{bd} is based on the largest bar in the steel load-bearing element.

3.2.3 Entire structure

If required, the slip (see details in Annex 7) occurring in tensile stressed coupler splices without the use of lock nuts must be taken into account for the design of the entire structure.

3.3 Installation

3.3.1 General

(1) DIN EN 14199 in conjunction with DIN SPEC 18539 applies to the installation of the composite piles (micropiles), unless otherwise stated in the text below.

(2) Prefabricated or pre-assembled DYWIDAG GEWI piles 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 and delivery documentation. The minimum hole diameter must be selected so that the DYWIDAG GEWI piles can be inserted without problems along with the required spacers and the minimum cement mortar coverage can be achieved.

(3) If transported by crane hook, the DYWIDAG GEWI piles must be carried at their pile head-side end directly on the steel or with bearing straps or must be placed in ducts.

(4) If in the case of a cased borehole, the projecting end of the drill set has an edged internal thread or rather a sharp-edged tube end, the DYWIDAG GEWI piles prepared may only be inserted into the borehole if an edge-free inserting trumpet or a tube nipple fully covering the internal thread of the casing has been placed onto the projecting end of the drill set. When inserting DYWIDAG GEWI piles according to Annex 2, care must be taken not to damage the prefabricated corrosion protection.

3.3.2 Contractor

(1) Execution of micro piles with the use of DYWIDAG GEWI piles and cement grout is only possible under the technical supervision of DYWIDAG-Systems International GmbH.

(2) Execution of micro piles with the use of DYWIDAG GEWI piles and cement grout may also be carried out by companies that hold a valid certificate issued by DYWIDAG-Systems International GmbH, stating that they have been comprehensively trained by the manufacturer in the execution of micro piles with DYWIDAG GEWI piles and cement grout.

3.3.3 Couplings

(1) Any necessary couplings are to be executed with couplers and may only be executed in accordance with the execution planning documentation.

(2) Shrink tubing used to prevent rotation for non-locked joints must be shrunk on using hot air, infrared radiation or a gas burner soft flame.

(3) In the case of DYWIDAG GEWI piles with load-bearing elements embedded in corrugated plastic sheathing injected with inner cement grout according to Annex 2, the "Densoplast Petrolatum" tape shall be melted by heating. Next, corrosion protection heat shrink sleeves must be shrunk on with hot air, infrared radiation or gas burner soft flame.

3.3.4 Pile shaft

(1) Cement grout according to the execution planning documentation is to be used for the production of the grout body of the micro pile.

(2) For the verification of the compressive strength of the grout body (cement grout), two series of 3 specimens per 7 manufacturing days on which piles are fabricated or per construction site are to be produced.

(3) Cement stone covers must be secured by means of spacers (see Annexes 1, 2 and 3) in accordance with the execution planning documentation.

3.3.5 Integration into the entire structure

(1) In the case of single-bar piles, the bond lengths $t_{1R/1B/1W}$ and t_2 of the pile neck protection in accordance with the execution planning documentation and Annexes 1, 2 and 5 must be observed.

(2) In the case of multi-bar piles, the bond lengths t_1 and t_2 in accordance with the execution planning documentation and Annexes 3 and 6 must be observed.

3.3.6 Declaration of conformity regarding the manufacture

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

(2) The declaration of conformity of the contractor must be prepared in accordance with DIN EN 14199, Section 10, supplemented by DIN SPEC 18539, Section 3.8. It must at least contain the following information:

- approval number,
- designation of the construction project,
- installation date,
- contractor's name and registered office,
- confirmation that the installation is in compliance with the design documents,
- documentation of the basic materials and delivery documents,
- nature of the controls or inspections, – date of the control or inspection,
- results of the controls and inspections and, if applicable, a comparison with the relevant requirements,
- special notes,
- name, company and signature of the person in charge of the controls and inspections.

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

Standards list

EN 197-1:2011-11	Cement - Part 1: Composition, specifications and conformity criteria of common cements;
DIN EN 206-1:2001-07	Concrete - Part 1: Specification, performance, production and conformity; German version EN 206-1:2000
DIN EN 206-1/A1:2004-10	Concrete - Part 1: Specification, performance, production and conformity
DIN EN 206-1/A2:2005-09	Concrete - Part 1: Specification, performance, production and conformity
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
EN 934-2:2009+A1:2012	Admixtures for concrete, mortar and grout - Part 2: Concrete admixtures - Definitions, requirements, conformity, marking and labelling;
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

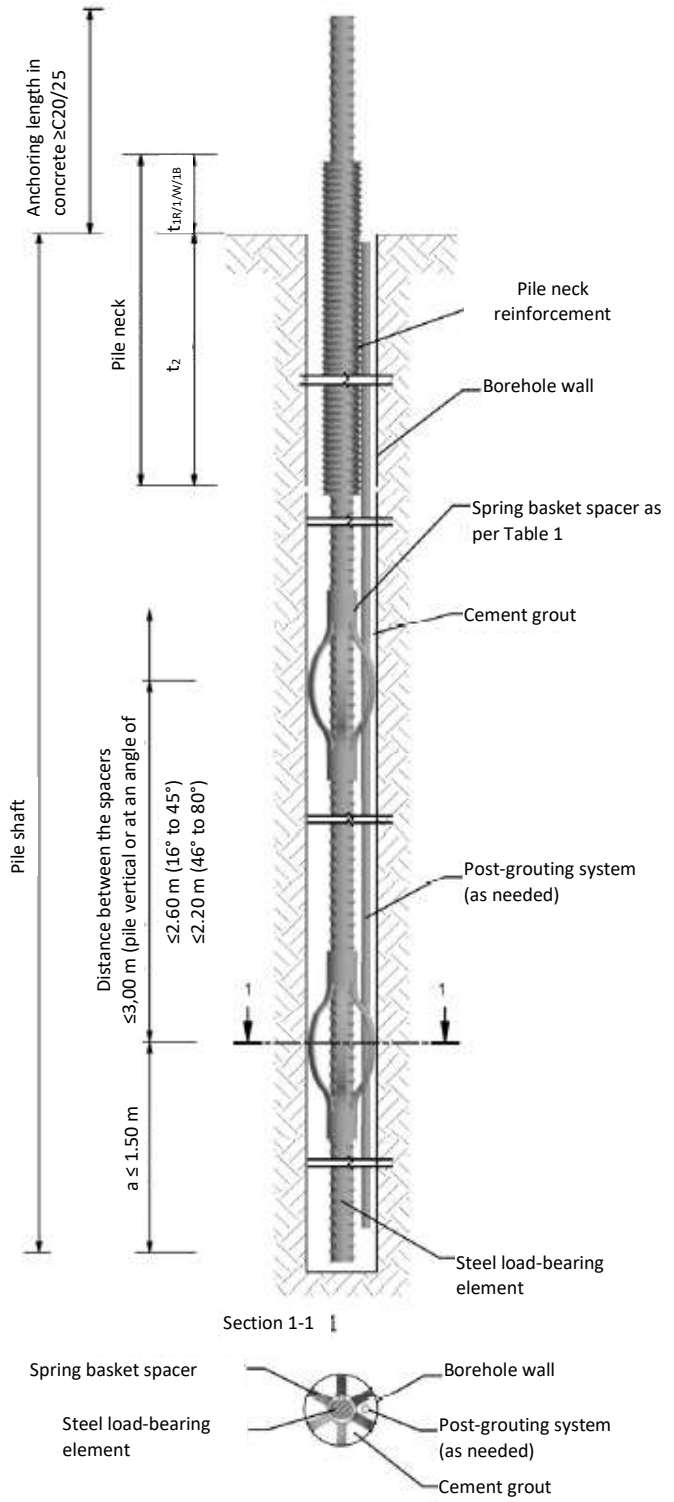
[2] Model Building Code (MBO), version dated November 2002, last amended by means of the resolution of the Conference of Building Ministers of 25.09.2020

DIN 1045-2:2008-08	Concrete, reinforced and prestressed concrete structures - Part 2: Concrete - Specification, properties, production and conformity - Application rules for DIN EN 206-1
DIN 1054:2021-04	Subsoil - Verification of the safety of earthworks and foundations - Supplementary rules to DIN EN 1997-1
DIN 1164-10:2013-03	Special cement - Part 10: Composition, requirements and conformity evaluation for cement with low effective alkali content
DIN EN 1991-1-1:2010-12	Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings, German version EN 1991-1-1:2002 + AC:2009
DIN EN 1991-1-1/NA:2010-12	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings
DIN EN 1991-1-1/NA/A1:2015-05	National Annex - Nationally determined parameters - Eurocode 1: Actions on structures - Part 1-1: General actions - Densities, self-weight, imposed loads for buildings, amendment A1
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 10204:2005-01	Metallic products - Types of inspection documents, German version EN 10204:2004
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
EN 12620:2002+A1:2008	Aggregates for concrete

DIN EN 14199:2012-01	Execution of special geotechnical works - Micropiles; German version EN 14199:2005
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 SPEC 18539:2012-02	Supplementary provisions to DIN EN 14199:2012-01, Execution of special geotechnical works - Micropiles
DIN EN ISO 19069-1:2015-06	Plastics - Polypropylene (PP) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 19069-1:2015) - German version EN ISO 19069-1:2015
DIN EN ISO 21306-1:2019-07	Plastics - Unplasticized Poly(Vinyl Chloride) (PVC-U) molding and extrusion materials - Part 1: Designation system and basis for specifications (ISO 21306-1:2019); German Version EN ISO 21306-1:2019
DIN 30672:2000-12	External organic coatings for the corrosion protection of buried and immersed pipelines for continuous operating temperatures up to 50°C - Tapes and shrinkable materials
DIN 50929-3:2018-03	Corrosion of metals - corrosion likelihood of metallic materials when subject to corrosion from the outside - Part 3: Buried and underwater pipelines and structural components

Bettina Hemme
Section Head

Certified
Jendryschik



Anchorage

1. Bond anchorage (shown)
   as per approval for Reinforcing steel bar with thread ribs
   Z-1.1-58, Z-1.1-59, Z-1.1-167
2. End anchorage / Plate anchorage
   as per approval Z-1.5-76, Z-1.5-149, Z-1.5-174
   For d=32, 40 and 50 mm and alternative plate anchorage with plate as per Annex 4

Pile neck reinforcement:

Corrugated plastic sheathing (PE, PVC, PP) with the internal Ø a_{Ri} as per Annex 5 (shown)

Alternatively:

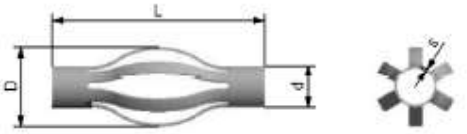
Spiral reinforcement or reinforcement cage as per Annex 5.

$t_{1R,1w,1B}$ see Annex 5

Table 1: Spring basket spacer

0 mm	20	25	28	32	40	50
min. □	70	80	100	100	100	125
L [mm]	235	245	300	300	300	300
d x s [mm]	25x1.9	32x2.4	40x3	40 x 3	50x3	63 x 3

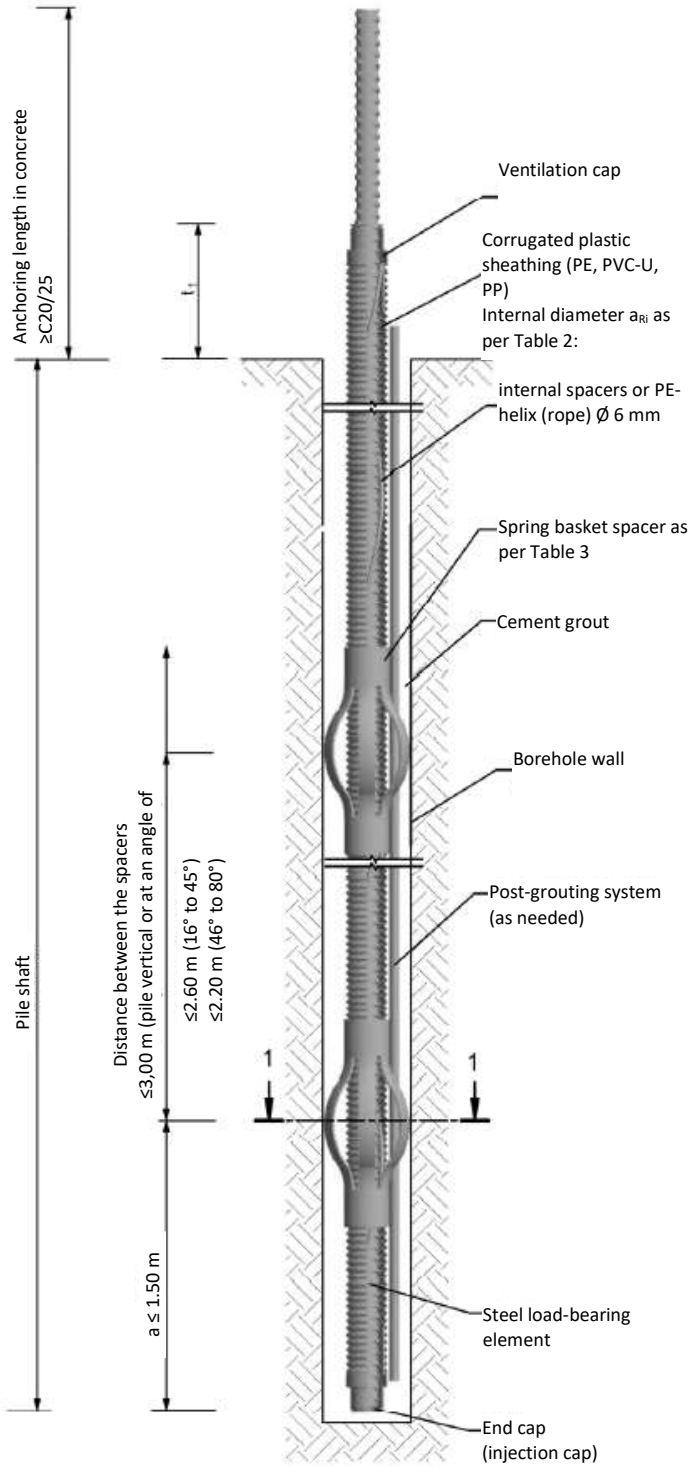
min. D must be increased by compression, dependent on the covering required in accordance with DIN SPEC 18539 A Annex C



DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

GEWI Single-bar Pile (SKS)

Annex 1



1. Bond anchorage (shown)

as per approval for reinforcing steel bar with thread ribs Z-1.1-58, Z-1.1-59 and Z-1.1-167

2. End anchorage / Plate anchorage

as per approval Z-1.5-76, Z-1.5-149, Z-1.5-174

for d = 32.40 and 50 mm alternatively

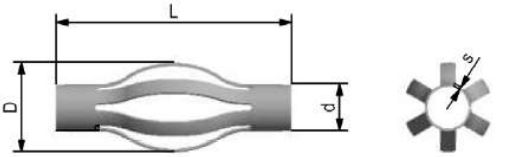
Plate anchorage with plate as per Annex 4.

Table 2: Corrugated plastic sheathing

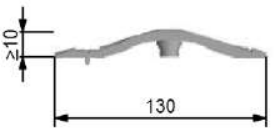
0 mm	20	25	28	32	40	50
a_{Ri} [mm]	>35	>39	>42	> 46	>55	>66
t_i [mm]	150	150	150	150	200	200

Table 3: Spring basket spacer

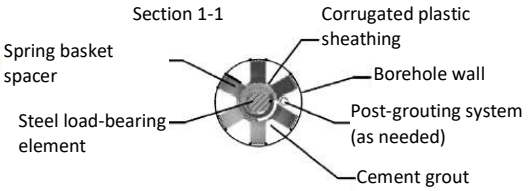
Ø mm	20	25	28	32	40	50
min. D [mm]	105	105	105	125	125	125
L [mm]	300	300	300	300	300	300
d x s [mm]	55x3	55x3	55x3	63x3	75x3.6	90x2.7



Alternatively: Segment spacer



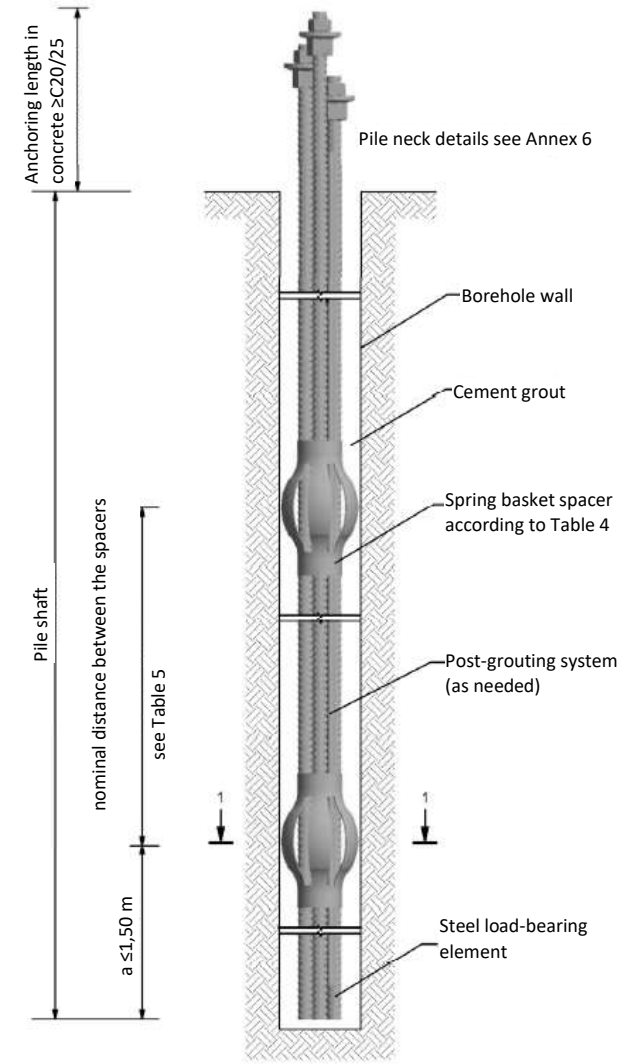
Width: 30 mm



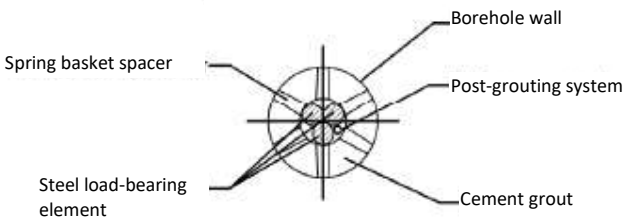
DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with Tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

GEWI – single-bar pile with corrugated plastic sheathing (DKS)

Annex 2



Section 1-1



Anchorage

End anchorage for reinforcing steel bar with thread ribs acc. to the approval Z-1.5-76, Z-1.5-149, Z-1.5-174

Table 4: Spring basket spacer

Parameter	d x s [mm]	min. D [mm]	L [mm]
A	90x2.7	150	285
B	110x3.2	175	285
C	125x3.7	190	285

min. D must be increased by compression, dependent on the covering required in accordance with DIN SPEC 18539 A Annex C

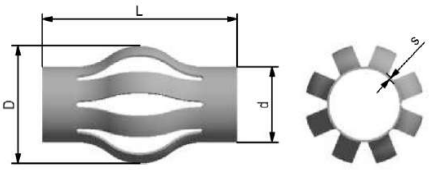


Table 5: Spring basket spacer

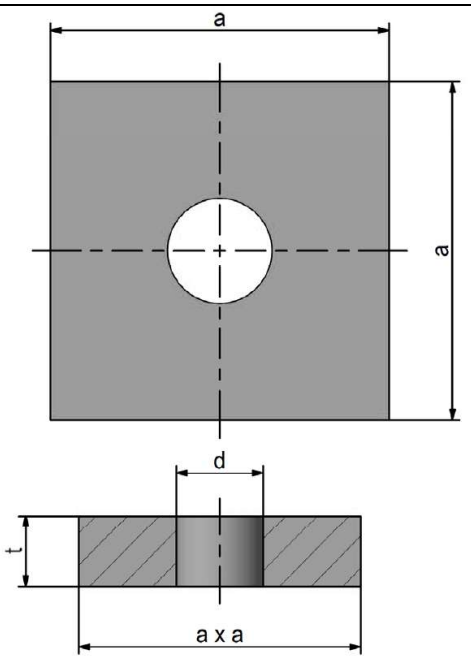
Distances of the spring basket spacers (in m) with a given inclination to the vertical and depending on the combination of steel load-bearing elements

Steel load-bearing elements number x Ø [mm]	3x32	3x40	3x50	2x40	2x50	1x40 1x50	2x40 1x50	1x40 2x50
Parameter	A	B	C	A	B	B	c	c
≤80°	2.00	1.30	1.50	2.00	1.20	1.50	1.90	1.70
≤60°	2.30	1.50	1.70	2.30	1.40	1.70	2.20	1.90
≤30°	3.00	2.60	3.00	3.00	2.50	3.00	3.00	3.00
vertical	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with Tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

GEWI – multi-bar pile (SKS)

Annex 3

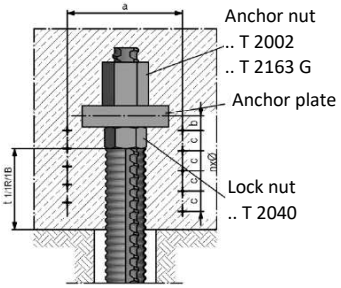


Anchor plate for plate anchorage
d=32, 40, 50 mm

Bar Ø		32	40	50
	a	120	150	190
	t	30	40	45
	d	37	46	58
Weight	kg	3.1	6,6	11.8
Material description		S235 or S355		

Rate dimensions in mm

GEWI tension pile plate anchorage (for ø 32 - 50 mm)

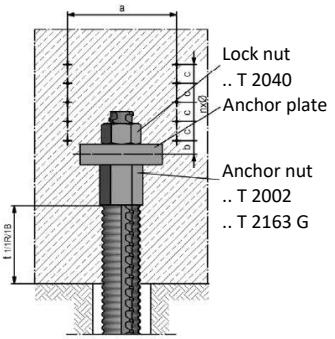


Pile neck reinforcement: see Annex 5

Additional reinforcement for plate anchorage			
	Ø32	Ø40	Ø50
n	3	3	5
Ø	8	10	10
a	190	230	285
b	20	25	25
c	40	45	45

All dimensions in mm

GEWI compression pile plate anchorage (for ø 32 - 50 mm)



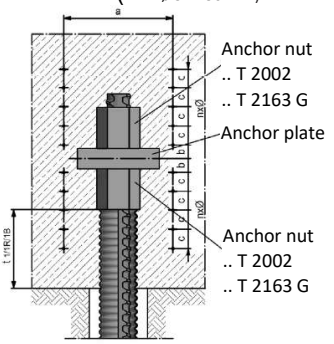
Pile neck reinforcement: see Annex 5

Additional reinforcement for plate anchorage			
	Ø32	Ø40	Ø50
n	3	3	5
Ø	8	10	10
a	190	230	285
b	20	25	25
c	40	45	45

All dimensions in mm

GEWI Pile for alternating load plate anchorage

(for ø 32 - 50 mm)



Pile neck reinforcement: see Annex 5

	Additional reinforcement for plate anchorage		
	Ø32	Ø40	Ø50
n*	3	3	5
Ø	8	10	10
a	190	230	285
b	20	25	25
c	40	45	45

All dimensions in mm
* above/below anchor plate

DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with Tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

Annex 4

Anchor plate and additional reinforcement for plate anchorage (only for ø 32 mm, Ø 40 mm and Ø 50 mm)

GEWI - single-bar pile, B500B S Ø 20; 25; 28; 32; 40; 50 mm
Pile neck reinforcement

		GEWI pile (SKS)					
	Bar Ø	20	25	28	32	40	50
Corrugated plastic sheathing	a_{Ri}	≥35	≥39	≥42	≥46	≥55	≥66
Bond length	t_{1R}	150	150	150	150	200	200
Length of reinforcement	t_2	600	600	600	600	600	600
Helix	$Ø_W$	4	4	4	4	4	4
	a_{WI}	≥45	≥50	≥55	≥57	≥65	≥75
	c_W	75	75	75	75	75	75
Longitudinal bars	n x Ø	4x Ø8	4x Ø8	4x Ø8	4x Ø8	4 x Ø8	4x Ø8
Bond length	t_{1W}	250	250	250	250	300	300
Length of reinforcement	t_2	600	600	600	600	600	600
Reinforcement cage made from N94 reinforcing steel mesh	a_{Bi}	≥45	≥50	≥55	≥57	≥65	≥75
Bond length	t_{1B}	250	250	250	250	300	300
Length of reinforcement	t_2	600	600	600	600	600	600

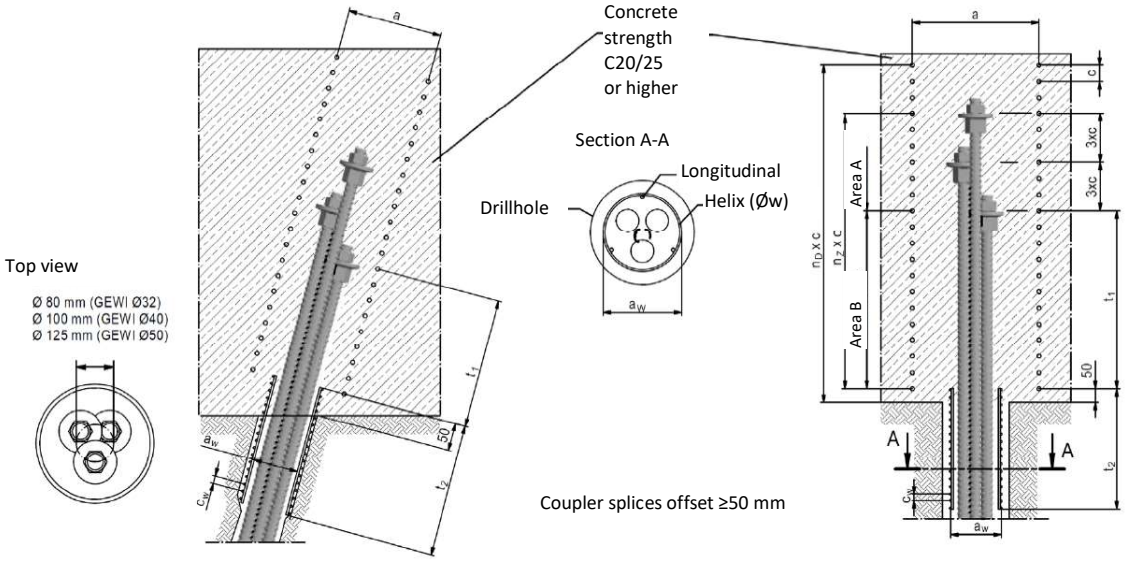
All dimensions in mm

DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm	Annex 5
GEWI – single-bar pile (SKS), pile neck reinforcement variants	

GEWI-multi-bar pile, B 500 B 0 32; 40; 50 mm

Anchorage – additional reinforcement – pile neck reinforcement

	Bars n x Ø	3x32	3x40	3x50	2x40	2x50	1 x 40 1 x 50	2 x 40 1 x 50	1 x 40 2 x 50
Locked End anchorage		◄ acc. to Z-1.5-76 Z-1.5-174	◄	◄	◄	acc. to Z-1.5-149 Z-1.5-174	►	►	►
Additional reinforcement made from B 500 B									
- for tension pile only	$n_{Z,A}$	7	7	7	4	4	4	7	7
	$n_{Z,B}$	6	8	10	9	11	10	10	10
	n_Z	13	15	17	13	15	14	17	17
	Ø	10	12	14	10	12	12	14	14
	a	275	325	425	300	375	325	350	400
	3 x c	135	135	160	135	160	160	160	160
- For pile with compression - or alternating load	$n_{D,A}$	10	10	10	7	7	7	10	10
	$n_{D,B}$	6	8	10	9	11	10	10	10
	n_D	16	18	20	16	18	17	20	20
	Ø	10	12	14	10	12	12	14	14
	a	275	325	425	300	375	325	350	400
	3 x c	135	135	160	135	160	160	160	160
Pile neck reinforcement									
- Total length	t	900	980	1160	900	1100	1100	1160	1160
- Length of reinforcement in concrete	t_1	300	350	550	410	610	530	550	550
- Length of pile shaft reinforcement	t_2	600	630	610	490	490	570	610	610
- Minimum bar bonding	t_1+ 50	350	400	600	460	660	580	600	600
Pile shaft reinforcement									
- Length	t_2	600	630	610	490	490	570	610	610
- Helix	$Ø_W$	6	6	6	6	6	6	6	6
	a_W	110	125	145	110	135	130	135	140
	c_W	80	60	45	80	65	80	55	50
- Longitudinal bars	n x Ø	4x8	3x10	3x12	4x8	4x8	4x8	3x10	3x12



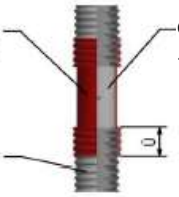
DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm	Annex 6
GEWI – multi-bar pile (SKS), transition/integration into the rising structure	

GEWI – pile (SKS)	GEWI – pile (DKS)

Compression splice
(contact splice)

for non-dynamic actions

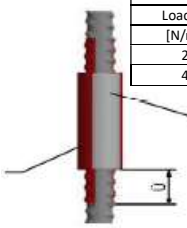
Corrosion protection heat shrink sleeve e.g. CPSM



Tension splice or
compression splice

for non-dynamic actions

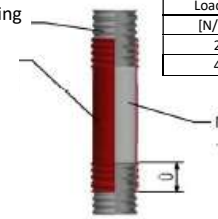
Slip values for unlocked tension splice	
Load (N_{Ed}) [N/mm²]	Slip [mm]
230	2
435	3



Corrugate sheathing

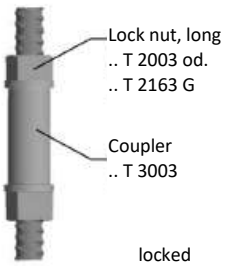
Corrosion protection heat shrink sleeve e.g. CPSM

Slip values for unlocked tension splice	
Load (N_{Ed}) [N/mm²]	Slip [mm]
230	2
435	3



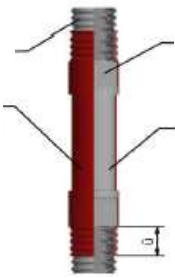
Tension/compression splice

for non-dynamic actions:
only tension splice
Lock nut, short.. T 2040



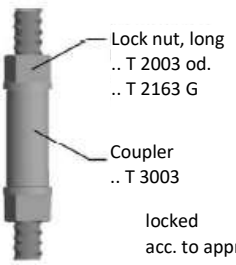
Corrugate sheathing

Corrosion protection heat shrink sleeve e.g. CPSM



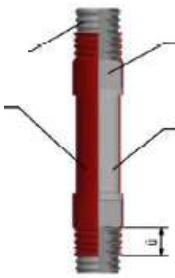
Tension splice, compression splice and tension/compression splice

for dynamic actions:



Corrugate sheathing

Corrosion protection heat shrink sleeve



– Coupler dimensions, lock nut dimensions – Tightening torques for bar tightening or coupler splice with lock nut	acc. to approval	Z-1.5-174 (Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm, Ø 50 mm) Z-1.5-76 (Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm) Z-1.5-149 (Ø 40 mm, Ø 50 mm)

Ü = shrink sleeve protrusion length > outer diameter of steel load-bearing element or outer diameter of ribbed pipe on both sides
A combination of couplers or anchorage elements from the approvals provided is not allowed

DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

GEWI – pile, coupler splice

Annex 7

	Inspection	Inspection method	FPCS[1]	EP/FÜ[2]	value
1. Incoming goods inspection:					
1.1	Reinforcing steel bar with thread ribs	Delivery document	every delivery	X	Conformity mark acc. to Z-1.1-58, Z-1.1-59 or Z-1.1-167
1.2	Anchoring and connecting means	Delivery document	every delivery	X	Conformity acc. to Z-1.5-76, Z-1.5-149 or Z-1.5-174
1.3	Plate for plate anchorage - Material - Dimensions	Delivery document Measurement*	every delivery every delivery	X X	Inspection cert. "2.1" shop drawings
1.4	Thickness/Diameter of the inner spacers	Measurement*	every delivery	X	> 5 mm
1.5	Corrugated plastic sheathing, end caps, injection caps and ventilation caps				
	Molding compound	DIN EN 10204	every delivery	X	Inspection cert. "2.1"
	Wall thickness of plastic ribbed pipes (at the inner and outer rib and flank)	Measurement*	1 per 100 pcs.	X	shop drawings
	Inner and outer diameter	Measurement*	1 per 100 pcs.	X	shop drawings
1.6	Heat shrink sleeves (fix heat shrink sleeves [1] and corrosion protection heat shrink sleeves [2])				
	Molding compound ([1] and [2])	DIN EN 10204	every delivery	X	Inspection cert. "2.1"
	-classification [2]: -application of adhesive [2]:	EN 12068 Measurement*	1 per 100 pcs. 1 per 100 pcs.	X X	C30 > 700 g/m²

Continued in Annex 8, page 2 of 2

[1] Internal Production Control System
[2] Initial testing/external monitoring (twice a year)

DYWIDAG GEWI – piles (micro piles) with load-bearing elements made of reinforcing steel bar with Tread ribs B500B, Ø 20 mm, Ø 25 mm, Ø 28 mm, Ø 32 mm, Ø 40 mm and Ø 50 mm

Minimum Requirements for the Internal Production Control System

Continued from Annex 8, page 1 of 2

Inspection		Inspection method	FPCS[1]	EP/FÜ[2]	value
2. Control during/after manufacture					
2.1	Corrosion protection heat shrink sleeves: Wall thickness at 3 sites in the shrunk condition	Sample and measurement*	1 per 100 pcs.	X	≥ 1.5 mm
2.2	Inner cement grout	DIN EN 445	DIN EN 446	X	DIN EN 447
2.3	All factory-applied corrosion protection measures	visual inspection	every load-bearing element	X	Work instructions
2.4	Components assembly	Delivery document	every delivery	X	Planning or execution documents

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

$$z = x - 1.64\ s$$

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

[1] Internal Production Control System
[2] Initial testing/external monitoring (twice a year)

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