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National technical approval / General construction technique permit

Number:
Z-14.7-759

Applicant:
DYWIDAG-Systems International GmbH
Neuhofweg 5
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Validity
from: **20 March 2021**
to: **20 March 2026**

Subject of decision:
DYWIDAG Multi-Strand Stay Cable DYNA Grip®

The subject named above is herewith granted a national technical approval (*allgemeine bauaufsichtliche Zulassung*) / general construction technique permit (*allgemeine Bauartgenehmigung*). This decision contains 16 pages and 13 Annexes of 29 pages). This national technical approval / general construction technique permit replaces national technical approval / general construction technique permit no. Z-14.7-759 of 24 January 2019. The subject concerned was granted the first national technical approval on 19 April 2016.

Translation authorised by DIBt

DIBt

I GENERAL PROVISIONS

- 1 This decision confirms the fitness for use and application of the subject concerned within the meaning of the Building Codes of the federal states (*Landesbauordnungen*).
- 2 This decision does not replace the permits, approvals and certificates required by law for carrying out construction projects.
- 3 This decision is granted without prejudice to the rights of third parties, in particular private property rights.
- 4 Notwithstanding further provisions in the 'Special Provisions', copies of this decision shall be made available to the user and installer of the subject concerned. The user and installer of the subject concerned shall also be made aware that this decision must be made available at the place of use or place of application. Upon request, copies of the decision shall be provided to the authorities involved.
- 5 This decision shall be reproduced in full only. Partial publication requires the consent of DIBt. Texts and drawings in promotional material shall not contradict this decision. In the event of a discrepancy between the German original and this authorised translation, the German version shall prevail.
- 6 This decision may be revoked. The provisions contained herein may subsequently be supplemented and amended, in particular if this is required by new technical findings.
- 7 This decision is based on the information and documents provided by the applicant. Alterations to this basis are not covered by this decision and shall be notified to DIBt without delay.
- 8 The general construction technique permit included in this decision also serves as a national technical approval for the construction technique.

II SPECIAL PROVISIONS

1 Subject concerned and field of use and application

1.1 Subject of approval and field of use

The subject of approval is the DYWIDAG multi-strand stay cable DYNA Grip® of the types DG-P 12 to DG-P 109 including its anchorage and corrosion protection system. The different sizes are shown in the annexes.

Annex 1 shows an overview of the cable system.

The DYWIDAG multi-strand stay cables DYNA Grip® consist of 5 to 109 galvanised, waxed and PE-sheathed 7-wire stay cable strands of steel grade St 1570/1770 or St 1660/1860, \varnothing 15.7 mm (0.62"), as well as of an anchorage construction comprising an anchor block, a dead anchor block, ring nut, bearing plate including a welded-on recess pipe, compaction clamp, PE stay pipe and damper connection.

A dead anchor block is used for the passive side. For the stressing anchor, a ring nut is screwed onto an anchor block.

The stay cable strands are anchored in the anchor blocks with wedges.

The stay cable strands used are not the subject of the present decision.

1.2 Subject of permit and field of application

The subject of the permit is the planning, design and execution of multi-strand stay cables covered by this decision as adjustable and exchangeable straight tendons in accordance with DIN EN 1993-1-11¹ in conjunction with the National Annex for bridge structures, standard building construction, guyed towers or similar constructions (*Nationaler Anhang für Brückenbauwerke, üblichen Hochbau, abgespannte Maste oder ähnliche Konstruktionen*).

The subject of the approval is classified as a Group C multi-strand stay cable in accordance with DIN EN 1993-1-11¹, Table 1.1, and shall meet the class 5 requirements in accordance with DIN EN 1993-1-11¹, Table 2.1.

The load transfer of cable forces into the structure is not the subject matter of this decision.

2 Provisions for the construction product

2.1 Properties and composition

2.1.1 General

The main dimensions and materials of the accessories shall correspond to the annexes, the documents deposited with DIBt and the following provisions.

For all components, traceability shall be ensured for each individual raw material within the meaning of DIN EN 1090-2², Section 5.2.

A test in accordance with 'fib Bulletin 89'³, Section 6.2.2, was carried out for type DG-P 19 in addition to tests in accordance with DIN EN 1993-1-11¹, Annex A. Corresponding documents are deposited with DIBt. Annex 13 shows a schematic diagram.

¹ DIN EN 1993-1-11:2010-12 Eurocode 3: Design of steel structures – Part 1-11: Design of structures with tension components in conjunction with the National Annex

² DIN EN 1090-2:2018-09 Execution of steel structures and aluminium structures - Part 2: Technical requirements for steel structures

³ fib Bulletin 89 Fédération internationale du béton (fib) Acceptance of cable systems using prestressing steels, March 2019

2.1.2 Anchor blocks and ring nut

The ring nut and the anchor blocks required to anchor the stay cable strands shall comply with the specifications provided in Annexes 2.1 and 2.2 and with the documents deposited with DIBt. The borehole exits of the anchor blocks shall be deburred. The conical boreholes of the anchor blocks shall be clean and free of rust and coated with a corrosion protection wax.

Verification of the material properties shall be provided by an inspection certificate "3.2" in accordance with DIN EN 10204⁴.

The anchor blocks and the ring nut shall be provided with a galvanic coating Fe//Zn25, load level 4 in accordance with DIN EN ISO 2081⁵.

2.1.3 Wedges

Only the wedges specified in Annex 3 shall be used. Detailed geometry and material specifications are deposited with DIBt.

Verification of the raw material properties shall be provided for each production batch by inspection certificate "3.1" in accordance with DIN EN 10204⁴.

2.1.4 Bearing plate and recess pipe

The main dimensions of the holes in the bearing plates to realise the cable system are given in Annexes 2.1 and 2.2. Further details are deposited with DIBt.

The bearing plate and the recess pipe as well as the required weld seams to attach the recess pipe to the bearing plate shall be calculated and designed on a project-specific basis in accordance with the Technical Building Rules (*Technische Baubestimmungen*). The data required for design, e.g. the diameter of the opening in the bearing plate, the dimensions of the ring nut and the anchor blocks, can be taken from Annexes 2.1 and 2.2.

Verification of the material properties shall be provided by test report "2.2" in accordance with DIN EN 10204⁴.

The bearing plates shall be protected against corrosion by an at least 80 µm thick galvanisation or by an equal coating.

2.1.5 Compression tube, sealing plates, spacers, compression plate and cap

The components shall correspond to the specifications provided in the annexes and to the documents deposited with DIBt.

2.1.6 Corrosion protection in the area of anchorages

The corrosion protection compound used shall meet the requirements laid down in the documents deposited with DIBt. In addition, it shall be compatible with the wax used in the stay cable strands and the other components of the anchorages.

Verification of the material properties of the corrosion protection compounds and the corrosion protection applications on the caps for the anchorage areas (stressing anchor and dead anchor) shall be provided by declaration of compliance with the order "2.1" in accordance with DIN EN 10204⁴.

⁴ DIN EN 10204:2005-01

Metallic products – Types of inspection documents

⁵ DIN EN ISO 2081:2009-05

Metallic and other inorganic coatings – Electroplated coatings of zinc with supplementary treatments on iron or steel

2.1.7 Stay pipe

The HDPE pipes used for the stay pipe on the free length shall correspond to the specifications in the annexes and to the documents deposited with DIBt. Annex 7 shows a schematic overview of the stay pipe of the multi-strand stay cable. The stay pipe shall be produced with an external helix in accordance with the documents deposited.

Verification of the material properties shall be provided by inspection certificate "3.1" in accordance with DIN EN 10204⁴.

2.1.8 Compaction clamps and elastomers

The compaction clamps shown in Annex 5 and Annex 6 shall correspond to the specifications in the annexes and the documents deposited with DIBt.

Unreinforced elastomers shall be used in accordance with the documents deposited with DIBt if guide deviators in accordance with Annex 6 are executed. Verification of the material properties shall be provided respectively by inspection certificates "3.1" in accordance with DIN EN 10204⁴.

The compaction clamp consists of two half-shells, which are connected through 4 prestressed bolts of steel grade 10.9 each.

2.2 Manufacture, transport, storage and marking

2.2.1 Manufacture

For the manufacture of the steel components, DIN EN 1090-2² shall be observed.

2.2.2 Transport and storage

The individual components of the cable system shall be transported and stored such that contaminations or damage are excluded.

2.2.3 Marking

The manufacturer shall affix the national conformity mark (*Ü-Zeichen*) to the delivery note for the construction product in accordance with the Conformity Marking Ordinances (*Übereinstimmungszeichen-Verordnungen*) of the federal states. The mark shall only be applied if the requirements given in Section 2.3 are met.

A delivery note shall be included in every delivery of the accessories mentioned under Section 2.3.2. The delivery note shall indicate, amongst others, for which type of the multi-strand stay cable system the accessories are intended and the factory in which they have been manufactured.

2.3 Confirmation of conformity

2.3.1 General

The confirmation of conformity of the construction product (accessories) with the provisions of the national technical approval included in this decision and the technical delivery terms of the stay cable manufacturers shall be issued for every manufacturing plant in the form of a certificate of conformity based on factory production control and regular external surveillance, including initial type-testing of the construction product in accordance with the following provisions.

To issue the certificate of conformity and for external surveillance including the associated product testing, the manufacturer of the construction product shall use a recognised certification body and a recognised inspection body for stressing systems, serial No. 1.3/1, and for cable tendons, serial No. 4.2/6, of the List of recognised testing laboratories, inspection and certification bodies under the Building Codes of the federal states (*Verzeichnis der Prüf-, Überwachungs- und Zertifizierungsstellen nach den Landesbauordnungen*) (see www.dibt.de).

The certification body shall send a copy of the certificate of conformity issued by it to DIBt.

The technical delivery terms, which contain the dimensions, the material and material properties of the accessories including admissible tolerances and the materials of the corrosion protection system, are deposited with DIBt, the certification body and the inspection body.

A copy of the initial type-testing evaluation report shall also be sent to DIBt.

2.3.2 Factory production control

2.3.2.1 General

A factory production control system shall be set up and implemented in each manufacturing plant. Factory production control shall be understood to be continuous surveillance of production by the manufacturer to ensure that the manufactured construction products meet the provisions of the national technical approval included in this decision.

The factory production control shall at least include the measures listed in Sections 2.3.2.2 to 2.3.2.9 below.

The results of factory production control shall be recorded and evaluated. The records shall at least include the following information:

- designation of the construction product or the starting material or the components,
- test certificates for the materials from Section 2.1 and documentation of certified test results to comply with the requirements
- type of check or test, indicating the test methods and the test specification,
- date of manufacture and testing of the construction product or the components or its parts,
- results of the checks and tests and comparison with the requirements,
- signature of the person responsible for factory production control.

The records shall be kept for at least five years and submitted to the inspection body used for external surveillance. They shall be presented to DIBt and the competent supreme building authority upon request.

If the test result is unsatisfactory, the manufacturer shall immediately take the necessary measures to resolve the defect. The external surveillance body shall be informed about those facts promptly and comprehensively. Construction products which do not meet the requirements shall be handled in such a way that they cannot be confused with compliant products. After the defect has been remedied, the relevant test shall be repeated immediately – where technically feasible and necessary to show that the defect has been eliminated.

The manufacturer shall keep the latest versions of each of the following documents available: Documentation of the operational prerequisites demonstrating at least the following points:

- structure of the technical division and responsibilities of the employees,
- proof of qualification of the personnel employed,
- proof of regular personnel training,
- contact person for the cable system,
- monitoring and filing system.

General process description for the executing specialist company, which comprises at least the following:

- current version of the approval and description of the cable system,

- specifications for storage, transport and assembly,
- work instructions for assembly and prestressing processes including corrosion protection measures (also temporarily),
- welding details,
- compilation of the safety and labour protection aspects to be observed,
- general quality assurance plan,
- training program for the construction site personnel entrusted with the prestressing operations.

The manufacturer shall be responsible for authorising the executing specialist companies.

2.3.2.2 Wedges

At least 5% of all wedges manufactured for a construction project shall be verified with regard to the dimensional accuracy, and at least 0.5% shall be verified in respect of their surface hardness, insert depth, and core strength. For the hardness measurement, it shall be observed that exactly the same test method is used from the manufacture to the testing and use of the wedges which is stated in the technical delivery terms.

The results shall be documented.

All wedges shall be visibly inspected with regard to the condition of the teeth, the cone surface and of the remaining surfaces by means of a yes/no check (no recording required).

2.3.2.3 Anchor blocks and ring nut

The dimensions, e.g. the hole spacing, the diameter, the thickness and the thread geometry, shall be verified on a minimum of 5%, however, on at least 5 pieces, of the respective components for a construction project. The cone holes, which accommodate the wedges, shall be verified with regard to the angle, diameter and surface quality.

In addition, a stress strain diagram shall be prepared for each steel charge of the anchor blocks and the ring nuts.

The results shall be documented.

All components shall also be visibly inspected with regard to their dimensions and gross faults by means of a yes/no check (no recording required).

2.3.2.4 Bearing plates

A minimum of 3% of the bearing plates shall be verified with regard to their dimensions. The results shall be documented.

In addition, every bearing plate shall be visibly inspected with regard to its dimensions and gross faults by means of a yes/no check (no recording required).

2.3.2.5 Stay pipe

The tensile strength, elastic modulus, elongation, density, melting index, and, in the case of black pipes, the carbon content and its distribution shall be determined for a minimum of 3 specimens of every 10 metric tons of the pipe material to be delivered, however, at least by means of 3 tests and at least one test for each pipe diameter.

The thermal stability for oxygen shall be determined for every 10 metric tons of the pipe material to be delivered, however, at least by means of one test and at least one test for each pipe diameter.

The wall thickness, diameter, and surface condition of the sheathing shall be determined for a minimum of 3 specimens of every 10 metric tons of the pipe material to be delivered, however, at least by means of 3 tests and at least one test for each pipe diameter.

A tensile and technological bend test shall be carried out on the welding seams of at least 4 mirror weld samples for each factory and/or construction site weld for every pipe diameter.

The results of the afore-mentioned tests shall be documented.

2.3.2.6 Compaction clamps

For the initial inspection of each size of compaction clamps from each supplier, the components shall be sawn and the inner quality of the components be inspected. All components delivered shall be visibly inspected. In the case of an abnormality, further inspections shall be initiated.

If a radiographic test in accordance with ASTM E446/186/280-98⁶ is carried out, it shall be verified that at least casting defect category 4 is fulfilled.

2.3.2.7 Elastomers in the compaction clamps

The density, Shore A hardness, elasticity, tensile strength and elongation at break, tear resistance and the compression set shall be determined for a minimum of 1 specimen of every 10 metric tons of the elastomer to be delivered, however, at least by means of 1 test.

In addition, a thermogravimetric mass determination shall be conducted.

All damping elements shall be inspected for their surface condition and dimensions.

The results of the aforementioned inspections/tests and measurements shall be documented.

2.3.2.8 Dimensions of accessories (pipes, caps, etc.)

The dimensions of accessories shall be verified for each delivery batch on a random basis.

2.3.3 External surveillance

The factory production control system shall be inspected regularly, i.e. at least once per half year, by means of external surveillance at each manufacturing plant.

Verification of the compaction clamp design shown in Annex 6 shall be provided by structural analysis. The structural analysis carried out shall be checked by a structural design control authority or by a structural design review engineer and certified to be correct. The test report shall be submitted during external surveillance.

Within the scope of external surveillance, initial type-testing of the construction product shall be carried out. Samples for sample checks shall be taken. The scope of sampling and testing shall be the responsibility of the recognised inspection body. The minimum scope, however, shall correspond to Table 1.

Table 1 Minimum sampling within the scope of external surveillance

Component	Aspect	Test/inspection	No. of samples
Anchor blocks and ring nut	Material in accordance with specification	Test / Inspection	1 each
	Detailed dimensions	Test	
	Visual inspection	Inspection	
Wedges	Material in accordance with specification	Test / Inspection	2
	Heat treatment / case hardening	Test	2 segments
	Geometry of the wedge teeth	Test	1
	Geometry, surface hardness	Test	5
	Visual inspection	Inspection	5

The results of the certification and external surveillance shall be kept for at least five years. The certification body or inspection body shall present them to DIBt and the competent supreme building authority upon request.

⁶ ASTM E446/...

Standard Reference Radiographs for ... Steel Castings

3 Provisions for planning, design and execution

3.1 General

For the planning and design of the multi-strand stay cable system DYNA Grip®, the Technical Building Rules, and in particular DIN EN 1993-1-1¹ in conjunction with the National Annex for the multi-strand stay cable design, as well as the relevant provisions of the national technical approval for the multi-strand stay cables used shall be taken into account unless otherwise specified in this decision.

The other accessories, including the anchorage of the cables and the load transfer, shall be designed in accordance with the Technical Building Rules unless otherwise specified below.

The verification concept set out in DIN EN 1990⁷ in conjunction with the National Annex shall apply.

3.2 Planning

3.2.1 Multi-strand stay cables

Only galvanised, waxed and PE-sheathed 7-wire stay cable strands of steel grade St 1570/1770 or St 1660/1860 shall be used which are covered by a national technical approval with the following dimensions and which have passed the identification tests as an individual strand anchored with a wedge pursuant to Annex 12.

Individual wires:	Outer wire diameter	$d = 5.2 \text{ mm}$
	Core wire diameter	$d' = 1.02d \text{ to } 1.04d$
Strand:	Nominal diameter	$3d \approx 15.7 \text{ mm (0.62")}$
	Nominal cross-section	$A_1 = 150 \text{ mm}^2$

Only stay cable strands with very low relaxation shall be used. Relaxation shall be limited to a maximum of 2.5 % after 1000 h with an applied test load of 70 % of the strand tensile strength in accordance with the isothermal relaxation test as defined in DIN EN ISO 15630-3⁸, Clause 9.

At the factory, the stay cable strands shall be provided with a corrosion protection system, consisting of the galvanisation of the individual wires, the corrosion protection wax applied to stay cable strands and a PE sheathing extruded onto the stay cable strands, with a minimum starting wall thickness of 1.50 mm.

The required number of stay cable strands shall be determined by means of ULS, SLS and fatigue verifications in accordance with DIN EN 1993-1-1¹ in conjunction with the National Annex.

The maximum stress in the stay cable strands in the SLS shall not exceed $0.45 f_{uk}$.

Possible configurations of the stay cable strands in the anchor blocks are given in Annex 10.

3.2.2 Bending radius of cables

The cables are straight in the final state, except for the sag. Deflections of the cables shall not be permitted.

⁷ DIN EN 1990:2010-12 Eurocode: Grundlagen der Tragwerksplanung in Verbindung mit dem nationalen Anhang

⁸ DIN EN ISO 15630 3:2020-02 Steel for the reinforcement and prestressing of concrete - Test methods - Part 3: Prestressing steel

3.2.3 Angular deviations at anchorages

Anchorages shall be planned in the direction of the cable tangent. The angular deviation of the cable tangent at the anchorages of max. $\alpha = \pm 0.6^\circ$, divided into $\alpha_1 = 0.3^\circ$ due to dimensional tolerances and $\alpha_2 = 0.3^\circ$ due to loads, has been proven by means of tests within the scope of the approval procedure. If the afore-mentioned angular deviation $\alpha = \pm 0.6^\circ$ is exceeded, specific verifications or measures are required in this regard, which are not covered by this decision.

3.2.4 Compaction clamps

The minimum distance of the compaction clamps to the bearing plates can be taken from Annex 5. If guide deviators are arranged in accordance with Annex 6, the dimensions specified therein for the exit pipes and the elastomeric rings shall be complied with.

The bolts for connecting the half-shells of the compaction clamps shall be prestressed with the standard prestressing force F_{p,C^*} .

The prestressing shall be carried out using the modified torque method in accordance with DIN EN 1993-1-8/NA⁹, Table NA.A.2, Column 4.

3.2.5 Guiding cables through components

Guiding the cables through the components in a straight way shall be ensured by appropriate opening sizes in the component, taking into account the design tolerances. It shall be excluded that the cables rest against a fixed component.

3.2.6 Preventing cable vibrations

As required by DIN EN 1993-1-11¹, NCI on 9.2, it shall be ensured with appropriate structural measures, e.g. the arrangement of cable dampers, that the vibrations of the cables are reduced such that their impact does not become fatigue relevant.

The reduction of rain/wind-induced vibrations due to the helix on the stay pipe may be taken into account.

The notes on cable vibrations given in DIN EN 1993-1-11¹ shall be taken into account.

3.2.7 Damper connection

For the connection points of external dampers, the standard configuration shown in Annex 8 shall be taken into account.

3.2.8 Cable protection

The stay pipe protects the stay cable strands against mechanical loads. It shall not be used as a corrosion protection measure. The cables shall be protected against damages as a result of external impacts (e.g. impact of vehicles, lightning, vandalism). To protect the cables on concrete structures against lightning, the specifications made by specialist planners shall be taken into account. Cables which are provided with an exit pipe made of steel in the accessible area are deemed to be sufficiently protected against vandalism.

3.2.9 Corrosion protection

a) Corrosion protection in the area of the anchorages

The PE sheathing of the stay cable strands is removed in the area of the strand protrusion as well as in the area of the wedge and compression tube to tension and anchor the strand. Coloured markings on the strand sheathing ensure that, after the stressing work has been completed, the PE sheathing of the strand enters the cylindrical bores of the anchor blocks. The area of the stay cable strands not protected by the PE sheathing shall be protected such that the cone holes, after completion of the stressing operations, can be individually filled with a corrosion protection compound.

⁹ DIN EN 1993-1-8/NA:2010-12 Eurocode 3: Design of steel structures
- Part 1-8: Design of joints, National Annex

The strand ends shall be enclosed by caps as shown in Annexes 2.1 and 2.2, which shall completely be filled with corrosion protection wax. Alternatively, every strand can individually be protected with a PE pipe comprising a plug and a corrosion protection compound as shown in Annex 3.

b) Corrosion protection of exposed steel parts

All surfaces of the steel parts shall be protected against corrosion with a protection system in accordance with DIN EN ISO 12944-5¹⁰ unless they are sufficiently protected by a corrosion protection compound or embedded at least 5 cm into concrete members.

It shall be observed that the protection system is chosen such that corrosivity category C5 in accordance with DIN EN ISO 12944-2¹¹ is ensured. For steel parts of the anchorage which are located inside of a closed construction corrosivity category C3 in accordance with DIN EN ISO 12944-2 may be chosen if an attack by corrosive substances can be excluded.

The surface shall be prepared as set out in DIN EN ISO 12944-4¹². For the execution of corrosion protection operations, DIN EN ISO 12944-7¹³ shall be observed.

3.2.10 Drainage measures

In order to prevent water collections, e.g. on the anchorages, appropriate drainage measures shall be taken. This can include, for example, arranging a drain outlet in the recess pipe or a drainage groove in the bearing plate. The results of the drainage measures shall be verifiable. This verification shall be included in the bridge test schedule.

3.2.11 Stay pipe

The length of the stay pipe shall be determined such that a minimum insertion depth of 15 cm is kept at the telescopic joints (Annex 7) under all climatic and geometric conditions.

The HDPE pipes are connected to each other using the butt-welding process taking into account the DVS guidelines as amended. The welding operations shall be conducted by plastics welders holding a valid test certificate of qualification test group I in accordance with DVS 2212-1¹⁴.

3.2.12 Accessibility for cable inspection and maintenance

The components of the multi-strand stay cables shall be accessible for inspection and maintenance purposes during their entire service life.

3.3 Design

3.3.1 Multi-strand stay cables

ULS, SLS and fatigue verifications shall be provided in accordance with DIN EN 1993-1-1¹¹ in conjunction with the National Annex and the national technical approvals for the stay cable strands used.

The material properties indicated in the national technical approval for the stay cable strands used, the characteristic value of the 0.1% yield strength $f_{p0,1,k}$, the characteristic value of the tensile strength f_{uk} (or f_{pk}) and the elastic modulus E_p , shall be used in the design.

¹⁰ DIN EN ISO 12944-5:2020-03 Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 5: Protective paint systems

¹¹ DIN EN ISO 12944-2:2018-04 - Part 2: Classification of environments

¹² DIN EN ISO 12944-4:2018-04 - Part 4: Types of surface and surface preparation

¹³ DIN EN ISO 12944-7:2018-04 - Part 7: Execution and supervision of paint work

¹⁴ DVS 2212-1:2015-12 DVS guideline - Qualification testing of plastics welders - Qualification test groups I and II

The characteristic value of the calculated breaking force F_{uk} and the characteristic value of the proof strength F_k in accordance with DIN EN 1993-1-11¹ Section 6.2(2) can be calculated as follows:

$$F_k = F_{0,1k} = A_m f_{p0,1,k}$$

$$F_{uk} = A_m f_{uk}$$

whereby

$f_{p0,1,k}$ The characteristic value of the 0.1% yield strength of the prestressing steel in accordance with the national technical approval for the stay cable strands

$f_{uk} = f_{pk}$ The characteristic value of the tensile strength of the prestressing steel (f_{pk}) in accordance with the national technical approval for the stay cable strands

$A_m = n A_l$ Metallic nominal cross section of the multi-strand stay cable

n Number of the stay cable strands in the cable

$A_l = 150 \text{ mm}^2$ Metallic nominal cross section of a strand in accordance with the national technical approval for the stay cable strands

In the SLS, the max. stress in the stay cable strands shall not exceed $0.45 f_{uk}$ without taking the bending stress into account.

For fatigue verifications, the following detail categories $\Delta\sigma_c$ for 2×10^6 load cycles shall be used:

$\Delta\sigma_c = 160 \text{ N/mm}^2$ for types DG-P 12 up to and including DG-P 61

$\Delta\sigma_c = 127 \text{ N/mm}^2$ for types DG-P 73 up to and including DG-P 109

3.3.2 Anchor blocks and ring nuts

The load-bearing capacity of the anchor blocks used and of the ring nut has been demonstrated by tests for the multi-strand stay cables designed in accordance with Section 3.3.1.

3.3.3 Compaction clamps

The load-bearing capacity of the compaction clamps when used in accordance with Annex 6 shall be verified by structural analysis checked by a structural design control authority or by a structural design review engineer. The load-bearing capacity of the compaction clamps when used in accordance with Annex 5 has been verified.

3.3.4 Elongation constraint of the cable

Prestressing losses in the cable due to slip can usually be neglected in the structural analysis.

3.3.5 Transfer of the cable loads to the building structure

The cable loads are transferred from the ring nut or from the dead anchor block to the bearing plates made of steel and from there to a steel structure and then, where applicable, to the structural concrete. A direct load transfer from the bearing plate to the structural concrete is not covered by this national technical approval.

The diameter of the opening $\emptyset G$ in the bearing plates specified in Annexes 2.1 and 2.2 shall not be exceeded.

The bearing plate design and the transfer of the cable loads into the structure shall be carried out on a project-specific basis in accordance with the Technical Building Rules.

3.4 Provisions for execution

3.4.1 Requirements and responsibilities

The technical division of the manufacturer shall have an engineer with at least five years of professional experience in the field of stay cable technology. The responsible technical experts entrusted with multi-strand stay cable works should have a professional experience in the afore-mentioned field of at least three years.

It is the manufacturer's responsibility to ensure that all required components of the cable are supplied and handed over properly to the construction site in accordance with the applicable approval. This also applies to special equipment required for the installation (jacks, grouting equipment, etc.) unless this equipment is provided by the executing specialist company itself.

3.4.2 Execution

3.4.2.1 General

The requirements relevant for stressing systems laid down in DIN 1045-3¹⁵, and, where applicable, the DIBt Principles for Using Stressing Systems (*DIBt-Grundsätze für die Anwendung von Spannverfahren*), version April 2006, shall apply mutatis mutandis.

The manufacturer shall comprehensively train and authorise the executing specialist companies to use this cable system on the basis of the general process description deposited with DIBt.

Assembly, installation and prestressing of the cables shall be carried on the basis of the corresponding work instructions to be prepared by the applicant which the executing specialist company shall adapt to the requirements of the particular project after consultation with the applicant.

The executing company shall provide a declaration of conformity in accordance with the provisions of Section 16 (a) (5) and Section, 21(2) of the Model Building Code MBO to confirm the conformity of the multi-strand stay cables as an adjustable and exchangeable straight tendon as specified in DIN EN 1993-1-11¹ with the general construction technique permit included in this decision.

3.4.2.2 Welding on anchorages

Welding operations shall no longer be performed on the anchorages on the construction site due to possible damages to the galvanisation.

3.4.2.3 Installation of cables

The executing specialist company shall ensure that, prior to the installation of all cable system components, the tests listed in Section 2.3.2 have been carried out and that external surveillance in accordance with Section 2.3.3 has taken place. Confirmation thereof can be furnished by requesting a corresponding confirmation of the upstream supplier signed by the body in charge and countersigned by the external surveillance body. This confirmation shall be included in the construction records. Furthermore, attention shall be paid that the components correspond to the respective specification. Prior to the installation of the multi-strands, the executing specialist company shall convince itself that the anchorages, the stay cable strands and all other components are intact and free of corrosion or contaminations.

Installation of the cables shall be conducted in accordance with the installation plan approved by the building owner and by the structural design review engineer.

For every construction project, an installation plan shall be prepared for every cable type, which shows the whole multi-strand stay cable designating also the individual components.

In the case of a stay pipe with transition sleeve, all lengths shall be verified and a minimum insertion depth of 15 cm shall be colour-marked for each pipe.

Usually, stay cable strands are inserted individually into the stay pipe of the multi-strand stay cable on the construction site. Attention shall be paid to the careful handling of the sheathed stay cable strands during transport, storage, and manufacture of the multi-strand stay cables.

Unless their transport and storage are otherwise defined in the national technical approval for stay cable strands, the stay cable strands are usually supplied on wooden drums with a minimum diameter of 1.00 m. If delivered without a drum, a minimum ring diameter of 1.20 m shall be observed.

The bending radius of the strands shall not be less than 0.50 m. Attention shall be paid that this bending radius is also kept during installation into the structure.

¹⁵ DIN 1045-3:2012-03

Concrete, reinforced and prestressed concrete structures
- Part 3: Execution of structures – Application rules for DIN EN 13670

All cone holes in the anchor blocks shall be filled with strands and wedges. Boreholes for which no load-bearing stay cable strands are planned shall be filled with wedged dummy strands. The arrangement of dummy strands shall be determined on a project-specific basis in accordance with Annex 10. The dummy strands in the compaction clamp shall be arranged analogously. Missing strands of an entire row may be replaced in the compaction clamp by filling pieces made of plastic as shown in Annex 11. The eccentricity thus created in the cable anchorage and its impact on the structure shall be checked and verified by means of structural analysis. It shall be ensured that the hole patterns on the anchor block and dead anchor block of the cables match exactly and that the wedges of the dummy strands, just like all other strands, are fastened.

In accordance with the planning documents, bearing plates and anchor blocks shall be perpendicular to the cable axis (cable tangent). The cone holes of the anchor blocks and the threads of the stressing anchors shall be clean, rust-free and coated with a corrosion protection wax during installation.

The PE sheathing of the strands shall be marked in a predefined distance to the dismantling point in such a way that will make it possible to check the penetration length of the PE-sheathed strands into the sealing unit of the anchorage. The penetration length shall be checked and documented after the stressing work has been completed.

Strands whose marked PE-sheathed part did not penetrate the cylindrical bores of the anchor blocks shall be exchanged.

During installation, one around 50 cm long sample shall be taken at two different points from the middle of each strand coil delivered to and processed at the construction site. The sampling shall be traceable and documented with a clear assignment to the strands in the cables. From those samples, the zinc layer thickness of one wire of the strands chosen shall be determined on a random basis, in coordination with the external surveillance body, for approx. 5% of the sample, however, on at least 3 pieces from different coils. The wax quantity and the thickness of the PE sheathing shall also be determined on a random basis for approx. 10% of the sample, however, on at least 10 pieces from different coils and on a maximum of 1 piece per coil. The results shall be compared with the requirements. In the case of greater deviations or irregularities further tests shall be ordered. The target/actual comparison shall be documented and included in the construction records.

The commencement of the installation work on the construction site shall be announced to the authority supervising the construction or the assigned construction site supervisor 48 hours in advance.

3.4.2.4 Applying the stressing force

Jacks shall be calibrated prior to stressing operations in accordance with DIN 51308¹⁶ and shall have a corresponding certificate. The certificate shall not be older than six months.

Usually, stay cable strands are tensioned unilaterally and individually using for example the ConTen method (see the description of the multi-strand stay cables in Annex 1.i, Section 7). This type of prestressing ensures that all strands of a cable have the same force. The stressing force of the strands shall be transferred such that, after stressing of a cable, all strands are tensioned with the same force. A deviation of the stressing forces of the individual strands of a cable of $\pm 2.5\%$ is admissible.

After tensioning the cable to the respective target force, the latter shall be verified by measuring the force and elongation, the deviation from the target force of the cable may amount to a maximum of $\pm 5\%$.

¹⁶ DIN 51308:2019-08

Verification of auxiliary devices for application and measuring of forces in building
- Clamp-devices, hydraulic cylinders, dynamometer for clamp aim

The stressing force can be regulated, i.e. increased or decreased, by turning the ring nut. To achieve this, the entire stressing anchor needs to be lifted by means of a multi-strand jack at the strand protrusions. The wedges must be secured against displacement by means of a wedge keeper plate.

Post-tensioning of the cables, releasing the wedges and reusing the wedges is admissible. Following post-tensioning and/or anchoring, the wedge bites on the strand resulting from the preceding stressing operations must be moved outwards in the wedges by at least 15 mm. Therefore, the wedges may no longer be released in the event of elongation due to stressing < 15 mm. Post-tensioning can then only be carried out as a bundle via the ring nut or washers must be used.

3.4.2.5 Post-wedging force and slip

In the final state, all wedges, incl. the wedges for dummy strands, shall be post-blocked individually. Post-blocking on the anchorage which lies opposite the tensioning side can be carried out at any time during the assembly. However, on the anchorage on the tensioning side, post-blocking may only be carried out when the stay cable strands no longer need to be prestressed individually.

The post-wedging force per wedge shall be 150 kN with a tolerance of $\pm 5\%$, already taking into account the jack friction. The stressing force already available in the strand shall be deducted for the determination of the post-wedging force required.

The post-wedging force for each strand shall be recorded in overviews in line with Annex 10. Dummy strands shall be marked in the overview.

The application of the post-wedging force shall be documented.

The slip on the anchorage, which shall be taken into account as an addition to the elongation due to stressing, shall be in the case of the working load being applied

- on the dead anchor: 3 mm,
- on the stressing anchor with ring nut: 4 mm.

The slip on the dead anchor can be neglected for the determination of the elongation due to stressing if the blocking was carried out prior to the application of the final stressing force.

3.4.2.6 Corrosion protection in the area of anchorages

Following post-blocking, the cone holes in the anchor blocks shall be individually filled with a corrosion protection compound in accordance with the system description in Annex 1.i and the corrosion protection plan. This project-related corrosion protection plan, including work instructions, shall be prepared by the cable supplier on the basis of the sample plan for the corrosion protection measures deposited with DIBt.

The rubber sealing of the anchorage is activated by equally tightening the threaded rods in the anchorages.

The strand protrusions of the stressing anchor shall be individually protected with PE protection pipes. For this purpose, the protection pipes shall be filled with a corrosion protection compound and pushed over the strand protrusions until the protection pipes come to rest in the holes of the wedge keeper plate. At the rear end of the pipe, a plug is mounted. Alternatively, the cavity within the caps may be completely filled with a corrosion protection compound.

The tightening torque of the threaded rods shall be stated in the assembly instructions.

The corrosion protection compound in the caps shall be injected - if required, in a heated state - in the areas on the anchorages intended for this purpose. Attention shall be paid to complete injection. This shall be checked, for example, by means of a volume comparison.

3.4.2.7 Protection measures during installation

During the installation, appropriate protection and drainage measures shall be provided. Prior to injecting the corrosion protection compound, all steel component surfaces to be protected shall be free of water and other contaminations.

4 Provisions for supervision of the construction project, use, maintenance and repair

Each construction project shall be supervised by an engineer qualified for this purpose, who is independent of the executing specialist company. Verification of qualification shall be provided to the construction owner. Within the scope of this supervision, it shall be ensured that internal control is carried out by the executing specialist company. Relevant components and parts as well as the assembly itself shall be visually inspected on a random basis. A body independent of the executing specialist company shall verify the exact installation of the multi-strand stay cables (checking the tangent angle between the cable anchorage and the building structure) by means of measurement. Without specific verification, a construction tolerance of 0.3° at maximum is admissible.

The method allows the DYNA Grip® cables being exchanged as a complete cable or in the form of individual strands from a cable.

The conditions under which cables may be exchanged, the maximum number of cables which may be exchanged at the same time and the required construction site precautions shall be stipulated and determined during the planning of the structure.

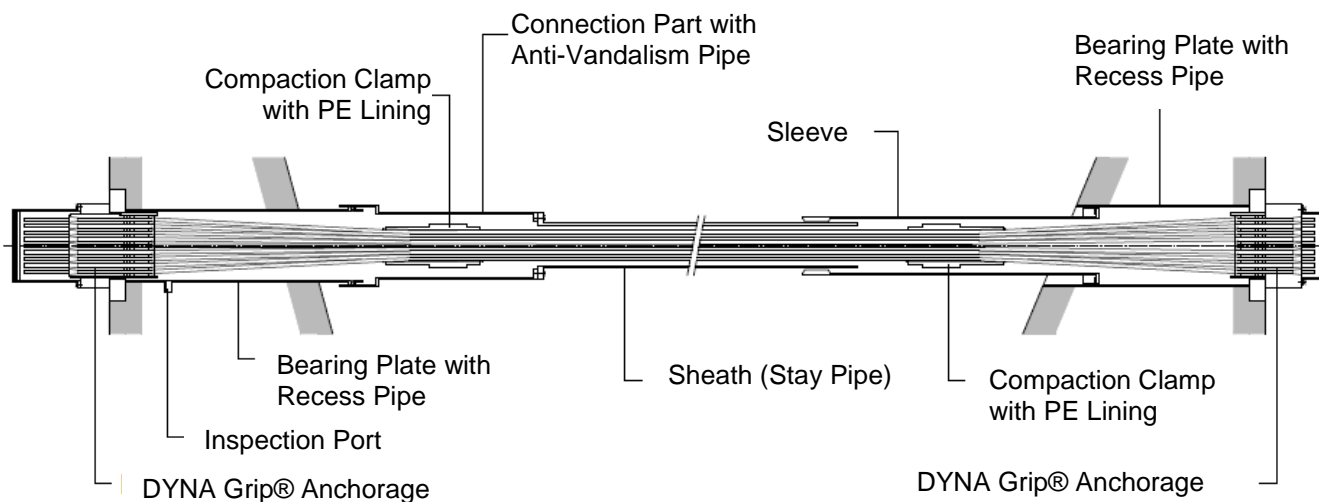
The multi-strand stay cables shall be inspected and maintained on a regular basis. In cooperation with the construction owner, an inspection and maintenance manual shall be prepared for the multi-strand stay cables, which shall include at least the details stated below:

- inspection and/or maintenance of the anchorage constructions,
- inspection of the compaction clamps,
- inspection of the exit pipes,
- inspection of the stay pipes,
- measurement of the gradient,
- inspection and maintenance of the strands; exchange of strands, if required,
- other inspections in the case of irregularities, e.g. vibrations noises.

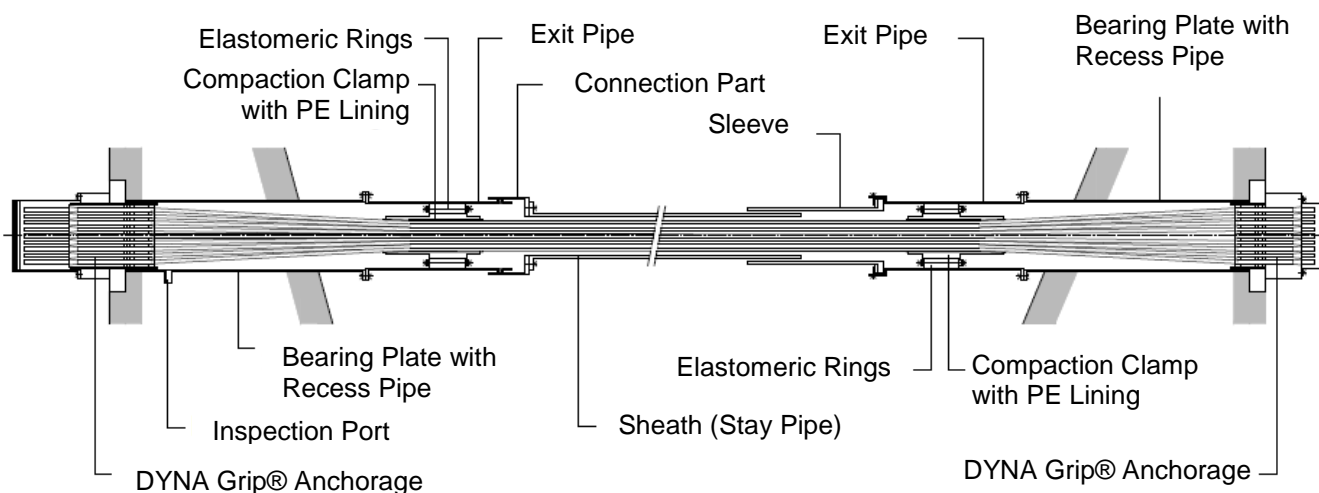
Andreas Schult
Head of Section

Drawn up by
Reimuth

Without Guide Deviator



With Double-sided Guide Deviator



DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Overview

Annex 1

System description of the DYWIDAG multi-strand stay cables type DYNA Grip®

1 Prestressing steel

7-wire stay cable strands are used as prestressing steel. These are galvanised, filled with wax and covered by a PE sheathing. The PE sheathing is applied such that it rests on the strand surface in a form-fitting manner.

The stay cable strands $\varnothing 15.7$ mm ($\varnothing 0.62$ ") with a nominal cross section of 150 mm² must be covered by a national technical approval and be designated as follows:

- prEN 10337-Y 1770 S7 Z-15,7-R1-F3-D2
- prEN 10337-Y 1860 S7 Z-15,7-R1-F3-D2

2 Stay cables

2.1 Description of the multi-strand stay cables

The DYWIDAG multi-strand stay cable type DYNA Grip® usually consists of parallel strands, anchored with wedges to a stressing and a dead anchor, and a stay pipe (sheath) made of polyethylene on the free length, which protects the multi-strands from environmental impacts. The multi-strand stay cables can be retightened, drained and replaced. Furthermore, stay cable strands can be individually removed and replaced.

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 1.1
System Description	

Max. cable sizes F_{uk}

Stay cable type	Maximum no. of strands	Breaking force F_{uk} in kN	
		prEN 10337-Y 1770 S7 Z-15,7-R1-F3-D2	prEN 10337-Y 1860 S7 Z-15,7-R1-F3-D2
DG-P 12	12	3.186	3.348
DG-P 19	19	5.045	5.301
DG-P 31	31	8.231	8.649
DG-P 37	37	9.824	10.323
DG-P 43	43	11.417	11.997
DG-P 55	55	14.603	15.345
DG-P 61	61	16.196	17.019
DG-P 73	73	19.382	20.367
DG-P 85	85	22.568	23.715
DG-P 91	91	24.161	25.389
DG-P 109	109	28.940	30.411

2.2 Stay cable production

The multi-strand stay cables are usually produced on-site in situ. Shorter multi-strand stay cables can be prefabricated both on-site and in the factory in order to be installed in the structure as a prefabricated element.

During on-site installation, the stay pipe is welded to the required length and lifted in place between the pylon and the superstructure by means of a crane, winch, etc. in a first step.

In a second step, the stay cable strands are individually fitted into the existing stay pipe and anchorages, arranged in parallel. Then, they are usually tensioned immediately to the required value in one or more stressing stages. It is also possible to stress only some of the strands while the remaining strands are installed loosely and stressed at a later point in time.

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

System Description

Annex 1.2

3 Anchorages

3.1 Wedges

To anchor the stay cable strands, 3-part wedges are used, which, due to a special production process, have a high fatigue resistance. The PE sheathing of the strands must be removed in the area of the wedges.

3.2 Stressing anchor

The stay cable strands are anchored in an anchor block, which is provided with an external thread. A ring nut is screwed onto the thread to transfer the load to a bearing plate, which is firmly fixed to the structure. The anchor block is provided with a steel pipe to accommodate the sealing unit. The stressing anchor can also be used as a dead anchor.

3.3 Dead anchor

The dead anchor is, similar to the anchor block, provided with a steel pipe to accommodate the sealing unit and is directly supported by the bearing plate. Stressing can be carried out on the dead anchor as well.

3.4 Bearing plate with recess pipe

The bearing plate and the recess pipe as well as the weld seams necessary to fasten the recess pipe to the bearing plate are verified on a project-specific basis. The alignment of the two components depends on the cable angle and is subject to an installation tolerance. Thus, the existing sag of the cable is taken into account.

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

System Description

Annex 1.3

3.5 Sealing

The steel pipe of the stressing and dead anchors contains three sealing plates made of NBR rubber, a spacer made of polyethylene and a compression plate made of steel. Threaded rods are mounted inside the compression plate, which are activated from the front side of the stressing and/or dead anchor after prestressing of the strands and post-blocking of the individual wedges. The cone holes are individually filled with a corrosion protection compound. Through the generated compression and lateral expansion of the sealing plates, the anchoring area is sealed against the intrusion of water. The PE sheathing of the strands comes to rest in the holes of the anchor block and/or dead anchor and is present in the area of the sealing.

3.6 Compression tube

In order to detain the strand's PE sheathing from entering into the wedge during stressing, a compression tube is pushed onto the unsheathed strand in front of the wedge on the stressing side.

4 Stay pipe

Polyethylene pipes as required by DIN 8074 / 8075 are used as stay pipes. They are welded to the required length by means of plastic welding in accordance with the DVS guidelines. On the pylon end, a protection sleeve is arranged, which allows the stay pipe free length variation due to temperature fluctuations.

On the deck side, the stay pipe is mounted to the connector with the aid of a flange connection (using an anti-vandalism pipe, where required), or, when using a compaction clamp, to the bearing pipe by means of a steel connection.

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 1.4
System Description	

5 Compaction clamp

In front of the anchorage, a compaction clamp is clamped onto the multi-strand stay cable. It consists of a steel bearing pipe with PE lining. The compaction clamp allows the packing of the multi-strand stay cable as compact as possible.

If the compaction clamp is provided with an additional guide deviator, it allows slip-free transmission of emerging transverse forces from traffic, wind, etc. The guide deviator consists of elastomer rings between the steel bearing pipe and the exit pipe, compressed with flange rings. It also has damping properties. For this, the exit pipe must have a force-fit flange connection to the structure which can also compensate for structural tolerances.

6 Damper connection

To connect an external damper, an additional two-part damper clamp can be mounted on the compaction clamp or on an additional steel bearing pipe. With the aid of a bottom opening in the anti-vandalism pipe, the damper is tension and pressure fixed to the cable. The opening is designed such that no rain penetrates into the anti-vandalism pipe.

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 1.5
System Description	

7 Stressing

The stay cable strands are stressed individually with single jacks using the ConTen method*, which ensures a uniform load in all strands in the final state. The extension path from the second stressing level must be at least 15 mm in order to avoid a double bite at the wedge tip.

After completion of the stressing operations using the ConTen method, all wedges are post-blocked individually. On the side opposite the stressing side, post-blocking may be carried out earlier.

With the aid of a gradient jack, it is possible to fully raise the stressing anchor, thereby increasing or decreasing the stressing force by turning the ring nut. For greater elongation due to stressing, multi-part washers may be inserted between the ring nut and the bearing plate.

8 Corrosion protection

After completion of all stressing operations, the cone holes are filled permanently with a corrosion protection compound. Furthermore, the seals on the anchorages are activated by tightening the threaded rods at a predetermined torque.

Wedges and strand protrusions at the anchorages are protected against external environmental impacts by caps made of steel. The strand protrusions can be protected either individually with PE pipes, filled with corrosion protection compound, or by filling the whole cap.

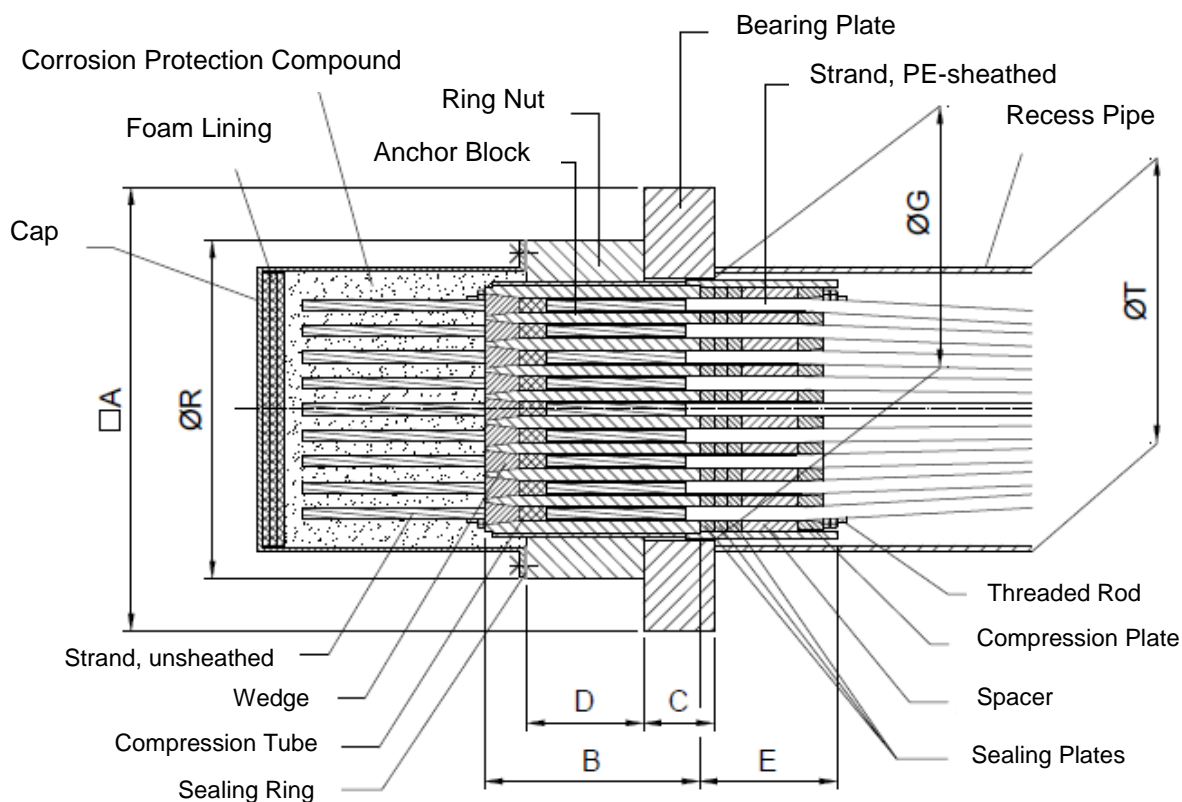
All exposed steel parts on the anchors, caps, flange connections, etc. are protected against corrosion in a manner appropriate for steel structures. The protection system of each cable component is determined on the basis of a project-specific corrosion protection plan.

*) deposited with DIBt

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 1.6
System Description	

In the table below, a comma is used as the decimal marker

Detailed documents
 deposited with DIBt



Cable type	$\square A^*$	C^*	$\varnothing R$	D	B	E	$\varnothing G$	$\varnothing T^*$
DG-P 12	300	30	244	90	238	195	183	219,1
DG-P 19	370	35	287	110	258	200	219	244,5
DG-P 31	460	40	350	120	268	205	267	298,5
DG-P 37	500	45	378	130	278	205	293	323,9
DG-P 43	600	60	420	140	290	210	329	355,6
DG-P 55	600	60	440	160	310	210	341	368,0
DG-P 61	640	65	480	165	315	215	371	406,4
DG-P 73	715	70	536	180	332	215	403	457,2
DG-P 85	780	75	554	190	342	230	429	457,2
DG-P 91	780	80	600	200	352	230	455	495
DG-P 109	855	85	636	230	384	245	479	521

*) Dimensions can be changed in consultation with applicant in accordance with the structural requirements

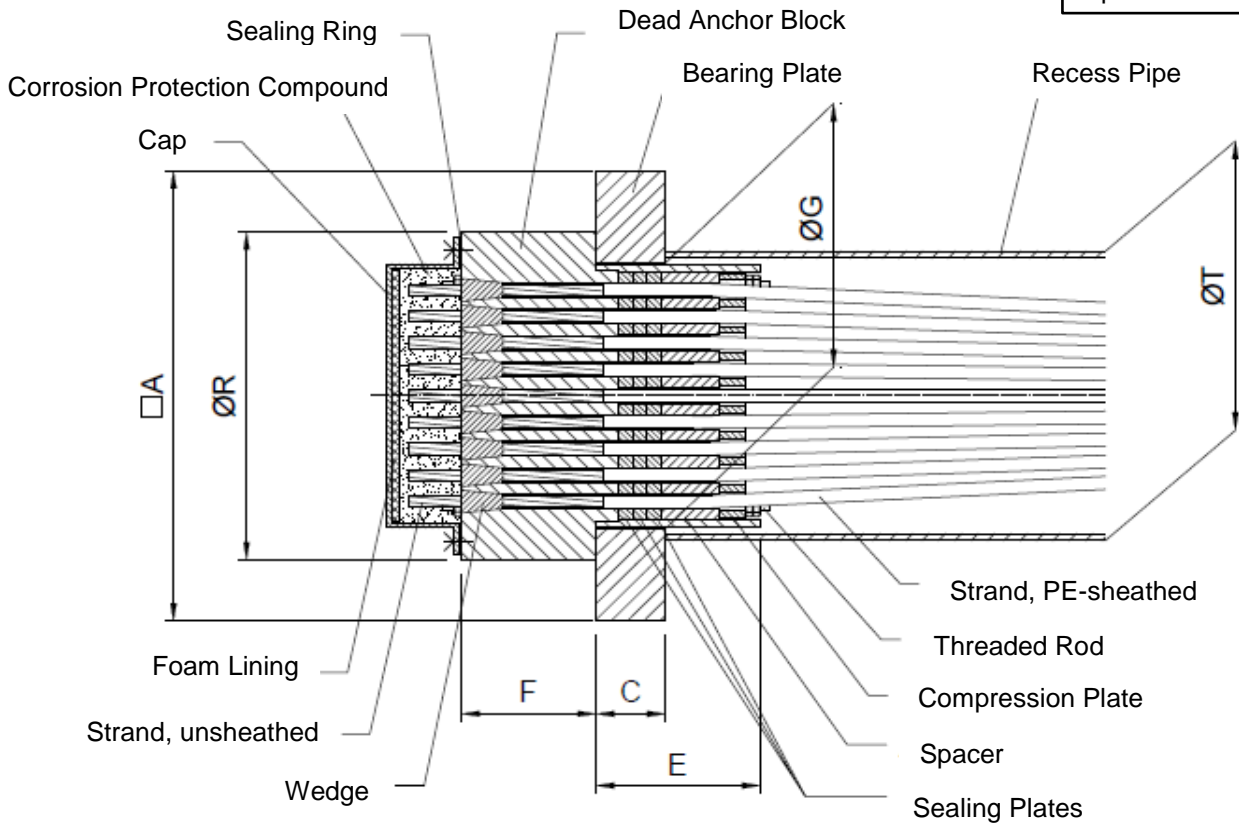
Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Stressing Anchor

Annex 2.1

Detailed documents
 deposited with DIBt



Cable type	A*	C*	R	F	E	G	T*
DG-P 12	300	30	215	120	225	183	219,1
DG-P 19	370	35	261	120	230	219	244,5
DG-P 31	460	40	324	135	235	267	298,5
DG-P 37	500	45	354	135	235	293	323,9
DG-P 43	600	60	398	150	240	329	355,6
DG-P 55	600	60	420	170	240	341	368,0
DG-P 61	640	65	450	170	245	371	406,4
DG-P 73	715	70	490	185	245	403	457,2
DG-P 85	780	75	522	190	260	429	457,2
DG-P 91	780	80	550	195	260	455	495
DG-P 109	855	85	586	210	275	479	521

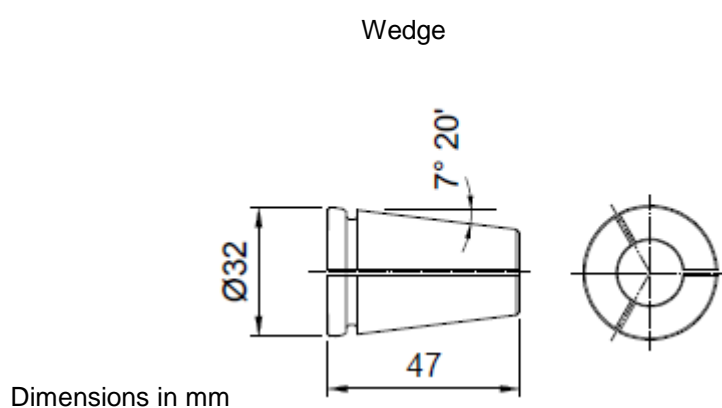
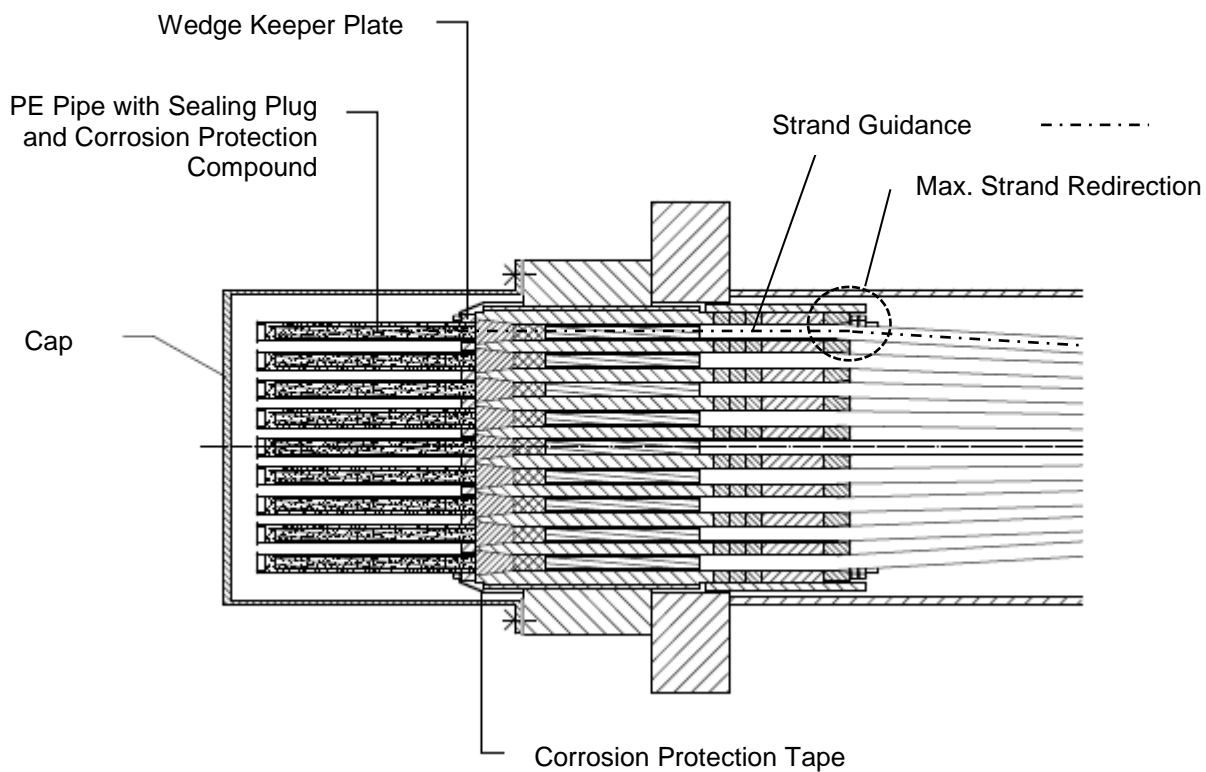
In this table,
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*) Dimensions can be changed in consultation with applicant in accordance with the structural requirements

Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 2.2
Dead Anchor	

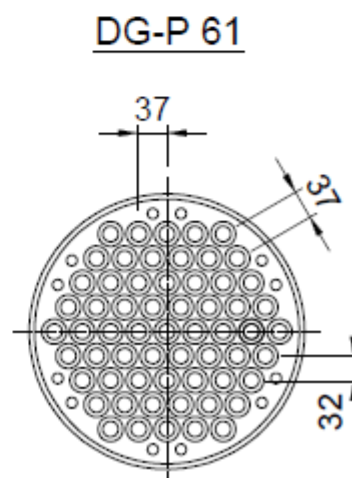
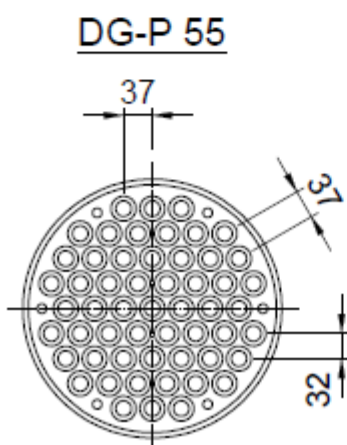
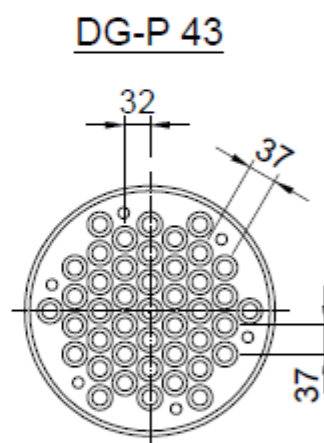
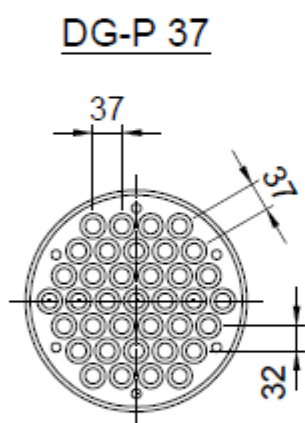
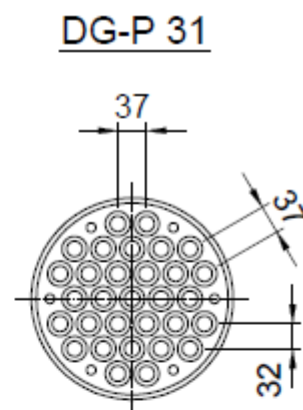
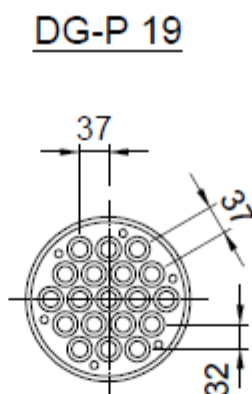
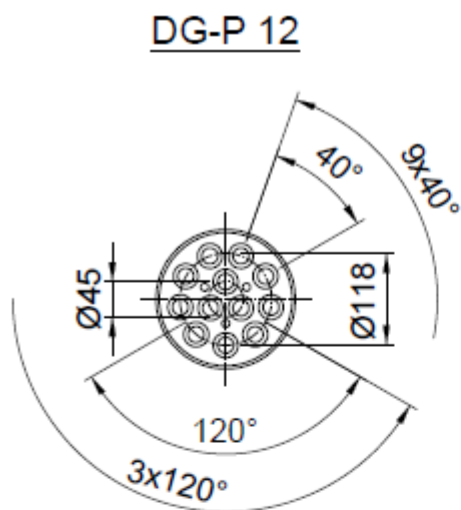
Detailed documents
 deposited with DIBt



DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Alternative Corrosion Protection of the Strand Protrusions
 Strand Guidance and Wedge

Annex 3



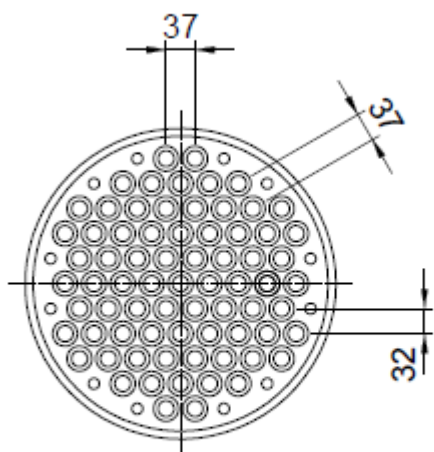
Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

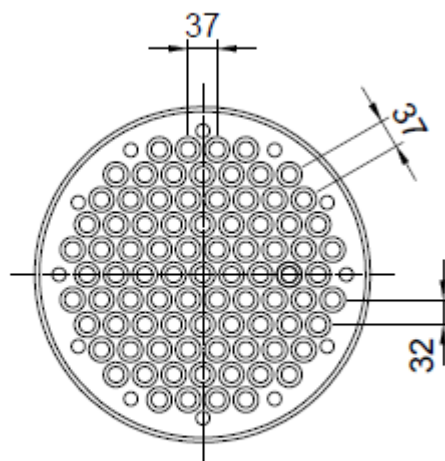
Hole Pattern

Annex 4.1

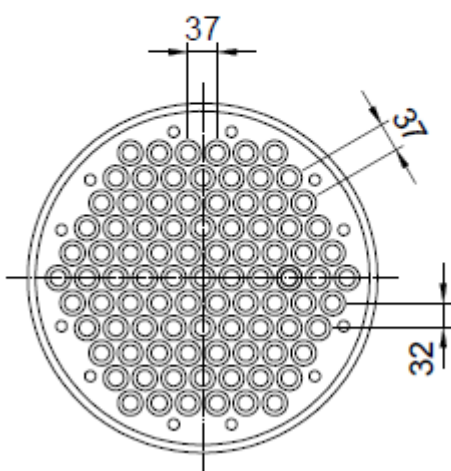
DG-P 73



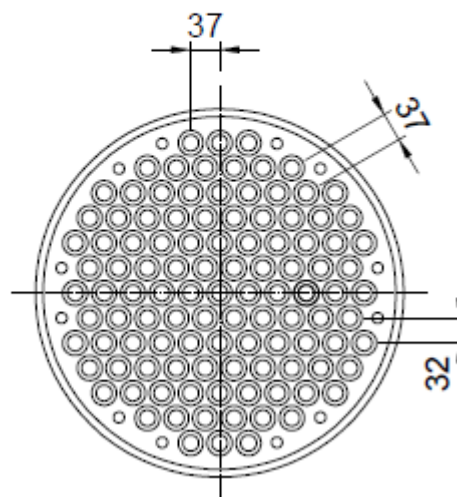
DG-P 85



DG-P 91



DG-P 109



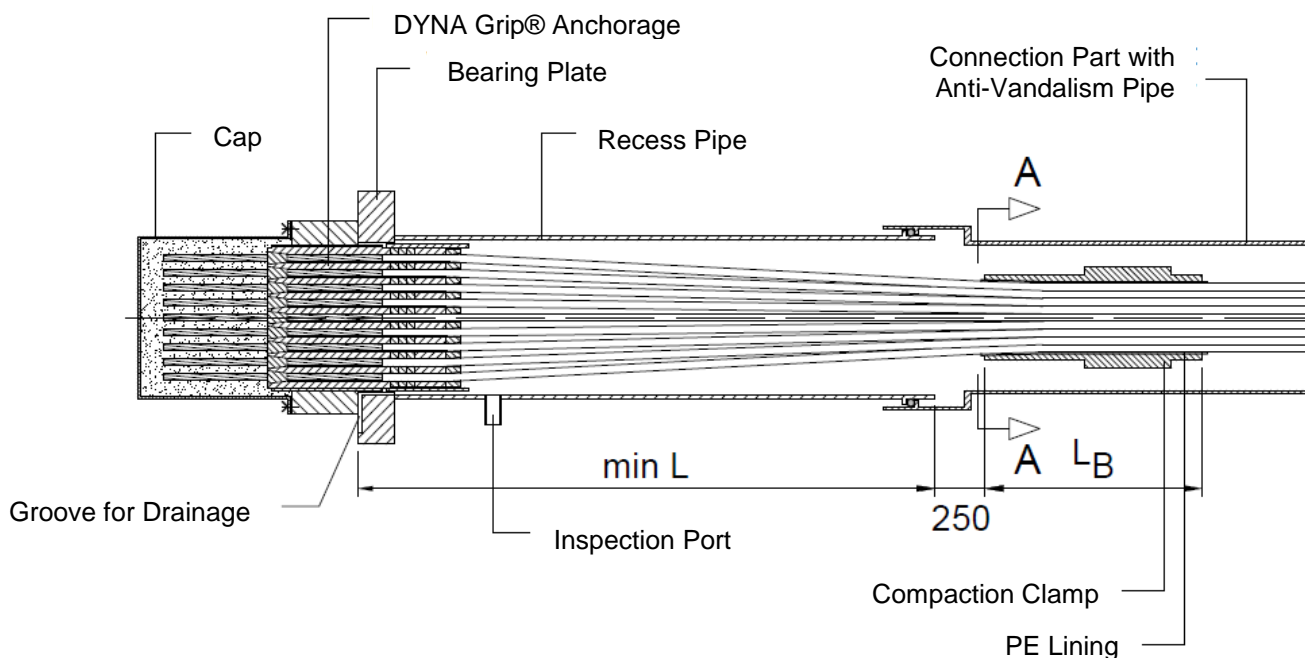
Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Hole Pattern

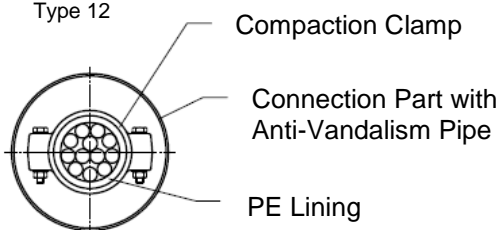
Annex 4.2

Detailed documents
 deposited with DIBt



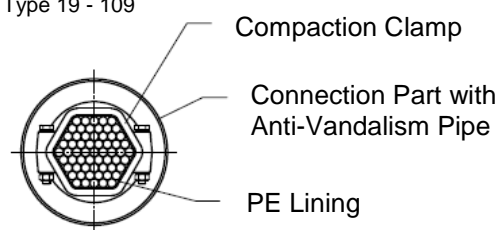
Section A-A

Type 12



Section A-A

Type 19 - 109



Cable type DG-P	12	19	31	37	43	55	61	73	85	91	109
min L Dead Anchor	520	720	990	1140	1330	1390	1560	1710	1810	1980	2660
min L Stressing Anchor	630	830	1100	1250	1440	1500	1670	1820	1920	2090	2770
L _B	380	390	480		540		550				

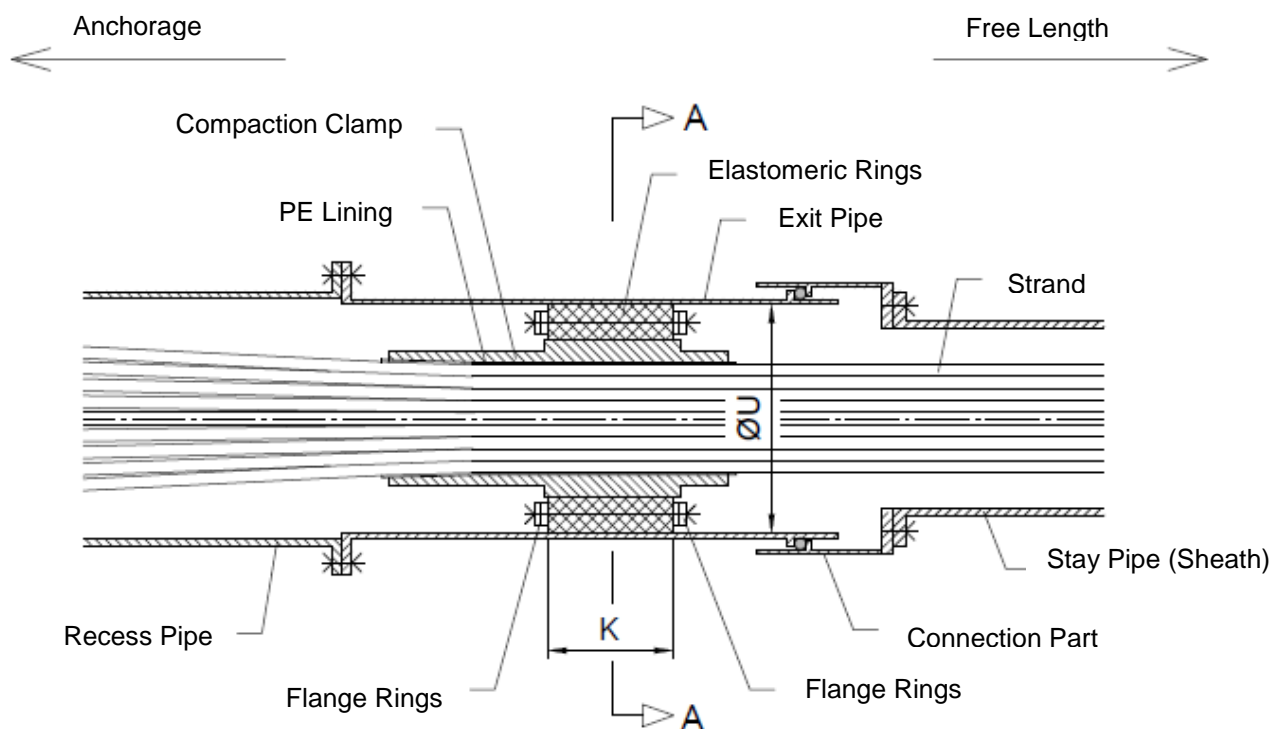
Dimensions apply to superstructure and pylon

Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

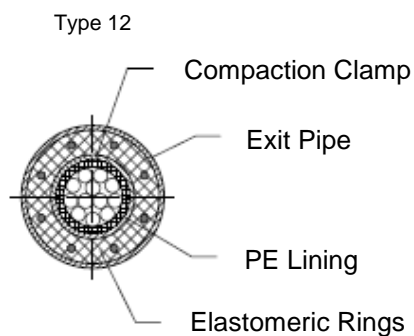
Lower Anchorage with Compaction Clamp without Guide Deviator

Annex 5

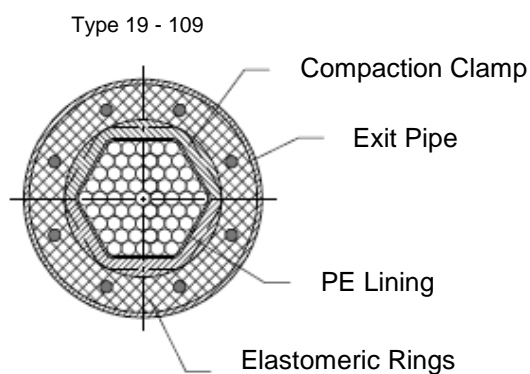


Detailed documents
 deposited with DIBt.

Section A-A



Section A-A



Cable type DG-P	12	19	31	37	43	55	61	73	85	91	109
ØU	181	203	254		310		377		426		
K	100	100	150		200		200		250		

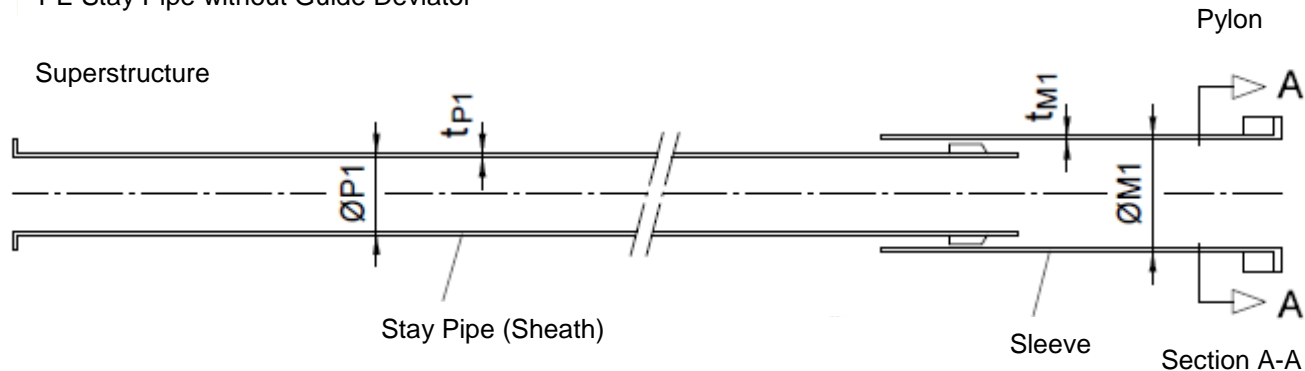
Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

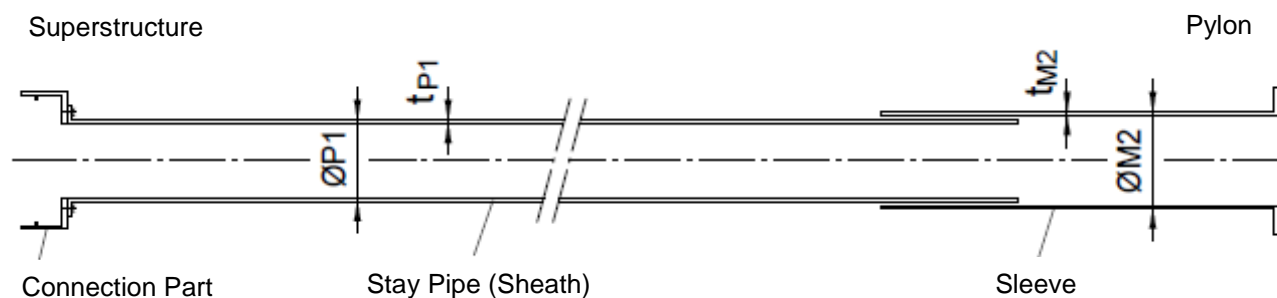
Compaction Clamp with Guide Deviator

Annex 6

PE Stay Pipe without Guide Deviator



PE Stay Pipe with Double-sided Guide Deviator



Cable type	ØP1*	tp1	ØM1	tm1	ØM2	tm2
DG-P 12	110	6,3	225	8,6	140	5,4
DG-P 19	125	7,1	225	8,6	160	6,2
DG-P 31	160	9,1	250	9,6	200	7,7
DG-P 37	180	10,2	250	9,6	225	8,6
DG-P 43	200	11,4	315	12,1	250	9,6
DG-P 55	200	11,4	315	12,1	250	9,6
DG-P 61	225	12,8	315	12,1	280	10,7
DG-P 73	250	14,2	355	13,6	315	12,1
DG-P 85	280	15,9	355	13,6	315	12,1
DG-P 91	280	15,9	355	13,6	315	12,1
DG-P 109	315	17,9	450	17,2	355	13,6

Detailed documents
 deposited with DIBt

In this table, a comma
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 marker

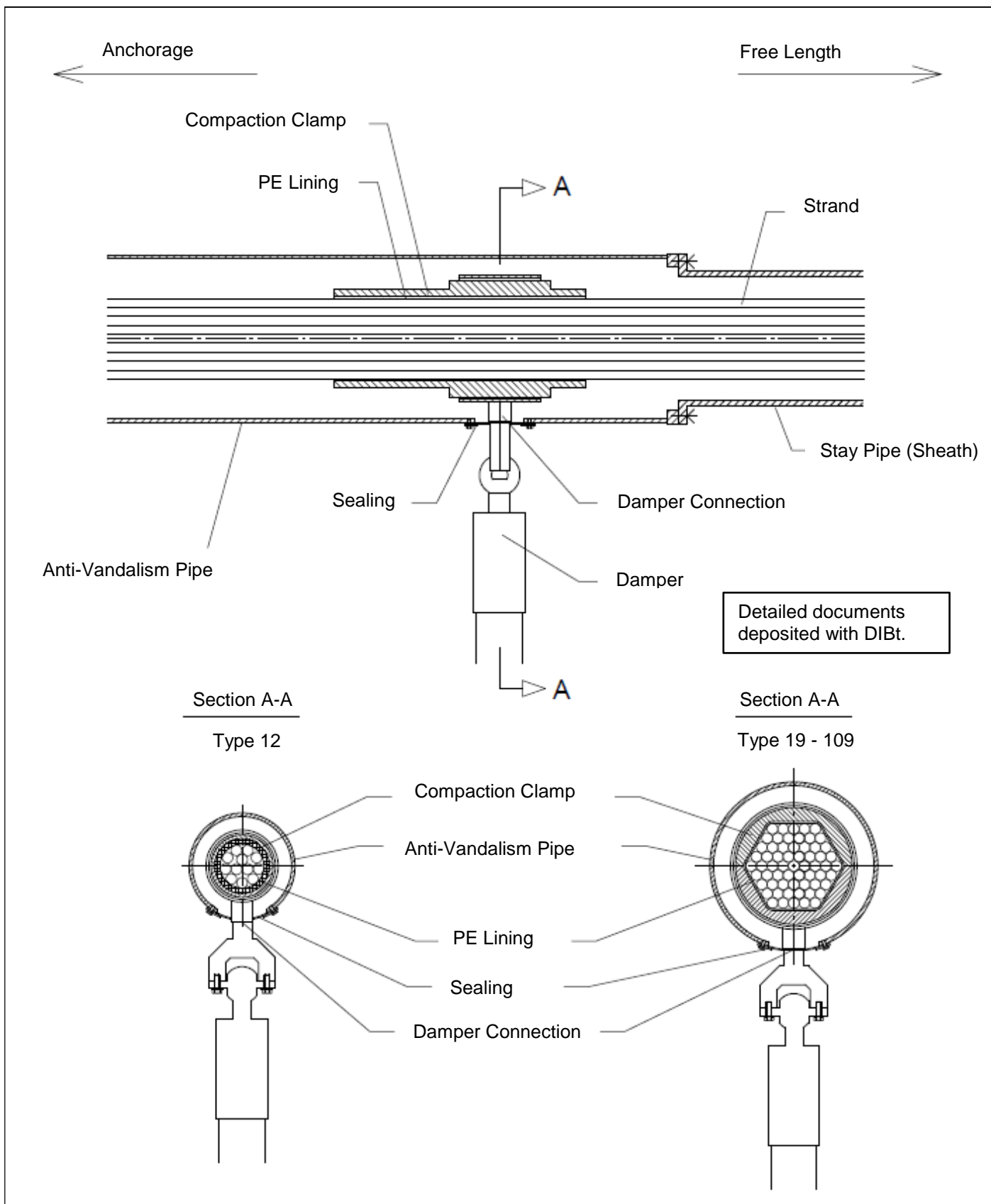
*) Dimensions can be changed in consultation with applicant in accordance with the structural requirements

Dimensions in mm

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

PE Stay Pipe

Annex 7



DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Damper Connection

Annex 8

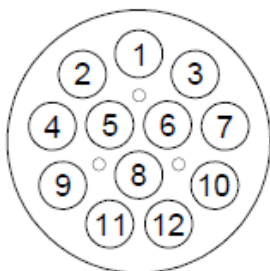
Designation	Material	Standard
Stay cable		
Stay cable strand	Y 1770 S7+Z-15,7-R1-F3-D2 Y 1860 S7+Z-15,7-R1-F3-D2	prEN 10337:2011
Corrosion protection compound	deposited with DIBt	
PE sheathing (strand)	HDPE, UV-resistant	DIN EN ISO 17855-1
Stay pipe (sheath)	PE80 / PE100, UV-resistant	DIN EN ISO 17855-1
Anchorage		
Bearing plate	S355J2	DIN EN 10025-2
Wedge	deposited with DIBt	
Compression tube	Structural Steel	DIN EN 10025-2
Anchor block (stressing anchor)	Structural Steel Quenched and Tempered Steel	DIN EN 10025-2 DIN EN ISO 683-2
Dead anchor block	Structural Steel Quenched and Tempered Steel	DIN EN 10025-2 DIN EN ISO 683-2
Ring nut	Structural Steel Quenched and Tempered Steel	DIN EN 10250-2 DIN EN ISO 683-1 und 2
Sealing plate	NBR Rubber	
Spacer	HMW PE	DIN EN ISO 17855-1
Compression plate	S355J2	DIN EN 10025-2
Threaded rod	Steel 8.8 galvanised	DIN 975
Cap	S235JR	DIN EN 10025-2
Corrosion protection compound	deposited with DIBt	
Compaction clamp		
PE lining	HDPE	DIN EN ISO 17855-1
Steel bearing pipe	Cast Structural Steel	EN 1563 DIN EN 10025-2
Elastomeric rings	CR Rubber	DIN EN 1337-3
Exit pipe	S355J2H	DIN EN 10210

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

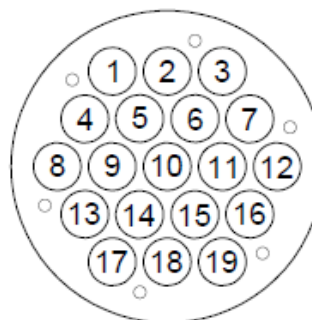
Material Specifications

Annex 9

DG-P 12



DG-P 19



No. of installed strands	Position of missing strands
5	1 / 2 / 3 / 9 10 / 11 / 12
6	1 / 2 / 3 8 / 11 / 12
7	4 / 7 / 8 11 / 12
8	4 / 7 / 11 / 12
9	8 / 11 / 12
10	11 / 12
11	8
12	-

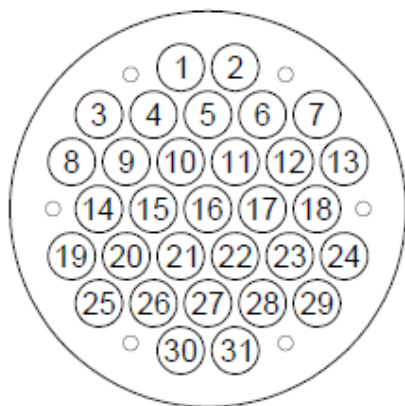
No. of installed strands	Position of missing strands
13	8 / 10 / 12 17 / 18 / 19
14	8 / 12 17 / 18 / 19
15	10 17 / 18 / 19
16	17 / 18 / 19
17	17 / 19
18	18
19	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

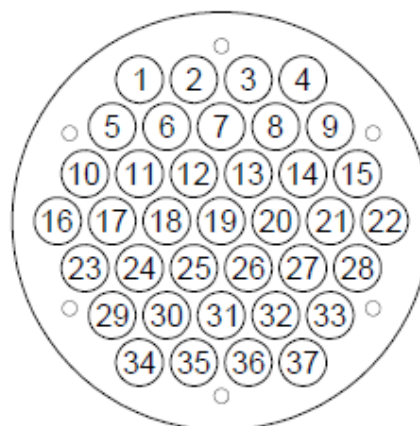
Strand Occupancy Type DG-P 12 and DG-P 19

Annex 10.1

DG-P 31



DG-P 37



No. of installed strands	Position of missing strands
20	8 / 9 / 10 / 11 / 12 / 13 14 / 18 / 27 / 30 / 31
21	8 / 9 / 10 / 11 / 12 13 / 16 / 27 / 30 / 31
22	8 / 9 / 10 / 11 / 12 13 / 27 / 30 / 31
23	14 / 15 / 16 / 17 / 18 27 / 30 / 31
24	8 / 13 / 14 / 18 / 27 30 / 31
25	14 / 16 / 18 / 27 30 / 31
26	14 / 18 / 27 / 30 / 31
27	16 / 27 / 30 / 31
28	27 / 30 / 31
29	30 / 31
30	30
31	-

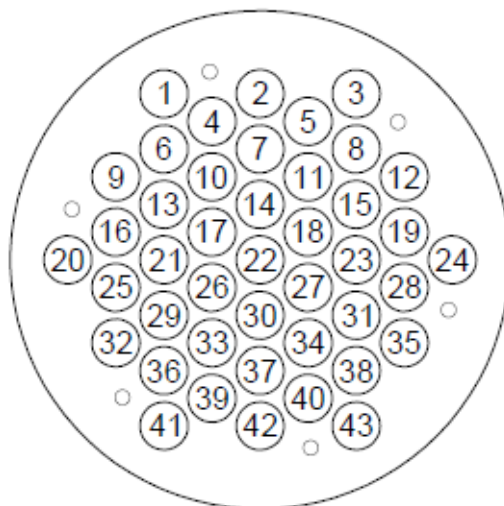
No. of installed strands	Position of missing strands
32	16 / 22 / 31 / 35 / 36
33	19 / 31 / 35 / 36
34	31 / 35 / 36
35	34 / 37
36	35
37	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 31 and DG-P 37

Annex 10.2

DG-P 43



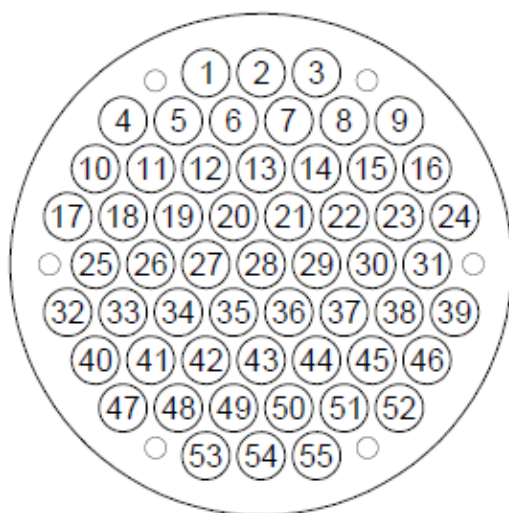
No. of installed strands	Position of missing strands
38	20 / 24 / 41 / 42 / 43
39	22 / 41 / 42 / 43
40	41 / 42 / 43
41	41 / 43
42	42
43	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 43

Annex 10.3

DG-P 55



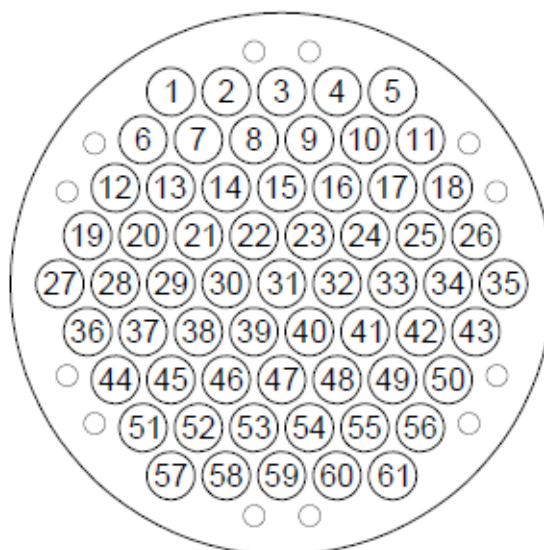
No. of installed strands	Position of missing strands
44	17 / 18 / 19 / 20 / 21 / 22 23 / 24 / 53 / 54 / 55
45	10 / 11 / 12 / 13 / 14 15 / 16 / 53 / 54 / 55
46	17 / 24 / 25 / 31 / 32 39 / 53 / 54 / 55
47	17 / 24 / 25 / 28 / 31 53 / 54 / 55
48	17 / 24 / 25 / 31 53 / 54 / 55
49	25 / 28 / 31 53 / 54 / 55
50	25 / 31 / 53 / 54 / 55
51	28 / 53 / 54 / 55
52	53 / 54 / 55
53	53 / 55
54	54
55	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 55

Annex 10.4

DG-P 61



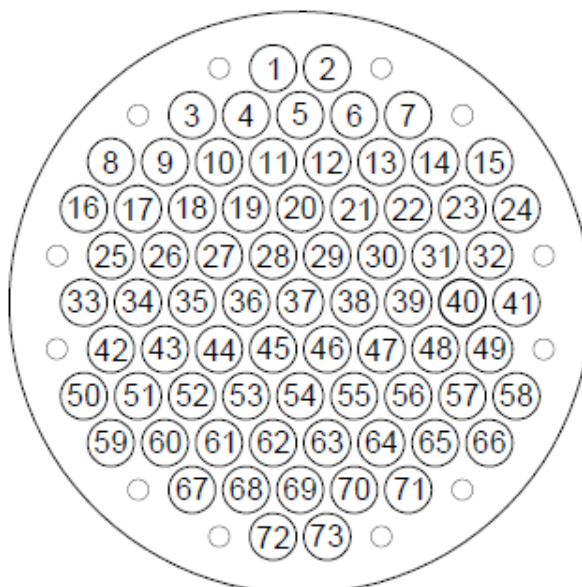
No. of installed strands	Position of missing strands
56	27 / 35 / 57 / 59 / 61
57	31 / 57 / 59 / 61
58	57 / 59 / 61
59	57 / 61
60	59
61	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 61

Annex 10.5

DG-P 73



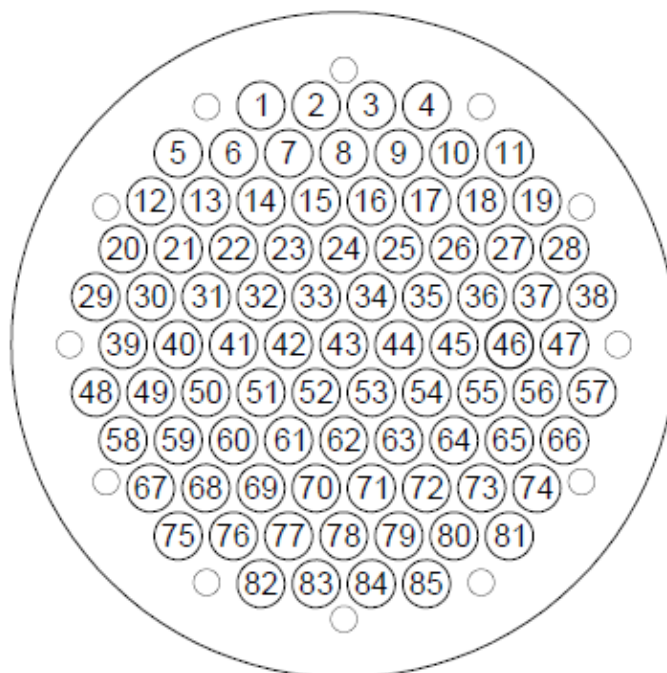
No. of installed strands	Position of missing strands
62	25 / 26 / 27 / 28 / 29 / 30 / 31 / 32 / 69 / 72 / 73
63	16 / 24 / 25 / 32 / 33 / 37 / 41 / 69 / 72 / 73
64	16 / 24 / 25 / 32 / 33 / 41 / 69 / 72 / 73
65	25 / 32 / 33 / 37 / 41 / 69 / 72 / 73
66	25 / 32 / 33 / 41 / 69 / 72 / 73
67	33 / 37 / 41 / 69 / 72 / 73
68	33 / 41 / 69 / 72 / 73
69	37 / 69 / 72 / 73
70	69 / 72 / 73
71	72 / 73
72	72
73	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 73

Annex 10.6

DG-P 85



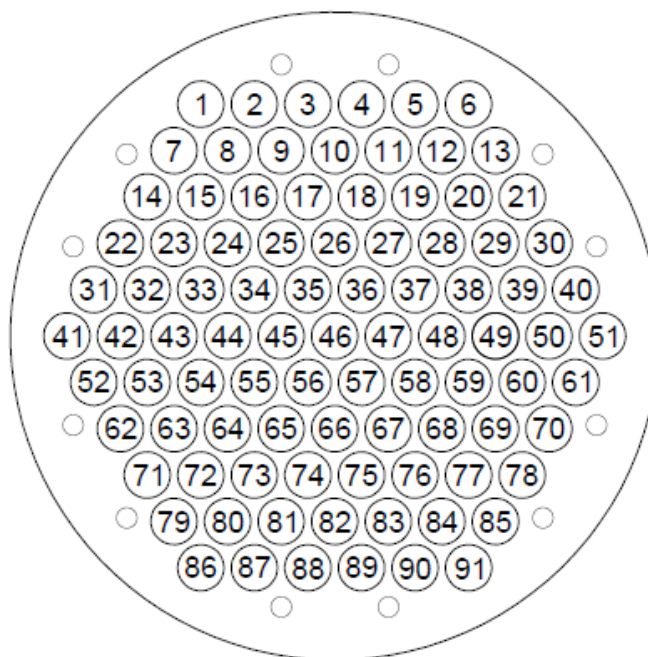
No. of installed strands	Position of missing strands
74	20 / 28 / 29 / 38 / 39 / 47 / 48 / 57 / 78 / 83 / 84
75	29 / 38 / 39 / 43 / 47 / 48 / 57 / 78 / 83 / 84
76	29 / 38 / 39 / 47 / 48 / 57 / 78 / 83 / 84
77	29 / 38 / 43 / 48 / 57 / 78 / 83 / 84
78	29 / 38 / 48 / 57 / 78 / 83 / 84
79	39 / 43 / 47 / 78 / 83 / 84
80	39 / 47 / 78 / 83 / 84
81	43 / 78 / 83 / 84
82	78 / 83 / 84
83	83 / 84
84	83
85	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 85

Annex 10.7

DG-P 91



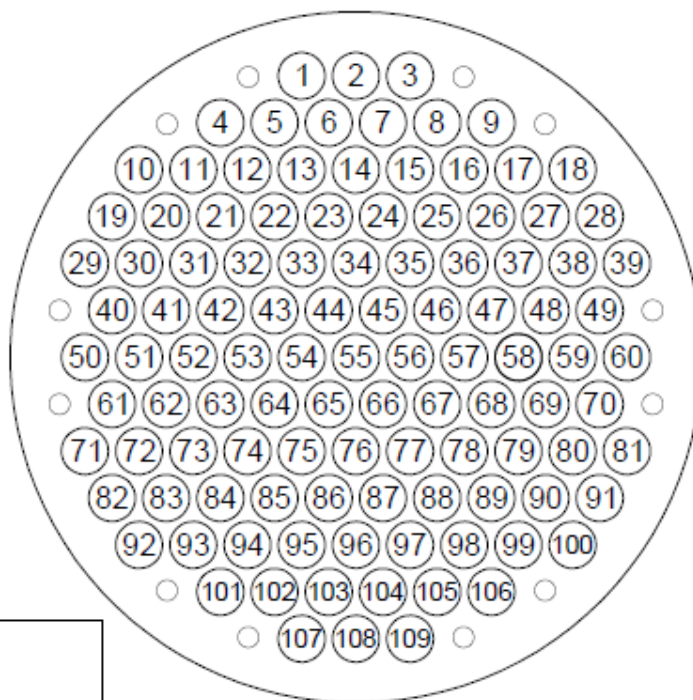
No. of installed strands	Position of missing strands
86	41 / 51 / 82 / 88 / 89
87	46 / 82 / 88 / 89
88	82 / 88 / 89
89	86 / 91
90	88
91	-

DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 91

Annex 10.8

DG-P 109



No. of installed strands	Position of missing strands
92	34 / 40 / 49 / 50 / 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 / 107 / 108 / 109
93	40 / 49 / 50 / 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 / 107 / 108 / 109
94	34 / 50 / 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 / 107 / 108 / 109
95	50 / 51 / 52 / 53 / 54 / 55 / 56 / 57 / 58 / 59 / 60 / 107 / 108 / 109
96	40 / 41 / 42 / 43 / 44 / 45 / 46 / 47 / 48 / 49 / 107 / 108 / 109
97	40 / 49 / 50 / 51 / 55 / 59 / 60 / 61 / 70 / 107 / 108 / 109
98	29 / 39 / 40 / 49 / 50 / 60 / 61 / 70 / 107 / 108 / 109
99	40 / 49 / 50 / 55 / 60 / 61 / 70 / 107 / 108 / 109

No. of installed strands	Position of missing strands
100	40 / 49 / 50 / 60 / 61 / 70 / 107 / 108 / 109
101	40 / 49 / 55 / 61 / 70 / 107 / 108 / 109
102	40 / 49 / 61 / 70 / 107 / 108 / 109
103	50 / 55 / 60 / 107 / 108 / 109
104	50 / 60 / 107 / 108 / 109
105	55 / 107 / 108 / 109
106	107 / 108 / 109
107	107 / 109
108	108
109	-

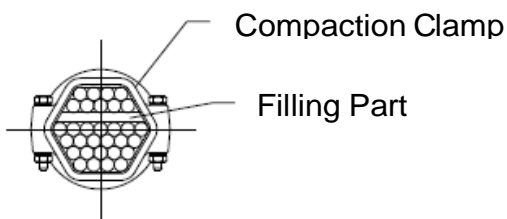
DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Strand Occupancy Type DG-P 109

Annex 10.9

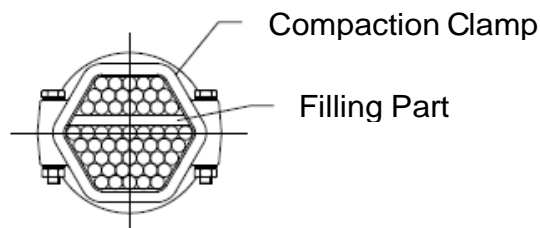
DG-P 31

20 - 22 installed strands

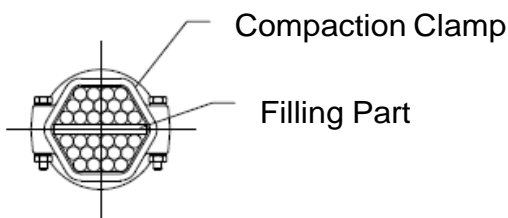


DG-P 55

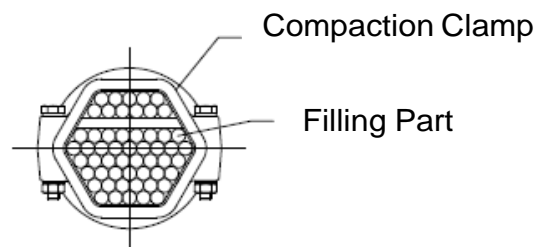
44 installed strands



23 installed strands

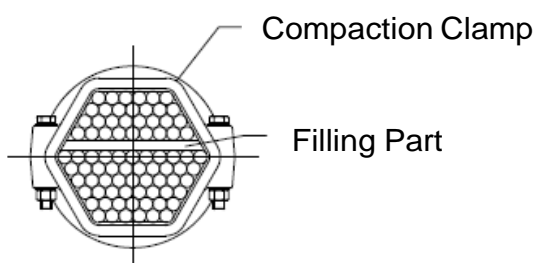


45 installed strands



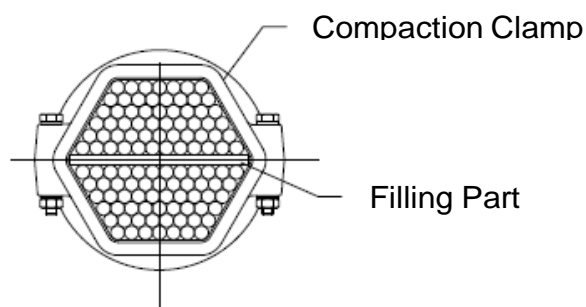
DG-P 73

62 installed strands



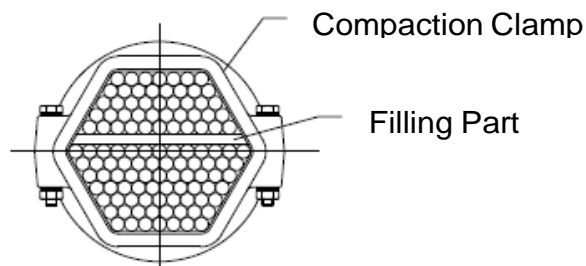
DG-P 109

92 - 95 installed strands



Arrangement of dummy strands
 in line with strand occupancy as
 per Annex 10

Detailed documents
 deposited with DIBt



DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Filling Parts Inside Compaction Clamp

Annex 11

Identification test of a wedge-anchored individual strand

1 General

Every time when the supplier of wedges or stay cable strands changes, identification tests of the stay cable strands anchored on both sides with wedges must be carried out. All wedge/stay cable strand combinations that at least consist of wedges or stay cable strands supplied by the new supplier must be tested.
The test results with all relevant details must be documented in a test report.

2 Fatigue tests

At least five fatigue tests must be carried out on single strands anchored with wedges on both sides.

In doing so, the anchor bodies of the single strands are supported at the bearings with an inclination analogously to the cable testing in accordance with DIN EN 1993-1-11, Annex A.

Deflections of strands that correlate to the maximum possible deflection at the end anchorage of the cable, have to be tested if guide structures for a single strand are used that comply with the strand guidance at the end anchorage of cables (see Annex 3).

After application of an upper load of $0.45 F_a$ a fatigue test with 2×10^6 load cycles and a stress range of 250 N/mm^2 at normal ambient temperature with a maximum frequency of 8 Hz must be carried out.

F_a represents the characteristic value for the actual breaking force of the strand. Then, a static tensile test, during which the load is slowly increased step by step, must be carried out on the test specimen in order to determine the remaining load-bearing capacity.

The test is considered passed, if

- no wire fractures were observed during the fatigue test
- no transverse cracks and/or no fragmental longitudinal fractures were detected on the wedges
- a remaining load-bearing capacity of $0.95 F_{pk}$ or $0.92 F_a$ is achieved (the larger value applies)

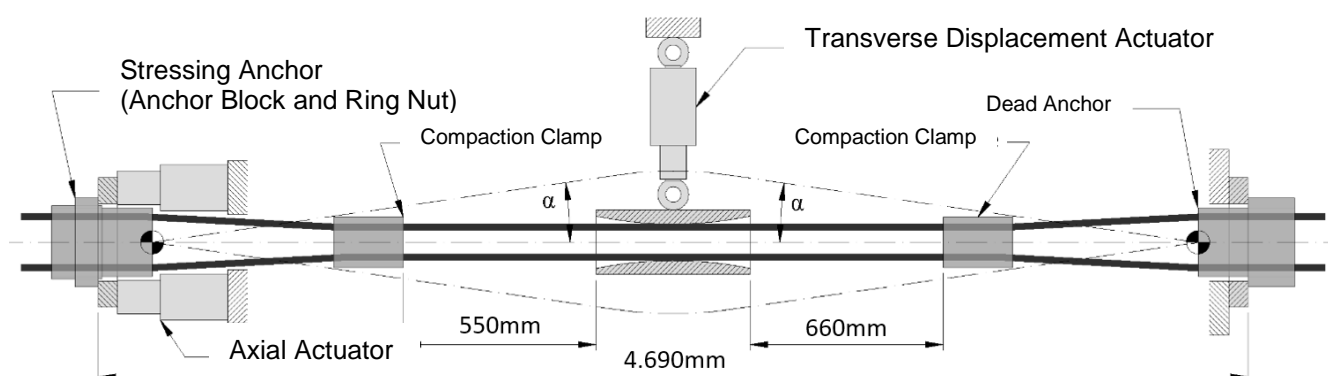
DYWIDAG Multi-Strand Stay Cable DYNA Grip®

Identification Test of a Wedge-anchored Individual Strand

Annex 12

Testing of flexural bending fatigue in accordance
with fib Bulletin 89, paragraph 6.2.2

Test set-up



Detailed documents
deposited with DIBt

DYWIDAG Multi-Strand Stay Cable DYNA Grip®	Annex 13
Schematic Diagram Fatigue Test with Bending Load	