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Bautechnisches Prüfamt
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Authorised and notified according to Article 10 of the Council Directive of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products (89/106/EEC)

Deutsches Institut für Bautechnik
DIBt

Mitglied der EOTA
Member of EOTA

European Technical Approval ETA-08/0376

English translation prepared by DIBt - Original version in German language

Handelsbezeichnung *Trade name*	Powers PURE150-PRO Verbundmörtel mit Ankerstange für Beton *Powers PURE150-PRO injection resin with anchor rod for concrete*
Zulassungsinhaber *Holder of approval*	Powers Fasteners Europe Stanley Black&Decker Deutschland GmbH Black-&-Decker Str. 40 65510 Idstein DEUTSCHLAND
Zulassungsgegenstand und Verwendungszweck *Generic type and use of construction product*	Verbunddübel zur Verankerung im Beton unter statischer, quasi-statischer oder seismischer Einwirkung (Leistungskategorie C1) *Bonded anchor for use in concrete under static, quasi-static or seismic action (performance category C1)*
Geltungsdauer: vom / *Validity: from*	4 April 2013
bis / *to*	4 April 2018
Herstellwerk *Manufacturing plant*	Powers Fasteners Europe BV Factory 2, Germany

Diese Zulassung umfasst *This Approval contains*	44 Seiten einschließlich 35 Anhänge *44 pages including 35 annexes*
Diese Zulassung ersetzt *This Approval replaces*	ETA-08/0376 mit Geltungsdauer vom 08.09.2011 bis 03.02.2014 *ETA-08/0376 with validity from 08.09.2011 to 03.02.2014*

I LEGAL BASES AND GENERAL CONDITIONS

1 This European technical approval is issued by Deutsches Institut für Bautechnik in accordance with:

- Council Directive 89/106/EEC of 21 December 1988 on the approximation of laws, regulations and administrative provisions of Member States relating to construction products[1], modified by Council Directive 93/68/EEC[2] and Regulation (EC) N° 1882/2003 of the European Parliament and of the Council[3];
- *Gesetz über das In-Verkehr-Bringen von und den freien Warenverkehr mit Bauprodukten zur Umsetzung der Richtlinie 89/106/EWG des Rates vom 21. Dezember 1988 zur Angleichung der Rechts- und Verwaltungsvorschriften der Mitgliedstaaten über Bauprodukte und anderer Rechtsakte der Europäischen Gemeinschaften (Bauproduktengesetz - BauPG) vom 28. April 1998*[4]*, as amended by Article 2 of the law of 8 November 2011*[5]*;*
- Common Procedural Rules for Requesting, Preparing and the Granting of European technical approvals set out in the Annex to Commission Decision 94/23/EC[6];
- Guideline for European technical approval of "Metal anchors for use in concrete - Part 5: Bonded anchors", ETAG 001-05.

2 Deutsches Institut für Bautechnik is authorized to check whether the provisions of this European technical approval are met. Checking may take place in the manufacturing plant. Nevertheless, the responsibility for the conformity of the products to the European technical approval and for their fitness for the intended use remains with the holder of the European technical approval.

3 This European technical approval is not to be transferred to manufacturers or agents of manufacturers other than those indicated on page 1, or manufacturing plants other than those indicated on page 1 of this European technical approval.

4 This European technical approval may be withdrawn by Deutsches Institut für Bautechnik, in particular pursuant to information by the Commission according to Article 5(1) of Council Directive 89/106/EEC.

5 Reproduction of this European technical approval including transmission by electronic means shall be in full. However, partial reproduction can be made with the written consent of Deutsches Institut für Bautechnik. In this case partial reproduction has to be designated as such. Texts and drawings of advertising brochures shall not contradict or misuse the European technical approval.

6 The European technical approval is issued by the approval body in its official language. This version corresponds fully to the version circulated within EOTA. Translations into other languages have to be designated as such.

[1] Official Journal of the European Communities L 40, 11 February 1989, p. 12
[2] Official Journal of the European Communities L 220, 30 August 1993, p. 1
[3] Official Journal of the European Union L 284, 31 October 2003, p. 25
[4] *Bundesgesetzblatt Teil I 1998*, p. 812
[5] *Bundesgesetzblatt Teil I 2011*, p. 2178
[6] Official Journal of the European Communities L 17, 20 January 1994, p. 34

II SPECIFIC CONDITIONS OF THE EUROPEAN TECHNICAL APPROVAL

1 Definition of product/ products and intended use

1.1 Definition of the construction product

The "Powers PURE150-PRO Injection resin with anchor rod for concrete" is a bonded anchor consisting of a cartridge with injection mortar Powers PURE150-PRO and a steel element. The steel elements are commercial threaded rods according to Annex 3 in the range of M 8 to M 30, reinforcing bar according to Annex 4 in the range of Ø 8 to Ø 32 or threaded sleeves with internal thread according to annex 5 size M 8 to M 20.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

An illustration of the product and intended use is given in Annexes 1 and 2.

1.2 Intended use

The anchor is intended to be used for anchorages for which requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 of Council Directive 89/106 EEC shall be fulfilled and failure of anchorages made with these products would cause risk to human life and/or lead to considerable economic consequences. Safety in case of fire (Essential Requirement 2) is not covered in this European technical approval.

The anchor is to be used only for anchorages subject to static or quasi-static actions in reinforced or unreinforced normal weight concrete of strength classes C20/25 at minimum and C50/60 at most according to EN 206:2000-12.

The anchor may be used in cracked or non-cracked concrete.

The anchor may be installed in dry or wet concrete or in flooded holes.

The anchor with threaded rods or rebar may also be used under seismic action (anchor performance category C1).

The anchor may be used in the following temperature ranges:

Temperature range I:	-40 °C to +40 °C	(max long term temperature +24 °C and max short term temperature +40 °C)
Temperature range II:	-40 °C to +60 °C	(max long term temperature +43 °C and max short term temperature +60 °C)
Temperature range III:	-40 °C to +72 °C	(max long term temperature +43 °C and max short term temperature +72 °C)

<u>Elements made of zinc coated steel:</u>

The element made of zinc plated or hot dipped galvanised steel may only be used in structures subject to dry internal conditions.

<u>Elements made of stainless steel A4:</u>

The element made of stainless steel 1.4401 or 1.4571 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure (including industrial and marine environment), or exposure to permanently damp internal conditions, if no particular aggressive conditions exist. Such particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Elements made of high corrosion resistant steel:

The element made of high corrosion resistant steel 1.4529 or 1.4565 may be used in structures subject to dry internal conditions and also in structures subject to external atmospheric exposure, in permanently damp internal conditions or in other particular aggressive conditions. Such particular aggressive conditions are e. g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Elements made of reinforcing bars:

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the reinforcing bars act as dowels to take up shear forces. Connections with post-installed reinforcing bars in concrete structures designed in accordance with EN1992-1-1:2004 are not covered by this European technical approval.

The provisions made in this European technical approval are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

2 Characteristics of the product and methods of verification

2.1 Characteristics of the product

The anchor corresponds to the drawings and provisions given in the Annexes. The characteristic material values, dimensions and tolerances of the anchor not indicated in the Annexes shall correspond to the respective values laid down in the technical documentation[7] of this European technical approval.

The characteristic values for the design of anchorages are given in the Annexes.

The two components of the injection mortar are delivered in unmixed condition in side-by side-cartridges of sizes 385 ml, 585 ml or 1400 ml according to Annex 2. Each cartridge is marked with the imprint "Powers PURE150-PRO", with processing notes, charge code, storage life, hazard code and curing- and processing time depending on temperature.

Elements made of reinforcing bars shall comply with the specifications given in Annex 4.

Internal threaded sleeves shall comply with the specifications given in Annex 5.

The marking of embedment depth for threaded rods and rebar may be done on jobsite.

2.2 Methods of verification

The assessment of fitness of the anchor for the intended use in relation to the requirements for mechanical resistance and stability and safety in use in the sense of the Essential Requirements 1 and 4 has been made in accordance with the "Guideline for European technical approval of Metal Anchors for Use in Concrete", Part 1 "Anchors in general" and Part 5 "Bonded anchors", on the basis of Option 1 and ETAG 001 Annex E "Assessment of Metal Anchors under Seismic Action".

7 The technical documentation of this European technical approval is deposited at the Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approved bodies involved in the attestation of conformity procedure, is handed over to the approved bodies.

In addition to the specific clauses relating to dangerous substances contained in this European technical approval, there may be other requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

3 Evaluation and attestation of conformity and CE marking

3.1 System of attestation of conformity

According to the Decision 96/582/EG of the European Commission[8] system 2(i) (referred to as System 1) of the attestation of conformity applies.

This system of attestation of conformity is defined as follows:

System 1: Certification of the conformity of the product by an approved certification body on the basis of:

(a) Tasks for the manufacturer:
- (1) factory production control;
- (2) further testing of samples taken at the factory by the manufacturer in accordance with a prescribed control plan;

(b) Tasks for the approved body:
- (3) initial type–testing of the product;
- (4) initial inspection of factory and of factory production control;
- (5) continuous surveillance, assessment and approval of factory production control.

Note: Approved bodies are also referred to as "notified bodies".

3.2 Responsibilities

3.2.1 Tasks for the manufacturer

3.2.1.1 Factory production control

The manufacturer shall exercise permanent internal control of production. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall insure that the product is in conformity with this European technical approval.

The manufacturer may only use initial/raw/constituent materials stated in the technical documentation of this European technical approval.

The factory production control shall be in accordance with the control plan which is part of the technical documentation of this European technical approval. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Deutsches Institut für Bautechnik.[9]

The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

8 Official Journal of the European Communities L 254 of 08.10.1996

9 The control plan is a confidential part of the European technical approval and only handed over to the approved body involved in the procedure of attestation of conformity. See section 3.2.2.

3.2.1.2 Other tasks for the manufacturer

The manufacturer shall, on the basis of a contract, involve a body which is approved for the tasks referred to in section 3.1 in the field of anchors in order to undertake the actions laid down in section 3.2.2 For this purpose, the control plan referred to in sections 3.2.1.1 and 3.2.2 shall be handed over by the manufacturer to the approved body involved.

The manufacturer shall make a declaration of conformity, stating that the construction product is in conformity with the provisions of this European technical approval.

3.2.2 Tasks for the approved bodies

The approved body shall perform the

- initial type-testing of the product,
- initial inspection of factory and of factory production control,
- continuous surveillance, assessment and approval of factory production control

in accordance with the provisions laid down in the control plan.

The approved body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The approved certification body involved by the manufacturer shall issue an EC certificate of conformity of the product stating the conformity with the provisions of this European technical approval.

In cases where the provisions of the European technical approval and its control plan are no longer fulfilled the certification body shall withdraw the certificate of conformity and inform Deutsches Institut für Bautechnik without delay.

3.3 CE marking

The CE marking shall be affixed on each packaging of the anchor. The letters "CE" shall be followed by the identification number of the approved certification body, where relevant, and be accompanied by the following additional information:

- the name and address of the holder of the approval (legal entity responsible for the manufacture),
- the last two digits of the year in which the CE marking was affixed,
- the number of the EC certificate of conformity for the product,
- the number of the European technical approval,
- the number of the guideline for European technical approval,
- use category (ETAG 001-1, Option 1, seismic performance category C1),
- size.

4 Assumptions under which the fitness of the product for the intended use was favourably assessed

4.1 Manufacturing

The European technical approval is issued for the product on the basis of agreed data/information, deposited at Deutsches Institut für Bautechnik, which identifies the product that has been assessed and judged. Changes to the product or production process, which could result in this deposited data/information being incorrect, should be notified to Deutsches Institut für Bautechnik before the changes are introduced.

Deutsches Institut für Bautechnik will decide whether or not such changes affect the approval and consequently the validity of the CE marking on the basis of the approval and if so whether further assessment or alterations to the approval shall be necessary.

4.2 Design of anchorages

The fitness of the anchor for the intended use is given under the following conditions:

The anchorages are designed either in accordance with the

The anchorages are designed in accordance with the

- EOTA Technical Report TR 029 "Design of bonded anchors"[10]

or in accordance with the

- CEN/TS 1992-4:2009

and EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action" under the responsibility of an engineer experienced in anchorages and concrete work.

Anchorages shall be positioned outside of plastic hinges of the concrete structure. Fastenings in stand-off installation or with a grout layer under seismic action are not covered by this European technical approval.

Post-installed reinforcing bars may be used as anchor designed in accordance with the EOTA Technical Report TR 029 or CEN/TS 1992-4:2009. The basic assumptions for the design according to anchor theory shall be observed. This includes the consideration of tension and shear loads and the corresponding failure modes as well as the assumption that the base material (concrete structural element) remains essentially in the serviceability limit state (either non-cracked or cracked) when the connection is loaded to failure. Such applications are e.g. concrete overlay or shear dowel connections or the connections of a wall predominantly loaded by shear and compression forces with the foundation, where the rebars act as dowels to take up shear forces. Connections with reinforcing bars in concrete structures designed in accordance with EN 1992-1-1:2004 (e.g. connection of a wall loaded with tension forces in one layer of the reinforcement with the foundation) are not covered by this European technical approval.

Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored.

The position of the anchor is indicated on the design drawings (e.g. position of the anchor relative to reinforcement or to supports, etc.).

4.3 Installation of anchors

The fitness for use of the anchor can only be assumed if the anchor is installed as follows:

- anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site,
- anchor installation in accordance with the manufacturer's specifications and drawings using the tools indicated in the technical documentation of this European technical approval,
- use of the anchor only as supplied by the manufacturer without exchanging the components,

[10] The Technical Report TR 029 "Design of Bonded Anchors" is published in English on EOTA website www.eota.eu.

- commercial standard threaded rods, washers and hexagon nuts may be used if the following requirements are fulfilled:
  - material, dimensions and mechanical properties of the metal parts according to the specifications given in Annex 3,
  - confirmation of material and mechanical properties of the metal parts by inspection certificate 3.1 according to EN 10204:2004, the documents should be stored,
  - marking of the threaded rod with the envisage embedment depth. This may be done by the manufacturer of the rod or the person on jobsite.
- embedded reinforcing bars shall comply with specifications given in Annex 4,
- checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower than that of the concrete to which the characteristic loads apply,
- check of concrete being well compacted, e.g. without significant voids,
- marking and keeping the effective anchorage depth,
- edge distance and spacing not less than the specified values without minus tolerances,
- positioning of the drill holes without damaging the reinforcement,
- drilling by hammer-drilling only,
- in case of aborted drill hole: the drill hole shall be filled with mortar,
- cleaning the drill hole in accordance with Annexes 7,
- during installation and curing of the chemical mortar the anchor component installation temperature shall be at least 5 °C; the temperature; observing the curing time according to Annex 7, Table 7 until the anchor may be loaded,
- for injection of the mortar in bore holes of diameter d_0 > 20 mm piston plugs according to Annex 8 shall be used for overhead or horizontal injection,
- installation torque moments are not required for functioning of the anchor. However, the torque moments given in Annex 6 must not be exceeded.

5 Recommendations concerning packaging, transport and storage

5.1 Responsibility of the manufacturer

The manufacturer is responsible to ensure that the information on the specific conditions according to 1 and 2 including Annexes referred to as well as sections 4.2, 4.3 and 5.2 is given to those who are concerned. This information may be made by reproduction of the respective parts of the European technical approval.

In addition all installation data shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The minimum data required are:

- drill bit diameter,
- hole depth,
- diameter of anchor rod,
- minimum effective anchorage depth,
- information on the installation procedure, including cleaning of the hole with the cleaning equipments, preferably by means of an illustration,
- anchor component installation temperature,
- ambient temperature of the concrete during installation of the anchor,

- admissible processing time (open time) of the mortar,
- curing time until the anchor may be loaded as a function of the ambient temperature in the concrete during installation,
- maximum torque moment,
- identification of the manufacturing batch,

All data shall be presented in a clear and explicit form.

5.2 Packaging, transport and storage

The cartridges shall be protected against sun radiation and shall be stored according to the manufacturer's installation instructions in dry condition at temperatures of at least +5 °C to not more than +25 °C.

Cartridges with expired shelf life must no longer be used.

The anchor shall only be packaged and supplied as a complete unit. Cartridges may be packed separately from metal parts.

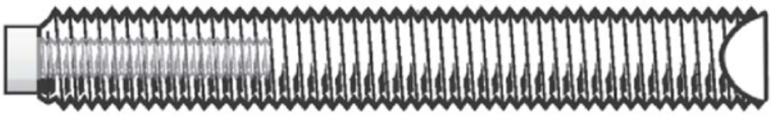
Georg Feistel
Head of Department

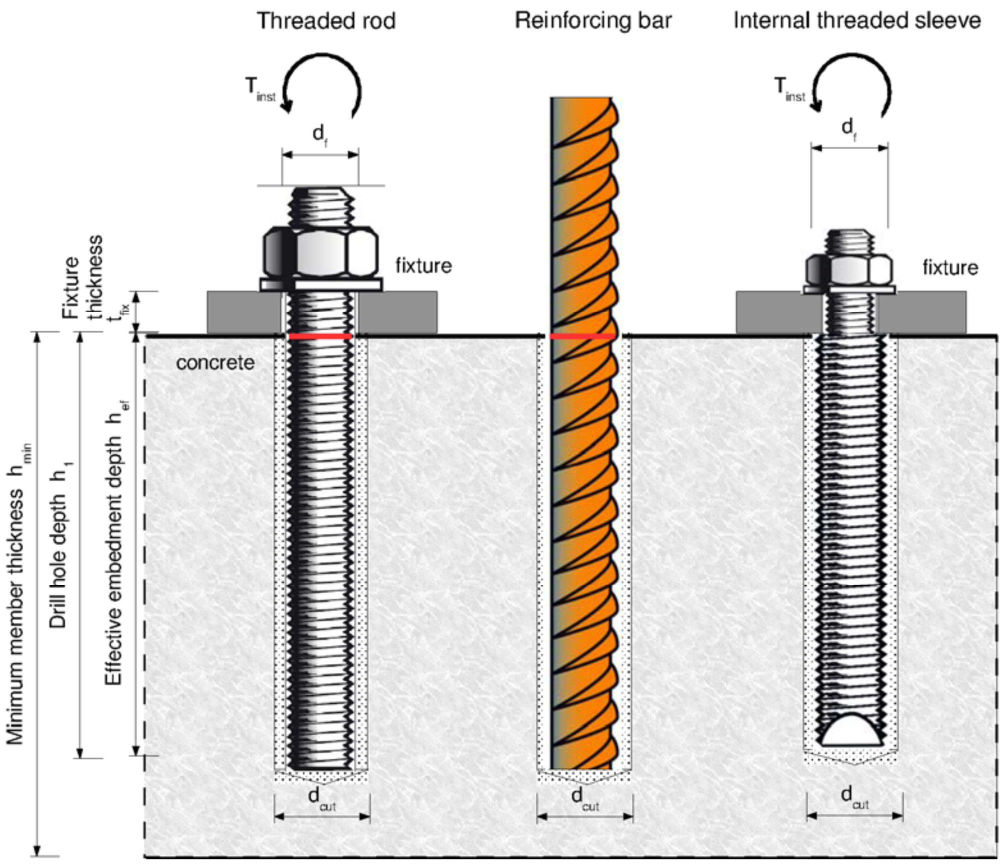
beglaubigt:
Lange

Threaded rod M8, M10, M12, M16, M20, M24, M27 and M30 with washer and nut

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28 and ∅ 32 acc. to Annex 4

Internal threaded sleeve M8, M10, M12, M16 and M20

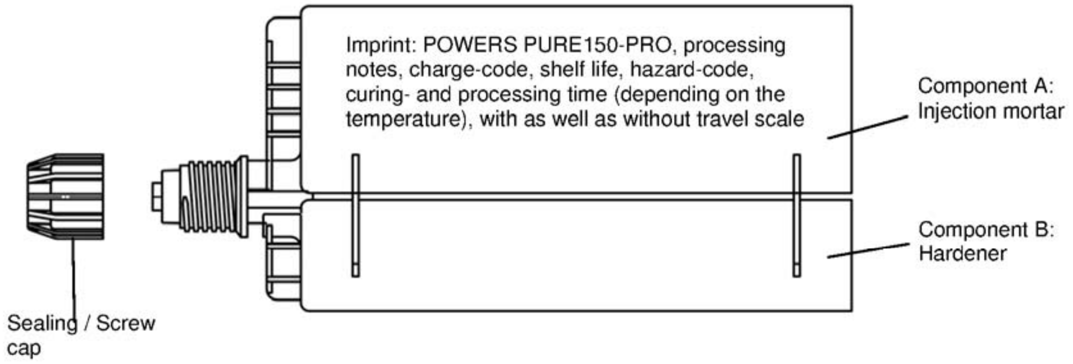




POWERS PURE150-PRO Injection resin with anchor rod for concrete Product and Installation	Annex 1

Cartridge: POWERS PURE150-PRO

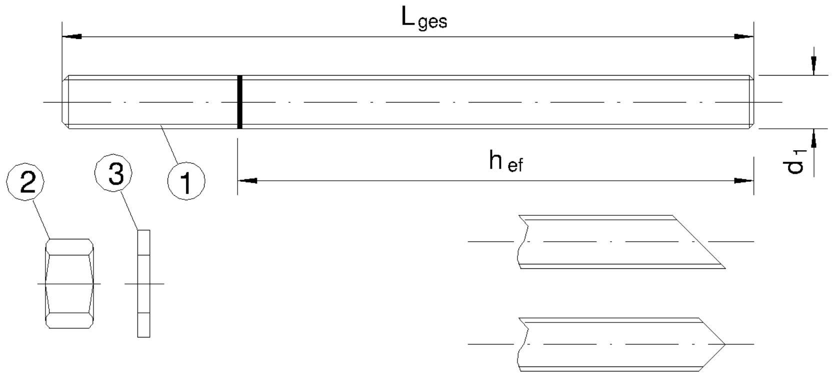
385 ml, 585 ml and 1400 ml injection mortar cartridge (Type: "side-by-side")



Static mixing nozzle:

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 2
Product (Injection mortar)	

Table 1: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461		
1	Anchor rod	Steel, EN 10087 or EN 10263 Property class 5.8, 8.8, EN ISO 898-1:1999
2	Hexagon nut, EN ISO 4032	Property class 5 (for class 5.8 rod) EN ISO 898-2, Property class 8 (for class 8.8 rod) EN ISO 898-2
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Steel, zinc plated
Stainless steel		
1	Anchor rod	Material 1.4401 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4401 / 1.4571 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4401 or 1.4571, EN 10088
High corrosion resistance steel		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Hexagon nut, EN ISO 4032	Material 1.4529 / 1.4565 EN 10088, > M24: Property class 50 (for class 50 rod) EN ISO 3506 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506
3	Washer, EN ISO 7089, EN ISO 7093, or EN ISO 7094	Material 1.4529 / 1.4565, EN 10088

Commercial standard rod with:
- Materials, dimensions and mechanical properties (Table 1a)
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 3
Materials (Threaded rod)	

Deutsches Institut für Bautechnik DIBt

Table 2: Materials (Reinforcing bar)

Abstract of EN 1992-1-1 Annex C, Table C.1, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Characteristic yield strength f_{yk} or $f_{0,2k}$ [N/mm²]		400 to 600	
Minimum value of $k = (f_t / f_y)_k$		≥ 1,08	≥ 1,15 < 1,35
Characteristic strain at maximum force ε_{uk} [%]		≥ 5,0	≥ 7,5
Bendability		Bend/ Rebend test	
Maximum deviation from nominal mass (individual bar) [%]	Nominal bar size [mm] ≤ 8 mm > 8 mm	± 6,0 ± 4,5	

Abstract of EN 1992-1-1 Annex C, Table C.2N, Properties of reinforcement:

Product form		**Bars and de-coiled rods**	
Class		**B**	**C**
Min. value of related rib area $f_{R,min}$	nominal diameter of the rebar [mm] 8 to 12 > 12	0,040 0,056	

Rib height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
(d: Nominal diameter of the bar; h: Rib height of the bar)

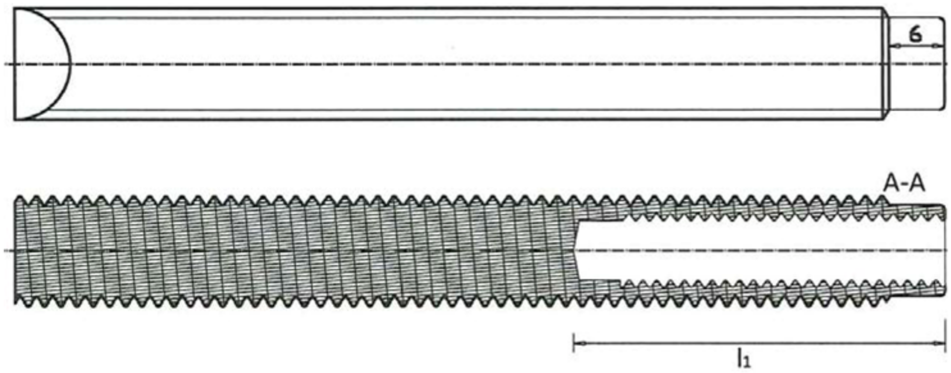
Regarding design of post-installed rebar as anchor see Section 4.2.

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Materials (Reinforcing bar)

Annex 4

Table 3: Materials (Internal threaded sleeve)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042		
1	Internal threaded sleeve	Steel, EN 10087 or EN 10263 Property class 5.8, EN ISO 898-1:1999
2	Corresponding steel screw	Steel screws property class 5.8 or 8.8, EN ISO 898-1 Zinc plated ≥ 5 µm according to EN ISO 4042
Stainless steel		
1	Internal threaded sleeve	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506 Stainless steel 1.4401, 1.4404, 1.4571 EN 10088
High corrosion resistance steel		
1	Internal threaded sleeve	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506 ≤ M24: Property class 70 EN ISO 3506
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506 High corrosion resistance steel 1.4529, 1.4565 EN 10088

Table 4: Installation parameters for threaded rod

Anchor size		M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Nominal drill hole diameter	d_0 [mm] =	10	12	14	18	24	28	32	35
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	60	70	80	90	96	108	120
	$h_{ef,max}$ [mm] =	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d_f [mm] ≤	9	12	14	18	22	26	30	33
Diameter of steel brush	d_b [mm] ≥	12	14	16	20	26	30	34	37
Torque moment	T_{inst} [Nm]	10	20	40	80	120	160	180	200
Thickness of fixture	$t_{fix,min}$ [mm] >	0							
	$t_{fix,max}$ [mm] <	1500							
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$					
Minimum spacing	s_{min} [mm]	40	50	60	80	100	120	135	150
Minimum edge distance	c_{min} [mm]	40	50	60	80	100	120	135	150

Table 5: Installation parameters for reinforcing bar

Rebar size		∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Nominal drill hole diameter	d_0 [mm] =	12	14	16	18	20	24	32	35	37
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	60	70	75	80	90	100	112	128
	$h_{ef,max}$ [mm] =	160	200	240	280	320	400	500	560	640
Diameter of steel brush	d_b [mm] ≥	14	16	18	20	22	26	34	37	40
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$						
Minimum spacing	s_{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	125	140	160

Table 6: Installation parameters for internal threaded sleeves

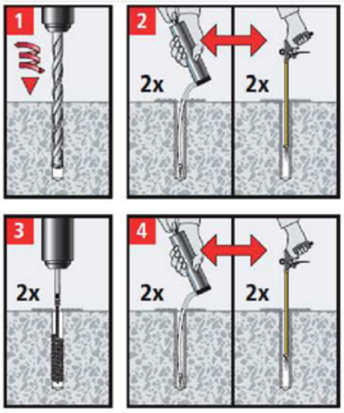
Internal thread size		M 8	M 10	M 12	M 16	M 20
External diameter size	[mm]	12	16	20	24	30
Nominal drill hole diameter	d_0 [mm]	14	18	24	28	35
Effective anchorage depth	h_{ef} [mm]	80	90	110	150	200
Diameter of clearance hole in the fixture	d_f [mm]	9	12	14	18	22
Diameter of steel brush	d_b [mm]	16	20	26	30	37
Torque moment	T_{inst} [Nm]	10	20	40	80	120
Minimum thickness of member	h_{min} [mm]	110	130	160	210	270
Minimum spacing	s_{min} [mm]	60	80	100	120	150
Minimum edge distance	c_{min} [mm]	60	80	100	120	150

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Installation parameters

Annex 6

Installation Instructions

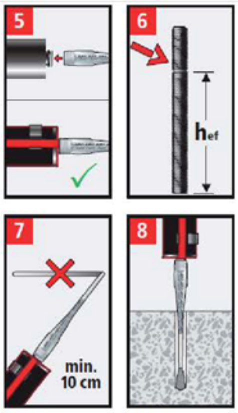


1 Drill a hole to the size and embedment required. Water must be removed prior to cleaning.

2 Starting from the rear of the hole, blow the hole clean with compressed air or a hand pump at least two times.If the rear of the drill hole cannot be reached an extension must be used.The hand pump is allowed for anchor sizes up to drill holediameter 20 mm.

3 Brush the hole with an appropriate sized wirebrush a minimum of two times. If the rear of the drill hole cannot be reached by brush an extension must be used.

4 Please repeat procedure two.

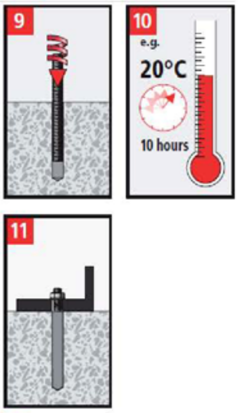


5 Attach a supplied static mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. For every working interruption longer than the recommended gel time, as well as for newcartridges, a new static-mixer must be used.

6 Prior to inserting the threaded rod into the filled hole, the position of the embedment depth must be marked on the anchor rods or rebar. Insert marked rebar/rod into unfilled hole to check if embedment is reached.

7 Prior to dispensing into the anchor hole, squeeze out a minimum of 10cm until the mortar shows a consistent colour.

8 Fill the cleaned hole approximately two-thirds with adhesive starting from the rear of the hole. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets.For embedments larger than 190 mm an extension-nozzle must be used. For overhead and horizontal installation with a diameter larger than 20 mm, use a piston plug and extension nozzle. Observe gel-working times.



9 Push the threaded rod or reinforcing bar into the hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The rod or rebar should be free of dirt, grease, oil or other foreign material.

10 Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured.

11 After full curing, the fixture can be installed. Make sure the max. torque is not exceeded. Ensure that the anchor is fully seated at the bottom of the hole (in case the threaded rod is not marked) and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed.

Table 7: Minimum curing time

Concrete temperature	Gelling-working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
≥ + 5 °C	120 min	50 h	100 h
≥ + 10 °C	90 min	30 h	60 h
≥ + 20 °C	30 min	10 h	20 h
≥ + 30 °C	20 min	6 h	12 h
≥ + 40 °C	12 min	4 h	8 h

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Installation instructions

Annex 7

Steel brush and extension

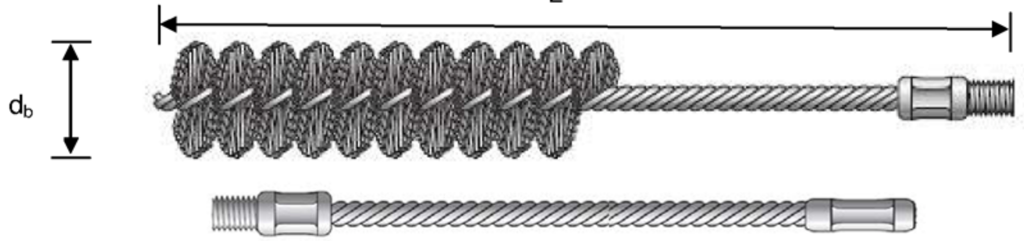
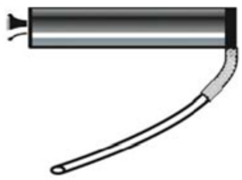


Table 8: Parameter cleaning and setting tools

Threaded rod [mm]	Internal threaded sleeve [mm]	Rebar [mm]	Drill bit ∅ d_0 [mm]	Brush diameters nominal d_b [mm]	Brush diameters minimum $d_{b,min}$ [mm]	Total length L [mm]	Piston plug denom. (∅) [mm]
M8			10	12	10,5	170	-
M10		8	12	14	12,5	170	-
M12	M8	10	14	16	14,5	200	-
		12	16	18	16,5	200	-
M16	M10	14	18	20	18,5	300	-
		16	20	22	20,5	300	-
M20	M12	20	24	26	24,5	300	#24 (22)
M24	M16		28	30	28,5	300	#28 (27)
M27		25	32	34	32,5	300	#28 (29)
M30	M20	28	35	37	35,5	300	#35 (34)
		32	37	40	37,5	300	#35 (36)



Hand pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm

Rec. compressed air tool (min 6 bar)
Drill bit diameter (d_0): 10 mm to 37 mm

Piston plug for overhead or horizontal installation
Drill bit diameter (d_0): 24 mm to 37 mm

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Cleaning and setting tools

Annex 8

Use category:

- Hammer-drilling

- Application in cracked concrete, option 1

- Installation in dry and wet concrete (for embedment depth h_{ef}≤20d)
  Static and quasi-static actions all steel elements
  Anchor seismic performance category C1 for threaded rods and rebar only

- Installation in flooded boreholes (for embedment depth h_{ef}≤12d)
  Only static and quasi-static actions all steel elements

- Overhead installation

Temperature ranges:

- 40°C to +40°C (max. short term temp. +40°C and max. long term temp. +24°C)

- 40°C to +60°C (max. short term temp. +60°C and max. long term temp. +43°C)

- 40°C to +72°C (max. short term temp. +72°C and max. long term temp. +43°C)

Design options:

- Annexes 10 to 21
  - Design according to TR029:
    - For static and quasi-static loading only
    - Design for applications in cracked and non cracked concrete

- Annexes 22 to 33
  - Design according to CEN/TS 1992-4
    - For static and quasi-static loading
    - Design for applications in cracked and non cracked concrete

- Annexes 34 to 35
  - Design for seismic action according to Technical Report "Design of Metal Anchors under Seismic Action"
    - Anchor seismic performance category C1 (see Annex 34)

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 9
Use categories, temperature ranges and design options	

Table 9: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel failure											
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50							
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87						2,86	
Combined pullout and concrete cone failure											
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25											
Temperature range I[4]: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		15	15	15	14	13	12	12	12
		$h_{ef} > 12d$		12	13	14	14	13	12	12	12
	flooded bore hole[5]	$h_{ef} \leq 12d$		15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II[4]: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		9,5	9,5	9,0	8,5	8,0	7,5	7,5	7,5
		$h_{ef} > 12d$		7,5	8,0	8,0	8,5	8,0	7,5	7,5	7,5
	flooded bore hole[5]	$h_{ef} \leq 12d$		9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III[4]: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		8,5	8,5	8,0	7,5	7,0	7,0	6,5	6,5
		$h_{ef} > 12d$		7,0	7,0	7,0	7,5	7,0	7,0	6,5	6,5
	flooded bore hole[5]	$h_{ef} \leq 12d$		8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8 [2]				2,1 [3]			
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		2,1 [3]							
Increasing factors for concrete ψ_c		C30/37		1,04							
		C40/50		1,08							
		C50/60		1,10							
Splitting failure											
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$							
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
		$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$							
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8 [2]				2,1 [3]			
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		2,1 [3]							

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1{,}2$ is included.
[3] The partial safety factor $\gamma_2 = 1{,}4$ is included.
[4] Explanations see chapter 1.2
[5] Applications in flooded holes only for $h_{ef} \leq 12d$ allowed

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Application with threaded rod
Design method A: Characteristic values for tension loads in uncracked concrete

Design TR029

Annex 10

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Table 10: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size threaded rod				M 12	M 16	M 20	M 24	M 27	M 30
Steel failure									
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50					
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87				2,86	
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I[4]: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		7,5	6,5	6,0	5,5	5,5	5,5
		$h_{ef} > 12d$		7,0	6,5	6,0	5,5	5,5	5,5
	flooded bore hole[5]	$h_{ef} \le 12d$		7,5	6,0	5,0	4,5	4,0	4,0
Temperature range II[4]: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5	3,5
		$h_{ef} > 12d$		4,0	4,0	3,5	3,5	3,5	3,5
	flooded bore hole[5]	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5	3,5
Temperature range III[4]: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0	3,0
		$h_{ef} > 12d$		3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole[5]	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0	3,0
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8 [2]	2,1 [3]				
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		2,1 [3]					
Increasing factors for concrete ψ_c		C30/37		1,04					
		C40/50		1,08					
		C50/60		1,10					
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \ge 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$					
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$					
		$h \le 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$					
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$					
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8 [2]	2,1 [3]				
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		2,1 [3]					

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1{,}2$ is included.
[3] The partial safety factor $\gamma_2 = 1{,}4$ is included.
[4] Explanations see chapter 1.2
[5] Applications in flooded holes only for $h_{ef} \le 12d$ allowed

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Table 11: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Concrete pry out failure										
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0							
Partial safety factor	γ_{Mcp} 1)		1,50 2)							
Concrete edge failure										
See chapter 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors										
Partial safety factor	γ_{Mc} 1)		1,50 2)							

1) In absence of other national regulations

2) The partial safety factor γ_2 = 1,0 is included.

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 12
Application with threaded rod Design method A: Characteristic values for shear loads in cracked and uncracked concrete **Design TR029**	

Table 12: Displacements for tension loads [1)]

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,035
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,044	0,052	0,061	0,079	0,096	0,114	0,127	0,140
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,043
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,161
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,032	0,037	0,042	0,048	0,054	0,062
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,21	0,21	0,21	0,21	0,21	0,21
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,037	0,043	0,049	0,055	0,063	0,071
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24

1) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 13: Displacements for shear loads [2)]

Anchor diameters			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Displacement	δ_{V0}	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 13
Application with threaded rod Displacements **Design TR029**	

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Table 14: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar			**Ø 8**	**Ø 10**	**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 25**	**Ø 28**	**Ø 32**
(Properties acc. to Annex 4)											
Characteristic tension resistance, B500B according to DIN488-2: 2009 [5)]	$N_{Rk,s}$	[kN]	28	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,40								
Combined pullout and concrete cone failure											
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25											
Temperature range I[4)]: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$	11	11	10	10	9,5	9,0	9,0	8,5	8,5
		$h_{ef} > 12d$	9,0	9,5	9,0	9,5	9,5	9,0	9,0	8,5	8,5
	flooded bore hole[6)]	$h_{ef} \leq 12d$	11	10	9,0	8,0	7,5	6,5	5,5	5,0	5,0
Temperature range II[4)]: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$	6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,0	5,0
		$h_{ef} > 12d$	5,0	5,5	6,0	5,5	6,0	5,5	5,5	5,0	5,0
	flooded bore hole[6)]	$h_{ef} \leq 12d$	6,5	6,5	6,5	6,0	6,0	5,5	4,5	4,5	4,0
Temperature range III[4)]: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$	6,0	6,0	5,5	5,5	5,5	5,0	4,5	4,5	4,5
		$h_{ef} > 12d$	5,0	5,0	5,0	5,0	5,5	5,0	4,5	4,5	4,5
	flooded bore hole[6)]	$h_{ef} \leq 12d$	6,0	6,0	5,5	5,5	5,5	5,0	4,0	4,0	3,5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8[2)]					2,1[3)]			
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		2,1[3)]								
Increasing factors for concrete ψ_c	C30/37		1,04								
	C40/50		1,08								
	C50/60		1,10								
Splitting failure											
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$								
	$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$								
	$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$								
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$								
Partial safety factor (dry and wet concrete)	γ_{Msp} [1)]		1,8[2)]					2,1[3)]			
Partial safety factor (flooded bore hole)	γ_{Msp} [1)]		2,1[3)]								

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,2 is included.
3) The partial safety factor γ_2 = 1,4 is included.
4) Explanations see chapter 1.2
5) For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $N_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.1).
6) Applications in flooded holes only for $h_{ef} \leq$ 12d allowed

Regarding design of post-installed rebar as anchor see chapter 4.2.

Table 15: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø28	Ø32
Steel failure (Properties acc. to Annex 4)									
Characteristic tension resistance, B500B according to DIN488-2: 2009 [5)]	$N_{Rk,s}$	[kN]	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ [1)]		1,40						
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I[4)]: 40°C/24°C	dry and wet concrete	$h_{ef}\leq 12d$ $h_{ef}>12d$	5,5 5,0	4,5 4,5	4,5 4,5	4,0 4,0	3,5 3,5	3,5 3,5	3,5 3,5
	flooded bore hole[6)]	$h_{ef}\leq 12d$	5,5	4,5	4,0	3,5	3,0	3,0	3,0
Temperature range II[4)]: 60°C/43°C	dry and wet concrete	$h_{ef}\leq 12d$ $h_{ef}>12d$	3,0 2,5	3,0 3,0	2,5 2,5	2,5 2,5	2,0 2,0	2,0 2,0	2,0 2,0
	flooded bore hole[6)]	$h_{ef}\leq 12d$	3,0	3,0	2,5	2,5	2,0	2,0	2,0
Temperature range III[4)]: 72°C/43°C	dry and wet concrete	$h_{ef}\leq 12d$ $h_{ef}>12d$	3,0 2,5	2,5 2,5	2,5 2,5	2,0 2,0	2,0 2,0	2,0 2,0	2,0 2,0
	flooded bore hole[6)]	$h_{ef}\leq 12d$	3,0	2,5	2,5	2,0	2,0	2,0	2,0
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8[2)]			2,1[3)]			
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ [1)]		2,1[3)]						
Increasing factors for concrete ψ_c	C30/37		1,04						
	C40/50		1,08						
	C50/60		1,10						
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]	$h\geq 2\cdot h_{ef}$		$1{,}0\cdot h_{ef}$						
	$2{,}0\cdot h_{ef}>h>1{,}3\cdot h_{ef}$		$5\cdot h_{ef}-2\cdot h$						
	$h\leq 1{,}3\cdot h_{ef}$		$2{,}4\cdot h_{ef}$						
Characteristic spacing	$s_{cr,sp}$	[mm]	$2\cdot c_{cr,sp}$						
Partial safety factor (dry and wet concrete)	γ_{Msp} [1)]		1,8[2)]			2,1[3)]			
Partial safety factor (flooded bore hole)	γ_{Msp} [1)]		2,1[3)]						

[1)] In absence of other national regulations
[2)] The partial safety factor γ_2 = 1,2 is included.
[3)] The partial safety factor γ_2 = 1,4 is included.
[4)] Explanations see chapter 1.2
[5)] For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $N_{Rk,s}$ shall be determined acc. to Technical Report TR 029, equation (5.1).
[6)] Applications in flooded holes only for $h_{ef}\leq$ 12d allowed

Regarding design of post-installed rebar as anchor see chapter 4.2.

Table 16: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Steel failure without lever arm (Properties acc. Annex 4)											
Characteristic shear resistance, B500B according to DIN488-2: 2009 3)	$V_{Rk,s}$	[kN]	14	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Steel failure with lever arm (Properties acc. Annex 4)											
Characteristic bending moment, B500B according to DIN488-2: 2009 4)	$M^0_{Rk,s}$	[Nm]	33	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Concrete pry out failure											
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0								
Partial safety factor	γ_{Mcp} 1)		1,50 2)								
Concrete edge failure											
See chapter 5.2.3.4 of Technical Report TR 029 for the design of bonded anchors											
Partial safety factor	γ_{Mc} 1)		1,50 2)								

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,0 is included.
3) For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $V_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.5).
4) For reinforcing bars, which do not comply with DIN 488: The characteristic resistance $M^0_{Rk,s}$ shall be determined acc. to Technical Report TR 029, Equation (5.6b).

Regarding design of post-installed rebar as anchor see chapter 4.2.

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Table 17: Displacements for tension loads [1)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Temperature range 40°C/24°C for uncracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,011	0,013	0,015	0,018	0,020	0,024	0,030	0,033	0,037
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,044	0,052	0,061	0,070	0,079	0,096	0,118	0,132	0,149
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,043
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,172
Temperature range 40°C/24°C for cracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,032	0,035	0,037	0,042	0,049	0,056	0,064
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,21	0,21	0,21	0,21	0,21	0,21	0,21
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,037	0,040	0,043	0,049	0,056	0,064	0,073
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24	0,24

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 18: Displacements for shear loads [2)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Displacement	δ_{V0}	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,07	0,06	0,06	0,05	0,05	0,04	0,04

[2)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

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Table 19: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size internal threaded sleeve				M 8	M 10	M 12	M 16	M 20
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25								
Temperature range I[5]: 40°C/24°C	dry and wet concrete	h_{ef}≤12d		15,0	14,0	13,0	12,0	12,0
	flooded bore hole	h_{ef}≤12d		13,0	10,0	9,5	8,5	7,0
Temperature range II[5]: 60°C/43°C	dry and wet concrete	h_{ef}≤12d		9,0	8,5	8,0	7,5	7,5
	flooded bore hole	h_{ef}≤12d		9,0	8,5	7,5	7,0	6,0
Temperature range III[5]: 72°C/43°C	dry and wet concrete	h_{ef}≤12d		8,0	7,5	7,0	7,0	6,5
	flooded bore hole	h_{ef}≤12d		8,0	7,5	7,0	6,0	5,5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8[3]		2,1[4]		
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		2,1[4]				
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Splitting failure								
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$				
		$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$				
		$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8[3]		2,1[4]		
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		2,1[4]				

[1] In absence of other national regulations
[2] The partial safety factor γ_2 = 1,0 is included.
[3] The partial safety factor γ_2 = 1,2 is included.
[4] The partial safety factor γ_2 = 1,4 is included.
[5] Explanations see chapter 1.2

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 18
Application with internal threaded sleeve Design method A: Characteristic values for tension loads in uncracked concrete **Design TR029**	

Table 20: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve				**M 8**	**M 10**	**M 12**	**M 16**	**M 20**
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ [1]		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25								
Temperature range I[5]: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		7,5	6,5	6,0	5,5	5,5
	flooded bore hole	$h_{ef} \leq 12d$		7,5	6,0	5,0	4,5	4,0
Temperature range II[5]: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5
	flooded bore hole	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5
Temperature range III[5]: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0
	flooded bore hole	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		1,8[3]		2,1[4]		
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1]		2,1[4]				
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Splitting failure								
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$				
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$				
		$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} [1]		1,8[3]		2,1[4]		
Partial safety factor (flooded bore hole)		γ_{Msp} [1]		2,1[4]				

[1] In absence of other national regulations
[2] The partial safety factor $\gamma_2 = 1{,}0$ is included.
[3] The partial safety factor $\gamma_2 = 1{,}2$ is included.
[4] The partial safety factor $\gamma_2 = 1{,}4$ is included.
[5] Explanations see chapter 1.2

Table 21: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm							
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25				
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56				
Steel failure with lever arm							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,25				
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454
Partial safety factor	$\gamma_{Ms,V}$ [1)]		1,56				
Concrete pryout failure							
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0				
Partial safety factor	γ_{Mcp} [1)]		1,50				
Concrete edge failure							
See chapter 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors							
Partial safety factor	γ_{Mc} [1)]		1,50				

[1)] In absence of other national regulations

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Table 22: Displacements for tension loads [1)]

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Temperature range 40°C/24°C for uncracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,015	0,020	0,024	0,029	0,035
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,061	0,079	0,096	0,114	0,140
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,018	0,023	0,028	0,033	0,043
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,070	0,091	0,111	0,131	0,161
Temperature range 40°C/24°C for cracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,032	0,037	0,042	0,048	0,055
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,210	0,210	0,210	0,210	0,210
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,037	0,043	0,049	0,055	0,063
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,240	0,240	0,240	0,240	0,240

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd}$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd}$ / 1,4;
(τ_{Sd}: design bond strength)

Table 23: Displacements for shear loads[2)]

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Displacement	δ_{V0}	[mm/ kN]	0,05	0,04	0,04	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,08	0,06	0,06	0,05	0,05

[2)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{V\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

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Table 24: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel failure											
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,50							
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ 1)		1,87						2,86	
Combined pullout and concrete cone failure											
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25											
Temperature range I 4): 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		15	15	15	14	13	12	12	12
		$h_{ef} > 12d$		12	13	14	14	13	12	12	12
	flooded bore hole 5)	$h_{ef} \leq 12d$		15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II 4): 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		9,5	9,5	9,0	8,5	8,0	7,5	7,5	7,5
		$h_{ef} > 12d$		7,5	8,0	8,0	8,5	8,0	7,5	7,5	7,5
	flooded bore hole 5)	$h_{ef} \leq 12d$		9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III 4): 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		8,5	8,5	8,0	7,5	7,0	7,0	6,5	6,5
		$h_{ef} > 12d$		7,0	7,0	7,0	7,5	7,0	7,0	6,5	6,5
	flooded bore hole 5)	$h_{ef} \leq 12d$		8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ 1)		1,8 2)				2,1 3)			
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ 1)		2,1 3)							
Increasing factors for concrete ψ_c		C30/37		1,04							
		C40/50		1,08							
		C50/60		1,10							
Factor ref. bond strength $\tau_{Rk,c}$		k_8		10,1							
Factor concrete cone equation		k_{ucr}		10,1							
Splitting failure											
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$							
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$							
		$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$							
Partial safety factor (dry and wet concrete)		γ_{Msp} 1)		1,8 2)				2,1 3)			
Partial safety factor (flooded bore hole)		γ_{Msp} 1)		2,1 3)							

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1{,}2$ is included.
3) The partial safety factor $\gamma_2 = 1{,}4$ is included.
4) Explanations see chapter 1.2
5) Applications in flooded holes only for $h_{ef} \leq 12d$ allowed

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex 22

Application with threaded rod
Design method A: Characteristic values for tension loads in uncracked concrete

Design CEN/TS 1992-4

Table 25: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size threaded rod				M 12	M 16	M 20	M 24	M 27	M 30
Steel failure									
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	67	125	196	282	368	449
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,50					
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		$N_{Rk,s}$	[kN]	59	110	171	247	230	281
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,87				2,86	
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I[4)]: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		7,5	6,5	6,0	5,5	5,5	5,5
		$h_{ef} > 12d$		7,0	6,5	6,0	5,5	5,5	5,5
	flooded bore hole[5)]	$h_{ef} \le 12d$		7,5	6,0	5,0	4,5	4,0	4,0
Temperature range II[4)]: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5	3,5
		$h_{ef} > 12d$		4,0	4,0	3,5	3,5	3,5	3,5
	flooded bore hole[5)]	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5	3,5
Temperature range III[4)]: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0	3,0
		$h_{ef} > 12d$		3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole[5)]	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0	3,0
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8 [2)]	2,1 [3)]				
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		2,1 [3)]					
Increasing factors for concrete ψ_c		C30/37		1,04					
		C40/50		1,08					
		C50/60		1,10					
Factor ref. bond strength $\tau_{Rk,c}$		k_8		7,2					
Factor concrete cone equation		k_{cr}		7,2					
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \ge 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$					
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$					
		$h \le 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$					
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$					
Partial safety factor (dry and wet concrete)		γ_{Msp} [1)]		1,8 [2)]	2,1 [3)]				
Partial safety factor (flooded bore hole)		γ_{Msp} [1)]		2,1 [3)]					

[1)] In absence of other national regulations
[2)] The partial safety factor $\gamma_2 = 1{,}2$ is included.
[3)] The partial safety factor $\gamma_2 = 1{,}4$ is included.
[4)] Explanations see chapter 1.2
[5)] Applications in flooded holes only for $h_{ef} \le 12d$ allowed

For seismic design see Annexes 34 and 35.

Table 26: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Steel failure without lever arm										
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98	141	184	224
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86	124	115	140
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Steel failure with lever arm										
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324	560	833	1123
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	1797
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25							
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454	784	832	1125
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56						2,38	
Factor bending	k_2		0,80							
Concrete pry out failure										
Factor k_3			2,0							
Partial safety factor	γ_{Mcp} 1)		1,50 2)							
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4							
Partial safety factor	γ_{Mc} 1)		1,50 2)							

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,0 is included.

For seismic design see Annexes 34 and 35.

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Table 27: Displacements for tension loads [1)]

Anchor size threaded rod			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,035
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,044	0,052	0,061	0,079	0,096	0,114	0,127	0,140
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,043
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,161
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,032	0,037	0,042	0,048	0,054	0,062
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,21	0,21	0,21	0,21	0,21	0,21
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25										
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,037	0,043	0,049	0,055	0,063	0,071
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1,4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1,4$;
(τ_{Sd}: design bond strength)

Table 28: Displacements for shear loads [2)]

Anchor diameters			M 8	M 10	M 12	M 16	M 20	M 24	M 27	M 30
Displacement	δ_{V0}	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

[2)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1,4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1,4$;
(V_d: design shear load)

Table 29: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure (Properties acc. to Annex 4)											
Characteristic tension resistance, B500B according to DIN488-2: 2009	$N_{Rk,s}$	[kN]	28	43	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,40								
Combined pullout and concrete cone failure											
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25											
Temperature range I 4): 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$	11	11	10	10	9,5	9,0	9,0	8,5	8,5
		$h_{ef} > 12d$	9,0	9,5	9,0	9,5	9,5	9,0	9,0	8,5	8,5
	flooded bore hole 5)	$h_{ef} \leq 12d$	11	10	9,0	8,0	7,5	6,5	5,5	5,0	5,0
Temperature range II 4): 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$	6,5	6,5	6,5	6,0	6,0	5,5	5,5	5,0	5,0
		$h_{ef} > 12d$	5,0	5,5	6,0	5,5	6,0	5,5	5,5	5,0	5,0
	flooded bore hole 5)	$h_{ef} \leq 12d$	6,5	6,5	6,5	6,0	6,0	5,5	4,5	4,5	4,0
Temperature range III 4): 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$	6,0	6,0	5,5	5,5	5,5	5,0	4,5	4,5	4,5
		$h_{ef} > 12d$	5,0	5,0	5,0	5,0	5,5	5,0	4,5	4,5	4,5
	flooded bore hole 5)	$h_{ef} \leq 12d$	6,0	6,0	5,5	5,5	5,5	5,0	4,0	4,0	3,5
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ 1)		1,8 2)					2,1 3)			
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ 1)		2,1 3)								
Increasing factors for concrete ψ_c	C30/37		1,04								
	C40/50		1,08								
	C50/60		1,10								
Factor ref. bond strength $\tau_{Rk,c}$	k_8		10,1								
Factor concrete cone equation	k_{ucr}		10,1								
Splitting failure											
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$								
	$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$								
	$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$								
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$								
Partial safety factor (dry and wet concrete)	γ_{Msp} 1)		1,8 2)					2,1 3)			
Partial safety factor (flooded bore hole)	γ_{Msp} 1)		2,1 3)								

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1{,}2$ is included.
3) The partial safety factor $\gamma_2 = 1{,}4$ is included.
4) Explanations see chapter 1.2
5) Applications in flooded holes only for $h_{ef} \leq 12d$ allowed

Regarding design of post-installed rebar as anchor see chapter 4.2.

Table 30: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø28	Ø32
Steel failure (Properties acc. to Annex 4)									
Characteristic tension resistance, B500B according to DIN488-2: 2009	$N_{Rk,s}$	[kN]	62	85	111	173	270	339	442
Partial safety factor	$\gamma_{Ms,N}$ 1)		1,40						
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I 4): 40°C/24°C	dry and wet concrete	$h_{ef}≤12d$	5,5	4,5	4,5	4,0	3,5	3,5	3,5
		$h_{ef}>12d$	5,0	4,5	4,5	4,0	3,5	3,5	3,5
	flooded bore hole 5)	$h_{ef}≤12d$	5,5	4,5	4,0	3,5	3,0	3,0	3,0
Temperature range II 4): 60°C/43°C	dry and wet concrete	$h_{ef}≤12d$	3,0	3,0	2,5	2,5	2,0	2,0	2,0
		$h_{ef}>12d$	2,5	3,0	2,5	2,5	2,0	2,0	2,0
	flooded bore hole 5)	$h_{ef}≤12d$	3,0	3,0	2,5	2,5	2,0	2,0	2,0
Temperature range III 4): 72°C/43°C	dry and wet concrete	$h_{ef}≤12d$	3,0	2,5	2,5	2,0	2,0	2,0	2,0
		$h_{ef}>12d$	2,5	2,5	2,5	2,0	2,0	2,0	2,0
	flooded bore hole 5)	$h_{ef}≤12d$	3,0	2,5	2,5	2,0	2,0	2,0	2,0
Partial safety factor (dry and wet concrete)	$\gamma_{Mp} = \gamma_{Mc}$ 1)		1,8 2)			2,1 3)			
Partial safety factor (flooded bore hole)	$\gamma_{Mp} = \gamma_{Mc}$ 1)		2,1 3)						
Increasing factors for concrete ψ_c	C30/37		1,04						
	C40/50		1,08						
	C50/60		1,10						
Factor ref. bond strength $\tau_{Rk,c}$	k_8		7,2						
Factor concrete cone equation	k_{cr}		7,2						
Splitting failure									
Characteristic edge distance $c_{cr,sp}$ [mm]	$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$						
	$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$						
	$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$						
Characteristic spacing	$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$						
Partial safety factor (dry and wet concrete)	γ_{Msp} 1)		1,8 2)			2,1 3)			
Partial safety factor (flooded bore hole)	γ_{Msp} 1)		2,1 3)						

1) In absence of other national regulations
2) The partial safety factor γ_2 = 1,2 is included.
3) The partial safety factor γ_2 = 1,4 is included.
4) Explanations see chapter 1.2
5) Applications in flooded holes only for h_{ef}≤ 12d allowed

Regarding design of post-installed rebar as anchor see chapter 4.2

For seismic design see Annexes 34 and 35.

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Table 31: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure without lever arm (Properties acc. Annex 4)											
Characteristic shear resistance, B500B according to DIN488-2: 2009	$V_{Rk,s}$	[kN]	14	22	31	42	55	86	135	169	221
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Steel failure with lever arm (Properties acc. Annex 4)											
Characteristic bending moment, B500B according to DIN488-2: 2009	$M^0_{Rk,s}$	[Nm]	33	65	112	178	265	518	1012	1422	2123
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,5								
Factor bending	k_2		0,8								
Concrete pry out failure											
Factor k_3			2,0								
Partial safety factor	γ_{Mcp} 1)		1,50 2)								
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4								
Partial safety factor	γ_{Mc} 1)		1,50 2)								

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1,0$ is included.

Regarding design of post-installed rebar as anchor see chapter 4.2

For seismic design see Annexes 34 and 35.

Table 32: Displacements for tension loads [1)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Temperature range 40°C/24°C for uncracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,011	0,013	0,015	0,018	0,020	0,024	0,030	0,033	0,037
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,044	0,052	0,061	0,070	0,079	0,096	0,118	0,132	0,149
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,043
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,172
Temperature range 40°C/24°C for cracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,032	0,035	0,037	0,042	0,049	0,056	0,064
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,21	0,21	0,21	0,21	0,21	0,21	0,21
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25											
Displacement	δ_{N0}	[mm/(N/mm²)]	-	-	0,037	0,040	0,043	0,049	0,056	0,064	0,073
Displacement	$\delta_{N\infty}$	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24	0,24

[1)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd}$ / 1,4;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd}$ / 1,4;
(τ_{Sd}: design bond strength)

Table 33: Displacements for shear loads [2)]

Anchor size reinforcing bar			∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Displacement	δ_{V0}	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/kN]	0,09	0,08	0,07	0,06	0,06	0,05	0,05	0,04	0,04

[2)] Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d$ / 1,4;
Displacement for long term load = $\delta_{V\infty} \cdot V_d$ / 1,4;
(V_d: design shear load)

**Table 34: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete**

Anchor size internal threaded sleeve				M 8	M 10	M 12	M 16	M 20
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25								
Temperature range I[5)]: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		15,0	14,0	13,0	12,0	12,0
	flooded bore hole	$h_{ef} \leq 12d$		13,0	10,0	9,5	8,5	7,0
Temperature range II[5)]: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		9,0	8,5	8,0	7,5	7,5
	flooded bore hole	$h_{ef} \leq 12d$		9,0	8,5	7,5	7,0	6,0
Temperature range III[5)]: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		8,0	7,5	7,0	7,0	6,5
	flooded bore hole	$h_{ef} \leq 12d$		8,0	7,5	7,0	6,0	5,5
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8[3)]		2,1[4)]		
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		2,1[4)]				
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Factor ref. bond strength $\tau_{Rk,c}$		k_8		10,1				
Factor concrete cone equation		k_{ucr}		10,1				
Splitting failure								
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1,0 \cdot h_{ef}$				
		$2,0 \cdot h_{ef} > h > 1,3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$				
		$h \leq 1,3 \cdot h_{ef}$		$2,4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} [1)]		1,8[3)]		2,1[4)]		
Partial safety factor (flooded bore hole)		γ_{Msp} [1)]		2,1[4)]				

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1,0$ is included.
3) The partial safety factor $\gamma_2 = 1,2$ is included.
4) The partial safety factor $\gamma_2 = 1,4$ is included.
5) Explanations see chapter 1.2

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex 30

Application with internal threaded sleeve
Design method A: Characteristic values for tension loads in uncracked concrete

Design CEN/TS 1992-4

Table 35: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve				M 8	M 10	M 12	M 16	M 20
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure								
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s}$	[kN]	18	29	42	78	122
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s}$	[kN]	29	46	67	125	196
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,50				
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and property class 70 (≤ M24)		$N_{Rk,s}$	[kN]	26	41	59	110	171
Partial safety factor		$\gamma_{Ms,N}$ [1)]		1,87				
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25								
Temperature range I[5)]: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		7,5	6,5	6,0	5,5	5,5
	flooded bore hole	$h_{ef} \leq 12d$		7,5	6,0	5,0	4,5	4,0
Temperature range II[5)]: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5
	flooded bore hole	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5
Temperature range III[5)]: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0
	flooded bore hole	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0
Partial safety factor (dry and wet concrete)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		1,8[3)]		2,1[4)]		
Partial safety factor (flooded bore hole)		$\gamma_{Mp} = \gamma_{Mc}$ [1)]		2,1[4)]				
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Factor ref. bond strength $\tau_{Rk,c}$		k_8		7,2				
Factor concrete cone equation		k_{cr}		7,2				
Splitting failure								
Characteristic edge distance $c_{cr,sp}$ [mm]		$h \geq 2 \cdot h_{ef}$		$1{,}0 \cdot h_{ef}$				
		$2{,}0 \cdot h_{ef} > h > 1{,}3 \cdot h_{ef}$		$5 \cdot h_{ef} - 2 \cdot h$				
		$h \leq 1{,}3 \cdot h_{ef}$		$2{,}4 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,sp}$	[mm]	$2 \cdot c_{cr,sp}$				
Partial safety factor (dry and wet concrete)		γ_{Msp} [1)]		1,8[3)]		2,1[4)]		
Partial safety factor (flooded bore hole)		γ_{Msp} [1)]		2,1[4)]				

1) In absence of other national regulations
2) The partial safety factor $\gamma_2 = 1{,}0$ is included.
3) The partial safety factor $\gamma_2 = 1{,}2$ is included.
4) The partial safety factor $\gamma_2 = 1{,}4$ is included.
5) Explanations see chapter 1.2

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex 31
Application with internal threaded sleeve Design method A: Characteristic values for tension loads in cracked concrete **Design CEN/TS 1992-4**	

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Table 36: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm							
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s}$	[kN]	9	15	21	39	61
Characteristic shear resistance, Steel, property class 8.8	$V_{Rk,s}$	[kN]	15	23	34	63	98
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25				
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$V_{Rk,s}$	[kN]	13	20	30	55	86
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56				
Steel failure with lever arm							
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s}$	[Nm]	19	37	65	166	324
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s}$	[Nm]	30	60	105	266	519
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,25				
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)	$M^0_{Rk,s}$	[Nm]	26	52	92	232	454
Partial safety factor	$\gamma_{Ms,V}$ 1)		1,56				
Factor bending	k_2		0,8				
Concrete pryout failure							
Factor k_3			2,0				
Partial safety factor	γ_{Mcp} 1)		1,50				
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4				
Partial safety factor	γ_{Mc} 1)		1,50				

1) In absence of other national regulations

Table 37: Displacements for tension loads[1)]

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Temperature range 40°C/24°C for uncracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,015	0,020	0,024	0,029	0,035
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,061	0,079	0,096	0,114	0,140
Temperature range 72°C/43°C and 60°C/43°C for uncracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,018	0,023	0,028	0,033	0,043
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,070	0,091	0,111	0,131	0,161
Temperature range 40°C/24°C for cracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,032	0,037	0,042	0,048	0,055
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,210	0,210	0,210	0,210	0,210
Temperature range 72°C/43°C and 60°C/43°C for cracked concrete C20/25							
Displacement	δ_{N0}	[mm/ (N/mm²)]	0,037	0,043	0,049	0,055	0,063
Displacement	$\delta_{N\infty}$	[mm/ (N/mm²)]	0,240	0,240	0,240	0,240	0,240

1) Calculation of the displacement for design load
Displacement for short term load = $\delta_{N0} \cdot \tau_{Sd} / 1{,}4$;
Displacement for long term load = $\delta_{N\infty} \cdot \tau_{Sd} / 1{,}4$;
(τ_{Sd}: design bond strength)

Table 38: Displacements for shear loads[2)]

Anchor size internal threaded sleeve			M 8	M 10	M 12	M 16	M 20
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Displacement	δ_{V0}	[mm/ kN]	0,05	0,04	0,04	0,03	0,03
Displacement	$\delta_{V\infty}$	[mm/ kN]	0,08	0,06	0,06	0,05	0,05

2) Calculation of the displacement for design load
Displacement for short term load = $\delta_{V0} \cdot V_d / 1{,}4$;
Displacement for long term load = $\delta_{V\infty} \cdot V_d / 1{,}4$;
(V_d: design shear load)

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Seismic design according to Technical Report "Design of Metal Anchors under Seismic Action":

The decision of selection of a higher seismic performance category than given in Table 39 is in the responsibility of each individual Member State.

Furthermore, the values $a_g \cdot S$ assigned to the seismicity level may be different in the National Annexes to EN 1998-1: 2004 (EC8) compared to the values given in Table 39.

The recommended category C1 and C2 given in Table 39 are given in the case that no National Requirements are defined.

Table 39: Recommended seismic performance categories for anchors

Seismicity		Importance class according to EN 1998-1: 2004, 4.2.5			
	$a_g \cdot S$ 2)	I	II	III	IV
Very low 1)	$a_g \cdot S \leq 0{,}05 \cdot g$	no additional requirement			
Low 1)	$0{,}05 \cdot g < a_g \cdot S \leq 0{,}1 \cdot g$	C1	C1 3) or C2 4)		C2
	$a_g \cdot S > 0{,}1 \cdot g$	C1	C2		

1) Definition according to EN 1998-1: 2004, 3.2.1
2) $a_g = \gamma_1 \cdot a_{gR}$ Design ground acceleration on type A ground (Ground types as defined in EN1998-1:2004, Table 3.1
$\gamma_1 =$ Importance factor (see EN1998-1: 2004, 4.2.5)
$a_{gR} =$ Reference peak ground acceleration on type A ground (see EN1998-1: 2004, 3.2.1)
S= Soil factor (e.g. according to EN1998-1: 2004, 4.2.5)
3) C1 for fixing of non-structural elements to structures
4) C2 for fixing of structural elements to structures

Seismic design equations to calculate characteristic seismic resistance for the relevant failure mode:

Basic characteristic seismic resistance $R^0_{k,seis}$

Tension: $R^0_{k,seis} = \alpha_{N,seis} \cdot R^0_k$
with $R^0_k = N_{Rk,s}, \tau_{Rk,cr}, N_{Rk,c}, N_{Rk,sp}$
$\alpha_{N,seis} =$ see Table 41 or Table 42 for $N_{Rk,s}$ and $\tau_{Rk,cr}$
$\alpha_{N,seis} =$ 1,0 for $N_{Rk,c}$ and $N_{Rk,sp}$

Shear: $R^0_{k,seis} = \alpha_{V,seis} \cdot R^0_k$
with $R^0_k = V_{Rk,s}, V_{Rk,c}, V_{Rk,cp}$
$\alpha_{V,seis} =$ see Table 41 or Table 42 for $V_{Rk,s}$
$\alpha_{V,seis} =$ 1,0 for $V_{Rk,c}$ and $V_{Rk,cp}$

Characteristic seismic resistance $R_{k,seis}$

Tension: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot R^0_{k,seis}$
Shear: $R_{k,seis} = \alpha_{gap} \cdot \alpha_{seis} \cdot R^0_{k,seis}$
with $\alpha_{seis} =$ see Table 40
$\alpha_{gap} =$ see Table 40

Seismic design resistance $R_{d,seis}$

$R_{d,seis} = R_{k,seis} / \gamma_{M,seis}$
with $\gamma_{M,seis} = \gamma_M$

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Table 40: Reduction factors α_{gap} und α_{seis} for resistance under seismic actions

Loading	Failure modes	α_{gap}	α_{seis} single fastener	α_{seis} fastener group
Tension	Steel failure	1,0	1,0	1,0
	Combined pullout and concrete failure	1,0	1,0	0,85
	Concrete cone failure	1,0	0,85	0,75
	Splitting failure	1,0	1,0	0,85
Shear	Steel failure without lever arm	0,5[1)]	1,0	0,85
	Steel failure with lever arm	-[2)]	-[2)]	-[2)]
	Concrete edge failure	0,5[1)]	1,0	0,85
	Concrete pryout failure	0,5[1)]	0,85	0,75

[1)] The limitation for the size of the clearance hole is given in TR029 Table 4.1
α_{gap}= 1,0 in case of no clearance between fastener and fixture
[2)] No performance determined

Table 41: Reduction factors for seismic design category C1 for *threaded rods*

Anchor size threaded rod			M 12	M 16	M 20	M24	M 27	M 30
Tension load								
Steel failure								
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0					
Compbined pullout and concrete cone failure								
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,92	0,95	0,95	1,0	1,0	1,0
Shear load without lever arm								
Seismic reduction factor	$\alpha_{V,seis}$	[-]	0,70					

Table 42: Reduction factors for seismic design category C1 for *reinforcing bars*

Anchor size reinforcing bar			∅ 12	∅ 14	∅ 16	∅ 20	∅ 25	∅ 28	∅ 32
Tension load									
Steel failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	1,0						
Combined pullout and concrete cone failure									
Seismic reduction factor	$\alpha_{N,seis}$	[-]	0,92	0,92	0,95	0,95	1,0	1,0	1,0
Shear load – Steel failure without lever arm									
Seismic reduction factor	$\alpha_{V,seis}$	[-]	0,70						

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Reduction factors for threaded rods and rebar
for design under seismic actions

Annex 35