Deutsches Institut für Bautechnik

Approval body for construction products and types of construction

Bautechnisches Prüfamt

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European Technical Assessment ETA-08/0376 of 4 May 2015

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	Powers PURE150-PRO injection resin with anchor rod for concrete
Product family to which the construction product belongs	Bonded anchor for use in concrete
Manufacturer	Powers Fasteners Europe Stanley Black&Decker Deutschland GmbH Black-&-Decker Str. 40 65510 Idstein DEUTSCHLAND
Manufacturing plant	Powers Fasteners Europe BV Factory 2, Germany
This European Technical Assessment contains	39 pages including 3 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 5: "Bonded anchors", April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.

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Specific Part

1 Technical description of the 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 element consist of a commercial threaded rod with washer and hexagon nut in the range of M8 to M30 or a reinforcing bar in the range of diameter 8 to 32 mm or threaded sleeves with internal thread of sizes M8 to M16.

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.

The product description is given in Annex A.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 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.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

Essential characteristic	Performance
Characteristic resistance for design according to TR 029	See Annex C 1 to C9
Characteristic resistance for design according to CEN/TS 1992-4:2009	See Annex C 10 to C 18
Characteristic resistance for design according to TR 045	See Annex C 22 to C 27
Displacements under tension and shear loads	See Annex C 19 to C 27

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Anchorages satisfy requirements for Class A1
Resistance to fire	No performance determined (NPD)

3.3 Hygiene, health and the environment (BWR 3)

Not applicable.

3.4 Safety in use (BWR 4)

The essential characteristics regarding Safety in use are included under the Basic Works Requirement Mechanical resistance and stability.

3.5 Protection against noise (BWR 5)

Not applicable.

3.6 Energy economy and heat retention (BWR 6)

Not applicable.

3.7 Sustainable use of natural resources (BWR 7)

The sustainable use of natural resources was not investigated.

3.8 General aspects

The verification of durability is part of testing the essential characteristics. Durability is only ensured if the specifications of intended use according to Annex B are taken into account.

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

According to Decision of the Commission of 24 June 1996 (96/582/EC) (OJ L 254 of 08.10.96 p. 62-65), the system of assessment and verification of constancy of performance (see Annex V and Article 65 Paragraph 2 to Regulation (EU) No 305/2011) given in the following table applies.

Product	Intended use	Level or class	System
Metal anchors for use in concrete (heavy-duty type)	For fixing and/or supporting concrete structural elements or heavy units such as cladding and suspended ceilings	—	1

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 4 May 2015 by Deutsches Institut für Bautechnik

Andreas Kummerow
p.p. Head of Department

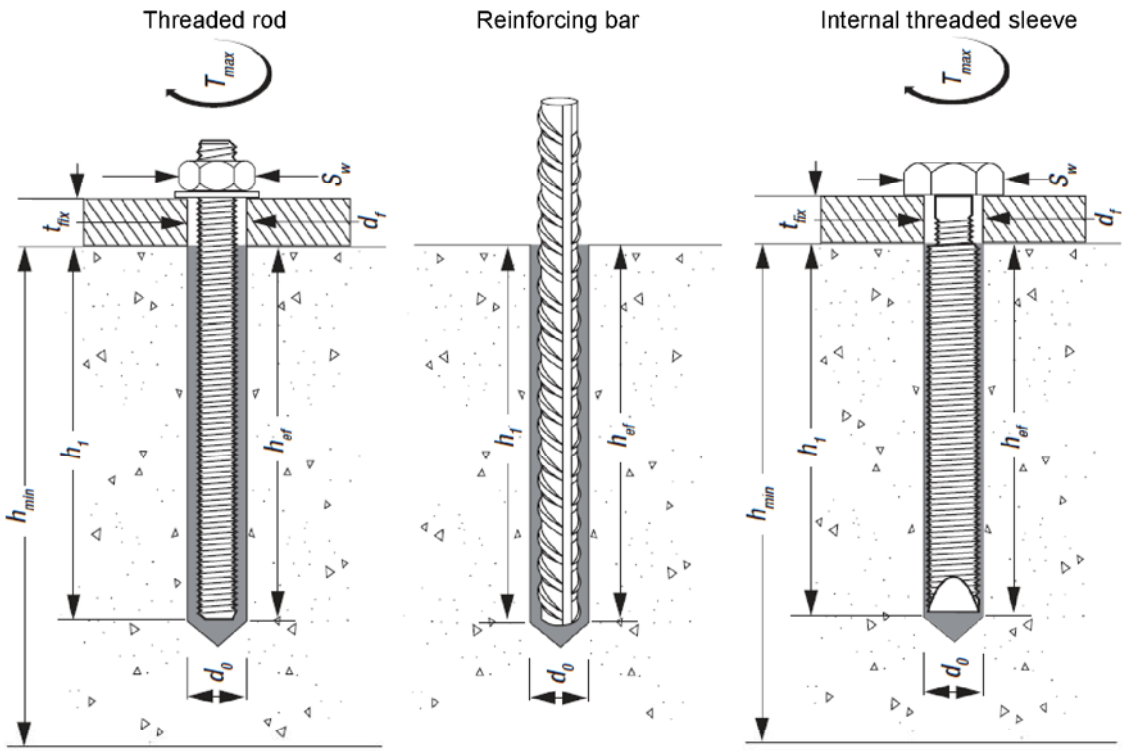
beglaubigt:
Lange

Deutsches Institut für Bautechnik

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

Reinforcing bar ∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 24, ∅ 25, ∅ 28 and ∅ 32

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



POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex A1
Product description Product and Installation	

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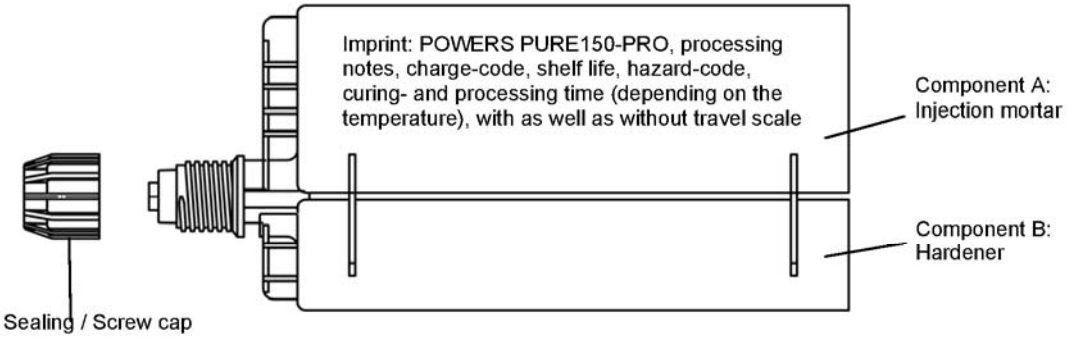
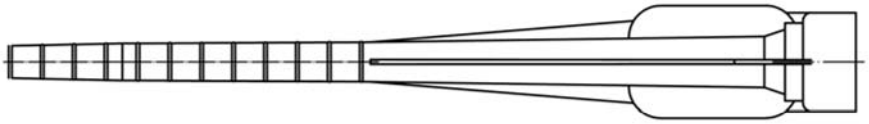
Cartridge: POWERS PURE150-PRO

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 A2
Product description Product (Injection mortar)	

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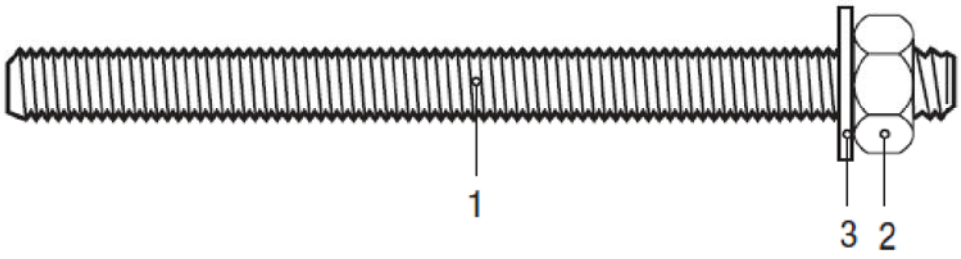
Table A1: Materials (Threaded rod)



Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042:1999 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009		
1	Anchor rod	Steel acc. EN 10087:1998 or EN 10263:2001 Property class 4.6, 5.8, 8.8 acc. EN 1993-1-8:2005+AC:2009 A_5 > 8% fracture elongation, $f_{uk} = f_{ub}$ $f_{yk} = f_{yb}$
2	Hexagon nut EN ISO 4032:2012	Steel acc. EN 10087:1998 or EN 10263:2001 Property class 4 (for class 4.6 rod) Property class 5 (for class 5.8 rod) Property class 8 (for class 8.8 rod) EN ISO 898-2:2012
3	Washer, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Steel, zinc plated
Stainless steel		
1	Anchor rod	Material 1.4401 / 1.4571, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506-1:2009 ≤ M24: Property class 70 EN ISO 3506-1:2009 A_5 > 8% fracture elongation, $f_{uk} = R_{m,min}$ $f_{yk} = R_{p0,2,min}$
2	Hexagon nut EN ISO 4032:2012	Material 1.4401 / 1.4571 EN 10088-1:2005, > M24: Property class 50 (for class 50 rod) EN ISO 3506-2:2009 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506-2:2009
3	Washer, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Material 1.4401 or 1.4571, EN 10088-1:2005
High corrosion resistance steel		
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:2005, > M24: Property class 50 EN ISO 3506-1:2009 ≤ M24: Property class 70 EN ISO 3506-1:2009 A_5 > 8% fracture elongation, $f_{uk} = R_{m,min}$ $f_{yk} = R_{p0,2,min}$
2	Hexagon nut EN ISO 4032:2012	Material 1.4529 / 1.4565 EN 10088-1:2005, > M24: Property class 50 (for class 50 rod) EN ISO 3506-2:2009 ≤ M24: Property class 70 (for class 70 rod) EN ISO 3506-2:2009
3	Washer, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Material 1.4529 / 1.4565, EN 10088-1:2005

Commercial standard rod with:
- Materials, dimensions and mechanical properties (Table A1)
- Inspection certificate 3.1 acc. to EN 10204:2004
- Marking of embedment depth

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex A3
Product description Material (Threaded rod)	

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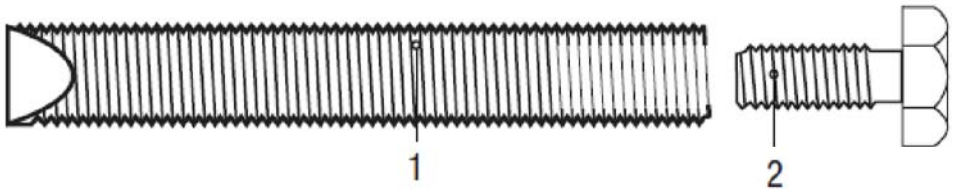
Table A2: Material (Reinforcing bar)

- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2009+AC:2010
- Rip height of the bar shall be in the range 0,05d≤h≤0,07d
  (d: Nominal diameter of the rebar, h: Rip height of the bar)

Reinforcing bar		
1	Rebar according EN 1992-1-1:2009+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN 1992-1-1/NA:2013 $f_{uk} = f_{tk} = k \cdot f_{yk}$

Table A3: Material (Internal threaded sleeve)



Part	**Designation**	**Material**
Steel, zinc plated ≥ 5 µm acc. EN ISO 4042:1999		
1	Internal threaded sleeve	Steel, EN 10087:2001 or EN 10263:2001 Property class 5.8, EN 1993-1-8:2005+AC:2009
2	Corresponding steel screw	Steel screws property class 5.8 or 8.8, EN ISO 898-1:2013 Zinc plated ≥ 5 µm acc. EN ISO 4042:1999
Stainless steel A4		
1	Internal threaded sleeve	Material 1.4401 / 1.4404 / 1.4571, EN 10088-1: 2005, Property class 70, EN ISO 3506-1:2009
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506-1:2009 Stainless steel 1.4401, 1.4404, 1.4571 EN 10088-1:2005
High corrosion resistance steel HCR		
1	Internal threaded sleeve	Material 1.4529 / 1.4565, EN 10088-1:2005, Property class 70, EN ISO 3506-1:2009
2	Corresponding steel screw	Steel screws property class 50 or 70 EN ISO 3506-1:2009 High corrosion resistance steel 1.4529, 1.4565 EN 10088-1:2005

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex A4
Product description Material (Reinforcing bar) Material (Internal threaded sleeve)	

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Specifications of intended use

Anchorages subject to:
- Static and quasi-static loads: Threaded rod M8 to M30, Rebar Ø8 to Ø32, Internal threaded rod M8 to M20.
- Seismic action for Performance Category C1: Threaded rod M12 to M30, Rebar Ø12 to Ø32.
- Seismic action for Performance Category C2: Threaded rod M12 and M16.

Base materials:
- Reinforced or unreinforced normal weight concrete according to EN 206-1:2000.
- Strength classes C20/25 to C50/60 according to EN 206-1:2000.
- Uncracked concrete: Threaded rod M8 to M30, Rebar Ø8 to Ø32, Internal threaded rod M8 to M20.
- Cracked concrete: Threaded rod M12 to M30, Rebar Ø12 to Ø32, Internal threaded rod M8 to M20.

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

Use conditions (Environmental conditions):
- Structures subject to dry internal conditions
  (zinc coated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist
  (high corrosion resistant steel).
  Note: 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).

Design:
- 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.).
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Anchorages under static or quasi-static actions are designed in accordance with:
  - EOTA Technical Report TR 029 "Design of bonded anchors", Edition September 2010 or
  - CEN/TS 1992-4:2009
- Anchorages under seismic actions (cracked concrete) are designed in accordance with:
  - EOTA Technical Report TR 045 "Design of Metal Anchors under Seismic Action", Edition February 2013
  - Anchorages shall be positioned outside of critical regions (e.g. plastic hinges) of the concrete structure.
  - Fastenings in stand-off installation or with a grout layer are not allowed.

Installation:
- Dry or wet concrete.
- Flooded holes (not sea water).
- Hole drilling by hammer drill mode.
- Overhead installation allowed.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex B1
Intended Use Specifications	

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Table B1: 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 B2: Installation parameters for reinforcing bar

Rebar size		∅ 8	∅ 10	∅ 12	∅ 14	∅ 16	∅ 20	∅ 24	∅ 25	∅ 28	∅ 32
Nominal drill hole diameter	d_0 [mm] =	12	14	16	18	20	24	28	32	35	37
Effective anchorage depth	$h_{ef,min}$ [mm] =	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$ [mm] =	160	200	240	280	320	400	480	500	560	640
Diameter of steel brush	d_b [mm] ≥	14	16	18	20	22	26	30	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	120	125	140	160
Minimum edge distance	c_{min} [mm]	40	50	60	70	80	100	120	125	140	160

Table B3: Installation parameters for internal threaded sleeve

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

Annex B2

Intended Use
Installation parameters

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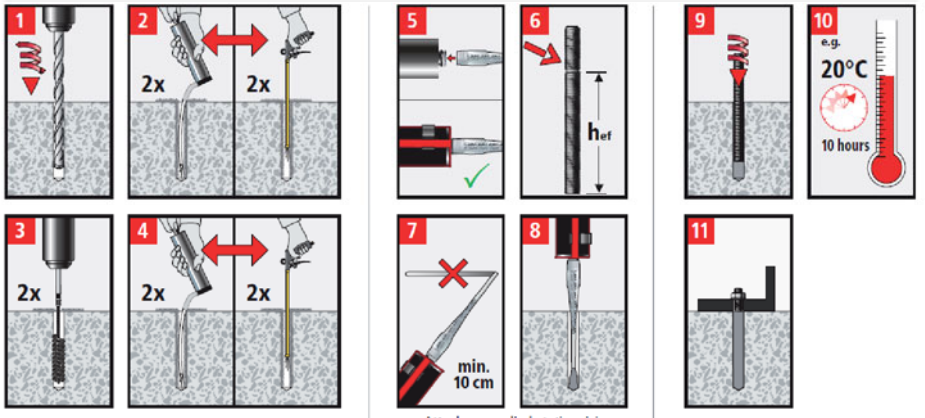
Installation Instructions



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 B4: 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	Annex B3
Intended Use Installation instructions Minimum curing time	

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Steel brush and extension

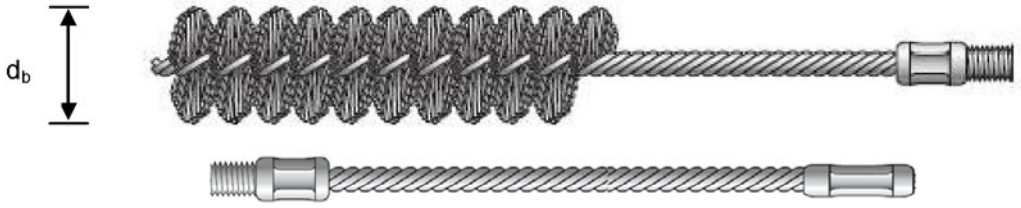
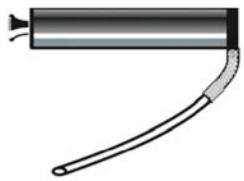


Table B5: Parameter cleaning and setting tools

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]	Piston plug denom. (∅) [mm]
M8			10	12	10,5	-
M10		8	12	14	12,5	-
M12	M8	10	14	16	14,5	-
		12	16	18	16,5	-
M16	M10	14	18	20	18,5	-
		16	20	22	20,5	-
M20	M12	20	24	26	24,5	#24 (22)
M24	M16	24	28	30	28,5	#28 (27)
M27		25	32	34	32,5	#28 (29)
M30	M20	28	35	37	35,5	#35 (34)
		32	37	40	37,5	#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	Annex B4
Intended Use Cleaning and setting tools	

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Table C1: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$							
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8	352,5	459,4	560,6
Combined pullout and concrete cone failure											
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete		$h_{ef} \le 12d$ $h_{ef} > 12d$	15 12	15 13	15 14	14 14	13 13	12 12	12 12	12 12
	flooded bore hole		$h_{ef} \le 12d$	15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II: 60°C/43°C	dry and wet concrete		$h_{ef} \le 12d$ $h_{ef} > 12d$	9,5 7,5	9,5 8,0	9,0 8,0	8,5 8,5	8,0 8,0	7,5 7,5	7,5 7,5	7,5 7,5
	flooded bore hole		$h_{ef} \le 12d$	9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III: 72°C/43°C	dry and wet concrete		$h_{ef} \le 12d$ $h_{ef} > 12d$	8,5 7,0	8,5 7,0	8,0 7,0	7,5 7,5	7,0 7,0	7,0 7,0	6,5 6,5	6,5 6,5
	flooded bore hole		$h_{ef} \le 12d$	8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
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]	$2 \cdot c_{cr,sp}$							
Installation safety factor (dry and wet concrete)		γ_2		1,2				1,4			
Installation safety factor (flooded bore hole)		γ_2		1,4							

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex C1
Performances **Design TR029** Application with threaded rod Characteristic values for tension loads in uncracked concrete	

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Table C2: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size threaded rod				**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure									
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$					
Stressed cross section		A_s	[mm²]	84,3	156,7	244,8	352,5	459,4	560,6
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$		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	$h_{ef} \leq 12d$		7,5	6,0	5,0	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		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	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5	3,5
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$		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	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C30/37		1,04					
		C40/50		1,08					
		C50/60		1,10					
Installation safety factor (dry and wet concrete)		γ_2		1,2		1,4			
Installation safety factor (flooded bore hole)		γ_2		1,4					

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Table C3: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic shear resistance	$V_{Rk,s}$	[kN]	See TR029, Chapter 5.2.3.2., Eq. (5.5), $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$							
Stressed cross section	A_s	[mm²]	36,6	58,0	84,3	156,7	244,8	352,5	459,4	560,6
Steel failure with lever arm										
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See TR029, Chapter 5.2.3.2., Eq. (5.6 b), $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$							
Elastic section modulus	W_{el}	[mm³]	31,2	62,3	109,1	276,6	540,3	933,4	1388,8	1872,2
Concrete pry out failure										
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0							
Installation safety factor	γ_2		1,0							
Concrete edge failure										
See chapter 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors										
Installation safety factor	γ_2		1,0							

POWERS PURE150-PRO Injection resin with anchor rod for concrete	Annex C3
Performances **Design TR029** Application with threaded rod Characteristic values for shear loads in cracked and uncracked concrete	

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Table C4: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar				**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$									
Stressed cross section		A_s	[mm²]	50,3	78,5	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Combined pullout and concrete cone failure													
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25													
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		14 11	14 12	13 12	13 12	12 12	12 12	11 11	11 11	11 11	11 11
	flooded bore hole	$h_{ef} \le 12d$		14	13	11	10	9,5	8,5	7,5	7,5	7,0	6,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		8,5 6,5	8,5 7,0	8,0 7,0	8,0 7,0	7,5 7,0	7,0 7,0	7,0 6,5	7,0 6,5	6,5 6,5	6,5 6,5
	flooded bore hole	$h_{ef} \le 12d$		8,5	8,5	8,0	8,0	7,5	7,0	6,0	6,0	5,5	5,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		7,5 6,0	7,5 6,0	7,5 6,0	7,0 6,5	7,0 6,5	6,5 6,0	6,0 6,0	6,0 6,0	6,0 5,5	6,0 5,5
	flooded bore hole	$h_{ef} \le 12d$		7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,5	5,0	4,5
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]	$2 \cdot c_{cr,sp}$									
Installation safety factor (dry and wet concrete)		γ_2		1,2					1,4				
Installation safety factor (flooded bore hole)		γ_2		1,4									

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Table C5: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar				**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$							
Stressed cross section		A_s	[mm²]	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Combined pullout and concrete cone failure											
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		7,5	7,0	6,5	6,0	5,5	5,5	5,5	5,5
		$h_{ef} > 12d$		7,0	6,5	6,5	6,0	5,5	5,5	5,5	5,5
	flooded bore hole	$h_{ef} \le 12d$		7,5	6,5	6,0	5,0	4,5	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,5	4,0	4,0	3,5	3,5	3,5	3,5	3,5
		$h_{ef} > 12d$		4,0	4,0	4,0	3,5	3,5	3,5	3,5	3,5
	flooded bore hole	$h_{ef} \le 12d$		4,5	4,0	4,0	3,5	3,5	3,5	3,5	3,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,0	3,5	3,5	3,0	3,0	3,0	3,0	3,0
		$h_{ef} > 12d$		3,5	3,5	3,5	3,0	3,0	3,0	3,0	3,0
	flooded bore hole	$h_{ef} \le 12d$		4,0	3,5	3,5	3,0	3,0	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C30/37		1,04							
		C40/50		1,08							
		C50/60		1,10							
Installation safety factor (dry and wet concrete)		γ_2		1,2			1,4				
Installation safety factor (flooded bore hole)		γ_2		1,4							

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Table C6: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure without lever arm												
Characteristic shear resistance	$V_{Rk,s}$	[kN]	See TR029, Chapter 5.2.3.2., Eq. (5.5), $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$									
Stressed cross section	A_s	[mm²]	50,3	78,5	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Steel failure with lever arm												
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See TR029, Chapter 5.2.3.2., Eq. (5.6 b), $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$									
Elastic section modulus	W_{el}	[mm³]	50,3	98,2	169,6	269,4	402,1	785,4	1357	1534	2155	3217
Concrete pry out failure												
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0									
Installation safety factor	γ_2		1,0									
Concrete edge failure												
See chapter 5.2.3.4 of Technical Report TR 029 for the design of bonded anchors												
Installation safety factor	γ_2		1,0									

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Table C7: Design according to TR029
Characteristic values for tension loads in uncracked concrete

Anchor size internal threaded sleeve				**M8**	**M10**	**M12**	**M16**	**M20**
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure (internal threaded sleeve)								
Characteristic tension resistance, Zinc plated		$N_{Rk,s}$	[kN]	19,5	42,8	71,1	83,7	135,7
Characteristic tension resistance, Stainless steel A4		$N_{Rk,s}$	[kN]	24,2	53,1	88,1	103,8	135,7
Steel failure (threaded rod)								
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$				
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25								
Temperature range I: 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: 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: 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
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]	$2 \cdot c_{cr,sp}$				
Installation safety factor (dry and wet concrete)		γ_2		1,2		1,4		
Installation safety factor (flooded bore hole)		γ_2		1,4				

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C7

Performances **Design TR029**
Application with internal threaded sleeve
Characteristic values for tension loads in uncracked concrete

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Table C8: Design according to TR029
Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve				**M8**	**M10**	**M12**	**M16**	**M20**
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure (internal threaded sleeve)								
Characteristic tension resistance, Zinc plated		$N_{Rk,s}$	[kN]	19,5	42,8	71,1	83,7	135,7
Characteristic tension resistance, A4 steel		$N_{Rk,s}$	[kN]	24,2	53,1	88,1	103,8	135,7
Steel failure (threaded rod)								
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See TR029, Chapter 5.2.2.2., Eq. (5.1), $N_{Rk,s} = A_s \cdot f_{uk}$				
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25								
Temperature range I: 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: 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: 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
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Installation safety factor (dry and wet concrete)		γ_2		1,2		1,4		
Installation safety factor (flooded bore hole)		γ_2		1,4				

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Table C9: Design according to TR029
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			**M8**	**M10**	**M12**	**M16**	**M20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm (internal threaded sleeve)							
Characteristic shear resistance, Zinc plated	$V_{Rk,s}$	[kN]	9,7	21,4	35,5	41,9	67,9
Characteristic shear resistance, A4 steel	$V_{Rk,s}$	[kN]	12,1	26,5	44,1	51,9	67,9
Steel failure without lever arm (threaded rod)							
Characteristic tension resistance	$V_{Rk,s}$	[kN]	See TR029, Chapter 5.2.3.2., Eq. (5.5), $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$				
Stressed cross section	A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Steel failure with lever arm (internal threaded sleeve)							
Characteristic bending moment, Zinc plated	$M^0_{Rk,s}$	[Nm]	46,5	131,8	267,2	405,7	824,5
Characteristic bending moment, A4 steel	$M^0_{Rk,s}$	[Nm]	57,7	163,4	331,3	503,0	824,5
Steel failure with lever arm (threaded rod)							
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See TR029, Chapter 5.2.3.2., Eq. (5.6 b), $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$				
Elastic section modulus	W_{el}	[mm³]	31,2	62,3	109,1	276,6	540,3
Concrete pryout failure							
Factor k in Equation (5.7) of Technical Report TR 029 for the design of Bonded Anchors			2,0				
Installation safety factor	γ_2		1,0				
Concrete edge failure							
See chapter 5.2.3.4 of Technical Report TR 029 for the design of Bonded Anchors							
Installation safety factor	γ_2		1,0				

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Table C10: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$							
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8	352,5	459,4	560,6
Combined pullout and concrete cone failure											
Characteristic bond $\tau_{Rk,ucr}$ [N/mm²] resistance in uncracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		15 12	15 13	15 14	14 14	13 13	12 12	12 12	12 12
	flooded bore hole	$h_{ef} \le 12d$		15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		9,5 7,5	9,5 8,0	9,0 8,0	8,5 8,5	8,0 8,0	7,5 7,5	7,5 7,5	7,5 7,5
	flooded bore hole	$h_{ef} \le 12d$		9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		8,5 7,0	8,5 7,0	8,0 7,0	7,5 7,5	7,0 7,0	7,0 7,0	6,5 6,5	6,5 6,5
	flooded bore hole	$h_{ef} \le 12d$		8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
Increasing factors for concrete ψ_c		C30/37		1,04							
		C40/50		1,08							
		C50/60		1,10							
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		10,1							
Concrete cone failure											
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$							
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		k_{ucr}		10,1							
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]	$2 \cdot c_{cr,sp}$							
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2				1,4			
Installation safety factor (flooded bore hole)		γ_{inst}		1,4							

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C10

Performances **Design CEN/TS 1992-4**
Application with threaded rod
Characteristic values for tension loads in uncracked concrete

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Table C11: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size threaded rod				**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure									
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$					
Stressed cross section		A_s	[mm²]	84,3	156,7	244,8	352,5	459,4	560,6
Combined pullout and concrete cone failure									
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \leq 12d$ $h_{ef} > 12d$		7,5 7,0	6,5 6,5	6,0 6,0	5,5 5,5	5,5 5,5	5,5 5,5
	flooded bore hole	$h_{ef} \leq 12d$		7,5	6,0	5,0	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$ $h_{ef} > 12d$		4,5 4,0	4,0 4,0	3,5 3,5	3,5 3,5	3,5 3,5	3,5 3,5
	flooded bore hole	$h_{ef} \leq 12d$		4,5	4,0	3,5	3,5	3,5	3,5
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \leq 12d$ $h_{ef} > 12d$		4,0 3,5	3,5 3,5	3,0 3,0	3,0 3,0	3,0 3,0	3,0 3,0
	flooded bore hole	$h_{ef} \leq 12d$		4,0	3,5	3,0	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C30/37		1,04					
		C40/50		1,08					
		C50/60		1,10					
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		7,2					
Concrete cone failure									
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$					
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$					
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		k_{ucr}		7,2					
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2		1,4			
Installation safety factor (flooded bore hole)		γ_{inst}		1,4					

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C11

Performances **Design CEN/TS 1992-4**
Application with threaded rod
Characteristic values for tension loads in cracked concrete

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Table C12: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size threaded rod			**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm										
Characteristic shear resistance	$V_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.3.2.1, $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$							
Stressed cross section	A_s	[mm²]	36,6	58,0	84,3	156,7	244,8	352,5	459,4	560,6
Steel failure with lever arm										
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See CEN/TS 1992-4-5, Chapter 6.3.2.2, $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$							
Elastic section modulus	W_{el}	[mm³]	31,2	62,3	109,1	276,6	540,3	933,4	1388,8	1872,2
Ductility factor	k_2		0,80							
Concrete pry out failure										
Factor acc. Eq. (27) CEN/TS 1992-4-5, chapter 6.3.3	k_3		2,0							
Installation safety factor	γ_{inst}		1,0							
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4							
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8d_{nom})$							
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30
Installation safety factor	γ_{inst}		1,0							

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Table C13: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size reinforcing bar				**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure													
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$									
Stressed cross section		A_s	[mm²]	50,3	78,5	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Combined pullout and concrete cone failure													
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25													
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		14 11	14 12	13 12	13 12	12 12	12 12	11 11	11 11	11 11	11 11
	flooded bore hole	$h_{ef} \le 12d$		14	13	11	10	9,5	8,5	7,5	7,5	7,0	6,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		8,5 6,5	8,5 7,0	8,0 7,0	8,0 7,0	7,5 7,0	7,0 7,0	7,0 6,5	7,0 6,5	6,5 6,5	6,5 6,5
	flooded bore hole	$h_{ef} \le 12d$		8,5	8,5	8,0	8,0	7,5	7,0	6,0	6,0	5,5	5,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		7,5 6,0	7,5 6,0	7,5 6,0	7,0 6,5	7,0 6,5	6,5 6,0	6,0 6,0	6,0 6,0	6,0 5,5	6,0 5,5
	flooded bore hole	$h_{ef} \le 12d$		7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,5	5,0	4,5
Increasing factors for concrete ψ_c		C30/37		1,04									
		C40/50		1,08									
		C50/60		1,10									
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		10,1									
Concrete cone failure													
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$									
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$									
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		k_{ucr}		10,1									
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]	$2 \cdot c_{cr,sp}$									
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2					1,4				
Installation safety factor (flooded bore hole)		γ_{inst}		1,4									

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Table C14: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size reinforcing bar				Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$							
Stressed cross section		A_s	[mm²]	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Combined pullout and concrete cone failure											
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		7,5	7,0	6,5	6,0	5,5	5,5	5,5	5,5
		$h_{ef} > 12d$		7,0	6,5	6,5	6,0	5,5	5,5	5,5	5,5
	flooded bore hole	$h_{ef} \le 12d$		7,5	6,5	6,0	5,0	4,5	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,5	4,0	4,0	3,5	3,5	3,5	3,5	3,5
		$h_{ef} > 12d$		4,0	4,0	4,0	3,5	3,5	3,5	3,5	3,5
	flooded bore hole	$h_{ef} \le 12d$		4,5	4,0	4,0	3,5	3,5	3,5	3,5	3,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,0	3,5	3,5	3,0	3,0	3,0	3,0	3,0
		$h_{ef} > 12d$		3,5	3,5	3,5	3,0	3,0	3,0	3,0	3,0
	flooded bore hole	$h_{ef} \le 12d$		4,0	3,5	3,5	3,0	3,0	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C30/37		1,04							
		C40/50		1,08							
		C50/60		1,10							
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		7,2							
Concrete cone failure											
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$							
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$							
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		k_{ucr}		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]	$2 \cdot c_{cr,sp}$							
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2			1,4				
Installation safety factor (flooded bore hole)		γ_{inst}		1,4							

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Table C15: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size reinforcing bar			**Ø8**	**Ø10**	**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure without lever arm												
Characteristic shear resistance	$V_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.3.2.1, $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$									
Stressed cross section	A_s	[mm²]	50,3	78,5	113,1	153,9	201,1	314,2	452,4	490,9	615,8	804,2
Steel failure with lever arm												
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See CEN/TS 1992-4-5, Chapter 6.3.2.2, $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$									
Elastic section modulus	W_{el}	[mm³]	50,3	98,2	169,6	269,4	402,1	785,4	1357	1534	2155	3217
Ductility factor	k_2		0,8									
Concrete pry out failure												
Factor acc. Eq. (27) CEN/TS 1992-4-5, chapter 6.3.3	k_3		2,0									
Installation safety factor	γ_{inst}		1,0									
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4									
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8d_{nom})$									
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation safety factor	γ_{inst}		1,0									

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Table C16: Design according to CEN/TS 1992-4
Characteristic values for tension loads in uncracked concrete

Anchor size internal threaded sleeve				**M8**	**M10**	**M12**	**M16**	**M20**
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure (internal threaded sleeve)								
Characteristic tension resistance, Zinc plated		$N_{Rk,s}$	[kN]	19,5	42,8	71,1	83,7	135,7
Characteristic tension resistance, A4 steel		$N_{Rk,s}$	[kN]	24,2	53,1	88,1	103,8	135,7
Steel failure (threaded rod)								
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$				
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,ucr}$ [N/mm²] in uncracked concrete C20/25								
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		15,0	14,0	13,0	12,0	12,0
	flooded bore hole	$h_{ef} \le 12d$		13,0	10,0	9,5	8,5	7,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		9,0	8,5	8,0	7,5	7,5
	flooded bore hole	$h_{ef} \le 12d$		9,0	8,5	7,5	7,0	6,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		8,0	7,5	7,0	7,0	6,5
	flooded bore hole	$h_{ef} \le 12d$		8,0	7,5	7,0	6,0	5,5
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		10,1				
Concrete cone failure								
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \cdot h_{ef}$				
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \cdot h_{ef}$				
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		k_{ucr}		10,1				
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]	$2 \cdot c_{cr,sp}$				
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2		1,4		
Installation safety factor (flooded bore hole)		γ_{inst}		1,4				

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Table C17: Design according to CEN/TS 1992-4
Characteristic values for tension loads in cracked concrete

Anchor size internal threaded sleeve				**M8**	**M10**	**M12**	**M16**	**M20**
External diameter				12	16	20	24	30
Effective anchorage depth		h_{ef}	[mm]	80	90	110	150	200
Steel failure (internal threaded sleeve)								
Characteristic tension resistance, Zinc plated		$N_{Rk,s}$	[kN]	19,5	42,8	71,1	83,7	135,7
Characteristic tension resistance, A4 steel		$N_{Rk,s}$	[kN]	24,2	53,1	88,1	103,8	135,7
Steel failure (threaded rod)								
Characteristic tension resistance		$N_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.2.2, $N_{Rk,s} = A_s \cdot f_{uk}$				
Stressed cross section		A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Combined pullout and concrete cone failure								
Characteristic bond resistance $\tau_{Rk,cr}$ [N/mm²] in cracked concrete C20/25								
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$		7,5	6,5	6,0	5,5	5,5
	flooded bore hole	$h_{ef} \le 12d$		7,5	6,0	5,0	4,5	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5
	flooded bore hole	$h_{ef} \le 12d$		4,5	4,0	3,5	3,5	3,5
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0
	flooded bore hole	$h_{ef} \le 12d$		4,0	3,5	3,0	3,0	3,0
Increasing factors for concrete ψ_c		C30/37		1,04				
		C40/50		1,08				
		C50/60		1,10				
Factor acc. CEN/TS 1992-4-5, chapter 6.2.2.3		k_8		7,2				
Concrete cone failure								
Characteristic edge distance		$c_{cr,N}$	[mm]	$1,5 \circ h_{ef}$				
Characteristic spacing		$s_{cr,N}$	[mm]	$3,0 \circ h_{ef}$				
Factor acc. CEN/TS 1992-4-5, chapter 6.2.3.1		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]	$2 \cdot c_{cr,sp}$				
Installation safety factor (dry and wet concrete)		γ_{inst}		1,2		1,4		
Installation safety factor (flooded bore hole)		γ_{inst}		1,4				

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C17

Performances **Design CEN/TS 1992-4**
Application with internal threaded sleeve
Characteristic values for tension loads in cracked concrete

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Table C18: Design according to CEN/TS 1992-4
Characteristic values for shear loads in cracked and uncracked concrete

Anchor size internal threaded sleeve			**M8**	**M10**	**M12**	**M16**	**M20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Steel failure without lever arm (internal threaded sleeve)							
Characteristic shear resistance, Zinc plated	$V_{Rk,s}$	[kN]	9,7	21,4	35,5	41,9	67,9
Characteristic shear resistance, A4 steel	$V_{Rk,s}$	[kN]	12,1	26,5	44,1	51,9	67,9
Steel failure without lever arm (threaded rod)							
Characteristic tension resistance	$V_{Rk,s}$	[kN]	See CEN/TS 1992-4-5, Chapter 6.3.2.1, $V_{Rk,s}=0,5 \cdot A_s \cdot f_{uk}$				
Stressed cross section	A_s	[mm²]	36,6	58,0	84,3	156,7	244,8
Steel failure with lever arm (internal threaded sleeve)							
Characteristic bending moment, Zinc plated	$M^0_{Rk,s}$	[Nm]	46,5	131,8	267,2	405,7	824,5
Characteristic bending moment, A4 steel	$M^0_{Rk,s}$	[Nm]	57,7	163,4	331,3	503,0	824,5
Ductility factor	k_2		0,8				
Steel failure with lever arm (threaded rod)							
Characteristic bending resistance	$M^0_{Rk,s}$	[Nm]	See CEN/TS 1992-4-5, Chapter 6.3.2.2, $M^0_{Rk,s}=1,2 \cdot W_{el} \cdot f_{uk}$				
Elastic section modulus	W_{el}	[mm³]	31,2	62,3	109,1	276,6	540,3
Ductility factor	k_2		0,8				
Concrete pryout failure							
Factor acc. Eq. (27) CEN/TS 1992-4-5, chapter 6.3.3	k_3		2,0				
Installation safety factor	γ_{inst}		1,0				
Concrete edge failure			See CEN/TS 1992-4-5, Section 6.3.4				
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8d_{nom})$				
Outside diameter of anchor	d_{nom}	[mm]	12	16	20	24	30
Installation safety factor	γ_{inst}		1,0				

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C18

Performances **Design CEN/TS 1992-4**
Application with internal threaded sleeve
Characteristic values for shear loads in cracked and uncracked concrete

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Table C19: Displacements for tension loads[1] (threaded rod)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Temperature range 40°C/24°C for uncracked concrete C20/25										
Displacement	δ_{N0} - Factor	[mm/(N/mm²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,035
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,043
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	-	-	0,032	0,037	0,042	0,048	0,054	0,062
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	-	-	0,037	0,043	0,049	0,055	0,063	0,071
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor$\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor$\cdot \tau$

Table C20: Displacements for shear loads [1] (threaded rod)

Anchor diameters			M8	M10	M12	M16	M20	M24	M27	M30
Displacement	δ_{V0} - Factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$ - Factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot \tau$
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot \tau$

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Table C21: Displacements for tension loads[1] (reinforcing bar)

Anchor size reinforcing bar			Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32
Temperature range 40°C/24°C for uncracked concrete C20/25												
Displacement	δ_{N0} - Factor	[mm/(N/mm²)]	0,011	0,013	0,015	0,018	0,020	0,024	0,029	0,030	0,033	0,037
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,044	0,052	0,061	0,070	0,079	0,096	0,114	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} - Factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,033	0,034	0,038	0,043
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,131	0,136	0,151	0,172
Temperature range 40°C/24°C for cracked concrete C20/25												
Displacement	δ_{N0} - Factor	[mm/(N/mm²)]	-	-	0,032	0,035	0,037	0,042	0,048	0,049	0,056	0,064
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	-	-	0,21	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} - Factor	[mm/(N/mm²)]	-	-	0,037	0,040	0,043	0,049	0,055	0,056	0,064	0,073
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	-	-	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor$\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor$\cdot \tau$

Table C22: Displacements for shear loads[1] (reinforcing bar)

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Displacement	δ_{V0} - Factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,04	0,03	0,03	0,03
Displacement	$\delta_{V\infty}$ - Factor	[mm/kN]	0,09	0,08	0,07	0,06	0,06	0,05	0,05	0,05	0,04	0,04

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot \tau$
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot \tau$

POWERS PURE150-PRO Injection resin with anchor rod for concrete

Annex C20

Performances
Displacements
(Reinforcing bar)

Deutsches Institut für Bautechnik DIBt

Table C23: Displacements for tension loads [1] (internal threaded sleeve)

Anchor size internal threaded sleeve			**M8**	**M10**	**M12**	**M16**	**M20**
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} - Factor	[mm/(N/mm²)]	0,015	0,020	0,024	0,029	0,035
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	0,018	0,023	0,028	0,033	0,043
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	0,032	0,037	0,042	0,048	0,055
Displacement	$\delta_{N\infty}$ - Factor	[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} - Factor	[mm/(N/mm²)]	0,037	0,043	0,049	0,055	0,063
Displacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,240	0,240	0,240	0,240	0,240

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor $\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor $\cdot \tau$

Table C24: Displacements for shear loads [1] (internal threaded sleeve)

Anchor size internal threaded sleeve			**M8**	**M10**	**M12**	**M16**	**M20**
External diameter			12	16	20	24	30
Effective anchorage depth	h_{ef}	[mm]	80	90	110	150	200
Displacement	δ_{V0} - Factor	[mm/kN]	0,05	0,04	0,04	0,03	0,03
Displacement	$\delta_{V\infty}$ - Factor	[mm/kN]	0,08	0,06	0,06	0,05	0,05

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot \tau$
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot \tau$

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Table C25: Characteristic values of resistance for seismic design category C1 for *threaded rods* under tension load

Anchor size threaded rod				**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure									
Characteristic tension resistance, Steel, property class 4.6		$N_{Rk,s,seis}$	[kN]	34	63	98	141	184	224
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s,seis}$	[kN]	42	78	122	176	230	280
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s,seis}$	[kN]	67	125	196	282	368	449
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)		$N_{Rk,s,seis}$	[kN]	59	110	171	247	230	281
Combined pull-out and concrete failure									
Characteristic bond resistance $\tau^0_{Rk,seis}$ [N/mm²] in cracked concrete C20/25									
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		7,1 6,5	6,2 6,2	5,7 5,7	5,5 5,5	5,5 5,5	5,5 5,5
	flooded bore hole	$h_{ef} \le 12d$		7,1	5,8	4,8	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		4,3 3,8	3,8 3,8	3,4 3,3	3,5 3,5	3,5 3,5	3,5 3,5
	flooded bore hole	$h_{ef} \le 12d$		4,3	3,8	3,4	3,5	3,5	3,5
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		3,9 3,3	3,4 3,3	3,0 2,9	3,0 3,0	3,0 3,0	3,0 3,0
	flooded bore hole	$h_{ef} \le 12d$		3,9	3,4	3,0	3,0	3,0	3,0
Installation safety factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,2		1,4			
Installation safety factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4					

Table C26: Displacements under tension load [1] for seismic design category C1 for *threaded rods*

Anchor size threaded rod			**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Temperature range 40°C/24°C for cracked concrete C20/25								
Desplacement	δ_{N0} - Factor	[mm/(N/mm²)]	0,032	0,037	0,042	0,048	0,054	0,062
Desplacement	$\delta_{N\infty}$ - Factor	[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								
Desplacement	δ_{N0} - Factor	[mm/(N/mm²)]	0,037	0,043	0,049	0,055	0,063	0,071
Desplacement	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,24	0,24	0,24	0,24	0,24	0,24

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor $\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor $\cdot \tau$

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Characteristic values of resistance and displacements for seismic design category C1 for threaded rods under tension loads

Table C27: Characteristic values of resistance for seismic design category C1 for *threaded rods* under shear load

Anchor size threaded rod			**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure without lever arm								
Characteristic shear resistance, Steel, property class 4.6	$V^0_{Rk,s,seis}$	[kN]	14	27	42	56	72	88
Characteristic shear resistance, Steel, property class 5.8	$V^0_{Rk,s,seis}$	[kN]	18	34	53	70	91	111
Characteristic shear resistance, Steel, property class 8.8	$V^0_{Rk,s,seis}$	[kN]	30	55	85	111	145	177
Characteristic shear resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)	$V^0_{Rk,s,seis}$	[kN]	26	48	75	98	91	111
Steel failure with lever arm								
Characteristic bending moment, Steel, property class 4.6	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)					
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)					
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)					
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)					
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0					

Table C28: Displacements under shear load [1] for seismic design category C1 for *threaded rods*

Anchor size threaded rod			**M 8**	**M 10**	**M 12**	**M 16**	**M 20**	**M 24**	**M 27**	**M 30**
Displacements	δ_{V0} - Factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
Displacements	$\delta_{V\infty}$ - Factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor· τ
$\delta_{V\infty} = \delta_{V\infty}$ - Factor· τ

Table C29: Characteristic values of resistance for seismic design category C1 for *reinforcing bars* under tension load

Anchor size reinforcing bar				**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure											
Characteristic tension resistance		$N_{Rk,s,seis}$	[kN]	62	85	111	173	249	270	339	442
Combined pull-out and concrete failure											
Characteristic bond resistance $\tau^0_{Rk,seis}$ [N/mm²] in cracked concrete C20/25											
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		6,9 6,4	6,4 5,9	6,2 6,2	5,7 5,7	5,5 5,5	5,5 5,5	5,5 5,5	5,5 5,5
	flooded bore hole	$h_{ef} \le 12d$		6,9	6,0	5,7	4,8	4,5	4,5	4,0	4,0
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		4,1 3,6	3,7 3,7	3,8 3,8	3,3 3,3	3,3 3,3	3,5 3,5	3,5 3,5	3,5 3,5
	flooded bore hole	$h_{ef} \le 12d$		4,1	3,7	3,8	3,3	3,5	3,5	3,5	3,0
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		3,7 3,2	3,2 3,2	3,3 3,3	2,9 2,9	2,9 2,9	3,0 3,0	3,0 3,0	3,0 3,0
	flooded bore hole	$h_{ef} \le 12d$		3,7	3,2	3,3	2,9	2,9	3,0	3,0	3,0
Installation safety factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,2			1,4				
Installation safety factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4							

Table C30: Displacements under tension load [1] for seismic design category C1 for *threaded rods*

Anchor size reinforcing bar			**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Temperature range 40°C/24°C for cracked concrete C20/25										
Displacements	δ_{N0} - Factor	[mm/(N/mm²)]	0,032	0,035	0,037	0,042	0,048	0,049	0,056	0,064
Displacements	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,21	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										
Displacements	δ_{N0} - Factor	[mm/(N/mm²)]	0,037	0,040	0,043	0,049	0,055	0,056	0,064	0,073
Displacements	$\delta_{N\infty}$ - Factor	[mm/(N/mm²)]	0,24	0,24	0,24	0,24	0,24	0,24	0,24	0,24

[1] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$ - Factor $\cdot \tau$
$\delta_{N\infty} = \delta_{N\infty}$ - Factor $\cdot \tau$

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Table C31: Characteristic values of resistance for seismic design category C1 for *reinforcing bars* under shear load

Anchor size reinforcing bar			**Ø12**	**Ø14**	**Ø16**	**Ø20**	**Ø24**	**Ø25**	**Ø28**	**Ø32**
Steel failure without lever arm										
Characteristic tension resistance	$V_{Rk,s,seis}$	[kN]	27,3	37,0	48,4	75,7	109	118	148	194
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)							
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0							

Table C32: Displacements under shear load [1] for seismic design category C1 for *threaded rods*

Anchor size reinforcing bar			**Ø 12**	**Ø 14**	**Ø 16**	**Ø 20**	**Ø 24**	**Ø 25**	**Ø 28**	**Ø 32**
Displacements	δ_{V0} - Factor	[mm/kN]	0,05	0,04	0,04	0,04	0,04	0,03	0,03	0,03
Displacements	$\delta_{V\infty}$ - Factor	[mm/kN]	0,07	0,06	0,06	0,05	0,05	0,05	0,04	0,04

[1] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$ - Factor$\cdot \tau$
$\delta_{V\infty} = \delta_{V\infty}$ - Factor$\cdot \tau$

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Table C33: Characteristic values of resistance for seismic design category C2 for *threaded rods* under tension load

Anchor size threaded rod				**M12**	**M16**
Steel failure					
Characteristic tension resistance, Steel, property class 4.6		$N_{Rk,s,seis}$	[kN]	34	63
Characteristic tension resistance, Steel, property class 5.8		$N_{Rk,s,seis}$	[kN]	42	78
Characteristic tension resistance, Steel, property class 8.8		$N_{Rk,s,seis}$	[kN]	62	125
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)		$N_{Rk,s,seis}$	[kN]	59	110
Combined pull-out and concrete failure					
Characteristic bond resistance $\tau^0_{Rk,seis}$ [N/mm²] in cracked concrete C20/25					
Temperature range I: 40°C/24°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		2,4 2,2	2,2 2,2
	flooded bore hole	$h_{ef} \le 12d$		2,4	2,1
Temperature range II: 60°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		1,4 1,3	1,4 1,3
	flooded bore hole	$h_{ef} \le 12d$		1,4	1,4
Temperature range III: 72°C/43°C	dry and wet concrete	$h_{ef} \le 12d$ $h_{ef} > 12d$		1,3 1,1	1,2 1,1
	flooded bore hole	$h_{ef} \le 12d$		1,3	1,2
Installation safety factor (dry and wet concrete)		$\gamma_2 = \gamma_{inst}$	[-]	1,2	
Installation safety factor (flooded bore hole)		$\gamma_2 = \gamma_{inst}$	[-]	1,4	

Table C34: Displacements under tension load [1] for seismic design category C2 for *threaded rods*

Anchor size threaded rod			**M12**	**M16**
Temperature range I: 40°C/24°C	$\delta_{N,seis(DLS)}$-Factor	[mm/(N/mm²)]	0,03	0,05
	$\delta_{N,seis(ULS)}$-Factor	[mm/(N/mm²)]	0,06	0,09
Temperature range II: 60°C/43°C	$\delta_{N,seis(DLS)}$-Factor	[mm/(N/mm²)]	0,03	0,05
	$\delta_{N,seis(ULS)}$-Factor	[mm/(N/mm²)]	0,06	0,09
Temperature range III: 72°C/43°C	$\delta_{N,seis(DLS)}$-Factor	[mm/(N/mm²)]	0,03	0,05
	$\delta_{N,seis(ULS)}$-Factor	[mm/(N/mm²)]	0,06	0,09

[1] Calculation of the displacement
$\delta_{N,seis(DLS)} = \delta_{N,seis(DLS)}\text{-Factor} \cdot \tau$

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Performances
Characteristic values of resistance for seismic design category C2 for threaded rods under tension loads and Displacements

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Table C35: Characteristic values of resistance for seismic design category C2 for *threaded rods* under shear load

Anchor size threaded rod			**M12**	**M16**
Steel failure without lever arm				
Characteristic tension resistance, Steel, property class 4.6	$V_{Rk,s,seis}$	[kN]	13	25
Characteristic tension resistance, Steel, property class 5.8	$V_{Rk,s,seis}$	[kN]	16,8	31,2
Characteristic tension resistance, Steel, property class 8.8	$V_{Rk,s,seis}$	[kN]	27,2	50,4
Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)	$V_{Rk,s,seis}$	[kN]	40,0	44,0
Steel failure with lever arm				
Characteristic bending moment, Steel, property class 4.6	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)	
Characteristic bending moment, Steel, property class 5.8	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)	
Characteristic bending moment, Steel, property class 8.8	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)	
Characteristic bending moment, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤M24)	$M^0_{Rk,s,seis}$	[Nm]	No Performance Determined (NPD)	
Installation safety factor	$\gamma_2 = \gamma_{inst}$	[-]	1,0	

Table C36: Displacements under shear load[1)] for seismic design category C2 for *threaded rods*

Anchor size threaded rod			**M12**	**M16**
All temperatures	$\delta_{V,seis(DLS)}$ -Factor	[mm/(N/mm²)]	0,2	0,1
	$\delta_{V,seis(ULS)}$ -Factor	[mm/(N/mm²)]	0,2	0,1

1) Calculation of the displacement
$\delta_{V,seis(DLS)} = \delta_{Vseis(DLS)}$-Factor $\cdot \tau$

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