



Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments



European Technical Assessment

ETA-16/0461 of 6 June 2016

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the Deutsches Institut für Bautechnik **European Technical Assessment:** Trade name of the construction product WPER500 Walraven Injection system for concrete Product family Bonded anchor for use in concrete to which the construction product belongs Manufacturer J. van Walraven B.V. Industrieweg 5 3641 RK MIJDRECHT NIEDERLANDE Manufacturing plant Walraven factory A3 This European Technical Assessment 27 pages including 3 annexes which form an integral part contains of this assessment This European Technical Assessment is Guideline for European technical approval of "Metal anchors for use in concrete", ETAG 001 Part 5: "Bonded issued in accordance with Regulation (EU) anchors", April 2013, No 305/2011, on the basis of used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011.



European Technical Assessment ETA-16/0461

Page 2 of 27 | 6 June 2016

English translation prepared by DIBt

The European Technical Assessment is issued by the Technical Assessment Body in its official language. Translations of this European Technical Assessment in other languages shall fully correspond to the original issued document and shall be identified as such.

Communication of this European Technical Assessment, including transmission by electronic means, shall be in full. However, partial reproduction may only be made with the written consent of the issuing Technical Assessment Body. Any partial reproduction shall be identified as such.

This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission in accordance with Article 25(3) of Regulation (EU) No 305/2011.



Page 3 of 27 | 6 June 2016

Specific Part

1 Technical description of the product

The "WPER500 Walraven Injection System for concrete" is a bonded anchor consisting of a cartridge with injection mortar WPER500 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.

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 and TR 045	See Annex C 1 to C6
Characteristic resistance for design according to CEN/TS 1992-4:2009 and TR 045	See Annex C 7 to C 12
Displacements under tension and shear loads	See Annex C 13 / C 14

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)

Regarding dangerous substances there may be requirements (e.g. transposed European legislation and national laws, regulations and administrative provisions) applicable to the products falling within the scope of this European Technical Assessment. In order to meet the provisions of Regulation (EU) No 305/2011, these requirements need also to be complied with, when and where they apply.

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.



European Technical Assessment ETA-16/0461

Page 4 of 27 | 6 June 2016

English translation prepared by DIBt

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

In accordance with guideline for European technical approval ETAG 001, April 2013, used as European Assessment Document (EAD) according to Article 66 Paragraph 3 of Regulation (EU) No 305/2011, the applicable European legal act is: [96/582/EC]. The system to be applied is: 1

The system to be applied is. T

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

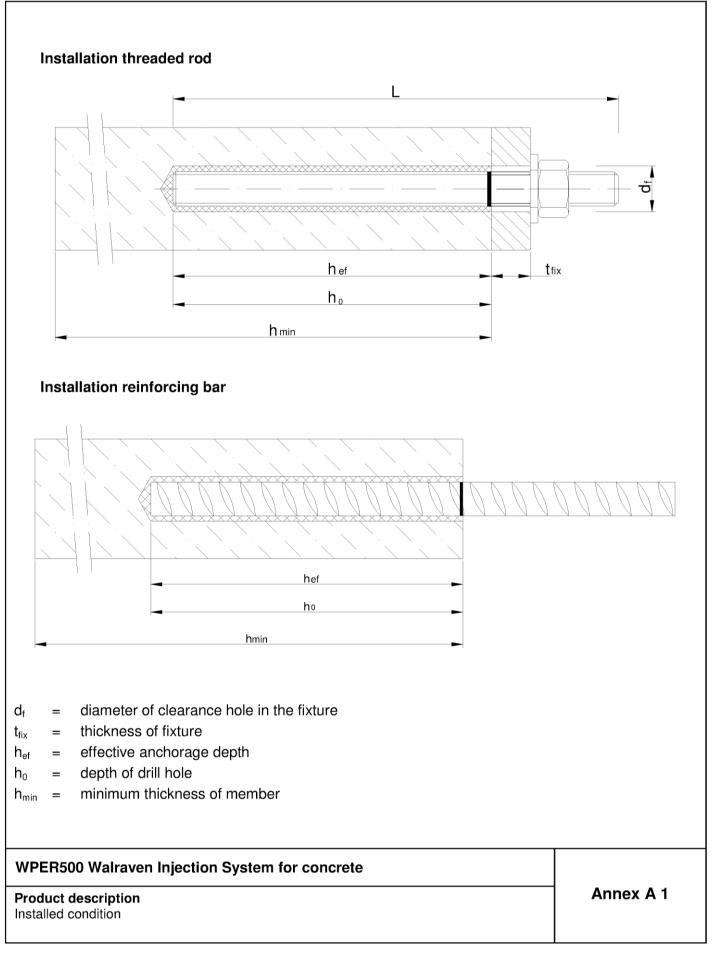
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 6 June 2016 by Deutsches Institut für Bautechnik

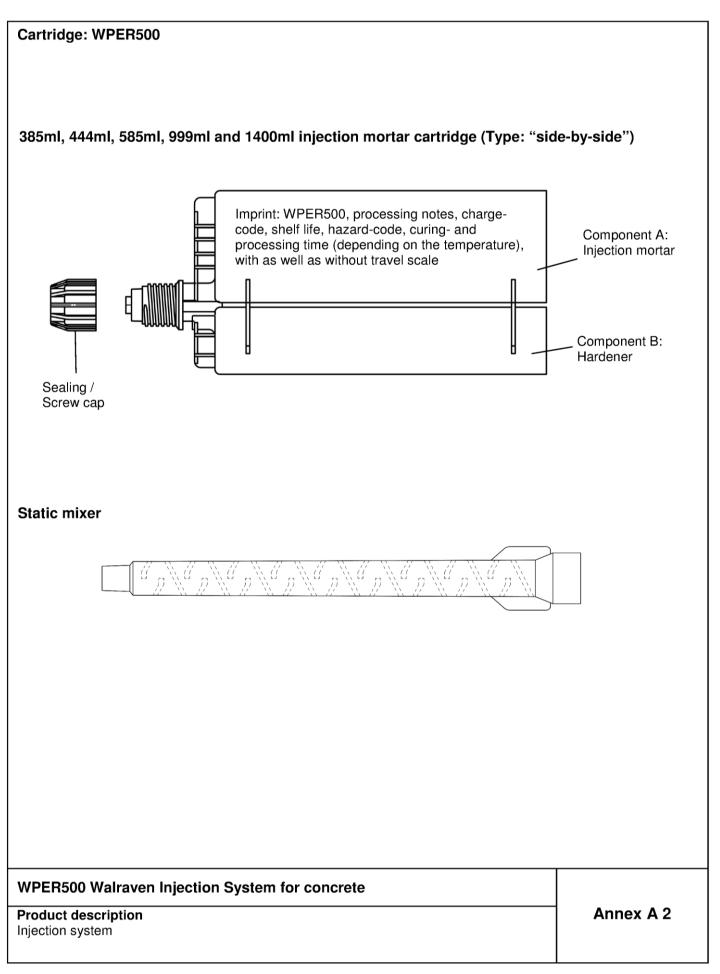
Uwe Bender Head of Department *beglaubigt:* Baderschneider

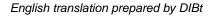
Page 5 of European Technical Assessment ETA-16/0461 of 6 June 2016













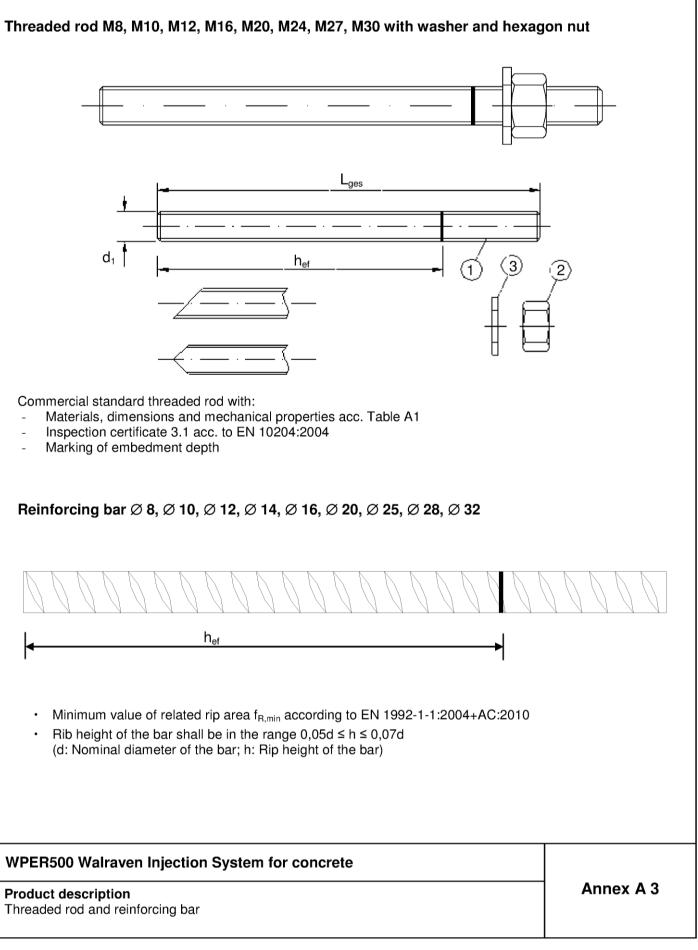




Table A1: Materials

PartDesignationMaterialSteel,zinc plated \geq 5 µm acc. to EN ISO 4042:1999 orSteel,hot-dip galvanised \geq 40 µm acc. to EN ISO1461:2009 and EN ISO 10684:2004+AC:2001Anchor rodSteel, EN 10087:1998 or EN 10263:20011Anchor rodProperty class 4.6, 5.8, 8.8, EN 1993-1-8:202Hexagon nut, EN ISO 4032:2012Steel acc. to EN 10087:1998 or EN 10263:22Hexagon nut, EN ISO 4032:2012Property class 4 (for class 4.6 rod) EN ISO 83Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000Steel, zinc plated or hot-dip galvanised1Anchor rodMaterial 1.4401 / 1.4404 / 1.4571, EN 10088 > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 \leq M24: Property class 50 (for class 50 rod) EN2Hexagon nut, EN ISO 4032:2012Material 1.4401 / 1.4404 / 1.4571 EN 10088 > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 50 (for class 50 rod) EN	005+AC:2009 2001 898-2:2012, 898-2:2012,
Steel, hot-dip galvanised \geq 40 µm acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:201Anchor rodSteel, EN 10087:1998 or EN 10263:2001 Property class 4.6, 5.8, 8.8, EN 1993-1-8:20 A5 > 8% fracture elongation2Hexagon nut, EN ISO 4032:2012Steel acc. to EN 10087:1998 or EN 10263:2 Property class 4 (for class 4.6 rod) EN ISO 887:1998 or EN 10263:2 Property class 5 (for class 5.8 rod) EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000Steel, zinc plated or hot-dip galvanisedSteinless steel1Anchor rodMaterial 1.4401 / 1.4404 / 1.4571, EN 10088 > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 	005+AC:2009 2001 898-2:2012, 898-2:2012,
1Anchor rodSteel, EN 10087:1998 or EN 10263:2001 Property class 4.6, 5.8, 8.8, EN 1993-1-8:200 A_5 > 8% fracture elongation2Hexagon nut, EN ISO 4032:2012Steel acc. to EN 10087:1998 or EN 10263:22 Property class 4 (for class 4.6 rod) EN ISO 8 Property class 5 (for class 5.8 rod) EN ISO 8 Property class 5 (for class 5.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 	005+AC:2009 2001 898-2:2012, 898-2:2012,
1Anchor rodProperty class 4.6, 5.8, 8.8, EN 1993-1-8:20 $A_5 > 8\%$ fracture elongation2Hexagon nut, EN ISO 4032:2012Steel acc. to EN 10087:1998 or EN 10263:2 Property class 4 (for class 4.6 rod) EN ISO 8 Property class 5 (for class 5.8 rod) EN ISO 8 Property class 5 (for class 5.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 	2001 898-2:2012, 898-2:2012,
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	2001 898-2:2012, 898-2:2012,
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	898-2:2012, 898-2:2012,
2Hexagon nut, EN ISO 4032:2012Property class 5 (for class 5.8 rod) EN ISO 8 Property class 8 (for class 5.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Steel, zinc plated or hot-dip galvanised3Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000Steel, zinc plated or hot-dip galvanised3Stainless steel1Anchor rodMaterial 1.4401 / 1.4404 / 1.4571, EN 10088 > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 $A_5 > 8\%$ fracture elongation4Material 1.4401 / 1.4404 / 1.4571 EN 10088	898-2:2012,
Property class 5 (for class 5.8 rod) EN ISO 8 Property class 5 (for class 5.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Property class 8 (for class 8.8 rod) EN ISO 8 Steel, zinc plated or hot-dip galvanised3Washer, EN ISO 887:2006, EN ISO 7094:2000Steel, zinc plated or hot-dip galvanised3EN ISO 7094:2000Steel, zinc plated or hot-dip galvanised5SteelMaterial 1.4401 / 1.4404 / 1.4571, EN 10088 > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 $A_5 > 8\%$ fracture elongation4Material 1.4401 / 1.4404 / 1.4571 EN 10088 \leq M24: Property class 70 EN ISO 3506-1:20 $A_5 > 8\%$ fracture elongation	
$\begin{array}{c c} & \text{Washer, EN ISO 887:2006,} \\ \hline \text{SN ISO 7089:2000, EN ISO 7093:2000 or} \\ \hline \text{EN ISO 7094:2000} \end{array} & \text{Steel, zinc plated or hot-dip galvanised} \\ \hline \textbf{Stainless steel} \\ \hline 1 & \text{Anchor rod} \end{array} & \begin{array}{c} \text{Material } 1.4401 / 1.4404 / 1.4571, EN 10088 \\ &> M24: \text{ Property class 50 EN ISO 3506-1:20} \\ &\leq M24: \text{ Property class 70 EN ISO 3506-1:20} \\ &\leq M24: Property cl$	898-2:2012
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	
$ \begin{array}{c c} 1 & \mbox{Anchor rod} & \mbox{Material } 1.4401 \ / \ 1.4404 \ / \ 1.4571, \ EN \ 10088 \\ & > M24: \ Property \ class \ 50 \ EN \ ISO \ 3506-1:200 \\ & \le M24: \ Property \ class \ 70 \ EN \ ISO \ 3506-1:200 \\ & A_5 \ > \ 8\% \ fracture \ elongation \\ & \ Material \ 1.4401 \ / \ 1.4571 \ EN \ 10088: \end{array} $	
1 Anchor rod > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 $A_5 > 8\%$ fracture elongation Material 1.4401 / 1.4404 / 1.4571 EN 10088:	
1 Anchor rod > M24: Property class 50 EN ISO 3506-1:20 \leq M24: Property class 70 EN ISO 3506-1:20 $A_5 > 8\%$ fracture elongation Material 1.4401 / 1.4404 / 1.4571 EN 10088:	8-1.2005
I Anchor rod ≤ M24: Property class 70 EN ISO 3506-1:20 A ₅ > 8% fracture elongation Material 1.4401 / 1.4404 / 1.4571 EN 10088:	
A ₅ > 8% fracture elongation Material 1.4401 / 1.4571 EN 10088:	
Material 1.4401 / 1.4404 / 1.4571 EN 10088	
	2005
≤ M24: Property class 70 (for class 70 rod) E	
Washer, EN ISO 887:2006,	
3 EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000 Material 1.4401, 1.4404 or 1.4571, EN 1008	88-1:2005
High corrosion resistance steel	
Material 1.4529 / 1.4565, EN 10088-1:2005,	,
> M24: Property class 50 EN ISO 3506-1:20	009
1 Anchor rod \leq M24: Property class 50 EN ISO 3506-1:20	009
$A_5 > 8\%$ fracture elongation	
Material 1.4529 / 1.4565 EN 10088-1:2005,	
2 Hexagon nut, EN ISO 4032:2012 > M24: Property class 50 (for class 50 rod) E	EN ISO 3506-2:2009
≤ M24: Property class 70 (for class 70 rod) E	EN ISO 3506-2:2009
Washer, EN ISO 887:2006, 3 EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000 HAISO 7093:2000 Or	
Reinforcing bars	
Bars and de-coiled rods class B or C	
1 Rebar EN 1992-1-1:2004+AC:2010, Annex C f_{yk} and k according to NDP or NCL of EN 198 $f_{uk} = f_{tk} = k \cdot f_{yk}$	92-1-1/NA:2013
$f_{uk} = f_{tk} = k \cdot f_{yk}$	
WPER500 Walraven Injection System for concrete	
Product description	Annex A 4
Materials	



Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads: M8 to M30, Rebar Ø8 to Ø32.
- Seismic action for Performance Category C1: M12 to M30, Rebar Ø12 to Ø32.
- Seismic action for Performance Category C2: 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.
- Non-cracked concrete: M8 to M30, Rebar Ø8 to Ø32.
- · Cracked concrete: M12 to M30, Rebar Ø12 to Ø32.

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: M8 to M30, Rebar Ø8 to Ø32.
- Flooded holes (not sea water): M8 to M30, Rebar Ø8 to Ø32.
- Hole drilling by hammer or compressed air 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.

WPER500 Walraven Injection System for concrete

Intended Use

Specifications



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 encharges depth	h _{ef,min} [mm] =	60	60	70	80	90	96	108	120
Effective anchorage depth	h _{ef,max} [mm] =	96	120	144	192	240	288	324	360
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							
Thickness of fixture	t _{fix,max} [mm] <				15	00			
Minimum thickness of member	h _{min} [mm]		_{ef} + 30 m ≥ 100 mn				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 rebar

	Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
d ₀ [mm] =	12	14	16	18	20	24	32	35	40
h _{ef,min} [mm] =	60	60	70	75	80	90	100	112	128
h _{ef,max} [mm] =	96	120	144	168	192	240	300	336	384
d _b [mm] ≥	14	16	18	20	22	26	34	37	41,5
h _{min} [mm]						h _{ef} + 2d ₀)		
s _{min} [mm]	40	50	60	70	80	100	125	140	160
c _{min} [mm]	40	50	60	70	80	100	125	140	160
	h _{ef,min} [mm] = h _{ef,max} [mm] = d _b [mm] ≥ h _{min} [mm] s _{min} [mm]	$\begin{array}{c} d_{0} \ [mm] = & 12 \\ h_{ef,min} \ [mm] = & 60 \\ h_{ef,max} \ [mm] = & 96 \\ d_{b} \ [mm] \ge & 14 \\ h_{min} \ [mm] & \begin{array}{c} h_{ef} + 3 \\ \ge & 100 \\ \end{array}$	$\begin{array}{c c} d_{0} \ [mm] = & 12 & 14 \\ \hline h_{ef,min} \ [mm] = & 60 & 60 \\ \hline h_{ef,max} \ [mm] = & 96 & 120 \\ \hline d_{b} \ [mm] \geq & 14 & 16 \\ \hline h_{min} \ [mm] & \begin{array}{c} h_{ef} + 30 \ mm \\ \geq & 100 \ mm \\ \end{array} \end{array}$	$\begin{array}{c cccc} d_0 \ [mm] = & 12 & 14 & 16 \\ \hline h_{ef,min} \ [mm] = & 60 & 60 & 70 \\ \hline h_{ef,max} \ [mm] = & 96 & 120 & 144 \\ \hline d_b \ [mm] \ge & 14 & 16 & 18 \\ \hline h_{min} \ [mm] & \frac{h_{ef} + 30 \ mm}{\ge 100 \ mm} \\ \hline s_{min} \ [mm] & 40 & 50 & 60 \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$				

WPER500 Walraven Injection System for concrete

Intended Use

Installation parameters



Steel brush



Table B3: Parameter cleaning and setting tools

Threaded Rod	Rebar	d₀ Drill bit - Ø	d₅ Brush - Ø	d _{b,min} min. Brush - Ø	Piston plug
(mm)	(mm)	(mm)	(mm)	(mm)	(No.)
M8		10	12	10,5	
M10	8	12	14	12,5	
M12	10	14	16	14,5	No
	12	16	18	16,5	piston plug required
M16	14	18	20	18,5] '
	16	20	22	20,5]
M20	20	24	26	24,5	# 24
M24		28	30	28,5	# 28
M27	25	32	34	32,5	# 32
M30	28	35	37	35,5	# 35
	32	40	41,5	40,5	# 38





Hand pump (volume 750 ml) Drill bit diameter (d₀): 10 mm to 20 mm



Recommended compressed air tool (min 6 bar) Drill bit diameter (d₀): 10 mm to 40 mm

Piston plug for overhead or horizontal installation Drill bit diameter (d_0) : 24 mm to 40 mm

WPER500 Walraven Injection System for concrete

Intended Use

Cleaning and setting tools



Installation inst	ructions	
	1. Drill with hammer drill a hole into the base material to the size a depth required by the selected anchor (Table B1 or Table B2). I drill hole: the drill hole shall be filled with mortar	
	Attention! Standing water in the bore hole must be removed	d before cleaning.
2x	2a. Starting from the bottom or back of the bore hole, blow the hole compressed air (min. 6 bar) or a hand pump (Annex B 3) a mini the bore hole ground is not reached an extension shall be used	mum of two times. If
or	The hand-pump can be used for anchor sizes up to bore hole d	iameter 20 mm.
2x }	For bore holes larger than 20 mm or deeper 240 mm, compress must be used.	sed air (min. 6 bar)
******	2b. Check brush diameter (Table B3) and attach the brush to a drill or a battery screwdriver. Brush the hole with an appropriate size > d _{b,min} (Table B3) a minimum of two times.	ed wire brush
2x	If the bore hole ground is not reached with the brush, a brush ex shall be used (Table B3).	xtension
	2c. Finally blow the hole clean again with compressed air (min. 6 based (Annex B 3) a minimum of two times. If the bore hole ground is extension shall be used. The hand-pump can be used for anchor sizes up to bore hole defined to bore hole defined and based.	not reached an iameter 20 mm.
or	For bore holes larger than 20 mm or deeper 240 mm, compress <u>must</u> be used.	sed air (min. 6 bar)
2x	After cleaning, the bore hole has to be protected against re an appropriate way, until dispensing the mortar in the bore the cleaning repeated has to be directly before dispensing In-flowing water must not contaminate the bore hole again.	hole. If necessary, the mortar.
	3. Attach a supplied static-mixing nozzle to the cartridge and load correct dispensing tool. Cut off the foil tube clip before use. For every working interruption longer than the recommended w (Table B4) as well as for new cartridges, a new static-mixer sha	orking time
Careford and a second s	4. Prior to inserting the anchor rod into the filled bore hole, the pose embedment depth shall be marked on the anchor rods.	sition of the
min. 3 full stroke	5. Prior to dispensing into the anchor hole, squeeze out separately full strokes and discard non-uniformly mixed adhesive component shows a consistent grey colour. For foil tube cartridges is must be minimum of six full strokes.	nts until the mortar
WPER500 Walrave	en Injection System for concrete	
Intended Use Installation instructior	าร	Annex B 4



Installation inst	ructions (continuation)
	6. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment larger than 190 mm an extension nozzle shall be used. For overhead and horizontal installation a piston plug (Annex B 3) and extension nozzle shall be used. Observe the gel-/ working times given in Table B4.
	Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The anchor should be free of dirt, grease, oil or other foreign material.
	8. Be sure that the anchor is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod should be fixed (e.g. wedges).
20°C e.g.	9. 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 (attend Table B4).
	 After full curing, the add-on part can be installed with the max. torque (Table B2) by using a calibrated torque wrench.

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		

WPER500 Walraven Injection System for concrete

Intended Use Installation instructions (continuation) Curing time



Steel, property class 3.4.5 Nikk,s [kN] 18 29 42 78 122 176 236 Characteristic tension resistance, Steel, property class 5.8 Nikk,s [kN] 18 29 42 78 122 176 236 Characteristic tension resistance, Steel, property class 5.8 Nikk,s [kN] 29 46 67 125 196 282 366 Characteristic tension resistance, Stainless steel At and HCR, property class 50 (>M24) and 70 (< M24) Nikk,s [kN] 26 41 59 110 171 247 236 Combined pull-out and concrete cone failure Nikk,s [kN] 26 41 59 110 171 247 236 Characteristic bond resistance in non-cracked concrete C20/25 Temperature range I: dry and wet concrete $\tau_{10k,wr}$ [N/mm²] 15 14 13 10 9,5 8,5 7,5 Temperature range II: dry and wet concrete $\tau_{10k,wr}$ [N/mm²] 9,5 9,0 8,5 7,5 7,0 6,0 5,5 Temperature range III: dry and wet concrete	ichor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	eel failure											
Steel, property class 5.8 Nnk.s [NN m.s [NN m.s] [N m.s] <	eel, property class 4.6		N _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
Steel, property class 8.8 Nmks [KN] 29 46 67 125 196 282 366 Characteristic tension resistance, property class 50 (>M24) and 70 (≤ M24) Nmks [KN] 26 41 59 110 171 247 230 Combined pull-out and concrete cone failure Combined pull-out and concrete cone failure [KN] 26 41 59 110 171 247 230 Combined pull-out and concrete cone failure Combined pull-out and concrete concrete C20/25 [KN] 15 15 14 13 12 12 Characteristic bond resistance in non-cracked concrete $\tau_{Rk,upr}$ [N/mm²] 15 14 13 10 9,5 8,5 7,5 7,5 Temperature range I: dry and wet concrete $\tau_{Rk,upr}$ [N/mm²] 9,5 9,5 9,0 8,5 8,0 7,5 7,0 6,5 Temperature range II: dry and wet concrete $\tau_{Rk,upr}$ [N/mm²] 8,5 8,5 8,0 7,5 7,0 6,5 Temperature range III: dry and wet concrete $\tau_{Rk,upr}$ [N/mm²] </td <td></td> <td>tance,</td> <td>N_{Rk,s}</td> <td>[kN]</td> <td>18</td> <td>29</td> <td>42</td> <td>78</td> <td>122</td> <td>176</td> <td>230</td> <td>280</td>		tance,	N _{Rk,s}	[kN]	18	29	42	78	122	176	230	280
Stainless steel A4 and HCR, property class 50 (sM24) and 70 (≤ M24) N _{Rk.s} [kN] 26 41 59 110 171 247 230 Combined pull-out and concrete cone failure Characteristic bond resistance in non-cracked concrete C20/25 Temperature range I: 40°C/24°C dry and wet concrete flooded bore hole $\tau_{Rk.uer}$ [N/mm²] 15 15 14 13 12 12 Temperature range I: 40°C/24°C dry and wet concrete flooded bore hole $\tau_{Rk.uer}$ [N/mm²] 15 14 13 10 9,5 8,5 7,5 7,5 7,5 7,5 7,5 7,5 7,5 7,5 7,0 6,5 6,5 Temperature range II: 60°C/43°C dry and wet concrete flooded bore hole $\tau_{Rk.uer}$ [N/mm²] 9,5 9,5 9,0 8,5 7,5 7,0 6,5 Temperature range III: 72°C/43°C dry and wet concrete flooded bore hole $\tau_{Rk.uer}$ [N/mm²] 8,5 8,5 8,0 7,5 7,0 6,0 5,5 Temperature range III: 72°C/43°C dry and wet concrete flooded bore hole τ		tance,	N _{Rk,s}	[kN]	29	46	67	125	196	282	368	449
$\begin{array}{c c c c c c c } \mbox{Characteristic bond resistance in non-cracked concrete C20/25} \\ \hline Temperature range I: \\ 40^{\circ}C/24^{\circ}C & \hline 10 ded bore hole & $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$	Stainless steel A4 and HCR,		$N_{{\sf R}k,s}$	[kN]	26	41	59	110	171	247	230	281
$\begin{array}{c c c c c c c } Temperature range I: \\ 40^{\circ}C/24^{\circ}C & \hline flooded bore hole & $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$	mbined pull-out and co	oncrete cone failure						-			-	
$\begin{array}{c c c c c c c } \mbox{Temperature range I:} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & $	aracteristic bond resistar	nce in non-cracked con	crete C20/2	5								
$\frac{11000000 \text{ bore hole}}{1000000 \text{ bore hole}} = \frac{1}{\tau_{\text{Fik,ucr}}} [N/\text{mm}^2] = 15 = 14 = 13 = 10 = 9,5 = 8,5 = 7,5 = 7,5 = 7,5 = 7,5 = 7,5 = 7,5 = 7,5 = 7,5 = 7,0 = 6,5 = 7,5 = 7,0 = 6,5 = 7,5 = 7,0 = 7,5 = 7,0 = 6,5 = 7,5 = 7,0 = 7,0 = $	mperature range I:	dry and wet concrete	$\tau_{\text{Rk,ucr}}$	[N/mm²]	15	15	15	14	13	12	12	12
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	°Ċ/24°C	flooded bore hole	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	15	14	13	10	9,5	8,5	7,5	7,0
$\frac{1}{10000000000000000000000000000000000$	mperature range II:	dry and wet concrete	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	9,5	9,5	9,0	8,5	8,0	7,5	7,5	7,5
$\begin{array}{c c c c c c c c c c c c c c c c c c c $	°Ċ/43°C	flooded bore hole	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
$\frac{100 \text{ ded bore hole}}{\text{ thoded bore hole}} \frac{\tau_{\text{Rk,ucr}}}{\tau_{\text{Rk,ucr}}} \frac{[\text{N/mm}^2]}{8,5} \frac{8,5}{8,0} \frac{7,5}{7,0} \frac{6,0}{5,5} \frac{5,5}{6,0} \frac{5,5}{5,5} \frac{1,04}{5,5} \frac{1,04}{5,5} \frac{1,04}{5,5} \frac{1,04}{5,5} \frac{1,08}{5,5} \frac{1,08}{5$	mperature range III:	dry and wet concrete	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	8,5	8,5	8,0	7,5	7,0	7,0	6,5	6,5
Increasing factors for concrete Ψ_c C40/501,08C40/501,10Splitting failureEdge distance $c_{cr,sp}$ [mm] $1,0 \cdot h_{ef} \le 2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right) \le 2,4 \cdot h_{ef}$ Axial distance $s_{cr,sp}$ [mm] $2 c_{cr,sp}$ Installation safety factor (dry and wet concrete) γ_2 1,21,4	.°Ċ/43°C	flooded bore hole	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
			C30/37					1,	04			
C50/601,10Splitting failureEdge distance $c_{cr,sp}$ [mm] $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right) \leq 2,4 \cdot h_{ef}$ Axial distance $s_{cr,sp}$ [mm] $2 c_{cr,sp}$ Installation safety factor (dry and wet concrete) γ_2 1,21,4	C C		C40/50		1,08							
Edge distance $c_{cr,sp}$ [mm] $1,0 \cdot h_{ef} \leq 2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right) \leq 2,4 \cdot h_{ef}$ Axial distance $s_{cr,sp}$ [mm] $2 c_{cr,sp}$ Installation safety factor (dry and wet concrete) γ_2 1,21,4			C50/60		1,10							
Axial distance $s_{cr,sp}$ [mm] $2 c_{cr,sp}$ Installation safety factor (dry and wet concrete) γ_2 1,21,4	litting failure											
Installation safety factor (dry and wet concrete) γ_2 1,2 1,4	ge distance		C _{cr,sp}	[mm]		1,0) ⋅ h _{ef} ≤ 2	2 · h _{ef} (2	$5 - \frac{h}{h_{ef}}$) ≤ 2,4 · I	ר _{ef}	
	ial distance		S _{cr,sp}	[mm]		2 c _{cr,sp}						
Installation safety factor (flooded bore hole) γ ₂ 1,4	stallation safety factor (dr	y and wet concrete)	γ2		1,2 1,4							
	stallation safety factor (flo	ooded bore hole)	γ2	1,4								

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for threaded rods under tension loads in non-cracked concrete (Design according to TR 029)



Anchor size threaded r	od			M 12	M 16	M 20	M24	M 27	M 30	
Steel failure										
Characteristic tension re Steel, property class 4.6	,	$N_{Rk,s} = N_{Rk,s,seis}$	[kN]	34	63	98	141	184	224	
Characteristic tension resistance, Steel, property class 5.8		N _{Rk,s} =N _{Rk,s,seis}	[kN]	42	78	122	176	230	280	
Characteristic tension resistance, Steel, property class 8.8 Characteristic tension resistance, Stainless steel A4 and HCR, property class 50 (>M24) and 70 (≤ M24)		N _{Rk,s} =N _{Rk,s,seis}	[kN]	67	125	196	282	368	449	
		N _{Rk,s} =N _{Rk,s,seis}	[kN]	59	110	171	247	230	281	
Combined pull-out and	concrete cone failure									
Characteristic bond resis	stance in cracked concret	e C20/25								
	$\tau_{\rm Rk,cr}$	[N/mm²]	7,5	6,5	6,0	5,5	5,5	5,5		
	dry and wet concrete	$\tau_{Rk,seis,C1}$	[N/mm²]	7,1	6,2	5,7	5,5	5,5	5,5	
Temperature range I:		$\tau_{\text{Rk,seis,C2}}$	[N/mm²]	2,4	2,2	No Performance Determined (NPD)				
10°C/24°C		$\tau_{\text{Rk,cr}}$	[N/mm²]	7,5	6,0	5,0	4,5	4,0	4,0	
	flooded bore hole	$\tau_{Rk,seis,C1}$	[N/mm²]	7,1	5,8	4,8	4,5	4,0	4,0	
		$\tau_{\text{Rk,seis,C2}}$	[N/mm²]	2,4	2,1	No Pe	rformance [Determined	(NPD)	
	dry and wet concrete	$\tau_{\text{Rk,cr}}$	[N/mm²]	4,5	4,0	3,5	3,5	3,5	3,5	
		$\tau_{Rk,seis,C1}$	[N/mm²]	4,3	3,8	3,4	3,5	3,5	3,5	
Temperature range II:		$\tau_{\text{Rk,seis,C2}}$	[N/mm²]	1,4	1,4	No Performance Determined (NPD)				
60°Ċ/43°C	flooded bore hole	$\tau_{\text{Rk,cr}}$	[N/mm²]	4,5	4,0	3,5	3,5	3,5	3,5	
		$\tau_{Rk,seis,C1}$	[N/mm²]	4,3	3,8	3,4	3,5	3,5	3,5	
		$\tau_{\text{Rk,seis,C2}}$	[N/mm²]	1,4	1,4	No Performance Determined (NPI			(NPD)	
		$\tau_{\rm Rk,cr}$	[N/mm²]	4,0	3,5	3,0	3,0	3,0	3,0	
	dry and wet concrete	$\tau_{\text{Rk,seis,C1}}$	[N/mm²]	3,9	3,4	3,0	3,0	3,0	3,0	
Temperature range III: 72°C/43°C		$\tau_{\text{Rk,seis,C2}}$	[N/mm ²]	1,3	1,2	No Pe	rformance [Determined	(NPD)	
		$\tau_{\rm Rk,cr}$	[N/mm²]	4,0	3,5	3,0	3,0	3,0	3,0	
	flooded bore hole	$\tau_{Rk,seis,C1}$	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,0	
		$\tau_{\text{Rk,seis,C2}}$	[N/mm²]	1,3	1,2	No Pe	rformance [Determined	(NPD)	
ncreasing factors for co	noroto	C30/37				1,	04			
only static or quasi-stati		C40/50				1,	08			
ψ_{c}		C50/60				1,	10			
nstallation safety factor	(dry and wet concrete)	γ2		1	,2		1,	,4		
Installation safety factor	(flooded bore hole)	γ2				1	,4			
		-								

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for threaded rods under tension loads in cracked concrete (Design according to TR 029 and TR 045)



Table C3: Characteristic values of resistance for threaded rods under shear loads in cracked and non-cracked concrete (Design according to TR 029 and TR 045) Anchor size threaded rod M 8 M 10 M 12 M 16 M 20 M24 M 27 M 30 Steel failure without lever arm V_{Rk.s} 7 12 17 49 71 92 112 [kN] 31 Characteristic shear resistance, No Performance 72 [kN] 14 27 42 56 88 V_{Rk,s,seis,C1} Steel, property class 4.6 Determined [kN] (NPD) 13 25 No Performance Determined (NPD) V_{Rk,s,seis,C2} $V_{Rk,s}$ [kN] 9 15 21 39 61 88 115 140 Characteristic shear resistance, No Performance 18 34 53 70 91 111 [kN] $V_{Rk,s,seis,C1}$ Steel, property class 5.8 Determined No Performance Determined (NPD) [kN] (NPD) 17 31 V_{Rk,s,seis,C2} $V_{Rk.s}$ [kN] 15 23 34 63 98 141 184 224 Characteristic shear resistance. No Performance [kN] 30 55 85 111 145 177 V_{Rk,s,seis,C1} Steel, property class 8.8 Determined 27 No Performance Determined (NPD) 50 V_{Rk,s,seis,C2} [kN] (NPD) $V_{\mathsf{Rk},\mathsf{s}}$ [kN] 13 20 30 55 86 124 115 140 Characteristic shear resistance, No Performance Stainless steel A4 and HCR, 48 [kN] 26 75 98 91 111 V_{Rk,s,seis,C1} Determined property class 50 (>M24) and 70 (\leq M24) [kN] 24 44 No Performance Determined (NPD) V_{Rk,s,seis,C2} (NPD) Steel failure with lever arm [Nm] 15 30 52 133 260 449 666 900 M⁰_{Rk,s} Characteristic bending moment, [Nm] $M^0_{Rk,s,seis,C1}$ Steel, property class 4.6 No Performance Determined (NPD) M⁰_{Rk,s,seis,C2} [Nm] 37 166 833 1123 [Nm] 19 65 324 560 М⁰_{Rk,s} Characteristic bending moment, M⁰_{Rk,s,seis,C1} [Nm] Steel, property class 5.8 No Performance Determined (NPD) M⁰_{Rk,s,seis,C2} [Nm] [Nm] 30 60 105 266 519 896 1333 1797 М⁰_{Rk,s} Characteristic bending moment, [Nm] M⁰Rk,s,seis,C1 Steel, property class 8.8 No Performance Determined (NPD) M⁰_{Rk,s,seis,C2} [Nm] 1125 M⁰_{Bk.s} [Nm] 26 52 92 232 454 784 832 Characteristic bending moment, Stainless steel A4 and HCR, [Nm] M⁰_{Rk,s,seis,C1} property class 50 (>M24) and 70 (\leq M24) No Performance Determined (NPD) [Nm] M⁰_{Rk,s,seis,C2} Concrete pry-out failure Factor k in equation (5.7) of Technical Report TR 029 for the design of Bonded k [-] 2,0 Anchors Installation safety factor 1,0 γ_2 Concrete edge failure Installation safety factor 1,0 γ_2 WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for threaded rods under shear loads in cracked and non-cracked concrete, (Design according to TR 029 and TR 045)



				tance for rebar under tension loads in າ according to TR 029)								
Anchor size reinfor	cing bar		_	Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure								I			1	
Characteristic tension	n resistance	$N_{Rk,s}$	[kN]	A _s • f _{uk}								
Combined pull-out	and concrete cone failu	'e										
Characteristic bond r	esistance in non-cracked	concrete C	20/25									
Temperature range I	$ au_{Rk,ucr}$	[N/mm²]	14	14	13	13	12	12	11	11	11	
40°C/24°C	flooded bore hole	$\tau_{\rm Rk,ucr}$	[N/mm²]	14	13	11	10	9,5	8,5	7,5	7,0	6,0
Temperature range I	dry and wet concrete	$ au_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	7,0	6,5	6,5
60°C/43°C	flooded bore hole	$\tau_{\rm Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	6,0	5,5	5,0
Temperature range III: 72°C/43°C	dry and wet II: concrete	$ au_{Rk,ucr}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,5	6,0	6,0	6,0
72°C/43°C flooded bore hole		$ au_{Rk,ucr}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,0	4,5
		C30/37		1,04								
Increasing factors for Ψ°	concrete	C40/50		1,08								
-		C50/60						1,10				
Splitting failure												
Edge distance		C _{cr,sp}	[mm]			1,0 · h _{ef}	≤2·h _e	_{of} (2,5 -	$\left(\frac{h}{h_{ef}}\right) \le 2$	2,4 · h _{ef}		
Axial distance		S _{cr,sp}	[mm]					2 c _{cr,sp}				
Installation safety fac concrete)	γ2		1,2 1,4									
Installation safety factor (flooded bore hole) y ₂				1,4								

WPER500 Walraven Injection System for concrete

Performances Characteristic val

Characteristic values of resistance for rebar under tension loads in non-cracked concrete (Design according to TR 029)



	Characteristic val							ads in	Ì	
Anchor size reinforci	ng bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure										
Characteristic tension	resistance	N _{Rk,s} =N _{Rk,s,seis,C1}	[kN]				$A_{s}\boldsymbol{\cdot}f_{uk}$			
Combined pull-out a	nd concrete cone failure									
Characteristic bond re	sistance in cracked concret	e C20/25								
	dry and wet concrete	$ au_{Rk,cr}$	[N/mm²]	7,5	7,0	6,5	6,0	5,5	5,5	5,5
Temperature range I:	dry and wer concrete	$ au_{\text{Rk,seis,C1}}$	[N/mm²]	6,9	6,4	6,2	5,7	5,5	5,5	5,5
40°C/24°C	flooded bore hole	$\tau_{\rm Rk,cr}$	[N/mm²]	7,5	6,5	6,0	5,0	4,5	4,0	4,0
	hooded bore hole	$\tau_{Rk,seis,C1}$	[N/mm²]	6,9	6,0	5,7	4,8	4,5	4,0	4,0
		$\tau_{Rk,cr}$	[N/mm²]	4,5	4,0	4,0	3,5	3,5	3,5	3,5
Temperature range II:	dry and wet concrete	$\tau_{Rk,seis,C1}$	[N/mm²]	4,1	3,7	3,8	3,3	3,5	3,5	3,5
60°C/43°C		$\tau_{Rk,cr}$	[N/mm²]	4,5	4,0	4,0	3,5	3,5	3,5	3,0
	flooded bore hole	$\tau_{Rk,seis,C1}$	[N/mm²]	4,1	3,7	3,8	3,3	3,5	3,5	3,0
	dur, and wat apparets	$\tau_{Rk,cr}$	[N/mm²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
Temperature range III	dry and wet concrete	$\tau_{\text{Rk,seis,C1}}$	[N/mm²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
72°C/43°C		$\tau_{Rk,cr}$	[N/mm²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole	$\tau_{\text{Rk,seis,C1}}$	[N/mm²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
		C30/37	•				1,04			
Increasing factors for a (only static or quasi-static)		C40/50					1,08			
Ψc		C50/60					1,10			
Installation safety facto	or (dry and wet concrete)	γ2			1,2			1	,4	
Installation safety facto	or (flooded bore hole)	γ_2					1,4			

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for rebar under tension loads in cracked concrete (Design according to TR 029 and TR 045)



Table C6: Characterist and non-crae											d
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											
	V _{Rk,s}	[kN]				0,	50 • A _s •	f _{uk}			
Characteristic shear resistance	$V_{Rk,s,seis,C1}$	[kN]	Deter	lo mance mined PD)			0,	44 • A _s •	f _{uk}		
Steel failure with lever arm											
Characteristic bending moment	M ⁰ _{Rk,s}	[Nm]				1.	.2 • W _{el} •	f _{uk}			
Characteristic bending moment	$M^0_{Rk,s,seis,C1}$	[Nm]			No F	Performa	nce Dete	rmined (N	IPD)		
Concrete pry-out failure											
Factor k in equation (5.7) of Technical Report TR 029 for the design of bonded anchors	k	[-]					2,0				
Installation safety factor	γ2						1,0				
Concrete edge failure											
Installation safety factor	γ2						1,0				
WPER500 Walraven Injectio	on System f	or con	crete						A		•
Performances Characteristic values of resistance f concrete, (Design according to TR 0			ads in c	racked a	and non-	-cracked	k		Ann	ex C (D



				M 8	M 10	M 12	M 16	M 20	M24	M 27	М 30
Steel failure											
Characteristic tension resista Steel, property class 4.6	ance,	N _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
Characteristic tension resist	ance,	N _{Rk.s}	[kN]	18	29	42	78	122	176	230	280
Steel, property class 5.8 Characteristic tension resista	ance,	N _{Rk.s}	[kN]	29	46	67	125	196	282	368	449
Steel, property class 8.8 Characteristic tension resista	ance.	INRk,s		29	40	07	125	190	202	300	443
Stainless steel A4 and HCR property class 50 (>M24) an	,	$N_{Rk,s}$	[kN]	26	41	59	110	171	247	230	281
Combined pull-out and co	ncrete failure										
Characteristic bond resistan	ce in non-cracked concrete	e C20/25									
Temperature range I:	dry and wet concrete	$ au_{Rk,ucr}$	[N/mm ²]	15	15	15	14	13	12	12	12
40°C/24°C	flooded bore hole	$ au_{Rk,ucr}$	[N/mm ²]	15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II:	dry and wet concrete	$ au_{Rk,ucr}$	[N/mm ²]	9,5	9,5	9,0	8,5	8,0	7,5	7,5	7,5
60°C/43°C	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm ²]	9,5	9,5	9,0	8,5	7,5	7,0	6,5	6,0
Temperature range III:	dry and wet concrete	$ au_{Rk,ucr}$	[N/mm ²]	8,5	8,5	8,0	7,5	7,0	7,0	6,5	6,5
72°C/43°C	flooded bore hole	$ au_{Rk,ucr}$	[N/mm ²]	8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
	·	C30/37					1,	04			
ncreasing factors for concre ∉₀	ete	C40/50					1,	08			
+ C		C50/60					1,	10			
Factor according to CEN/TS 1992-4-5 Section 6	223	k ₈	[-]				10),1			
Concrete cone failure											
Factor according to CEN/TS 1992-4-5 Section 6	231	k _{ucr}	[-]				10),1			
Edge distance	.2.0.1	C _{cr,N}	[mm]				1,5	i h _{ef}			
Axial distance		S _{cr,N}	[mm]				3,0	h _{ef}			
Splitting failure											
Edge distance		C _{cr,sp}	[mm]		1	,0 ⋅ h _{ef} ≤	2 · h _{ef} 2	$5 - \frac{h}{h_{ef}}$	≤ 2,4 · h _a	ef	
Axial distance		S _{cr,sp}	[mm]				2 c	cr,sp			
Installation safety factor (dry	and wet concrete)	γinst			1	,2			1	,4	
Installation actatulation (flag	oded bore hole)	γinst					1	,4			

Performances Characteristic values of resistance for threaded rods under tension loads in non-cracked concrete (Design according to CEN/TS 1992-4)



Table C8:Characteristic values of resistance for threaded rods under tension loads in
cracked concrete (Design according to CEN/TS 1992-4 and TR 045)

Anchor size threaded rod	l			M 12	M 16	M 20	M24	M27	M30
Steel failure									
Characteristic tension resis Steel, property class 4.6	tance,	N _{Rk,s} =N _{Rk,s,seis}	[kN]	34	63	98	141	184	224
Characteristic tension resis Steel, property class 5.8		N _{Rk,s} =N _{Rk,s,seis}	[kN]	42	78	122	176	230	280
Characteristic tension resis Steel, property class 8.8		$N_{Rk,s} = N_{Rk,s,seis}$	[kN]	67	125	196	282	368	449
Characteristic tension resis Stainless steel A4 and HCF property class 50 (>M24) a	٦,	$N_{\text{Rk,s}} = N_{\text{Rk,s,seis}}$	[kN]	59	110	171	247	230	281
Combined pull-out and co	oncrete failure								
Characteristic bond resista	nce in cracked concrete C2	0/25							
		$\tau_{\rm Rk,cr}$	[N/mm ²]	7,5	6,5	6,0	5,5	5,5	5,5
	dry and wet concrete	$\tau_{\rm Rk,seis,C1}$	[N/mm ²]	7,1	6,2	5,7	5,5	5,5	5,5
Temperature range I:		$\tau_{\rm Rk,seis,C2}$	[N/mm ²]	2,4	2,2	No Perf	ormance I	Determine	d (NPD
40°C/24°C		τ _{Rk,cr}	[N/mm ²]	7,5	6,0	5,0	4,5	4,0	4,0
	flooded bore hole	τ _{Rk,seis,C1}	[N/mm ²]	7,1	5,8	4,8	4,5	4.0	4,0
		τ _{Rk,seis,C2}	[N/mm ²]	2,4	2,1			Determine	
		τ _{Rk,cr}	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	3,5
	dry and wet concrete	TRk,seis,C1	[N/mm ²]	4,3	3,8	3,4	3,5	3,5	3,5
	ary and wer concrete		[N/mm ²]	1,4	1,4	- / -	-	Determine	
Temperature range II: 60°C/43°C		τ _{Rk,seis,C2}	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	3,5
	flooded bore hole	τ _{Rk,cr}	[N/mm ²]	4,3		3,5	3,5	3,5	3,5
	housed bore hole	τ _{Rk,seis,C1}			3,8		-	Determine	
		$\tau_{\rm Rk,seis,C2}$	[N/mm ²]	1,4	1,4				<u> </u>
		$ au_{Rk,cr}$	[N/mm ²]	4,0	3,5	3,0	3,0	3,0	3,0
	dry and wet concrete	τ _{Rk,seis,C1}	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,0
Temperature range III: 72°C/43°C		$\tau_{\rm Rk,seis,C2}$	[N/mm ²]	1,3	1,2			Determine	<u> </u>
72-0/43-0		$\tau_{\rm Rk,cr}$	[N/mm ²]	4,0	3,5	3,0	3,0	3,0	3,0
	flooded bore hole	$\tau_{\rm Rk,seis,C1}$	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,0
		$\tau_{\text{Rk,seis,C2}}$	[N/mm ²]	1,3	1,2			Determine	d (NPD
ncreasing factors for conci		C30/37				,	04		
only static or quasi-static a	actions)	C40/50				1,	08		
Ψc		C50/60				1,	10		
Factor according to CEN/TS 1992-4-5 Section	6.2.2.3	k ₈	[-]			7	,2		
Concrete cone failure									
Factor according to CEN/TS 1992-4-5 Section	6.2.3.1	k _{cr}	[-]			7	,2		
Edge distance		C _{cr,N}	[mm]			1,5	i h _{ef}		
Axial distance		S _{cr,N}	[mm]			3,0) h _{ef}		
Installation safety factor (dr	y and wet concrete)	γinst		1	,2			,4	
Installation safety factor (flo	- ,	γinst				1	,4		
		1.00					, ·		

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for threaded rods under tension loads in cracked concrete (Design according to CEN/TS 1992-4 and TR 045)



Table C9: Characteristic values of resistance for threaded rods under shear loads in cracked and non-cracked concrete (Design according to CEN/TS 1992-4 and TR 045)

			M 8	M 10	M 12	M 16	M 20	M24	M 27	М 3
Steel failure without lever arm										
	$V_{Rk,s}$	[kN]	7	12	17	31	49	71	92	112
Characteristic shear resistance, Steel, property class 4.6	V _{Rk,s,seis,C1}	[kN]	No Perf	ormance	14	27	42	56	72	88
	$V_{Rk,s,seis,C2}$	[kN]	Determin	ed (NPD)	13	25	No Per	formance l	Determined	(NPD)
	V _{Rk,s}	[kN]	9	15	21	39	61	88	115	140
Characteristic shear resistance, Steel, property class 5.8	$V_{Rk,s,seis,C1}$	[kN]		ormance	18	34	53	70	91	111
	V _{Rk,s,seis,C2}	[kN]	Determin	ed (NPD)	17	31	No Per	formance I	Determined	d (NPD
Characteristic cheer, registered	V _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
Characteristic shear resistance, Steel, property class 8.8	$V_{\text{Rk},s,seis,C1}$	[kN]		ormance	30	55	85	111	145	177
	$V_{\text{Rk},s,seis,C2}$	[kN]	Determin	ed (NPD)	27	50	No Per	formance I	Determined	d (NPD
Characteristic shear resistance,	V _{Rk,s}	[kN]	13	20	30	55	86	124	115	14(
Stainless steel A4 and HCR, property class 50 (>M24) and 70 (\leq M24)	V _{Rk,s,seis,C1}	[kN]		ormance	26	48	75	98	91	111
	V _{Rk,s,seis,C2}	[kN]	Determin	ed (NPD)	24	44	No Per	formance I	Determined	d (NPD
Ductility factor according to CEN/TS 1992-4-5 Section 6.3.2.1	k ₂					0	,8			
Steel failure with lever arm	•									
	M ⁰ _{Rk,s}	[Nm]	15	30	52	133	260	449	666	900
Characteristic bending moment, Steel, property class 4.6	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Por	formance I	Determiner			
	M ⁰ _{Rk,s,seis,C2}	[Nm]					Jetenninet			
	M ⁰ _{Rk,s}	[Nm]	19	37	65	166	324	560	833	112
Characteristic bending moment, Steel, property class 5.8	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Per	formance I	Determined			
	M ⁰ _{Rk,s,seis,C2}	[Nm]			110 1 01			. (
Characteristic handing memort	M ⁰ _{Rk,s}	[Nm]	30	60	105	266	519	896	1333	179
Characteristic bending moment, Steel, property class 8.8	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Per	formance l	Determined	(NPD)		
	M ⁰ _{Rk,s,seis,C2}	[Nm]								
Characteristic bending moment,	M ⁰ _{Rk,s}	[Nm]	26	52	92	232	454	784	832	112
Stainless steel A4 and HCR, property class 50 (>M24) and 70 (\leq M24)	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Per	formance I	Determined	d (NPD)		
	M ⁰ _{Rk,s,seis,C2}	[Nm]						. ,		
Concrete pry-out failure										
Factor in equation (27) of	k ₃					2	,0			
CEN/TS 1992-4-5 Section 6.3.3	γinst					1	,0			
nstallation safety factor										
						l _f = min(h	l _{ef} ; 8 d _{nom})			
nstallation safety factor	lf	[mm]								
nstallation safety factor Concrete edge failure ³⁾	l _f d _{nom}	[mm] [mm]	8	10	12	16	20	24	27	30

Characteristic values of resistance for threaded rods under shear loads in cracked and non-cracked concrete, (Design according to CEN/TS 1992-4 and TR 045)



		acteristic value cracked concre									ls in		
Anchor size reinforc	ing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic tension	resista	nce	N _{Rk,s}	[kN]					$A_{s} \boldsymbol{\cdot} f_{uk}$				
Combined pull-out a	nd con	crete failure											
Characteristic bond re	esistanc	e in non-cracked concre	ete C20/25	5									
Temperature range I:		dry and wet concrete	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	14	14	13	13	12	12	11	11	11
40°C/24°C		flooded bore hole	$\tau_{\rm Rk,ucr}$	[N/mm ²]	14	13	11	10	9,5	8,5	7,5	7,0	6,0
Temperature range II:	:	dry and wet concrete	$\tau_{\rm Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	7,0	6,5	6,5
60°C/43°C		flooded bore hole	$ au_{Rk,ucr}$	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	6,0	5,5	5,0
Temperature range III	:	dry and wet concrete	$ au_{Rk,ucr}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,5	6,0	6,0	6,0
72°C/43°C		flooded bore hole	$\tau_{\text{Rk,ucr}}$	[N/mm²]	7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,0	4,5
			C30/37						1,04				
Increasing factors for ψ_c	concret	e	C40/50						1,08				
			C50/60						1,10				
Factor according to CEN/TS 1992-4-5 Sec	ction 6.2	2.2.3	k ₈	[-]					10,1				
Concrete cone failur	e												
Factor according to CEN/TS 1992-4-5 Sec	ction 6.2	2.3.1	k _{ucr}	[-]					10,1				
Edge distance			C _{cr,N}	[mm]					1,5 h _{ef}				
Axial distance			S _{cr,N}	[mm]					3,0 h _{ef}				
Splitting failure				_									
Edge distance			C _{cr,sp}	[mm]			1,0 · h _e	_{ef} ≤2·h _a	ef (2,5	$\left(\frac{h}{h_{ef}}\right) \le 2$,4 · h _{ef}		
Axial distance			S _{cr,sp}	[mm]					$2 c_{\text{cr,sp}}$				
Installation safety fact	or (dry a	and wet concrete)	γinst				1,2				1	,4	
Installation safety fact	or (floo	ded bore hole)	γinst						1,4				
Performances	ies of r	n Injection Syste esistance for rebar ur N/TS 1992-4)				cracked	concre	te			Anne	x C 1	0



	aracteristic valu crete (Design a							ds in (cracke	ed
Anchor size reinforcing	j bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure										
Characteristic tension res	sistance	$N_{Rk,s} = N_{Rk,s,scis,C1}$	[kN]				$A_{s}\boldsymbol{\cdot}f_{uk}$			
Combined pull-out and	concrete failure	•	•							
Characteristic bond resis	tance in cracked concre	te C20/25								
		$ au_{\mathrm{Rk,cr}}$	[N/mm ²]	7,5	7,0	6,5	6,0	5,5	5,5	5,5
Temperature range I:	dry and wet concrete	$\tau_{\rm Rk,seis,C1}$	[N/mm²]	6,9	6,4	6,2	5,7	5,5	5,5	5,5
40°C/24°C		$\tau_{\rm Rk,cr}$	[N/mm ²]	7,5	6,5	6,0	5,0	4,5	4,0	4,0
	flooded bore hole	$\tau_{\rm Rk,seis,C1}$	[N/mm²]	6,9	6,0	5,7	4,8	4,5	4,0	4,0
		$\tau_{\rm Rk,cr}$	[N/mm²]	4,5	4,0	4,0	3,5	3,5	3,5	3,5
Temperature range II:	dry and wet concrete	$\tau_{\rm Rk,seis,C1}$	[N/mm²]	4,1	3,7	3,8	3,3	3,5	3,5	3,5
60°C/43°C		$\tau_{Rk,cr}$	[N/mm ²]	4,5	4,0	4,0	3,5	3,5	3,5	3,0
	flooded bore hole	τ _{Rk,seis,C1}	[N/mm ²]	4,1	3,7	3,8	3,3	3,5	3,5	3,0
		τ _{Rk,cr}	[N/mm ²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
Temperature range III:	dry and wet concrete	τ _{Rk,seis,C1}	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
72°C/43°C		$\tau_{\rm Rk,cr}$	[N/mm ²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole	$\tau_{\rm Rk,seis,C1}$	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
Increasing factors for cor		C30/37					1,04			
(only static or quasi-static		C40/50					1,08			
ψ_{c}		C50/60					1,10			
Factor according to CEN/TS 1992-4-5 Section	n 6.2.2.3	k ₈	[-]				7,2			
Concrete cone failure										
Factor according to CEN/TS 1992-4-5 Sectio	n 6.2.3.1	k _{cr}	[-]				7,2			
Edge distance		C _{cr,N}	[mm]				1,5 h_{ef}			
Axial distance		S _{cr,N}	[mm]				3,0 h _{ef}			
Installation safety factor	(dry and wet concrete)	γinst			1,2			1	,4	
Installation safety factor	(flooded bore hole)	γinst					1,4			

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for rebar under tension loads in cracked concrete (Design according to CEN/TS 1992-4 and TR 045)

Г



Table C12: Characteristic value and non-cracked co)
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											
	$V_{Rk,s}$	[kN]				0,9	50 • A _s •	f _{uk}			
Characteristic shear resistance	V ⁰ _{Rk,s,seis,C1}	[kN]	N Perfori Deteri (NF	mance mined			0,4	14 • A _s •	f _{uk}		
Ductility factor according to CEN/TS 1992-4-5 Section 6.3.2.1	k ₂						0,8				
Steel failure with lever arm											
Characteristic bending moment	M ⁰ _{Rk,s}	[Nm]				1.:	2 · W _{el} ·	f _{uk}			
Characteristic bending moment	$M^0_{\rm Rk,s,seis,C1}$	[Nm]			No Pe	erformar	ice Dete	rmined ((NPD)		
Concrete pry-out failure											
Factor in equation (27) of CEN/TS 1992-4-5 Section 6.3.3	k ₃						2,0				
Installation safety factor	γinst						1,0				
Concrete edge failure											
Effective length of anchor	lf	[mm]				$I_f = m$	nin(h _{ef} ; 8	d _{nom})			
Outside diameter of anchor	d _{nom}	[mm]	8	10	12	14	16	20	25	28	32
Installation safety factor	γinst						1,0				

WPER500 Walraven Injection System for concrete

Performances

Characteristic values of resistance for rebar under shear loads in cracked and non-cracked concrete, (Design according to CEN/TS 1992-4 and TR 045)



Anchor size thread	ded rod		M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Non-cracked conc	rete C20/25	under static and o	quasi-static	c action						
Temperature range I:	δ_{N0} -factor	[mm/(N/mm ²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,03
40°C/24°C	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,044	0,052	0,061	0,079	0,096	0,114	0,127	0,14
Temperature range II:	δ_{N0} -factor	[mm/(N/mm ²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,04
60°C/43°C	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,16
Temperature range III:	δ_{N0} -factor	[mm/(N/mm ²)]	0,013	0,015	0,018	0,023	0,028	0,033	0,037	0,04
72°C/43°C	$\delta_{N\infty}\text{-}factor$	[mm/(N/mm ²)]	0,050	0,060	0,070	0,091	0,111	0,131	0,146	0,16
Cracked concrete	C20/25 und	er static, quasi-sta	atic and sei	ismic C	1 action					
Temperature range I:	δ_{N0} -factor	[mm/(N/mm ²)]			0,032	0,037	0,042	0,048	0,053	0,05
40°C/24°Cັ	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]			0,21	0,21	0,21	0,21	0,21	0,21
Temperature range II:	δ_{N0} -factor	[mm/(N/mm ²)]		ormance mined	0,037	0,043	0,049	0,055	0,061	0,06
60°C/43°C	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]		PD)	0,24	0,24	0,24	0,24	0,24	0,24
Temperature range III:	δ_{N0} -factor	[mm/(N/mm ²)]			0,037	0,043	0,049	0,055	0,061	0,06
72°C/43°C	$\delta_{N\infty}\text{-}factor$	[mm/(N/mm ²)]			0,24	0,24	0,24	0,24	0,24	0,24
Cracked concrete	C20/25 und	er seismic C2 acti	on							
Temperature range I:	$\delta_{N,seis(DLS)}$	[mm/(N/mm²)]			0,03	0,05				
40°C/24°C	$\delta_{N,seis(ULS)}$	[mm/(N/mm ²)]			0,06	0,09				
Temperature range II:	$\delta_{N,seis(DLS)}$	[mm/(N/mm²)]		ormance	0,03	0,05				
່60°C/43°C ັ	$\delta_{N,seis(ULS)}$	[mm/(N/mm²)]	Deter (NI	mined PD)	0,06	0,09	No Peri	ormance I	Jetermine	a (NPL
						,				
Temperature range III:	$\delta_{N,seis(\text{DLS})}$	[mm/(N/mm²)]	```	()	0,03	0,05				
Temperature range III: 72°C/43°C ¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor	$\delta_{N,seis(ULS)}$ e displacemento $\tau;$	[mm/(N/mm ²)]			0,03 0,06	0,05				
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor	$ \begin{array}{l} \delta_{\text{N,seis(ULS)}} \\ \text{e displacement} \\ \cdot \ \tau; \\ \cdot \ \tau; \end{array} $	[mm/(N/mm ²)]		· 	0,06	0,09				
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor	δ _{N,seis(ULS)} e displacemen · τ; · τ; splaceme	[mm/(N/mm ²)]		· 	0,06	0,09	M 20	M24	M 27	M 30
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread	$\delta_{N,seis(ULS)}$ e displacement · τ ; · τ ; splacement ded rod	[mm/(N/mm²)] nt	ur load ¹⁾ (1	thread	0,06 ed rod M 12	0,09) M 16	0		M 27	M 30
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread	$\delta_{N,seis(ULS)}$ e displacement · τ ; · τ ; splacement ded rod	[mm/(N/mm²)] nt	ur load ¹⁾ (1	thread	0,06 ed rod M 12	0,09) M 16	0		M 27	
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and o All temperature	$δ_{N,seis(ULS)}$ e displacement · τ; · τ; splacement ded rod cracked cor	[mm/(N/mm ²)] nt ents under shea	r load ¹⁾ (1 M 8 er static, qu	thread M 10 Jasi-sta	0,06 ed rod M 12 tic and s	0,09) M 16 seismic	C1 act	ion		0,03
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and o All temperature ranges	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacement \\ \cdot \ \tau; \\ \cdot \ \tau; \\ splacement \\ ded \ rod \\ cracked \ cor \\ \hline \delta_{Vo} \mbox{-}factor \\ \hline \delta_{V\infty} \mbox{-}factor \\ \end{array}$	[mm/(N/mm²)] nt ents under shea ncrete C20/25 unde [mm/(kN)] [mm/(kN)]	Ir load ¹⁾ (1 M 8 Pr static, qu 0,06 0,09	thread M 10 Jasi-stat	0,06 ed rod M 12 tic and s 0,05	0,09) M 16 seismic 0,04	C1 act	i on 0,03	0,03	0,03
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and d All temperature ranges Cracked concrete	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ \cdot \ \tau; \\ splaceme \\ ded \ rod \\ cracked \ cor \\ \hline \delta_{Vo} \ factor \\ \hline \delta_{V\infty} \ factor \\ \hline C20/25 \ und \\ \end{array}$	Imm/(N/mm²)] nt ents under shea ncrete C20/25 under [mm/(kN)] [mm/(kN)] ler seismic C2 action	er static, qu 0,06 0,09 0n	thread M 10 Jasi-sta 0,06 0,08	0,06 ed rod M 12 tic and 1 0,05 0,08	0,09) M 16 seismic 0,04 0,06	0,04	i on 0,03	0,03	M 30 0,03 0,05
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and d All temperature ranges Cracked concrete All temperature	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ splacemen \\ ded \ rod \\ cracked \ cor \\ \delta_{V0} \mbox{-}factor \\ \delta_{V\infty} \mbox{-}factor \\ cracked \ cor \\ \delta_{V,seis(DLS)} \\ \end{array}$	ents under shea	nr Ioad ¹⁾ (1 M 8 er static, qu 0,06 0,09 on No Perfi Deter	thread M 10 Jasi-stat 0,06 0,08	0,06 ed rod M 12 tic and s 0,05 0,08	0,09) M 16 seismic 0,04 0,06	0,04 0,06	i on 0,03	0,03	0,03
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and d All temperature ranges Cracked concrete All temperature ranges	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ splacemen \\ ded \ rod \\ cracked \ cor \\ \delta_{V0} \mbox{-} factor \\ \hline \delta_{V,seis(DLS)} \\ \delta_{V,seis(ULS)} \\ \end{array}$	ents under shea	nr Ioad ¹⁾ (1 M 8 er static, qu 0,06 0,09 on No Perfi Deter	thread M 10 Jasi-sta 0,06 0,08	0,06 ed rod M 12 tic and 1 0,05 0,08	0,09) M 16 seismic 0,04 0,06	0,04 0,06	ion 0,03 0,05	0,03	0,03
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \end{array}$	ents under shea	nr Ioad ¹⁾ (1 M 8 er static, qu 0,06 0,09 on No Perfi Deter	thread M 10 Jasi-stat 0,06 0,08	0,06 ed rod M 12 tic and s 0,05 0,08	0,09) M 16 seismic 0,04 0,06	0,04 0,06	ion 0,03 0,05	0,03	0,03
¹⁾ Calculation of the $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and d Anchor size thread Anchor size thread 	$\begin{array}{c} \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \end{array}$	ents under shea	er static, qu 0,06 0,09 0n No Perfi Deter (Ni	thread M 10 Jasi-stat 0,06 0,08	0,06 ed rod M 12 tic and s 0,05 0,08	0,09) M 16 seismic 0,04 0,06	0,04 0,06	ion 0,03 0,05	0,03	0,03



Anchor size reinfo	orcing bar		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Non-cracked cond	crete C20/	25 under static	and qua	asi-stati	ic actior	้า					
Temperature range I:	δ_{N0} -factor	[mm/(N/mm ²)]	0,011	0,013	0,015	0,018	0,020	0,024	0,030	0,033	0,03
40°C/24°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm ²)]	0,044	0,052	0,061	0,070	0,079	0,096	0,118	0,132	0,14
Temperature range II:	δ_{N0} -factor	[mm/(N/mm²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,04
60°C/43°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,17
Temperature range III:	δ_{N0} -factor	[mm/(N/mm ²)]	0,013	0,015	0,018	0,020	0,023	0,028	0,034	0,038	0,04
72°C/43°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm²)]	0,050	0,060	0,070	0,081	0,091	0,111	0,136	0,151	0,17
Cracked concrete	C20/25 u	nder static, qua	asi-statio	c and se	eismic C	1 actio	n				
Temperature range I:	δ_{N0} -factor	[mm/(N/mm ²)]			0,032	0,035	0,037	0,042	0,049	0,055	0,06
40°C/24°Cັ	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm²)]		-	0,21	0,21	0,21	0,21	0,21	0,21	0,21
Temperature range II:	δ_{N0} -factor	[mm/(N/mm ²)]			0,037	0,040	0,043	0,049	0,056	0,063	0,07
60°C/43°C	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]		-	0,24	0,24	0,24	0,24	0,24	0,24	0,24
Temperature range III:	δ_{N0} -factor	[mm/(N/mm ²)]			0,037	0,040	0,043	0,049	0,056	0,063	0,07
72°C/43°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm ²)]]	-	0,24	0,24	0,24	0,24	0,24	0,24	0,24
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \\ \delta_{N\infty} &= \delta_{N\infty} \text{-factor} \end{split}$	· τ;	nent under s	hear lo	ad ¹⁾ (r	ebar)				1		
$\delta_{N_{\infty}} = \delta_{N_{\infty}}$ -factor Table C16: D	τ; isplacen		hear lo Ø 8	oad ¹⁾ (r ∅ 10	ebar) Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 3:
$\delta_{N_{\infty}} = \delta_{N_{\infty}}$ -factor Table C16: D Anchor size reinfo	isplacen		Ø 8	Ø 10	Ø 12		Ø 16	Ø 20	Ø 25	Ø 28	Ø3
$\delta_{N_{\infty}} = \delta_{N_{\infty}}$ -factor Table C16: D Anchor size reinfo For concrete C20/ All temperature	isplacen		Ø 8	Ø 10	Ø 12		Ø 16 0,04	Ø 20 0,04	Ø 25 0,03	Ø 28 0,03	Ø 3 2 0,03
$\delta_{N_{\infty}} = \delta_{N_{\infty}}$ -factor Table C16: D Anchor size reinfor For concrete C20/ All temperature ranges	isplacen prcing bar 25 under s δ_{V0} -factor $\delta_{V\infty}$ -factor	static, quasi-st [mm/(kN)] [mm/(kN)]	Ø 8 atic and	Ø 10 seismi	Ø 12 c C1 act	ion					
$\delta_{N_{\infty}} = \delta_{N_{\infty}}$ -factor Table C16: D Anchor size reinfo For concrete C20/	$\tau;$ isplacen prcing bar 25 under s δ_{Vo} -factor $\delta_{V\infty}$ -factor ie displacen \cdot V;	static, quasi-st [mm/(kN)] [mm/(kN)]	Ø 8 atic and 0,06	Ø 10 seismid 0,05	Ø 12 c C1 act 0,05	i on 0,04	0,04	0,04	0,03	0,03	0,03