



Approval body for construction products and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments



European Technical Assessment

General Part

Technical Assessment Body issuing the European Technical Assessment:

Trade name of the construction product

Product family to which the construction product belongs

Manufacturer

Manufacturing plant

This European Technical Assessment contains

This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of

ETA-10/0087 of 20 October 2014

Deutsches Institut für Bautechnik

VJ Technology Injection system HPE for concrete

Bonded anchor with anchor rod for use in concrete

VJ Technology Brunswick Road; Cobbs Wood Ind. Estate ASHFORD KENT TN23 1EN . GROSSBRITANNIEN

VJ Technology, Plant1 Germany

27 pages including 3 annexes which form an integral part of this assessment

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.

Deutsches Institut für Bautechnik

Kolonnenstraße 30 B | 10829 Berlin | GERMANY | Phone: +49 30 78730-0 | Fax: +49 30 78730-320 | Email: dibt@dibt.de | www.dibt.de



European Technical Assessment ETA-10/0087

Page 2 of 27 | 20 October 2014

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This European Technical Assessment may be withdrawn by the issuing Technical Assessment Body, in particular pursuant to information by the Commission according to Article 25 Paragraph 3 of Regulation (EU) No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



Specific Part

1 Technical description of the product

The "VJ Technology Injection System HPE for concrete" is a bonded anchor consisting of a cartridge with injection mortar HPE 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.



European Technical Assessment ETA-10/0087

Page 4 of 27 | 20 October 2014

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

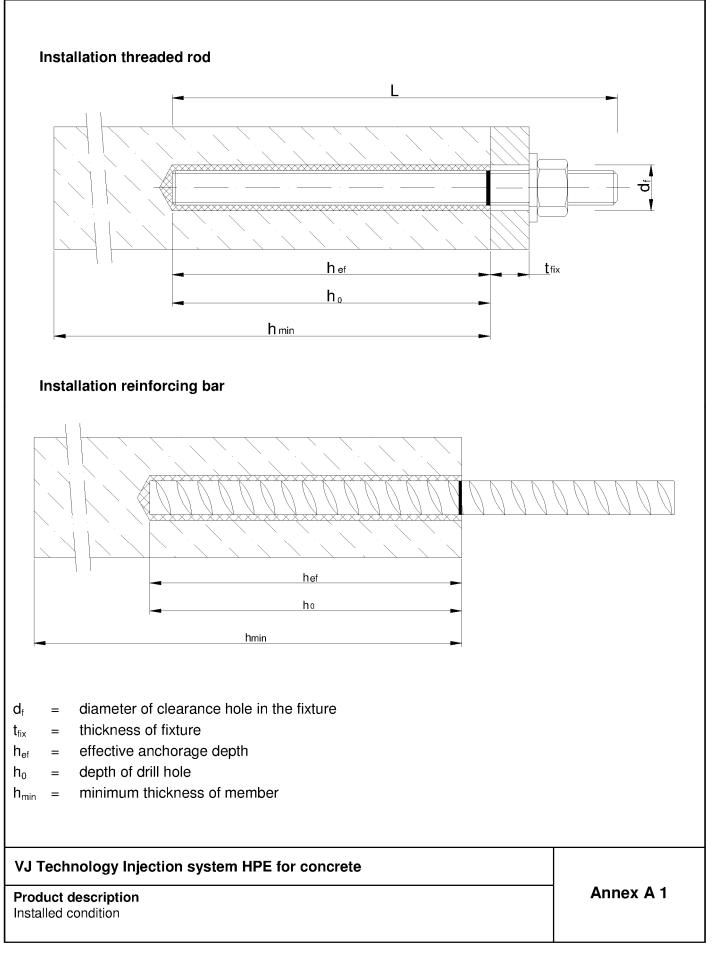
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 20 October 2014 by Deutsches Institut für Bautechnik

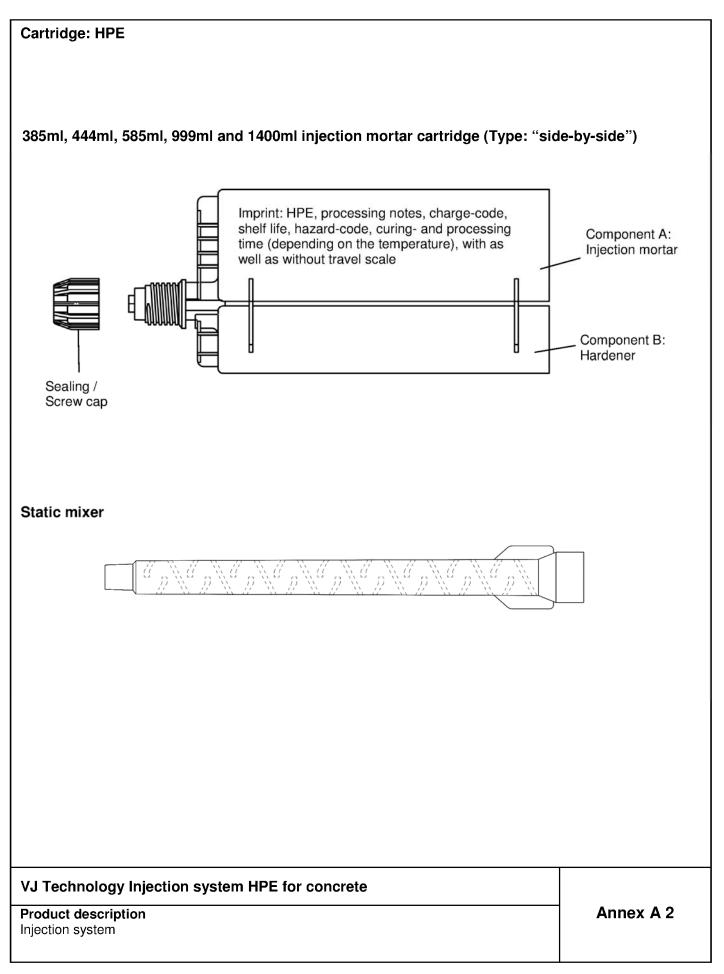
Uwe Bender Head of Department *beglaubigt:* Baderschneider

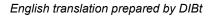
Page 5 of European Technical Assessment ETA-10/0087 of 20 October 2014













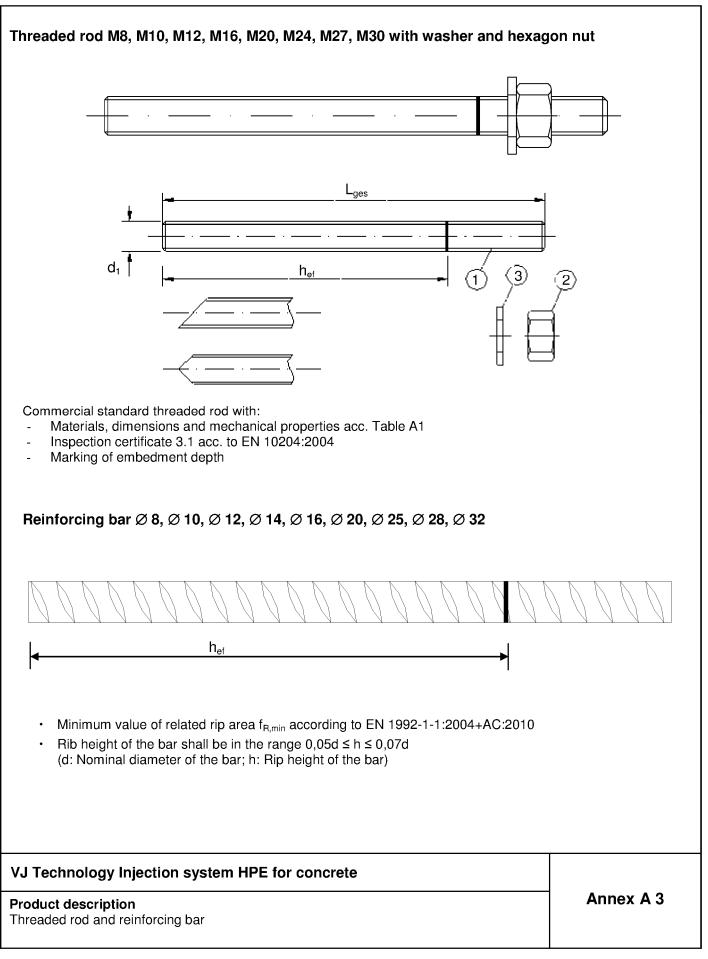




Table A1: Materials

Part	Designation	Material				
	, zinc plated ≥ 5 μm acc. to EN ISO 4042:19 , hot-dip galvanised ≥ 40 μm acc. to EN IS		C:2009			
1	Anchor rod	Steel, EN 10087:1998 or EN 10263:200 Property class 4.6, 5.8, 8.8, EN 1993-1-6				
2	Hexagon nut, EN ISO 4032:2012	Steel acc. to EN 10087:1998 or EN 10263:2001 Property class 4 (for class 4.6 rod) EN ISO 898-2:2012, Property class 5 (for class 5.8 rod) EN ISO 898-2:2012, Property class 8 (for class 8.8 rod) EN ISO 898-2:2012				
3	Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Steel, zinc plated or hot-dip galvanised				
Stain	less steel					
1	Anchor rod	Material 1.4401 / 1.4404 / 1.4571, EN 10 > M24: Property class 50 EN ISO 3506- ≤ M24: Property class 70 EN ISO 3506-	1:2009			
2	Hexagon nut, EN ISO 4032:2012	Material 1.4401 / 1.4404 / 1.4571 EN 10 > M24: Property class 50 (for class 50 ro ≤ M24: Property class 70 (for class 70 ro	od) EN ISO 3506-2:2009			
3	Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Material 1.4401, 1.4404 or 1.4571, EN	10088-1:2005			
High	corrosion resistance steel					
1	Anchor rod	Material 1.4529 / 1.4565, EN 10088-1:20 > M24: Property class 50 EN ISO 3506- ≤ M24: Property class 70 EN ISO 3506-	1:2009			
2	Hexagon nut, EN ISO 4032:2012	Material 1.4529 / 1.4565 EN 10088-1:20 > M24: Property class 50 (for class 50 ro ≤ M24: Property class 70 (for class 70 ro	05, od) EN ISO 3506-2:2009			
3	Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Material 1.4529 / 1.4565, EN 10088-1:20				
Reinf	orcing bars					
1	Rebar EN 1992-1-1:2004+AC:2010, Annex C	Bars and de-coiled rods class B or C f_{yk} and k according to NDP or NCL of EN $f_{uk} = f_{tk} = k \cdot f_{yk}$	I 1992-1-1/NA:2013			
Prod	echnology Injection system HPE for c	concrete	Annex A 4			
Mate	rials					
62700 1			9 06 01 204/14			



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.

VJ Technology Injection system HPE 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 encharge 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] ≥	n]≥ 12 14 16 20 26 30 34		34	37					
Torque moment	T _{inst} [Nm] ≤	≤ 10 20 40 80 120 160 180		200						
Thiskness of firth we	t _{fix,min} [mm] >	0								
Thickness of fixture	t _{fix,max} [mm] <	ı] < 1500								
Minimum thickness of member	h _{min} [mm]		_{ef} + 30 m ≥ 100 mn	+ 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 rebar

Rebar size		Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Nominal drill hole diameter	d ₀ [mm] =	12	14	16	18	20	24	32	35	40
Effective anchorage depth	h _{ef,min} [mm] =	60	60	70	75	80	90	100	112	128
Enective anchorage depth	h _{ef,max} [mm] =	96	120	144	168	192	240	300	336	384
Diameter of steel brush	d _b [mm] ≥	14	16	18	20	22	26	34	37	41,5
Minimum thickness of member	h _{min} [mm]	h _{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$						
Minimum spacing	s _{min} [mm]	40	50	60	70	80	100	125	140	160
Minimum edge distance	c _{min} [mm]	40	50	60	70	80	100	125	140	160

VJ Technology Injection system HPE for concrete

Intended Use

Installation parameters

Annex B 2



Steel brush Table B3: Parameter cleaning and setting tools d_{b,min} Threaded Piston d₀ d_{b} Rebar min. Rod Drill bit - Ø Brush - Ø plug Brush - Ø (mm) (mm) (mm)(mm) (mm)(No.) M8 10 12 10.5 M10 8 12 14 12,5 No M12 10 14 16 14,5 piston plug 12 16 18 16,5 required M16 14 18 20 18,5 16 20 22 20,5 20 24 26 M20 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









Recommended compressed air tool (min 6 bar) Drill bit diameter (d_0): 10 mm to 40 mm

Piston plug for overhead or horizontal installation Drill bit diameter (d₀): 24 mm to 40 mm

VJ Technology Injection system HPE for concrete

Intended Use

Cleaning and setting tools

Annex B 3



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 remove	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.
2× 1	For bore holes larger than 20 mm or deeper 240 mm, compress must be used.	sed air (min. 6 bar)
<u> </u>	 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. If the bore hole ground is not reached with the brush, a brush ex shall be used (Table B3). 	ed wire brush
or	20. Finally blow the hole clean again with compressed air (min. 6 bit (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 d For bore holes larger than 20 mm or deeper 240 mm, compress must be used.	not reached an iameter 20 mm.
2	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
	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 compone shows a consistent grey colour. For foil tube cartridges is must be minimum of six full strokes.	nts until the mortar
VJ Technology Inj	ection system HPE for concrete	
Intended Use Installation instruction	ns	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	≥ + 30 °C 20 min		12 h
≥ + 40 °C	12 min	4 h	8 h

VJ Technology Injection system HPE for concrete

Intended Use Installation instructions (continuation) Curing time Annex B 5



		4 M 27	M 30				
98	8 141	1 184	224				
122	22 176	6 230	280				
196	96 282	2 368	449				
171	71 247	7 230	281				
		·					
13	3 12	12	12				
9,5	,5 8,5	5 7,5	7,0				
8,0	0 7,5	5 7,5	7,5				
7,5	5 7,0	6,5	6,0				
7,0	,0 7,0	6,5	6,5				
7,0	,0 6,0) 5,5	5,5				
1,04							
1,08							
1,10							
/							
$1,0 \cdot h_{ef} \le 2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}}\right) \le 2,4 \cdot h_{ef}$							
2 C _{cr,sp}							
		1,4					
1,4							

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



Anchor size threaded r	rod			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 ⁰ _{Rk,s,seis}	[kN]	34	63	98	141	184	224	
Characteristic tension re Steel, property class 5.8	esistance,	N _{Rk,s} =N ⁰ _{Rk,s,seis}	[kN]	42	78	122	176	230	280	
Characteristic tension re Steel, property class 8.8	esistance,	N _{Rk,s} =N ⁰ _{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} =N ⁰ _{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								
		$\tau_{\rm Bk,cr}$	[N/mm ²]	7,5	6,5	6,0	5,5	5,5	5,5	
	dry and wet concrete	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	7,1	6,2	5,7	5,5	5,5	5,5	
emperature range I:		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	2,4	2,2	No Performance Determined (NPD)				
0°C/24°C	flooded bore hole	τ _{Rk,cr}	[N/mm ²]	7,5	6,0	5,0	4,5	4,0	4,0	
		$\tau^0_{Rk,seis,C1}$	[N/mm ²]	7,1	5,8	4,8	4,5	4,0	4,0	
		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	2,4	2,1	No Pe	rformance I	Determined	l (NPD)	
		τ _{Rk,cr}	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	3,5	
Temperature range II: 60°C/43°C	dry and wet concrete	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	4,3	3,8	3,4	3,5	3,5	3,5	
		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	1,4	1,4	No Performance Determined (NPD)				
		τ _{Rk,cr}	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	3,5	
	flooded bore hole	$\tau^0_{\text{Rk,seis,C1}}$	[N/mm ²]	4,3	3,8	3,4	3,5	3,5	3,5	
		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	1,4	1,4	No Pe	rformance l	Determined	I (NPD)	
	dry and wet concrete	τ _{Rk,cr}	[N/mm ²]	4,0	3,5	3,0	3,0	3,0	3,0	
		$\tau^0_{Rk,seis,C1}$	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,0	
emperature range III:		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	1,3	1,2	No Performance Determined (NPD				
′2°C/43°C		τ _{Rk,cr}	[N/mm ²]	4,0	3,5	3,0	3,0	3,0	3,0	
	flooded bore hole	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,0	
		$\tau^0_{\text{Rk,seis,C2}}$	[N/mm ²]	1,3	1,2	No Performance Determined (N				
ncreasing factors for co	ncrete	C30/37		1,04						
only static or quasi-stati		C40/50		1,08						
h ^c		C50/60		1,10						
Splitting failure			1							
Edge distance		C _{cr,sp}	[mm]		1,0 ⋅ h _{ef} ≤	$\leq 2 \cdot h_{ef} \left(2 \right)$	$(5 - \frac{h}{h_{ef}}) \le$	≤ 2,4 · h _{ef}		
Axial distance		S _{cr,sp}	[mm]			2 c	cr,sp			
nstallation safety factor	(dry and wet concrete)	γ2		1,2			1	,4		
nstallation safety factor	(flooded bore hole)	γ2		1,4						
		1								

Performances

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

Annex C 2



$\begin{array}{c} V_{\text{Rik},s} \\ \hline V^0_{\text{Rik},s,seis,C1} \\ \hline V^0_{\text{Rik},s,seis,C2} \\ \hline V_{\text{Rik},s} \\ \hline V^0_{\text{Rik},s,seis,C1} \\ \end{array}$	[kN] [kN] [kN] [kN]		12 ormance mined	17 14	31 27	49	71	92	112
$\frac{V^{0}_{\text{Rk,s,seis,C1}}}{V^{0}_{\text{Rk,s,seis,C2}}}$ $\frac{V^{0}_{\text{Rk,s}}}{V_{\text{Rk,s}}}$	[kN] [kN]	No Perf Deter	ormance mined		-	-		-	112
V ⁰ _{Rk,s,seis,C2} V _{Rk,s} V ⁰ _{Rk,s,seis,C1}	[kN]	Deter	mined	14	27	42	FC		
V ⁰ _{Rk,s,seis,C2} V _{Rk,s} V ⁰ _{Rk,s,seis,C1}							00	72	88
V _{Rk,s} V ⁰ _{Rk,s,seis,C1}	[kN]	,	PD)	13	25	No Perf	ormance l	Determine	d (NPE
		9	15	21	39	61	88	115	140
	[kN]		ormance	18	34	53	70	91	111
$V^0_{\ Rk,s,seis,C2}$	[kN]		mined PD)	17	31	No Perf	ormance l	Determine	d (NPE
V _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
V ⁰ _{Rk,s,seis,C1}	[kN]		ormance	30	55	85	111	145	177
	[kN]			27	50	No Perf	ormance l	Determine	d (NPE
V _{Rk,s}	[kN]	13	20	30	55	86	124	115	140
$V^0_{Rk,s,seis,C1}$	[kN]			26	48	75	98	91	111
$V^0_{\text{Rk}, s, seis, C2}$	[kN]			40	44	No Perf	ormance l	Determine	ed (NPE
M ⁰ _{Rk,s}	[Nm]	15	30	52	133	260	449	666	900
M ⁰ _{Rk,s,seis,C1}	[Nm]			No Dorf		Datarmina			
M ⁰ _{Rk,s,seis,C2}	[Nm]			No Perio	ormance i	Jetermine	a (NPD)		
M ⁰ _{Rk,s}	[Nm]	19	37	65	166	324	560	833	112
M ⁰ _{Rk,s,seis,C1}	[Nm]		No Performance Determined (NPD)						
$M^0_{\rm Rk,s,seis,C2}$	[Nm]			NOFER	Jimance i	Jelennine	u (INFD)		
$M^0_{Rk,s}$	[Nm]	30	60	105	266	519	896	1333	179
M ⁰ _{Rk,s,seis,C1}	[Nm]	No Performance Dete			Determine	termined (NPD)			
M ⁰ _{Rk,s,seis,C2}	[Nm]						u ((11 D)		
M ⁰ _{Rk,s}	[Nm]	26	52	92	232	454	784	832	112
M ⁰ _{Rk,s,seis,C1}	[Nm]	No Performance Determined (NPD)							
$M^0_{\rm Rk,s,seis,C2}$	[Nm]		No Feromance Determined (NFD)						
k	[-]				2	0			
γ2					1	,0			
1		1							
γ2					1	0			
	V ⁰ _{Rk,s,seis,C2} V _{Rk,s} V ⁰ _{Rk,s,seis,C1} V ⁰ _{Rk,s,seis,C2} M ⁰ _{Rk,s,seis,C2} M ⁰ _{Rk,s,seis,C1} M ⁰ _{Rk,s,seis,C2} M ⁰ _{Rk,s,seis,C1} M ⁰ _{Rk,s,seis,C2} M ⁰ _{Rk,s,seis,C1} M ⁰ _{Rk,s,seis,C2}	V ⁰ _{Rk,s,seis,C2} [kN] V _{Rk,s} [kN] V ⁰ _{Rk,s,seis,C1} [kN] V ⁰ _{Rk,s,seis,C2} [kN] M ⁰ _{Rk,s,seis,C2} [Nm] M ⁰ _{Rk,s,seis,C1} [Nm] M ⁰ _{Rk,s,seis,C2} [Nm]	ν HK,S,Seis,C2 [kN] Deter (NI V _{Rk,S} [kN] 13 V ⁰ _{Rk,S,Seis,C1} [kN] No Perf Deter (NI V ⁰ _{Rk,S,Seis,C2} [kN] 15 M ⁰ _{Rk,S,Seis,C2} [Nm] 15 M ⁰ _{Rk,S,Seis,C2} [Nm] 19 M ⁰ _{Rk,S,Seis,C1} [Nm] 19 M ⁰ _{Rk,S,Seis,C2} [Nm] 19 M ⁰ _{Rk,S,Seis,C2} [Nm] 30 M ⁰ _{Rk,S,Seis,C2} [Nm] 30 M ⁰ _{Rk,S,Seis,C2} [Nm] 30 M ⁰ _{Rk,S,Seis,C2} [Nm] 4 M ⁰ _{Rk,S,Seis,C2} [Nm] 30 M ⁰ _{Rk,S,Seis,C2} [Nm] 4 M ⁰ _{Rk,S,Seis,C2} [Nm] 4 M ⁰ _{Rk,S,Seis,C2} [Nm] 5 M ⁰ _{Rk,S,Seis,C2} [Nm] 4 M ⁰ _{Rk,S,Seis,C2} [Nm] 5 M ⁰ _{Rk,S,Seis,C2} [Nm] 5 M ⁰ _{Rk,S,Seis,C2} [Nm] 5 M ⁰ _{Rk,S,Seis,C2} [Nm] 5	$\begin{array}{ c c c c } & \begin{tabular}{ c c c c c } & \begin{tabular}{ c c c c c c c } & \begin{tabular}{ c c c c c c c } & \begin{tabular}{ c c c c c c c c } & \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	$ \begin{array}{ c c c c c c c } \hline P(R,s,seis,C2 & [KN] & Determined (NPD) & 27 \\ \hline 27 & 27 & 27 & 27 & 27 & 27 & 27 & 27$	$\begin{array}{ c c c c } & $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$	$\begin{array}{ c c c c c c c } \hline P(R,S,Sells,C2 & [KN] & Determined (NPD) & 27 & 50 & No Perfection (NPD) & 27 & 50 & No Perfection (NPD) & 27 & 50 & No Perfection (NPD) & 20 & 30 & 55 & 86 & 20 & 20 & 20 & 20 & 20 & 20 & 20 & 2$	$\begin{array}{c c c c c c c c } \hline Pressure (NPD) & 10 & 10 & 10 & 10 & 10 & 10 & 10 & 1$	$\begin{array}{ c c c c c } \hline \begin{tabular}{ c c c } \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c c } \hline \begin{tabular}{ c c c c c } \hline \begin{tabular}{ c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c } \hline \begin{tabular}{ c c c c c c c c } \hline \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$



	Characteristic v non-cracked co								on loa	ds in		
Anchor size reinford	ing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure							•		•			
Characteristic tensior	resistance	N _{Rk,s}	[kN]					$A_{s}\boldsymbol{\cdot}f_{uk}$				
Combined pull-out a	and concrete cone failur	e										
Characteristic bond re	esistance in uncracked co	oncrete C20)/25									
Temperature range I:	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	14	14	13	13	12	12	11	11	11
40°C/24°C	flooded bore hole	$\tau_{\rm Rk,ucr}$	[N/mm ²]	14	13	11	10	9,5	8,5	7,5	7,0	6,0
Temperature range II	dry and wet concrete	$\tau_{Rk,ucr}$	[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	τ _{Rk,ucr}	[N/mm²]	8,5	8,5	8,0	8,0	7,5	7,0	6,0	5,5	5,0
Temperature range II	dry and wet I: concrete	$\tau_{\rm Rk,ucr}$	[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	$\tau_{Rk,ucr}$	[N/mm ²]	7,5	7,5	7,5	7,0	7,0	6,0	5,5	5,0	4,5
		C30/37	•					1,04	1	1		1
Increasing factors for Ψ_c	concrete	C40/50						1,08				
1.0		C50/60						1,10				
Splitting failure												
Edge distance		C _{cr,sp}	[mm]			1,0 ⋅ h _{ef}	≤2·h _e	_{ef} (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)	tor (dry and wet	γ2				1,2				1	,4	
	tor (flooded bore hole)	γ2						1,4				

VJ Technology Injection system HPE for concrete

Performances

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

Annex C 4



	Characteristic val cracked concrete							ads in		
Anchor size reinforc	ing bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure										
Characteristic tension	resistance	N _{Rk,s} =N ⁰ _{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	te C20/25								
	dry and wat concrete	τ _{Rk,cr}	[N/mm²]	7,5	7,0	6,5	6,0	5,5	5,5	5,5
Temperature range I:	dry and wet concrete	$\tau^0_{Rk,seis,C1}$	[N/mm²]	6,9	6,4	6,2	5,7	5,5	5,5	5,5
40°C/24°C	flooded bore hole	τ _{Rk,cr}	[N/mm ²]	7,5	6,5	6,0	5,0	4,5	4,0	4,0
		$\tau^0_{Rk,seis,C1}$	[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	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	4,1	3,7	3,8	3,3	3,5	3,5	3,5
60°C/43°C		$ au_{\mathrm{Rk,cr}}$	[N/mm ²]	4,5	4,0	4,0	3,5	3,5	3,5	3,0
	flooded bore hole	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	4,1	3,7	3,8	3,3	3,5	3,5	3,0
		$ au_{\mathrm{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	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
72°C/43°C		$ au_{\mathrm{Rk,cr}}$	[N/mm ²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
		C30/37					1,04			
Increasing factors for (only static or quasi-st	concrete atic actions)	C40/50					1,08			
ψ_{c}		C50/60					1,10			
Splitting failure										
Edge distance		C _{cr,sp}	[mm]		1,0 · h,	_{ef} ≤2 ⋅ h	_{ef} (2,5 –	$\frac{h}{h_{ef}} \le 2$,4 · h _{ef}	
Axial distance		S _{cr,sp}	[mm]				2 c _{cr,sp}	.,		
Installation safety fact	or (dry and wet concrete)	γ2			1,2			1	,4	
Installation safety fact	or (flooded bore hole)	γ2					1,4			
vj lechnolog	y Injection system	HPE for conc	rete							

Performances

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

Annex C 5



Table C6: Characterist and non-crae										racked	k
Anchor size reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure without lever arm										I I	
	V _{Rk,s}	[kN]				0,	50 • A _s •	f _{uk}			
Characteristic shear resistance	V ⁰ _{Rk,s,seis,C1}	[kN]	Perfor 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}			
	$M^0_{Rk,s,seis,C1}$	[Nm]			No F	Performar	nce Dete	rmined (1	NPD)		
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	1										
Installation safety factor	γ ₂						1,0				
VJ Technology Injection sy	stem HPE f	ior con	crete							ov 0 0	
Performances Characteristic values of resistance f concrete, (Design according to TR (ads in c	racked a	and non-	-crackec	1		Ann	ex C 6)



Anchor size threaded rod				M 8	M 10	M 12	M 16	M 20	M24	M 27	М 30
Steel failure											•
Characteristic tension resis Steel, property class 4.6	tance,	N _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
Characteristic tension resis	tance,	N _{Rk.s}	[kN]	18	29	42	78	122	176	230	280
Steel, property class 5.8 Characteristic tension resis	tance,	· ·			46	67	125	196	282		449
Steel, property class 8.8 Characteristic tension resis	tance	N _{Rk,s}	[kN]	29	40	67	125	196	282	368	449
Stainless steel A4 and HCF property class 50 (>M24) ar	۲,	N _{Rk,s}	[kN]	26	41	59	110	171	247	230	281
Combined pull-out and co	oncrete failure										
Characteristic bond resistar	nce in non-cracked concrete	e C20/25									
Temperature range I:	dry and wet concrete	$\tau_{\rm Rk,ucr}$	[N/mm ²]	15	15	15	14	13	12	12	12
40°Ċ/24°C	flooded bore hole	$\tau_{\rm Rk,ucr}$	[N/mm ²]	15	14	13	10	9,5	8,5	7,5	7,0
Temperature range II:	dry and wet concrete	$\tau_{\rm Rk,ucr}$	[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	$\tau_{\rm Rk,ucr}$	[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	$\tau_{\rm Rk,ucr}$	[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	$\tau_{\rm Rk,ucr}$	[N/mm ²]	8,5	8,5	8,0	7,5	7,0	6,0	5,5	5,5
	·	C30/37			•		1,	04		•	•
Increasing factors for concr Ψ_{c}	ete	C40/50					1,	08			
10		C50/60					1,	10			
Factor according to CEN/TS 1992-4-5 Section 6	6.2.2.3	k ₈	[-]				10),1			
Concrete cone failure											
Factor according to CEN/TS 1992-4-5 Section 6	5.2.3.1	k _{ucr}	[-]				10),1			
Edge distance		C _{cr,N}	[mm]				1,5	5 h _{ef}			
Axial distance		S _{cr,N}	[mm]				3,0) h _{ef}			
Splitting failure				I							
Edge distance		C _{cr,sp}	[mm]		1	,0 ⋅ h _{ef} ≤	$2 \cdot h_{ef} (2,$	$5 - \frac{h}{h_{ef}}$	≤ 2,4 · h _e	əf	
Axial distance		S _{cr,sp}	[mm]				2 c	cr,sp			
Installation safety factor (dr	y and wet concrete)	γ2			1	,2			1	,4	
Installation safety factor (flo	oded bore hole)	γ2					1	,4			

(Design according to CEN/TS 1992-4)

8.06.01-294/14



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

Anchor size threaded roc	1			M 12	M 16	M 20	M24	M27	M3
Steel failure									
Characteristic tension resis Steel, property class 4.6	,	$N_{\text{Rk,s}} = N_{\text{Rk,s,seis}}^{0}$	[kN]	34	63	98	141	184	224
Characteristic tension resis Steel, property class 5.8	,	$N_{Rk,s} = N_{Rk,s,seis}^0$	[kN]	42	78	122	176	230	280
Characteristic tension resis Steel, property class 8.8	stance,	$N_{Rk,s} = N_{Rk,s,seis}^{0}$	[kN]	67	125	196	282	368	44
Characteristic tension resis Stainless steel A4 and HCI property class 50 (>M24) a	R,	$N_{Rk,s} = N^0_{Rk,s,seis}$	[kN]	59	110	171	247	230	28 [.]
Combined pull-out and c	oncrete failure								
Characteristic bond resista	nce in cracked concrete C2	20/25							
		$ au_{Rk,cr}$	[N/mm ²]	7,5	6,5	6,0	5,5	5,5	5,5
	dry and wet concrete	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	7,1	6,2	5,7	5,5	5,5	5,
Temperature range I:		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	2,4	2,2	No Perf	ormance I	Determine	d (NF
10°C/24°C		$\tau_{\rm Rk,cr}$	[N/mm ²]	7,5	6,0	5,0	4,5	4,0	4,
	flooded bore hole	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	7,1	5,8	4,8	4,5	4,0	4,
		$\tau^0_{Rk,seis,C2}$	[N/mm ²]	2,4	2,1	No Perf	ormance I	Determine	d (NF
		$\tau_{Rk,cr}$	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	3,
	dry and wet concrete	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	4,3	3,8	3,4	3,5	3,5	3,
Femperature range II:		τ ⁰ _{Rk,seis,C2}	[N/mm ²]	1,4	1,4	No Perf	ormance I	<u> </u>	
60°C/43°C		τ _{Rk,cr}	[N/mm ²]	4,5	4,0	3,5	3,5	3,5	<u>,</u> З,
	flooded bore hole	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	4,3	3,8	3.4	3,5	3.5	3,
		τ ⁰ _{Rk,seis,C2}	[N/mm ²]	1,4	1,4	- 1	ormance I	- , -	
		τ _{Rk,cr}	[N/mm ²]	4,0	3,5	3,0	3,0	3,0	3,
	dry and wet concrete	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	3,9	3,4	3.0	3,0	3.0	3.
Comporatura rango III.		τ ⁰ _{Rk,seis,C2}	[N/mm ²]	1,3	1,2	,	ormance I	· ·	, í
Femperature range III: 72°C/43°C		τ _{Rk,cr}	[N/mm ²]	4,0	3,5	3.0	3,0	3,0	3.
	flooded bore hole	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	3,9	3,4	3,0	3,0	3,0	3,
		τ ⁰ _{Rk,seis,C2}	[N/mm ²]	1,3	1,2	,	ormance I	L '	,
		C30/37	[]	1,0	.,_		04	2010111110	a (11
ncreasing factors for conc only static or quasi-static a		C40/50					08		
$\mu_{\rm c}$		C50/60					10		
actor according to									
CEN/TS 1992-4-5 Section	6.2.2.3	к ₈	[-]			/	,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	5 h _{ef}		
Axial distance		S _{cr,N}	[mm]			3,0) h _{et}		
Splitting failure									
Edge distance		C _{cr,sp}	[mm]		1,0 · h _{ef} ∶	≤2·h _{ef} (2	,5 - <u>h</u> h _{ef})≤	≤2,4 ⋅ h _{ef}	
Axial distance		S _{cr,sp}	[mm]			2 0	Cr,sp		
nstallation safety factor (di	ry and wet concrete)	γ2		1	,2		1	,4	
nstallation safety factor (flo	ooded bore hole)	γ2				1	,4		
VJ Technology In	jection system HP	E for concrete							
Performances Characteristic values o	f resistance for threaded	rods under tensio	n loads in cr	acked co	ncrete		An	nex C	8



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 or TR 045)

			M 8	M 10	M 12	M 16	M 20	M24	M 27	M 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	$V^0_{Rk,s,seis,C1}$	[kN]	No Perfe	ormance	14	27	42	56	72	88
	$V^0_{Rk,s,seis,C2}$	[kN]	Determin	ed (NPD)	13	25	No Per	formance	Determined	d (NPD
	$V_{Rk,s}$	[kN]	9	15	21	39	61	88	115	14(
Characteristic shear resistance, Steel, property class 5.8	$V^0_{Rk,s,seis,C1}$	[kN]		ormance	18	34	53	70	91	11
	$V^0_{Rk,s,seis,C2}$	[kN]	Determin	ed (NPD)	17	31	No Per	rformance	Determined	d (NPD
	V _{Rk,s}	[kN]	15	23	34	63	98	141	184	224
Characteristic shear resistance, Steel, property class 8.8	$V^0_{Rk,s,seis,C1}$	[kN]		ormance	30	55	85	111	145	17
	V ⁰ _{Rk,s,seis,C2}	[kN]	Determin	ed (NPD)	27	50	No Per	formance	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 (< M24)	$V^0_{Rk,s,seis,C1}$	[kN]		ormance	26	48	75	98	91	11
property class 50 (>M24) and 70 (\leq M24)	V ⁰ _{Rk,s,seis,C2}	[kN]	Determin	ed (NPD)	40	44	No Per	rformance	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	90
Characteristic bending moment, Steel, property class 4.6	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Der	fauna auto a l				
	M ⁰ _{Rk,s,seis,C2}	[Nm]			No Per	formance I	Jetermined	J (NPD)		
	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 Por	formance I	Dotormino			
	M ⁰ _{Rk,s,seis,C2}	[Nm]			NO F EI	ionnance i	Jetenninet			
	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 I	Determiner			
	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,	M ⁰ _{Rk,s,seis,C1}	[Nm]			No Per	formance I	Determiner			
property class 50 (>M24) and 70 (\leq M24)	M ⁰ _{Rk,s,seis,C2}	[Nm]					Setermine			
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	γ2					1	,0			
Concrete edge failure ³⁾			-							
Effective length of anchor	l _f	[mm]				l _t = min(h	l _{ef} ; 8 d _{nom})			
	d _{nom}	[mm]	8	10	12	16	20	24	27	30
Outside diameter of anchor	1					1	,0			

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



	haracteristic value on-cracked concre									ls in		
Anchor size reinforcin	ıg bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure						1	1		1			
Characteristic tension re	esistance	N _{Rk,s}	[kN]					$A_{s}\boldsymbol{\cdot}f_{uk}$				
Combined pull-out and	d concrete failure		1									
Characteristic bond resi	stance in non-cracked concre	ete C20/2	5									
Temperature range I:	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm ²]	14	14	13	13	12	12	11	11	11
40°C/24°C	flooded bore hole	τ _{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	$\tau_{Rk,ucr}$	[N/mm ²]	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	$\tau_{Rk,ucr}$	[N/mm ²]	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	$\tau_{\text{Rk,ucr}}$	[N/mm ²]	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					1,04		•		
Increasing factors for cc ψ_c	oncrete	C40/50						1,08				
		C50/60						1,10				
Factor according to CEN/TS 1992-4-5 Secti	on 6.2.2.3	k ₈	[-]					10,1				
Concrete cone failure												
Factor according to CEN/TS 1992-4-5 Secti	on 6.2.3.1	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	ef (2,5	<u>h</u> h _{ef})≤2	,4 ⋅ h _{ef}		
Axial distance		S _{cr,sp}	[mm]					$2 c_{cr,sp}$				
Installation safety factor	(dry and wet concrete)	γ2	·			1,2				1	,4	
Installation safety factor	(flooded bore hole)	γ2						1,4				
Performances	Injection system HF s of resistance for rebar ur o CEN/TS 1992-4)				cracked	concre	te			Anne	x C 1(D



	aracteristic valu ncrete (Design a							ds in	cracke	əd
Anchor size reinforcing	g bar			Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 32
Steel failure				•	•				•	
Characteristic tension re	esistance	N _{Rk,s} =N ⁰ _{Rk,s,seis,C1}	[kN]				$A_{s}\boldsymbol{\cdot}f_{uk}$			
Combined pull-out and	l concrete failure									
Characteristic bond resis	stance in cracked concre	ete C20/25								
		τ _{Rk,cr}	[N/mm ²]	7,5	7,0	6,5	6,0	5,5	5,5	5,5
Tomporatura rango li	dry and wet concrete	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	6,9	6,4	6,2	5,7	5,5	5,5	5,5
Temperature range I: 40°C/24°C		τ _{Rk,cr}	[N/mm ²]	7,5	6,5	6,0	5,0	4,5	4,0	4,0
	flooded bore hole	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	6,9	6,0	5,7	4,8	4,5	4,0	4,0
		τ _{Rk.cr}	[N/mm ²]	4,5	4,0	4.0	3,5	3,5	3,5	3,5
T	dry and wet concrete	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	4,1	3,7	3,8	3,3	3,5	3,5	3,5
Temperature range II: 60°C/43°C		τ _{Rk,cr}	[N/mm ²]	4,5	4.0	4.0	3,5	3,5	3,5	3,0
	flooded bore hole	τ ⁰ _{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
	dry and wet concrete	τ ⁰ _{Rk,seis,C1}	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
Temperature range III: 72°C/43°C		τ _{Rk.cr}	[N/mm ²]	4,0	3,5	3,5	3,0	3,0	3,0	3,0
	flooded bore hole	$\tau^0_{Rk,seis,C1}$	[N/mm ²]	3,7	3,2	3,3	2,9	3,0	3,0	3,0
		C30/37		0,7	0,2	0,0	1,04	0,0	0,0	0,0
Increasing factors for co (only static or quasi-stati		C40/50					1,08			
ψ_c		C50/60					1,10			
Factor according to CEN/TS 1992-4-5 Section	on 6.2.2.3	k ₈	[-]				7,2			
Concrete cone failure										
Factor according to CEN/TS 1992-4-5 Section	on 6 2 3 1	k _{cr}	[-]				7,2			
Edge distance	511 0.2.0.1	C _{cr,N}	[mm]				1,5 h _{et}			
Axial distance		S _{cr,N}	[mm]				3,0 h _{et}			
Splitting failure			•							
Edge distance		C _{cr,sp}	[mm]		1,0 ·	h _{ef} ≤2 ⋅ h	$n_{ef}\left(2,5-\frac{1}{h}\right)$	$\frac{h}{n_{ef}} \ge 2,4$	∙h _{ef}	
Axial distance		S _{cr,sp}	[mm]				2 c _{cr,sp}			
Installation safety factor	(dry and wet concrete)	γ ₂			1,2			1	,4	
Installation safety factor	(flooded bore hole)	γ2					1,4			
				·						
Performances	Injection system			ked cond	crete			Ann	ex C 1	11

Z63789.14

(Design according to CEN/TS 1992-4 or TR 045)



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]				0,5	50 • A _s •	f _{uk}			
Characteristic shear resistance	V ⁰ _{Rk,s,seis,C1}	[kN]	Perfor	lo mance mined PD)			0,4	l4 • A₅ •	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	$M^{o}_{Rk,s}$	[Nm]				1.3	2 ∙ W _{el} ∙	f _{uk}			
Characteristic bending moment	M ⁰ _{Rk,s,seis,C1}	[Nm]			No P€	erformar	nce 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	γ ₂						1,0				
Concrete edge failure											
Effective length of anchor	If	[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	γ2						1,0				

VJ Technology Injection system HPE 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 or TR 045)

Annex C 12



Anchor size threa	ded rod		M 8	M 10	M 12	M 16	M 20	M24	M 27	M 30
Non-cracked cond	rete C20/25	under static and o	quasi-statio	c action		I		ł	•	
Temperature range I:	δ_{N0} -factor	[mm/(N/mm ²)]	0,011	0,013	0,015	0,020	0,024	0,029	0,032	0,035
40°C/24°C	$\delta_{N_\infty}\text{-factor}$	[mm/(N/mm ²)]	0,044	0,052	0,061	0,079	0,096	0,114	0,127	0,140
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	$\delta_{N_{\infty}}$ -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	1		1	1	1
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°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm ²)]	N D f		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	δ _{N∞} -factor	[mm/(N/mm ²)]	(N	PD)	0,24	0,24	0,24	0,24	0,24	0,24
Temperature range III: 72°C/43°C	δ_{N0} -factor	[mm/(N/mm ²)]			0,037	0,043	0,049	0,055	0,061	0,06
	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm²)]			0,24	0,24	0,24	0,24	0,24	0,24
Cracked concrete	1	er seismic C2 acti	on				1			
Temperature range I:	$\delta_{N,seis(DLS)}$	[mm/(N/mm ²)]			0,03	0,05				
40°C/24°C	$\delta_{N,seis(ULS)}$	[mm/(N/mm ²)]	No Porf	ormance	0,06	0,09				
Temperature range II: 60°C/43°C	δ _{N,seis(DLS)}	[mm/(N/mm ²)]	Deter	mined	0,03	0,05	No Perf	ormance l	Determine	d (NPC
	δ _{N,seis(ULS)}	[mm/(N/mm ²)] [mm/(N/mm ²)]	(NI	PD)	0,06	0,09				
Temperature range III:	$\delta_{N,seis(DLS)}$	[[]][[]][]][]][]][][]][]][]][]][]][]][]					1			
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor	$\begin{tabular}{ c c c c c }\hline & \delta_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \end{tabular}$	[mm/(N/mm ²)]	_		0,03 0,06	0,05				
$\begin{array}{l} & 72^\circ\text{C}/43^\circ\text{C} \\ \end{array} \\ \begin{array}{l} ^{1)} \text{ Calculation of th} \\ \delta_{N0} = \delta_{N0}\text{-factor} \\ \delta_{N\infty} = \delta_{N\infty}\text{-factor} \end{array}$	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$	[mm/(N/mm ²)]	ur load ¹⁾ (1	thread	0,06	0,09				
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di	$\delta_{N,seis(ULS)}$ e displacemen · τ ; · τ ;	[mm/(N/mm ²)]	ur load ¹⁾ (1	thread	0,06	0,09	M 20	M24	M 27	M 30
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size threa	$\delta_{N,seis(ULS)}$ e displacemen · τ ; · τ ; displacement ded rod	[mm/(N/mm ²)]	M 8	M 10	0,06 ed rod M 12	0,09) M 16			M 27	M 30
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread	$\delta_{N,seis(ULS)}$ e displacemen · τ ; · τ ; displacement ded rod	[mm/(N/mm ²)] nt	M 8	M 10	0,06 ed rod M 12	0,09) M 16			M 27	M 30
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and All temperature	$\delta_{N,seis(ULS)}$ e displacement · τ ; · τ ; isplacement ded rod cracked cor	[mm/(N/mm ²)] nt ents under shea	M 8 er static, qu	M 10 Jasi-stat	0,06 ed rod M 12 tic and s	0,09) M 16 seismic	C1 act	ion		1
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size threa Non-cracked and All temperature ranges	$\begin{array}{c} \overline{\delta_{N,seis(ULS)}} \\ e \ displacement \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \hline splacement \\ \hline ded \ rod \\ \hline cracked \ cor \\ \hline \delta_{Vo} \mbox{-}factor \\ \hline \delta_{V\infty} \mbox{-}factor \\ \hline \end{array}$	[mm/(N/mm²)] nt ents under shea ncrete C20/25 unde [mm/(kN)]	M 8 er static, qu 0,06 0,09	M 10 Jasi-stat 0,06	0,06 ed rod M 12 tic and s 0,05	0,09) M 16 seismic 0,04	0,04	i on 0,03	0,03	0,03
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and All temperature ranges Cracked concrete	$\begin{array}{c} \overline{\delta_{N,seis(ULS)}} \\ e \ displacement \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \hline splacement \\ \hline ded \ rod \\ \hline cracked \ cor \\ \hline \overline{\delta_{V0}} \ factor \\ \hline \overline{\delta_{V\infty}} \ factor \\ \hline cr20/25 \ und \\ \hline \end{array}$	[mm/(N/mm ²)] nt ents under shea hcrete C20/25 unde [mm/(kN)] [mm/(kN)]	M 8 er static, qu 0,06 0,09 on No Perf	M 10 Jasi-stat 0,06 0,08	0,06 ed rod M 12 tic and s 0,05	0,09) M 16 seismic 0,04	C1 act i 0,04 0,06	ion 0,03 0,05	0,03	0,03
$72^{\circ}C/43^{\circ}C$ ¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -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	$\begin{array}{c} \overline{\delta_{N,seis(ULS)}} \\ e \ displacement \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \hline splacement \\ \hline ded \ rod \\ \hline cracked \ cor \\ \hline \delta_{Vo} \mbox{-}factor \\ \hline \delta_{V\infty} \mbox{-}factor \\ \hline \end{array}$	[mm/(N/mm ²)] nt ents under shea ncrete C20/25 unde [mm/(kN)] [mm/(kN)] er seismic C2 acti	M 8 er static, qu 0,06 0,09 on No Perfi Deter	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	C1 act i 0,04 0,06	i on 0,03	0,03	0,03
¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C14: Di Anchor size thread Non-cracked and All temperature ranges	$\begin{array}{c} \overline{\delta}_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ \cdot \ \tau; \\ \end{array}$	imm/(N/mm²)] Int	M 8 er static, qu 0,06 0,09 on No Perfi Deter	M 10 Jasi-stat 0,06 0,08 ormance mined	0,06 ed rod M 12 tic and s 0,05 0,08	0,09) M 16 seismic 0,04 0,06	C1 act i 0,04 0,06	ion 0,03 0,05	0,03	0,03
¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -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 ¹⁾ Calculation of th $\delta_{V0} = \delta_{V\infty}$ -factor $\delta_{V\infty} = \delta_{V\infty}$ -factor	$\begin{array}{c} \overline{\delta}_{N,seis(ULS)} \\ e \ displacemen \\ \cdot \ \tau; \\ \hline splacemen \\ \hline ded \ rod \\ \hline cracked \ cor \\ \hline \delta_{Vo}-factor \\ \hline \delta_{Vo}-factor \\ \hline cracked \ cor \\ \hline \delta_{V,seis(ULS)} \\ \hline e \ displacemen \\ \cdot \ V; \\ \cdot \ V; \\ \hline \end{array}$	imm/(N/mm²)] Int	M 8 er static, qu 0,06 0,09 on No Perf Deter (Ni	M 10 Jasi-stat 0,06 0,08 ormance mined	0,06 ed rod M 12 tic and s 0,05 0,08	0,09) M 16 seismic 0,04 0,06	C1 act i 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 action	้า	1	1			
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	$\delta_{N_\infty}\text{-factor}$	[mm/(N/mm ²)]	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°C	$\delta_{N_{\infty}}$ -factor	[mm/(N/mm ²)]	1	-	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	$\delta_{N\infty}\text{-factor}$	[mm/(N/mm²)]		-	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
¹⁾ Calculation of th $\delta_{N0} = \delta_{N0}$ -factor $\delta_{N\infty} = \delta_{N\infty}$ -factor Table C16: D	· τ; · τ;		hear Ic	ad ¹⁾ (r	ebar)			1			
$\begin{split} \delta_{\text{N0}} &= \delta_{\text{N0}}\text{-factor}\\ \delta_{\text{N\infty}} &= \delta_{\text{N\infty}}\text{-factor} \end{split}$ Table C16: D	τ; τ; isplacen	nent under s	hear lo	øad ¹⁾ (r ∅10	ebar) Ø 12	Ø 14	Ø 16	Ø 20	Ø 25	Ø 28	Ø 3
$\begin{split} \delta_{\text{N0}} &= \delta_{\text{N0}}\text{-factor} \\ \delta_{\text{N\infty}} &= \delta_{\text{N\infty}}\text{-factor} \end{split}$ Table C16: D Anchor size reinfo	τ; τ; isplacen prcing bar	nent under s	Ø 8	Ø 10	Ø 12		Ø 16	Ø 20	Ø 25	Ø 28	Ø 3:
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \\ \delta_{N\infty} &= \delta_{N\infty} \text{-factor} \end{split}$ Table C16: D Anchor size reinfo For concrete C20/	τ; τ; isplacen prcing bar	nent under s	Ø 8	Ø 10	Ø 12		Ø 16	Ø 20 0,04	Ø 25 0,03	Ø 28	Ø 3 2 0,03
$\begin{split} \delta_{N0} &= \delta_{N0}\text{-factor} \\ \delta_{N\infty} &= \delta_{N\infty}\text{-factor} \end{split}$ Table C16: D Anchor size reinfor For concrete C20/	τ; τ; isplacen prcing bar 25 under s δ_{V0} -factor $\delta_{V\infty}$ -factor	nent under s static, quasi-st [mm/(kN)] [mm/(kN)]	Ø 8 atic and	Ø 10 seismie	Ø 12 c C1 act	ion	[1	1	
$\begin{split} \delta_{N0} &= \delta_{N0} \text{-factor} \\ \delta_{N\infty} &= \delta_{N\infty} \text{-factor} \end{split}$ Table C16: D Anchor size reinfor For concrete C20/ All temperature ranges	τ; τ; isplacen prcing bar 25 under s δ_{Vo} -factor $\delta_{V\infty}$ -factor ne displacen V;	nent under s 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	0,0