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European Technical Assessment Body for construction products



European Technical Assessment

ETA-25/0056 of 20 March 2025

English translation prepared by DIBt - Original version in German language

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

Deutsches Institut für Bautechnik

Injection system Vesta PRO-200 PLUS Seismic for

Bonded fasteners and bonded expansion fasteners for use in concrete

Fikstek Bağlanti Teknolojileri San. ve Tic. LTD. ŞTI. Dudullu OSB, DES San.Sit., 103. Sok, No:58 Y. Dudullu, Ümraniye 34776 ISTANBUL TÜRKEI

Vesta Factory No:10 Germany

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

EAD 330499-02-0601

European Technical Assessment ETA-25/0056

English translation prepared by DIBt



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Specific Part

1 Technical description of the product

The "Injection system Vesta PRO-200 PLUS Seismic for concrete" is a bonded anchor consisting of a cartridge with injection mortar Vesta PRO-200 PLUS Seismic and a steel element according to Annex A 3 and A 5.

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 and/or 100 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 to tension load (static and quasi-static loading)	See Annex C 1 to C 4, C 6 to C 7, C 9 to C 10, B 3
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 5, C 8, C 11
Displacements under short-term and long-term loading	See Annex C 12 to C 14
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 15 to C 23

3.2 Safety in case of fire (BWR 2)

Essential characteristic	Performance
Reaction to fire	Class A1
Resistance to fire	See Annex C 24 to C 26

3.3 Hygiene, health and the environment (BWR 3)

Essential characteristic	Performance
Content, emission and/or release of dangerous substances	No performance assessed

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

In accordance with EAD 330499-02-0601 the applicable European legal act is: [96/582/EC]. The system to be applied is: 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 March 2025 by Deutsches Institut für Bautechnik

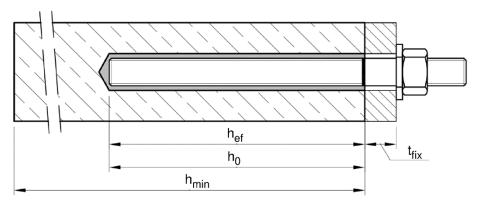
Dipl.-Ing. Beatrix Wittstock Head of Section

beglaubigt: Baderschneider

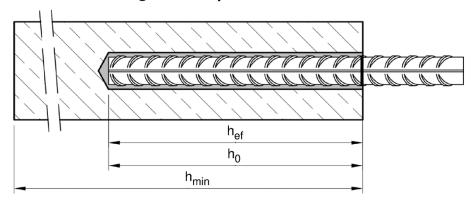


Installation threaded rod M8 up to M30

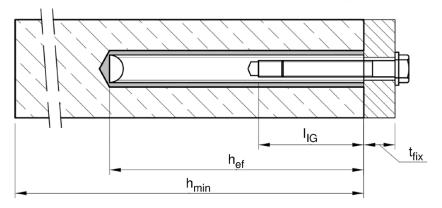
prepositioned installation or push through installation (annular gap filled with mortar)



Installation reinforcing bar Ø8 up to Ø32



Installation internal threaded anchor rod IG-M6 up to IG-M20



 t_{fix} = thickness of fixture t_{fix} = drill hole depth

 h_{ef} = effective embedment depth I_{IG} = thread engagement length

 h_{min} = minum thickness of member

Injection system Vesta PRO-200 PLUS Seismic for concrete

Product description
Installed condition

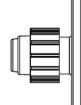
Annex A 1



Cartridge system

Coaxial Cartridge:

150 ml, 280 ml, 300 ml up to 333 ml and 380 ml up to 420 ml



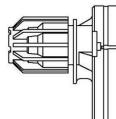
Imprint:

Vesta PRO-200 PLUS Seismic

Processing and safety instructions, shelf life, charge number, manufacturer's information, quantity information

Side-by-Side Cartridge:

235 ml, 345 ml up to 360 ml and 825 ml

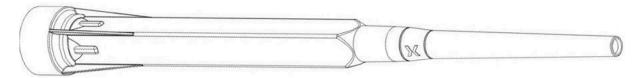


Imprint:

Vesta PRO-200 PLUS Seismic

Processing and safety instructions, shelf life, charge number, manufacturer's information, quantity information

Static mixer PM-19E



Piston plug VS and mixer extension VL



Injection system Vesta PRO-200 PLUS Seismic for concrete

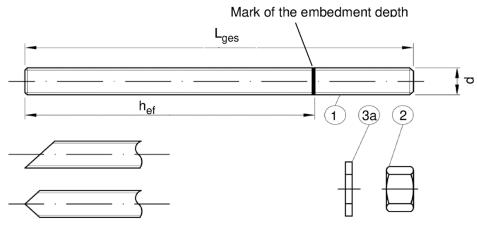
Product description

Injection system

Annex A 2



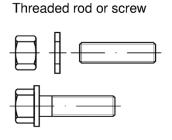
Threaded rod M8 up to M30 with washer and hexagon nut

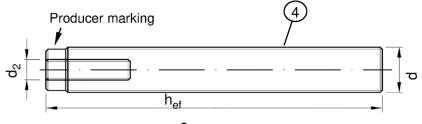


Commercial standard rod with:

- Materials, dimensions and mechanical properties acc. to Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004. The document shall be stored.
- Marking of embedment depth

Internal threaded rod IG-M6 to IG-M20





Marking Internal thread

Mark

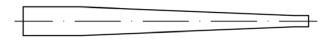
M8 Thread size (Internal thread)
A4 additional mark for stainless steel

HCR additional mark for high-corrosion resistance steel

Filling washer VFS



Mixer reduction nozzle MR



Injection system Vesta PRO-200 PLUS Seismic for concrete

Product description

Threaded rod; Internal threaded rod Filling washer; Mixer reduction nozzle

Annex A 3



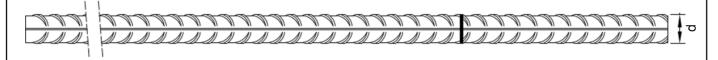
Та	ble A1: Mate	rials								
Part	Designation	Material								
- zi - h	inc plated ≥ 5 ot-dip galvanised ≥ 4	acc. to EN ISO 683-4: µm acc. to EN ISC 0 µm acc. to EN ISC 5 µm acc. to EN ISC	4042 146	2:2022 or 1:2022 and EN ISO 10684:	2004+AC:2009 or					
		Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture				
			4.6	f _{uk} = 400 N/mm ²	f _{yk} = 240 N/mm ²	A ₅ > 8%				
1	acc.		4.8	f _{uk} = 400 N/mm ²	f _{yk} = 320 N/mm ²	A ₅ > 8%				
		acc. to EN ISO 898-1:2013	5.6	f _{uk} = 500 N/mm ²	f _{yk} = 300 N/mm ²	A ₅ > 8%				
		EN 150 696-1:2013	5.8	f _{uk} = 500 N/mm ²	f _{yk} = 400 N/mm ²	A ₅ > 8%				
			8.8	f _{uk} = 800 N/mm ²	f _{yk} = 640 N/mm ²	$A_5 \ge 12\%^{3}$				
2	4 for anchor rod class 4.6 or 4.8									
3a	Steel zinc plated hot-din galvanised or sherardized									
3b	Filling washer	Steel, zinc plated, ho	Steel, zinc plated, hot-dip galvanised or sherardized							
	Internal threaded	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture				
4	anchor rod	acc. to		f _{uk} = 500 N/mm ²	$f_{yk} = 400 \text{ N/mm}^2$	$A_5 > 8\%$				
		EN ISO 898-1:2013	8.8	$f_{uk} = 800 \text{ N/mm}^2$	$f_{yk} = 640 \text{ N/mm}^2$	$A_5 > 8\%$				
Stai	nless steel A4 (Mater	rial 1.4401 / 1.4404 / 1	.457	1 / 1.4567 or 1.4541, acc. t 1 / 1.4362 or 1.4578, acc. t r 1.4565, acc. to EN 10088	o EN 10088-1:2014)					
		Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture				
1	Threaded rod ¹⁾⁴⁾		50	f _{uk} = 500 N/mm ²	f _{yk} = 210 N/mm ²	A ₅ ≥ 8%				
'	Tilleaded fod 77	acc. to EN ISO 3506-1:2020	70	f _{uk} = 700 N/mm ²	f _{yk} = 450 N/mm ²	$A_5 \ge 12\%^{3}$				
		EN 130 3306-1.2020	80	f _{uk} = 800 N/mm ²	f _{vk} = 600 N/mm ²	$A_5 \ge 12\%^{(3)}$				
	1	and to	50	for anchor rod class 50						
2	Hexagon nut ¹⁾⁴⁾	acc. to EN ISO 3506-1:2020	70	for anchor rod class 70						
			80	for anchor rod class 80	5.44 . FN.40000.4	0011				
3a	Washer	A4: Material 1.4401 / HCR: Material 1.452	/ 1.44 9 or 1	107 / 1.4311 / 1.4567 or 1.4 104 / 1.4571 / 1.4362 or 1.4 1.4565, acc. to EN 10088-1 EN ISO 7089:2000, EN ISC	578, acc. to EN 10088-1 : 2014	:2014				
3b	Filling washer	Stainless steel A4, H	ligh c	orrosion resistance steel						
	Internal threaded	Property class		Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture				
4	anchor rod ¹⁾²⁾	acc. to	50	f _{uk} = 500 N/mm ²	f _{yk} = 210 N/mm ²	A ₅ > 8%				
		EN ISO 3506-1:2020	70	f _{uk} = 700 N/mm ²	f _{yk} = 450 N/mm ²	A ₅ > 8%				
1)	Property class 70 or 80) for anchor rods and he	exago	n nuts up to M24 and Intern	al threaded anchor rods u	p to IG-M16				

- 1) Property class 70 or 80 for anchor rods and hexagon nuts up to M24 and Internal threaded anchor rods up to IG-M16
- 2) for IG-M20 only property class 50
- 3) $A_5 > 8\%$ fracture elongation if no use for seismic performance category C2
- 4) Property class 80 only for stainless steel A4 and HCR

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Product description Materials threaded rod and internal threaded rod	Annex A 4







Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010 Rib height of the bar shall be in the range $0.05d \le h_{rib} \le 0.07d$ (d: Nominal diameter of the bar; h_{rib} : Rib height of the bar)

Table A2: Materials Reinforcing bar

Part	Designation	Material
Reba	ar	
1	Reinforcing steel according to EN 1992 1 1:2004+AC:2010, Annex C	Bars and rebars from ring class B or C f_{yk} and k according to NDP or NCI according to EN 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Product description Materials reinforcing bar	Annex A 5



Specification of the intendent Fasteners subject to (Static and		:					
	Working lif	e 50 years	Working	g life 100 years			
Base material	uncracked concrete	cracked concrete	uncracked concrete	cracked concrete			
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling	Ø8 to	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20 I: - 40 °C to +40 °C1) I: - 40					
Temperature Range:	I: - 40 °C II: - 40 °C III: - 40 °C IV: - 40 °C		°C to +40 °C¹) °C to +80 °C²)				
Fasteners subject to (seismic ac	etion):						
	Performance	Performa	nce Category C2				
Base material		cracked concrete					
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling	M8 to Ø8 to	M12 to M24					
Temperature Range:	I: - 40 °C II: - 40 °C III: - 40 °C IV: - 40 °C	II: - 40 III: - 40	°C to +40 °C ¹⁾ °C to +80 °C ²⁾ °C to +120 °C ^{3) 5)} °C to +160 °C ^{4) 5)}				
Fasteners subject to (Fire expos	ure):						
Base material		uncracked and c	racked concrete				
HD: Hammer drilling HDB: Hammer drilling with hollow drill bit CD: Compressed air drilling		M8 to Ø8 to IG-M6 to	Ø32,				
Temperature Range:		II: - 40 °C III: - 40 °C	to +40 °C¹) to +80 °C²) to +120 °C³) to +160 °C⁴)				
1) (max. long-term temperature +24°C 2) (max. long-term temperature +50°C 3) (max. long-term temperature +72°C 4) (max. long-term temperature +100°C 5) Only for working life of 50 years	and max. short-term to and max. short-term to	emperature +80°C) emperature +120°C)					
Injection system Vesta PRO-20 Intended use Specifications							



Base materials:

- Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A2:2021.
- Strength classes C20/25 to C50/60 according to EN 206:2013 + A2:2021.

Use conditions (Environmental conditions):

- Structures subject to dry internal conditions (all materials).
- For all other conditions according to EN 1993-1-4:2006+ A1:2015 corresponding to corrosion resistance class:
 - Stainless steel Stahl A2 according to Annex A 4, Table A1: CRC II
 - Stainless steel Stahl A4 according to Annex A 4, Table A1: CRC III
 - High corrosion resistance steel HCR according to Annex A 4, Table A1: CRC V

Design:

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the fastener is indicated on the design drawings (e. g. position of the fastener relative to reinforcement or to supports, etc.).
- Fasteners are designed under the responsibility of an engineer experienced in fasteners and concrete work.
- The fasteners are designed in accordance to EN 1992-4:2018 and Technical Report TR 055, Edition February 2018
- The fasteners under fire exposure are designed in accordance to Technical Report TR 082, Edition June 2023.

Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB) or compressed air (CD).
- Overhead installation allowed.
- Fastener installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Installationtemperature in concrete:
 - -5°C up to +40°C for the standard variation of temperature after installation.

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Intended use Specifications (Continued)	Annex B 2



Table B1: Installation parameters for threaded rod											
Threaded rod		M8	M10	M12	M16	M20	M24	M27	M30		
Diameter of elemen	t	$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole di	ameter	d ₀	[mm]	10	12	14	18	22	28	30	35
Effective embedme			[mm]	60	60	70	80	90	96	108	120
Effective embedmer	п аерті	h _{ef,max}	[mm]	160	200	240	320	400	480	540	600
Diameter of	Prepositioned ins	stallation d _f ≤	[mm]	9	12	14	18	22	26	30	33
clearance hole in the fixture ¹⁾	Push through installation d _f		[mm]	12	14	16	20	24	30	33	40
Maximum installatio	n torque	max T _{inst}	[Nm]	10	20	40 ²⁾	60	100	170	250	300
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	75	95	115	125	140
Minimum edge dista	ınce	c _{min}	[mm]	35	40	45	50	60	65	75	80

 $^{^{1)}}$ For application under seismic loading the diameter of clearance hole in the fixture shall be at maximum $d_1 + 1mm$ or alternatively the annular gap between fixture and threaded rod shall be filled force-fit with mortar.

Table B2: Installation parameters for reinforcing bar

Reinforcing bar		Ø 8 ¹⁾	Ø 10 ¹⁾	Ø 12 ¹⁾	Ø 14	Ø 16	Ø 20	Ø 24 ¹⁾	Ø 25 ¹⁾	Ø 28	Ø 32	
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	14	16	20	24	25	28	32
Nominal drill hole diameter	d ₀	[mm]	10 12	12 14	14 16	18	20	25	30 32	30 32	35	40
Effective embedment depth	h _{ef,min}	[mm]	60	60	70	75	80	90	96	100	112	128
Effective embedment depth	h _{ef,max}	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h _{min}	[mm]		h _{ef} + 30 mm ≥ 100 mm				h _e	f + 2d ₀			
Minimum spacing	s _{min}	[mm]	40	50	60	70	75	95	120	120	130	150
Minimum edge distance	c _{min}	[mm]	35	40	45	50	50	60	70	70	75	85

¹⁾ both nominal drill hole diameter can be used

Table B3: Installation parameters for Internal threaded anchor rod

Internal threaded anchor rod						IG-M12	IG-M16	IG-M20
Internal diameter of anchor rod	d ₂		6	8	10	12	16	20
Outer diameter of anchor rod1)	$d = d_{nom}$	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d ₀		12	14	18	22	28	35
Effective embedment depth	h _{ef,min}	[mm]	60	70	80	90	96	120
Effective embedment depth	h _{ef,max}		200	240	320	400	480	600
Diameter of clearance hole in the fixture	d _f ≤		7	9	12	14	18	22
Maximum installation torque	max T _{inst}	[Nm]	10	10	20	40	60	100
Thread engagement length min/max	l _{IG}	[mm]	8/20	8/20	10/25	12/30	16/32	20/40
Minimum thickness of member	h _{min}	[mm]		30 mm 0 mm	h _{ef} + 2d ₀			
Minimum spacing	s _{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c _{min}	[mm]	40	45	50	60	65	80
1) Martin and the state of the	•					•		

¹⁾ With metric threads

Injection system Vesta PRO-200 PLUS Seismic for concrete

Intended use

Installation parameters

Annex B 3

²⁾ Maximum installation torque for M12 with steel Grade 4.6 is 35 Nm



				mount Mildelphila									
Threaded Rod	Re- inforcing bar	Internal threaded anchor rod	d ₀ Drill bit - Ø HD, HDB, CD	d _t Brush	•	d _{b,min} min. Brush - Ø	Piston plug	Installation direction and u					
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]		■	\rightarrow	1			
M8	8		10	RB10	11,5	10,5							
M10	8 / 10	IG-M6	12	RB12	13,5	12,5		N. I. and the second second					
M12	10 / 12	IG-M8	14	RB14	15,5	14,5		No plug required					
	12		16	RB16	17,5	16,5							
M16	14	IG-M10	18	RB18	20,0	18,5	VS18		_				
	16		20	RB20	22,0	20,5	VS20						
M20		IG-M12	22	RB22	24,0	22,5	VS22						
	20		25	RB25	27,0	25,5	VS25	h _{ef} >	h _{ef} >				
M24		IG-M16	28	RB28	30,0	28,5	VS28	250 mm	250 mm	all			
M27	24 / 25		30	RB30	31,8	30,5	VS30	230 111111	230 111111				
	24 / 25		32	RB32	34,0	32,5	VS32						
M30	28	IG-M20	35	RB35	37,0	35,5	VS35	_					
	32		40	RB40	43,5	40,5	VS40						



minimum negative pressure of 253 hPa and a flow rate of minimum 150 $\rm m^3/h$ (42 l/s).

Hand pump (Volume 750 ml, $h_0 \le 10 d_s$, $d_0 \le 20$ mm)



Compressed air tool

(min 6 bar)



Brush RB



Piston Plug VS



Brush extension RBL



Injection system Vesta PRO-200 PLUS Seismic for concrete	
Intended use Cleaning and setting tools	Annex B 4



Table B5:	Workin	g time and cu	ring time	
Tempera	ature in bas	se material	Maximum working time	Minimum curing time 1)
	Т		t _{work}	t _{cure}
- 5°C	to	- 1 °C	50 min	5 h
0°C	to	+ 4°C	25 min	3,5 h
+ 5°C	to	+ 9°C	15 min	2 h
+ 10°C	to	+ 14°C	10 min	1 h
+ 15°C	to	+ 19°C	6 min	40 min
+ 20 °C	to	+ 29 °C	3 min	30 min
+ 30 °C	to	+ 40 °C	2 min	30 min
Car	tridge tempe	erature	+5°C to	+40°C

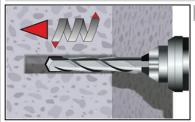
¹⁾ The minimum curing time is only valid for dry base material. In wet base material the curing time must be doubled.

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Intended use Working time and curing time	Annex B 5



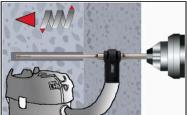
Installation instructions

Drilling of the bore hole



1a. Hammer drilling (HD) / Compressed air drilling (CD)

Drill a hole to the required embedment depth.
Drill bit diameter according to Table B1, B2 or B3.
Aborted drill holes shall be filled with mortar.
Proceed with Step 2 (MAC or CAC).



1b. Hollow drill bit system (HDB) (see Annex B 4)

Drill a hole to the required embedment depth.

Drill bit diameter according to Table B1, B2 or B3.

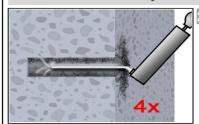
The hollow drilling system removes the dust and cleans the bore hole.

Proceed with Step 3.

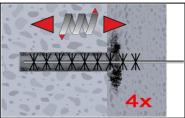
Attention! Standing water in the bore hole must be removed before cleaning.

Manual Air Cleaning (MAC)

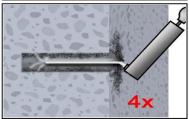
for bore hole diameter $d_0 \le 20$ mm and bore hole depth $h_0 \le 10d_{nom}$ (uncracked concrete only)



Blow the bore hole clean minimum 4x from the bottom or back by hand pump (Annex B 4).



Brush the bore hole minimum 4x with brush RB according to Table B4 over the entire embedment depth in a twisting motion (if necessary, use a brush extension RBL).

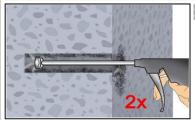


Finally blow the bore hole clean minimum 4x from the bottom or back by hand pump (Annex B 4).

Compressed Air Cleaning (CAC):

All diameter in cracked and uncracked concrete, all drilling methods

2c.



2a. Blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

Injection system Vesta PRO-200 PLUS Seismic for concrete

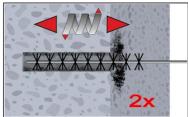
Intended use

Installation instructions

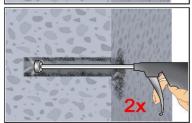
Annex B 6



Installation instructions (continuation)

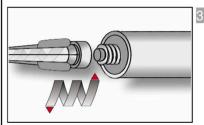


Brush the bore hole minimum 2x with brush RB according to Table B4 over the entire embedment depth in a twisting motion. (If necessary, a brush extension shall be used .RBL)



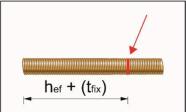
Finally blow the bore hole clean minimum 2x with compressed air (min. 6 bar) (Annex B 4) over the entire embedment depth until return air stream is free of noticeable dust. (If necessary, an extension shall be used.)

Cleaned bore hole has to be protected against re-contamination in an appropriate way, If necessary, repeat cleaning process directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.



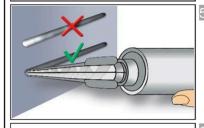
Screw on static-mixing nozzle PM-19E and load the cartridge into an appropriate dispensing tool.

For every working interruption longer than the maximum working time t_{work} (Annex B 5) as well as for new cartridges, a new static-mixer shall be used.



Mark embedment depth on the anchor rod. Consider t_{fix} in case of push through installations.

The anchor rod shall be free of dirt, grease, oil or other foreign material.



Not proper mixed mortar is not sufficient for fastening. Dispense and discard mortar until an uniform grey colour is shown (at least 3 full strokes).



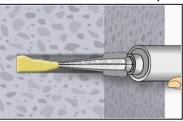
Piston plugs VS and mixer nozzle extensions VL shall be used according to Table B4 for the following applications:

- Horizontal and vertical downwards direction: Drill bit-Ø d₀ ≥ 18 mm and embedment depth h_{ef} > 250mm
- Vertical upwards direction: Drill bit-Ø d₀ ≥ 18 mm
 Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Intended use Installation instructions (continuation)	Annex B 7

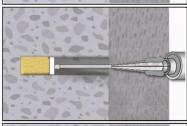


Installation instructions (continuation)



7a. Injecting mortar without piston plug VS

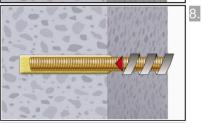
Starting at bottom of the hole and fill the hole up to approximately two-thirds with mortar. (If necessary, a mixer nozzle extension shall be used.) Slowly withdraw of the static mixing nozzle avoid creating air pockets Observe the temperature related working time t_{work} (Annex B 5).



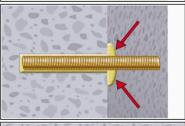
Injecting mortar with piston plug VS

Starting at bottom of the hole and fill the hole up to approximately two-thirds with mortar. (If necessary, a mixer nozzle extension shall be used.) During injection the piston plug is pushed out of the bore hole by the back pressure of the mortar.

Observe the temperature related working time t_{work} (Annex B 5).

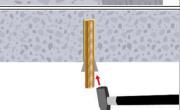


Insert the anchor rod while turning slightly up to the embedment mark.



Annular gap between anchor rod and base material must be completely filled with mortar. In case of push through installation the annular gap in the fixture must be filled with mortar also.

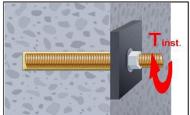
Otherwise, the installation must be repeated starting from step 7 before the maximum working time t_{work} has expired.



For application in vertical upwards direction the anchor rod shall be fixed (e.g. wedges).



Temperature related curing time t_{cure} (Annex B 5) must be observed. Do not move or load the fastener during curing time.



Install the fixture by using a calibrated torque wrench. Observe maximum installation torque (Table B1 or B3).

In case of static requirements (e.g. seismic), fill the annular gab in the fixture with mortar (Annex A 2). Therefore replace the washer by the filling washer VFS and use the mixer reduction nozzle MR.

Injection system Vesta PRO-200 PLUS Seismic for concrete

Intended use

Installation instructions (continuation)

Annex B 8



Т	Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods												
Th	readed rod			M8	M10	M12	M16	M20	M24	M27	M30		
Cro	oss section area	A _s	[mm²]	36,6	58	84,3	157	245	353	459	561		
Ch	aracteristic tension resistance, Steel failu	re ¹⁾											
Ste	eel, Property class 4.6 and 4.8	N _{Rk,s}	[kN]	15 (13)	23 (21)	34	63	98	141	184	224		
Ste	eel, Property class 5.6 and 5.8	N _{Rk,s}	[kN]	18 (17)	29 (27)	42	78	122	176	230	280		
Ste	eel, Property class 8.8	N _{Rk,s}	[kN]	29 (27)	46 (43)	67	125	196	282	368	449		
Sta	ainless steel A2, A4 and HCR, class 50	N _{Rk,s}	[kN]	18	29	42	79	123	177	230	281		
Sta	ainless steel A2, A4 and HCR, class 70	N _{Rk,s}	[kN]	26	41	59	110	171	247	_3)	_3)		
	ainless steel A4 and HCR, class 80	N _{Rk,s}	[kN]	29	46	67	126	196	282	_3)	_3)		
Characteristic tension resistance, Partial factor ²⁾													
Ste	eel, Property class 4.6 and 5.6	γ _{Ms,N}	[-]				2,0	0					
I	eel, Property class 4.8, 5.8 and 8.8	γ _{Ms,N}	[-]				1,	5					
<u> </u>	ainless steel A2, A4 and HCR, class 50	γ _{Ms,N}	[-]				2,8						
Sta	ainless steel A2, A4 and HCR, class 70	γ _{Ms,N}	[-]	1,87									
I—	ainless steel A4 and HCR, class 80	γ _{Ms,N}	[-]	1,6									
Ch	aracteristic shear resistance, Steel failure	1)	I										
اءا	Steel, Property class 4.6 and 4.8	V ⁰ _{Rk,s}	[kN]	9 (8)	14 (13)	20	38	59	85	110	135		
r arm	Steel, Property class 5.6 and 5.8	V ⁰ Rk,s	[kN]	11 (10)	17 (16)	25	47	74	106	138	168		
eve	Steel, Property class 8.8	V ⁰ Rk,s	[kN]	15 (13)	23 (21)	34	63	98	141	184	224		
out	Stainless steel A2, A4 and HCR, class 50	V ⁰ Rk,s	[kN]	9	15	21	39	61	88	115	140		
Without lever	Stainless steel A2, A4 and HCR, class 70	V ⁰ Rk,s	[kN]	13	20	30	55	86	124	_3)	_3)		
>	Stainless steel A4 and HCR, class 80	V ⁰ Rk,s	[kN]	15	23	34	63	98	141	_3)	_3)		
	Steel, Property class 4.6 and 4.8	M ⁰ Rk,s	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900		
arm	Steel, Property class 5.6 and 5.8	M ⁰ Rk,s	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123		
lever a	Steel, Property class 8.8	M ⁰ Rk,s	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797		
h le	Stainless steel A2, A4 and HCR, class 50	M ⁰ Rk,s	[Nm]	19	37	66	167	325	561	832	1125		
	Stainless steel A2, A4 and HCR, class 70	M ⁰ Rk,s	[Nm]	26	52	92	232	454	784	_3)	_3)		
	Stainless steel A4 and HCR, class 80	M ⁰ Rk,s	[Nm]	30	59	105	266	519	896	_3)	_3)		
Ch	aracteristic shear resistance, Partial facto												
Ste	eel, Property class 4.6 and 5.6	γ _{Ms,V}	[-]				1,6	57					
Ste	eel, Property class 4.8, 5.8 and 8.8	γ _{Ms,V}	[-]				1,2	25					
Sta	ainless steel A2, A4 and HCR, class 50	γ _{Ms,V}	[-]				2,3	88					
Sta	ainless steel A2, A4 and HCR, class 70	γ _{Ms,V}	[-]				1,5	6					
Sta	ainless steel A4 and HCR, class 80	γ _{Ms,V}	[-]				1,3	3					

 $^{^{1)}}$ Values are only valid for the given stress area A_s . Values in brackets are valid for undersized threaded rods with smaller stress area A_s for hot-dip galvanised threaded rods according to EN ISO 10684:2004+AC:2009.

³⁾ Fastener type not part of the ETA

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values for steel tension resistance and steel shear resistance of threaded rods	Annex C 1

²⁾ in absence of national regulation



Table C2:	Characteristic values of tension load for a working life of 50 and 100 years	s under static and quasi-static action
Fastener		All Anchor types and sizes

Fastener				All Anchor types and sizes
Concrete cone f	ailure			
Uncracked concr	ete	k _{ucr,N}	[-]	11,0
Cracked concrete	9	k _{cr,N}	[-]	7,7
Edge distance		c _{cr,N}	[mm]	1,5 h _{ef}
Axial distance			[mm]	2 c _{cr,N}
Splitting				
	h/h _{ef} ≥ 2,0			1,0 h _{ef}
Edge distance	$2.0 > h/h_{ef} > 1.3$	c _{cr,sp}	[mm]	$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$
	h/h _{ef} ≤ 1,3			2,4 h _{ef}
Axial distance	•	s _{cr,sp}	[mm]	2 c _{cr,sp}

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances	Annex C 2
Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years	



	led rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel fa			1		1			,				
	teristic tension resi	stance	N _{Rk,s}	[kN]	A _s ⋅ f _{uk} (or see Table C1)							
Partial 1		ananaka fallana	γ _{Ms,N}	[-]				see Ta	ible C1			
	ned pull-out and cateristic bond resista		d concrete C2	0/25								
	I: 24°C/40°C		τ _{Rk,ucr}	[N/mm²]	17	17	16	15	14	13	13	13
e ran	II: 50°C/80°C	Dry, wet		[N/mm²]	17	17	16	15	14	13	13	13
ratur		concrete and flooded bore	^τ Rk,ucr	+								
Femperature range	III: 72°C/120°C	hole	^τ Rk,ucr	[N/mm ²]	15	14	14	13	12	12	11	11
<u>'</u>	IV: 100°C/160°C		^τ Rk,ucr	[N/mm ²]	12	11	11	10	9,5	9,0	9,0	9,0
	teristic bond resista	ance in cracked o	oncrete C20/2	25								
ange	I: 24°C/40°C		^τ Rk,cr	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
ure r	<u>a</u> 11: 50°C/80°C	Dry, wet concrete and	^τ Rk,cr	[N/mm²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
oerat	III: 72°C/120°C	flooded bore hole	τ _{Rk,cr}	[N/mm²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
Tem	IV: 100°C/160°C		τ _{Rk,cr}	[N/mm²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Redukt	tion factor ψ ⁰ sus in α	cracked and uncr	acked concre	te C20/25								
nge	I: 24°C/40°C		Ψ^0 sus		0,90							
ure ra ==	II: 50°C/80°C	Dry, wet concrete and flooded bore hole			0,87							
eratı	But an			[-]	0,75							
Гетр	IV: 100°C/160°C				0,66							
Increas	sing factors for cond	rete	Ψς	[-]	(f _{ck} / 20) ^{0,1}							
Charac	teristic bond resista	ance depending		τ _{Rk,ucr} =			Ψο	• τ _{Rk,u}	ıcr,(C20	(25)		
on the	concrete strength c	lass		τ _{Rk,cr} =			Ψ	c • τ _{Rk,}	cr,(C20/	25)		
	ete cone failure											
	nt parameter							see Ta	ble C2			
Splittin	ng .nt parameter							see Ta	hla Ca	,		
	ation factor				<u> </u>			3CC 18	IDI O UZ			
		MAC					1,2			No Per		nce
for dry	and wet concrete	CAC	_ γ _{inst}	[-]				1	,0	ass	essed	
		HDB	_ · IIISt	"1					, <u>o</u> ,2			
for floo	ded bore hole	CAC							,4			
Inject	tion system Ves	ta PRO-200 PL	US Seismic	for concre	ete							
Chara	rmances cteristic values of te vorking life of 50 yea		static and qua	si-static actio	n					Anne	x C 3	;



Threaded rod			of 100 yea	rs								
					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic to	Characteristic tension resistance N _{Rk,s} [kN]						A _s · f	_{uk} (or s	ee Tab	le C1)		
Partial factor			γ _{Ms,N}	[-]				see Ta	able C1			
Combined pul	l-out and o	concrete failure										
Characteristic b	ond resista	ance in uncracke	d concrete C2	0/25								
Temperature range :II :50°C	:/40°C	Dry, wet concrete and	^τ Rk,ucr,100	[N/mm²]	17	17	16	15	14	13	13	13
Tem II: 50°C	C/80°C	flooded bore hole	^τ Rk,ucr,100	[N/mm²]	17	17	16	15	14	13	13	13
Characteristic b	ond resista	ance in cracked c	oncrete C20/2	:5								
Temperature range II: 24°C	5/40°C	Dry, wet concrete and flooded bore hole	^τ Rk,cr,100	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
He	C/80°C		^τ Rk,cr,100	[N/mm²]	5,5	6,0	6,5	6,5	6,5	6,5	6,5	6,5
Reduktion facto	or ψ ⁰ sus,100	in cracked and ι	incracked con	crete C20/25	5							
Temperature range :II 24°C		Dry, wet concrete and	Ψ ⁰ sus,100		0,90							
He	C/80°C	flooded bore hole	Ψ sus,100	[-]	0,87							
Increasing factor	ors for cond	crete	Ψς	[-]				(f _{ck} /	20) ^{0,1}			
Characteristic b	ond resista	ance depending	τρ	Rk,ucr,100 =	Ψc • ^τ Rk,ucr,100,(C20/25)							
on the concrete				Rk,cr,100 =	Ψc • ^τ Rk,cr,100,(C20/25)							
Concrete cone	failure		1	1111,01,100				1111,01	,100,(02	.0,20)		
Relevant param	neter							see Ta	able C2	<u> </u>		
Splitting												
Relevant param	neter							see Ta	able C2	2		
Installation fac	ctor											
for dry and wet	concrete	MAC					1,2				rformar sessed	ıce
ioi diy and wet	COHOLEGE	CAC	γ_{inst}	[-]	1,0							
for the colonial		HDB	-		1,2							
for flooded bore	e nole	CAC						1	,4			

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (threaded rod)	Annex C 4

Installation factor



1,0

				nder s	tatic a	ınd qu	asi-sta	atic acti	on
		M8	M10	M12	M16	M20	M24	M27	M30
V ⁰ Rk,s	[kN]			0,6 •	A _s ·f _{uk}	(or see	Table C	1)	
V ⁰ _{Rk,s}	[kN]			0,5 •	A _s ·f _{uk}	(or see	Table C	1)	
γ _{Ms,V}	[-]				see	Table C	1		
k ₇	[-]					1,0			
•									
M ⁰ Rk,s	[Nm]			1,2 •	W _{el} • f _{uk}	(or see	Table C	;1)	
W _{el}	[mm³]	31	62	109	277	541	935	1387	1874
γ _{Ms,V}	[-]				see	Table C	1		
k ₈	[-]					2,0			
γ _{inst}	[-]					1,0			
I _f	[mm]		n	nin(h _{ef} ;	12 · d _{nor}	m)		min(h _{ef} ;	300mm)
d _{nom}	[mm]	8	10	12	16	20	24	27	30
	V ⁰ _{Rk,s} V ⁰ _{Rk,s} γ _{Ms,V} k ₇ M ⁰ _{Rk,s} W _{el} γ _{Ms,V}	V ⁰ _{Rk,s}	M8 M8 M8 M8 M8 M8 M8 M8	ife of 50 and 100 years M8 M10 V ⁰ _{Rk,s} [kN] γ _{Ms,v} [-] k ₇ [-] M ⁰ _{Rk,s} [Nm] W _{el} [mm³] 31 62 γ _{Ms,v} [-] k ₈ [-] γ _{inst} [-]	M8 M10 M12 V ⁰ _{Rk,s} [kN] 0,6 · V ⁰ _{Rk,s} [kN] 0,5 · γ _{Ms,v} [-] M ⁰ _{Rk,s} [Nm] 1,2 · W _{el} [mm³] 31 62 109 γ _{Ms,v} [-] I _f [mm] min(h _{ef} ;	$ \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 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 c c c c c c c c c c c c $	$\begin{array}{c c c c c c c c c c c c c c c c c c c $

[-]

 γ_{inst}

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (threaded rod)	Annex C 5



1,4

Tabl		acteristic value working life of			ads un	der sta	tic and	quasi-s	static ac	etion		
Interna	al threaded anchor	rods			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20		
Steel fa	ailure ¹⁾											
Charac	teristic tension resi	stance, 5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123		
Steel, s	strength class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196		
Partial	factor, strength clas	ss 5.8 and 8.8	γ _{Ms,N}	[-]	1,5							
	teristic tension resi 4 and HCR, Streng		N _{Rk,s}	[kN]	14	14 26 41 59 110						
Partial	factor		$\gamma_{Ms,N}$	[-]			1,87			2,86		
Combi	ned pull-out and o	oncrete cone failu	re									
	teristic bond resista	ance in uncracked co	oncrete C	20/25								
nre	I: 24°C/40°C		τ _{Rk,ucr}	[N/mm ²]	17	16	15	14	13	13		
nperat range	II: 50°C/80°C	Dry, wet concrete	τ _{Rk,ucr}	[N/mm ²]	17	16	15	14	13	13		
Temperature range	III: 72°C/120°C	flooded bore hole	τ _{Rk,ucr}	[N/mm ²]	14	14	13	12	12	11		
Tel	IV: 100°C/160°C		τ _{Rk,ucr}	[N/mm ²]	11	11	10	9,5	9,0	9,0		
Charac	teristic bond resista	ance in cracked con	crete C20)/25								
<u>re</u>	I: 24°C/40°C		τ _{Rk,cr}	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0		
nperatı range	II: 50°C/80°C	Dry, wet concrete and flooded bore hole	τ _{Rk,cr}	[N/mm ²]	7,5	8,0	9,0	8,5	7,0	7,0		
Temperature range	III: 72°C/120°C		τ _{Rk,cr}	[N/mm ²]	6,5	7,0	7,5	7,0	6,0	6,0		
Ter	IV: 100°C/160°C		τ _{Rk,cr}	[N/mm ²]	5,5	6,0	6,5	6,0	5,5	5,5		
Redukt	ion factor ψ ⁰ sus in α	cracked and uncrack	ked concr	ete C20/2	5		'					
<u> </u>	I: 24°C/40°C						0,	90				
ratu ye	II: 50°C/80°C	Dry, wet concrete			0,87							
Temperature range	III: 72°C/120°C	and flooded bore hole	Ψ^0 sus	[-]			0.	75				
Ter	IV: 100°C/160°C	Thooded bore hole						66				
	sing factors for cond	rete	Ψς	[-]				20) ^{0,1}				
			1 7 0									
	teristic bond resista crete strength clas	. 0		τ _{Rk,ucr} =				ucr,(C20/25)				
	ete cone failure			$\tau_{Rk,cr} =$			Ψc ^τ Rk,	cr,(C20/25)				
	nt parameter						see Ta	able C2				
	ng failure						200 10					
	nt parameter						see Ta	able C2				
Installa	ation factor											
		MAC				1,2			ormance a	assessed		
for dry	and wet concrete	CAC	γ _{inst}	[-]				,0				
		HDB	1				1	,2				

¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.

CAC

for flooded bore hole

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under static and quasi-static action for a working life of 50 years (internal threaded anchor rod)	Annex C 6

²⁾ For IG-M20 strength class 50 is valid



1,0

1,2

1,4

Tabl	e C7: Cha	racteristi	c valu	es of ter	nsion la	oads ur	nder sta	tic and	guasi-s	static ac	 etion		
		a working				Judo u.			quao. c		7.1.011		
	al threaded ancho	or rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20		
Steel fa	ailure ¹⁾												
Charac	teristic tension res	sistance,	5.8	$N_{Rk,s}$	[kN]	10	17	29	42	76	123		
Steel, s	strength class		8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196		
Partial	factor, strength cla	ass 5.8 and 8	8.8	γ _{Ms,N}	[-]	1,5							
	cteristic tension res A4 and HCR, Stren			N _{Rk,s}	[kN]	14	14 26 41 59 110						
Partial	factor			γ _{Ms,N}	[-]			1,87			2,86		
Combi	ned pull-out and	concrete co	one fail	ure									
Charac	teristic bond resis	tance in unc	racked	concrete C2	20/25								
nperature range	I: 24°C/40°C	Dry, wet co	oncrete	^τ Rk,ucr,100	[N/mm²]	17	16	15	14	13	13		
Temperature range	II: 50°C/80°C	and flooded bo	re hole	^τ Rk,ucr,100	[N/mm²]	17	16	15	14	13	13		
Charac	teristic bond resis	tance in crac	cked cor	ncrete C20/	25								
Temperature range	I: 24°C/40°C	Dry, wet co	oncrete	^τ Rk,cr,100	[N/mm²]	6,0	6,5	6,5	6,5	6,5	6,5		
Tempe	II: 50°C/80°C	flooded bo	re hole	^τ Rk,cr,100	[N/mm²]	6,0	6,5	6,5	6,5	6,5	6,5		
Redukt	tion factor $\psi^0_{sus,10}$	o in cracked	and un	cracked co	ncrete C2	20/25							
Temperature range	I: 24°C/40°C	Dry, wet co		Ψ^0 sus,100	[-]	0,90							
Tempe	II: 50°C/80°C	flooded bo	re hole	Ψ sus,100	[-]			0,	87				
Increas	sing factors for cor	crete		Ψc	[-]			(f _{ck} /	20) ^{0,1}				
Charac	cteristic bond resis	tance denen	dina		ucr,100 =		Ų	[/] c • ^τ Rk,ucı		25)			
	concrete strength		unig		,cr,100 =			Ψc • τ _{Rk,cr}					
Concre	ete cone failure			וחג	,01,100			· 0 HK,01	,100,(020/2	<u> </u>			
	int parameter							see Ta	able C2				
	ng failure												
	int parameter							see Ta	able C2				
Installa	ation factor	_											
		MAC					1,2		No Perf	ormance a	assessed		

[-]

 γ_{inst}

CAC

HDB

CAC

for dry and wet concrete

for flooded bore hole

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under static and quasi-static action for a working life of 100 years (internal threaded anchor rod)	Annex C 7

¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.

²⁾ For IG-M20 strength class 50 is valid



1,0

Table C8: Character for a work						static a	and qua	si-stati	c action			
Internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20			
Steel failure without lever arm ¹)				•							
Characteristic shear resistance,	5.8	V ⁰ Rk,s	[kN]	5	9	15	21	38	61			
Steel, strength class	8.8	V ⁰ Rk,s	[kN]	8	14	23	34	60	98			
Partial factor, strength class 5.8 a	and 8.8	γ _{Ms,V}	[-]				1,25					
Characteristic shear resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		V ⁰ Rk,s	[kN]	7	13	20	30	55	40			
Partial factor		γ _{Ms,V}	[-]	1,56 2,38								
Ductility factor		k ₇	[-]				1,0					
Steel failure with lever arm ¹⁾												
Characteristic bending moment,	5.8	M ⁰ Rk,s	[Nm]	8	19	37	66	167	325			
Steel, strength class	8.8	М ⁰ _{Rk,s}	[Nm]	12	30	60	105	267	519			
Partial factor, strength class 5.8 a	and 8.8	γ _{Ms,V}	[-]				1,25					
Characteristic bending moment, Stainless Steel A4 and HCR, Strength class 70 ²⁾		M ⁰ _{Rk,s}	[Nm]	11	26	52	92	233	456			
Partial factor		γ _{Ms,V}	[-]			1,56			2,38			
Concrete pry-out failure												
Factor		k ₈	[-]				2,0					
Installation factor		γinst	[-]				1,0					
Concrete edge failure												
Effective length of fastener		I _f	[mm]		min	(h _{ef} ; 12 • c	i _{nom})		min(h _{ef} ; 300m			
Outside diameter of fastener		d _{nom}	[mm]	10	12	16	20	24	30			

¹⁾ Fastenings (incl. nut and washer) must comply with the appropriate material and property class of the internal threaded rod. The characteristic tension resistance for steel failure is valid for the internal threaded rod and the fastening element.

[-]

 γ_{inst}

Installation factor

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (internal threaded anchor rod)	Annex C 8

²⁾ For IG-M20 strength class 50 is valid



Reinforcing bar Steel failure Characteristic tension Cross section area				years											
Characteristic tension					Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
Cross section area															
	n resis	tance	N _{Rk,s}	[kN]					A _s ·	f _{uk} 1)					
			A _s	[mm ²]	50	79	113	154	201	314	452	491	616	804	
Partial factor			γ _{Ms,N}	[-]					1,4	4 ²⁾					
Combined pull-out															
Characteristic bond		nce in uncra	cked concre												
<u>e</u> <u>I: 24°C/40°C</u>		Dry, wet	^τ Rk,ucr	[N/mm ²]	14	14	14	14	13	13	13	13	13	13	
T: 20°C/120°C/10°C/10°C/10°C/10°C/10°C/10°C/10°C/1	_	concrete and	^τ Rk,ucr	[N/mm ²]	14	14	14	14	13	13	13	13	13	13	
를 현 III: 72°C/120	NO	flooded	^τ Rk,ucr	[N/mm ²]	13	12	12	12	12	11	11	11	11	11	
⊢ IV: 100°C/16	60°C	bore hole	^τ Rk,ucr	[N/mm ²]	9,5	9,5	9,5	9,0	9,0	9,0	9,0	9,0	8,5	8,5	
Characteristic bond		nce in cracke	ed concrete	C20/25											
<u> </u>		Dry, wet	^τ Rk,cr	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0	
III: 72°C/120	_	concrete and	τ _{Rk,cr}	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0	
III: 72°C/120 IV: 100°C/10	NO 1	and flooded	^τ Rk,cr	[N/mm²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0	
ਲ IV: 100°C/1€		bore hole	τ _{Rk,cr}	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0	
Reduktion factor ψ ⁰ ,	sus in c	racked and ι		oncrete C2	0/25										
ը I: 24°C/40°C	;	Dry, wet			0,90										
ege II: 50°C/80°	c	concrete	Ψ^0 sus	r-1					0,8	87					
ह्य हा।: 72°C/120	ill: 72°C/120°C		Ψsus	[-]	0,75										
IV: 100°C/16	60°C	bore hole							0,0						
Increasing factors for			Ψc	[-]	(f _{ck} / 20) ^{0,1}										
Characteristic bond depending on the co				τ _{Rk,ucr} =	Ψc * ^τ Rk,ucr,(C2										
class				$\tau_{Rk,cr} =$				Ψс	• τ _{Rk,c}	cr,(C20	/25)				
Concrete cone faile											_				
Relevant parameter									see Ta	ble C2	2				
Splitting									-	hl- 21	<u> </u>				
Relevant parameter									see Ta	ible C2					
Installation factor		MAC					1,2			No	Perfor	mance	2000	seed	
for dry and wet cond	rete	CAC	1				٦,٢		l		. 611011	mance	43363	JJGU	
		HDB	γinst	[-]						,2					
for flooded bore hole		CAC							1,	,4					



	ing bar				Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 3	
Steel fai	lure														
Characte	eristic tension res	istance	N _{Rk,s}	[kN]					A _s ·	f _{uk} 1)					
Cross se	ection area		A _s	[mm²]	50	79	113	154	201	314	452	491	616	804	
Partial fa	actor		γ _{Ms,N}	[-]					1.	4 ²⁾					
Combine	ed pull-out and	concrete fail													
	eristic bond resist			te C20/25											
Temperature range	: 24°C/40°C	Dry, wet concrete and	^τ Rk,ucr,100	[N/mm²]	14	14	14	14	13	13	13	13	13	13	
	II: 50°C/80°C	flooded bore hole	^τ Rk,ucr,100	[N/mm²]	14	14	14	14	13	13	13	13	13	13	
	eristic bond resist	ance in crack	ed concrete	C20/25											
Temperature range 	: 24°C/40°C	Dry, wet concrete and	^τ Rk,cr,100	[N/mm ²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0	
Tempe rar -	II: 50°C/80°C	flooded bore hole	^τ Rk,cr,100	[N/mm ²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0	
Reduktio	on factor ψ ⁰ sus,10	₀ in cracked a	nd uncracke	ed concrete	C20/	25									
Temperature range 			0,40	[-]	0,90										
Tempe ran	II: 50°C/80°C	and flooded bore hole	Ψ ⁰ sus,100		0,87										
Increasir	ng factors for con	crete	Ψς	[-]	(f _{ck} / 20) ^{0,1}										
	eristic bond resist		τ _{Rk}	,ucr,100 =	Ψc • τRk,ucr,100,(C20/25)										
class	ng on the concret	e strength		lk,cr,100 =	Ψc • τ _{Rk,cr,100}						,(C20/25)				
	e cone failure								To	able C					
Splitting	t parameter							,	see 12	ible C					
	t parameter								soo Ta	able C					
	ion factor							•	See 12	ible 02					
iiiStaiiati	ion factor	MAC					1,2			No	Dorfor	mance	2000	scod	
for dry ar	nd wet concrete	CAC	-				1,2		1	,0	1 61101	mance	assec	sseu	
ioi aiy ai	na wat danarata	HDB	γinst	[-]						,2					
for floode	ed bore hole	CAC	1							, <u> </u>					
	nall be taken from sence of national r		ons of reinford	cing bars											



Table C11: Characterist for a workin					ındeı	r stat	tic ar	nd qı	uasi-	static	action	า
Reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure without lever arm			•	•		•	•			•		
Characteristic shear resistance	V ⁰ _{Rk,s}	[kN]					0,50	·As·	f _{uk} 1)			
Cross section area	A _s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	γ _{Ms,V}	[-]						1,5 ²⁾				
Ductility factor	k ₇	[-]						1,0				
Steel failure with lever arm	·											
Characteristic bending moment	M ⁰ _{Rk,s}	[Nm]					1.2 •	w _{el} •	f _{uk} 1)			
Elastic section modulus	W _{el}	[mm³]	50	98	170	269	402	785	1357	1534	2155	3217
Partial factor	γ _{Ms,V}	[-]						1,5 ²⁾				
Concrete pry-out failure	·	•										
Factor	k ₈	[-]						2,0				
Installation factor	γinst	[-]						1,0				
Concrete edge failure	•	-1										
Effective length of fastener	I _f	[mm]		ı	min(h _e	_{ef} ; 12 ·	d _{nom})		min(h _{ef} ; 300	mm)
Outside diameter of fastener	d _{nom}	[mm]	8	10	12	14	16	20	24	25	28	32
Installation factor	γ _{inst}	[-]						1,0				

¹⁾ f_{uk} shall be taken from the specifications of reinforcing bars

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads under static and quasi-static action for a working life of 50 and 100 years (rebar)	Annex C 11

²⁾ in absence of national regulation



Threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked concrete Ca	20/25 under s	tatic and quasi-s	⊥ tatic acti	on for a	workin	g life of	 50 and 1	⊔ I00 year	s	
Temperature range I: 24°C/40°C II: 50°C/80°C	δ _{N0} -factor	[mm/(N/mm²)]	0,031	0,032	0,034	0,037	0,039	0,042	0,044	0,046
	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,047	0,051	0,054	0,057	0,060
Temperature range III: 72°C/120°C	δ_{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,038	0,041	0,044	0,046	0,048
	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,042	0,044	0,045	0,049	0,053	0,056	0,059	0,062
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,121	0,126	0,131	0,142	0,153	0,163	0,171	0,179
IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,146	0,157	0,168	0,176	0,184
Cracked concrete unde	er static and o	quasi-static actio	n for a w	orking l	ife of 50	and 100	0 years			
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,081	0,083	0,085	0,090	0,095	0,099	0,103	0,106
I: 24°C/40°C II: 50°C/80°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,104	0,107	0,110	0,116	0,122	0,128	0,133	0,137
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,093	0,098	0,103	0,107	0,110
III: 72°C/120°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,121	0,127	0,133	0,138	0,143
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,312	0,321	0,330	0,349	0,367	0,385	0,399	0,412
IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,321	0,330	0,340	0,358	0,377	0,396	0,410	0,424

¹⁾ Calculation of the displacement

 $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$ $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \cdot \tau;$ τ : action bond stress for tension

Table C13: Displacements under shear load¹⁾

Threaded rod	M8	M10	M12	M16	M20	M24	M27	M30		
Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
All temperature	δ_{V0} -factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	0,03	0,03	0,03
ranges	$\delta_{V\infty}$ -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05

¹⁾ Calculation of the displacement

 $\delta v_0 = \delta v_0$ -factor $\cdot V$;

V: action shear load

 $\delta_{V\infty} = \delta_{V\infty}\text{-factor }\cdot V;$

Injection system Vesta PRO-200 PLUS Seismic for concret	e
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Performances

Displacements under static and quasi-static action for a working life of 50 and 100 years (threaded rod)

Annex C 12



Table C14: Displa	acements u	nder tension	load ¹⁾						
Internal threaded ancho	or rods		IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20	
Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years									
Temperature range	δ _{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,037	0,039	0,042	0,046	
I: 24°C/40°C II: 50°C/80°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,042	0,044	0,047	0,051	0,054	0,060	
Temperature range III: 72°C/120°C	δ _{N0} -factor	[mm/(N/mm²)]	0,034	0,035	0,038	0,041	0,044	0,048	
	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,044	0,045	0,049	0,053	0,056	0,062	
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,126	0,131	0,142	0,153	0,163	0,179	
IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,129	0,135	0,146	0,157	0,168	0,184	
Cracked concrete unde	r static and qu	asi-static action	for a work	ing life of	50 and 100	years			
Temperature range I: 24°C/40°C	δ_{N0} -factor	[mm/(N/mm²)]	0,083	0,085	0,090	0,095	0,099	0,106	
II: 50°C/80°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,170	0,110	0,116	0,122	0,128	0,137	
Temperature range	δ _{N0} -factor	[mm/(N/mm²)]	0,086	0,088	0,093	0,098	0,103	0,110	
III: 72°C/120°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,111	0,114	0,121	0,127	0,133	0,143	
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,321	0,330	0,349	0,367	0,385	0,412	
IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,330	0,340	0,358	0,377	0,396	0,424	

¹⁾ Calculation of the displacement

 $\delta_{N0} = \delta_{N0}\text{-factor} \cdot \tau;$ τ : action bond stress for tension

 $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \ \cdot \ \tau;$

Table C15: Displacements under shear load¹⁾

Internal threaded	IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20				
Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
All temperature	δ_{V0} -factor	[mm/kN]	0,07	0,06	0,06	0,05	0,04	0,04		
ranges	$\delta_{V\infty}$ -factor	[mm/kN]	0,10	0,09	0,08	0,08	0,06	0,06		

¹⁾ Calculation of the displacement

 $\delta_{V0} = \delta_{V0}$ -factor \cdot V; V: action shear load

 $\delta_{V\infty} = \delta_{V\infty}$ -factor $\cdot V$;

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Displacements under static and quasi-static action for a working life of 50 and 100 years (internal threaded anchor rod)	Annex C 13



Table C16:	Displace	ments under	tensi	on loa	ad ¹⁾							
Reinforcing bar			Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Uncracked concre	ete under sta	atic and quasi-s	tatic ac	tion for	a work	ing life	of 50 a	nd 100	years			
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,031	0,032	0,034	0,035	0,037	0,039	0,042	0,043	0,045	0,048
I: 24°C/40°C II: 50°C/80°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,040	0,042	0,044	0,045	0,047	0,051	0,054	0,055	0,058	0,063
Temperature	δ_{N0} -factor	[mm/(N/mm²)]	0,032	0,034	0,035	0,036	0,038	0,041	0,044	0,045	0,047	0,050
range III: 72°C/120°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,042	0,044	0,045	0,047	0,049	0,053	0,056	0,057	0,060	0,065
Temperature	δ_{N0} -factor	[mm/(N/mm²)]	0,121	0,126	0,131	0,137	0,142	0,153	0,163	0,164	0,172	0,186
range IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,124	0,129	0,135	0,141	0,146	0,157	0,168	0,169	0,177	0,192
Cracked concrete	under statio	and quasi-stat	ic actio	n for a	workin	g life of	50 and	l 100 ye	ears			
Temperature range	δ_{N0} -factor	[mm/(N/mm²)]	0,081	0,083	0,085	0,087	0,090	0,095	0,099	0,099	0,103	0,108
I: 24°C/40°C II: 50°C/80°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,104	0,107	0,110	0,113	0,116	0,122	0,128	0,128	0,133	0,141
Temperature	δ_{N0} -factor	[mm/(N/mm²)]	0,084	0,086	0,088	0,090	0,093	0,098	0,103	0,103	0,107	0,113
range III: 72°C/120°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,108	0,111	0,114	0,118	0,121	0,127	0,133	0,133	0,138	0,148
Temperature	δ_{N0} -factor	[mm/(N/mm²)]	0,312	0,321	0,330	0,340	0,349	0,367	0,385	0,385	0,399	0,425
range IV: 100°C/160°C	$\delta_{N\infty}$ -factor	[mm/(N/mm²)]	0,321	0,330	0,340	0,349	0,358	0,377	0,396	0,396	0,410	0,449

¹⁾ Calculation of the displacement

 $\delta_{N0} = \delta_{N0}$ -factor $\cdot \tau$;

 τ : action bond stress for tension

 $\delta_{N\infty} = \delta_{N\infty}\text{-factor} \ \cdot \ \tau;$

Displacements under shear load¹⁾ Table C17:

Reinforcing bar	Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Uncracked and cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,06	0,05	0,05	0,04	0,04	0,04	0,03	0,03	0,03	0,03
	$\delta_{V\infty}$ -factor	[mm/kN]	0,09	0,08	0,08	0,06	0,06	0,05	0,05	0,05	0,04	0,04

¹⁾ Calculation of the displacement

 $\delta_{V0} = \delta_{V0}$ -factor · V;

V: action shear load

 $\delta_{V\infty} = \delta_{V\infty}$ -factor $\cdot V$;

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Displacements under static and quasi-static action for a working life of 50 and 100 years (rebar)	Annex C 14



Tab	Table C18: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years											
Thread	led rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel f	ailure											
Charac	teristic tension resis	[kN]				1,0 •	$N_{Rk,s}$					
Partial	factor		γ _{Ms,N}	[-]				see Ta	able C1			
Combi	ned pull-out and c	oncrete failure										
Charac	teristic bond resista	concrete C2	20/25									
<u>e</u>	<u>υ</u> Ι: 24°C/40°C		^τ Rk,eq,C1	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
nperatu range	II: 50°C/80°C	Dry, wet concrete and	τ _{Rk,eq,C1}	[N/mm ²]	7,0	7,5	8,0	9,0	8,5	7,0	7,0	7,0
Temperature range	III: 72°C/120°C	flooded bore hole	τ _{Rk,eq,C1}	[N/mm ²]	6,0	6,5	7,0	7,5	7,0	6,0	6,0	6,0
Te	IV: 100°C/160°C	Tiole	τ _{Rk,eq,C1}	[N/mm ²]	5,5	5,5	6,0	6,5	6,0	5,5	5,5	5,5
Increas	sing factors for conc	ete	Ψс	[-]	1,0							
	teristic bond resista concrete strength cl	1	$\tau_{\text{Rk,eq,C1}} = \qquad \qquad \psi_{\text{C}} \cdot \tau_{\text{Rk,eq,C1,(C20/25)}}$									
Installa	ation factor											
for dry	for dry and wet concrete								,0			
		HDB	γ _{inst}	[-]					,2			
for floo	ded bore hole	CAC		1,4								

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years (threaded rod)	Annex C 15



Table C19:		cteristic va ormance cat											
Threaded rod					M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure													
Characteristic tens	sion resist	ance	N _{Rk,s,eq,C1}	[kN]	1,0 • N _{Rk,s}								
Partial factor			γ _{Ms,N}	[-]				see Ta	able C1				
Combined pull-out and concrete failure													
Characteristic bon	d resistar	ce in cracked a	nd uncracked o	concrete C2	0/25								
range I: 24°C/40)°C	Dry, wet concrete and	^τ Rk,eq,C1	[N/mm²]	5,5	6	6,5	6,5	6,5	6,5	6,5	6,5	
Temperature range II: 24°C/80	0°C	flooded bore hole	^τ Rk,eq,C1	[N/mm²]	5,5	6	6,5	6,5	6,5	6,5	6,5	6,5	
Increasing factors	for concre	ete	Ψс	[-]				1	,0				
Characteristic bond resistance depending on the concrete strength class $\tau_{Rk,eq,C1} = \psi_c \cdot \tau_{Rk,eq,C1,(C20/25)}$													
Installation facto	r												
for dry and wet co	ncrete	CAC						1	,0				
		γ _{inst}	[-]					,2					
for flooded bore ho	ole	CAC						1	,4				

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years (threaded rod)	Annex C 16



Table C20:	Characterist								-	'S		
Threaded rod				M8	M10	M12	M16	M20	M24	M27	M30	
Steel failure	Steel failure											
Characteristic she (Seismic C1)	ear resistance	V _{Rk,s,eq,C1}	[kN]				0,70) • V ⁰ Rk	,s			
Partial factor $\gamma_{Ms,V}$ [-] see Table C1												
Factor for annular gap α_{gap} [-] $0.5 (1.0)^{1)}$												

¹⁾ Value in brackets valid for filled annular gab between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads under seismic action (performance category C1) (threaded rod)	Annex C 17



1,4

Tabl	Table C21: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years													
Reinforcing bar Ø 8 Ø 10 Ø 12 Ø 14 Ø 16 Ø 20 Ø 24 Ø 25 Ø 28 Ø 32														
Steel fa	ailure													
Charac	teristic tension res	istance	N _{Rk,s,eq,C1}	[kN]					1,0 • A	s • fuk	1)			
Cross	section area		A _s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial	factor		γ _{Ms,N}	[-]					1,	4 ²⁾				
Combi	ned pull-out and	concrete fail	ure											
Charac	teristic bond resist	ance in crack	ed and uncra	acked cond	crete C	20/25								
range	I: 24°C/40°C	Dry wet	τ _{Rk,eq,C1}	[N/mm ²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
				[N/mm²]	5,5	5,5	6,0	6,5	6,5	6,5	6,5	7,0	7,0	7,0
Part of the second state of the second stat					4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
[em]	IV: 100°C/160°C	bore hole	τ _{Rk,eq,C1}	[N/mm²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0

 pera	III: 72°C/120°C	flooded	^τ Rk,eq,C1	[N/mm²]	4,5	5,0	5,0	5,5	5,5	5,5	5,5	6,0	6,0	6,0
Tempera	IV: 100°C/160°C	bore hole	τ _{Rk,eq,C1}	[N/mm ²]	4,0	4,5	4,5	5,0	5,0	5,0	5,0	5,0	5,0	5,0
Incre	asing factors for cond	rete	Ψс	[-]					1	,0				
	acteristic bond resistanding on the concrete		τ _F	Rk,eq,C1 =	$\Psi_{\rm C} \cdot \tau_{\rm Rk,eq,C1,(C20/25)}$									
Insta	Illation factor													
for dr	for dry and wet concrete CAC 1,0													
101 01	Ty and wel concrete	HDB	γinst	[-]					1	,2				

 $^{^{1)}\,}f_{uk}$ shall be taken from the specifications of reinforcing bars

CAC

for flooded bore hole

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 years (rebar)	Annex C 18

²⁾ in absence of national regulation



1,0

1,2

1,4

Tabl		aracteristic erformance									n			
Reinfo	rcing bar				Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel f	Steel failure													
Characteristic tension resistance $N_{Rk,s,eq,C1}$ [kN] $1,0 \cdot A_s \cdot f_{uk}^{1)}$														
									804					
Partial factor $\gamma_{Ms,N}$ [-] 1,4 ²⁾														
Combi	ned pull-out an	d concrete fail	ure											
Charac	teristic bond res	istance in crack	ed and uncra	acked cond	crete (20/25								
Temperature range	I: 24°C/40°C	Dry, wet concrete and	^τ Rk,eq,C1	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0
Tempe	[N/mm²]	4,5	4,5	4,5	4,5	4,5	4,0	4,0	4,0	4,0	4,0			
Increas	sing factors for c	[-]	1,0											
	Characteristic bond resistance depending on the concrete strength $\tau_{Rk,\epsilon}$							Ψ _c •	τ _{Rk,ec}	ı,C1,(C	20/25)			

[-]

CAC

HDB

CAC

 γ_{inst}

class

Installation factor

for dry and wet concrete

for flooded bore hole

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C1) for a working life of 100 years (rebar)	Annex C 19

 $^{^{1)}\,}f_{uk}$ shall be taken from the specifications of reinforcing bars

²⁾ in absence of national regulation



Table C23:	Table C23: Characteristic values of shear loads under seismic action (performance category C1) for a working life of 50 and 100 years												
Reinforcing bar				Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure													
Characteristic shea	r resistance	V _{Rk,s,eq}	[kN]					0,35	·As·	f _{uk} 1)			
Cross section area		A _s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor $\gamma_{Ms,V}$ [-] 1,5 ²⁾													
Factor for annular gap $\alpha_{ m gap}$ [-] 0,5 (1,0) $^{3)}$													

 $^{^{1)}}$ f_{uk} shall be taken from the specifications of reinforcing bars

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (rebar)	Annex C 20

²⁾ in absence of national regulation

³⁾ Value in brackets valid for filled annular gab between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended



Tabl		ecteristic val					on			
Thread	led rod				M12	M16	M20	M24		
Steel fa	ailure					-				
Steel, s Stainles	teristic tension resist strength class 8.8 ss Steel A4 and HCF th class ≥70		N _{Rk,s,eq,C2}	[kN]		1,0 •	$N_{Rk,s}$			
Partial t	factor	·	γ _{Ms,N}	[-]		see Ta	able C1			
Combi	ned pull-out and co	ncrete failure								
Charac	teristic bond resistan	ice in cracked a	nd uncracked	concrete C20)/25					
<u>e</u>	I: 24°C/40°C	Dry wot	τ _{Rk,eq,C2}	[N/mm ²]	3,6	3,5	3,3	2,3		
Temperature range	II: 50°C/80°C	Dry, wet concrete and	τ _{Rk,eq,C2}	[N/mm ²]	3,6	3,5	3,3	2,3		
mpe ran	III: 72°C/120°C	flooded bore	τ _{Rk,eq,C2}	[N/mm ²]	3,1	2,8	2,0			
Tel	IV: 160°C/100°C	hole	τ _{Rk,eq,C2}	[N/mm²]	2,5	2,7	2,5	1,8		
Increas	sing factors for concre	ete	Ψс	[-]		1	,0			
	teristic bond resistan concrete strength cla			τ _{Rk,eq,C2} =		Ψc • τ _{Rk,eq}	,C2,(C20/25)			
Installa	ation factor									
for dry	and wet concrete	CAC					,0			
		HDB	γinst	[-]	1,2					
for floor	ded bore hole	CAC				1	,4			

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 years (threaded rod)	Annex C 21



Table		acteristic va ormance cat					-		
Thread	ed rod				M12	M16	M20	M24	
Steel fa	ailure								
Steel, s Stainles	teristic tension resis trength class 8.8 ss Steel A4 and HCF h class ≥70	ŕ	N _{Rk,s,eq,C2}	[kN]	1,0 • N _{Rk,s}				
Partial f	factor		γ _{Ms,N}	[-]		see Ta	able C1		
Combin	ned pull-out and co	ncrete failure							
Charact	teristic bond resistar	nce in cracked a	nd uncracked	concrete C2	0/25				
rature ge	I: 24°C/40°C	Dry, wet concrete and	^τ Rk,eq,C2	[N/mm²]	3,6 3,5 3,3 2				
Tempe	I: 24°C/40°C Dry, wet concrete and flooded bore hole		^τ Rk,eq,C2	[N/mm²]	3,6	3,5	3,3	2,3	
Increas	ing factors for concr	ete	Ψс	[-]		1	,0		
	teristic bond resistar concrete strength cla			τ _{Rk,eq,C2} =		Ψc • τ _{Rk,ec}	1,C2,(C20/25)		
Installa	tion factor								
for dry a	and wet concrete	CAC HDB	γinst	[-]			,0 ,2		
for flood	ded bore hole	CAC	1		1,4				

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension loads under seismic action (performance category C2) for a working life of 100 years (threaded rod)	Annex C 22



Table C26: Characteristic values of shear loads under seismic action (performance category C2) for a working life of 50 and 100 years

Threaded rod		M12	M16	M20	M24		
Steel failure							
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥70	V _{Rk,s,eq,C2}	[kN]		0,70 •	V ⁰ Rk,s		
Partial factor	γ _{Ms,V}	[-]	see Table C1				
Factor for annular gap	$\alpha_{\sf gap}$	[-]	0,5 (1,0)1)				

¹⁾ Value in brackets valid for filled annular gab between fastener and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended

Table C27: Displacements under tension load

Threaded rod		M12	M16	M20	M24	
Cracked concrete under seismic action (performance category C2) for a working life of 50 and 100 years						
All temperature	$\delta_{N,eq,C2(50\%)} = \delta_{N,eq,C2(DLS)}$	[mm]	0,24	0,27	0,29	0,27
ranges	$\delta_{N,eq,C2(100\%)} = \delta_{N,eq,C2(ULS)}$	[mm]	0,55	0,51	0,50	0,58

Table C28: Displacements under shear load

Threaded rod			M12	M16	M20	M24
	under seismic action (of 50 and 100 years	(performance	category C2)			
All temperature	$\delta_{V,eq,C2(50\%)} = \begin{cases} \delta_{V,eq,C2(50\%)} = \\ \delta_{V,eq,C2(DLS)} \end{cases}$	mm]	3,6	3,0	3,1	3,5
ranges	$\delta_{V,eq,C2(100\%)} = \delta_{V,eq,C2(ULS)}$	mm]	7,0	6,6	7,0	9,3

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of shear loads Displacements under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)	Annex C 23



hammer drilled he		oles	(HD), co	mpres	sed ai							ner
Threaded rod					М8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic tension			Fire -	30	1,1	1,7	3,0	5,7	8,8	12,7	16,5	20,2
resistance; Steel, Stainless Steel A2, A4 and HCR,	N _{Rk,s,fi}	[kN]	exposure	60	0,9	1,4	2,3	4,2	6,6	9,5	12,4	15,1
strength class 5.8 resp. 50	TRK,S,II	[,,,,]	time [min]	90	0,7	1,0	1,6	3,0	4,7	6,7	8,7	10,7
and higher	<u> </u>			120	0,5	0,8	1,2	2,2	3,4	4,9	6,4	7,9
Characteristic bond resistagiven temperature θ	ance in cra	cked a	and uncrac	ked con	crete C	20/25 ι	ib to C	50/60 u	nder fi	re cond	ditions	for a
			θ < 2	4°C				1	,0			
Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	24°C ≤ θ ≤ 379°C				1,3	01 • е ⁻⁽),011∙θ≤	1,0		
			θ > 37	79°C				0	,0			
Reduction Factor k _{ff} (θ) [-]	100		150	200	250	3	000	350	4	100	450	
			16	mneratiii								
Characteristic bond				emperatu								
resistance for a given	$\tau_{Rk,fi}(\theta)$		[N/mm²]				k _{fi,p} ((θ) • τ _{Rk}	.,cr,(C20	/25) ¹⁾		
resistance for a given temperature (θ)							k _{fi,p} ((θ) • τ _{Rk}	.,cr,(C20/	/25) ¹⁾		
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear			[N/mm²]				k _{fi,p} ((θ) • τ _{Rk}	8,8	/25) ¹⁾	16,5	20,2
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless	arm]	re θ [°C]					·	16,5 12,4	20,2
resistance for a given temperature (θ) Steel failure without lever at Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50		[kN]	[N/mm²] Fire exposure time	30	re θ [°C]	1,7	3,0	5,7	8,8	12,7	_	
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher	arm V _{Rk,s,fi}	[kN]	[N/mm²] Fire exposure	30 60	1,1 0,9	1,7	3,0	5,7 4,2	8,8	12,7	12,4	15,1
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher Steel failure with lever arm	arm V _{Rk,s,fi}	[kN]	[N/mm²] Fire exposure time	30 60 90 120	1,1 0,9 0,7	1,7 1,4 1,0 0,8	3,0 2,3 1,6 1,2	5,7 4,2 3,0 2,2	8,8 6,6 4,7 3,4	12,7 9,5 6,7 4,9	12,4 8,7 6,4	15,1 10,7 7,9
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher Steel failure with lever arm Characteristic bending	arm V _{Rk,s,fi}	[kN]	Fire exposure time [min]	30 60 90 120	1,1 0,9 0,7 0,5	1,7 1,4 1,0 0,8	3,0 2,3 1,6 1,2	5,7 4,2 3,0 2,2	8,8 6,6 4,7 3,4	12,7 9,5 6,7 4,9	12,4 8,7 6,4 59,9	15,1 10,7 7,9 81,0
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher Steel failure with lever arm Characteristic bending moment; Steel, Stainless Steel A2, A4 and HCR,	arm V _{Rk,s,fi}	[kN]	Fire exposure fire exposure	30 60 90 120 30 60	1,1 0,9 0,7 0,5	1,7 1,4 1,0 0,8 2,2 1,8	3,0 2,3 1,6 1,2 4,7 3,5	5,7 4,2 3,0 2,2 12,0 9,0	8,8 6,6 4,7 3,4 23,4 17,5	12,7 9,5 6,7 4,9 40,4 30,3	12,4 8,7 6,4 59,9 44,9	15,1 10,7 7,9 81,0 60,7
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher Steel failure with lever arm Characteristic bending moment; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50	arm V _{Rk,s,fi}		Fire exposure time [min]	30 60 90 120 30 60 90	1,1 0,9 0,7 0,5	1,7 1,4 1,0 0,8 2,2 1,8 1,3	3,0 2,3 1,6 1,2 4,7 3,5 2,5	5,7 4,2 3,0 2,2 12,0 9,0 6,3	8,8 6,6 4,7 3,4 23,4 17,5 12,3	12,7 9,5 6,7 4,9 40,4 30,3 21,3	12,4 8,7 6,4 59,9 44,9 31,6	15,1 10,7 7,9 81,0 60,7 42,7
resistance for a given temperature (θ) Steel failure without lever a Characteristic shear resistance; Steel, Stainless	V _{Rk,s,fi}	[Nm]	Fire exposure [min] Fire exposure time [min]	30 60 90 120 30 60 90 120	1,1 0,9 0,7 0,5	1,7 1,4 1,0 0,8 2,2 1,8 1,3	3,0 2,3 1,6 1,2 4,7 3,5 2,5 1,8	5,7 4,2 3,0 2,2 12,0 9,0 6,3 4,7	8,8 6,6 4,7 3,4 23,4 17,5 12,3 9,1	12,7 9,5 6,7 4,9 40,4 30,3 21,3 15,7	12,4 8,7 6,4 59,9 44,9 31,6 23,3	10,7 7,9 81,0 60,7
resistance for a given temperature (θ) Steel failure without lever at Characteristic shear resistance; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher Steel failure with lever arm Characteristic bending moment; Steel, Stainless Steel A2, A4 and HCR, strength class 5.8 resp. 50 and higher 1) τ _{Rk,cr,(C20/25)} characteristic	V _{Rk,s,fi} M ⁰ _{Rk,s,fi} ic bond resis	[Nm]	Fire exposure time [min] Fire exposure time [min]	30 60 90 120 30 60 90 120 concrete	1,1 0,9 0,7 0,5 1,1 0,9 0,7 0,5 for conc	1,7 1,4 1,0 0,8 2,2 1,8 1,3	3,0 2,3 1,6 1,2 4,7 3,5 2,5 1,8	5,7 4,2 3,0 2,2 12,0 9,0 6,3 4,7	8,8 6,6 4,7 3,4 23,4 17,5 12,3 9,1	12,7 9,5 6,7 4,9 40,4 30,3 21,3 15,7	12,4 8,7 6,4 59,9 44,9 31,6 23,3	15,1 10,7 7,9 81,0 60,7 42,7

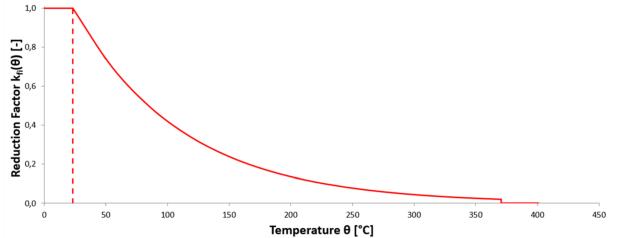


Table C30: Characteristic values of tension and shear loads under fire exposure in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)

Internal threaded anchor rods					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Steel failure										
Characteristic tension			Fire	30	0,3	1,1	1,7	3,0	5,7	8,8
resistance; Steel, Stainless	N	FI.A.17	exposure time	60	0,2	0,9	1,4	2,3	4,2	6,6
Steel A4 and HCR, strength	N _{Rk,s,fi} [[kN]		90	0,2	0,7	1,0	1,6	3,0	4,7
class 5.8 and 8.8 resp. 70			[min]	120	0,1	0,5	0,8	1,2	2,2	3,4

Characteristic bond resistance in cracked and uncracked concrete C20/25 up to C50/60 under fire conditions for a given temperature θ

<u> </u>			θ < 24°C	1,0
Temperature reduction factor	$k_{fi,p}(\theta)$	[-]	24°C ≤ θ ≤ 379°C	1,301 • e ^{-0,011 • θ} ≤ 1,0
			θ > 379°C	0,0



				emperatu						
Characteristic bond resistance for a given temperature (θ)	$\tau_{Rk,fi}(\theta)$	[N/mm²]				$k_{fi,p}(\theta) \cdot \tau_{Rk,cr,(C20/25)}^{1)}$				
Steel failure without lever a	ırm									
Characteristic shear		[kN]	Fire exposure time [min]	30	0,3	1,1	1,7	3,0	5,7	8,8
resistance; Steel, Stainless Steel A4 and HCR, strength	V _{Rk,s,fi}			60	0,2	0,9	1,4	2,3	4,2	6,6
				90	0,2	0,7	1,0	1,6	3,0	4,7
class 5.8 and 8.8 resp. 70				120	0,1	0,5	0,8	1,2	2,2	3,4
Steel failure with lever arm	•									
Characteristic bending			Fire	30	0,2	1,1	2,2	4,7	12,0	23,4
	NAO	[MIM]	ovnosuro	60	0,2	0,9	1,8	3,5	9,0	17,5
Steel A4 and HCR, strength class 5.8 and 8.8 resp. 70	M ⁰ _{Rk,s,fi} [N	ן נואוזון 	[Nm] exposure time [min] -	90	0,1	0,7	1,3	2,5	6,3	12,3
				120	0,1	0,5	1,0	1,8	4,7	9,1

τ_{Rk,cr,(C20/25)} characteristic bond resistance for cracked concrete for concrete strength class C20/25 for the relevant temperature range

Injection system Vesta PRO-200 PLUS Seismic for concrete	
Performances Characteristic values of tension and shear loads under fire exposure (internal threaded anchor rod)	Annex C 25



urineu	teristic ver drilled holes wi	hole		compre	esse	d air					•			er
Reinforcing bar					Ø8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure														
Characteristic tension resistance; BSt 500		[kN]	time [min]	30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	16,1
	N _{Rk,s,fi}			60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	7,4	9,2	12,1
	HK,S,fi			90	0,4	0,8	1,5	2,0	2,6	4,1	5,9	6,4	8,0	10,5
				120	0,3	0,6	1,1	1,5	2,0	3,1	4,5	4,9	6,2	8,0
Characteristic bond resigned temperature θ	stance in c	racke	d and uncr	acked c	oncre	te C2	0/25 u	p to C	50/60	unde	r fire o	condit	ions f	for a
given temperature v		[-]	θ < 22	2°C					1	,0				
Temperature reduction factor	$k_{fi,p}(\theta)$		22°C ≤ θ ≤ 370°C		1,268 • e ^{-0,011} • ∈ 1,0									
	II,p \		$\theta > 37$	0,0										
Reduction Factor k _{ff} (θ) [-]	0 10	0	150	200 Tempera		250 9 [°C]	30	0	350		400		450	
. ,			[N/mm²]			$k_{fi,p}(\theta) \cdot \tau_{Rk,cr,(C20/25)}^{1)}$								
temperature (θ)														
	er arm													
temperature (θ)	er arm		Eiro	30	0,5	1,2	2,3	3,1	4,0	6,3	9,0	9,8	12,3	<u> </u>
temperature (θ) Steel failure without leve Characteristic shear		[kN]	Fire exposure	60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	9,8	9,2	12,1
temperature (θ) Steel failure without leve	V _{Rk,s,fi}	[kN]	I I	60 90	0,5	1,0	1,7 1,5	2,3	3,0	4,7 4,1	6,8 5,9	9,8 7,4 6,4	9,2	12,1 10,5
temperature (θ) Steel failure without leve Characteristic shear resistance; BSt 500	$V_{Rk,s,fi}$	[kN]	exposure	60	0,5	1,0	1,7	2,3	3,0	4,7	6,8	9,8	9,2	16,1 12,1 10,5 8,0
temperature (θ) Steel failure without leve Characteristic shear	$V_{Rk,s,fi}$	[kN]	exposure	60 90	0,5	1,0	1,7 1,5	2,3	3,0	4,7 4,1	6,8 5,9 4,5	9,8 7,4 6,4	9,2 8,0 6,2	12,1 10,5 8,0
temperature (θ) Steel failure without leve Characteristic shear resistance; BSt 500 Steel failure with lever ar	V _{Rk,s,fi}		exposure time [min]	60 90 120	0,5 0,4 0,3	1,0 0,8 0,6	1,7 1,5 1,1	2,3 2,0 1,5	3,0 2,6 2,0	4,7 4,1 3,1	6,8 5,9 4,5 32,6	9,8 7,4 6,4 4,9	9,2 8,0 6,2	12,1 10,5 8,0
temperature (θ) Steel failure without leve Characteristic shear resistance; BSt 500	$V_{Rk,s,fi}$		exposure time [min] Fire exposure	60 90 120	0,5 0,4 0,3	1,0 0,8 0,6	1,7 1,5 1,1	2,3 2,0 1,5	3,0 2,6 2,0	4,7 4,1 3,1	6,8 5,9 4,5 32,6 24,4	9,8 7,4 6,4 4,9	9,2 8,0 6,2 51,7 38,8	12,1 10,5 8,0 77,2 57,9
temperature (θ) Steel failure without leve Characteristic shear resistance; BSt 500 Steel failure with lever and Characteristic bending	V _{Rk,s,fi}		exposure time [min]	60 90 120 30 60	0,5 0,4 0,3 0,6 0,5	1,0 0,8 0,6 1,8 1,5	1,7 1,5 1,1 4,1 3,1	2,3 2,0 1,5 6,5 4,8	3,0 2,6 2,0 9,7 7,2	4,7 4,1 3,1 18,8 14,1	6,8 5,9 4,5 32,6 24,4 21,2	9,8 7,4 6,4 4,9 36,8 27,6	9,2 8,0 6,2 51,7 38,8 33,6	12,1 10,5 8,0 77,2 57,9 50,2
temperature (θ) Steel failure without leve Characteristic shear resistance; BSt 500 Steel failure with lever and Characteristic bending	V _{Rk,s,fi}	[Nm]	Fire exposure time [min]	60 90 120 30 60 90 120	0,5 0,4 0,3 0,6 0,5 0,4	1,0 0,8 0,6 1,8 1,5 1,2 0,9	1,7 1,5 1,1 4,1 3,1 2,6 2,0	2,3 2,0 1,5 6,5 4,8 4,2 3,2	3,0 2,6 2,0 9,7 7,2 6,3 4,8	4,7 4,1 3,1 18,8 14,1 12,3 9,4	6,8 5,9 4,5 32,6 24,4 21,2 16,3	9,8 7,4 6,4 4,9 36,8 27,6 23,9 18,4	9,2 8,0 6,2 51,7 38,8 33,6 25,9	12,1 10,5 8,0 77,2 57,9 50,2