

Approval body for construction products
and types of construction

Bautechnisches Prüfamt

An institution established by the Federal and
Laender Governments



European Technical Assessment

ETA-21/0953
of 29 November 2021

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the
European Technical Assessment:

Deutsches Institut für Bautechnik

Trade name of the construction product

TILCA® TIM P-E Injection System for concrete

Product family
to which the construction product belongs

Bonded fastener for use in concrete

Manufacturer

EFCO Befestigungstechnik AG
Grabenstraße 1
8606 NÄNIKON
SCHWEIZ

Manufacturing plant

EFCO Befestigungstechnik AG, Plant 2

This European Technical Assessment
contains

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

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

EAD 330499-01-0601, Edition 04/2020

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Specific Part

1 Technical description of the product

The "TILCA® TIM P-E Injection system for concrete" is a bonded anchor consisting of a cartridge with injection mortar Injection mortar TILCA TIM P-E and a steel element according to Annex A3 and A5.

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 B 3, C 1 to C 5, C 7 to C 9, C 11 to C13
Characteristic resistance to shear load (static and quasi-static loading)	See Annex C 1, C 6, C 10, C 14
Displacements under short-term and long-term loading	See Annex C 15 to C 17
Characteristic resistance and displacements for seismic performance categories C1 and C2	See Annex C 18 to C 21

3.2 Hygiene, health and the environment (BWR 3)

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

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

In accordance with the European Assessment Document EAD 330499-01-0601 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.

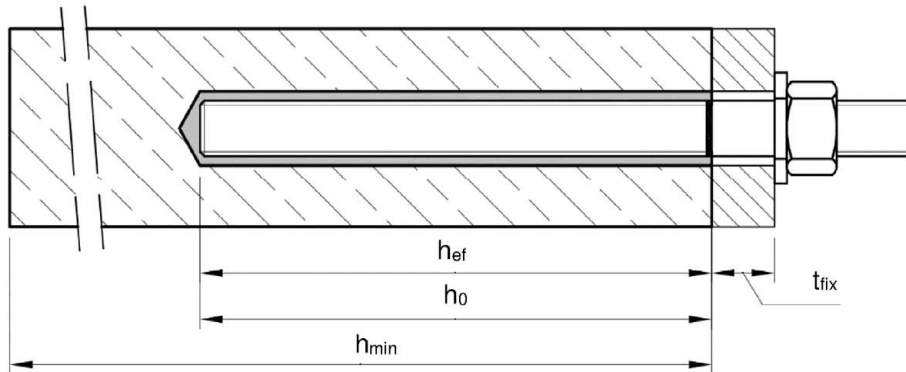
Issued in Berlin on 29 November 2021 by Deutsches Institut für Bautechnik

Dipl.-Ing. Beatrix Wittstock
Head of section

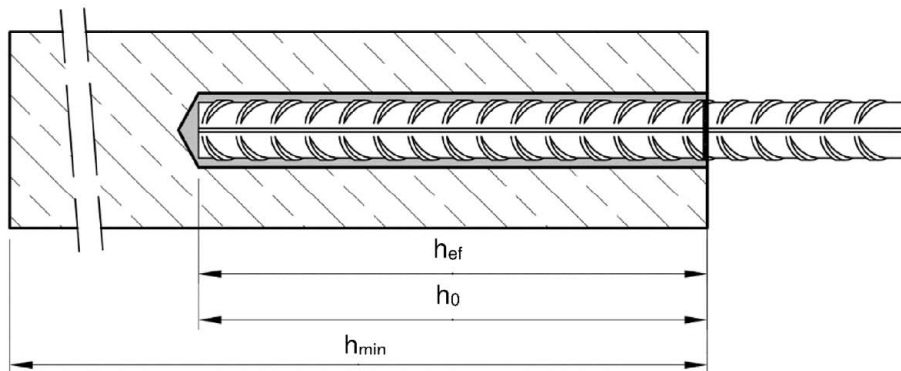
beglaubigt:
Baderschneider

Installation threaded rod M8 up to M30

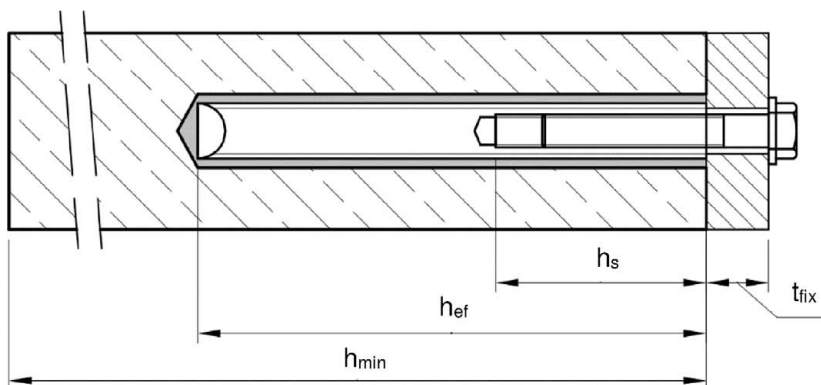
prepositioned installation or
push through installation (annular gap filled with mortar)



Installation reinforcing bar Ø8 up to Ø32



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



- t_{fix} = thickness of fixture
 h_{ef} = effective anchorage depth
 h_0 = depth of drill hole
 h_{min} = minimum thickness of member

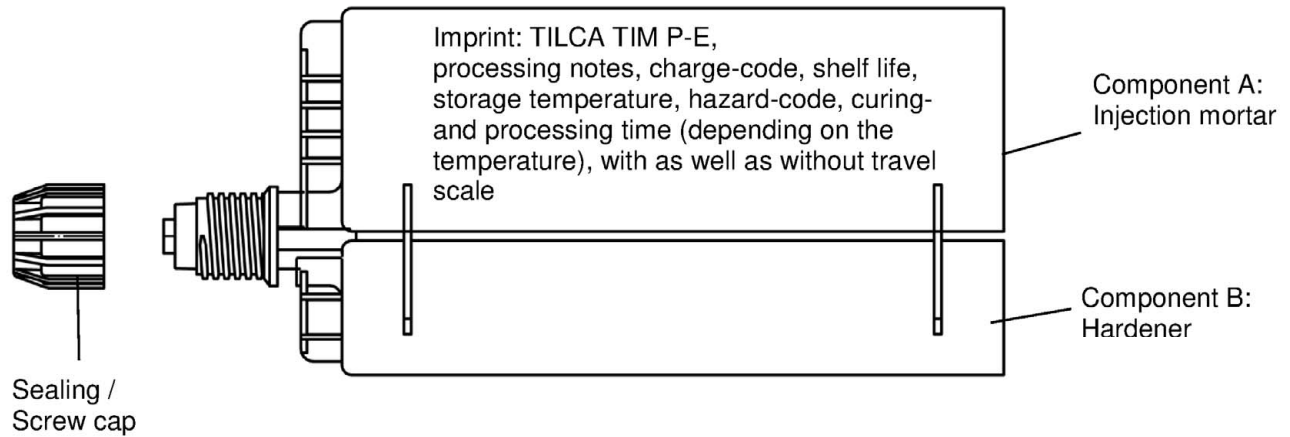
TILCA® TIM P-E Injection System for concrete

Product description
Installed condition

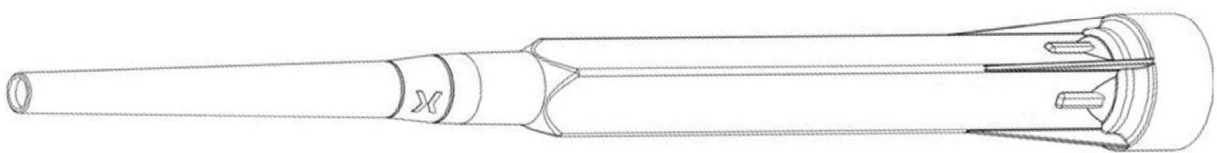
Annex A 1

Cartridge: TILCA TIM P-E

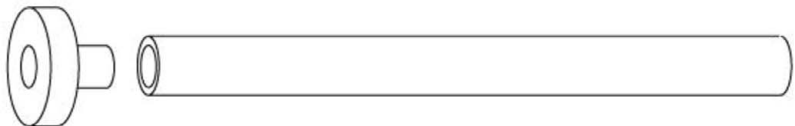
440ml, 585ml and 1400ml cartridge (Type: "side-by-side")



Static Mixer PM-19E



Piston Plug IA and Mixer Extension VL

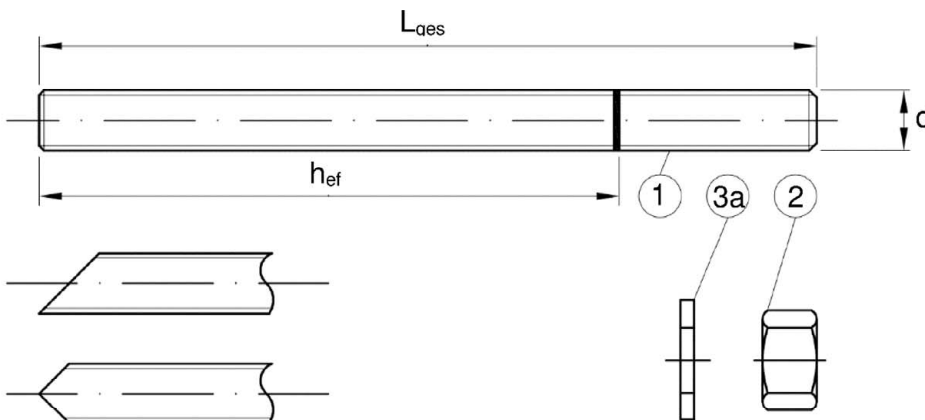


TILCA® TIM P-E Injection System for concrete

Product description
Injection system

Annex A 2

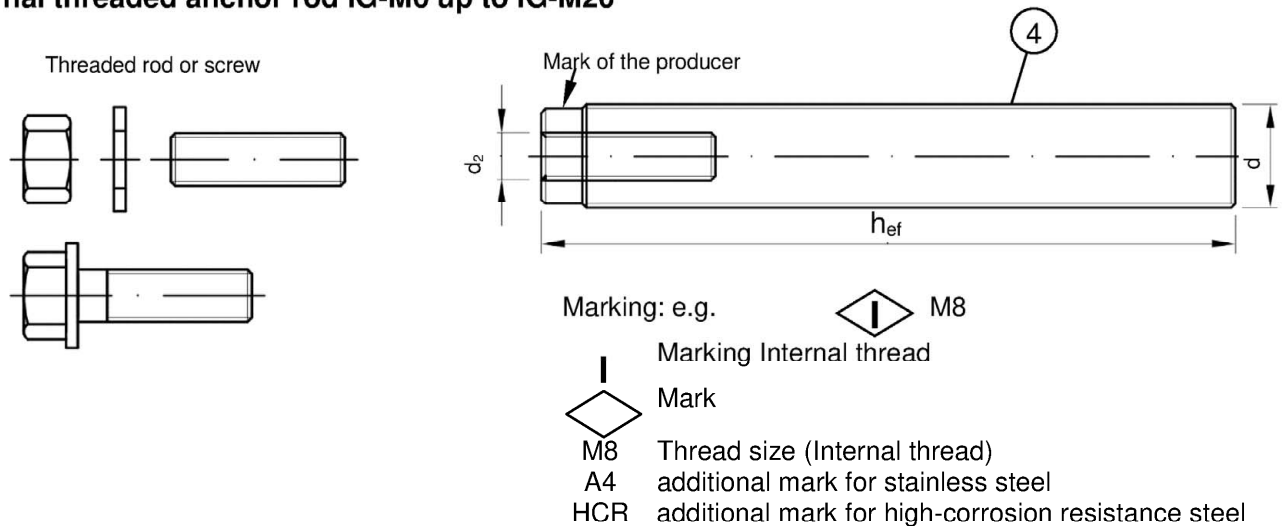
Threaded rod M8 up to M30 with washer and hexagon nut



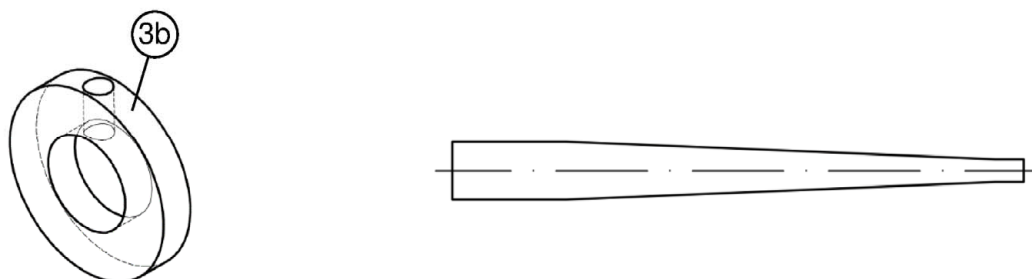
Commercial standard threaded rod with:

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

Internal threaded anchor rod IG-M6 up to IG-M20



Filling washer VS and mixer reduction nozzle MR for filling the annular gap between anchor rod and fixture



TILCA® TIM P-E Injection System for concrete

Product description

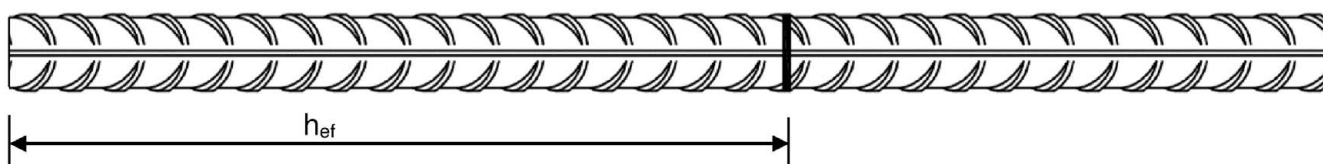
Threaded rod, internal threaded rod and filling washer

Annex A 3

Table A1: Materials

Part	Designation	Material				
Steel, zinc plated (Steel acc. to EN ISO 683-4:2018 or EN 10263:2001)						
- zinc plated ≥ 5 µm acc. to EN ISO 4042:2018 or						
- hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009 and EN ISO 10684:2004+AC:2009 or						
- sherardized ≥ 45 µm acc. to EN ISO 17668:2016						
1	Threaded rod	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	4.6	f _{uk} = 400 N/mm ²	f _{yk} = 240 N/mm ²	A ₅ > 8%
			4.8	f _{uk} = 400 N/mm ²	f _{yk} = 320 N/mm ²	A ₅ > 8%
			5.6	f _{uk} = 500 N/mm ²	f _{yk} = 300 N/mm ²	A ₅ > 8%
			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 ≥ 12% ³⁾
2	Hexagon nut	acc. to EN ISO 898-2:2012	4	for anchor rod class 4.6 or 4.8		
			5	for anchor rod class 5.6 or 5.8		
			8	for anchor rod class 8.8		
3a	Washer	Steel, zinc plated, hot-dip galvanised or sherardized (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Steel, zinc plated, hot-dip galvanised or sherardized				
4	Internal threaded anchor rod	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 898-1:2013	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 > 8%
Stainless steel A2 (Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014)						
Stainless steel A4 (Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014)						
High corrosion resistance steel (Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014)						
1	Threaded rod ¹⁾⁴⁾	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2020	50	f _{uk} = 500 N/mm ²	f _{yk} = 210 N/mm ²	A ₅ ≥ 8%
			70	f _{uk} = 700 N/mm ²	f _{yk} = 450 N/mm ²	A ₅ ≥ 12% ³⁾
	80		f _{uk} = 800 N/mm ²	f _{yk} = 600 N/mm ²	A ₅ ≥ 12% ³⁾	
2	Hexagon nut ¹⁾⁴⁾	acc. to EN ISO 3506-1:2020	50	for anchor rod class 50		
			70	for anchor rod class 70		
			80	for anchor rod class 80		
3a	Washer	A2: Material 1.4301 / 1.4307 / 1.4311 / 1.4567 or 1.4541, acc. to EN 10088-1:2014 A4: Material 1.4401 / 1.4404 / 1.4571 / 1.4362 or 1.4578, acc. to EN 10088-1:2014 HCR: Material 1.4529 or 1.4565, acc. to EN 10088-1: 2014 (e.g.: EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000)				
3b	Filling washer	Stainless steel A4, High corrosion resistance steel				
4	Internal threaded anchor rod ¹⁾²⁾	Property class	Characteristic steel ultimate tensile strength	Characteristic steel yield strength	Elongation at fracture	
		acc. to EN ISO 3506-1:2020	50	f _{uk} = 500 N/mm ²	f _{yk} = 210 N/mm ²	A ₅ > 8%
			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 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 <u>no</u> use for seismic performance category C2 ⁴⁾ Property class 80 only for stainless steel A4 and HCR						
TILCA® TIM P-E Injection System for concrete					Annex A 4	
Product description Materials threaded rod and internal threaded rod						

Reinforcing bar Ø8 up to Ø32



- 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 $0,05d \leq h \leq 0,07d$
(d: Nominal diameter of the bar; h: Rip height of the bar)

Table A2: Materials

Part	Designation	Material
Reinforcing 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 1992-1-1/NA $f_{uk} = f_{tk} = k \cdot f_{yk}$
TILCA® TIM P-E Injection System for concrete Product description Materials reinforcing bar		

Annex A 5

Specifications of intended use				
Anchorages subject to (Static and quasi-static loads):				
	for a working life of 50 years		for a working life of 100 years	
Base material	Uncracked concrete	cracked concrete	Uncracked concrete	cracked concrete
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20		M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	
Diamond drilling (DD)	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed	M8 to M30, Ø8 to Ø32, IG-M6 to IG-M20	No performance assessed
Temperature Range:	I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +72 °C ²⁾		I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +72 °C ²⁾	
Anchorages subject to (Seismic action):				
	for Performance Category C1		for Performance Category C2	
Base material	Cracked and uncracked concrete			
Hammer drilling (HD), Hammer drilling with hollow drill bit (HDB) or compressed air drilling (CD)	M8 to M30, Ø8 to Ø32		M12 to M24	
Diamond drilling (DD)	No performance assessed		No performance assessed	
Temperature Range:	I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +72 °C ²⁾		I: - 40 °C to +40 °C ¹⁾ II: - 40 °C to +72 °C ²⁾	
¹⁾ (max long term temperature +24 °C and max short term temperature +40 °C) ²⁾ (max long term temperature +50 °C and max short term temperature +72 °C) Base materials: • Compacted, reinforced or unreinforced normal weight concrete without fibres according to EN 206:2013 + A1:2016. • Strength classes C20/25 to C50/60 according to EN 206:2013 + A1:2016. 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				
TILCA® TIM P-E Injection System for concrete			Annex B 1	
Intended Use Specifications				

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.
- The anchorages are designed in accordance to EN 1992-4:2018 and Technical Report TR 055, Edition February 2018

Installation:

- Dry, wet concrete or flooded bore holes (not sea-water).
- Hole drilling by hammer (HD), hollow (HDB), compressed air (CD) or diamond drill mode (DD).
- 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.

TILCA® TIM P-E Injection System for concrete

Intended Use
Specifications

Annex B 2

Table B1: Installation parameters for threaded rod

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Diameter of element	$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30
Nominal drill hole diameter	d_0	[mm]	10	12	14	18	22	28	30	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	80	90	96	108	120
	$h_{ef,max}$	[mm]	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	Prepositioned installation $d_f \leq$	[mm]	9	12	14	18	22	26	30	33
	Push through installation d_f	[mm]	12	14	16	20	24	30	33	40
Maximum torque moment	$\max T_{inst} \leq$	[Nm]	10	20	40 ¹⁾	60	100	170	250	300
Minimum thickness of member	h_{min}	[mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$				
Minimum spacing	s_{min}	[mm]	40	50	60	75	95	115	125	140
Minimum edge distance	c_{min}	[mm]	35	40	45	50	60	65	75	80

¹⁾ Maximum Torque moment for M12 with steel Grade 4.6 is 35 Nm

Table B2: Installation parameters for rebar

Anchor size			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	14	16	18	20	25	30	32	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640
Minimum thickness of member	h_{min}	[mm]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$						
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

Anchor size			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Internal diameter of anchor rod	d_2	[mm]	6	8	10	12	16	20
Outer diameter of anchor rod ¹⁾	$d = d_{nom}$	[mm]	10	12	16	20	24	30
Nominal drill hole diameter	d_0	[mm]	12	14	18	22	28	35
Effective embedment depth	$h_{ef,min}$	[mm]	60	70	80	90	96	120
	$h_{ef,max}$	[mm]	200	240	320	400	480	600
Diameter of clearance hole in the fixture	$d_f \leq$	[mm]	7	9	12	14	18	22
Maximum torque moment	$\max T_{inst} \leq$	[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]	$h_{ef} + 30 \text{ mm} \geq 100 \text{ mm}$			$h_{ef} + 2d_0$		
Minimum spacing	s_{min}	[mm]	50	60	75	95	115	140
Minimum edge distance	c_{min}	[mm]	40	45	50	60	65	80

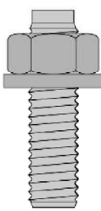
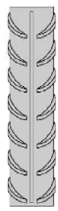
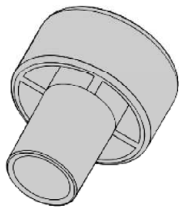
¹⁾ With metric threads according to EN 1993-1-8:2005+AC:2009

TILCA® TIM P-E Injection System for concrete

Intended Use
Installation parameters

Annex B 3

Table B4: Parameter cleaning and setting tools

										
Threaded Rod	Rebar	Internal threaded anchor rod	d_0 Drill bit - Ø HD, HDB, CD, DD	d_b Brush - Ø		$d_{b,min}$ min. Brush - Ø	Piston plug	Installation direction and use of piston plug		
[mm]	[mm]	[mm]	[mm]		[mm]	[mm]				
M8	8		10	RB10	11,5	10,5	No plug required			
M10	8 / 10	IG-M6	12	RB12	13,5	12,5				
M12	10 / 12	IG-M8	14	RB14	15,5	14,5				
	12		16	RB16	17,5	16,5				
M16	14	IG-M10	18	RB18	20,0	18,5	IA18	$h_{ef} > 250 \text{ mm}$	$h_{ef} > 250 \text{ mm}$	all
	16		20	RB20	22,0	20,5	IA20			
M20		IG-M12	22	RB22	24,0	22,5	IA22			
	20		25	RB25	27,0	25,5	IA25			
M24		IG-M16	28	RB28	30,0	28,5	IA28			
M27	24 / 25		30	RB30	31,8	30,5	IA30			
	24 / 25		32	RB32	34,0	32,5	IA32			
M30	28	IG-M20	35	RB35	37,0	35,5	IA35			
	32		40	RB40	43,5	40,5	IA40			

CAC - Rec. compressed air tool (min 6 bar)

Drill bit diameter (d_0): all diameters



HDB – Hollow drill bit system

Drill bit diameter (d_0): all diameters

The hollow drill bit system contains the Heller Duster Expert hollow drill bit and a class M vacuum with minimum negative pressure of 253 hPa and flow rate of minimum 150 m³/h (42 l/s).



TILCA® TIM P-E Injection System for concrete

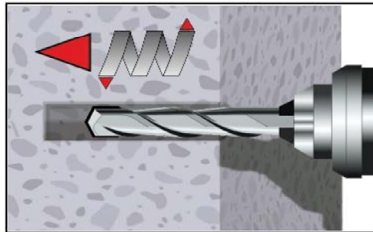
Intended Use

Cleaning and setting tools

Annex B 4

Installation instructions

Drilling of the bore hole (HD, HDB, CD)

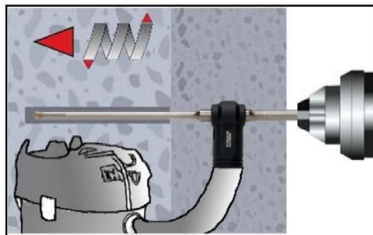


1a. Hammer (HD) or compressed air drilling (CD)

Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3).

Proceed with Step 2.

In case of aborted drill hole, the drill hole shall be filled with mortar.



1b. Hollow drill bit system (HDB) (see Annex B 3)

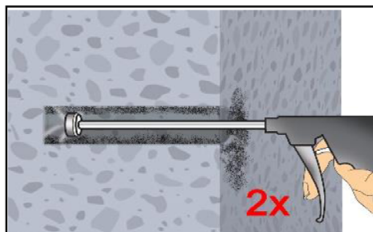
Drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2 or B3). This drilling system removes the dust and cleans the bore hole during drilling (all conditions).

Proceed with Step 3.

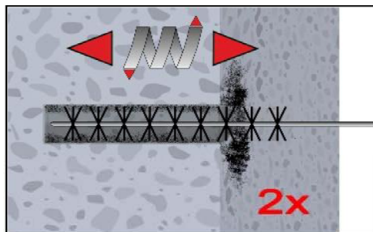
In case of aborted drill hole, the drill hole shall be filled with mortar.

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

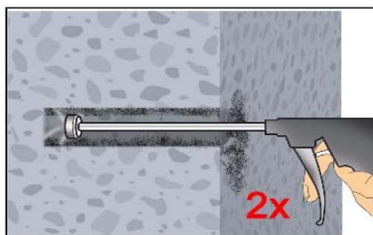
CAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B4) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension must be used.



2c. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.

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

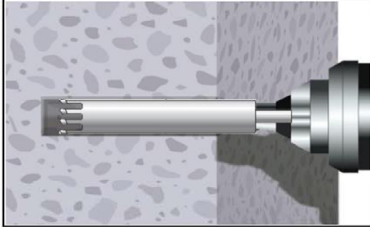
TILCA® TIM P-E Injection System for concrete

Intended Use
Installation instructions

Annex B 5

Installation instructions (continuation)

Drilling of the bore hole (DD)



1a. Diamond drilling (DD)

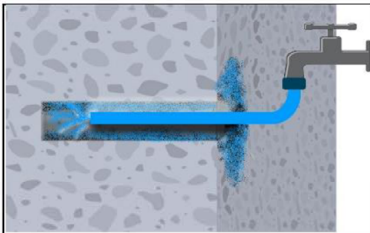
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1, B2, or B3).

Proceed with Step 2.

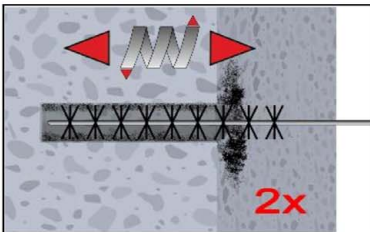
In case of aborted drill hole, the drill hole shall be filled with mortar.

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

SPCAC: Cleaning for dry, wet and water-filled bore holes with all diameter in uncracked and cracked concrete

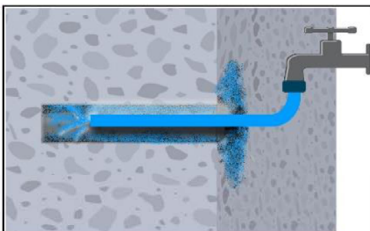


2a. Rinsing with water until clear water comes out.

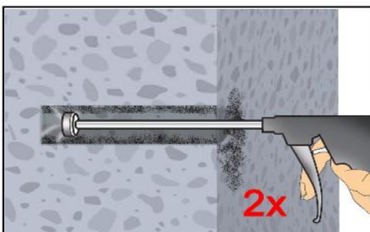


2b. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B4) a minimum of two times.

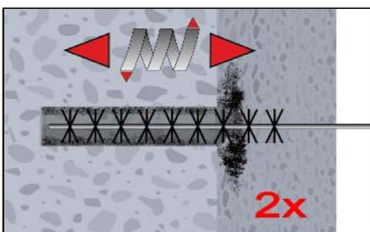
If the bore hole ground is not reached with the brush, a brush extension must be used.



2c. Rinsing again with water until clear water comes out.



2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



2e. Check brush diameter (Table B4). Brush the hole with an appropriate sized wire brush $> d_{b,min}$ (Table B4) a minimum of two times.

If the bore hole ground is not reached with the brush, a brush extension must be used.

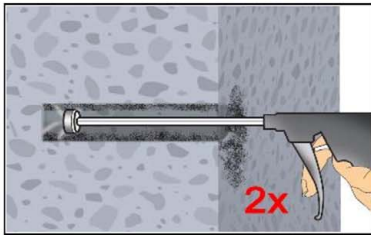
TILCA® TIM P-E Injection System for concrete

Intended Use

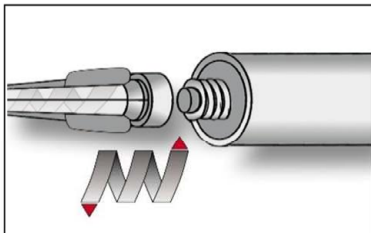
Installation instructions (continuation)

Annex B 6

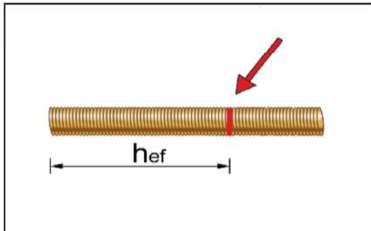
Installation instructions (continuation)



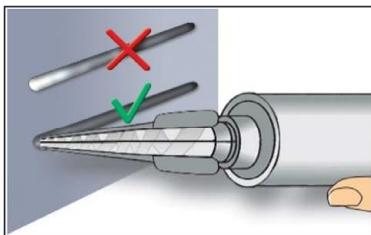
- 2f. Finally blow the hole clean again with compressed air (min. 6 bar) (Annex B 4) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached an extension shall be used.



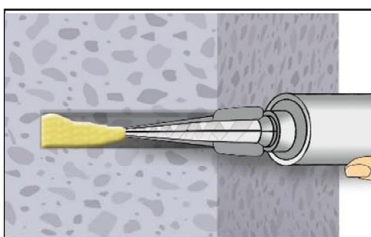
3. Attach the supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.
For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used.



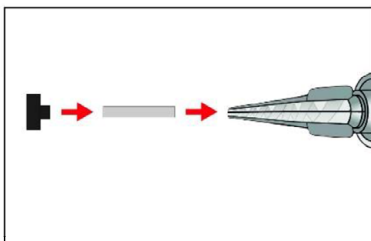
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey or red colour.



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. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used. Observe the gel-/ working times given in Table B5.



7. Piston plugs shall be used according to Table B4 for the following applications:
- Horizontal assembly (horizontal direction) and ground erection (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$ mm
 - Overhead assembly (vertical upwards direction): Drill bit-Ø $d_0 \geq 18$ mm
- Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.

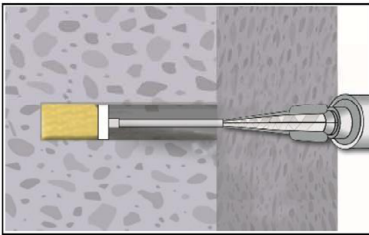
TILCA® TIM P-E Injection System for concrete

Intended Use

Installation instructions (continuation)

Annex B 7

Installation instructions (continuation)

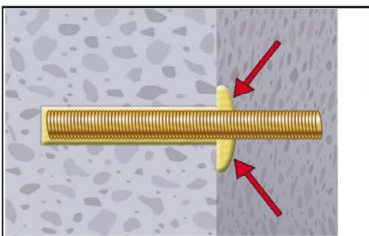


8. Insert piston plug to back of the hole and inject adhesive. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used.
During injection the piston plug is naturally pushed out of the borehole by the back pressure of the mortar. Observe the gel-/ working times given in Table B5.

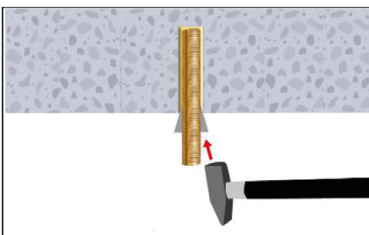


9. Push the fixing element into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment mark has reached the surface level.

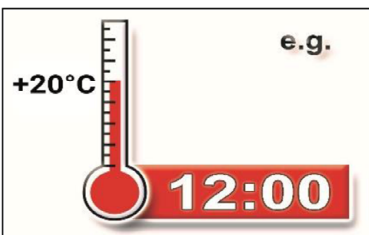
The anchor shall be free of dirt, grease, oil or other foreign material.



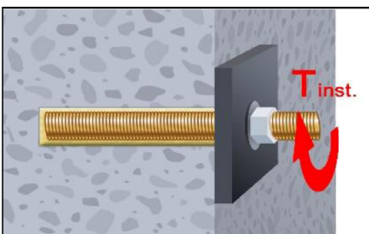
10. After inserting the anchor, the annular gap between anchor rod and concrete, in case of a push through installation additionally also the fixture, must be complete filled with mortar. If excess mortar is not visible at the top of the hole, the requirement is not fulfilled and the application has to be renewed.



11. For overhead application the anchor rod shall be fixed (e.g. wedges) until the mortar has started to harden.



12. 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 B5).



13. After full curing, the add-on part can be installed with up to the max. torque (Table B1 or B3) by using a calibrated torque wrench. In case of prepositioned installation the annular gap between anchor and fixture can be optional filled with mortar. Therefor substitute the washer by the filling washer and connect the mixer reduction nozzle to the tip of the mixer. The annular gap is filled with mortar, when mortar oozes out of the washer.

TILCA® TIM P-E Injection System for concrete

Intended Use

Installation instructions (continuation)

Annex B 8

Table B5: Maximum working time and minimum curing time

Concrete temperature	Gelling working time	Minimum curing time in dry concrete	Minimum curing time in wet concrete
0 °C to + 4 °C	90 min	144 h	288 h
+ 5 °C to + 9 °C	80 min	48 h	96 h
+ 10 °C to + 14 °C	60 min	28 h	56 h
+ 15 °C to + 19 °C	40 min	18 h	36 h
+ 20 °C to + 24 °C	30 min	12 h	24 h
+ 25 °C to + 34 °C	12 min	9 h	18 h
+ 35 °C to + 39 °C	8 min	6 h	12 h
+40 °C	8 min	4 h	8 h
Cartridge temperature	+5°C to +40°C		
TILCA® TIM P-E Injection System for concrete			Annex B 9
Intended Use Curing time			

Table C1: Characteristic values for steel tension resistance and steel shear resistance of threaded rods

Size			M8	M10	M12	M16	M20	M24	M27	M30	
Cross section area	A _s	[mm²]	36,6	58	84,3	157	245	353	459	561	
Characteristic tension resistance, Steel failure ¹⁾											
Steel, Property class 4.6 and 4.8	N _{Rk,s}	[kN]	15 (13)	23 (21)	34	63	98	141	184	224	
Steel, Property class 5.6 and 5.8	N _{Rk,s}	[kN]	18 (17)	29 (27)	42	78	122	176	230	280	
Steel, Property class 8.8	N _{Rk,s}	[kN]	29 (27)	46 (43)	67	125	196	282	368	449	
Stainless steel A2, A4 and HCR, class 50	N _{Rk,s}	[kN]	18	29	42	79	123	177	230	281	
Stainless steel A2, A4 and HCR, class 70	N _{Rk,s}	[kN]	26	41	59	110	171	247	– ³⁾	– ³⁾	
Stainless steel A4 and HCR, class 80	N _{Rk,s}	[kN]	29	46	67	126	196	282	– ³⁾	– ³⁾	
Characteristic tension resistance, Partial factor ²⁾											
Steel, Property class 4.6 and 5.6	γ _{Ms,N}	[-]	2,0								
Steel, Property class 4.8, 5.8 and 8.8	γ _{Ms,N}	[-]	1,5								
Stainless steel A2, A4 and HCR, class 50	γ _{Ms,N}	[-]	2,86								
Stainless steel A2, A4 and HCR, class 70	γ _{Ms,N}	[-]	1,87								
Stainless steel A4 and HCR, class 80	γ _{Ms,N}	[-]	1,6								
Characteristic shear resistance, Steel failure ¹⁾											
Without lever arm	Steel, Property class 4.6 and 4.8	V ⁰ _{Rk,s}	[kN]	9 (8)	14 (13)	20	38	59	85	110	135
	Steel, Property class 5.6 and 5.8	V ⁰ _{Rk,s}	[kN]	11 (10)	17 (16)	25	47	74	106	138	168
	Steel, Property class 8.8	V ⁰ _{Rk,s}	[kN]	15 (13)	23 (21)	34	63	98	141	184	224
	Stainless steel A2, A4 and HCR, class 50	V ⁰ _{Rk,s}	[kN]	9	15	21	39	61	88	115	140
	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⁾
With lever arm	Steel, Property class 4.6 and 4.8	M ⁰ _{Rk,s}	[Nm]	15 (13)	30 (27)	52	133	260	449	666	900
	Steel, Property class 5.6 and 5.8	M ⁰ _{Rk,s}	[Nm]	19 (16)	37 (33)	65	166	324	560	833	1123
	Steel, Property class 8.8	M ⁰ _{Rk,s}	[Nm]	30 (26)	60 (53)	105	266	519	896	1333	1797
	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⁾
Characteristic shear resistance, Partial factor ²⁾											
Steel, Property class 4.6 and 5.6	γ _{Ms,V}	[-]	1,67								
Steel, Property class 4.8, 5.8 and 8.8	γ _{Ms,V}	[-]	1,25								
Stainless steel A2, A4 and HCR, class 50	γ _{Ms,V}	[-]	2,38								
Stainless steel A2, A4 and HCR, class 70	γ _{Ms,V}	[-]	1,56								
Stainless steel A4 and HCR, class 80	γ _{Ms,V}	[-]	1,33								
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. ²⁾ in absence of national regulation ³⁾ Anchor type not part of the ETA											
TILCA® TIM P-E Injection System for concrete							Annex C 1				
Performances Characteristic values for steel tension resistance and steel shear resistance of threaded rods											

Table C2: Characteristic values for Concrete cone failure and Splitting with all kind of action

Anchor			All Anchor type and sizes	
Concrete cone failure				
Uncracked concrete		$k_{ucr,N}$	[-]	11,0
Cracked concrete		$k_{cr,N}$	[-]	7,7
Edge distance		$c_{cr,N}$	[mm]	1,5 h_{ef}
Axial distance		$s_{cr,N}$	[mm]	2 $c_{cr,N}$
Splitting				
Edge distance	$h/h_{ef} \geq 2,0$	$c_{cr,sp}$	[mm]	1,0 h_{ef}
	$2,0 > h/h_{ef} > 1,3$			$2 \cdot h_{ef} \left(2,5 - \frac{h}{h_{ef}} \right)$
	$h/h_{ef} \leq 1,3$			2,4 h_{ef}
Axial distance		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$

TILCA® TIM P-E Injection System for concrete

Performances

Characteristic values for Concrete cone failure and Splitting with all kind of action

Annex C 2

Table C3: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years												
Anchor size threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \cdot f_{uk}$ (or see Table C1)								
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1								
Combined pull-out and concrete failure												
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	20	20	19	19	18	17	16	16
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	17	16	16	16	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
	I: 40°C/24°C	flooded bore hole			16	16	16	15	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,cr}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ^0_{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ^0_{sus}	[-]	0,80							
	II: 72°C/50°C				0,68							
Increasing factors for concrete ψ_c			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0								
for flooded bore hole (HD; HDB, CD)				1,2								
TILCA® TIM P-E Injection System for concrete									Annex C 3			
Performances Characteristic values of tension loads under static and quasi-static action												

Table C4: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic tension resistance		N _{Rk,s}	[kN]	A _s • f _{uk} (or see Table C1)								
Partial factor		γ _{Ms,N}	[-]	see Table C1								
Combined pull-out and concrete failure												
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	20	20	19	19	18	17	16	16
	II: 72°C/50°C				15	15	15	14	13	13	12	12
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete	τ _{Rk,ucr,100}	[N/mm²]	17	16	16	16	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
	I: 40°C/24°C	flooded bore hole			16	16	16	15	15	14	14	13
	II: 72°C/50°C				14	14	14	13	13	12	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD) , compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,cr,100}	[N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ _c			C25/30		1,02							
			C30/37		1,04							
			C35/45		1,07							
			C40/50		1,08							
			C45/55		1,09							
			C50/60		1,10							
Concrete cone failure												
Relevant parameter				see Table C2								
Splitting												
Relevant parameter				see Table C2								
Installation factor												
for dry and wet concrete (HD; HDB, CD)		γ _{inst}	[-]	1,0								
for flooded bore hole (HD; HDB, CD)				1,2								
TILCA® TIM P-E Injection System for concrete									Annex C 4			
Performances Characteristic values of tension loads under static and quasi-static action												

Table C5: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years												
Anchor size threaded rod					M8	M10	M12	M16	M20	M24	M27	M30
Steel failure												
Characteristic tension resistance			N _{Rk,s}	[kN]	A _s · f _{uk} (or see Table C1)							
Partial factor			γ _{Ms,N}	[-]	see Table C1							
Combined pull-out and concrete failure for a working life of 50 years												
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr}	[N/mm²]	15	14	14	13	12	12	11	11
	II: 72°C/50°C				12	12	11	10	9,5	9,5	9,0	9,0
Reduction factor ψ ⁰ _{sus} in uncracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ ⁰ _{sus}	[-]	0,77							
	II: 72°C/50°C				0,72							
Increasing factors for concrete ψ _c			C25/30		1,04							
			C30/37		1,08							
			C35/45		1,12							
			C40/50		1,15							
			C45/55		1,17							
			C50/60		1,19							
Combined pull-out and concrete failure for a working life of 100 years												
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)												
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	15	14	14	13	12	12	11	11
	II: 72°C/50°C				11	11	10	10	9,5	9,0	8,5	8,5
Increasing factors for concrete ψ _c			C25/30		1,04							
			C30/37		1,08							
			C35/45		1,12							
			C40/50		1,15							
			C45/55		1,17							
			C50/60		1,19							
Concrete cone failure												
Relevant parameter					see Table C2							
Splitting												
Relevant parameter					see Table C2							
Installation factor												
for dry and wet concrete (DD)			γ _{inst}	[-]	1,0							
for flooded bore hole (DD)					1,2		1,4					
TILCA® TIM P-E Injection System for concrete									Annex C 5			
Performances Characteristic values of tension loads under static and quasi-static action												

Table C6: Characteristic values of shear loads under static and quasi-static action										
Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure without lever arm										
Characteristic shear resistance Steel, strength class 4.6, 4.8 and 5.6, 5.8	$V_{Rk,s}^0$	[kN]	0,6 • A _s • f _{uk} (or see Table C1)							
Characteristic shear resistance Steel, strength class 8.8 Stainless Steel A2, A4 and HCR, all strength classes	$V_{Rk,s}^0$	[kN]	0,5 • A _s • f _{uk} (or see Table C1)							
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Ductility factor	k ₇	[-]	1,0							
Steel failure with lever arm										
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	1,2 • W _{el} • f _{uk} (or see Table C1)							
Elastic section modulus	W _{el}	[mm³]	31	62	109	277	541	935	1387	1874
Partial factor	$\gamma_{Ms,V}$	[-]	see Table C1							
Concrete pry-out failure										
Factor	k ₈	[-]	2,0							
Installation factor	γ_{inst}	[-]	1,0							
Concrete edge failure										
Effective length of fastener	l _f	[mm]	min(h _{ef} ; 12 • d _{nom})						min(h _{ef} ; 300mm)	
Outside diameter of fastener	d _{nom}	[mm]	8	10	12	16	20	24	27	30
Installation factor	γ_{inst}	[-]	1,0							

Table C7: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years										
Anchor size internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20	
Steel failure ¹⁾										
Characteristic tension resistance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123	
Steel, strength class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196	
Partial factor, strength class 5.8 and 8.8		γ _{Ms,N}	[-]	1,5						
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		N _{Rk,s}	[kN]	14	26	41	59	110	124	
Partial factor		γ _{Ms,N}	[-]	1,87						2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr}	[N/mm²]	20	19	19	18	17	16
	II: 72°C/50°C				15	15	14	13	13	12
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete	τ _{Rk,ucr}	[N/mm²]	16	16	16	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole			16	16	15	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,cr}	[N/mm²]	7,0	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ ⁰ _{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ ⁰ _{sus}	[-]	0,80					
	II: 72°C/50°C				0,68					
Increasing factors for concrete ψ _c			C25/30		1,02					
			C30/37		1,04					
			C35/45		1,07					
			C40/50		1,08					
			C45/55		1,09					
			C50/60		1,10					
Concrete cone failure										
Relevant parameter				see Table C2						
Splitting failure										
Relevant parameter				see Table C2						
Installation factor										
for dry and wet concrete (HD; HDB, CD)			γ _{inst}	[-]	1,0					
for flooded bore hole (HD; HDB, CD)					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.										
²⁾ For IG-M20 strength class 50 is valid										
TILCA® TIM P-E Injection System for concrete								Annex C 7		
Performances Characteristic values of tension loads under static and quasi-static action										

Table C8: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years										
Anchor size internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20	
Steel failure ¹⁾										
Characteristic tension resistance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123	
Steel, strength class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196	
Partial factor, strength class 5.8 and 8.8		γ _{Ms,N}	[-]	1,5						
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		N _{Rk,s}	[kN]	14	26	41	59	110	124	
Partial factor		γ _{Ms,N}	[-]	1,87						2,86
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	20	19	19	18	17	16
	II: 72°C/50°C				15	15	14	13	13	12
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete	τ _{Rk,ucr,100}	[N/mm²]	16	16	16	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
	I: 40°C/24°C	flooded bore hole			16	16	15	15	14	13
	II: 72°C/50°C				14	14	13	13	12	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	6,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ _c			C25/30		1,02					
			C30/37		1,04					
			C35/45		1,07					
			C40/50		1,08					
			C45/55		1,09					
			C50/60		1,10					
Concrete cone failure										
Relevant parameter				see Table C2						
Splitting failure										
Relevant parameter				see Table C2						
Installation factor										
for dry and wet concrete (HD; HDB, CD)		γ _{inst}	[-]	1,0						
for flooded bore hole (HD; HDB, CD)				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. ²⁾ For IG-M20 strength class 50 is valid										
TILCA® TIM P-E Injection System for concrete								Annex C 8		
Performances Characteristic values of tension loads under static and quasi-static action										

Table C9: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years										
Anchor size internal threaded anchor rods				IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20	
Steel failure ¹⁾										
Characteristic tension resistance,	5.8	N _{Rk,s}	[kN]	10	17	29	42	76	123	
Steel, strength class	8.8	N _{Rk,s}	[kN]	16	27	46	67	121	196	
Partial factor, strength class 5.8 and 8.8		γ _{Ms,N}	[-]	1,5						
Characteristic tension resistance, Stainless Steel A4 and HCR, Strength class 70 ²⁾		N _{Rk,s}	[kN]	14	26	41	59	110	124	
Partial factor		γ _{Ms,N}	[-]	1,87					2,86	
Combined pull-out and concrete cone failure for a working life of 50 years										
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr}	[N/mm²]	14	14	13	12	12	11
	II: 72°C/50°C				12	11	10	9,5	9,5	9,0
Reduction factor ψ ⁰ _{sus} in uncracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ ⁰ _{sus}	[-]	0,77					
	II: 72°C/50°C				0,72					
Increasing factors for concrete ψ _c			C25/30		1,04					
			C30/37		1,08					
			C35/45		1,12					
			C40/50		1,15					
			C45/55		1,17					
			C50/60		1,19					
Combined pull-out and concrete cone failure for a working life of 100 years										
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)										
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	14	14	13	12	12	11
	II: 72°C/50°C				11	10	10	9,5	9,0	8,5
Increasing factors for concrete ψ _c			C25/30		1,04					
			C30/37		1,08					
			C35/45		1,12					
			C40/50		1,15					
			C45/55		1,17					
			C50/60		1,19					
Concrete cone failure										
Relevant parameter				see Table C2						
Splitting failure										
Relevant parameter				see Table C2						
Installation factor										
for dry and wet concrete (DD)		γ _{inst}	[-]	1,0						
for flooded bore hole (DD)				1,2	1,4					
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										
TILCA® TIM P-E Injection System for concrete								Annex C 9		
Performances Characteristic values of tension loads under static and quasi-static action										

Table C10: Characteristic values of shear loads under static and quasi-static action

Anchor size for 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, Steel, strength class	5.8	V ⁰ _{Rk,s}	[kN]	5	9	15	21	38	61
	8.8	V ⁰ _{Rk,s}	[kN]	8	14	23	34	60	98
Partial factor, strength class 5.8 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, Steel, strength class	5.8	M ⁰ _{Rk,s}	[Nm]	8	19	37	66	167	325
	8.8	M ⁰ _{Rk,s}	[Nm]	12	30	60	105	267	519
Partial factor, strength class 5.8 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		γ _{inst}	[-]	1,0					
Concrete edge failure									
Effective length of fastener		l _f	[mm]	min(h _{ef} ; 12 • d _{nom})					min(h _{ef} ; 300mm)
Outside diameter of fastener		d _{nom}	[mm]	10	12	16	20	24	30
Installation factor		γ _{inst}	[-]	1,0					
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									
TILCA® TIM P-E Injection System for concrete								Annex C 10	
Performances Characteristic values of shear loads under static and quasi-static action									

Table C11: Characteristic values of tension loads under static and quasi-static action for a working life of 50 years														
Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
Steel failure														
Characteristic tension resistance		N _{Rk,s}	[kN]	A _s · f _{uk} 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⁾										
Combined pull-out and concrete failure														
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr}	[N/mm²]	16	16	16	16	16	16	15	15	15	15
	II: 72°C/50°C				12	12	12	12	12	12	12	12	11	11
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete	τ _{Rk,ucr}	[N/mm²]	14	14	13	13	13	13	13	13	13	13
	II: 72°C/50°C				12	12	12	11	11	11	11	11	11	11
	I: 40°C/24°C	flooded bore hole			13	13	13	13	13	13	13	13	13	13
	II: 72°C/50°C				11	11	11	11	11	11	11	11	11	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,cr}	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C				6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Reduction factor ψ ⁰ _{sus} in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ ⁰ _{sus}	[-]	0,80									
	II: 72°C/50°C				0,68									
Increasing factors for concrete ψ _c			C25/30		1,02									
			C30/37		1,04									
			C35/45		1,07									
			C40/50		1,08									
			C45/55		1,09									
			C50/60		1,10									
Concrete cone failure														
Relevant parameter				see Table C2										
Splitting														
Relevant parameter				see Table C2										
Installation factor														
for dry and wet concrete (HD; HDB, CD)		γ _{inst}	[-]	1,0										
for flooded bore hole (HD; HDB, CD)				1,2										
1) f _{uk} shall be taken from the specifications of reinforcing bars 2) in absence of national regulation														
TILCA® TIM P-E Injection System for concrete												Annex C 11		
Performances Characteristic values of tension loads under static and quasi-static action														

Table C12: Characteristic values of tension loads under static and quasi-static action for a working life of 100 years

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32		
Steel failure														
Characteristic tension resistance		N _{Rk,s}	[kN]	A _s · f _{uk} 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⁾										
Combined pull-out and concrete failure														
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes (HD) and compressed air drilled holes (CD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	16	16	16	16	16	16	15	15	15	15
	II: 72°C/50°C				12	12	12	12	12	12	12	12	11	11
Characteristic bond resistance in uncracked concrete C20/25 in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete	τ _{Rk,ucr,100}	[N/mm²]	14	14	13	13	13	13	13	13	13	13
	II: 72°C/50°C				12	12	12	11	11	11	11	11	11	11
	I: 40°C/24°C	flooded bore hole			13	13	13	13	13	13	13	13	13	13
	II: 72°C/50°C				11	11	11	11	11	11	11	11	11	11
Characteristic bond resistance in cracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,cr,100}	[N/mm²]	6,5	6,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5	7,5
	II: 72°C/50°C				5,5	5,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5	6,5
Increasing factors for concrete ψ _c		C25/30		1,02										
		C30/37		1,04										
		C35/45		1,07										
		C40/50		1,08										
		C45/55		1,09										
		C50/60		1,10										
Concrete cone failure														
Relevant parameter			see Table C2											
Splitting														
Relevant parameter			see Table C2											
Installation factor														
for dry and wet concrete (HD; HDB, CD)		γ _{inst}	[-]	1,0										
for flooded bore hole (HD; HDB, CD)				1,2										
1) f _{uk} shall be taken from the specifications of reinforcing bars 2) in absence of national regulation														
TILCA® TIM P-E Injection System for concrete									Annex C 12					
Performances Characteristic values of tension loads under static and quasi-static action														

Table C13: Characteristic values of tension loads under static and quasi-static action for a working life of 50 and 100 years

Anchor size reinforcing bar				Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32	
Steel failure														
Characteristic tension resistance		N _{Rk,s}	[kN]	A _s · f _{uk} 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⁾										
Combined pull-out and concrete failure for a working life of 50 years														
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr}	[N/mm²]	14	13	13	13	12	12	11	11	11	11
	II: 72°C/50°C				11	11	10	10	10	9,5	9,5	9,5	9,0	9,0
Reduction factor ψ ⁰ _{sus} in uncracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	ψ ⁰ _{sus}	[-]	0,77									
	II: 72°C/50°C				0,72									
Increasing factors for concrete ψ _c			C25/30		1,04									
			C30/37		1,08									
			C35/45		1,12									
			C40/50		1,15									
			C45/55		1,17									
			C50/60		1,19									
Combined pull-out and concrete failure for a working life of 100 years														
Characteristic bond resistance in uncracked concrete C20/25 in diamond drilled holes (DD)														
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,ucr,100}	[N/mm²]	14	13	13	13	12	12	11	11	11	11
	II: 72°C/50°C				11	10	10	10	9,5	9,0	9,0	9,0	8,5	8,5
Increasing factors for concrete ψ _c			C25/30		1,04									
			C30/37		1,08									
			C35/45		1,12									
			C40/50		1,15									
			C45/55		1,17									
			C50/60		1,19									
Concrete cone failure														
Relevant parameter				see Table C2										
Splitting														
Relevant parameter				see Table C2										
Installation factor														
for dry and wet concrete (DD)		γ _{inst}	[-]	1,0										
for flooded bore hole (DD)				1,2				1,4						
1) ¹⁾ f _{uk} shall be taken from the specifications of reinforcing bars 2) ²⁾ in absence of national regulation														
TILCA® TIM P-E Injection System for concrete										Annex C 13				
Performances Characteristic values of tension loads under static and quasi-static action														

Table C14: Characteristic values of shear loads under static and quasi-static action

Anchor size reinforcing bar			Ø 8	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	$V_{Rk,s}^0$	[kN]	$0,5 \cdot A_s \cdot f_{uk}^{1)}$									
Cross section area	A_s	[mm²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	$1,5^{2)}$									
Ductility factor	k_7	[-]	$1,0$									
Steel failure with lever arm												
Characteristic bending moment	$M_{Rk,s}^0$	[Nm]	$1.2 \cdot W_{el} \cdot f_{uk}^{1)}$									
Elastic section modulus	W_{el}	[mm³]	50	98	170	269	402	785	1357	1534	2155	3217
Partial factor	$\gamma_{Ms,V}$	[-]	$1,5^{2)}$									
Concrete pry-out failure												
Factor	k_8	[-]	$2,0$									
Installation factor	γ_{inst}	[-]	$1,0$									
Concrete edge failure												
Effective length of fastener	l_f	[mm]	$\min(h_{ef}; 12 \cdot d_{nom})$							$\min(h_{ef}; 300mm)$		
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 ²⁾ in absence of national regulation												
TILCA® TIM P-E Injection System for concrete									Annex C 14			
Performances Characteristic values of shear loads under static and quasi-static action												

Table C15: Displacements under tension load¹⁾ in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,028	0,029	0,030	0,033	0,035	0,038	0,039	0,041
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,038	0,039	0,040	0,044	0,047	0,051	0,052	0,055
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,047	0,049	0,051	0,055	0,059	0,064	0,067	0,070
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years										
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,069	0,071	0,072	0,074	0,076	0,079	0,081	0,082
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,100	0,115	0,122	0,128	0,135	0,142	0,155	0,171
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,092	0,095	0,096	0,099	0,102	0,106	0,109	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,134	0,154	0,163	0,172	0,181	0,189	0,207	0,229

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 C16: Displacements under tension load¹⁾ in diamond drilled holes (DD)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked concrete under static and quasi-static action for a working life of 50 years										
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,018	0,019	0,019	0,020	0,022	0,023	0,024	0,025
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,052	0,053	0,055	0,058	0,062	0,065	0,068	0,070
Uncracked concrete under static and quasi-static action for a working life of 100 years										
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,011	0,012	0,012	0,013	0,014	0,014	0,015	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,020	0,021	0,021	0,023	0,024	0,025	0,026	0,027
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,013	0,014	0,014	0,015	0,016	0,016	0,018	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,038	0,039	0,040	0,043	0,045	0,047	0,049	0,051

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 C17: Displacements under shear load¹⁾ for all drilling methods

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked and cracked concrete under static and quasi-static action										
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,06	0,06	0,05	0,04	0,04	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

¹⁾ Calculation of the displacement

$$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V;$$

V : action shear load

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

TILCA® TIM P-E Injection System for concrete

Performances

Displacements under static and quasi-static action (threaded rods)

Annex C 15

Table C18: Displacements under tension load¹⁾ in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)

Anchor size Internal threaded anchor rod			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 I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,029	0,030	0,033	0,035	0,038	0,041
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,029	0,030	0,033	0,035	0,038	0,041
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,039	0,040	0,044	0,047	0,051	0,055
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,049	0,051	0,055	0,059	0,064	0,070
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years								
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,071	0,072	0,074	0,076	0,079	0,082
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,115	0,122	0,128	0,135	0,142	0,171
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,095	0,096	0,099	0,102	0,106	0,110
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,154	0,163	0,172	0,181	0,189	0,229

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 C19: Displacements under tension load¹⁾ in diamond drilled holes (DD)

Anchor size Internal threaded anchor rod			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 years								
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,019	0,019	0,020	0,022	0,023	0,025
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,053	0,055	0,058	0,062	0,065	0,070
Uncracked concrete under static and quasi-static action for a working life of 100 years								
Temperature range I: 40°C/24°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,012	0,012	0,013	0,014	0,014	0,015
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,021	0,021	0,023	0,024	0,025	0,027
Temperature range II: 72°C/50°C	δ_{N0} -factor	[mm/(N/mm ²)]	0,014	0,014	0,015	0,016	0,016	0,018
	$\delta_{N\infty}$ -factor	[mm/(N/mm ²)]	0,039	0,040	0,043	0,045	0,047	0,051

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 C20: Displacements under shear load¹⁾ for all drilling methods

Anchor size Internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Uncracked and cracked concrete under static and quasi-static action								
All temperature ranges	δ_{V0} -factor	[mm/kN]	0,07	0,06	0,06	0,05	0,04	0,04
	$\delta_{V\infty}$ -factor	[mm/kN]	0,10	0,09	0,08	0,08	0,06	0,06

¹⁾ Calculation of the displacement

$$\delta_{V0} = \delta_{V0}\text{-factor} \cdot V;$$

V : action shear load

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

TILCA® TIM P-E Injection System for concrete

Performances

Displacements under static and quasi-static action (Internal threaded anchor rod)

Annex C 16

Table C21: Displacements under tension load ¹⁾ in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Uncracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temp.- range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
	δ _{N∞} -factor	[mm/(N/mm²)]	0,028	0,029	0,030	0,031	0,033	0,035	0,038	0,038	0,040	0,043
Temp.- range II: 72°C/50°C	δ _{N0} -factor	[mm/(N/mm²)]	0,038	0,039	0,040	0,042	0,044	0,047	0,051	0,051	0,054	0,058
	δ _{N∞} -factor	[mm/(N/mm²)]	0,047	0,049	0,051	0,053	0,055	0,059	0,065	0,065	0,068	0,072
Cracked concrete under static and quasi-static action for a working life of 50 and 100 years												
Temp.- range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm²)]	0,069	0,071	0,072	0,073	0,074	0,076	0,079	0,079	0,081	0,084
	δ _{N∞} -factor	[mm/(N/mm²)]	0,115	0,122	0,128	0,135	0,142	0,155	0,171	0,171	0,181	0,194
Temp.- range II: 72°C/50°C	δ _{N0} -factor	[mm/(N/mm²)]	0,092	0,095	0,096	0,098	0,099	0,102	0,106	0,106	0,109	0,113
	δ _{N∞} -factor	[mm/(N/mm²)]	0,154	0,163	0,172	0,181	0,189	0,207	0,229	0,229	0,242	0,260
¹⁾ Calculation of the displacement δ _{N0} = δ _{N0} -factor · τ; τ: action bond stress for tension δ _{N∞} = δ _{N∞} -factor · τ;												
Table C22: Displacements under tension load ¹⁾ in diamond drilled holes (DD)												
Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Uncracked concrete under static and quasi-static action for a working life of 50 years												
Temp.- range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm²)]	0,008	0,009	0,009	0,01	0,011	0,012	0,013	0,013	0,014	0,015
	δ _{N∞} -factor	[mm/(N/mm²)]	0,018	0,018	0,019	0,020	0,021	0,024	0,027	0,027	0,028	0,031
Temp.- range II: 72°C/50°C	δ _{N0} -factor	[mm/(N/mm²)]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	δ _{N∞} -factor	[mm/(N/mm²)]	0,048	0,051	0,054	0,058	0,061	0,068	0,076	0,076	0,081	0,088
Uncracked concrete under static and quasi-static action for a working life of 100 years												
Temp.- range I: 40°C/24°C	δ _{N0} -factor	[mm/(N/mm²)]	0,008	0,009	0,009	0,010	0,011	0,012	0,013	0,013	0,014	0,015
	δ _{N∞} -factor	[mm/(N/mm²)]	0,018	0,020	0,021	0,022	0,024	0,026	0,029	0,029	0,031	0,034
Temp.- range II: 72°C/50°C	δ _{N0} -factor	[mm/(N/mm²)]	0,009	0,011	0,011	0,012	0,013	0,014	0,015	0,015	0,016	0,018
	δ _{N∞} -factor	[mm/(N/mm²)]	0,035	0,037	0,040	0,042	0,045	0,049	0,055	0,055	0,059	0,064
¹⁾ Calculation of the displacement δ _{N0} = δ _{N0} -factor · τ; τ: action bond stress for tension δ _{N∞} = δ _{N∞} -factor · τ;												
Table C23: Displacements under shear load ¹⁾ for all drilling methods												
Anchor size reinforcing bar			Ø 8	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												
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
	δ _{V∞} -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 δ _{V0} = δ _{V0} -factor · V; V: action shear load δ _{V∞} = δ _{V∞} -factor · V;												
TILCA® TIM P-E Injection System for concrete										Annex C 17		
Performances Displacements under static and quasi-static action (rebar)												

Table C24: Characteristic values of tension loads under seismic action (performance category C1) for a working life of 50 and 100 years

Anchor size threaded rod				M8	M10	M12	M16	M20	M24	M27	M30
Steel failure											
Characteristic tension resistance		$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot N_{Rk,s}$							
Partial factor		$\gamma_{Ms,N}$	[-]	see Table C1							
Combined pull-out and concrete failure											
Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)											
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5
	II: 72°C/50°C		$\tau_{Rk,eq,C1}$	[N/mm²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete ψ_C		C25/30 to C50/60			1,0						
Installation factor											
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0							
for flooded bore hole (HD; HDB, CD)				1,2							

Table C25: Characteristic values of shear loads under seismic action (performance category C1)

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure										
Characteristic shear resistance (Seismic C1)	$V_{Rk,s,eq,C1}$	[kN]	$0,70 \cdot V^0_{Rk,s}$							
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 gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

TILCA® TIM P-E Injection System for concrete

Performances

Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (threaded rod)

Annex C 18

**Table C26: Characteristic values of tension loads under seismic action
(performance category C1) for a working life of 50 and 100 years**

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure												
Characteristic tension resistance	$N_{Rk,s,eq,C1}$	[kN]	$1,0 \cdot A_s \cdot f_{uk}^{1)}$									
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,N}$	[-]	$1,4^{2)}$									
Combined pull-out and concrete failure												
Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)												
Temperature range I: 40°C/24°C II: 72°C/50°C	Dry, wet concrete and flooded bore hole	$\tau_{Rk,eq,C1}$	[N/mm ²]	7,0	7,0	8,5	8,5	8,5	8,5	8,5	8,5	8,5
		$\tau_{Rk,eq,C1}$	[N/mm ²]	6,0	6,0	7,0	7,0	7,0	7,0	7,0	7,0	7,0
Increasing factors for concrete ψ_C		C25/30 to C50/60		1,0								
Installation factor												
for dry and wet concrete (HD; HDB, CD)		γ_{inst}	[-]	1,0								
for flooded bore hole (HD; HDB, CD)				1,2								

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

²⁾ in absence of national regulation

**Table C27: Characteristic values of shear loads under seismic action
(performance category C1)**

Anchor size reinforcing bar			Ø 8	Ø 10	Ø 12	Ø 14	Ø 16	Ø 20	Ø 24	Ø 25	Ø 28	Ø 32
Steel failure												
Characteristic shear resistance	$V_{Rk,s,eq,C1}$	[kN]	$0,35 \cdot A_s \cdot f_{uk}^{1)}$									
Cross section area	A_s	[mm ²]	50	79	113	154	201	314	452	491	616	804
Partial factor	$\gamma_{Ms,V}$	[-]	1,5 ²⁾									
Factor for annular gap	α_{gap}	[-]	0,5 (1,0) ³⁾									

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

²⁾ in absence of national regulation

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

TILCA® TIM P-E Injection System for concrete

Performances

Characteristic values of tension and shear loads under seismic action (performance category C1) for a working life of 50 and 100 years (rebar)

Annex C 19

Table C28: Characteristic values of tension loads under seismic action (performance category C2) for a working life of 50 and 100 years

Anchor size threaded rod				M12	M16	M20	M24	
Steel failure								
Characteristic tension resistance, Steel, strength class 8.8 Stainless Steel A4 and HCR, Strength class ≥70		N _{Rk,s,eq,C2}	[kN]	1,0 · N _{Rk,s}				
Partial factor		γ _{Ms,N}	[-]	see Table C1				
Combined pull-out and concrete failure								
Characteristic bond resistance in cracked and uncracked concrete C20/25 in hammer drilled holes (HD), compressed air drilled holes (CD) and in hammer drilled holes with hollow drill bit (HDB)								
Temperature range	I: 40°C/24°C	Dry, wet concrete and flooded bore hole	τ _{Rk,eq,C2}	[N/mm²]	5,8	4,8	5,0	5,1
	II: 72°C/50°C		τ _{Rk,eq,C2}	[N/mm²]	5,0	4,1	4,3	4,4
Increasing factors for concrete ψ _C		C25/30 to C50/60		1,0				
Installation factor								
for dry and wet concrete (HD; HDB, CD)		γ _{inst}	[-]	1,0				
for flooded bore hole (HD; HDB, CD)				1,2				

Table C29: Characteristic values of shear loads under seismic action (performance category C2)

Anchor size 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]	$0,70 \cdot V_{Rk,s}^0$		
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 gap between anchor and clearance hole in the fixture. Use of special filling washer Annex A 3 is recommended.

TILCA® TIM P-E Injection System for concrete

Performances

Characteristic values of tension and shear loads under seismic action (performance category C2) for a working life of 50 and 100 years (threaded rod)

Annex C 20

Table C30: Displacements under tension load (threaded rod)

Anchor size threaded rod			M12	M16	M20	M24
Uncracked and cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{N,eq,C2}(DLS)$	[mm]	0,21	0,24	0,27	0,36
	$\delta_{N,eq,C2}(ULS)$	[mm]	0,54	0,51	0,54	0,63

Table C31: Displacements under shear load (threaded rod)

Anchor size threaded rod			M12	M16	M20	M24
Uncracked and cracked concrete under seismic action (performance category C2)						
All temperature ranges	$\delta_{V,eq,C2}(DLS)$	[mm]	3,1	3,4	3,5	4,2
	$\delta_{V,eq,C2}(ULS)$	[mm]	6,0	7,6	7,3	10,9

TILCA® TIM P-E Injection System for concrete

Performances

Displacements under seismic action (performance category C2) (threaded rods)

Annex C 21