Multifix SE1000 SEISMIC

585 ML, ART. 9571001000

PURE EPOXY

NOTE: THE INSTRUCTIONS IN THIS DOCUMENTATION ARE BASED ON TESTS AND EXPERIENCE AND HAVE BEEN PREPARED TO THE BEST OF OUR KNOWLEDGE AND CONSCIENCE. DUE TO THE VARIETY OF DIFFERENT MATERIALS AND SUBSTRATES AND THE MANY DIFFERENT POSSIBLE APPLICATIONS BEYOND OUR CONTROL, WE ASSUME NO REPONSIBILITY FOR THE RESULTS ACHIEVED. SINCE THE CONSTRUCTION AND NATURE OF THE SUBSTRATE AND THE PROCESSING CONDITIONS ARE BEYOND OUR CONTROL, WE DO NOT ACCEPT ANY LIABILITY FOR THIS PUBLICATION. IN ANY CASE, IT IS RECOMMENDED TO CARRY OUT APPROPRIATE TESTS BEFORE USE.

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1. General

Product description

The Multifix SE1000 Seismic mortar is a 2-component 585 ml reaction resin mortar based on a pure epoxy. This high performance product may be used in combination with a hand-, battery-, or pneumatic tool and a static mixer. It was designed especially for the anchoring of threaded rods, reinforcing bars or internal threaded rod sleeves into concrete.

Properties and benefits

- European Technical Assessment for bonded fasteners used in concrete acc. to EAD 330499-01-0601 (Option 1, Seismic C1 and C2, 100 years working life): ETA-20/1280
- European Technical Assessment for post-installed rebar acc. to EAD 330087-00-0601: ETA-22/0365
- Fire resistance test report acc. to DIN EN 1363-1
- For heavy anchoring - doweling and post-installed rebar connection
- Overhead application
- Waterfilled bore holes
- Suitable for attachment points with small edge- and axial distances due to an anchoring free of expansion forces
- High chemical resistance
- Low odour
- High bending and pressure strength
- Colour gray
- Cartridge can be reused up to the end of the shelf life by replacing the static mixer or resealing cartridge with the sealing cap
- State-of-the-art ingredients, complies with the latest REACH regulations, free off Phenol, (CAS# 108-95-2), DETA/TETA (CAS# 111-40-0), Benzyl alcohols (CAS# 100-51-6), Bisphenol-A (CAS# 80-05-7)

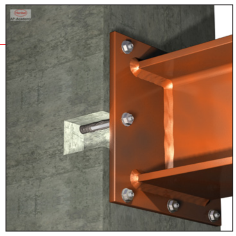
Applications

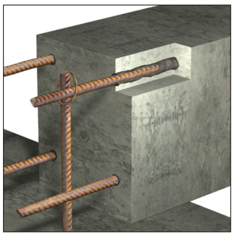
Suitable for the fixation of facades, roofs, wood constructions, metal constructions; metal profils, columns, beams, consoles, railings, sanitary devices, cable trays, piping, post-installed rebar connections (reconstruction or reinforcement) etc.

Handling and storage

- Storage: store in a cold and dark place, storage temperature: from +5 °C up to +35 °C
- Shelf life: 24 months for cartridges
- Expiration date marked on the cartridges

Applications and intended use





- Base material:
  cracked and non-cracked concrete, light-concrete, porous-concrete, solid masonry, hollow brick, natural stone (Attention! natural stone, can discolour; shall be checked in advance.
- Anchor elements:
  Threaded rods (zinc plated or hot dip, stainless steel and high corrosion resistance steel), reinforcing bars, internal threaded rods, profiled rod, steel section with undercuts (e.g. perforated section)
- Temperature range:
  installation temperature 0 °C up to +40 °C;
  cartridge temperature min. +5 °C; optimal +40 °C;
  base material temperature after full curing -40 °C to +72 °C

Mortar properties

Properties	Test Method	Result
UV resistance	-	Pass
Watertightness	DIN EN 12390-8	0 mm
Density	-	1,5 kg / dm³
Compressive strength	EN 196 Part 1	122 N / mm²
Flexural strength	EN 196 Part 1	66 N / mm²
Axial tensile strength	DIN EN ISO 527-2	44 N / mm²
E modulus	DIN EN ISO 527-2	6300 N / mm²
Shrinkage	DIN 52450	< 1,4 ‰
Hardness Shore A	DIN EN ISO 868	99,4
Hardness Shore D	DIN EN ISO 868	86,1
Electrical resistance	IEC 93	$8{,}0 * 10^{12}\ \Omega$
Thermal conductivity	DIN EN 993-15	0,5 W / m·K
Spec. Heat capacity	DIN EN 993-15	1350 J / kg · K

Reactivity

Temperature of base material	Gel- and working time	Full curing time in dry base material 1)
0 °C to +4 °C	90 min	144 h
+5 °C to +9 °C	80 min	48 h
+10 °C to +14 °C	60 min	28 h
+15 °C to +19 °C	40 min	18 h
+20 °C to +24 °C	30 min	12 h
+25 °C to +34 °C	12 min	9 h
+35 °C to +39 °C	8 min	6 h
+40 °C	8 min	4 h
Cartridge temperature	+5 °C to +40 °C	

1) The curing times in wet concrete has to be doubled.

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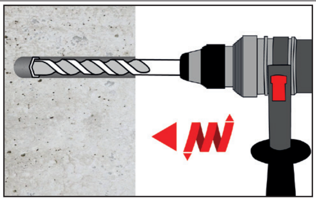
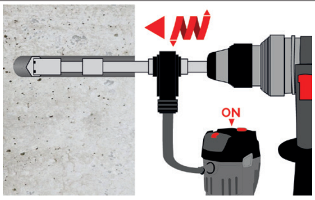
2. Anchorage in concrete

Installation instructions

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



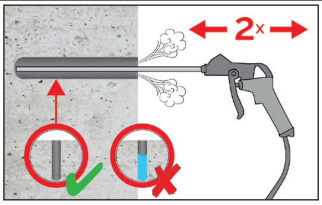
1a. Hammer drilling (HD) or compressed air drilling (CD).
Drill a hole into the base material to the size and embedment depth required by the selected anchor (see page 8). Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.



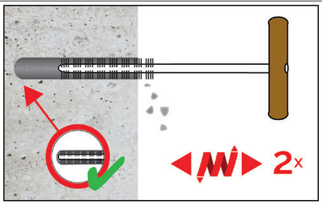
2a. Hollow drill bit system (HDB)
Drill a hole into the base material to the size and embedment depth required by the selected anchor (see page 9). This drilling system removes the dust and cleans the bore hole during drilling (all conditions). Proceed with Step 3.
In case of aborted drill hole, the drill hole shall be filled with mortar.

Attention! Standing water must be removed before cleaning.

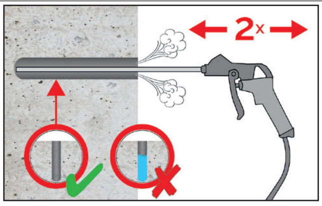
CAC: Cleaning for all drill hole diameter in non-cracked and cracked concrete



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (see page 8) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.



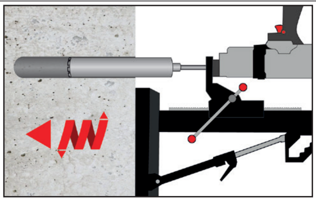
2b. Check brush diameter (see page 8). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (see page 8) a minimum of two times in a twisting motion. If the bore hole ground is not reached with the brush, a brush extension must be used.



2c. Finally blow the hole clean again with compressed air (min. 6 bar) (see page 8) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must 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.

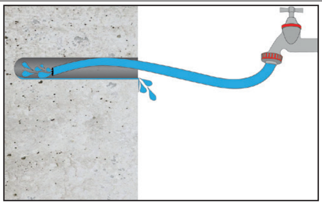
Drilling of the bore hole (DD)



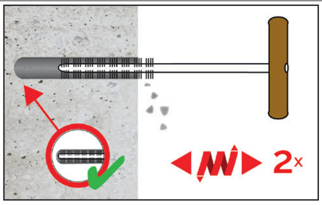
1a. Diamond drilling (DD)
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor (see page 9).
Proceed with Step 2.
In case of aborted drill hole, the drill hole shall be filled with mortar.

Attention! Standing water must be removed before cleaning.

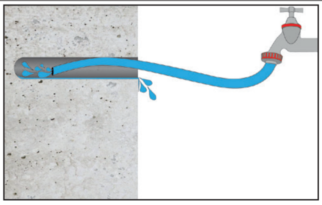
SPCAC: Cleaning for dry, wet and water-filled bore holes with all diameter in non-cracked and cracked concrete



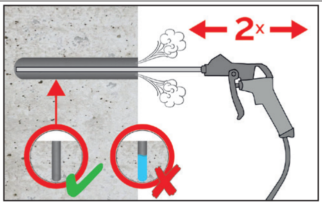
2a. Rinsing with water until clear water comes out.



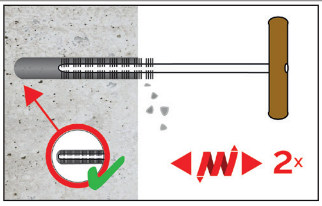
2b. Check brush diameter (see page 9). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (see page 9) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension must be used.



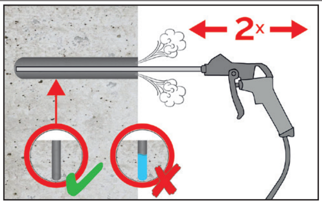
2c. Rinsing again with water until clear water comes out.



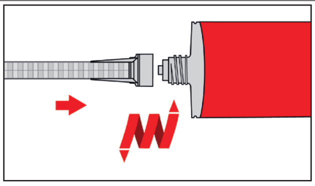
2d. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (see page 9) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.



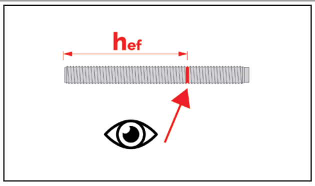
2e. Check brush diameter (see page 9). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (see page 9) a minimum of two times in a twisting motion. If the bore hole ground is not reached with the brush, a brush extension must be used.



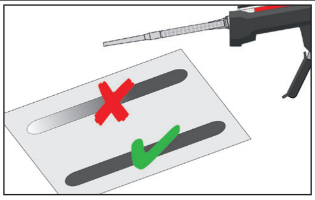
2f. Finally blow the hole clean again with compressed air (min. 6 bar) (see page 9) a minimum of two times until return air stream is free of noticeable dust. If the bore hole ground is not reached, an extension must be used.



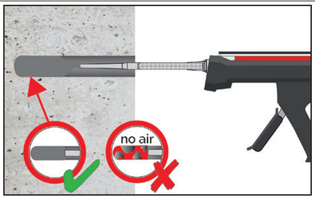
3. Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. After every working interruption longer than the recommended working time (see page 4) as well as for new cartridges, a new static-mixer shall be used.



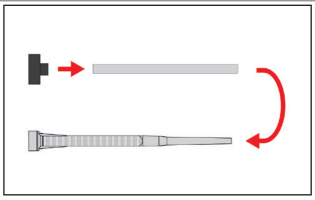
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes (≥ 10 cm) and discard non-uniformly mixed adhesive components until the mortar shows a consistent gray colour.



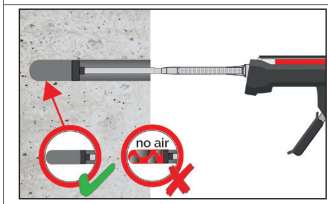
6. Starting from the bottom resp. back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw of the static mixing nozzle as the hole is filled avoids creating air pockets. If the bore hole ground is not reached with the static-mixing nozzle, a appropriate extension must be used. Observe the gel-/ working times given (see page 4).



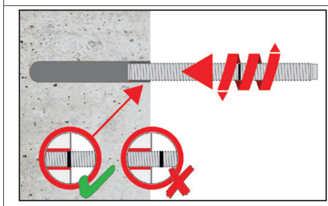
7. Piston plugs shall be used acc. to table on page 9 for the following application:

- Horizontal assembly (horizontal direction) and ground erection (vertical downwards): Drill bit-Ø d_0 ≥ 18 mm and embedment depth h_{ef} > 250mm
- Overhead assembly (vertical upwards direction): Drill bit-Ø d_0 ≥ 18 mm.

Assemble mixing nozzle, mixer extension and piston plug before injecting mortar.

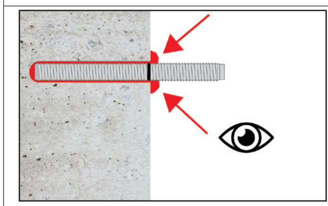


8. Insert piston plug to back of the hole and inject adhesive. If the bottom or back of the anchor hole is not reached, an appropriate extension nozzle must be used.
During injection the piston plug is naturally pushed out of the borehole by the back pressure of the mortar.
Observe the gel-/working times given in the table on page 4.

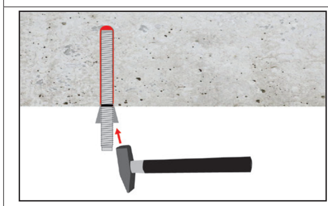


9. Push the fixing element into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment mark has reached the surface level.

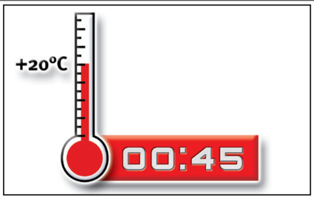
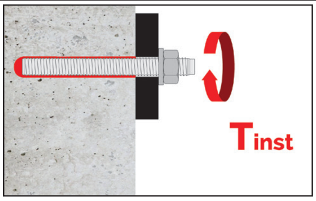
Anchor should be free of dirt, grease, oil or other foreign material.



10. After inserting the anchor, the annular gab 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 using e.g. wedges until the mortar has started to harden.

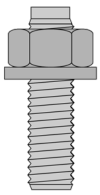
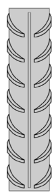
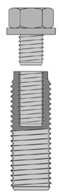
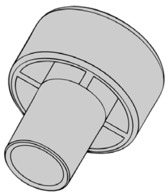
	**12.** Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (see page 4).
	**13.** After full curing, the add-on part can be installed with up to the max. torque (see page 9) by using a calibrated torque wrench. It can be optional filled the annular gap between anchor and fixture 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, until mortar flows out from the washer.

Installation accessories

CAC - Rec. compressed air tool (min. 6 bar)
Drill bit diameter (d_0): all diameters

Brush RBT and brush extension

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).

										
Threaded rod	Rebar	Internal threaded anchor rod	d_0 Drill bit - Ø HD	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	RBT 10	11,5	10,5	No piston plug required			
M10	8 / 10	IG-M6	12	RBT 12	13,5	12,5				
M12	10 / 12	IG-M8	14	RBT 14	15,5	14,5				
-	12	-	16	RBT 16	17,5	16,5				
M16	14	IG-M10	18	RBT 18	20,0	18,5	# 18	h_{ef} > 250 mm	h_{ef} > 250 mm	all
-	16	-	20	RBT 20	22,0	20,5	# 20			
M20	-	IG-M12	22	RBT 22	24,0	22,5	# 22			
-	20	-	25	RBT 25	27,0	25,5	# 25			

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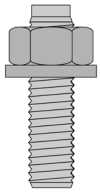
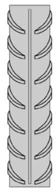
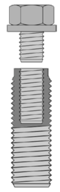
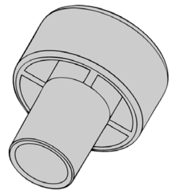
										
Threaded rod	Rebar	Internal threaded anchor rod	d_0 Drill bit - Ø HD	d_b Brush-Ø		$d_{b,min}$ min. Brush-Ø	Piston plug	Installation direction and use of piston plug		
[mm]	[mm]	[mm]	[mm]	[-]	[mm]	[mm]	[-]	⬇	➡	⬆
M24	-	IG-M16	28	RBT 28	30,0	28,5	TT 28	h_{ef} > 250 mm	h_{ef} > 250 mm	all
M27	24 / 25	-	30	RBT 30	31,8	30,5	# 30			
-	24 / 25	-	32	RBT 32	34,0	32,5	TT 32			
M30	28	IG-M20	35	RBT 35	37,0	35,5	TT 35			
-	32	-	40	RBT 40	43,5	40,5	# 40			
M33	-	-	38	RBT 38	40,0	38,8	TT 38			
M36	-	-	42	RBT 42	44,0	42,8	# 42			
-	36	-	45	RBT 45	47,0	45,8	# 45			
M39	-	-	45	RBT 45	47,0	45,8	# 45			
-	40	-	50	RBT 50	52,0	50,8	# 50			
M42	-	-	52	RBT 52	54,0	52,8	# 52			
M48	-	-	60	RBT 60	62,0	60,8	# 60			

Installation parameters

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30	M33	M36	M39	M42	M48
Outer diameter of anchor	$d = d_{nom}$	[mm]	8	10	12	16	20	24	27	30	33	36	39	42	48
Nominal drill hole diameter	d_0	[mm]	10	12	14	18	22	28	30	35	38	42	45	52	60
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	80	90	96	108	120	132	144	156	168	192
	$h_{ef,max}$	[mm]	160	200	240	320	400	480	540	600	660	720	780	840	960
Diameter of clearance hole in the fixture[1)]	Pre-positioned anchorage d_f	[mm]	9	12	14	18	22	26	30	33	36	39	42	45	52
	In-place anchorage d_f	[mm]	12	14	16	20	24	30	33	40	40	44	47	54	62
Maximum torque moment	$T_{inst} \leq$	[Nm]	10	20	35	60	100	170	250	300	330	360	390	460	550
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	165	180	195	210	240
Minimum edge distance	C_{min}	[mm]	35	40	45	50	60	65	75	80	165	180	195	210	240

1) When used under seismic load, the diameter of the through hole in fixture must not exceed d_1 + 1 mm or alternatively, the annular gap between the fixture and the anchor rod must be force-filled with mortar.

Rebar size			ø8 [1)]	ø10 [1)]	ø12 [1)]	ø14	ø16	ø20	ø24 [1)]	ø25 [1)]	ø28	ø32	ø36	ø40
Outer diameter of anchor	$d = d_{nom}$	[mm]	8	10	12	14	16	20	25	25	28	32	36	40
Nominal drill hole diameter	d_0	[mm]	10 / 12	12 / 14	14 / 16	18	20	25	30 / 32	30 / 32	35	40	45	50
Effective embedment depth	$h_{ef,min}$	[mm]	60	60	70	75	80	90	96	100	112	128	144	240
	$h_{ef,max}$	[mm]	160	200	240	280	320	400	480	500	560	640	720	800
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 mm		$h_{ef} + 2d_0$									
Minimum spacing	S_{min}	[mm]	40	50	60	70	75	95	120	120	130	150	180	200
Minimum edge distance	C_{min}	[mm]	35	40	45	50	50	60	70	70	75	85	180	200

[1)] Both nominal drill hole diameters d_0 can be used.

Size internal threaded anchor rod			IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Internal diameter of anchor	d_2	[mm]	6	8	10	12	16	20
Outer diameter of anchor[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	[mm]	7	9	12	14	18	22
Maximum torque moment	T_{inst}	[Nm]	10	10	20	40	60	100
Thread engagement length (min/max)	I_{IG}	[mm]	8/20	8/20	10/25	12/30	16/32	20/40
Minimum thickness of member	h_{min}	[mm]	h_{ef} + 30 mm ≥ 100 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

Recommended loads

Threaded rod

The recommended loads are only valid for single anchors for a roughly design, if the following conditions are valid:

- $c \geq 1{,}5 \times h_{ef}$ $s \geq 3{,}0 \times h_{ef}$ $h \geq 2 \times h_{ef}$
- ψ_{sus} = 1,0; percentage of dead load ≤ ψ^0_{sus} see table below
- The recommended loads have been calculated using the partial safety factors for resistances stated in the ETA and with a partial safety factor for actions of γ_f=1.4. The partial safety factor for seismic action is γ_1 = 1,0.

If the conditions are not fulfilled the loads must be calculated acc. to EN 1992-4.
For further details observe ETA-20/1280.

Recommended loads for a working life of 50 years • Property class 8.8 • Concrete - C20/25 • **Hammer- (HD) and compressed air drilling (CD)** • dry, wet concrete					M8	M10	M12	M16	M20	M24	M27	M30	M33 [4]	M36 [4]	M39 [4]	M42 [4]	M48 [4]
Recommended tension load	40°C / 24°C [1] ψ^0_{sus} = 0,80	non-cracked	$N_{rec,stat}$	[kN]	13,8	20,0	27,0	32,7	51,9	71,3	92,6	103,9	111,7	127,8	144,6	168,0	205,3
		cracked	$N_{rec,stat}$	[kN]	6,7	9,4	16,8	22,9	36,3	49,9	64,8	72,7	78,2	89,5	101,2	117,6	143,7
			$N_{rec,eq,C1}$	[kN]	6,7	9,4	16,8	22,9	36,3	49,9	64,8	72,7	NPA				
			$N_{rec,eq,C2}$	[kN]	NPA	NPA	16,0	20,1	35,6	49,9	NPA	NPA					
	72°C / 50°C [1] ψ^0_{sus} = 0,68	non-cracked	$N_{rec,stat}$	[kN]	13,8	20,0	27,0	32,7	51,9	71,3	92,6	103,9					
		cracked	$N_{rec,stat}$	[kN]	5,7	8,1	13,8	20,9	35,6	49,9	64,8	72,7					
			$N_{rec,eq,C1}$	[kN]	5,7	8,1	13,8	20,9	35,6	49,9	64,8	72,7					
			$N_{rec,eq,C2}$	[kN]	NPA	NPA	13,8	17,2	30,6	46,4	NPA	NPA					
Recommended shear load without lever arm [2) 3)]		non-cracked	$V_{rec,stat}$	[kN]	8,6	11,9	16,5	20,8	34,1	48,1	63,5	72,3	93,3	106,1	120,3	140,4	174,6
		cracked	$V_{rec,stat}$	[kN]	6,9	8,4	11,7	14,8	24,2	34,0	45,0	51,2	66,1	75,2	85,2	99,5	123,7
			$V_{rec,eq,C1}$	[kN]	6,9	8,4	11,7	14,8	24,2	34,0	45,0	51,2	NPA				
			$V_{rec,eq,C2}$	[kN]	NPA	NPA	11,7	14,8	24,2	34,0	NPA	NPA					
Embedment depth			h_{ef}	[mm]	80	90	110	125	170	210	250	270	320	350	380	420	480
Edge distance			c ≥	[mm]	120	135	165	187,5	255	315	375	405	480	525	570	630	720
Axial distance (spacing)			s ≥	[mm]	240	270	330	375	510	630	750	810	960	1050	1140	1260	1440

1) Short term temperature / long term temperature.

2) Shear loads are valid for all specified temperature ranges.

3) In case of seismic action, the annular gap between the anchor rod and the through hole of the attachment must be filled with mortar, otherwise a_{gap} = 0,5 acc. to ETA-20/1280 must be taken into account.

4) Application is not covered by the ETA-20/1280.

$N_{rec,stat}$, $V_{rec,stat}$ = Recommended load under static and quasi-static action

$N_{rec,eq}$, $V_{rec,eq}$ = Recommended load under seismic action

NPA = no performance accessed

Recommended loads for a working life of 50 years • Property class 8.8 • Concrete - C20/25 • **Diamond drilling (DD)** • dry, wet concrete					M8	M10	M12	M16	M20	M24	M27	M30	M33 [4]	M36 [4]	M39 [4]	M42 [4]	M48 [4]
Recommended tension load	40°C / 24°C [1] ψ^0_{sus} = 0,77	non-cracked	$N_{rec,stat}$	[kN]	13,8	18,8	27,0	32,7	51,9	71,3	92,6	103,9	111,7	127,8	144,6	168,0	205,3
	72°C / 50°C [1] ψ^0_{sus} = 0,72	non-cracked	$N_{rec,stat}$	[kN]	11,5	16,2	21,7	29,9	48,3	71,3	90,9	103,9	NPA				
Recommended shear load without lever arm [2) 3)]		non-cracked	$V_{rec,stat}$	[kN]	8,6	11,9	16,5	20,8	34,1	48,1	63,5	72,3	93,3	106,1	120,3	140,4	174,6

Recommended loads for a working life of 50 years • Property class 8.8 • Concrete - C20/25 • **Diamond drilling (DD)** • dry, wet concrete			M8	M10	M12	M16	M20	M24	M27	M30	M33 [4)]	M36 [4)]	M39 [4)]	M42 [4)]	M48 [4)]
Embedment depth	h_{ef}	[mm]	80	90	110	125	170	210	250	270	320	350	380	420	480
Edge distance	c ≥	[mm]	120	135	165	188	255	315	375	405	480	525	570	630	720
Axial distance (spacing)	s ≥	[mm]	240	270	330	375	510	630	750	810	960	1050	1140	1260	1440

1) Short term temperature / long term temperature.
2) Shear loads are valid for all specified temperature ranges.
3) In case of seismic action, the annular gap between the anchor rod and the through hole of the attachment must be filled with mortar, otherwise a_{gap} = 0,5 acc. to ETA-20/1280 must be taken into account.
4) Application is not covered by the ETA-20/1280.

$N_{rec,stat}$, $V_{rec,stat}$ = Recommended load under static and quasi-static action
$N_{rec,eq}$, $V_{rec,eq}$ = Recommended load under seismic action

Internal threaded rod

The recommended loads are only valid for single anchors for a roughly design, if the following conditions are valid:

- c ≥ 1,5 x h_{ef} s ≥ 3,0 x h_{ef} h ≥ 2 x h_{ef}
- ψ_{sus} = 1,0; percentage of dead load ≤ ψ^0_{sus} see table below
- The recommended loads have been calculated using the partial safety factors for resistances stated in the ETA and with a partial safety factor for actions of γ_f=1.4. The partial safety factor for seismic action is γ_1 = 1,0.

If the conditions are not fulfilled the loads must be calculated acc. to EN 1992-4.
For further details observe ETA-20/1280.

Recommended loads for a working life of 50 years • Property class 8.8 • Concrete - C20/25 • **Hammer- (HD) and compressed air drilling (CD)** • dry, wet concrete					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Recommended tension load	40°C / 24°C [1)] ψ^0_{sus} = 0,80	non-cracked	$N_{rec,stat}$	[kN]	7,6	13,8	21,9	31,9	57,6	93,3
		cracked	$N_{rec,stat}$	[kN]	7,6	13,8	21,9	31,9	49,9	76,8
	72°C / 50°C [1)] ψ^0_{sus} = 0,68	non-cracked	$N_{rec,stat}$	[kN]	7,6	13,8	21,9	31,9	57,6	93,3
		cracked	$N_{rec,stat}$	[kN]	7,6	13,8	20,9	31,9	49,9	76,8
Recommended shear load without lever arm [2) 3)]		non-cracked	$V_{rec,stat}$	[kN]	6,4	12,0	18,4	27,2	48,8	78,4
		cracked	$V_{rec,stat}$	[kN]	4,6	8,6	13,1	19,4	34,9	54,1
Embedment depth			h_{ef}	[mm]	90	110	125	170	210	280
Edge distance			c ≥	[mm]	165	188	255	315	420	420
Axial distance			s ≥	[mm]	330	375	510	630	840	840

Recommended loads for a working life of 50 years • Property class 8.8 • Concrete - C20/25 • **Diamond drilling (DD)** • dry, wet concrete					IG-M6	IG-M8	IG-M10	IG-M12	IG-M16	IG-M20
Recommended tension load	40°C / 24°C [1)] ψ^0_{sus} = 0,77	non-cracked	$N_{rec,stat}$	[kN]	7,6	13,8	21,9	31,9	57,6	93,3
	72°C / 50°C [1)] ψ^0_{sus} = 0,72	non-cracked	$N_{rec,stat}$	[kN]	7,6	13,8	21,9	31,9	57,6	93,3
Recommended shear load without lever arm [2) 3)]		non-cracked	$V_{rec,stat}$	[kN]	4,6	8,6	13,1	19,4	34,9	56,0
Embedment depth			h_{ef}	[mm]	90	110	125	170	210	280
Edge distance			c ≥	[mm]	165	188	255	315	420	420
Axial distance			s ≥	[mm]	330	375	510	630	840	840

1) Short term temperature/ long term temperature.

2) Shear loads are valid for all specified temperature ranges.

3) In case of seismic action, the annular gap between the anchor rod and the through hole of the attachment must be filled with mortar, otherwise a_{gap} = 0,5 acc. to ETA-20/1280 must be taken into account.

$N_{rec,stat}$, $V_{rec,stat}$ = Recommended load under static and quasi-static action

$N_{rec,eq}$, $V_{rec,eq}$ = Recommended load under seismic action

Rebar

The recommended loads are only valid for single anchors for a roughly design, if the following conditions are valid:

- $c \geq 1{,}5 \times h_{ef}$ $s \geq 3{,}0 \times h_{ef}$ $h \geq 2 \times h_{ef}$
- ψ_{sus} = 1,0; percentage of dead load ≤ ψ^0_{sus} see table below
- The recommended loads have been calculated using the partial safety factors for resistances stated in the ETA and with a partial safety factor for actions of γ_f=1.4. The partial safety factor for seismic action is γ_1 = 1,0.

If the conditions are not fulfilled the loads must be calculated acc. to EN 1992-4.
For further details observe ETA-22/0365.

Recommended loads for a working life of 50 years • Property class BSt 500 • Concrete - C20/25 • **Hammer- (HD) and compressed air drilling (CD)** • dry, wet concrete					Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32	Ø36 [4]	Ø40 [4]
Recommended tension load	40°C / 24°C [1] ψ^0_{sus} = 0,80	non-cracked	$N_{rec,stat}$	[kN]	14,3	20,0	27,0	28,9	32,7	51,9	68,8	71,3	92,6	103,9	127,8	144,6
		cracked	$N_{rec,stat}$	[kN]	6,7	9,4	16,8	20,2	22,9	36,3	48,1	49,9	64,8	72,7	89,5	101,2
			$N_{rec,eq,C1}$	[kN]	6,7	9,4	16,8	20,2	22,9	36,3	48,1	49,9	64,8	72,7	NPA	
	72°C / 50°C [1] ψ^0_{sus} = 0,68	non-cracked	$N_{rec,stat}$	[kN]	11,5	16,2	23,7	28,9	32,7	51,9	68,8	71,3	92,6	103,9		
		cracked	$N_{rec,stat}$	[kN]	5,7	8,1	13,8	16,9	20,9	35,6	48,1	49,9	64,8	72,7		
			$N_{rec,eq,C1}$	[kN]	5,7	8,1	13,8	16,9	20,9	35,6	48,1	49,9	64,8	72,7		
Recommended shear load without lever arm [2] [3]		non-cracked	$V_{rec,stat}$	[kN]	6,7	10,5	14,8	18,0	20,8	34,1	46,4	48,4	63,8	73,0	106,1	121,3
		cracked	$V_{rec,stat}$	[kN]	6,7	8,4	11,7	12,8	14,8	24,2	32,8	34,3	45,2	51,7	75,2	86,0
			$V_{rec,eq,C1}$	[kN]	6,5	8,4	11,7	12,8	14,8	24,2	32,8	34,3	45,2	36,2	NPA	
Embedment depth			h_{ef}	[mm]	80	90	110	115	125	170	205	210	250	270	350	380
Edge distance			c ≥	[mm]	120	135	165	173	188	255	308	315	375	405	525	570
Axial distance			s ≥	[mm]	240	270	330	345	375	510	615	630	750	810	1050	1140

[1] Short term temperature/ long term temperature.

[2] Shear loads are valid for all specified temperature ranges.

[3] In case of seismic action, the annular gap between the bar and the through hole of the attachment must be filled with mortar, otherwise a_{gap} = 0,5 acc. to ETA-22/0365 must be taken into account.

[4] Application is not covered by the ETA-22/0365.

$N_{rec,stat}$, $V_{rec,stat}$ = Recommended load under static and quasi-static action

$N_{rec,eq}$, $V_{rec,eq}$ = Recommended load under seismic action

NPA = no performance assessed

Recommended loads for a working life of 50 years • Property class BSt 500 • Concrete - C20/25 • **Diamond drilling (DD)** • dry, wet concrete					Ø8	Ø10	Ø12	Ø14	Ø16	Ø20	Ø24	Ø25	Ø28	Ø32	Ø36 [4]	Ø40 [4]
Recommended tension load	40°C / 24°C [1] ψ^0_{sus} = 0,77	non-cracked	$N_{rec,stat}$	[kN]	13,4	17,5	25,7	28,9	32,7	51,9	68,8	71,3	92,6	103,9	127,8	144,6
	72°C / 50°C [1] ψ^0_{sus} = 0,72	non-cracked	$N_{rec,stat}$	[kN]	10,5	14,8	19,7	24,1	29,9	48,3	68,8	71,3	92,6	103,9	NPA	
Recommended shear load without lever arm [2) 3)]		non-cracked	$V_{rec,stat}$	[kN]	6,7	10,5	14,8	18,0	20,8	34,1	46,4	48,4	63,8	73,0	106,1	121,3
Embedment depth			h_{ef}	[mm]	80	90	110	115	125	170	205	210	250	270	350	380
Edge distance			c ≥	[mm]	120	135	165	173	188	255	308	315	375	405	525	570
Axial distance			s ≥	[mm]	240	270	330	345	375	510	615	630	750	810	1050	1140

1) Short term temperature/ long term temperature.

2) Shear loads are valid for all specified temperature ranges.

3) In case of seismic action, the annular gap between the bar and the through hole of the attachment must be filled with mortar, otherwise a_{gap} = 0,5 acc. to ETA-22/0365 must be taken into account.

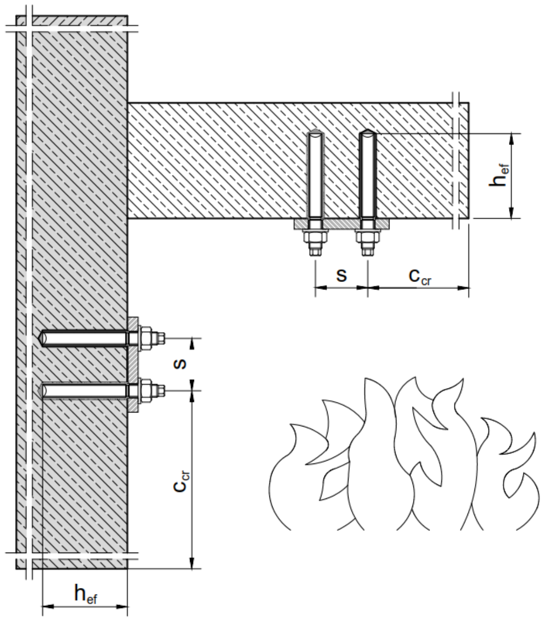
4) Application is not covered by the ETA-22/0365.

$N_{rec,stat}$, $V_{rec,stat}$ = Recommended load under static and quasi-static action

$N_{rec,eq}$, $V_{rec,eq}$ = Recommended load under seismic action

Fire resistance

The present recommended loads of the fire resistance is assessed with respect to its fire resistance properties as anchor applications in walls and ceilings. The assessment is based on the results of the Test Report EBB 170019_1, tests performed according to the requirements of DIN EN 1363-1:2012 and Technical Report 020.



The recommended tension and shear loads under fire exposure of the following table are only valid if the following conditions are met:

- Concrete class min. C20/25
- $c \geq 2{,}0 \times h_{ef}$
- $s \geq 4{,}0 \times h_{ef}$
- Threaded rod zinc plated: Property class min. 5.8 (EN 1993-1-8:2005+AC:2009)
- Threaded rod made of stainless steel and high corrosion resistance steel: Property class min. 70 (EN ISO 3506-1:2009)

The recommended loads have been calculated using the partial safety factor for resistances under fire exposure of $\gamma_{M,fi}$ = 1.0 and with a partial safety factor for actions of γ_F = 1.0.

Embedmend depth h_{ef}	Diameter	Recommended load $N_{rec,fi(t)}$ as function of fire resistance time in minutes							
		R30		R60		R90		R120	
		non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked
[mm]	[mm]	[kN]		[kN]		[kN]		[kN]	
80	M8	1,1	1,1	0,9	0,9	0,4	0,3	0,0	0,0
85		1,1	1,1	0,9	0,9	0,7	0,6	0,0	0,0
90		1,1	1,1	0,9	0,9	0,7	0,7	0,3	0,2
95		1,1	1,1	0,9	0,9	0,7	0,7	0,5	0,4
≥ 100		1,1	1,1	0,9	0,9	0,7	0,7	0,5	0,5
90	M10	1,7	1,7	1,4	1,4	0,9	0,7	0,0	0,0
95		1,7	1,7	1,4	1,4	1,0	0,9	0,2	0,2
100		1,7	1,7	1,4	1,4	1,0	1,0	0,6	0,5
105		1,7	1,7	1,4	1,4	1,0	1,0	0,8	0,8
≥ 110		1,7	1,7	1,4	1,4	1,0	1,0	0,8	0,8

Steel failure is decisive for the values in the grey cells.

Intermediate values can be interpolated linearly. Extrapolation is not permitted.

Embed-mend depth h_{ef}	Dia-meter	Recommended load $N_{rec,fi(t)}$ as function of fire resistance time in minutes							
		R30		R60		R90		R120	
		non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked
[mm]	[mm]	[kN]		[kN]		[kN]		[kN]	
100	M12	3,0	3,0	2,3	2,2	1,5	1,1	0,1	0,1
105		3,0	3,0	2,3	2,3	1,6	1,4	0,7	0,5
110		3,0	3,0	2,3	2,3	1,6	1,6	1,2	0,9
115		3,0	3,0	2,3	2,3	1,6	1,6	1,2	1,2
≥ 120		3,0	3,0	2,3	2,3	1,6	1,6	1,2	1,2
110	M16	5,7	5,7	4,0	3,0	1,9	1,4	0,1	0,1
115		5,7	5,7	4,2	3,4	2,5	1,9	0,7	0,6
120		5,7	5,7	4,2	3,9	3,0	2,3	1,4	1,1
125		5,7	5,7	4,2	4,2	3,0	2,8	2,1	1,5
130		5,7	5,7	4,2	4,2	3,0	3,0	2,2	2,0
135		5,7	5,7	4,2	4,2	3,0	3,0	2,2	2,2
≥ 140		5,7	5,7	4,2	4,2	3,0	3,0	2,2	2,2
120	M20	8,8	8,0	5,2	3,9	2,4	1,8	0,1	0,1
125		8,8	8,8	6,0	4,5	3,2	2,4	0,8	0,6
130		8,8	8,8	6,6	5,1	4,0	3,0	1,7	1,3
135		8,8	8,8	6,6	5,6	4,7	3,5	2,6	1,9
140		8,8	8,8	6,6	6,2	4,7	4,1	3,3	2,5
145		8,8	8,8	6,6	6,6	4,7	4,7	3,4	3,1
150		8,8	8,8	6,6	6,6	4,7	4,7	3,4	3,4
≥ 155		8,8	8,8	6,6	6,6	4,7	4,7	3,4	3,4
130	M24	12,71	10,17	6,67	5,00	3,07	2,30	0,10	0,08
135		12,71	11,26	7,58	5,69	4,03	3,03	0,87	0,66
140		12,71	12,40	8,49	6,37	4,97	3,72	2,07	1,56
145		12,71	12,71	9,40	7,05	5,89	4,41	3,10	2,33
150		12,71	12,71	9,53	7,74	6,71	5,10	4,06	3,05
155		12,71	12,71	9,53	8,51	6,71	5,78	4,94	3,74
160		12,71	12,71	9,53	9,39	6,71	6,46	4,94	4,43
165		12,71	12,71	9,53	9,53	6,71	6,71	4,94	4,94
≥ 170		12,71	12,71	9,53	9,53	6,71	6,71	4,94	4,94
135	M27	15,25	11,44	7,40	5,55	3,08	2,31	0,01	0,01
140		16,52	12,63	8,43	6,32	4,20	3,15	0,37	0,28
145		16,52	13,90	9,47	7,10	5,29	3,97	1,74	1,30
150		16,52	15,16	10,49	7,86	6,33	4,75	2,99	2,24
155		16,52	16,52	11,52	8,64	7,38	5,53	4,13	3,10
160		16,52	16,52	12,39	9,42	8,41	6,31	5,21	3,91
165		16,52	16,52	12,39	10,31	8,72	7,07	6,26	4,69
170		16,52	16,52	12,39	11,30	8,72	7,84	6,43	5,47
175		16,52	16,52	12,39	12,37	8,72	8,60	6,43	6,24
180		16,52	16,52	12,39	12,39	8,72	8,72	6,43	6,43
≥ 185		16,52	16,52	12,39	12,39	8,72	8,72	6,43	6,43

Steel failure is decisive for the values in the grey cells.

Intermediate values can be interpolated linearly. Extrapolation is not permitted.

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Embed-mend depth h_{ef}	Dia-meter	Recommended load $N_{rec,fi(t)}$ as function of fire resistance time in minutes							
		R30		R60		R90		R120	
		non-cracked	cracked	non-cracked	cracked	non-cracked	cracked	non-cracked	cracked
[mm]	[mm]	[kN]		[kN]		[kN]		[kN]	
140	M30	17,15	12,86	8,19	6,14	3,07	2,30	0,00	0,00
145		18,88	14,16	9,35	7,01	4,38	3,28	0,19	0,14
150		20,2	15,52	10,50	7,87	5,60	4,20	1,24	0,93
155		20,2	16,96	11,65	8,74	6,79	5,09	2,80	2,10
160		20,2	18,43	12,80	9,60	7,96	5,97	4,14	3,10
165		20,2	19,92	13,94	10,45	9,12	6,84	5,38	4,03
170		20,2	20,20	15,12	11,34	10,27	7,70	6,58	4,93
175		20,2	20,20	15,12	12,36	10,66	8,56	7,74	5,81
180		20,2	20,20	15,12	13,49	10,66	9,41	7,85	6,67
185		20,2	20,20	15,12	14,69	10,66	10,27	7,85	7,53
190		20,2	20,20	15,12	15,15	10,66	10,66	7,85	7,85
≥ 195		20,2	20,20	15,12	15,15	10,66	10,66	7,85	7,85

Steel failure is decisive for the values in the grey cells.

Intermediate values can be interpolated linearly. Extrapolation is not permitted.

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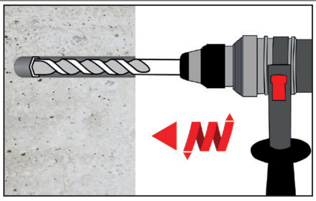
3. Post-installed rebar

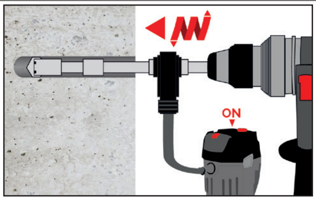
Installation instructions

A) Bore hole drilling

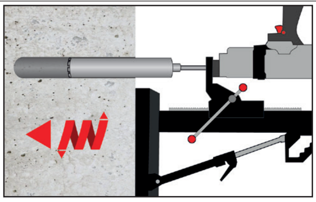
Note: Before drilling, remove carbonated concrete and clean contact areas. In case of aborted drill hole, the drill hole shall be filled with mortar.



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 reinforcing bar.
Proceed with Step B1.



1b. Hollow drill bit system (HDB).
Drill a hole into the base material to the size and embedment depth required by the selected reinforcing bar. This drill system removes the dust and cleans the bore hole during drilling.
Proceed with Step C.

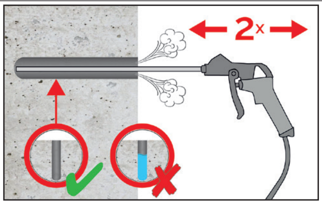


1c. Diamond drilling (DD).
Drill with diamond drill a hole into the base material to the size and embedment depth required by the selected anchor.
Proceed with Step B2.

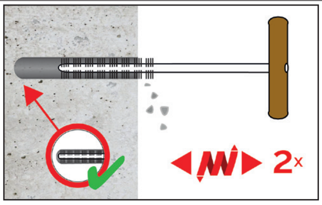
Attention! Standing water in the bore hole must be removed before cleaning.

B1) Bore hole cleaning

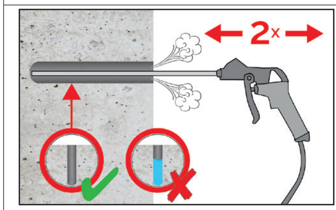
CAC: Cleaning for all bore hole diameter and bore hole depth with drilling method HD and CD



2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (see page 22) a minimum of two times until return air stream is free of noticable dust.
If the bore hole ground is not reached, an extension shall be used.

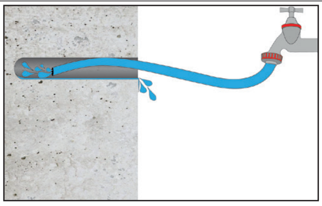
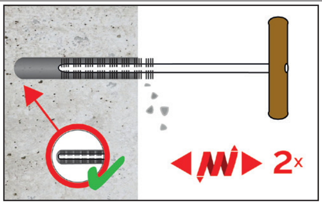
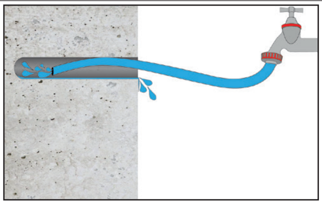
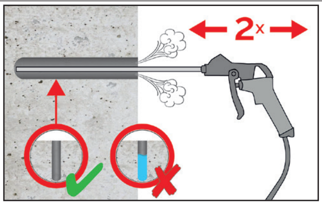
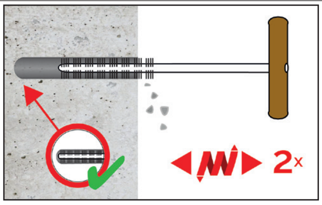
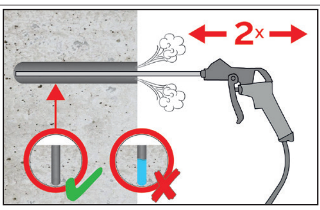


2b. Check the brush diameter (see page 22). Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (see page 22) a minimum of two times.
If the bore hole ground is not reached with the brush, a brush extension shall be used.



2c. Finally blow the hole clean again with compressed air (min. 6 bar) (see page 22) a minimum of two times until return air stream is free of noticable 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 dispending 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.

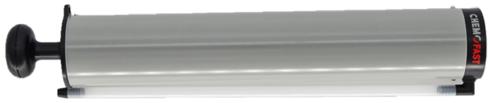
B2) Bore hole cleaning	
SPCAC: Cleaning for all bore hole diameter and bore hole depth with drilling method DD	
	**2a.** Rinsing with water until clear water comes out.
	**2b.** Check the brush diameter (see page 22). Brush the hole with an ap-propriate sized wire brush > $d_{b,min}$ (see page 22) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension shall be used.
	**2c.** Rinsing again with water until clear water comes out.
Attention! Standing water in the bore hole must be removed before cleaning.	
	**2a.** Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) (see page 22) a minimum of two times until return air stream is free of noticable dust. If the bore hole ground is not reached, an extension shall be used
	**2b.** Check the brush diameter (see page 22). Brush the hole with an ap-propriate sized wire brush > $d_{b,min}$ (see page 22) a minimum of two times. If the bore hole ground is not reached with the brush, a brush extension shall be used.
	**2c.** Finally blow the hole clean again with compressed air (min. 6 bar) (see page 22) a minimum of two times un-til return air stream is free of noticable 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 dispending 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.	

Cleaning and installation tools

Rec. compressed air tool hand slide valve
(min. 6 bar)

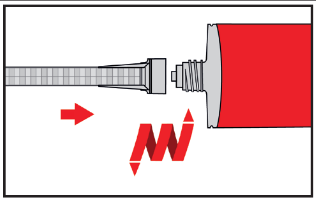
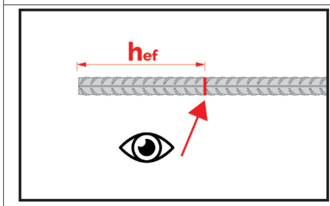
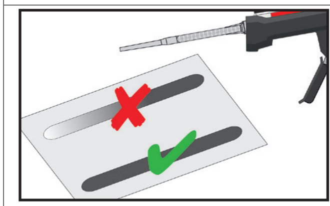
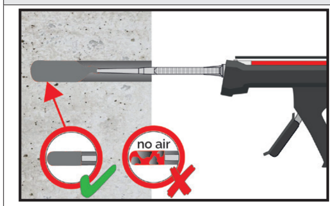
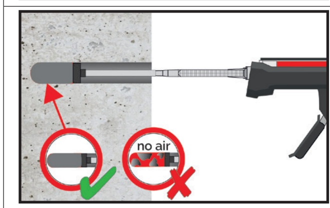
Brush RBT and brush extension

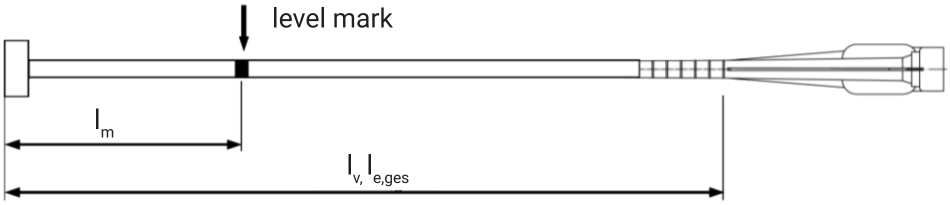
Hand pump (volume 750 ml)



SDS Plus Adapter

HDB - Hollow drill bit

C) Preparation of bar and cartridge	
	**3a.** Attach the static mixer tightly onto the cartridge and insert the cartridge into a suitable dispensing tool. For every working interruption longer than the recommended working time (see page 4) as well as for new cartridges, a new static-mixer shall be used.
	**3b.** Prior to inserting the reinforcing bar into the filled bore hole, the position of the embedment depth shall be marked (e.g. with tape) on the reinforcing bar and insert bar in empty hole to verify hole and depth l_v (see page 24). The bar should be free of dirt, grease, oil or other foreign material.
	**3c.** Prior to dispensing into the anchor hole, squeeze out separately the mortar until it shows a consistent gray colour, but a minimum of three full strokes (≥ 10 cm) and discard non-uniformly mixed adhesive components.
D) Filling the bore hole	
 	**4.** Starting from the bottom or back of the cleaned bore hole with adhesive, until the level mark at the mixer extension (see below) is visible at the top of the hole. Slowly withdraw the static mixing nozzle and using a piston plugs during injection of the mortar, helps to avoid creating air pockets. For overhead and horizontal installation and bore holes deeper than 240 mm a piston plug and the appropriate mixer extension must be used. Observe the gel-/working times given on table page 4.



Injection tool must be marked by mortar level mark l_m and anchorage depth l_v resp. $l_{e,ges}$ with tape or marker.
Quick estimation: $l_m = 1/3 * l_v$

Continue injection until mortar level mark l_m becomes visible.

Optimum mortar volume: $l_m = l_v$ rep. $l_{e,ges} * (1,2 * Ø^2/d_0^2 * 0,2)$ [mm]

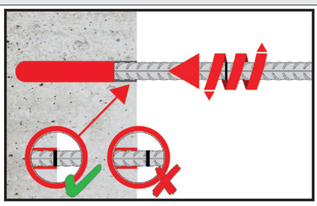
Brushes, piston plugs, maximum embedment depth and mixer extension, hammer (HD), diamond (DD) and compressed air drilling (CD)

Bar size Ø	Tension anchor Ø	Drill bit-Ø HD	Drill bit-Ø DD	Drill bit-Ø CD	d_b Brush - Ø	d_b Brush - Ø	$d_{b,min}$ min. Brush - Ø	Piston plug	Cartridge: 585 ml, Hand or battery tool, $l_{v,max}$	Cartridge: 585 ml, Hand or battery tool, Mixer extension	Cartridge: 585 ml, Pneumatic tool, $l_{v,max}$	Cartridge: 585 ml, Pneumatic tool, Mixer extension
[mm]	[mm]	[mm]	[mm]	[mm]	[-]	[mm]	[mm]	[Nr.]	[cm]	[-]	[cm]	[-]
8	-	10		-	RB10	11,5	10,5	-	250	VL 10/0,75 or VL 16/1,8	250	VL 10/0,75 or VL 16/1,8
	-	12		-	RB12	13,5	12,5	-	700		800	
10	-	12		-	RB12	13,5	12,5	-	250		250	
	-	14		-	RB14	15,5	14,5	#14	700		1000	
12	ZA-M12	14		-	RB14	15,5	14,5	#14	250		250	
		16			RB16	17,5	16,5	#16	700		1300	
14	-	18			RB18	20,0	18,5	#18				
16	ZA-M16	20			RB20	22,0	20,5	#20				
20	ZA-M20	25		-	RB25	27,0	25,5	#25	500		1000	
		-		26	RB26	28,0	26,5	#25				
22	-	28			RB28	30,0	28,5	#28				
24/25	ZA-M24	32			RB32	34,0	32,5	#32				
28	-	35			RB35	37,0	35,5	#35				
32/34	-	40			RB40	43,5	40,5	#40				
36	-	45			RB45	47,0	45,5	#45	-	-		
40	-	-	52	-	RB52	54,0	52,5	#52				
		55	-	55	RB55	58,0	55,5	#55				

Brushes, piston plugs, maximum embedment depth and mixer extension, hollow drill bit system (HDB)

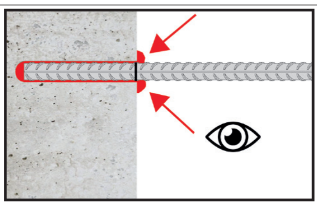
Bar size Ø	Tension anchor Ø	Drill bit-Ø HDB	d_b Brush - Ø		$d_{b,min}$ min. Brush - Ø	Piston plug	Cartridge: 585 ml Hand or battery tool $l_{v,max}$	Mixer extension	Pneumatic tool $l_{v,max}$	Mixer extension
[mm]	[mm]	[mm]	[-]	[mm]	[mm]	[Nr.]	[cm]	[-]	[cm]	[-]
8	-	10	No cleaning required			-	250	VL 10/0,75 or VL 16/1,8	250	VL 10/0,75 or VL 16/1,8
	-	12				-	700		800	
10	-	12				-	250		250	
	-	14				VS14	700		1000	
12	ZA-M12	14					250		250	
		16				VS16	700		1000	
14	-	18				VS18				
16	ZA-M16	20				VS20				
20	ZA-M20	25				VS25	500			
22	-	28				VS28				
24/25	ZA-M24	32				VS32				
28	-	35				VS35				
32/34	-	40				VS40				

E) Inserting the rebar

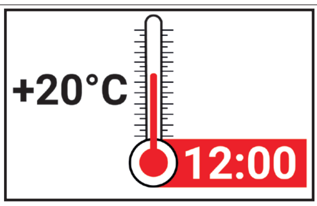


5a. Push the reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached.

The bar should be free of dirt, grease, oil or other foreign material.



5b. Be sure that the bar is inserted in the bore hole until the embedment mark is at the concrete surface and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod shall be fixed e.g. with wedges.



5c. Observe gelling time t_{gel} . Attend that the gelling time can vary according to the base material temperature (see page 4). It is not allowed to move the bar after gelling time t_{gel} has elapsed. Allow the adhesive to cure to the specified time prior to applying any load. Do not move or load the bar until it is fully cured (attend table on page 4). After full curing time t_{cure} has elapsed, the add-on part can be installed.

Design anchorage and lap length

The calculation of the design anchoring lengths of reinforcing bars, if used as end anchoring or as overlapping joint, has to consider the details and provisions of the approval ETA-22/0365 and the EN 1992-1-1:2004+AC:2010.
The design load with corresponding failure mode („pull-out failure“ or „steel failure“) were determined for selected rebar diameters and anchorage lengths. The results for end anchoring and overlapping joints are given in the tables below.

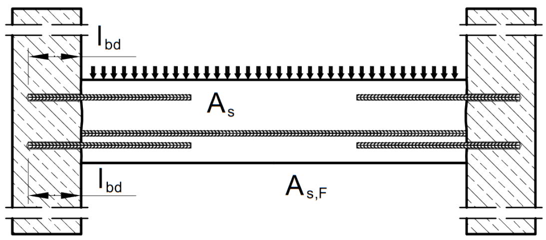
The calculations are based on following assumptions:

- Rebar BSt 500 S, f_{yk} = 500 N/mm², material safety factor of γ_s = 1,15
- Concrete class C20/25 and „good bond conditions“ acc. EN 1992-1-1:2004+AC:2010 considered. Rebar diameters ≤ d = 32 mm.
- The bond properties of the bars is considered by the coefficients:

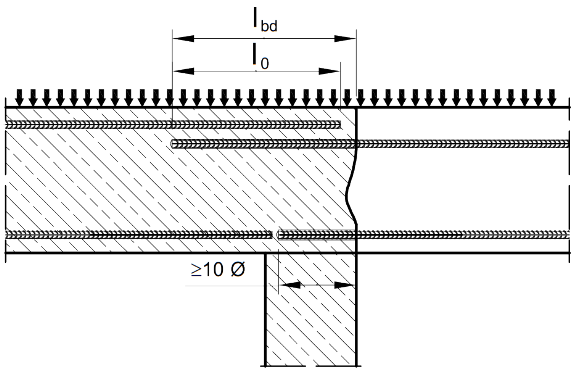
a_1	= 1,0;	is for the effect of the form of the bars assuming adequate cover; 1,0 for straight rebars
a_2	= 1,0;	is for the effect of concrete minimum cover; has to be checked
a_3	= 1,0;	is for the effect of confinement by transverse reinforcement; 1,0 for no transverse reinforcement
a_4	= 1,0;	is for the influence of one or more welded transverse bars; 1,0 for no welded transverse reinforcement
a_5	= 1,0;	is for the effect of the pressure transverse; 1,0 if no transverse pressure is assumed
a_6	= 1,5;	is for the percentage of lapped bars relative to the total cross-section area, 1,5 due to the given situation on the construction side

All drilling methods (hammer drilling (HD), compressed air drilling (CD), Hollow drill bit (HDB), Diamond drilling (DD)) are considered by the amplification factor of a_{lb} = 1,0

End anchoring of slabs or beams (e.g. designed as simply supported)



Overlapping joint for rebar connections of slabs and beams



Rebar Ø8 - Ø32			End anchoring			Overlapping joint		
• Concrete class C20/25 • Rebar BSt 500 S; f_{yk} = 500 N/mm² • Hammer- (HD), hollow- (HDB), compressed air (CD) or diamond drilling (DD)			$a_1 = a_2 = a_3 = a_4 = a_5 = 1{,}0$ $a_{lb} = 1{,}0$			$a_1 = a_2 = a_3 = a_4 = a_5 = 1{,}0$ $a_6 = 1{,}5$ $a_{lb} = 1{,}0$		
d	$N_{Rd,s}$	$l_{v,max}$	l_{bd}	N_{Rd}	Volume Mortar	l_0	N_{Rd}	Volume Mortar [1)]
[mm]	[kN]	[mm]	[mm]	[kN]	[ml]	[mm]	[kN]	[ml]
Ø8	21,9	1000 (1000)	113	6,6	9	200	7,7	15
			200	11,6	15	320	12,3	24
			290	16,8	22	440	17,0	33
			378	21,9	29	567	21,9	43
Ø10	34,1	1000 (1000)	142	10,2	13	213	10,2	19
			250	18,1	23	380	18,3	34
			360	26,0	33	550	26,5	50
			473	34,1	43	709	34,1	64
Ø12	49,2	1200 (1000)	170	14,8	18	255	14,8	27
			300	26,0	32	450	26,0	48
			430	37,3	45	650	37,6	69
			567	49,2	60	851	49,2	90
Ø14	66,9	1400 (1000)	198	20,1	24	298	20,1	36
			350	35,4	42	530	35,7	64
			500	50,6	60	760	51,3	92
			662	66,9	80	992	66,9	120
Ø16	87,4	1600 (1000)	227	26,2	31	340	26,2	46
			400	46,2	54	600	46,2	81
			580	67,1	79	860	66,3	117
			756	87,4	103	1134	87,4	154
Ø20	136,6	2000 (1000)	284	41,0	60	425	41,0	90
			500	72,3	106	760	73,2	161
			720	104,0	153	1090	105,0	231
			945	136,6	200	1418	136,6	301
Ø22	165,3	2000 (1000)	312	49,6	22	468	49,6	132
			550	87,4	39	830	88,0	235
			790	125,6	56	1190	126,1	336
			1040	165,3	73	1560	165,3	441
Ø24	196,7	2000 (1000)	340	59,0	144	510	59,0	216
			600	104,0	253	910	105,2	384
			860	149,1	363	1310	151,4	553
			1134	196,7	479	1701	196,7	718
Ø25	213,4	2000 (1000)	354	64,0	133	532	64,0	200
			630	113,8	237	950	114,4	357
			910	164,4	342	1360	163,8	511
			1181	213,4	444	1772	213,4	666

[1)] Mortar volume of the overlap joint. The mortar volume of the concrete cover c_1, at the face of the existing reinforcing steel, was not taken into account.

[2)] $l_{v,max}$ is limited to 1000 mm, see ETA-22/0365.

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Rebar Ø8 - Ø32 • Concrete class C20/25 • Rebar BSt 500 S; f_{yk} = 500 N/mm² • Hammer- (HD), hollow- (HDB), compressed air (CD) or diamond drilling (DD)			End anchoring $a_1 = a_2 = a_3 = a_4 = a_5 = 1{,}0$ $a_{lb} = 1{,}0$			Overlapping joint $a_1 = a_2 = a_3 = a_4 = a_5 = 1{,}0$ $a_6 = 1{,}5$ $a_{lb} = 1{,}0$		
d	$N_{Rd,s}$	$l_{v,max}$	l_{bd}	N_{Rd}	Volume Mortar	l_0	N_{Rd}	Volume Mortar [1)]
[mm]	[kN]	[mm]	[mm]	[kN]	[ml]	[mm]	[kN]	[ml]
Ø28	267,7	2000 (1000)	397	80,3	165	595	80,3	247
			710	143,6	295	1060	143,0	441
			1020	206,4	424	1520	205,0	632
			1323	267,7	550	1985	267,7	825

[1)] Mortar volume of the overlap joint. The mortar volume of the concrete cover c_1, at the face of the existing reinforcing steel, was not taken into account.

[2)] $l_{v,max}$ is limited to 1000 mm, see ETA-22/0365.

The specified design load N_{Rd} (End anchoring, Overlapping joints) can be converted to further concrete classes, while maintaining the previously accepted boundary conditions and anchorage lengths l_{bd} or lap length l_0, with the approach as follows:

$N_{Rd,con}$ = min ($N_{Rd,s}$; N_{Rd} * $f_{bd,con}$- Factor) [kN]

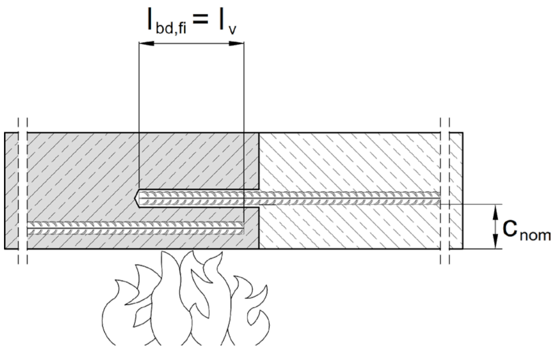
The conversion factor $f_{bd,con}$ can be taken from the table below:

Rebar Ø	Ø8 to Ø32 mm ZA-M12 to ZA-M24		Ø 34 mm		Ø 36 mm		Ø 40 mm	
Concrete class	f_{bd}	$f_{bd,con}$ - Factor	f_{bd}	$f_{bd,con}$ - Factor	f_{bd}	$f_{bd,con}$ - Factor	f_{bd}	$f_{bd,con}$ - Factor
[-]	[N/mm²]	[-]	[N/mm²]	[-]	[N/mm²]	[-]	[N/mm²]	[-]
C12/15	1,6	0,70	1,6	0,70	1,5	0,68	1,5	0,71
C16/20	2,0	0,87	2,0	0,87	1,9	0,86	1,8	0,86
C20/25	2,3	1,00	2,3	1,00	2,2	1,00	2,1	1,00
C25/30	2,7	1,17	2,6	1,13	2,6	1,18	2,5	1,19
C30/37	3,0	1,30	2,9	1,26	2,9	1,32	2,8	1,33
C35/45	3,4	1,48	3,3	1,43	3,3	1,50	3,1	1,48
C40/50	3,7	1,61	3,6	1,57	3,6	1,64	3,4	1,62
C45/55	4,0	1,74	3,9	1,70	3,8	1,73	3,7	1,76
C50/60	4,3	1,87	4,2	1,83	4,1	1,86	4,0	1,90

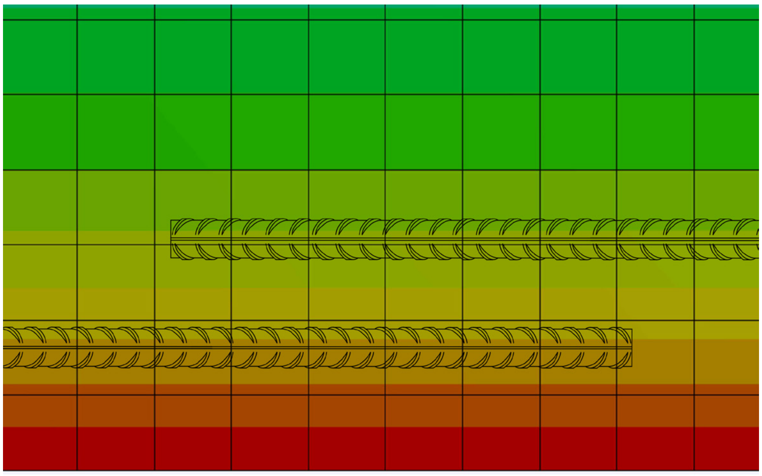
Fire resistance - Overlapping joints

The present tables are supplying the mean reduction factor $\bar{k}_{\Theta(x)}$, needed for determining the design bond strength $f_{bd,fi}$ of post-installed rebar connections under fire exposure in a fire-resistance grating.

The specified mean reduction factor $\bar{k}_{\Theta(x)}$ is valid for slab to slab connections (overlapping joints), where the lower surface is exposed perpendicular to fire (one side), the temperature is uniform. Therefore the bond resistance is uniform along the bond also and depends on the concrete cover and the duration of the fire.



The heat development of structural members is calculated by a fire model, based on the standard uniform-temperature-time-curve (UTTC) acc. to ISO 834-1 and tries to simulate a real fire.
Below the calculated heat distribution of a slab after a temperature impact of 14400 sec. (240 min) for the fire-resistance grade R240.



The effect of heat on the bond strength of the mortar was determined by tests and is expressed by the reduction factor $k_{b,fi}$ (Θ) given in the ETA-22/0365.

The calculation of the required design lap length l_0 shall be carried out in accordance with EN 1992-1-1:2004+AC:2010, section 8.7.3 and the provisions of the ETA-22/0365 shall be met.
The design value of the bond strength $f_{bd,fi}$ under fire exposure has to be calculated by the following equation:

$$f_{bd,fi} = \bar{k}_{\Theta(x)} * f_{bd,PIR} * \gamma_c / \gamma_{M,fi} * f_{bd,fi,con} \leq f_{bd,PIR}$$

with:

- $f_{bd,fi}$ = Design value of the bond strength under fire exposure in N/mm²
- $\bar{k}_{\Theta(x)}$ = Mean reduction factor under fire exposure as a function of the temperature profile, given in the tables below
- $f_{bd,PIR}$ = Design value of the bond strength in cold condition acc. ETA-22/0365, tab. C2 depending on concrete class, rebar diameter, drilling method and bonding range acc. EN 1992-1-1 in N/mm²
- γ_c = Partial safety factor of concrete acc. EN 1992-1-1; 1,5 in absence of national regulation
- $\gamma_{M,fi}$ = Partial safety factor of fire exposure acc. EN 1992-1-2; 1,0 in absence of national regulation
- $f_{bd,fi,con}$ = Conversion factor taking into account the influence of the concrete class

The mean reduction factor $\bar{k}_{\Theta(x)}$ for slab to slab connections with rebar Ø8 - Ø32 mm and fire at 30, 60, 90, 120, 180 or 240 min is given for a concrete cover c_{nom} in the present table and valid for good bond conditions only:

Overlapping joint						
Rebar Ø8 - Ø40 mm	Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ 2)					
	Fire-resistance grading					
c_{nom} 1)	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]
10						
15	0,00					
20						
25						
30	0,07	0,00				
35	0,09		0,00			
40	0,12			0,00		
45	0,16					
50	0,21	0,07			0,00	0,00
55	0,28	0,08				
60	0,36	0,10	0,06			
65	0,47	0,13	0,07			
70	0,58	0,15	0,08			
75	0,72	0,18	0,10	0,06		
80	0,86	0,22	0,11	0,07		
85	1,00	0,26	0,13	0,08		
90	1,00	0,31	0,15	0,10		

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Overlapping joint						
Rebar Ø8 - Ø40 mm	Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ [2]					
	Fire-resistance grading					
c_{nom} [1]	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]
95	1,00	0,36	0,17	0,11	0,06	0,00
100	1,00	0,42	0,20	0,13	0,07	
105	1,00	0,49	0,23	0,14	0,08	
110	1,00	0,57	0,27	0,16	0,09	0,06
115	1,00	0,65	0,31	0,18	0,10	0,07
120	1,00	0,76	0,35	0,21	0,11	0,07
125	1,00	0,86	0,40	0,24	0,12	0,08
130	1,00	0,97	0,46	0,27	0,14	0,09
135	1,00	1,00	0,52	0,31	0,15	0,10
140	1,00	1,00	0,58	0,34	0,17	0,11
145	1,00	1,00	0,66	0,39	0,19	0,12
150	1,00	1,00	0,74	0,44	0,21	0,13
155	1,00	1,00	0,83	0,49	0,23	0,14
160	1,00	1,00	0,94	0,54	0,26	0,16
165	1,00	1,00	1,00	0,61	0,29	0,17
170	1,00	1,00	1,00	0,68	0,32	0,19
175	1,00	1,00	1,00	0,74	0,35	0,21
180	1,00	1,00	1,00	0,81	0,38	0,23

[1] c_{nom} = concrete cover
[2] $\bar{k}_{\Theta(x)}$= Mean reduction factor over the embedment depth of the rebar as a function of the temperature profile l

Intermediate values of $\bar{k}_{\Theta(x)}$ may be interpolated linearly. Extrapolation is not permitted.

The bond strength $f_{bd,PIR}$ depends on the concrete class and rebar diameter as well as the corresponding conversion factor $f_{bd,fi,con}$ and can be found in the following table:

Concrete class	Ø-Rebar	$f_{bd,PIR}$ (all drilling methods)	$f_{bd,fi,con}$ - Factor
[-]	[mm]	[N/mm²]	[-]
C12/15	Ø8 - Ø34	1,6	1,44
	Ø36, Ø40	1,5	1,53
C16/20	Ø8 - Ø34	2,0	1,15
	Ø36	1,9	1,21
	Ø40	1,8	1,28
C20/25	Ø8 - Ø34	2,3	1,00
	Ø36	2,2	1,05
	Ø40	2,1	1,10
C25/30	Ø8 - Ø32	2,7	0,85
	Ø34, Ø36	2,6	0,88
	Ø40	2,5	0,92
C30/37	Ø8 - Ø32	3,0	0,77
	Ø34, Ø36	2,9	0,79
	Ø40	2,8	0,82
C35/45	Ø8 - Ø32	3,4	0,68
	Ø34, Ø36	3,3	0,70
	Ø40	3,1	0,74
C40/50	Ø8 - Ø32	3,7	0,62
	Ø34, Ø36	3,6	0,64
	Ø40	3,4	0,68
C45/55	Ø8 - Ø32	4,0	0,58
	Ø34	3,9	0,59
	Ø36	3,8	0,61
	Ø40	3,7	0,62
C50/60	Ø8 - Ø32	4,3	0,53
	Ø34	4,2	0,55
	Ø36	4,1	0,56
	Ø40	4,0	0,58

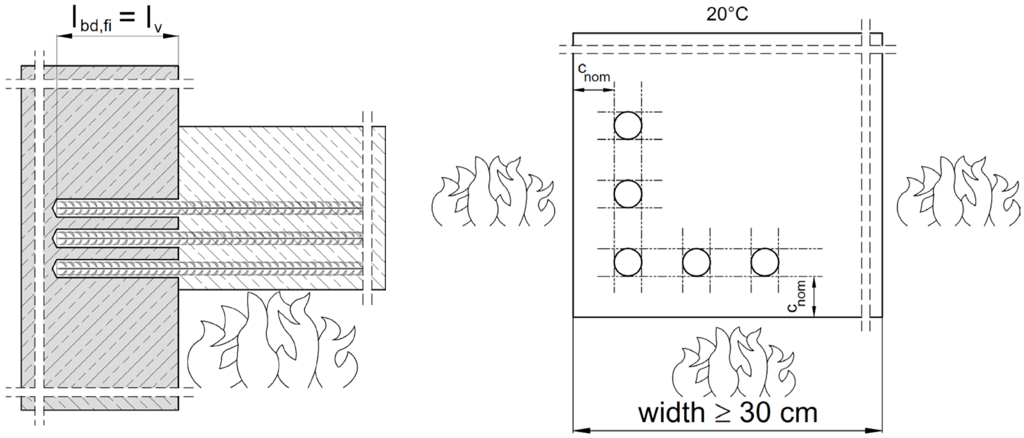
The given values does not deal with the mechanical design at ambient temperature, these shall be done in addition and related to ETA-22/0365.

Post-installed rebar connections shall be designed in ambient temperature conditions before being designed in fire conditions.

The partial safety factor for actions can be assumed to be γ_F = 1,0 for determining recommended loads.

Fire resistance - Beam/wall or column/slab

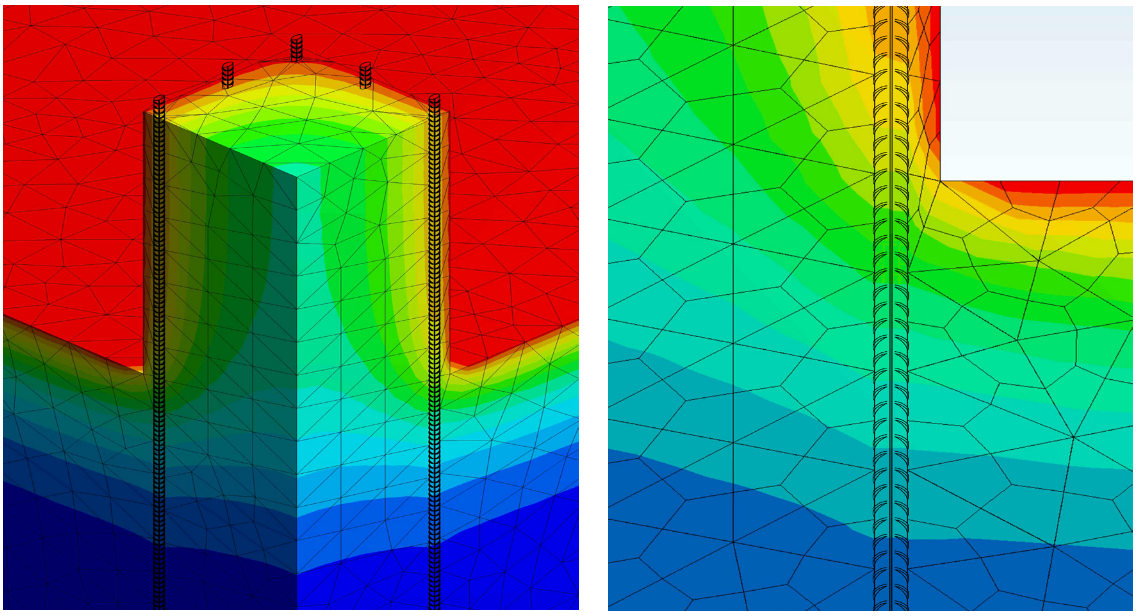
The present table is supplying the mean reduction factor $\bar{k}_{\Theta(x)}$, needed for determining the design bond strength $f_{bd,fi}$ of post-installed rebar connections under fire exposure in a fire-resistance rating.
The mean reduction factor $\bar{k}_{\Theta(x)}$ is valid for beam to wall or column to slab connections, where the rebar is bonded inside the wall or slab, there is a temperature gradient in the thickness of the wall respectively slab if the beam (three sides) or column is exposed to fire (four sides).



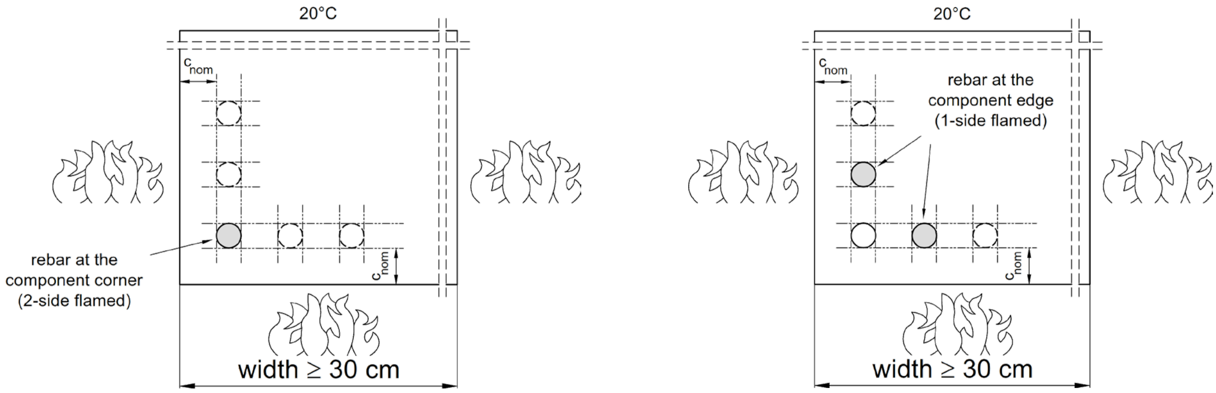
The temperature along the bonding interface is not uniform and depends on the fire duration, the anchoring length and the concrete cover of the rebar inside the beam (which acts as a protection against thermal exposure). Therefore, the temperature profiles along the bond are determined for each fire duration, for each bonded length and for the concrete covers inside the beam of c_{nom} = 10, 20, 30 and 40 mm.

The given mean reduction factor $\bar{k}_{\Theta(x)}$ is a mean value as a function of the temperature profile along the bonding length.

The calculated model of the fire is based on the standard uniform-temperature-time-curve (UTTC) acc. to ISO 834-1 and tries to simulate the heat development of structural members at a real fire. Below the calculated heat distribution of a beam / column and wall / slab after a temperature impact of 14400 sec. (240 min) for the fire-resistance grade R240.



The fire model determines the heat distribution for rebars at the component corner (2 sides flamed) and at the component edge (1 side flamed).



The effect of heat on the bond strength of the mortar was determined by tests and is expressed by the reduction factor $k_{b,fi}$ (Θ) given in the ETA-22/0365.
The calculation of the required design lap length l_0 shall be carried out in accordance with EN 1992-1-1:2004+AC:2010, section 8.7.3 and the provisions of the ETA-22/0365 shall be met.
The design value of the bond strength $f_{bd,fi}$ under fire exposure has to be calculated by the following equation:

$$f_{bd,fi} = \bar{k}_{\Theta(x)} * f_{bd,PIR} * \gamma_c / \gamma_{M,fi} * f_{bd,fi,con} \leq f_{bd,PIR}$$

with:

$f_{bd,fi}$ = Design value of the bond strength under fire exposure in N/mm²

$\bar{k}_{\Theta(x)}$ = Mean reduction factor under fire exposure as a function of the temperature profile, given in the tables below

$f_{bd,PIR}$ = Design value of the bond strength in cold condition acc. ETA-22/0365, tab. C2 depending on concrete class, rebar diameter, drilling method and bonding range acc. EN 1992-1-1 in N/mm²

γ_c = Partial safety factor of concrete acc. EN 1992-1-1; 1,5 in absence of national regulation

$\gamma_{M,fi}$ = Partial safety factor of fire exposure acc. EN 1992-1-2; 1,0 in absence of national regulation

$f_{bd,fi,con}$ = Conversion factor taking into account the influence of the concrete class

The mean reduction factor $\bar{k}_{\Theta(x)}$ for e.g. beam on wall or column on slab applications for concrete covers of c_{nom} = 10, 20, 30 and 40 mm with the corresponding diameter of the rebar and fire-resistance grading at 30, 60, 90, 120, 180 or 240 min is given for a rebar at the edge (1 side flamed) or at the corner (2 sides flamed) in the following tables and valid for good bond conditions:

End anchoring - Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ [3]												
c_{nom} = 10 mm [1]	Rebar at the edge (1 side flamed)						Rebar at the corner (2 sides flamed)					
Rebar Ø8 - Ø20	Fire-resistance grading						Fire-resistance grading					
l_v [2]	R30	R60	R90	R120	R180	R240	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
80	0,29	0,10	0,07	0,05	0,03	0,03	0,16	0,06	0,04	0,03	0,02	0,02
90	0,36	0,12	0,08	0,06	0,04	0,03	0,21	0,08	0,05	0,03	0,02	0,02
100	0,42	0,15	0,09	0,07	0,04	0,03	0,27	0,10	0,06	0,04	0,03	0,02
110	0,48	0,18	0,11	0,08	0,05	0,03	0,34	0,12	0,07	0,05	0,03	0,03
120	0,52	0,23	0,13	0,09	0,05	0,04	0,39	0,14	0,08	0,06	0,04	0,03
130	0,56	0,28	0,15	0,10	0,06	0,04	0,44	0,17	0,10	0,07	0,04	0,03
140	0,59	0,33	0,19	0,12	0,07	0,05	0,48	0,21	0,13	0,08	0,05	0,04
150	0,62	0,38	0,22	0,14	0,08	0,05	0,51	0,25	0,16	0,10	0,06	0,04
160	0,64	0,41	0,27	0,17	0,09	0,06	0,54	0,30	0,19	0,12	0,07	0,05
170	0,66	0,45	0,31	0,20	0,11	0,07	0,57	0,34	0,24	0,15	0,08	0,06
180	0,68	0,48	0,35	0,24	0,12	0,08	0,60	0,38	0,28	0,18	0,09	0,06
190	0,70	0,51	0,38	0,28	0,14	0,09	0,62	0,41	0,32	0,21	0,11	0,07
200	0,71	0,53	0,42	0,31	0,16	0,10	0,64	0,44	0,35	0,25	0,13	0,08
210	0,73	0,55	0,44	0,34	0,18	0,11	0,65	0,47	0,38	0,29	0,15	0,09
220	0,74	0,57	0,47	0,37	0,21	0,13	0,67	0,49	0,41	0,32	0,17	0,11
230	0,75	0,59	0,49	0,40	0,24	0,14	0,68	0,51	0,44	0,35	0,20	0,12
240	0,76	0,61	0,51	0,43	0,27	0,16	0,70	0,53	0,46	0,38	0,23	0,14
250	0,77	0,63	0,53	0,45	0,30	0,18	0,71	0,55	0,48	0,40	0,26	0,16
260	0,78	0,64	0,55	0,47	0,33	0,21	0,72	0,57	0,50	0,43	0,29	0,18
270	0,79	0,65	0,57	0,49	0,35	0,23	0,73	0,58	0,52	0,45	0,32	0,20
280	0,79	0,67	0,58	0,51	0,38	0,26	0,74	0,60	0,54	0,47	0,34	0,23
290	0,80	0,68	0,60	0,53	0,40	0,28	0,75	0,61	0,55	0,48	0,36	0,26
300	0,81	0,69	0,61	0,54	0,42	0,31	0,76	0,63	0,57	0,50	0,39	0,28
310	0,81	0,70	0,62	0,56	0,44	0,33	0,77	0,64	0,58	0,52	0,41	0,30
320	0,82	0,71	0,63	0,57	0,45	0,35	0,77	0,65	0,60	0,53	0,42	0,33
350	0,84	0,73	0,67	0,61	0,50	0,41	0,79	0,68	0,63	0,57	0,47	0,38
400	0,86	0,77	0,71	0,66	0,56	0,48	0,82	0,72	0,68	0,63	0,54	0,46
450	0,87	0,79	0,74	0,69	0,61	0,54	0,84	0,75	0,71	0,67	0,59	0,52
500	0,88	0,81	0,77	0,72	0,65	0,58	0,85	0,78	0,74	0,70	0,63	0,57
550	0,90	0,83	0,79	0,75	0,68	0,62	0,87	0,80	0,76	0,73	0,66	0,61
600	0,90	0,84	0,81	0,77	0,71	0,65	0,88	0,81	0,78	0,75	0,69	0,64
700	0,92	0,87	0,83	0,80	0,75	0,70	0,90	0,84	0,82	0,79	0,74	0,69
800	0,93	0,88	0,85	0,83	0,78	0,74	0,91	0,86	0,84	0,81	0,77	0,73
900	0,94	0,90	0,87	0,85	0,81	0,77	0,92	0,88	0,86	0,83	0,80	0,76
1000	0,94	0,91	0,88	0,86	0,83	0,79	0,93	0,89	0,87	0,85	0,82	0,78

[1] c_{nom} = concrete cover
[2] l_v = embedment length of the bar in the concrete
[3] $\bar{k}_{\Theta(x)}$ = Mean reduction factor over the embedment depth of the rebar as a function of the temperature profile

Intermediate values of $\bar{k}_{\Theta(x)}$ may be interpolated linearly. Extrapolation is not permitted.

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End anchoring - Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ [3]												
c_{nom} **= 20 mm** [1]	Rebar at the edge (1 side flamed)						Rebar at the corner (2 sides flamed)					
Rebar Ø8 - Ø20	Fire-resistance grading						Fire-resistance grading					
l_v [2]	R30	R60	R90	R120	R180	R240	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
80	0,38	0,14	0,09	0,06	0,04	0,03	0,20	0,08	0,05	0,04	0,03	0,02
90	0,43	0,16	0,10	0,07	0,04	0,03	0,24	0,09	0,06	0,04	0,03	0,02
100	0,49	0,18	0,11	0,07	0,05	0,03	0,28	0,10	0,07	0,05	0,03	0,03
110	0,53	0,21	0,12	0,08	0,05	0,04	0,33	0,12	0,07	0,05	0,04	0,03
120	0,57	0,23	0,13	0,09	0,06	0,04	0,38	0,14	0,08	0,06	0,04	0,03
130	0,60	0,27	0,15	0,10	0,06	0,04	0,43	0,16	0,10	0,07	0,04	0,03
140	0,63	0,30	0,17	0,11	0,07	0,05	0,47	0,19	0,11	0,08	0,05	0,04
150	0,66	0,35	0,19	0,13	0,07	0,05	0,51	0,22	0,13	0,09	0,06	0,04
160	0,68	0,39	0,22	0,14	0,08	0,06	0,54	0,26	0,14	0,10	0,06	0,04
170	0,70	0,42	0,24	0,16	0,09	0,06	0,56	0,30	0,17	0,11	0,07	0,05
180	0,71	0,46	0,28	0,18	0,10	0,07	0,59	0,34	0,19	0,13	0,08	0,05
190	0,73	0,48	0,31	0,20	0,11	0,07	0,61	0,37	0,22	0,15	0,09	0,06
200	0,74	0,51	0,35	0,23	0,12	0,08	0,63	0,40	0,25	0,17	0,10	0,07
210	0,76	0,53	0,38	0,25	0,14	0,09	0,65	0,43	0,29	0,19	0,11	0,07
220	0,77	0,55	0,41	0,28	0,15	0,10	0,66	0,46	0,32	0,22	0,12	0,08
230	0,78	0,57	0,43	0,32	0,17	0,11	0,68	0,48	0,35	0,25	0,14	0,09
240	0,79	0,59	0,46	0,34	0,19	0,12	0,69	0,50	0,38	0,28	0,15	0,10
250	0,79	0,61	0,48	0,37	0,21	0,13	0,70	0,52	0,40	0,31	0,17	0,11
260	0,80	0,62	0,50	0,39	0,23	0,15	0,72	0,54	0,43	0,33	0,20	0,13
270	0,81	0,64	0,52	0,42	0,26	0,16	0,73	0,56	0,45	0,36	0,22	0,14
280	0,82	0,65	0,53	0,44	0,28	0,18	0,74	0,57	0,47	0,38	0,25	0,16
290	0,82	0,66	0,55	0,46	0,31	0,20	0,74	0,59	0,49	0,40	0,27	0,18
300	0,83	0,67	0,56	0,48	0,33	0,22	0,75	0,60	0,50	0,42	0,30	0,20
310	0,83	0,68	0,58	0,49	0,35	0,24	0,76	0,62	0,52	0,44	0,32	0,22
320	0,84	0,69	0,59	0,51	0,37	0,26	0,77	0,63	0,53	0,46	0,34	0,24
350	0,85	0,72	0,63	0,55	0,43	0,33	0,79	0,66	0,57	0,51	0,40	0,31
400	0,87	0,75	0,67	0,61	0,50	0,41	0,82	0,70	0,63	0,57	0,47	0,39
500	0,90	0,80	0,74	0,69	0,60	0,53	0,85	0,76	0,70	0,65	0,58	0,52
600	0,91	0,84	0,78	0,74	0,67	0,61	0,88	0,80	0,75	0,71	0,65	0,60
700	0,93	0,86	0,81	0,78	0,71	0,66	0,89	0,83	0,79	0,75	0,70	0,65
800	0,94	0,88	0,84	0,80	0,75	0,71	0,91	0,85	0,81	0,78	0,74	0,70
900	0,94	0,89	0,85	0,83	0,78	0,74	0,92	0,87	0,83	0,81	0,77	0,73
1000	0,95	0,90	0,87	0,84	0,80	0,76	0,93	0,88	0,85	0,83	0,79	0,76
1500	0,97	0,93	0,91	0,90	0,87	0,84	0,95	0,92	0,90	0,88	0,86	0,84
2000	0,97	0,95	0,93	0,92	0,90	0,88	0,96	0,94	0,93	0,91	0,89	0,88

[1] c_{nom} = concrete cover
[2] l_v = embedment length of the bar in the concrete
[3] $\bar{k}_{\Theta(x)}$ = Mean reduction factor over the embedment depth of the rebar as a function of the temperature profile

Intermediate values of $\bar{k}_{\Theta(x)}$ may be interpolated linearly. Extrapolation is not permitted.

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End anchoring - Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ [3]												
c_{nom} = 30 mm [1]	Rebar at the edge (1 side flamed)						Rebar at the corner (2 sides flamed)					
Rebar Ø8 - Ø28	Fire-resistance grading						Fire-resistance grading					
l_v [2]	R30	R60	R90	R120	R180	R240	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
80	0,59	0,20	0,11	0,08	0,05	0,03	0,33	0,11	0,07	0,05	0,03	0,03
90	0,64	0,22	0,12	0,08	0,05	0,04	0,37	0,12	0,07	0,05	0,04	0,03
100	0,68	0,24	0,13	0,09	0,05	0,04	0,42	0,14	0,08	0,06	0,04	0,03
110	0,71	0,27	0,15	0,10	0,06	0,04	0,47	0,15	0,09	0,06	0,04	0,03
120	0,73	0,29	0,16	0,11	0,06	0,04	0,51	0,17	0,10	0,07	0,05	0,03
130	0,75	0,32	0,17	0,11	0,07	0,05	0,55	0,19	0,11	0,08	0,05	0,04
140	0,77	0,36	0,19	0,12	0,07	0,05	0,58	0,22	0,12	0,08	0,05	0,04
150	0,78	0,39	0,21	0,14	0,08	0,05	0,61	0,25	0,14	0,09	0,06	0,04
160	0,80	0,43	0,23	0,15	0,08	0,06	0,63	0,28	0,15	0,10	0,06	0,05
170	0,81	0,46	0,25	0,16	0,09	0,06	0,66	0,31	0,17	0,11	0,07	0,05
180	0,82	0,49	0,28	0,18	0,10	0,07	0,68	0,35	0,19	0,13	0,08	0,05
190	0,83	0,52	0,31	0,19	0,11	0,07	0,69	0,38	0,21	0,14	0,08	0,06
200	0,84	0,55	0,34	0,21	0,11	0,08	0,71	0,41	0,24	0,16	0,09	0,06
210	0,85	0,57	0,37	0,23	0,12	0,08	0,72	0,44	0,27	0,17	0,10	0,07
220	0,85	0,59	0,40	0,26	0,14	0,09	0,73	0,47	0,30	0,19	0,11	0,08
230	0,86	0,60	0,42	0,28	0,15	0,10	0,75	0,49	0,33	0,22	0,12	0,08
240	0,86	0,62	0,45	0,31	0,16	0,10	0,76	0,51	0,36	0,24	0,13	0,09
250	0,87	0,64	0,47	0,34	0,18	0,11	0,77	0,53	0,38	0,27	0,15	0,10
260	0,88	0,65	0,49	0,36	0,19	0,12	0,78	0,55	0,41	0,30	0,16	0,11
270	0,88	0,66	0,51	0,39	0,21	0,13	0,78	0,57	0,43	0,32	0,18	0,12
280	0,88	0,68	0,53	0,41	0,23	0,15	0,79	0,58	0,45	0,35	0,20	0,13
290	0,89	0,69	0,54	0,43	0,25	0,16	0,80	0,60	0,47	0,37	0,22	0,14
300	0,89	0,70	0,56	0,45	0,28	0,17	0,81	0,61	0,48	0,39	0,24	0,16
310	0,90	0,71	0,57	0,46	0,30	0,19	0,81	0,62	0,50	0,41	0,27	0,17
320	0,90	0,72	0,58	0,48	0,32	0,20	0,82	0,63	0,52	0,43	0,29	0,19
350	0,91	0,74	0,62	0,53	0,38	0,26	0,83	0,66	0,56	0,48	0,35	0,25
400	0,92	0,77	0,67	0,59	0,46	0,35	0,85	0,71	0,61	0,54	0,43	0,34
500	0,94	0,82	0,73	0,67	0,57	0,48	0,88	0,77	0,69	0,63	0,55	0,47
600	0,95	0,85	0,78	0,72	0,64	0,57	0,90	0,80	0,74	0,70	0,62	0,56
700	0,95	0,87	0,81	0,76	0,69	0,63	0,92	0,83	0,78	0,74	0,68	0,62
800	0,96	0,89	0,83	0,79	0,73	0,68	0,93	0,85	0,81	0,77	0,72	0,67
900	0,96	0,90	0,85	0,82	0,76	0,71	0,94	0,87	0,83	0,80	0,75	0,71
1000	0,97	0,91	0,87	0,83	0,78	0,74	0,94	0,88	0,85	0,82	0,77	0,74
1500	0,98	0,94	0,91	0,89	0,86	0,83	0,96	0,92	0,90	0,88	0,85	0,82
2000	0,98	0,95	0,93	0,92	0,89	0,87	0,97	0,94	0,92	0,91	0,89	0,87

[1] c_{nom} = concrete cover
[2] l_v = embedment length of the bar in the concrete
[3] $\bar{k}_{\Theta(x)}$ = Mean reduction factor over the embedment depth of the rebar as a function of the temperature profile

Intermediate values of $\bar{k}_{\Theta(x)}$ may be interpolated linearly. Extrapolation is not permitted.

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End anchoring - Mean reduction factor under fire exposure $\bar{k}_{\Theta(x)}$ [3]												
c_{nom} **= 40 mm** [1]	Rebar at the edge (1 side flamed)						Rebar at the corner (2 sides flamed)					
Rebar Ø8 - Ø40	Fire-resistance grading						Fire-resistance grading					
l_v [2]	R30	R60	R90	R120	R180	R240	R30	R60	R90	R120	R180	R240
[mm]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]
80	0,87	0,29	0,15	0,10	0,06	0,04	0,58	0,17	0,10	0,07	0,04	0,03
90	0,88	0,31	0,16	0,10	0,06	0,04	0,62	0,19	0,10	0,07	0,04	0,03
100	0,89	0,33	0,17	0,11	0,06	0,04	0,66	0,20	0,11	0,08	0,05	0,04
110	0,90	0,35	0,18	0,12	0,06	0,05	0,69	0,22	0,12	0,08	0,05	0,04
120	0,91	0,38	0,19	0,12	0,07	0,05	0,72	0,24	0,13	0,09	0,05	0,04
130	0,92	0,41	0,21	0,13	0,07	0,05	0,74	0,26	0,14	0,09	0,06	0,04
140	0,92	0,44	0,22	0,14	0,08	0,05	0,76	0,28	0,15	0,10	0,06	0,04
150	0,93	0,47	0,24	0,15	0,08	0,06	0,77	0,31	0,16	0,11	0,06	0,05
160	0,93	0,50	0,25	0,16	0,09	0,06	0,79	0,34	0,18	0,12	0,07	0,05
170	0,94	0,53	0,27	0,17	0,09	0,06	0,80	0,37	0,19	0,13	0,07	0,05
180	0,94	0,56	0,29	0,18	0,10	0,06	0,81	0,40	0,21	0,14	0,08	0,06
190	0,94	0,58	0,31	0,19	0,10	0,07	0,82	0,43	0,23	0,15	0,09	0,06
200	0,95	0,60	0,34	0,21	0,11	0,07	0,83	0,46	0,25	0,16	0,09	0,06
210	0,95	0,62	0,36	0,22	0,12	0,08	0,84	0,49	0,27	0,17	0,10	0,07
220	0,95	0,64	0,39	0,24	0,12	0,08	0,85	0,51	0,30	0,19	0,11	0,07
230	0,95	0,65	0,42	0,26	0,13	0,09	0,85	0,53	0,32	0,21	0,11	0,08
240	0,96	0,67	0,44	0,27	0,14	0,09	0,86	0,55	0,35	0,22	0,12	0,08
250	0,96	0,68	0,46	0,30	0,15	0,10	0,86	0,57	0,38	0,24	0,13	0,09
260	0,96	0,69	0,48	0,32	0,16	0,10	0,87	0,59	0,40	0,26	0,14	0,10
270	0,96	0,71	0,50	0,34	0,17	0,11	0,87	0,60	0,42	0,29	0,15	0,10
280	0,96	0,72	0,52	0,36	0,19	0,12	0,88	0,62	0,44	0,31	0,17	0,11
290	0,96	0,73	0,54	0,39	0,20	0,13	0,88	0,63	0,46	0,34	0,18	0,12
300	0,96	0,74	0,55	0,41	0,21	0,13	0,89	0,64	0,48	0,36	0,20	0,13
310	0,97	0,74	0,57	0,43	0,23	0,14	0,89	0,65	0,50	0,38	0,21	0,14
320	0,97	0,75	0,58	0,44	0,24	0,15	0,89	0,66	0,51	0,40	0,23	0,15
350	0,97	0,77	0,62	0,49	0,30	0,19	0,90	0,69	0,55	0,45	0,29	0,18
400	0,97	0,80	0,66	0,55	0,39	0,26	0,92	0,73	0,61	0,52	0,38	0,26
500	0,98	0,84	0,73	0,64	0,51	0,40	0,93	0,79	0,69	0,61	0,50	0,41
600	0,98	0,87	0,78	0,70	0,59	0,50	0,94	0,82	0,74	0,68	0,58	0,51
700	0,98	0,89	0,81	0,75	0,65	0,57	0,95	0,85	0,78	0,72	0,64	0,58
800	0,99	0,90	0,83	0,78	0,69	0,63	0,96	0,87	0,81	0,76	0,69	0,63
900	0,99	0,91	0,85	0,80	0,73	0,67	0,96	0,88	0,83	0,79	0,72	0,67
1000	0,99	0,92	0,87	0,82	0,75	0,70	0,97	0,89	0,84	0,81	0,75	0,70
1500	0,99	0,95	0,91	0,88	0,84	0,80	0,98	0,93	0,90	0,87	0,83	0,80
2000	0,99	0,96	0,93	0,91	0,88	0,85	0,98	0,95	0,92	0,90	0,88	0,85

[1] c_{nom} = concrete cover
[2] l_v = embedment length of the bar in the concrete
[3] $\bar{k}_{\Theta(x)}$ = Mean reduction factor over the embedment depth of the rebar as a function of the temperature profile

Intermediate values of $\bar{k}_{\Theta(x)}$ may be interpolated linearly. Extrapolation is not permitted.

The bond strength $f_{bd,PIR}$ depends on the concrete class and rebar diameter as well as on the corresponding conversion factor $f_{bd,fi,con}$ and can be found for rebar at the corner or at the edge in the following table:

Concrete class	Ø-Rebar	$f_{bd,PIR}$ (all drilling methods)	$f_{bd,fi,con}$ - Factor
[-]	[mm]	[N/mm²]	[-]
C12/15	Ø8 - Ø34	1,6	1,44
	Ø36, Ø40	1,5	1,53
C16/20	Ø8 - Ø34	2,0	1,15
	Ø36	1,9	1,21
	Ø40	1,8	1,28
C20/25	Ø8 - Ø34	2,3	1,00
	Ø36	2,2	1,05
	Ø40	2,1	1,10
C25/30	Ø8 - Ø32	2,7	0,85
	Ø34, Ø36	2,6	0,88
	Ø40	2,5	0,92
C30/37	Ø8 - Ø32	3,0	0,77
	Ø34, Ø36	2,9	0,79
	Ø40	2,8	0,82
C35/45	Ø8 - Ø32	3,4	0,68
	Ø34, Ø36	3,3	0,70
	Ø40	3,1	0,74
C40/50	Ø8 - Ø32	3,7	0,62
	Ø34, Ø36	3,6	0,64
	Ø40	3,4	0,68
C45/55	Ø8 - Ø32	4,0	0,58
	Ø34	3,9	0,59
	Ø36	3,8	0,61
	Ø40	3,7	0,62
C50/60	Ø8 - Ø32	4,3	0,53
	Ø34	4,2	0,55
	Ø36	4,1	0,56
	Ø40	4,0	0,58

The given values does not deal with the mechanical design at ambient temperature, these shall be done in addition and related to ETA-22/0365.

Post-installed rebar connections shall be designed in ambient temperature conditions before being designed in fire conditions.

The bond resistance $f_{bd,fi}$ shall not be applied for beam to beam connections.

The partial safety factor for actions can be assumed to be γ_F = 1.0 for determining recommended loads.

4. Chemical resistance

Chemical Agent	Concentration	Resistant	Not resistant
Accumulator acid			x
Acetic acid	10%		x
Acetic acid	40%		x
Laitance		x	
Acetone	5%		x
Acetone	10%		x
Acetone	100%		x
Ammonia, aqueous solution	5%	x	
Ammonia, aqueous solution	32%		x
Aniline	100%		x
Beer	100%	x	
Chlorine	All	x	
Benzol	100%		x
Boric Acid, aqueous solution		x	
Calcium carbonate, suspended in water	All	x	
Calcium chloride, suspended in water		x	
Calcium hydroxide, suspended in water		x	
Chlorinated lime (Calcium hypochlorite)	10%		x
Carbon tetrachloride	100%	x	
Caustic soda solution	10%	x	
Caustic soda solution	40%	x	
Citric acid	10%		x
Citric acid	50%		x
Citric acid	All	x	
Chlorine water, swimming pool	All		x
Demineralized water	All		x
Diesel oil	100%	x	
Ethyl alcohol, aqueous solution	100%		x
Ethyl alcohol, aqueous solution	50%		x
Formic acid	10%	x	
Formic acid	30%		x
Formic acid	100%		x
Formaldehyde, aqueous solution	20%	x	
Formaldehyde, aqueous solution	30%	x	
Freon		x	
Fuel Oil		x	
Gasoline (premium grade)	100%	x	
Glycol (Ethylene glycol)		x	
Hydraulic fluid	Conc.		x
Hydrochloric acid (Muriatic Acid)	Conc.		x
Hydrogen peroxide	10%		x
Hydrogen peroxide	30%		x
Isopropyi alcohol	100%		x
Lactic acid	10%		x
Lactic acid	All		x
Linseed oil	100%	x	
Lubricating oil	100%	x	
Magnesium chloride, aqueous solution	All	x	
Methanol	100%		x
Standard benzine			x
Motor oil (SAE 20 W-50)	100%	x	
Nitric acid	10%		x
Oleic acid	100%	x	
Perchloroethylene	100%	x	
Petroleum	100%	x	
Phenol, aqueous solution	8%		x

Results shown in the table are applicable to brief periods of chemical contact with full cured adhesive (e.g. temporary contact with adhesive during a spill).

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Chemical Agent	Concentration	Resistant	Not resistant
Benzyl alocohol	100%		x
Phosphoric acid	85%	x	
Phosphoric acid	10%	x	
Potash lye (Potassium hydroxide)	10%	x	
Potash lye (Potassium hydroxide)	40%	x	
Potassium carbonate, aqueous solution	All	x	
Potassium chlorite, aqueous solution	All	x	
Potassium nitrate, aqueous solution	All	x	
Sea water, salty	All	x	
Sodium carbonate	All	x	
Sodium chloride, aqueous solution	All	x	
Sodium phosphate, aqueous solution	All	x	
Sodium silicate	All	x	
Sulfuric acid	10%		x
Sulfuric acid	30%		x
Sulfuric acid	70%		x
Tartaric acid	All	x	
Tetrachloroethylene	100%	x	
Toluene			x
Trichloroethylene	100%		x
Turpentine	100%	x	

Results shown in the table are applicable to brief periods of chemical contact with full cured adhesive (e.g. temporary contact with adhesive during a spill).