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European Technical Assessment

ETA 19/0699
of 26/01/2020

Technical Assessment Body issuing the ETA: Technical and Test Institute for Construction Prague	
Trade name of the construction product	G&B Fissaggi Gebofix PRO VE-SF SISMIK Gebofix PRO VE-SF SISMIK Nordic
Product family to which the construction product belongs	Product area code: 33 Bonded injection type anchor for use in cracked and uncracked concrete
Manufacturer	G&B FISSAGGI Corso Savona, 22 10029 Villatellone (TO) ITALY
Manufacturing plant	G&B Fissaggi S.r.l. Plant 4
This European Technical Assessment contains	19 pages including 16 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

1. Technical description of the product

The G&B Fissaggi Gebofix PRO VE-SF SISMIK, Gebofix PRO VE-SF SISMIK Nordic is a bonded anchor consisting of a cartridge with injection mortar and a steel element. The steel element consists of a commercial threaded rod with washer and hexagon nut in the range M8 to M30 or a reinforcing bar in the range of diameter 8 to 32 mm.

The steel element is placed into a drilled hole filled with injection mortar and is anchored via the bond between metal part, injection mortar and concrete.

The illustration and the description of the product are given in Annex A.

2. Specification of the intended use in accordance with the applicable EAD

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 provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the 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
Static and quasi-static loading	
Resistance to steel failure (tension)	See Annex C1, C2, C4
Resistance to combined pull-out and concrete failure	See Annex C1, C2, C4
Resistance to concrete cone failure	See Annex C1, C2, C4
Edge distance to prevent splitting under load	See Annex C1, C2, C4
Robustness	See Annex C1, C2, C4
Maximum setting torque moment	See Annex B2
Minimum edge distance and spacing	See Annex B2
Resistance to steel failure (shear)	See Annex C3, C5
Resistance to pry-out failure	See Annex C3, C5
Resistance to concrete edge failure	See Annex C3, C5
Displacements under short term and long term loading	See Annex C6
Durability of metal parts	See Annex B1
Seismic performance C1 and C2	
Resistance to steel failure	See Annex C2, C3
Resistance to pull-out	See Annex C2
Factor for annular gap	See Annex C3
Displacement	See Annex C6

3.2 Hygiene, health and environment (BWR 3)

No performance determined.

3.3 General aspects relating to fitness for use

Durability and serviceability are only ensured if the specifications of intended use according to Annex B 1 are kept.

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

According to the Decision 96/582/EC of the European Commission[1] the system of assessment verification of constancy of performance (see Annex V to Regulation (EU) No 305/2011) given in the following table apply.

Product	Intended use	Level or class	System
Metal anchors for use in concrete	For fixing and/or supporting to concrete, structural elements (which contributes to the stability of the works) or heavy units	-	1

5. Technical details necessary for the implementation of the AVCP system, as provided in the applicable EAD

5.1 Tasks of the manufacturer

The manufacturer may only use raw materials stated in the technical documentation of this European Technical Assessment.

The factory production control shall be in accordance with the control plan which is a part of the technical documentation of this European Technical Assessment. The control plan is laid down in the context of the factory production control system operated by the manufacturer and deposited at Technical and Test Institute for Construction Prague.[2] The results of factory production control shall be recorded and evaluated in accordance with the provisions of the control plan.

5.2 Tasks of the notified bodies

The notified body shall retain the essential points of its actions referred to above and state the results obtained and conclusions drawn in a written report.

The notified certification body involved by the manufacturer shall issue a certificate of constancy of performance of the product stating the conformity with the provisions of this European Technical Assessment.

In cases where the provisions of the European Technical Assessment and its control plan are no longer fulfilled the notified body shall withdraw the certificate of constancy of performance and inform Technical and Test Institute for Construction Prague without delay.

Issued in Prague on 26.01.2020

By

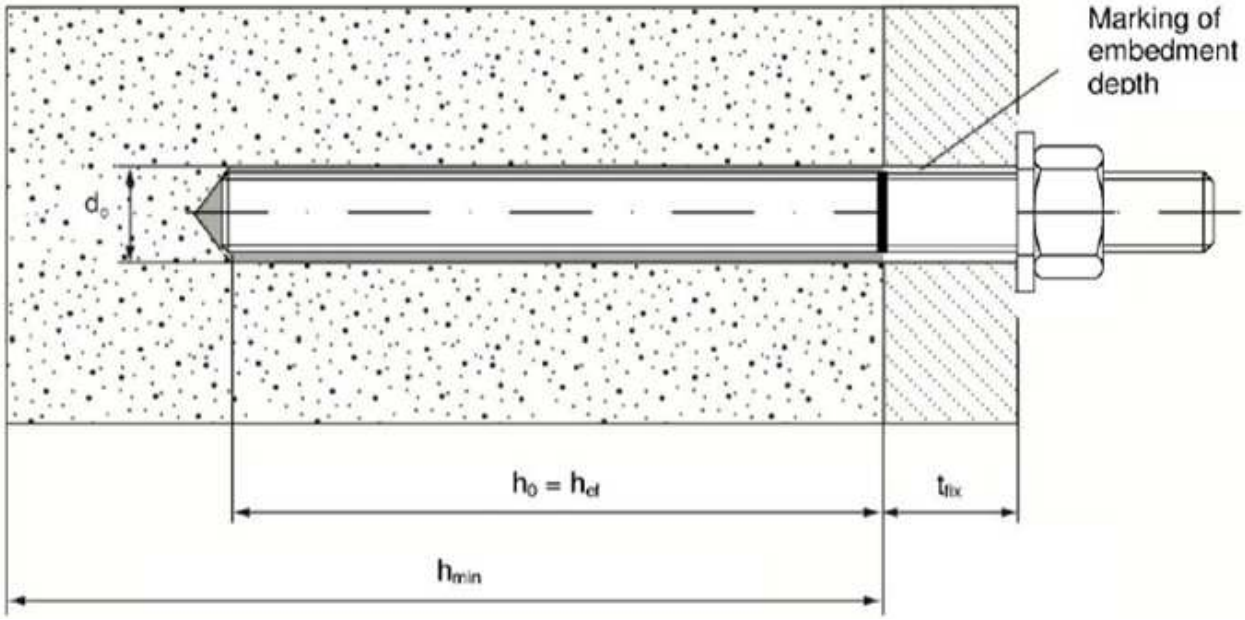
Ing. Mária Schaan

Head of the Technical Assessment Body

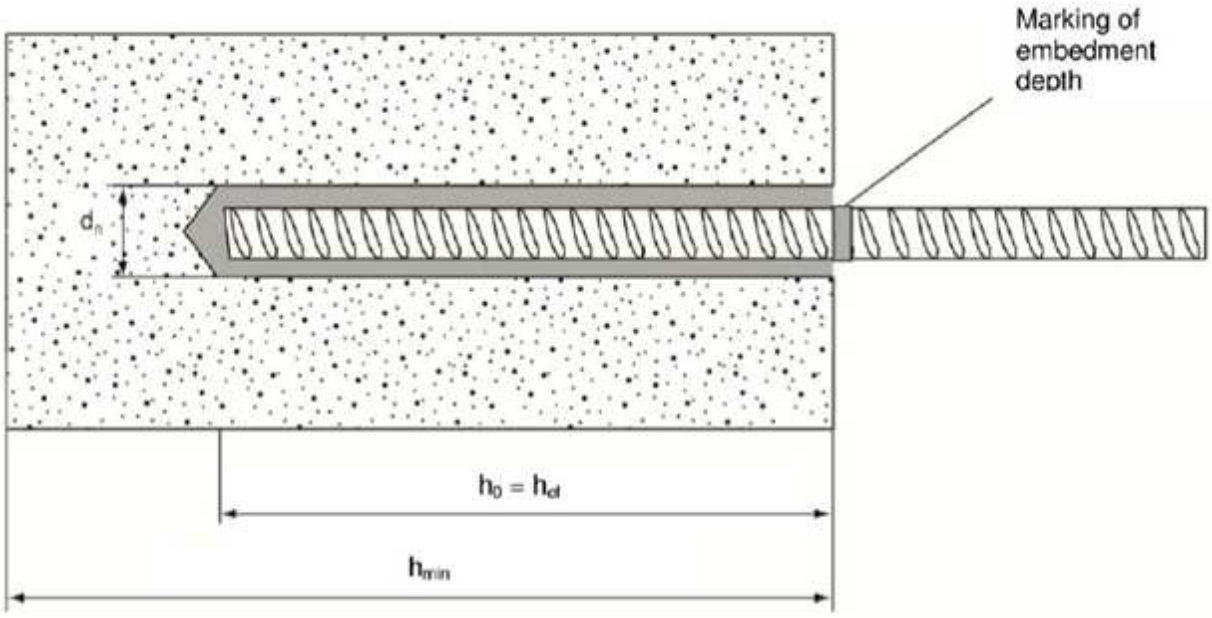
[1] Official Journal of the European Communities L 254 of 08.10.1996

[2] The control plan is a confidential part of the documentation of the European Technical Assessment, but not published together with the ETA and only handed over to the approved body involved in the procedure of AVCP.

Installation threaded rod



Installation reinforcing bar



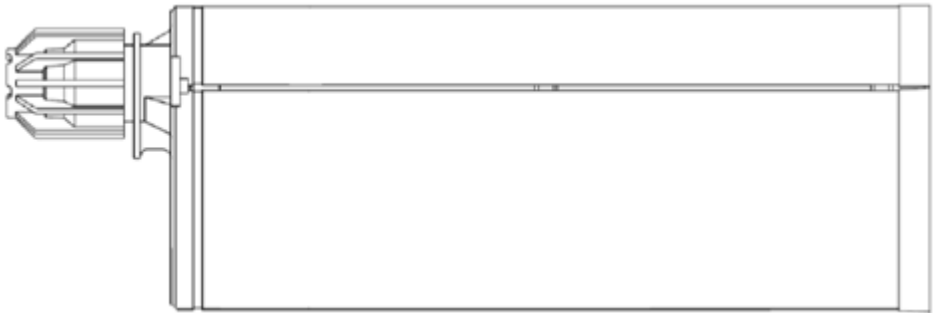
d_0 = nominal drill hole diameter
t_{fix} = thickness of fixture
h_{ef} = effective anchorage depth
h_0 = depth of drill hole
h_{min} = minimum thickness of member

G&B Fissaggi Gebofix PRO VE-SF SISMIK, G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic	**Annex A 1**
Product description Installed conditions	

Injection mortar: G&B Fissaggi Gebofix PRO VE-SF SISMIK, Gebofix PRO VE-SF SISMIK Nordic

150 ml, 380 ml to 420 ml cartridge (Type: coaxial)

345 ml and 825 ml cartridge (Type: “side-by-side”)



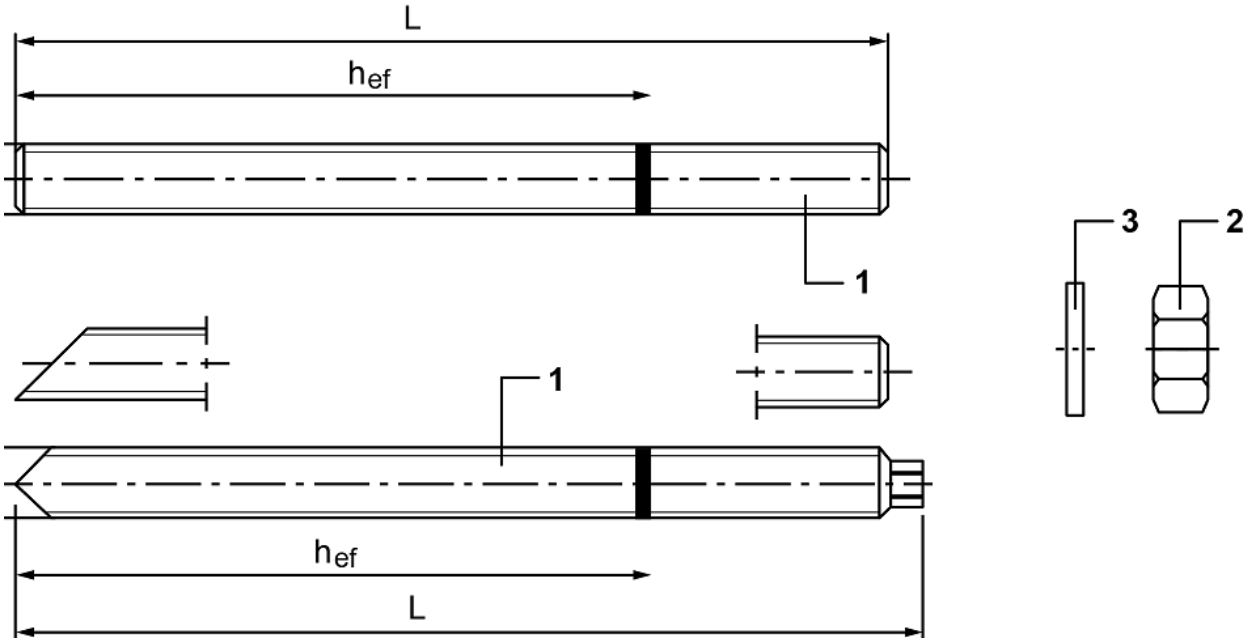
165 ml and 300 ml cartridge (Type: “foil tube”)

Cartridge label: G&B Fissaggi Gebofix PRO VE-SF SISMIK or G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic, processing notes, charge-code, shelf life hazard-code, curing- and processing time (depending on the temperature), with as well as without travel scale

Static mixer

G&B Fissaggi Gebofix PRO VE-SF SISMIK, G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic	**Annex A 2**
Product description Injection system	

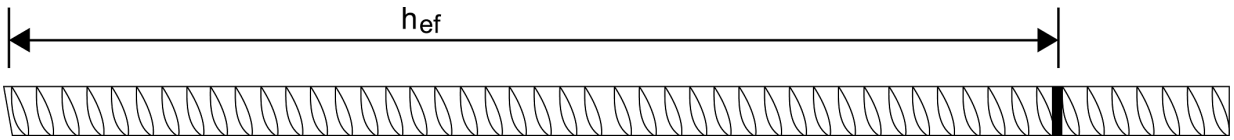
Threaded rod M8, M10, M12, M16, M20, M24, M27, M30 with washer and hexagon nut



Commercial standard rod with:

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

Reinforcing bar Ø8, Ø10, Ø12, Ø14, Ø16, Ø20, Ø25, Ø32



- Minimum value of related rib area $f_{R,min}$ according to EN 1992-1-1:2004+AC:202
- Rib height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
  (d: Nominal diameter of the bar; h: Rib height of the bar)

G&B Fissaggi Gebofix PRO VE-SF SISMIK, **G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic**	**Annex A 3**
Product description Threaded rod and reinforcing bar	

Table A1: Materials

Part	Designation	Material
Steel, zinc plated ≥ 5 µm acc. to EN ISO 4042:2009 or Steel, hot-dip galvanised ≥ 40 µm acc. to EN ISO 10684:2004+AC:2009		
1	Anchor rod	Steel, EN 10087:1998 or EN 10263:2001 Property class 4.6, 5.8, 8.8, EN 1993-1-8:2005+AC:2009 A_5 > 8% fracture elongation
2	Hexagon nut, EN ISO 4032:2012	Steel acc. to EN 10087:1998 or EN 10263:2001 Property class 4 (for class 4.6 rod) EN ISO 898-2:2012, Property class 5 (for class 5.8 rod) EN ISO 898-2:2012, Property class 8 (for class 8.8 rod) EN ISO 898-2:2012
3	Washer, EN ISO 887:2006, EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000	Steel, zinc plated or hot-dip galvanised
Stainless steel		
1	Anchor rod	Material: A2-70, A4-70, A4-80, EN ISO 3506
2	Hexagon nut EN ISO 4032	According to threaded rod
3	Washer EN ISO 887, EN ISO 7089, EN ISO 7093 or EN ISO 7094	According to threaded rod
High corrosion resistant steel		
1	Anchor rod	Material: 1.4529, 1.4565, EN 10088-1
2	Hexagon nut EN ISO 4032	According to threaded rod
3	Washer EN ISO 887, EN ISO 7089, EN ISO 7093 or EN ISO 7094	According to threaded rod
Reinforcing bars		
1	Rebar according to 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:2013 $f_{uk} = f_{tk} = k*f_{yk}$

Specifications of intended use

Anchorages subject to:

- Static and quasi-static loads: M8 to M30, Rebar Ø8 to Ø32.
- Seismic performance category C1: threaded rod size M10, M12, M16, M20, M24
- Seismic performance category C2: threaded rod size M12, M16, M20

Base materials

- Reinforced or unreinforced normal weight concrete according to EN 206:2013.
- Strength classes C20/25 to C50/60 according to EN 206:2013
- Uncracked concrete: threaded rod M8 to M30, Rebar Ø8 to Ø32.
- Cracked concrete: threaded rod M12 to M24.

Temperature range:

- I: -40°C to +40°C (max long term temperature +24°C and max short term temperature +40°C)
- II: -40°C to +80°C (max long term temperature +50°C and max short term temperature +80°C)

Use conditions (Environmental conditions)

- (X1) Structures subject to dry internal conditions (zinc coated steel, stainless steel, high corrosion resistance steel).
- (X2) Structures subject to external atmospheric exposure including industrial and marine environment and to permanently damp internal condition, if no particular aggressive conditions exist (stainless steel A4, high corrosion resistance steel).
- (X3) Structures subject to external atmospheric exposure and to permanently damp internal condition, with particular aggressive conditions exist (high corrosion resistance steel).

Note: Particular aggressive conditions are e.g. permanent, alternating immersion in seawater or the splash zone of seawater, chloride atmosphere of indoor swimming pools or atmosphere with extreme chemical pollution (e.g. in desulphurization plants or road tunnels where de-icing materials are used).

Concrete conditions:

- I1: installation in dry or wet (water saturated) concrete and use in service in dry or wet concrete.
- I2: installation in water-filled (not sea water) and use in service in dry or wet concrete.

Design:

- The anchorages are designed in accordance with the EN 1992-4 under the responsibility of an engineer experienced in anchorages and concrete work.
- 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.
- Anchorages under seismic actions (cracked concrete) have to be designed in accordance with EN 1992-4.

Installation:

- Hole drilling by hammer drill mode.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

Installation direction:

- D3 – downward and horizontal and upwards (e.g. overhead) installation

G&B Fissaggi Gebofix PRO VE-SF SISMIK, **G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic**	**Annex B 1**
Intended use Specifications	

Table B1: Installation parameters for threaded rod

Anchor size		**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Nominal drill hole diameter	d_0 [mm] =	10	12	14	18	22	26	30	35
Effective anchorage depth	$h_{ef,min}$ [mm] =	64	80	96	128	160	192	216	240
	$h_{ef,max}$ [mm] =	160	200	240	320	400	480	540	600
Diameter of clearance hole in the fixture	d_f [mm] ≤	9	12	14	18	22	26	30	33
Diameter of the steel brush	d_b [mm] ≥	12	14	16	20	26	30	35	43
Torque moment	max T_{inst} [Nm] ≤	10	20	40	80	150	200	240	275
Thickness of fixture	$t_{fix,min}$ [mm] >	0							
	$t_{fix,max}$ [mm] <	1500							
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm				h_{ef} + $2d_0$			
Minimum spacing	s_{min} [mm]	35	40	50	65	80	96	110	120
Minimum edge distance	c_{min} [mm]	35	40	50	65	80	96	110	120

Table B2: Installation parameters for rebar

Rebar size		**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Nominal drill hole diameter	d_0 [mm] =	12	14	16	20	25	32	40
Effective anchorage depth	$h_{ef,min}$ [mm] =	64	80	96	128	160	200	256
	$h_{ef,max}$ [mm] =	160	200	240	320	400	500	640
Diameter of the steel brush	d_b [mm] ≥	14	16	18	22	31	35	43
Minimum thickness of member	h_{min} [mm]	h_{ef} + 30 mm ≥ 100 mm				h_{ef} + $2d_0$		
Minimum spacing	s_{min} [mm]	35	40	50	65	80	100	130
Minimum edge distance	c_{min} [mm]	35	40	50	65	80	100	130

Table B3: Parameters for cleaning and setting tools

Anchor	Size (mm)	Nominal drill bit diameter d_o (mm)	Steel Brush d_b (mm)	Steel Brush (min brush diameter) $d_{b,min}$ (mm)
				
Threaded Rod 	M8	10	12	10.5
	M10	12	14	12.5
	M12	14	16	14.5
	M16	18	20	18.5
	M20	22	26	22.5
	M24	26	30	26.5
	M27	30	35	30.5
	M30	35	43	35.5
Rebar 	Ø8	12	14	12.5
	Ø10	14	16	14.5
	Ø12	16	18	16.5
	Ø16	20	22	20.5
	Ø20	25	31	25.5
	Ø25	32	35	32.5
	Ø32	40	43	40.5

Hand pump (volume 750 ml)
Drill bit diameter (d_0): 10 mm to 20 mm

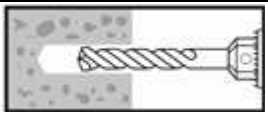
Compressed air tool (min 6 bar)
Drill bit diameter (d_0): 10 mm to 40 mm

G&B Fissaggi Gebofix PRO VE-SF SISMIK,
G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic

Intended use
Cleaning and setting tools

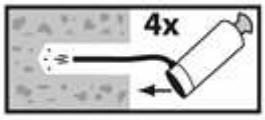
Annex B 3

Installation instructions



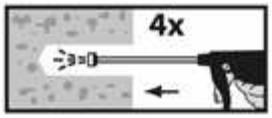
1. Drill with hammer drill a hole into the base material to the size and embedment depth required by the selected anchor (Table B1 or Table B2). In case of aborted drill hole: the drill hole shall be filled with mortar

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



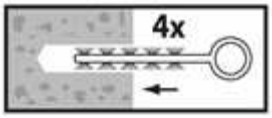
2a. Starting from the bottom or back of the bore hole, blow the hole clean with compressed air (min. 6 bar) or a hand pump (Annex B3) a minimum of four times. If the bore hole ground is not reached an extension shall be used.

or



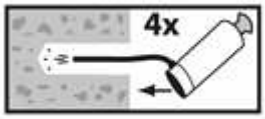
The hand pump can only be used for anchor sizes in uncracked concrete up to bore hole diameter 20mm or embedment depth up to 240mm.

Compressed air (min. 6 bar) can be used for all sizes in cracked and uncracked concrete.

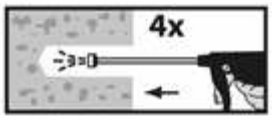


2b. Check brush diameter (Table B3) and attach the brush to a drilling machine or battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B3) a minimum of four times.
If the bore hole ground is not reached with the brush, a brush extension shall be used (Table B3).

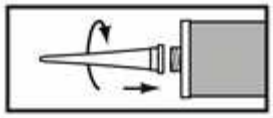
2c. Finally blow the hole clean again with compressed air or a hand pump (Annex B3) a minimum of four times. If the bore hole ground is not reached an extension shall be used.
The hand pump can only be used for anchor sizes in uncracked concrete up to bore hole diameter 20mm or embedment depth up to 240mm.
Compressed air (min. 6 bar) can be used for all sizes in cracked and uncracked concrete.



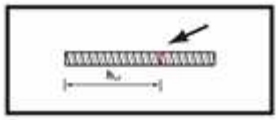
or



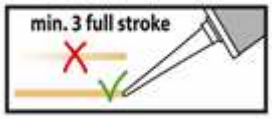
After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning repeated has to be directly before dispensing the mortar.



3. Attach a supplied static mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool. Cut off the foil tube clip before use.
For every working interruption longer than the working time (Table B4 and B5) as well as for new cartridges, a new static-mixer shall be used.



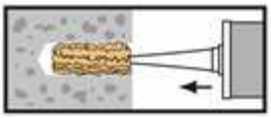
4. Prior to inserting the anchor rod into the filled bore hole, the position of the embedment depth shall be marked on the anchor rods.



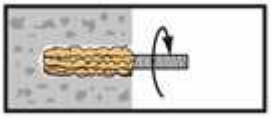
5. Prior to dispensing into the anchor hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent colour. For foil tube cartridges is must be discarded a minimum of six full strokes.

G&B Fissaggi Gebofix PRO VE-SF SISMIK, **G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic**	
Intended use Installation instructions	**Annex B 4**

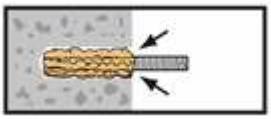
Installation instructions (continuation)



6. Starting from the bottom or back of the cleaned anchor hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid creating air pockets. For embedment depth larger than 190 mm an extension nozzle shall be used. For overhead and horizontal installation in bore holes a piston plug and extansion nozzle according to Annex B3 shall be used. Observe the gel-/ Working times given in Tabe B4 and B5.

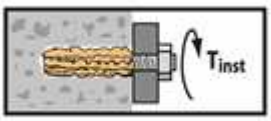


7. Push the threaded rod or reinforcing bar into the anchor hole while turning slightly to ensure positive distribution of the adhesive until the embedment depth is reached. The anchor should be free of dirt, grease, oil or other foreign material.



8. Be sure that the anchor is fully seated at the bottom of the hole and that excess mortar is visible at the top of the hole. If these requirements are not maintained, the application has to be renewed. For overhead application the anchor rod should be fixed (e.g. wedges).

9. Allow the adhesive to cure to the specified time to applying any load or torque. Do not move or load the anchor until it is fully cured (attend Table B4 and B5).



10. After full curing, the add-on part can be installed with the max. torque (Table B1) by using a calibrated torque wrench.

Table B4: Minimum curing time – G&B Fissaggi Gebofix PRO VE-SF SISMIK

Base material temperature	Gel time (working time)	Minimum curing time in dry concrete[1)]
+5°C to +9°C	10 min	145 min
+10°C to +19°C	6 min	85 min
+20°C to +29°C	4 min	50 min
+30°C	4 min	40 min
Cartridge temperature	+5°C to +20°C	

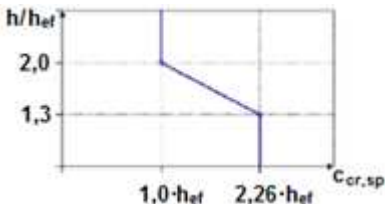
[1)] In wet concrete the curing time **must** be doubled.

Table B5: Minimum curing time – G&B Fissaggi Gebofix PRO VE-SF SISMIK Nordic

Base material temperature	Gel time (working time)	Minimum curing time in dry concrete[1)]
0°C to +4°C	10 min	2.5 h
+5°C to +9°C	6 min	80 min
+10°C	6 min	60 min
Cartridge temperature	0°C to +20°C	

[1)] In wet concrete the curing time **must** be doubled.

Table C1: Characteristic values of resistance for threaded rods under tension loads in uncracked concrete

Anchor size threaded rod				**M8**	**M10**	**M12**	**M16**	**M20**	**M24**	**M27**	**M30**
Steel failure											
Characteristic tension resistance		$N_{Rk,s}$	[kN]	$A_s \times f_{uk}$							
Combined pull-out and concrete cone failure											
Characteristic bond resistance in uncracked concrete C20/25											
Temperature range I: 40°C / 24°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	10.0	9.0	8.5	8.0	7.5	7.0	5.5	5.0
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	8.0	7.0	6.5	6.0	No Performance Determined			
Temperature range II: 80°C / 50°C	dry and wet concrete	$\tau_{Rk,ucr}$	[N/mm²]	9.0	8.5	8.0	7.5	7.0	6.5	5.0	4.5
	flooded bore hole	$\tau_{Rk,ucr}$	[N/mm²]	7.5	6.5	6.0	5.5	No Performance Determined			
Increasing factors for concrete Ψ_c		C30/37		1.04							
		C40/50		1.08							
		C50/60		1.10							
Concrete cone failure											
Factor for concrete cone failure		$k_{ucr,N}$	[-]	11							
Edge distance		$c_{cr,N}$	[mm]	1.5 h_{ef}							
Axial distance		$s_{cr,N}$	[mm]	3.0 h_{ef}							
Splitting failure											
Edge distance $c_{cr,sp}$ [mm] for	$h / h_{ef} \geq 2.0$			1.0 h_{ef}							
	$2.0 > h / h_{ef} > 1.3$			4.6 h_{ef} – 1.8 h							
	$h / h_{ef} \leq 1.3$			2.26 h_{ef}							
Axial distance		$s_{cr,sp}$	[mm]	2 $c_{cr,sp}$							
Installation safety factor (dry and wet concrete)		γ_{inst}		1.2						1.4	
Installation safety factor (flooded bore hole)		γ_{inst}		1.4				No Performance Determined			

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Performances
Characteristic values of resistance for threaded rods under tension loads in uncracked concrete

Annex C 1

Table C2: Characteristic values of resistance for threaded rods under tension loads in cracked concrete

Anchor size threaded rod				M10	M12	M16	M20	M24
Steel failure								
Characteristic tension resistance	$N_{Rk,s}$ $N_{Rk,s,eq,C1}$ $N_{Rk,s,eq,C2}$		[kN]	$A_s \times f_{uk}$				
Combined pull-out and concrete cone failure								
Characteristic bond resistance in cracked concrete C20/25								
Temperature range I: 40°C/24°C	dry and wet concrete	$\tau_{Rk.cr}$	[N/mm²]	5.0	5.0	5.0	5.0	5.0
		$\tau_{Rk,p,eq,C1}$	[N/mm²]	3.1	3.7	3.7	3.7	3.8
		$\tau_{Rk,p,eq,C2}$	[N/mm²]	NPD	1.1	1.3	1.5	NPD
	flooded bore hole	$\tau_{Rk.cr}$	[N/mm²]	4.0	5.0	5.0	No Performance Determined	
		$\tau_{Rk,p,eq,C1}$	[N/mm²]	3.1	3.7	3.7		
		$\tau_{Rk,p,eq,C2}$	[N/mm²]	No Performance Determined				
Temperature range II: 80°C/50°C	dry and wet concrete	$\tau_{Rk.cr}$	[N/mm²]	3.5	4.0	4.0	4.0	4.0
		$\tau_{Rk,p,eq,C1}$	[N/mm²]	2.2	2.7	2.7	2.7	2.8
		$\tau_{Rk,p,eq,C2}$	[N/mm²]	NPD	1.0	1.2	1.4	NPD
	flooded bore hole	$\tau_{Rk.cr}$	[N/mm²]	3.0	4.0	4.0	No Performance Determined	
		$\tau_{Rk,p,eq,C1}$	[N/mm²]	1.9	2.7	2.7		
		$\tau_{Rk,p,eq,C2}$	[N/mm²]	No Performance Determined				
Increasing factors for concrete Ψ_c		C30/37		1.04				
		C40/50		1.08				
		C50/60		1.10				
Concrete cone failure								
Factor for concrete cone failure		$k_{cr.N}$	[-]	7.7				
Edge distance		$c_{cr.N}$	[mm]	$1.5\ h_{ef}$				
Axial distance		$s_{cr.N}$	[mm]	$3.0\ h_{ef}$				
Installation safety factor (dry and wet concrete)		γ_{inst}		1.2				
Installation safety factor (flooded bore hole)		γ_{inst}		1.4			NPD	

The anchor for seismic performance shall be used with minimum rupture elongation after fracture A_5 equal to 19%.

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Performances
Characteristic values of resistance for threaded rods under tension loads in cracked concrete

Annex C 2

Table C3: Characteristic values of resistance for threaded rods under shear loads in cracked and uncracked concrete

Anchor size threaded rod			M8	M10	M12	M16	M20	M24	M27	M30
Steel failure without lever arm										
Characteristic shear resistance	$V_{Rk.s}$	[kN]	$0.5 \times A_s \times f_{uk}$							
	$V_{Rk.s.eq.C1}$	[kN]	NPD	$0.35 \times A_s \times f_{uk}$					NPD	
	$V_{Rk.s.eq.C2}$	[kN]	NPD		$0.26 \times A_s \times f_{uk}$			No Performance Determined		
Characteristic shear load resistance $V_{Rk,s,eq}$ shall be multiplied by following reduction factor for **hot-dip galvanized** commercial standard rods										
Reduction factor for hot-dip galvanized rods	$\alpha_{v,h\text{-}dg,c1}$		NPD	0.57	0.56	0.49	0.56	0.61	NPD	
	$\alpha_{v,h\text{-}dg,c2}$		NPD		0.46	0.61	0.61	NPD		
Factor for annular gap	α_{gap}		0.5							
Ductility factor	k_7		1.0 for steel with rupture elongation $A_5 > 8\%$							
Steel failure with lever arm										
Characteristic bending moment	$M^0_{Rk.s}$	[Nm]	$1.2 * W_{el} * f_{uk}$							
	$M^0_{Rk.s.eq.C1}$	[Nm]	No Performance Determined							
	$M^0_{Rk.s.eq.C2}$	[Nm]								
Concrete pry-out failure										
Factor for resistance to pry-out failure	k_8		2.0							
Concrete edge failure										
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$							
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	24	27	30

The anchor for seismic performance shall be used with minimum rupture elongation after fracture A_5 equal to 19%.

Table C4: Characteristic values of resistance for rebar under tension loads in uncracked concrete

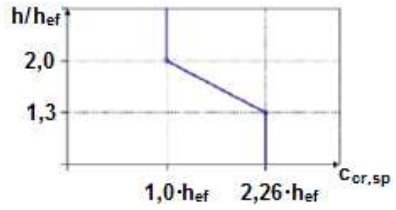
Anchor size reinforcing bar				**Ø8**	**Ø10**	**Ø12**	**Ø16**	**Ø20**	**Ø25**	**Ø32**
Steel failure										
Characteristic tension resistance		$N_{Rk.s}$	[kN]	$A_s \times f_{uk}$						
Combined pull-out and concrete cone failure										
Characteristic bond resistance in uncracked concrete C20/25										
Temperature range I: 40°C/24°C	Dry and wet concrete	$\tau_{Rk.ucr}$	[N/mm²]	8.5	9.0	9.0	8.0	8.0	8.0	5.0
	Flooded bore hole	$\tau_{Rk.ucr}$	[N/mm²]	7.5	8.5	8.5	8.0	NPD		
Temperature range II: 80°C/50°C	Dry and wet concrete	$\tau_{Rk.ucr}$	[N/mm²]	7.5	8.0	8.0	7.5	7.5	7.0	4.5
	Flooded bore hole	$\tau_{Rk.ucr}$	[N/mm²]	6.5	7.0	7.0	6.5	NPD		
Increasing factors for concrete Ψ_c		C50/60		1.0						
Concrete cone failure										
Factor for concrete cone failure		k_{ucr}	[-]	11						
Edge distance		$c_{cr.N}$	[mm]	1.5 h_{ef}						
Axial distance		$s_{cr.N}$	[mm]	3.0 h_{ef}						
Splitting failure										
Edge distance $c_{cr.sp}$ [mm] for	$h / h_{ef} \geq 2.0$			1.0 h_{ef}						
	$2.0 > h / h_{ef} > 1.3$			4.6 h_{ef} – 1.8 h						
	$h / h_{ef} \leq 1.3$			2.26 h_{ef}						
Axial distance		$s_{cr.sp}$	[mm]	2 $c_{cr.sp}$						
Partial safety factor (dry and wet concrete)		γ_{inst}		1.2						
Partial safety factor (flooded bore hole)		γ_{inst}		1.4				NPD		

Table C5: Characteristic values of resistance for rebar rods under shear loads in uncracked concrete

Anchor size reinforcing bar			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Steel failure without lever arm									
Characteristic shear resistance	$V_{Rk.s}$	[kN]	$0.50 \times A_s \times f_{uk}$						
Ductility factor	k_7		1.0 for steel with rupture elongation $A_5 > 8\%$						
Steel failure with lever arm									
Characteristic bending moment	$M^0_{Rk.s}$	[Nm]	$1.2 * W_{el} * f_{uk}$						
Concrete pry-out failure									
Factor for resistance to pry-out failure	k_8		2.0						
Concrete edge failure									
Effective length of anchor	l_f	[mm]	$l_f = \min(h_{ef}; 8\ d_{nom})$						
Outside diameter of anchor	d_{nom}	[mm]	8	10	12	16	20	25	32

Table C6: Displacement of threaded rod under tension and shear load

Anchor size			M8	M10	M12	M16	M20	M24	M27	M30
Uncracked concrete										
Tension load										
Displacement	δ_{N0}	[mm/kN]	0,05	0,04	0,03	0,02	0,02	0,02	0,01	0,01
	$\delta_{N\infty}$	[mm/kN]	0,11	0,09	0,06	0,04	0,03	0,02	0,02	0,02
Shear load										
Displacement	δ_{V0}	[mm/kN]	0,48	0,30	0,20	0,11	0,10	0,08	0,06	0,05
	$\delta_{V\infty}$	[mm/kN]	0,72	0,45	0,30	0,17	0,14	0,12	0,10	0,08
Cracked concrete										
Tension load										
Displacement	δ_{N0}	[mm]		0,08	0,09	0,05	0,03	0,02		
	$\delta_{V\infty}$	[mm/kN]		0,51	0,32	0,18	0,13	0,11		

Table C7: Displacement of rebar rod under tension and shear load

Rebar size			Ø8	Ø10	Ø12	Ø16	Ø20	Ø25	Ø32
Uncracked concrete									
Tension load									
Displacement	δ_{N0}	[mm/kN]	0,04	0,03	0,02	0,02	0,01	0,01	0,01
	$\delta_{N\infty}$	[mm/kN]	0,09	0,07	0,05	0,03	0,02	0,01	0,01
Shear load									
Displacement	δ_{V0}	[mm/kN]	0,05	0,04	0,03	0,02	0,01	0,01	0,01
	$\delta_{V\infty}$	[mm/kN]	0,08	0,06	0,05	0,03	0,02	0,01	0,01

Table C8: Displacement of threaded rod under tension and shear load – seismic category C2

Anchor size			M12	M16	M20
Displacement	$\delta_{N,eq(DLS)}$	[mm]	0,57	0,35	0,85
	$\delta_{N,eq(ULS)}$	[mm]	7,62	6,75	7,28
	$\delta_{V,eq(DLS)}$	[mm]	5,29	4,12	4,94
	$\delta_{V,eq(ULS)}$	[mm]	10,20	9,05	10,99