**Approval body for construction products and types of construction**

**Bautechnisches Prüfamt**

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

# European Technical Assessment

# ETA-18/1114 of 2 April 2019

English translation prepared by DIBt - Original version in German language

**General Part**

| | |
|---|---|
| Technical Assessment Body issuing the European Technical Assessment: | Deutsches Institut für Bautechnik |
| Trade name of the construction product | 292 Alfa Injection mortar for concrete |
| Product family to which the construction product belongs | Bonded fastener for use in concrete |
| Manufacturer | Alfa GmbH<br>Ferdinand-Porsche-Straße 10<br>73479 Ellwangen<br>DEUTSCHLAND |
| Manufacturing plant | Werk 1,D und Werk 2, D |
| This European Technical Assessment contains | 29 pages including 3 annexes which form an integral part of this assessment |
| This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of | EAD 330499-01-0601 |

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## Specific Part

## 1 Technical description of the product

The "292 Alfa Injection mortar for concrete" is a bonded anchor consisting of a cartridge with injection mortar 292 Alfa and a steel element. The steel element consist of a threaded rod with washer and hexagon nut in the range of M8 to M30, reinforcing bar in the range of diameter ∅8 to ∅32 mm or internal threaded rod IG-M6 to IG-M20.

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

The product description is given in Annex A.

## 2 Specification of the intended use in accordance with the applicable European Assessment Document

The performances given in Section 3 are only valid if the anchor is used in compliance with the specifications and conditions given in Annex B.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the anchor of at least 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

## 3 Performance of the product and references to the methods used for its assessment

### 3.1 Mechanical resistance and stability (BWR 1)

| Essential characteristic | Performance |
|---|---|
| Characteristic resistance to tension load (static and quasi-static loading) | See Annex C 1, C 2, C 3, C 6, C 7, C 9, C 10 |
| Characteristic resistance to shear load (static and quasi-static loading) | See Annex C 1, C 4, C 8, C 11 |
| Displacements (static and quasi-static loading) | See Annex C 13 and C 14 |
| Characteristic resistance for seismic performance category C1 | See Annex C 5 and C 12 |
| Characteristic resistance and displacements for seismic performance category C2 | No performance assessed |

### 3.2 Hygiene, health and the environment (BWR 3)

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

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

In accordance with the European Assessment Document EAD 330499-01-0601 the applicable European legal act is: [96/582/EC].

The system to be applied is: 1

## 5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable European Assessment Document

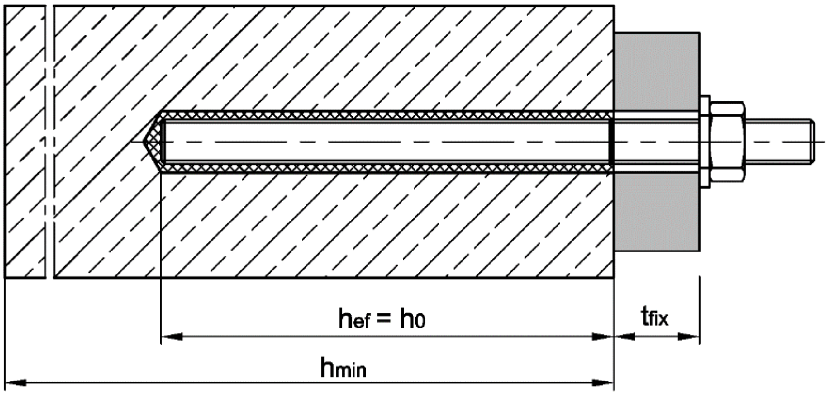
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Deutsches Institut für Bautechnik.

Issued in Berlin on 2 April 2019 by Deutsches Institut für Bautechnik

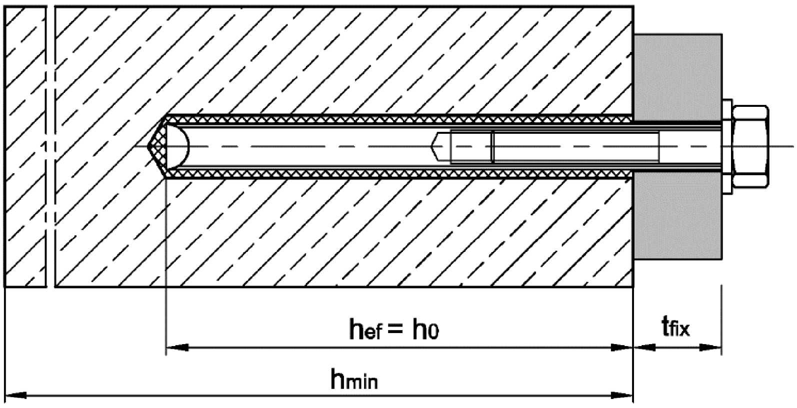
BD Dipl.-Ing. Andreas Kummerow
Head of Department

*beglaubigt:*
Baderschneider

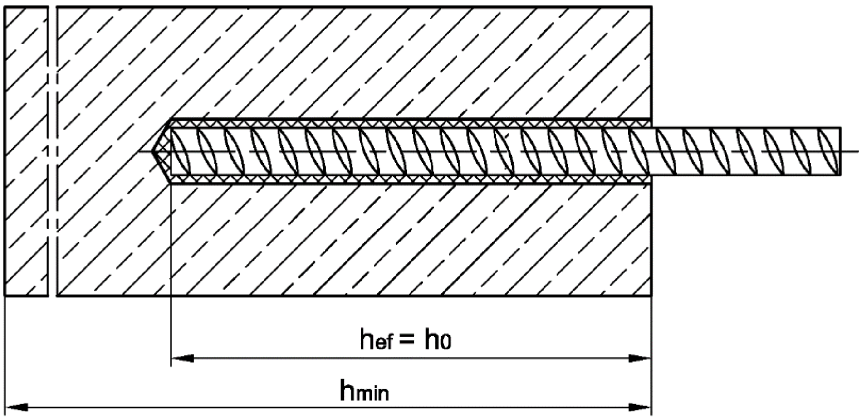
## Installation threaded rod M8 to M30




## Installation internally threaded anchor rod IG-M6 to IG-M20




## Installation reinforcing bar Ø8 to Ø32




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

**292 Alfa Injectionmortar for concrete**

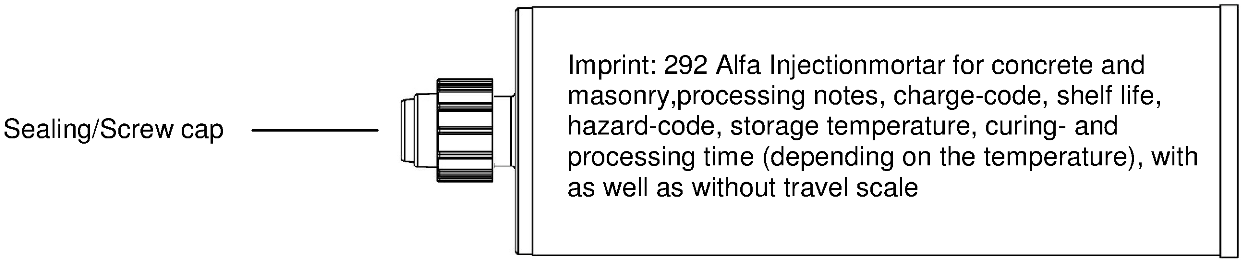
**Product description**
Installation situation

**Annex A1**

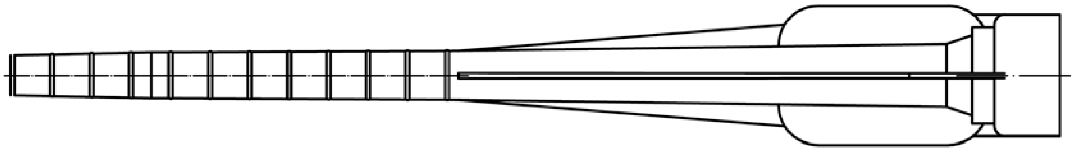
*English translation prepared by DIBt*

## Cartridge 292 Alfa Injectionmortar

### 280 ml cartridge (Type: coaxial)




### Static mixer

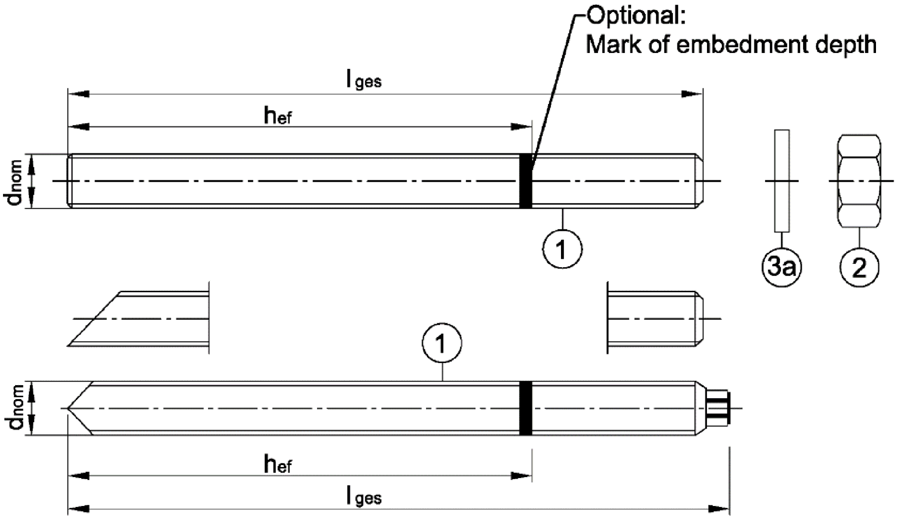


| 292 Alfa Injectionmortar for concrete | Annex A2 |
|---|---|
| **Product description**<br>Cartridges and attachments | |

## Anchor rods

**302/314 Alfa anchor rods or anchor rods with hexagon head** with washer and hexagon nut
**M8, M10, M12, M16, M20, M24, M27, M30**

**3834/3837 Alfa threaded rod** (material sold by the meter, to be cut at the required length)
**M8, M10, M12, M16, M20, M24, M27, M30**



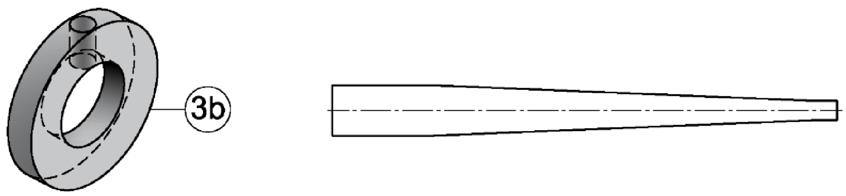

Marking: ◇ M10

| | |
|---|---|
| ◇ | Identifying mark of manufacturing plant |
| M10 | Size of thread |
| A4 | additional marking for stainless steel |
| HCR | additional marking for High corrosion resistant steel |

**Commercial standard threaded rod with:**

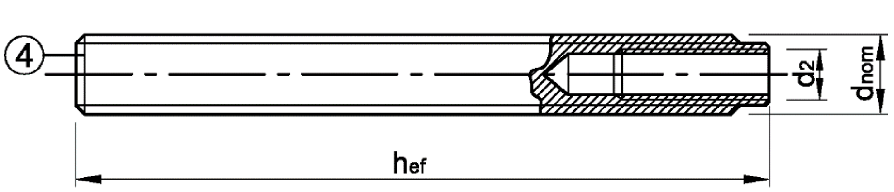
- Materials, dimensions and mechanical properties see Table A1
- Inspection certificate 3.1 acc. to EN 10204:2004

**Washer with bore and reducing adapter for filling the gap between threaded rod and fixture**




## Internally threaded anchor rod

**IG M6, IG M8, IG M10, IG M12, IG M16, IG M20**




Marking e.g.: ◇ M8

| | |
|---|---|
| ◇ | Identifying mark of manufacturing plant |
| I | Internal thread |
| M8 | Size of internal thread |
| A4 | additional marking for stainless steel |
| HCR | additional marking for high corrosion resistant steel |

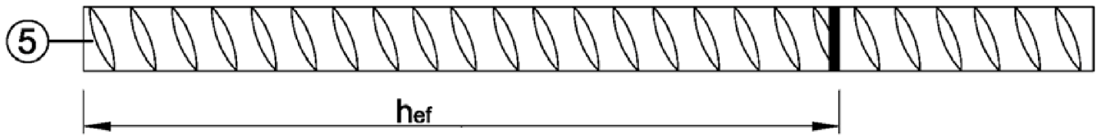
| | |
|---|---|
| **292 Alfa Injectionmortar for concrete** | **Annex A3** |
| **Product description**<br>Threaded rods and internally threaded anchor rod | |

## Table A1: Materials

| Part | Designation | | Material | |
|---|---|---|---|---|
| **Steel, zinc plated**<br>electroplated ≥ 5 µm acc. to EN ISO 4042:1999 or hot-dip galvanised ≥ 40 µm acc. to EN ISO 1461:2009, EN ISO 10684:2004+AC:2009 or sherardized ≥ 40µm acc. to EN ISO 17668:2016 | | | | |
| 1 | Threaded rod | Property class 4.6 | $f_{uk}$≥ 400 N/mm²; $f_{yk}$≥ 240 N/mm²; $A_5$ > 8 % fracture elongation | EN 10087:1998, EN 10263:2001; commercial standard threaded rod: EN ISO 898-1:2013 |
| | | Property class 4.8 | $f_{uk}$≥ 400 N/mm²; $f_{yk}$≥ 320 N/mm²; $A_5$ > 8 % fracture elongation | |
| | | Property class 5.6 | $f_{uk}$≥ 500 N/mm²; $f_{yk}$≥ 300 N/mm²; $A_5$ > 8 % fracture elongation | |
| | | Property class 5.8 | $f_{uk}$≥ 500 N/mm²; $f_{yk}$≥ 400 N/mm²; $A_5$ > 8 % fracture elongation | |
| | | Property class 8.8 | $f_{uk}$≥ 800 N/mm²; $f_{yk}$≥ 640 N/mm²; $A_5$ > 8 % fracture elongation | |
| 2 | Hexagon nut | | Steel, zinc plated<br>Property class 4 (for class 4.6 or 4.8 rod)<br>Property class 5 (for class 5.6 or 5.8 rod)<br>Property class 8 (for class 8.8 rod) | EN ISO 898-2:2012 |
| 3a | Washer | | Steel, zinc plated<br>(e.g.: EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000) | |
| 3b | Washer with bore | | Steel, zinc plated | |
| 4 | Internally threaded anchor rod | | Steel, electroplated, $A_5$ > 8 % fracture elongation<br>Property class 5.8 and 8.8 | EN 10087:1998 |
| **Stainless steel A4** | | | | |
| 1 | Threaded rod | | Material 1.4401 / 1.4404 / 1.4571 / 1.4578 / 1.4362 / 1.4062 | EN 10088-1:2014 |
| | | Property class 50 | $f_{uk}$= 500 N/mm²; $f_{yk}$= 210 N/mm²; $A_5$ > 8 % fracture elongation | EN ISO 3506-1:2009 |
| | | Property class 70 | $f_{uk}$= 700 N/mm²; $f_{yk}$= 450 N/mm²; $A_5$ > 8 % fracture elongation<br>M8 to M24 | |
| 2 | Hexagon nut | | Stainless Steel A4<br>Property class 50 (for class 50 rod)<br>Property class 70 (for class 70 rod; ≤ M24) | EN ISO 3506-2:2009 |
| 3a | Washer | | Stainless Steel A4<br>(e.g.: EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000) | EN 10088-1: 2014 |
| 3b | Washer with bore | | Material 1.4401 / 1.4404 / 1.4571 / 1.4362 | |
| 4 | Internally threaded anchor rod | | Material 1.4401 / 1.4404 / 1.4571 / 1.4362;<br>$A_5$ > 8 % fracture elongation<br>Property class 50 (IG-M20)<br>Property class 70 (IG-M8 to IG-M16) | EN 10088-1: 2014 |
| **High corrosion resistant steel HCR** | | | | |
| 1 | Threaded rod | | Material 1.4529 / 1.4565 | EN 10088-1: 2014 |
| | | Property class 50 | $f_{uk}$= 500 N/mm²; $f_{yk}$= 210 N/mm²; $A_5$ > 8 % fracture elongation | EN ISO 3506-1: 2009 |
| | | Property class 70 | $f_{uk}$= 700 N/mm²; $f_{yk}$= 450 N/mm²; $A_5$ > 8 % fracture elongation<br>M8 to M24 | |
| 2 | Hexagon nut | | Material 1.4529 / 1.4565<br>Property class 50 ((for class 50 rod)<br>Property class 70 (for class 70 rod; ≤ M24) | EN 10088-1: 2014<br>EN ISO 3506-2:2009 |
| 3a | Washer | | Material 1.4529 / 1.4565<br>(e.g.: EN ISO 7089:2000, EN ISO 7093:2000 or EN ISO 7094:2000) | EN 10088-1: 2014 |
| 3b | Washer with bore | | Material 1.4529 / 1.4565 | |
| 4 | Internally threaded anchor rod | | Material 1.4529 / 1.4565, $A_5$ > 8 % fracture elongation<br>Property class 50 (IG-M20)<br>Property class 70 (IG-M8 to IG-M16) | EN 10088-1: 2014 |

## Reinforcing bar

**∅ 8, ∅ 10, ∅ 12, ∅ 14, ∅ 16, ∅ 20, ∅ 25, ∅ 28, ∅ 32**




- Minimum value of related rip area $f_{R,min}$ according to EN 1992-1-1:2004+AC:2010
- Rip height of the bar shall be in the range 0,05d ≤ h ≤ 0,07d
  (d: Nominal diameter of the bar; h: Rip height of the bar)

### Table A2: Material rebar

| Part | Designation | Material |
|---|---|---|
| **Rebar** | | |
| 5 | Rebar<br>EN 1992-1-1:2004+AC:2010,<br>Annex C | Bars and de-coiled rods class B or C<br>$f_{yk}$ and k according to NDP or NCL of EN 1992-1-1/NA:2013<br>$f_{uk} = f_{tk} = k \cdot f_{yk}$ |

## Specification of intended use

| 292 Alfa Injectionmortar for concrete | Anchor rod | Internally threaded anchor rod | rebar |
|---|---|---|---|
| | 302/314 Alfa anchor rods, anchor rods wit hexagon head, 3834/3837 Alfa threaded rods, commercial standard threaded rod | IG | |
| Static or quasi-static action | M8 - M30 (zinc plated, A4, HCR) | IG-M6 - IG-M20 (electroplated, A4, HCR) | Ø8 - Ø32 |
| Seismic action, category C1 | M8 - M30 (zinc plated[1)], A4, HCR) | - | Ø8 - Ø32 |
| Base materials | Compacted reinforced or unreinforced normal weight concrete without fibres acc. to EN 206:2013<br>Strength classes acc. to EN 206:2013 C20/25 to C50/60<br>Cracked and uncracked concrete | | |
| Temperature Range I -40 °C to +40 °C | max long term temperature +24 °C and max short term temperature +40 °C | | |
| Temperature Range II -40 °C to +80 °C | max long term temperature +50 °C and max short term temperature +80 °C | | |
| Temperature Range III -40 °C to +120 °C | max long term temperature +72 °C and max short term temperature +120 °C | | |

1) except hot-dip galvanised

**Use conditions (Environmental conditions):**

- Structures subject to dry internal conditions
  (zinc coated steel, stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure (including industrial and marine environment) and to permanently damp internal condition, if no particular aggressive conditions exist
  (stainless steel or high corrosion resistant steel).
- Structures subject to external atmospheric exposure and to permanently damp internal condition, if other particular aggressive conditions exist
  (high corrosion resistant steel).

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

**Design:**

- Verifiable calculation notes and drawings are prepared taking account of the loads to be anchored. The position of the anchor is indicated on the design drawings (e. g. position of the anchor relative to reinforcement or to supports, etc.).
- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Anchorages are designed in accordance with: EN 1992-4:2018 and EOTA Technical Report TR 055

**Installation:**

- Dry or wet concrete: M8 to M30, IG-M6 to IG-M20, Rebar Ø8 to Ø32.
- Flooded holes (not sea water): M8 to M16, IG-M6 to IG-M10, Rebar Ø8 to Ø16.
- Hole drilling by hammer or compressed air drill mode or vacuum drill mode.
- Overhead installation allowed.
- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.

## Table B1: Installation parameters for threaded rod

| Threaded rod | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ = | [mm] | 10 | 12 | 14 | 18 | 24 | 28 | 32 | 35 |
| Effective anchorage depth | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 80 | 90 | 96 | 108 | 120 |
| | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 320 | 400 | 480 | 540 | 600 |
| Diameter of clearance hole in the fixture[1] | $d_f$ ≤ | [mm] | 9 | 12 | 14 | 18 | 22 | 26 | 30 | 33 |
| Installation torque | $T_{inst}$ ≤ | [Nm] | 10 | 20 | 40 | 80 | 120 | 160 | 180 | 200 |
| 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 | 80 | 100 | 120 | 135 | 150 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 50 | 60 | 80 | 100 | 120 | 135 | 150 |

[1] for application under seismic loading the diameter of clearance hole in the fixture shall be at maximum $d_{nom}$ + 1mm or alternatively the annular gap between fixture and threaded rod shall be completely filled with mortar

## Table B2: Installation parameters for internally threaded anchor rod

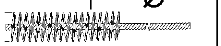
| Internally threaded anchor rod | | | IG-M 6 | IG-M 8 | IG-M 10 | IG-M 12 | IG-M 16 | IG-M 20 |
|---|---|---|---|---|---|---|---|---|
| Inner diameter of threaded rod | $d_2$ = | [mm] | 6 | 8 | 10 | 12 | 16 | 20 |
| Outer diameter of threaded rod[2] | $d_{nom}$ = | [mm] | 10 | 12 | 16 | 20 | 24 | 30 |
| Nominal drill hole diameter | $d_0$ = | [mm] | 12 | 14 | 18 | 24 | 28 | 35 |
| Effective anchorage 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[1] | $d_f$ ≤ | [mm] | 7 | 9 | 12 | 14 | 18 | 22 |
| Installation torque | $T_{inst}$ ≤ | [Nm] | 10 | 10 | 20 | 40 | 60 | 100 |
| Minimum screw-in depth | $l_{IG}$ | [mm] | 8 | 8 | 10 | 12 | 16 | 20 |
| Minimum thickness of member | $h_{min}$ | [mm] | $h_{ef}$ + 30 mm ≥ 100 mm | | $h_{ef} + 2d_0$ | | | |
| Minimum spacing | $s_{min}$ | [mm] | 50 | 60 | 80 | 100 | 120 | 150 |
| Minimum edge distance | $c_{min}$ | [mm] | 50 | 60 | 80 | 100 | 120 | 150 |

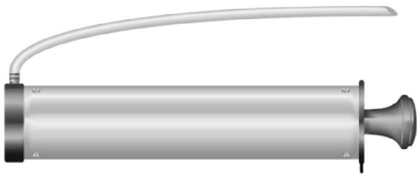
[1] With metric thread acc. to EN 1993-1-8:2005+AC:2009

## Table B3: Installation parameters for rebar

| Rebar | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ = | [mm] | 12 | 14 | 16 | 18 | 20 | 24 | 32 | 35 | 40 |
| Effective anchorage depth | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 75 | 80 | 90 | 100 | 112 | 128 |
| | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 280 | 320 | 400 | 500 | 560 | 640 |
| Minimum thickness of member | $h_{min}$ | [mm] | $h_{ef}$ + 30 mm ≥ 100 mm | | $h_{ef} + 2d_0$ | | | | | | |
| Minimum spacing | $s_{min}$ | [mm] | 40 | 50 | 60 | 70 | 80 | 100 | 125 | 140 | 160 |
| Minimum edge distance | $c_{min}$ | [mm] | 40 | 50 | 60 | 70 | 80 | 100 | 125 | 140 | 160 |

## Table B4: Parameter cleaning and setting tools

| Threaded rod  | Internally threaded anchor rod  | Rebar  | Drill bit Ø  | Brush Ø | min. Brush Ø  | Retaining washer  | Installation direction and use of retaining washer | | |
|---|---|---|---|---|---|---|---|---|---|
| [-] | [-] | Ø [mm] | $d_0$ [mm] | $d_b$ [mm] | $d_{b,min}$ [mm] | [-] | ⬇ | ➡ | ⬆ |
| M8 | | | 10 | 12 | 10,5 | No **retaining washer** required | | | |
| M10 | IG M6 | 8 | 12 | 14 | 12,5 | | | | |
| M12 | IG M8 | 10 | 14 | 16 | 14,5 | | | | |
| | | 12 | 16 | 18 | 16,5 | | | | |
| M16 | IG M10 | 14 | 18 | 20 | 18,5 | 18 | $h_{ef}$ > 250mm | $h_{ef}$ > 250mm | all |
| | | 16 | 20 | 22 | 20,5 | 20 | | | |
| M20 | IG M12 | 20 | 24 | 26 | 24,5 | 24 | | | |
| M24 | IG M16 | | 28 | 30 | 28,5 | 28 | | | |
| M27 | | 25 | 32 | 34 | 32,5 | 32 | | | |
| M30 | IG M20 | 28 | 35 | 37 | 35,5 | 35 | | | |
| | | 32 | 40 | 41,5 | 40,5 | 40 | | | |



**Blow-out pump (volume 750ml)**
Drill bit diameter ($d_0$): 10 mm to 20 mm
Anchorage depth ($h_{ef}$): ≤ 10 $d_{nom}$
for uncracked concrete

**Recommended compressed air tool (min 6 bar)**
All applications

**Retaining washer for overhead or horizontal installation**
Drill bit diameter ($d_0$):
18 mm to 40 mm


**Steel brush**
Drill bit diameter ($d_0$): all diameters

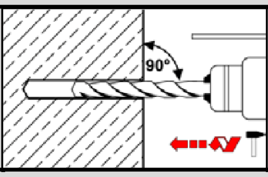
**292 Alfa Injectionmortar for concrete**

**Intended Use**
Cleaning and setting tools

**Annex B3**

## Installation instructions

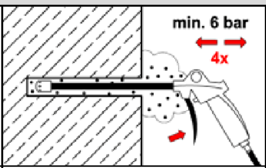
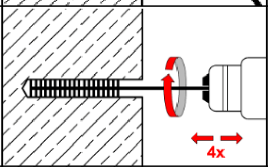
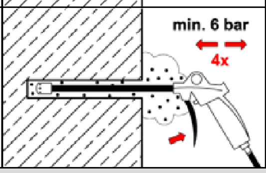
### Drilling of the hole

| | | |
|---|---|---|
| 1. |  | Drill the borehole by apllying the drilling method acc. to Annex B1, the drill bit diameter (Table B4) and the selected borehole depth.<br>In case of aborted drill hole, the drill hole shall be filled with mortar |

### Cleaning

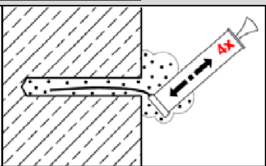
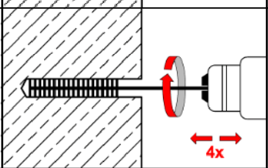
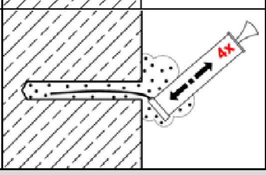
**Attention! Standing water in the bore hole must be removed before cleaning!**

**Cleaning with compressed air**
(all diameters, cracked and uncracked concrete)

| | | |
|---|---|---|
| 2a. |  | Starting from the bottom or back of the bore hole, blow out the hole with compressed air (min. 6 bar) **four** times.<br>If the bore hole ground is not reached, an extension must be used. |
| 2b. |  | Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) **four** times.<br>If the bore hole ground is not reached, a brush extension shall be used. |
| 2c. |  | Finally blow the hole clean again with compressed air (min. 6 bar)<br>**four** times. If the bore hole ground is not reached an extension shall be used. |

2.

**Manual cleaning**
Uncracked concrete: Bore hole diameter $d_0 \leq$ 20mm and effective anchorage depth $h_{ef} \leq 10\ d_{nom}$
Cracked concrete: Bore hole diameter: 14mm $\leq d_0 \leq$ 20mm and effective anchorage depth $h_{ef} \leq 10\ d_{nom}$

| | | |
|---|---|---|
| 2a. |  | Starting from the bottom or back of the bore hole, blow the hole clean with the blow-out pump **four** times. |
| 2b. |  | Attach the brush to a drilling machine or a battery screwdriver. Brush the hole with an appropriate sized wire brush > $d_{b,min}$ (Table B4) **four** times.<br>If the bore hole ground is not reached, a brush extension shall be used. |
| 2c. |  | Finally blow the hole clean again with the blow-out pump **four** times. |

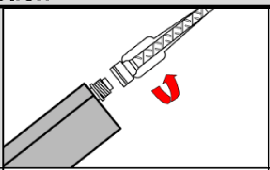
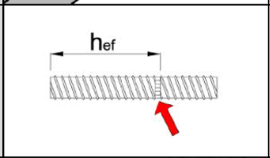
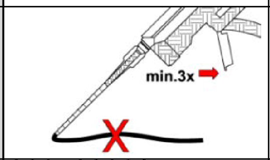
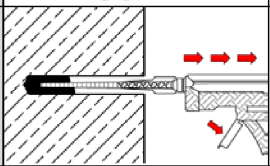
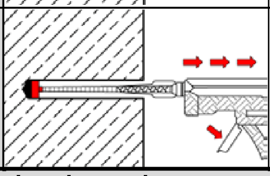
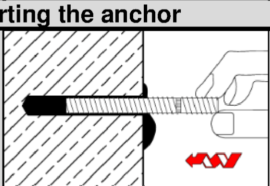
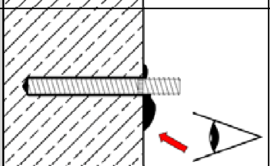
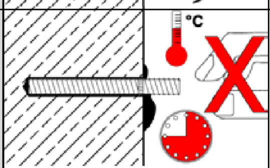
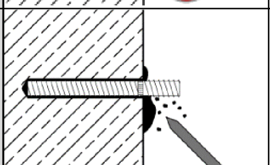
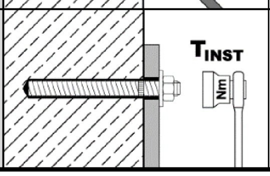
**After cleaning, the bore hole has to be protected against re-contamination in an appropriate way, until dispensing the mortar in the bore hole. If necessary, the cleaning has to be repeated directly before dispensing the mortar. In-flowing water must not contaminate the bore hole again.**

**292 Alfa Injectionmortar for concrete**

**Intended Use**
Installation instructions

**Annex B4**

**Installation instructions (continuation)**

| | | |
|---|---|---|
| **Injection** | | |
| 3. |  | Attach a supplied static-mixing nozzle to the cartridge and load the cartridge into the correct dispensing tool.<br>For every working interruption longer than the recommended working time (Table B5) as well as for new cartridges, a new static-mixer shall be used. |
| 4. |  | Before injecting the mortar, mark the required anchorage depth on the fastening element. |
| 5. |  | Prior to dispensing into the drill hole, squeeze out separately a minimum of three full strokes and discard non-uniformly mixed adhesive components until the mortar shows a consistent grey colour. For tubular film cartridges dismiss a minimum of six full strokes. |
| 6a. |  | Starting from the bottom or back of the cleaned drill hole fill the hole up to approximately two-thirds with adhesive. Slowly withdraw the static mixing nozzle as the hole fills to avoid air pockets. For embedment larger than 190mm an extension nozzle shall be used.<br>Observe the gel-/ working times given in Table B5. |
| 6b. |  | Retaining washer and mixer nozzle extensions shall be used according to Annex B3 for the following applications:<br>• Horizontal installation (horizontal direction) and ground installation (vertical downwards direction): Drill bit-Ø $d_0 \geq 18$ mm and embedment depth $h_{ef} > 250$mm<br>• Overhead installation: Drill bit-Ø $d_0 \geq 18$ mm |
| **Inserting the anchor** | | |
| 7. |  | Push the threaded rod into the hole while turning slightly to ensure proper distribution of the adhesive until the embedment depth is reached.<br>The anchor shall be free of dirt, grease, oil or other foreign material. |
| 8. |  | Make sure that the anchor is fully seated up to the full embedment depth and that excess mortar is visible at the top of the hole. If these requirements are not maintained, pull out the rod immediately and start again with step 6.<br>For overhead installation, the anchor should be fixed (e.g. by wedges). |
| 9. |  | Allow the adhesive to cure to the specified time prior to applying any load or torque. Do not move or load the anchor until it is fully cured (Table B5). |
| 10. |  | Remove excess mortar. |
| 11. |  | The fixture can be mounted after curing time. Apply installation torque Tinst according to Table B1or B2 by using a calibrated torque wrench. Optionally, the annular gap between anchor rod and attachment can be filled with mortar. Therefor replace the regular washer by washer with bore and plug on reducing adapter on static mixer.<br>Annular gap is completely filled, when excess mortar seeps out. |

**292 Alfa Injectionmortar for concrete**

**Intended Use**
Installation instructions (continuation)

**Annex B5**

## Table B5: Maximum processing time and minimum curing time, 292 Alfa Injectionmortar

| Concrete temperature | Maximum processing time | Minimum curing time in dry concrete[1)] |
|---|---|---|
| -10°C to -6°C | 90 min[2)] | 24 h[2)] |
| -5°C to -1°C | 90 min | 14 h |
| 0°C to +4°C | 45 min | 7 h |
| +5°C to +9°C | 25 min | 2 h |
| +10°C to +19°C | 15 min | 80 min |
| +20°C to +29°C | 6 min | 45 min |
| +30°C to +34°C | 4 min | 25 min |
| +35°C to +39°C | 2 min | 20 min |
| + 40°C | 1,5 min | 15 min |
| Cartridge temperature | + 5°C to + 40°C | |

[1)] In wet concrete the curing time must be doubled.
[2)] Cartridge temperature must be at min. + 15°C.

**Table C1:** Characteristic **steel resistances** for **threaded rods** under tension and shear loads

| Threaded rod | | | | M 8 | M 10 | M 12 | M 16 | M 20 | M 24 | M 27 | M 30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| **Tension load** | | | | | | | | | | | |
| Characteristic tension resistance | Steel, Property class 4.6 and 4.8 | $N_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| | Steel, Property class 5.6 and 5.8 | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 230 | 280 |
| | Steel, Property class 8.8 | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 368 | 449 |
| | Stainless steel A4 and HCR, Property class 50 | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 79 | 123 | 177 | 230 | 281 |
| | Stainless steel A4 and HCR, Property class 70 | $N_{Rk,s}$ | [kN] | 26 | 41 | 59 | 110 | 171 | 247 | - | - |
| Partial factor | Steel, Property class 4.6 | $\gamma_{Ms,N}$ | [-] | 2,0 | | | | | | | |
| | Steel, Property class 4.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| | Steel, Property class 5.6 | $\gamma_{Ms,N}$ | [-] | 2,0 | | | | | | | |
| | Steel, Property class 5.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| | Steel, Property class 8.8 | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | | | |
| | Stainless steel A4 and HCR, Property class 50 | $\gamma_{Ms,N}$ | [-] | 2,86 | | | | | | | |
| | Stainless steel A4 and HCR, Property class 70 | $\gamma_{Ms,N}$ | [-] | 1,87 | | | | | | - | - |
| **Shear load** | | | | | | | | | | | |
| **Steel failure <u>without</u> lever arm** | | | | | | | | | | | |
| Characteristic shear resistance | Steel, Property class 4.6 and 4.8 | $V^0_{Rk,s}$ | [kN] | 7 | 12 | 17 | 31 | 49 | 71 | 92 | 112 |
| | Steel, Property class 5.6 and 5.8 | $V^0_{Rk,s}$ | [kN] | 9 | 15 | 21 | 39 | 61 | 88 | 115 | 140 |
| | Steel, Property class 8.8 | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| | Stainless steel A4 and HCR, Property class 50 | $V^0_{Rk,s}$ | [kN] | 9 | 15 | 21 | 39 | 61 | 88 | 115 | 140 |
| | Stainless steel A4 and HCR, Property class 70 | $V^0_{Rk,s}$ | [kN] | 13 | 20 | 30 | 55 | 86 | 124 | - | - |
| **Steel failure <u>with</u> lever arm** | | | | | | | | | | | |
| Characteristic bending moment | Steel, Property class 4.6 and 4.8 | $M^0_{Rk,s}$ | [Nm] | 15 | 30 | 52 | 133 | 260 | 449 | 666 | 900 |
| | Steel, Property class 5.6 and 5.8 | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 65 | 166 | 324 | 560 | 833 | 1123 |
| | Steel, Property class 8.8 | $M^0_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 | 896 | 1333 | 1797 |
| | Stainless steel A4 and HCR, Property class 50 | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 66 | 167 | 325 | 561 | 832 | 1125 |
| | Stainless steel A4 and HCR, Property class 70 | $M^0_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 232 | 454 | 784 | - | - |
| Partial factor | Steel, Property class 4.6 | $\gamma_{Ms,V}$ | [-] | 1,67 | | | | | | | |
| | Steel, Property class 4.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| | Steel, Property class 5.6 | $\gamma_{Ms,V}$ | [-] | 1,67 | | | | | | | |
| | Steel, Property class 5.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| | Steel, Property class 8.8 | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | | | |
| | Stainless steel A4 and HCR, Property class 50 | $\gamma_{Ms,V}$ | [-] | 2,38 | | | | | | | |
| | Stainless steel A4 and HCR, Property class 70 | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | | - | - |

**292 Alfa Injectionmortar for concrete**

**Performance**
Characteristic steel resistances for **threaded rods** under **tension** and **shear loads**

**Annex C1**

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

| Threaded rod | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s}$ | [kN] | see table C1 | | | | | | | |
| **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] | 4,0 | 5,0 | 5,5 | 5,5 | 5,5 | 5,5 | 6,5 | 6,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 4,0 | 4,0 | 5,5 | 5,5 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,5 | 4,0 | 4,0 | 4,0 | 4,0 | 4,5 | 4,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,0 | 4,0 | 4,0 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,cr}$ | [N/mm²] | 2,0 | 2,5 | 3,0 | 3,0 | 3,0 | 3,0 | 3,5 | 3,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 2,0 | 2,5 | 3,0 | 3,0 | no performance determined (NPD) | | | |
| Increasing factor for $\tau_{Rk,cr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | | | |
| | | | C30/37 | 1,04 | | | | | | | |
| | | | C35/45 | 1,07 | | | | | | | |
| | | | C40/50 | 1,08 | | | | | | | |
| | | | C45/55 | 1,09 | | | | | | | |
| | | | C50/60 | 1,10 | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | |
| Factor $k_1$ | | $k_{cr,N}$ | [-] | 7,7 | | | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | | | |
| Axial distance | | $s_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | no performance determined (NPD) | | | |

**Table C3:** Characteristic values for **threaded rods** under **tension loads** in **uncracked concrete**

| Threaded rod | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s}$ | [kN] | see table C1 | | | | | | | |
| **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 | 12 | 12 | 12 | 12 | 11 | 10 | 9 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 7,5 | 8,5 | 8,5 | 8,5 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 7,5 | 9 | 9 | 9 | 9 | 8,5 | 7,5 | 6,5 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 5,5 | 6,5 | 6,5 | 6,5 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 5,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 5,5 | 5,0 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 4,0 | 5,0 | 5,0 | 5,0 | no performance determined (NPD) | | | |
| Increasing factor for $\tau_{Rk,ucr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | | | |
| | | | C30/37 | 1,04 | | | | | | | |
| | | | C35/45 | 1,07 | | | | | | | |
| | | | C40/50 | 1,08 | | | | | | | |
| | | | C45/55 | 1,09 | | | | | | | |
| | | | C50/60 | 1,10 | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | |
| Factor $k_1$ | | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | | | |
| Axial distance | | $s_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | | | |
| **Splitting failure** | | | | | | | | | | | |
| Edge distance for | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | 2 $c_{cr,sp}$ | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | no performance determined (NPD) | | | |

**Table C4:** Characteristic values for **threaded rods** under **shear loads** in **cracked and uncracked concrete**

| **Threaded rod** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | |
| Characteristic shear resistance | $V^0_{Rk,s}$ | [kN] | see table C1 | | | | | | | |
| Ductility factor | $k_7$ | [-] | 0,8 | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | |
| Characteristic bending moment | $M^0_{Rk,s}$ | [Nm] | see table C1 | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | |
| Pry-out Faktor | $k_8$ | [-] | 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 |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | |

**Table C5:** Characteristic values for **threaded rods** under **seismic action,** category **C1**

| **Threaded rod** | | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tension load** | | | | | | | | | | | |
| **Steel failure** | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s,eq}$ | [kN] | $1{,}0 \cdot N_{Rk,s}$ (see table C1) | | | | | | | |
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | |
| Characteristic bond resistance in concrete C20/25 to C50/60 | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 2,5 | 3,1 | 3,7 | 3,7 | 3,7 | 3,8 | 4,5 | 4,5 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 2,5 | 2,5 | 3,7 | 3,7 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 1,6 | 2,2 | 2,7 | 2,7 | 2,7 | 2,8 | 3,1 | 3,1 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 1,6 | 1,9 | 2,7 | 2,7 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 1,3 | 1,6 | 2,0 | 2,0 | 2,0 | 2,1 | 2,4 | 2,4 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 1,3 | 1,6 | 2,0 | 2,0 | no performance determined (NPD) | | | |
| Increasing factor for $\tau_{Rk,seis}$ | | $\psi_c$ | [-] | 1,0 | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | no performance determined (NPD) | | | |
| **Shear load** | | | | | | | | | | | |
| **Steel failure without lever arm** | | | | | | | | | | | |
| Characteristic shear resistance | | $V_{Rk,s,eq}$ | [kN] | $0{,}7 \cdot V^0_{Rk,s}$ (see table C1) | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | |
| Characteristic bending moment | | $M^0_{Rk,s,eq}$ | [Nm] | No Performance Determined (NPD) | | | | | | | |

**292 Alfa Injectionmortar for concrete**

**Performance**
Characteristic values for **threaded rods** under **seismic action**, category **C1**

**Annex C5**

**Table C6:** Characteristic values of **tension loads** for **internally threaded anchor rods** in **cracked concrete**

| **Internally threaded anchor rod** | | | | **IG-M 6** | **IG-M 8** | **IG-M 10** | **IG-M 12** | **IG-M 16** | **IG-M20** |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** [1] | | | | | | | | | |
| Characteristic shear resistance Steel, strength class 5.8 | | $N_{Rk,s}$ | [kN] | 10 | 18 | 29 | 42 | 79 | 123 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | |
| Characteristic shear resistance Steel, strength class 8.8 | | $N_{Rk,s}$ | [kN] | 16 | 27 | 46 | 67 | 121 | 196 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | |
| Characteristic shear resistance Stainless steel A4 / HCR, strength class 70 | | $N_{Rk,s}$ | [kN] | 14 | 26 | 41 | 59 | 110 | 124 [2] |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,87 | | | | | 2,86 |
| **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 | 5,5 | 5,5 | 5,5 | 5,5 | 6,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 4,0 | 5,5 | 5,5 | no performance determined (NPD) | | |
| 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 | 4,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 3,0 | 4,0 | 4,0 | no performance determined (NPD) | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,0 | 3,0 | 3,0 | 3,0 | 3,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,0 | 3,0 | no performance determined (NPD) | | |
| Increasing factor for $\tau_{Rk,cr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | |
| | | | C30/37 | 1,04 | | | | | |
| | | | C35/45 | 1,07 | | | | | |
| | | | C40/50 | 1,08 | | | | | |
| | | | C45/55 | 1,09 | | | | | |
| | | | C50/60 | 1,10 | | | | | |
| **Concrete cone failure** | | | | | | | | | |
| Factor $k_1$ | | $k_{cr,N}$ | [-] | 7,7 | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | |
| Spacing | | $s_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,2 | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | no performance determined (NPD) | | |

[1] Fastening screws or threaded rods (incl. nut and washer) must compley with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element
[2] For IG M20: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

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**Table C7:** Characteristic values of **tension loads** for **internally threaded anchor rods** in **uncracked concrete**

| **Internally threaded anchor rod** | | | | **IG-M 6** | **IG-M 8** | **IG-M 10** | **IG-M 12** | **IG-M 16** | **IG-M 20** |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** [1] | | | | | | | | | |
| Characteristic shear resistance Steel, strength class 5.8 | | $N_{Rk,s}$ | [kN] | 10 | 18 | 29 | 42 | 79 | 123 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | |
| Characteristic shear resistance Steel, strength class 8.8 | | $N_{Rk,s}$ | [kN] | 16 | 27 | 46 | 67 | 121 | 196 |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,5 | | | | | |
| Characteristic shear resistance Stainless steel A4 / HCR, strength class 70 | | $N_{Rk,s}$ | [kN] | 14 | 26 | 41 | 59 | 110 | 124 [2] |
| Partial factor | | $\gamma_{Ms,N}$ | [-] | 1,87 | | | | | 2,86 |
| **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] | 12 | 12 | 12 | 12 | 11 | 9,0 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 8,5 | 8,5 | 8,5 | no performance determined | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 9,0 | 9,0 | 9,0 | 9,0 | 8,5 | 6,5 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 6,5 | 6,5 | 6,5 | no performance determined | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 5,0 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 5,0 | 5,0 | 5,0 | no performance determined | | |
| Increasing factor for $\tau_{Rk,ucr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | |
| | | | C30/37 | 1,04 | | | | | |
| | | | C35/45 | 1,07 | | | | | |
| | | | C40/50 | 1,08 | | | | | |
| | | | C45/55 | 1,09 | | | | | |
| | | | C50/60 | 1,10 | | | | | |
| **Concrete cone failure** | | | | | | | | | |
| Factor $k_1$ | | $k_{ucr,N}$ | [-] | 11,0 | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | |
| Spacing | | $s_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | |
| **Splitting failure** | | | | | | | | | |
| Edge distance | $h/h_{ef} \geq 2,0$ | $c_{cr,sp}$ | [mm] | 1,0 $h_{ef}$ | | | | | |
| | $2,0 > h/h_{ef} > 1,3$ | | | 2 * $h_{ef}$ (2,5 – h / $h_{ef}$) | | | | | |
| | $h/h_{ef} \leq 1,3$ | | | 2,4 $h_{ef}$ | | | | | |
| Spacing | | $s_{cr,sp}$ | [mm] | 2 $c_{cr,sp}$ | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,2 | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | no performance determined | | |

[1] Fastening screws or threaded rods (incl. nut and washer) must compley with the appropriate material and property class of the internally threaded anchor rod. The characteristic tension resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element.
[2] For IG M20: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70



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**Performance**
Characteristic values for **internally threaded anchor rods** under **tension loads** in **uncracked concrete**

**Annex C7**

**Table C8:** Characteristic values for **internally threaded anchor rods** under **shear loads** in **cracked and uncracked concrete**

| Internally threaded anchor rod | | | IG-M 6 | IG-M 8 | IG-M 10 | IG-M 12 | IG-M 16 | IG-M 20 |
|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm**[1] | | | | | | | | |
| Characteristic shear resistance Steel, strength class 5.8 | $V^0_{Rk,s}$ | [kN] | 5 | 9 | 15 | 21 | 39 | 61 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Characteristic shear resistance Steel, strength class 8.8 | $V^0_{Rk,s}$ | [kN] | 8 | 14 | 23 | 34 | 60 | 98 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Characteristic shear resistance Stainless steel A4 / HCR, strength class 70 | $V^0_{Rk,s}$ | [kN] | 7 | 13 | 20 | 30 | 55 | 62 [2] |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | 2,38 |
| Ductility factor | $k_7$ | [-] | 0,8 | | | | | |
| **Steel failure with lever arm**[1] | | | | | | | | |
| Characteristic bending moment, Steel, strength class 5.8 | $M^0_{Rk,s}$ | [Nm] | 8 | 19 | 37 | 66 | 167 | 325 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Characteristic bending moment, Steel, strength class 8.8 | $M^0_{Rk,s}$ | [Nm] | 12 | 30 | 60 | 105 | 267 | 519 |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,25 | | | | | |
| Characteristic bending moment, Stainless steel A4 / HCR, strength class 70 | $M^0_{Rk,s}$ | [Nm] | 11 | 26 | 53 | 92 | 234 | 643 [2] |
| Partial factor | $\gamma_{Ms,V}$ | [-] | 1,56 | | | | | 2,38 |
| **Concrete pry-out failure** | | | | | | | | |
| Pry-out Faktor | $k_8$ | [-] | 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] | 10 | 12 | 16 | 20 | 24 | 30 |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | |

[1] Fastening screws or threaded rods (incl. nut and washer) must compley with the appropriate material and property class of the internally threaded anchor rod. The characteristic shear resistance for steel failure of the given strength class are valid for the internally threaded anchor rod and the fastening element

[2] For IG M20: Internally threaded rod: strength class 50; Fastening screws or threaded rods (incl. nut and washer): strength class 70

## Table C9: Characteristic values for **rebar** under **tension loads** in **cracked concrete**

| **Rebar** | | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ [1) ] | | | | | | | | |
| **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] | 4,0 | 5,0 | 5,5 | 5,5 | 5,5 | 5,5 | 5,5 | 6,5 | 6,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 4,0 | 4,0 | 5,5 | 5,5 | 5,5 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,5 | 4,0 | 4,0 | 4,0 | 4,0 | 4,0 | 4,5 | 4,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 2,5 | 3,0 | 4,0 | 4,0 | 4,0 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,cr}$ | [N/mm²] | 2,0 | 2,5 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,5 | 3,5 |
| | flooded bore hole | $\tau_{Rk,cr}$ | [N/mm²] | 2,0 | 2,5 | 3,0 | 3,0 | 3,0 | no performance determined (NPD) | | | |
| Increasing factors for $\tau_{Rk,cr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | | | | |
| | | | C30/37 | 1,04 | | | | | | | | |
| | | | C35/45 | 1,07 | | | | | | | | |
| | | | C40/50 | 1,08 | | | | | | | | |
| | | | C45/55 | 1,09 | | | | | | | | |
| | | | C50/60 | 1,10 | | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | | |
| Factor $k_1$ | | $k_{cr,N}$ | [-] | 7,7 | | | | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | 1,5 $h_{ef}$ | | | | | | | | |
| Axial distance | | $s_{cr,N}$ | [mm] | 3,0 $h_{ef}$ | | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | | no performance determined (NPD) | | | |

[1)] $f_{uk} = f_{tk} = k \cdot f_{yk}$

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**Table C10:** Characteristic values for **rebar** under **tension loads** in **uncracked concrete**

| Rebar | | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s}$ | [kN] | $A_s \cdot f_{uk}$ 1) | | | | | | | | |
| **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 | 12 | 12 | 12 | 12 | 12 | 11 | 10 | 8,5 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 7,5 | 8,5 | 8,5 | 8,5 | 8,5 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 7,5 | 9,0 | 9,0 | 9,0 | 9,0 | 9,0 | 8,0 | 7,0 | 6,0 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 5,5 | 6,5 | 6,5 | 6,5 | 6,5 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,ucr}$ | [N/mm²] | 5,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,5 | 6,0 | 5,0 | 4,5 |
| | flooded bore hole | $\tau_{Rk,ucr}$ | [N/mm²] | 4,0 | 5,0 | 5,0 | 5,0 | 5,0 | no performance determined (NPD) | | | |
| Increasing factors for $\tau_{Rk,ucr}$ | | $\psi_c$ | C25/30 | 1,02 | | | | | | | | |
| | | | C30/37 | 1,04 | | | | | | | | |
| | | | C35/45 | 1,07 | | | | | | | | |
| | | | C40/50 | 1,08 | | | | | | | | |
| | | | C45/55 | 1,09 | | | | | | | | |
| | | | C50/60 | 1,10 | | | | | | | | |
| **Concrete cone failure** | | | | | | | | | | | | |
| Factor $k_1$ | | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | | |
| Edge distance | | $c_{cr,N}$ | [mm] | $1{,}5\ h_{ef}$ | | | | | | | | |
| Axial distance | | $s_{cr,N}$ | [mm] | $3{,}0\ h_{ef}$ | | | | | | | | |
| **Splitting failure** | | | | | | | | | | | | |
| Edge distance for | | $c_{cr,sp}$ | [mm] | $1{,}0 \cdot h_{ef} \leq 2 \cdot h_{ef}\left(2{,}5 - \frac{h}{h_{ef}}\right) \leq 2{,}4 \cdot h_{ef}$ | | | | | | | | |
| Axial distance | | $s_{cr,sp}$ | [mm] | $2\ c_{cr,sp}$ | | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | | no performance determined (NPD) | | | |

1) $f_{uk} = f_{tk} = k \cdot f_{yk}$



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**Performance**
Characteristic values for **rebar** under **tension loads** in **uncracked concrete**

**Annex C10**

**Table C11:** Characteristic values for **rebar** under **shear loads** in **cracked and uncracked concrete**

| Rebar | | | Ø 8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | | | | | | |
| Characteristic shear resistance | $V^0_{Rk,s}$ | [kN] | $0{,}50 \cdot A_s \cdot f_{uk}$ [1] | | | | | | | | |
| Ductility factor | $k_7$ | [-] | 0,8 | | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | |
| Characteristic bending moment | $M^0_{Rk,s}$ | [Nm] | $1{,}2 \cdot W_{el} \cdot f_{uk}$ [1] | | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | | |
| Pry-out factor | $k_8$ | [-] | 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 | 14 | 16 | 20 | 25 | 28 | 32 |
| Installation factor | $\gamma_{inst}$ | [-] | 1,0 | | | | | | | | |

[1] $f_{uk} = f_{tk} = k \cdot f_{yk}$

## Table C12: Characteristic values for **rebar** under **seismic action**, category **C1**

| **Rebar** | | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tension load** | | | | | | | | | | | | |
| **Steel failure** | | | | | | | | | | | | |
| Characteristic tension resistance | | $N_{Rk,s,eq}$ | [kN] | $A_s \cdot f_{uk}$ [1)] | | | | | | | | |
| **Combined pull-out and concrete cone failure** | | | | | | | | | | | | |
| Characteristic bond resistance in concrete C20/25 to C50/60 | | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 2,5 | 3,1 | 3,7 | 3,7 | 3,7 | 3,7 | 3,8 | 4,5 | 4,5 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 2,5 | 2,5 | 3,7 | 3,7 | 3,7 | no performance determined (NPD) | | | |
| Temperature range II: 80°C/50°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 1,6 | 2,2 | 2,7 | 2,7 | 2,7 | 2,7 | 2,8 | 3,1 | 3,1 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 1,6 | 1,9 | 2,7 | 2,7 | 2,7 | no performance determined (NPD) | | | |
| Temperature range III: 120°C/72°C | dry and wet concrete | $\tau_{Rk,eq}$ | [N/mm²] | 1,3 | 1,6 | 2,0 | 2,0 | 2,0 | 2,0 | 2,1 | 2,4 | 2,4 |
| | flooded bore hole | $\tau_{Rk,eq}$ | [N/mm²] | 1,3 | 1,6 | 2,0 | 2,0 | 2,0 | no performance determined (NPD) | | | |
| Increasing factor for $\tau_{Rk,seis}$ | | $\psi_c$ | [-] | 1,0 | | | | | | | | |
| Installation factor (dry and wet concrete) | | $\gamma_{inst}$ | [-] | 1,0 | 1,2 | | | | | | | |
| Installation factor (flooded bore hole) | | $\gamma_{inst}$ | [-] | 1,4 | | | | | no performance determined (NPD) | | | |
| **Shear load** | | | | | | | | | | | | |
| **Steel failure without lever arm** | | | | | | | | | | | | |
| Characteristic shear resistance | | $V_{Rk,s,eq}$ | [kN] | $0,35 \cdot A_s \cdot f_{uk}$ [1)] | | | | | | | | |
| **Steel failure with lever arm** | | | | | | | | | | | | |
| Characteristic bending moment | | $M^0_{Rk,s,eq}$ | [Nm] | no performance determined (NPD) | | | | | | | | |

[1)] $f_{uk} = f_{tk} = k \cdot f_{yk}$

## Table C13: **Displacements** under **tension loads**[1)]
(threaded rod and internally threaded anchor rod)

| Threaded rod | | | M8 | M10 IG-M6 | M12 IG-M8 | M16 IG- M10 | M20 IG-M12 | M24 IG-M16 | M27 | M30 IG-M20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Uncracked concrete C20/25** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,021 | 0,023 | 0,026 | 0,031 | 0,036 | 0,041 | 0,045 | 0,049 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,030 | 0,033 | 0,037 | 0,045 | 0,052 | 0,060 | 0,065 | 0,071 |
| Temperature range II: 80°C/50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,050 | 0,056 | 0,063 | 0,075 | 0,088 | 0,100 | 0,110 | 0,119 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,072 | 0,081 | 0,090 | 0,108 | 0,127 | 0,145 | 0,159 | 0,172 |
| Temperature range III: 120°C/72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,050 | 0,056 | 0,063 | 0,075 | 0,088 | 0,100 | 0,110 | 0,119 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,072 | 0,081 | 0,090 | 0,108 | 0,127 | 0,145 | 0,159 | 0,172 |
| **Cracked concrete C20/25** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,090 | | 0,070 | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,105 | | 0,105 | | | | | |
| Temperature range II: 80°C/50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,219 | | 0,170 | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,255 | | 0,245 | | | | | |
| Temperature range III: 120°C/72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,219 | | 0,170 | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,255 | | 0,245 | | | | | |

[1)] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$-Faktor $\cdot \tau$;   $\tau$: acting bond stress for tension load
$\delta_{N\infty} = \delta_{N\infty}$-Faktor $\cdot \tau$;

## Table C14: **Displacements** under **shear load**[1)]
(threaded rod and internally threaded anchor rod)

| Threaded rod | | | M8 | M10 IG-M6 | M12 IG-M8 | M16 IG- M10 | M20 IG-M12 | M24 IG-M16 | M27 | M30 IG-M20 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Uncracked concrete C20/25** | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |
| **Cracked concrete C20/25** | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,12 | 0,12 | 0,11 | 0,10 | 0,09 | 0,08 | 0,08 | 0,07 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,18 | 0,18 | 0,17 | 0,15 | 0,14 | 0,13 | 0,12 | 0,10 |

[1)] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$-factor $\cdot V$;   V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}$-factor $\cdot V$;

## Table C15: **Displacements** under **tension load**[1)] (rebar)

| **Rebar** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Uncracked concrete C20/25** | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,021 | 0,023 | 0,026 | 0,028 | 0,031 | 0,036 | 0,043 | 0,047 | 0,052 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,030 | 0,033 | 0,037 | 0,041 | 0,045 | 0,052 | 0,061 | 0,071 | 0,075 |
| Temperature range II: 80°C/50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,050 | 0,056 | 0,063 | 0,069 | 0,075 | 0,088 | 0,104 | 0,113 | 0,126 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,072 | 0,081 | 0,090 | 0,099 | 0,108 | 0,127 | 0,149 | 0,163 | 0,181 |
| Temperature range III: 120°C/72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,050 | 0,056 | 0,063 | 0,069 | 0,075 | 0,088 | 0,104 | 0,113 | 0,126 |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,072 | 0,081 | 0,090 | 0,099 | 0,108 | 0,127 | 0,149 | 0,163 | 0,181 |
| **Cracked concrete C20/25** | | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,090 | | 0,070 | | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,105 | | 0,105 | | | | | | |
| Temperature range II: 80°C/50°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,219 | | 0,170 | | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,255 | | 0,245 | | | | | | |
| Temperature range III: 120°C/72°C | $\delta_{N0}$-factor | [mm/(N/mm²)] | 0,219 | | 0,170 | | | | | | |
| | $\delta_{N\infty}$-factor | [mm/(N/mm²)] | 0,255 | | 0,245 | | | | | | |

[1)] Calculation of the displacement
$\delta_{N0} = \delta_{N0}$-Faktor $\cdot \tau$; $\tau$: acting bond stress for tension load
$\delta_{N\infty} = \delta_{N\infty}$-Faktor $\cdot \tau$;

## Table C16: **Displacements** under **shear load**[1)] (rebar)

| **Rebar** | | | **Ø 8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Uncracked concrete C20/25** | | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 |
| **Cracked concrete C20/25** | | | | | | | | | | | |
| All temperature ranges | $\delta_{V0}$-factor | [mm/(kN)] | 0,12 | 0,12 | 0,11 | 0,11 | 0,10 | 0,09 | 0,08 | 0,07 | 0,06 |
| | $\delta_{V\infty}$-factor | [mm/(kN)] | 0,18 | 0,18 | 0,17 | 0,16 | 0,15 | 0,14 | 0,12 | 0,11 | 0,10 |

[1)] Calculation of the displacement
$\delta_{V0} = \delta_{V0}$-factor $\cdot V$; V: acting shear load
$\delta_{V\infty} = \delta_{V\infty}$-factor $\cdot V$;



**292 Alfa Injectionmortar for concrete**

**Performance**
Displacements (rebar)

**Annex C14**