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# European Technical Assessment

# ETA-21/0244 of 30/12/2021

## General Part

| | |
|---|---|
| **Technical Assessment Body issuing the European Technical Assessment** | Instytut Techniki Budowlanej |
| **Trade name of the construction product** | R-KEX-II |
| **Product family to which the construction product belongs** | Bonded fasteners with threaded rod, rod with inner thread and rebar for use in concrete |
| **Manufacturer** | RAWLPLUG S.A.<br>ul. Kwidzyńska 6<br>51-416 Wrocław<br>Poland |
| **Manufacturing plant** | Manufacturing Plant no. 3 |
| **This European Technical Assessment contains** | 38 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** | European Assessment Document EAD 330499-01-0601 "Bonded fasteners for use in concrete" |
| **This version replaces** | ETA-21/0244 issued on 11/03/2021 |

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## Specific Part

### 1 Technical description of the product

The R-KEX-II are bonded anchors (injection type) consisting of a injection mortar cartridge using an applicator gun equipped with a special mixing nozzle and steel element.
The steel element consists of:

- threaded anchor rod sizes M8 to M30 made of:
  - galvanized carbon steel,
  - carbon steel with zinc flake coating,
  - stainless steel,
  - high corrosion resistant stainless steel,

with hexagon nut and washer,

- anchor rod with inner thread sizes M6/Ø10 to M16/Ø24 made of:
  - galvanized carbon steel,
  - stainless steel,
  - high corrosion resistant stainless steel,
- rebar sizes Ø8 to Ø32.

The steel element is placed into a drilled hole previously injected (using an applicator gun) with a mortar with a slow and slight twisting motion. The rod or rebar is anchored by the bond between steel element and concrete.

The product description is given in Annex A.

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

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

The provisions given in this European Technical Assessment are based on an assumed working life of the anchor of 50 and/or 100 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer or the Technical Assessment Body, 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 Performance of the product

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

| Essential characteristic | Performance |
|---|---|
| Characteristic resistance to static and quasi-static loading, displacements | See Annexes C1 to C13 |
| Characteristic resistance to seismic performance category C1, displacements | See Annexes C14 to C16 |
| Characteristic resistance to seismic performance category C2, displacements | See Annex C17 |

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

No performance assessed.

## 3.2 Methods used for the assessment

The assessment has been made in accordance with the EAD 330499-01-0601.

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

According to Decision 96/582/EC of the European Commission the system 1 of assessment and verification of constancy of performance applies (see Annex V to regulation (EU) No 305/2011).

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

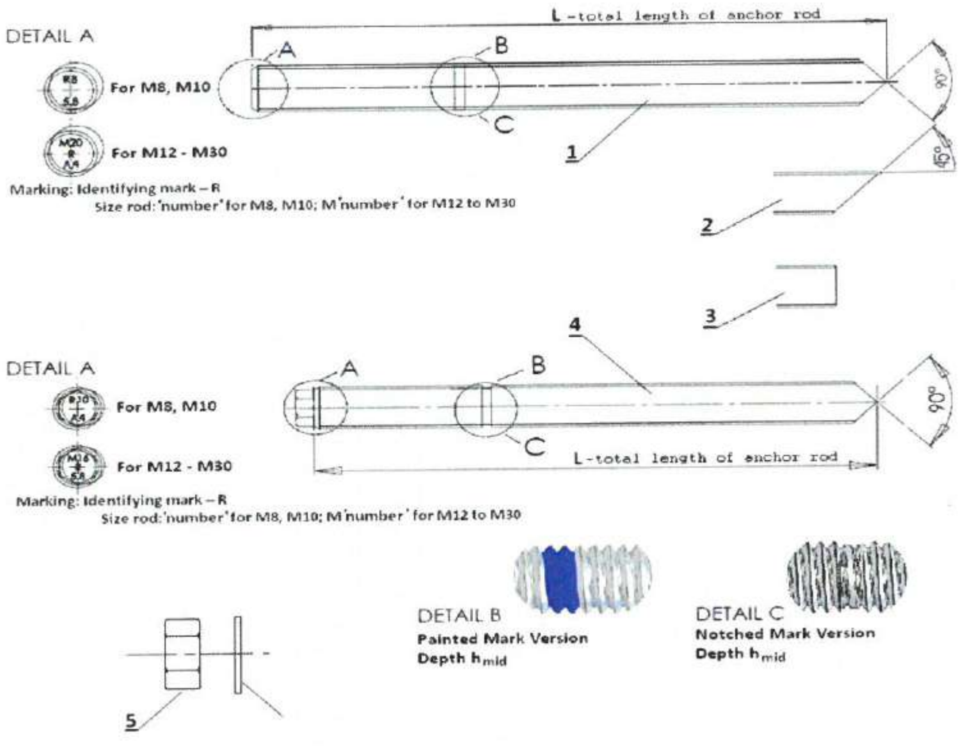
Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited at Instytut Techniki Budowlanej.

For type testing the results of the tests performed as part of the assessment for the European Technical Assessment shall be used unless there are changes in the production line or plant. In such cases the necessary type testing has to be agreed between Instytut Techniki Budowlanej and the notified body.

Issued in Warsaw on 30/12/2021 by Instytut Techniki Budowlanej

Anna Panek, MSc
Deputy Director of ITB

## Threaded anchor rods



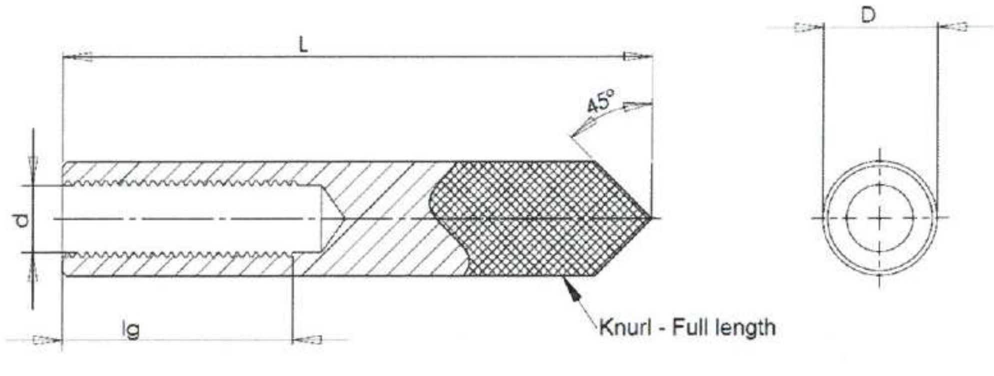

1. Anchor rod R-STUDS
2. 45° shape with anchor rod
3. The flat end of anchor rod
4. Anchor rod R-STUDS
5. Hexagonal nut
6. Washer

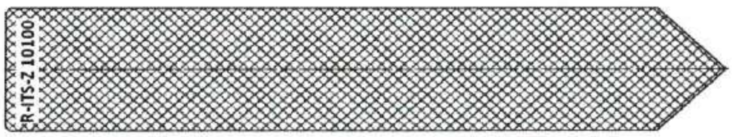
R-KEX-II

**Product description**
Threaded anchor rods

**Annex A1**
of European Technical Assessment ETA-21/0244

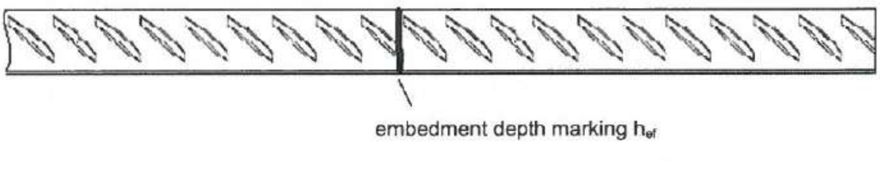
**Anchor rods with inner thread**




Marking: R - identifying mark
ITS - product index
Z - carbon steel or A4 - stainless steel
XX - thread size
YYY - length of sleeve

**Rebar**




| R-KEX-II | **Annex A2** of European Technical Assessment ETA-21/0244 |
|---|---|
| **Product description** Anchor rods with inner thread and rebar | |

**Table A1: Threaded rods**

| Part | Designation | | |
|---|---|---|---|
| | **Steel, zinc plated** | **Stainless steel** | **High corrosion resistance stainless steel (HCR)** |
| Threaded rod | Steel, property class 5.8 to 12.9 acc. to EN ISO 898-1 electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coating ≥ 8 µm acc. EN ISO 10683<br>elongation at fracture $A_5$ > 8% | Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088; property class 70 and 80 (A4-70 and A4-80) acc. to EN ISO 3506<br>Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015<br>elongation at fracture $A_5$ > 8% | Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088; property class 70 acc. to EN ISO 3506<br>Corrosion resistance class CRC V acc. to EN 1993-1-4:2006+A1:2015<br>elongation at fracture $A_5$ > 8% |
| Hexagon nut | Steel, property class 5 to 12, acc. to EN ISO 898-2; electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coating ≥ 8 µm acc. EN ISO 10683 | Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088; property class 70 and 80 (A4-70 and A4-80) acc. to EN ISO 3506<br>Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015 | Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088; property class 70 acc. to EN ISO 3506<br>Corrosion resistance class CRC V acc. to EN 1993-1-4:2006+A1:2015 |
| Washer | Steel, acc. to EN ISO 7089; electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684 or non-electrolytically applied zinc flake coating ≥ 8 µm acc. EN ISO 10683 | Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088<br>Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015 | Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088<br>Corrosion resistance class CRC V acc. to EN 1993-1-4:2006+A1:2015 |

Commercial threaded rods (in the case of rods made of galvanized steel – standard rods with property class ≤ 8.8 only), with:

- material and mechanical properties according to Table A1,
- confirmation of material and mechanical properties by inspection certificate 3.1 according to EN-10204:2004; the documents shall be stored,
- marking of the threaded rod with the embedment depth.

Note: Commercial standard threaded rods made of galvanized steel with property class above 8.8 are not permitted in some Member States.

**Table A2: Rods with inner thread**

| Part | Designation | | |
|---|---|---|---|
| | Steel, zinc plated | Stainless steel | High corrosion resistance stainless steel |
| Rod with inner thread | Steel, property class 5.8 to 8.8 acc. to EN ISO 898-1 electroplated ≥ 5 µm acc. to EN ISO 4042 or hot-dip galvanized ≥ 45 µm acc. to EN ISO 10684<br>elongation at fracture $A_5$ > 8% | Steel 1.4401, 1.4404, 1.4571 acc. to EN 10088; property class 70 and 80 (A4-70 and A4-80) acc. to EN ISO 3506<br>Corrosion resistance class CRC III acc. to EN 1993-1-4:2006+A1:2015<br>elongation at fracture $A_5$ > 8% | Steel 1.4529, 1.4565, 1.4547 acc. to EN 10088; property class 70 acc. to EN ISO 3506<br>elongation at fracture $A_5$ > 8% |

**Table A3: Reinforcing bars (rebar) according to EN 1992-1-1, Annex C**

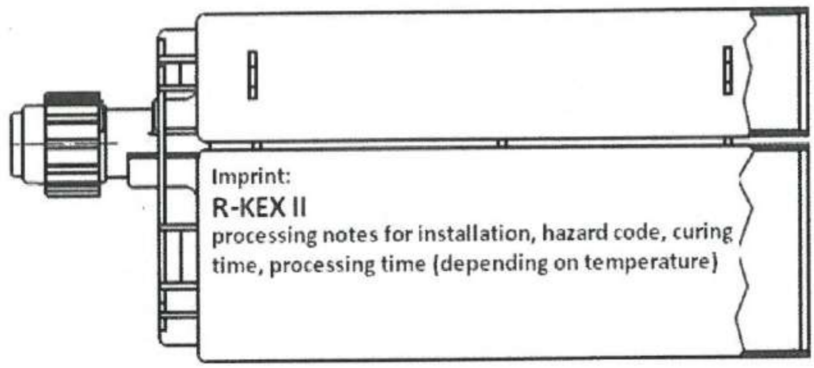
| Product form | | Bars and de-coiled rods | |
|---|---|---|---|
| Class | | B | C |
| Characteristic yield strength $f_{yk}$ or $f_{0,2k}$ [N/mm²] | | 400 to 600 | |
| Minimum value of $k = (f_t / f_y)_k$ | | ≥ 1,08 | ≥ 1,15<br>< 1,35 |
| Characteristic strain at maximum force, $\varepsilon_{uk}$ [%] | | ≥ 5,0 | ≥ 7,5 |
| Bendability | | Bend / Rebend test | |
| Maximum deviation from nominal mass (individual bar) [%] | Nominal bar size [mm]<br>≤ 8<br>> 8 | ± 6,0<br>± 4,5 | |
| Bond: minimum relative rib area, $f_{R,min}$ | Nominal bar size [mm]<br>8 to 12<br>> 12 | 0,040<br>0,056 | |

**Rib height**: The maximum rib height is: $h_{rib} \leq 0{,}07 \cdot Ø$

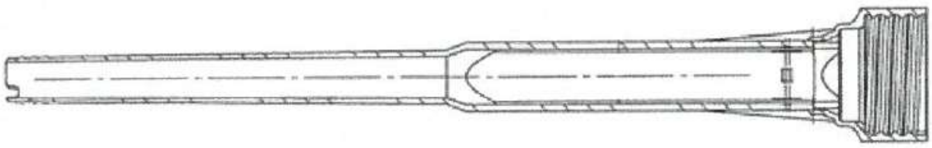
**Table A4: Injection mortar**

| Product | Composition |
|---|---|
| R-KEX-II<br>(two component injection mortar) | Epoxy system with fillers |

Side by side cartridge – 385 to 1100 ml




Mixer for cartrige



| R-KEX-II | Annex A5 |
| --- | --- |
| **Product description**<br>Cartridge type and size | of European Technical Assessment ETA-21/0244 |

## Specification of intended use

**Anchors subject to:**

Static and quasi-static loads: threaded rod size M8 to M30, rod with inner thread sizes M6/Ø10 to M16/Ø24 and rebar Ø8 to Ø32.
Seismic performance category C1: threaded rod size M8 to M30 and rebar Ø8 to Ø32.
Seismic performance category C2: threaded rod size M12 to M24.

**Base material:**

- Reinforced or unreinforced normal weight concrete of strength class C20/25 to C50/60 according to EN 206:2013+A1:2016.
- Cracked and uncracked concrete – threaded rod size M8 to M30 and rebar Ø8 to Ø32.
- Uncracked concrete only – rod with inner thread sizes M6/Ø10 to M16/Ø24.

**Temperature ranges:**

**Installation temperature (temperature of substrate):**

- +5°C to +30°C.

**In-service temperature:**

The anchors may be used in the following temperature range:

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

**Use conditions (environmental conditions):**

- Structures subject to dry internal conditions: all materials.
- For all other conditions according to EN 1993-1-4 corresponding to corrosion resistance class (CRC):
  - stainless steel A4 according to Annex A3, Table A1: CRC III,
  - high corrosion resistance steel (HCR) according to Annex A3, Table A1: CRC V.

**Design methods:**

- Anchorages are designed in accordance with EN 1992-4:2018 and Technical Report TR 055.
- Anchorages under seismic actions have to be designed in accordance with EOTA Technical Report TR 045.
- Anchorages are designed 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 (e.g. position of the anchor relative to reinforcement or to supports, etc.).

**Installation:**

- Dry or wet concrete (use category I1).
- Flooded holes (use category I2).
- Installation direction D3 (downward, horizontal and upwards installation).
- The anchors are suitable for hammer drilled holes or diamond core drilled holes.

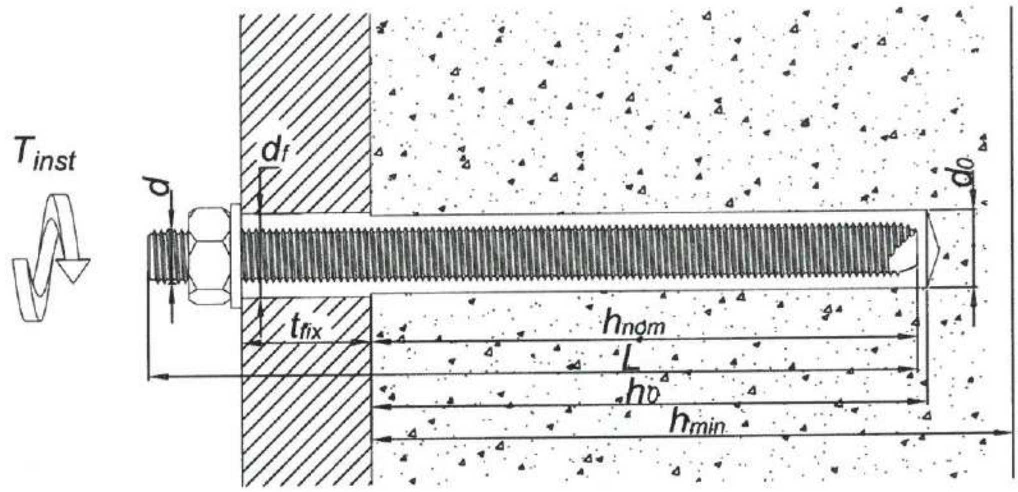



**Table B1: Installation parameters – threaded anchor rod**

| Size | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|
| Nominal drilling diameter | $d_0$ [mm] | 10 | 12 | 14 | 18 | 22 or 24 | 28 | 35 |
| Maximum diameter hole in the fixture | $d_f$ [mm] | 9 | 12 | 14 | 18 | 22 | 26 | 33 |
| Effective embedment depth | $h_{ef,min}$ [mm] | 60 | 70 | 80 | 100 | 120 | 140 | 165 |
| | $h_{ef,max}$ [mm] | 160 | 200 | 240 | 320 | 400 | 480 | 600 |
| Depth of the drilling hole | $h_0$ [mm] | $h_{ef}$ + 5 mm | | | | | | |
| Minimum thickness of the concrete slab | $h_{min}$ [mm] | $h_{ef}$ + 30 mm; ≥ 100 mm | | | $h_{ef} + 2d_0$ | | | |
| Maximum installation torque | $T_{inst,max}$ [Nm] | 10 | 20 | 40 | 80 | 120 | 180 | 200 |
| Minimum spacing | $s_{min}$ [mm] | 40 | 40 | 40 | 50 | 60 | 70 | 85 |
| Minimum edge distance | $c_{min}$ [mm] | 40 | 40 | 40 | 50 | 60 | 70 | 85 |

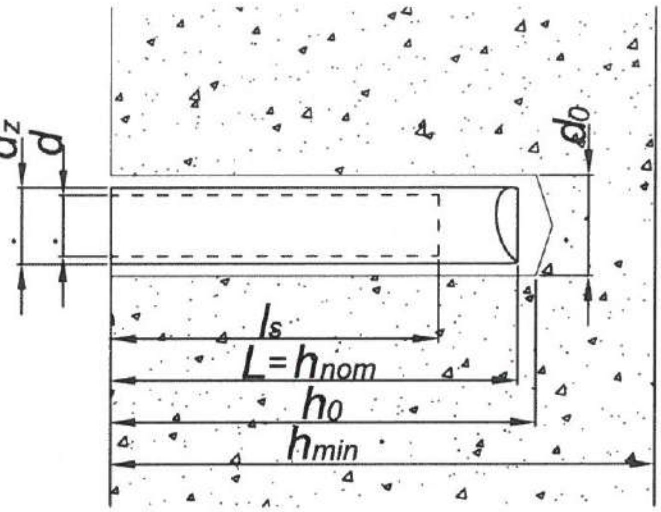



**Table B2: Installation parameters – anchor rod with inner thread**

| **Size** | | **M6/ Ø10/ 75** | **M8/ Ø12/ 75** | **M8/ Ø12/ 90** | **M10/ Ø16/ 75** | **M10/ Ø16/ 100** | **M12/ Ø16/ 100** | **M16/ Ø24/ 125** |
|---|---|---|---|---|---|---|---|---|
| Nominal drilling diameter | $d_0$ [mm] | 12 | 14 | 14 | 20 | 20 | 20 | 28 |
| Maximum diameter hole in the fixture | $d_f$ [mm] | 7 | 9 | 9 | 12 | 12 | 14 | 18 |
| Effective embedment depth | $h_{ef} = h_{nom}$ [mm] | 75 | 75 | 90 | 75 | 100 | 100 | 125 |
| Thread length, min | $l_s$ [mm] | 24 | 25 | 25 | 30 | 30 | 35 | 50 |
| Depth of the drilling hole | $h_0$ [mm] | $h_{ef}$ + 5 mm | | | | | | |
| Minimum thickness of the concrete slab | $h_{min}$ [mm] | $h_{ef}$ + 30 mm; ≥ 100 mm | | | $h_{ef} + 2d_0$ | | | |
| Maximum installation torque | $T_{inst,max}$ [Nm] | 3 | 5 | 5 | 10 | 10 | 20 | 40 |
| Minimum spacing | $s_{min}$ [mm] | 40 | 40 | 50 | 40 | 50 | 50 | 70 |
| Minimum edge distance | $c_{min}$ [mm] | 40 | 40 | 50 | 40 | 50 | 50 | 70 |

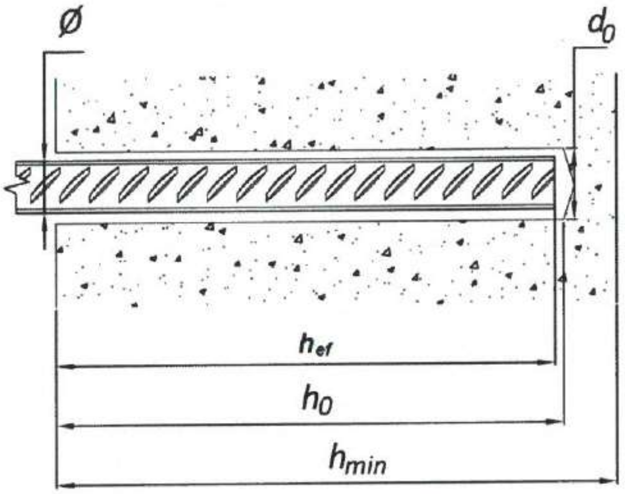


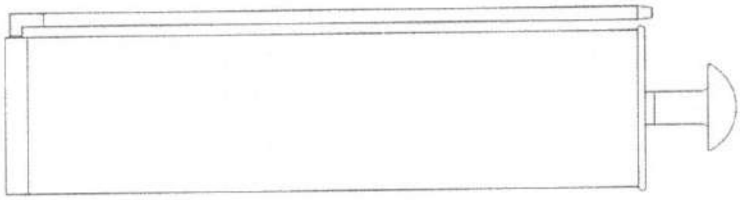

**Table B3: Installation parameters – rebar**

| Size | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|
| Nominal drilling diameter | $d_0$ [mm] | 10 or 12 | 12 or 14 | 14 or 18 | 18 | 22 | 26 | 32 | 40 |
| Effective embedment depth | $h_{ef,min}$ [mm] | 60 | 70 | 80 | 80 | 100 | 120 | 140 | 165 |
| | $h_{ef,max}$ [mm] | 160 | 200 | 240 | 280 | 320 | 400 | 500 | 640 |
| Depth of the drilling hole | $h_0$ [mm] | $h_{ef}$ + 5 mm | | | | | | | |
| Minimum thickness of the concrete slab | $h_{min}$ [mm] | $h_{ef}$ + 30 mm; ≥ 100 mm | | | | $h_{ef} + 2d_0$ | | | |
| Minimum spacing | $s_{min}$ [mm] | 40 | 40 | 40 | 40 | 50 | 60 | 70 | 85 |
| Minimum edge distance | $c_{min}$ [mm] | 40 | 40 | 40 | 40 | 50 | 60 | 70 | 85 |

**Table B4: Maximum processing time and minimum curing time**

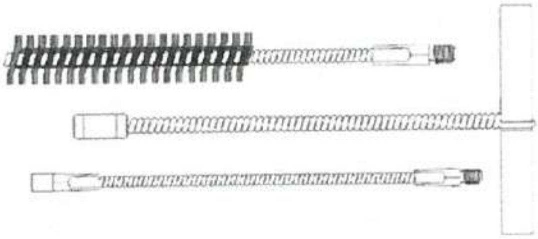
| R-KEX-II | | | |
|---|---|---|---|
| **Mortar temperature [°C]** | **Concrete (substrate) temperature [°C]** | **Maximum processing time [min.]** | **Minimum curing time[1) ] [min.]** |
| +5 | +5 | 150 | 2880 |
| +10 | +10 | 120 | 1080 |
| +20 | +20 | 35 | 480 |
| +25 | +30 | 12 | 300 |

[1)] The minimum time from the end of the mixing to the time when the anchor may be torque or loaded (whichever is longer). Minimum mortar temperature for installation +5°C; maximum mortar temperature for installation +25°C. For wet condition and flooded holes the curing time must be doubled.

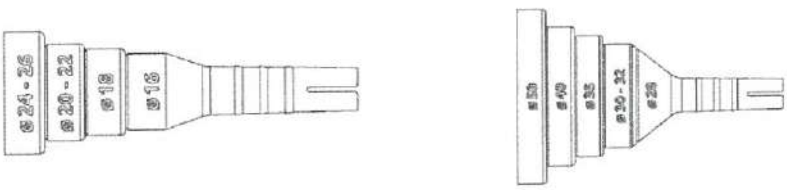


**Manual blower pump R-BLOWPUMP**

**Steel brush R-BRUSH**



**Steel brush with extension R-BRUSH-T**




**Dosing plug R-NOZ-P**

**Temporary positioning wedge**

**Mixer nozzle extension R-NOZ-EXT**

| R-KEX-II | **Annex B6**<br>of European<br>Technical Assessment<br>ETA-21/0244 |
|---|---|
| **Intended use**<br>Tools (1) | |

| Dispenser | Cartridge size |
|---|---|
|  Manual gun for side by side cartridges R-GUN-385-P | 385 ml |
|  Manual gun for side by side cartridges R-GUN-600-P | 385, 600 ml |
|  Cordless dispenser gun  Pneumatic dispenser gun | 385, 600 ml |
|  Manual gun for side by side cartridges R-GUN-MULTI | 385, 600 ml |

**Table B5: Brush diameter for threaded rod**

| Threaded rod diameter | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| $d_b$ | Brush diameter | [mm] | 12 | 14 | 16 | 20 | 26 | 30 | 37 |

**Table B6: Brush diameter for rod with inner thread**

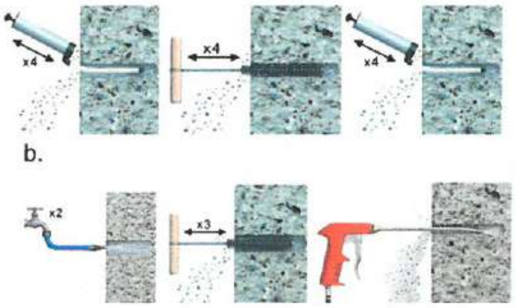
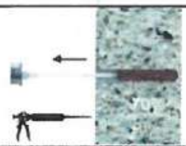
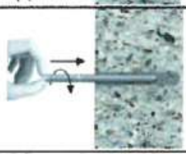
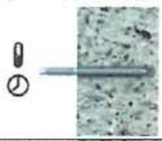
| Threaded rod diameter | | | M6/Ø10 | M8/Ø12 | M10/Ø16 | M12/ Ø16 | M16/Ø24 |
|---|---|---|---|---|---|---|---|
| $d_b$ | Brush diameter | [mm] | 16 | 16 | 22 | 22 | 30 |

**Table B7: Brush diameter for rebar**

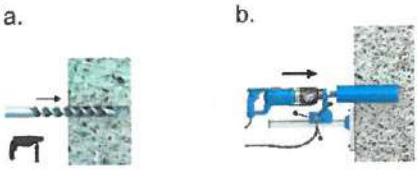
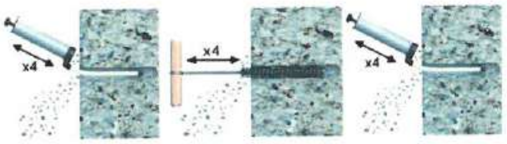
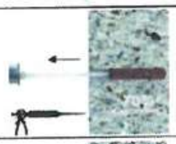
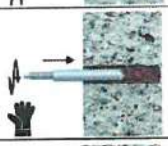
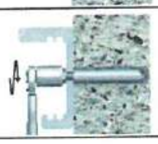
| Rebar diameter | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| $d_b$ | Brush diameter | [mm] | 14 | 16 | 20 | 20 | 24 | 28 | 37 | 42 |

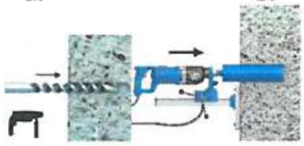
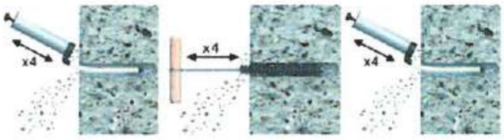
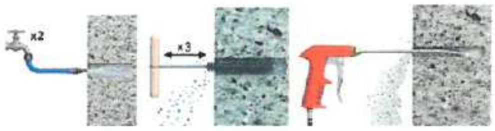
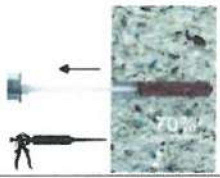
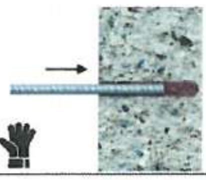
**Table B8: Dosing plug diameter**

| Hole diameter [mm] | 16 | 18 | 20 | 22 | 24 | 25 | 26 | 28 | 30 | 32 | 35 | 40 | 50 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Dosing plug R-NOZ-P diameter | Ø16 | Ø18 | Ø20 to Ø22 | | Ø24 to Ø26 | | | Ø28 | Ø30 to 32 | | Ø35 | Ø40 | Ø50 |

| | |
|---|---|
| 1.<br>a. b.<br> | 1. Hole drilling.<br>a. Hammer drilling.<br>Drill hole to the required diameter and depth using a rotary hammer drilling machine.<br>b. Diamond core drilling.<br>Drill hole to the required diameter and depth using a diamond core drilling machine and the corresponding core bit are used. |
| 2.<br>a.<br>b.<br> | 2. Hole cleaning.<br>a. Manual cleaning with brush and hand pump for hammer drilled hole:<br>– starting from the drill hole bottom blow the hole at least 4 times using the hand pump,<br>– using the specified brush, mechanically brush out the hole at least 4 times,<br>– starting from the drill hole bottom, blow at least 4 times with the hand pump.<br>b. Cleaning hole, diamond drilling, with compressed air:<br>– flush the hole from the bottom with water at least 2 times,<br>– using the specified brush, mechanically brush out the hole at least 3 times,<br>– starting from the drill hole bottom, blow at least 2 times with the hand pump. |
| 3.<br> | 3. Insert cartridge into dispenser and attach nozzle. Dispense to waste until even colour is obtained (min. 10 cm). |
| 4.<br> | 4. Insert the mixing nozzle to the far end of the hole and inject mortar, slowly withdrawing the nozzle as the hole is filled to 2/3 of its depth. |
| 5.<br> | 5. Immediately insert the threaded rod, slowly and with slight twisting motion. Remove any excess mortar around the hole before it sets. |
| 6.<br> | 6. Leave the fixing undisturbed until the curing time elapses. |
| 7.<br> | 7. Attach fixture and tighten the nut to the required torque. The installation torque cannot exceed $T_{inst,max}$. |

| | |
|---|---|
| **R-KEX-II** | **Annex B9**<br>of European Technical Assessment ETA-21/0244 |
| **Intended use**<br>Installation instruction – threaded rod | |

| | |
|---|---|
| 1.<br>a. b.<br> | 1. Hole drilling.<br>a. Hammer drilling.<br>Drill hole to the required diameter and depth using a rotary hammer drilling machine.<br>b. Diamond core drilling.<br>Drill hole to the required diameter and depth using a diamond core drilling machine and the corresponding core bit are used. |
| 2.<br>a.<br><br>b.<br> | 2. Hole cleaning.<br>a. Manual cleaning with brush and hand pump for hammer drilled hole:<br>– starting from the drill hole bottom blow the hole at least 4 times using the hand pump,<br>– using the specified brush, mechanically brush out the hole at least 4 times,<br>– starting from the drill hole bottom, blow at least 4 times with the hand pump.<br>b. Cleaning hole, diamond drilling, with compressed air:<br>– flush the hole from the bottom with water at least 2 times,<br>– using the specified brush, mechanically brush out the hole at least 3 times,<br>– starting from the drill hole bottom, blow at least 2 times with the hand pump. |
| 3.<br> | 3. Insert cartridge into dispenser and attach nozzle. Dispense to waste until even colour is obtained (min. 10 cm). |
| 4.<br> | 4. Insert the mixing nozzle to the far end of the hole and inject mortar, slowly withdrawing the nozzle as the hole is filled to 2/3 of its depth. |
| 5.<br> | 5. Immediately insert the rod with inner thread, slowly and with slight twisting motion. Remove any excess mortar around the hole before it sets. |
| 6.<br> | 6. Leave the fixing undisturbed until the curing time elapses. |
| 7.<br> | 7. Attach fixture and tighten the bolt to the required torque. The installation torque cannot exceed $T_{inst,max}$. |

| | |
|---|---|
| 1.<br>a. b.<br> | 1. Hole drilling.<br>a. Hammer drilling.<br>Drill hole to the required diameter and depth using a rotary hammer drilling machine.<br>b. Diamond core drilling.<br>Drill hole to the required diameter and depth using a diamond core drilling machine and the corresponding core bit are used. |
| 2.<br>a.<br><br>c.<br> | 2. Hole cleaning.<br>a. Manual cleaning with brush and hand pump for hammer drilled hole:<br>– starting from the drill hole bottom blow the hole at least 4 times using the hand pump,<br>– using the specified brush, mechanically brush out the hole at least 4 times,<br>– starting from the drill hole bottom, blow at least 4 times with the hand pump.<br>b. Cleaning hole, diamond drilling, with compressed air:<br>– flush the hole from the bottom with water at least 2 times,<br>– using the specified brush, mechanically brush out the hole at least 3 times,<br>– starting from the drill hole bottom, blow at least 2 times with the hand pump. |
| 3.<br> | 3. Insert cartridge into dispenser and attach nozzle. Dispense to waste until even colour is obtained (min. 10 cm). |
| 4.<br> | 4. Insert the mixing nozzle to the far end of the hole and inject mortar, slowly withdrawing the nozzle as the hole is filled to 2/3 of its depth. |
| 5.<br> | 5. Immediately insert the rebar, slowly and with slight twisting motion. Remove any excess mortar around the hole before it sets. |
| 6.<br> | 6. Leave the fixing undisturbed until the curing time elapses. |

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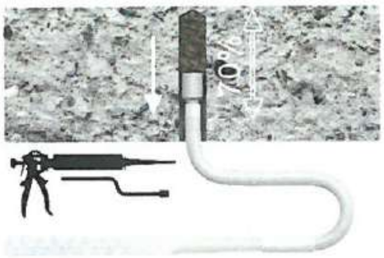
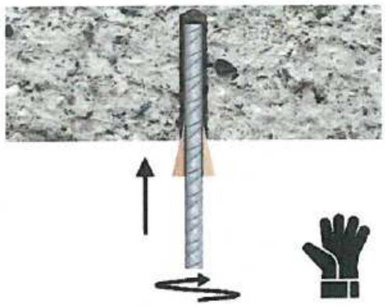
| **R-KEX-II** | **Annex B11**<br>of European Technical Assessment ETA-21/0244 |
| **Intended use**<br>Installation instruction – rebar | |

| | |
|---|---|
|  | 1. Inject from the bottom of the hole. Inject the mortar about 2/3 of the hole depth. For best performance use extension and appropriately sized piston plug assembled on the mixer. |
|  | 2. Drive the rebar immediately into the hole. Use temporary interlocking element e.g wedges. |
|  | 3. Leave the fixing undisturbed until the curing time elapses. To avoid the slipping of the rebar during the open time of the product (due to the rebar own weight) use a temporary interlocking element. |

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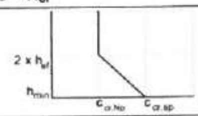
| **R-KEX-II** | **Annex B12**<br>of European Technical Assessment ETA-21/0244 |
| **Intended use**<br>Installation instruction – rebar – overhead installation | |

**Table C1-1: Characteristic resistance to tension load for threaded rod in uncracked concrete – static and quasi-static loads**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | |
| Steel, property class 5.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 280 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| Steel, property class 8.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 126 | 196 | 282 | 449 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| Steel, property class 10.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 37 | 58 | 84 | 157 | 245 | 353 | 561 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | |
| Steel, property class 12.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 44 | 70 | 101 | 188 | 294 | 424 | 673 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | |
| Stainless steel, property class A4-70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 26 | 41 | 59 | 110 | 171 | 247 | 393 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | | | |
| Stainless steel, property class A4-80 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 126 | 196 | 282 | 448 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,60 | | | | | | |
| High corrosion resistant stainless steel, property class 70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 25 | 40 | 59 | 110 | 171 | 247 | 393 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling, working life 50 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 17,0 | 16,0 | 17,0 | 15,0 | 15,0 | 13,0 | 12,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 15,0 | 14,0 | 15,0 | 13,0 | 13,0 | 12,0 | 10,0 |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – diamond core drilling, working life 50 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 14,0 | 15,0 | 16,0 | 14,0 | 14,0 | 12,0 | 11,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 12,0 | 14,0 | 14,0 | 13,0 | 13,0 | 11,0 | 10,0 |
| **Factors – working life 50 years** | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | |
| | | C40/50 | 1,07 | | | | | | |
| | | C50/60 | 1,09 | | | | | | |
| Sustained load factor for $\tau_{Rk,ucr,50}$ in uncracked concrete | $\psi^0_{sus,50}$ | 40°C/24°C | 0,75 | | | | | | |
| | | 80°C/50°C | 0,72 | | | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling, working life 100 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 17,0 | 16,0 | 17,0 | 15,0 | 15,0 | 13,0 | 12,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 15,0 | 14,0 | 15,0 | 13,0 | 13,0 | 12,0 | 10,0 |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – diamond core drilling, working life 100 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 14,0 | 15,0 | 16,0 | 14,0 | 14,0 | 12,0 | 11,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 12,0 | 14,0 | 14,0 | 13,0 | 13,0 | 11,0 | 10,0 |
| **Factors – working life 100 years** | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | |
| | | C40/50 | 1,07 | | | | | | |
| | | C50/60 | 1,09 | | | | | | |

[1] In the absence of other national regulation

**Table C1-2: Characteristic resistance to tension load for threaded rod in uncracked concrete – static and quasi-static loads**

| **Size** | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M30** |
|---|---|---|---|---|---|---|---|---|---|
| **Concrete cone failure in uncracked concrete** | | | | | | | | | |
| Factor for uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | | | | | |
| Spacing | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | | | | | |
| **Splitting failure** | | | | | | | | | |
| Edge distance | $c_{cr,sp}$ for $h_{min}$ | [mm] | $2,0 \cdot h_{ef}$ | | | | | $1,5 \cdot h_{ef}$ | |
| | $c_{cr,sp}$ for $h_{min} < h$ [1] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation) | |  | | | | | | |
| | $c_{cr,sp}$ for $h$ [1] $\geq 2 \cdot h_{ef}$ | | $c_{cr,N}$ | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | | | | | |
| **Installation safety factors for combined pull-out, concrete cone and splitting failure** | | | | | | | | | |
| Installation safety factor for in use category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Installation safety factor for in use category I2 | | | 1,2 | | | | | | |

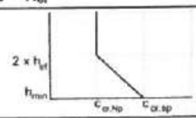
[1] h – concrete member thickness

**Table C2-1: Characteristic resistance to tension loads for threaded rod in cracked concrete – static and quasi-static loads**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | |
| Steel, property class 5.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 280 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| Steel, property class 8.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 448 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| Steel, property class 10.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 36 | 58 | 84 | 157 | 245 | 353 | 561 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | |
| Steel, property class 12.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 43 | 69 | 101 | 188 | 294 | 423 | 673 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | |
| Stainless steel, property class A4-70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 25 | 40 | 59 | 109 | 171 | 247 | 392 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | | | |
| Stainless steel, property class A4-80 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 448 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,60 | | | | | | |
| High corrosion resistant stainless steel, property class 70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 25 | 40 | 59 | 109 | 171 | 247 | 392 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | | | |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – hammer drilling, working life 50 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 8,0 | 8,0 | 7,0 | 7,0 | 7,0 | 6,0 | 5,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 7,0 | 7,0 | 6,0 | 6,0 | 6,0 | 5,0 | 4,0 |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – diamond core drilling, working life 50 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,5 | 7,0 | 8,0 | 7,0 | 8,0 | 7,0 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,0 | 6,5 | 7,5 | 6,5 | 7,0 | 6,5 | 3,5 |
| **Factors – working life 50 years** | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | |
| | | C40/50 | 1,07 | | | | | | |
| | | C50/60 | 1,09 | | | | | | |
| Sustained load factor for $\tau_{Rk,ucr,50}$ in uncracked concrete | $\psi^0_{sus,50}$ | 40°C/24°C | 0,75 | | | | | | |
| | | 80°C/50°C | 0,72 | | | | | | |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – hammer drilling, working life 100 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 8,0 | 8,0 | 6,5 | 7,0 | 7,0 | 6,0 | 5,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 6,5 | 7,0 | 6,0 | 6,0 | 6,0 | 5,0 | 4,0 |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – diamond core drilling, working life 100 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,5 | 7,0 | 8,0 | 7,0 | 7,0 | 6,0 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,0 | 6,5 | 7,0 | 6,0 | 6,5 | 5,0 | 3,5 |
| **Factors – working life 100 years** | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,00 | | | | | | |
| | | C40/50 | 1,00 | | | | | | |
| | | C50/60 | 1,00 | | | | | | |

[1] In the absence of other national regulation

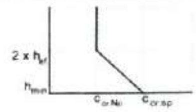
**Table C2-2: Characteristic resistance to tension load for threaded rod in cracked concrete – static and quasi-static loads**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Concrete cone failure in cracked concrete** | | | | | | | | | |
| Factor for cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | | |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | | | | | |
| Spacing | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | | | | | |
| **Splitting failure** | | | | | | | | | |
| Edge distance | $c_{cr,sp}$ for $h_{min}$ | [mm] | $2,0 \cdot h_{ef}$ | | | | | $1,5 \cdot h_{ef}$ | |
| | $c_{cr,sp}$ for $h_{min} < h$ [1] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation) | |  | | | | | | |
| | $c_{cr,sp}$ for $h$ [1] $\geq 2 \cdot h_{ef}$ | | $c_{cr,N}$ | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | | | | | |
| **Installation safety factors for combined pull-out, concrete cone and splitting failure** | | | | | | | | | |
| Installation safety factors for in use category I1 | $\gamma_{inst}$ | [-] | 1,0 | | | | | | |
| Installation safety factors for in use category I2 | | | 1,2 | | | | | | |

[1] h – concrete member thickness

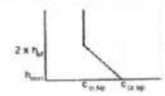
| | |
|---|---|
| **R-KEX-II** | **Annex C4** of European Technical Assessment ETA-21/0244 |
| **Performances**<br>Characteristic resistance to tension loads in cracked concrete – threaded rod | |

**Table C3: Characteristic resistance to tension load for rod with inner thread in uncracked concrete – static and quasi-static loads**

| Size | | | M6 / Ø10 | M8 / Ø12 | M10 / Ø16 | M12 / Ø16 | M16 /Ø24 |
|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | |
| Steel, property class 5.8 | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 10 | 18 | 29 | 42 | 78 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | |
| Steel, property class 8.8 | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 16 | 29 | 46 | 67 | 125 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | |
| Stainless steel, property class A4-70 | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 14 | 25 | 40 | 59 | 109 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | |
| Stainless steel, property class A4-80 | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 16 | 29 | 46 | 67 | 125 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,60 | | | | |
| High corrosion resistant stainless steel, property class 70 | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | 14 | 25 | 40 | 59 | 109 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,87 | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling** | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 8,0 | 12,0 | 12,0 | 11,0 | 10,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 7,5 | 11,0 | 11,0 | 10,0 | 9,0 |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | |
| | | C40/50 | 1,07 | | | | |
| | | C50/60 | 1,09 | | | | |
| Sustained load factor for $\tau_{Rk,ucr,50}$ in uncracked concrete | $\psi^0_{sus,50}$ | 40°C/24°C | 0,75 | | | | |
| | | 80°C/50°C | 0,72 | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling, working life 100 years** | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 8,0 | 12,0 | 12,0 | 11,0 | 10,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 7,5 | 11,0 | 10,0 | 10,0 | 9,0 |
| **Factors – working life 100 years** | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | |
| | | C40/50 | 1,07 | | | | |
| | | C50/60 | 1,09 | | | | |
| **Resistance to concrete cone failure in uncracked concrete – hammer drilling** | | | | | | | |
| Factor for uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | | | |
| Spacing | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | | | |
| **Splitting failure** | | | | | | | |
| Edge distance | $c_{cr,sp}$ for $h_{min}$ | [mm] | $2,0 \cdot h_{ef}$ | | | | $1,5 \cdot h_{ef}$ |
| | $c_{cr,sp}$ for $h_{min} < h$ [2] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation) | |  | | | | |
| | $c_{cr,sp}$ for $h$ [2] $\geq 2 \cdot h_{ef}$ | | $c_{cr,N}$ | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | | | |
| **Installation safety factors for combined pull-out, concrete cone and splitting failure** | | | | | | | |
| Installation safety factors for use category I1 | $\gamma_{inst}$ | [-] | 1,2 | | | | |
| Installation safety factors for use category I2 | | | 1,2 | | | | |

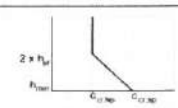
[1] In the absence of other national regulation
[2] h – concrete member thickness

**Table C4: Characteristic resistance to tension load for rebar in uncracked concrete – static and quasi-static loads**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s$ [3] $\cdot f_{uk}$ | | | | | | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling, working life 50 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 11,0 | 12,0 | 12,0 | 10,0 | 12,0 | 12,0 | 9,5 | 8,5 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 10,0 | 11,0 | 11,0 | 9,0 | 11,0 | 11,0 | 8,5 | 7,5 |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – diamond core drilling, working life 50 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 9,5 | 11,0 | 10,0 | 10,0 | 10,5 | 11,0 | 9,0 | 8,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,50}$ | [N/mm²] | 8,5 | 10,0 | 9,0 | 9,0 | 9,0 | 10,0 | 8,0 | 7,0 |
| **Factors – working life 50 years** | | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | | |
| | | C40/50 | 1,07 | | | | | | | |
| | | C50/60 | 1,09 | | | | | | | |
| Sustained load factor for $\tau_{Rk,ucr,50}$ in uncracked concrete | $\psi^0_{sus,50}$ | 40°C/24°C | 0,75 | | | | | | | |
| | | 80°C/50°C | 0,72 | | | | | | | |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – hammer drilling, working life 100 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 11,0 | 12,0 | 12,0 | 10,0 | 12,0 | 12,0 | 9,5 | 8,5 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 10,0 | 11,0 | 11,0 | 9,0 | 11,0 | 11,0 | 8,5 | 7,5 |
| **Combined pull-out and concrete cone failure in uncracked concrete C20/25 – diamond core drilling, working life 100 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 9,5 | 11,0 | 10,0 | 10,0 | 10,5 | 11,0 | 9,0 | 8,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,ucr,100}$ | [N/mm²] | 8,5 | 10,0 | 9,0 | 9,0 | 9,0 | 10,0 | 8,0 | 7,0 |
| **Factors – working life 100 years** | | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | | |
| | | C40/50 | 1,07 | | | | | | | |
| | | C50/60 | 1,09 | | | | | | | |
| **Concrete cone failure in uncracked concrete** | | | | | | | | | | |
| Factor for uncracked concrete | $k_{ucr,N}$ | [-] | 11,0 | | | | | | | |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | | | | | | |
| Spacing | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Edge distance | $c_{cr,sp}$ for $h_{min}$ | [mm] | $2,0 \cdot h_{ef}$ | | | | | | $1,5 \cdot h_{ef}$ | |
| | $c_{cr,sp}$ for $h_{min} < h$ [2] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation) | |  | | | | | | | |
| | $c_{cr,sp}$ for $h$ [2] $\geq 2 \cdot h_{ef}$ | | $c_{cr,N}$ | | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | | | | | | |
| **Installation safety factors for combined pull-out, concrete cone and splitting failure** | | | | | | | | | | |
| Installation safety factors for use category I1 | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | |
| Installation safety factors for use category I2 | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | |

[1] In the absence of other national regulation
[2] h – concrete member thickness
[3] Stressed cross section of the steel

**Table C5: Characteristic resistance to tension loads for rebar in cracked concrete – static and quasi-static loads**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s}$ | [kN] | $A_s$[3] · $f_{uk}$ | | | | | | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,40 | | | | | | | |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – hammer drilling, working life 50 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,5 | 5,0 | 5,5 | 5,5 | 5,0 | 5,0 | 5,4 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,0 | 4,5 | 5,0 | 5,0 | 4,5 | 4,5 | 5,0 | 3,0 |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – diamond core drilling. working life 50 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,0 | 5,0 | 5,5 | 4,5 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,50}$ | [N/mm²] | 5,0 | 5,0 | 5,5 | 5,5 | 4,5 | 5,0 | 4,0 | 4,0 |
| **Factors – working life 50 years** | | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | | |
| | | C40/50 | 1,07 | | | | | | | |
| | | C50/60 | 1,09 | | | | | | | |
| Sustained load factor for $\tau_{Rk,ucr,50}$ in uncracked concrete | $\psi^0_{sus,50}$ | 40°C/24°C | 0,75 | | | | | | | |
| | | 80°C/50°C | 0,72 | | | | | | | |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – hammer drilling, working life 100 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,5 | 5,0 | 5,5 | 5,5 | 5,0 | 5,0 | 5,4 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,0 | 4,5 | 5,0 | 5,0 | 4,5 | 4,5 | 5,0 | 3,0 |
| **Combined pull-out and concrete cone failure in cracked concrete C20/25 – diamond core drilling, working life 100 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,5 | 5,5 | 6,0 | 6,0 | 5,0 | 5,0 | 4,5 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,cr,100}$ | [N/mm²] | 5,0 | 5,0 | 5,5 | 5,5 | 4,5 | 4,5 | 4,0 | 4,0 |
| **Factors – working life 100 years** | | | | | | | | | | |
| Increasing factor | $\psi_c$ | C30/37 | 1,04 | | | | | | | |
| | | C40/50 | 1,07 | | | | | | | |
| | | C50/60 | 1,09 | | | | | | | |
| **Concrete cone failure in cracked concrete** | | | | | | | | | | |
| Factor for cracked concrete | $k_{cr,N}$ | [-] | 7,7 | | | | | | | |
| Edge distance | $c_{cr,N}$ | [mm] | $1,5 \cdot h_{ef}$ | | | | | | | |
| Spacing | $s_{cr,N}$ | [mm] | $3,0 \cdot h_{ef}$ | | | | | | | |
| **Splitting failure** | | | | | | | | | | |
| Edge distance | $c_{cr,sp}$ for $h_{min}$ | [mm] | $2,0 \cdot h_{ef}$ | | | | | | $1,5 \cdot h_{ef}$ | |
| | $c_{cr,sp}$ for $h_{min} < h$ [2] $< 2 \cdot h_{ef}$ ($c_{cr,sp}$ from linear interpolation) | |  | | | | | | | |
| | $c_{cr,sp}$ for $h$ [2] $\geq 2 \cdot h_{ef}$ | | $c_{cr,N}$ | | | | | | | |
| Spacing | $s_{cr,sp}$ | [mm] | $2,0 \cdot c_{cr,sp}$ | | | | | | | |
| **Partial safety factor for combined pull-out, concrete cone and splitting failure** | | | | | | | | | | |
| Installation safety factors for in use category I1 | $\gamma_{inst}$ | [-] | 1,2 | | | | | | | |
| Installation safety factors for in use category I2 | | | 1,2 | | | | | | | |

[1] In the absence of other national regulation
[2] h – concrete member thickness
[3] Stressed cross section of the steel element

**Table C6: Characteristic resistance to shear loads for threaded rod – steel failure without lever arm**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel, property class 5.8** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 11 | 17 | 25 | 47 | 73 | 106 | 168 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,25 | | | | | | |
| **Steel, property class 8.8** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 224 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,25 | | | | | | |
| **Steel, property class 10.9** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 280 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| **Steel, property class 12.9** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 22 | 35 | 51 | 94 | 147 | 212 | 336 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| **Stainless steel, property class A4-70** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 13 | 20 | 29 | 55 | 86 | 124 | 196 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,56 | | | | | | |
| **Stainless steel, property class A4-80** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 224 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,33 | | | | | | |
| **High corrosion resistant stainless steel, property class 70** | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 13 | 20 | 29 | 55 | 86 | 124 | 196 |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,56 | | | | | | |

[1)] In the absence of other national regulation

**Table C7: Characteristic resistance to shear loads for threaded rod – steel failure with lever arm**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel, property class 5.8** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 19 | 37 | 65 | 166 | 324 | 561 | 1124 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,25 | | | | | | |
| **Steel, property class 8.8** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 | 898 | 1799 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,25 | | | | | | |
| **Steel, property class 10.9** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 37 | 75 | 131 | 333 | 649 | 1123 | 2249 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| **Steel, property class 12.9** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 45 | 90 | 157 | 400 | 779 | 1347 | 2698 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,50 | | | | | | |
| **Stainless steel, property class A4-70** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 233 | 454 | 786 | 1574 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,56 | | | | | | |
| **Stainless steel, property class A4-80** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 30 | 60 | 105 | 266 | 519 | 898 | 1799 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,33 | | | | | | |
| **High corrosion resistant stainless steel, property class 70** | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 26 | 52 | 92 | 233 | 454 | 786 | 1574 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | 1,56 | | | | | | |

[1] In the absence of other national regulation

**Table C8: Characteristic resistance to shear loads – pry out and concrete edge failure for threaded rod**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Pry out failure** | | | | | | | | | |
| Factor | $k_8$ | [-] | 2 | | | | | | |
| **Concrete edge failure** | | | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 30 |
| Effective length of anchor under shear loading | $l_f$ | [mm] | min ($h_{ef}$; $12d_{nom}$) | | | | | | min ($h_{ef}$; $8d_{nom}$) |

**Table C9: Characteristic resistance to shear loads for rod with inner thread – steel failure without lever arm**

| Size | | | M6/ Ø10 | M8/ Ø12 | M10/ Ø16 | M12/ Ø16 | M16/ Ø24 |
|---|---|---|---|---|---|---|---|
| **Steel, property class 5.8** | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 6,0 | 11,0 | 17,0 | 25,0 | 47,0 |
| Factor considering ductility | $k_7$ | [-] | | | 1,0 | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,25 | | |
| **Steel, property class 8.8** | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 8,0 | 14,6 | 23,2 | 33,7 | 62,8 |
| Factor considering ductility | $k_7$ | [-] | | | 1,0 | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,25 | | |
| **Stainless steel, property class A4-70** | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 7,0 | 12,8 | 20,3 | 29,5 | 55,0 |
| Factor considering ductility | $k_7$ | [-] | | | 1,0 | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,56 | | |
| **Stainless steel, property class A4-80** | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 8,0 | 14,6 | 23,2 | 33,7 | 62,8 |
| Factor considering ductility | $k_7$ | [-] | | | 1,0 | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,33 | | |
| **High corrosion resistant stainless steel, property class 70** | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | 7,0 | 12,8 | 20,3 | 29,5 | 55,0 |
| Factor considering ductility | $k_7$ | [-] | | | 1,0 | | |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,56 | | |

[1] In the absence of other national regulation

**Table C10: Characteristic resistance to shear loads for rod with inner thread – steel failure with lever arm**

| Size | | | M6/ Ø10 | M8/ Ø12 | M10/ Ø16 | M12/ Ø16 | M16/ Ø24 |
|---|---|---|---|---|---|---|---|
| **Steel, property class 5.8** | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 7,6 | 18,7 | 37,4 | 65,5 | 166,5 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,25 | | |
| **Steel, property class 8.8** | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 12,2 | 30,0 | 59,8 | 104,8 | 266,4 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,25 | | |
| **Stainless steel, property class A4-70** | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 10,7 | 26,2 | 52,3 | 91,7 | 233,1 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,56 | | |
| **Stainless steel, property class A4-80** | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 12,2 | 30,0 | 59,8 | 104,8 | 266,4 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,33 | | |
| **High corrosion resistant stainless steel, property class 70** | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | 10,7 | 26,2 | 52,3 | 91,7 | 233,1 |
| Partial safety factor [1] | $\gamma_{Ms}$ | [-] | | | 1,56 | | |

[1] In the absence of other national regulation

**Table C11: Characteristic resistance to shear loads – pry out and concrete edge failure for rod with inner thread**

| Size | | | M6 /Ø10 | M8/ Ø12 | M10/ Ø16 | M12/ Ø16 | M16/ Ø24 |
|---|---|---|---|---|---|---|---|
| **Pry out failure** | | | | | | | |
| Factor | $k_8$ | [-] | | | 2 | | |
| **Concrete edge failure** | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 10 | 12 | 16 | 16 | 24 |
| Effective length of anchor under shear loading | $l_f$ | [mm] | | | min ($h_{ef}$; $12d_{nom}$) | | |

| | |
|---|---|
| **R-KEX-II** | **Annex C10** of European Technical Assessment ETA-21/0244 |
| **Performances** Characteristic resistance to shear loads in cracked and uncracked concrete – rod with inner thread | |

**Table C12: Characteristic resistance to shear loads for rebar – steel failure without lever arm**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rebar** | | | | | | | | | | |
| Characteristic resistance | $V^0_{Rk,s}$ | [kN] | $0,5 \cdot A_s{}^{2)} \cdot f_{uk}$ | | | | | | | |
| Factor considering ductility | $k_7$ | [-] | 1,0 | | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,5 | | | | | | | |

[1)] In the absence of other national regulation
[2)] Stressed cross section of the steel element

**Table C13: Characteristic resistance to shear loads for rebar – steel failure with lever arm**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Rebar** | | | | | | | | | | |
| Characteristic resistance | $M^0_{Rk,s}$ | [Nm] | $1,2 \cdot W_{el}{}^{2)} \cdot f_{uk}$ | | | | | | | |
| Partial safety factor [1)] | $\gamma_{Ms}$ | [-] | 1,5 | | | | | | | |

[1)] In the absence of other national regulation
[2)] Elastic section modulus calculated from the stressed cross section of steel element

**Table C14: Characteristic resistance to shear loads – pry out and concrete edge failure for rebar**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Pry out failure** | | | | | | | | | | |
| Factor | $k_8$ | [-] | 2 | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 25 | 32 |
| Effective length of anchor under shear loading | $l_f$ | [mm] | min ($h_{ef}$; $12d_{nom}$) | | | | | | min ($h_{ef}$; $8d_{nom}$) | |

**Table C15: Displacement under tension loads – threaded rod**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in uncracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | |
| Displacement [1] | $\delta_{N0}$ | [mm] | 0,33 | 0,40 | 0,41 | 0,47 | 0,52 | 0,56 | 0,70 |
| | $\delta_{N\infty}$ | [mm] | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 |
| **Characteristic displacement in cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | |
| Displacement [1] | $\delta_{N0}$ | [mm] | 0,20 | 0,20 | 0,24 | 0,28 | 0,39 | 0,44 | 0,46 |
| | $\delta_{N\infty}$ | [mm] | 3,0 | 3,0 | 2,5 | 2,6 | 2,5 | 2,4 | 3,0 |

[1] These values are suitable for each temperature range and categories specified in Annex B1
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · N; $\delta_N = \delta_{N\infty}$-factor · N; (N – applied tension load)

**Table C16: Displacement under shear loads – threaded rod**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in cracked and uncracked concrete C20/25 to C50/60 under shear loads** | | | | | | | | | |
| Displacement [1] | $\delta_{V0}$ | [mm] | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| | $\delta_{V\infty}$ | [mm] | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 |

[1] These values are suitable for each temperature range and categories specified in Annex B1
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · V; $\delta_N = \delta_{N\infty}$-factor · V; (V – applied shear load)

**Table C17: Displacement under tension loads – rod with inner thread**

| Size | | | M6/Ø10 | M8/Ø12 | M10/Ø16 | M12/Ø16 | M16/Ø24 |
|---|---|---|---|---|---|---|---|
| **Characteristic displacement in uncracked concrete C20/25 to C50/60 under tension loads** | | | | | | | |
| Displacement [1] | $\delta_{N0}$ | [mm] | 0,25 | 0,25 | 0,26 | 0,32 | 0,37 |
| | $\delta_{N\infty}$ | [mm] | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 |

[1] These values are suitable for each temperature range and categories specified in Annex B1
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · N; $\delta_N = \delta_{N\infty}$-factor · N; (N – applied tension load)

**Table C18: Displacement under shear loads – rod with inner thread**

| Size | | | M6/Ø10 | M8/Ø12 | M10/Ø16 | M12/ Ø16 | M16/Ø24 |
|---|---|---|---|---|---|---|---|
| **Characteristic displacement in uncracked concrete C20/25 to C50/60 under shear loads** | | | | | | | |
| Displacement [1] | $\delta_{V0}$ | [mm] | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| | $\delta_{V\infty}$ | [mm] | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 |

[1] These values are suitable for each temperature range and categories specified in Annex B1
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · V; $\delta_N = \delta_{N\infty}$-factor · V; (V – applied shear load)

**Table C19: Displacement under tension loads – rebar**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in uncracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | | |
| Displacement [1] | $\delta_{N0}$ | [mm] | 0,25 | 0,25 | 0,32 | 0,37 | 0,43 | 0,45 | 0,48 | 0,53 |
| | $\delta_{N\infty}$ | [mm] | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 | 0,75 |
| **Characteristic displacement in cracked concrete C20/25 to C50/60 under tension loads** | | | | | | | | | | |
| Displacement | $\delta_{N0}$ | [mm] | 0,2 | 0,2 | 0,24 | 0,30 | 0,31 | 0,34 | 0,38 | 0,40 |
| | $\delta_{N\infty}$ | [mm] | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 | 3,0 |

[1] These values are suitable for each temperature range and categories specified in Annex B1.
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · N; $\delta_N = \delta_{N\infty}$-factor · N; (N – applied tension load)

**Table C20: Displacement under shear loads – rebar**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic displacement in cracked and uncracked concrete C20/25 to C50/60 under shear loads** | | | | | | | | | | |
| Displacement [1] | $\delta_{V0}$ | [mm] | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 | 2,5 |
| | $\delta_{V\infty}$ | [mm] | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 | 3,7 |

[1] These values are suitable for each temperature range and categories specified in Annex B1
Calculation of the displacement: $\delta_{N0} = \delta_{N0}$-factor · V; $\delta_N = \delta_{N\infty}$-factor · V; (V – applied shear load)

**Table C21: Characteristic resistance to tension load – threaded rod under seismic performance category C1**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | |
| Steel, property class 5.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 280 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,50 | | | | | | |
| Steel, property class 8.8 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 448 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,50 | | | | | | |
| Steel, property class 10.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 36 | 58 | 84 | 157 | 245 | 353 | 561 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,4 | | | | | | |
| Steel, property class 12.9 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 43 | 69 | 101 | 188 | 294 | 423 | 673 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,4 | | | | | | |
| Stainless steel, property class A4-70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 25 | 40 | 59 | 109 | 171 | 247 | 392 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,87 | | | | | | |
| Stainless steel, property class A4-80 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 448 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,60 | | | | | | |
| High corrosion resistant stainless steel, property class 70 | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | 25 | 40 | 59 | 109 | 171 | 247 | 392 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,87 | | | | | | |
| **Combined pull-out and concrete cone failure, working life 50 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,C1}$ | [N/mm²] | 6,0 | 7,0 | 6,5 | 7,0 | 6,0 | 5,5 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,C1}$ | [N/mm²] | 5,0 | 6,5 | 5,5 | 6,0 | 5,5 | 5,0 | 3,5 |
| **Combined pull-out and concrete cone failure, working life 100 years** | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,C1}$ | [N/mm²] | 6,0 | 7,0 | 6,0 | 6,5 | 6,0 | 5,5 | 4,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,C1}$ | [N/mm²] | 5,0 | 6,0 | 5,5 | 6,0 | 5,5 | 5,0 | 3,5 |

Note: Design method according to TR 045

[1] In the absence of other national regulation

**Table C22: Characteristic resistance to tension load – rebar under seismic performance category C1**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | | | | |
| Characteristic resistance | $N_{Rk,s,C1}$ | [kN] | $A_s{}^{2)} \cdot f_{uk}$ | | | | | | | |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,40 | | | | | | | |
| **Combined pull-out and concrete cone failure, working life 50 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,C1}$ | [N/mm²] | 4,0 | 4,5 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 3,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,C1}$ | [N/mm²] | 3,5 | 4,0 | 4,5 | 4,5 | 4,5 | 4,5 | 4,5 | 2,5 |
| **Combined pull-out and concrete cone failure, working life 100 years** | | | | | | | | | | |
| Temperature range I: 40°C/24°C | $\tau_{Rk,C1}$ | [N/mm²] | 3,5 | 4,5 | 5,0 | 5,0 | 5,0 | 3,5 | 5,0 | 3,0 |
| Temperature range II: 80°C/50°C | $\tau_{Rk,C1}$ | [N/mm²] | 3,5 | 4,0 | 4,5 | 4,5 | 4,5 | 4,0 | 4,5 | 2,5 |

Note: Design method according to TR 045

[1] In the absence of other national regulation

[2] Stressed cross section of the steel element

**Table C23: Characteristic resistance to shear loads – threaded rod under seismic performance category C1 – steel failure without lever arm**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| **Steel failure with threaded rod grade 5.8** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 7,7 | 11,9 | 17,5 | 32,9 | 51,1 | 74,2 | 117,6 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,25 | | | | | | |
| **Steel failure with threaded rod grade 8.8** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 10,2 | 16,1 | 23,5 | 44,1 | 68,6 | 98,7 | 156,8 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,25 | | | | | | |
| **Steel failure with threaded rod grade 10.9** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 12,6 | 20,3 | 29,4 | 54,6 | 85,4 | 123,2 | 196 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,5 | | | | | | |
| **Steel failure with threaded rod grade 12.9** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 15,4 | 24,5 | 35,7 | 65,8 | 102,9 | 148,4 | 235,2 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,5 | | | | | | |
| **Steel failure with stainless steel threaded rod A4-70** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 9,1 | 14,4 | 20,7 | 38,5 | 59,9 | 86,5 | 137,4 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,56 | | | | | | |
| **Steel failure with stainless steel threaded rod A4-80** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 10,2 | 16,1 | 23,5 | 44,1 | 68,6 | 98,7 | 157,2 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,33 | | | | | | |
| **Steel failure with high corrosion stainless steel grade 70** | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | 9,1 | 14,4 | 20,7 | 38,5 | 59,9 | 86,5 | 137,4 |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,56 | | | | | | |

[1] In the absence of other national regulation

**Table C24: Characteristic resistance to shear loads – rebar under seismic performance category C1 – steel failure without lever arm**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Steel failure with rebar** | | | | | | | | | | |
| Characteristic resistance | $V_{Rk,s,C1}$ | [kN] | $0,35 \cdot A_s^{2)} \cdot f_{uk}$ | | | | | | | |
| Partial safety factor [1] | $\gamma_{Ms,C1}$ | [-] | 1,5 | | | | | | | |

[1] In the absence of other national regulation
[2] Stressed cross section of the steel element

**Table C25: Displacement under tension loads – threaded rod under seismic performance category C1**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{N,C1}$ | [mm] | 2,8 | 3,0 | 3,0 | 3,2 | 3,3 | 4,0 | 5,5 |

**Table C26: Displacement under shear loads – threaded rod under seismic performance category C1**

| Size | | | M8 | M10 | M12 | M16 | M20 | M24 | M30 |
|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V,C1}$ | [mm] | 3,4 | 4,0 | 5,0 | 5,3 | 5,9 | 6,0 | 6,5 |

**Table C27: Displacement under tension loads – rebar under seismic performance category C1**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{N,C1}$ | [mm] | 3,0 | 3,3 | 3,5 | 3,9 | 4,1 | 4,5 | 5,6 | 6,0 |

**Table C28: Displacement under shear loads – rebar under seismic performance category C1**

| Size | | | Ø8 | Ø10 | Ø12 | Ø14 | Ø16 | Ø20 | Ø25 | Ø32 |
|---|---|---|---|---|---|---|---|---|---|---|
| Displacement | $\delta_{V,C1}$ | [mm] | 3,6 | 3,7 | 4,0 | 4,6 | 4,8 | 5,5 | 6,6 | 7,0 |

**Table C29: Characteristic resistance to tension load (threaded rod) – seismic performance category C2**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Characteristic resistance | $N_{Rk,s,C2}$ | [N/mm²] | $N_{Rk,s}$ | $N_{Rk,s}$ | $N_{Rk,s}$ | $N_{Rk,s}$ |
| **Combined pull-out and concrete cone failure (uncracked and cracked concrete)** | | | | | | |
| Characteristic bond resistance temperature range -40°C / +40°C | $\tau_{Rk,C2}$ | [N/mm²] | 5,65 | 3,93 | 5,18 | 3,65 |
| Characteristic bond resistance temperature range -40°C / +80°C | $\tau_{Rk,C2}$ | [N/mm²] | 5,03 | 3,50 | 4,61 | 3,25 |

**Table C30: Characteristic resistance to shear load (threaded rod) – seismic performance category C2**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Steel failure with threaded rod grade 5.8** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 11,6 | 13,7 | 26,3 | 47,0 |
| **Steel failure with threaded rod grade 8.8** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 18,5 | 22,0 | 42,1 | 75,1 |
| **Steel failure with threaded rod grade 10.9** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 23,2 | 27,4 | 52,6 | 93,9 |
| **Steel failure with threaded rod grade 12.9** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 27,8 | 32,9 | 63,2 | 112,6 |
| **Stainless steel, property class A4-70** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 15,8 | 19,2 | 36,9 | 66,0 |
| **Stainless steel, property class A4-80** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 18,5 | 22,0 | 42,1 | 75,1 |
| **High corrosion resistant stainless steel, property class 70** | | | | | | |
| Characteristic resistance | $V_{Rk,s,C2}$ | [N/mm²] | 15,8 | 19,2 | 36,9 | 66,0 |

**Table C31: Displacements under tensile and shear load (threaded rod) – seismic performance category C2**

| Size | | | M12 | M16 | M20 | M24 |
|---|---|---|---|---|---|---|
| **Displacements for tensile and shear load for seismic performance category C2** | | | | | | |
| Displacement in tensile at damage limitation states [1)] | $\delta_{N,eq,C2 (DLS)}$ | [mm] | 0,85 | 1,14 | 0,77 | 0,94 |
| Displacement in tensile at ultimate limit state [1)] | $\delta_{N,eq,C2 (ULS)}$ | [mm] | 1,70 | 2,01 | 2,07 | 1,91 |
| Displacement in shear at damage limitation states [1)] | $\delta_{V,eq,C2 (DLS)}$ | [mm] | 3,01 | 2,28 | 3,60 | 3,15 |
| Displacement in shear at ultimate limit state [1)] | $\delta_{V,eq,C2 (ULS)}$ | [mm] | 6,44 | 8,81 | 7,57 | 8,21 |

[1)] All temperature ranges