# EUROPEAN TECHNICAL ASSESSMENT

# BZ PLUS

EUROPEAN TECHNICAL ASSESSMENT
OPTION 1

Scell-it®

CSTB
le futur en construction

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# European Technical Assessment

# ETA-15/0528 du 03/11/2015

*English translation prepared by CSTB - Original version in French language*

## General Part

| | |
|---|---|
| Nom commercial<br>*Trade name* | **Scell-It BZPLUS** |
| Famille de produit<br>*Product family* | **Cheville métallique à expansion par vissage à couple contrôlé, de fixation dans le béton fissuré et non fissuré diamètres M8, M10, M12 et M16**<br>***Torque-controlled expansion anchor for use in cracked and uncracked concrete: sizes M8, M10, M12 and M16*** |
| Titulaire<br>*Manufacturer* | SCELL-IT<br>28 rue Paul Dubrule<br>59810 LESQUIN<br>France |
| Usine de fabrication<br>*Manufacturing plants* | Plant 9 |
| Cette evaluation contient:<br>*This Assessment contains* | 16 pages incluant 12 annexs qui font partie intégrante de cette évaluation<br>16 *pages including 12 annexs which form an integral part of this assessment* |
| Base de l'ETE<br>*Basis of ETA* | ETAG 001, Version Avril 2013, utilisée en tant que EAD<br>*ETAG 001, Edition April 2013 used as EAD* |
| Cette évaluation remplace:<br>*This Assessment replaces* | |

*Les traductions de cette Evaluation Technique Européenne dans d'autres langues doivent correspondre pleinement au document original et doivent être identifiées comme telles. La communication de cette évaluation technique européenne, y compris la transmission par voie électronique, doit être complète. Cependant, une reproduction partielle peut être faite, avec le consentement écrit de l'organisme d'évaluation technique d'émission. Toute reproduction partielle doit être identifiée comme telle.*

## Specific Part

## 1 Technical description of the product

The Scell-It BZPLUS anchor is an anchor made of zinc electroplated steel which is placed into a drilled hole and anchored by torque-controlled expansion.

The anchor is placed into a drilled hole and anchored by torque-controlled expansion.

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

## 2 Specification of the intended use

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

The provisions made in this European technical assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

## 3 Performance of the product

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

| Essential characteristic | Performance |
|---|---|
| Characteristic tension resistance acc. ETAG001, Annex C | See Annex C1 |
| Characteristic shear resistance acc. ETAG001, Annex C | See Annex C2 |
| Characteristic tension resistance acc. CEN/TS 1992-4 | See Annex C5 |
| Characteristic shear resistance acc. CEN/TS 1992-4 | See Annex C6 |
| Displacements | See Annex C9 |

### 3.2 Safety in case of fire (BWR 2)

| Essential characteristic | Performance |
|---|---|
| Reaction to fire | Anchorages satisfy requirements for Class A1 |
| Characteristic tension resistance under fire acc. ETAG001, Annex C | See Annex C3 |
| Characteristic shear resistance under fire acc. ETAG001, Annex C | See Annex C4 |
| Characteristic tension resistance under fire acc. CEN/TS 1992-4 | See Annex C7 |
| Characteristic shear resistance under fire acc. CEN/TS 1992-4 | See Annex C8 |

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

Regarding dangerous substances contained in this European technical approval, there may be requirements applicable to the products falling within its scope (e.g. transposed European legislation and national laws, regulations and administrative provisions). In order to meet the provisions of the Construction Products Directive, these requirements need also to be complied with, when and where they apply.

### 3.4 Safety in use (BWR 4)

For Basic requirement Safety in use the same criteria are valid as for Basic Requirement Mechanical resistance and stability.

### 3.5 Protection against noise (BWR 5)

Not relevant.

### 3.6 Energy economy and heat retention (BWR 6)

Not relevant.

### 3.7 Sustainable use of natural resources ( (BWR 7)

For the sustainable use of natural resources no performance was determined for this product.

### 3.8 General aspects relating to fitness for use

Durability and Serviceability are only ensured if the specifications of intended use according to Annex B1 are kept.

## 4 Assessment and verification of constancy of performance (AVCP)

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

| Product | Intended use | Level or class | System |
|---|---|---|---|
| Metal anchors for use in concrete | For fixing to and/or supporting concrete structural elements (which contributes to the stability of the works) or heavy units (such as wall panelling or suspended ceilings) | — | 1 |

## 5 Technical details necessary for the implementation of the AVCP system

Technical details necessary for the implementation of the Assessment and verification of constancy of performance (AVCP) system are laid down in the control plan deposited at Centre Scientifique et Technique du Bâtiment.

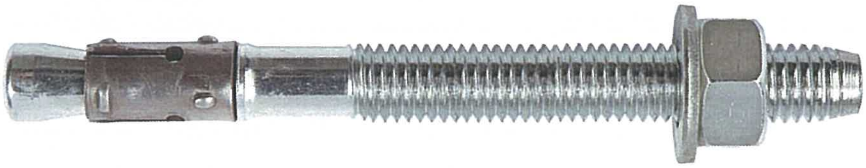
The manufacturer shall, on the basis of a contract, involve a notified body approved in the field of anchors for issuing the certificate of conformity CE based on the control plan.

**The original French version is signed by**

Charles Baloche
Technical Director

1 Official Journal of the European Communities L 254 of 08.10.1996

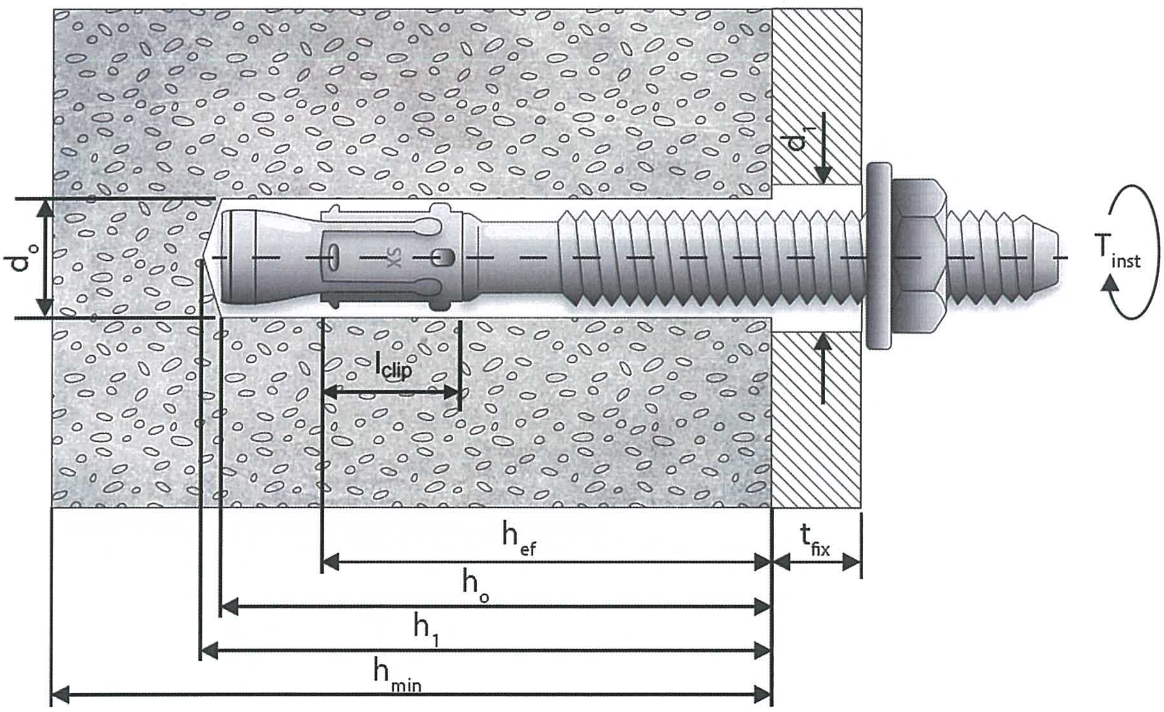
**Assembled anchor BZPLUS:**



**Marking on the bolt:**

TB1-PLUS
followed by MX/L where
X = thread diameter
L = total lengh

**Installed anchor:**




Intended use:

**Use in cracked or uncracked concrete in dry internal conditions**

**Different parts of the anchor:**

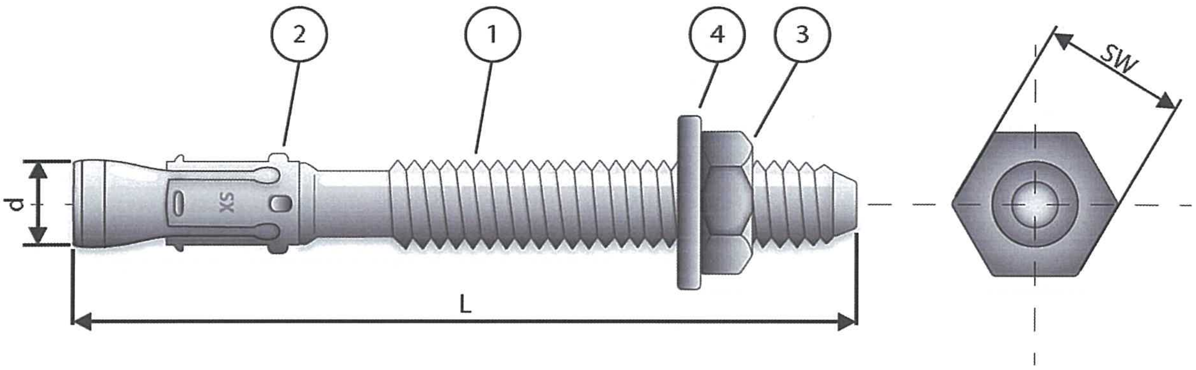



**Table 1: Materials**

| Part | Designation | Material | Protection |
|---|---|---|---|
| 1 | Thread bolt | Coldform steel, grade C-1035 | Zinc plated 5 µm |
| 2 | Expansion clip | Stainless steel | - |
| 3 | Hexagonal nut | Steel, DIN 934 or DIN EN ISO 4032, Grade 8 acc. to DIN EN ISO 20898-2 | Zinc plated |
| 4 | Washer | Steel, DIN 125 or EN ISO 7089 DIN 9021 or D IN EN ISO 7093 | Zinc plated |

## Specifications of intended use

**Anchorages subject to:**

- Static, quasi-static and fire.

**Base materials:**

- Cracked concrete and non-cracked concrete
- Reinforced or unreinforced normal weight concrete of strength classes C 20/25 at least to C50/60 at most according to EN 206: 2000-12.

**Use conditions (Environmental conditions):**

- Structures subject to dry internal conditions.

**Design:**

- The anchorages are designed in accordance with the ETAG001 Annex C “Design Method for Anchorages” or CEN/TS 1992-4-4 " Design of fastenings for use in concrete” under the responsibility of an engineer experienced in anchorages and concrete work.
- For application with resistance under fire exposure the anchorages are designed in accordance with method given in TR020 “Evaluation of Anchorage in Concrete concerning Resistance to Fire”.
- 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.

**Installation:**

- Anchor installation carried out by appropriately qualified personnel and under the supervision of the person responsible for technical matters of the site.
- Use of the anchor only as supplied by the manufacturer without exchanging the components of an anchor.
- Anchor installation in accordance with the manufacturer’s specifications and drawings and using the appropriate tools.
- Effective anchorage depth, edge distances and spacing not less than the specified values without minus tolerances.
- Hole drilling by hammer drill.
- Cleaning of the hole of drilling dust.
- Application of specified torque moment using a calibrated torque wrench.
- In case of aborted hole, drilling of new hole at a minimum distance of twice the depth of the aborted hole, or smaller distance provided the aborted drill hole is filled with high strength mortar and no shear or oblique tension loads in the direction of aborted hole.

**Table 2: Anchor dimensions**

| | | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|---|
| Length of the anchor | Min. | L | [mm] | 60 | 85 | 90 | 115 |
| | Max. | | [mm] | 240 | 220 | 220 | 220 |
| Fixture thickness | Min. | $t_{fix}$ | [mm] | 1 | 1 | 1 | 1 |
| | Max. | | [mm] | 185 | 140 | 130 | 100 |
| Length expansion sleeve | | $l_{clip}$ | [mm] | 14 | 18 | 22 | 26 |
| Width torque wrench | | SW | [mm] | 13 | 17 | 19 | 24 |

**Table 3: Installation data**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| Drill hole diameter | $d_0$ | [mm] | ≤ 8,45 | ≤ 10,45 | ≤ 12,5 | ≤ 16,5 |
| Drill hole depth | $h_1$ | [mm] | 55 | 75 | 75 | 100 |
| Embedment depth | $h_{ef}$ | [mm] | 40 | 60 | 60 | 80 |
| Installation torque | $T_{inst}$ | [Nm] | 30 | 50 | 70 | 130 |
| Diameter through hole fixture | $d_1$ | [mm] | 9 | 12 | 14 | 18 |
| | | | | | | |
| Min. member thickness | $h_{min}$ | [mm] | 100 | 120 | 120 | 160 |
| | | | | | | |
| Minimum edge distance | $c_{min}$ | [mm] | 65 | 60 | 80 | 85 |
| Minimum spacing | $s_{min}$ | [mm] | 65 | 150 | 80 | 85 |

**Table 4: Characteristic values for tension loads in case of static and quasi static loading for design method A acc. ETAG001, Annex C**

| | | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | | |
| Char. resistance | | $N_{Rk,s}$ | [kN] | 22,2 | 31,6 | 43,4 | 75,4 |
| Partial safety factor | | $\gamma_{Ms}$ [1] | [-] | 1,88 | 1,88 | 1,88 | 1,88 |
| **Pullout failure** $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$ | | | | | | | |
| Char. resistance in concrete C20/25 | cracked | $N^0_{Rk,p}$ | [kN] | 3 | 9 | 12 | 12 |
| | non-cracked | $N^0_{Rk,p}$ | [kN] | 6 | 12 | 12 | 35 |
| Partial safety factor for cracked or non-cracked concrete | | $\gamma_{Mp}$ [1] | [-] | 1,8 [3] | 1,8 [3] | 2,1 [2] | 2,1 [2] |
| Increasing factor for $N_{RK}$ | concrete C30/37 | $\Psi_c$ | [-] | 1,22 | 1,22 | 1,22 | 1,22 |
| | concrete C40/50 | | [-] | 1,41 | 1,41 | 1,41 | 1,41 |
| | concrete C50/60 | | [-] | 1,55 | 1,55 | 1,55 | 1,55 |
| **Concrete cone failure and splitting failure** | | | | | | | |
| Effective embedment depth | | $h_{ef}$ | [mm] | 40 | 60 | 60 | 80 |
| Partial safety factor for craked or non-cracked concrete | | $\gamma_{Mc}=\gamma_{Msp}$ [1] | [-] | 1,8 [3] | 1,8 [3] | 2,1 [2] | 2,1 [2] |
| Increasing factor for $N_{RK}$ | concrete C30/37 | $\Psi_c$ | [-] | 1,22 | 1,22 | 1,22 | 1,22 |
| | concrete C40/50 | | [-] | 1,41 | 1,41 | 1,41 | 1,41 |
| | concrete C50/60 | | [-] | 1,55 | 1,55 | 1,55 | 1,55 |
| Char. spacing | concrete cone failure | $s_{cr,N}$ | [mm] | 120 | 180 | 180 | 240 |
| | splitting failure | $s_{cr,sp}$ | [mm] | 200 | 300 | 360 | 400 |
| Char. edge distance | concrete cone failure | $c_{cr,N}$ | [mm] | 60 | 90 | 90 | 120 |
| | splitting failure | $c_{cr,sp}$ | [mm] | 100 | 150 | 180 | 200 |

[1] In absence of other national regulations
[2] The value contains an installation safety factor $\gamma_2$= 1.4
[3] The value contains an installation safety factor $\gamma_2$= 1.2

**Table 5: Characteristic values for shear loads in case of static and quasi static loading for design method A acc. ETAG001, Annex C**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | |
| Char. resistance | $V_{Rk,s}$ | [kN] | 8,1 | 17,6 | 24,7 | 45,9 |
| Partial safety factor | $\gamma_{Ms}$ [1)] | [-] | 1,25 | 1,25 | 1,25 | 1,25 |
| **Steel failure with lever arm** | | | | | | |
| Char. bending resistance | $M^0_{Rk,s}$ | [Nm] | 22,8 | 45,5 | 76,6 | 194,8 |
| Partial safety factor | $\gamma_{Ms}$ [1)] | [-] | 1,25 | 1,25 | 1,25 | 1,25 |
| **Concrete pry-out failure** | | | | | | |
| Factor in equation (5.6) of ETAG Annex C, § 5.2.3.3 | k | [-] | 1,0 | 2,0 | 2,0 | 2,0 |
| Partial safety factor | $\gamma_{Mc}$ [1)] | [-] | 1,5 | 1,5 | 1,5 | 1,5 |
| **Concrete edge failure** | | | | | | |
| Effective length of anchor under shear loading | $l_f$ | [mm] | 40 | 60 | 60 | 80 |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 |
| Partial safety factor | $\gamma_{Mc}$ [1)] | [-] | 1,5 | 1,5 | 1,5 | 1,5 |

[1)] In absence of other national regulations

**Table 6: Characteristic tension resistance in cracked and non-cracked concrete under fire exposure for design method A acc. ETAG001, Annex C**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Characteristic resistance | R30 $N_{Rk,s,fi}$ | [kN] | 0,4 | 0,9 | 1,7 | 3,1 |
| | R60 $N_{Rk,s,fi}$ | [kN] | 0,3 | 0,8 | 1,3 | 2,4 |
| | R90 $N_{Rk,s,fi}$ | [kN] | 0,3 | 0,6 | 1,1 | 2,0 |
| | R120 $N_{Rk,s,fi}$ | [kN] | 0,2 | 0,5 | 0,8 | 1,6 |
| **Pullout failure (cracked and non-cracked concrete)** | | | | | | |
| Char. resistance in concrete ≥ C20/25 | R30 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R60 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R90 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R120 $N_{Rk,p,fi}$ | [kN] | 0,6 | 1,8 | 2,4 | 3,2 |
| **Concrete cone and splitting failure[2] (cracked and non-cracked concrete)** | | | | | | |
| Char. resistance in concrete ≥ C20/25 | R30 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R60 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R90 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R120 $N^0_{Rk,c,fi}$ | [kN] | 1,5 | 4,0 | 4,0 | 8,2 |
| Characteristic spacing | $s_{cr,N,fi}$ | [mm] | 160 | 240 | 240 | 320 |
| Characteristic edge distance | $c_{cr,N,fi}$ | [mm] | 80 | 120 | 120 | 160 |

[1] Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.1.

[2] As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

**Table 7: Characteristic shear resistance in cracked and non-cracked concrete under fire exposure for design method A acc. ETAG001, Annex C**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | |
| Characteristic resistance | R30 $V_{Rk,s,fi}$ | [kN] | 0,4 | 0,9 | 1,7 | 3,1 |
| | R60 $V_{Rk,s,fi}$ | [kN] | 0,3 | 0,8 | 1,3 | 2,4 |
| | R90 $V_{Rk,s,fi}$ | [kN] | 0,3 | 0,6 | 1,1 | 2,0 |
| | R120 $V_{Rk,s,fi}$ | [kN] | 0,2 | 0,5 | 0,8 | 1,6 |
| **Steel failure with lever arm** | | | | | | |
| Characteristic bending moment | R30 $M^0_{Rk,s,fi}$ | [Nm] | 0,4 | 1,1 | 2,6 | 6,7 |
| | R60 $M^0_{Rk,s,fi}$ | [Nm] | 0,3 | 1,0 | 2,0 | 5,0 |
| | R90 $M^0_{Rk,s,fi}$ | [Nm] | 0,3 | 0,7 | 1,7 | 4,3 |
| | R120 $M^0_{Rk,s,fi}$ | [Nm] | 0,2 | 0,6 | 1,3 | 3,3 |
| **Concrete pry-out failure** | | | | | | |
| Factor in equation (5.6) of ETAG Annex C, § 5.2.3.3 | k | [-] | 1,0 | 2,0 | 2,0 | 2,0 |
| Characteristic resistance | R30 $V_{Rk,cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R60 $V_{Rk, cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R90 $V_{Rk, cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R120 $V_{Rk, cp,fi}$ | [kN] | 1,5 | 8,0 | 8,0 | 16,5 |
| **Concrete edge failure** | | | | | | |
| Eff. length of anchor under shear loading | $l_f$ | [mm] | 40 | 60 | 60 | 80 |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 |

1) Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.2.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

**Table 8: Characteristic values for tension loads in case of static and quasi static loading for design design method A acc. CEN/TS 1992-4**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Char. resistance | $N_{Rk,s}$ | [kN] | 22,2 | 31,6 | 43,4 | 75,4 |
| Partial safety factor | $\gamma_{Ms}$ 1) | [-] | 1,88 | 1,88 | 1,88 | 1,88 |
| **Pullout failure** $N_{Rk,p} = \Psi_c \times N^0_{Rk,p}$ | | | | | | |
| Char. resistance in concrete C20/25 – cracked | $N^0_{Rk,p}$ | [kN] | 3 | 9 | 12 | 12 |
| Char. resistance in concrete C20/25 – non-cracked | $N^0_{Rk,p}$ | [kN] | 6 | 12 | 12 | 35 |
| Partial safety factor for cracked or non-cracked concrete | $\gamma_{Mp}$ 1) | [-] | 1,8 3) | 1,8 3) | 2,1 2) | 2,1 2) |
| Increasing factor for $N_{RK,p}$ – concrete C30/37 | $\Psi_c$ | [-] | 1,22 | 1,22 | 1,22 | 1,22 |
| Increasing factor for $N_{RK,p}$ – concrete C40/50 | $\Psi_c$ | [-] | 1,41 | 1,41 | 1,41 | 1,41 |
| Increasing factor for $N_{RK,p}$ – concrete C50/60 | $\Psi_c$ | [-] | 1,55 | 1,55 | 1,55 | 1,55 |
| **Concrete cone failure and splitting failure** | | | | | | |
| Effective embedment depth | $h_{ef}$ | [mm] | 40 | 60 | 60 | 80 |
| Factor for cracked concrete | $k_{cr}$ | [-] | 7,2 | 7,2 | 7,2 | 7,2 |
| Factor for non cracked concrete | $k_{ucr}$ | [-] | 10,1 | 10,1 | 10,1 | 10,1 |
| Partial safety factor | $\gamma_{Mc}=\gamma_{Msp}$ 1) | [-] | 1,8 3) | 1,8 3) | 2,1 2) | 2,1 2) |
| Char. spacing – concrete cone failure | $s_{cr,N}$ | [mm] | 120 | 180 | 180 | 240 |
| Char. spacing – splitting failure | $s_{cr,sp}$ | [mm] | 200 | 300 | 360 | 400 |
| Char. edge distance – concrete cone failure | $c_{cr,N}$ | [mm] | 60 | 90 | 90 | 120 |
| Char. edge distance – splitting failure | $c_{cr,sp}$ | [mm] | 100 | 150 | 180 | 200 |

1) In absence of other national regulations

2) The value contains an installation safety factor $\gamma_2 = 1.4$

3) The value contains an installation safety factor $\gamma_2 = 1.2$

**Table 9: Characteristic values for shear loads in case of static and quasi static loading for design design method A acc. CEN/TS 1992-4**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | |
| Char. resistance | $V_{Rk,s}$ | [kN] | 8,1 | 17,6 | 24,7 | 45,9 |
| Factor considering ductility | $k_2$ | [-] | 0,8 | 0,8 | 0,8 | 0,8 |
| Partial safety factor | $\gamma_{Ms}$ 1) | [-] | 1,25 | 1,25 | 1,25 | 1,25 |
| **Steel failure with lever arm** | | | | | | |
| Char. bending moment | $M^0_{Rk,s}$ | [Nm] | 22,8 | 45,5 | 76,6 | 194,8 |
| Partial safety factor | $\gamma_{Ms}$ 1) | [-] | 1,25 | 1,25 | 1,25 | 1,25 |
| **Concrete pry-out failure** | | | | | | |
| Factor in equation (16) of CEN/TS 1992-4-4, § 6.2.2.3 | $k_3$ | [-] | 1,0 | 2,0 | 2,0 | 2,0 |
| Partial safety factor | $\gamma_{Mc}$ 1) | [-] | 1,5 | 1,5 | 1,5 | 1,5 |
| **Concrete edge failure** | | | | | | |
| Effective length of anchor under shear loading | $l_f$ | [mm] | 40 | 60 | 60 | 80 |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 |
| Partial safety factor | $\gamma_{Mc}$ 1) | [-] | 1,5 | 1,5 | 1,5 | 1,5 |

1) In absence of other national regulations

**Table 10: Characteristic tension resistance in cracked and non-cracked concrete under fire exposure for design method A acc. CEN/TS 1992-4**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure** | | | | | | |
| Characteristic resistance | R30 $N_{Rk,s,fi}$ | [kN] | 0,4 | 0,9 | 1,7 | 3,1 |
| | R60 $N_{Rk,s,fi}$ | [kN] | 0,3 | 0,8 | 1,3 | 2,4 |
| | R90 $N_{Rk,s,fi}$ | [kN] | 0,3 | 0,6 | 1,1 | 2,0 |
| | R120 $N_{Rk,s,fi}$ | [kN] | 0,2 | 0,5 | 0,8 | 1,6 |
| **Pullout failure (cracked and non-cracked concrete)** | | | | | | |
| Char. resistance in concrete ≥ C20/25 | R30 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R60 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R90 $N_{Rk,p,fi}$ | [kN] | 0,8 | 2,3 | 3,0 | 4,0 |
| | R120 $N_{Rk,p,fi}$ | [kN] | 0,6 | 1,8 | 2,4 | 3,2 |
| **Concrete cone and splitting failure 2) (cracked and non-cracked concrete)** | | | | | | |
| Char. resistance in concrete ≥ C20/25 | R30 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R60 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R90 $N^0_{Rk,c,fi}$ | [kN] | 1,8 | 5,0 | 5,0 | 10,3 |
| | R120 $N^0_{Rk,c,fi}$ | [kN] | 1,5 | 4,0 | 4,0 | 8,2 |
| Characteristic spacing | $s_{cr,N,fi}$ | [mm] | 160 | 240 | 240 | 320 |
| Characteristic edge distance | $c_{cr,N,fi}$ | [mm] | 80 | 120 | 120 | 160 |

1) Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.1.

2) As a rule, splitting failure can be neglected when cracked concrete and reinforcement is assumed.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

**Table 11: Characteristic shear resistance in cracked and non-cracked concrete under fire exposure for design method A acc. CEN/TS 1992-4**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Steel failure without lever arm** | | | | | | |
| Characteristic resistance | R30 $V_{Rk,s,fi}$ | [kN] | 0,4 | 0,9 | 1,7 | 3,1 |
| | R60 $V_{Rk,s,fi}$ | [kN] | 0,3 | 0,8 | 1,3 | 2,4 |
| | R90 $V_{Rk,s,fi}$ | [kN] | 0,3 | 0,6 | 1,1 | 2,0 |
| | R120 $V_{Rk,s,fi}$ | [kN] | 0,2 | 0,5 | 0,8 | 1,6 |
| **Steel failure with lever arm** | | | | | | |
| Characteristic bending moment | R30 $M^0_{Rk,s,fi}$ | [Nm] | 0,4 | 1,1 | 2,6 | 6,7 |
| | R60 $M^0_{Rk,s,fi}$ | [Nm] | 0,3 | 1,0 | 2,0 | 5,0 |
| | R90 $M^0_{Rk,s,fi}$ | [Nm] | 0,3 | 0,7 | 1,7 | 4,3 |
| | R120 $M^0_{Rk,s,fi}$ | [Nm] | 0,2 | 0,6 | 1,3 | 3,3 |
| **Concrete pry-out failure** | | | | | | |
| Factor in equation (16) of CEN/TS 1992-4-4, § 6.2.2.3 | $k_3$ | [-] | 1,0 | 2,0 | 2,0 | 2,0 |
| Characteristic resistance | R30 $V_{Rk,cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R60 $V_{Rk, cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R90 $V_{Rk, cp,fi}$ | [kN] | 1,8 | 10,0 | 10,0 | 20,6 |
| | R120 $V_{Rk, cp,fi}$ | [kN] | 1,5 | 8,0 | 8,0 | 16,5 |
| **Concrete edge failure** | | | | | | |
| Eff. length of anchor under shear loading | $l_f$ | [mm] | 40 | 60 | 60 | 80 |
| Outside diameter of anchor | $d_{nom}$ | [mm] | 8 | 10 | 12 | 16 |

1) Design under fire exposure is performed according to the design method given in TR 020. Under fire exposure usually cracked concrete is assumed. The design equations are given in TR 020, Section 2.2.2.

TR 020 covers design for fire exposure from one side. For fire attack from more than one side the edge distance must be increased to $c_{min} \geq 300$ mm and $\geq 2 \cdot h_{ef}$.

**Table 12: Displacements under tension loading**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Tension load in non-cracked concrete C20/25 [kN]** | | | 2,38 | 4,76 | 5,44 | 11,90 |
| Displacement | $\delta_{N0}$ | [mm] | 0,05 | 0,10 | 0,06 | 0,30 |
| | $\delta_{N\infty}$ | [mm] | 0,65 | 1,17 | 1,53 | 0,65 |
| **Tension load in non-cracked concrete C50/60 [kN]** | | | 3,69 | 9,92 | 10,20 | 18,45 |
| Displacement | $\delta_{N0}$ | [mm] | 0,05 | 0,24 | 0,10 | 0,10 |
| | $\delta_{N\infty}$ | [mm] | 0,65 | 1,17 | 1,53 | 0,65 |
| **Tension load in cracked concrete C20/25 [kN]** | | | 1,19 | 4,76 | 4,08 | 4,08 |
| Displacement | $\delta_{N0}$ | [mm] | 0,05 | 0,83 | 1,04 | 0,40 |
| | $\delta_{N\infty}$ | [mm] | 1,15 | 1,17 | 1,53 | 1,14 |
| **Tension load in cracked concrete C50/60 [kN]** | | | 1,85 | 4,76 | 10,20 | 6,33 |
| Displacement | $\delta_{N0}$ | [mm] | 2,95 | 0,94 | 1,89 | 3,43 |
| | $\delta_{N\infty}$ | [mm] | 2,95 | 1,17 | 1,53 | 3,43 |

**Tableau 13: Displacements under shear loading**

| | | | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| **Shear load in cracked and non-cracked concrete C20/25 to C50/60** | | **[kN]** | 4,63 | 9,14 | 9,52 | 26,23 |
| Displacement | $\delta_{V0}$ | [mm] | 5,50 | 5,26 | 5,84 | 3,60 |
| | $\delta_{V\infty}$ | [mm] | 8,25 | 7,89 | 8,76 | 5,40 |

Additional displacement due to anular gap between anchor and fixture is to be taken into account.