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SLOVENIAN NATIONAL BUILDING AND CIVIL ENGINEERING INSTITUTE

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

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| European Technical Assessment | ETA-14/0345 |
|---|---|
| | of 13.10.2014 |

*English version prepared by ZAG*

## I   GENERAL PART

| | |
|---|---|
| Komercialno ime *Trade name* | **Safety Plus II** |
| Imetnik tehnične ocene *Holder of Technical Assessment* | **Rawlplug Limited** **Skibo Drive** **Thornliebank Industrial Estate** **Glasgow G46 8JR** |
| Družina proizvoda *Product family* | **Torzijsko kontrolirano zatezno kovinsko sidro iz galvansko pocinkanega jekla velikosti M6, M8, M10, M12 in M16 za vgradnjo beton** *Torque controlled expansion anchor made of galvanised steel of sizes M6, M8, M10, M12 and M16 for use in concrete* |
| Proizvodni obrat *Manufacturing plant* | **Manufacturing Plant No.2** |
| Ta Evropska tehnična ocena vsebuje *This European Technical Assessment contains* | 14 strani vključno s 11 prilogami, ki so sestavni del te ocene *14 pages including 11 annexes, which form an integral part of the document* |
| Ta Evropska tehnična ocena je izdana na podlagi Uredbe (EU) št. 305/2001 na osnovi *This European Technical Assessment is issued in according to Regulation (EU) No 305/2011, on the basis of* | Smernice za evropska tehnična soglasja ETAG 001 – del 1 in 2, izdaja 2013, ki se uporablja kot EAD *Guideline for European Technical Approval ETAG 001 – part 1 and 2, edition 2013, used as EAD* |

## II   SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT

### 1   Technical description of the product

The Safety Plus II in the range of M6, M8, M10, M12 and M16 is an anchor made of galvanised steel, which is placed into a drilled hole and anchored by torque-controlled expansion.

An illustration and description of the anchor are given in Annex A.

### 2   Specification of the intended use

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

The provisions made in this European Technical Assessment are based on an assumed working life of the anchor of 50 years. The indications given on the working life cannot be interpreted as a guarantee given by the manufacturer, 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 this assessment

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

The essential characteristics for mechanical resistance and stability are listed in Annexes C1 to C4.

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

The essential characteristics for safety in case of fire are listed in Annex C5.

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

Regarding dangerous substances contained in this European Technical Assessment, there may be requirements applicable to the products falling within its scope (e.g. transported European legislation and national laws, regulations and administrative provisions). In order to meet provisions of the regulation (EU) No 305/2011, these requirements need also to be complied with, when 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 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 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] 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.

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[1]   Official Journal of the European Communities L 254 of 8.10.1996

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

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

### 5.1 Tasks for the manufacturer

The manufacturer shall exercise permanent internal control of production of concerned product. All the elements, requirements and provisions adopted by the manufacturer shall be documented in a systematic manner in the form of written policies and procedures, including records of results performed. This production control system shall ensure that the product is in conformity with this European Technical Assessment.

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

The factory production control shall be in accordance with the Control plan which is a part of the technical documentation of this European Technical Assessment. The Control plan[2] is laid down in the context of the factory production control system operated by the manufacturer and deposited at Slovenian National Building and Civil Engineering Institute (ZAG Ljubljana). The results of factory production Control shall be recorded and evaluated in accordance with the provisions of the control plan.

The manufacturer shall, on the basis of a contract, involve a body, which is notified for the tasks referred to in a section 4 in the field of anchors in order to undertake the actions laid down in section 5.2. For this purpose the Control plan referred to in sections 5.1 and 5.2 shall be handed over by the manufacturer to the notified body involved.

The manufacturer shall make a Declaration of performance, stating that the construction product is in conformity with the provisions of this European Technical Assessment.

### 5.2 Tasks for the notified bodies

The notified body shall retain the essential points of its actions defined in Annex V of Regulation (EU) No. 305/2011 for system 1 and state results obtained and conclusions drawn in a written report.

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

In cases where the provisions of the European Technical Assessment and its Control plan are no longer fulfilled the notified body shall withdraw the certificate of constancy of performance and inform the Slovenian National Building and Civil Engineering Institute (ZAG Ljubljana) without delay.
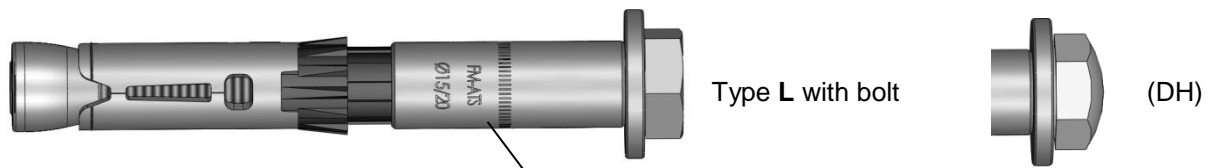
Issued in Ljubljana on 13.10.2014

Signed by:

Franc Capuder, M.Sc., Research Engineer

*Head of Service of TAB*

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[2] The Control plan is a confidential part of the technical documentation of this European Technical Assessment, but not published together with the ETA, and handed over only to the notified body or bodies involved in the procedure of attestation of conformity.

Type **L** with bolt                    (DH)

**Marking:** Identification mark of the producer - trade name of the anchor
nominal drill hole diameter / max thickness of fixture
(and line for minimum embedment and max thickness of fixture)
e.g.:    FM-ATS
        Ø15/20

Type **P** with threaded bar          Type **C** with countersunk screw          Sleeve for M16 size
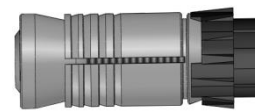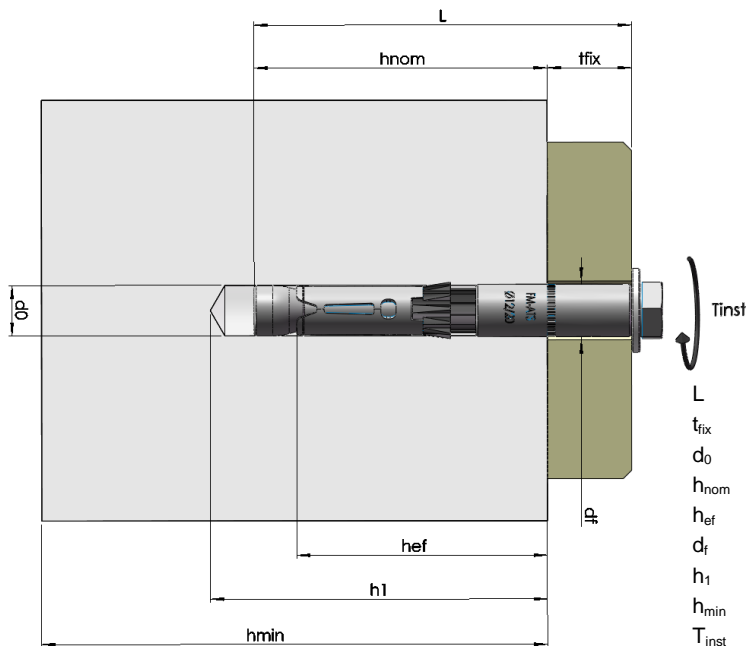
$L$ = length of the anchor (mm)
$t_{fix}$ = thickness of fixture (mm)
$d_0$ = nominal drill hole diameter (mm)
$h_{nom}$ = minimum installation depth (mm)
$h_{ef}$ = effective anchorage depth (mm)
$d_f$ = diameter of clearance hole in the fixture (mm)
$h_1$ = depth of drill hole (mm)
$h_{min}$ = minimum thickness of the concrete member (mm)
$T_{inst}$ = torque moment (Nm)

| **Safety Plus II** | **Annex A1** |
|---|---|
| **Product description**<br>Product and intended use | |

R-SPL-II-L

(type DH)

1    2    3    4    5   6     (6)

R-SPL-II-P

7   8

R-SPL-II-C

9
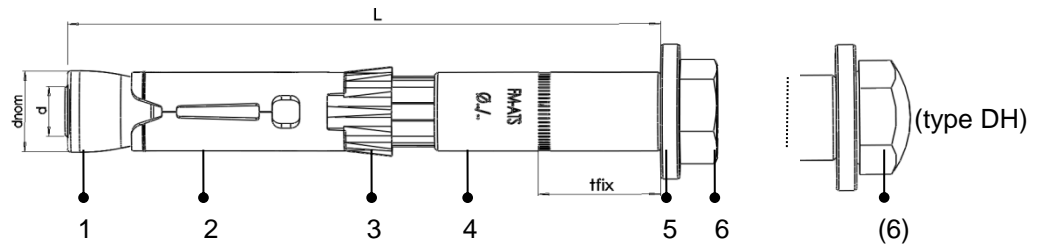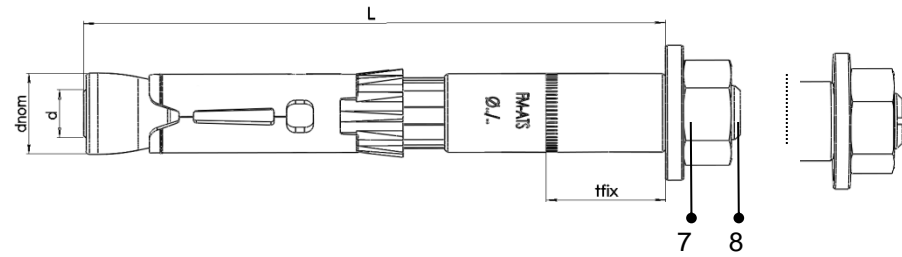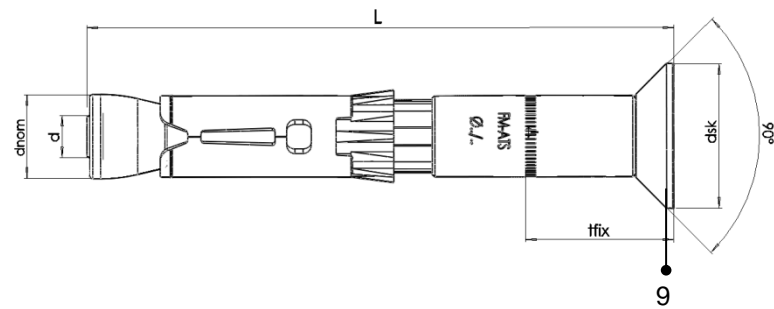
1 Cone
2 Expansion sleeve
3 Plastic sleeve
4 Distance sleeve
5 Washer
6 Hexagonal screw
7 Hexagonal nut
8 Threaded bar
9 Countersunk screw

| Safety Plus II | |
|---|---|
| **Product description**<br>Product and components | **Annex A2** |

Table A1: Materials

| | Part of anchor | Material |
|---|---|---|
| 1 | Cone | hardened steel EN 10087 [1] |
| 2 | Expansion sleeve | M6÷M12 hardened steel EN 10132[1] - M16 steel EN 10087[1] |
| 3 | Plastic sleeve | Pa6 ISO 1874/1 |
| 4 | Distance sleeve | Steel EN 10025[1] |
| 5 | Washer | Steel EN 10139[1] |
| 6 | Hexagon screw | Steel grade 8.8 EN ISO 898/1[1] (DIN 931 -DIN 933 - type SH=head large) |
| 7 | Hexagonal nut | Steel grade 8 DIN 934[1] (EN ISO 898/2) |
| 8 | Threaded bar | Steel grade 8.8 EN ISO 898/1[1] |
| 9 | Countersunk screw | Steel grade 8.8 EN ISO 898/1[1] |

[1] Zinc electroplated 5μm according to EN ISO 4042

| **Safety Plus II** | |
|---|---|
| **Product description** <br> Materials | **Annex A3** |

**Specifications of intended use**

**Anchorages subjected to:**

- Static, quasi static, seismic load and fire.

**Base materials:**

- Cracked and non-cracked concrete.
- Reinforced and unreinforced normal weight concrete of strength class C20/25 at minimum and C50/60 at maximum according to EN 206-1:2000/A2:2005.

**Use conditions (Environmental conditions):**

- Structures subjected to dry internal conditions.

**Design:**

- Anchorages are designed under the responsibility of an engineer experienced in anchorages and concrete work.
- Anchorages under static and quasi-static actions are designed in accordance with ETAG 001, Annex C, design method A, Edition August 2010 or CEN/TS 1992-4.
- For seismic application the anchorages are designed in accordance with TR 045 "Design of metal anchors for use in concrete under seismic actions".
- For application with resistance under fire exposure the anchorages are designed in accordance with method given in TR 020 "Evaluation of anchorage in concrete concerning resistance to fire".
- Verifiable calculation notes and drawings are prepared taking into account of the load 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:**

- Anchor installation carried out by appropriately qualified personnel and under supervision of the person responsible for technical matters of the site.
- Use of the anchor only supplied by the manufacturer without exchanging the components of the anchor.
- Anchor installation in accordance with the manufacturer's specification and drawings and using the appropriate tools.
- Checks before placing the anchor to ensure that the strength class of the concrete in which the anchor is to be placed is in the range given and is not lower than of the concrete to which the characteristic loads apply.
- Check of concrete being well compacted, e.g. without significant voids.
- 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.
- Positioning of the drill holes without damaging the reinforcement.
- 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.

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|---|---|
| **Safety Plus II** | |
| **Intended use**<br>Specification | **Annex B1** |

Table B1: Dimensions

| Anchor size | | | M6 | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|---|
| Nominal diameter of anchor | | $d_{nom}$ [mm] | 10 | 12 | 15 | 18 | 24 |
| Minimum installation depth | | $h_{nom} \geq$ [mm] | 60 | 70 | 80 | 100 | 115 |
| Length of the anchor | | L [mm] | $t_{fix}$ + 60 | $t_{fix}$ + 70 | $t_{fix}$ + 80 | $t_{fix}$ + 100 | $t_{fix}$ + 115 |
| Thickness of the fixture | Type L (DH)/P | $t_{fix,min}$ [mm] | 0 | 0 | 0 | 0 | 0 |
| | Type C | $t_{fix,min}$ [mm] | 5 | 6 | 7 | 8 | - |
| | Type L (DH)/P/C | $t_{fix,max}$ [mm] | 200 | 250 | 300 | 350 | 400 |
| Nominal diameter of the head of the countersunk screw Type C | | $d_{sk}$ [mm] | 17 | 21 | 26 | 31 | - |

| | |
|---|---|
| **Safety Plus II** | |
| **Intended use** Dimensions of the anchors | **Annex B2** |
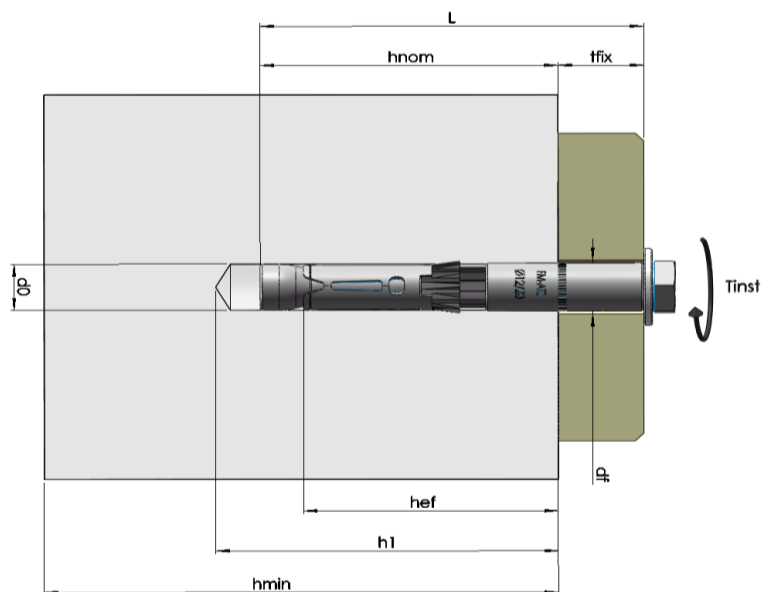
Table B2: Installation data

| Anchor size | | M6 | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| Nominal drill hole diameter | $d_0$ [mm] | 10 | 12 | 15 | 18 | 24 |
| Cutting diameter of drill bit | $d_{cut} \leq$ [mm] | 10,45 | 12,50 | 15,50 | 18,50 | 24,55 |
| Depth of drill hole | $h_1 \geq$ [mm] | 75 | 85 | 95 | 115 | 130 |
| Minimum installation depth | $h_{nom} \geq$ [mm] | 60 | 70 | 80 | 100 | 115 |
| Effective anchorage depth | $h_{ef}$ [mm] | 49 | 59 | 67 | 88 | 99 |
| Diameter of clearance hole in the fixture | $d_f \leq$ [mm] | 12 | 14 | 17 | 20 | 26 |
| Length of the anchor | L [mm] | $t_{fix}$ + 60 | $t_{fix}$ + 70 | $t_{fix}$ + 80 | $t_{fix}$ + 100 | $t_{fix}$ + 115 |
| Torque moment | $T_{inst}$ [Nm] | 10 | 20 | 45 | 80 | 150 |

Table B3: Minimum thickness of concrete member spacing, and edge distances

| Anchor size | | M6 | M8 | M10 | M12 | M16 |
|---|---|---|---|---|---|---|
| Minimum thickness of the concrete member | $h_{min}$ [mm] | 100 | 120 | 140 | 180 | 200 |
| Minimum spacing | $s_{min}$ [mm] | 50 | 60 | 70 | 80 | 100 |
| | for c [mm] $\geq$ | 75 | 90 | 100 | 150 | 200 |
| Minimum edge distance | $c_{min}$ [mm] | 50 | 60 | 70 | 80 | 100 |
| | for s $\geq$ [mm] | 75 | 90 | 100 | 150 | 200 |

| **Safety Plus II** | |
|---|---|
| **Intended use** <br> Installation parameters | **Annex B3** |

Table C1: **Characteristic values for Tension loads in case of static and quasi-static loading for design method A acc. ETAG 001, Annex C or CEN/TS1992-4**

| Essential characteristics | | | Performance | | | | |
|---|---|---|---|---|---|---|---|
| | | | M6 | M8 | M10 | M12 | M16 |
| **Installation parameters** | | | | | | | |
| $d_0$ | Nominal diameter of drill bit | [mm] | 10 | 12 | 15 | 18 | 24 |
| $h_{nom}$ | Anchorage depth | [mm] | 60 | 70 | 80 | 100 | 115 |
| $h_{ef}$ | Effective anchorage depth | [mm] | 49 | 59 | 67 | 88 | 99 |
| $h_{min}$ | Minimum thickness of concrete member | [mm] | 100 | 120 | 140 | 180 | 200 |
| $T_{inst}$ | Torque moment | [Nm] | 10 | 20 | 45 | 80 | 150 |
| $s_{min}$ | Minimum spacing | [mm] | 50 | 60 | 70 | 80 | 100 |
| for c ≥ | Edge distance | [mm] | 75 | 90 | 100 | 150 | 200 |
| $c_{min}$ | Minimum edge distance | [mm] | 50 | 60 | 70 | 80 | 100 |
| for s ≥ | Spacing | [mm] | 75 | 90 | 100 | 150 | 200 |
| **Tension steel failure mode** | | | | | | | |
| $N_{Rk,s}$ | Characteristic tension steel failure | [kN] | 16 | 29 | 46 | 67 | 126 |
| $\gamma_{MsN}$ | Partial safety factor | [-] | | | 1,5 | | |
| **Pull-out failure mode** | | | | | | | |
| $N_{Rk,p}$ | Characteristic pull-out failure in non-cracked concrete | [kN] | [1] | [1] | [1] | [1] | [1] |
| $N_{Rk,p}$ | Characteristic pull-out failure in cracked concrete | [kN] | 9 | 12 | 16 | 25 | [1] |
| $\gamma_2$ | Partial safety factor | [-] | | | 1,0 | | |
| $\gamma_{Mp}$ | | [-] | | | 1,5 | | |
| $s_{cr,N}$ | Characteristic spacing | [mm] | | | 3 x $h_{ef}$ | | |
| $c_{cr,N}$ | Characteristic edge distance | [mm] | | | 1,5 x $h_{ef}$ | | |
| $\psi_C$ **C30/37** | | [-] | | | 1,22 | | |
| $\psi_C$ **C40/50** | Increasing factor for $N_{Rk,p}$ in non-cracked concrete | [-] | | | 1,41 | | |
| $\psi_C$ **C50/60** | | [-] | | | 1,55 | | |
| **Concrete Cone failure mode** | | | | | | | |
| $k_{cr}$ | Factor for cracked concrete CEN/TS 1992-4-4 §. 6.2.1.4 | [-] | | | 7,2 | | |
| $k_{ucr}$ | Factor for un-cracked concrete CEN/TS 1992-4-4 §. 6.2.1.4 | [-] | | | 10,1 | | |
| $\gamma_{Mc}$ | Partial safety factor | [-] | | | 1,5 | | |
| **Splitting failure mode** | | | | | | | |
| $s_{cr,sp}$ | Characteristic spacing | [mm] | | | 3 x $h_{ef}$ | | |
| $c_{cr,sp}$ | Characteristic edge distance | [mm] | | | 1,5 x $h_{ef}$ | | |
| $\gamma_{Msp}$ | Partial safety factor | [-] | | | 1,5 | | |
| **Displacement under tension load** | | | | | | | |
| Non-cracked concrete C20/25 | | | | | | | |
| N | Service tension load | [kN] | 7,7 | 10,9 | 13,2 | 19,8 | 23,6 |
| $\delta_{N0}$ | Short term displacement | [mm] | 0,47 | 0,81 | 0,30 | 0,25 | 0,20 |
| $\delta_{N\infty}$ | Long term displacement | [mm] | 2,38 | 2,49 | 1,99 | 1,12 | 2,15 |
| Cracked concrete C20/25 | | | | | | | |
| N | Service tension load | [kN] | 4,3 | 5,7 | 7,6 | 11,9 | 16,9 |
| $\delta_{N0}$ | Short term displacement | [mm] | 1,21 | 0,83 | 1,25 | 0,98 | 0,96 |
| $\delta_{N\infty}$ | Long term displacement | [mm] | 2,38 | 2,49 | 1,99 | 1,12 | 2,15 |

[1] Pull-out failure is not decisive

| **Safety Plus II** | **Annex C1** |
|---|---|
| **Design acc. to ETAG 001-Annex C or CEN/TS 1992-4** Characteristic resistance under Tension loads – BWR 1 | |

Table C2: **Characteristic values for Shear loads in case of static and quasi-static loading for design method A acc. ETAG 001-Annex C or CEN/TS 1992-4**

| Essential characteristics | | | Performance | | | | |
|---|---|---|---|---|---|---|---|
| | | | M6 | M8 | M10 | M12 | M16 |
| **Shear steel failure** | | | | | | | |
| $V_{Rk,s}$ | Characteristic shear steel failure | [kN] | 14 | 26 | 42 | 50 | 97 |
| $M^0_{Rk,s}$ | Bending moment characteristic failure | [Nm] | 12 | 30 | 60 | 105 | 266 |
| $\gamma_{MsV}$ | Partial safety factor | [-] | 1,25 | | | | |
| **Shear concrete pry-out and edge failure** | | | | | | | |
| k | Factor in equation (5.6) of ETAG 001 Annex C § 5.2.3.3 | [mm] | 1,0 | | 2,0 | | |
| $K_3$ | Factor in equation (16) of CEN/TS 1992-4 § 6.2.2.3 | [mm] | 1,0 | | 2,0 | | |
| $l_{ef}$ | Effective anchorage depth | [mm] | 49 | 59 | 67 | 88 | 99 |
| $d_{nom}$ | Diameter of anchor | [mm] | 10 | 12 | 15 | 18 | 24 |
| $\gamma_{Mc}$ | Partial safety factor | [-] | 1,5 | | | | |
| **Displacement under shear load** | | | | | | | |
| V | Service shear load | [kN] | 8,0 | 14,9 | 24,0 | 28,6 | 55,4 |
| $\delta_{V0}$ | Short term displacement | [mm] | 1,39 | 1,94 | 2,71 | 1,69 | 2,69 |
| $\delta_{V\infty}$ | Long term displacement | [mm] | 2,09 | 2,91 | 4,07 | 2,54 | 4,04 |

| **Safety Plus II** | |
|---|---|
| **Design acc. to ETAG 001-Annex C or CEN/TS 1992-4** Characteristic resistance under Shear loads – BWR 1 | **Annex C2** |

Table C3: **Characteristic values for resistance in case of Seismic performance category C1 acc. TR045 "Design of Metal anchor under Seismic Actions"**

| Essential characteristics | | | Performance | | | | |
|---|---|---|---|---|---|---|---|
| | | | M6 | M8 | M10 | M12 | M16 |
| **Tension steel failure** | | | | | | | |
| $N_{Rk,s,seis\ C1}$ | Characteristic tension steel failure | [kN] | 16 | 29 | 46 | 67 | 126 |
| $\gamma_{MsN,seis}$ [2] | Partial safety factor | [-] | | | 1,5 | | |
| **Pull-out failure mode** $\quad N_{Rk,p,seis} = \psi_C \times N^0_{Rk,p,seis}$ | | | | | | | |
| $N_{Rk,p,seis\ C1}$ | Characteristic pull-out failure | [kN] | 6,8 | 12 | 16 | 25 | 35,5[1] |
| $\gamma_{Mp,seis}$ [2] | Partial safety factor | [-] | | | 1,5 | | |
| **Shear steel failure** | | | | | | | |
| $V_{Rk,s,seisC1}$ | Characteristic steel failure | [kN] | 9,8 | 13 | 20 | 20 | 48,5 |
| $\gamma_{MsV,seis}$ [2] | Partial safety factor | [-] | | | 1,25 | | |

[1] Pull-out failure is not decisive
[2] Recommended partial safety factors under seismic action ($\gamma_{M,seis}$) are the same as for static loading

| | |
|---|---|
| **Safety Plus II** | |
| **Design according to TR 045** <br> Characteristic resistance under Seismic actions – BWR 1 | **Annex C3** |

Table C4: **Characteristic values for resistance in case of Seismic performance category C2 acc. TR045 "Design of Metal anchor under Seismic Actions"**

| Essential characteristics | | | Performance | | | | |
|---|---|---|---|---|---|---|---|
| | | | M6 | M8 | M10 | M12 | M16 |
| **Tension steel failure** | | | | | | | |
| $N_{Rk,s,seis\ C2}$[2] | Characteristic tension steel failure | [kN] | - | 29 | 46 | 67 | 126 |
| $\gamma_{MsN}$[3] | Partial safety factor | [-] | | | 1,5 | | |
| **Pull-out failure** $\quad N_{Rk,p,seis} = \psi_C \times N^0_{Rk,seis}$ | | | | | | | |
| $N_{Rk,s,seis\ C2}$[2] | Characteristic pull-out failure | [kN] | - | 3,9 | 7,8 | 15,3 | 28,8 |
| $\gamma_{MpN}$[3] | Partial safety factor | [-] | | | 1,5 | | |
| $\delta_{N,sei(DSL)}$[1][2] | Displacement at DSL | [mm] | - | 2,7 | 4,9 | 3,6 | 3,1 |
| $\delta_{N,sei(USL)}$[1][2] | Displacement at USL | [mm] | - | 12,8 | 15,2 | 14,0 | 11,5 |
| **Shear steel failure** | | | | | | | |
| $V_{Rk,s,seis\ C2}$[2] | Characteristic failure | [kN] | - | 10,2 | 17,0 | 17,0 | 43,9 |
| $\gamma_{MsV}$[3] | Partial safety factor | [-] | | | 1,25 | | |
| $\delta_{V,sei(DSL)}$[1][2] | Displacement at DSL | [mm] | - | 3,5 | 2,7 | 2,5 | 2,7 |
| $\delta_{V,sei(USL)}$[1][2] | Displacement at USL | [mm] | - | 6,8 | 6,3 | 5,8 | 6,1 |

[1] Displacements represent mean values

[2] Smaller displacement may be required in the design in the case of displacement sensitive fastenings or "rigid" supports. The characteristic resistance associated with such smaller displacement may be determined by linear interpolation or proportional reduction.

[3] Recommended partial safety factors under seismic action ($\gamma_{M,seis}$) are the same as for static loading

| **Safety Plus II** | **Annex C4** |
|---|---|
| **Design according to TR 045** <br> Characteristic resistance under Seismic actions - BWR 1 | |

Table C5: **Characteristic resistance under Fire exposure for design design acc. to TR020**

| Essential characteristics | | | Performance | | | | |
|---|---|---|---|---|---|---|---|
| | | | M6 | M8 | M10 | M12 | M16 |
| **Tension steel failure mode** | | | | | | | |
| $N_{Rk,s,fi,30}$ | Duration = 30 minutes | [kN] | 0,20 | 0,37 | 0,87 | 1,69 | 3,14 |
| $N_{Rk,s,fi,60}$ | Duration = 60 minutes | [kN] | 0,18 | 0,33 | 0,75 | 1,26 | 2,36 |
| $N_{Rk,s,fi,90}$ | Duration = 90 minutes | [kN] | 0,14 | 0,26 | 0,58 | 1,10 | 2,04 |
| $N_{Rk,s,fi,120}$ | Duration = 120 minutes | [kN] | 0,10 | 0,18 | 0,46 | 0,84 | 1,57 |
| **Pull-out failure mode** | | | | | | | |
| $N_{Rk,p,fi,30}$ | Duration = 30 minutes | [kN] | 2,25 | 3,00 | 4,00 | 6,25 | 8,88 |
| $N_{Rk,p,fi,60}$ | Duration = 60 minutes | [kN] | 2,25 | 3,00 | 4,00 | 6,25 | 8,88 |
| $N_{Rk,p,fi,90}$ | Duration = 90 minutes | [kN] | 2,25 | 3,00 | 4,00 | 6,25 | 8,88 |
| $N_{Rk,p,fi,120}$ | Duration = 120 minutes | [kN] | 1,80 | 2,40 | 3,20 | 5,00 | 7,10 |
| **Concrete cone failure mode** | | | | | | | |
| $N_{Rk,c,fi,30}$ | Duration = 30 minutes | [kN] | 3,03 | 4,81 | 6,61 | 13,08 | 17,55 |
| $N_{Rk,c,fi,60}$ | Duration = 60 minutes | [kN] | 3,03 | 4,81 | 6,61 | 13,08 | 17,55 |
| $N_{Rk,c,fi,90}$ | Duration = 90 minutes | [kN] | 3,03 | 4,81 | 6,61 | 13,08 | 17,55 |
| $N_{Rk,c,fi,120}$ | Duration = 120 minutes | [kN] | 2,42 | 3,85 | 5,29 | 10,46 | 14,04 |
| $s_{cr,N}$ | Characteristic spacing | [mm] | 4 x $h_{ef}$ | | | | |
| $c_{cr,N}$ | Characteristic edge distance | [mm] | 2 x $h_{ef}$ | | | | |
| $s_{min}$ | Minimum spacing | [mm] | 50 | 60 | 70 | 80 | 100 |
| $c_{min}$ | Minimum edge distance | [mm] | $c_{min} = 2\ h_{ef}$; if fire attack from more than one side, the edge distance of the anchor has to be $\geq$ 300mm and $\geq 2\ h_{ef}$ | | | | |
| $\gamma_{M,fi}$ | Partial safety factor | [-] | 1,0[1] | | | | |
| **Shear steel failure without lever arm** | | | | | | | |
| $V_{Rk,s,fi,30}$ | Duration = 30 minutes | [kN] | 0,20 | 0,37 | 0,87 | 1,69 | 3,14 |
| $V_{Rk,s,fi,60}$ | Duration = 60 minutes | [kN] | 0,18 | 0,33 | 0,75 | 1,26 | 2,36 |
| $V_{Rk,s,fi,90}$ | Duration = 90 minutes | [kN] | 0,14 | 0,26 | 0,58 | 1,10 | 2,04 |
| $V_{Rk,s,fi,120}$ | Duration = 120 minutes | [kN] | 0,10 | 0,18 | 0,46 | 0,84 | 1,57 |
| **Shear steel failure with lever arm** | | | | | | | |
| $M^0_{Rk,s,fi,30}$ | Duration = 30 minutes | [Nm] | 0,15 | 0,37 | 1,12 | 2,62 | 6,66 |
| $M^0_{Rk,s,fi,60}$ | Duration = 60 minutes | [Nm] | 0,14 | 0,34 | 0,97 | 1,96 | 5,00 |
| $M^0_{Rk,s,fi,90}$ | Duration = 90 minutes | [Nm] | 0,11 | 0,26 | 0,75 | 1,70 | 4,33 |
| $M^0_{Rk,s,fi,120}$ | Duration = 120 minutes | [Nm] | 0,08 | 0,19 | 0,60 | 1,31 | 3,33 |
| **Shear concrete pry-out failure** | | | | | | | |
| k | Factor in equation (5.6) of ETAG Annex C § 5.2.3.3 | [mm] | 1,0 | | 2,0 | | |
| **Shear concrete edge failure** | | | | | | | |

The characteristic resistance $V^0_{Rk,c,fi}$ in C 20/25 to C5 0/60 concrete is determined by:
$V^0_{Rk,c,fi} = 0,25 \times V^0_{Rk,c}$ ($\leq$ R90) and $V^0_{Rk,c,fi} = 0,20 \times V^0_{Rk,c}$ (R120)
with $V^0_{Rk,c}$ initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature acc. ETAG 001, Annex C, 5.2.3.4.

[1] In the absence of other national regulations

| **Safety Plus II** | |
|---|---|
| **Design according to TR020** <br> Characteristic resistance under Fire exposure - BWR 2 | **Annex C5** |