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## European Technical Assessment

**ETA-15/0145**  
of 24. 3. 2016

English version prepared by ZAG

### GENERAL PART

**Technical Assessment Body issuing the ETA***Organ za tehnično ocenjevanje, ki je izdal ETA***Trade name of the construction product***Komercialno ime gradbenega proizvoda***Product family to which the construction product belongs***Družina proizvoda***Manufacturer***Proizvajalec***Manufacturing plant***Proizvodni obrat***This European Technical Assessment contains***Ta Evropska tehnična ocena vsebuje***This European Technical Assessment is issued in accordance with regulation (EU) No 305/2011, on the basis of***Ta Evropska tehnična ocena je izdana na podlagi Uredbe (EU) št. 305/2011 na osnovi***This ETA replaces***Ta ETA zamenjuje*

ZAG Ljubljana

MTP-ssA4

**33: Torque controlled expansion anchor made of stainless steel of sizes M8, M12, M12 and M16 for use in concrete***33: Torzijsko kontrolirano zatezno nerjaveče kovinsko sidro velikosti M8, M10, M12 in M16 za vgradnjo v beton***Técnicas Expansivas S.L.****P.I.La Portalanda II****c/Segador 13****26006 Logroño****SPAIN**

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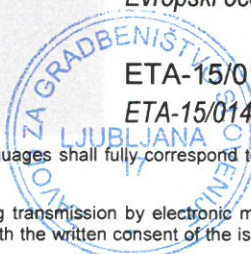
**Index plant 8***Index obrat 8***12 pages including 9 Annexes which form an integral part of this assessment***12 strani vključno z 9 prilogami, ki so sestavni del te tehnične ocene***ETAG 001 – Part 1 and 2, edition 2013, used as European Assessment Document (EAD)***ETAG 001 – 1. in 2. del, izdaja 2013, ki se uporablja kot Evropski ocenitveni dokument (EAD)*

ETA-15/0145, issued on 24.03.2015

ETA-15/0145, izdan dne 24.03.2015

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## **SPECIFIC PART OF THE EUROPEAN TECHNICAL ASSESSMENT**

### **1 Technical description of the product**

The MTP-ssA4 in the range of M8, M10, M12 and M16 is an anchor made of stainless steel, which is placed into a drilled hole and anchored by torque-controlled expansion.

For the installed anchor see Figure given in Annex A1.

### **2 Specification and 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**

According to the decision 96/582/EC of the European Commission<sup>1</sup> the system of assessment and verification of constancy of performance (AVCP) **1** apply.

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

Technical details necessary for the implementation of the AVCP system are laid down in the Control Plan deposited at ZAG Ljubljana.

Issued in Ljubljana on 24. 3. 2016

Signed by:

Franc Capuder, M.Sc., Research Engineer

*Head of Service of TAB*



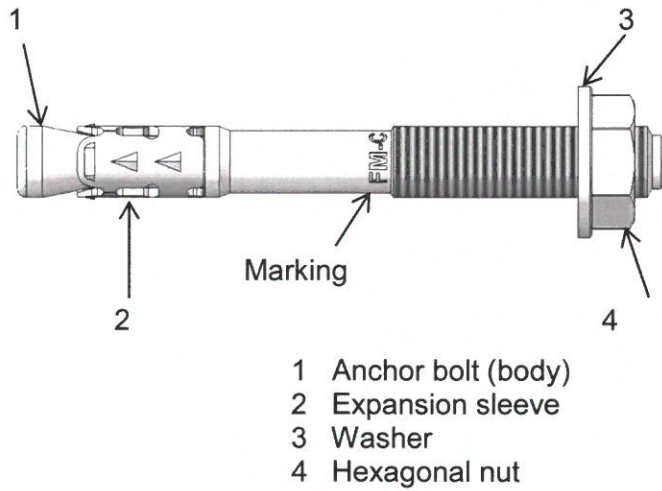


Figure A1: anchor

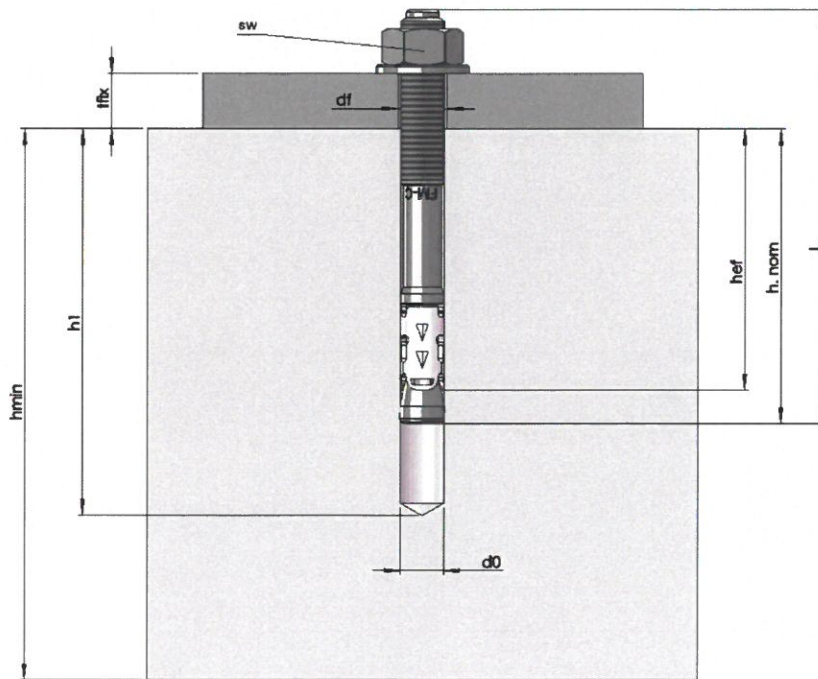



Figure A2: Installed MTP-ssA4 anchor

|   |  |
|---|--|
| <p><b>MTP-ssA4</b></p>  | <p><b>Annex A1</b></p>  |
| <p><b>Product description</b><br/>                 Product and intended use</p> |  |

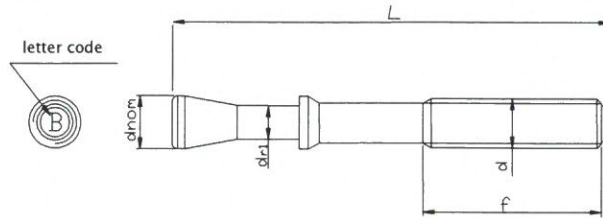


Table A1: Dimensions

|     | dxL     | Marking        | Letter code ID | L (mm) | d <sub>nom</sub> (mm) | d <sub>r1</sub> (mm) | f (mm) |
|-----|---------|----------------|----------------|--------|-----------------------|----------------------|--------|
| M8  | M8x68   | FM-C 8/4 A4    | A              | 68     | 8                     | 5,8                  | 30     |
|     | M8x75   | FM-C 8/10 A4   | B              | 75     |                       |                      | 30     |
|     | M8x90   | FM-C 8/25 A4   | C              | 90     |                       |                      | 40     |
|     | M8x115  | FM-C 8/50 A4   | D              | 115    |                       |                      | 60     |
|     | M8x135  | FM-C 8/70 A4   | E              | 135    |                       |                      | 80     |
|     | M8x165  | FM-C 8/100 A4  | G              | 165    |                       |                      | 80     |
| M10 | M10x90  | FM-C 10/10 A4  | A              | 90     | 10                    | 7,4                  | 40     |
|     | M10x105 | FM-C 10/25 A4  | B              | 105    |                       |                      | 55     |
|     | M10x115 | FM-C 10/35 A4  | C              | 115    |                       |                      | 55     |
|     | M10x135 | FM-C 10/55 A4  | D              | 135    |                       |                      | 85     |
|     | M10x155 | FM-C 10/75 A4  | E              | 155    |                       |                      | 85     |
|     | M10x185 | FM-C 10/105 A4 | F              | 185    |                       |                      | 85     |
| M12 | M12x110 | FM-C 12/10 A4  | A              | 110    | 12                    | 8,8                  | 65     |
|     | M12x120 | FM-C 12/20 A4  | B              | 120    |                       |                      | 65     |
|     | M12x130 | FM-C 12/30 A4  | P              | 130    |                       |                      | 65     |
|     | M12x145 | FM-C 12/45 A4  | C              | 145    |                       |                      | 85     |
|     | M12x170 | FM-C 12/70 A4  | D              | 170    |                       |                      | 85     |
|     | M12x200 | FM-C 12/100 A4 | E              | 200    |                       |                      | 85     |
| M16 | M16x130 | FM-C 16/10 A4  | A              | 130    | 16                    | 11,8                 | 65     |
|     | M16x150 | FM-C 16/30 A4  | B              | 150    |                       |                      | 85     |
|     | M16x185 | FM-C 16/60 A4  | C              | 185    |                       |                      | 85     |
|     | M16x220 | FM-C 16/100 A4 | D              | 220    |                       |                      | 85     |

Table A2: Materials

| Part | Component          | Material  | Coating |
|------|--------------------|---|---------|
| 1    | Anchor body (bolt) | Stainless steel X2CrNiMo17-12-2 acc. to EN 10088-3 (wr. 1.4404)                                   |         |
| 2    | Expansion sleeve   | Stainless steel X2CrNiMo17-12-2 acc. to EN 10088-2 (wr. 1.4404);                                  | *       |
| 3    | Washer             | DIN 125/1 A4 (normal), DIN 9021 A4 (large)<br>Stainless steel AISI 316 similar acc. to EN 10088-2 |         |
| 4    | Hexagonal nut      | DIN 934 A4-80<br>Stainless Steel AISI 316 similar acc. to ISO 3506-2                              | *       |

\*Functional coating

MTP-ssA4

Product description  
Product and materials

Annex A2





**Specifications of intended use**

**Anchorage 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):**

- The anchor may be used in concrete subject to dry internal conditions and also in concrete subject to external atmospheric exposure (including industrial and marine environment), or exposure in permanent damp internal conditions, if no particular aggressive conditions exist.

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

**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 1992-4-4.
- 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 an 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 that of the concrete to which the characteristic loads apply for.
- 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.


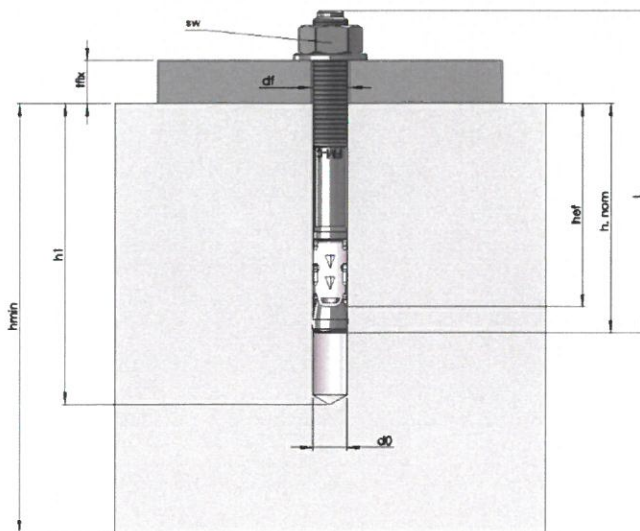
|                                      |  |
|--------------------------------------|--|
| <b>MTP-ssA4</b>                      | <b>Annex B1</b><br> |
| <b>Intended use</b><br>Specification |  |

Table B1: Installation data

|     | dxL     | ID | t <sub>fix</sub><br>[mm] | d <sub>0</sub><br>[mm] | h <sub>1</sub><br>[mm] | h <sub>nom</sub><br>[mm] | h <sub>ef</sub><br>[mm] | d <sub>f</sub><br>[mm] | h <sub>min</sub><br>[mm] | T <sub>inst</sub><br>[Nm] | sw<br>[mm] | Marking        |
|-----|---------|----|--------------------------|------------------------|------------------------|--------------------------|-------------------------|------------------------|--------------------------|---------------------------|------------|----------------|
| M8  | M8x68   | A  | 4                        | 8                      | 70                     | 54                       | 48                      | 9                      | 100                      | 20                        | 13         | FM-C 8/4 A4    |
|     | M8x75   | B  | 10                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 8/10 A4   |
|     | M8x90   | C  | 25                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 8/25 A4   |
|     | M8x115  | D  | 50                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 8/50 A4   |
|     | M8x135  | E  | 70                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 8/70 A4   |
|     | M8x165  | G  | 100                      |                        |                        |                          |                         |                        |                          |                           |            | FM-C 8/100 A4  |
| M10 | M10x90  | A  | 10                       | 10                     | 80                     | 67                       | 60                      | 12                     | 120                      | 40                        | 17         | FM-C 10/10 A4  |
|     | M10x105 | B  | 25                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 10/25 A4  |
|     | M10x115 | C  | 35                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 10/35 A4  |
|     | M10x135 | D  | 55                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 10/55 A4  |
|     | M10x155 | E  | 75                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 10/75 A4  |
|     | M10x185 | F  | 105                      |                        |                        |                          |                         |                        |                          |                           |            | FM-C 10/105 A4 |
| M12 | M12x110 | A  | 10                       | 12                     | 100                    | 81                       | 72                      | 14                     | 150                      | 60                        | 19         | FM-C 12/10 A4  |
|     | M12x120 | B  | 20                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 12/20 A4  |
|     | M12x130 | P  | 30                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 12/30 A4  |
|     | M12x145 | C  | 45                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 12/45 A4  |
|     | M12x170 | D  | 70                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 12/70 A4  |
|     | M12x200 | E  | 100                      |                        |                        |                          |                         |                        |                          |                           |            | FM-C 12/100 A4 |
| M16 | M16x130 | A  | 10                       | 16                     | 115                    | 97                       | 86                      | 18                     | 170                      | 120                       | 24         | FM-C 16/10 A4  |
|     | M16x150 | B  | 30                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 16/30 A4  |
|     | M16x185 | C  | 60                       |                        |                        |                          |                         |                        |                          |                           |            | FM-C 16/60 A4  |
|     | M16x220 | D  | 100                      |                        |                        |                          |                         |                        |                          |                           |            | FM-C 16/100 A4 |



MTP-ssA4

Intended use

Installation data

Annex B2





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/TS1992-4-4**

| Essential characteristics              |   |      | Performance    |     |     |      |
|--|---|------|----------------|-----|-----|------|
|  |   |      | M8             | M10 | M12 | M16  |
| <b>Installation parameters</b>         |   |      |                |     |     |      |
| $d_0$                                  | Nominal diameter of drill bit                             | [mm] | 8              | 10  | 12  | 16   |
| $h_{nom}$                              | Anchorage depth   | [mm] | 54             | 67  | 81  | 97   |
| $h_{ef}$                               | Effective anchorage depth                                 | [mm] | 48             | 60  | 72  | 86   |
| $h_{min}$                              | Minimum thickness of concrete member                      | [mm] | 100            | 120 | 150 | 170  |
| $T_{inst}$                             | Torque moment   | [Nm] | 20             | 40  | 60  | 120  |
| $s_{min}$                              | Minimum spacing   | [mm] | 50             | 55  | 60  | 70   |
| <b>for <math>c \geq</math></b>         | Edge distance   | [mm] | 50             | 70  | 80  | 100  |
| $c_{min}$                              | Minimum edge distance                                     | [mm] | 50             | 50  | 60  | 70   |
| <b>for <math>s \geq</math></b>         | Spacing   | [mm] | 50             | 110 | 120 | 130  |
| <b>Tension steel failure mode</b>      |   |      |                |     |     |      |
| $N_{Rk,s}$                             | Characteristic tension steel failure                      | [kN] | 21             | 34  | 49  | 88   |
| $\gamma_{MsN}$                         | Partial safety factor                                     | [-]  | 1,5            |     |     |      |
| <b>Pull-out failure mode</b>           |   |      |                |     |     |      |
| $N_{Rk,p}$                             | Characteristic pull-out failure in non-cracked concrete   | [kN] | 9              | 16  | 20  | 35   |
| $N_{Rk,p}$                             | Characteristic pull-out failure in cracked concrete       | [kN] | 5              | 9   | 12  | 25   |
| $\gamma_2$                             | 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                        | Increasing factor for $N_{Rk,p}$ in non-cracked concrete  | [-]  | 1,22           |     |     |      |
| $\psi_C$ C40/50                        |   | [-]  | 1,41           |     |     |      |
| $\psi_C$ C50/60                        |   | [-]  | 1,55           |     |     |      |
| <b>Concrete Cone failure mode</b>      |   |      |                |     |     |      |
| $k_{cr}$                               | 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            |     |     |      |
| <b>Splitting failure mode</b>          |   |      |                |     |     |      |
| $s_{cr,sp}$                            | 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            |     |     |      |
| <b>Displacement under tension load</b> |   |      |                |     |     |      |
| Non-cracked concrete C20/25            |   |      |                |     |     |      |
| $N$                                    | Service tension load                                      | [kN] | 4,3            | 7,6 | 9,5 | 16,7 |
| $\delta_{N0}$                          | Short term displacement                                   | [mm] | 0,3            | 0,4 | 0,4 | 0,3  |
| $\delta_{N\infty}$                     | Long term displacement                                    | [mm] | 1,4            | 1,5 | 0,9 | 1,4  |
| Cracked concrete C20/25                |   |      |                |     |     |      |
| $N$                                    | Service tension load                                      | [kN] | 2,4            | 4,3 | 5,7 | 11,9 |
| $\delta_{N0}$                          | Short term displacement                                   | [mm] | 0,7            | 0,6 | 0,7 | 0,7  |
| $\delta_{N\infty}$                     | Long term displacement                                    | [mm] | 1,4            | 1,5 | 0,9 | 1,4  |

<sup>1)</sup> The pull-out is not decisive

**MTP-ssA4**

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

**Annex C1**

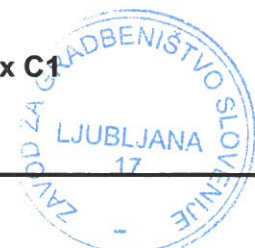




Table C2: **Characteristic values for Shear loads in case of static and quasi-static loading for design method A acc. ETAG 001-Annex C or CEN/TS 1992-4-4**

| Essential characteristics                      |  |      | Performance |      |      |      |
|--|--|------|-------------|------|------|------|
|  |  |      | M8          | M10  | M12  | M16  |
| <b>Shear steel failure</b>                     |  |      |             |      |      |      |
| $V_{Rk,s}$                                     | Characteristic shear steel failure                     | [kN] | 11,9        | 18,8 | 27,4 | 51,0 |
| $M^0_{Rk,s}$                                   | Bending moment characteristic failure                  | [Nm] | 24          | 49   | 85   | 216  |
| $\gamma_{MsV}$                                 | Partial safety factor                                  | [-]  | 1,3         |      |      |      |
| $K_2$  | Factor considering ductility                           | [-]  | 0,8         |      |      |      |
| <b>Shear concrete pry-out and edge failure</b> |  |      |             |      |      |      |
| $K$  | 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 1992-4-4 § 6.2.2.3   | [mm] | 1,0         | 2,0  |      |      |
| $l_{ef}$                                       | Effective anchorage depth                              | [mm] | 48          | 60   | 72   | 86   |
| $d_{nom}$                                      | Diameter of anchor                                     | [mm] | 8           | 10   | 12   | 16   |
| $\gamma_{Mc}$                                  | Partial safety factor                                  | [-]  | 1,5         |      |      |      |
| <b>Displacement under shear load</b>           |  |      |             |      |      |      |
| $V$  | Service shear load                                     | [kN] | 6,5         | 10,4 | 15,1 | 28,0 |
| $\delta_{V0}$                                  | Short term displacement                                | [mm] | 0,8         | 0,9  | 1,2  | 2,5  |
| $\delta_{V\infty}$                             | Long term displacement                                 | [mm] | 1,3         | 1,3  | 1,8  | 3,8  |

MTP-ssA4

Design acc. to ETAG 001-Annex C or CEN/TS 1992-4-4  
Characteristic resistance under Shear loads – BWR 1

Annex C2



**Table C3: Characteristic values for resistance in case of Seismic performance category C1 acc. TR 045 “Design of Metal anchor under Seismic Actions”**

| Essential characteristics  |  |      | Performance |      |      |      |
|--|--|------|-------------|------|------|------|
|  |  |      | M8          | M10  | M12  | M16  |
| <b>Tension steel failure</b>   |  |      |             |      |      |      |
| $N_{Rk,s,seis\ C1}$  | Characteristic tension steel failure               | [kN] | 21          | 34   | 49   | 88   |
| $\gamma_{MsN,seis}^{1)}$   | Partial safety factor                              | [-]  | 1,5         |      |      |      |
| <b>Pull-out failure mode</b> $N_{Rk,p,seis} = \psi_c \times N_{Rk,p,seis}^0$ |  |      |             |      |      |      |
| $N_{Rk,p,seis\ C1}$  | Characteristic pull-out failure in concrete C20/25 | [kN] | 4,1         | 9,0  | 12,0 | 25,0 |
| $\gamma_{Mp,seis}^{1)}$  | Partial safety factor                              | [-]  | 1,5         |      |      |      |
| <b>Shear steel failure</b>   |  |      |             |      |      |      |
| $V_{Rk,s,seis\ C1}$  | Characteristic shear steel failure                 | [kN] | 8,0         | 12,3 | 15,8 | 36,6 |
| $\gamma_{MsV,seis}^{1)}$   | Partial safety factor                              | [-]  | 1,3         |      |      |      |

<sup>1)</sup> The recommended partial safety factors under seismic action ( $\gamma_{M,seis}$ ) are the same as for static loading

**MTP-ssA4**

**Design according to TR 045**  
Characteristic resistance under Seismic actions – BWR 1

**Annex C3**





Table C4: Characteristic values for resistance in case of Seismic performance category C2 acc. TR 045 "Design of Metal anchor under Seismic Actions"

| Essential characteristics   |  |      | Performance |      |      |      |
|---|--|------|-------------|------|------|------|
|   |  |      | M8          | M10  | M12  | M16  |
| <b>Tension steel failure</b>  |  |      |             |      |      |      |
| $N_{Rk,s,seis} C2^{2)}$   | Characteristic tension steel failure               | [kN] | 21          | 34   | 49   | 88   |
| $\gamma_{MsN}^{3)}$   | Partial safety factor                              | [-]  | 1,5         |      |      |      |
| <b>Pull-out failure</b> $N_{Rk,p,seis} = \psi_C \times N_{Rk,seis}$ |  |      |             |      |      |      |
| $N_{Rk,s,seis} C2^{2)}$   | Characteristic pull-out failure in concrete C20/25 | [kN] | -           | 2,4  | 8,8  | 21,9 |
| $\gamma_{MpN}^{3)}$   | Partial safety factor                              | [-]  | 1,5         |      |      |      |
| $\delta_{N,sei(DLS)}^{1)2)}$  | Displacement at DLS                                | [mm] | -           | 2,9  | 4,9  | 6,3  |
| $\delta_{N,sei(ULS)}^{1)2)}$  | Displacement at ULS                                | [mm] | -           | 15,8 | 15,7 | 21,0 |
| <b>Shear steel failure</b>  |  |      |             |      |      |      |
| $V_{Rk,s,seis} C2^{2)}$   | Characteristic shear failure                       | [kN] | -           | 12,3 | 15,8 | 36,6 |
| $\gamma_{MsV}^{3)}$   | Partial safety factor                              | [-]  | 1,3         |      |      |      |
| $\delta_{V,sei(DLS)}^{1)2)}$  | Displacement at DLS                                | [mm] | -           | 2,4  | 5,2  | 6,0  |
| $\delta_{V,sei(ULS)}^{1)2)}$  | Displacement at ULS                                | [mm] | -           | 4,1  | 9,7  | 10,7 |

<sup>1)</sup> The listed displacement represent mean values

<sup>2)</sup> A 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.

<sup>3)</sup> The recommended partial safety factors under seismic action ( $\gamma_{M,seis}$ ) are the same as for static loading

**MTP-ssA4**

**Design according to TR 045**

Characteristic resistance under Seismic actions - BWR 1



**Annex C4**

Table C5: Characteristic resistance under Fire exposure for design acc. to TR 020

| Essential characteristics   |  |      | Performance   |     |     |      |
|---|--|------|---|-----|-----|------|
|   |  |      | M8  | M10 | M12 | M16  |
| <b>Tension steel failure mode</b>   |  |      |   |     |     |      |
| FR <sub>k,s,fi,30</sub>   | Duration = 30 minutes                              | [kN] | 0,5   | 1,1 | 1,8 | 3,3  |
| FR <sub>k,s,fi,60</sub>   | Duration = 60 minutes                              | [kN] | 0,4   | 0,9 | 1,5 | 2,7  |
| FR <sub>k,s,fi,90</sub>   | Duration = 90 minutes                              | [kN] | 0,3   | 0,7 | 1,2 | 2,2  |
| FR <sub>k,s,fi,120</sub>  | Duration = 120 minutes                             | [kN] | 0,3   | 0,6 | 1,0 | 1,8  |
| <b>Pull-out failure mode</b>  |  |      |   |     |     |      |
| FR <sub>k,p,fi,30</sub>   | Duration = 30 minutes                              | [kN] | 1,3   | 2,3 | 3,0 | 6,3  |
| FR <sub>k,p,fi,60</sub>   | Duration = 60 minutes                              | [kN] | 1,3   | 2,3 | 3,0 | 6,3  |
| FR <sub>k,p,fi,90</sub>   | Duration = 90 minutes                              | [kN] | 1,3   | 2,3 | 3,0 | 6,3  |
| FR <sub>k,p,fi,120</sub>  | Duration = 120 minutes                             | [kN] | 1,0   | 1,8 | 2,4 | 5,0  |
| <b>Concrete cone failure mode</b>   |  |      |   |     |     |      |
| FR <sub>k,c,fi,30</sub>   | Duration = 30 minutes                              | [kN] | 2,9   | 5,0 | 7,9 | 12,3 |
| FR <sub>k,c,fi,60</sub>   | Duration = 60 minutes                              | [kN] | 2,9   | 5,0 | 7,9 | 12,3 |
| FR <sub>k,c,fi,90</sub>   | Duration = 90 minutes                              | [kN] | 2,9   | 5,0 | 7,9 | 12,3 |
| FR <sub>k,c,fi,120</sub>  | Duration = 120 minutes                             | [kN] | 2,3   | 4,0 | 6,3 | 9,9  |
| s <sub>cr,N</sub>   | Characteristic spacing                             | [mm] | 4 x h <sub>ef</sub>   |     |     |      |
| c <sub>cr,N</sub>   | Characteristic edge distance                       | [mm] | 2 x h <sub>ef</sub>   |     |     |      |
| s <sub>min</sub>  | Minimum spacing                                    | [mm] | 50  | 50  | 60  | 70   |
| c <sub>min</sub>  | Minimum edge distance                              | [mm] | c <sub>min</sub> = 2 h <sub>ef</sub><br>if fire attack from more than one side, the edge distance of the anchor has to be ≥ 300mm and ≥ 2 h <sub>ef</sub> |     |     |      |
| γ <sub>M,fi</sub>   | Partial safety factor                              | [-]  | 1,0 <sup>1)</sup>   |     |     |      |
| <b>Shear steel failure without lever arm</b>  |  |      |   |     |     |      |
| VR <sub>k,s,fi,30</sub>   | Duration = 30 minutes                              | [kN] | 0,7   | 1,5 | 2,5 | 4,7  |
| VR <sub>k,s,fi,60</sub>   | Duration = 60 minutes                              | [kN] | 0,6   | 1,2 | 2,1 | 3,9  |
| VR <sub>k,s,fi,90</sub>   | Duration = 90 minutes                              | [kN] | 0,4   | 0,9 | 1,7 | 3,1  |
| VR <sub>k,s,fi,120</sub>  | Duration = 120 minutes                             | [kN] | 0,4   | 0,8 | 1,4 | 2,5  |
| <b>Shear steel failure with lever arm</b>   |  |      |   |     |     |      |
| M <sup>0</sup> <sub>Rk,s,fi,30</sub>  | Duration = 30 minutes                              | [Nm] | 0,7   | 1,9 | 3,9 | 10,0 |
| M <sup>0</sup> <sub>Rk,s,fi,60</sub>  | Duration = 60 minutes                              | [Nm] | 0,6   | 1,5 | 3,3 | 8,3  |
| M <sup>0</sup> <sub>Rk,s,fi,90</sub>  | Duration = 90 minutes                              | [Nm] | 0,4   | 1,2 | 2,6 | 6,7  |
| M <sup>0</sup> <sub>Rk,s,fi,120</sub>   | Duration = 120 minutes                             | [Nm] | 0,4   | 1,0 | 2,1 | 5,3  |
| <b>Shear concrete pry-out failure</b>   |  |      |   |     |     |      |
| k   | Factor in equation (5.6) of ETAG Annex C § 5.2.3.3 | [mm] | 1,0   | 2,0 |     |      |
| <b>Shear concrete edge failure</b>  |  |      |   |     |     |      |
| The characteristic resistance V <sup>0</sup> <sub>Rk,c,fi</sub> in C 20/25 to C5 0/60 concrete is determined by:<br>V <sup>0</sup> <sub>Rk,c,fi</sub> = 0,25 × V <sup>0</sup> <sub>Rk,c</sub> (≤ R90) and V <sup>0</sup> <sub>Rk,c,fi</sub> = 0,20 × V <sup>0</sup> <sub>Rk,c</sub> (R120)<br>with V <sup>0</sup> <sub>Rk,c</sub> initial value of the characteristic resistance in cracked concrete C20/25 under normal temperature acc. ETAG 001, Annex C, 5.2.3.4. |  |      |   |     |     |      |

<sup>1)</sup> In absence of other national regulations

MTP-ssA4

Design according to TR 020  
Characteristic resistance under Fire exposure - BWR 2

Annex C5

