FRIULSIDER YOUR FIXING FACTORY

# Declaration of Performance

## DoP nr. kemep

Bonded anchor resin in cartridge

CE

1. Identification of the product: **KEM EP**

2. Identification code (art. 11.4), for the batch or serial number see packaging:

| Type of Cartridge | Format | Cod. |
|---|---|---|
| Side-by-side | 440-585-1400 ml | 93301000000 /01-02-03-04-05-06-07-08 (440ml)<br>93401000000 /01-02-03-04-05-06-07-08 (585ml) |

3. Intended use:

| Generic type | Bonded anchor for anchorage of **Threaded Rod** and **Rebar** as **ETA-20/1284** |
|---|---|
| Base Material | **Concrete** C20/25 to C50/60 acc. to EN 206:2013+A1:2016 |
| Use category | ▪ Installation in dry, wet concrete and flooded boreholes (not sea-water)<br>▪ Overhead installation<br>▪ Hammer drilling, compressed air drilling, hollow drill bit system or diamond drilling.<br>▪ Working life of 50 and 100 years |
| Material & Durability | ▪ Threaded rod in all categories of steel provided for dry and internal conditions<br>▪ Threaded rod Stainless Steel A2 cl. 50-70 acc. to EN ISO 3506-1:2009 for corrosion resistance class CRC II according to EN 1993-1-4:2006+A1:2015<br>▪ Threaded rod Stainless Steel A4 cl. 50-80 acc. to EN ISO 3506-1:2009 for corrosion resistance class CRC III according to EN 1993-1-4:2006+A1:2015<br>▪ High corrosion Resistant Steel HCR cl.50-80 acc. to EN ISO 3506-1:2009 for corrosion resistance class CRC V according to EN 1993-1-4:2006+A1:2015<br>▪ Rebar Class B and C as EN 1992-1-1:2004+AC:2010, Annex C |
| Loading | **Static, quasi-static and Seismic load** |
| Temperature Range | - 40°C to +40°C max long term temperature +24°C and max short term temperature +40°C<br>- 40°C to +72°C max long term temperature +50°C and max short term temperature +72°C |

| Generic type | Bonded anchor for anchorage of **Post-Installed Rebar Connection** as **ETA-21/0802** |
|---|---|
| Base material | Non-carbonated Concrete C12/15 to C50/60 acc. to EN206-1:2013+A1.2016 [max 0,4 % CL] |
| Use category | ▪ Installation in dry and wet concrete (not flooded boreholes)<br>▪ Overlapping joint for rebar connections of slabs and beams<br>▪ Overlapping joint at a foundation of a wall or column<br>▪ Anchoring of reinforcement of building components stressed primarily in compression<br>▪ End anchoring of slabs or beams designed as simply supported<br>▪ Anchoring of reinforcement to cover the line of acting tensile force<br>▪ Hammer drilling, compressed air drilling, hollow drill bit system or diamond drilling.<br>▪ Working life of 50 and 100 years |
| Material & Durability | ▪ Rebar Class B and C as EN 1992-1-1:2004+AC:2010, Annex C |
| Loading | **Static, quasi-static and Fire exposure as EN1992-1** |
| Temperature Range | -40°C to +80°C max long term temperature +50°C and max short term temperature +80°C |
| Fire Reaction | Class A1 |

4. Manufacturer (art. 11.5): **Friulsider** SpA via trieste,1 - 33048 San Giovanni al Natisone (UD) - Italy

5. Authorised representative (art. 12.2): Not Relevant

6. System of Assessment AVCP (annex V): **System 1**

| 7/8. Harmonised Specification & Notified Body: | Name of Body | System of Assessment | Reference | EAD / hEN Document |
|---|---|---|---|---|
| Technical Specification Document | DiBt [TAB] | 1 | ETA-20/1284 | **EAD 330499-01-0601** |
| Constancy of Performance & FPC | IFSW 2873 [NB] | 1 | 2873-CPR-M 527-22/10.2020 | **EAD 330499-01-0601** |
| Technical Specification Document | DiBt [TAB] | 1 | ETA-21/0802 | **EAD 330087-01-0601** |
| Constancy of Performance & FPC | IFSW 2873 [NB] | 1 | 2873-CPR-M 527-24 | **EAD 330087-01-0601** |

9. Declared Performance: **See Annexes**

10. The performance of the product identified in points 1 and 2 is in conformity with declared performance in point 9.
This declaration of performance is issued under the sole responsibility of Friulsider SpA.

Signed for and behalf of the manufacturer by:

| Function | Name | Signature | Place and date of issue |
|---|---|---|---|
| Technical Manager | Raffaele Palmieri | Raffaele Palmieri | San Giovanni al Natisone, 10-11-2022 |

***ANNEX I°***

**Declared Performances** acc. to **ETA-20/1284** & EAD 330499-01-0601 - **Design method** acc. to **EN 1992-4:2018** and Technical Report TR 055

| ESSENTIAL CHARACTERISTICS | | | | | PERFORMANCE - **THREADED RODS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation parameters | | | | **d** | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
| $d_0$ | Nominal diameter of drill bit | | | [mm] | 10 | 12 | 14 | 18 | 22 | 28 | 30 | 35 |
| **As** | Cross section area | | | [mm²] | 36,6 | 58 | 84,3 | 157 | 245 | 353 | 459 | 561 |
| $h_{ef}$ | Effective embedment depth | | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 80 | 90 | 96 | 108 | 120 |
| | | | $h_{ef,std}$ | [mm] | 80 | 90 | 110 | 125 | 170 | 210 | 240 | 270 |
| | | | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 320 | 400 | 480 | 540 | 600 |
| $h_{min}$ | Minimum thickness of the concrete member | | | [mm] | $h_{ef}$ + 30 ≥ 100mm | | | $h_{ef}$ + 2•$d_0$ | | | | |
| $T_{inst}$ | Torque moment (max) | | | [Nm] | 10 | 20 | 40[1] | 60 | 100 | 170 | 250 | 300 |
| $s_{min}$ | Minimum spacing | | | [mm] | 40 | 50 | 60 | 75 | 95 | 115 | 125 | 140 |
| $c_{min}$ | Minimum edge distance | | | [mm] | 35 | 40 | 45 | 50 | 60 | 65 | 75 | 80 |
| **TENSION Steel failure** | | | | | | | | | | | | |
| $N_{Rk,s}$ | Tension Steel characteristic failure | cl. 4.8 - 4.6 | | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| | | cl. 5.8 - 5.6 | | [kN] | 18 | 29 | 42 | 78 | 122 | 176 | 230 | 280 |
| | | cl. 8.8 | | [kN] | 29 | 46 | 67 | 125 | 196 | 282 | 368 | 449 |
| | | A4-70 (50) | | [kN] | 26 | 41 | 59 | 110 | 171 | 247 | (230) | (281) |
| $\gamma_{m,sN}$[2] | Partial safety factor | cl. 4.6-5.6 | | [-] | 2,0 | | | | | | | |
| | | cl. 4.8-5.8-8.8 | | [-] | 1,5 | | | | | | | |
| | | A4-70 (50) | | [-] | 1,87 | | | | | | (2,86) | |
| **Combined pull-out and concrete failure** | | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| $\tau_{Rk,ucr}$ $\tau_{Rk,ucr,100}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - dry, wet concrete and flooded bore hole | HD, CD[3] | 40°/24°C | [MPa] | **20** | **20** | **19** | **19** | **18** | **17** | **16** | **16** |
| | | | 72°/50°C | [MPa] | **15** | **15** | **15** | **14** | **13** | **13** | **12** | **12** |
| | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - dry and wet concrete | HDB[3] | 40°/24°C | [MPa] | **17** | **16** | **16** | **16** | **15** | **14** | **14** | **13** |
| | | | 72°/50°C | [MPa] | **14** | **14** | **14** | **13** | **13** | **12** | **12** | **11** |
| | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - flooded bore hole | HDB[3] | 40°/24°C | [MPa] | **16** | **16** | **16** | **15** | **15** | **14** | **14** | **13** |
| | | | 72°/50°C | [MPa] | **14** | **14** | **14** | **13** | **13** | **12** | **12** | **11** |
| $\tau_{Rk,ucr}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 years - dry, wet concrete and flooded bore hole | DD[3] | 40°/24°C | [MPa] | **15** | **14** | **14** | **13** | **12** | **12** | **11** | **11** |
| | | | 72°/50°C | [MPa] | **12** | **12** | **11** | **10** | **9,5** | **9,5** | **9,0** | **9,0** |
| $\tau_{Rk,ucr,100}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 100 years - dry, wet concrete and flooded bore hole | DD[3] | 40°/24°C | [MPa] | **15** | **14** | **14** | **13** | **12** | **12** | **11** | **11** |
| | | | 72°/50°C | [MPa] | **11** | **11** | **10** | **10** | **9,5** | **9,0** | **8,5** | **8,5** |
| $\tau_{Rk,cr}$ | Characteristic bond resistance in **cracked concrete** C20/25 for a working life of 50 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **7,0** | **7,0** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** |
| | | | 72°/50°C | [MPa] | **6,0** | **6,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** |
| $\tau_{Rk,cr,100}$ | Characteristic bond resistance in **cracked concrete** C20/25 for a working life of 100 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **6,5** | **6,5** | **7,5** | **7,5** | **7,5** | **7,5** | **7,5** | **7,5** |
| | | | 72°/50°C | [MPa] | **5,5** | **5,5** | **6,5** | **6,5** | **6,5** | **6,5** | **6,5** | **6,5** |
| $\tau_{Rk,eq,C1}$ | Characteristic bond resistance for **Seismic Category C1** for a working life of 50 and 100 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **7,0** | **7,0** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** |
| | | | 72°/50°C | [MPa] | **6,0** | **6,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** |
| $\tau_{Rk,eq,C2}$ | Characteristic bond resistance for **Seismic Category C2** for a working life of 50 and 100 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | - | - | **5,8** | **4,8** | **5,0** | **5,1** | - | - |
| | | | 72°/50°C | [MPa] | - | - | **5,0** | **4,1** | **4,3** | **4,4** | - | - |
| $\psi_c$ | Increasing factor for concrete | HD, CD, HDB[3] | C30/37 | [-] | 1,04 | | | | | | | |
| | | | C40/50 | [-] | 1,08 | | | | | | | |
| | | | C50/60 | [-] | 1,10 | | | | | | | |
| | | DD[3] | C30/37 | [-] | 1,08 | | | | | | | |
| | | | C40/50 | [-] | 1,15 | | | | | | | |
| | | | C50/60 | [-] | 1,19 | | | | | | | |
| | Increasing factor for concrete for **Seismic** action | C25/30 to C50/60 | | [-] | 1,00 | | | | | | | |
| $\psi^0_{sus}$ | Reduction factor for concrete C20/25 cracked and un-cracked | HD, CD, HDB[3] | 40°/24°C | [-] | 0,80 | | | | | | | |
| | | | 72°/50°C | [-] | 0,68 | | | | | | | |
| | | DD[3] | 40°/24°C | [-] | 0,77 | | | | | | | |
| | | | 72°/50°C | [-] | 0,72 | | | | | | | |

| **Concrete cone failure** | | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $k_{cr,N}$ | Factor acc. to EN 1992-4 § 7.2.1.4 cracked | | | [-] | 7,7 | | | | | | | |
| $k_{ucr,N}$ | Factor acc. to EN 1992-4 § 7.2.1.4 un-cracked | | | [-] | 11,0 | | | | | | | |
| $c_{cr,N}$ | Critical edge distance | | | [mm] | $1,5 \cdot h_{ef}$ | | | | | | | |
| $s_{cr,N}$ | Critical spacing | | | [mm] | $2,0 \cdot c_{cr,N}$ | | | | | | | |
| **Splitting failure** | | | | | | | | | | | | |
| $c_{cr,sp}$ | Critical edge distance for Splitting | | $h / h_{ef} \geq 2,0$ | [mm] | $1,0 \cdot h_{ef}$ | | | | | | | |
| | | | $2,0 > h / h_{ef} > 1,3$ | | $2,0 \cdot h_{ef} \cdot (2,5 - h / h_{ef})$ | | | | | | | |
| | | | $h / h_{ef} \leq 1,3$ | | $2,4 \cdot h_{ef}$ | | | | | | | |
| $s_{cr,sp}$ | Critical spacing for Splitting | | | [mm] | $2,0 \cdot C_{cr,sp}$ | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor for dry and wet concrete | HD, CD, HDB, DD[3] | | [-] | 1,0 | | | | | | | |
| | Installation safety factor for flooded bore hole | HD, CD, HDB[3] | | [-] | 1,0 | | | | | | | |
| | | DD[3] | | [-] | 1,2 | | | 1,4 | | | | |
| $\gamma_{inst}$ | Installation safety factor for **Seismic** category for dry and wet concrete | HD, CD, HDB[3] | | [-] | 1,0 | | | | | | | |
| | Installation safety factor for **Seismic** category for flooded bore hole | HD, CD, HDB[3] | | [-] | 1,2 | | | | | | | |

| **Displacement under Tension Load in Concrete** | | | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\delta_{N0}$ | Short term displacement **un-cracked concrete** | HD, CD, HDB[3] | working life of 50 and 100 years | 40°/24°C | $\left[\frac{mm}{MPa}\right]$ | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
| | | | | 72°/50°C | | 0,038 | 0,039 | 0,040 | 0,044 | 0,047 | 0,051 | 0,052 | 0,055 |
| | | DD[3] | working life of 50 years | 40°/24°C | | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
| | | | | 72°/50°C | | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
| | | | working life of 100 years | 40°/24°C | | 0,011 | 0,012 | 0,012 | 0,013 | 0,014 | 0,014 | 0,015 | 0,015 |
| | | | | 72°/50°C | | 0,013 | 0,014 | 0,014 | 0,015 | 0,016 | 0,016 | 0,018 | 0,018 |
| $\delta_{N\infty}$ | Long term displacement **un-cracked concrete** | HD, CD, HDB[3] | working life of 50 and 100 years | 40°/24°C | $\left[\frac{mm}{MPa}\right]$ | 0,028 | 0,029 | 0,030 | 0,033 | 0,035 | 0,038 | 0,039 | 0,041 |
| | | | | 72°/50°C | | 0,047 | 0,049 | 0,051 | 0,055 | 0,059 | 0,064 | 0,067 | 0,070 |
| | | DD[3] | working life of 50 years | 40°/24°C | | 0,018 | 0,019 | 0,019 | 0,020 | 0,022 | 0,023 | 0,024 | 0,025 |
| | | | | 72°/50°C | | 0,052 | 0,053 | 0,055 | 0,058 | 0,062 | 0,065 | 0,068 | 0,070 |
| | | | working life of 100 years | 40°/24°C | | 0,020 | 0,021 | 0,021 | 0,023 | 0,024 | 0,025 | 0,026 | 0,027 |
| | | | | 72°/50°C | | 0,038 | 0,039 | 0,040 | 0,043 | 0,045 | 0,047 | 0,049 | 0,051 |
| $\delta_{N0}$ | Short term displacement **cracked concrete** | HD, CD, HDB[3] | working life of 50 and 100 years | 40°/24°C | $\left[\frac{mm}{MPa}\right]$ | 0,069 | 0,071 | 0,072 | 0,074 | 0,076 | 0,079 | 0,081 | 0,082 |
| | | | | 72°/50°C | | 0,092 | 0,095 | 0,096 | 0,099 | 0,102 | 0,106 | 0,109 | 0,110 |
| $\delta_{N\infty}$ | Long term displacement **cracked concrete** | HD, CD, HDB[3] | working life of 50 and 100 years | 40°/24°C | $\left[\frac{mm}{MPa}\right]$ | 0,100 | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 |
| | | | | 72°/50°C | | 0,134 | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 |
| $\delta_{N,eq,C2(DLS)}$ | Displacement for **Seismic C2** at DLS | | | | [mm] | - | - | 0,21 | 0,24 | 0,27 | 0,36 | - | - |
| $\delta_{N,eq,C2(ULS)}$ | Displacement for **Seismic C2** at ULS | | | | | - | - | 0,54 | 0,51 | 0,54 | 0,63 | - | - |

[1] Maximum Torque moment with steel grade 4.6 is 35 Nm
[2] In absence of national regulation
[3] HD=hammer drilling, CD=compr. air drilling, HDB=hollow drilling, DD=diamond drilling.
[4] Calculation of the displacement = $\delta_N * \tau$

***ANNEX II°***

**Declared Performances** acc. to **ETA-20/1284** & EAD 330499-01-0601 - **Design method** acc. to **EN 1992-4:2018** and Technical Report TR 055

| ESSENTIAL CHARACTERISTICS | | | | PERFORMANCE - **THREADED RODS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SHEAR Steel failure** | | | | **M8** | **M10** | **M12** | **M16** | **M20** | **M24** | **M27** | **M30** |
| $V^0_{Rk,s}$ | Shear Steel characteristic failure | cl. 4.8 - 4.6 | [kN] | 9 | 14 | 20 | 38 | 59 | 85 | 110 | 135 |
| | | cl. 5.8 - 5.6 | [kN] | 11 | 17 | 25 | 47 | 74 | 106 | 138 | 168 |
| | | cl. 8.8 | [kN] | 15 | 23 | 34 | 63 | 98 | 141 | 184 | 224 |
| | | A4-70 (50) | [kN] | 13 | 20 | 30 | 55 | 86 | 124 | (115) | (140) |
| $V_{Rk,s,eq,C1}$ | Shear Steel characteristic failure **Seismic C1** | | [kN] | $0{,}70 \cdot V^0_{Rk,s}$ | | | | | | | |
| $V_{Rk,s,eq,C2}$ | Shear Steel characteristic failure **Seismic C2** | | [kN] | $0{,}70 \cdot V^0_{Rk,s}$ | | | | | | | |
| $\alpha_{gap}$ | Seismic factor for annular gap | | [-] | 0,5 (1,0)[1] | | | | | | | |
| $M^0_{Rk,s}$ | Characteristic Bending Moment | cl. 4.8 - 4.6 | [Nm] | 15 | 30 | 52 | 133 | 260 | 449 | 666 | 900 |
| | | cl. 5.8 - 5.6 | [Nm] | 19 | 37 | 65 | 166 | 324 | 560 | 833 | 1123 |
| | | cl. 8.8 | [Nm] | 30 | 60 | 105 | 266 | 519 | 896 | 1333 | 1797 |
| | | A4-70 (50) | [Nm] | 26 | 52 | 92 | 232 | 454 | 784 | (832) | (1125) |
| $\gamma_{m,sV}$ | Partial safety factor | cl. 4.6-5.6 | [-] | 1,67 | | | | | | | |
| | | cl. 4.8-5.8-8.8 | [-] | 1,25 | | | | | | | |
| | | A4-70 (50) | [-] | 1,56 | | | | | | (2,38) | |
| $k_7$ | Ductility factor acc. to EN 1992-4 § 7.2.2.3.1 | | [-] | 1,0 | | | | | | | |
| **Concrete pry-out failure** | | | | | | | | | | | |
| $k_8$ | Factor acc. to EN 1992-4 § 7.2.2.4 | | [-] | 2,0 | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor | | [-] | 1,0 | | | | | | | |
| **Concrete edge failure** | | | | | | | | | | | |
| $l_f$ | Effective length of anchor | | [-] | $l_f = \min(h_{ef};\ 12 \cdot d_{nom})$ | | | | | | $l_f = \min(h_{ef};300mm)$ | |
| $d_{nom}$ | Outside diameter of anchor | | [mm] | 8 | 10 | 12 | 16 | 20 | 24 | 27 | 30 |
| $\gamma_{inst}$ | Installation safety factor | | [-] | 1,0 | | | | | | | |
| **Displacement under Shear Load** | | | | M8 | M10 | M12 | M16 | M20 | M24 | M27 | M30 |
| $\delta_{V0}$ | Short term displacement in **Concrete** | | [mm/kN] | 0,06 | 0,06 | 0,05 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| $\delta_{V\infty}$ | Long term displacement in **Concrete** | | [mm/kN] | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,05 |
| $\delta_{V,eq,C2(DLS)}$ | Displacement for **Seismic C2** at DLS | | [mm] | - | - | 3,1 | 3,4 | 3,5 | 4,2 | - | - |
| $\delta_{V,eq,C2(ULS)}$ | Displacement for **Seismic C2** at ULS | | [mm] | - | - | 6,0 | 7,6 | 7,3 | 10,9 | - | - |

[1] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use a special filling washer as required in ETA-20/1284.

[2] Calculation of the displacement = $\delta_V * V$

***ANNEX III°***

**Declared Performances** acc. to **ETA-20/1284** & EAD 330499-01-0601 - **Design method** acc. to **EN 1992-4:2018** and Technical Report TR 055

| ESSENTIAL CHARACTERISTICS | | | | | PERFORMANCE - **REBAR** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation parameters | | | | **d** | **Ø8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
| $d_0$ | Nominal diameter of drill bit | | | [mm] | 10 \| 12 | 12 \| 14 | 14 \| 16 | 18 | 20 | 25 | 32 | 35 | 40 |
| $h_{ef}$ | Effective embedment depth | | $h_{ef,min}$ | [mm] | 60 | 60 | 70 | 75 | 80 | 90 | 100 | 112 | 128 |
| | | | $h_{ef,std}$ | [mm] | 80 | 90 | 110 | 115 | 125 | 170 | 210 | 250 | 280 |
| | | | $h_{ef,max}$ | [mm] | 160 | 200 | 240 | 280 | 320 | 400 | 500 | 560 | 640 |
| $h_{min}$ | Minimum thickness of the concrete member | | | [mm] | $h_{ef} + 30 \geq 100$ | | | $h_{ef} + 2d_0$ | | | | | |
| $s_{min}$ | Minimum spacing | | | [mm] | 40 | 50 | 60 | 70 | 75 | 95 | 120 | 130 | 150 |
| $c_{min}$ | Minimum edge distance | | | [mm] | 35 | 40 | 45 | 50 | 50 | 60 | 70 | 75 | 85 |
| **TENSION Steel failure** | | | | | | | | | | | | | |
| $N_{Rk,s}$ $N_{Rk,s,eq,C1}$ | Tension Steel characteristic failure for static, quasi static and seismic action | | | [kN] | $A_s \cdot f_{uk}$ [1] | | | | | | | | |
| $A_{,s}$ | Area resistant | | | [mm²] | 50 | 79 | 113 | 154 | 201 | 314 | 491 | 616 | 804 |
| $\gamma_{m,sN}$ | Partial safety factor | | | [-] | 1,4 [2] | | | | | | | | |
| **Combined pull-out and concrete cone failure** | | | | | Ø8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
| $\tau_{Rk,ucr}$ $\tau_{Rk,ucr,100}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - dry, wet concrete and flooded bore hole | HD, CD[3] | 40°/24°C | [MPa] | **16** | **16** | **16** | **16** | **16** | **16** | **15** | **15** | **15** |
| | | | 72°/50°C | [MPa] | **12** | **12** | **12** | **12** | **12** | **12** | **12** | **11** | **11** |
| | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - dry and wet concrete | HDB[3] | 40°/24°C | [MPa] | **14** | **14** | **13** | **13** | **13** | **13** | **13** | **13** | **13** |
| | | | 72°/50°C | [MPa] | **12** | **12** | **12** | **11** | **11** | **11** | **11** | **11** | **11** |
| | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 and 100 years - flooded bore hole | HDB[3] | 40°/24°C | [MPa] | **13** | **13** | **13** | **13** | **13** | **13** | **13** | **13** | **13** |
| | | | 72°/50°C | [MPa] | **11** | **11** | **11** | **11** | **11** | **11** | **11** | **11** | **11** |
| $\tau_{Rk,ucr}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 50 years - dry, wet concrete and flooded bore hole | DD[3] | 40°/24°C | [MPa] | **14** | **13** | **13** | **13** | **12** | **12** | **11** | **11** | **11** |
| | | | 72°/50°C | [MPa] | **11** | **11** | **10** | **10** | **10** | **9,5** | **9,5** | **9,0** | **9,0** |
| $\tau_{Rk,ucr,100}$ | Characteristic bond resistance in **un-cracked concrete** C20/25 for a working life of 100 years - dry, wet concrete and flooded bore hole | DD[3] | 40°/24°C | [MPa] | **14** | **13** | **13** | **13** | **12** | **12** | **11** | **11** | **11** |
| | | | 72°/50°C | [MPa] | **11** | **10** | **10** | **10** | **9,5** | **9,0** | **9,0** | **8,5** | **8,5** |
| $\tau_{Rk,cr}$ | Characteristic bond resistance in **cracked concrete** C20/25 for a working life of 50 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **7,0** | **7,0** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** |
| | | | 72°/50°C | [MPa] | **6,0** | **6,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** |
| $\tau_{Rk,cr,100}$ | Characteristic bond resistance in **cracked concrete** C20/25 for a working life of 100 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **6,5** | **6,5** | **7,5** | **7,5** | **7,5** | **7,5** | **7,5** | **7,5** | **7,5** |
| | | | 72°/50°C | [MPa] | **5,5** | **5,5** | **6,5** | **6,5** | **6,5** | **6,5** | **6,5** | **6,5** | **6,5** |
| $\tau_{Rk,eq,C1}$ | Characteristic bond resistance, **Seismic** category C1 for a working life of 50 and 100 years - dry, wet concrete and flooded bore hole | HD, CD, HDB[3] | 40°/24°C | [MPa] | **7,0** | **7,0** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** | **8,5** |
| | | | 72°/50°C | [MPa] | **6,0** | **6,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** | **7,0** |
| $\psi_c$ | Increasing factor for concrete | HD, CD, HDB[3] | C30/37 | [-] | 1,04 | | | | | | | | |
| | | | C40/50 | [-] | 1,08 | | | | | | | | |
| | | | C50/60 | [-] | 1,10 | | | | | | | | |
| | | DD[3] | C30/37 | [-] | 1,08 | | | | | | | | |
| | | | C40/50 | [-] | 1,15 | | | | | | | | |
| | | | C50/60 | [-] | 1,19 | | | | | | | | |
| | Increasing factor for concrete for **Seismic** action | C25/30 to C50/60 | | [-] | 1,00 | | | | | | | | |
| $\psi^0_{sus}$ | Reduction factor for concrete C20/25 cracked and un-cracked. | HD, CD, HDB[3] | 40°/24°C | [-] | 0,80 | | | | | | | | |
| | | | 72°/50°C | [-] | 0,68 | | | | | | | | |
| | | DD[3] | 40°/24°C | [-] | 0,77 | | | | | | | | |
| | | | 72°/50°C | [-] | 0,72 | | | | | | | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Concrete cone failure** | | | | | | | | | | |
| $k_{cr,N}$ | Factor acc. to EN 1992-4 § 7.2.1.4 cracked | [-] | 7,7 | | | | | | | |
| $k_{ucr,N}$ | Factor acc. to EN 1992-4 § 7.2.1.4 un-cracked | [-] | 11 | | | | | | | |
| $c_{cr,N}$ | Critical edge distance | [mm] | $1,5 \cdot h_{ef}$ | | | | | | | |
| $s_{cr,N}$ | Critical spacing | [mm] | $2,0 \cdot c_{cr,N}$ | | | | | | | |
| **Splitting failure** | | | Ø8 | Ø 10 | Ø 12 | Ø 14 | Ø 16 | Ø 20 | Ø 25 | Ø 28 | Ø 32 |
| $c_{cr,sp}$ | Critical edge distance for Splitting | $h / h_{ef} \geq 2,0$ | $1,0 \cdot h_{ef}$ | | | | | | | |
| | | $2,0 > h / h_{ef} > 1,3$ [mm] | $2,0 \cdot h_{ef} \cdot (2,5 - h / h_{ef})$ | | | | | | | |
| | | $h / h_{ef} \leq 1,3$ | $2,4 \cdot h_{ef}$ | | | | | | | |
| $s_{cr,sp}$ | Critical spacing for Splitting | [mm] | $2,0 \cdot C_{cr,sp}$ | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor for dry and wet concrete | HD, CD, HDB, DD[3] [-] | 1,0 | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor for flooded bore hole | HD, CD, HDB[3] [-] | 1,2 | | | | | | | |
| | | DD[3] [-] | 1,2 | | | | 1,4 | | | |
| $\gamma_{inst}$ | Installation safety factor for **Seismic** category for dry and wet concrete | HD, CD, HDB[3] | 1,0 | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor for **Seismic** category for flooded bore hole | HD, CD, HDB[3] | 1,2 | | | | | | | |
| **Displacement under Tension Load** | | | **Ø8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
| $\delta_{N0}$ | Short term displacement **un-cracked concrete** | HD, CD, HDB[3] working life of 50 and 100 years 40°/24°C | 0,028 | 0,029 | 0,030 | 0,031 | 0,033 | 0,035 | 0,038 | 0,040 | 0,043 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,038 | 0,039 | 0,040 | 0,042 | 0,044 | 0,047 | 0,051 | 0,054 | 0,058 |
| | | DD[3] working life of 50 years 40°/24°C | 0,008 | 0,009 | 0,009 | 0,010 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,009 | 0,011 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,018 |
| | | working life of 100 years 40°/24°C | 0,008 | 0,009 | 0,009 | 0,010 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,009 | 0,011 | 0,011 | 0,011 | 0,012 | 0,013 | 0,014 | 0,015 | 0,018 |
| $\delta_{N\infty}$ | Long term displacement **un-cracked concrete** | HD, CD, HDB[3] working life of 50 and 100 years 40°/24°C | 0,028 | 0,029 | 0,030 | 0,031 | 0,033 | 0,035 | 0,038 | 0,040 | 0,043 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,047 | 0,049 | 0,051 | 0,053 | 0,055 | 0,059 | 0,065 | 0,068 | 0,072 |
| | | DD[3] working life of 50 years 40°/24°C | 0,018 | 0,018 | 0,019 | 0,020 | 0,021 | 0,024 | 0,027 | 0,028 | 0,031 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,048 | 0,051 | 0,054 | 0,058 | 0,061 | 0,068 | 0,076 | 0,081 | 0,088 |
| | | working life of 100 years 40°/24°C | 0,018 | 0,020 | 0,021 | 0,022 | 0,024 | 0,026 | 0,029 | 0,031 | 0,034 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,035 | 0,037 | 0,040 | 0,042 | 0,045 | 0,049 | 0,055 | 0,059 | 0,064 |
| $\delta_{N0}$ | Short term displacement **cracked concrete** | HD, CD, HDB[3] working life of 50 years 40°/24°C | 0,069 | 0,071 | 0,072 | 0,073 | 0,074 | 0,076 | 0,079 | 0,081 | 0,084 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,092 | 0,095 | 0,096 | 0,098 | 0,099 | 0,102 | 0,106 | 0,109 | 0,113 |
| $\delta_{N\infty}$ | Long term displacement **cracked concrete** | HD, CD, HDB[3] working life of 100 years 40°/24°C | 0,115 | 0,122 | 0,128 | 0,135 | 0,142 | 0,155 | 0,171 | 0,181 | 0,194 |
| | | 72°/50°C $\left[\frac{mm}{MPa}\right]$ | 0,154 | 0,163 | 0,172 | 0,181 | 0,189 | 0,207 | 0,229 | 0,242 | 0,260 |

[1] $f_{uk}$ shall be taken from the specifications of reinforcing bars

[2] In absence of other national regulations.

[3] HD=hammer drilling, CD=compr. air drilling, HDB=hollow drilling, DD=diamond drilling.

[4] Calculation of the displacement = $\delta_N \times \tau$

## *ANNEX IV°*

**Declared Performances** acc. to **ETA-20/1284** & EAD 330499-01-0601 - **Design method** acc. to **EN 1992-4:2018** and Technical Report TR 055

| ESSENTIAL CHARACTERISTICS | | | PERFORMANCE - **REBAR** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **SHEAR Steel failure** | | | **Ø8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
| $V^0_{Rk,s}$ | Shear Steel characteristic failure | [kN] | $0,5 \cdot A_s \cdot f_{uk}$ [1] | | | | | | | | |
| $V_{Rk,s,eq,C1}$ | Shear Steel characteristic failure for **Seismic action** | | $0,35 \cdot A_s \cdot f_{uk}$ [1] | | | | | | | | |
| $M^0_{Rk,s}$ | Bending Moment characteristic failure | [Nm] | $1,2 \cdot W_{el} \cdot f_{uk}$ [1] | | | | | | | | |
| $W_{el}$ | Elastic section modulus | [mm³] | 50 | 98 | 170 | 269 | 402 | 785 | 1534 | 2155 | 3217 |
| $\gamma_{m,sV}$ | Partial safety factor | [-] | 1,5 [2] | | | | | | | | |
| $k_7$ | Ductility factor acc. to EN 1992-4 § 7.2.2.3.1 | [-] | 1,0 | | | | | | | | |
| $\alpha_{gap}$ | Seismic factor for annular gap | [-] | 0,5 (1,0)[3] | | | | | | | | |
| **Concrete Pryout failure** | | | | | | | | | | | |
| $k_8$ | Factor acc. to EN 1992-4 § 7.2.2.4 | [-] | 2,0 | | | | | | | | |
| $\gamma_{inst}$ | Installation safety factor | [-] | 1,0 | | | | | | | | |
| **Concrete Edge failure** | | | | | | | | | | | |
| $l_f$ | Effective length of anchor | [-] | min ($h_{ef}$; 12•$d_{nom}$) | | | | | | min ($h_{ef}$; 300mm) | | |
| $d_{nom}$ | Outside diameter of anchor | [mm] | 8 | 10 | 12 | 14 | 16 | 20 | 25 | 28 | 32 |
| $\gamma_{inst}$ | Installation safety factor | [-] | 1,0 | | | | | | | | |
| **Displacement under Shear Load** [3] | | | **Ø8** | **Ø 10** | **Ø 12** | **Ø 14** | **Ø 16** | **Ø 20** | **Ø 25** | **Ø 28** | **Ø 32** |
| $\delta_{V0}$ | Short term displacement in **Concrete** | [mm/kN] | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 | 0,04 | 0,03 | 0,03 | 0,03 |
| $\delta_{V\infty}$ | Long term displacement in **Concrete** | | 0,09 | 0,08 | 0,08 | 0,06 | 0,06 | 0,05 | 0,05 | 0,04 | 0,04 |

[1] $f_{uk}$ shall be taken from the specifications of reinforcing bars
[2] In absence of other national regulations
[3] Value in brackets valid for filled annular gab between anchor and clearance hole in the fixture. Use a special filling washer as required in ETA-20/1284.
[4] Calculation of the displacement = $\delta_V$ x V

## *ANNEX V°*

**Declared Performances** acc. to **ETA-21/0802** & EAD 330087-01-0601 - **Design method** acc. to **EN 1992-1-1:2004 +AC:2010, EN 1992-1-2:2004 +AC.2008 and Annex B2 and B3**

| ESSENTIAL CHARACTERISTICS | | | | | PERFORMANCE **POST-INSTALLED REBAR CONNECTION** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Installation parameters | | | | **d** | **Ø8** | **Ø10** | **Ø12** | **Ø14** | **Ø16** | **Ø20** | **Ø22** | **Ø24** | **Ø25** | **Ø28** | **Ø32** | **Ø34** | **Ø36** | **Ø40** |
| $d_0$ | Nominal diameter of drill bit | | | [mm] | see table B5 and B6 of ETA-20/1283 | | | | | | | | | | | | | |
| $l_{v,MAX}$ | Maximum embedment depth | | HD/CD/DD [1] | [mm] | 800 | 1000 | 1300 | | | 1000 | | | | | | | | |
| | | | HDB [1] | [mm] | 800 | 1000 | | | | | | | | | | - | - | |
| $l_{b,min}$ | Minimum anchorage length | | | [mm] | acc. to Eq. 8.6 and Eq. 8.7 of EN 1992-1-1:2004+AC2010 | | | | | | | | | | | | | |
| $l_{0,min}$ | Lap length | | | [mm] | acc. to Eq. 8.11 of EN 1992-1-1:2004+AC2010 | | | | | | | | | | | | | |
| $\alpha_{lb}$ $\alpha_{lb,100y}$ $\alpha_{lb,seis}$ $\alpha_{lb,seis,100y}$ | Amplification factor for $l_{b,min}$ and $l_{0,min}$; static, quasi static and seismic action; working life 50 and 100 years | | | [-] | 1,0 | | | | | | | | | | | | | |
| $c_{min}$ [2] | Minimum concrete cover min c | Without drilling Aid | HD/HDB [1] | [mm] | 30 mm + 0,06•$l_v \geq 2$•Ø | | | | | | | | 40 mm + 0,06•$l_v \geq 2$•Ø | | | | | |
| | | | DD [1] | [mm] | drill rig used as drilling aid | | | | | | | | | | | | | |
| | | | CD [1] | [mm] | 50 mm + 0,08•$l_v$ | | | | | | | | 60 mm + 0,08•$l_v \geq 2$•Ø | | | | | |
| | | With drilling Aid | HD/HDB/DD [1] | [mm] | 30 mm + 0,02•$l_v \geq 2$•Ø | | | | | | | | 40 mm + 0,02•$l_v \geq 2$•Ø | | | | | |
| | | | CD [1] | [mm] | 50 mm + 0,02•$l_v$ | | | | | | | | 60 mm + 0,02•$l_v \geq 2$•Ø | | | | | |
| $s_{min}$ | Minimum spacing | | | [mm] | ≥ 5•Ø ≥ 50 mm | | | | | | | | | | | | | |

| **Design values of ultimate bond stress:** $f_{bd,PIR}=k_b \cdot f_{bd}$ - $f_{bd,PIR,100y}=k_{b,100y} \cdot f_{bd}$ $f_{bd,PIR,seis}=k_{b,seis} \cdot f_{bd}$ - $f_{bd,PIR,seis,100y}=k_{b,seis,100y} \cdot f_{bd}$ | | C12/15 | C16/20 | C20/25 | C25/30 | C30/37 | C35/45 | C40/50 | C45/55 | C50/60 |
|---|---|---|---|---|---|---|---|---|---|---|
| $f_{bd,PIR}$ $f_{bd,PIR,100y}$ **Design value of ultimate bond stress *"for good conditions"; static and quasi static loading*** | Ø8 to Ø32 mm | 1,6 | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,3 |
| | Ø34 mm | 1,6 | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 | 4,2 |
| | Ø36 mm | 1,5 | 1,9 | 2,2 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 | 4,1 |
| | Ø40 mm | 1,5 | 1,8 | 2,1 | 2,5 | 2,8 | 3,1 | 3,4 | 3,7 | 4,0 |
| $f_{bd,PIR,seis}$ $f_{bd,PIR,seis,100y}$ **Design value of ultimate bond stress *"for good conditions"; Seismic action*** | Ø8 to Ø32 mm | - | 2,0 | 2,3 | 2,7 | 3,0 | 3,4 | 3,7 | 4,0 | 4,3 |
| | Ø34 mm | - | 2,0 | 2,3 | 2,6 | 2,9 | 3,3 | 3,6 | 3,9 | 4,2 |
| | Ø36 mm | - | 1,9 | 2,2 | 2,6 | 2,9 | 3,3 | 3,6 | 3,8 | 4,1 |
| | Ø40 mm | - | 1,8 | 2,1 | 2,5 | 2,8 | 3,1 | 3,4 | 3,7 | 4,0 |
| $\eta_1$ *factor "for all other bond conditions"* | | 0,7 | | | | | | | | |
| $k_b$ $k_{b,100y}$ Reduction factor for static and quasi static loading | Ø8 to Ø40 mm | 1,0 | | | | | | | | |
| $k_{b,seis}$ $k_{b,100y,seis}$ Reduction factor for seismic action | Ø10 to Ø40 mm | - | 1,0 | | | | | | | |

| **FIRE EXPOSURE** | | | |
|---|---|---|---|
| $f_{bd,fi}$ **Bond design value resistance Under FIRE EXPOSURE; working life 50 years** | [N/mm²] | | [3] $f_{bd,fi} = k_{fi}(\theta) \cdot f_{bd,PIR} \cdot \gamma_c / \gamma_{M,fi}$ |
| $f_{bd,fi,100y}$ **Bond design value resistance Under FIRE EXPOSURE; working life 100 years** | [N/mm²] | | [3] $f_{bd,fi,100y} = k_{fi,100y}(\theta) \cdot f_{bd,PIR,100y} \cdot \gamma_c / \gamma_{M,fi}$ |
| $k_{fi}(\theta)$ $k_{fi,100y}(\theta)$ Reduction factor at increased temperature | θ ≤278° | | $4673{,}8 \cdot \theta^{-1{,}598}/(f_{bd,PIR} \cdot 4{,}3) \leq 1{,}0$ |
| | θ >278° | | 0 |

[1] HD=hammer drilling, CD=compr. air drilling, DD=diamond drilling, HDB=hollow drilling.
[2] The minimum concrete cover acc. EC 1992-1-1:2004+AC:2010 must be observed.
[3] With: $\gamma_c$ = 1,5 (recommended partial safety factor acc.to EN 1992-1-1:2004+AC:2010)
$\gamma_{M,fi}$ = 1,0 (recommended partial safety factor acc.to EN 1992-1-2:2004+AC:2008)

**Example graph of Reduction factor $k_{fi}(\theta)$, $k_{fi,100y}(\theta)$ for concrete classes C20/25 for good bond conditions:**