



TECHNICAL REPORT

Design of bonded screw fasteners for use in concrete

TR 075

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1 SCOPE

This Technical Report provides an amendment to EN 1992-4 [1] for the design of concrete screws in combination with bonding material, which are used to transmit actions to the concrete (connection of structural elements and non-structural elements to structural components). The physical models used for the design method are based on a combination of tests and numerical analysis consistent with EN 1990:2002 [2], Section 5.2 and EN 1992-4 [1].

2 TERMS, DEFINITIONS AND SYMBOLS

The terms, definitions and symbols used in this Technical Report are given in EAD 332795-00-0601 [3].

3 DESIGN PROCEDURE

3.1 General design provisions

In general, the design provisions for bonded fasteners given in EN 1992-4 [1] apply also for bonded screw fasteners, i.e., concrete screws in combination with bonding material, as defined in the scope of EAD 332795-00 [3]. Deviating from EN 1992-4 [1], this design method is valid for a fixed embedment depth. Thus, the characteristic bond resistance τ_{Rk} given in the relevant equations of EN 1992-4 [1] for combined pull-out and concrete cone failure is replaced by the characteristic resistance $N_{Rk,p}$. The relevant equations are modified accordingly. All other design provisions given in EN 1992-4 [1] for bonded fasteners remain valid.

3.2 Combined pull-out and concrete cone failure

The equations in EN 1992-4 [1] which are replaced in this Technical Report are listed in Table 1.

Table 1. Replaced equations.

Equation no. in EN 1992-4	(7.14)	(7.15)	(7.18)	(7.19)
Replaced by equation no. in this Technical Report	(2)	(3)	(5)	(6)

The characteristic resistance in case of combined pull-out and concrete cone failure, $N_{Rk,p}$, is

$$N_{Rk,p} = N_{Rk,p}^0 \cdot \frac{A_{p,N}}{A_{p,N}^0} \cdot \Psi_{g,Np} \cdot \Psi_{s,Np} \cdot \Psi_{re,N} \cdot \Psi_{ec,Np} \quad (1)$$

The initial value of the characteristic resistance for a single fastener is

$$N_{Rk,p}^0 = \Psi_{sus} \cdot N'_{Rk,p} \quad (2)$$

Where

The value $N'_{Rk,p}$ is given in the relevant ETA, for uncracked and cracked concrete.

The characteristic spacing is

$$s_{cr,Np} = 4,1 \cdot \left(\Psi_{sus} \cdot \frac{d}{h_{ef}} \cdot N_{Rk,p,ucr,C20/25} \right)^{0,5} \leq 3h_{ef} \quad (3)$$

Where

d = shaft diameter of concrete screw (= nominal diameter)

$N_{Rk,p,ucr,C20/25}$ = $N_{Rk,ucr}$ for concrete strength class C20/25

The factor $\Psi_{g,Np}$ takes account for a group effect for closely spaced fasteners.

$$\Psi_{g,Np} = \Psi_{g,Np}^0 - \left(\frac{s}{s_{cr,Np}} \right)^{0,5} \cdot (\Psi_{g,Np}^0 - 1) \geq 1 \quad (4)$$

Where

$$\Psi_{g,Np}^0 = \sqrt{n} - (\sqrt{n} - 1) \cdot \left(\frac{N'_{Rk,p}}{N_{Rk,c}} \right)^{1,5} \geq 1 \quad (5)$$

$$N_{Rk,c} = k_3 \cdot h_{ef}^{1,5} \cdot \sqrt{f_{ck}} \quad (6)$$

k_3 = $k_{cr,N}$ = 7,7 for cracked concrete

= $k_{ucr,N}$ = 11,0 for uncracked concrete

3.3 Seismic loading

The design method for post-installed fasteners under seismic loading provided in Annex C of EN 1992-4 [1] applies. For combined pull-out and concrete failure, in case of bonded screw fasteners, R_{eq}^0 shall be determined according to 7.2.1.6 of EN 1992-4 [1] and clause **Error! Reference source not found.** of this Technical Report replacing the characteristic pullout resistance $N'_{Rk,p}$ with $N_{Rk,p,eq}$ given in the relevant European Technical Product Specification.

3.4 Fire resistance

The design method for post-installed fasteners under fire exposure provided in Annex D of EN 1992-4 [1] applies. In case of bonded screw fasteners under tension, for the verification of combined pullout and concrete failure, the value $N_{Rk,p,fi}$ should be taken from the relevant European Technical Product Specification and replace $N'_{Rk,p}$ in equations (2) and (5) in clause **Error! Reference source not found.** of this Technical Report.

4 REFERENCE DOCUMENTS

- [1] EN 1992-4:2018, Eurocode 2 – Design of concrete structures – Part 4: Design of fastenings for use in concrete.
- [2] EN 1990:2002, Eurocode – Basis of structural design.
- [3] EAD 332795-00-0601:2020-12, ed 02/2022, Bonded Screw Fasteners for Use in Concrete