ETA
European Technical Approval

ETA TR 023
n° 08/0201

Fire behaviour

See page 26

FIRE TEST
CSTB
PV 553 03 0516
PV 26007642-a

Epoxy-acrylate resin
Steel reinforcement fixings for reinforced concrete

Mechanical characteristics of rebar

Nominal steel bar Ø		8	10	12	14	16	20	25	32	40
Sections (cm²)		0.503	0.785	1.13	1.54	2.01	3.14	4.91	8.04	12.57
Min. resistances to failure (kN)	Fe E400	21.13	32.97	47.46	64.68	84.42	131.88	206.22	337.68	527.94
	Fe E500	25.90	40.43	58.20	79.31	103.52	161.71	252.87	414.06	647.36
Ultimate limit load N_{Rd} (kN)	**Fe E500**	**21.85**	**34.15**	**49.17**	**66.93**	**87.42**	**136.59**	**213.43**	**349.56**	**546.36**

The mechanical characteristics of the high adhesion rebars are defined in the NFA 35-016 and NFA 35-017 standards.

Sizing rules for steel reinforcement fixings for concrete according to Eurocode 2 regulations and ETA 08/0201

The basic anchorage length $L_{b,rqd}$ (mm) for the ultimate limit load for rebar F_{RD} (N) is given by following equation:

$$L_{b,rqd} = \frac{F_{Rd}}{\Pi \cdot \varnothing \cdot \eta_1 \cdot \eta_2 \cdot f_{bd}}$$

Concrete class	f_{ck} (Mpa)	f_{bd} (Mpa)
C20/25	20	**2,3**
C25/30	25	**2,7**
C30/37	30	**3,0**
C35/45	35	**3,4**
C40/50	40	**3,7**
C45/55	45	**4,0**
C50/60	50	**4,3**

F_{Rd}: Design ultimate load (N)

f_{bd}: Design value of the bond strength in N/mm²

$\varnothing$: Rebar diameter (mm)

η_1: depends on bond conditions - η_1=1 (good bond conditions). See § 8.4.2 (EN 1992-1-1)

η_2: depends on rebar diameter - η_2 = 1 for Øbar ≤ 32 mm

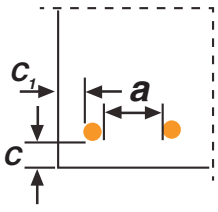
The design anchorage length L_{bd} (mm) is determined as follow:

$$L_{bd} = L_{b,rqd} \cdot \alpha_2 \cdot \alpha_5$$

With α_2 : **Influence of concrete minimum cover**.

$$\alpha 2 = 1 - 0.15(Cd - \varnothing_{bar})/\varnothing_{bar} \geq 0,7$$

$$Cd = \min\left(c\,;c_1\,;\frac{a}{2}\right)$$



With α_5 : **Influence of the confinement by transverse pressure**.

The factor α_5 take into account of the effect of the pressure transverse to the plane of splitting along the design length.

$$\alpha_5 = 1 - 0,04.p \geq 0,7$$

p (Mpa)	α_5
3	0,88
5	0,8
7	0,72

where *p* is the transverse pressure at the ultimate limit state along L_{bd} in MPa.

Limit of this formula

- The max. anchor depth will be limited to 900 mm

Eurocode 2 table for straight rebar anchoring

CONCRETE C25/30 - HAMMER DRILLING

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Rebar Ø	Drilling Ø d_0	Anchor length L_{bd}	Ultimate limit load (daN) without influence of centre distance and/or edge (1) ($\alpha 2 = 0.7$)	Ultimate limit load (daN) with influence of centre distance and/or edge (2) ($\alpha 2 = 1$)	Number of fixings for Epobar 410ml cartridge (3)
8mm	10mm	150mm	1454 daN	1018 daN	80,6
		190mm	1842 daN	1289 daN	63,6
		226mm	**2185 daN**	1534 daN	53,5
		322mm	-	**2185 daN**	37,5
10mm	12mm	181mm	2193 daN	1535 daN	54,6
		230mm	2787 daN	1951 daN	43,0
		285mm	**3415 daN**	2417 daN	34,7
		403mm	-	**3415 daN**	24,5
12mm	15mm	218mm	3170 daN	2219 daN	24,7
		280mm	4072 daN	2850 daN	19,2
		340mm	**4917 daN**	3461 daN	15,8
		484mm	-	**4917 daN**	11,1
14mm	18mm	252mm	4275 daN	2993 daN	13,4
		330mm	5598 daN	3919 daN	10,3
		395mm	**6693 daN**	4691 daN	8,6
		564mm	-	**6693 daN**	6,0
16mm	20mm	290mm	5623 daN	3936 daN	10,4
		370mm	7174 daN	5022 daN	8,2
		451mm	**8742 daN**	6121 daN	6,7
		645mm	-	**8742 daN**	4,7
20mm	25mm	362mm	8773 daN	6141 daN	5,3
		470mm	11391 daN	7973 daN	4,1
		564mm	**13659 daN**	9568 daN	3,4
		805mm	-	**13659 daN**	2,4
25mm	32mm	453mm	13723 daN	9606 daN	2,4
		550mm	16662 daN	11663 daN	2,0
		705mm	**21342 daN**	14950 daN	1,5
		900mm	-	19085 daN	1,2
28mm	35mm	568mm	19272 daN	13490 daN	1,7
		650mm	22054 daN	15438 daN	1,5
		789mm	26770 daN	17613 daN	1,3
		900mm	-	21375 daN	1,1
32mm	40mm	580mm	22490 daN	15743 daN	1,3
		690mm	26756 daN	18729 daN	1,1
		790mm	30633 daN	21443 daN	1,0
		900mm	34899 daN	24429 daN	0,8

(1) Absence of edge distances greater than or equal to 7.Ø
(2) Presence of edge distances and/or centre distances less than 7.Ø
(3) The number of fixings per cartridge is calculated taking into account a wastage factor of 20%
$1,2 \times (d_0^2 - Ø_{rebar}^2) \times \Pi \times L_{bd}/4$

Applications

- Reinforcement starter bars
- Reinforcement anchors for diaphragm walls

Epoxy-acrylate resin – high performance
Steel reinforcement fixings for reinforced concrete

Sizing rules for steel reinforcement fixings for concrete using the bond strength (cf. p. 15)

Mechanical characteristics of rebar

Nominal steel bar Ø		8	10	12	14	16	20	25	32	40
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The mechanical characteristics of the high adhesion rebars are defined in the NFA 35-016 and NFA 35-017 standards.

Anchorage length calculated from the bond strength

From the bond strength of the SPIT EPOBAR Resin, the table below gives the minimum anchorage length for rebar Fe E500, in concrete class ≥ C20/25

Rebar Ø (mm)	8	10	12	14	16	20	25	32	40
Drilling Ø (mm)	10	12	15	18	20	25	32	40	50
Min. anchorage length (mm)	**120**	**150**	**180**	**210**	**245**	**305**	**380**	**485**	**605**
Ultimate limit load (kN)	21,85	34,15	49,17	66,93	87,42	136,59	213,43	349,56	546,36
Nb. anchoring / crt. 410	100	66	30	16	12	6	3	1,6	0,8

Calculation method

- Characteristic bond strength

  τ_{Rk} : 17.85 N/mm² issues from confirmed test and from the calculation using the rebar diameter (available for rebar diameter 8 to 40 mm). [$\tau_{Rk} = \tau_{Ru'm}$ x 0.75].

- Design bond strength τ_{Rd} :

$$\tau_{Rd} = \frac{\tau_{Rk}}{\gamma_M = 2.16} \left[\gamma_M : \text{safety partial factor}\right]$$

- Calculation of the minimum anchorage length of the rebar

$$l_s = \frac{A_s \cdot f_{yk}}{\Pi \cdot \text{Ø}_{fer} \cdot \tau_{Rd}}$$