Rebar design

General

Considering the hypothesis proved during the SPIT tests that the ultimate bond strength of resin versus concrete is at least equal to that of high adhesion rebar in concrete, we can apply the formulas given in the Eurocode 2 – article 5 (P18-711-5), §5.2.2.3 to determine the anchoring depth ls (mm), which can be given by the equation:

$$L_b = \frac{\phi_t}{4}\left(\frac{f_{yd}}{f_{bd}}\right)$$

Øt : Drill hole diameter for the $Ø_{steel\text{-}bar}$ considered (mm)

f_{yd}: Elastic limit of rebar in N/mm²

f_{bd}: Design values of the ultimate bond resistance N/mm²

$$f_{bd} = 2,25 \cdot \eta_1 \cdot \eta_2 \cdot f_{ctd}$$

$$f_{ctd} = \frac{f_{ctk5\%}}{\gamma_c}$$

Concrete strength class	f_{ck} (N/mm²)	$f_{ctk5\%}$(N/mm²)
C20/25	20	**1.5**
C25/30	25	**1.8**
C30/37	30	**2.0**
C35/45	35	**2.2**
C40/50	40	**2.5**
C45/55	45	**2.7**

γ_c: Safety partial factor equal to 1.5

N_{RD}: Maximum ultimate limit load for rebar (N)

$$N_{RD} = As \cdot f_{yd}$$

So for a design ultimate load F_{Rd} (≤ N_{Rd}), The embedment depth L_s is given by the following equation:

$$L_b = F_{Rd} \cdot \frac{\phi_t}{4} \cdot \left(\frac{f_{yd}}{f_{bd}}\right) \cdot \frac{1}{As \cdot f_{yd}} = F_{Rd} \cdot \frac{\phi_t}{4} \cdot \left(\frac{f_{yd}}{2,25 \cdot \eta_1 \cdot \eta_2 \cdot \frac{f_{ctk5\%}}{\gamma_c}}\right) \cdot \frac{1}{\left(\frac{\pi \cdot \phi_t^2}{4}\right) \cdot f_{yd}}$$

$$L_b = \frac{1}{1.5 \cdot \eta_1 \cdot \eta_2 \cdot \pi} \cdot \frac{F_{Rd}}{\phi_t \cdot f_{ctk5\%}}$$

After simplification , we obtain: $L_b \approx \dfrac{F_{Rd}}{4.71 \cdot \eta_1 \cdot \eta_2 \cdot \phi_t \cdot f_{ctk5\%}}$

With η_1 = 1 in good bond conditions.
In the opposite case, η_1 = 0,7 (see §8.4.2 - EN 1992-1-1 Standard, for more details).

η_2 = 1 for $Ø_{bar}$ ≤ 32 mm
η_2 = 0,92 for $Ø_{bar}$ = 40 mm

EXAMPLE

- Concrete C25/30 ($f_{ctk5\%}$=1,8 N/mm²)
- Rebar diameter: 12 mm
- Hole diameter: 15 mm

With this data, to obtain the design value of resistance equal to 35 kN, the necessary embedment depth is:

$$L_b = \frac{35.10^3}{4.71 \cdot 15.1,8} = 275\text{mm}$$