▼ Detailed Calculation Report

# Calculation Description

2w342fsd

# Concrete Anchorage Length Calculation

According to Eurocode 2 Section 8.4
Calculation Date: 10/13/2025, 9:39:09 AM

## INPUT PARAMETERS

### Basic Parameters

| | | |
|---|---|---|
| $S_{Ed}$ | 220 kN | Design tension force |
| $\varphi_l$ | 25 mm | Rebar diameter |
| $n_l$ | 3 | Number of rebars |
| $\varphi_t$ | 12 mm | Transverse rebar dia. |
| $n_{l,orth}$ | 0 | Orthogonal bars |

### Material Properties

| | | |
|---|---|---|
| $f_{ck}$ | 30 MPa | Concrete strength |
| $\gamma_c$ | 1.8 | Concrete safety factor |
| $\alpha_{cc}$ | 0.85 | Concrete coefficient |
| $f_{yk}$ | 500 MPa | Steel strength |
| $\gamma_s$ | 1.25 | Steel safety factor |
| $\sigma_{sEd}$ | Auto-calculated | Design stress |

### Cover & Spacing

| | | |
|---|---|---|
| c | 40 mm | Cover (top/bottom) |
| $c_1$ | 50 mm | Cover (sides) |
| c/c $\varphi_l$ | 200 mm | Rebar spacing |

### Configuration

| | |
|---|---|
| **Bond condition** | Good |
| **Loading type** | Tension |
| **Bar type** | straight |
| **Bar shape** | Straight |
| **Element type** | Slab |
| K | 0.05 |
| $\alpha_4$ | 1.0 |
| p | 0 MPa |

**$l_{bd}$ = 394.4 mm**
Design Anchorage Length

## CALCULATION RESULTS

### Bond Strength (EC2 8.4.2)

| | | |
|---|---|---|
| $\eta_1$ | 1.00 | Bond condition factor |
| $\eta_2$ | 1.000 | Bar diameter factor |
| $f_{ctk,0.05}$ | 2.03 MPa | Concrete tensile str. |
| $f_{ctd}$ | 0.957 MPa | Design tensile str. |
| **$f_{bd}$** | **2.154 MPa** | **Design bond strength** |

### Basic Length (EC2 8.4.3)

| | | |
|---|---|---|
| $f_{yd}$ | 400.00 MPa | Design yield strength |
| $\sigma_{sd}$ | 149.39 MPa | Design stress |
| $A_{s,l}$ | 1472.62 mm² | Total rebar area |
| **$l_{b,rqd}$** | **433.43 mm** | **Basic anchorage length** |

### Alpha Factors

| | | |
|---|---|---|
| $\alpha_1$ | 1.000 | Bar shape |
| $\alpha_2$ | 0.910 | Concrete cover |
| $\alpha_3$ | 1.000 | Transverse reinf. |
| $\alpha_4$ | 1.000 | Welded reinf. |
| $\alpha_5$ | 1.000 | Transverse pressure |
| **$\alpha_{total}$** | **0.9100** | **Product of all α** |

### Final Calculation

| | | |
|---|---|---|
| $c_d$ | 40.00 mm | Minimum cover |
| a | 175.00 mm | Clear spacing |
| K | 0.05 | Transverse coeff. |
| $l_{b,min}$ | 250.00 mm | Minimum length |
| **$l_{bd}$** | **394.4 mm** | **Design anch. length** |

**Constraint Check:** $\alpha_2 \times \alpha_3 \times \alpha_5 = 0.910$ ✓ $\geq 0.7$

## DETAILED CALCULATION STEPS

=== BASIC PARAMETERS ===

$A_{s,l} = n_l \times \pi \times \varphi_l^2 / 4 = 3 \times \pi \times 25^2 / 4 = 1472.62\ mm^2$

$\sigma_{sEd} = SEd \times 1000 / A_{s,l} = 220 \times 1000 / 1472.62 = 149.39\ MPa$

$f_{yd} = f_{yk} / \gamma_s = 500 / 1.25 = 400.00\ MPa$

$\sigma_{sd} = \sigma_{sEd} = 149.39\ MPa$ (using actual stress)

$a = c/c_{\varphi l} - \varphi_l = 200 - 25 = 175.00\ mm$

$cd = \min(a/2, c1, c) = \min(87.50, 50, 40) = 40.00\ mm$ (straight bars)

=== 8.4.2 DESIGN BOND STRENGTH ===

$\eta_1 = 1$ (good bond conditions)

$\eta_2 = 1.000$ ($\varphi \leq 32\ mm$)

$f_{ctk,0.05} = 2.03\ MPa$ (from concrete grade)

$f_{ctd} = \alpha_{cc} \times f_{ctk,0.05} / \gamma_c = 0.85 \times 2.03 / 1.8 = 0.957\ MPa$

$f_{bd} = 2.25 \times \eta_1 \times \eta_2 \times f_{ctd} = 2.25 \times 1 \times 1.000 \times 0.957 = 2.154\ MPa$

=== 8.4.3 BASIC REQUIRED ANCHORAGE LENGTH ===

$f_{yd} = f_{yk} / \gamma_s = 500 / 1.25 = 400.00\ MPa$

$l_{b,rqd} = (\varphi_l / 4) \times (\sigma_{sd} / f_{bd}) = (25 / 4) \times (149.39 / 2.154) = 433.43\ mm$

=== 8.4.4 DESIGN ANCHORAGE LENGTH ===

$K = 0.05$ (orthogonal reinforcement outside bars)

--- Alpha Factors ---

$\alpha_1 = 1$ (straight bars)

$\alpha_2 = \max(0.7, \min(1.0, 1 - 0.15 \times (cd - \varphi_l) / \varphi_l))$

$= \max(0.7, \min(1.0, 1 - 0.15 \times (40.00 - 25) / 25))$

$= \max(0.7, \min(1.0, 0.9100))$

$= 0.910$

$\Sigma A_{st} = n_{l,orth} \times \pi \times \varphi_t^2 / 4 = 0 \times \pi \times 12^2 / 4 = 0.00\ mm^2$

$\Sigma A_{st,min} = 0.25 \times A_{s,l} = 0.25 \times 1472.62 = 368.16\ mm^2$

$\lambda = (\Sigma A_{st} - \Sigma A_{st,min}) / A_{s,l} = (0.00 - 368.16) / 1472.62 = -0.2500$

$\alpha_3 = \max(0.7, \min(1.0, 1 - K \times \lambda)) = \max(0.7, \min(1.0, 1 - 0.05 \times -0.2500)) = 1.000$

$\alpha_4 = 1$ (user input)

$\alpha_5 = \max(0.7, \min(1.0, 1 - 0.04 \times p)) = \max(0.7, \min(1.0, 1 - 0.04 \times 0)) = 1.000$

Constraint: $\alpha_2 \times \alpha_3 \times \alpha_5 = 0.910 \times 1.000 \times 1.000 = 0.910$

Constraint check: 0.910 >= 0.7 ? OK

--- Minimum Anchorage Length ---

$l_{b,min} = \max(0.3 \times l_{b,rqd}, 10 \times \varphi_l, 100)$

$= \max(0.3 \times 433.43, 10 \times 25, 100)$

$= 250.00\ mm$ (tension)

--- Final Design Anchorage Length ---

$\alpha_{total} = \alpha_1 \times \alpha_2 \times \alpha_3 \times \alpha_4 \times \alpha_5$

$= 1 \times 0.910 \times 1.000 \times 1 \times 1.000$

$= 0.9100$

$l_{bd}$ (calculated) $= \alpha_{total} \times l_{b,rqd} = 0.9100 \times 433.43 = 394.42\ mm$

$l_{bd} = \max(l_{bd}\ (calculated), l_{b,min}) = \max(394.42, 250.00) = 394.42\ mm$

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