

End anchorage

Bottom reinforcement at supports · EN 1992-1-1 §9.2.1.3 – 9.2.1.5, §8.4 · UK NA / PN-EN

Reference	NAE-RC-035 · version 1.0
Standards	BS EN 1992-1-1:2004 with UK NA · PN-EN 1992-1-1:2008 with Polish NA (NDP sources listed on the NDP sheet)
National Annex	Selectable: UK NA to BS EN 1992-1-1 or Polish NA to PN-EN 1992-1-1
Issued	29 October 2026

What it does

Bottom bars of a beam at a support: the tensile force to be anchored from the shifted moment curve, the area to take into the support (with the minimum share of the span steel) and the anchorage length from the face of the support against the length available.

How to use

1. Open the Calculation sheet and select the National Annex.
2. Fill in the shaded input cells. Everything else is calculated.
3. Read the Results block; every step below it quotes its clause. Print or save as PDF for your calculation package.

Scope and limitations

Beam with bottom bars running into the support. Force to anchor $F_{Ed} = |V_{Ed}| a_l / z + N_{Ed}$ (9.3, 9.2.1.4(2)), $z = 0.9 d$, $a_l = z \cot \theta / 2$ with vertical links (9.2.1.3(2), $\alpha = 90^\circ$) or $a_l = d$ without shear reinforcement; N_{Ed} the axial tension to be added (0 if none). Area at the support at least F_{Ed} / f_{yd} and $\beta_2 A_{s,span}$ (9.2.1.4(1), 9.2.1.5(1), $\beta_2 = 0.25$ recommended, kept by the UK NA and the PL NA). Anchorage to 8.4 with the stress $\sigma_{sd} = F_{Ed} / A_s$ in the bars, η_1 by Figure 8.2, η_2 for $\phi > 32$, α_1 and α_2 from Table 8.2 for straight bars or bends and hooks, $\alpha_3 = \alpha_4 = \alpha_5 = 1$ (no credit for links or transverse pressure, conservative), $l_{bd} \geq l_{b,min}$ (8.6). End supports: l_{bd} measured from the face of the support (Figure 9.3) within its width less the end cover (9.2.1.4(3): from the line of contact with the support). Intermediate supports: straight bars only, continuing at least 10ϕ beyond the face (9.2.1.5(2)); bends and hooks there need their mandrel rule, not covered), and continuous where the support may see sagging (9.2.1.5(3)). Bottom bars in one layer at the bottom ($h - d$ at least $c + \phi/2$), member cast horizontally: $\eta_1 = 1$ (good bond) when $h \leq 250$ mm, when the bar centre is within 250 mm of the bottom for $h \leq 600$ mm, or at least 300 mm below the top for $h > 600$ mm (Figure 8.2); $\eta_1 = 0.7$ otherwise (8.4.2(2)). Indirect supports need suspension reinforcement as well (9.2.5), not covered. $\beta_2 = 0.25$ is the recommended value, kept by the UK NA and by the PL NA (NA.9). V_{Ed} may be entered with either sign, its magnitude is used. $f_{yk} 400 - 500$ MPa.

The second-generation EN 1992-1-1:2023 is not yet implemented.

Further reading and independent cross-check

- The Concrete Centre, How to design concrete structures using Eurocode 2: Detailing.
- The Concrete Centre, Concise Eurocode 2, 11 (detailing).

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About NA Engineering

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Revision history

v1.0	29 Oct 2026 · First issue
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Project
Element
Date

Job no.
Made by
Checked

Inputs · beam, bars and support

Shaded cells only

	National Annex		UK NA (BS EN)	
Table 3.1	Concrete strength class		C32/40	
3.2.2	Reinforcement characteristic yield strength (≤ 500 MPa)	f_{yk}	500	MPa
9.2.1.4, 9.2.1.5	Support		End support (direct)	
	Width of the support (in the span direction)	t	450	mm
4.4.1	End cover beyond the bar ends	c_{end}	40	mm
	Overall depth of the beam	h	500	mm
	Effective depth	d	450	mm
	Cover to the bottom bars (side and bottom)	c	35	mm
	Bottom bars taken into the support: number	n	4	
	Diameter	φ	16	mm
Figure 8.3	Clear gap between those bars	a	60	mm
Table 8.2	Anchorage form		Bend or hook	
9.2.1.4(1)	Bottom steel in the span	$A_{s,span}$	1473	mm ²
9.2.1.3(2)	Links in the beam		Yes	
6.2.3(2)	Strut inclination used for shear $\cot \theta$	$\cot \theta$	2.50	

Inputs · design actions

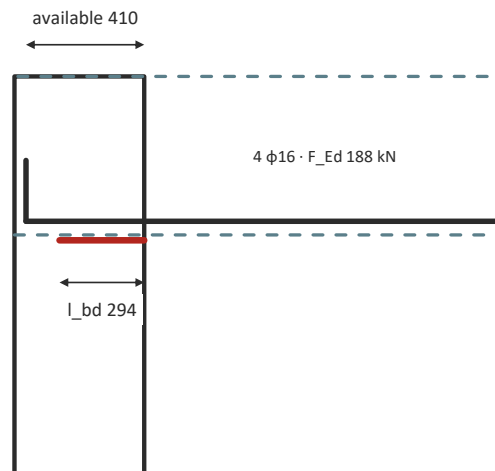
Ultimate limit state, at the support

	Shear force at the support (either sign)	V_{Ed}	150.0	kN
	Axial tension to add (0 = none)	N_{Ed}	0.0	kN
	Inputs valid and consistent			OK

Results

Steel at the support need / provided		0.54		OK
Anchorage needed / available		0.72		OK
Force to anchor	F_{Ed}	187.5	kN	
Anchorage length needed from the face	l	294	mm	

Your support, elevation · the bottom bars running into the support, the length needed from its face (red: lbd at an end support, 10 ϕ at an intermediate one) and the length



Calculation

2.4.2.4(1)				
2.4.2.4(1)				
3.1.6(2)	Coefficient on tensile strength	α_{ct}	1.00	NDP sheet
Table 3.1	Characteristic cylinder strength	f_{ck}	32	MPa
Table 3.1	Mean tensile strength	f_{ctm}	3.02	MPa
3.2.7	Design yield strength	f_{yd}	434.8	MPa
6.2.3(1)	Lever arm 0.9 d	z	405	mm
9.2.1.3(2)	Shift $a_l = z \cot \theta / 2$ with links, d without	a_l	506	mm
(9.3)	Force to anchor $ V_{Ed} a_l / z + N_{Ed}$	F_{Ed}	187.5	kN
9.2.1.4(1)	Minimum share of the span steel $\beta_2 A_{s,span}$, $\beta_2 = 0.25$	$\beta_2 A_s$	368	mm ²
	Needed at the support $\max(F_{Ed} / f_{yd}; \beta_2 A_{s,span})$	$A_{s,req}$	431	mm ²
	Provided $n \pi \phi^2 / 4$	$A_{s,prov}$	804	mm ²
9.2.1.4	Provided $\geq$ needed		804	mm ² OK

Calculation · anchorage, 8.4

3.1.6(2), 8.4.2(2)	fctd (fctk, 0.05 not above the C60/75 value)	f_{ctd}	1.41	MPa
Figure 8.2	η_1 : 1 if $h \leq 250$, bar ≤ 250 from the bottom ($h \leq 600$) or ≥ 300 be	η_1	1.0	
(8.2)	Bond stress $2.25 \eta_1 \eta_2 f_{ctd}$	f_{bd}	3.18	MPa
8.4.3(2)	Stress in the bars $F_{Ed} / A_{s,prov}$ ($\leq f_{yd}$)	σ_{sd}	233.1	MPa
(8.3)	Basic length $\phi \sigma_{sd} / (4 f_{bd})$	$l_{b,rqd}$	294	mm
Figure 8.3	Cover dimension straight $\min(a/2; c)$; bend $\min(a/2; c)$	c_d	30	mm
Table 8.2	α_1 (bend or hook with $cd > 3 \phi$: 0.7)	α_1	1.00	
Table 8.2	α_2 straight $1 - 0.15 (cd - \phi) / \phi$; bend $1 - 0.15 (cd - 3\phi) / \phi$ (0.7 –	α_2	1.000	
(8.6)	Minimum $\max(0.3 l_{b,rqd}; 10 \phi; 100)$	$l_{b,min}$	160	mm
(8.4)	Design anchorage length $\max(\alpha_1 \alpha_2 l_{b,rqd}; l_{b,min})$	l_{bd}	294	mm
9.2.1.4(3), 9.2.1.5(	Needed from the face (end: lbd; intermediate: 10 ϕ)	l_{req}	294	mm
	Available (support width – end cover)	l_{av}	410	mm
9.2.1.4(3)	Available $\geq$ needed		410	mm OK

A bend or hook counts from the face along the bar to the start of the bend plus the bend (8.4.4, Figure 8.1); check the mandrel diameter (8.3) and that the bend fits in the support. At an intermediate support the bars should be continuous or lapped where sagging may occur there.

Nationally Determined Parameters

Values used by the Calculation sheet for the selected National Annex. Sources: UK NA to BS EN 1992-1-1:2004, Table NA.1; PN-EN 1992-1-1:2008, Załącznik krajowy NA. Edit only if your project specifies different values.

Parameter	Clause	UK NA	PL NA	Notes
Partial factor, concrete γ_c	2.4.2.4(1)	1.5	1.4	Persistent & transient. UK NA: recommended; PL: NA.2, Table NA.2
Partial factor, reinforcement γ_s	2.4.2.4(1)	1.15	1.15	UK NA: recommended; PL: NA.2, Table NA.2
α_{cc} (compression in flexure / axial)	3.1.6(1)	0.85	1	UK NA: 0.85; PL: recommended (NA.9)
α_{cc} (shear and punching)	3.1.6(1)	1	1	UK NA: 1.0 for other phenomena; PL: recommended (NA.9)
α_{ct} (design tensile strength)	3.1.6(2)	1	1	Recommended value in both annexes
CRd,c numerator (CRd,c = value / γ_c)	6.2.2(1), 6.4.4(1)	0.18	0.18	Recommended value in both annexes
k1 (axial stress term, punching)	6.4.4(1)	0.1	0.1	Recommended value in both annexes
$v_{Rd,max}$ factor ($v_{Rd,max} = \text{factor} \cdot v \cdot f_{cd}$)	6.4.5(3)	0.5	0.4	UK NA: 0.5 v fcd; PL: recommended value (NA.9), 0.4 v fcd since EN 1992-1-1 AC:2010 (PN-EN 1992-1-1:2008)
kmax ($v_{Ed} \leq k_{max} \cdot v_{Rd,c}$ at u1)	6.4.5	2	1.5	UK NA 6.4.5(3): 2 vRd,c. PL: no limit in PN-EN 1992-1-1:2008; 1.5 (A1:2014 recommendation) applied conse
ϕ_{large} (large bar threshold, mm)	8.8(1)	40	32	UK NA: 40 mm; PL: 32 mm recommended (NA.9)
cot θ upper limit (variable strut)	6.2.3(2)	2.5	2	UK NA: 2.5 (1.25 with axial tension); PL: NA.4, $1 \leq \cot \theta \leq 2.0$
k1 (x/d limit, $\delta \geq k_1 + k_2 x_u/d$)	5.5(4)	0.4	0.44	UK NA for $f_{yk} \leq 500$ MPa; PL: recommended (NA.9)
k2 (x/d limit, $\epsilon_{cu2} = 0.0035$)	5.5(4)	1	1.25	UK NA: $0.6 + 0.0014/\epsilon_{cu2}$; PL: $1.25(0.6 + 0.0014/\epsilon_{cu2})$
Upper limit on the (310/ σ_s) factor (0 = none)	7.4.2(2)	1.5	0	UK NA Table NA.5 Note 5: (310/ σ_s) or (500/ f_{yk})($A_s,prov/A_s,req$) ≤ 1.5 ; PL: none
L/d not to exceed 40 K (1 = applies)	7.4.2(2)	1	0	UK NA Table NA.5 Note 6; not in EN text
ϕ_{min} (longitudinal bars in columns, mm)	9.5.2(1)	12	6	UK NA: 12 mm; PL: NA.6, 6 mm
k3 (crack spacing)	7.3.4(3)	3.4	3.4	Recommended value in both annexes
k4 (crack spacing)	7.3.4(3)	0.425	0.425	Recommended value in both annexes