

Flat slab

Flat slab panel, one direction · coefficients, column and middle strips · EN 1992-1-1 §6.1, §7.4, §9.4, Annex I · UK NA / PN

Reference	NAE-RC-023 · 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

Bending design of a flat slab panel in one direction: total moments across the panel width from coefficients, their split into column and middle strips, the top and bottom bars of each strip, the concentration of top steel over the columns, the moment transferred to an edge column and deflection by the span to depth ratio. Run the sheet once for each direction; punching at the columns is checked with RC-002.

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

Uniformly loaded flat slab of constant thickness without drops, on a rectangular grid of columns, no lateral load on the slab-column frame. Total moments across the panel width ly: F l times the coefficients of TCC How to design concrete structures using Eurocode 2, chapter 7 (Flat slabs), Table 3, the same as Concise Eurocode 2 Table 15.2 (20 % redistribution at the supports, $\delta = 0.8, 5.5$), which apply only where the bays exceed 30 m^2 , $Q_k \leq 1.25 \text{ Gk}$, $q_k \leq 5 \text{ kN/m}^2$, at least three spans with the shortest more than 0.85 the longest and a substantially uniform load: the load ratios are checked and the rest must be confirmed, otherwise every coefficient result fails; their use under the PL annex is the designer's decision. Moments at the column centrelines, not reduced to the column face (conservative). Column strip $0.5 \min(l_x, l_y)$ wide (EN 1992-1-1 Figure I.1), taking the percentage entered of the hogging (60 to 80 %) and sagging (50 to 70 %) moments (Table I.1; the BS 8110 split 75 / 55 % is allowed by Concise EC2 5.7.2.1). Each strip designed as a 1 m slab strip: rectangular stress block, no compression bars, x/d of the bars provided at the supports within the 5.5(4) limit for $\delta = 0.8$, $A_{s,\min}$ (9.1N), spacing $\leq \min(2h, 250)$ (9.3.1.1(3)). Over the columns half the total top steel lies within $0.125 l_y$ of the column line (9.4.1(2)), checked with the column strip bars spread evenly and only where the panels on both sides of the column line are alike (otherwise a warning: combine the two half panels by hand); at an edge column the transferred moment is limited to $0.17 b_e d^2 f_{ck}$ with $b_e = c_x + y$ (9.4.2(1), Annex I.1.2(5)) and carried by the column strip top bars within b_e (rectangular section of width b_e ; anchor them at the edge). Deflection by (7.16) on the longer span with $K = 1.2$ (flat slab, Table 7.4N), the 8.5/l factor for brittle partitions and the steel stress factor ($UK \leq 1.5, \leq 40 \text{ K}$), using the column strip bottom bars. Concrete classes up to C50/60, $f_{yk} \leq 500 \text{ MPa}$. Punching (RC-002), crack widths, fire and openings are separate checks. 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, chapter 7: Flat slabs.
 - The Concrete Centre, Concise Eurocode 2, 5.7 and Table 15.2.
 - The Concrete Centre, RC Spreadsheets v4, TCC33 Flat slabs (licensed product) can be used as an independent cross-check.
- NA Engineering is not affiliated with The Concrete Centre or CIRIA; their publications are referenced for information only.

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 · panel and reinforcement

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
8.2(2)	Maximum aggregate size	d_g	20	mm
	Span type in the direction designed		Interior span	TCC flat slabs Table 3
	Table 3 conditions met (bays $> 30 \text{ m}^2$, ≥ 3 similar spans, uniform load)		Yes	
	Span in the direction designed (column centres)	l_x	7500	mm
	Panel width across it (column centres)	l_y	7500	mm
	Slab thickness	h	275	mm
4.4.1	Nominal cover	c_{nom}	25	mm
	Bars of this direction in the outer layers?		Yes	No: inside the other bars
	Diameter of the bars of the other direction	φ_o	16	mm
	Column size (square)	c	400	mm
Table I.1	Column strip share of the hogging moment		75%	0.60 to 0.80
Table I.1	Column strip share of the sagging moment		55%	0.50 to 0.70
	Column strip, top: bar diameter		16	mm
	Column strip, top: spacing		100	mm
	Column strip, bottom: bar diameter		12	mm
	Column strip, bottom: spacing		150	mm
	Middle strip, top: bar diameter		16	mm
	Middle strip, top: spacing		200	mm
	Middle strip, bottom: bar diameter		12	mm
	Middle strip, bottom: spacing		200	mm
9.4.1(2)	Panels each side of the column line alike (width and load)?		Yes	No: check by hand
9.4.2	Edge column: width along the slab edge	c_x	400	mm Continuous end only
Figure 9.9	Edge column: slab edge to its inner face	y	400	mm Continuous end only

Inputs · loads

Characteristic, per m^2

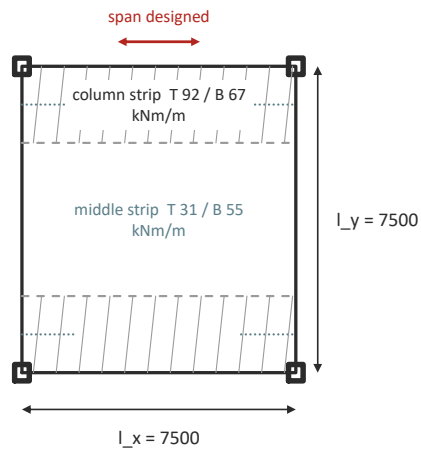
	Permanent load in addition to the self weight	g_k	1.50	kN/m^2
	Variable load	q_k	4.00	kN/m^2
EN 1990 A1.2(B)	Partial factor, permanent	γ_G	1.35	
EN 1990 A1.2(B)	Partial factor, variable	γ_Q	1.50	
7.4.2(2)	Brittle partitions on a span over 8.5 m?		No	
	Inputs valid and consistent			OK

Results

Column strip, top (hogging) $A_{s,req} / A_{s,prov}$	0.46		OK
Column strip, bottom (sagging) $A_{s,req} / A_{s,prov}$	0.89		OK
Middle strip, top (hogging) $A_{s,req} / A_{s,prov}$	0.38		OK
Middle strip, bottom (sagging) $A_{s,req} / A_{s,prov}$	0.97		OK
Top steel over the columns (half within $0.125 l_y$, 9.4.1(2))	0.61		OK
Edge column: transferred moment ($0.17 b_e d^2 f_{ck}$; bars in b_e)	n/a		n/a
Deflection actual $l/d \div$ limiting l/d (longer span)	0.64		OK
Detailing (clear gaps, layers, $A_{s,max}$)	165	mm	OK
Table 3 conditions Q_k / G_k	0.48		OK

Punching at each column: RC-002 (8 for the column position). Analyse the other direction with this sheet as well.

Your panel in plan, to scale · column strips (shaded edges), middle strip and the band over the columns for 9.4.1(2); design moments per metre width



Calculation · loads and moments

2.4.2.4(1)	Partial factor, concrete	γ_c	1.50	NDP sheet
2.4.2.4(1)	Partial factor, reinforcement	γ_s	1.15	NDP sheet
3.1.6(1)	Coefficient on compressive strength (flexure)	α_{cc}	0.85	NDP sheet
5.5(4)	Coefficient for x/d limit	k_1	0.40	NDP sheet
5.5(4)	Coefficient for x/d limit	k_2	1.00	NDP sheet
7.4.2(2)	Upper limit on the stress / area factor		1.50	NDP sheet
7.4.2(2)	$L/d \leq 40K$ applies (1 = yes)		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
3.1.6(1)	Design compressive strength $\alpha_{cc} f_{ck} / \gamma_c$	f_{cd}	18.13	MPa
3.2.7	Design yield strength	f_{yd}	434.8	MPa
	Self weight 25 h	g_{sw}	6.88	kN/m ²
EN 1990 (6.10)	Design load $\gamma_G (g_k + g_{sw}) + \gamma_Q q_k$	n	17.31	kN/m ²
	Total load on the panel $F = n l_x l_y$	F	973.5	kN
Table 3	Span moment across the panel width (coefficient $\times F l_x$)	M_{span}	460.0	kNm
Table 3	Left support moment (edge column: continuous end)	M_{left}	460.0	kNm
Table 3	Right support moment	M_{right}	460.0	kNm
	Larger hogging moment	M_{hog}	460.0	kNm
Figure I.1	Column strip width $0.5 \min(l_x; l_y)$	b_{cs}	3750	mm

Figure I.1	Middle strip width $l_y - b_{cs}$	b_{ms}	3750	mm
Table I.1	Column strip, top: $m = \text{share} \times M / b$	m	92.0	kNm/m
Table I.1	Column strip, bottom: $m = \text{share} \times M / b$	m	67.5	kNm/m
Table I.1	Middle strip, top: $m = \text{share} \times M / b$	m	30.7	kNm/m
Table I.1	Middle strip, bottom: $m = \text{share} \times M / b$	m	55.2	kNm/m

Calculation · bending of the strips (1 m strips)

5.5(4)	Redistribution ratio of the coefficients	δ	0.80	
5.5(4)	Limiting neutral axis depth $\min((\delta - k_1)/k_2; \epsilon_{cu}/(\epsilon_{cu} + \epsilon_{yd}))$	$x_{u/d}$	0.400	
3.1.7(3)	Limiting K (α_{cc}/γ_c) $0.8\xi(1 - 0.4\xi)$	K'	0.152	
	Effective depth, top bars $h - c - (\phi_o) - \phi/2$	d_t	242	mm
	Effective depth, bottom bars	d_b	244	mm
9.3.1.1(3)	Maximum spacing of the main bars $\min(2h; 250)$	s_{max}	250	mm
	Column strip, top: $K = M / (b d^2 f_{ck})$	K	0.049	
3.1.7(3)	Column strip, top: lever arm $d(1 - 0.4\xi) \leq 0.95 d$	z	230	mm
	Column strip, top: A_s required $M / (f_{yd} z)$	$A_{s,req}$	920	mm ² /m
(9.1N)	Column strip, top: $A_{s,min} \max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	381	mm ² /m
	Column strip, top: A_s provided $1000 \pi \phi^2 / (4 s)$	$A_{s,prov}$	2011	mm ² /m
5.5(4)	Column strip, top: x/d of the bars provided $A_s f_{yd} / (0.8 b f_{cd} d)$	x/d	0.249	
	Column strip, top: $A_{s,prov} \geq \max(A_{s,req}; A_{s,min}), s \leq s_{max}, x/d$	A_s	2011	mm ² /m
	Column strip, bottom: $K = M / (b d^2 f_{ck})$	K	0.035	
3.1.7(3)	Column strip, bottom: lever arm $d(1 - 0.4\xi) \leq 0.95 d$	z	232	mm
	Column strip, bottom: A_s required $M / (f_{yd} z)$	$A_{s,req}$	669	mm ² /m
(9.1N)	Column strip, bottom: $A_{s,min} \max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	384	mm ² /m
	Column strip, bottom: A_s provided $1000 \pi \phi^2 / (4 s)$	$A_{s,prov}$	754	mm ² /m
5.5(4)	Column strip, bottom: x/d of the bars provided $A_s f_{yd} / (0.8 b f_{cd} d)$	x/d	0.093	
	Column strip, bottom: $A_{s,prov} \geq \max(A_{s,req}; A_{s,min}), s \leq s_{max}$	A_s	754	mm ² /m
	Middle strip, top: $K = M / (b d^2 f_{ck})$	K	0.016	
3.1.7(3)	Middle strip, top: lever arm $d(1 - 0.4\xi) \leq 0.95 d$	z	230	mm
	Middle strip, top: A_s required $M / (f_{yd} z)$	$A_{s,req}$	307	mm ² /m
(9.1N)	Middle strip, top: $A_{s,min} \max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	381	mm ² /m
	Middle strip, top: A_s provided $1000 \pi \phi^2 / (4 s)$	$A_{s,prov}$	1005	mm ² /m
5.5(4)	Middle strip, top: x/d of the bars provided $A_s f_{yd} / (0.8 b f_{cd} d)$	x/d	0.125	
	Middle strip, top: $A_{s,prov} \geq \max(A_{s,req}; A_{s,min}), s \leq s_{max}, x/d$	A_s	1005	mm ² /m
	Middle strip, bottom: $K = M / (b d^2 f_{ck})$	K	0.029	
3.1.7(3)	Middle strip, bottom: lever arm $d(1 - 0.4\xi) \leq 0.95 d$	z	232	mm
	Middle strip, bottom: A_s required $M / (f_{yd} z)$	$A_{s,req}$	548	mm ² /m
(9.1N)	Middle strip, bottom: $A_{s,min} \max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	384	mm ² /m
	Middle strip, bottom: A_s provided $1000 \pi \phi^2 / (4 s)$	$A_{s,prov}$	565	mm ² /m
5.5(4)	Middle strip, bottom: x/d of the bars provided $A_s f_{yd} / (0.8 b f_{cd} d)$	x/d	0.069	
	Middle strip, bottom: $A_{s,prov} \geq \max(A_{s,req}; A_{s,min}), s \leq s_{max}$	A_s	565	mm ² /m

Calculation · columns, deflection and detailing

9.4.1(2)	Top steel within $0.125 l_y$ of the column line (bars spread evenly	A_s	3770	mm ²
9.4.1(2)	$\geq$ half the total required (panels alike each side; else by hand)			OK
Figure 9.9	Edge column: effective width $b_e = c_x + y$	b_e	0	mm
9.4.2(1)	Edge column: largest transferable moment $0.17 b_e d^2 f_{ck}$	$M_{t,max}$	0.0	kNm
9.4.2(1)	Edge column: top bars in b_e for the edge moment $M / (f_{yd} z)$, b	$A_{s,e}$	0	mm ²
9.4.2(1)	Edge column: column strip top bars within b_e	$A_{s,e,prov}$	0	mm ²
9.4.2(1)	Edge column: $M \leq 0.17 b_e d^2 f_{ck}$ and the bars in b_e carry it	M	460.0	kNm
Table 7.4N	Flat slab: $K = 1.2$ on the longer span	l	7500	mm
7.4.2	Tension bars for deflection $A_{s,req} / (b d)$, column strip bottom	ρ	0.00274	N/A: bending fails
(7.16)	Reference ratio $\rho_0 = \sqrt{f_{ck}} \cdot 10^{-3}$	ρ_0	0.00566	
(7.16)	Basic span to depth ratio ($K = 1.2$)	l/d	58.0	
7.4.2(2)	Long span factor $8.5 / l$ ($l > 8.5$ m, brittle partitions)	F_2	1.000	
(7.17)	Steel stress factor ($A_{s,prov} / A_{s,req}$)(500 / f_{yk}) ($UK \leq 1.5$)	F_3	1.126	

7.4.2	Limiting span to depth ratio (UK NA: ≤ 40 K)	l/d_{lim}	48.0	
	Actual span to depth ratio (longer span / d of the bottom bars)	l/d	30.7	
7.4.2	Deflection $l/d \leq \text{limit}$ (with the bending checks passing)	l/d	30.7	OK
8.2(2)	Minimum clear gap $\max(\phi; d_g + 5; 20)$	a_{min}	25	mm
8.2(2)	Vertical gap between the top and bottom layers	a_v	165	mm
9.2.1.1(3)	Maximum reinforcement $0.04 A_c$	$A_{s,max}$	11000	mm ² /m
8.2(2), 9.2.1.1(3)	Clear gaps of all bars, between the layers; $A_s \leq A_{s,max}$	a	84	mm

Place the column strip top bars with half of the total over the column within 0.125 ly of it (9.4.1(2)); at an edge column place the bars perpendicular to the free edge within be (9.4.2(1)). Bottom bars through the columns: at least two in each direction (9.4.1(3)); curtail and anchor all bars for the moments (9.2.1.3).

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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