

Robustness ties

Tying systems for accidental situations · EN 1992-1-1 §9.10 · UK NA / PN-EN

Reference	NAE-RC-036 · 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 Issued	Selectable: UK NA to BS EN 1992-1-1 or Polish NA to PN-EN 1992-1-1 29 October 2026

What it does

Tie forces for the robustness of a framed concrete building (9.10.2): the peripheral tie at each floor, the internal ties spread in two directions and the horizontal ties to the external columns, with the steel needed and a check of the bars entered.

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

Tying systems of EN 1992-1-1 9.10.2 with the values of the National Annex. UK NA: $F_t = 20 + 4 n_0 \leq 60$ kN; peripheral tie (9.15) as corrected by AC:2010, $F_{tie,per} = l_1 q_1 \geq Q_2$, with $q_1 = (20 + 4 n_0)$ kN/m and $Q_2 = 60$ kN: the larger of the two, taken literally (much larger than the force $F_t \leq 60$ kN of BS 8110 practice; check the reading your project adopts); internal ties $F_{tie,int} = [(g_k + q_k) / 7.5] (l_r / 5) F_t \geq F_t$ kN/m, spread evenly in the slab, at most 1.5 l_r apart; ties to external columns the greater of $2 F_t \leq (l_s / 2.5) F_t$ and 3 % of the design vertical load at that level, kN per column. PL NA (recommended values, NA.9): $F_{tie,per} = 10 l_1 \geq 70$ kN, $F_{tie,int} = 20$ kN/m, $F_{tie,col} = 150$ kN. Internal ties grouped at beams, floors without screeds (9.10.2.3(4)) and ties to walls ($F_{tie,fac}$ per metre) are not covered. Ties carry their force at the characteristic strength, $\gamma_s = 1.0$ for the accidental situation (2.4.2.4, Table 2.1N); steel provided for other purposes may be counted (9.10.1(4)). Ties must be continuous, lapped and anchored (9.10.1(5), 9.10.2.3(2)). Vertical ties of panel buildings (9.10.2.5), the key elements and the class of the building to EN 1991-1-7 and the national regulations (e.g. PD 6687, Approved Document A) are not covered. $f_{yk} 400 - 500$ 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 (tying).
- The Concrete Centre, Concise Eurocode 2, 11.6 (tying systems).

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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Disclaimer

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Revision history

v1.0 29 Oct 2026 · First issue

Project
Element
Date

Job no.
Made by
Checked

Inputs · building and floor
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
UK NA 9.10.2	Number of storeys	n_0	6	
9.10.2.2(2)	Length of the end span (peripheral tie)	l_1	7.50	m
9.10.2.3	Greater span between supports in the tie direction	l_r	7.50	m
UK NA 9.10.2.3(3)	Floor loads $g_k + q_k$ (average)	g_{k+q_k}	9.00	kN/m ²
UK NA 9.10.2.4(2)	Floor to ceiling height	l_s	3.00	m
UK NA 9.10.2.4(2)	Design vertical load in the external column at that level	N_{Ed}	2500	kN

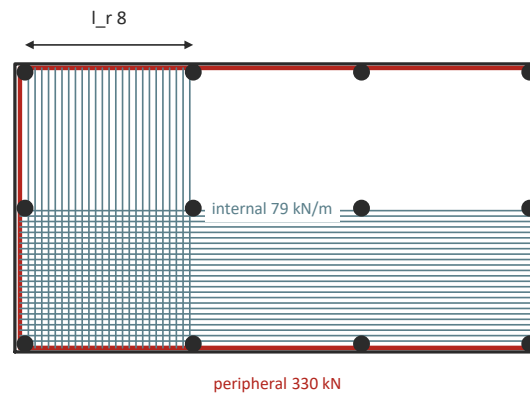
Inputs · ties provided
Bars counted at f_{yk}

9.10.2.2	Peripheral tie: bars	n_p	4	
	Diameter	φ_p	20	mm
9.10.2.3	Internal ties: diameter	φ_i	12	mm
	Spacing	s_i	300	mm
9.10.2.4	Column tie: bars	n_c	2	
	Diameter	φ_c	16	mm
Inputs valid and consistent				OK

Results

Peripheral tie need / provided	0.53	OK
Internal ties need / provided (and spacing)	0.42	OK
Tie to an external column need / provided	0.37	OK
Tie forces peripheral / internal / column	330 kN / 79.2 kN/m / 75 kN	

Your floor, plan · peripheral tie (red), internal ties spread at their spacing in both directions (blue, first bay only), columns; bays of l_r



Calculation

UK NA 9.10.2	$F_t = 20 + 4 n_0 \leq 60$ (UK)	F_t	44.0	kN
(9.15) AC:2010	Peripheral $l_1 q_1 \geq Q_2$: UK $\max\{(20 + 4 n_0) l_1; 60\}$; PL $\max\{10 l_1$	$F_{tie,per}$	330.0	kN
9.10.2.3(3)	Internal UK $\max\{[(g_k + q_k)/7.5](l_r/5) F_t; F_t\}$; PL 20	$F_{tie,int}$	79.20	kN/m
9.10.2.3	Largest spacing of internal ties (UK 1.5 l_r)	s_{max}	11250	mm
9.10.2.4(2)	Column UK $\max\{\min(2 F_t; (l_s/2.5) F_t); 0.03 N_{Ed}\}$; PL 150	$F_{tie,col}$	75.0	kN

Calculation · steel at f_{yk} (accidental, $\gamma_s = 1.0$)

	Peripheral F / f_{yk}	A_{per}	660	mm ²	
	Provided $n_p \pi \phi p^2 / 4$	$A_{per,prov}$	1257	mm ²	
9.10.2.2	Peripheral tie		1257	mm ²	OK
	Internal F / f_{yk} per metre	A_{int}	158	mm ² /m	
	Provided $\pi \phi i^2 / 4 \cdot 1000 / s_i$	$A_{int,prov}$	377	mm ² /m	
9.10.2.3	Internal ties and their spacing		377	mm ² /m	OK
	Column F / f_{yk}	A_{col}	150	mm ²	
	Provided $n_c \pi \phi c^2 / 4$	$A_{col,prov}$	402	mm ²	
9.10.2.4	Tie to the column		402	mm ²	OK

Internal ties here are spread evenly in the slab at the spacing entered; ties grouped at beams need the force of their tributary width and are not checked. Corner columns are tied in both directions.

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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 $v_{Rd,c}$. 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