

Pad footing

Reinforced concrete foundations · EN 1992-1-1 §6.2, §6.4.4, §9.8 · UK NA / PN-EN

Reference	NAE-RC-006 · 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) · EN 1990 load combination by the user
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

Rectangular pad footing under one rectangular column: gross bearing pressure against an allowable value, bending at the column faces in both directions, one-way shear at d from the faces and punching at the column base to 6.4.4(2), with the column anywhere on the footing and a moment about one axis.

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

Rigid footing, linear soil pressure, no tension at the base (partial contact when $e > L/6$). Eccentricities above $L/3$ need special precautions (EN 1997-1 6.5.4) and are not covered: the sheet reports FAIL. Moment about the y axis only (eccentricity along L); column offset along x only. Bearing is checked with characteristic loads against an allowable gross pressure given by the geotechnical engineer; EN 1997-1 bearing resistance, sliding and settlement are not covered. Structural checks take the design contact pressure from the column loads, footing and backfill (γG on the weights, also where favourable; check with 1.0 if that governs the eccentricity), less the downward load of footing and backfill. A negative moment at a column face is reported as top tension (9.8.2.1(3)); top bars are not designed. Bending is taken at the column faces with the whole width effective; across B the pressure is uniform. One-way shear is checked at d from the faces without the $av/2d$ reduction (conservative). Punching uses closed control perimeters inside the base at $a = 0.1d$ to $2d$, the net pressure inside each perimeter deducted (6.48) using the pressure at the column centre, and (6.51) with W at distance a . Perimeters running to a free edge (6.4.2(4)) are not checked; the sheet warns when the column is within d of an edge. No shear reinforcement. Concrete classes up to C50/60. 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: Foundations.
 - The Concrete Centre, Worked Examples to Eurocode 2: Volume 1 (pad footing).
 - The Concrete Centre, RC Spreadsheets v4, TCC81 Foundation Pads (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

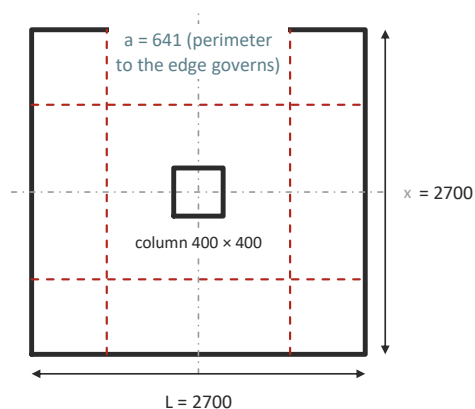
v1.0	29 Oct 2026 · First issue
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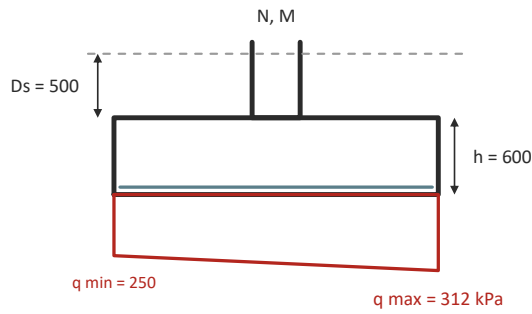
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Checked

Inputs · geometry
Shaded cells only

	National Annex		UK NA (BS EN)	
Table 3.1	Concrete strength class		C30/37	
3.2.2	Reinforcement characteristic yield strength (≤ 500 MPa)	f_{yk}	500	MPa
	Footing length (x, direction of the moment)	L	2700	mm
	Footing width (y)	B	2700	mm
	Footing depth	h	600	mm
	Column dimension in x	c_x	400	mm
	Column dimension in y	c_y	400	mm
	Column offset from the footing centre in x (+ / -)	o_x	0	mm 0 = central column
4.4.1.3(4)	Nominal cover to the bottom bars (≥ 40 on blinding)	c_{nom}	50	mm 75 if cast on soil
8.2(2)	Maximum aggregate size	d_g	20	mm
	Bottom bars spanning x (lower layer), diameter	φ_x	16	mm
	Bottom bars spanning x, centres	s_x	200	mm
	Bottom bars spanning y (upper layer), diameter	φ_y	16	mm
	Bottom bars spanning y, centres	s_y	200	mm

Your footing in plan, to scale · punching perimeter at the governing a (blue) · shear sections at d (dashed)

Inputs · loads and ground
Column loads at the top of the footing

	Column load, permanent	G_k	900	kN
	Column load, variable	Q_k	400	kN
	Column moment about y, permanent (+ = pressure up at +x)	$M_{G,k}$	30.0	kNm
	Column moment about y, variable	$M_{Q,k}$	40.0	kNm
EN 1990 A1.2(B)	Partial factor, permanent	γ_G	1.35	
EN 1990 A1.2(B)	Partial factor, variable	γ_Q	1.50	
	Depth of backfill over the footing	D_s	500	mm
	Unit weight of backfill	γ_{soil}	18.0	kN/m ³
	Allowable gross bearing pressure	q_{allow}	250	kPa From the ground investigation
	Inputs valid and consistent			OK



Results

Bearing pressure, characteristic q / q_{allow}	q_{max}	0.89		OK
Eccentricity, characteristic e / L	e	0.018		OK
Bending, bars spanning x $A_{s,prov} / A_{s,req}$	$A_{s,x}$	1.23		OK
Bending, bars spanning y $A_{s,prov} / A_{s,req}$	$A_{s,y}$	1.27		OK
Top face: hogging moment at a column face	M_{top}	0.0	kNm	OK
One-way shear at d $V_{Ed} / V_{Rd,c}$ (worse direction)		0.78		OK
Punching v_{Ed} / v_{Rd} at the critical perimeter		0.90		OK

Punching perimeters run around the column, to one edge or to a corner of the base, whichever is shortest (6.4.2(4)); perimeters reaching two opposite edges are left to the one-way shear check and flagged. Bars are taken as spread uniformly over the footing. Where the footing is much wider than the column, consider concentrating bars near the column. Anchor the bars to 9.8.2.2 and provide starter bars to the column.

Calculation · bearing (characteristic)

8.2(2)	Minimum clear gap between bars $\max(\phi x; \phi y; d_g + 5; 20)$	a_{min}	25	mm	
8.2(2)	Clear gap, x bars $s_x - \phi x$		184	mm	OK
8.2(2)	Clear gap, y bars $s_y - \phi y$		184	mm	OK
	Self weight of footing $25 \text{ kN/m}^3 \cdot L \cdot B \cdot h$	W_f	109.4	kN	
	Backfill over the footing $\gamma_{soil} (L \cdot B - c_x \cdot c_y) \cdot D_s$	W_s	64.2	kN	
	Moment of the backfill (none over the column) $-\gamma_{soil} c_x c_y D_s c$	M_{ws}	0.00	kNm	
	Total vertical load at the base $G_k + Q_k + W_f + W_s$	N_k	1473.5	kN	
	Moment about the base centre $M_{G,k} + M_{Q,k} + (G_k + Q_k) \cdot e_x + N \cdot e_y$	M_k	70.0	kNm	
	Eccentricity $ M_k / N_k$	e_k	48	mm	
	Maximum pressure $(e \leq L/6: N/(BL)(1 + 6e/L); \text{ else } 2N / (3B(L/2 - e)))$	q_{max}	223.5	kPa	
	Maximum pressure against the allowable	q_{allow}	250	kPa	OK

Calculation · ULS contact pressure

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
3.1.6(1)	Coefficient on compressive strength (shear)	α_{cc}	1.00		NDP sheet
6.2.2(1), 6.4.4(1)	Coefficient $0.18 / \gamma_c$	$C_{Rd,c}$	0.120		NDP sheet
6.4.5(3)	Factor on v_{fcd} for $v_{Rd,max}$		0.50		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
Table 3.1	Characteristic cylinder strength	f_{ck}	30	MPa	
Table 3.1	Mean tensile strength	f_{ctm}	2.90	MPa	

EN 1990 (6.10)	Design column load $\gamma G \text{ Gk} + \gamma Q \text{ Qk}$	N_{Ed}	1815.0	kN
EN 1990 (6.10)	Design column moment $\gamma G \text{ MG,k} + \gamma Q \text{ MQ,k}$	M_{Ed}	100.5	kNm
	Downward load of footing and backfill $\gamma G \text{ (25 h} + \gamma \text{soil Ds)}$	w_d	32.4	kPa
	Total design load at the base $N_{Ed} + \gamma G \text{ (Wf} + \text{Ws)}$	N_t	2049.3	kN
	Moment about the base centre $M_{Ed} + N_{Ed} \text{ ox} + \gamma G \text{ Mws}$	M_t	100.5	kNm
	Eccentricity $ M_t / N_t$	e_d	49	mm
EN 1997-1 6.5.4	Design eccentricity $e \leq L/3$ (beyond: special precautions, not cc)	$L/3$	900	mm

OK

Below, x is measured from the base centre in metres towards the more heavily loaded edge; a column offset against the moment is mirrored accordingly. Footing and backfill (factored by γG) are included in the contact pressure and subtracted again as the downward load w on the parts of the base that are checked.

	Column centre ox , towards the heavier edge	x_c	0.000	m
	Length in contact (L , or $3(L/2 - e)$)	L_c	2.700	m
	Maximum design pressure (gross)	$q_{Ed,max}$	311.7	kPa
	Pressure gradient	q_b	22.7	kPa/m
	Pressure at the base centre (linear)	q_a	281.1	kPa
	Start of contact $x_0 = L/2 - L_c$	x_0	-1.350	m
	Minimum design pressure (gross)	$q_{Ed,min}$	250.5	kPa

Calculation · bending

	Effective depth, x bars $h - c - \phi x/2$	d_x	542	mm
	Effective depth, y bars $h - c - \phi x - \phi y/2$	d_y	526	mm
	Column face on the heavier side	x_R	0.200	m
	Column face on the lighter side	x_L	-0.200	m
	Moment at the face, heavier side $B \int (q - w)(x - x_R) dx$	M_R	483.2	kNm
	Moment at the face, lighter side $B \int (q - w)(x_L - x) dx$	M_L	404.9	kNm
	Design moment for x bars, bottom (whole width B)	$M_{Ed,x}$	483.2	kNm
	Zero shear between the light edge and the face (hogging extren	x_s	-1.350	m
	Moment there (negative = top tension)	M_s	0.0	kNm
9.8.2.1(3)	Largest hogging moment (top tension, negative)	M_{top}	0.0	kNm
	Design moment for y bars (whole length L) $(N_t/B - w L)((B - cy)$	$M_{Ed,y}$	444.0	kNm
3.2.7	Design yield strength	f_{yd}	434.8	MPa
3.2.7	Neutral axis depth at first yield	ξ_y	0.617	
5.5(4)	Limiting neutral axis depth, no redistribution $\min((1 - k_1)/k_2; \xi_1)$	$x_{u/d}$	0.600	
3.1.7(3)	Limiting K (acc/ γc) $0.8 \xi (1 - 0.4 \xi)$	K'	0.207	
	K for x bars $M_{Ed,x} / (b d^2 f_{ck}) \leq K'$	K_x	0.020	
	Lever arm, x bars $\leq 0.95 d$	z_x	515	mm
	Required, x bars $M_{Ed,x} / (f_{yd} z)$	$A_{s,req,x}$	2158	mm ²
(9.1N)	Minimum, x bars $\max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min,x}$	2204	mm ²
	Provided, x bars $\pi \phi^2/4 \cdot b / s$	$A_{s,prov,x}$	2714	mm ²
	K for y bars $M_{Ed,y} / (b d^2 f_{ck}) \leq K'$	K_y	0.020	
	Lever arm, y bars $\leq 0.95 d$	z_y	500	mm
	Required, y bars $M_{Ed,y} / (f_{yd} z)$	$A_{s,req,y}$	2044	mm ²
(9.1N)	Minimum, y bars $\max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min,y}$	2139	mm ²
	Provided, y bars $\pi \phi^2/4 \cdot b / s$	$A_{s,prov,y}$	2714	mm ²

OK

OK

OK

OK

Calculation · one-way shear at d from the column faces

	Shear at d, heavier side	V_R	447.2	kN
	Shear at d, lighter side	V_L	369.3	kN
	Design shear across B (x bars)	$V_{Ed,x}$	447.2	kN
	Design shear across L (y bars) $ N_t/B - w L ((B - cy)/2 - dy)$	$V_{Ed,y}$	419.0	kN
6.2.2(1)	Reinforcement ratio, x bars	$\rho_{l,x}$	0.0019	
(6.2)	Resistance, x direction $\max(CR_{d,c} k (100 \rho f_{ck})^{1/3}; v_{min}) b d$	$V_{Rd,c,x}$	571.7	kN
(6.2)	Shear, x direction $V_{Ed} \leq V_{Rd,c}$	$V_{Ed,x}$	447.2	kN
6.2.2(1)	Reinforcement ratio, y bars	$\rho_{l,y}$	0.0019	
(6.2)	Resistance, y direction $\max(CR_{d,c} k (100 \rho f_{ck})^{1/3}; v_{min}) b d$	$V_{Rd,c,y}$	559.6	kN
(6.2)	Shear, y direction $V_{Ed} \leq V_{Rd,c}$	$V_{Ed,y}$	419.0	kN

OK

OK

Calculation · punching at the column base, 6.4.4(2)

	Mean effective depth	d	534	mm		
6.4.4(1)	Size factor $1 + \sqrt{200/d} \leq 2$	k	1.612			
6.4.4(1)	Mean ratio $\sqrt{(p_x p_y)} \leq 0.02$	ρ_I	0.0019			
(6.50)	Basic resistance $\max(\text{CRd}, c k (100 p_{fck})^{1/3}; v_{min})$	$v_{Rd,c}$	0.392	MPa		
Table 6.1	k for the column moment (ratio c_x/c_y)	k	0.600			
	Net pressure at the column centre $q - w$ (signed)	q_c	248.7	kPa		
	Column face to the edge, +x side	e_r	1150	mm		
	Column face to the edge, -x side	e_l	1150	mm		
	Column face to the edges in y	e_y	1150	mm		
	No backfill over the column $\gamma_G \gamma_{soil} D_s c_x c_y$	ΔW	1.9	kN		
6.4.5(3)	Column perimeter	u_0	1600	mm		
(6.41)	W at the column face $c x^2/2 + c_x c_y$	W_0	240000	mm ²		
(6.51)	β at the column face $1 + k M E d u_0 / (N E d W_0)$	θ_0	1.221			
(6.6N)	Strength reduction factor $0.6(1 - f_{ck}/250)$	v	0.528			
6.4.5(3)	Maximum punching stress $v_{max} v_{acc} f_{ck} / \gamma_c$	$v_{Rd,max}$	5.280	MPa		
(6.53)	Shear stress at the column face $\beta_0 N E d / (u_0 d)$	$v_{Ed,0}$	2.595	MPa	OK	
	a (mm)	u (mm)	VEd,red (kN)	vEd (MPa)	vRd (MPa)	vEd / vRd
	27	1768	1762.1	2.246	15.694	0.14
	53	1936	1749.8	2.006	7.847	0.26
	80	2103	1736.4	1.808	5.231	0.35
	107	2271	1721.9	1.643	3.923	0.42
	134	2439	1706.2	1.503	3.139	0.48
	160	2607	1689.5	1.382	2.616	0.53
	187	2774	1671.6	1.276	2.242	0.57
	214	2942	1652.6	1.183	1.962	0.60
	240	3110	1632.5	1.100	1.744	0.63
	267	3278	1611.3	1.026	1.569	0.65
	294	3445	1589.0	0.959	1.427	0.67
	320	3613	1565.6	0.898	1.308	0.69
	347	3645	1541.0	0.848	1.207	0.70
	374	3687	1515.3	0.824	1.121	0.74
	401	3729	1488.6	0.800	1.046	0.76
	427	3771	1460.7	0.776	0.981	0.79
	454	3813	1431.7	0.752	0.923	0.81
	481	3855	1401.6	0.729	0.872	0.84
	507	3897	1370.3	0.705	0.826	0.85
	534	3939	1338.0	0.681	0.785	0.87
	561	3981	1304.5	0.657	0.747	0.88
	587	4023	1269.9	0.633	0.713	0.89
	614	4065	1234.2	0.610	0.682	0.89
	641	4107	1197.4	0.586	0.654	0.90
	668	4149	1159.5	0.562	0.628	0.90
	694	4190	1120.5	0.538	0.604	0.89
	721	4232	1080.3	0.514	0.581	0.88
	748	4274	1039.1	0.491	0.560	0.88
	774	4316	996.7	0.467	0.541	0.86
	801	4358	953.2	0.443	0.523	0.85
	828	4400	908.6	0.419	0.506	0.83
	854	4442	862.9	0.395	0.490	0.81
	881	4484	816.1	0.372	0.476	0.78
	908	4526	768.1	0.348	0.462	0.75
	935	4568	719.1	0.324	0.448	0.72
	961	4610	668.9	0.300	0.436	0.69
	988	4652	617.6	0.276	0.424	0.65
	1015	4694	565.2	0.253	0.413	0.61
	1041	4736	511.7	0.229	0.402	0.57
	1068	4778	457.1	0.205	0.392	0.52
	1068	4778	457.1	0.205	0.392	0.52

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Perimeters at $a = 0.05d \dots 2d$ from the column face (6.4.4(2)) and those just touching each edge. Each row checks the closed perimeter and the perimeters to one edge and to a corner (6.4.2(4)) that fit, and reports the one with the highest stress: $vEd = (VEd,red / u + k MEd / W) / d$ from (6.51), with u and W (6.39) of that same perimeter about the column axis. $VEd,red = NEd$ – net upward load inside (6.48), signed, no backfill over the column: exact for the closed perimeter in full contact, a lower bound of the relief (using the lowest net pressure on the base) for perimeters to an edge. Rows marked – reach two opposite edges. $vRd = vRd,c \cdot 2d/a$ (6.50). The governing row is shaded.

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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 $(310/\sigma_s)$ factor (0 = none)	7.4.2(2)	1.5	0	UK NA Table NA.5 Note 5: $(310/\sigma_s)$ or $(500/f_{yk})(A_{s,prov}/A_{s,req}) \leq 1.5$; 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