

Partially loaded area

Concentrated force on a partially loaded area · EN 1992-1-1 §6.7, §6.5.3 · UK NA / PN-EN

Reference	NAE-RC-029 · 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
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What it does

Bearing resistance of concrete under a concentrated force on the end face of a member (a bearing, a column or beam seat, an anchor plate), with the transverse tension from the spreading of the force and the ties to carry it in the two directions across the force.

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

Uniform force on a rectangular loaded area $A_{c0} = a \times y$ on the end face of a rectangular member $B_x \times B_y$, of length H in the direction of the force. Bearing: $F_{Rdu} = A_{c0} f_{cd} \sqrt{A_{c1}/A_{c0}} \leq 3.0 f_{cd} A_{c0}$ (6.63) with A_{c1} the largest design distribution area of the same shape and centre (6.7(3), Figure 6.29): sides at most three times those of A_{c0} , inside the member (the nearer edge on each axis), and the spreading height H at least the increase of each side. $f_{cd} = \alpha_{cc} f_{ck} / \gamma_c$ with the α_{cc} of the National Annex for compression (UK 0.85, conservative against the 1.0 the UK NA allows for other phenomena; PL 1.0). Ties: a local bursting calculation on the symmetric prism about the force (the idealisation used for anchorage zones: width $b = a + 2 \times$ the nearer edge distance, i.e. the member width less twice the eccentricity), with the stress fields of 6.5.3(3), Figure 6.25; A_{c1} serves the bearing only. Partial discontinuity ($b \leq H/2$): $T = 0.25 (1 - a/b) F$ (6.58), ties spread over the depth about $0.1 b$ to b below the face. Full discontinuity ($b > H/2$) with $a \leq H/2$: the larger of (6.58) and $0.25 (1 - 0.7 a/H) F$, i.e. (6.59) with its printed h read as H (the reading of the SIS interpretation service, the more onerous one), ties spread over 0.1 to $1.0 \times H/2$. Full discontinuity with $a > H/2$ is outside Figure 6.25: the sheet reports FAIL (use a strut-and-tie model). The tie check is an area check: the spread of the bars, their anchorage (8.4) and the node resistance (6.5.4) are to be verified separately. The prism idealisation can understate the bursting of a highly eccentric force, and a force at an edge ($b = a$) gives no bursting tension from it: the sheet flags such a direction for a separate check. Spalling at the loaded face, a force not uniform on A_{c0} , high shear forces and several forces close together (6.7(2), (3)) need further checks. $f_{yk} 400 - 500$ MPa.

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

Further reading and independent cross-check

- The Concrete Centre, Concise Eurocode 2, 7.7 (partially loaded areas).
- SIS, Swedish Institute for Standards, interpretation questions on SS-EN 1992-1-1, transverse tension (6.59) ("Dragkraft"): h read as H . Check the corrigenda and the National Annex edition in use.
- IStructE, Manual for the design of concrete building structures to Eurocode 2 (bearings and local effects).
- The Concrete Centre, RC Spreadsheets v4 (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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Disclaimer

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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 · loaded area and member

Shaded cells only

	National Annex		UK NA (BS EN)	
Table 3.1	Concrete strength class		C32/40	
3.2.2	Ties: characteristic yield strength (≤ 500 MPa)	f_{yk}	500	MPa
6.7(2)	Loaded area: side along x	a_x	300	mm
6.7(2)	Loaded area: side along y	a_y	200	mm
	Member: width along x	B_x	600	mm
	Member: width along y	B_y	800	mm
Figure 6.29	Loaded area from the -x edge of the member	e_x	150	mm
Figure 6.29	Loaded area from the -y edge of the member	e_y	300	mm
Figure 6.25	Member length in the direction of the force	H	1500	mm
6.7(4)	Ties across x (bars within the tie zone below the face)	n_x	4	
	Diameter	φ_x	12	mm
6.7(4)	Ties across y	n_y	4	
	Diameter	φ_y	16	mm

Inputs · design action

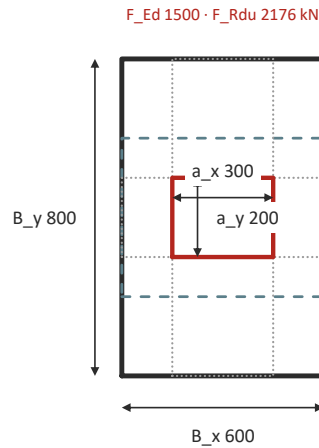
Ultimate limit state

Concentrated force, uniform on the loaded area	F_{Ed}	1500.0	kN
Inputs valid and consistent			OK

Results

Bearing F_{Ed} / F_{Rdu} (6.63)		0.69		OK
Ties across x, area need / provided		0.95		OK
Ties across y, area need / provided		0.97		OK
Bearing resistance	F_{Rdu}	2176	kN	
Enhancement $\sqrt{A_{c1} / A_{c0}}$ (≤ 3)		2.00		
Ties needed across x / across y	A_s	431 / 782	mm ²	

Your bearing, to scale · plan of the member: loaded area (solid), design distribution area A_{c1} for the bearing (dashed) and the symmetric prisms that size the ties (dotted)



Calculation · bearing

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
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
6.7(2)	Loaded area $a_x a_y$	A_{c0}	60000	mm ²
	Nearer edge distance along x $\min(e_x; B_x - a_x - e_x)$	$e_{x,min}$	150	mm
	Nearer edge distance along y $\min(e_y; B_y - a_y - e_y)$	$e_{y,min}$	300	mm
Figure 6.29	Scale of A_{c1} within the member along x $1 + 2 e_{x,min} / a_x$	k_x	2.000	
Figure 6.29	Along y $1 + 2 e_{y,min} / a_y$	k_y	4.000	
Figure 6.29	Spreading height $H \geq b_2 - a_x$ and $d_2 - a_y$: $1 + H / \max(a_x; a_y)$	k_h	6.000	
6.7(3)	Scale used $\min(3; k_x; k_y; k_h) = \sqrt{A_{c1} / A_{c0}}$	k	2.000	
Figure 6.29	Distribution area sides $k a_x, k a_y$	b_2	600	mm
		d_2	400	mm
(6.63)	$F_{Rdu} = A_{c0} f_{cd} \sqrt{A_{c1} / A_{c0}} \leq 3.0 f_{cd} A_{c0}$	F_{Rdu}	2176.0	kN
(6.63)	$F_{Ed} \leq F_{Rdu}$		1500.0	kN

Calculation · transverse tension, Figure 6.25

6.5.3(3)	Symmetric prism across x $b = a_x + 2 e_{x,min}$	b_x	600	mm
Figure 6.25	Discontinuity across x (partial: $b \leq H/2$)		partial	
Figure 6.25	Full discontinuity needs $a_x \leq H/2$: outside otherwise		inside	
Figure 6.25	Depth of the tie zone (partial b, full H/2)	$z_{t,x}$	600	mm

Count only the ties across x between these depths below the face			60 – 600 mm	
(6.58), (6.59)	$T_x = 0.25 F \max(1 - a/b; \text{full: } 1 - 0.7 a/H)$	T_x	187.5	kN
6.5.2	Ties needed across x T_x / f_{yd}	$A_{s,x}$	431	mm ²
	Provided $n_x \pi \phi x^2 / 4$	$A_{s,x,prov}$	452	mm ²
6.7(4)	Ties across x: inside Fig. 6.25, area provided $\geq$ needed		452	mm ² OK
6.7(2)	Force at an edge across x (the prism proves nothing there)			no
6.5.3(3)	Symmetric prism across y $b = a_y + 2 e_{y,min}$	b_y	800	mm
Figure 6.25	Discontinuity across y (partial: $b \leq H/2$)		full	
Figure 6.25	Full discontinuity needs $a_y \leq H/2$: outside otherwise		inside	
Figure 6.25	Depth of the tie zone (partial b, full H/2)	$z_{t,y}$	750	mm
Count only the ties across y between these depths below the face			75 – 750 mm	
(6.58), (6.59)	$T_y = 0.25 F \max(1 - a/b; \text{full: } 1 - 0.7 a/H)$	T_y	340.0	kN
6.5.2	Ties needed across y T_y / f_{yd}	$A_{s,y}$	782	mm ²
	Provided $n_y \pi \phi y^2 / 4$	$A_{s,y,prov}$	804	mm ²
6.7(4)	Ties across y: inside Fig. 6.25, area provided $\geq$ needed		804	mm ² OK
6.7(2)	Force at an edge across y (the prism proves nothing there)			no

Spread the ties over about 0.1 to 1.0 of the tie zone depth below the loaded face, each direction its own zone. The check is of the area only: anchor the ties where the compression field curves (8.4) and check the nodes under the plate (6.5.4) separately; at a free edge the bars need end anchorage (bends or loops), as the prism reaches the edge. A direction loaded at an edge ($e_{min} = 0$) is flagged: the prism gives $b = a$, which does not prove that no ties are needed.

Prepared with NA Engineering calculation tools · naengineering.uk · adrian@naengineering.uk. Free for use by competent engineers; see the About sheet for scope and disclaimer.

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