

Basement wall

Wall propped by the floor slab · earth pressure at rest, ground water and surcharge · EN 1997-1, EN 1992-1-1

Reference	NAE-RC-020 · 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 1997-1 9.5 (earth pressure at rest), UK DA1 / PL DA2 · EN 1990 (6.10)
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

A basement wall spanning vertically between the ground floor slab (a prop at the top) and the basement slab, pinned or fixed at the base, under the earth pressure at rest, the ground water and a surcharge on the ground behind it. The sheet gives the reactions, the largest span moment and where it occurs, the moment at a fixed base and the shear, and checks the vertical reinforcement of both faces and the shear without links, with the pressure and moment diagrams drawn to scale.

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

Lateral loads only: a 1 m strip spanning vertically, constant thickness, rigid supports, the top prop in place (construction stages before it acts are not covered). The axial load from above, its eccentricity and second order effects (5.8, 6.1) need a separate column-type check of the wall; so do the inside water pressure, the self weight, cracking (water-resisting walls: BS EN 1992-3 and CIRIA C766), the horizontal bars, the joints, links in the wall and the global stability of the basement (uplift, sliding). Level ground at or below the top support with a uniform surcharge q ; one soil, drained, $c' = 0$, normally consolidated: $K_0 = 1 - \sin \phi'$ (EN 1997-1 9.5.2(3)); compaction pressures are outside the scope. Unit weight γ above the water level, γ_{sat} below; hydrostatic water, $\gamma_w = 9.81 \text{ kN/m}^3$. Enter the design water level: the highest that can occur in the design life, drainage failure included (EN 1997-1 2.4.6.1). Factor sets: (1) the γ_G and γ_Q entered on the earth and water and on K_0 q , with the characteristic ϕ' : UK DA1 combination 1 (1.35, 1.5) and PL DA2 (A1 + M1; with the Polish NA the less favourable of 6.10a / 6.10b governs, and 1.35 / 1.5 is the conservative single expression); (2) UK only, DA1 combination 2: $\gamma_G = 1.0$, $\gamma_Q = 1.3$, $\tan \phi'd = \tan \phi' / 1.25$. Sources: NA+A1:2014 to BS EN 1997-1:2004+A1:2013 (Design Approach 1, factors of Annex A.3); PN-EN 1997-1:2008 with Ap2:2010, NA.2.6 (DA2 for GEO, bearing as DA2*); the action factors of A1 are used here for the STR design of the wall, whose resistance follows PN-EN 1992-1-1); PN-EN 1990:2004 with its National Annex (the less favourable of 6.10a and 6.10b). Each result is the worst of the sets on its own; they are not simultaneous actions. A real base is neither pinned nor fixed: check both if in doubt. The second-generation EN 1997-1:2024 and EN 1992-1-1:2023 are not yet implemented.

Further reading and independent cross-check

- The Concrete Centre, How to design concrete structures using Eurocode 2: Retaining walls / basements.
 - The Institution of Structural Engineers, Design of basements; CIRIA C766 for crack control.
 - The Concrete Centre, RC Spreadsheets v4, TCC61 Basement wall (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 · wall 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 between the supports (top slab to the base slab)	L	3500	mm
	Wall thickness	t	300	mm
	Support at the base		Pinned	
4.4.1	Nominal cover to the vertical bars	c_{nom}	45	mm
	Inner face vertical bars: diameter	φ_{in}	12	mm
	Inner face vertical bars: spacing	s_{in}	200	mm
	Soil face vertical bars: diameter	φ_{out}	12	mm
	Soil face vertical bars: spacing	s_{out}	200	mm

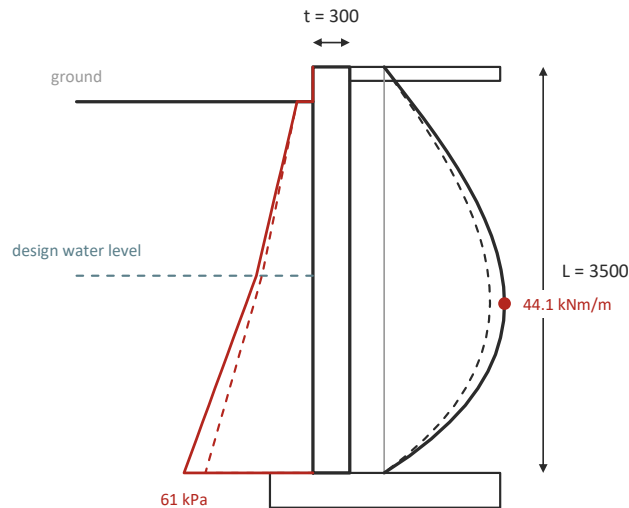
Inputs · soil, water and loads
Characteristic values

	Ground level below the top support	h_0	300	mm
EN 1997-1 2.4.6.1	Design water level below the ground (large: dry)	z_w	1500	mm
	Soil unit weight above the water level	γ	19.0	kN/m ³
	Soil saturated unit weight	γ_{sat}	20.0	kN/m ³
	Soil angle of shearing resistance	φ'_k	30.0	°
	Surcharge on the ground (variable)	q	10.0	kPa
EN 1990 A1.2(B)	Partial factor, permanent (earth and water), set 1	γ_G	1.35	
EN 1990 A1.2(B)	Partial factor, variable (surcharge), set 1	γ_Q	1.50	
	Inputs valid and consistent			OK

Results

Largest span moment (tension on the inner face)	$M_{Ed,span}$	44.1	kNm/m	
Moment at the base (tension on the soil face)	$M_{Ed,base}$	0.0	kNm/m	
Largest shear (at a support)	V_{Ed}	67.5	kN/m	OK
Vertical reinforcement inner and soil faces		565 / 565	mm ² /m	OK

Your wall, to scale · design pressure on the soil side (red) and bending moment (dark), tension on the inner face to the right · set 1 solid, UK DA1 combination 2 dashed



Calculation · pressures and actions (per metre run)

9.5.2(3)	Coefficient of earth pressure at rest $1 - \sin \phi'$	K_0	0.500	
UK DA1-2	Set 2: K_0 with $\tan \phi'd = \tan \phi' / 1.25$ (M2)	$K_{0,d}$	0.581	
$p(z) = \gamma Q K_0 q + \gamma G [K_0 \gamma z_1 + (K_0 (\gamma_{sat} - \gamma_w) + \gamma_w) z_2]$, z_1 depth above the water level, z_2 below it; no pressure above the ground. Set 1: the γG , γQ entered, K_0 ; set 2 (UK DA1 combination 2): $\gamma G = 1.0$, $\gamma Q = 1.3$, $K_{0,d}$.				
	Set 1: design pressure at the base	p_b	60.94	kPa
	Set 1: total load on the wall $\int p$	W	100.21	kN/m
	Set 1: reaction at the top support (prop force)	R_{top}	32.69	kN/m
	Set 1: reaction at the base	R_{base}	67.52	kN/m
	Set 1: depth of the largest span moment ($V = 0$)	x	2.040	m
	Set 1: largest span moment	M_{span}	44.06	kNm/m
	Set 1: moment at the base (pinned: 0)	M_{base}	0.00	kNm/m
	Set 2 (UK): design pressure at the base	p_b	50.83	kPa
	Set 2 (UK): total load on the wall $\int p$	W	87.43	kN/m
	Set 2 (UK): reaction at the top support (prop force)	R_{top}	29.36	kN/m
	Set 2 (UK): reaction at the base	R_{base}	58.07	kN/m
	Set 2 (UK): depth of the largest span moment ($V = 0$)	x	2.018	m
	Set 2 (UK): largest span moment	M_{span}	38.77	kNm/m
	Set 2 (UK): moment at the base (pinned: 0)	M_{base}	0.00	kNm/m
	Largest span moment (worst set)	M_{span}	44.06	kNm/m
	Moment at the base (worst set)	M_{base}	0.00	kNm/m
	Largest shear $\max(R_{top}; R_{base})$, worst set	V_{Ed}	67.52	kN/m

Exact integration: 3-point Gauss on each part where the pressure is linear. Fixed base: the prop force makes the deflection at the top zero, $R = \int p b^2 (3L - b) / (2L^3) d\xi$ with $b = L - \xi$ (constant EI). The maximum span moment lies where the shear is zero, solved exactly in the part where the shear changes sign.

Calculation · EN 1992-1-1 (STR)

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
6.2.2(1), 6.4.4(1)	Coefficient 0.18 / γ_c	$C_{Rd,c}$	0.120	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
5.6.3	Limit on K without compression bars ($\xi \leq 0.45$)	K'	0.167	
8.2(2)	Minimum clear gap $\max(\phi; d_g + 5; 20)$	a_{min}	25	mm
	Inner face: effective depth $t - c - \phi/2$	d	249	mm
	Inner face: $K = M / (b d^2 f_{ck})$	K	0.022	
3.1.7(3)	Inner face: lever arm $d (1 - 0.4\xi) \leq 0.95 d$	z	237	mm
	Inner face: A_s required $M / (f_{yd} z)$	$A_{s,req}$	428	mm ² /m
(9.1N)	Inner face: A_s ,min $\max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	392	mm ² /m
	Inner face: A_s provided $1000 \pi \phi^2 / (4 s)$ (span)	$A_{s,prov}$	565	mm ² /m
(6.2)	Inner face: $VR_{d,c}$ (no links)	$V_{Rd,c}$	128.7	kN/m
9.3.1.1(3)	Inner face: maximum bar spacing	s_{max}	250	mm
	Inner face: bending $A_s,prov \geq \max(A_s,req; A_s,min)$	A_s	565	mm ² /m OK
(6.2)	Inner face: shear $V_{Ed} \leq VR_{d,c}$	V_{Ed}	67.5	kN/m OK
9.3.1.1(3)	Inner face: spacing $\leq s_{max}$, clear gap $\geq a_{min}$, $A_s \leq 0.04 A_c$	s	200	mm OK
	Soil face: effective depth $t - c - \phi/2$	d	249	mm
	Soil face: $K = M / (b d^2 f_{ck})$	K	0.000	
3.1.7(3)	Soil face: lever arm $d (1 - 0.4\xi) \leq 0.95 d$	z	237	mm
	Soil face: A_s required $M / (f_{yd} z)$	$A_{s,req}$	0	mm ² /m
(9.1N)	Soil face: A_s ,min $\max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	392	mm ² /m
	Soil face: A_s provided $1000 \pi \phi^2 / (4 s)$ (base)	$A_{s,prov}$	565	mm ² /m
(6.2)	Soil face: $VR_{d,c}$ (no links)	$V_{Rd,c}$	128.7	kN/m
9.3.1.1(3), 9.6.2(3)	Soil face: maximum bar spacing	s_{max}	400	mm
	Soil face: bending $A_s,prov \geq \max(A_s,req; A_s,min)$	A_s	565	mm ² /m OK
(6.2)	Soil face: shear $V_{Ed} \leq VR_{d,c}$	V_{Ed}	67.5	kN/m OK
9.3.1.1(3), 9.6.2(3)	Soil face: spacing $\leq s_{max}$, clear gap $\geq a_{min}$, $A_s \leq 0.04 A_c$	s	200	mm OK
9.6.2(2)	Wall minimum: each face $\geq 0.001 A_c$ (half of 0.002 A_c)	$A_{s,min}$	565	mm ² /m OK
9.6.2(1)	Wall maximum: both faces $\leq 0.04 A_c$	$A_{s,v}$	1131	mm ² /m OK

The soil face is designed for the base moment; for a pinned base it carries the wall minimum. $VR_{d,c}$ with the bars of each face anchored beyond the section (6.2.2(1)); the shear is taken at the support centreline (conservative, 6.2.1(8)). The thickness check keeps a clear gap between the two layers of vertical bars, measured with the cover to the vertical bars (horizontal bars inside them).

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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
vRd,max factor (vRd,max = factor · v · fcd)	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 (vEd ≤ kmax · vRd,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, $\delta \geq k1 + k2 x_u/d$)	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