

Stair flight

Inclined slab spanning between supports · EN 1992-1-1 §6.1, §6.2, §7.4, §9.3 · UK NA / PN-EN

Reference	NAE-RC-015 · 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) · stair loads to EN 1991-1-1 (imposed load from the user)
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

Design of a straight reinforced concrete stair flight spanning between two supports as an inclined slab: loads on plan from the waist and the steps, the design moment and shear, main and distribution bars, shear without links, deflection by the span to depth ratio and the slab detailing rules.

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

Straight flight of equal steps spanning longitudinally, simply supported at the foot and the head ($M = n L^2 / 8$, $V = n L / 2$ on the horizontal span L), 1 m wide strip. Loads per m^2 on plan: waist $\gamma_c t / \cos \theta$, steps $\gamma_c r / 2$, finishes and the imposed load from the user (EN 1991-1-1 Table 6.2: stairs). The section is the waist, d measured at right angles to the soffit. Deflection by (7.16) with $K = 1.0$ on the horizontal span, the $(A_{s,prov} / A_{s,req})(500 / f_{yk})$ factor ($UK \leq 1.5$), $7/L$ for spans over 7 m with brittle partitions and the UK 40K cap. The shear is the support reaction $n L / 2$ (conservative for the section normal to the waist). Not checked here: the concentrated imposed load of EN 1991-1-1 (6.2.1(3), Table 6.2) as a local check, the reinforcement of free edges (9.3.1.4) and top bars at the supports for partial fixity (9.3.1.2(2)). Landings, flights spanning across the stair, cantilever steps and stairs built into walls on their sides are outside the scope. $f_{yk} 400 - 500$ MPa (3.2.2(3)). 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: Slabs.
 - The Concrete Centre, RC Spreadsheets v4, TCC71 Stair flight (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

Project
Element
Date

Job no.
Made by
Checked

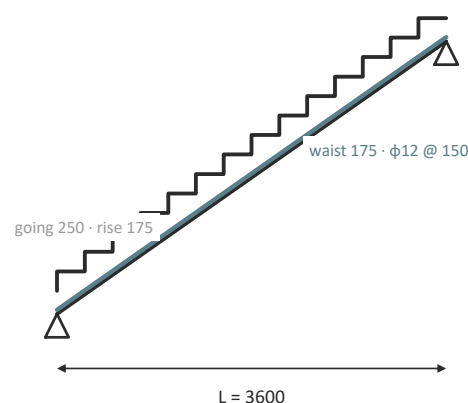
Inputs · flight
Shaded cells only

	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
5.3.2.2	Horizontal effective span (5.3.2.2: clear span + a1 + a2)	L	3600	mm
	Going	g	250	mm
	Rise	r	175	mm
	Waist thickness (at right angles to the soffit)	t	175	mm
4.4.1	Nominal cover	c_{nom}	25	mm
	Main bars: diameter	φ	12	mm
	Main bars: spacing	s	150	mm
	Distribution bars: diameter	φ_d	10	mm
	Distribution bars: spacing	s_d	300	mm

Inputs · loads
Characteristic, per m² on plan

	Finishes	g_k	1.00	kN/m ²
	Imposed load (EN 1991-1-1 Table 6.2, stairs)	q_k	3.00	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 7 m?		No	
	Inputs valid and consistent			OK

Your flight, to scale · steps, waist, supports and main bars · steps redrawn to fit L (up to 24)


Results

Bending $A_{s,req} / A_{s,prov}$	0.58	OK
Shear without links $V_{Ed} / V_{Rd,c}$	0.33	OK
Deflection actual $l/d \div$ limiting l/d	0.63	OK

Detailing (distribution bars, spacing, A_s , max)	262	mm ² /m	OK
Comfort 2r + g (550 – 700 mm, usual range)	600	mm	OK

Calculation · loads and actions (per m width)

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
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
	Pitch $\theta = \tan(r / g)$	ϑ	35.0	°
	Waist on plan $25 t / \cos \theta$	g_w	5.34	kN/m ²
	Steps $25 r / 2$	g_s	2.19	kN/m ²
EN 1990 (6.10)	Design load $\gamma_G (g_w + g_s + g_k) + \gamma_Q q_k$	n	16.01	kN/m ²
	Design moment $n L^2 / 8$	M_{Ed}	25.9	kNm/m
	Design shear $n L / 2$ (support reaction, conservative)	V_{Ed}	28.8	kN/m

Calculation · waist section

	Effective depth $t - c - \phi/2$	d	144	mm
	$K = M / (b d^2 f_{ck})$	K	0.039	
3.1.7(3)	Limit on K without compression bars ($\xi \leq 0.45$)	K'	0.167	
	As required $M / (f_{yd} z)$, $z = d (1 - 0.4\xi) \leq 0.95 d$	$A_{s,req}$	436	mm ² /m
(9.1N)	As,min $\max(0.26 f_{ctm}/f_{yk}; 0.0013) b d$	$A_{s,min}$	226	mm ² /m
	As provided $1000 \pi \phi^2 / (4 s)$	$A_{s,prov}$	754	mm ² /m
(6.2)	Shear resistance without links	$V_{Rd,c}$	88.4	kN/m
9.3.1.1(3)	Bending $A_{s,prov} \geq \max(A_{s,req}; A_{s,min})$, main spacing $\leq s_{max}$	A_s	754	mm ² /m
(6.2)	Shear $V_{Ed} \leq V_{Rd,c}$	V_{Ed}	28.8	kN/m

Calculation · deflection and detailing

7.4.2	$\rho = \max(A_{s,req}; A_{s,min}) / (b d)$	ρ	0.00303	N/A: bending fails
(7.16)	$\rho_0 = \sqrt{f_{ck}} \cdot 10^{-3}$	ρ_0	0.00566	
(7.16)	Basic span to depth ratio ($K = 1.0$)	l/d	41.5	
7.4.2(2)	Steel stress factor ($A_{s,prov} / A_{s,req}$)(500 / f_{yk}) ($UK \leq 1.5$)	F_3	1.500	
7.4.2(2)	Long span factor $7 / L$ ($L > 7$ m, brittle partitions)	F_2	1.000	
7.4.2	Limiting span to depth ratio ($UK NA: \leq 40$)	l/d_{lim}	40.0	
	Actual L / d	l/d	25.0	
7.4.2	Deflection $l/d \leq \text{limit}$	l/d	25.0	OK
9.3.1.1(3)	Maximum main bar spacing at maximum moment $\min(2h; 250)$	s_{max}	250	mm
8.2(2)	Minimum clear gap $\max(\phi; dg + 5; 20)$	a_{min}	25	mm
	Distribution bars provided	$A_{s,d}$	262	mm ² /m
9.3.1.1	Distribution $\geq 20\%$ main, spacings, clear gaps, $A_s \leq 0.04 A_c$		262	mm ² /m

Still to detail: top bars over both supports for 25 % of the span moment, extending 0.2 L (9.3.1.2(2)); bottom bars anchored into the supports (9.3.1.2(1)); U-bars or equivalent along free edges (9.3.1.4); the local check of the concentrated imposed load (EN 1991-1-1 6.2.1(3)).

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