Column effective length

Effective length and slenderness of a column · EN 1992-1-1 §5.8.3 · UK NA / PN-EN

Reference	NAE-RC-037 · 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
Issued	29 October 2026

What it does

Effective length of a column in a regular frame from the relative flexibility of the restraints at its two ends (5.15 braced, 5.16 unbraced), its slenderness and the slenderness limit above which second-order effects must be included.

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

Rectangular column, bending about the axis with the depth h entered, clear height l between the restraints. At each end: beams (one or two, rectangular gross sections), a fixed foundation (k = 0.1, the least value of 5.8.3.2(3)) or a pin (k = ∞). k = (EI / l)column / Σ κ (EI / L)beam, with the column above or below added to the column term when it contributes to the rotation (5.8.3.2(4)), κ the rotational stiffness factor of the beams entered: 4 far end fixed, 3 pinned for uncracked elastic beams; the stiffness of the restraining beams must include cracking unless they are shown to be uncracked at ULS (5.8.3.2(5)), for which κ = 2 is a common allowance (TCC guidance). E the same throughout; k not less than 0.1. Braced (5.15): l0 = 0.5 l √((1 + k1/(0.45 + k1))(1 + k2/(0.45 + k2))); unbraced (5.16): l0 = l max(√(1 + 10 k1 k2 / (k1 + k2)); (1 + k1/(1 + k1))(1 + k2/(1 + k2))). Slenderness λ = l0 / i, i = h / √12 (5.14); limit λlim = 20 A B C / √n (5.13N) with A and B entered (0.7 and 1.1 when not known) and C = 1.7 − rm, rm = M01 / M02 with |M02| ≥ |M01|, positive when both end moments give tension on the same side, negative otherwise. rm = 1 (C = 0.7) is taken for unbraced columns and for braced columns whose first-order moments arise mainly from imperfections or transverse load (5.8.3.1(1)); n = NEd / (Ac fcd). The second-order design itself is RC-008. Unbraced columns pinned at both ends are unstable and FAIL.
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: Columns (effective length, slenderness).
- The Concrete Centre, Concise Eurocode 2, 5.6 (slenderness).

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Revision history

v1.0	29 Oct 2026 · First issue

Project		Job no.	
Element		Made by	
Date		Checked	

Inputs · column and frame

Shaded cells only

	National Annex		**UK NA (BS EN)**		
Table 3.1	Concrete strength class		**C32/40**		
5.8.3.2	Frame		**Braced**		
	Clear height between restraints	l	**3500**	mm	
	Column: width b	b	**400**	mm	
	Column: depth h (in the direction of buckling)	h	**400**	mm	
	Beam stiffness factor κ in κ EI / L	κ	**2.0**		4 fixed, 3 pinned far end
5.8.3.2(3)	Top end		**Beams**		
	Top: number of beams (1 – 2)	n	**2**		
	Top beam 1: b × h × span	b	**300**	mm	
		h	**600**	mm	
		L	**6000**	mm	
	Top beam 2: b × h × span	b	**300**	mm	
		h	**600**	mm	
		L	**6000**	mm	
5.8.3.2(4)	Top: column beyond the node, same section (0 = none or not c	l_{adj}	**3500**	mm	
5.8.3.2(3)	Bottom end		**Beams**		
	Bottom: number of beams (1 – 2)	n	**2**		
	Bottom beam 1: b × h × span	b	**300**	mm	
		h	**600**	mm	
		L	**6000**	mm	
	Bottom beam 2: b × h × span	b	**300**	mm	
		h	**600**	mm	
		L	**6000**	mm	
5.8.3.2(4)	Bottom: column beyond the node, same section (0 = none or n	l_{adj}	**0**	mm	

Inputs · for the slenderness limit

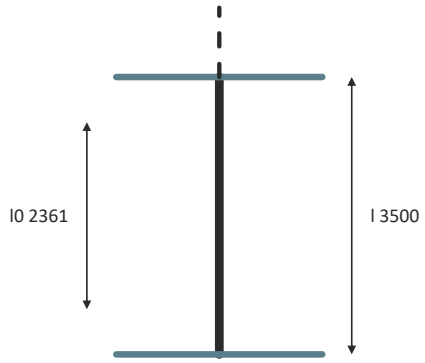
Ultimate limit state

	Axial force	N_{Ed}	**2000**	kN	
5.8.3.1(1)	Factor A = 1 / (1 + 0.2 ϕef)	A	**0.70**		
5.8.3.1(1)	Factor B = √(1 + 2 ω)	B	**1.10**		
5.8.3.1(1)	Braced: first-order moments from (unbraced: either, not used)		**End moments only**		
5.8.3.1(1)	End moments: rm = M01 / M02, |M02| ≥ |M01| (+ same side i	r_m	**1.00**		
	Inputs valid and consistent				**OK**

Results

	Effective length	l_0	**2361**	mm	
	Effective length factor	$l_{0/l}$	**0.675**		
	Slenderness λ / λlim (5.8.3.1)		**1.57**		**Slender: 2nd order**
	Slenderness λ and its limit	λ	**20.4 / 13.0**		

Your column, elevation · clear height l, the beams framing in at each end (schematic, drawn longer for the longer span), the column beyond a node when counted (dashed),



k1 0.34 · k2 0.17 · λ 20

Calculation · relative flexibilities

	Column I / l (E cancels)	$I_{c/l}$	6.095E+05	mm³	
5.8.3.2(3)	Beams at the top Σ κ I / L	$\Sigma \kappa I_{b/L}$	3.600E+06	mm³	
5.8.3.2(4)	Column term at the top I/l + I/l_adj	$\Sigma I_{c/l}$	1.219E+06	mm³	
5.8.3.2(3)	k at the top (≥ 0.1; fixed 0.1, pinned ∞)	k_1	0.339		
5.8.3.2(3)	Beams at the bottom Σ κ I / L	$\Sigma \kappa I_{b/L}$	3.600E+06	mm³	
5.8.3.2(4)	Column term at the bottom I/l + I/l_adj	$\Sigma I_{c/l}$	6.095E+05	mm³	
5.8.3.2(3)	k at the bottom (≥ 0.1; fixed 0.1, pinned ∞)	k_2	0.169		

Calculation · effective length and slenderness

(5.15)	Braced 0.5 l √((1 + k1/(0.45 + k1))(1 + k2/(0.45 + k2)))	$l_{0,br}$	2361	mm	
(5.16)	Unbraced l max(√(1 + 10 k1 k2/(k1 + k2)); (1 + k1/(1 + k1))(1 + k	$l_{0,unbr}$	5107	mm	
5.8.3.2	Used	l_0	**2361**	mm	
(5.14)	Slenderness l0 / i, i = h / √12	λ	20.4		
2.4.2.4(1)	Partial factor, concrete	γ_c	1.50		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	
(5.13N)	Relative axial force NEd / (Ac fcd)	n	0.689		
5.8.3.1(1)	C = 1.7 − rm (unbraced, imperfections or transverse load: rm = 1	C	0.70		
(5.13N)	Limit 20 A B C / √n	λ_{lim}	13.0		
5.8.3.1(1)	λ ≤ λlim: second-order effects may be ignored		20.4		**FAIL**

For a column restrained differently about its two axes, run the sheet once for each axis with h the depth in that direction. Where a column is pinned at one end k = ∞ is represented by 10^9.

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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 γc	2.4.2.4(1)	**1.5**	**1.4**	Persistent & transient. UK NA: recommended; PL: NA.2, Table NA.2
Partial factor, reinforcement γs	2.4.2.4(1)	**1.15**	**1.15**	UK NA: recommended; PL: NA.2, Table NA.2
αcc (compression in flexure / axial)	3.1.6(1)	**0.85**	**1**	UK NA: 0.85; PL: recommended (NA.9)
αcc,pl (plain concrete, compression)	12.3.1(1)	**0.6**	**0.8**	UK NA Table NA.1: 0.6; PL: recommended (NA.9)
αcc (shear and punching)	3.1.6(1)	**1**	**1**	UK NA: 1.0 for other phenomena; PL: recommended (NA.9)
αct (design tensile strength)	3.1.6(2)	**1**	**1**	Recommended value in both annexes
CRd,c numerator (CRd,c = value / γc)	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 · ν · fcd)	6.4.5(3)	**0.5**	**0.4**	UK NA: 0.5 ν fcd; PL: recommended value (NA.9), 0.4 ν fcd since EN 1992-1-1 AC:2010 (PN-EN 1992-1-1:200
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
ϕlarge (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 ≤ cot θ ≤ 2.0
k1 (x/d limit, δ ≥ k1 + k2 xu/d)	5.5(4)	**0.4**	**0.44**	UK NA for fyk ≤ 500 MPa; PL: recommended (NA.9)
k2 (x/d limit, εcu2 = 0.0035)	5.5(4)	**1**	**1.25**	UK NA: 0.6 + 0.0014/εcu2; PL: 1.25(0.6 + 0.0014/εcu2)
Upper limit on the (310/σs) factor (0 = none)	7.4.2(2)	**1.5**	**0**	UK NA Table NA.5 Note 5: (310/σs) or (500/fyk)(As,prov/As,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
ϕmin (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