Flanged beam

T and L beams in sagging · EN 1992-1-1 §5.3.2.1, §6.1, §6.2.4 · UK NA / PN-EN

Reference	NAE-RC-031 · 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

Bending design of a T or L beam with the flange (a slab cast with it) in compression: the effective flange width, the neutral axis in the flange or in the web, the tension steel needed, and the longitudinal shear between the web and the flange with the transverse steel it needs in the flange.

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

Sagging moment only (flange in compression), tension bars in one layer at d, no compression steel: where K > K′ the sheet reports FAIL. Effective width to 5.3.2.1 (5.7), (5.7a), (5.7b): beff,i = min(0.2 bi + 0.1 l0; 0.2 l0; bi) with bi half the clear distance to the next web and l0 the distance between points of zero moment (Figure 5.2, entered). Rectangular stress block λ = 0.8, η = 1 (fck ≤ 50 MPa), fcd = αcc fck / γc. Stress block (0.8 x) in the flange when MEd ≤ fcd beff hf (d − hf/2): the section is rectangular beff wide; otherwise the outstands carry fcd (beff − bw) hf and the web the rest, its depth limited by K′ (5.5(4), no redistribution). As,min to (9.1N) with bt = bw, As,max 0.04 Ac. The flange transverse bars must fit in hf with at least 20 mm above and below them; θf limits (6.2.4(4)) and k = 0.4 (6.2.4(6)) are the recommended values, kept by the UK NA and the PL NA (NA.9). The neutral axis x is shown from equilibrium; the steel uses z ≤ 0.95 d (conservative). Bars in one layer; their centres are h − d from the bottom and from the sides of the web, with at least 25 mm of concrete outside them (cover to the bars, links included; the cover for durability and fire is for the designer). Flange shear (6.2.4): ΔFd is the force in the larger outstand at MEd, built up over Δx (entered and checked: at most half the distance between zero and maximum moment and, with point loads, at most their spacing; the whole outstand force over that length is conservative); vEd = ΔFd / (hf Δx); no extra steel if vEd ≤ k fctd (k = 0.4, 6.2.4(6)); otherwise Asf / sf = vEd hf / (fyd cot θf) with the largest cot θf ≤ 2.0 (26.5° ≤ θf ≤ 45° for a compression flange) that keeps vEd ≤ v fcd sin θf cos θf (6.22). Where the flange also bends across the web, provide the larger of Asf and half Asf plus the bending steel (6.2.4(5)), not checked here. Vertical shear of the web: RC-004. fyk 400 – 500 MPa.
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: Beams (flanged beams, flange shear).
- The Concrete Centre, Concise Eurocode 2, 5.3 and 7.2.
- The Concrete Centre, RC Spreadsheets v4 (licensed product) can be used as an independent cross-check.

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About NA Engineering

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Disclaimer

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Revision history

v1.0	29 Oct 2026 · First issue

Project		Job no.	
Element		Made by	
Date		Checked	

Inputs · section

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	
	Section		**T-beam (flange both sides)**		
	Web width	b_w	**300**	mm	
	Overall depth	h	**600**	mm	
	Flange thickness	h_f	**150**	mm	
	Effective depth to the tension bars	d	**545**	mm	
Figure 5.3	Half the clear distance to the next web, side 1	b_1	**1350**	mm	
Figure 5.3	Side 2 (T-beam only)	b_2	**1350**	mm	
Figure 5.2	Distance between points of zero moment	l_0	**6000**	mm	0.85 l1 end span, 0.7 l2 inner
	Tension bars: number (1 – 8)	n	**4**		
	Diameter	φ	**25**	mm	
6.2.4(4)	Flange transverse bars crossing the web face: diameter	φ_f	**10**	mm	
	Spacing	s_f	**200**	mm	

Inputs · design actions

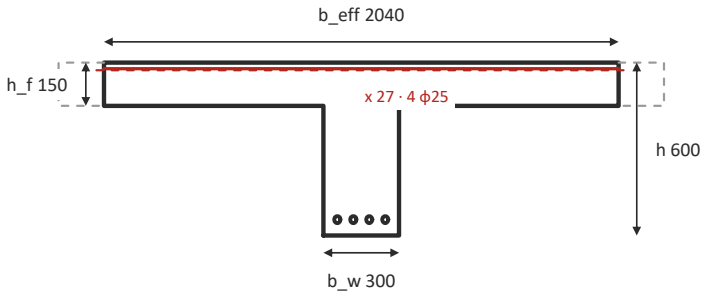
Ultimate limit state

	Sagging moment	M_{Ed}	**420.0**	kNm	
6.2.4(3)	Distance from zero to maximum moment	a_M	**3000**	mm	
6.2.4(3)	Spacing of point loads in that length (0 = none)	a_P	**0**	mm	
6.2.4(3)	Length over which the flange force builds up (≤ a_M / 2, ≤ a_P)	Δx	**1500**	mm	
	Inputs valid and consistent				**OK**

Results

Bending As,req / As,prov (K ≤ K', As,min, As,max)		**0.95**		OK
Flange shear, struts vEd / v fcd sin θf cos θf (6.22)		**0.34**		OK
Flange transverse steel need / provided (6.21)		**0.68**		OK
Effective flange width	b_{eff}	**2040**	mm	
Neutral axis (stress block 0.8 x in the flange or reaching th	x	**27**	mm	**block in flange**
Tension steel needed / provided	A_s	**1866 / 1963**	mm²	

Your section, to scale · effective flange (solid), the slab beyond it (dashed), the compression block (shaded edge), neutral axis and bars



Calculation · effective 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
3.1.6(1)	Coefficient on compressive strength (shear)	α_{cc}	1.00		NDP sheet
3.1.6(2)	Coefficient on tensile strength	α_{ct}	1.00		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}	32	MPa	
Table 3.1	Mean tensile strength	f_{ctm}	3.02	MPa	
(5.7a), (5.7b)	Side 1 min(0.2 b1 + 0.1 l0; 0.2 l0; b1)	$b_{eff,1}$	870	mm	
(5.7a), (5.7b)	Side 2 min(0.2 b2 + 0.1 l0; 0.2 l0; b2) (0 for an L-beam)	$b_{eff,2}$	870	mm	
(5.7)	Effective flange width bw + Σ beff,i	b_{eff}	**2040**	mm	

Calculation · bending

3.1.6(1)	Design compressive strength αcc fck / γc	f_{cd}	18.13	MPa	
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 x/d, no redistribution min((1 − k1)/k2; ξy)	$x_{u/d}$	0.600		
3.1.7(3)	Limiting K (αcc/γc) 0.8 ξ (1 − 0.4 ξ)	K'	0.207		
3.1.7(3)	Flange alone fcd beff hf (d − hf/2)	M_f	2607.9	kNm	
	Outstands when the stress block reaches the web fcd (beff − bw	F_{out}	0.0	kN	
	Moment for the rectangle (beff, or bw after the outstands)	M_r	420.0	kNm	
	Width of the rectangle	b_r	2040	mm	
3.1.7(3)	K = Mr / (br d² fck)	K	0.022		

	Lever arm of the rectangle ≤ 0.95 d	z	518	mm	N/A: K > K'
	Neutral axis from equilibrium 1.25 d (1 − √(1 − 2K / (αcc/γc))) (z	x	27	mm	
	Tension steel needed Fout / fyd + Mr / (fyd z)	A_s	**1866**	mm²	
(9.1N)	Minimum max(0.26 fctm/fyk; 0.0013) bw d	$A_{s,min}$	257	mm²	
9.2.1.1(3)	Gross area for As,max = 0.04 Ac (effective flange)	A_c	441000	mm²	
	Provided n π ϕ² / 4	$A_{s,prov}$	1963	mm²	
6.1, 9.2.1.1	K ≤ K'; As,min ≤ As,prov ≤ 0.04 Ac; As,prov ≥ As		1963	mm²	**OK**

Calculation · shear between web and flange, 6.2.4

	Larger outstand	$b_{eff,i}$	870	mm	
6.2.4(3)	Force in it at MEd (block in flange: Mr/z · bo/beff; reaching the	ΔF_d	346.0	kN	
(6.20)	Longitudinal shear stress ΔFd / (hf Δx)	v_{Ed}	**1.538**	MPa	
3.1.6	fcd for shear αcc fck / γc; fctd = αct 0.7 fctm / γc	f_{cd}	21.33	MPa	
3.1.6(2)		f_{ctd}	1.411	MPa	
(6.6N)	v = 0.6 (1 − fck/250)	v	0.523		
6.2.4(4)	Ratio r = vEd / (v fcd) (struts need r ≤ 0.5)	r	0.138		
6.2.4(4)	cot θf largest ≤ 2.0 with sin θf cos θf ≥ r	$\cot\vartheta_f$	2.000		
(6.22)	vEd ≤ v fcd sin θf cos θf		1.538	MPa	**OK**
6.2.4(6)	No extra steel below 0.4 fctd	$k f_{ctd}$	0.564	MPa	
(6.21)	Transverse steel needed vEd hf / (fyd cot θf) (0 below k fctd)	A_{sf/s_f}	0.265	mm²/mm	
	Provided π ϕf² / 4 / sf	A_{sf/s_f}	0.393	mm²/mm	
(6.21)	Flange transverse steel: provided ≥ needed		0.393	mm²/mm	**OK**

The transverse bars counted here cross the web face over the full flange thickness and are anchored on both sides. Combine them with any slab bending steel to 6.2.4(5). The bars are drawn in one layer evenly spread over the web.

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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 (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