NOTHING BEATS A GREAT TEMPLATE

Preface

Content
Interactive design aids for steel elements in accordance to BS EN 1993

Guidelines of use
After installing a free trial or demo version the interactive templates will be available free of charge. The only requirement is a registration at www.VCmaster.com.

The examples provided have been created using VCmaster. All annotated and illustrated design aids can be used as a basis to create own templates. In order to do this a full version of VCmaster is necessary.

All templates are linked to various databases by TAB()- or SEL() functions. For instructional purposes these links are displayed in this document, but can also be hidden when printing.

What is VCmaster?
VCmaster is a software application for technical documentation specifically designed for engineers. The unique software concept integrates all structural design and CAD software. Universal interfaces guarantee data transfer, so that the output of all programs can be transposed.

Beside its functions for documentation, VCmaster offers an intuitive concept enabling engineers to carry out calculations. The input of mathematic formulas can be executed in natural notation directly in the document itself. The software significantly supports the reuse of structural calculations and documents. VCmaster simplifies modifications and adjustments and automates standard tasks. Collaboration with work-groups or with other offices and clients is uncomplicated as well. As a result, processing time and costs can be considerably reduced.

System Requirements
VCmaster 2016 or newer

Development and Copyrights
Developed in Germany
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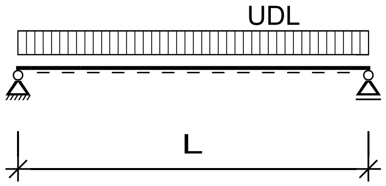
Contents

Chapter 1: Beams

Beam deflection



Dimensions

Beam span L = 5.00 m
Slab span s = 4.00 m
Slab thickness h = 200.00 mm

Properties

Serial size: SEL("EC3_BS/"type; ID;) = 305x165x54
2nd moment of area I_y = TAB("EC3_BS/"type; Iy; ID=size) = 11700.00 cm^4

Loads on steel beam

Imposed load on slabs Q_k = 5.00 kN/m²

Slab: $h*s*L*25 = 0.20*4.00*5.00*25$ = 100.00 kN
Screed: $s*L*1.2 = 4.00*5.00*1.2$ = 24.00 kN
Steel beam: TAB("EC3_BS/"type; m; ID=size) * L / 100 = 2.70 kN

G_k = 126.70 kN

Imposed load Q_k = $Q_k*s*L = 5.00*4.00*5.00$ = 100.00 kN

Deflection under dead load

$$w_D = \frac{5*G_k*L^3*10^3}{384*E*I_y*10^4} = \frac{5*126.70*5000^3*10^3}{384*210000*11700.00*10^4} = 8.4\ \text{mm}$$

Deflection under imposed load

$$w_I = \frac{5*Q_k*L^3*10^3}{384*E*I_y*10^4} = \frac{5*100.00*5000^3*10^3}{384*210000*11700.00*10^4} = 6.6\ \text{mm}$$

Deflection limit

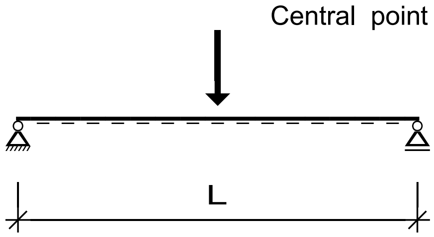
The criteria apply only to deflection under imposed loads. For beams supporting plastered finishes:

Deflection limit $w_{max} = \frac{L}{360} = \frac{5000}{360}$ = 13.9 mm

The beam meets the deflection criteria:

$$\frac{w_I}{w_{max}} = \mathbf{0.47 \leq 1}$$

Beam deflection (Central point load)



Dimensions an loads

Beam span L = 5.00 m
Imposed load on beam Q_k = 100.00 kN

Properties

Serial size: SEL("EC3_BS/"type; ID;) = 305x165x54
2nd moment of area I_y = TAB("EC3_BS/"type; Iy; ID=size) = 11700.00 cm^4

Deflection under imposed load

$$w_l = \frac{Q_k * L^3 * 10^3}{48 * E * I_y * 10^4} = \frac{100.00 * 5000^3 * 10^3}{48 * 210000 * 11700.00 * 10^4} = 10.6 \text{ mm}$$

Deflection limit

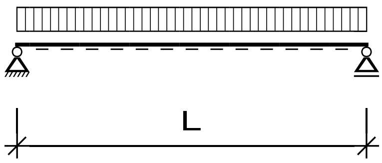
The criteria apply only to deflection under imposed loads. For beams supporting plastered finishes:

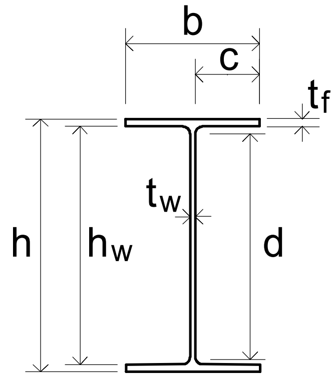
$$\text{Deflection limit } w_{max} = \frac{L}{360} = \frac{5000}{360} = 13.9 \text{ mm}$$

The beam meets the deflection criteria:

$$\frac{w_l}{w_{max}} = \mathbf{0.76 \leq 1}$$

Design buckling resistance moment of an unrestrained steel beam





Properties

Adopted serial size:	SEL("EC3_BS/"type; ID;)	=	254x146x43
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	259.60 mm
Breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	147.30 mm
2nd moment of area I_z =	TAB("EC3_BS/"type; Iz; ID=size)	=	677.00 cm^4
Plastic modulus $W_{pl,y}$ =	TAB("EC3_BS/"type; $W_{pl,y}$; ID=size)	=	566.00 cm^3
Warping constant I_w =	TAB("EC3_BS/"type; Iw ; ID=size)	=	0.103 dm^6
Torsion constant I_T =	TAB("EC3_BS/"type; IT ; ID=size)	=	23.90 cm^4
Beam span L =			5.00 m

Calculation of M_{cr}

C_1 = TAB("EC3_BS/C"; C1; Sel = Sel) = 1.00

$$M_{cr} = C_1 * \frac{\pi^2 * E * I_z}{L^2} * \sqrt{\frac{I_w}{I_z} + \frac{L^2 * G * I_T}{\pi^2 * E * I_z}} = 125.13 \text{ kNm}$$

Calculation of the design buckling resistance moment $M_{b,Rd}$

$$\lambda_{LT} = \sqrt{\frac{f_y * W_{pl,y}}{M_{cr} * 10^3}} = \sqrt{\frac{275.00 * 566.00}{125.13 * 10^3}} = 1.115 \text{ kNm}$$

α_{LT} = TAB("EC3_BS/alpha"; α_{LT}; Type=type; Limit>h/b) = 0.34

$\lambda_{LT,0}$ = 0.40

β = 0.75

$$\Phi_{LT} = 0.5 * (1 + \alpha_{LT} * (\lambda_{LT} - \lambda_{LT,0}) + \beta * \lambda_{LT}^2) = 1.088$$

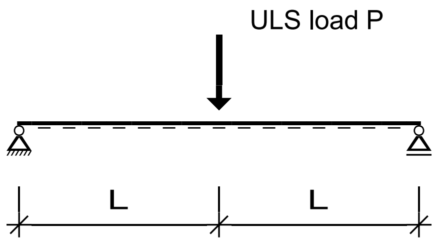
$$\chi_{LT} = MIN\left(\frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta * \lambda_{LT}^2}}; 1.00 ; \frac{1}{\lambda_{LT}^2}\right) = 0.629$$

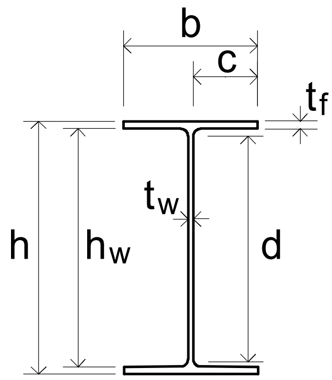
$$f = MIN\left(1 - 0.5 * \left(1 - \frac{1}{\sqrt{C_1}}\right) * \left(1 - 2.0 * (\lambda_{LT} - 0.8)^2\right) ; 1.0\right) = 1.000$$

$$\chi_{LT,mod} = MIN\left(\frac{\chi_{LT}}{f} ; \frac{1}{\lambda_{LT}^2}; 1.0\right) = 0.629$$

$$M_{b,Rd} = \frac{\chi_{LT,mod} * f_y * W_{pl,y}}{10^3} = \frac{0.629 * 275.00 * 566.00}{10^3} = \mathbf{97.90 \text{ kNm}}$$

Steel beam with central lateral restraint





Loads and lengths

Single central point load P_d = 100.00 kN
Span L_{span} = 6000.00 mm
Effiective unstrained length L = 3000.00 mm

$$M_{Ed} = \frac{P_d * L_{span}}{4} = \frac{100.00*6.00}{4} = 150.00 \text{ kNm}$$

Properties

Adopted serial size:	SEL("EC3_BS/"type; ID;)	=	305x165x54
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	310.40 mm
Breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	166.90 mm
2nd moment of area I_z =	TAB("EC3_BS/"type; Iz; ID=size)	=	1063.00 cm^4
Plastic modulus $W_{pl,y}$ =	TAB("EC3_BS/"type; $W_{pl,y}$; ID=size)	=	846.00 cm^3
Warping constant I_w =	TAB("EC3_BS/"type; Iw ; ID=size)	=	0.234 dm^6
Torsion constant I_T =	TAB("EC3_BS/"type; IT ; ID=size)	=	34.80 cm^4

Calculation of M_{cr}

C_1 = TAB("EC3_BS/C"; C1; Sel = Sel) = 1.77

$$M_{cr} = C_1 * \frac{\pi^2 * E * I_z}{L^2} * \sqrt{\frac{I_w}{I_z} + \frac{L^2 * G * I_T}{\pi^2 * E * I_z}} = 793.39 \text{ kNm}$$

Calculation of the design buckling resistance moment $M_{b,Rd}$

$$\lambda_{LT} = \sqrt{\frac{f_y * W_{pl,y}}{M_{cr} * 10^3}} = \sqrt{\frac{275.00*846.00}{793.39*10^3}} = 0.542$$

α_{LT} = TAB("EC3_BS/alpha"; α_{LT}; Type=type; Limit>h/b) = 0.34

$\lambda_{LT,0}$ = 0.40

β = 0.75

$$\Phi_{LT} = 0.5 * (1 + \alpha_{LT} * (\lambda_{LT} - \lambda_{LT,0}) + \beta * \lambda_{LT}^2) = 0.634$$

$$\chi_{LT} = MIN\left(\frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta * \lambda_{LT}^2}}; 1.00 ; \frac{1}{\lambda_{LT}^2}\right) = 0.943$$

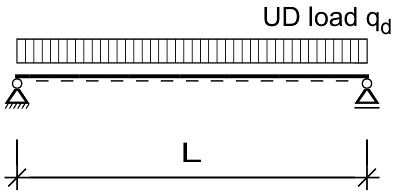
$f = \text{MIN}\left(1 - 0.5 * \left(1 - \frac{1}{\sqrt{C_1}}\right) * \left(1 - 2.0 * (\lambda_{LT} - 0.8)^2\right); 1.0\right) = 0.892$

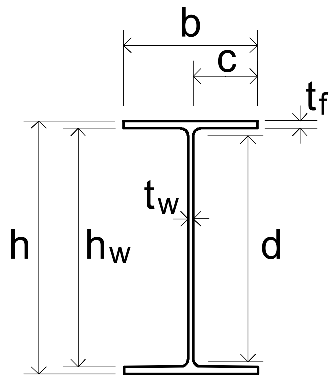
$\chi_{LT,mod} = \text{MIN}\left(\frac{\chi_{LT}}{f}; \frac{1}{\lambda_{LT}^2}; 1.0\right) = 1.000$

$M_{b,Rd} = \frac{\chi_{LT,mod} * f_y * W_{pl,y}}{10^3} = \frac{1.000 * 275.00 * 846.00}{10^3} = 232.65$ kNm

$\frac{M_{Ed}}{M_{b,Rd}} =$ **$0.64 \leq 1$**

Buckling resistance of a steel beam





Loads and lengths

UD load for ultimate limit states q_d = 15.00 kN/m
Span L_{span} = 6000.00 mm
Effiective unstrained length L = L_{span} = 6000.00 mm

$$M_{Ed} = \frac{q_d * L_{span}^2}{8} = \frac{15.00 * 6.00^2}{8} = 67.50 \text{ kNm}$$

Properties

Adopted serial size:	SEL("EC3_BS/"type; ID;)	=	254x146x43
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	259.60 mm
Breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	147.30 mm
2nd moment of area I_z =	TAB("EC3_BS/"type; Iz; ID=size)	=	677.00 cm^4
Plastic modulus $W_{pl,y}$ =	TAB("EC3_BS/"type; $W_{pl,y}$; ID=size)	=	566.00 cm^3
Warping constant I_w =	TAB("EC3_BS/"type; Iw ; ID=size)	=	0.103 dm^6
Torsion constant I_T =	TAB("EC3_BS/"type; IT ; ID=size)	=	23.90 cm^4

Calculation of M_{cr}

C_1 = TAB("EC3_BS/C"; C1; Sel = Sel) = 1.13

$$M_{cr} = C_1 * \frac{\pi^2 * E * I_z}{L^2} * \sqrt{\frac{I_w}{I_z} + \frac{L^2 * G * I_T}{\pi^2 * E * I_z}} = 112.19 \text{ kNm}$$

Calculation of the design buckling resistance moment $M_{b,Rd}$

$$\lambda_{LT} = \sqrt{\frac{f_y * W_{pl,y}}{M_{cr} * 10^3}} = \sqrt{\frac{275.00 * 566.00}{112.19 * 10^3}} = 1.178$$

α_{LT} = TAB("EC3_BS/alpha"; α_{LT}; Type=type; Limit>h/b) = 0.34

$\lambda_{LT,0}$ = 0.40

β = 0.75

$\Phi_{LT} = 0.5 * (1 + \alpha_{LT} * (\lambda_{LT} - \lambda_{LT,0}) + \beta * \lambda_{LT}^2)$ = 1.153

$$\chi_{LT} = MIN\left(\frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta * \lambda_{LT}^2}}; 1.00 ; \frac{1}{\lambda_{LT}^2}\right) = 0.592$$

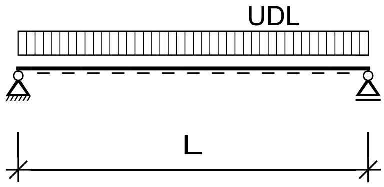
$$f = MIN\left(1 - 0.5 \cdot \left(1 - \frac{1}{\sqrt{C_1}}\right) \cdot \left(1 - 2.0 \cdot (\lambda_{LT} - 0.8)^2\right); 1.0\right) = 0.979$$

$$\chi_{LT,mod} = MIN\left(\frac{\chi_{LT}}{f}; \frac{1}{\lambda_{LT}^2}; 1.0\right) = 0.605$$

$$M_{b,Rd} = \frac{\chi_{LT,mod} \cdot f_y \cdot W_{pl,y}}{10^3} = \frac{0.605 \cdot 275.00 \cdot 566.00}{10^3} = 94.17\ kNm$$

$$\frac{M_{Ed}}{M_{b,Rd}} = \mathbf{\underline{0.72 \leq 1}}$$

Laterally restrained steel floor beam



Properties

Beam span L = 6.00 m
Slab span s = 4.50 m
Slab thickness h = 200.00 mm

Loads

Imposed load on slabs Q_k = 5.00 kN/m²

Slab:	$h*s*L*25 = 0.20*4.50*6.00*25$	=	135.00 kN
Screed:	$s*L*1.2 = 4.50*6.00*1.2$	=	32.40 kN
Steel beam:	TAB("EC3_BS/"type; m; ID=size) * L / 100	=	3.14 kN

G_k = 170.54 kN

Imposed load Q_k = $Q_k*s*L = 5.00*4.50*6.00$ = 135.00 kN

Total UD load for ultimate limit states:
F = $1.35*G_k + 1.50*Q_k = 1.35*170.54 + 1.50*135.00$ = 432.73 kN

Calculation

$$M = \frac{F*L}{8} = \frac{432.73*6.00}{8} = 324.55 \text{ kNm}$$

Plastic section modulus W_{PL} required:

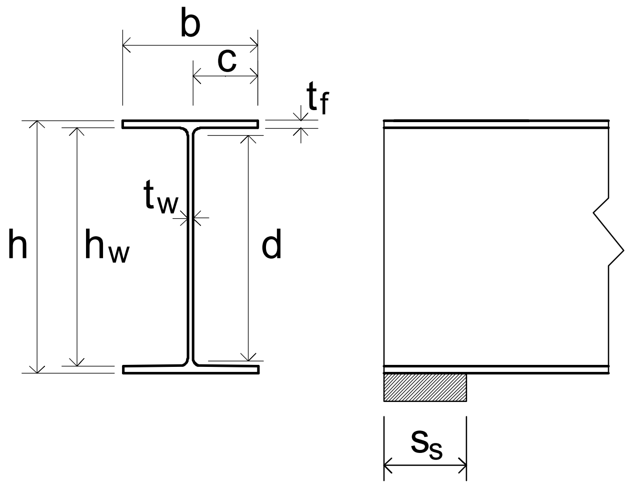
$$W_{PL,required} = \frac{M*10^6*\gamma_M}{1000*f_y} = \frac{324.55*10^6*1.00}{1000*275.00} = 1180.18 \text{ cm}^3$$

Assumed UB

Serial size:	SEL("EC3_BS/"type; ID; $W_{pl,y} > W_{PL,required}$)	=	**356x171x67**
$W_{PL,UB}$ =	TAB("EC3_BS/"type; $W_{pl,y}$; ID=size)	=	1211.00 cm³

$$\frac{W_{PL,required}}{W_{PL,UB}} = \frac{1180.18}{1211.00} = \mathbf{0.97 \le 1}$$

Resistance to transverse forces at an end bearing



Load and dimension

F_{Ed} =	200.00 kN
Stiff bearing s_s =	100.00 mm

Steel properties

Adopted serial size:	SEL("EC3_BS/"type; ID;)	=	254x146x43
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	259.60 mm
Flange breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	147.30 mm
Flange thickness t_f =	TAB("EC3_BS/"type; tf; ID=size)	=	12.70 mm
Web thickness t_w =	TAB("EC3_BS/"type; tw; ID=size)	=	7.20 mm

Calculation

Web height h_w = $h - 2 * t_f$ = 234.20 mm

k_F = $MIN\left(2 + 6 * \left(\frac{s_s}{h_w}\right); 6\right)$ = 4.56

l_e = $MIN\left(\frac{k_F * E * t_w^2}{2 * f_y * h_w}; s_s\right)$ = 100.00 mm

m_1 = $\frac{b}{t_w} = \frac{147.30}{7.20}$ = 20.46

Determine three values for the effective loaded length l_y

$l_{y,1}$ = $s_s + 2 * t_f * (1 + \sqrt{m_1}) = 100.00 + 2 * 12.70 * (1 + \sqrt{20.46})$ = 240.3 mm

$l_{y,2}$ = $l_e + t_f * \sqrt{\frac{m_1}{2} + \left(\frac{l_e}{t_f}\right)^2} = 100.00 + 12.70 * \sqrt{\frac{20.46}{2} + \left(\frac{100.00}{12.70}\right)^2}$ = 207.9 mm

$l_{y,3}$ = $l_e + t_f * \sqrt{m_1} = 100.00 + 12.70 * \sqrt{20.46}$ = 157.4 mm

l_y = $MIN(l_{y,1}; l_{y,2}; l_{y,3})$ = 157.4 mm

Critical force F_{cr} = $0.9 * k_F * E * \frac{t_w^3}{h_w} = 0.9 * 4.56 * 210000 * \frac{7.20^3}{234.20}$ = $1373.53 * 10^3$ N

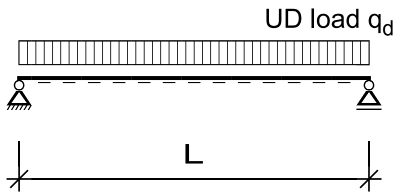
Relativ slenderness $\lambda_F = \sqrt{\frac{l_y * t_w * f_y}{F_{cr}}} = \sqrt{\frac{157.4 * 7.20 * 275.00}{1373530}}$ = 0.476

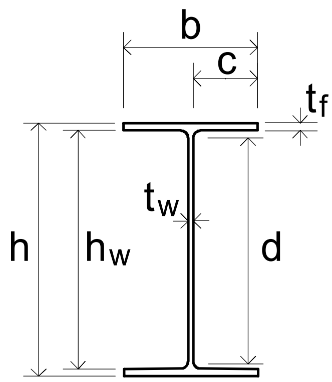
Reduction factor $\chi_F =$ MIN($\frac{0.5}{\lambda_F}$; 1.00) = 1.00

Design resistance $F_{Rd} = f_y * \chi_F * l_y * t_w$ = 27.50 * 1.00 * 15.74 * 0.72 = 311.65 kN

$\frac{F_{Ed}}{F_{Rd}} = \frac{200.00}{311.65}$ = **0.64 ≤ 1**

Shear capacity of a beam





Loads and lengths

UD load for ultimate limit states q_d = 30.00 kN/m

Span L = 6000.00 mm

$V_{Ed} = \dfrac{q_d * L}{2} = \dfrac{30.00 * 6.00}{2}$ = 90.00 kN

Properties

Adopted serial size: SEL("EC3_BS/"type; ID;) = 254x146x43

Steel : SEL("EC3_BS/steel"; ID;) = S275

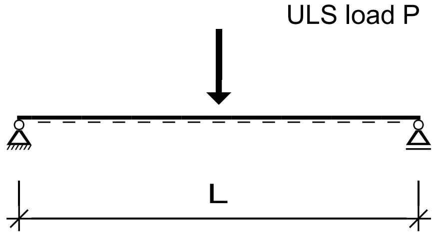
Shear Area A_v = TAB("EC3_BS/"type; A_v; ID=size) = 20.20 cm²

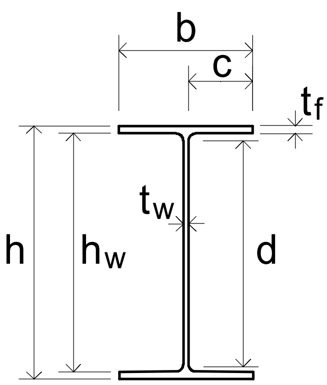
Shear resistance

$V_{pl,Rd} = A_v * \left(\dfrac{fy}{\sqrt{3} * \gamma_M}\right) = 20.20 * \left(\dfrac{27.50}{\sqrt{3} * 1.00}\right)$ = 320.72 kN

$\dfrac{V_{Ed}}{V_{pl,Rd}}$ = **0.28 < 1**

Shear capacity of a beam (Central point load)





Loads and lengths

UD load for ultimate limit states P_d = 200.00 kN

Span L = 6000.00 mm

$V_{Ed} = \frac{P_d}{2} = \frac{200.00}{2}$ = 100.00 kN

Properties

Adopted serial size: SEL("EC3_BS/"type; ID;) = 254x102x22

Steel : SEL("EC3_BS/steel"; ID;) = S275

Shear Area A_v = TAB("EC3_BS/"type; A_v; ID=size) = 15.60 cm²

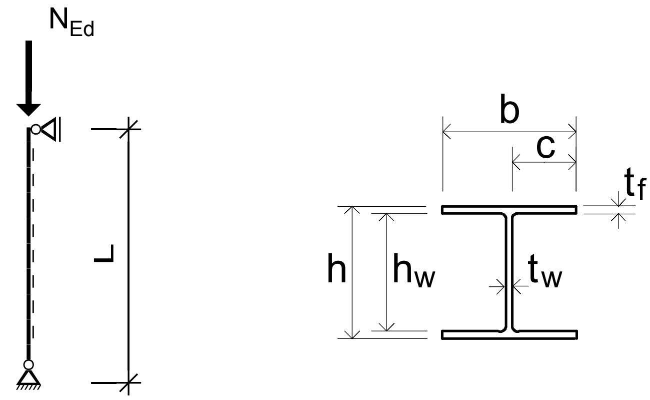
Shear resistance

$V_{pl,Rd} = A_v * \left(\frac{fy}{\sqrt{3} * \gamma_M}\right) = 15.60 * \left(\frac{27.50}{\sqrt{3} * 1.00}\right)$ = 247.68 kN

$\frac{V_{Ed}}{V_{pl,Rd}}$ = **<u>0.40 < 1</u>**

Chapter 2: Columns

Design compression resistance of a column



Loads and lengths

Axial load N_{Ed} = 1000.00 kN

Length L_{span} = 3000.00 mm

Length factor β **=** TAB("EC3_BS/LenFact"; f; r=r) = 1.00

Effective length L = $L_{span} * \beta$ = 3000.00 mm

Axis = z-z

Properties

Adopted serial size: SEL("EC3_BS/"type; ID;) = 203x203x52

Steel : SEL("EC3_BS/steel"; ID;) = S355

2nd moment of area I = IF(Axis ="z-z"; Iz; Iy) = 1778.00 cm^4

Area A = TAB("EC3_BS/"type; A; ID=size) = 66.30 cm^2

Calculation

Critical buckling load N_{cr} = $\frac{\pi^2 * E * I}{L^2 * 10^3} = \frac{3.14159^2 * 210000 * 17780000}{3000.00^2 * 10^3}$ = 4094.56 kN

Plastic axial force capacity = $A * f_y = 66.30 * 35.50$ = 2353.65 kN

Slenderness λ = $\sqrt{\frac{A * f_y}{N_{cr}}} = \sqrt{\frac{66.30 * 35.50}{4094.56}}$ = 0.76

Curve = TAB("EC3_BS/BuckCurve"; c; type = type; f>tf ; a=Axis) = c

Buckling curve value α = TAB("EC3_BS/buckling"; α; curve=Curve) = 0.49

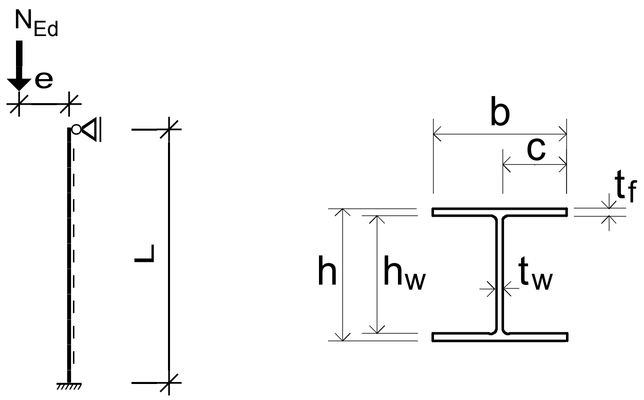
Φ = $0.5 * (1 + \alpha * (\lambda - 0.2) + \lambda^2)$ = 0.93

χ = $MIN(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}};1.0)$ = 0.682

Compression resistance N_{Rd} = $\chi * f_y * A = 0.682 * 35.50 * 66.30$ = 1605.19 kN

$\frac{N_{Ed}}{N_{Rd}} = \frac{1000.00}{1605.19}$ = **0.62 ≤ 1**

Column with moment from eccentric load



Loads and lengths

Axial load N_{Ed} =			400.00 kN
Eccentricity e =			80.90 mm
$M_{y,Ed}$ =	$N_{Ed} * e = 400.00 * 0.0809$	=	32.36 kNm
Length L_{span} =			2800.00 mm
Length factor β =	TAB("EC3_BS/LenFact"; f; r=r)	=	0.85
Effective length L =	$L_{span} * \beta$	=	2380.00 mm

Properties

Serial size:	SEL("EC3_BS/"type; ID;)	=	152x152x37
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	161.80 mm
Breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	154.40 mm

Buckling about the z-z axis

Critical buckling load N_{cr} = $\frac{\pi^2 * E * I_z}{L^2 * 10^3} = \frac{3.14159^2 * 210000 * 7060000}{2380.00^2 * 10^3}$ = 2583.27 kN

Plastic axial force capacity = $A * f_y = 47.10 * 27.50$ = 1295.25 kN

Slenderness λ = $\sqrt{\frac{A * f_y}{N_{cr}}} = \sqrt{\frac{47.10 * 27.50}{2583.27}}$ = 0.71

Buckling curve value α = TAB("EC3_BS/buckling"; α; curve=Curve) = 0.49

Φ = $0.5 * (1 + \alpha * (\lambda - 0.2) + \lambda^2)$ = 0.88

χ = $MIN(\frac{1}{\Phi + \sqrt{\Phi^2 - \lambda^2}};1.0)$ = 0.714

Compression resistance N_{Rd} = $\chi * f_y * A = 0.714 * 27.50 * 47.10$ = 924.81 kN

$\frac{N_{Ed}}{N_{Rd}} = \frac{400.00}{924.81}$ = **0.43 ≤ 1**

Bending about the y-y axis

$$M_{cr} = C_1 \cdot \frac{\pi^2 \cdot E \cdot I_z}{L^2} \cdot \sqrt{\frac{I_w}{I_z} + \frac{L^2 \cdot G \cdot I_T}{\pi^2 \cdot E \cdot I_z}} = 279.26 \text{ kNm}$$

$$\lambda_{LT} = \sqrt{\frac{f_y \cdot W_{pl,y}}{M_{cr} \cdot 10^3}} = \sqrt{\frac{275.00 \cdot 309.00}{279.26 \cdot 10^3}} = 0.552$$

α_{LT} = TAB("EC3_BS/alpha"; α_{LT}; Type=type; Limit>h/b) = 0.34

$\lambda_{LT,0}$ = 0.40

β = 0.75

$$\Phi_{LT} = 0.5 \cdot (1 + \alpha_{LT} \cdot (\lambda_{LT} - \lambda_{LT,0}) + \beta \cdot \lambda_{LT}^2) = 0.640$$

$$\chi_{LT} = \text{MIN}\left(\frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \beta \cdot \lambda_{LT}^2}}; 1.00; \frac{1}{\lambda_{LT}^2}\right) = 0.939$$

$$f = \text{MIN}\left(1 - 0.5 \cdot \left(1 - \frac{1}{\sqrt{C_1}}\right) \cdot \left(1 - 2.0 \cdot (\lambda_{LT} - 0.8)^2\right); 1.0\right) = 1.000$$

$$\chi_{LT,mod} = \text{MIN}\left(\frac{\chi_{LT}}{f}; \frac{1}{\lambda_{LT}^2}; 1.0\right) = 0.939$$

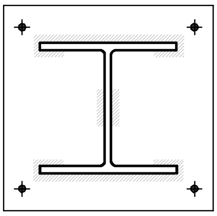
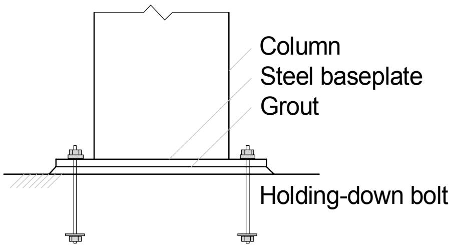
$$M_{y,b,Rd} = \frac{\chi_{LT,mod} \cdot f_y \cdot W_{pl,y}}{10^3} = \frac{0.939 \cdot 275.00 \cdot 309.00}{10^3} = 79.79 \text{ kNm}$$

$$\frac{M_{y,Ed}}{M_{y,b,Rd}} = \frac{32.36}{79.79} = \underline{\mathbf{0.41 \leq 1}}$$

Interaction check

$$\frac{N_{Ed}}{N_{Rd}} + \frac{M_{y,Ed}}{M_{y,b,Rd}} = \frac{400.00}{924.81} + \frac{32.36}{79.79} = \underline{\mathbf{0.84 \leq 1}}$$

Stanchion baseplate

Load

Axial load N_{Ed} = 800.00 kN

Material properties

Serial size:	SEL("EC3_BS/"type; ID;)	=	203x203x60
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Depth h =	TAB("EC3_BS/"type; h; ID=size)	=	209.60 mm
Breadth b =	TAB("EC3_BS/"type; b; ID=size)	=	205.80 mm

Yield strength of concrete f_{yk} = 30.00 N/mm²

Bearing strength of concrete f_{jd} = $0.67 * f_{yk}$ = 20.10 N/mm²

Minimum outstand

$$c = 0.5 * \left(\frac{N_{Ed} * 10^3}{2 * b * f_{jd}} - t_f \right) = 0.5 * \left(\frac{800.00 * 10^3}{2 * 205.80 * 20.10} - 14.20 \right) = 41 \text{ mm}$$

Minimum baseplate thickness

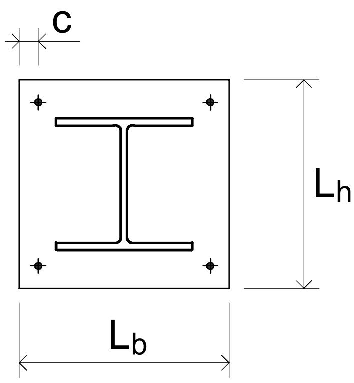
$$t_b = c * \sqrt{3 * \frac{f_{jd}}{fy}} = 41 * \sqrt{3 * \frac{20.10}{275.00}} = 19 \text{ mm}$$

Baseplate dimensions

L_h = h + 2 * c = 292 mm

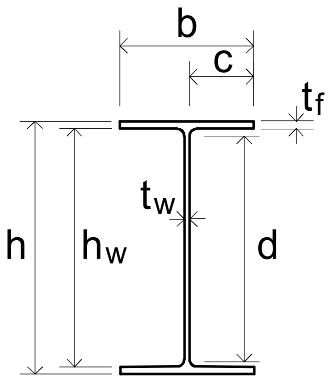
L_b = b + 2 * c = 288 mm

Note that the more detailed design rules in EC3 may show a smaller baseplate is structurally adequate. However, detailed consideration of the edge spacing and clearance required for the holding-down bolts may show that a smaller baseplate is not practically.



Chapter 3: Section Properties

Classifications of cross-section



Profile type:	SEL("EC3_BS/Profile"; Ret;)	=	UB
Serial size:	SEL("EC3_BS/"type; ID;)	=	254x146x43
Steel :	SEL("EC3_BS/steel"; ID;)	=	S275
Flange thickness t_f =	TAB("EC3_BS/"type; tf; ID=size)	=	12.70 mm
Nominal yield stength f_y =	TAB("EC3_BS/nom_fy"; fy; Steel=Steel; t>t_f)	=	275.00 N/mm²
Coefficient ε =	$\sqrt{\frac{235}{f_y}}$	=	0.92

Flange check

Flange outstand c =	TAB("EC3_BS/"type; c; ID=size)	=	62.50 mm
Limit l_F =	$\frac{c}{t_f * \varepsilon}$	=	5.35

Class = TAB("EC3_BS/classes"; Class; Check ="Flange"; Val>l_F) = Class 1

Web in bending

Depth d =	TAB("EC3_BS/"type; d; ID=size)	=	219.00 mm
Web thickness t_w =	TAB("EC3_BS/"type; t_w; ID=size)	=	7.20 mm
Limit l_W =	$\frac{d}{t_w * \varepsilon}$	=	33.06

Class = TAB("EC3_BS/classes"; Class; Check ="Bending"; Val>l_W) = Class 1

Web in compression

Class = TAB("EC3_BS/classes"; Class; Check ="Compression"; Val>l_W) = Class 2

Results

Overall section class for bending = **Class 1**

Overall section class for compression = **Class 2**