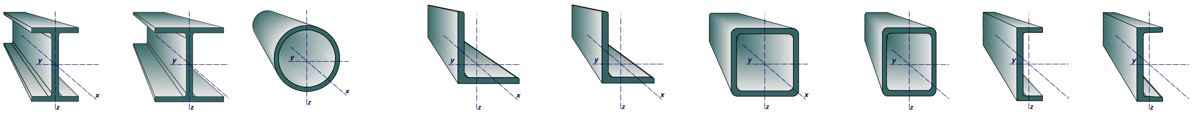
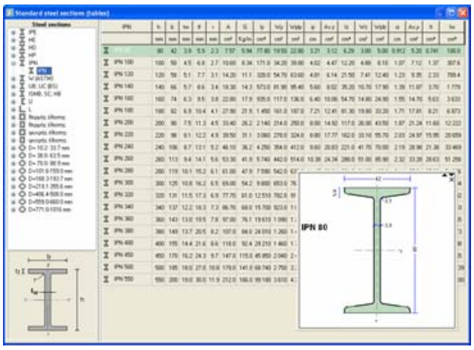
Design tables for Structural Steel Sections (Eurocode 3, EN1993-1-1:2005)

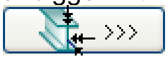
Tables with all the international steel sections, with their **dimensions**, **properties**, **classification**, **resistance and buckling resistance values** according to Eurocode 3, EN1993-1-1:2005. The tables are extended to welded section with dimensions given from the user.



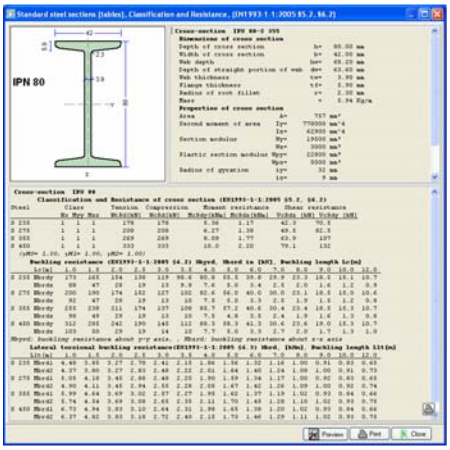
Tables with dimensions and properties of standard steel sections



From the left tree you select the section type e.g. IPE, HE etc. On the right the table shows all the standard sections for this group and their dimensions and properties. Moving up and down the table on the right the section drawing is shown in scale (you can grab and move the section drawing around the window and you can make it small or bigger with the arrows).

Click  or double click on a section and you obtain analytical report for the classification, resistance values and buckling resistance of the selected section.

Symbols



h [mm]:	Depth of cross section
b [mm]:	Width of cross section
hw [mm]:	Web depth
dw [mm]:	Depth of straight portion of web
tw [mm]:	Web thickness
tf [mm]:	Flange thickness
r [mm]:	Radius of root fillet
G [Kg/m]:	Mass
A [cm^2]:	Area
Iy [cm^4]:	Moment of area about axis y-y
Iz [cm^4]:	Second moment of area about axis z-z
Wy [cm^3]:	Section modulus about axis y-y
Wz [cm^3]:	Section modulus about axis z-z
Wpy [cm]:	Plastic section modulus about axis y-y
Wpz [cm^3]:	Plastic section modulus about axis z-z
iy [cm]:	Radius of gyration about y-y axis
iz [cm]:	Radius of gyration about z-z axis
Avz [cm^2]:	Shear area parallel to web
Avy [cm^2]:	Shear area parallel to flanges
It [cm^4]:	Torsional constant
Iw [cm^6]:	Warping constant

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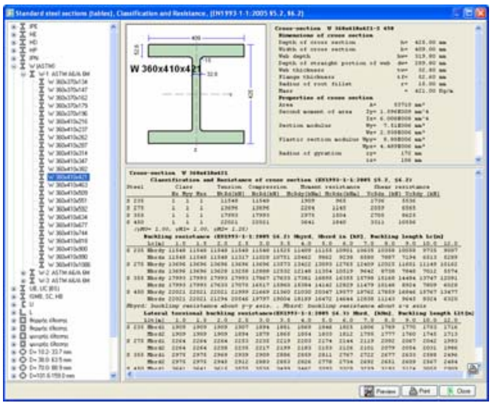
Classification and resistance of standard steel sections

Classification of cross section according to EN1993-1-1:2005 §5.5.
Resistance values of cross section according to EN1993-1-1:2005 §6.2.
Buckling resistance and lateral buckling resistance according to EN1993-1-1:2005 §6.3

From the tree on the left you select the section with its designation. On the right a drawing of the section profile is displayed together with the section dimensions and properties.

On the right window are also displayed:

- **Classification** (1,2,3,4) according to EN1993-1-1:2005 §5.5 for axial loading and loading with bending moments.
- **Resistances** of the section in compression, bending in y-y and z-z axis, and shear according to EN1993-1-1:2005 §6.2
- **Buckling resistance** for various buckling lengths (Lc) according to EN1993-1-1:2005 §6.3.1
- **Lateral torsional buckling resistance** for various lateral buckling lengths (L_{lt}) according to EN1993-1-1:2005 §6.3.2



Symbols

NtRd [kN]:	Tension resistance EN1993-1-1:2005 §6.2.3
NcRd [kN]:	Compression resistance EN1993-1-1:2005 §6.2.4
Mcrdy [kNm]:	Bending resistance about the strong y-y axis EN1993-1-1:2005 §6.2.5
Mcrdz [kNm]:	Bending resistance about the weak z-z axis EN1993-1-1:2005 §6.2.5
Vcrdz [kN]:	Shear resistance in the axis z-z parallel to web EN1993-1-1 §6.2.6
Vcrdy [kN]:	Shear resistance in the axis y-y axis parallel to flanges EN1993-1-1:2005 §6.2.6
Nbrdy [kN]: **Nbrdz [kN]:**	Buckling resistance in compression about the strong y-y or weak z-z axis, for various buckling lengths Lc (1.00,1.50…15 m) EN1993-1-1:2005 §6.3.1
Mbrd1 [kNm]: **Mbrd2 [kNm]:**	Lateral torsional buckling resistance for various lengths between constrains Llt (1.00,1.50 ….15 m) EN1993-1-1:2005 §6.3.2
Mbrd1:	Lateral torsional buckling resistance for constant (uniform) bending moment diagram along the beam
Mbrd2:	Lateral torsional buckling resistance for parabolic bending moment diagram along the beam

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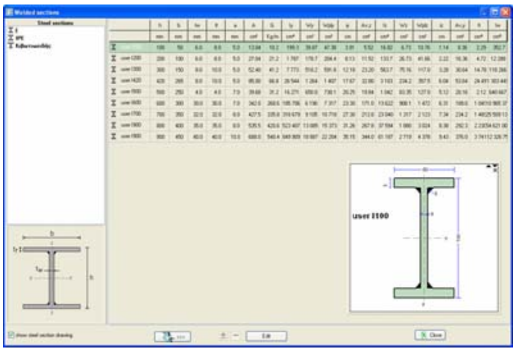
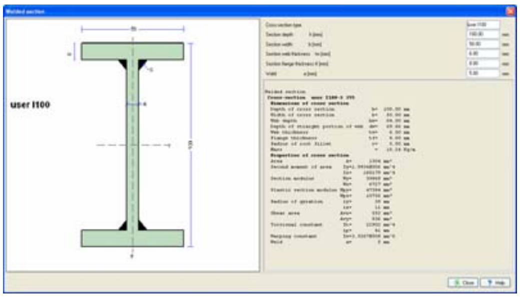
Tables with dimensions and properties of user defined welded steel sections

Click [Edit] and you enter the window where you can enter the basic dimensions of a welded steel section. The strength properties of the section are listed at the same time.
For adding new section or deleting existing click [+] [−]. Click [Stop edit] to stop editing.



Classification and resistance of user defined welded steel sections

Same as for standard sections.



Parameters

The classification of the sections the strength and buckling resistances are produced for four steel grades, S235, S275, S355 and S450. The names and the basic values of steel grades can be changed from Parameters/Structural steel.
To do changes first click to unlock [Locked]

Properties of structural steel

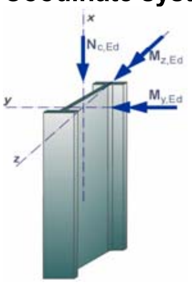
Steel	Grade	fy (MPa) t<=40mm	fu (MPa) t<=40mm	fy (MPa) 40<t<=100mm	fu (MPa) 40<t<=100mm
S 235	EN 10025-2	235	360	215	360
S 275	EN 10025-2	275	430	255	410
S 355	EN 10025-2	355	510	335	470
S 450	EN 10025-2	440	550	410	550

The partial factors for materials γ_{M0}, γ_{M1}, γ_{M2} which are use for the classification and resistance can be changed from Parameters/ Partial factors for materials.
To do changes first click to unlock [Locked]

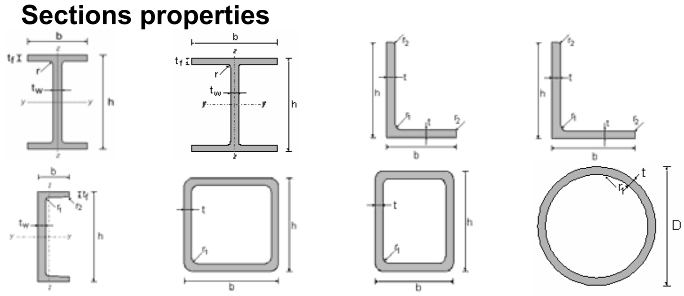
Partial factors for materialsEN1993-1-1:2005, §6.1

γM0= 1.00
γM1= 1.00
γM2= 1.25

Coodinate system



Sections properties



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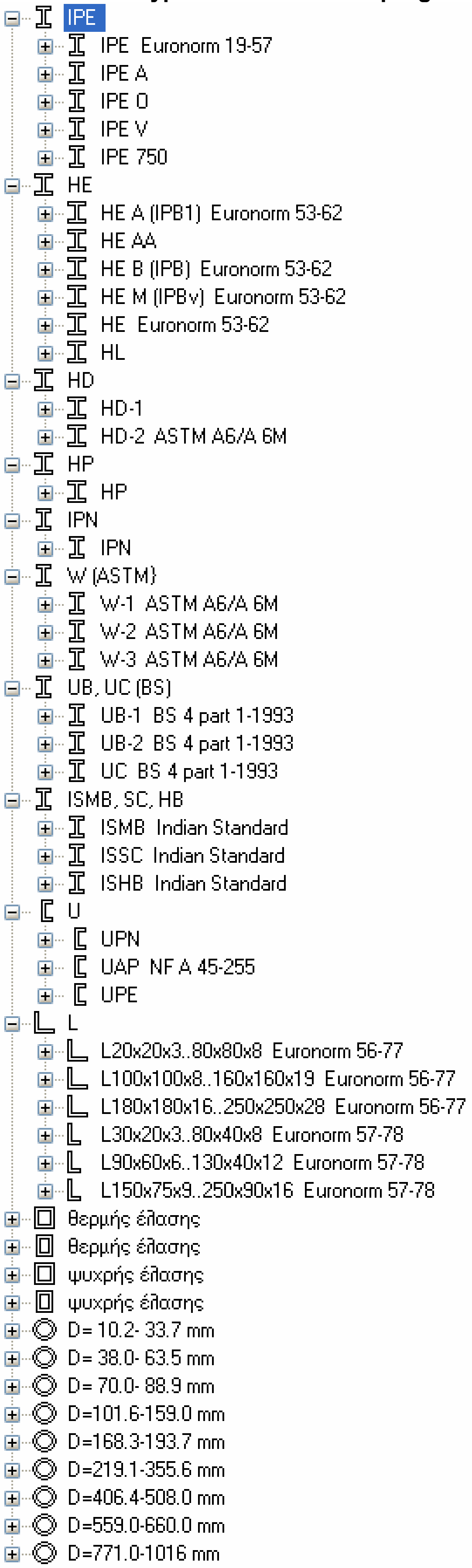
Steel section types included in the program



European I-beams	IPE 80-600 IPE A 80-600 IPE O 180-600 IPE V 400-600 IPE 750
European wide flange beams	HE A 100-1000 HE AA 100-1000 HE B 100-1000 HEM 100-1000 HE 400-1000 HL 1000/1100
Beams with very wide flanges	HD 260x54.1 – 400x1086
Wide flange columns	HP 200x57.2 – 400x231
Wide flange bearing piles	IPN 80-550
European standard beams	W 360x370x134 W 1100x400x499
American wide flange beams	UB 178x102x19 UB 914x419x388
British universal beams	UC 152x152x23 UC 356x406x634
British universal columns	UPN 30-65 UPN 80-400
European standard channels	UAP 80-300 UPE 80-400
Channels with parallel flanges	L 20x20x3 L 250x250x28
Equal angels	L 30x20x3 L 250x90x16
Unequal angels	Ø 10.2x1.0 Ø 1016x400
Circular hollow sections	20x20x1.6 400x400x12.5
Square hollow sections cold formed	40x40x2.6 400x400x20.0
Square hollow sections hot rolled	30x20x1.5 500x300x12.5
Rectangular hollow sections cold formed	50x30x2.6 400x260x17.5
Rectangular hollow sections hot rolled	

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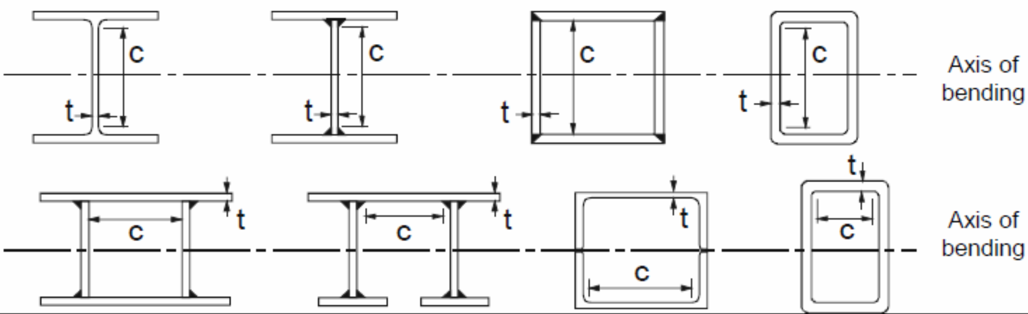
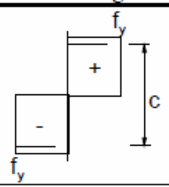
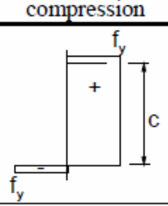
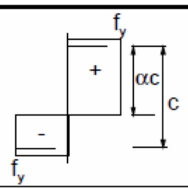
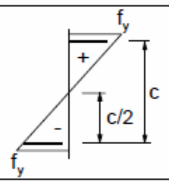
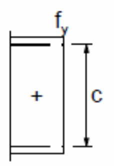
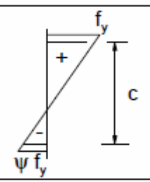
Classification of cross sections EN 1993-1-1:2005 § 5.5

The design of steel elements can been done with elastic or plastic analysis depending on the class of the cross section.
The design of sections of classes 1 and 2 is based on the plastic resistance, the design of cross-sections of class 3 is base on elastic resistance and the design of cross-sections of class 4 is based on elastic resistance and effective cross section properties.
The classification of cross sections in 1, 2, 3 and 4 classes depends on the ratios of thickness to width of the parts of the cross-section which are in compression according to tables 5.2 of EN 1993-1-1:2005.

Table 5.2 EN 1993-1-1:2005 – Internal compression parts

Internal compression parts

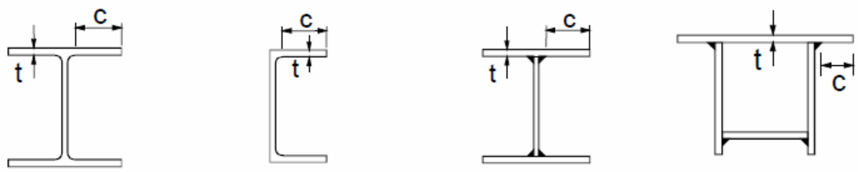


Class	Part subject to bending	Part subject to compression	Part subject to bending and compression
Stress distribution in parts (compression positive)			
1	$c/t \le 72\varepsilon$	$c/t \le 33\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \frac{396\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \frac{36\varepsilon}{\alpha}$
2	$c/t \le 83\varepsilon$	$c/t \le 38\varepsilon$	when $\alpha > 0{,}5$: $c/t \le \frac{456\varepsilon}{13\alpha - 1}$ when $\alpha \le 0{,}5$: $c/t \le \frac{41{,}5\varepsilon}{\alpha}$
Stress distribution in parts (compression positive)			
3	$c/t \le 124\varepsilon$	$c/t \le 42\varepsilon$	when $\psi > -1$: $c/t \le \frac{42\varepsilon}{0{,}67 + 0{,}33\psi}$ when $\psi \le -1^{*)}$: $c/t \le 62\varepsilon(1-\psi)\sqrt{(-\psi)}$

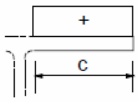
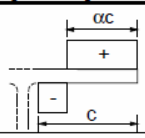
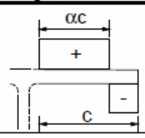
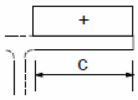
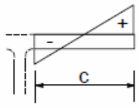
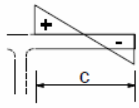
$\varepsilon = \sqrt{235/f_y}$	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

Table 5.2 EN 1993-1-1:2005 – Outstanding flanges

Outstand flanges



Rolled sections — Welded sections

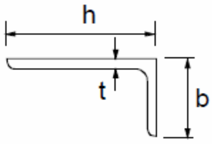
Class	Part subject to compression	Part subject to bending and compression: Tip in compression	Part subject to bending and compression: Tip in tension
Stress distribution in parts (compression positive)			
1	$c/t \le 9\varepsilon$	$c/t \le \frac{9\varepsilon}{\alpha}$	$c/t \le \frac{9\varepsilon}{\alpha\sqrt{\alpha}}$
2	$c/t \le 10\varepsilon$	$c/t \le \frac{10\varepsilon}{\alpha}$	$c/t \le \frac{10\varepsilon}{\alpha\sqrt{\alpha}}$
Stress distribution in parts (compression positive)			
3	$c/t \le 14\varepsilon$	$c/t \le 21\varepsilon\sqrt{k_\sigma}$ For k_σ see EN 1993-1-5	

$\varepsilon = \sqrt{235/f_y}$						
	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71

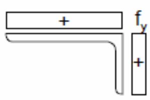
Table 5.2 EN 1993-1-1:2005 - Angles

Angles

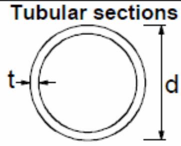
Refer also to "Outstand flanges" (see sheet 2 of 3)



Does not apply to angles in continuous contact with other components

Class	Section in compression
Stress distribution across section (compression positive)	
3	$h/t \le 15\varepsilon : \frac{b+h}{2t} \le 11{,}5\varepsilon$

Tubular sections



Class	Section in bending and/or compression
1	$d/t \le 50\varepsilon^2$
2	$d/t \le 70\varepsilon^2$
3	$d/t \le 90\varepsilon^2$ **NOTE** For $d/t > 90\varepsilon^2$ see EN 1993-1-6.

$\varepsilon = \sqrt{235/f_y}$						
	f_y	235	275	355	420	460
	ε	1,00	0,92	0,81	0,75	0,71
	ε^2	1,00	0,85	0,66	0,56	0,51

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Ultimate limit states EN 1993-1-1:2005 § 6.2

Tension EN 1993-1-1:2005 § 6.2.3

$$\frac{N_{Ed}}{N_{t,Rd}} \leq 1$$ (EN 1993-1-1, 6.5)

Design plastic resistance of the cross-section.

$$N_{pl,Rd} = \frac{A \cdot f_y}{\gamma_{M0}}$$ (EN 1993-1-1, 6.6)

Design ultimate resistance of net cross-section at holes for fasteners.

$$N_{u,Rd} = \frac{0.9 A_{net} \cdot f_u}{\gamma_{M2}}$$ (EN 1993-1-1, 6.7)

A *area of cross-section*
A_{net} *area of net cross-section (minus holes)*
f_y *yield strength of steel*
f_u *ultimate strength of steel*
γ_{M0} , γ_{M2} *partial factors for material*

Compression EN 1993-1-1:2005 § 6.2.4

$$\frac{N_{Ed}}{N_{c,Rd}} \leq 1$$ (EN 1993-1-1, 6.9)

$$N_{c,Rd} = \frac{A \cdot fy}{\gamma_{M0}}$$ for class 1, 2, 3 cross-sections (EN 1993-1-1, 6.10)

$$N_{c,Rd} = \frac{A_{eff} \cdot fy}{\gamma_{M0}}$$ for class 4 cross-sections (EN 1993-1-1, 6.11)

A *area of cross-section*
A_{eff} *effective area of cross-section*
fy *yield strength of steel*
γ_{M0} *partial factors for material*

In case the design value of shear is $V_{Ed} > 0.50 V_{pl,Rd}$ the reduced yield strength is used.

$(1-\rho) fy$, where $\rho = \left(\frac{2V_{Ed}}{V_{pl,Rd}} - 1\right)^2$ (EN 1993-1-1, 6.29)

Bending moment EN 1993-1-1:2005 § 6.2.5

$$\frac{M_{Ed}}{M_{c,Rd}} \leq 1$$ (EN 1993-1-1, 6.12)

Design resistance of cross section for bending about the principal (y-y) or secondary (z-z) axis.

$$M_{y,Rd} = M_{pl,y,Rd} = \frac{W_{pl,y} \cdot fy}{\gamma_{M0}}$$ for class 1, 2 cross-sections (EN 1993-1-1, 6.13)

$$M_{z,Rd} = M_{pl,z,Rd} = \frac{W_{pl,z} \cdot fy}{\gamma_{M0}}$$ for class 1, 2 cross-sections

$$M_{y,Rd} = M_{el,y,Rd} = \frac{W_{el,y} \cdot fy}{\gamma_{M0}}$$ for class 3 cross-sections (EN 1993-1-1, 6.14)

$$M_{z,Rd} = M_{el,z,Rd} = \frac{W_{el,z} \cdot fy}{\gamma_{M0}}$$ for class 3 cross-sections

$$M_{y,Rd} = M_{c,y,Rd} = \frac{W_{eff,y} \cdot fy}{\gamma_{M0}}$$ for class 4 cross-sections (EN 1993-1-1, 6.15)

$$M_{z,Rd} = M_{c,z,Rd} = \frac{W_{eff,z} \cdot fy}{\gamma_{M0}}$$ for class 4 cross-sections

$W_{pl,y}$ $W_{pl,z}$ *plastic section modulus about principal and secondary axis,*

$W_{el,y}$ $W_{el,z}$ *elastic section modulus about principal and secondary axis,*

$W_{eff,y}$ $W_{eff,z}$ *effective section modulus about principal and secondary axis,*

fy *yield strength of steel*

γ_{M0} *partial factors for material*

When bending moment acts together with axial force design check is performed according to :

$$\frac{M_{Ed}}{M_{N,Rd}} \leq 1$$ (EN 1993-1-1, 6.31)

$$M_{N,Rd} = M_{pl,Rd}\left[1-\left(\frac{N_{Ed}}{N_{pl,Rd}}\right)^2\right]$$ (EN 1993-1-1, 6.32)

In case the design value of shear is $V_{Ed} > 0.50 V_{pl,Rd}$ the reduced yield strength is used.

$(1-\rho) fy$, where ρ = $\left(\frac{2V_{Ed}}{V_{pl,Rd}} - 1\right)^2$ (EN 1993-1-1, 6.29)

Bi-axial bending EN 1993-1-1:2005 § 6.2.9

$$\left(\frac{M_{y,Ed}}{M_{y,Rd}}\right)^{\alpha}+\left(\frac{M_{z,Ed}}{M_{zRd}}\right)^{\beta}\leq 1 \qquad \text{(EN 1993-1-1, 6.41)}$$

For I and H sections: α=2, β=5n, β≥1 ($n=N_{Ed}/N_{pl,Rd}$)
For circular hollow sections: α=2, β=2
For rectangular hollow sections $\alpha=\beta=1.66/(1-1.13\,n^2)$

Shear EN 1993-1-1:2005 § 6.2.6

$$\frac{V_{Ed}}{V_{c,Rd}}\leq 1 \qquad \text{(EN 1993-1-1, 6.17)}$$

Plastic shear resistance parallel to the cross-section web.

$$V_{z,Rd}=V_{pl,z,Rd}=\frac{A_{vz}\cdot f_y}{\sqrt{3}\gamma_{M0}} \qquad \text{(EN 1993-1-1, 6.18)}$$

Plastic shear resistance parallel to the cross-section flanges.

$$V_{y,Rd}=V_{pl,y,Rd}=\frac{A_{vy}\cdot f_y}{\sqrt{3}\gamma_{M0}} \qquad \text{(EN 1993-1-1, 6.18)}$$

A_{vy} A_{vz} *shear areas parallel to the cross-section web or flanges,*
fy *yield strength of steel*
γ_{M0} *partial factors for material*

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Buckling resistance of uniform members in compression EN 1993-1-1:2005 § 6.3.1

Buckling resistance due to compression.

$$\frac{N_{Ed}}{N_{b,Rd}} \leq 1 \qquad \text{(EN 1993-1-1, 6.46)}$$

$$N_{b,Rd} = \frac{\chi A f_y}{\gamma_{M1}} \text{ for class 1, 2, 3 cross-sections} \qquad \text{(EN 1993-1-1, 6.47)}$$

$$N_{b,Rd} = \frac{\chi A_{eff} f_y}{\gamma_{M1}} \text{ for class 4 cross-sections} \qquad \text{(EN 1993-1-1, 6.48)}$$

The reduction factor χ is determined from the non-dimensional slenderness $\overline{\lambda}$

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - \overline{\lambda}^2}} \leq 1 \qquad \text{(EN 1993-1-1, 6.49)}$$

$$\Phi = 0.5\left[1 + \alpha\left(\overline{\lambda} - 0.2\right) + \overline{\lambda}^2\right]$$

$$\overline{\lambda} = \sqrt{\frac{A f_y}{N_{cr}}}; N_{cr} = \frac{\pi^2 \mathrm{EA}}{\lambda^2}; \lambda = \frac{l_{eff}}{i}; i = \sqrt{\frac{I}{A}}$$

$\overline{\lambda}$ *non-dimensional slenderness,*
N_{cr} *elastic critical buckling load,*
Lcr equivalent buckling length,
λ slenderness,
i radious of gyration.

The imperfection factor α which corresponds to the appropriate buckling curve ao,a,b,c,d should obtained from Table 6.2 of Eurocode 3, EN 1993-1-1:2005:

Buckling curve	a_o	a	b	C	d
Imperfection factor α	0.13	0.21	0.34	0.49	0.76

Equivalent buckling lengths Lcr/L

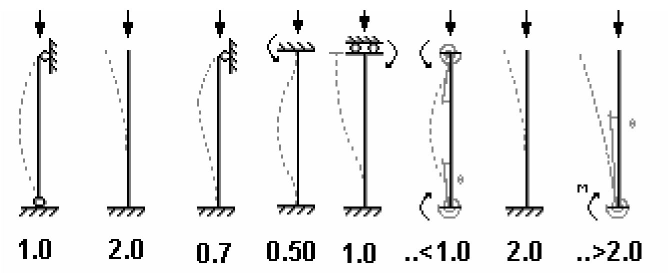
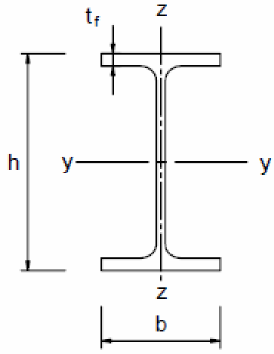
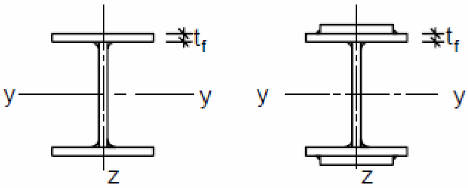
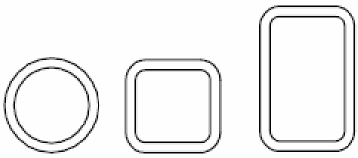
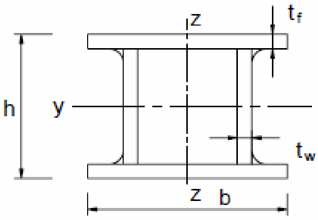
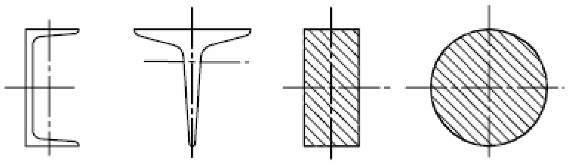
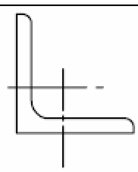


Table 6.2 EN 1993-1-1:2005 Selection of buckling curve of a cross-section

	Cross section	Limits		Buckling about axis	Buckling curve S 235, S 275, S 355, S 420	Buckling curve S 460
Rolled sections		$h/b > 1,2$	$t_f \leq 40$ mm	y – y z – z	a b	a_0 a_0
			$40 \text{ mm} < t_f \leq 100$	y – y z – z	b c	a a
		$h/b \leq 1,2$	$t_f \leq 100$ mm	y – y z – z	b c	a a
			$t_f > 100$ mm	y – y z – z	d d	c c
Welded I-sections		$t_f \leq 40$ mm		y – y z – z	b c	b c
		$t_f > 40$ mm		y – y z – z	c d	c d
Hollow sections		hot finished		any	a	a_0
		cold formed		any	c	c
Welded box sections		generally (except as below)		any	b	b
		thick welds: $a > 0,5t_f$ $b/t_f < 30$ $h/t_w < 30$		any	c	c
U-, T- and solid sections				any	c	c
L-sections				any	b	b

Lateral torsional buckling for uniform members EN 1993-1-1:2005 § 6.3.2

Lateral torsional buckling of uniform members in bending.

$$\frac{M_{Ed}}{M_{b,Rd}} \leq 1 \qquad \text{(EN 1993-1-1, 6.54)}$$

$$M_{b,Rd} = \frac{\chi_{LT} W_y f_y}{\gamma_{M1}} \qquad \text{(EN 1993-1-1, 6.55)}$$

$W_y = W_{pl,y}$ for class 1, 2 cross-sections,

$W_y = W_{el,y}$ for class 3 cross-sections,

$W_y = W_{eff,y}$ for class 4 cross-sections.

The reduction factor χ_{LT} is determined from the non-dimensional slenderness $\overline{\lambda}_{LT}$

$$\chi_{LT} = \frac{1}{\Phi_{LT} + \sqrt{\Phi_{LT}^2 - \overline{\lambda}_{LT}^2}} \leq 1 \qquad \text{(EN 1993-1-1, 6.56)}$$

$$\Phi_{LT} = 0.5\left[1 + \alpha_{LT}\left(\overline{\lambda}_{LT} - 0.2\right) + \overline{\lambda}_{LT}^2\right]$$

$$\overline{\lambda}_{LT} = \sqrt{\frac{W_y f_y}{M_{cr}}}$$

The imperfection factor α which corresponds to the appropriate buckling curve a,b,c,d:

Buckling curve	a	b	C	d
Imperfection factor α_{LT}	0.21	0.34	0.49	0.76

Recommended values for torsional buckling curves:
Rolled Sections h/b<2 buckling curve a, h/b>2 buckling curve b
Welded sections h/b<2 buckling curve c, h/b>2 buckling curve d

The critical elastic moment for lateral torsional buckling is computed according to Annex F of Eurocode 3-1-1 (1992).

$$M_{cr} = C_1 \frac{\pi^2 EI_z}{(kL)^2}\left[\sqrt{\left(\frac{k}{k_w}\right)^2 \frac{I_w}{I_z} + \frac{(kL)^2 GI_t}{\pi^2 EI_z} + \left(C_2 Z_g - C_3 Z_j\right)^2} - \left(C_2 Z_g - C_3 Z_j\right)\right]$$

C1, C2, C3, coefficients depending on the loading conditions and support conditions,
for a beam with uniform bending moment diagram C1=1.000, C2=0.000, C3=1.000
for a beam with parabolic bending moment diagram C1=1.132, C2=0.459, C3=0.525

I_t *St. Venant torsional constant,*

I_w *warping constant,*

I_z *second moment of inertia about the weak axis,*

L *beam length between the support points,*

k , k_w *coefficients depending on the support conditions,*

Z_g *distance of shear center from point of load application*

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Uniform members in bending and compression EN 1993-1-1:2005 § 6.3.4

$$\frac{N_{Ed}}{x_y N_{Rk}/\gamma_{M1}} + k_{yy}\frac{M_{Y,Ed}}{\chi_{LT} M_{y,Rk}/\gamma_{M1}} + k_{yz}\frac{M_{z,Ed}}{M_{z,Rk}/\gamma_{M1}} \le 1 \qquad \text{(EN 1993-1-1, 6.61)}$$

$$\frac{N_{Ed}}{x_z N_{Rk}/\gamma_{M1}} + k_{zy}\frac{M_{Y,Ed}}{\chi_{LT} M_{y,Rk}/\gamma_{M1}} + k_{zz}\frac{M_{z,Ed}}{M_{z,Rk}/\gamma_{M1}} \le 1 \qquad \text{(EN 1993-1-1, 6.62)}$$

$N_{Rk} = Af_y$

$M_{y,Rk} = W_{pl,y} f_y$ for class 1, 2 cross-sections

$M_{y,Rk} = W_{el,y} f_y$ for class 3 cross-sections,

$M_{y,Rk} = W_{eff,y} f_y$ for class 4 cross-sections,

$M_{z,Rk} = W_{pl,z} f_y$ for class 1, 2 cross-sections

$M_{z,Rk} = W_{el,z} f_y$ for class 3 cross-sections,

$M_{z,Rk} = W_{eff,z} f_y$ for class 4 cross-sections.

The interaction coefficients k_{yy}, k_{yz}, k_{zy}, k_{zz} are determined from tables B.1 and B.2

Table B.1 interaction coefficients k_{yy}, k_{yz}, k_{zy}, k_{zz}

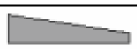
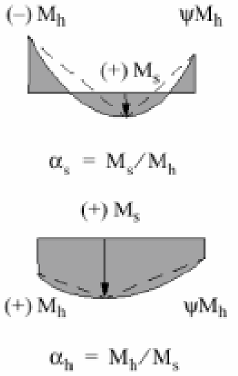
Interaction factors	Type of sections	Design assumption: elastic cross-sectional properties class 3, class 4	Design assumption: plastic cross-sectional properties class 1, class 2
k_{yy}	I-sections RHS-sections	$C_{my}\left(1+0{,}6\bar{\lambda}_y \frac{N_{Ed}}{\chi_y N_{Rk}/\gamma_{M1}}\right)$ $\le C_{my}\left(1+0{,}6\frac{N_{Ed}}{\chi_y N_{Rk}/\gamma_{M1}}\right)$	$C_{my}\left(1+(\bar{\lambda}_y-0{,}2)\frac{N_{Ed}}{\chi_y N_{Rk}/\gamma_{M1}}\right)$ $\le C_{my}\left(1+0{,}8\frac{N_{Ed}}{\chi_y N_{Rk}/\gamma_{M1}}\right)$
k_{yz}	I-sections RHS-sections	k_{zz}	$0{,}6\ k_{zz}$
k_{zy}	I-sections RHS-sections	$0{,}8\ k_{yy}$	$0{,}6\ k_{yy}$
k_{zz}	I-sections	$C_{mz}\left(1+0{,}6\bar{\lambda}_z \frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$ $\le C_{mz}\left(1+0{,}6\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$	$C_{mz}\left(1+(2\bar{\lambda}_z-0{,}6)\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$ $\le C_{mz}\left(1+1{,}4\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$
	RHS-sections		$C_{mz}\left(1+(\bar{\lambda}_z-0{,}2)\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$ $\le C_{mz}\left(1+0{,}8\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right)$
For I- and H-sections and rectangular hollow sections under axial compression and uniaxial bending $M_{y,Ed}$ the coefficient k_{zy} may be $k_{zy} = 0$.			

Table B.2

Interaction factors	Design assumptions	
	elastic cross-sectional properties class 3, class 4	plastic cross-sectional properties class 1, class 2
k_{yy}	k_{yy} from Table B.1	k_{yy} from Table B.1
k_{yz}	k_{yz} from Table B.1	k_{yz} from Table B.1
k_{zy}	$\left[1-\frac{0,05\bar{\lambda}_z}{(C_{mLT}-0,25)}\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right] \ge \left[1-\frac{0,05}{(C_{mLT}-0,25)}\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right]$	$\left[1-\frac{0,1\bar{\lambda}_z}{(C_{mLT}-0,25)}\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right] \ge \left[1-\frac{0,1}{(C_{mLT}-0,25)}\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}\right]$ for $\bar{\lambda}_z < 0,4$: $k_{zy} = 0,6+\bar{\lambda}_z \le 1-\frac{0,1\bar{\lambda}_z}{(C_{mLT}-0,25)}\frac{N_{Ed}}{\chi_z N_{Rk}/\gamma_{M1}}$
k_{zz}	k_{zz} from Table B.1	k_{zz} from Table B.1

Factor	Bending axis	Points braced in direction
Cmy	y-y	z-z
Cmz	z-z	y-y
CmLT	y-y	y-y

Table B.3

Moment Diagram	Range		C_{my}, C_{mz} и C_{mLT} under loading	
			Distributed	Concentrated
	$-1 \le \psi \le 1$		$0,6 + 0.4\psi \ge 0,4$	
	$0 \le \alpha_s \le 1$	$-1 \le \psi \le 1$	$0,2 + 0.8\alpha_s \ge 0,4$	$0,2 + 0.8\alpha_s \ge 0,4$
	$-1 \le \alpha_s < 0$	$0 \le \psi \le 1$	$0,1 - 0.8\alpha_s \ge 0,4$	$-0.8\alpha_s \ge 0,4$
		$-1 \le \psi < 0$	$0,1(1-\psi) - 0.8\alpha_s \ge 0,4$	$0,2(-\psi) - 0.8\alpha_s \ge 0,4$
	$0 \le \alpha_h \le 1$	$-1 \le \psi \le 1$	$0,95 + 0,05\alpha_h$	$0,90 + 0,10\alpha_h$
	$-1 \le \alpha_h < 0$	$0 \le \psi \le 1$	$0,95 + 0,05\alpha_h$	$0,90 + 0,10\alpha_h$
		$-1 \le \psi < 0$	$0,95 + 0,05\alpha_h(1+2\psi)$	$0,90 - 0,10\alpha_h(1+2\psi)$

Bibliography

Eurocode 3, EN1993-1-1:2005

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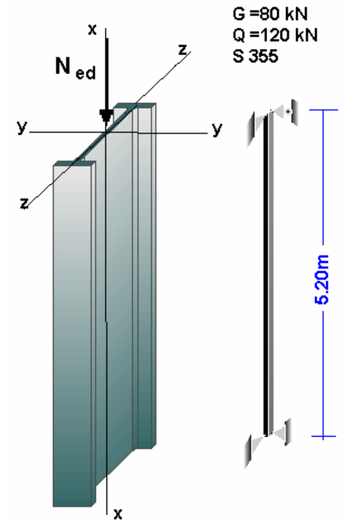
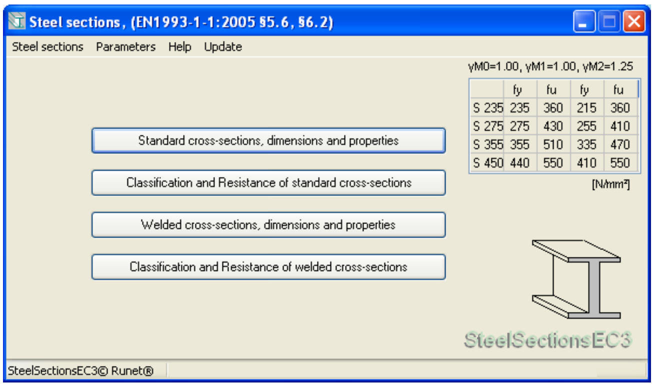
Examples

Example 1

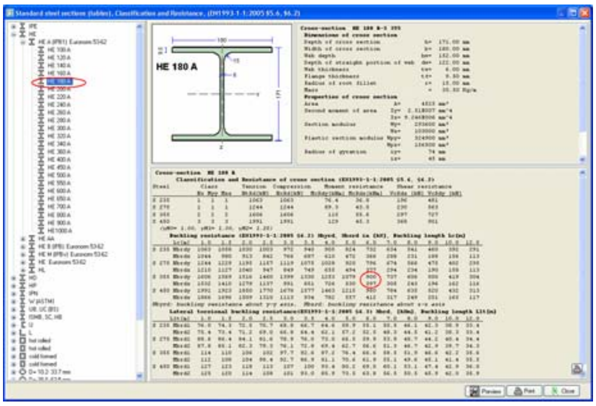
Steel column 5.20 m.
Axial load G = 80 kN, variable axial load Q = 120 kN.
Steel S 355.
Total axial design load:
Ned =1.35xG+1.50xQ=1.35x80+1.50x120 = 288 kN
Buckling lengths: Liy=5.20 m, Liz=5.20 m





In the main program screen, click  .

From the tree control on the left select section type **HEA**.
Click + and all the sections of type HEA are displayed.
For steel grade **S 355** and buckling length **5.20 m** (table values between 5.0 m and 6.0m), check Nbyrd and Nbzrd (buckling resistances in compression in y-y and z-z axis) to be greater than the design load of the column Ned=288 kN.
Section **HE 180 A** is OK.
For buckling length **6.0m**>5.20m, the section has, buckling resistances in compression **Nbyrd = 900 kN** > 288 kN and **Nbzrd = 397 kN** >288 kN.



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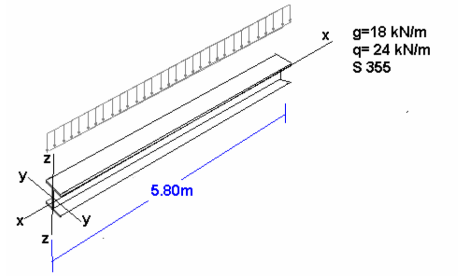
Example 2



Beam 5.80 m with loads.
Permanent load g = 18 kN/m.
Variable load q = 24 kN/m.
Steel S 355.
Design load:
qed = 1.35x18.0+1.50x24.0 = 60.30 kN/m
Maximum design bending moment:
My,ed = 60.30x5.80^2/8 = 253.6 kNm
Maximum design shearing force:
Vz,ed = 60.30x5.80/2 = 174.9 kN

In the main program screen, click 

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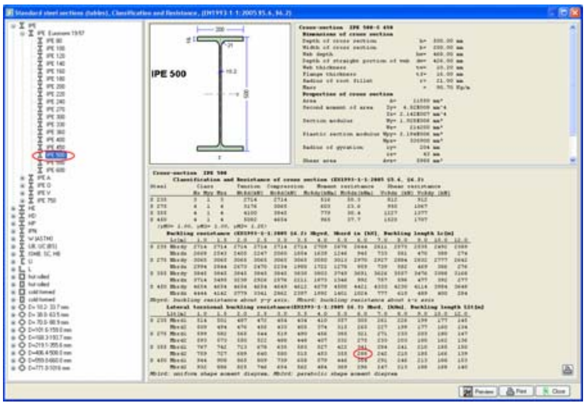

From the tree control on the left select section type **IPE**.
Click + and all the sections of type IPE are displayed.
For steel grade **S 355** and lateral buckling length L_{Lt}=**5.80 m** (table 6.0m), check Mbrd2 (parabolic bending moment diagram) to be greater than the maximum bending moment acting on the beam My,ed = 253.6 kNm.
Section **IPE 500** is OK.
For lateral buckling length **6.0m**>5.80 m, has resistance in bending moment due to lateral buckling **Mbrd2 = 288** kNm>253.6 kNm
From the table above you can check the resistances in shear and bending.
Shear resistance **Vc,rdz = 1227 kN**, bending resistance **Mc,rdy = 779 kNm**.