Steel column design

Required steel area calculation

$$A_{req} = \frac{N_{ED}}{\frac{f_y}{\gamma_M}}$$

where:

N_{ED} is the load action on the column

γ_M is partial safety factor for steel

f_y is steel yield strength (for S275 and S355 steel grade, refer EN 10025-2 (Table 7))

Steel section - universal steel column sheet (Universal columns)

Depth , width, flange thickness, web thickness, root radius and radius of gyration on both axis are provided from the steel section sheet.

Section class

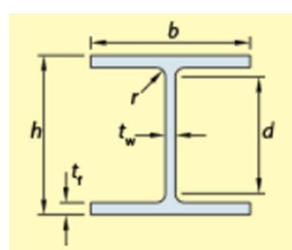
Outstand flange

$$\frac{c}{t} = \frac{B - t_w - 2\ x\ r}{2t}$$

Internal compression part

$$\frac{c}{t} = \frac{D - 2t_f - 2\ x\ r}{t}$$

	Flange outstand limiting value, c/t_f	Web in bending limiting value, d/t_w
Class 1	9 ε	72 ε
Class 2	10 ε	83 ε
Class 3	14 ε	124 ε
Class 4	If it does not meet Class 3 requirements, the section is classified as Class 4	



where :

$\varepsilon = (235/\ f_y)^{0.5}$

where :

f_y is steel yield strength

Compression resistance

$$\frac{N_{ED}}{N_{c,Rd}} \leq 1.0$$

where :

N_{Ed} is the design value of the axial compression load

$N_{c,Rd}$ is the design resistance to axial compression, given by the minimum of

i) *Plastic resistance*

$N_{c,Rd} = \frac{Af_y}{\gamma_M}$ (for class 1,2 or 3)

$N_{c,Rd} = \frac{A_{eff} f_y}{\gamma_M}$ (for class 4)

where :

A and A_{eff} are area and effective area of steel

f_y is steel yield strength (for S275 and S355 steel grade, refer EN 10025-2 (Table 7))

γ_M is partial safety factor for steel

ii) *Buckling resistance*

$N_{b,Rd}$, in general the flexural buckling resistance, which govern the design of a member in pure compression.

$N_{b,Rd} = \chi \frac{Af_y}{\gamma_M}$ (for class 1,2 or 3)

$N_{b,Rd} = \chi \frac{A_{eff} f_y}{\gamma_M}$ (for class 4)

where :

χ is a reduction factor for the relevant buckling mode

A and A_{eff} are area and effective area of steel.

f_y is steel yield strength (for S275 and S355 steel grade, refer EN 10025-2 (Table 7))

γ_M is partial safety factor for steel

Reduction factors (χ)

Buckling lengths – Assuming that the design forces were obtained by a second order structural analysis, the buckling lengths are considered (conservatively) equal to the real lengths (mid-distance between floors), given by:

$$\chi = \frac{1}{\Phi + \sqrt{\Phi^2 - (\lambda^*)^2}}$$

where :

$$\Phi = 0.5\,[\,1 + \alpha(\lambda^* - 0.2) + (\lambda^*)^2]$$

where :

λ^* is slenderness coefficient - which ever maximum is to be used for the design from λ_x^* and λ_y^*.

$$\lambda_x^* = \frac{\lambda_x}{\lambda_1} \qquad \lambda_y^* = \frac{\lambda_y}{\lambda_1}$$

where :

$$\lambda_1 = \pi\sqrt{\frac{E}{f_y}}$$

where :

E is elastic modulus of steel

f_y is steel yield strength (for S275 and S355 steel grade, refer EN 10025-2 (Table 7))

i_x and i_y are radius of gyration in x and y axis

L_{Ex} and L_{Ey} are the effective length of the column in the x-z and y-z axis; $L_E = L * K$

K = 1.0, pinned at both end

K = 0.7, fixed at one end and pinned at the other end

K = 0.5, fixed at both end

K = 2.0, fixed at one end and free at the other end (cantilever)

α is buckling factor in flexural buckling mode about x and y axis

Selection of buckling curve for a cross-section (refer Table EN 1993-1-1: 2005 (E))

If h/b > 1.2

t_f ≤ 40 mm, a and b are values of bucking curve about axis x-x and y-y.

40mm < t_f ≤ 100, b and c are values of bucking curve about axis x-x and y-y.

If h/b ≤ 1.2

t_f ≤ 100 mm, b and c are values of bucking curve about axis x-x and y-y.

t_f > 100, d is the value of both bucking curve about axis x-x and y-y.

Steel Grade	f_y (N/mm^2)			
	nominal thickness of element, t (mm)			
	t≤16	16< t ≤ 40	40 < t ≤ 63	63 < t ≤ 80
S 275	275	265	255	245
S 355	355	345	335	325

EN 10025-2 (Table 7)

Table 6.1: Imperfection factors for buckling curves

Buckling curve	a_0	a	b	c	d
Imperfection factor α	0,13	0,21	0,34	0,49	0,76