EuroBeam from Greentram Software

Typical calculations produced by the pre-release version

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EuroBeam 1.00c 100028

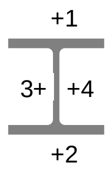
SCIExamples.eub

Column calculation to EN1993-1-1 using S275 steel

Location: WES 5/11 simple column + base

Length: 5.0 m.

Po	Dur	Load	kN	Factored load 6.10a	Factored load 6.10b	Offset	Moment y-y 6.10a	Moment y-y 6.10b	Moment z-z 6.10a	Moment z-z 6.10b
A	G	Upper floors 8m dead	88.8 x 2 = 177.6	239.8	221.8					
A	G	Upper floors 6m dead	66.6 x 2 = 133.2	179.8	166.3					
A	QB	Upper floors 8m live	79.2 x 2 = 158.4	166.3	237.6					
A	QB	Upper floors 6m live	59.3 x 2 = 118.6	124.5	177.9					
1	G	First floor 8m dead	88.8	119.9	110.9	100	27.22	25.18		
1	QB	First floor 8m live	79.2	83.2	118.8	100	18.88	26.97		
2	G	First floor 6m dead	66.6	89.9	83.2	100	-20.41	-18.88		
2	QB	First floor 6m live	59.4	62.4	89.1	100	-14.16	-20.23		
Total load			881.8	1,065.8	**1,205.6**		11.53	**13.04**	**0.00**	0.00



Load offsets are measured in mm. from faces of member; moments in kNm

Use: **254 x 254 x 73 UKC S275**

Section properties: Gross area, A_g = 93.1cm^2 T = 14.2mm r_v = 6.48 cm
D = 254.1 mm t = 8.60 mm $W_{pl,y}$ = 992 cm^3 Z_y = 307 cm^3

Design strength, p_y = 275 N/mm^2 ε = 0.924

Classification: Flange: c/t = 110.3/14.2 = 7.77 <= 9ε (8.32): Class 1, plastic

Major axis: L_{Ex} = 1.0L = 5.00 m. Slenderness, λ_y = 5.00 x 100/11.1 = 45.0
Minor axis: L_{Ey} = 1.0L = 5.00 m. Slenderness, λ_z = 5.00 x 100/6.48 = 77.2

Compression:

Design axial load, N_{Ed} = 1,206 kN

Design compression resistance, $N_{c,Rd} = Af_y/\gamma_{M0}$ = 93.1 x 100 x 275/(1.0 x 1000) = 2,560 kN

Calculate flexural buckling resistances, $N_{c,Rd}$

Buckling about y-y (major) axis

$\bar{\lambda}_v = \lambda_v/93.9\varepsilon$ = 45.0/(93.9 x 0.924) = 0.519
Use curve b: α = 0.340 $\phi = 0.5(1 + \alpha(\bar{\lambda}-0.2)\bar{\lambda}^2)$ = 0.689
$\chi = 1/(\phi + \surd(\phi^2 - \bar{\lambda}^2))$ = 0.876
Design buckling resistance, $N_{b,z,Rd} = \chi A_{fy}/\gamma_{M1}$ = 0.876 x 93.1 x 1000 x 275/(1.0 x 1000) = 2,242 kN OK

Buckling about z-z (minor) axis

$\bar{\lambda}_z = \lambda_z/93.9\varepsilon$ = 77.2/ (93.9 x 0.924) = 0.889
Use curve c: α = 0.490 $\phi = 0.5(1 + \alpha(\bar{\lambda}-0.2)\bar{\lambda}^2)$ = 1.06
$\chi = 1/(\phi + \surd(\phi^2 - \bar{\lambda}^2))$ = 0.607
Design buckling resistance, $N_{b,z,Rd} = \chi A_{fy}/\gamma_{M1}$ = 0.607 x 93.1 x 1000 x 275/(1.0 x 1000) = 1,553 kN OK

Bending about y-y (major) axis:

Design moment, $M_{y,Ed}$: 13.0 kNm

Classification: Flange: c/t = 110.3/14.2 = 7.77 <= 9ε (8.32): Class 1, plastic
Table 5.2   Web: c/t = 200.3/8.6 = 23.3 <= 72ε (66.6): Class 1, plastic

Moment capacity, $M_{c,y,Rd} = p_y.W_{pl,y}$ = 275 x 992/1000 = 272.8 kNm OK

Calculate Buckling Resistance Moment

Design buckling resistance moment, $M_{b,Rd} = \chi_{LT,mod}.M_{c,Rd}$

$M_{cr} = C_1(\pi^2 EI_z/L_{eff}^2)[\surd(I_w/I_z + L_{eff}^2 GI_t/(\pi^2 EI_z)]$ = 549.4 NCCI SN003 2(1)

$\bar{\lambda}_{LT} = \surd(M_{c,y,Rd}/M_{cr})$ = 0.705

$\bar{\lambda}_{LT,0}$ = 0.4 β = 0.75 [EC3 UK NA 2.17]

Use buckling curve b: α = 0.340 [EC3 Tables 6.3/6.4 NA2.17]

$\phi_{LT} = 0.5[1 + \alpha_{LT}(\bar{\lambda}_{LT} - \bar{\lambda}_{LT,0}) + \beta\bar{\lambda}_{LT}^2]$ = 0.738

$\chi_{LT} = 1/[\phi_{LT} + \surd(\phi_{LT}^2 - \beta\bar{\lambda}_{LT}^2)]$ = 0.867 [EC3 (6.56)]
$M_{b,y,Rd} = \phi_{LT}.M_{c,y,Rd}/\gamma_M$ = 0.738 x 272.8/1.0 = 236.6 kNm

Bending about z-z (minor) axis: N/A

Summary:

F_c/P_c = 1,206/1,553 =	0.776	[1]	
M_x/M_{bs} = 13.0/236.6 =	0.055	[2]	
$M_y/p_y.Z_y$ =	0.000	[3] x 1.5 NCCI SN048	
Sum of stress ratios [1] + [2] + 1.5 x [3] =	**0.831**	OK	

Baseplate calculation ***(considering axial load only)***

Design compression force on baseplate, N_{Ed} = 1,206kN
Concrete grade C30/37: cylinder strength, f_{ck} = 30 N/mm^2
Concrete strength, $f_{cd} = \alpha_{cc}.f_{ck}/\gamma_M$ = 0.85 x 30/1.5 = 17.0 N/mm^2
Concrete design strength, $f_{jd} = \beta_j.\alpha.f_{cd}$ = 17.0 N/mm^2 (β = 2/3; α taken as 1.5) [SN037 A2]

Minimum area required = F_c/f_{jd} = 1,206 x 1000/17 = 70,916mm^2

Base is sized as a large projection base plate (equal projection from all faces of member) [EC3-1-8 6.2.5]

Min required projection, c = 37.2mm Minimum base plate size = 329 x 330 mm

Minimum thickness = $c\surd(3 \times f_{jd}/f_y)$ = 16.3 mm (f_y = 265 N/mm^2)

Use 400 x 400 x 20mm S275 base plate

Pressure on underside of plate = 1,206/70,916 = 17.0 N/mm^2

Bending stress at root of plate projection = 17.0 x 37.2 x (37.2/2)/(20 x 20/6) = 177 N/mm^2 OK

As α taken as 1.5, min. base size = 1.5 x min plate size = 494 x 493 mm. - actual size to be determined by soil conditions