1 Demo

2 Standard

Calculation standard EN 1995-1-1
Calculation according to Czech national annex.

Coefficient γ_M for basic combinations	:	1,300
Coefficient γ_M for accidental combinations	:	1,000

3 Member 1

3.1 Input data

Length: 4,580 m
Service class: 1

Section

Name: rectangle

TIMBER, SOLID SQUARED - RECTANGLE	
Cross-section dimension	
cross-section height	h = 200,0 mm
cross-section width	b = 150,0 mm
Cross-sectional characteristics	
cross-sectional area	A = 3,000E+04 mm^2
distance of centroid from left edge of min. cross-section envelope	y_{cg} = 75,0 mm
distance of centroid from bottom edge of min. cross-section envelope	z_{cg} = 100,0 mm
moment of inertia w.r.t. horizontal centroidal axis	I_y = 1,000E+08 mm^4
moment of inertia w.r.t. vertical centroidal axis	I_z = 5,625E+07 mm^4
radius of gyration normal to horizontal centroidal axis	i_y = 57,7 mm
radius of gyration normal to vertical centroidal axis	i_z = 43,3 mm

Material

Name: C22 - coniferous
Calculation ignores coefficient k_h for increasing timber strength.
Material characteristics:

Elastic modulus	$E_{0,mean}$	:	10000	MPa
Shear modulus	G_{mean}	:	630	MPa
Bending strength	$f_{m,k}$	:	22,0	MPa
Tensile strength in fibre direction	$f_{t,0,k}$	:	13,0	MPa
Compressive strength in fibre direction	$f_{c,0,k}$	:	20,0	MPa
Shear strength	$f_{v,k}$	:	2,4	MPa
Compressive strength perpendicular to fibres	$f_{c,90,k}$	:	2,4	MPa
Tensile strength perpendicular to fibres	$f_{t,90,k}$	:	0,5	MPa
5% elastic modulus quantile	$E_{0,05}$	:	6700	MPa
Characteristic density value	ρ_k	:	340,0	kg/m^3

Load - internal forces

Loads count: 2
Load 1: compression + bending:

	N[kN]	V_3[kN]	M_2[kNm]	V_2[kN]	M_3[kNm]
Max. value	0,000	10,000	3,500	0,000	0,000

	N[kN]	V_3[kN]	M_2[kNm]	V_2[kN]	M_3[kNm]
Min. value	-152,000	-10,000	0,000	0,000	0,000

Load 2: tension:

	N[kN]	V_3[kN]	M_2[kNm]	V_2[kN]	M_3[kNm]
Max. value	160,000	0,000	0,000	0,000	0,000
Min. value	160,000	0,000	0,000	0,000	0,000

Load 1: compression + bending:
Long-term load

X[m]	N[kN]	V_3[kN]	M_2[kNm]	V_2[kN]	M_3[kNm]
0,000	-95,000	10,000	0,000	0,000	0,000
2,290	-123,500	10,000	3,500		
2,290		-10,000			
4,580	-152,000	-10,000	0,000	0,000	0,000

Load 2: tension:
Short-term load

X[m]	N[kN]	V_3[kN]	M_2[kNm]	V_2[kN]	M_3[kNm]
0,000	160,000	0,000	0,000	0,000	0,000
4,580	160,000	0,000	0,000	0,000	0,000

Buckling

buckling perpendicular to z:

Sector No.	Start [m]	End [m]	Length for buckling [m]	Buckling length factor k_z	Buckling length $L_{cr,z}$ [m]
1	0,000	2,290	2,290	1,000	2,290
2	2,290	4,580	2,290	1,000	2,290

buckling perpendicular to y:

Sector No.	Start [m]	End [m]	Length for buckling [m]	Buckling length factor k_y	Buckling length $L_{cr,y}$ [m]
1	0,000	2,290	2,290	1,000	2,290
2	2,290	4,580	2,290	1,000	2,290

LTB

Calculation without buckling

3.2 Results

Intermediate results

Compression and bending moment combination check:
Axial force N =-123,500 kN
Bending moment M_y = 3,500 kNm
Bending moment M_z = 0,000 kNm
Slenderness for buckling perpendicular to z λ_z = 52,9
Slenderness for buckling perpendicular to y λ_y = 39,7
Critical slenderness λ = 52,9
Calculation of buckling effect:
Rel. slenderness $\lambda_{rel,y}$ = 0,690
k_y = 0,777
$k_{c,y}$ = 0,882
Rel. slenderness $\lambda_{rel,z}$ = 0,920
k_z = 0,985

$k_{c,z}$ = 0,748
Material partial safety factor γ_M = 1,300
Modification coefficient k_{mod} = 0,700
Design strength in compression $f_{c,0,d}$ = 10,769 MPa
Coefficient for increasing characteristic strength in bending from M_y: $k_{h,My}$ = 1,000
Coefficient for increasing characteristic strength in bending from M_z: $k_{h,Mz}$ = 1,000
Material partial safety factor γ_M = 1,300
Modification coefficient k_{mod} = 0,700
Design strength in bending from moment M_y: $f_{m,y,d}$ = 11,846 MPa
Design strength in bending from moment M_z: $f_{m,z,d}$ = 11,846 MPa
Check in upper left-hand cross-section corner:
W_y = -1,000E03 cm^3
W_z = -7,500E02 cm^3
$\sigma_{c,0,d}/(k_{c,y}*f_{c,0,d})$ = -0,434
$\sigma_{m,y,d}/f_{m,y,d}$ = -0,295
$k_m*\sigma_{m,z,d,fi}/f_{m,d,fi}$ = 0,000
| -0,434 + -0,295 + 0,000 | < 1 Pass

Shear forces check:
Shear force V_z = 10,000 kN
Shear force V_y = 0,000 kNm
Material partial safety factor γ_M = 1,300
Modification coefficient k_{mod} = 0,700
Design strength in shear $f_{v,d}$ = 1,292 MPa
Crack effect coefficient k_{cr} = 0,670
Check in cross-section center of gravity:
first moment of area S_y = 7,500E02 cm^3
Thickness t_y = 150,0 mm
stress $\tau_{Vz} = V_z*S_y/(I_y*k_{cr}*t_y)$ = 0,746 MPa
first moment of area S_z = 5,625E02 cm^3
thickness t_z = 200,0 mm
stress $\tau_{Vy} = V_y*S_z/(I_z*k_{cr}*t_z)$ = 0,000 MPa
$\sqrt{(\tau_{Vz}^2+\tau_{Vy}^2)}/f_{v,d}$ = 0,577
0,577 < 1 Pass

Slenderness check
Calculated member slenderness: 52,9
Limit member slenderness: 120,0
Slenderness ok
Check of axial tension:
Coefficient for increasing characteristic tensile strength k_h = 1,000
Material partial safety factor γ_M = 1,300
Modification coefficient k_{mod} = 0,900
Design tensile strength $f_{t,0,d}$ = 9,000 MPa
$\sigma_{t,0,d}/f_{t,0,d}$ = 0,593
0,593 < 1 Pass

Slenderness check
Calculated member slenderness: 52,9
Limit member slenderness: 120,0
Slenderness ok

Overall check

Decisive load: Load 1: compression + bending

Internal forces: N = -123,500 kN; M_y = 3,500 kNm; M_z = 0,000 kNm; V_z = 10,000 kN; V_y = 0,000 kN

Compression and bending moment combination check:
Resistances: N_R = 284,826 kN; $M_{y,R}$ = -11,846 kNm
| -0,434 + -0,295 + 0,000 | = |-0,729 | < 1 **Pass**

Shear forces check:
Resistance: V_R = 17,317 kN
0,577 < 1 **Pass**

Member slenderness check:
member slenderness: 52,9
limit slenderness: 120,0
Member slenderness ok

Section ok

Utilization

Section utilization: 72,9 %