Standard

Standard **EN 1995-1-2/Czech Rep.**.

Reliability of timber in fire : $\gamma_{M,fi}$ = 1,000

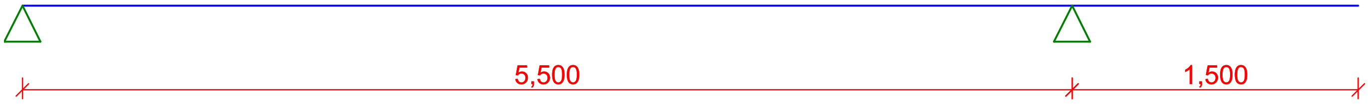
1 Beam T5

1.1 Input data

Length: 7,000 m

1.1.1 Geometry

x [m]	Point kind	A/L [m]	I/L [m³]
0,000	hinged	-	-
5,500	hinged	-	-
7,000	free	-	-



Cross-section

Sector No.	Start [m]	End [m]	Section	Rotation [°]
1	0,000	7,000	Rectangle 120x240	0,0

Døevo, celistvý hraniný - Rectangle 120x240	
Cross-section dimension	
cross-section height	h = 240,0 mm
cross-section width	b = 120,0 mm
Cross-sectional characteristics	
cross-sectional area	A = 28,8E+03 mm^2
distance of centroid from left edge of min. cross-section envelope	y_{cg} = 60,0 mm
distance of centroid from bottom edge of min. cross-section envelope	z_{cg} = 120,0 mm
moment of inertia w.r.t. horizontal centroidal axis	I_y = 138E+06 mm^4
moment of inertia w.r.t. vertical centroidal axis	I_z = 34,6E+06 mm^4
radius of gyration normal to horizontal centroidal axis	i_y = 69,3 mm
radius of gyration normal to vertical centroidal axis	i_z = 34,6 mm

Material

Name: S10 (C24) - coniferous
Calculation uses coefficient k_h for increasing tensile and bending strength.

1.1.2 Load

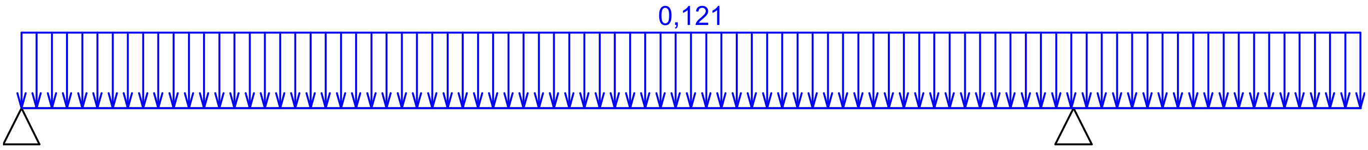
Load cases

no.	Name	Code	Type	γ_f ($\gamma_{f,inf}$)*	Factors for combinations				
					ξ	Categ.**	ψ_0	ψ_1	ψ_2
1	G1 self weight	Self weight	Permanent	1,35(0,90)	0,85	-	-	-	-
2	G2 permanent load	Force	Permanent	1,35(0,90)	0,85	-	-	-	-
3	Q3 variable 01	Force	Long-term variable	1,50	-	A	0,70	0,50	0,30

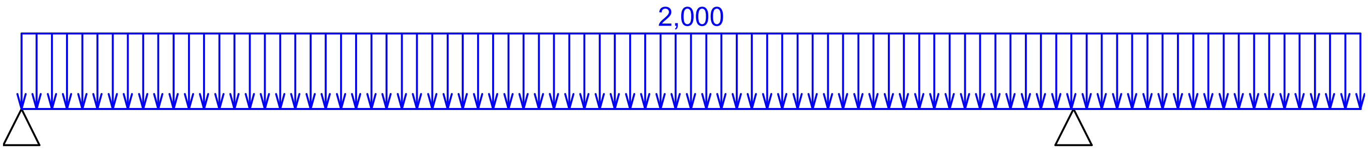
no.	Name	Code	Type	γ_f ($\gamma_{f,inf}$)*	Factors for combinations				
					ξ	Categ.**	ψ_0	ψ_1	ψ_2
4	Q4 variable 02	Force	Long-term variable	1,50	-	A	0,70	0,50	0,30
5	Q5 variable 03	Force	Long-term variable	1,50	-	A	0,70	0,50	0,30

* $\gamma_{f,inf}$ for favourable dead loads
** Category of live loads according to table A1.1 in EN 1990

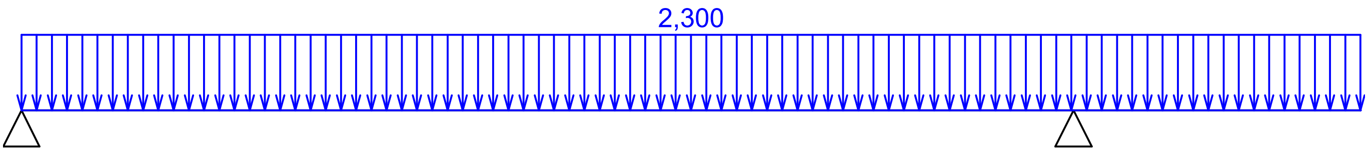
G1 self weight - load				
Type	Coor.x [m]	Length [m]	Size1	Size2
uniform	0,000	7,000	0,121kN/m	-



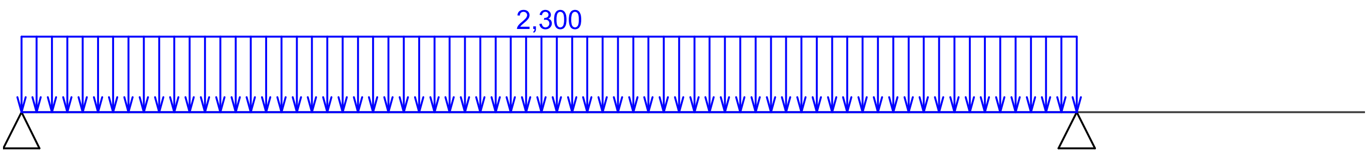
G2 permanent load - load				
Type	Coor.x [m]	Length [m]	Size1	Size2
uniform	0,000	7,000	2,000kN/m	-



Q3 variable 01 - load				
Type	Coor.x [m]	Length [m]	Size1	Size2
uniform	0,000	7,000	2,300kN/m	-



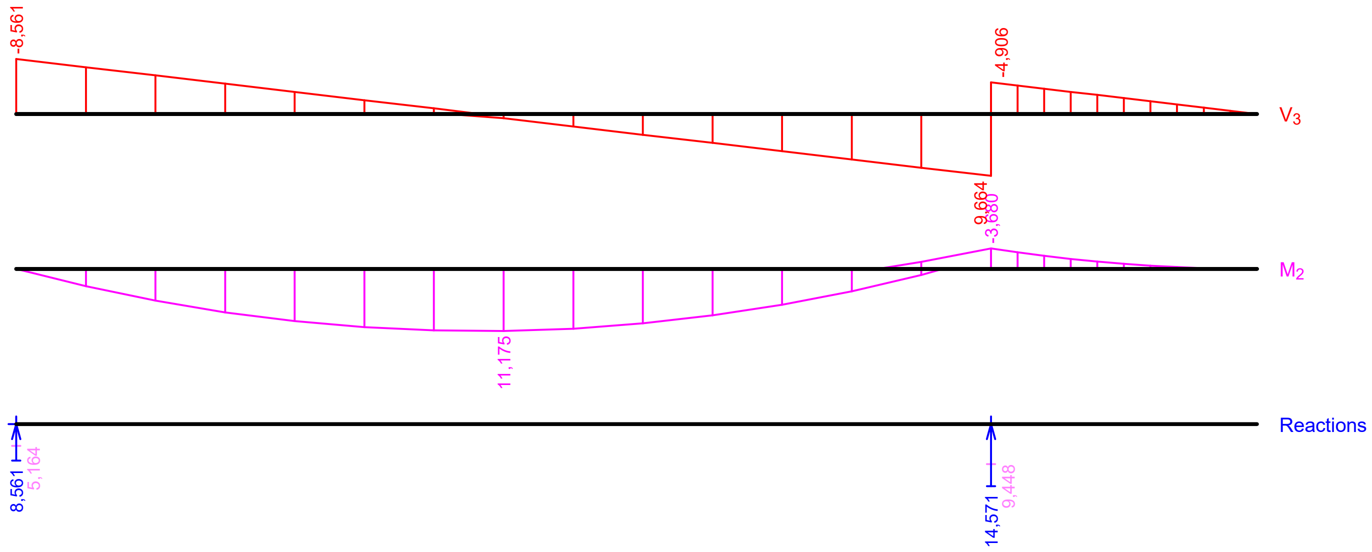
Q4 variable 02 - load				
Type	Coor.x [m]	Length [m]	Size1	Size2
uniform	0,000	5,500	2,300kN/m	-



Q5 variable 03 - load				
Type	Coor.x [m]	Length [m]	Size1	Size2
uniform	5,500	1,500	2,300kN/m	-

Envelopes

Envelope accidental design (ULS)								
x [m]	Max M_2 [kNm]	Min M_2 [kNm]	Max V_3 [kN]	Min V_3 [kN]	Max R_z [kN]	Min R_z [kN]	Max RO_x [kNm]	Min RO_x [kNm]
0,000	0,000	0,000	-5,164	-8,561	8,561	5,164	-	-
0,393	3,105	1,861	-4,330	-7,276	-	-	-	-
0,786	5,708	3,396	-3,497	-5,990	-	-	-	-
1,179	7,807	4,605	-2,663	-4,705	-	-	-	-
1,571	9,400	5,486	-1,832	-3,423	-	-	-	-
1,964	10,495	6,043	-0,998	-2,137	-	-	-	-
2,357	11,086	6,275	-0,164	-0,852	-	-	-	-
2,750	11,175	6,180	0,669	0,434	-	-	-	-
3,143	10,745	5,749	1,955	1,267	-	-	-	-
3,536	9,813	4,992	3,240	2,101	-	-	-	-
3,929	8,377	3,908	4,526	2,934	-	-	-	-
4,321	6,444	2,503	5,808	3,766	-	-	-	-
4,714	4,003	0,768	7,093	4,599	-	-	-	-
5,107	1,060	-1,293	8,379	5,433	-	-	-	-
5,500	-2,386L	-3,680L	9,664L	6,266L	14,571	9,448	-	-
5,500	-2,386R	-3,680R	-3,181R	-4,906R	-	-	-	-
5,650	-1,933	-2,981	-2,863	-4,416	-	-	-	-
5,800	-1,527	-2,355	-2,545	-3,925	-	-	-	-
5,950	-1,169	-1,803	-2,227	-3,435	-	-	-	-
6,100	-0,859	-1,325	-1,909	-2,944	-	-	-	-
6,250	-0,597	-0,920	-1,591	-2,453	-	-	-	-
6,400	-0,382	-0,589	-1,273	-1,963	-	-	-	-
6,550	-0,215	-0,331	-0,954	-1,472	-	-	-	-
6,700	-0,095	-0,147	-0,636	-0,981	-	-	-	-
6,850	-0,024	-0,037	-0,318	-0,491	-	-	-	-
7,000	0,000	0,000	0,000	0,000	-	-	-	-



Reactions extremes

Reactions extremes accidental design (ULS)	
x [m]	Reaction
0,000	Max R_z = 8,561kN - Q4:G1+G2
0,000	Min R_z = 5,164kN - Q5:G1+G2
5,500	Max R_z = 14,571kN - Q3:G1+G2
5,500	Min R_z = 9,448kN - G1+G2

Lateral-torsional buckling

Buckling due to bending moment M_y:

Sector No.	Start [m]	End [m]	l_{z1} [m]	Beam and load type	Load position
1	0,000	7,000	7,000	beam with distributed load	on the top

1.2 Results

Intermediate results

Determination of effective cross-section at time t = 15,0 min (Method of reduced cross-section):

Nominal design charring rate β_n = 0,80 mm/min
Nominal design charring depth $d_{char,n}$ = 12,0 mm
Factor for determining effective charring depth k_0 = 0,750
Effective charring depth d_{ef} = 17,2 mm
Effective cross-section: b = 85,5 mm; h = 222,8 mm

Bending moment check:

Bending moment M_y = 6,827 kNm
Calculation of buckling from moment M_y:
Critical stress $\sigma_{m,crit}$ = 28,082 MPa
rel. slenderness $\lambda_{rel,m}$ = 0,924
buckling coefficient k_{crit} = 0,867
Coefficient for increasing characteristic strength in bending from M_y: $k_{h,My}$ = 1,000
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in bending from moment M_y: $f_{m,y,20}$ = 30,000 MPa
Design strength in bending from moment M_y: $f_{m,y,d,fi}$ = 30,000 MPa

Check in bottom left-hand cross-section corner:
W_y = 7,071E05 mm^3
W_z = -2,714E05 mm^3
$\sigma_{m,y,d,fi}/(k_{crit}M_y{*}f_{m,d,fi})$ = 0,371
0,371 < 1 Pass

Shear forces check:
Shear force V_z = 0,434 kN
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in shear $f_{v,20}$ = 5,000 MPa
Design strength in shear $f_{v,d,fi}$ = 5,000 MPa
Crack effect coefficient k_{cr} = 0,670
Check in cross-section centre of gravity:
first moment of area S_y = 5,303E05 mm^3
Thickness t_y = 85,5 mm
stress $\tau_{Vz} = V_z{*}S_y/(I_y{*}k_{cr}{*}t_y)$ = 0,051 MPa
first moment of area S_z = 2,035E05 mm^3
thickness t_z = 222,8 mm
stress $\tau_{Vy} = V_y{*}S_z/(I_z{*}k_{cr}{*}t_z)$ = 0,000 MPa
$\sqrt{(\tau_{Vz}^2+\tau_{Vy}^2)}/f_{v,d,fi}$ = 0,010
0,010 < 1 Pass
Slenderness for buckling perpendicular to z λ_z = 283,6
Slenderness for buckling perpendicular to y λ_y = 108,9
Critical slenderness λ = 283,6

Determination of effective cross-section at time t = 15,0 min (Method of reduced cross-section):
Nominal design charring rate β_n = 0,80 mm/min
Nominal design charring depth $d_{char,n}$ = 12,0 mm
Factor for determining effective charring depth k_0 = 0,750
Effective charring depth d_{ef} = 17,2 mm
Effective cross-section: b = 85,5 mm; h = 222,8 mm

Bending moment check:
Bending moment M_y = 6,180 kNm
Calculation of buckling from moment M_y:
Critical stress $\sigma_{m,crit}$ = 28,082 MPa
rel. slenderness $\lambda_{rel,m}$ = 0,924
buckling coefficient k_{crit} = 0,867
Coefficient for increasing characteristic strength in bending from M_y: $k_{h,My}$ = 1,000
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in bending from moment M_y: $f_{m,y,20}$ = 30,000 MPa
Design strength in bending from moment M_y: $f_{m,y,d,fi}$ = 30,000 MPa
Check in bottom left-hand cross-section corner:
W_y = 7,071E05 mm^3
W_z = -2,714E05 mm^3
$\sigma_{m,y,d,fi}/(k_{crit}M_y{*}f_{m,d,fi})$ = 0,336
0,336 < 1 Pass

Shear forces check:
Shear force V_z = 0,669 kN
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000

20% quantile of strength in shear $f_{v,20}$ = 5,000 MPa
Design strength in shear $f_{v,d,fi}$ = 5,000 MPa
Crack effect coefficient k_{cr} = 0,670
Check in cross-section centre of gravity:
first moment of area S_y = 5,303E05 mm^3
Thickness t_y = 85,5 mm
stress $\tau_{Vz} = V_z*S_y/(I_y*k_{cr}*t_y)$ = 0,079 MPa
first moment of area S_z = 2,035E05 mm^3
thickness t_z = 222,8 mm
stress $\tau_{Vy} = V_y*S_z/(I_z*k_{cr}*t_z)$ = 0,000 MPa
$\sqrt{(\tau_{Vz}^2+\tau_{Vy}^2)}/f_{v,d,fi}$ = 0,016
0,016 < 1 Pass
Slenderness for buckling perpendicular to z λ_z = 283,6
Slenderness for buckling perpendicular to y λ_y = 108,9
Critical slenderness λ = 283,6

Determination of effective cross-section at time t = 15,0 min (Method of reduced cross-section):
Nominal design charring rate β_n = 0,80 mm/min
Nominal design charring depth $d_{char,n}$ = 12,0 mm
Factor for determining effective charring depth k_0 = 0,750
Effective charring depth d_{ef} = 17,2 mm
Effective cross-section: b = 85,5 mm; h = 222,8 mm

Bending moment check:
Bending moment M_y = 11,175 kNm
Calculation of buckling from moment M_y:
Critical stress $\sigma_{m,crit}$ = 28,082 MPa
rel. slenderness $\lambda_{rel,m}$ = 0,924
buckling coefficient k_{crit} = 0,867
Coefficient for increasing characteristic strength in bending from M_y: $k_{h,My}$ = 1,000
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in bending from moment M_y: $f_{m,y,20}$ = 30,000 MPa
Design strength in bending from moment M_y: $f_{m,y,d,fi}$ = 30,000 MPa
Check in bottom left-hand cross-section corner:
W_y = 7,071E05 mm^3
W_z = -2,714E05 mm^3
$\sigma_{m,y,d,fi}/(k_{crit}M_y*f_{m,d,fi})$ = 0,608
0,608 < 1 Pass

Shear forces check:
Shear force V_z = 0,434 kN
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in shear $f_{v,20}$ = 5,000 MPa
Design strength in shear $f_{v,d,fi}$ = 5,000 MPa
Crack effect coefficient k_{cr} = 0,670
Check in cross-section centre of gravity:
first moment of area S_y = 5,303E05 mm^3
Thickness t_y = 85,5 mm
stress $\tau_{Vz} = V_z*S_y/(I_y*k_{cr}*t_y)$ = 0,051 MPa
first moment of area S_z = 2,035E05 mm^3
thickness t_z = 222,8 mm
stress $\tau_{Vy} = V_y*S_z/(I_z*k_{cr}*t_z)$ = 0,000 MPa

$\sqrt{}(\tau_{Vz}^2+\tau_{Vy}^2)/f_{v,d,fi}$ = 0,010
0,010 < 1 Pass
Slenderness for buckling perpendicular to z λ_z = 283,6
Slenderness for buckling perpendicular to y λ_y = 108,9
Critical slenderness λ = 283,6

Determination of effective cross-section at time t = 15,0 min (Method of reduced cross-section):
Nominal design charring rate β_n = 0,80 mm/min
Nominal design charring depth $d_{char,n}$ = 12,0 mm
Factor for determining effective charring depth k_0 = 0,750
Effective charring depth d_{ef} = 17,2 mm
Effective cross-section: b = 85,5 mm; h = 222,8 mm

Bending moment check:
Bending moment M_y = 10,528 kNm
Calculation of buckling from moment M_y:
Critical stress $\sigma_{m,crit}$ = 28,082 MPa
rel. slenderness $\lambda_{rel,m}$ = 0,924
buckling coefficient k_{crit} = 0,867
Coefficient for increasing characteristic strength in bending from M_y: $k_{h,My}$ = 1,000
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in bending from moment M_y: $f_{m,y,20}$ = 30,000 MPa
Design strength in bending from moment M_y: $f_{m,y,d,fi}$ = 30,000 MPa
Check in bottom left-hand cross-section corner:
W_y = 7,071E05 mm^3
W_z = -2,714E05 mm^3
$\sigma_{m,y,d,fi}/(k_{crit}M_y*f_{m,d,fi})$ = 0,573
0,573 < 1 Pass

Shear forces check:
Shear force V_z = 0,669 kN
Material partial safety factor $\gamma_{M,fi}$ = 1,000
Modification coefficient $k_{mod,fi}$ = 1,000
20% quantile of strength in shear $f_{v,20}$ = 5,000 MPa
Design strength in shear $f_{v,d,fi}$ = 5,000 MPa
Crack effect coefficient k_{cr} = 0,670
Check in cross-section centre of gravity:
first moment of area S_y = 5,303E05 mm^3
Thickness t_y = 85,5 mm
stress $\tau_{Vz} = V_z*S_y/(I_y*k_{cr}*t_y)$ = 0,079 MPa
first moment of area S_z = 2,035E05 mm^3
thickness t_z = 222,8 mm
stress $\tau_{Vy} = V_y*S_z/(I_z*k_{cr}*t_z)$ = 0,000 MPa
$\sqrt{}(\tau_{Vz}^2+\tau_{Vy}^2)/f_{v,d,fi}$ = 0,016
0,016 < 1 Pass
Slenderness for buckling perpendicular to z λ_z = 283,6
Slenderness for buckling perpendicular to y λ_y = 108,9
Critical slenderness λ = 283,6

Overall check

Check in required fire resistance time t = 15,0 min:
Method of reduced cross-section
Charring depth $d_{char,n}$ = 12,0 mm

Decisive load: Q4:G1+G2
Internal forces: M_y = 11,175 kNm; V_z = 0,434 kN
Bending moment check:
Resistance: $M_{y,R,t,fi}$ = 18,383 kNm
0,608 < 1 **Pass**

Shear forces check:
Resistance: $V_{R,t,fi}$ = 42,534 kN
0,010 < 1 **Pass**

Section ok