File :....voorbeeld uitdraai\TimberFrameRoofDutch.xfr2

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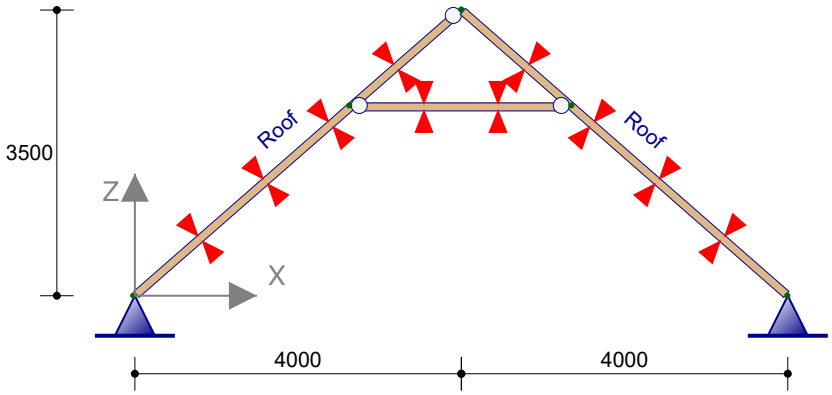
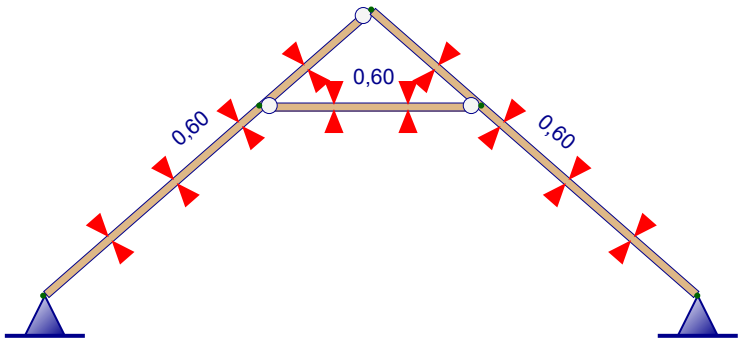
Applied standards: : DIN EN 1995-1-1:2010-12 + DIN EN 1995-1-1/NA:2013-08
Consequence class : CC1

Gravity acceleration g : 9,81 m/s ^{2}

1 Input Data



Load widths



1.1 NODES

Node Number	Coordinates		Restraints		
	X [mm]	Z [mm]	Tx	Tz	Ry
1	0	0	A	A	
2	8000	0	A	A	
3	2635	2313			
4	5357	2313			
5	4000	3500			

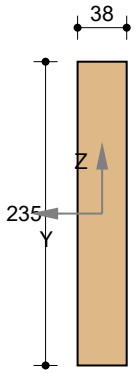
1.2 BEAMS

Beam Number	Node		Beam type	Profile	Length [mm]
	from	to			
1	1	5		38 x 235	5315
2	5	2		38 x 235	5315
3	3	4		38 x 235	2722

1.3 PROFILES

Profile Number	Name	Weight [kg/m]	E [N/mm²]	A [mm²]	Iy [mm4]	Wy;el_1 [mm³]	Wy;el_2 [mm³]
1	38 x 235	3,4	9000	8,93E3	4,1097E7	3,4976E5	3,4976E5

38 x 235



Material data

Grade C18
Service class 1
Material type Solid timber γ_M = 1,30 k_{def} = 0,60
Elasticity Modulus E = 9000 N/mm²

		$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$
		18,00	11,00	0,40	18,00	2,20	3,40 N/mm²
Load-duration class	k_{mod}	$f_{m,d}$	$f_{t,0,d}$	$f_{t,90,d}$	$f_{c,0,d}$	$f_{c,90,d}$	$f_{v,d}$
Permanent	0,60	8,31	5,08	0,18	8,31	1,02	1,57 N/mm²
Medium-term	0,80	11,08	6,77	0,25	11,08	1,35	2,09
Short-term	0,90	12,46	7,62	0,28	12,46	1,52	2,35

Density	ρ_{mean} =	380 kg/m³	ρ_k =	320 kg/m³
Elasticity Modulus	$E_{0,mean}$ =	9000 N/mm²	$E_{90,mean}$ =	300 N/mm²
Elasticity Modulus (creep)	$E_{0,fin}$ =	5625 N/mm²	$E_{90,fin}$ =	188 N/mm²
Elasticity Modulus	$E_{0,05}$ =	6000 N/mm²	$E_{0,d}$ =	6923 N/mm²
Shear strength	G_{mean} =	560 N/mm²	$G_{0,05}$ =	380 N/mm²

Cross section data

Maximum coordinate	y_{max} =	19,0 mm	z_{max} =	117,5 mm
Minimum coordinate	y_{min} =	-19,0 mm	z_{min} =	-117,5 mm
Centroid	z_s =	0,0 mm	y_s =	0,0 mm
Area / Weight	A =	8930,0 mm²	G =	3,4 kg/m
First moment of area	S_y =	262319 mm³	S_z =	42418 mm³
Moment of inertia	I_y =	41096604 mm⁴	I_z =	1074577 mm⁴
Radius of gyration	i_y =	67,8 mm	i_z =	11,0 mm
Elastic section modulus	$W_{y;el}$ =	349758 mm³	$W_{z;el}$ =	56557 mm³
Product moment of area	C_{yz} =	0 mm³	angle =	0,00 degrees
Moment of inertia	I_{max} =	41096604 mm⁴	I_{min} =	1074577 mm⁴
Radius of gyration	i_{max} =	67,8 mm	i_{min} =	11,0 mm

1.4 Snow loads

Characteristic snow load on the ground : 0,246 kN/m ^{2}

Pitch of roof	41,2 degrees	μ_1 = 0,50	μ_2 = 1,60
Pitch of roof	-41,2 degrees	μ_1 = 0,50	μ_2 = 1,60

Note that snow loads for multi-span roofs according art. 5.3.4 - figure 5.4 is not taken into account.

Load arrangements art. 5.2

$$s_k = 0{,}164Z - 0{,}082 + \frac{A}{966} = 0{,}164 \times 2 - 0{,}082 + \frac{0{,}0}{966} = 0{,}246 \text{ kN/m}^2 \quad \text{(T C.1)}$$

1.5 Wind pressures

Wind zone	: II	Period of reference wind T	: 50 year
Terrain category	: II Area with low vegetation and isolated obstacles		
Height of the building h	: 7,00 m	Height above terrain	: 7,0 m
Width of the building	: 8,50 m	Depth of the building d	: 12,0 m
A - the distance end wall - centre truss	: 3,60 m	B - Load width truss	: 0,6 m

Terrain roughness art. 4.3.2

$$k_r(z) = 0{,}19 \times \left(\frac{z_0}{z_{0,II}}\right)^{0{,}07} = 0{,}19 \times \left(\frac{0}{0{,}05}\right)^{0{,}07} = 0 \quad \text{(4.5)}$$

$$k_r(z) = 0{,}19 \times \left(\frac{z_0}{z_{0,II}}\right)^{0{,}07} = 0{,}19 \times \left(\frac{0}{0{,}05}\right)^{0{,}07} = 0 \quad \text{(4.5)}$$

Wind turbulence art. 4.4

Peak velocity pressure art. 4.5

$$q_p(z) = (1 + 7.I_v(z)) \cdot \tfrac{1}{2} \cdot \rho \cdot V_m^2(z) = (1 + 7 \times 0) \times \tfrac{1}{2} \times 1{,}25 \times 0^2 = 0 \text{ kN/m}^2 \quad \text{(4.8)}$$

Determination of $c_s c_d$ art. 6.2

$c_s c_d$ = 1,00

1.6 Wind loads

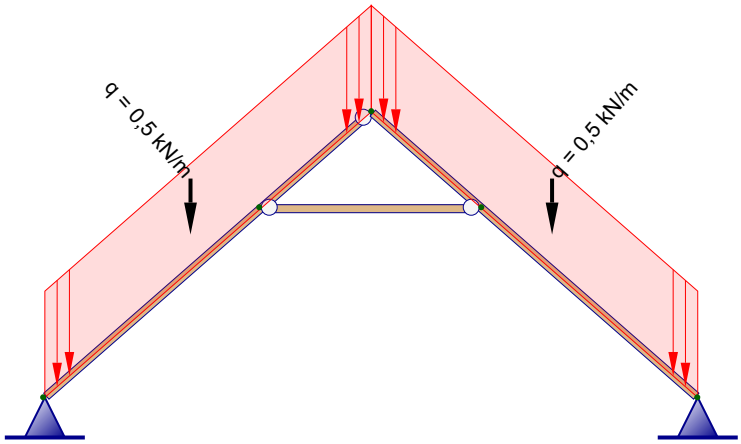
Ref.	Hoek [graden]	Zone	Cpi/Cpe	ze [m]	qp(ze) [kN/m2]	breedte [m]	qw [kN/m]	Art.
qw01	41,2	→ G	+0,700	7,00	0,000	0,6	0,000	Table 7.4
qw02	41,2	→ G	-0,127	7,00	0,000	0,6	0,000	"
qw03	41,2	→ H	+0,549	7,00	0,000	0,6	0,000	"
qw04	41,2	→ H	-0,051	7,00	0,000	0,6	0,000	"
qw05	-41,2	→ I	-0,251	7,00	0,000	0,6	0,000	"
qw06	-41,2	→ I	0,000	7,00	0,000	0,6	0,000	"
qw07	-41,2	→ J	-0,351	7,00	0,000	0,6	0,000	"
qw08	-41,2	→ J	0,000	7,00	0,000	0,6	0,000	"
qw09	41,2	↑ H	-0,875	7,00	0,000	0,6	0,000	"
qw10	41,2	↑ H	-0,875	7,00	0,000	0,6	0,000	"

Ref.	Hoek [graden]	Zone	Cpi/Cpe	ze [m]	qp(ze) [kN/m2]	breedte [m]	qw [kN/m]	Art.
qw11	-41,2	↑ H	-0,875	7,00	0,000	0,6	0,000	"
qw12	-41,2	↑ H	-0,875	7,00	0,000	0,6	0,000	"
qw13		→	-0,300	7,00	0,000	0,6	0,000	Art. 7.2.9
qw14		→	+0,200	7,00	0,000	0,6	0,000	"
qw15		↑	-0,300	7,00	0,000	0,6	0,000	"
qw16		↑	+0,200	7,00	0,000	0,6	0,000	"

1.7 LOAD CASES

no.	Description	Type	ψ0	ψ1	ψ2
1	Permanente belasting	Dead load incl. self-weight	1,00	1,00	1,00
2	Veranderlijke belasting	A:domestic	0,40	0,50	0,30
3	Sneeuw 1	Snow	0,00	0,20	0,00
4	Sneeuw 2	Snow	0,00	0,20	0,00
5	Sneeuw 3	Snow	0,00	0,20	0,00
6	Wind van links A + Onderdruk	Wind	0,00	0,20	0,00
7	Wind van links A + Overdruk	Wind	0,00	0,20	0,00
8	Wind van links B + Onderdruk	Wind	0,00	0,20	0,00
9	Wind van links B + Overdruk	Wind	0,00	0,20	0,00
10	Wind van links C + Onderdruk	Wind	0,00	0,20	0,00
11	Wind van links C + Overdruk	Wind	0,00	0,20	0,00
12	Wind van links D + Onderdruk	Wind	0,00	0,20	0,00
13	Wind van links D + Overdruk	Wind	0,00	0,20	0,00
14	Wind loodrecht A + Onderdruk	Wind	0,00	0,20	0,00
15	Wind loodrecht A + Overdruk	Wind	0,00	0,20	0,00

1.8 LOAD CASE 1 Permanente belasting Including self-weight

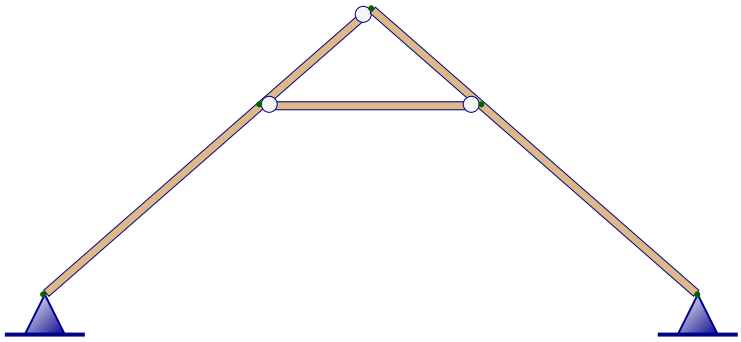


***) Loads due to self-weight are not drawn!**
Total self-weight: : 9 kg.

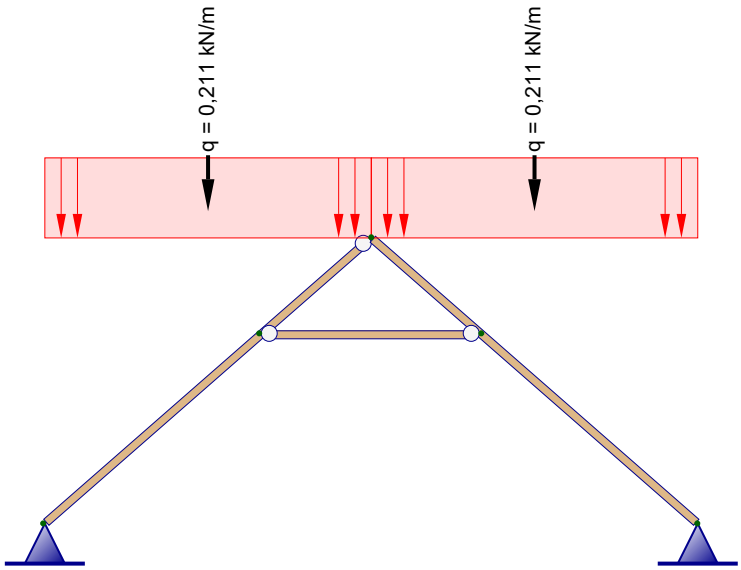
1.8.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	q	-0,500 kN/m	-0,500 kN/m	-41,2	1	0	5315
2	q	-0,500 kN/m	-0,500 kN/m	41,2	5	0	5315
3	q	-0,033 kN/m	-0,033 kN/m	0,0	3	0	2722

1.9 LOAD CASE 2 Veranderlijke belasting



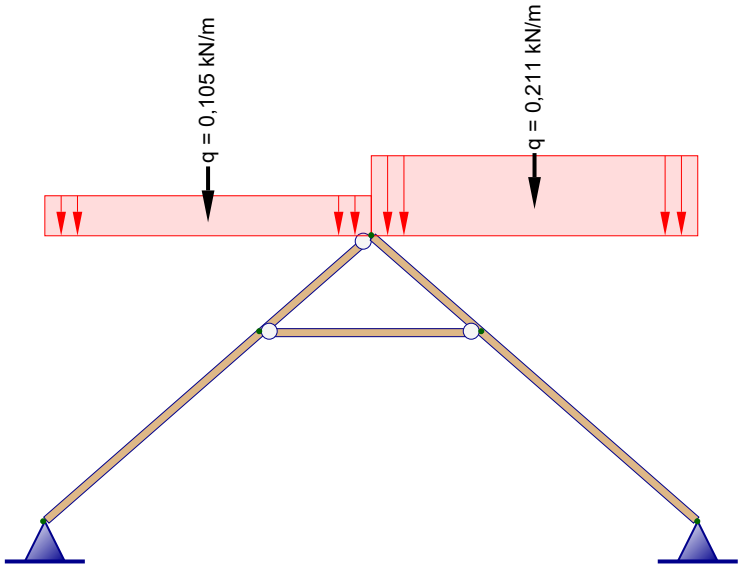
1.10 LOAD CASE 3 Sneeuw 1



1.10.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1		-0,211 kN/m	-0,211 kN/m	-41,2	1	0	5315
2		-0,211 kN/m	-0,211 kN/m	41,2	5	0	5315

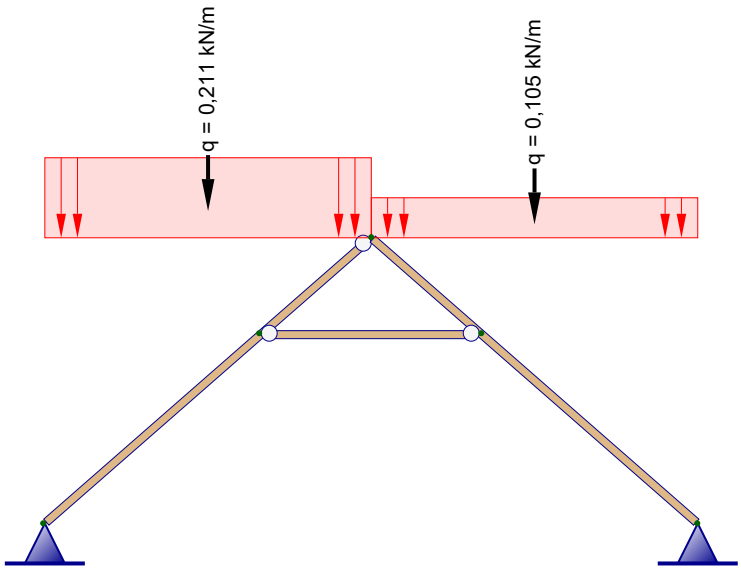
1.11 LOAD CASE 4 Sneeuw 2



1.11.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1		-0,105 kN/m	-0,105 kN/m	-41,2	1	0	5315
2		-0,211 kN/m	-0,211 kN/m	41,2	5	0	5315

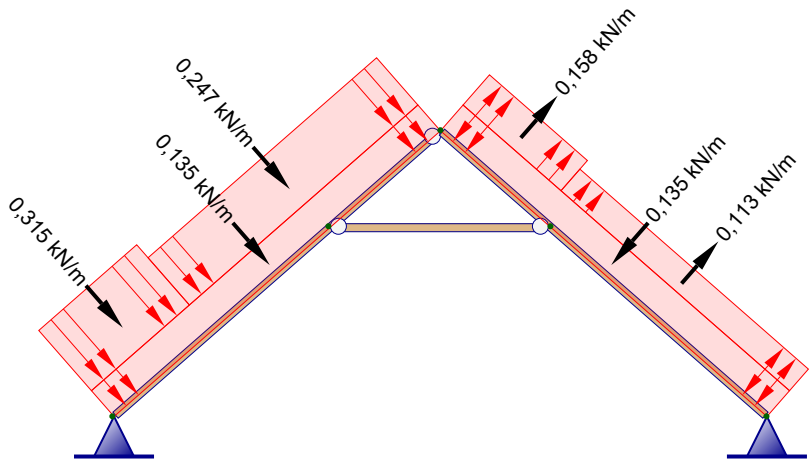
1.12 LOAD CASE 5 Sneeuw 3



1.12.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1		-0,211 kN/m	-0,211 kN/m	-41,2	1	0	5315
2		-0,105 kN/m	-0,105 kN/m	41,2	5	0	5315

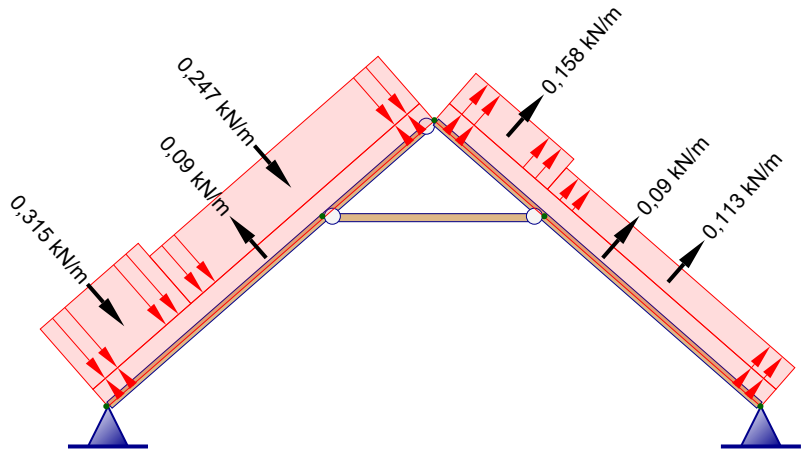
1.13 LOAD CASE 6 Wind van links A + Onderdruk



1.13.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw01	-0,315 kN/m	-0,315 kN/m	0,0	1	0	1595
1	qw03	-0,247 kN/m	-0,247 kN/m	0,0	1	1595	3720
1	qw13	-0,135 kN/m	-0,135 kN/m	0,0	1	0	5315
2	qw05	0,113 kN/m	0,113 kN/m	0,0	5	1595	3720
2	qw07	0,158 kN/m	0,158 kN/m	0,0	5	0	1595
2	qw13	-0,135 kN/m	-0,135 kN/m	0,0	5	0	5315

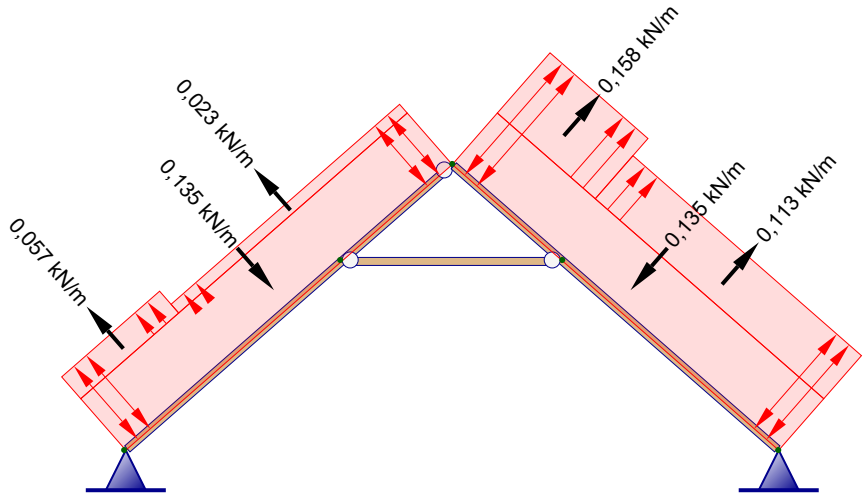
1.14 LOAD CASE 7 Wind van links A + Overdruk



1.14.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw01	-0,315 kN/m	-0,315 kN/m	0,0	1	0	1595
1	qw03	-0,247 kN/m	-0,247 kN/m	0,0	1	1595	3720
1	qw14	0,090 kN/m	0,090 kN/m	0,0	1	0	5315
2	qw05	0,113 kN/m	0,113 kN/m	0,0	5	1595	3720
2	qw07	0,158 kN/m	0,158 kN/m	0,0	5	0	1595
2	qw14	0,090 kN/m	0,090 kN/m	0,0	5	0	5315

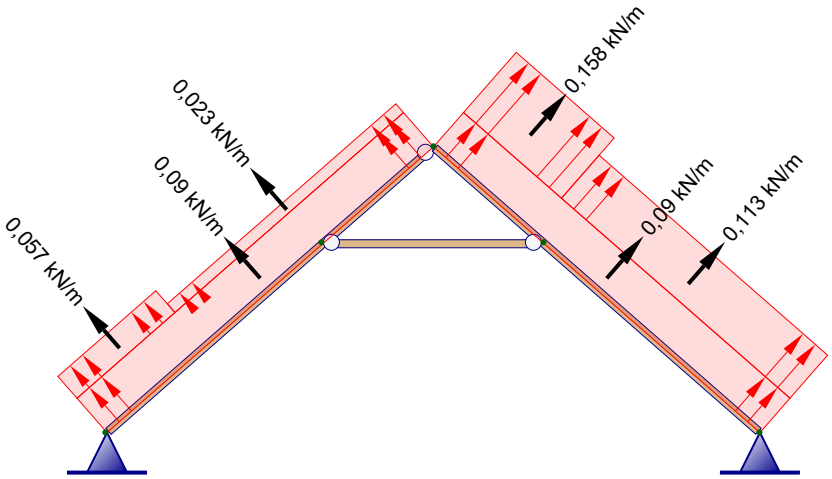
1.15 LOAD CASE 8 Wind van links B + Onderdruk



1.15.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw02	0,057 kN/m	0,057 kN/m	0,0	1	0	1595
1	qw04	0,023 kN/m	0,023 kN/m	0,0	1	1595	3720
1	qw13	-0,135 kN/m	-0,135 kN/m	0,0	1	0	5315
2	qw05	0,113 kN/m	0,113 kN/m	0,0	5	1595	3720
2	qw07	0,158 kN/m	0,158 kN/m	0,0	5	0	1595
2	qw13	-0,135 kN/m	-0,135 kN/m	0,0	5	0	5315

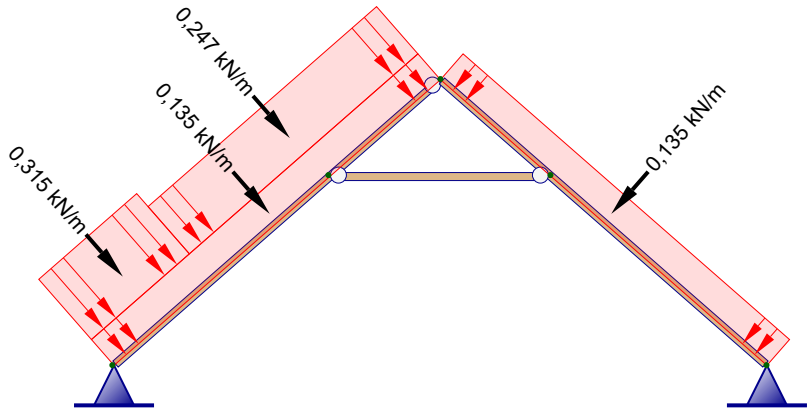
1.16 LOAD CASE 9 Wind van links B + Overdruk



1.16.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw02	0,057 kN/m	0,057 kN/m	0,0	1	0	1595
1	qw04	0,023 kN/m	0,023 kN/m	0,0	1	1595	3720
1	qw14	0,090 kN/m	0,090 kN/m	0,0	1	0	5315
2	qw05	0,113 kN/m	0,113 kN/m	0,0	5	1595	3720
2	qw07	0,158 kN/m	0,158 kN/m	0,0	5	0	1595
2	qw14	0,090 kN/m	0,090 kN/m	0,0	5	0	5315

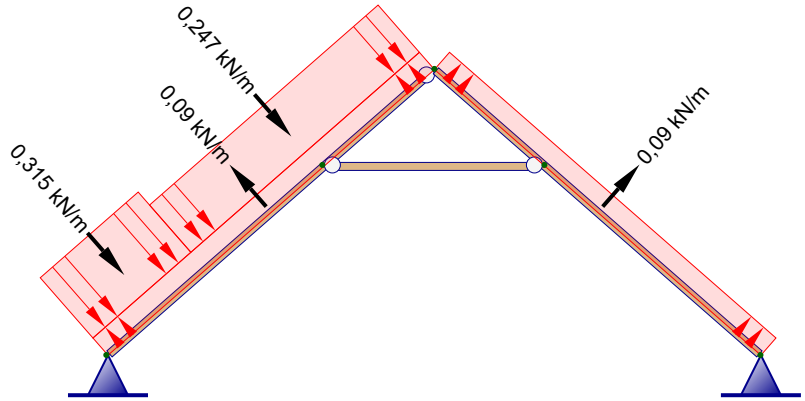
1.17 LOAD CASE 10 Wind van links C + Onderdruk



1.17.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw01	-0,315 kN/m	-0,315 kN/m	0,0	1	0	1595
1	qw03	-0,247 kN/m	-0,247 kN/m	0,0	1	1595	3720
1	qw13	-0,135 kN/m	-0,135 kN/m	0,0	1	0	5315
2	qw13	-0,135 kN/m	-0,135 kN/m	0,0	5	0	5315

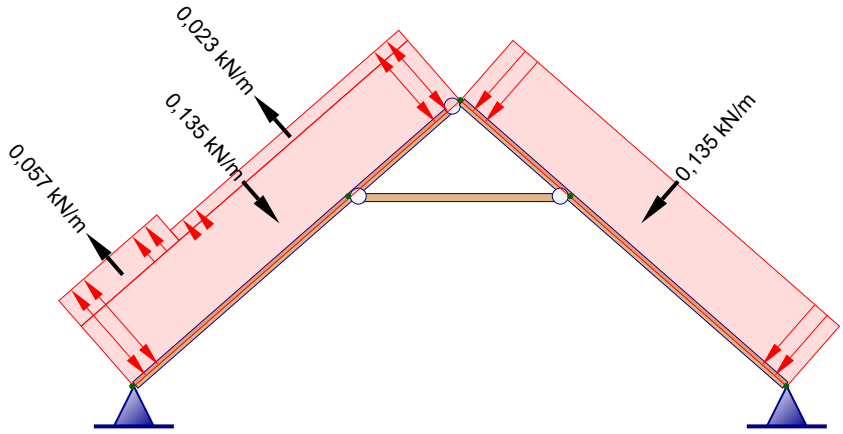
1.18 LOAD CASE 11 Wind van links C + Overdruk



1.18.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw01	-0,315 kN/m	-0,315 kN/m	0,0	1	0	1595
1	qw03	-0,247 kN/m	-0,247 kN/m	0,0	1	1595	3720
1	qw14	0,090 kN/m	0,090 kN/m	0,0	1	0	5315
2	qw14	0,090 kN/m	0,090 kN/m	0,0	5	0	5315

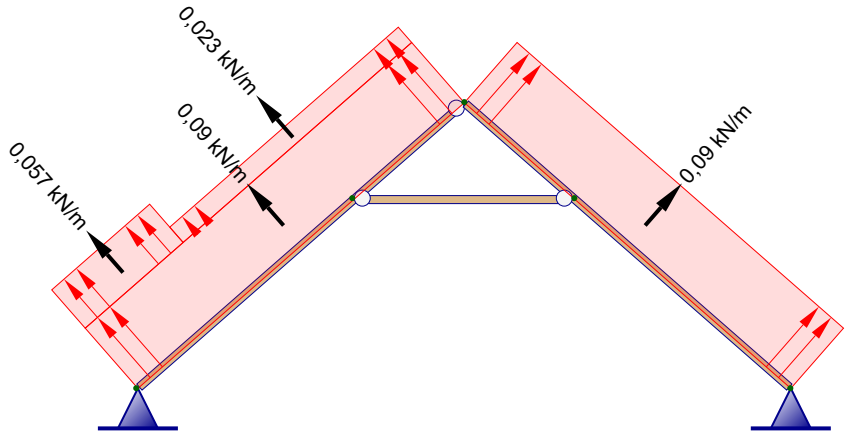
1.19 LOAD CASE 12 Wind van links D + Onderdruk



1.19.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw02	0,057 kN/m	0,057 kN/m	0,0	1	0	1595
1	qw04	0,023 kN/m	0,023 kN/m	0,0	1	1595	3720
1	qw13	-0,135 kN/m	-0,135 kN/m	0,0	1	0	5315
2	qw13	-0,135 kN/m	-0,135 kN/m	0,0	5	0	5315

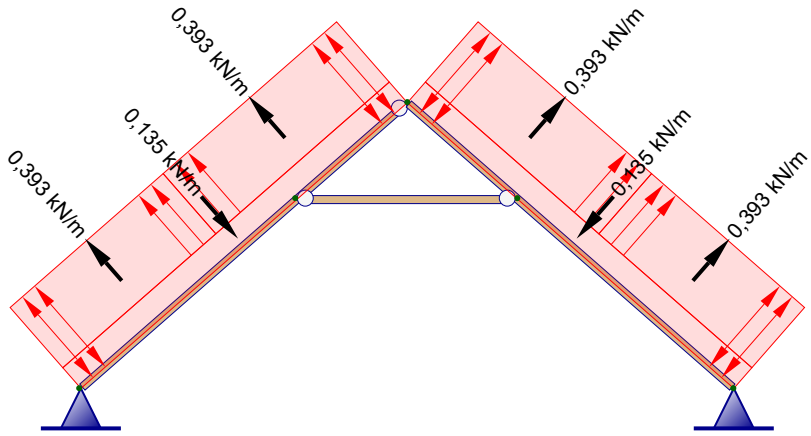
1.20 LOAD CASE 13 Wind van links D + Overdruk



1.20.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw02	0,057 kN/m	0,057 kN/m	0,0	1	0	1595
1	qw04	0,023 kN/m	0,023 kN/m	0,0	1	1595	3720
1	qw14	0,090 kN/m	0,090 kN/m	0,0	1	0	5315
2	qw14	0,090 kN/m	0,090 kN/m	0,0	5	0	5315

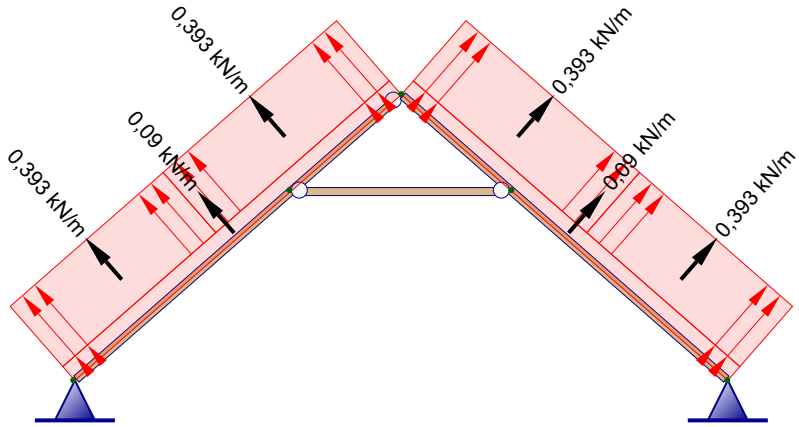
1.21 LOAD CASE 14 Wind loodrecht A + Onderdruk



1.21.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw09	0,393 kN/m	0,393 kN/m	0,0	1	0	2491
1	qw10	0,393 kN/m	0,393 kN/m	0,0	1	2491	2824
1	qw15	-0,135 kN/m	-0,135 kN/m	0,0	1	0	5315
2	qw11	0,393 kN/m	0,393 kN/m	0,0	5	0	2824
2	qw12	0,393 kN/m	0,393 kN/m	0,0	5	2824	2491
2	qw15	-0,135 kN/m	-0,135 kN/m	0,0	5	0	5315

1.22 LOAD CASE 15 Wind loodrecht A + Overdruk



1.22.1 Beam loads

Beam Number	Loads				Distance from		
	Type	q1	q2	Angle	Node	a [mm]	L [mm]
1	qw09	0,393 kN/m	0,393 kN/m	0,0	1	0	2491
1	qw10	0,393 kN/m	0,393 kN/m	0,0	1	2491	2824
1	qw16	0,090 kN/m	0,090 kN/m	0,0	1	0	5315
2	qw11	0,393 kN/m	0,393 kN/m	0,0	5	0	2824
2	qw12	0,393 kN/m	0,393 kN/m	0,0	5	2824	2491
2	qw16	0,090 kN/m	0,090 kN/m	0,0	5	0	5315

2 Calculation Results

2.1 ULTIMATE LIMIT STATES (ULS)

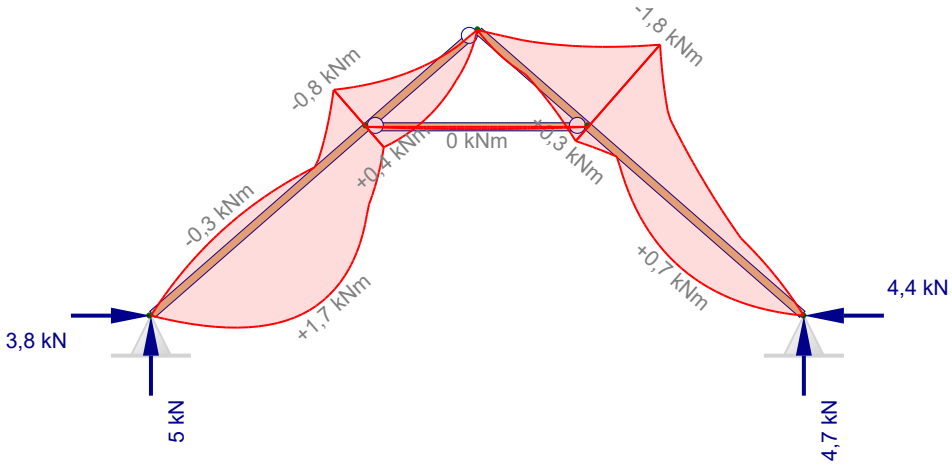
2.1.1 Load combinations

Geometric nonlinear analysis

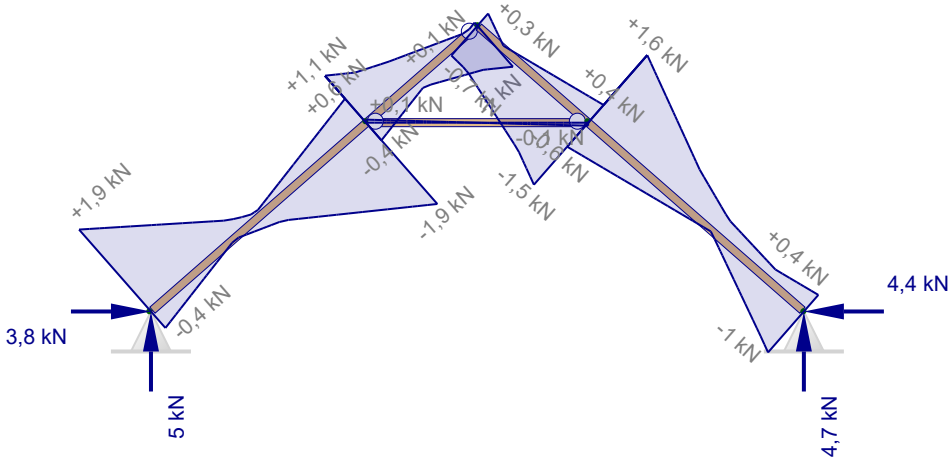
Combination Number	Description	Type
1	Permanente belasting	ULS
2	Veranderlijke belasting	ULS
3	Sneeuw 1	ULS
4	Sneeuw 2	ULS
5	Sneeuw 3	ULS
6	Wind van links A + Onderdruk	ULS
7	Wind van links A + Overdruk	ULS
8	Wind van links B + Onderdruk	ULS
9	Wind van links B + Overdruk	ULS
10	Wind van links C + Onderdruk	ULS
11	Wind van links C + Overdruk	ULS
12	Wind van links D + Onderdruk	ULS
13	Wind van links D + Overdruk	ULS
14	Wind loodrecht A + Onderdruk	ULS
15	Wind loodrecht A + Overdruk	ULS

Combination Number	Load case (ψ x γ)									
	1	2	3	4	5	6	7	8	9	10
1	1,00x1,20	0,40x1,50								
2	1,00x1,20	1,00x1,50								
3	1,00x1,20	0,40x1,50	1,00x1,50							
4	1,00x1,20	0,40x1,50		1,00x1,50						
5	1,00x1,20	0,40x1,50			1,00x1,50					
6	1,00x1,20	0,40x1,50				1,00x1,50				
7	1,00x1,20	0,40x1,50					1,00x1,50			
8	1,00x1,20	0,40x1,50						1,00x1,50		
9	1,00x1,20	0,40x1,50							1,00x1,50	
10	1,00x1,20	0,40x1,50								1,00x1,50
11	1,00x1,20	0,40x1,50								
12	1,00x1,20	0,40x1,50								
13	1,00x1,20	0,40x1,50								
14	1,00x1,20	0,40x1,50								
15	1,00x1,20	0,40x1,50								

Combination Number	Load case (ψ x γ)									
	11	12	13	14	15					
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11	1,00x1,50									
12		1,00x1,50								
13			1,00x1,50							
14				1,00x1,50						
15					1,00x1,50					



Envelop M-line



Envelop D-line

2.1.2 Envelope reaction forces

Node Number	Combination Number	Fx [kN]	Fz [kN]	My [kNm]
1	3	**3,770**	4,510	
	10	2,925	**4,986**	
	15	**0,987**	**0,346**	
2	6	**-4,409**	4,325	
	10	-4,329	**4,723**	
	15	**-0,987**	**0,343**	
Minimum / maximum values				
2	6	**-4,409**		
1	3	**3,770**		
2	15		**0,343**	
1	10		**4,986**	

2.1.3 Envelope beam forces

Beam Number	Combination Number	Node Number	x-local [mm]	Nx-local [kN]	Vz-local [kN]	My-local [kNm]
1	3	1		**5,808**	0,903	0,000
	6	1		4,813	**1,942**	0,000
	4	3		-1,156	0,934	**-0,805**
	6		1737	-4,126	0,000	**1,675**
	7	3		-0,126	0,376	**0,443**
	10	3		**-4,102**	**-1,927**	-0,332
	7	5		**0,589**	0,866	0,000
2	6	5		**0,891**	-0,616	0,000
	4		3785	-4,657	0,000	**0,738**
	6	4		-1,603	-1,382	**-1,789**
	10	4		-1,421	**-1,468**	-1,584
	10	4		**-4,980**	**1,599**	-1,584
	15	4		-0,625	0,418	**0,310**
	10	2		**-6,368**	0,697	0,000
3	6	3		4,186	**0,054**	0,000
	10	3		**4,692**	0,054	0,000
	11	3		2,848	**0,054**	0,000
	15	3		**-1,436**	0,054	0,000
	6		1361	-4,186	0,000	**0,037**
	6	4		-4,186	**0,054**	0,000
	10	4		**-4,692**	0,054	0,000
	11	4		-2,848	**0,054**	0,000
	15	4		**1,436**	0,054	0,000

2.2 SERVICE LIMIT STATES (SLS)

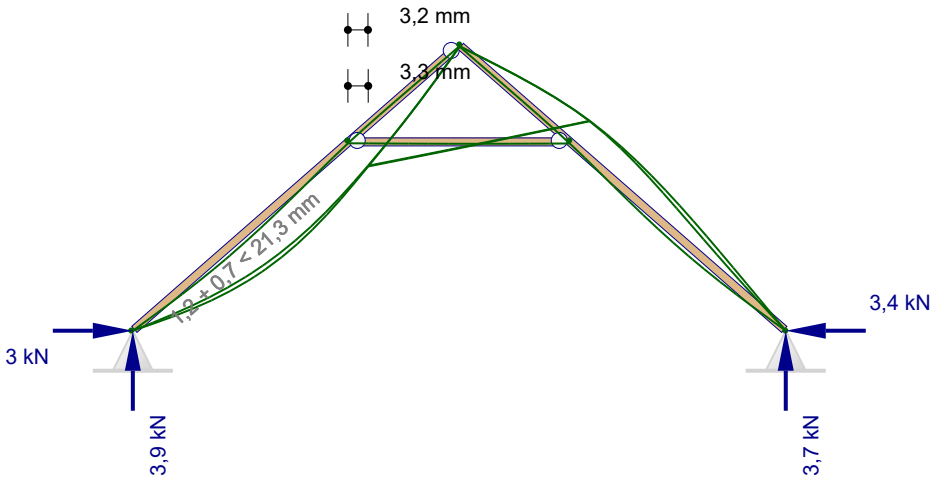
2.2.1 Load combinations

Geometric nonlinear analysis

Combination Number	Description	Type
16	Permanente belasting	SLS
17	Veranderlijke belasting	SLS
18	Sneeuw 1	SLS
19	Sneeuw 2	SLS
20	Sneeuw 3	SLS
21	Wind van links A + Onderdruk	SLS
22	Wind van links A + Overdruk	SLS
23	Wind van links B + Onderdruk	SLS
24	Wind van links B + Overdruk	SLS
25	Wind van links C + Onderdruk	SLS
26	Wind van links C + Overdruk	SLS
27	Wind van links D + Onderdruk	SLS
28	Wind van links D + Overdruk	SLS
29	Wind loodrecht A + Onderdruk	SLS
30	Wind loodrecht A + Overdruk	SLS
31	BGT Blijvend	SLS Permanent
32	BGT Quasi blijvend (in connection with creep)	SLS Quasi permanent

Combination Number	Load case (ψ x γ)									
	1	2	3	4	5	6	7	8	9	10
16	1,00x1,00	0,40x1,00								
17	1,00x1,00	1,00x1,00								
18	1,00x1,00	0,40x1,00	1,00x1,00							
19	1,00x1,00	0,40x1,00		1,00x1,00						
20	1,00x1,00	0,40x1,00			1,00x1,00					
21	1,00x1,00	0,40x1,00				1,00x1,00				
22	1,00x1,00	0,40x1,00					1,00x1,00			
23	1,00x1,00	0,40x1,00						1,00x1,00		
24	1,00x1,00	0,40x1,00							1,00x1,00	
25	1,00x1,00	0,40x1,00								1,00x1,00
26	1,00x1,00	0,40x1,00								
27	1,00x1,00	0,40x1,00								
28	1,00x1,00	0,40x1,00								
29	1,00x1,00	0,40x1,00								
30	1,00x1,00	0,40x1,00								
31	1,00x1,00									
32	1,00x1,00	0,30x1,00								

Combination Number	Load case (ψ x γ)									
	11	12	13	14	15					
16										
17										
18										
19										
20										
21										
22										
23										
24										
25										
26	1,00x1,00									
27		1,00x1,00								
28			1,00x1,00							
29				1,00x1,00						
30					1,00x1,00					
31										
32										



Envelop displacements

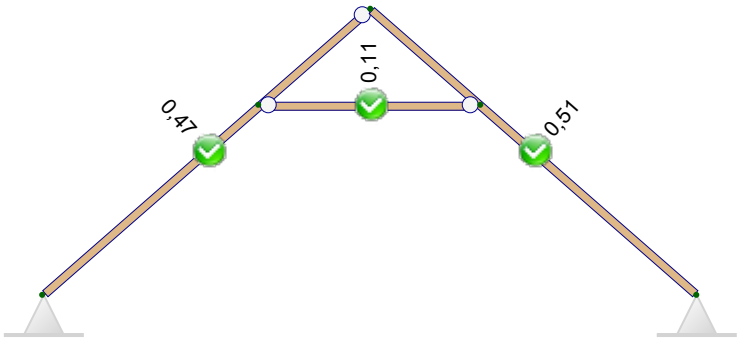
2.2.2 Envelope node displacements

Node Number	Combination Number	dx [mm]	dz [mm]	dr [mrad]
1	18	**0,0**	0,0	-1,6
	21	0,0	0,0	**-5,3**
	25	0,0	**0,0**	-4,4
	30	**0,0**	**0,0**	**0,3**
2	19	0,0	0,0	**2,1**
	21	**0,0**	0,0	-1,4
	22	0,0	0,0	**-2,1**
	25	0,0	**0,0**	-0,2
	30	**0,0**	**0,0**	-0,3
3	19	**-0,5**	**0,3**	0,3
	21	**3,3**	**-3,9**	**2,3**
	30	0,0	0,0	**-0,1**
4	19	**-0,6**	**-0,9**	**-0,8**
	22	**3,2**	**3,4**	**1,1**
5	19	0,0	-0,3	**-0,5**
	21	**0,1**	-0,2	**3,4**
	25	0,0	**-0,3**	2,3

Node Number	Combination Number	dx [mm]	dz [mm]	dr [mrad]
5	28	**0,0**	-0,2	-0,2
	30	0,0	**-0,1**	0,0
Minimum / maximum values				
4	19	**-0,6**		
3	21	**3,3**		
3	21		**-3,9**	
4	22		**3,4**	
1	21			**-5,3**
5	21			**3,4**

2.3 EN1995 CHECKS

The check of the timber members in the ultimate limit state according to EN 1995-1-1 is based on a geometrical non-linear analysis (second order analysis) using the imperfections as given in 5.4.4.



Beam Number	Profile	Combination Number	Article	U.C.
1	38 x 235	7	6.1.2	0,01
		3	6.1.4	0,05
		6	6.1.7	0,14
		7	6.2.3	0,13
		6	6.2.4	0,39
		6	6.3.2	0,47
		6	6.3.3	0,31
		21	Deflection	0,36
		21	Deflection	0,27
2	38 x 235	15	6.1.2	0,00
		10	6.1.4	0,06
		10	6.1.7	0,11
		15	6.2.3	0,08
		6	6.2.4	0,41
		6	6.3.2	0,51
		6	6.3.3	0,34
		22	Deflection	0,20
		22	Deflection	0,29
3	38 x 235	15	6.1.2	0,02

Beam Number	Profile	Combination Number	Article	U.C.
3	38 x 235	10	6.1.4	0,04
		31	6.1.7	0,00
		15	6.2.3	0,03
		31	6.2.4	0,01
		10	6.3.2	0,11
		10	6.3.3	0,10

2.4 CALCULATION OF UNITY CHECKS

2.4.1 Beam 1 - 38 x 235 (C18 Service class:1)

Tension parallel to the grain art. 6.1.2

Combination : 7 x = 5315,1 mm Nx = 0,589 kN Vz = -0,866 kN My = 0 kNm
Load-duration class : Short-term

$$\sigma_{t,0,d} = \frac{N_{t,Ed}}{A} = \frac{588,5}{8930} = 0,1 \text{ N/mm}^2 < f_{t,0,d} = 7,6 \text{ N/mm}^2 \quad (6.1)$$

Compression parallel to the grain art. 6.1.4

Combination : 3 x = 0 mm Nx = -5,808 kN Vz = 0,903 kN My = 0 kNm
Load-duration class : Short-term

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{5807,9}{8930} = 0,7 \text{ N/mm}^2 < f_{c,0,d} = 12,5 \text{ N/mm}^2 \quad (6.2)$$

Shear art. 6.1.7

Combination : 6 x = 0 mm Nx = -4,813 kN Vz = 1,942 kN My = 0 kNm
Load-duration class : Short-term

$$\tau_d = \frac{V_{z,Ed}\ S}{b\ Iy} = \frac{1941,7 \text{ x } 262319}{38 \text{ x } 41096604} = 0,3 \text{ N/mm}^2 < f_{v,d} = 2,4 \text{ N/mm}^2 \quad (6.13)$$

Combined bending and axial tension art. 6.2.3

Combination : 7 x = 4053,9 mm Nx = 0,09 kN Vz = 0 kN My = 0,546 kNm
Load-duration class : Short-term

$$\sigma_{t,0,d} = \frac{N_{c,Ed}}{A} = \frac{90}{8930} = 0 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{0,546 \text{ x } 10^6}{350 \text{ x } 10^3} = 1,6 \text{ N/mm}^2$$

$$\frac{\sigma_{t,0,d}}{f_{t,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \frac{0,0}{7,6} + \frac{1,6}{12,5} = 0,13 < 1.00 \quad (6.17)$$

Combined bending and axial compression art. 6.2.4

Combination : 6 x = 1737,3 mm Nx = -4,126 kN Vz = 0 kN My = 1,675 kNm
Load-duration class : Short-term

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{4126}{8930} = 0,5 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{1,675 \text{ x } 10^6}{350 \text{ x } 10^3} = 4,8 \text{ N/mm}^2$$

$$\left(\frac{\sigma_{c,0,d}}{f_{t,0,d}} \right)^2 + \frac{\sigma_{m,y,d}}{f_{m,y,d}} = \left(\frac{0,5}{12,5} \right)^2 + \frac{4,8}{12,5} = 0,39 < 1.00 \quad (6.19)$$

Columns subjected to either compression or combined compression and bending art. 6.3.2

Combination : 6 x = 1737,3 mm Nx = -4,126 kN Vz = 0 kN My = 1,675 kNm
Load-duration class : Short-term

$$\lambda_y = \frac{L_{cr,y}}{i_y} = \frac{5315}{67,8} = 78,35 \qquad \lambda_{rel,y} = \frac{\lambda_y}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{78,35}{\pi}\sqrt{\frac{18,0}{6000}} = 1,366 \quad (6.21)$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{1063}{11,0} = 96,91 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{96,91}{\pi}\sqrt{\frac{18,0}{6000}} = 1,689 \quad (6.22)$$

$$k_y = 0,5(1 + \beta_c(\lambda_{rel,y} - 0,3) + \lambda_{rel,y}^2 = 0,5 \times (1 + 0,2 \times (1,366 - 0,3) + 1,366^2 = 1,54 \quad (6.27)$$

$$k_{c,y} = \frac{1}{k_y + \sqrt{k_y^2 - \lambda_{rel,y}^2}} = \frac{1}{1,54 + \sqrt{1,54^2 - 1,37^2}} = 0,44 \quad (6.25)$$

$$k_z = 0,5(1 + \beta_c(\lambda_{rel,z} - 0,3) + \lambda_{rel,z}^2 = 0,5 \times (1 + 0,2 \times (1,689 - 0,3) + 1,689^2 = 2,07 \quad (6.28)$$

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{2,07 + \sqrt{2,07^2 - 1,69^2}} = 0,31 \quad (6.26)$$

$$\sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{4126}{8930} = 0,5 \text{ N/mm}^2 \qquad \sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{1,675 \times 10^6}{350 \times 10^3} = 4,8 \text{ N/mm}^2$$

$$\frac{\sigma_{c,0,d}}{k_{c,y} f_{c,0,d}} + \frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0,5}{0,44 \times 12,5} + \frac{4,8}{12,5} + 0,7 \times \frac{0,0}{16,2} = 0,47 < 1.00 \quad (6.23)$$

$$\frac{\sigma_{c,0,d}}{k_{c,z} f_{c,0,d}} + k_m \frac{\sigma_{m,y,d}}{f_{m,y,d}} + \frac{\sigma_{m,z,d}}{f_{m,z,d}} = \frac{0,5}{0,31 \times 12,5} + 0,7 \times \frac{4,8}{12,5} + \frac{0,0}{16,2} = 0,39 < 1.00 \quad (6.24)$$

Beams subjected to either bending or combined bending and compression art. 6.3.3

Combination : 6 x = 1737,3 mm Nx = -4,813 kN Vz = 0,745 kN My = 1,675 kNm
Load-duration class : Short-term

Number of lateral restraints: 4
Distances lateral restraints: 1063 1063 1063 1063 1063
Simply supported: Uniformly distributed load

$\rightarrow l_{ef} = 0,9 \times l = 0,9 \times 1063 = 957$ mm $\qquad l_{ef} = l_{ef} + 2h = 957 + 2 \times 235 = 1063$ mm

$$\sigma_{m,crit} = \frac{0,78\, b^2}{h\, l_{ef}} E_{0,05} = \frac{0,78 \times 38^2}{235 \times 1063} \times 6000 = 27,1 \text{ N/mm}^2 \quad (6.32)$$

$$\lambda_{rel,m} = \sqrt{\frac{f_{m,k}}{\sigma_{m,crit}}} = \sqrt{\frac{18}{27,1}} = 0,816 \quad (6.30)$$

$0,75 < \lambda_{rel,m} < 1,4 \quad \rightarrow k_{crit} = 1,56 - 0,75\ \lambda_{rel,m} = 1,56 - 0,75 \times 0,816 = 0,948$ (6.34)

$$\sigma_{m,y,d} = \frac{M_{y,Ed}}{W_y} = \frac{1,675 \times 10^{6}}{350 \times 10^{3}} = 4,8\ N/mm^2 \qquad \sigma_{c,0,d} = \frac{N_{c,Ed}}{A} = \frac{4813}{8930} = 0,5\ N/mm^2$$

$$\lambda_z = \frac{L_{cr,z}}{i_z} = \frac{1063}{11,0} = 96,91 \qquad \lambda_{rel,z} = \frac{\lambda_z}{\pi}\sqrt{\frac{f_{c,0,k}}{E_{0,005}}} = \frac{96,91}{\pi}\sqrt{\frac{18,0}{6000}} = 1,689$$ (6.22)

$k_z = 0,5(1 + \beta_c(\lambda_{rel,z} - 0,3) + \lambda_{rel,z}^2 = 0,5 \times (1 + 0,2 \times (1,689 - 0,3) + 1,689^2 = 2,07$ (6.28)

$$k_{c,z} = \frac{1}{k_z + \sqrt{k_z^2 - \lambda_{rel,z}^2}} = \frac{1}{2,07 + \sqrt{2,07^2 - 1,69^2}} = 0,31$$ (6.26)

$$\left(\frac{\sigma_{m,d}}{k_{crit} f_{m,d}}\right)^2 + \frac{\sigma_{c,d}}{k_{c,d} f_{c,0,d}} = \left(\frac{4,8}{0,95 \times 12,5}\right)^2 + \frac{0,5}{0,31 \times 12,5} = 0,31 < 1.00$$ (6.35)

Deflection

Combination : 21 x = 2190,1 mm Nx = -3,184 kN Vz = -0,367 kN My = 1,1 kNm
Load-duration class : Short-term

Local node displacements d z1 = 0 mm d z2 = -0,2 mm

$w_{fin.,z} = w_z + k_{def}\ w_{SLS\ Quasi\ permanent,z} = -6,9 + 0,6 \times -1,2 = -7,6$ mm

$$\frac{|w_{fin.,z}|}{w_{fin.,z,max}} = \frac{|-7,6|}{5315 / 250} = \frac{|-7,6|}{21,3} = 0,36 < 1,0$$

$w_{add.,z} = w_z - w_{SLS\ Permanent,z} = -6,9 + 1,2 = -5,7$ mm

$$\frac{|w_{add.,z}|}{w_{add.,z,max}} = \frac{|-5,7|}{5315 / 250} = \frac{|-5,7|}{21,3} = 0,27 < 1,0$$

Deflection

Combination : 21 x = 2190,1 mm Nx = -3,184 kN Vz = -0,367 kN My = 1,1 kNm
Load-duration class : Short-term

Local node displacements d z1 = 0 mm d z2 = -0,2 mm

$w_{fin.,z} = w_z + k_{def}\ w_{SLS\ Quasi\ permanent,z} = -6,9 + 0,6 \times -1,2 = -7,6$ mm

$$\frac{|w_{fin.,z}|}{w_{fin.,z,max}} = \frac{|-7,6|}{5315 / 250} = \frac{|-7,6|}{21,3} = 0,36 < 1,0$$

$w_{add.,z} = w_z - w_{SLS\ Permanent,z} = -6,9 + 1,2 = -5,7$ mm

$$\frac{|w_{add.,z}|}{w_{add.,z,max}} = \frac{|-5,7|}{5315 / 250} = \frac{|-5,7|}{21,3} = 0,27 < 1,0$$