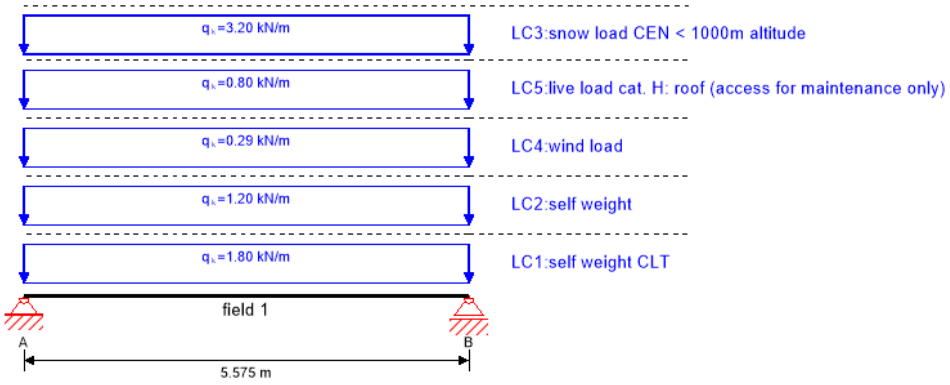
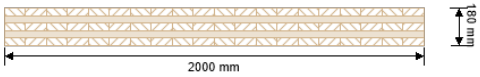
system



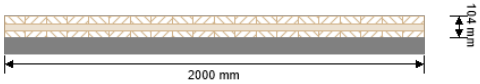
global utilization ratio										88 %
ULS	21 %	ULS fire	11 %	SLS	49 %	SLS vibration	88 %	support	-1 %	

section: CLT 180 L5s



layer	thickness	orientation	material
1	40.0 mm	0°	C24 spruce ETA (2019)
2	30.0 mm	90°	C24 spruce ETA (2019)
3	40.0 mm	0°	C24 spruce ETA (2019)
4	30.0 mm	90°	C24 spruce ETA (2019)
5	40.0 mm	0°	C24 spruce ETA (2019)
t_{CLT}	**180.0 mm**		

section fire: CLT 180 L5s



layer	thickness	orientation	material
1	40.0 mm	0°	C24 spruce ETA (2019)
2	30.0 mm	90°	C24 spruce ETA (2019)
3	34.0 mm	0°	C24 spruce ETA (2019)
t_{CLT}	**104.0 mm**		
fire resistance class:R 90	time	**90 min**	

fire protection layering : 12.5 mm gypsum plasterboard Type F
gypsum plasterboard Type A (acc. to EN 520)gypsum plasterboard Type F (acc. to EN 520)

$t_{ch,h}$	$t_{f,h}$	$t_{a,h}$	$d_{ta,h}$	k_0	d_0	$d_{char,0,h}$	$d_{ef,h}$
[min]	[min]	[min]	[mm]	[-]	[mm]	[mm]	[mm]
21	24	42	25	1	7	69.0	76.0

material values

material	$f_{m,k}$	$f_{t,0,k}$	$f_{t,90,k}$	$f_{c,0,k}$	$f_{c,90,k}$	$f_{v,k}$	$f_{r,k\ min}$	$E_{0,mean}$	G_{mean}	$G_{r,mean}$
	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]	[N/mm²]
C24 spruce ETA (2019) C24 spruce ETA (2019)	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,000.00	690.00	50.00

load

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC1	self weight CLT	G	permanent	0.6	1	1.35	1	1	1
LC1	self weight CLT	G	permanent						

load case groups

	load case category	Typ	duration	Kmod	γ_{inf}	γ_{sup}	Ψ_0	Ψ_1	Ψ_2
LC2 LC2	self weight self weight	G G	permanent permanent	0.6	1	1.35	1	1	1
LC3 LC3	snow load CEN < 1000m altitude snow load CEN < 1000m altitude	Q Q	short term short term	0.9	0	1.5	0.5	0.2	0
LC4 LC4	wind load wind load	Q Q	short term short term	0.9	0	1.5	0.6	0.2	0
LC5 LC5	live load cat. H: roof (access for maintenance only) live load cat. H: roof (access for maintenance only)	Q Q	short term short term	0.9	0	1.5	0	0	0

LC1:self weight CLT

continuous load	
field	load at start
	[kN/m]
1 1	1.80

LC2:self weight

continuous load	
field	load at start
	[kN/m]
1 1	1.20

LC3:snow load CEN < 1000m altitude

continuous load	
field	load at start
	[kN/m]
1 1	3.20

LC4:wind load

continuous load	
field	load at start
	[kN/m]
1 1	0.29

LC5:live load cat. H: roof (access for maintenance only)

continuous load	
field	load at start
	[kN/m]
1 1	0.80

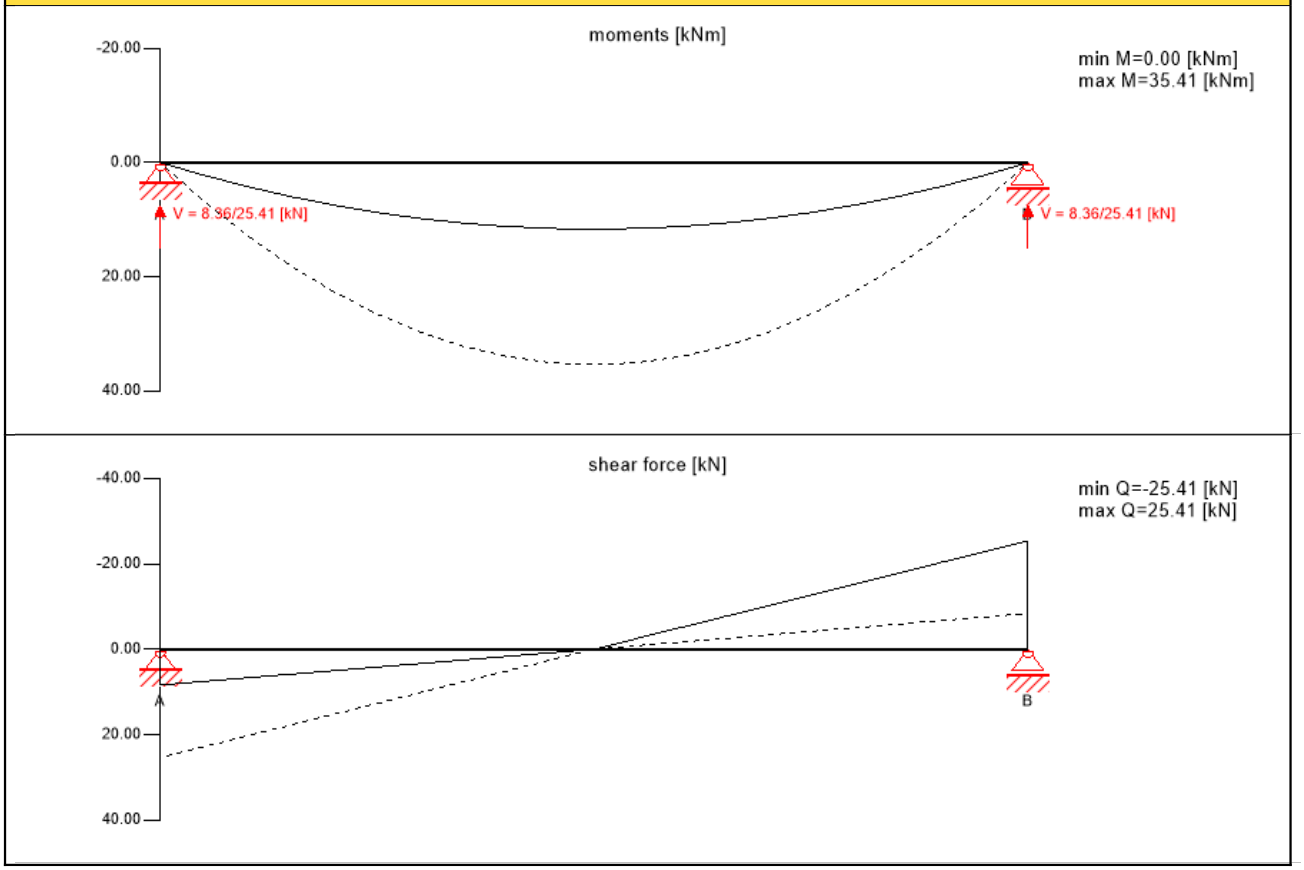
ULS combinations	
	combination rule
LCO1 LCO1	1.35/1.00 * LC1 + 1.35/1.00 * LC2 1.35/1.00 * LC1 + 1.35/1.00 * LC2
LCO2 LCO2	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3
LCO3 LCO3	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.60 * LC4 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.60 * LC4
LCO4 LCO4	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.60 * LC4 + 1.50/0.00 * 0.00 * LC5 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.60 * LC4 + 1.50/0.00 * 0.00 * LC5
LCO5 LCO5	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4
LCO6 LCO6	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC3 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC3
LCO7 LCO7	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC3 + 1.50/0.00 * 0.00 * LC5 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.50 * LC3 + 1.50/0.00 * 0.00 * LC5
LCO8 LCO8	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5
LCO9 LCO9	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.50 * LC3 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.50 * LC3
LCO10 LCO10	1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.50 * LC3 + 1.50/0.00 * 0.60 * LC4 1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.50 * LC3 + 1.50/0.00 * 0.60 * LC4

ULS combinations fire	
	combination rule
LCO11 LCO11	1.00/1.00 * LC1 + 1.00/1.00 * LC2 1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO12 LCO12	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3
LCO13 LCO13	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4
LCO14 LCO14	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5
LCO15 LCO15	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4
LCO16 LCO16	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3
LCO17 LCO17	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC5
LCO18 LCO18	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5
LCO19 LCO19	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3
LCO20 LCO20	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4

SLS characteristic combination	
	combination rule
LCO21 LCO21	1.00/1.00 * LC1 + 1.00/1.00 * LC2 1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO22 LCO22	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC3 + 1.00/0.00 * 0.60 * LC4 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC3 + 1.00/0.00 * 0.60 * LC4 + 1.00/0.00 * 0.00 * LC5
LCO23 LCO23	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.50 * LC3 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.50 * LC3 + 1.00/0.00 * 0.00 * LC5
LCO24 LCO24	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.50 * LC3 + 1.00/0.00 * 0.60 * LC4 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.50 * LC3 + 1.00/0.00 * 0.60 * LC4

SLS quasi-permanent combination	
	combination rule
LCO25 LCO25	1.00/1.00 * LC1 + 1.00/1.00 * LC2 1.00/1.00 * LC1 + 1.00/1.00 * LC2
LCO26 LCO26	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5
LCO27 LCO27	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC5 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC5
LCO28 LCO28	1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4

Ultimate limit state (ULS) - design results



ULS flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	2.79	24.00	1.25	0.90	1.10	19.01	35.41	-3.91	21 %	LCO3 LCO3

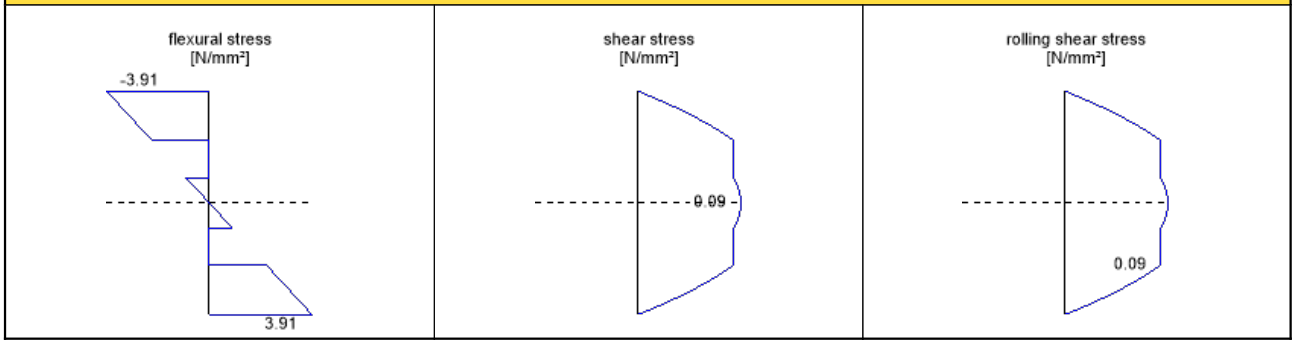
ULS shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	0.0	4.00	1.25	0.90	2.88	25.41	0.09	3 %	LCO3 LCO3

ULS rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	0.0	1.15	1.25	0.90	0.83	25.41	0.09	11 %	LCO3 LCO3

stress diagram



flexural stress analysis

$M_{y,d}$ =	35.41	kNm		$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN		γ_m =	1.25	-	
				k_{mod} =	0.90	-	
				$k_{sys,y}$ =	1.10	-	
				k_{hm} =	1.00	-	
				k_l =	1.00	-	
$\sigma_{t,d}$ =	0.00	N/mm²		$f_{t,d}$ =	10.08	N/mm²	
$\sigma_{m,y,d}$ =	-3.91	N/mm²	<	$f_{m,y,d}$ =	19.01	N/mm²	✓

utilization ratio 21 %

shear stress analysis

V_d =	25.41	kN		$f_{v,k}$ =	4.00	N/mm²	
				γ_m =	1.25		
				k_{mod} =	0.90		
$\tau_{v,d}$ =	0.09	N/mm²	<	$f_{v,d}$ =	2.88	N/mm²	✓

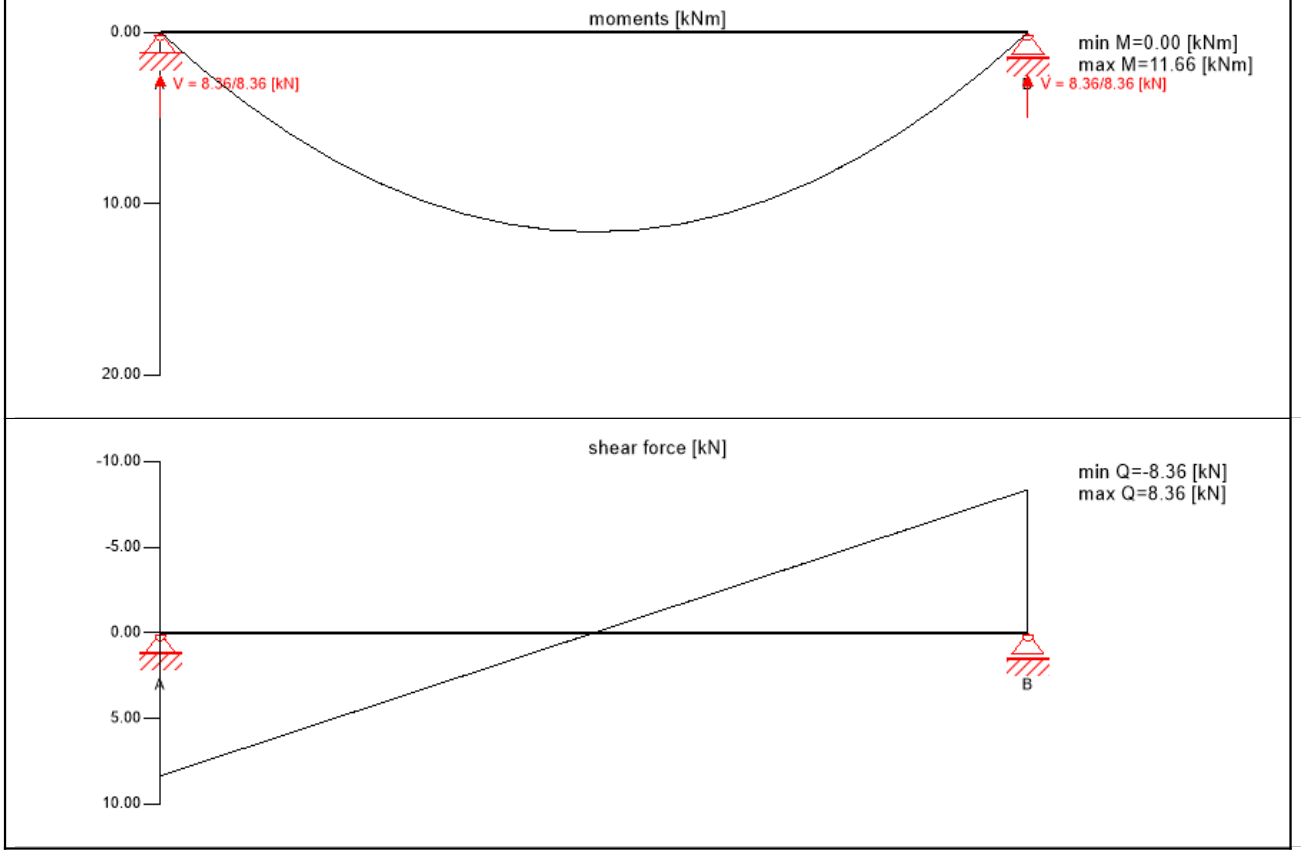
utilization ratio 3 %

rolling shear analysis

V_d =	25.41	kN		$f_{r,k}$ =	1.15	N/mm²	
				γ_m =	1.25	-	
				k_{mod} =	0.90	-	
$\tau_{r,d}$ =	0.09	N/mm²	<	$f_{r,d}$ =	0.83	N/mm²	✓

utilization ratio 11 %

Ultimate limit state (ULS) fire design - results



ULS fire flexural design

field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	k_{fi}	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[-]	[N/mm²]	[kNm]	[N/mm²]		
1	2.79	24.00	1.00	1.00	1.10	1.15	30.36	11.66	3.40	11 %	LCO11 LCO11

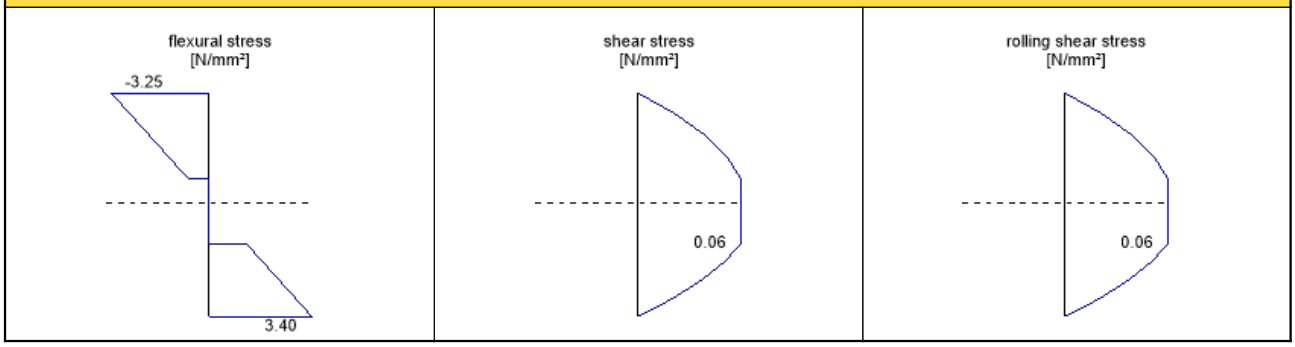
ULS fire shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	5.58	4.00	1.00	1.00	1.15	4.60	-8.36	0.06	1 %	LCO11 LCO11

ULS fire rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	k_{fi}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm²]	[-]	[-]	[-]	[N/mm²]	[kN]	[N/mm²]		
1	5.58	1.15	1.00	1.00	1.15	1.32	-8.36	0.06	4 %	LCO11 LCO11

stress diagram



flexural stress analysis fire

$M_{y,d}$ =	11.66	kNm		$f_{m,k}$ =	24.00	N/mm²	
$N_{t,d}$ =	0.00	kN		γ_m =	1.00	-	
				k_{mod} =	1.00	-	
				$k_{sys,y}$ =	1.10	-	
				k_{hm} =	1.00	-	
				k_l =	1.00	-	
				k_{fi} =	1.15	-	
$\sigma_{t,d}$ =	0.00	N/mm²		$f_{t,d}$ =	16.10	N/mm²	
$\sigma_{m,y,d}$ =	3.40	N/mm²	<	$f_{m,y,d}$ =	30.36	N/mm²	✓

utilization ratio 11 %

shear stress analysis fire

V_d =	-8.36	kN		$f_{v,k}$ =	4.00	N/mm²	
				γ_m =	1.00		
				k_{mod} =	1.00		
				k_{fi} =	1.15		
$\tau_{v,d}$ =	0.06	N/mm²	<	$f_{v,d}$ =	4.60	N/mm²	✓

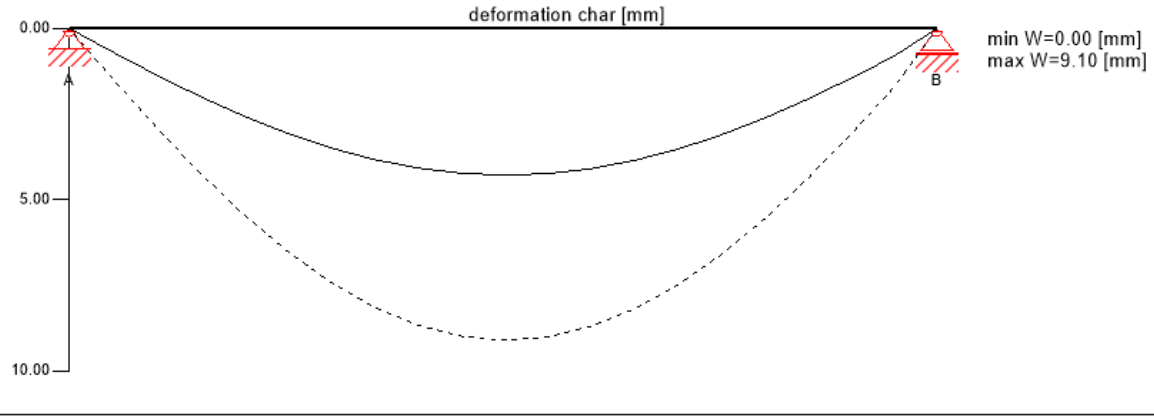
utilization ratio 1 %

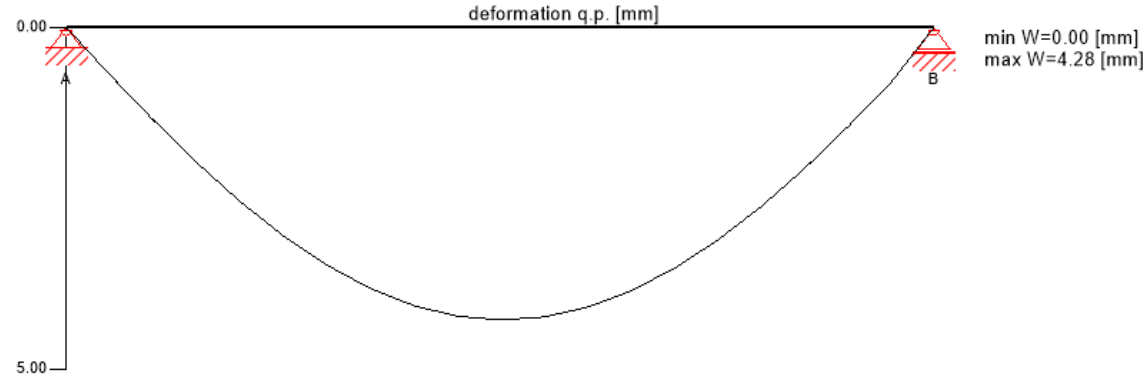
rolling shear analysis fire

V_d =	-8.36	kN		$f_{r,k}$ =	1.15	N/mm²	
				γ_m =	1.00	-	
				k_{mod} =	1.00	-	
				k_{fi} =	1.15	-	
$\tau_{r,d}$ =	0.06	N/mm²	<	$f_{r,d}$ =	1.32	N/mm²	✓

utilization ratio 4 %

Service limit state design (SLS) - design results





w_{inst} = w[char]

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/300	18.6	9.1	49 %

w_{fin} = w[char] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/150	37.2	12.5	34 %

$w_{net,fin}$ = w[q.p.] + w[q.p.]*kdef

field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/250 L/250	22.3	7.7	35 %

vibration analysis

general		
total mass	2.37	[t]
tributary width	2.8	[m]
stiffness longitudinal direction	9792.0	[kNm²]
stiffness cross direction	1872.0	[kNm²]
modal damping	1.0	[%]
α	0.0	[-]
man weight	700.0	[N]
modal mass	1183.7	[kg]

vibration analysis

analysis							
criterion	calc.	class I	class II	class I	class II	cl. I	cl. II
frequency criterion min	9.046 [Hz]	4.5 [Hz]	4.5 [Hz]	50 %	50 %	✓	✓
frequency criterion	9.046 [Hz]	8.0 [Hz]	6.0 [Hz]	88 %	66 %	✓	✓
acceleration criterion	0.317 [m/s²]	0.05 [m/s²]	0.1 [m/s²]	635 %	317 %	×	×
stiffness criterion	0.133 [mm]	0.25 [mm]	0.5 [mm]	53 %	27 %	✓	✓

support reaction

load case category	k_{mod}	A_V	B_V
		[kN]	
self weight CLT	0.6	5.02	5.02
		5.02	5.02
self weight	0.6	3.35	3.34
		3.35	3.34
snow load CEN < 1000m altitude	0.9	8.92	8.92
		0.00	0.00
wind load	0.9	0.82	0.82
		0.00	0.00
live load cat. H: roof (access for maintenance only)	0.9	2.23	2.23
		0.00	0.00

Disclaimer

The software was created to assist engineers in their daily business. The software is an engineering software that is dealing with a very complex matter of structural analysis and building physics analysis. Therefore, this software shall only be operated by skilled, experienced engineers, with a deep understanding of structural engineering and building physics related to timber structures. The user of the software is obliged to check all input values, no matter if they were given by the user or given by default by the software and all results for plausibility.
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