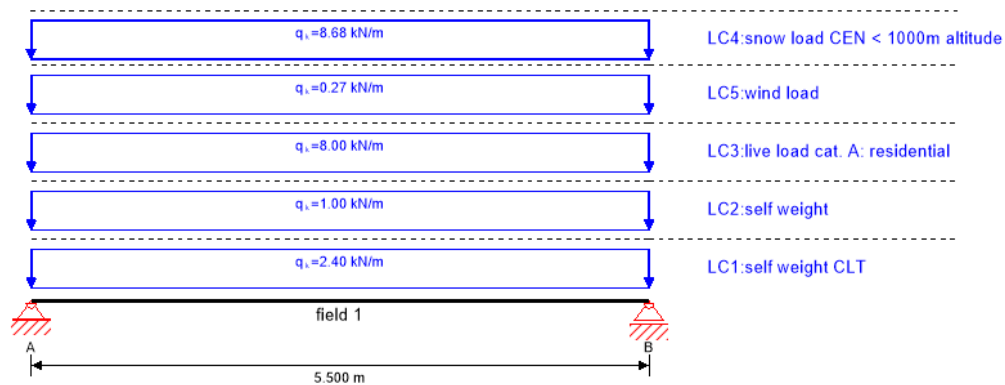


system

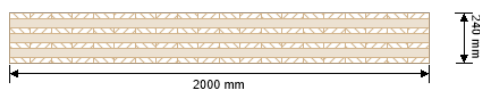


global utilization ratio

77 %

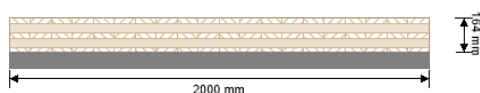
ULS	42 %	ULS fire	12 %	SLS	77 %	SLS vibration	68 %	support	-1 %
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section: CLT 240 L7s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce ETA (2019)
2	40.0 mm	90°	C24 spruce ETA (2019)
3	30.0 mm	0°	C24 spruce ETA (2019)
4	40.0 mm	90°	C24 spruce ETA (2019)
5	30.0 mm	0°	C24 spruce ETA (2019)
6	40.0 mm	90°	C24 spruce ETA (2019)
7	30.0 mm	0°	C24 spruce ETA (2019)
t _{CLT}	240.0 mm		

section fire: CLT 240 L7s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce ETA (2019)
2	40.0 mm	90°	C24 spruce ETA (2019)
3	30.0 mm	0°	C24 spruce ETA (2019)
4	40.0 mm	90°	C24 spruce ETA (2019)
5	24.0 mm	0°	C24 spruce ETA (2019)
t _{CLT}	164.0 mm		
time	90 min		

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/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[N/mm ²]
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						
LC2	self weight	G	permanent	0.6	1	1.35	1	1	1
LC2	self weight	G	permanent						
LC3	live load cat. A: residential	Q	medium term	0.8	0	1.5	0.7	0.5	0.3
LC3	live load cat. A: residential	Q	medium term						
LC4	snow load CEN < 1000m altitude	Q	short term	0.9	0	1.5	0.5	0.2	0
LC4	snow load CEN < 1000m altitude	Q	short term						
LC5	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0
LC5	wind load	Q	short term						

LC1:self weight CLT

continuous load

field	load at start
	[kN/m]
1	2.40
1	

LC2:self weight

continuous load

field	load at start
	[kN/m]
1	1.00
1	

LC3:live load cat. A: residential

continuous load

field	load at start
	[kN/m]
1	8.00
1	

LC4:snow load CEN < 1000m altitude

continuous load

field	load at start
	[kN/m]
1	8.68
1	

LC5:wind load	
continuous load	
field	load at start
	[kN/m]
1	0.27
1	

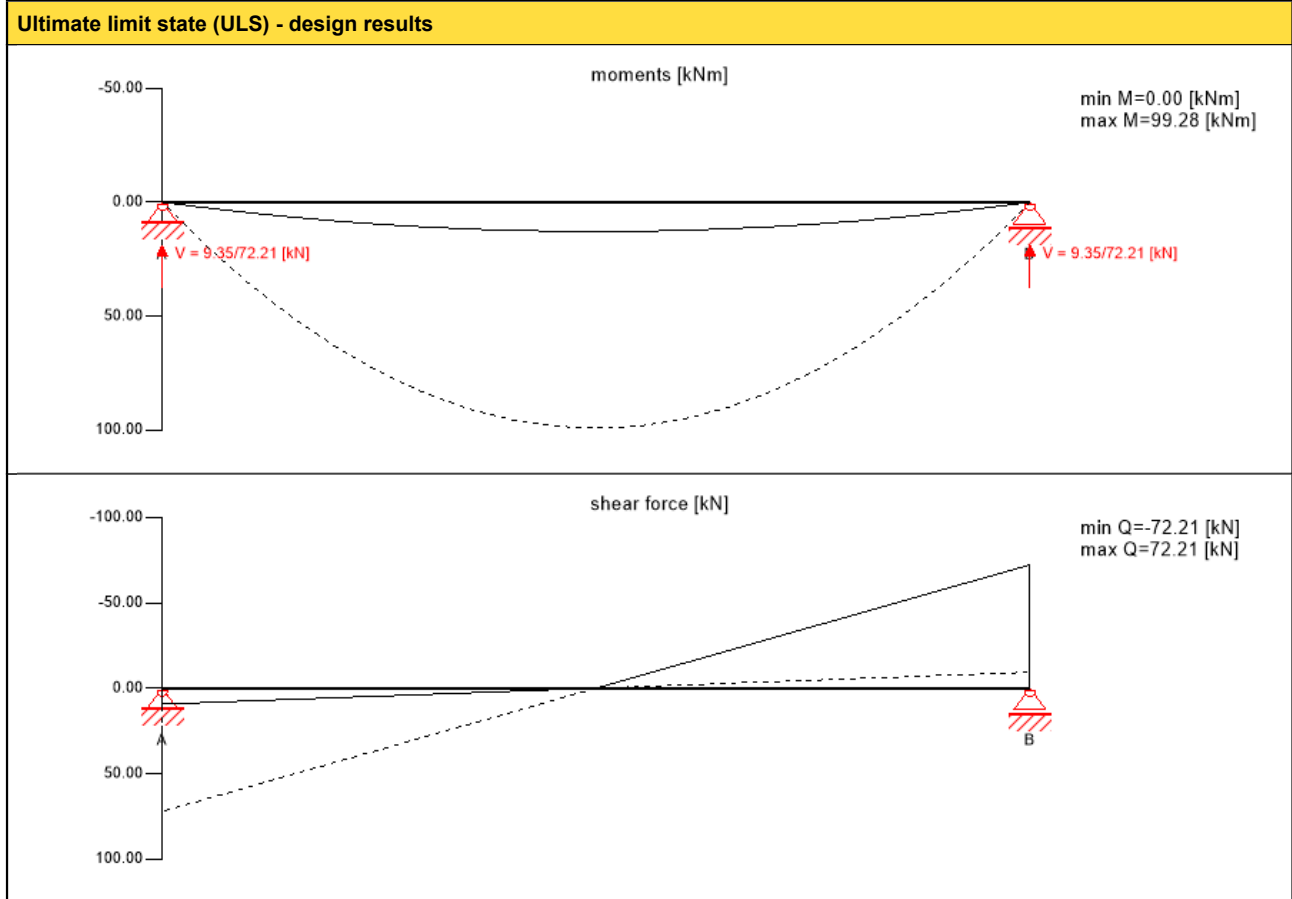
ULS combinations	
	combination rule
LCO1	$1.35/1.00 * LC1 + 1.35/1.00 * LC2$
LCO1	$1.35/1.00 * LC1 + 1.35/1.00 * LC2$
LCO2	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3$
LCO2	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3$
LCO3	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.50 * LC4$
LCO3	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.50 * LC4$
LCO4	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.50 * LC4 + 1.50/0.00 * 0.60 * LC5$
LCO4	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC3 + 1.50/0.00 * 0.50 * LC4 + 1.50/0.00 * 0.60 * LC5$
LCO5	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4$
LCO5	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4$
LCO6	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.70 * LC3$
LCO6	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.70 * LC3$
LCO7	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.70 * LC3 + 1.50/0.00 * 0.60 * LC5$
LCO7	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC4 + 1.50/0.00 * 0.70 * LC3 + 1.50/0.00 * 0.60 * LC5$
LCO8	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5$
LCO8	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5$
LCO9	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC3$
LCO9	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC3$
LCO10	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC3 + 1.50/0.00 * 0.50 * LC4$
LCO10	$1.35/1.00 * LC1 + 1.35/1.00 * LC2 + 1.50/0.00 * LC5 + 1.50/0.00 * 0.70 * LC3 + 1.50/0.00 * 0.50 * LC4$

ULS combinations fire	
	combination rule
LCO11	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO11	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO12	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3$
LCO12	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3$
LCO13	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$
LCO13	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$
LCO14	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5$
LCO14	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5$
LCO15	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4$
LCO15	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4$
LCO16	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3$
LCO16	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3$
LCO17	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC5$
LCO17	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC5$
LCO18	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5$
LCO18	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5$
LCO19	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3$
LCO19	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3$
LCO20	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$
LCO20	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$

SLS characteristic combination	
	combination rule
LCO21	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO21	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO22	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC3 + 1.00/0.00 * 0.50 * LC4 + 1.00/0.00 * 0.60 * LC5$
LCO22	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC3 + 1.00/0.00 * 0.50 * LC4 + 1.00/0.00 * 0.60 * LC5$
LCO23	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.70 * LC3 + 1.00/0.00 * 0.60 * LC5$
LCO23	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC4 + 1.00/0.00 * 0.70 * LC3 + 1.00/0.00 * 0.60 * LC5$
LCO24	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.70 * LC3 + 1.00/0.00 * 0.50 * LC4$
LCO24	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * LC5 + 1.00/0.00 * 0.70 * LC3 + 1.00/0.00 * 0.50 * LC4$

SLS quasi-permanent combination	
	combination rule
LCO25	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$
LCO25	$1.00/1.00 * LC1 + 1.00/1.00 * LC2$

SLS quasi-permanent combination	
	combination rule
LCO26	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5$
LCO26	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5$
LCO27	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC5$
LCO27	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC5$
LCO28	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$
LCO28	$1.00/1.00 * LC1 + 1.00/1.00 * LC2 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC3 + 1.00/0.00 * 0.00 * LC4$

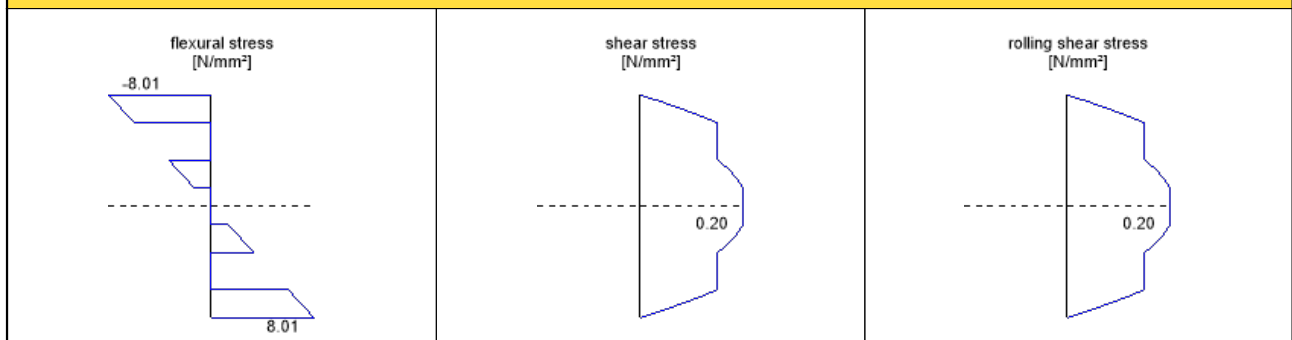


ULS flexural design										
field	dist.	$f_{m,k}$	γ_m	k_{mod}	$k_{sys,y}$	$f_{m,y,d}$	$M_{y,d}$	$\sigma_{m,y,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.75	24.00	1.25	0.90	1.10	19.01	99.28	8.01	42 %	LCO7 LCO7

ULS shear analysis									
field	dist.	$f_{v,k}$	γ_m	k_{mod}	$f_{v,d}$	V_d	$\tau_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.5	4.00	1.25	0.90	2.88	-72.21	0.20	7 %	LCO7 LCO7

ULS rolling shear									
field	dist.	$f_{r,k}$	γ_m	k_{mod}	$f_{r,d}$	V_d	$\tau_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.5	1.05	1.25	0.90	0.76	-72.21	0.20	27 %	LCO7 LCO7

stress diagram



flexural stress analysis

$M_{y,d} =$	99.28	kNm	$f_{m,k} =$	24.00	N/mm ²	
$N_{t,d} =$	0.00	kN	$\gamma_m =$	1.25	-	
			$k_{mod} =$	0.90	-	
			$k_{sys,y} =$	1.10	-	
			$k_{nm} =$	1.00	-	
			$k_l =$	1.00	-	
$\sigma_{t,d} =$	0.00	N/mm ²	$f_{t,d} =$	10.08	N/mm ²	
$\sigma_{m,y,d} =$	8.01	N/mm ²	$f_{m,y,d} =$	19.01	N/mm ²	✓

utilization ratio

42 %

shear stress analysis

$V_d =$	-	kN	$f_{v,k} =$	4.00	N/mm ²	
	72.21		$\gamma_m =$	1.25		
			$k_{mod} =$	0.90		
$\tau_{v,d} =$	0.20	N/mm ²	$f_{v,d} =$	2.88	N/mm ²	✓

utilization ratio

7 %

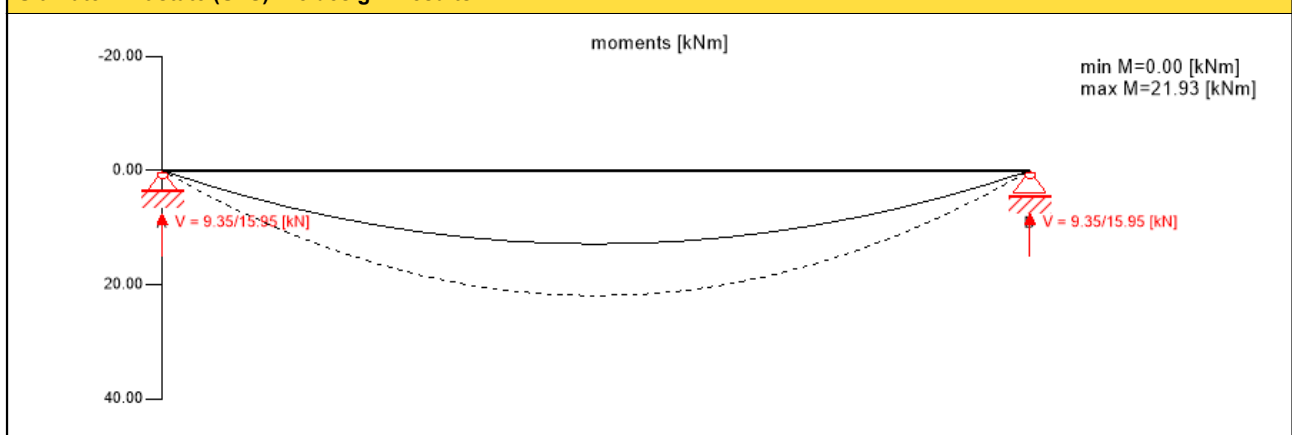
rolling shear analysis

$V_d =$	-72.21	kN	$f_{r,k} =$	1.05	N/mm ²	
			$\gamma_m =$	1.25	-	
			$k_{mod} =$	0.90	-	
$\tau_{r,d} =$	0.20	N/mm ²	$f_{r,d} =$	0.76	N/mm ²	✓

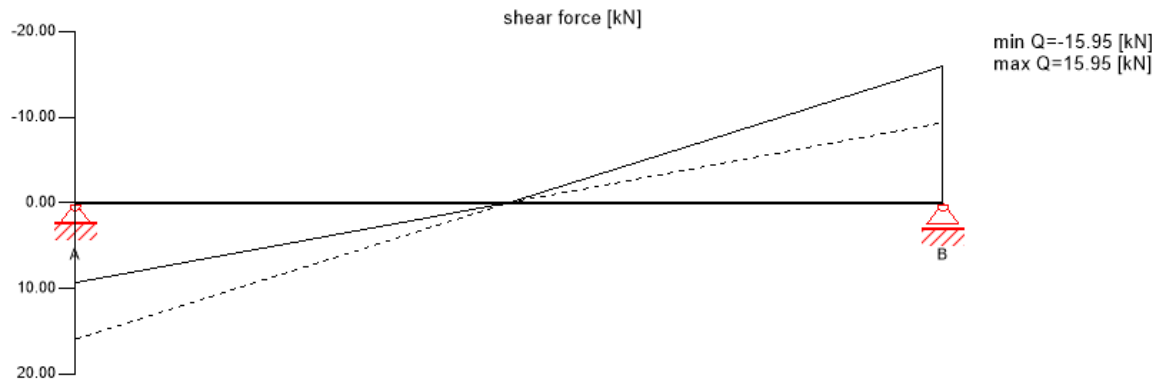
utilization ratio

27 %

Ultimate limit state (ULS) fire design - results



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/mm ²]	[-]	[-]	[-]	[-]	[N/mm ²]	[kNm]	[N/mm ²]		
1	2.75	24.00	1.00	1.00	1.10	1.15	30.36	21.93	3.61	12 %	LCO12 LCO12

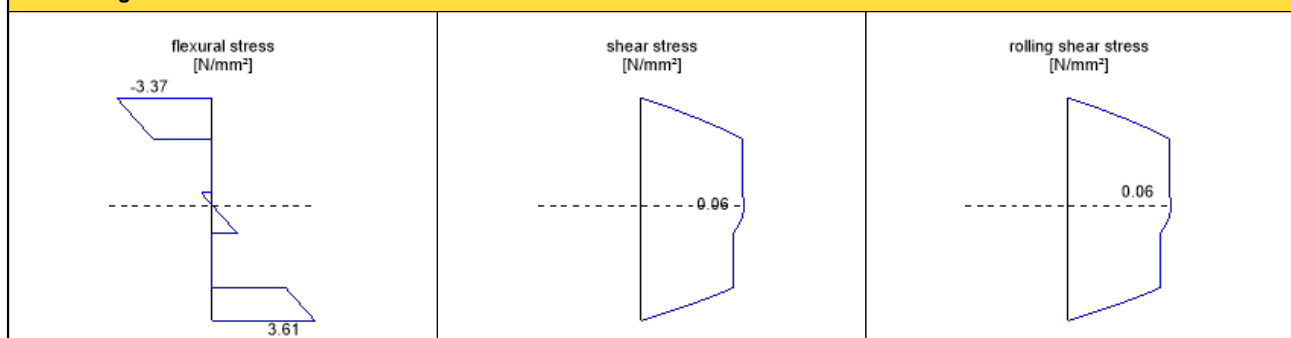
ULS fire shear analysis

field	dist.	$f_{v,k}$	γ_m	k_{mod}	k_{fi}	$f_{v,d}$	V_d	$T_{v,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.5	4.00	1.00	1.00	1.15	4.60	-15.95	0.06	1 %	LCO12 LCO12

ULS fire rolling shear

field	dist.	$f_{r,k}$	γ_m	k_{mod}	k_{fi}	$f_{r,d}$	V_d	$T_{r,d}$	ratio	
	[m]	[N/mm ²]	[-]	[-]	[-]	[N/mm ²]	[kN]	[N/mm ²]		
1	5.5	1.05	1.00	1.00	1.15	1.21	-15.95	0.06	5 %	LCO12 LCO12

stress diagram

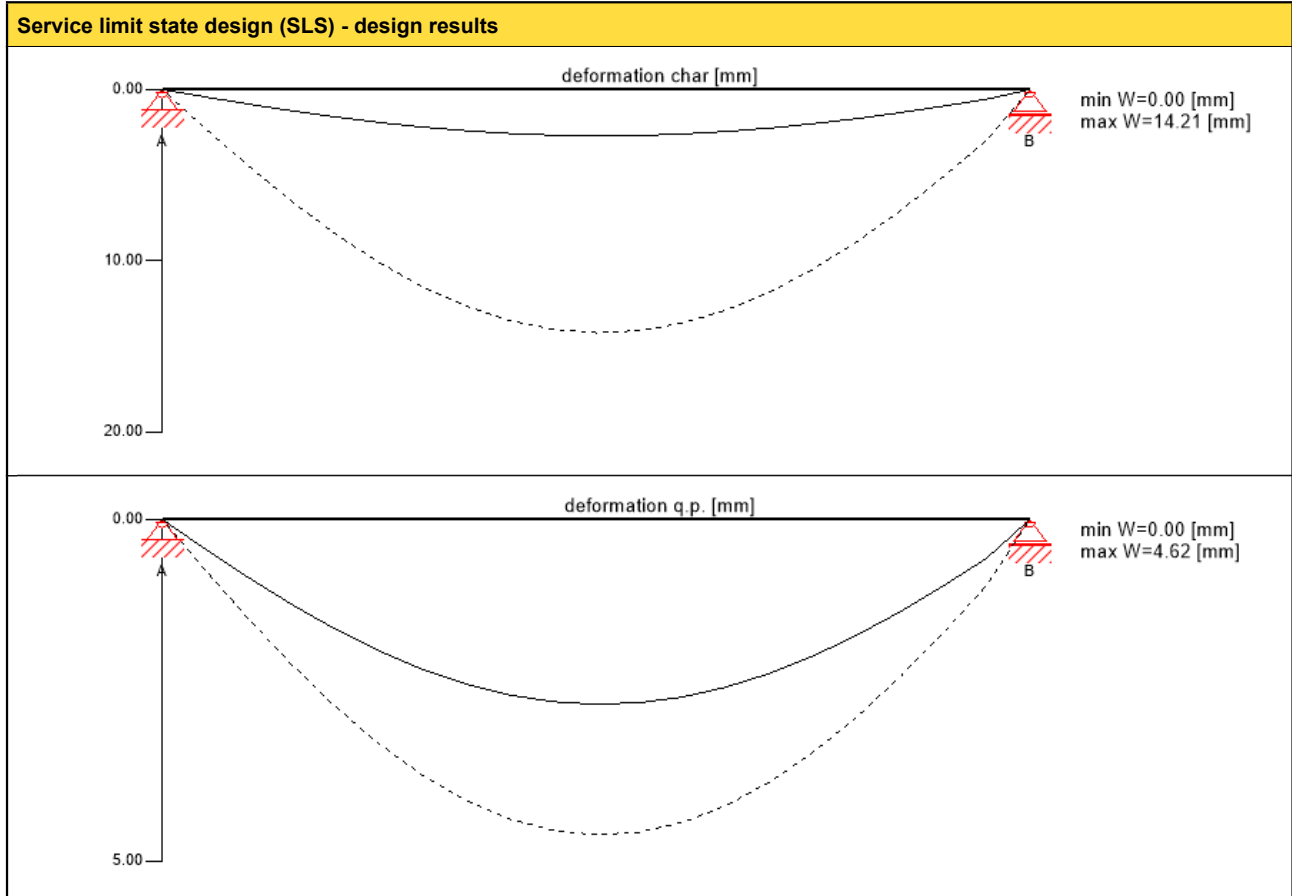


flexural stress analysis fire

$M_{y,d} =$	21.93	kNm	$f_{m,k} =$	24.00	N/mm ²
$N_{t,d} =$	0.00	kN	$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{sys,y} =$	1.10	-
			$k_{nm} =$	1.00	-
			$k_i =$	1.00	-
			$k_{fi} =$	1.15	-
$\sigma_{t,d} =$	0.00	N/mm ²	$f_{t,d} =$	16.10	N/mm ²
$\sigma_{m,y,d} =$	3.61	N/mm ²	$f_{m,y,d} =$	30.36	N/mm ²
utilization ratio					12 %

shear stress analysis fire					
$V_d =$	-	kN	$f_{v,k} =$	4.00	N/mm ²
	15.95		$\gamma_m =$	1.00	
			$k_{mod} =$	1.00	
			$k_{fi} =$	1.15	
$T_{v,d} =$	0.06	N/mm ²	$f_{v,d} =$	4.60	N/mm ²
		<			✓
utilization ratio				1 %	

rolling shear analysis fire					
$V_d =$	-15.95	kN	$f_{r,k} =$	1.05	N/mm ²
			$\gamma_m =$	1.00	-
			$k_{mod} =$	1.00	-
			$k_{fi} =$	1.15	-
$T_{r,d} =$	0.06	N/mm ²	$f_{r,d} =$	1.21	N/mm ²
		<			✓
utilization ratio				5 %	



$w_{inst} = w[char]$					
field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/300	18.3	14.2	77 %

$w_{fin} = w[char] + w[q.p.] \cdot k_{def}$					
field	K_{def}	limit	w_{limit}	$w_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/150	36.7	17.9	49 %

$w_{net,fin} = w[q.p.] + w[q.p.]*k_{def}$					
field	K_{def}	limit	W_{limit}	$W_{calc.}$	ratio
		[-]	[mm]	[mm]	
1	0.8	L/250 L/250	22.0	8.3	38 %

vibration analysis

general			
total mass		2.62	[t]
tributary width		2.8	[m]
stiffness longitudinal direction		17856.0	[kNm²]
stiffness cross direction		9792.0	[kNm²]
modal damping		1.0	[%]
α		0.0	[-]
man weight		700.0	[N]
modal mass		1309.2	[kg]

analysis							
criterion	calc.	class I	class II	class I	class II	cl. I	cl. II
frequency criterion min	11.789 [Hz]	4.5 [Hz]	4.5 [Hz]	38 %	38 %	✓	✓
frequency criterion	11.789 [Hz]	8.0 [Hz]	6.0 [Hz]	68 %	51 %	✓	✓
acceleration criterion	0.096 [m/s²]	0.05 [m/s²]	0.1 [m/s²]	191 %	96 %	✗	✓
stiffness criterion	0.071 [mm]	0.25 [mm]	0.5 [mm]	28 %	14 %	✓	✓

support reaction			
load case category	k_{mod}	A_v	B_v
		[kN]	
self weight CLT	0.6	6.60	6.60
		6.60	6.60
self weight	0.6	2.75	2.75
		2.75	2.75
live load cat. A: residential	0.8	22.00	22.00
		0.00	0.00
snow load CEN < 1000m altitude	0.9	23.87	23.87
		0.00	0.00
wind load	0.9	0.75	0.75
		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.

The use of the results of the software should not be relied upon as the basis for any decision or action. Any use of results of the software is only allowed, if the results have been verified and approved regarding completeness and correctness by a project structural/building physics engineer. The user has the possibility to make print-outs from the software. Any modification of those are not allowed.

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