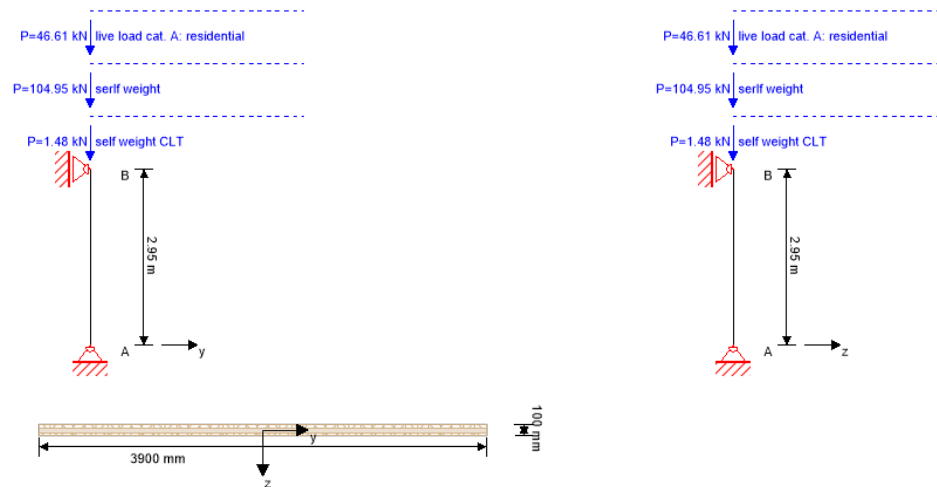


## system



## global utilization ratio

21 %

ULS	21 %	ULS fire	-1 %
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## section: CLT 100 C3s

layer	thickness	orientation	material
1	30.0 mm	90°	C24 spruce
2	40.0 mm	0°	C24 spruce
3	30.0 mm	90°	C24 spruce
$t_{CLT}$	100.0 mm		

## 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 <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]
C24 spruce	24.00	14.00	0.12	21.00	2.50	4.00	1.25	12,500.00	690.00	50.00

## load

## load case groups

	load case category	Typ	duration	Kmod	$\gamma_{inf}$	$\gamma_{sup}$	$\psi_0$	$\psi_1$	$\psi_2$
LC2	self weight CLT	G	permanet	0.6	1	1.35	1	1	1
LC3	serif weight	G	permanet	0.6	1	1.35	1	1	1
LC1	live load cat. A: residential	Q	medium term	0.8	0	1.5	0.7	0.5	0.3

## LC2:self weight CLT

vertical load		
$P_k$	ex. y	ex. z
[kN]	[m]	[m]
1.475	0.00	0.00

### LC3:serlf weight

#### vertical load

P <sub>k</sub>	ex. y	ex. z
[kN]	[m]	[m]
104.95	0.03	0.05

### LC1:live load cat. A: residential

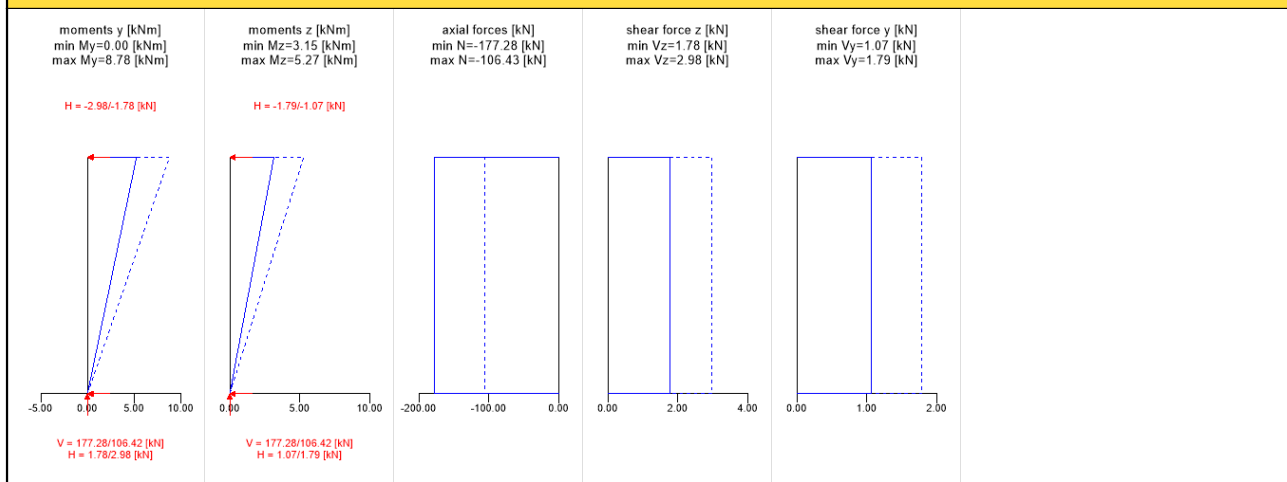
#### vertical load

P <sub>k</sub>	ex. y	ex. z
[kN]	[m]	[m]
46.61	0.03	0.05

### ULS combinations

	combination rule
LCO1	1.12/1.00 * LC2 + 1.12/1.00 * LC3
LCO2	1.12/1.00 * LC2 + 1.12/1.00 * LC3 + 1.25/0.00 * LC1

### Ultimate limit state (ULS) - design results



### ULS flexural design

dist.	γ <sub>m</sub>	k <sub>mod</sub>	k <sub>sys,y</sub>	f <sub>m,k</sub>	f <sub>m,y,d</sub>	f <sub>t,d</sub>	f <sub>c,d</sub>
[m]	[-]	[-]	[-]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]
2.95	1.25	0.80	1.10	24.00	16.90	8.96	13.44
M <sub>y,d</sub>	N <sub>c,d</sub>	N <sub>t,d</sub>	σ <sub>m,y,d</sub>	σ <sub>c,d</sub>	σ <sub>t,d</sub>	ratio	
[kNm]	[kN]	[kN]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]		
8.78	-	0.00	1.44	0.76	0.00	9 %	LCO2
	177.28						

### ULS shear analysis

dist.	f <sub>v,k</sub>	γ <sub>m</sub>	k <sub>mod</sub>	f <sub>v,d</sub>	V <sub>d</sub>	T <sub>v,d</sub>	ratio	
[m]	[N/mm <sup>2</sup> ]	[-]	[-]	[N/mm <sup>2</sup> ]	[kN]	[N/mm <sup>2</sup> ]		
0.0	4.00	1.25	0.80	2.56	2.98	0.01	0 %	LCO2

### ULS rolling shear

dist.	f <sub>r,k</sub>	γ <sub>m</sub>	k <sub>mod</sub>	f <sub>r,d</sub>	V <sub>d</sub>	T <sub>r,d</sub>	ratio	
[m]	[N/mm <sup>2</sup> ]	[-]	[-]	[N/mm <sup>2</sup> ]	[kN]	[N/mm <sup>2</sup> ]		
0.0	1.05	1.25	0.80	0.67	2.98	0.01	2 %	LCO2

ULS shear design in plane of CLT - gross section								
dist.	$f_{v,IP,Gross,k}$	$\gamma_m$	$k_{mod}$	$f_{v,IP,Gross,d}$	$V_d$	$T_{IP,Gross,d}$	ratio	
[m]	[N/mm <sup>2</sup> ]	[-]	[-]	[N/mm <sup>2</sup> ]	[kNm]	[N/mm <sup>2</sup> ]		
0.0	3.50	1.25	0.80	2.24	1.79	0.01	0 %	LCO2

ULS shear design in plane of CLT - net section								
dist.	$f_{v,IP,Net,k}$	$\gamma_m$	$k_{mod}$	$f_{v,IP,Net,d}$	$V_{Net,d}$	$T_{v,IP,Net,d}$	ratio	
[m]	[N/mm <sup>2</sup> ]	[-]	[-]	[N/mm <sup>2</sup> ]	[kNm]	[N/mm <sup>2</sup> ]		
0.0	8.00	1.25	0.80	5.12	1.79	0.02	0 %	LCO2

ULS shear design in plane of CLT - gross section kombiniert						
dist.	$\gamma_m$	$k_{mod}$	$V_d$	$T_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm <sup>2</sup> ]		
2.95	1.25	0.80	2.98	0.01	0 %	LCO2

ULS shear design in plane of CLT - net section kombiniert						
dist.	$\gamma_m$	$k_{mod}$	$V_d$	$T_{v,d}$	ratio	
[m]	[-]	[-]	[kN]	[N/mm <sup>2</sup> ]		
2.95	1.25	0.80	2.98	0.01	0 %	LCO2

ULS torsional shear design in plane of CLT - in face glued surfaces											
$f_{v,T,Node,k}$	$\gamma_m$	$k_{mod}$	$f_{v,T,Node,d}$	$V_{\delta,d}$	$\delta M_t$	n	a	$I_p$	ratio		
[N/mm <sup>2</sup> ]	[-]	[-]	[N/mm <sup>2</sup> ]	[kNm]	[kNm]	[-]	[m]	[mm <sup>4</sup> ]			
2.50	1.25	0.80	1.60	1.79	0.27	52	0.150	84375010.00	0 %	LCO2	

ULS buckling design											
dist.	$\gamma_m$	$k_{mod}$	$k_{sys,y}$	$k_{sys,z}$	$f_{m,k}$	$f_{m,y,d}$	$f_{m,z,d}$	$f_{t,d}$	$f_{c,d}$		
[m]	[-]	[-]	[-]	[-]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]		
2.95	1.25	0.80	1.10	1.00	24.00	16.90	15.36	0.00	13.44		
$l_{k,y}$	$l_{k,z}$	$\lambda_y$	$\lambda_z$	$\lambda_{rel,y}$	$\lambda_{rel,z}$	$\beta_c$	$k_y$	$k_z$	$k_{c,y}$	$k_{c,z}$	
[m]	[m]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	[-]	
2.950	2.950	82	3	1.30	0.04	0.2	1.45	0.48	0.48	1.00	
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{m,z,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio				
[kNm]	[kN]	[kN]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]					
8.78	-177.28	0.00	1.44	0.03	0.76	0.00	21 %	LCO2			

ULS lateral torsional buckling design										
dist.	$\gamma_m$	$k_{mod}$	$k_{sys,y}$	$f_{m,k}$	$f_{m,y,d}$	$f_{t,d}$	$f_{c,d}$			
[m]	[-]	[-]	[-]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]			
2.95	1.25	0.80	1.10	24.00	16.90	0.00	13.44			
$l_{ef}$	$l_k$	$\lambda_y$	$\lambda_{rel,y}$	$\lambda_{rel,m}$	$\beta_c$	$k_y$	$k_{c,y}$	$\sigma_{m,crit}$	$k_{crit}$	
[m]	[m]	[-]	[-]	[-]	[-]	[-]	[-]	[N/mm <sup>2</sup> ]	[-]	
2.950	2.950	82	1.30	1.67	0.2	1.45	0.48	8.57	0.36	
$M_{y,d}$	$N_{c,d}$	$N_{t,d}$	$\sigma_{m,y,d}$	$\sigma_{c,d}$	$\sigma_{t,d}$	ratio				
[kNm]	[kN]	[kN]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]	[N/mm <sup>2</sup> ]					
8.78	-177.28	0.00	1.44	0.76	0.00	12 %	LCO2			

flexural stress analysis											
$M_{y,d} =$	8.78	kNm	$f_{m,k} =$	24.00	N/mm <sup>2</sup>						
$N_{c,d} =$	-177.28	kN	$\gamma_m =$	1.25	-						
			$k_{mod} =$	0.80	-						
			$k_{sys,y} =$	1.10	-						
			$k_{hm} =$	1.00	-						
			$k_l =$	1.00	-						
$\sigma_{c,d} =$	0.76	N/mm <sup>2</sup>	$f_{c,d} =$	13.44	N/mm <sup>2</sup>						
$\sigma_{m,y,d} =$	1.44	N/mm <sup>2</sup>	$f_{m,y,d} =$	16.90	N/mm <sup>2</sup>						✓
utilization ratio										9 %	

shear stress analysis					
$V_d =$	2.98	kN	$f_{v,k} =$	4.00	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{v,d} =$	0.01	N/mm <sup>2</sup>	$f_{v,d} =$	2.56	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

rolling shear analysis					
$V_d =$	2.98	kN	$f_{r,k} =$	1.05	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{r,d} =$	0.01	N/mm <sup>2</sup>	$f_{r,d} =$	0.67	N/mm <sup>2</sup>
		<			✓
utilization ratio					2 %

shear analysis gross section					
$V_d =$	1.79	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{IP,Gross,d} =$	0.01	N/mm <sup>2</sup>	$f_{v,IP,Gross,d} =$	2.24	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

shear analysis net section					
$V_{Net,d} =$	1.79	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{v,IP,Net,d} =$	0.02	N/mm <sup>2</sup>	$f_{v,IP,Net,d} =$	5.12	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

shear analysis gross section combined					
$V_d =$	2.98	kN	$f_{v,k} =$	4.00	N/mm <sup>2</sup>
$V_{Gross,d} =$	1.79	kNm	$f_{v,IP,Gross,k} =$	3.50	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{v,d} =$	0.01	N/mm <sup>2</sup>	$f_{v,d} =$	2.56	N/mm <sup>2</sup>
$T_{IP,Gross,d} =$	0.01	N/mm <sup>2</sup>	$f_{v,IP,Gross,d} =$	2.24	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

shear analysis net section combined					
$V_d =$	2.98	kN	$f_{v,k} =$	4.00	N/mm <sup>2</sup>
$V_{Net,d} =$	1.79	kNm	$f_{v,IP,Net,k} =$	8.00	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{v,d} =$	0.01	N/mm <sup>2</sup>	$f_{v,d} =$	2.56	N/mm <sup>2</sup>
$T_{IP,Net,d} =$	0.02	N/mm <sup>2</sup>	$f_{v,IP,Net,d} =$	5.12	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

torsional shear design in plane of CLT - in face glued surfaces					
$V_{\phi,d} =$	1.79	kNm	$f_{v,T,Node,k} =$	2.50	N/mm <sup>2</sup>
			$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
$T_{T,Node,d} =$	0.00	N/mm <sup>2</sup>	$f_{v,T,Node,d} =$	1.60	N/mm <sup>2</sup>
		<			✓
utilization ratio					0 %

buckling analysis					
$M_{y,d} =$	8.78	kNm	$f_{m,k} =$	24.00	N/mm <sup>2</sup>
$N_{c,d} =$	-177.28	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
			$k_{sys,y} =$	1.10	-
$\sigma_{c,d} =$	0.76	N/mm <sup>2</sup>	$f_{c,d} =$	13.44	N/mm <sup>2</sup>
$\sigma_{m,y,d} =$	1.44	N/mm <sup>2</sup>	$f_{m,y,d} =$	16.90	N/mm <sup>2</sup>
$\sigma_{m,z,d} =$	0.03	N/mm <sup>2</sup>	$f_{m,z,d} =$	15.36	N/mm <sup>2</sup>
		<			✓
utilization ratio					21 %

lateral torsional buckling analysis					
$M_{y,d} =$	8.78	kNm	$f_{m,k} =$	24.00	N/mm <sup>2</sup>
$N_{c,d} =$	-177.28	kN	$\gamma_m =$	1.25	-
			$k_{mod} =$	0.80	-
			$k_{sys,y} =$	1.10	-
			$k_{hm} =$	1.00	-
			$k_l =$	1.00	-
$\sigma_{c,d} =$	0.76	N/mm <sup>2</sup>	$f_{c,d} =$	13.44	N/mm <sup>2</sup>
$\sigma_{m,y,d} =$	1.44	N/mm <sup>2</sup>	$f_{m,y,d} =$	16.90	N/mm <sup>2</sup>
		<			✓
utilization ratio				12 %	

support reaction						
load case category	$k_{mod}$	$A_y$	$A_z$	$B_x$	$B_y$	$B_z$
		[kN]	[kN]	[kN]	[kN]	[kN]
self weight CLT	0.6	0.00	0.00	1.48	0.00	0.00
		0.00	0.00	1.48	0.00	0.00
serlf weight	0.6	-1.07	-1.78	104.95	1.07	1.78
		-1.07	-1.78	104.95	1.07	1.78
live load cat. A: residential	0.8	0.00	0.00	0.00	0.47	0.79
		-0.47	-0.79	46.61	0.00	0.00

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