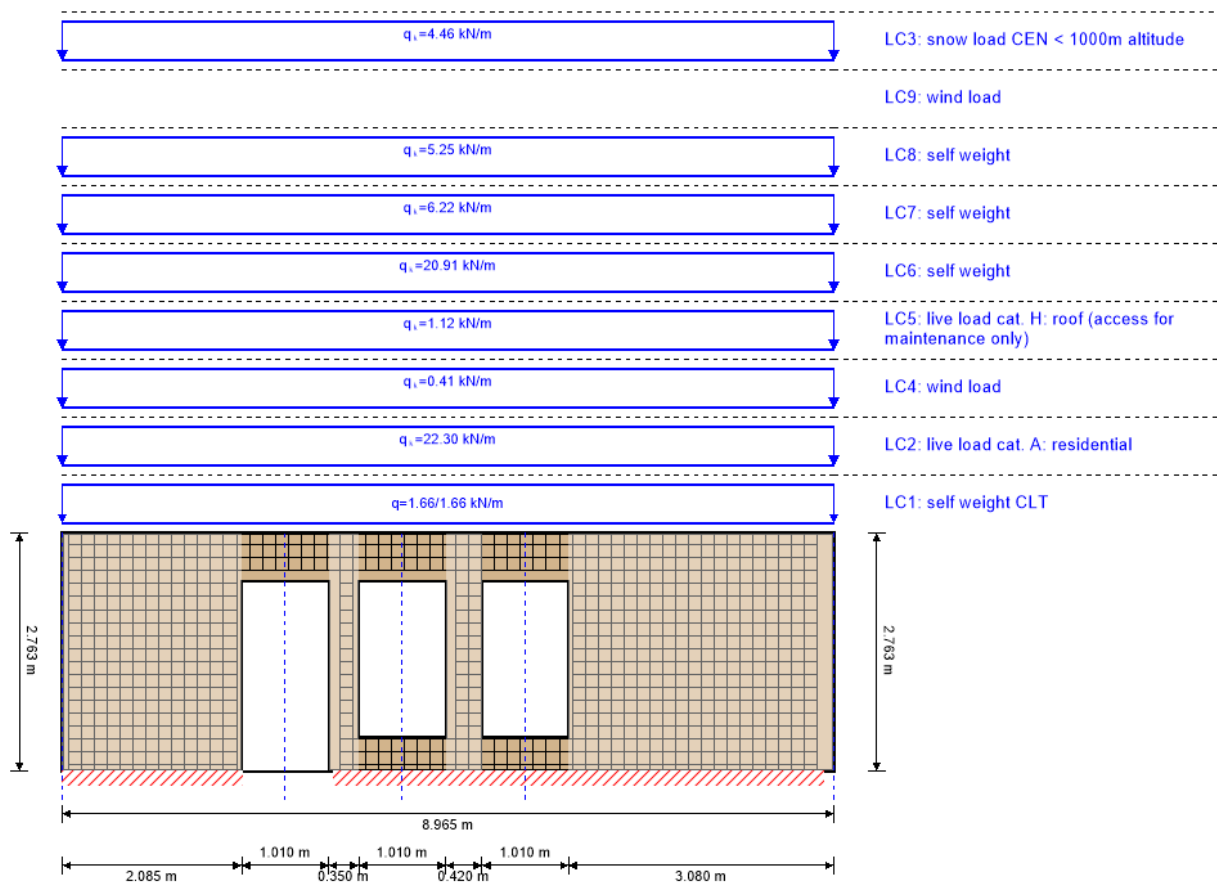


system

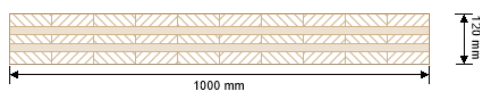


global utilization ratio

67 %

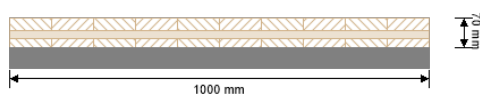
ULS	59 %	ULS fire	67 %	SLS	12 %
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section: CLT 120 L5s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce ETA (2019)
2	20.0 mm	90°	C24 spruce ETA (2019)
3	20.0 mm	0°	C24 spruce ETA (2019)
4	20.0 mm	90°	C24 spruce ETA (2019)
5	30.0 mm	0°	C24 spruce ETA (2019)
t _{CLT}	120.0 mm		

section fire: CLT 120 L5s



layer	thickness	orientation	material
1	30.0 mm	0°	C24 spruce ETA (2019)
2	20.0 mm	90°	C24 spruce ETA (2019)
3	20.0 mm	0°	C24 spruce ETA (2019)
t _{CLT}	70.0 mm		

section fire: CLT 120 L5s									
fire resistance class:R 90				time		90 min			
fire protection layering : 2 x 12.5 mm gypsum plasterboard Type F				$t_{ch,h}$	$t_{f,h}$	$t_{a,h}$	$d_{ta,h}$	k_0	d_0
gypsum plasterboard Type A (acc. to EN 520)gypsum plasterboard Type F (acc. to EN 520)				[min]	[min]	[min]	[mm]	[-]	[mm]
				49	54	72	25	1	7
						$d_{char,0,h}$	$d_{ef,h}$		
						[mm]	[mm]		
						40.0	47.0		

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	live load cat. A: residential	Q	medium term	0.8	0	1.5	0.7	0.5	0.3	
LC2	live load cat. A: residential	Q	medium term							
LC3	snow load CEN < 1000m altitude	Q	short term	0.9	0	1.5	0.5	0.2	0	
LC3	snow load CEN < 1000m altitude	Q	short term							
LC4	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0	
LC4	wind load	Q	short term							
LC5	live load cat. H: roof (access for maintenance only)	Q	short term	0.9	0	1.5	0	0	0	
LC5	live load cat. H: roof (access for maintenance only)	Q	short term							
LC6	self weight	G	permanent	0.6	1	1.35	1	1	1	
LC6	self weight	G	permanent							
LC7	self weight	G	permanent	0.6	1	1.35	1	1	1	
LC7	self weight	G	permanent							
LC8	self weight	G	permanent	0.6	1	1.35	1	1	1	
LC8	self weight	G	permanent							
LC9	wind load	Q	short term	0.9	0	1.5	0.6	0.2	0	
LC9	wind load	Q	short term							

LC1:self weight CLT			
trapezoidal load			
distance from start	$q_{k,a}$	load at end	load length
[m]	[kN/m]		[m]
0.000	1.6578	1.66	8.965

LC2:live load cat. A: residential	
continuous load	
q_k	
[kN/m]	
22.3	

LC3:snow load CEN < 1000m altitude

continuous load

q_k

[kN/m]

4.46

LC4:wind load

continuous load

q_k

[kN/m]

0.41

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

continuous load

q_k

[kN/m]

1.115

LC6:self weight

continuous load

q_k

[kN/m]

20.90625

LC7:self weight

continuous load

q_k

[kN/m]

6.216

LC8:self weight

continuous load

q_k

[kN/m]

5.2492

LC9:wind load

load out of plane

load at start	direction	load covers openings
0.57	local local	✓

ULS combinations

	combination rule
LCO1	$1.35/1.00 * LC1 + 1.35/1.00 * LC6 + 1.35/1.00 * LC7 + 1.35/1.00 * LC8$
LCO1	$1.35/1.00 * LC1 + 1.35/1.00 * LC6 + 1.35/1.00 * LC7 + 1.35/1.00 * LC8$

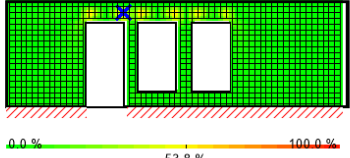
[illegible]

[illegible]

ULS combinations fire	
	combination rule
LCO18 LCO18	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC2
LCO19 LCO19	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3
LCO20 LCO20	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4
LCO21 LCO21	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC5 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC9
LCO22 LCO22	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC9
LCO23 LCO23	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC9 + 1.00/0.00 * 0.30 * LC2
LCO24 LCO24	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC9 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3
LCO25 LCO25	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC9 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4
LCO26 LCO26	1.00/1.00 * LC1 + 1.00/1.00 * LC6 + 1.00/1.00 * LC7 + 1.00/1.00 * LC8 + 1.00/0.00 * 0.00 * LC9 + 1.00/0.00 * 0.30 * LC2 + 1.00/0.00 * 0.00 * LC3 + 1.00/0.00 * 0.00 * LC4 + 1.00/0.00 * 0.00 * LC5

Ultimate limit state (ULS) - design results

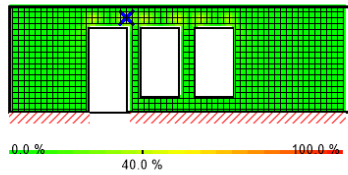
utilization rate of shear stress in plane on net section



0.0 % 53.8 % 100.0 %

LCO2							
Id	X	Z	k _{mod}	f _{IP,Netto,k}	Q	T _{IP,Net,d}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	0.8	3.9	-16.12	1.34	54 %

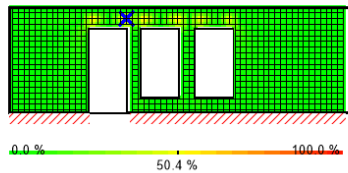
utilization rate of shear stress in plane of gross section



LCO2

Id	X	Z	k _{mod}	f _{v,IP,Brutto,k}	Q	τ _{IP,Gross,d}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	0.8	3.5	-16.12	0.90	40 %

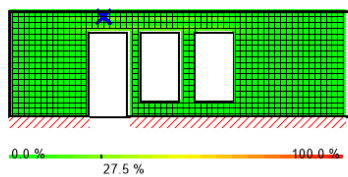
utilization rate of torsional shear stress in face glued surfaces



LCO2

Id	X	Z	k _{mod}	f _{v,IP,T,k}	Q	T _{T,Node,d}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	0.8	2.5	-16.12	0.81	50 %

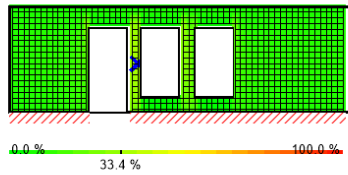
utilization rate of axial force horizontal



LCO2

Id	X	Z	k _{mod}	f _{m,k}	N _{h,max}	M _y	σ _{h,max}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[kNm]	[N/mm ²]	[%]
1079	2.475	2.625	0.8	24.02	25.3675	0.0000	4.23	28 %

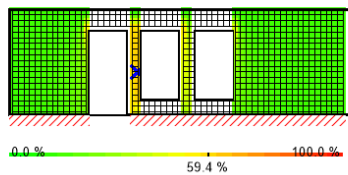
utilization rate of axial force vertical



LCO25

Id	X	Z	k_{mod}	$f_{m,k}$	$N_{v,max}$	M_y	$\sigma_{v,max}$	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[kNm]	[N/mm ²]	[%]
554	3.375	1.275	0.9	24.05	1.3244	3.1515	5.77	33 %

utilization rate for buckling

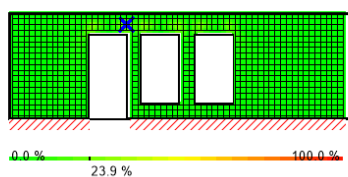


LCO6

Id	X	Z	l_k	λ_y	β_c	$k_{c,y}$	$f_{c,d}$	$\sigma_{c,0,d}$	$\sigma_{m,y,d}$	ratio
[-]	[m]	[m]	[m]	[-]	[-]	[-]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[%]
495	3.375	1.125	2.763	69	0.2	0.594	15.12	4.88	0.87	59 %

Ultimate limit state (ULS) fire design - results

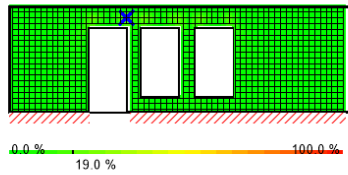
utilization rate of shear stress in plane on net section



LCO2

Id	X	Z	k_{mod}	$f_{IP,Netto,k}$	Q	$T_{IP,Net,d}$	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	1	3.9	-8.04	1.07	24 %

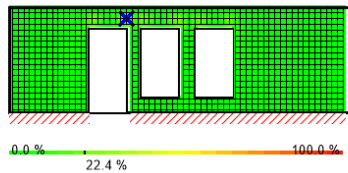
utilization rate of shear stress in plane of gross section



LCO2

Id	X	Z	k _{mod}	f _{v,IP,Brutto,k}	Q	τ _{IP,Gross,d}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	1	3.5	-8.04	0.77	19 %

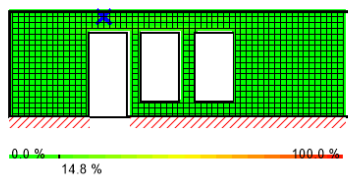
utilization rate of torsional shear stress in face glued surfaces



LCO2

Id	X	Z	k _{mod}	f _{v,IP,T,k}	Q	T _{T,Node,d}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[N/mm ²]	[%]
1024	3.075	2.475	1	2.5	-8.04	0.64	22 %

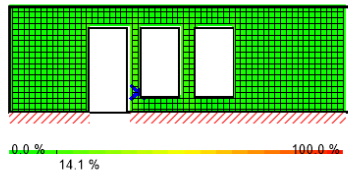
utilization rate of axial force horizontal



LCO2

Id	X	Z	k _{mod}	f _{m,k}	N _{h,max}	M _y	σ _{h,max}	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[kNm]	[N/mm ²]	[%]
1079	2.475	2.625	1	24.0	2.2757	0.0000	4.09	15 %

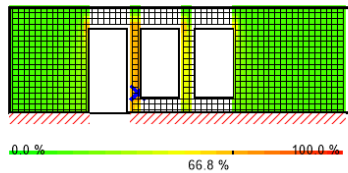
utilization rate of axial force vertical



LCO2

Id	X	Z	k_{mod}	$f_{m,k}$	$N_{v,max}$	M_y	$\sigma_{v,max}$	ratio
[-]	[m]	[m]	[-]	[N/mm ²]	[kN]	[kNm]	[N/mm ²]	[%]
259	3.375	0.525	1	24.0	29.2225	0.0000	3.90	14 %

utilization rate for buckling

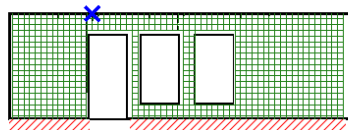


LCO2

Id	X	Z	l_k	λ_y	β_c	$k_{c,y}$	$f_{c,d}$	$\sigma_{c,0,d}$	$\sigma_{m,y,d}$	ratio
[-]	[m]	[m]	[m]	[-]	[-]	[-]	[N/mm ²]	[N/mm ²]	[N/mm ²]	[%]
259	3.375	0.525	2.763	118	0.2	0.242	24.15	3.90	0.00	67 %

Service limit state design (SLS) - design results

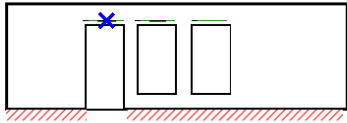
horizontal deformation



LCO2

Id	X	Z	w_{limit}	limit	$V_{h,max}$	ratio
[-]	[m]	[m]	[mm]	[mm]	[mm]	[%]
927	2.175	2.763	9.2	L/300 = 9.2 L/300 = 9.2	0.3405	3.7 %

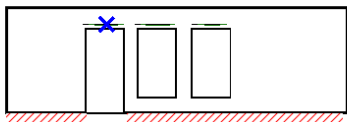
$$w_{inst} = w[char]$$



LCO2

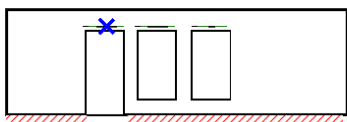
Id	X	Z	K _{def}	L _{ref}	limit	w _{limit}	w _{calc.}	ratio
[-]	[m]	[m]		[m]	[-]	[mm]	[mm]	
962	2.625	2.325	0.8	1.0	1/300	3.4	0.4	12 %

$$w_{fin} = w[char] + w[q.p.] \cdot k_{def}$$



Id	X	Z	K _{def}	L _{ref}	limit	w _{limit}	w _{calc.}	ratio
[-]	[m]	[m]		[m]	[-]	[mm]	[mm]	
962	2.625	2.325	0.8	1.0	1/150	6.7	0.6	9 %

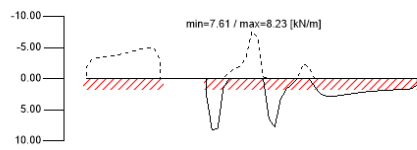
$$w_{net,fin} = w[q.p.] + w[q.p.] \cdot k_{def}$$



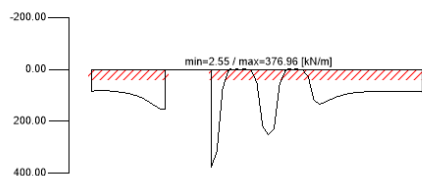
Id	X	Z	K _{def}	L _{ref}	limit	w _{limit}	w _{calc.}	ratio
[-]	[m]	[m]		[m]	[-]	[m]	[mm]	
962	2.625	2.325	0.8	1.0	L/250 L/250	4.0	0.5	12 %

support reaction

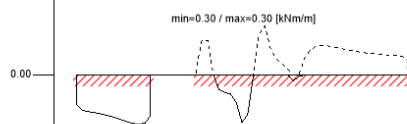
support reaction horizontal min/max



support reaction vertical min/max

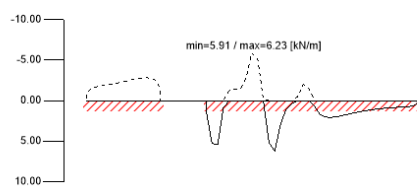


support reaction moment min/max

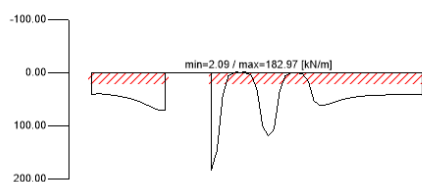


fire support reaction

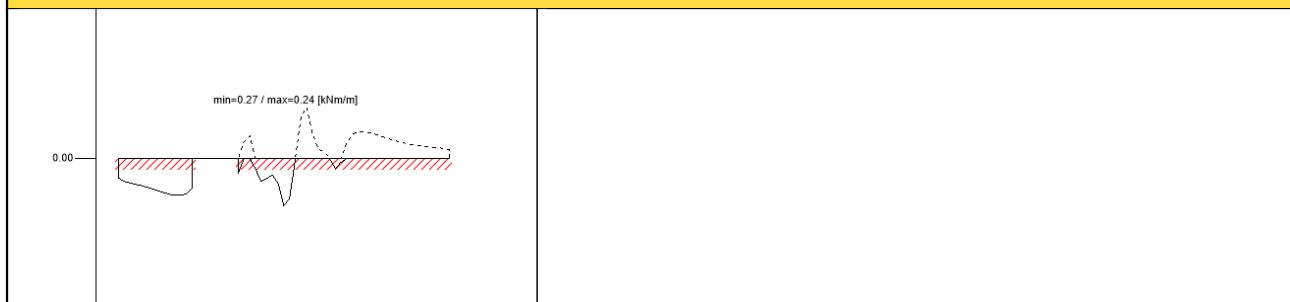
fire support reaction horizontal min/max



fire support reaction vertical min/max



fire support reaction moment min/max



Disclaimer

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