POSITION 141: PANEL 4

1. Input parameters

verifications acc. to DIN EN 1995, Germany

1.1. floor diaphragm

panel width b = 11.500 m with ⊥ h_{eff} = 5.625 m, panel height h = 6.250 m with ⊥ h_{eff} = 3.750m
b < 2 h ⇒ acc. to NCI Zu 9.2.3.2 (NA.5) load application by continuous distributing beams
(or setting of h_{eff} = b/2)

1.2. ribs

solid coniferous timber, C24 (S10), NKL 1, ρ_k = 350 kg/m³, a_r = 0.625 m
edge **100/220**, inner **100/220 mm**, oriented in y-direction
edge beams **100/220 mm**, inner beams **100/220 mm**

1.3. sheathing top

OSB 4 with ρ_k = 550 kg/m³, NKL 1, b/h/t = 1250/2500/28.00 mm in y-direction

1.4. sheathing bottom

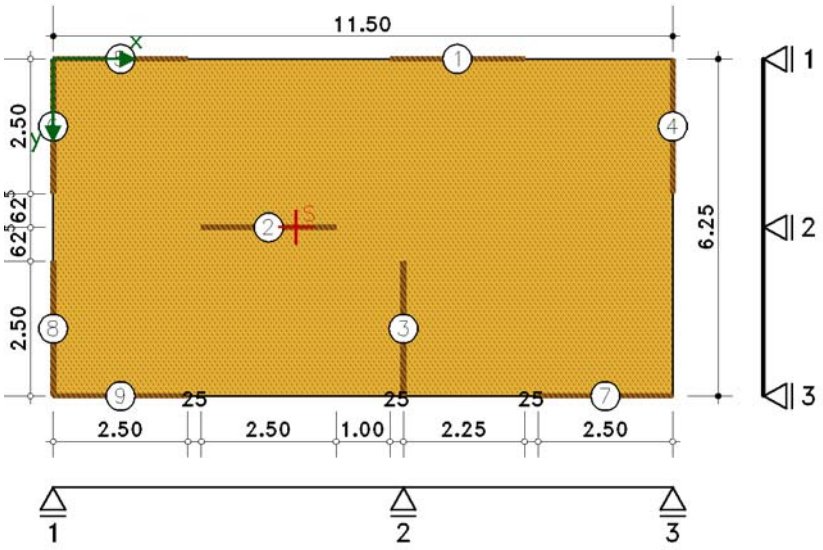
Fermacell 12,5 mm with ρ_k = 1150 kg/m³, NKL 1, b/h/t = 625/2000/12.50 mm in x-direction

1.5. Fasteners top

nail, 3.1 x 65.0 mm, d_k = -1.0 mm, not predrilled
detailed verification acc. to DIN EN 1995, 8.2.2, distance a_v = 62 mm, 1-row

1.6. Fasteners bottom

nail, 3.1 x 65.0 mm, d_k = -1.0 mm, not predrilled
detailed verification acc. to DIN EN 1995, 8.2.2, distance a_v = 80 mm, 1-row
elevation scale 1:1.406



1.7. sheet edges

no free sheet edges

1.8. walls

Nr	x_a	x_e	y_a	y_e	l
-	m	m	m	m	m
1	6.250	8.750	0.000	0.000	2.500
2	2.750	5.250	3.125	3.125	2.500
3	6.500	6.500	3.750	6.250	2.500
4	11.500	11.500	0.000	2.500	2.500
9	0.000	2.500	6.250	6.250	2.500
5	0.000	2.500	0.000	0.000	2.500
6	0.000	0.000	0.000	2.500	2.500
7	9.000	11.500	6.250	6.250	2.500
8	0.000	0.000	6.250	3.750	2.500

1.9. spans in x-direction

axis	l m	walls
1	6.500	6+8
2	5.000	3
3	0.000	4

1.10. spans in y-direction

axis	l m	walls
1	3.125	1+5
2	3.125	2
3	0.000	9+7

2. results

2.1. wall forces

x_s = 4.500 m, y_s = 3.125 m, I_p = 331.41 m^5, $e_{x,s}$ = -1.250 m, $e_{y,s}$ = 0.000 m (wall eccentricity)

2.1.1. Load combination 1:

wind in x-direction, application of load from one side

w_x = 4.00 kN/m, $e_{y,w}$ = 0.000 m ⇒ $w_{l,x}$ = 4.00 kN/m, $w_{r,x}$ = 4.00 kN/m, ΔMx = -0.00 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	2.500	0.000	-3.125	5.000	0.000	5.000
2	2.500	3.125	0.000	5.000	-0.000	5.000
9	2.500	6.250	3.125	5.000	-0.000	5.000
5	2.500	0.000	-3.125	5.000	0.000	5.000
7	2.500	6.250	3.125	5.000	-0.000	5.000

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	10.000	0.000	---	---	---	---
-	1x	---	---	10.000	-2.500	12.500	2.500
2x	-	5.000	11.719	---	---	---	---
-	2x	---	---	2.500	-10.000	12.500	0.625
3x	-	10.000	0.000	---	---	---	---

2.1.2. Load combination 2:

wind in x-direction, application of load from one side

w_x = 4.00 kN/m, $e_{y,w}$ = 0.600 m ⇒ $w_{l,x}$ = 1.70 kN/m, $w_{r,x}$ = 6.30 kN/m, ΔMx = -15.00 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	2.500	0.000	-3.125	5.000	0.354	5.354
2	2.500	3.125	0.000	5.000	-0.000	5.000
9	2.500	6.250	3.125	5.000	-0.354	4.646
5	2.500	0.000	-3.125	5.000	0.354	5.354
7	2.500	6.250	3.125	5.000	-0.354	4.646

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	10.707	0.000	---	---	---	---
-	1x	---	---	10.707	1.807	---	---
2x	-	5.000	21.429	---	---	---	---
-	2x	---	---	6.807	-9.293	26.725	1.496
3x	-	9.293	19.420	---	---	---	---

2.1.3. Load combination 3:

wind in x-direction, application of load from one side

w_x = 3.06 kN/m, $e_{y,w}$ = 0.656 m ⇒ $w_{l,x}$ = 1.13 kN/m, $w_{r,x}$ = 4.99 kN/m, ΔMx = -12.55 kNm

Nr	l_x m	y_i m	$y_i - y_s$ m	$F_{x,wx}$ kN	$F_{x,\Delta Mx}$ kN	$F_{v,x,d}$ kN
1	2.500	0.000	-3.125	3.825	0.296	4.121
2	2.500	3.125	0.000	3.825	-0.000	3.825
9	2.500	6.250	3.125	3.825	-0.296	3.529
5	2.500	0.000	-3.125	3.825	0.296	4.121
7	2.500	6.250	3.125	3.825	-0.296	3.529

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	8.242	0.000	---	---	---	---
-	1x	---	---	8.242	1.690	---	---
2x	-	3.825	17.086	---	---	---	---
-	2x	---	---	5.515	-7.058	21.576	1.558
3x	-	7.058	16.243	---	---	---	---

2.1.4. Load combination 4:

wind in y-direction, application of load from one side

w_y = 3.57 kN/m, $e_{x,w}$ = 0.000 m ⇒ $w_{l,y}$ = 3.57 kN/m, $w_{r,y}$ = 3.57 kN/m, ΔMy = -51.32 kNm

Nr	l_y m	x_i m	x_i-x_s m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	6.500	-2.000	10.264	0.774	11.038
4	2.500	11.500	-7.000	10.264	2.710	12.974
6	2.500	0.000	4.500	10.264	-1.742	8.522
8	2.500	0.000	4.500	10.264	-1.742	8.522

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	17.043	0.000	---	---	---	---
-	1y	---	---	17.043	-6.162	40.683	4.774
2y	-	11.038	35.365	---	---	---	---
-	2y	---	---	4.876	-12.974	38.696	1.366
3y	-	12.974	15.122	---	---	---	---

2.1.5. Load combination 5:

wind in y-direction, application of load from one side

w_y = 3.57 kN/m, $e_{x,w}$ = 0.750 m ⇒ $w_{l,y}$ = 2.17 kN/m, $w_{r,y}$ = 4.97 kN/m, ΔMy = -82.11 kNm

Nr	l_y m	x_i m	x_i-x_s m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	6.500	-2.000	10.264	1.239	11.503
4	2.500	11.500	-7.000	10.264	4.336	14.600
6	2.500	0.000	4.500	10.264	-2.787	7.476
8	2.500	0.000	4.500	10.264	-2.787	7.476

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	14.953	0.000	---	---	---	---
-	1y	---	---	14.953	-4.304	42.702	5.307
2y	-	11.503	40.168	---	---	---	---
-	2y	---	---	7.198	-14.600	46.811	1.812
3y	-	14.600	24.196	---	---	---	---

2.1.6. Load combination 6:

wind in y-direction, application of load from one side

w_y = 2.91 kN/m, $e_{x,w}$ = 0.563 m ⇒ $w_{l,y}$ = 2.06 kN/m, $w_{r,y}$ = 3.76 kN/m, ΔMy = -60.67 kNm

Nr	l_y m	x_i m	x_i-x_s m	$F_{y,wy}$ kN	$F_{y,\Delta My}$ kN	$F_{v,y,d}$ kN
3	2.500	6.500	-2.000	8.366	0.915	9.282
4	2.500	11.500	-7.000	8.366	3.204	11.570
6	2.500	0.000	4.500	8.366	-2.060	6.307
8	2.500	0.000	4.500	8.366	-2.060	6.307

axis	span	A_y kN	M_y kNm	$V_{l,y}$ kNm	$V_{r,y}$ kNm	$M_{max,y}$ kNm	x_{max} m
1y	-	12.613	0.000	---	---	---	---
-	1y	---	---	12.613	-3.886	34.320	5.170
2y	-	9.282	31.766	---	---	---	---
-	2y	---	---	5.396	-11.570	36.451	1.714
3y	-	11.570	17.878	---	---	---	---

2.2. verification of flanges

LK	$M_{max,d}$ kNm	h_{eff} m	$F_{c,d}$ kN	$\sigma_{c,d}$ N/mm²	k_c -	k_{mod} -	u -
1	12.500	1.563	8.000	0.364	1.000	1.000	0.023
2	26.725	1.563	17.104	0.777	1.000	1.000	0.048
3	21.576	1.563	13.809	0.628	1.000	1.000	0.039
4	40.683	5.625	7.233	0.329	1.000	1.000	0.020
5	46.811	5.625	8.322	0.378	1.000	1.000	0.023
6	36.451	5.625	6.480	0.295	1.000	1.000	0.018

2.3. Verification of diaphragm loading

sheathing

γ = 1.30, f_{vk1} = 0.0 N/mm², f_{ck1} = 0.0 N/mm², f_{vk2} = 4 N/mm², f_{ck2} = 9 N/mm², k_{v1} = 0.66, k_{v2} = 0.50

2.3.1. Load combination 1:

with h_{eff} = 11.500 m, $_{max}V_d$ = 10.000 kN ⇒ s_{v0d} = 0.87 N/mm, s_{v90d} = 4.00 N/mm (shear flow)

sheathing 1

k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²

f_{v0d} = 7.52 N/mm (fastener)

f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive

f_{v0d} = 0.00 N/mm (shear force buckling)

f_{v90d} = 11.39 N/mm (fastener)

f_{v90d} = 0.00 N/mm (plate shear strength)

f_{v90d} = 0.00 N/mm (shear force buckling) ⇒ decisive

sheathing 2

k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²

f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive

f_{v0d} = 10.85 N/mm (plate shear strength)

f_{v0d} = 7.60 N/mm (shear force buckling)

f_{v90d} = 5.70 N/mm (fastener) ⇒ decisive

f_{v90d} = 38.82 N/mm (plate shear strength)

f_{v90d} = 15.53 N/mm (shear force buckling)

⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 15.53 N/mm²

⇒ utilization: U_0 = 0.23, U_{90} = 0.70, U_{komb} = 0.74 ⇒ **U = 0.74 verification successful**

2.3.2. Load combination 2:

with h_{eff} = 11.500 m, $_{max}V_d$ = 10.707 kN ⇒ s_{v0d} = 0.93 N/mm, s_{v90d} = 4.00 N/mm (shear flow)

sheathing 1

k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²

f_{v0d} = 7.52 N/mm (fastener)

f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive

f_{v0d} = 0.00 N/mm (shear force buckling)

f_{v90d} = 11.39 N/mm (fastener)

f_{v90d} = 0.00 N/mm (plate shear strength)

f_{v90d} = 0.00 N/mm (shear force buckling) ⇒ decisive

sheathing 2

k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²

f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive

f_{v0d} = 10.85 N/mm (plate shear strength)

f_{v0d} = 7.60 N/mm (shear force buckling)

f_{v90d} = 5.70 N/mm (fastener) ⇒ decisive

f_{v90d} = 38.82 N/mm (plate shear strength)

f_{v90d} = 15.53 N/mm (shear force buckling)

⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 15.53 N/mm²

⇒ utilization: U_0 = 0.25, U_{90} = 0.70, U_{komb} = 0.74 ⇒ **U = 0.74 verification successful**

2.3.3. Load combination 3:

with h_{eff} = 11.500 m, $_{max}V_d$ = 8.242 kN ⇒ s_{v0d} = 0.72 N/mm, s_{v90d} = 3.06 N/mm (shear flow)

sheathing 1

k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²

f_{v0d} = 7.52 N/mm (fastener)

f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive

f_{v0d} = 0.00 N/mm (shear force buckling)

f_{v90d} = 11.39 N/mm (fastener)

f_{v90d} = 0.00 N/mm (plate shear strength)

f_{v90d} = 0.00 N/mm (shear force buckling) ⇒ decisive

sheathing 2

k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²

f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive

f_{v0d} = 10.85 N/mm (plate shear strength)

f_{v0d} = 7.60 N/mm (shear force buckling)

f_{v90d} = 5.70 N/mm (fastener) ⇒ decisive
f_{v90d} = 38.82 N/mm (plate shear strength)
f_{v90d} = 15.53 N/mm (shear force buckling)
⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 15.53 N/mm²
⇒ utilization: U_0 = 0.19, U_{90} = 0.54, U_{komb} = 0.57 ⇒ **U = 0.57 verification successful**

2.3.4. Load combination 4:

with h_{eff} = 5.625 m, $_{max}V_d$ = 17.043 kN ⇒ s_{v0d} = 3.03 N/mm
sheathing 1
k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²
f_{v0d} = 7.52 N/mm (fastener)
f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive
f_{v0d} = 0.00 N/mm (shear force buckling)
sheathing 2
k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²
f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive
f_{v0d} = 10.85 N/mm (plate shear strength)
f_{v0d} = 7.60 N/mm (shear force buckling)
⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 7.60 N/mm²
⇒ utilization: U_0 = 0.81 ⇒ **U = 0.81 verification successful**

2.3.5. Load combination 5:

with h_{eff} = 5.625 m, $_{max}V_d$ = 14.953 kN ⇒ s_{v0d} = 2.66 N/mm
sheathing 1
k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²
f_{v0d} = 7.52 N/mm (fastener)
f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive
f_{v0d} = 0.00 N/mm (shear force buckling)
sheathing 2
k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²
f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive
f_{v0d} = 10.85 N/mm (plate shear strength)
f_{v0d} = 7.60 N/mm (shear force buckling)
⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 7.60 N/mm²
⇒ utilization: U_0 = 0.71 ⇒ **U = 0.71 verification successful**

2.3.6. Load combination 6:

with h_{eff} = 5.625 m, $_{max}V_d$ = 12.613 kN ⇒ s_{v0d} = 2.24 N/mm
sheathing 1
k_{mod} = 1.00, $F_{v,Rd}$ = 706 N, f_{v0d} = 0.00 N/mm², f_{v90d} = 0.00 N/mm²
f_{v0d} = 7.52 N/mm (fastener)
f_{v0d} = 0.00 N/mm (plate shear strength) ⇒ decisive
f_{v0d} = 0.00 N/mm (shear force buckling)
sheathing 2
k_{mod} = 0.95, $F_{v,Rd}$ = 456 N, f_{v0d} = 2.63 N/mm², f_{v90d} = 5.70 N/mm²
f_{v0d} = 3.76 N/mm (fastener) ⇒ decisive
f_{v0d} = 10.85 N/mm (plate shear strength)
f_{v0d} = 7.60 N/mm (shear force buckling)
⇒ total load carrying capacity: f_{v0d} = 0.00 N/mm², f_{v90d} = 7.60 N/mm²
⇒ utilization: U_0 = 0.60 ⇒ **U = 0.60 verification successful**

3. Summary

maximum utilization of all verifications U_{max} = 0.81 ≤ 1 ⇒ **all verifications successful**