POSITION 135: PANEL 3

1. Input parameters
verifications acc. to DIN EN 1995, Germany

1.1. floor diaphragm
panel width b = 7.500 m with ⊥ h_{eff} = 3.750 m, panel height h = 8.750 m with ⊥ h_{eff} = 3.750m

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 x-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 = 1250/2500/22.00 mm in y-direction
input parameters for the verification of sheathing in bending stress
dead load: 0.121 kN/m²
permanent area load g: 1.000 kN/m²
transient area load q: 3.000 kN/m² (load class: housing, office rooms)
W = 80.667 mm³/m, $f_{v,k}$ = 6.90 N/mm², $f_{m,k}$ = 8.00 N/mm²

1.4. sheathing bottom
Agepan DWD (user defined) with ρ_k = 550 kg/m³, NKL 1, b/h/t = 1000/2000/12.50 mm in x-direction

1.5. user defined parameters fibreboard Agepan DWD
stiffness parameters [N/mm²]

plate action effect	parallel	vertical
mod-ela E_{mean}	1300	1300
shear mod. G_{mean}	420	420

diaphragm act. eff.	parallel	vertical
mod-ela E_{mean}	1200	1200
shear mod. G_{mean}	420	420

strength parameters [N/mm²]

plate action effect	parallel	vertical
bending $f_{m,k}$	11.00	11.00
compr.$f_{c,k}$	0.18	0.18
shear $f_{v,k}$	3.70	3.70

diaphragm act. eff.	parallel	vertical
bending $f_{m,k}$	11.00	11.00
tens$f_{c,k}$	7.90	7.20
compr.$f_{c,k}$	6.90	7.20
shear $f_{v,k}$	3.70	3.70

modification coefficients k_{mod}

service class	1	2	3
permanent	0.15	0.15	0.00
long-term	0.40	0.30	0.00
med.-term	0.60	0.45	0.00
sh.-term	0.80	0.60	0.00
instantan.	1.10	0.80	0.00

deformation parameters k_{def}

service class	1	2	3
k_{def}	2.25	2.25	2.25

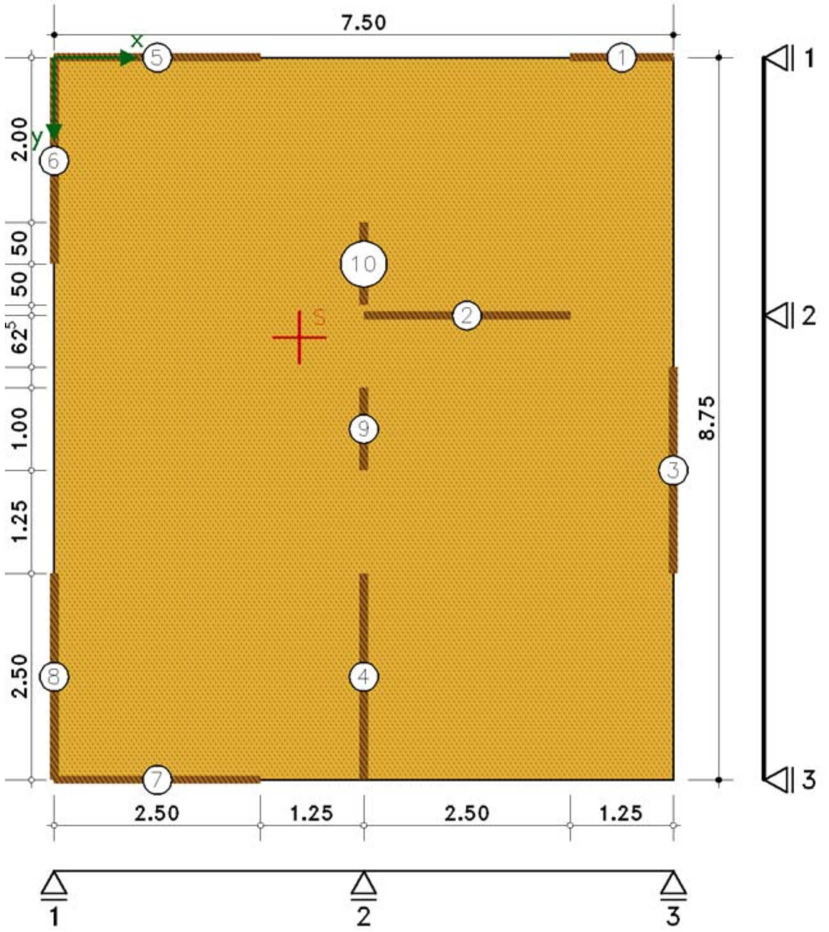
input parameters for the verification of sheathing in bending stress
dead load: 0.121 kN/m²
permanent area load g: 1.000 kN/m²
transient area load q: 3.000 kN/m² (load class: housing, office rooms)
W = 80.667 mm³/m, $f_{v,k}$ = 6.90 N/mm², $f_{m,k}$ = 8.00 N/mm²

1.6. Fasteners top

staple, 1.53 x 50 mm, br = 5.5 mm , resined, timber at fibre saturation point
detailed verification acc. to DIN EN 1995, 8.2.2, distance a_v = 50 mm, 1-row
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2)

1.7. Fasteners bottom

staple, 1.53 x 50 mm, br = 5.5 mm , resined, timber at fibre saturation point
detailed verification acc. to DIN EN 1995, 8.2.2, distance a_v = 100 mm, 1-row
$F_{v,Rk}$ increased acc. to DIN EN 1995, 8.2.2(2)
elevation scale 1:0.917



1.8. sheet edges

free sheet edges successful acc. to DIN EN 1995-1-1/NA:2013-08, NCI zu 9.2.3.2 (NA.9),
if the following conditions are satisfied:
- the sheets are staggered by a minimum beam spacing of a_r = 0.625 m
- the sheets are fixed also to all beams
  with nails in distance a_1

1.9. walls

Nr	x_a	x_e	y_a	y_e	l
-	m	m	m	m	m
1	6.250	7.500	0.000	0.000	1.250
2	3.750	6.250	3.125	3.125	2.500
3	7.500	7.500	3.750	6.250	2.500
4	3.750	3.750	6.250	8.750	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	0.000	2.500	8.750	8.750	2.500
8	0.000	0.000	8.750	6.250	2.500
9	3.750	3.750	5.000	4.000	1.000
10	3.750	3.750	3.000	2.000	1.000

1.10. spans in x-direction

axis	l m	walls
1	3.750	8+6
2	3.750	9+10+
3	0.000	3

1.11. spans in y-direction

axis	l m	walls
1	3.125	5+1
2	5.625	2
3	0.000	7

1.12. deflection

the conditions acc. to DIN EN 1995-1-1/NA:2013-08, NCI zu 9.2.3.2 (NA.12) for the simplified method for verification of deflections are satisfied

2. results

2.1. wall forces

x_s = 2.969 m, y_s = 3.393 m, I_p = 213.24 m^5, $e_{x,s}$ = -0.781 m, $e_{y,s}$ = -0.982 m (wall eccentricity)

2.1.1. Load combination 1: Wx

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

w_x = 4.50 kN/m, $e_{y,w}$ = 0.750 m $\Rightarrow$ $w_{l,x}$ = 2.19 kN/m, $w_{r,x}$ = 6.81 kN/m, ΔM_x = 68.20 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	1.250	0.000	-3.393	5.625	-1.356	4.269
2	2.500	3.125	-0.268	11.250	-0.214	11.036
5	2.500	0.000	-3.393	11.250	-2.713	8.537
7	2.500	8.750	5.357	11.250	4.284	15.534

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	12.806	0.000	---	---	---	---
-	1x	---	---	12.806	3.392	---	---
2x	-	11.036	26.654	---	---	---	---
-	2x	---	---	14.428	-15.534	50.310	3.097
3x	-	15.534	31.391	---	---	---	---

2.1.2. Load combination 2: Wy

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

w_x = 4.30 kN/m, $e_{y,w}$ = 0.000 m $\Rightarrow$ $w_{l,x}$ = 4.30 kN/m, $w_{r,x}$ = 4.30 kN/m, ΔM_x = 36.95 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	1.250	0.000	-3.393	5.375	-0.735	4.640
2	2.500	3.125	-0.268	10.750	-0.116	10.634
5	2.500	0.000	-3.393	10.750	-1.470	9.280
7	2.500	8.750	5.357	10.750	2.321	13.071

axis	span	A_x kN	M_x kNm	$V_{l,x}$ kNm	$V_{r,x}$ kNm	$M_{max,x}$ kNm	y_{max} m
1x	-	13.920	0.000	---	---	---	---
-	1x	---	---	13.920	0.483	---	---
2x	-	10.634	22.504	---	---	---	---
-	2x	---	---	11.117	-13.071	36.874	2.585
3x	-	13.071	17.008	---	---	---	---

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	50.310	3.750	13.416	0.610	1.000	1.000	0.038
2	36.874	3.750	9.833	0.447	1.000	1.000	0.028

2.3. Verification of diaphragm loading

sheathing

$\gamma = 1.30$, $f_{vk1} = 6.9$ N/mm², $f_{ck1} = 13.7$ N/mm², $f_{vk2} = 4$ N/mm², $f_{ck2} = 7$ N/mm², $k_{v1} = 0.66$, $k_{v2} = 0.50$

2.3.1. Load combination 1: Wx

with $h_{eff} = 3.750$ m, ${}_{max}V_d = 15.534$ kN ⇒ $s_{v0d} = 4.14$ N/mm

sheathing 1

$k_{mod} = 1.00$, $F_{v,Rd} = 560$ N, $f_{v0d} = 5.31$ N/mm², $f_{v90d} = 11.20$ N/mm²

f_{v0d} = 7.39 N/mm (fastener) ⇒ decisive

f_{v0d} = 38.53 N/mm (plate shear strength)

f_{v0d} = 47.47 N/mm (shear force buckling)

sheathing 2

$k_{mod} = 0.95$, $F_{v,Rd} = 580$ N, $f_{v0d} = 2.70$ N/mm², $f_{v90d} = 5.80$ N/mm²

f_{v0d} = 3.83 N/mm (fastener) ⇒ decisive

f_{v0d} = 11.15 N/mm (plate shear strength)

f_{v0d} = 7.81 N/mm (shear force buckling)

⇒ total load carrying capacity: $f_{v0d} = 0.00$ N/mm², $f_{v90d} = 7.81$ N/mm²

⇒ utilization: $U_0 = 0.40$ ⇒ **U = 0.40 verification successful**

2.3.2. Load combination 2: Wy

with $h_{eff} = 3.750$ m, ${}_{max}V_d = 13.920$ kN ⇒ $s_{v0d} = 3.71$ N/mm

sheathing 1

$k_{mod} = 1.00$, $F_{v,Rd} = 560$ N, $f_{v0d} = 5.31$ N/mm², $f_{v90d} = 11.20$ N/mm²

f_{v0d} = 7.39 N/mm (fastener) ⇒ decisive

f_{v0d} = 38.53 N/mm (plate shear strength)

f_{v0d} = 47.47 N/mm (shear force buckling)

sheathing 2

$k_{mod} = 0.95$, $F_{v,Rd} = 580$ N, $f_{v0d} = 2.70$ N/mm², $f_{v90d} = 5.80$ N/mm²

f_{v0d} = 3.83 N/mm (fastener) ⇒ decisive

f_{v0d} = 11.15 N/mm (plate shear strength)

f_{v0d} = 7.81 N/mm (shear force buckling)

⇒ total load carrying capacity: $f_{v0d} = 0.00$ N/mm², $f_{v90d} = 7.81$ N/mm²

⇒ utilization: $U_0 = 0.36$ ⇒ **U = 0.36 verification successful**

2.4. verification der Biege- und shear stress der sheathing

duration of load medium-term ⇒ $k_{mod} = 0.700$, $f_{v,d} = 3.72$ N/mm², $f_{m,d} = 4.31$ N/mm²

$V_d = 1.879$ kN/m, $\tau_d = 0.13$ N/mm², $u_\sigma = 0.034$ ⇒ **verification successful**

$M_d = 0.294$ kNm/m, $\sigma_d = 3.64$ N/mm², $u_\sigma = 0.845$ ⇒ **verification successful**

3. Summary

maximum utilization of all verifications $U_{max} = 0.84 \leq 1$ ⇒ **all verifications successful**