1. Eingabedaten Wandscheibe aus Brettsperrholz

Nachweise nach DIN EN 1995, Deutschland, Nutzungsklasse 1

1.1. Berechnungseinstellungen

Netzdichtefaktor = 2 [-]

2. Systembeschreibung

Systemlänge l = 8500 mm, Systemhöhe h = 3100 mm

2.1. Wandtyp

BSP 94 (benutzerdefiniert), Aufbau 30.0-**34.0**-30.0 Nadelvollholz, C24 (S10)
Decklagen in y-Richtung, d = 94.0 mm ⇒ d_x = 34 mm, d_y = 60 mm,
Schmalflächen nicht verleimt

2.2. Statische Werte

Schubkorrekturfaktor κ_x = 0.193873, κ_y = 0.673801
Brettbreite b = 150 mm, Achsabstand der Bretter a = 150 mm
Nachweis nach Brettsperrholzhandbuch mit t^* = 68.0 mm, t_m = 34.0 mm

2.3. Festigkeiten

$f_{c0,k}$ = 21.00 N/mm², $f_{t0,k}$ = 14.50 N/mm², $f_{v,k}$ = 5.00 N/mm², $f_{tor,k}$ = 2.50 N/mm², $f_{vR,k}$ = 50.00 N/mm²

2.4. Rechteckige Öffnungen

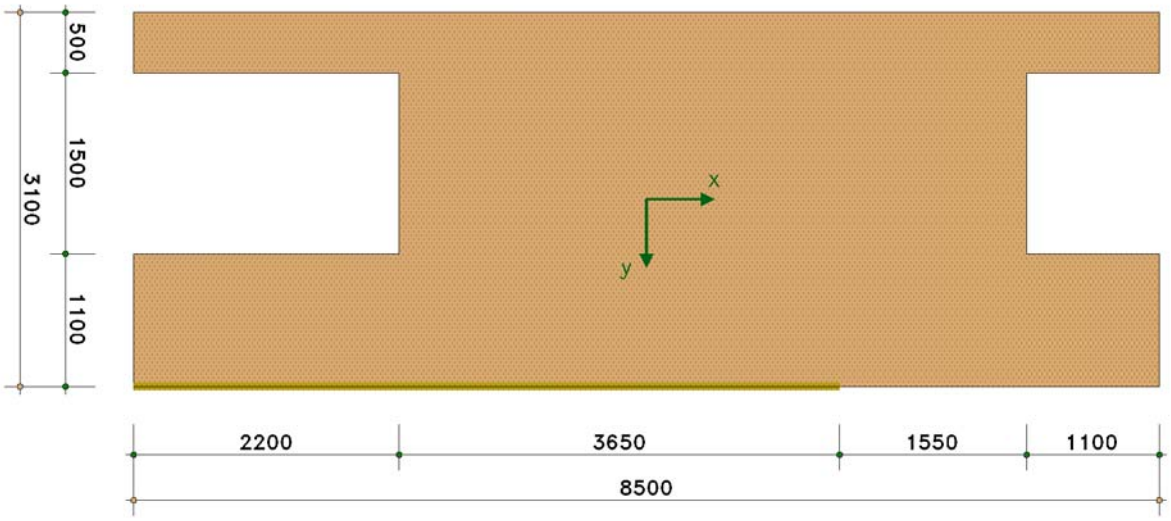
Name	x [mm]	y [mm]	Breite [mm]	Höhe [mm]
Öffnung 1	-4350	-1050	2300	1500
Öffnung 2	3150	-1050	1100	1500

2.5. Linienlager

Name	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	Lager - x kN/mm²	Lager - y kN/mm²	Lager - mz kNm/m
Lagerlinie 1	-4250	1550	1600	1550	starr	starr	10000

2.6. Wandscheibe

Ansicht Maßstab 1:628



3. Einwirkungen / Lasten

Beschreibung der Belastungsstruktur

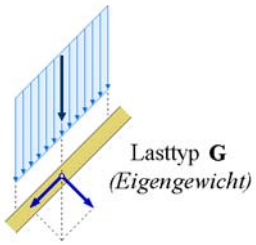
Auf der linken Seite sind die Beziehungen der Einwirkungen, Lastfallordner und Lastfälle zueinander in einer Baumstruktur dargestellt. Auf der rechten Seite sind die überlagerungsspezifischen Eigenschaften den links stehenden Objekten zugeordnet angegeben. Ein Lastfallordner entspricht überlagerungstechnisch einer Extremierung der in ihm definierten Objekte und kann seinerseits wiederum additiv oder alternativ überlagert werden.

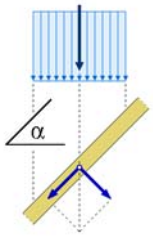
verwendete Symbole: Einwirkung Lastfallordner Lastfall Imperfektionsfälle

Beschreibung der Belastungsstruktur

Auf der linken Seite sind die Beziehungen der Einwirkungen, Lastfallordner und Lastfälle zueinander in einer Baumstruktur dargestellt. Auf der rechten Seite sind die überlagerungsspezifischen Eigenschaften den links stehenden Objekten zugeordnet angegeben. Ein Lastfallordner entspricht überlagerungstechnisch einer Extremierung der in ihm definierten Objekte und kann seinerseits wiederum additiv oder alternativ überlagert werden.

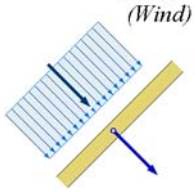
1: ständige Lasten	**ständige Lasten**
1: g1	additiv
2: g2	additiv
3: g3	additiv
4: g4	additiv
8: g5o	additiv
9: g5u	additiv
2: Nutzlasten (1)	**veränderliche Nutzlasten in Wohn-, Büroräumen**
5: Nutzlasten (1/1)	additiv
3: Schneelasten	**veränderliche Schneelasten**
6: Schneelast (1)	alternativ in Gruppe A
4: Windlasten	**veränderliche Windlasten**
7: WH1	alternativ in Gruppe B
10: WH2	additiv





Lasttyp **S**
(Schnee)

Beim Lasttyp S wird die Lastresultierende mit dem Faktor *cos α* reduziert.



Lasttyp **W**
(Wind)

1: Ständige Einwirkung: ständige Lasten

g1

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g1 Dach 2,10*1,91	G	-4250	-1550	4250	-1550	0.00	0.00	4.01	4.01

g2

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g2 Wand 0,95*(3,10+	G	-4250	-1550	4250	-1550	0.00	0.00	3.33	3.33

g3

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g3 Decke 2,10*1,91	G	-4250	-1550	4250	-1550	0.00	0.00	4.01	4.01

g4

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g4 Wand 0,95*3,10	G	-4250	-1550	4250	-1550	0.00	0.00	2.94	2.94

g5o

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g5 Wand 0,95*(3,10+	G	4250	-1550	4250	-1050	0.00	0.00	4.78	4.78

g5u

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
g5 Wand 0,95*(3,10+	G	4250	450	4250	1550	0.00	0.00	4.78	4.78

2: Veränderliche Einwirkung: Nutzlasten (1)

Nutzlasten (1/1)

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
q Decke 2,03*2,00	S	-4250	1550	4250	1550	0.00	0.00	4.06	4.06

3: Veränderliche Einwirkung: Schneelasten
Schneelast (1)

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
Schnee Dach 2,03*1,	S	-4250	-1550	4250	-1550	0.00	0.00	3.65	3.65

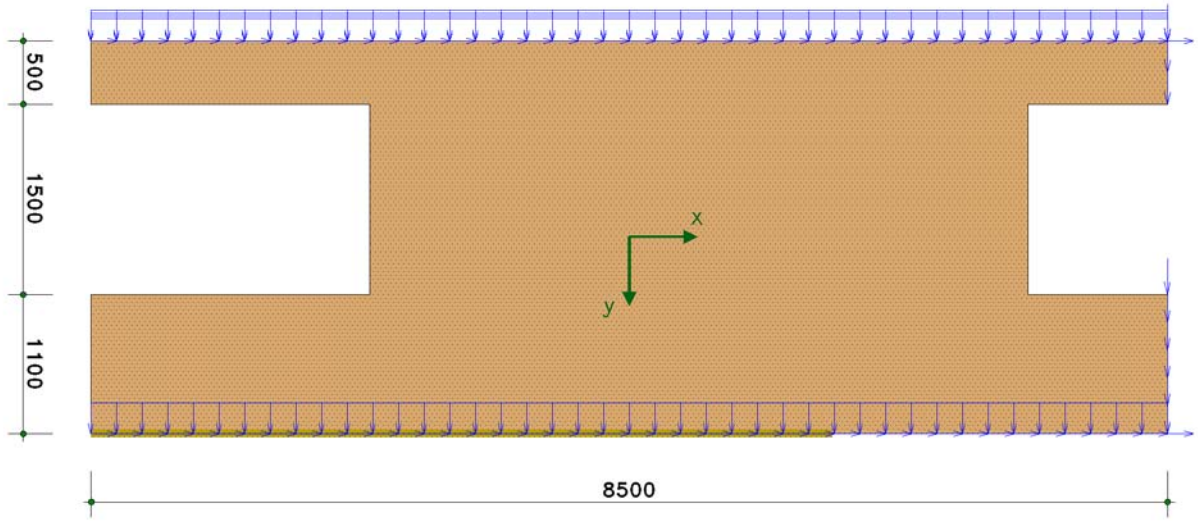
4: Veränderliche Einwirkung: Windlasten
WH1

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
WH1 unten 1,3*3,10*	W	-4250	1550	4250	1550	2.97	2.97	0.00	0.00

WH2

Name Linienlast	Typ [-]	x_a [mm]	y_a [mm]	x_e [mm]	y_e [mm]	$qx(l)_a$ [kN/m]	$qx(l)_e$ [kN/m]	$qy(m)_a$ [kN/m]	$qy(m)_e$ [kN/m]
WH2 oben 1,3*1,95*1	W	-4250	-1550	4250	-1550	1.87	1.87	0.00	0.00

Alle Lasten Maßstab 1:598

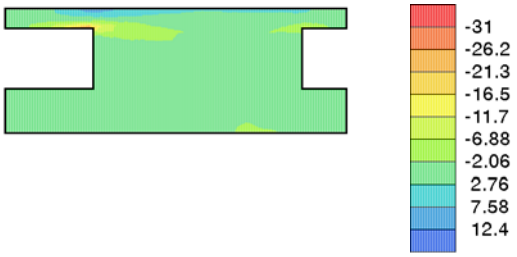


4. Nachweisergebnisse

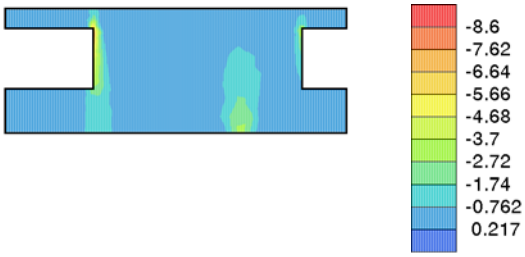
4.1. EC 5 Tragfähigkeit (Th.I.Ord.)

4.1.1. Zusammenfassung

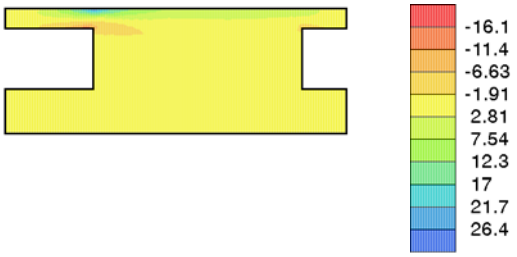
Normalspannungen $\sigma_{xx,min}$ [N/mm²]
min $\sigma_{xx,min}$ = -30.99 N/mm², max $\sigma_{xx,min}$ = 12.40 N/mm²



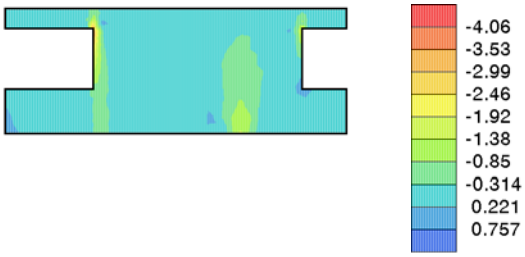
Normalspannungen $\sigma_{yy,min}$ [N/mm²]
min $\sigma_{yy,min}$ = -8.60 N/mm², max $\sigma_{yy,min}$ = 0.22 N/mm²



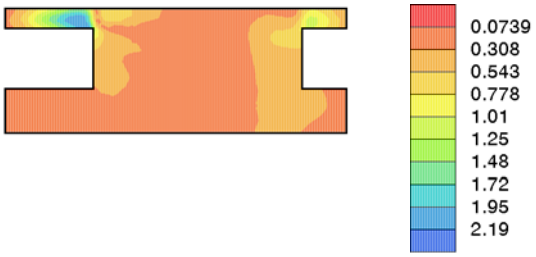
Normalspannungen $\sigma_{xx,max}$ [N/mm²]
min $\sigma_{xx,max}$ = -16.08 N/mm², max $\sigma_{xx,max}$ = 26.43 N/mm²



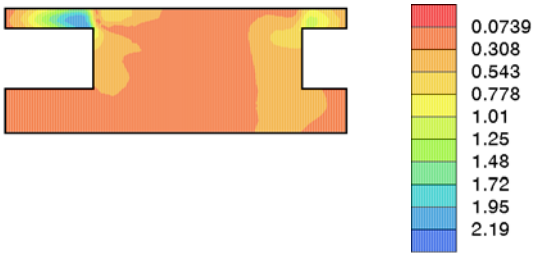
Normalspannungen $\sigma_{yy,min}$ [N/mm²]
min $\sigma_{yy,max}$ = -4.06 N/mm², max $\sigma_{yy,max}$ = 0.76 N/mm²



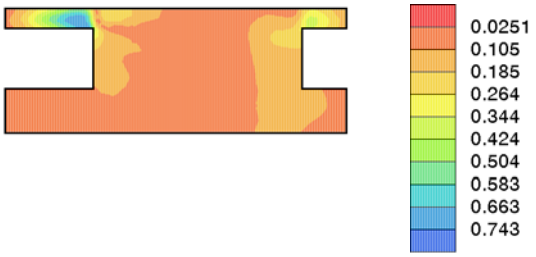
Schubspannungen τ_{xy} [N/mm²]
min τ\xy = 0.07 N/mm², max τ_{xy} = 2.19 N/mm²



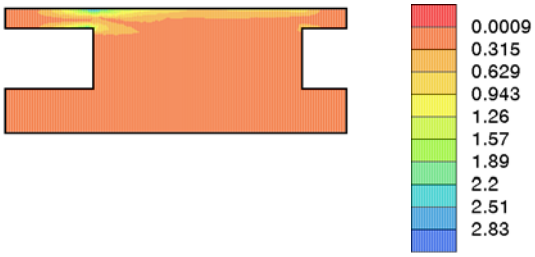
Schubspannungen τ_{yx} [N/mm²]
min τ_{yx} = 0.07 N/mm², max τ_{yx} = 2.19 N/mm²



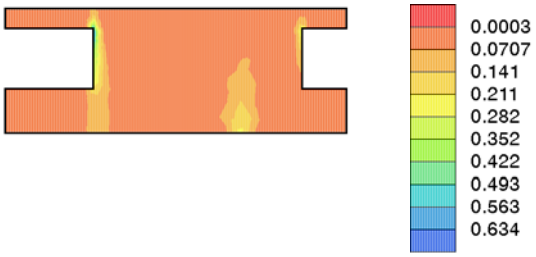
Torsionsschubspannungen τ_{tor} [N/mm²]
min τ_{tor} = 0.03 N/mm², max τ_{tor} = 0.74 N/mm²



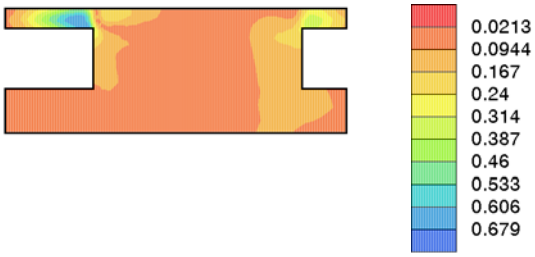
Ausnutzung $U_{\sigma xx}$
min $U_{\sigma xx}$ = 0.001, max $U_{\sigma xx}$ = 2.828



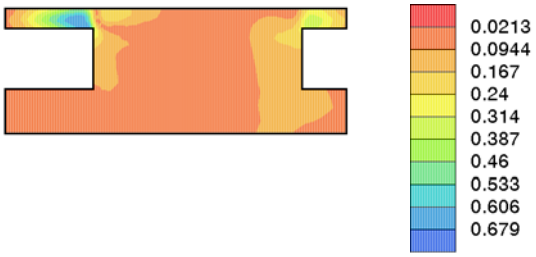
Ausnutzung $U_{\sigma yy}$
min $U_{\sigma yy}$ = 0.000, max $U_{\sigma yy}$ = 0.634



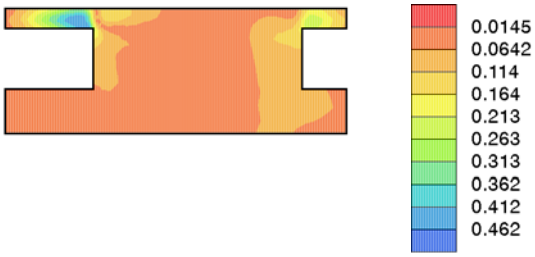
Ausnutzung $U_{\sigma yy}$
min $U_{\sigma yy}$ = 0.000, max $U_{\sigma yy}$ = 0.634



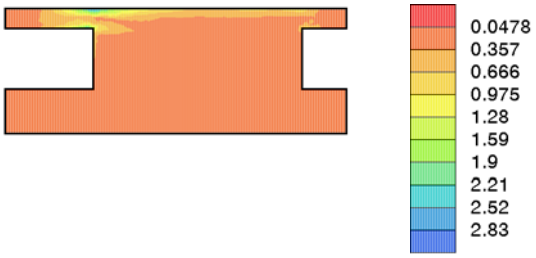
Ausnutzung $U_{\sigma yy}$
min $U_{\sigma yy}$ = 0.000, max $U_{\sigma yy}$ = 0.634



Ausnutzung $U_{\sigma yy}$
min $U_{\sigma yy}$ = 0.000, max $U_{\sigma yy}$ = 0.634



Gesamtausnutzung U
min U = 0.048, max U = 2.828



5. Detailnachweispunkte

POSITION 1, KNOTEN 13 BEI X = 1.60 M, Y = 1.55 M

Querschnittsbeschreibung

BSP 94 (benutzerdefiniert), Aufbau 30.0-**34.0**-30.0 Nadelvollholz, C24 (S10)
d_x = 34.0 mm, d_y = 60.0 mm, b = 150 mm, e = 150 mm (Achsabst. d. Bretter), $t*$ = 68.0 mm, t_m = 34.0 mm
$f_{c0,k}$ = 21.00 N/mm², $f_{t0,k}$ = 14.50 N/mm², $f_{v,k}$ = 5.00 N/mm², $f_{tor,k}$ = 2.50 N/mm²

Lastfallergebnisse

Nr	u_x mm	u_y mm	v_z ‰	n_{xx} kN/m	n_{yy} kN/m	n_{xy} kN/m	Bezeichnung
Einwirkung 1: ständige Lasten							
1	-0.00	0.00	0.00	-10.40	-25.44	0.50	g1
2	-0.00	0.00	0.00	-8.62	-21.09	0.41	g2
3	-0.00	0.00	0.00	-10.40	-25.44	0.50	g3
4	-0.00	0.00	0.00	-7.63	-18.68	0.37	g4
8	-0.00	0.00	0.00	-4.79	-8.15	0.14	g5o
9	-0.00	0.00	0.00	-17.89	-17.25	-0.16	g5u
Einwirkung 2: Nutzlasten (1)							
5	-0.00	0.00	0.00	-16.15	-25.71	0.38	Nutzlasten (1/1)
Einwirkung 3: Schneelasten							
6	-0.00	0.00	0.00	-9.47	-23.18	0.45	Schneelast (1)
Einwirkung 4: Windlasten							
7	0.00	0.00	0.00	15.40	1.27	-0.17	WH1
10	-0.00	0.00	0.00	-6.97	-22.90	-1.79	WH2

Nachweis 1: EC 5 Tragfähigkeit (Th.I.Ord.)

Ergebnisse der Lastkombinationen

Typ	u_x mm	u_y mm	v_z ‰	n_{xx} kN/m	n_{yy} kN/m	n_{xy} kN/m	Faktorisierung
Extremierung 1: Fall 1 (kmod=0.60)							
min u_x	-0.00	0.00	0.00	-66.60	-122.33	1.71	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)
max u_x	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min u_y	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max u_y	-0.00	0.00	0.00	-66.60	-122.33	1.71	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)
min v_z	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max v_z	-0.00	0.00	0.00	-66.60	-122.33	1.71	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)
min n_{xx}	-0.00	0.00	0.00	-66.60	-122.33	1.71	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)
max n_{xx}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{yy}	-0.00	0.00	0.00	-66.60	-122.33	1.71	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)
max n_{yy}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{xy}	-0.00	0.00	0.00	-55.59	-96.65	1.21	Lf1+Lf2+Lf4+Lf8+1.35*Lf9
max n_{xy}	-0.00	0.00	0.00	-60.34	-116.29	1.76	1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9
Extremierung 2: Fall 2 (kmod=0.80)							
min u_x	-0.00	0.00	0.00	-90.82	-160.90	2.28	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5
max u_x	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min u_y	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max u_y	-0.00	0.00	0.00	-90.82	-160.90	2.28	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5
min v_z	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max v_z	-0.00	0.00	0.00	-90.82	-160.90	2.28	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5
min n_{xx}	-0.00	0.00	0.00	-90.82	-160.90	2.28	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5
max n_{xx}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{yy}	-0.00	0.00	0.00	-90.82	-160.90	2.28	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5
max n_{yy}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{xy}	-0.00	0.00	0.00	-55.59	-96.65	1.21	Lf1+Lf2+Lf4+Lf8+1.35*Lf9
max n_{xy}	-0.00	0.00	0.00	-84.56	-154.86	2.33	1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+1.5*Lf5
Extremierung 3: Fall 3 (kmod=0.90)							
min u_x	-0.00	0.00	0.00	-97.76	-184.09	2.79	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+1.5*Lf6
max u_x	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min u_y	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max u_y	-0.00	0.00	0.00	-97.76	-184.09	2.79	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+1.5*Lf6
min v_z	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max v_z	-0.00	0.00	0.00	-97.76	-184.09	2.79	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+1.5*Lf6
min n_{xx}	-0.00	0.00	0.00	-97.92	-178.28	2.62	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5+0.5*1.5*Lf6
max n_{xx}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{yy}	-0.00	0.00	0.00	-97.76	-184.09	2.79	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+1.5*Lf6
max n_{yy}	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
min n_{xy}	-0.00	0.00	0.00	-55.59	-96.65	1.21	Lf1+Lf2+Lf4+Lf8+1.35*Lf9
max n_{xy}	-0.00	0.00	0.00	-91.50	-178.06	2.84	1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
Extremierung 4: Fall 4 (kmod=1.00)							
min u_x	-0.00	0.00	0.00	-104.03	-204.71	1.18	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+0.6*1.5*Lf10+1.5*Lf6
max u_x	-0.00	0.00	0.00	-26.23	-88.71	1.01	Lf1+Lf2+Lf4+Lf8+Lf9+1.5*Lf7
min u_y	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max u_y	-0.00	0.00	0.00	-90.17	-203.56	1.03	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+0.6*1.5*Lf10+1.5*Lf6.....
	...+0.6*1.5*Lf7						
min v_z	-0.00	0.00	0.00	-49.33	-90.61	1.26	Lf1+Lf2+Lf4+Lf8+Lf9
max v_z	-0.00	0.00	0.00	-78.01	-199.16	-0.49	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+1.5*Lf10+0.5*1.5*Lf6+1.5*Lf7
min n_{xx}	-0.00	0.00	0.00	-104.20	-198.89	1.01	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5+0.6*1.5*Lf10+0.5*1.5*Lf6
max n_{xx}	-0.00	0.00	0.00	-26.23	-88.71	1.01	Lf1+Lf2+Lf4+Lf8+Lf9+1.5*Lf7
min n_{yy}	-0.00	0.00	0.00	-104.03	-204.71	1.18	1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+0.6*1.5*Lf10+1.5*Lf6
max n_{yy}	-0.00	0.00	0.00	-26.23	-88.71	1.01	Lf1+Lf2+Lf4+Lf8+Lf9+1.5*Lf7
min n_{xy}	-0.00	0.00	0.00	-42.94	-129.10	-1.73	Lf1+Lf2+Lf4+Lf8+1.35*Lf9+1.5*Lf10+1.5*Lf7
max n_{xy}	-0.00	0.00	0.00	-91.50	-178.06	2.84	1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6

Nachweis der Lastkombinationen

Extremierung 1/1: min n_{xx}
Schnittgrößen: nxx = -66.60 N/mm, nyy = -122.33 N/mm, nxy = 1.71 N/mm, k_{mod} = 0.60
σ_{xx} = -1.959 N/mm², σ_{yy} = -2.039 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.202, $U_{\sigma y}$ = 0.210 ⇒ **U_σ = 0.210**
τ_{xy} = 0.050 N/mm², τ_{yx} = 0.050 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 ⇒ **U_τ = 0.022**
n_{xy} = 1.707 N/mm², τ_{tor} = 0.017 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.015**
⇒ **U = 0.210**

Extremierung 1/1: max n_{xx}
Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.60
σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.150, $U_{\sigma y}$ = 0.156 ⇒ **U_σ = 0.156**
τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.016, $U_{\tau yx}$ = 0.016 ⇒ **U_τ = 0.016**
n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.011**
⇒ **U = 0.156**

Extremierung 1/1: min n_{yy}
Schnittgrößen: nxx = -66.60 N/mm, nyy = -122.33 N/mm, nxy = 1.71 N/mm, k_{mod} = 0.60
σ_{xx} = -1.959 N/mm², σ_{yy} = -2.039 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.202, $U_{\sigma y}$ = 0.210 ⇒ **U_σ = 0.210**
τ_{xy} = 0.050 N/mm², τ_{yx} = 0.050 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 ⇒ **U_τ = 0.022**
n_{xy} = 1.707 N/mm², τ_{tor} = 0.017 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.015**
⇒ **U = 0.210**

Extremierung 1/1: max n_{yy}
Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.60
σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.150, $U_{\sigma y}$ = 0.156 ⇒ **U_σ = 0.156**
τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.016, $U_{\tau yx}$ = 0.016 ⇒ **U_τ = 0.016**
n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.011**
⇒ **U = 0.156**

Extremierung 1/1: min n_{xy}
Schnittgrößen: nxx = -55.59 N/mm, nyy = -96.65 N/mm, nxy = 1.21 N/mm, k_{mod} = 0.60
σ_{xx} = -1.635 N/mm², σ_{yy} = -1.611 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.169, $U_{\sigma y}$ = 0.166 ⇒ **U_σ = 0.169**
τ_{xy} = 0.036 N/mm², τ_{yx} = 0.036 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.015, $U_{\tau yx}$ = 0.015 ⇒ **U_τ = 0.015**
n_{xy} = 1.209 N/mm², τ_{tor} = 0.012 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.010**
⇒ **U = 0.169**

Extremierung 1/1: max n_{xy}
Schnittgrößen: nxx = -60.34 N/mm, nyy = -116.29 N/mm, nxy = 1.76 N/mm, k_{mod} = 0.60
σ_{xx} = -1.775 N/mm², σ_{yy} = -1.938 N/mm², γ = 1.30, $f_{c0,d}$ = 9.692 N/mm², $f_{t0,d}$ = 6.692 N/mm²
$U_{\sigma x}$ = 0.183, $U_{\sigma y}$ = 0.200 ⇒ **U_σ = 0.200**
τ_{xy} = 0.052 N/mm², τ_{yx} = 0.052 N/mm², $f_{v,d}$ = 2.308 N/mm²
$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 ⇒ **U_τ = 0.022**
n_{xy} = 1.762 N/mm², τ_{tor} = 0.018 N/mm², $f_{tor,d}$ = 1.154 N/mm², **U_{tor} = 0.015**
⇒ **U = 0.200**

Extremierung 1/2: min n_{xx}
Schnittgrößen: nxx = -90.82 N/mm, nyy = -160.90 N/mm, nxy = 2.28 N/mm, k_{mod} = 0.80
σ_{xx} = -2.671 N/mm², σ_{yy} = -2.682 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²
$U_{\sigma x}$ = 0.207, $U_{\sigma y}$ = 0.208 ⇒ **U_σ = 0.208**
τ_{xy} = 0.067 N/mm², τ_{yx} = 0.067 N/mm², $f_{v,d}$ = 3.077 N/mm²
$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 ⇒ **U_τ = 0.022**
n_{xy} = 2.278 N/mm², τ_{tor} = 0.023 N/mm², $f_{tor,d}$ = 1.538 N/mm², **U_{tor} = 0.015**
⇒ **U = 0.208**

Extremierung 1/2: max n_{xx}
Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.80
σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²
$U_{\sigma x}$ = 0.112, $U_{\sigma y}$ = 0.117 ⇒ **U_σ = 0.117**
τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 3.077 N/mm²
$U_{\tau xy}$ = 0.012, $U_{\tau yx}$ = 0.012 ⇒ **U_τ = 0.012**
n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.538 N/mm², **U_{tor} = 0.008**
⇒ **U = 0.117**

Extremierung 1/2: min n_{yy}
Schnittgrößen: nxx = -90.82 N/mm, nyy = -160.90 N/mm, nxy = 2.28 N/mm, k_{mod} = 0.80
σ_{xx} = -2.671 N/mm², σ_{yy} = -2.682 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²
$U_{\sigma x}$ = 0.207, $U_{\sigma y}$ = 0.208 ⇒ **U_σ = 0.208**
τ_{xy} = 0.067 N/mm², τ_{yx} = 0.067 N/mm², $f_{v,d}$ = 3.077 N/mm²
$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 ⇒ **U_τ = 0.022**
n_{xy} = 2.278 N/mm², τ_{tor} = 0.023 N/mm², $f_{tor,d}$ = 1.538 N/mm², **U_{tor} = 0.015**

$\Rightarrow$ **U = 0.208**

Extremierung 1/2: max n_{yy}

Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.80

σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²

$U_{\sigma x}$ = 0.112, $U_{\sigma y}$ = 0.117 $\Rightarrow$ **U_σ = 0.117**

τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 3.077 N/mm²

$U_{\tau xy}$ = 0.012, $U_{\tau yx}$ = 0.012 $\Rightarrow$ **U_τ = 0.012**

n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.538 N/mm², **Utor = 0.008**

$\Rightarrow$ **U = 0.117**

Extremierung 1/2: min n_{xy}

Schnittgrößen: nxx = -55.59 N/mm, nyy = -96.65 N/mm, nxy = 1.21 N/mm, k_{mod} = 0.80

σ_{xx} = -1.635 N/mm², σ_{yy} = -1.611 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²

$U_{\sigma x}$ = 0.127, $U_{\sigma y}$ = 0.125 $\Rightarrow$ **U_σ = 0.127**

τ_{xy} = 0.036 N/mm², τ_{yx} = 0.036 N/mm², $f_{v,d}$ = 3.077 N/mm²

$U_{\tau xy}$ = 0.012, $U_{\tau yx}$ = 0.012 $\Rightarrow$ **U_τ = 0.012**

n_{xy} = 1.209 N/mm², τ_{tor} = 0.012 N/mm², $f_{tor,d}$ = 1.538 N/mm², **Utor = 0.008**

$\Rightarrow$ **U = 0.127**

Extremierung 1/2: max n_{xy}

Schnittgrößen: nxx = -84.56 N/mm, nyy = -154.86 N/mm, nxy = 2.33 N/mm, k_{mod} = 0.80

σ_{xx} = -2.487 N/mm², σ_{yy} = -2.581 N/mm², γ = 1.30, $f_{c0,d}$ = 12.923 N/mm², $f_{t0,d}$ = 8.923 N/mm²

$U_{\sigma x}$ = 0.192, $U_{\sigma y}$ = 0.200 $\Rightarrow$ **U_σ = 0.200**

τ_{xy} = 0.069 N/mm², τ_{yx} = 0.069 N/mm², $f_{v,d}$ = 3.077 N/mm²

$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 $\Rightarrow$ **U_τ = 0.022**

n_{xy} = 2.334 N/mm², τ_{tor} = 0.023 N/mm², $f_{tor,d}$ = 1.538 N/mm², **Utor = 0.015**

$\Rightarrow$ **U = 0.200**

Extremierung 1/3: min n_{xx}

Schnittgrößen: nxx = -97.92 N/mm, nyy = -178.28 N/mm, nxy = 2.62 N/mm, k_{mod} = 0.90

σ_{xx} = -2.880 N/mm², σ_{yy} = -2.971 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.198, $U_{\sigma y}$ = 0.204 $\Rightarrow$ **U_σ = 0.204**

τ_{xy} = 0.077 N/mm², τ_{yx} = 0.077 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.022, $U_{\tau yx}$ = 0.022 $\Rightarrow$ **U_τ = 0.022**

n_{xy} = 2.619 N/mm², τ_{tor} = 0.026 N/mm², $f_{tor,d}$ = 1.731 N/mm², **Utor = 0.015**

$\Rightarrow$ **U = 0.204**

Extremierung 1/3: max n_{xx}

Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.90

σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.100, $U_{\sigma y}$ = 0.104 $\Rightarrow$ **U_σ = 0.104**

τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.011, $U_{\tau yx}$ = 0.011 $\Rightarrow$ **U_τ = 0.011**

n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.731 N/mm², **Utor = 0.007**

$\Rightarrow$ **U = 0.104**

Extremierung 1/3: min n_{yy}

Schnittgrößen: nxx = -97.76 N/mm, nyy = -184.09 N/mm, nxy = 2.79 N/mm, k_{mod} = 0.90

σ_{xx} = -2.875 N/mm², σ_{yy} = -3.068 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.198, $U_{\sigma y}$ = 0.211 $\Rightarrow$ **U_σ = 0.211**

τ_{xy} = 0.082 N/mm², τ_{yx} = 0.082 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.024, $U_{\tau yx}$ = 0.024 $\Rightarrow$ **U_τ = 0.024**

n_{xy} = 2.788 N/mm², τ_{tor} = 0.028 N/mm², $f_{tor,d}$ = 1.731 N/mm², **Utor = 0.016**

$\Rightarrow$ **U = 0.211**

Extremierung 1/3: max n_{yy}

Schnittgrößen: nxx = -49.33 N/mm, nyy = -90.61 N/mm, nxy = 1.26 N/mm, k_{mod} = 0.90

σ_{xx} = -1.451 N/mm², σ_{yy} = -1.510 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.100, $U_{\sigma y}$ = 0.104 $\Rightarrow$ **U_σ = 0.104**

τ_{xy} = 0.037 N/mm², τ_{yx} = 0.037 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.011, $U_{\tau yx}$ = 0.011 $\Rightarrow$ **U_τ = 0.011**

n_{xy} = 1.264 N/mm², τ_{tor} = 0.013 N/mm², $f_{tor,d}$ = 1.731 N/mm², **Utor = 0.007**

$\Rightarrow$ **U = 0.104**

Extremierung 1/3: min n_{xy}

Schnittgrößen: nxx = -55.59 N/mm, nyy = -96.65 N/mm, nxy = 1.21 N/mm, k_{mod} = 0.90

σ_{xx} = -1.635 N/mm², σ_{yy} = -1.611 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.112, $U_{\sigma y}$ = 0.111 $\Rightarrow$ **U_σ = 0.112**

τ_{xy} = 0.036 N/mm², τ_{yx} = 0.036 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.010, $U_{\tau yx}$ = 0.010 $\Rightarrow$ **U_τ = 0.010**

n_{xy} = 1.209 N/mm², τ_{tor} = 0.012 N/mm², $f_{tor,d}$ = 1.731 N/mm², **Utor = 0.007**

$\Rightarrow$ **U = 0.112**

Extremierung 1/3: max n_{xy}

Schnittgrößen: nxx = -91.50 N/mm, nyy = -178.06 N/mm, nxy = 2.84 N/mm, k_{mod} = 0.90

σ_{xx} = -2.691 N/mm², σ_{yy} = -2.968 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²

$U_{\sigma x}$ = 0.185, $U_{\sigma y}$ = 0.204 $\Rightarrow$ **U_σ = 0.204**

τ_{xy} = 0.084 N/mm², τ_{yx} = 0.084 N/mm², $f_{v,d}$ = 3.462 N/mm²

$U_{\tau xy}$ = 0.024, $U_{\tau yx}$ = 0.024 $\Rightarrow$ **U_τ = 0.024**

n_{xy} = 2.844 N/mm², τ_{tor} = 0.028 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.016**
⇒ **U = 0.204**

Extremierung 1/4: min n_{xx}
Schnittgrößen: nxx = -104.20 N/mm, nyy = -198.89 N/mm, nxy = 1.01 N/mm, k_{mod} = 0.90
σ_{xx} = -3.065 N/mm², σ_{yy} = -3.315 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.211, $U_{\sigma y}$ = 0.228 ⇒ **U_σ = 0.228**
τ_{xy} = 0.030 N/mm², τ_{yx} = 0.030 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.009, $U_{\tau yx}$ = 0.009 ⇒ **U_τ = 0.009**
n_{xy} = 1.011 N/mm², τ_{tor} = 0.010 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.006**
⇒ **U = 0.228**

Extremierung 1/4: max n_{xx}
Schnittgrößen: nxx = -26.23 N/mm, nyy = -88.71 N/mm, nxy = 1.01 N/mm, k_{mod} = 0.90
σ_{xx} = -0.771 N/mm², σ_{yy} = -1.478 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.053, $U_{\sigma y}$ = 0.102 ⇒ **U_σ = 0.102**
τ_{xy} = 0.030 N/mm², τ_{yx} = 0.030 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.009, $U_{\tau yx}$ = 0.009 ⇒ **U_τ = 0.009**
n_{xy} = 1.009 N/mm², τ_{tor} = 0.010 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.006**
⇒ **U = 0.102**

Extremierung 1/4: min n_{yy}
Schnittgrößen: nxx = -104.03 N/mm, nyy = -204.71 N/mm, nxy = 1.18 N/mm, k_{mod} = 0.90
σ_{xx} = -3.060 N/mm², σ_{yy} = -3.412 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.210, $U_{\sigma y}$ = 0.235 ⇒ **U_σ = 0.235**
τ_{xy} = 0.035 N/mm², τ_{yx} = 0.035 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.010, $U_{\tau yx}$ = 0.010 ⇒ **U_τ = 0.010**
n_{xy} = 1.180 N/mm², τ_{tor} = 0.012 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.007**
⇒ **U = 0.235**

Extremierung 1/4: max n_{yy}
Schnittgrößen: nxx = -26.23 N/mm, nyy = -88.71 N/mm, nxy = 1.01 N/mm, k_{mod} = 0.90
σ_{xx} = -0.771 N/mm², σ_{yy} = -1.478 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.053, $U_{\sigma y}$ = 0.102 ⇒ **U_σ = 0.102**
τ_{xy} = 0.030 N/mm², τ_{yx} = 0.030 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.009, $U_{\tau yx}$ = 0.009 ⇒ **U_τ = 0.009**
n_{xy} = 1.009 N/mm², τ_{tor} = 0.010 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.006**
⇒ **U = 0.102**

Extremierung 1/4: min n_{xy}
Schnittgrößen: nxx = -42.94 N/mm, nyy = -129.10 N/mm, nxy = -1.73 N/mm, k_{mod} = 0.90
σ_{xx} = -1.263 N/mm², σ_{yy} = -2.152 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.087, $U_{\sigma y}$ = 0.148 ⇒ **U_σ = 0.148**
τ_{xy} = 0.051 N/mm², τ_{yx} = 0.051 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.015, $U_{\tau yx}$ = 0.015 ⇒ **U_τ = 0.015**
n_{xy} = -1.727 N/mm², τ_{tor} = 0.017 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.010**
⇒ **U = 0.148**

Extremierung 1/4: max n_{xy}
Schnittgrößen: nxx = -91.50 N/mm, nyy = -178.06 N/mm, nxy = 2.84 N/mm, k_{mod} = 0.90
σ_{xx} = -2.691 N/mm², σ_{yy} = -2.968 N/mm², γ = 1.30, $f_{c0,d}$ = 14.538 N/mm², $f_{t0,d}$ = 10.038 N/mm²
$U_{\sigma x}$ = 0.185, $U_{\sigma y}$ = 0.204 ⇒ **U_σ = 0.204**
τ_{xy} = 0.084 N/mm², τ_{yx} = 0.084 N/mm², $f_{v,d}$ = 3.462 N/mm²
$U_{\tau xy}$ = 0.024, $U_{\tau yx}$ = 0.024 ⇒ **U_τ = 0.024**
n_{xy} = 2.844 N/mm², τ_{tor} = 0.028 N/mm², $f_{tor,d}$ = 1.731 N/mm², **U_{tor} = 0.016**
⇒ **U = 0.204**

Zusammenfassung:

$\sigma_{xx,min}$ = -3.06 N/mm²	Ex1/4:1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+1.5*Lf5+0.6*1.5*Lf10. ...+0.5*1.5*Lf6
$\sigma_{yy,min}$ = -3.41 N/mm²	Ex1/4:1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5..... ...+0.6*1.5*Lf10+1.5*Lf6
$\sigma_{xx,max}$ = -0.77 N/mm²	Ex1/4:Lf1+Lf2+Lf4+Lf8+Lf9+1.5*Lf7
$\sigma_{yy,max}$ = -1.48 N/mm²	Ex1/4:Lf1+Lf2+Lf4+Lf8+Lf9+1.5*Lf7
τ_{xy} = 0.08 N/mm²	Ex1/3:1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
τ_{yx} = 0.08 N/mm²	Ex1/3:1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
τ_{tor} = 0.03 N/mm²	Ex1/3:1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
$U_{\sigma,xx}$ = 0.23 N/mm²	Ex1/4:1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5..... ...+0.6*1.5*Lf10+1.5*Lf6
$U_{\sigma,yy}$ = 0.02 N/mm²	Ex1/3:1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
U_τ = 0.02 N/mm²	Ex1/3:1.35*(Lf1+Lf2+Lf4+Lf8)+Lf9+0.7*1.5*Lf5+1.5*Lf6
$U_{\tau,tor}$ = 0.23 N/mm²	Ex1/4:1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5..... ...+0.6*1.5*Lf10+1.5*Lf6

Max. Ausnutzung: U = 0.235 ≤ 1 ⇒ **Nachweis erfüllt**

Zusammenfassung aller Nachweise

Lastkombination Ausnutzung: Nw1:Ex1/4[min n_{yy}]:1.35*(Lf1+Lf2+Lf4+Lf8+Lf9)+0.7*1.5*Lf5+0.6*1.5*Lf10 +1.5*Lf6
Max. Ausnutzung: U = 0.235 ≤ 1 ⇒ **Nachweis erfüllt**

6. Zusammenfassung

Gesamtausnutzung aller Nachweise $u_{max,Ges}$ = 2.828 > 1 ⇒ nicht ok. !!