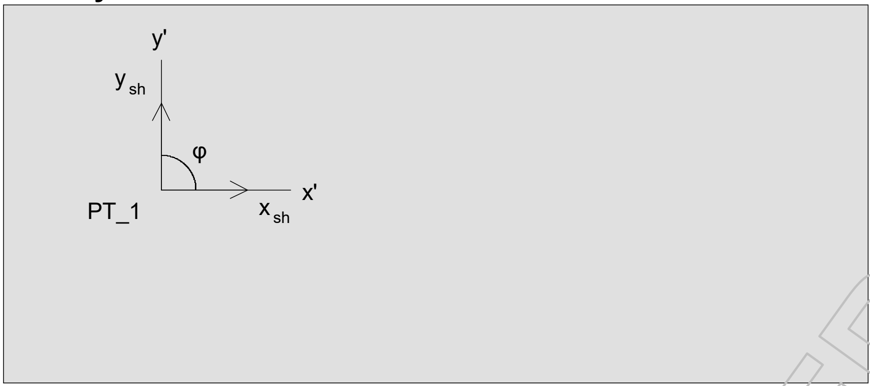
P.1.1 - PT_1 (N541)
Maximum of load combinations

Geometry



Global coordinates:
$x = 5.84$ m
$y = 7.16$ m
$z = 0.00$ m

Reinforcement directions:
$\varphi = 90.00$ °

Thickness:
$t = 0.20$ m

1.00 m

x_{sh}, y_{sh} : local coordinate system of shell
x', y': reinforcement directions

Concrete (EN 1992-1-1: 3.1.7)

C35/45

$f_{ck} = 35.00\ N/mm^2$ $\quad \varepsilon_{c2} = 0.00200$ $\quad \varepsilon_{cu3} = 0.0035$ $\quad \varphi_{ef} = 2.00$

$f_{ctm} = 3.20\ N/mm^2$ $\quad E_{cm} = 34000\ N/mm^2$

$\gamma_{C,U} = 1.50$ $\quad \gamma_{C,Ua} = 1.20$ $\quad \alpha_{cc} = 0.85$

$\lambda = 0.8 - \max(f_{ck} - 50, 0) / 400 =$
$= 0.8 - \max(35.00 - 50, 0) / 400 = 0.80$ (3.19, 3.20)

$\eta = 1.0 - \max(f_{ck} - 50, 0) / 200 =$
$= 1.0 - \max(35.00 - 50, 0) / 200 = 1.00$ (3.21, 3.22)

$f_{cd,U} = \eta \cdot \alpha_{cc} \cdot f_{ck} / \gamma_{C,U} = 1.00 \cdot 0.85 \cdot 35.00 / 1.50 = 19.83\ N/mm^2$ (3.15) + Fig. 3.5

$f_{cd,Ua} = \eta \cdot \alpha_{cc} \cdot f_{ck} / \gamma_{C,Ua} = 1.00 \cdot 0.85 \cdot 35.00 / 1.20 =$
$= 24.79\ N/mm^2$ (3.15) + Fig. 3.5

$\varepsilon_{yd} = (1 - \lambda) \cdot \varepsilon_{cu3} = (1 - 0.80) \cdot 0.0035 = 0.0007$ Fig. 3.5

Applied reinforcement

Face, direction	Quality	Diameter [mm]	Cover [mm]	Spacing [mm]	Area [mm^2/m]
Bottom, x'	B500C	12	35	200	565
Bottom, y'	B500C	10	47	400	196
Top, x'	B500C	12	35	200	565
Top, y'	B500C	6	47	400	71
Top, y'	B500C	10	47	400	196

Equivalent reinforcement

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
Quality	B500C	B500C	B500C	B500C
Diameter [mm]	12	10	12	8
Cover [mm]	35	47	35	47
c = Cover + Φ/2 [mm]	41	52	41	51
E_s [N/mm ^{2}]	200000	200000	200000	200000
Applied, UL [mm ^{2}/m]	565	196	565	267
$f_{sy,UL}$ [N/mm ^{2}]	435	435	435	435
Applied, SL [mm ^{2}/m]	565	196	565	267
$f_{sy,SL}$ [N/mm ^{2}]	500	500	500	500

Equivalent reinforcement calculation is based on calculation parameter data.

Other calculation parameter data

Allowed crackwidth, top: 1.00 mm
Allowed crackwidth, bottom: 1.00 mm
Minimum reinforcement: Yes
Compressed reinf.: No

Required reinforcement, bottom x'

LC: 'LC1ULS'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = -22.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -4.48	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = 0.00
$m_{y',bot}$ = 0.00	$n_{y',+}$ = 0.00
$m_{x',top}$ = -22.40	$n_{x',-}$ = 0.00
$m_{y',top}$ = -4.48	$n_{y',-}$ = 0.00

Calculation is based on Wood-Armer and Nemeth methods.

Maximum reinforcement

$A_{s,max} = 0.04 \cdot b \cdot t = 0.04 \cdot 1000 \cdot 200 = 8000 \ mm^2/m$ (EN 1992-1-1 9.2.1.1(3))

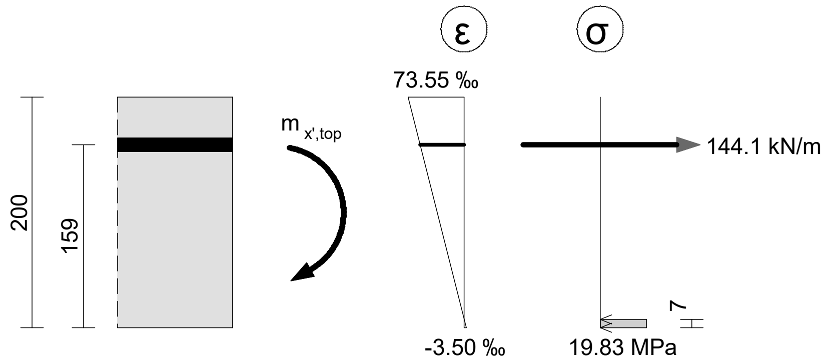
Calculation of required reinforcement from different m-n combinations

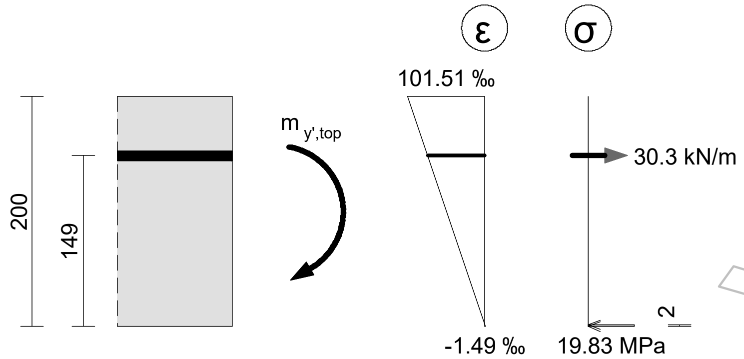
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-22.40	-22.40	0.00	0.00	-4.48
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully compr.	Fully compr.	Tension reinf.
$A_{sb,x'}$ [mm^2/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm^2/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm^2/m]	0	0	332	332	-	-	-
$A_{st,y'}$ [mm^2/m]	-	-	-	-	0	0	70

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-4.48
$n_{[dir][face]}$ [kN/m]	0.00
Case	Tension reinf.
$A_{sb,x'}$ [mm^2/m]	-
$A_{sb,y'}$ [mm^2/m]	0
$A_{st,x'}$ [mm^2/m]	-
$A_{st,y'}$ [mm^2/m]	70

Necessary reinforcement is calculated by considering equivalent reinforcement data.

If no reinforcement is required, the ultimate resistance of the concrete section is represented in the stress figures.





Minimum reinforcement

$A_{s,min} = \max(0.26 \cdot f_{ctm} / f_{yk} \cdot b_t \cdot d,\ 0.0013 \cdot b_t \cdot d)$ (EN 1992-1-1 9.2.1.1(1))

$s_{max,slabs,primary} = \min(3 \cdot t,\ 400)$ (EN 1992-1-1 9.3.1.1(3))

$s_{max,slabs,secondary} = \min(3.5 \cdot t,\ 450)$ (EN 1992-1-1 9.3.1.1(3))

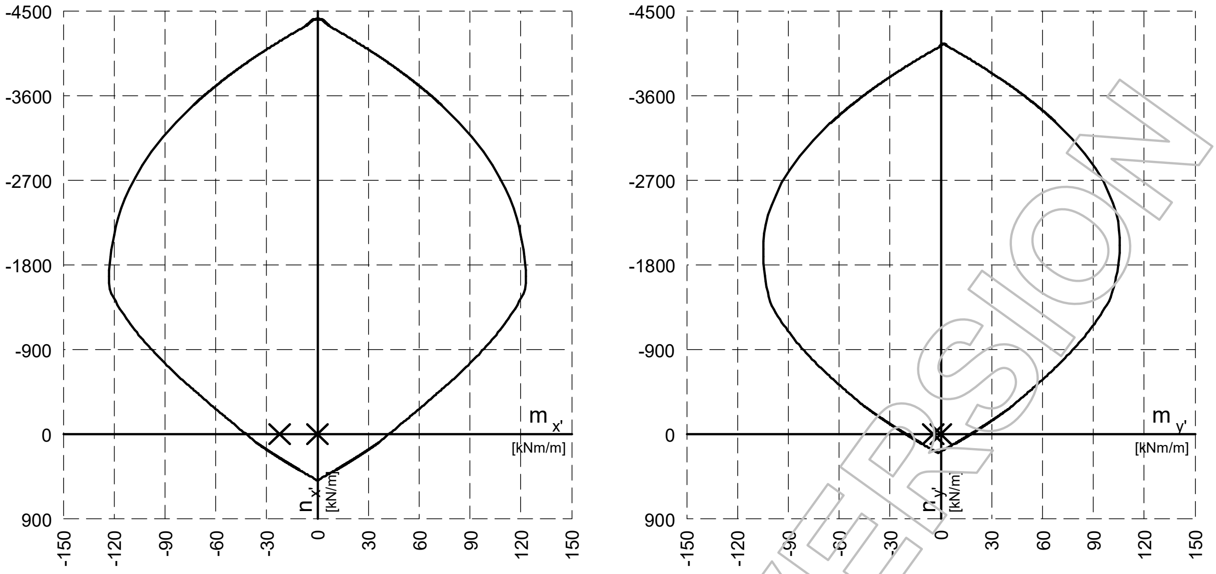
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

$A_{s,min,final,primary} = \max(A_{s,min},\ A_{s,min,smax})$

$A_{s,min,final,secondary} = \max(A_{s,min},\ A_{s,min,smax},\ 0.2 \cdot A_{s,primary,applied})$

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	149
$A_{s,min}$ [mm²/m]	0	0	265	248
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	10	10
$A_{s,min,smax}$ [mm²/m]	-	-	196	175
$A_{s,min,final}$ [mm²/m]	0	0	265	248

Interaction curves based on applied reinforcement



Utilization

$A_{s,req} = \max(A_{s,calc}, A_{s,min,final})$

$A_{s,missing} = A_{s,req} - A_{s,applied}$

$\text{Utilization} = A_{s,req} / A_{s,applied} \cdot 100$

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,req}$ [mm ^{2}/m]	-	-	332	248
$A_{s,applied}$ [mm ^{2}/m]	565	196	565	267
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	59	93

The amount of required reinforcement is based on an optimum calculation because several solutions are possible.

Required reinforcement, bottom y'
LC: 'LC1ULS'

Internal forces

Moments [kN m /m]	Normal forces [kN /m]
$m_{x,sh}$ = -22.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -4.48	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = 0.00
$m_{y',bot}$ = 0.00	$n_{y',+}$ = 0.00
$m_{x',top}$ = -22.40	$n_{x',-}$ = 0.00
$m_{y',top}$ = -4.48	$n_{y',-}$ = 0.00

Calculation is based on Wood-Armer and Nemeth methods.

Maximum reinforcement

$A_{s,max}$ = 0.04 · b · t = 0.04 · 1000 · 200 = 8000 mm ^{2}/m (EN 1992-1-1 9.2.1.1(3))

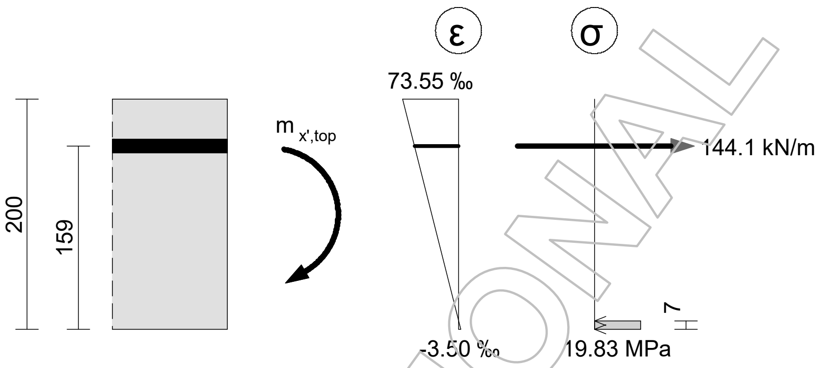
Calculation of required reinforcement from different m-n combinations

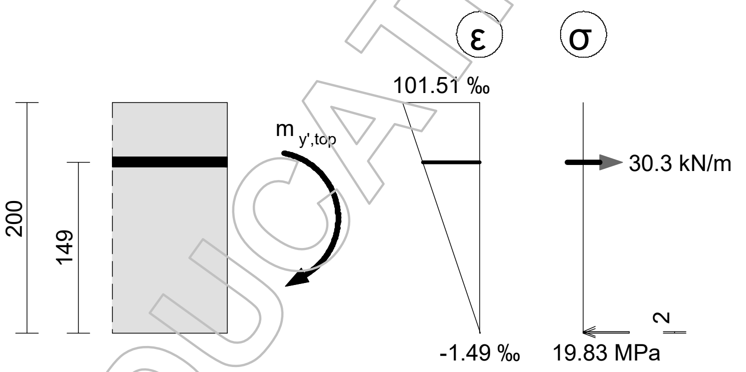
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-22.40	-22.40	0.00	0.00	-4.48
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully compr.	Fully compr.	Tension reinf.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	332	332	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	70

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-4.48
$n_{[dir][face]}$ [kN/m]	0.00
Case	Tension reinf.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	70

Necessary reinforcement is calculated by considering equivalent reinforcement data.

If no reinforcement is required, the ultimate resistance of the concrete section is represented in the stress figures.





Minimum reinforcement

$A_{s,min}$ = max (0.26 · f_{ctm} / f_{yk} · b_t · d, 0.0013 · b_t · d) (EN 1992-1-1 9.2.1.1(1))

$s_{max,slabs,primary}$ = min (3 · t, 400) (EN 1992-1-1 9.3.1.1(3))

$s_{max,slabs,secondary}$ = min (3.5 · t, 450) (EN 1992-1-1 9.3.1.1(3))

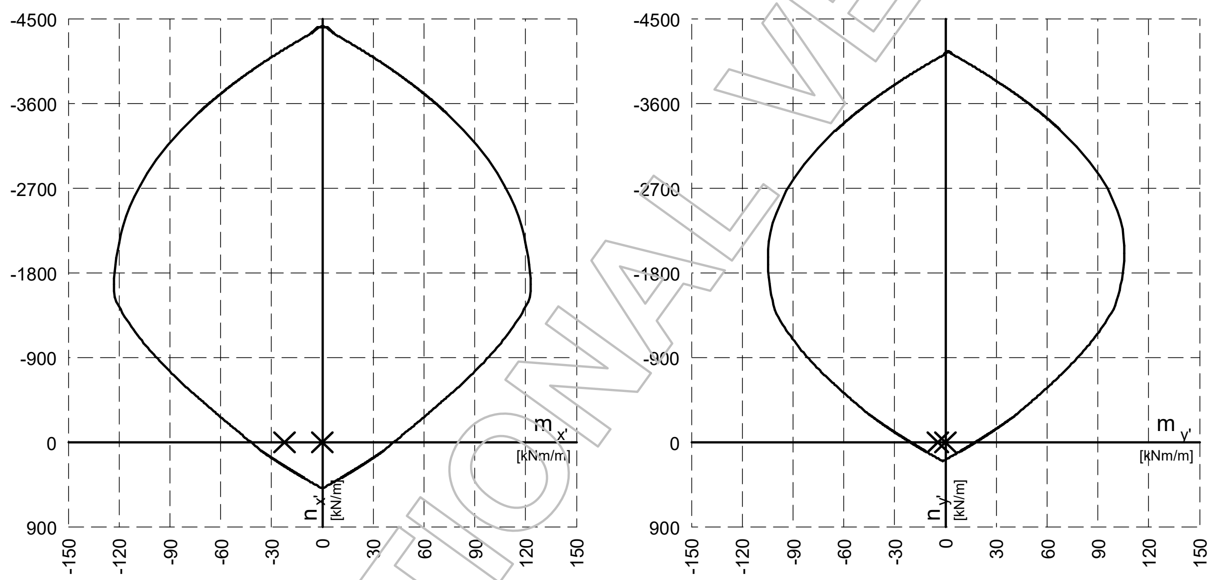
$A_{s,min,smax}$ = 1000 / s_{max} · Φ^2 · π / 4

$A_{s,min,final,primary}$ = max ($A_{s,min}$, $A_{s,min,smax}$)

$A_{s,min,final,secondary}$ = max ($A_{s,min}$, $A_{s,min,smax}$, 0.2 · $A_{s,primary,applied}$)

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	149
$A_{s,min}$ [mm ^{2}/m]	0	0	265	248
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	10	10
$A_{s,min,smax}$ [mm ^{2}/m]	-	-	196	175
$A_{s,min,final}$ [mm ^{2}/m]	0	0	265	248

Interaction curves based on applied reinforcement



Utilization

$A_{s,req} = \max(A_{s,calc}, A_{s,min,final})$

$A_{s,missing} = A_{s,req} - A_{s,applied}$

Utilization $= A_{s,req} / A_{s,applied} \cdot 100$

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,req}$ [mm ^{2}/m]	-	-	332	248
$A_{s,applied}$ [mm ^{2}/m]	565	196	565	267
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	59	93

The amount of required reinforcement is based on an optimum calculation because several solutions are possible.

Required reinforcement, top x'

LC: 'LC1ULS'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = -22.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -4.48	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = 0.00
$m_{y',bot}$ = 0.00	$n_{y',+}$ = 0.00
$m_{x',top}$ = -22.40	$n_{x',-}$ = 0.00
$m_{y',top}$ = -4.48	$n_{y',-}$ = 0.00

Calculation is based on Wood-Armer and Nemeth methods.

Maximum reinforcement

$A_{s,max}$ = 0.04 · b · t = 0.04 · 1000 · 200 = 8000 mm^2/m (EN 1992-1-1 9.2.1.1(3))

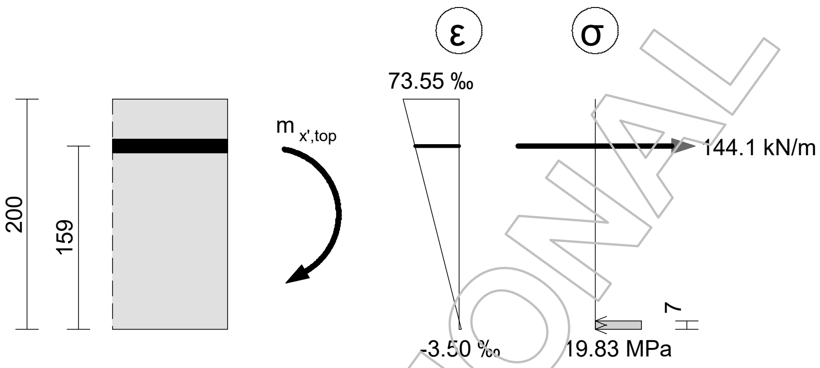
Calculation of required reinforcement from different m-n combinations

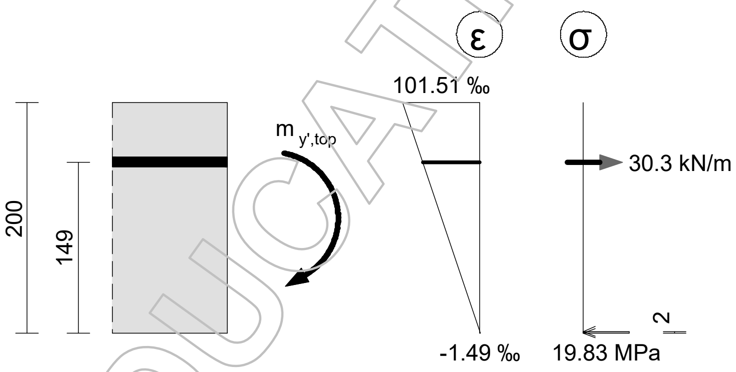
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-22.40	-22.40	0.00	0.00	-4.48
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully compr.	Fully compr.	Tension reinf.
$A_{sb,x'}$ [mm^2/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm^2/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm^2/m]	0	0	332	332	-	-	-
$A_{st,y'}$ [mm^2/m]	-	-	-	-	0	0	70

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-4.48
$n_{[dir][face]}$ [kN/m]	0.00
Case	Tension reinf.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	70

Necessary reinforcement is calculated by considering equivalent reinforcement data.

If no reinforcement is required, the ultimate resistance of the concrete section is represented in the stress figures.





Minimum reinforcement

$A_{s,min}$ = max (0.26 $\cdot f_{ctm} / f_{yk} \cdot b_t \cdot d$, 0.0013 $\cdot b_t \cdot d$) (EN 1992-1-1 9.2.1.1(1))

$s_{max,slabs,primary}$ = min (3 $\cdot$ t, 400) (EN 1992-1-1 9.3.1.1(3))

$s_{max,slabs,secondary}$ = min (3.5 $\cdot$ t, 450) (EN 1992-1-1 9.3.1.1(3))

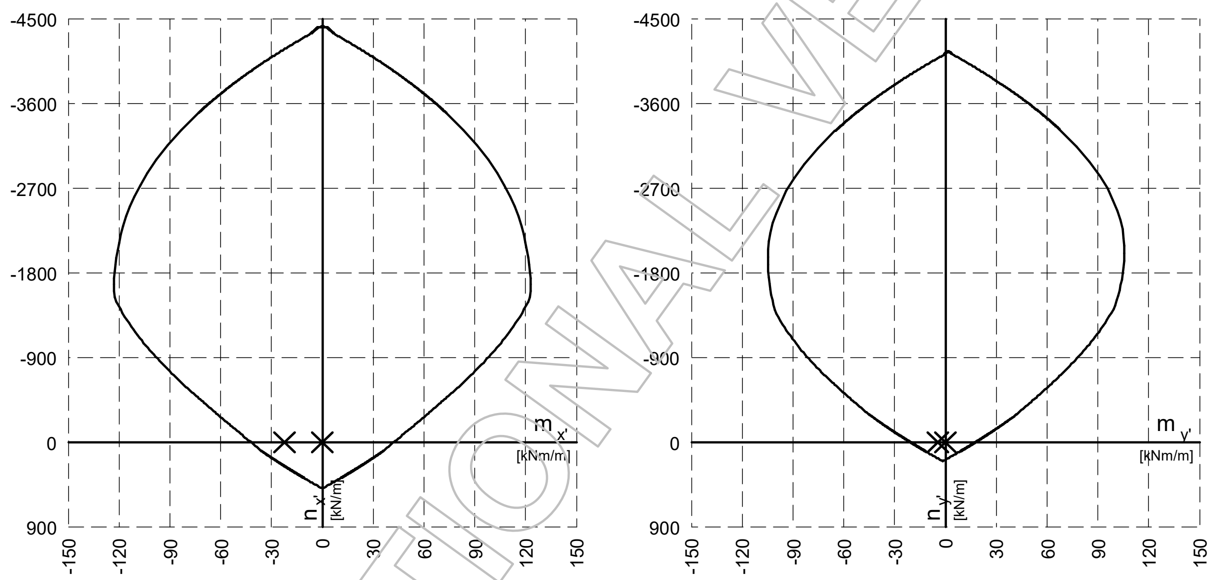
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

$A_{s,min,final,primary}$ = max ($A_{s,min}$, $A_{s,min,smax}$)

$A_{s,min,final,secondary}$ = max ($A_{s,min}$, $A_{s,min,smax}$, 0.2 $\cdot A_{s,primary,applied}$)

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	149
$A_{s,min}$ [mm ^{2}/m]	0	0	265	248
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	10	10
$A_{s,min,smax}$ [mm ^{2}/m]	-	-	196	175
$A_{s,min,final}$ [mm ^{2}/m]	0	0	265	248

Interaction curves based on applied reinforcement



Utilization

$A_{s,req}$ = max ($A_{s,calc}$, $A_{s,min,final}$)

$A_{s,missing}$ = $A_{s,req}$ - $A_{s,applied}$

Utilization = $A_{s,req}$ / $A_{s,applied}$ · 100

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,req}$ [mm ^{2}/m]	-	-	332	248
$A_{s,applied}$ [mm ^{2}/m]	565	196	565	267
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	59	93

The amount of required reinforcement is based on an optimum calculation because several solutions are possible.

Required reinforcement, top y'

LC: 'LC1ULS'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = -22.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -4.48	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = 0.00
$m_{y',bot}$ = 0.00	$n_{y',+}$ = 0.00
$m_{x',top}$ = -22.40	$n_{x',-}$ = 0.00
$m_{y',top}$ = -4.48	$n_{y',-}$ = 0.00

Calculation is based on Wood-Armer and Nemeth methods.

Maximum reinforcement

$A_{s,max} = 0.04 \cdot b \cdot t = 0.04 \cdot 1000 \cdot 200 = 8000 \text{ mm}^2/\text{m}$ (EN 1992-1-1 9.2.1.1(3))

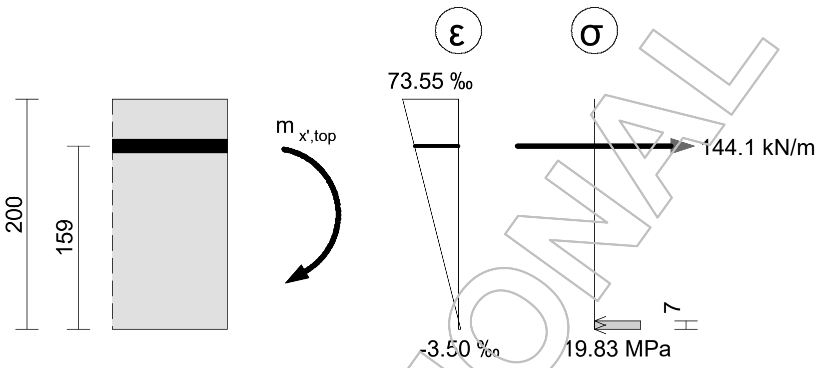
Calculation of required reinforcement from different m-n combinations

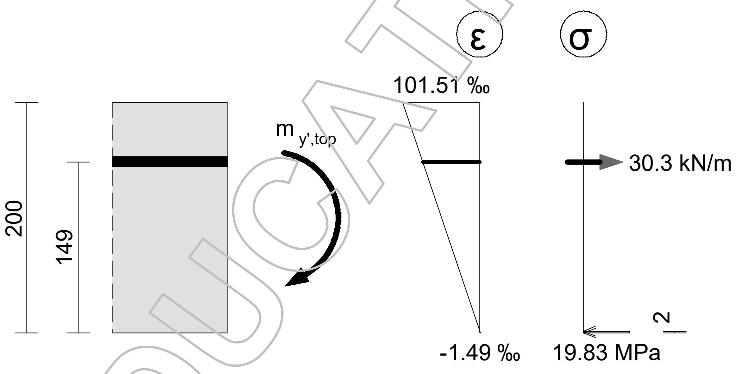
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-22.40	-22.40	0.00	0.00	-4.48
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully compr.	Fully compr.	Tension reinf.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	332	332	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	70

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-4.48
$n_{[dir][face]}$ [kN/m]	0.00
Case	Tension reinf.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	70

Necessary reinforcement is calculated by considering equivalent reinforcement data.

If no reinforcement is required, the ultimate resistance of the concrete section is represented in the stress figures.





Minimum reinforcement

$A_{s,min} = \max(0.26 \cdot f_{ctm} / f_{yk} \cdot b_t \cdot d,\ 0.0013 \cdot b_t \cdot d)$ (EN 1992-1-1 9.2.1.1(1))

$s_{max,slabs,primary} = \min(3 \cdot t,\ 400)$ (EN 1992-1-1 9.3.1.1(3))

$s_{max,slabs,secondary} = \min(3.5 \cdot t,\ 450)$ (EN 1992-1-1 9.3.1.1(3))

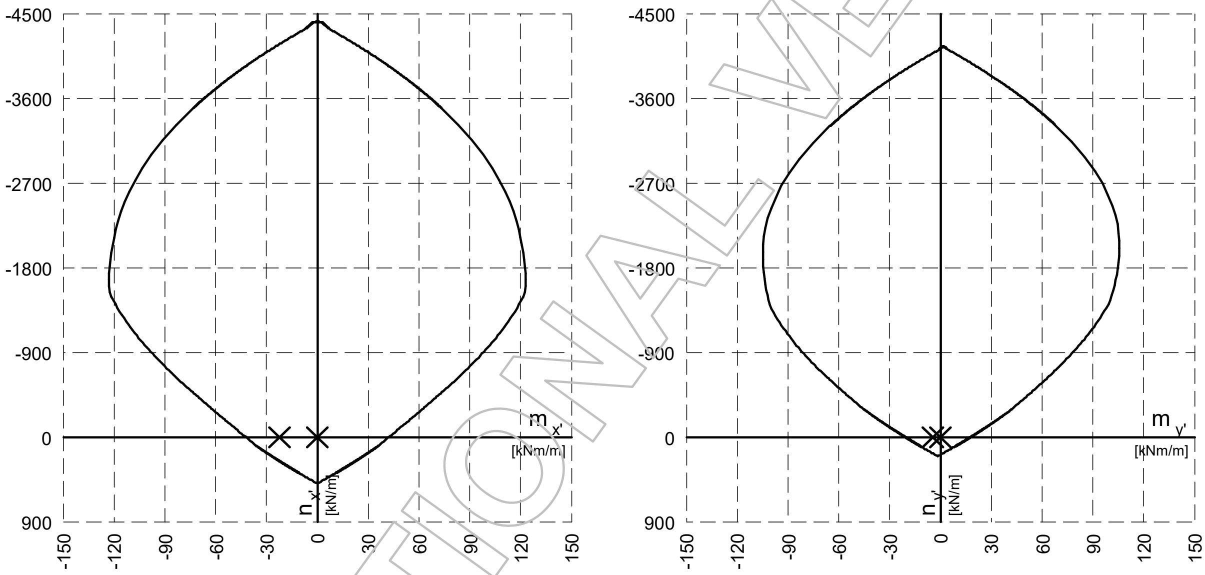
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

$A_{s,min,final,primary} = \max(A_{s,min},\ A_{s,min,smax})$

$A_{s,min,final,secondary} = \max(A_{s,min},\ A_{s,min,smax},\ 0.2 \cdot A_{s,primary,applied})$

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	149
$A_{s,min}$ [mm ^{2}/m]	0	0	265	248
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	10	10
$A_{s,min,smax}$ [mm ^{2}/m]	-	-	196	175
$A_{s,min,final}$ [mm ^{2}/m]	0	0	265	248

Interaction curves based on applied reinforcement



Utilization

$A_{s,req}$ = max ($A_{s,calc}$, $A_{s,min,final}$)

$A_{s,missing}$ = $A_{s,req}$ - $A_{s,applied}$

Utilization = $A_{s,req}$ / $A_{s,applied}$ · 100

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,req}$ [mm ^{2}/m]	-	-	332	248
$A_{s,applied}$ [mm ^{2}/m]	565	196	565	267
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	59	93

The amount of required reinforcement is based on an optimum calculation because several solutions are possible.

Shear capacity

LC: 'LC1ULS'

Internal forces

Normal forces [kN /m]	Shear forces [kN /m]
$n_{x,sh} = 0.00$	$v_{xz,sh} = 24.54$
$n_{y,sh} = 0.00$	$v_{yz,sh} = -0.00$
$n_{xy,sh} = 0.00$	

Design forces

$$v_{max} = \sqrt{v_{xz,sh}^{2} + v_{yz,sh}^{2}} = \sqrt{24.54^{2} + -0.00^{2}} = 24.54 \quad kN/m$$

$$\alpha = \operatorname{atan}\left(\frac{v_{yz,sh}}{v_{xz,sh}}\right) = \operatorname{atan}\left(\frac{-0.00}{24.54}\right) = -0.01 \quad ^\circ$$

$$n_{\alpha} = 0.00 \quad kN/m$$

Calculation of shear capacity in the main direction (EN 1992-1-1: 6.2.2)

$$A_{s,\alpha} = 565 \quad mm^{2}/m$$

$$d_{eff} = \frac{d_x + d_y}{2} = \frac{159 + 149}{2} = 154 \quad mm$$

$$\rho_{\alpha} = \min\left(\frac{A_{s,\alpha}}{d_{eff}}, 0.02\right) = \min\left(\frac{565}{154}, 0.02\right) = 0.00368$$

$$\sigma_{\alpha} = \frac{n_{\alpha}}{t} = \frac{0.00}{0.20} = 0.0000 \quad N/mm^{2}$$

$$\sigma_{cp,\alpha} = \min\left(-(\sigma_{\alpha}), 0.2 \cdot f_{cd,U}\right) = \min\left(-(0.0000), 0.2 \cdot 19.83\right) = 0.0000 \quad N/mm^{2} \quad *$$

$$C_{Rd,c} = \frac{0.15}{\gamma_{C,U}} = \frac{0.15}{1.5} = 0.10$$

$$k = \min\left(1 + \sqrt{\frac{200}{d_{eff}}}, 2.0\right) = \min\left(1 + \sqrt{\frac{200}{154}}, 2.0\right) = 2.00$$

$$k_1 = 0.30$$

$$v_{min} = 0.035 \cdot k^{3/2} \cdot f_{ck}^{1/2} = 0.035 \cdot 2.00^{3/2} \cdot 35.00^{1/2} = 0.5857 \qquad (6.3.N)$$

$$v_{Rd,c} = \max\left(C_{Rd,c} \cdot k \cdot (100.0 \cdot \rho_{\alpha} \cdot f_{ck})^{1/3} + k_1 \cdot \sigma_{cp,\alpha}, v_{min} + k_1 \cdot \sigma_{cp,\alpha}\right) \cdot d_{eff} =$$

$$= \max\left(0.10 \cdot 2.00 \cdot (100.0 \cdot 0.00368 \cdot 35.00)^{1/3} + 0.30 \cdot 0.0000, 0.5857 + 0.30 \cdot 0.0000\right) \cdot$$

$$= 90.05 \quad kN/m \qquad (6.2.a, 6.2.b)$$

$$v_{Rd,c} > v_{max} \rightarrow \text{Utilization} = \frac{v_{max}}{v_{Rd,c}} \cdot 100 = \frac{24.54}{90.05} \cdot 100 = 27 \ \%$$

* EN 1992-1-1: 6.2.2 considers tension forces with negative sign.

Shell buckling

Not calculated, there is no relevant buckling region at the point.

Crack width, bottom

LC: 'LC1SqLS'

Internal forces

Moments [kN m /m]	Normal forces [kN /m]
$m_{x,sh}$ = -12.82	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -2.56	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Direction of crack width

No crack on bottom face.

α_{top} = 180.00 °

Calculated by Gvozdiev method.

Stresses

Face, direction	Bottom, α	Bottom, α +90°	Top, α	Top, α +90°
n [kN /m]	-	-	0.00	-
m [kN m /m]	-	-	-12.82	-
$A_{s,eq[face]}$ [mm ^{2}/m]	-	-	565	-
$c_{\alpha[face]}$ [mm]	-	-	41	-
$A_{s,eq[other face]}$ [mm ^{2}/m]	-	-	565	-
$c_{\alpha[other face]}$ [mm]	-	-	41	-
$\sigma_{I,c[face]}$ [N /mm ^{2}]	-	-	1.86	-
$\sigma_{I,c[other face]}$ [N /mm ^{2}]	-	-	-1.86	-
$\sigma_{II,s[face]}$ [N /mm ^{2}]	-	-	-	-
$\sigma_{II,s[other face]}$ [N /mm ^{2}]	-	-	-	-
x_{II} [mm]	-	-	-	-
Evaluation*	Not cracked	Not cracked	Not cracked	No reinf.

*No reinf: $A_{s,eq} \le 0$

Not cracked: ($\sigma_{I,c[bottom]} \le f_{ctm}$ and $\sigma_{I,c[top]} \le f_{ctm}$) or $x_{II} \le 0$ or $x_{II} > t$

Cracked: otherwise

Crack width

$$A_{c,eff} = \max\left(\min\left(t/2,\ 2.5 \cdot c_\alpha,\ (t - x_{II})/3\right),\ c_\alpha + 1.5 \cdot \Phi_\alpha\right)$$

$$\rho_{p,eff} = A_s / A_{c,eff}$$

$$\varepsilon = \max\left(\frac{\sigma_{II,s} - \frac{0.4 \cdot f_{ctm}}{\rho_{p,eff}} \cdot \left(1 + \frac{E_s}{E_{c,m}} \cdot \rho_{p,eff}\right)}{E_s},\ \frac{0.6 \cdot \sigma_{II,s}}{E_s}\right)$$

$$k_2 = \frac{\varepsilon_{bottom} + \varepsilon_{top}}{2 \cdot \max(\varepsilon_{bottom}, \varepsilon_{top})}$$

$$s_\alpha \le 5 \cdot c_\alpha \rightarrow s_{r,max} = k_3 \cdot (c_\alpha - \Phi_\alpha / 2) + k_1 \cdot k_2 \cdot k_4 \cdot \Phi_\alpha \cdot \frac{A_{c,eff}}{A_s}$$

$$s_\alpha > 5 \cdot c_\alpha \rightarrow s_{r,max} = 1.3 \cdot (t - x_{II})$$

$$c_w = s_{r,max} \cdot \varepsilon_{[face]}$$

Face, direction	Bottom, α	Bottom, $\alpha+90°$	Top, α	Top, $\alpha+90°$
$A_{c,eff[face]}$ [mm ^{2}/m]	-	-	-	-
$\rho_{p,eff[face]}$	-	-	-	-
$\varepsilon_{[face]}$	-	-	-	-
$A_{c,eff[other\ face]}$ [mm ^{2}/m]	-	-	-	-
$\varepsilon_{[other\ face]}$	-	-	-	-
Φ_{dir} [mm]	-	-	-	-
s_{dir} [mm]	-	-	-	-
k_1	-	-	-	-
k_2	-	-	-	-
k_3	-	-	-	-
k_4	-	-	-	-
$s_{r,max}$ [mm]	-	-	-	-
c_w [mm]	-	-	-	-

Utilization

$$\text{Utilization} = c_w / c_{w,lim} \cdot 100$$

Face, direction	Bottom, α	Bottom, $\alpha+90°$	Top, α	Top, $\alpha+90°$
$c_{w,lim}$ [mm]	1.00	1.00	1.00	1.00
Utilization [%]	-	-	-	-

Crack width, top

LC: 'LC1SqLS'

Internal forces

Moments [kN m /m]	Normal forces [kN /m]
$m_{x,sh}$ = -12.82	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -2.56	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Direction of crack width

No crack on bottom face.

α_{top} = 180.00 °

Calculated by Gvozdiev method.

Stresses

Face, direction	Bottom, α	Bottom, α +90°	Top, α	Top, α +90°
n [kN /m]	-	-	0.00	-
m [kN m /m]	-	-	-12.82	-
$A_{s,eq[face]}$ [mm^2/m]	-	-	565	-
$c_{\alpha[face]}$ [mm]	-	-	41	-
$A_{s,eq[other face]}$ [mm^2/m]	-	-	565	-
$c_{\alpha[other face]}$ [mm]	-	-	41	-
$\sigma_{I,c[face]}$ [N/mm^2]	-	-	1.86	-
$\sigma_{I,c[other face]}$ [N/mm^2]	-	-	-1.86	-
$\sigma_{II,s[face]}$ [N/mm^2]	-	-	-	-
$\sigma_{II,s[other face]}$ [N/mm^2]	-	-	-	-
x_{II} [mm]	-	-	-	-
Evaluation*	Not cracked	Not cracked	Not cracked	No reinf.

*No reinf: $A_{s,eq} \le 0$

Not cracked: $(\sigma_{I,c[bottom]} \le f_{ctm}$ and $\sigma_{I,c[top]} \le f_{ctm})$ or $x_{II} \le 0$ or $x_{II} > t$

Cracked: otherwise

Crack width

$$A_{c,eff} = \max\left(\min\left(t/2,\ 2.5 \cdot c_\alpha,\ (t - x_{II})/3\right),\ c_\alpha + 1.5 \cdot \Phi_\alpha\right)$$

$$\rho_{p,eff} = A_s / A_{c,eff}$$

$$\varepsilon = \max\left(\frac{\sigma_{II,s} - \frac{0.4 \cdot f_{ctm}}{\rho_{p,eff}} \cdot \left(1 + \frac{E_s}{E_{c,m}} \cdot \rho_{p,eff}\right)}{E_s},\ \frac{0.6 \cdot \sigma_{II,s}}{E_s}\right)$$

$$k_2 = \frac{\varepsilon_{bottom} + \varepsilon_{top}}{2 \cdot \max\left(\varepsilon_{bottom},\ \varepsilon_{top}\right)}$$

$$s_\alpha \leq 5 \cdot c_\alpha \rightarrow s_{r,max} = k_3 \cdot (c_\alpha - \Phi_\alpha / 2) + k_1 \cdot k_2 \cdot k_4 \cdot \Phi_\alpha \cdot \frac{A_{c,eff}}{A_s}$$

$$s_\alpha > 5 \cdot c_\alpha \rightarrow s_{r,max} = 1.3 \cdot (t - x_{II})$$

$$c_w = s_{r,max} \cdot \varepsilon_{[face]}$$

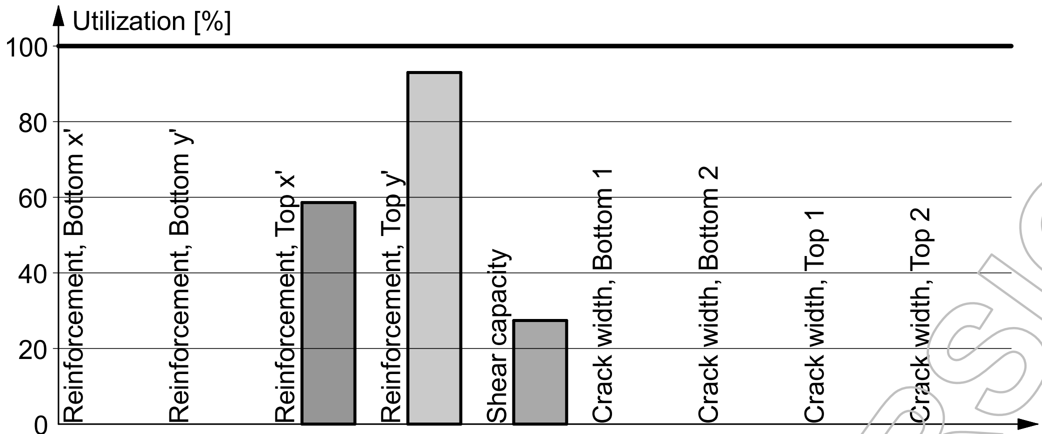
Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$A_{c,eff[face]}$ [mm²/m]	-	-	-	-
$\rho_{p,eff[face]}$	-	-	-	-
$\varepsilon_{[face]}$	-	-	-	-
$A_{c,eff[other face]}$ [mm²/m]	-	-	-	-
$\varepsilon_{[other face]}$	-	-	-	-
Φ_{dir} [mm]	-	-	-	-
s_{dir} [mm]	-	-	-	-
k_1	-	-	-	-
k_2	-	-	-	-
k_3	-	-	-	-
k_4	-	-	-	-
$s_{r,max}$ [mm]	-	-	-	-
c_w [mm]	-	-	-	-

Utilization

$$\text{Utilization} = c_w / c_{w,lim} \cdot 100$$

Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$c_{w,lim}$ [mm]	1.00	1.00	1.00	1.00
Utilization [%]	-	-	-	-

Summary


Utilization [%]
100
80
60
40
20
0
Reinforcement, Bottom x'
Reinforcement, Bottom y'
Reinforcement, Top x'
Reinforcement, Top y'
Shear capacity
Crack width, Bottom 1
Crack width, Bottom 2
Crack width, Top 1
Crack width, Top 2