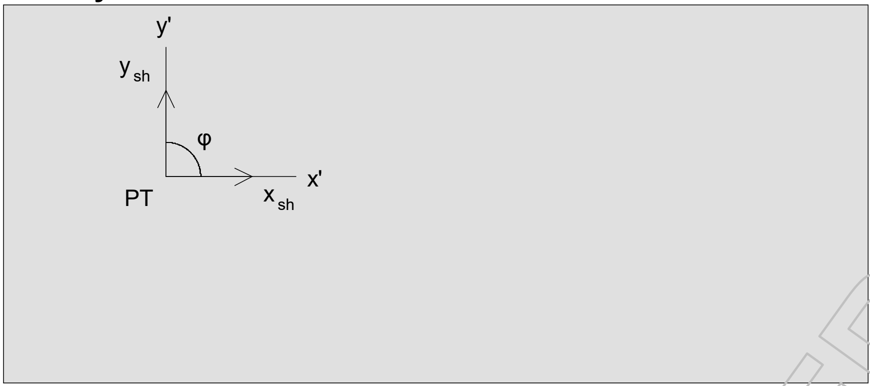
P.1.1 - PT (N615)
Maximum of load combinations

Geometry



Global coordinates:
$x = 6.01$ m
$y = 7.64$ 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

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

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

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

$\lambda = 0.8 - \max(f_{ck} - 50, 0) / 400 =$
$= 0.8 - \max(35.00 - 50, 0) / 400 = 0.80$ (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	175	646
Top, y'	B500C	10	47	400	196
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	10
Cover [mm]	35	47	35	47
c = Cover + Φ/2 [mm]	41	52	41	52
E_s [N/mm^2]	200000	200000	200000	200000
Applied, UL [mm^2/m]	565	196	646	393
$f_{sy,UL}$ [N/mm^2]	435	435	435	435
Applied, SL [mm^2/m]	565	196	646	393
$f_{sy,SL}$ [N/mm^2]	500	500	500	500

Equivalent reinforcement calculation is based on calculation parameter data.

Other calculation parameter data

Allowed crackwidth, top: 0.39 mm
Allowed crackwidth, bottom: 0.39 mm

Minimum reinforcement: Yes
Compressed reinf.: No

Required reinforcement, bottom x'

LC: 'LC1ULS'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = -26.88	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -5.38	$n_{y,sh}$ = 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
$m_{x',top}$ = -26.88	$n_{x',-}$ = 0.00
$m_{y',top}$ = -5.38	$n_{y',-}$ = 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))

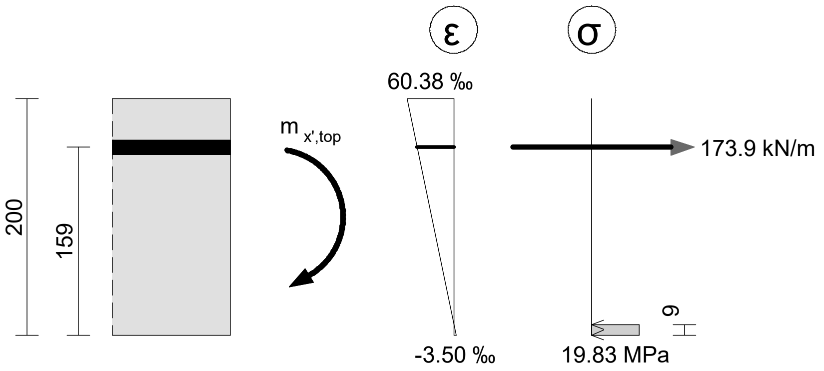
Calculation of required reinforcement from different m-n combinations

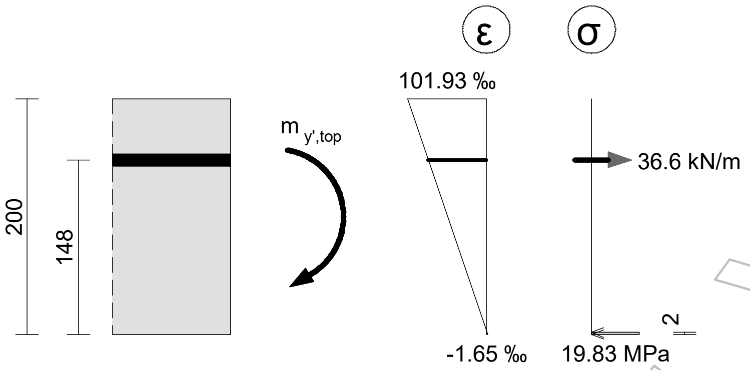
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-26.88	-26.88	0.00	0.00	-5.38
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully 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	400	400	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	84

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-5.38
$n_{[dir][face]}$ [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]	84

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))

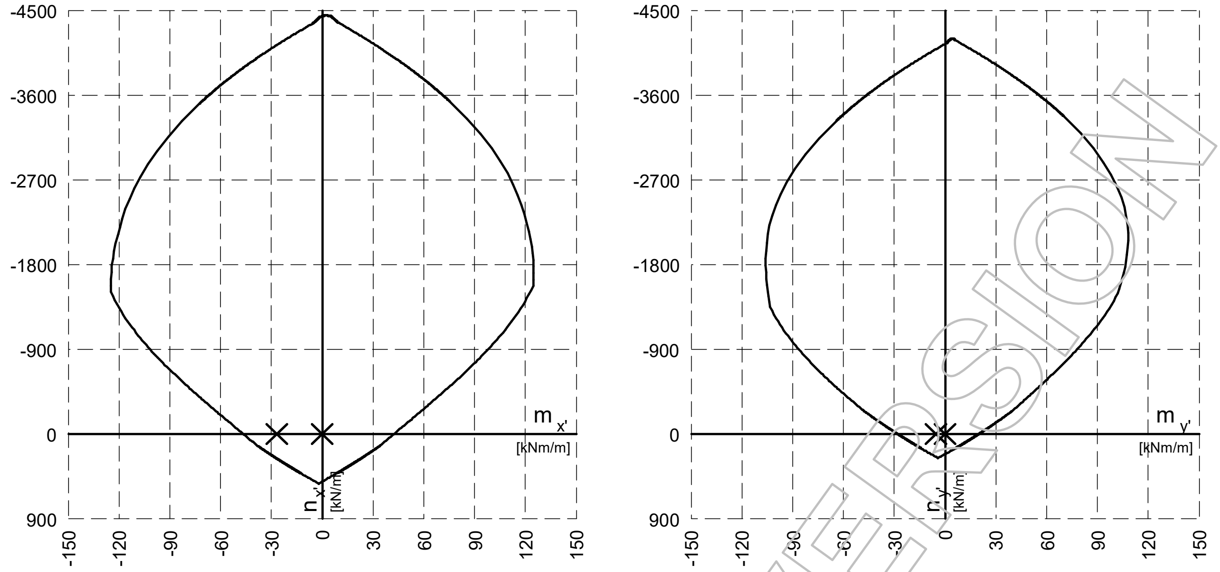
$A_{s,min,smax}$ = 1000 / s_{max} · Φ^2 · π / 4

$A_{s,min,final,primary}$ = 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	148
$A_{s,min}$ [mm²/m]	0	0	265	247
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	12	10
$A_{s,min,smax}$ [mm²/m]	-	-	283	251
$A_{s,min,final}$ [mm²/m]	0	0	283	251

Interaction curves based on applied reinforcement



Utilization

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

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

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,req}$ [mm ^{2}/m]	-	-	400	251
$A_{s,applied}$ [mm ^{2}/m]	565	196	646	393
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	62	64

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]
$m_{x,sh}$ = -26.88	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -5.38	$n_{y,sh}$ = 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
$m_{x',top}$ = -26.88	$n_{x',-}$ = 0.00
$m_{y',top}$ = -5.38	$n_{y',-}$ = 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))

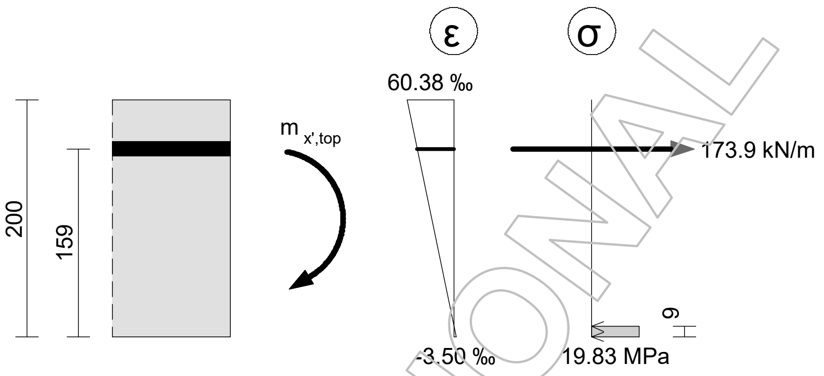
Calculation of required reinforcement from different m-n combinations

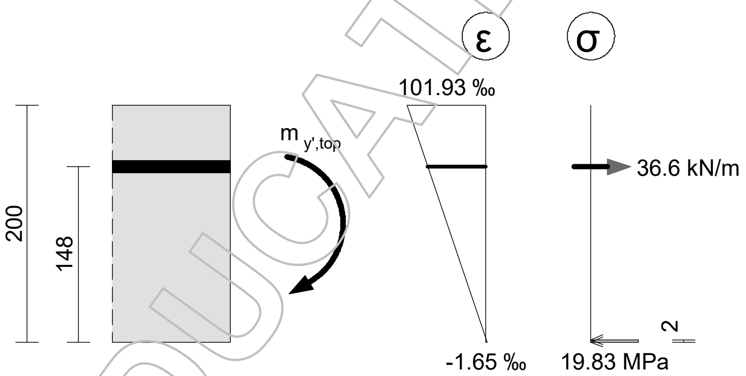
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m / m]	0.00	0.00	-26.88	-26.88	0.00	0.00	-5.38
$n_{[dir][face]}$ [kN / m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully 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	400	400	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	84

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-5.38
$n_{[dir][face]}$ [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]	84

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))

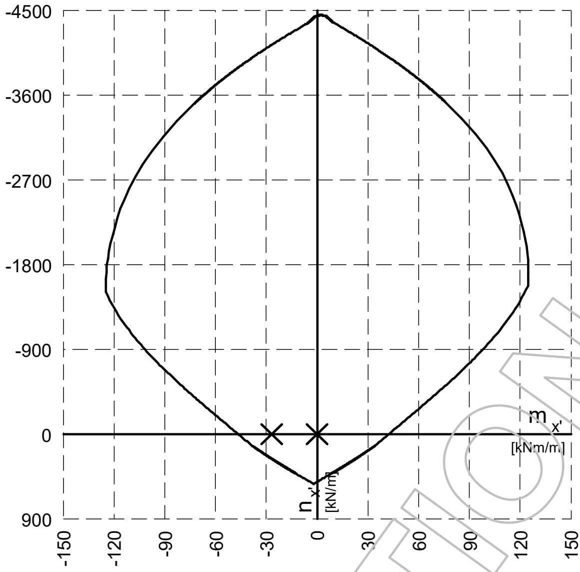
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

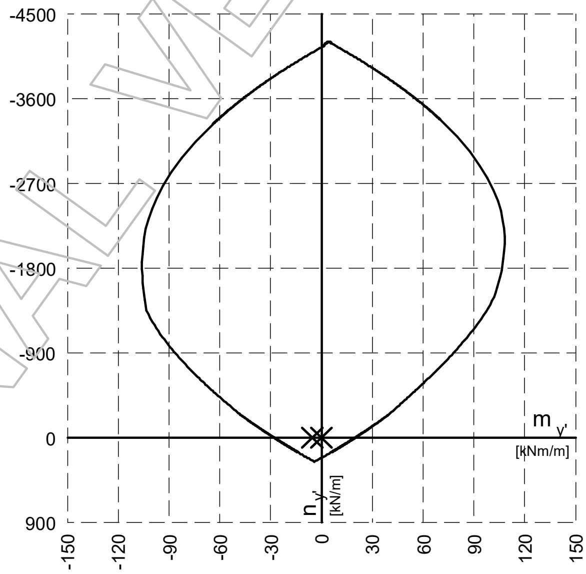
$A_{s,min,final,primary} = \max(A_{s,min},\ A_{s,min,smax})$

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	148
$A_{s,min}$ [mm^2/m]	0	0	265	247
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	12	10
$A_{s,min,smax}$ [mm^2/m]	-	-	283	251
$A_{s,min,final}$ [mm^2/m]	0	0	283	251

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]	-	-	400	251
$A_{s,applied}$ [mm^2/m]	565	196	646	393
$A_{s,missing}$ [mm^2/m]	-	-	-	-
Utilization [%]	0	0	62	64

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]
$m_{x,sh}$ = -26.88	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -5.38	$n_{y,sh}$ = 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
$m_{x',top}$ = -26.88	$n_{x',-}$ = 0.00
$m_{y',top}$ = -5.38	$n_{y',-}$ = 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))

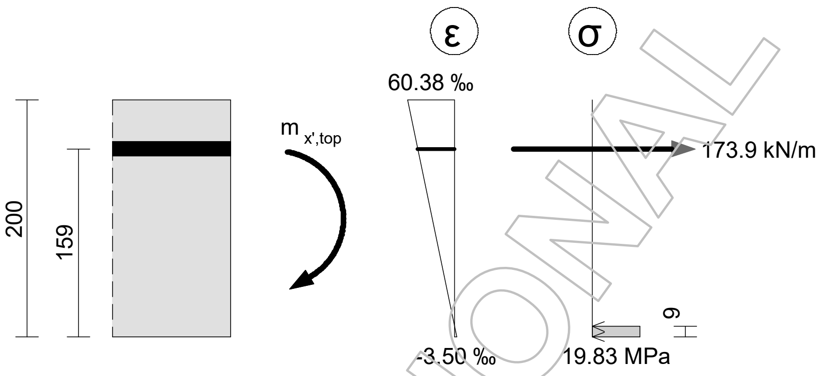
Calculation of required reinforcement from different m-n combinations

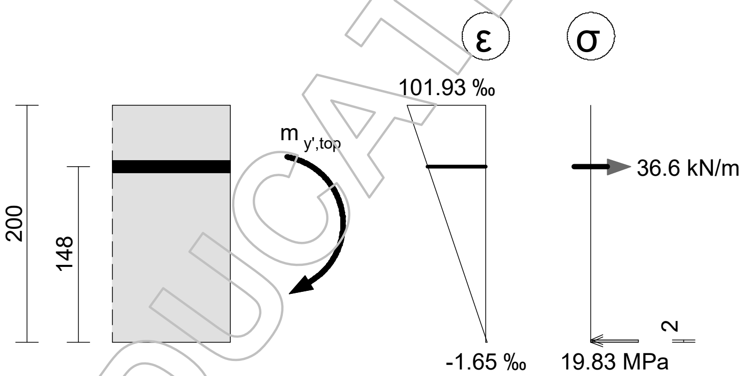
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m/m]	0.00	0.00	-26.88	-26.88	0.00	0.00	-5.38
$n_{[dir][face]}$ [kN/m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully 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	400	400	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	84

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m / m]	-5.38
$n_{[dir][face]}$ [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]	84

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))

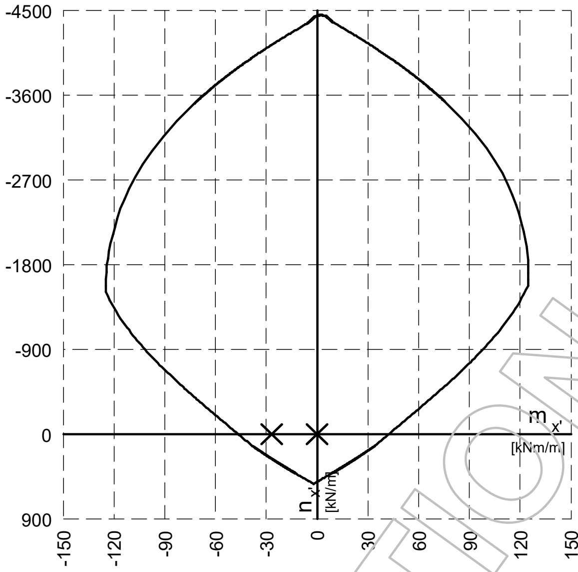
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

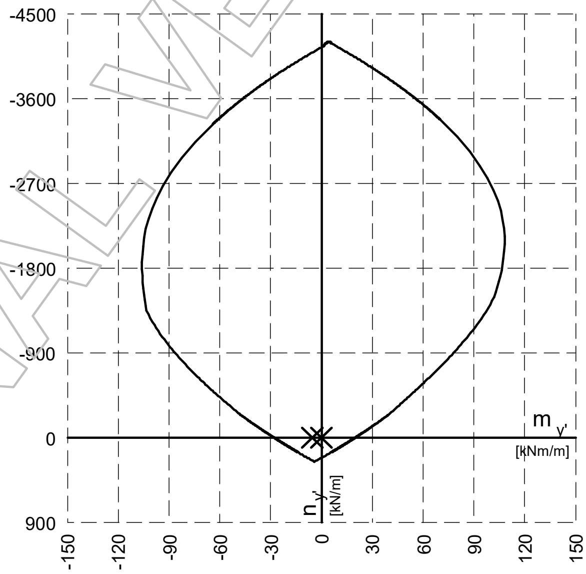
$A_{s,min,final,primary} = \max(A_{s,min}, \; A_{s,min,smax})$

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	148
$A_{s,min}$ [mm ^{2}/m]	0	0	265	247
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	12	10
$A_{s,min,smax}$ [mm ^{2}/m]	-	-	283	251
$A_{s,min,final}$ [mm ^{2}/m]	0	0	283	251

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]	-	-	400	251
$A_{s,applied}$ [mm ^{2}/m]	565	196	646	393
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	62	64

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]
$m_{x,sh}$ = -26.88	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -5.38	$n_{y,sh}$ = 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
$m_{x',top}$ = -26.88	$n_{x',-}$ = 0.00
$m_{y',top}$ = -5.38	$n_{y',-}$ = 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))

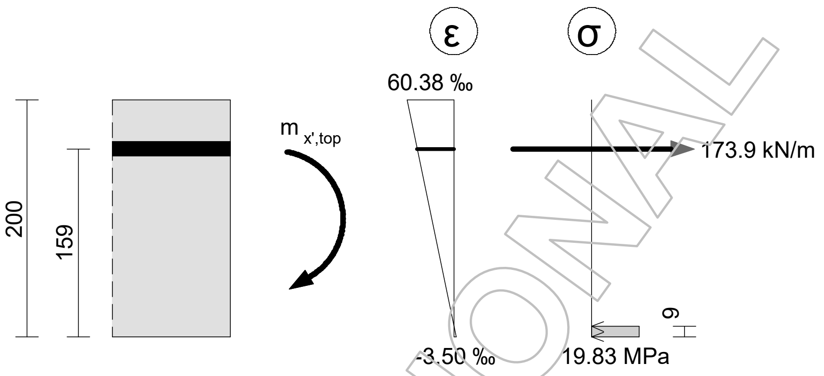
Calculation of required reinforcement from different m-n combinations

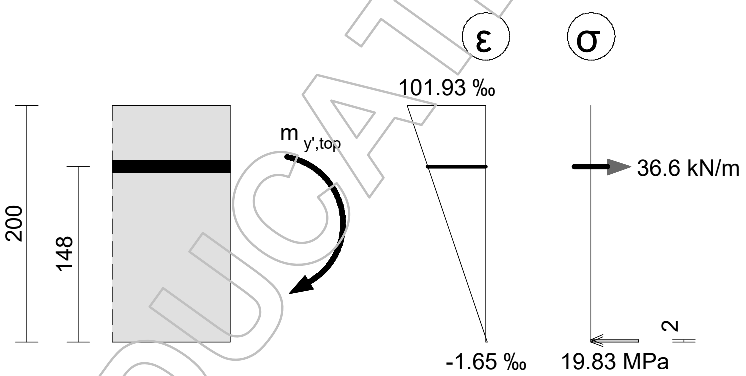
Face, direction	Bottom, x'	Bottom, x'	Top, x'	Top, x'	Bottom, y'	Bottom, y'	Top, y'
Sign of n	+	-	+	-	+	-	+
$m_{[dir][face]}$ [kN m / m]	0.00	0.00	-26.88	-26.88	0.00	0.00	-5.38
$n_{[dir][face]}$ [kN / m]	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Case	Fully compr.	Fully compr.	Tension reinf.	Tension reinf.	Fully 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	400	400	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	84

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-5.38
$n_{[dir][face]}$ [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]	84

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))

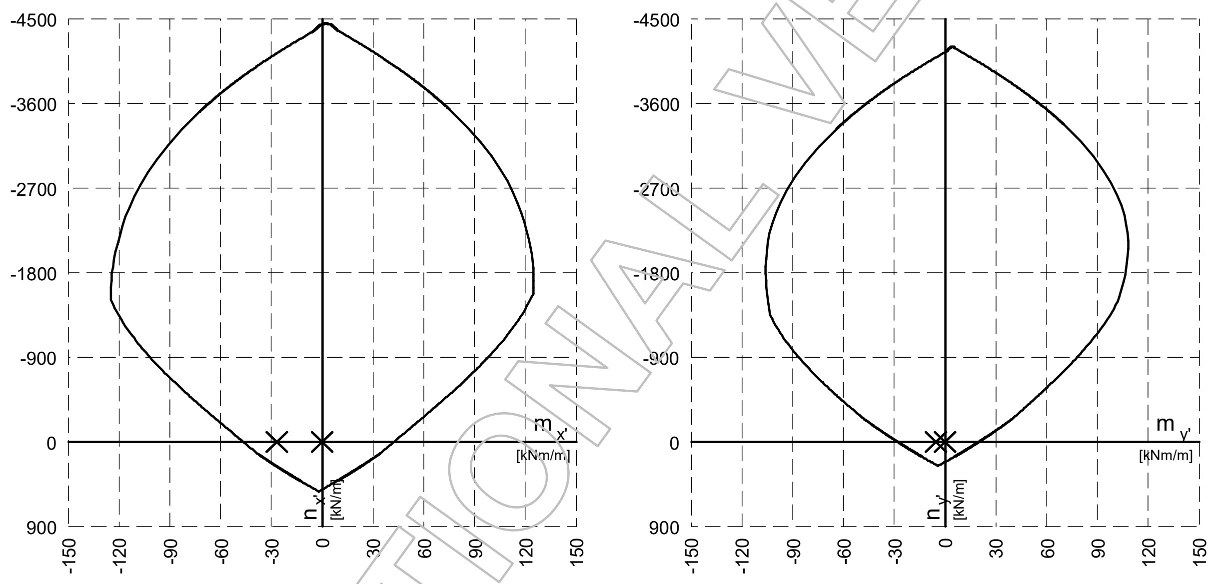
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

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

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
d [mm]	0	0	159	148
$A_{s,min}$ [mm ^{2}/m]	0	0	265	247
Type	No reinf.	No reinf.	Primary	Secondary
s_{max} [mm]	-	-	400	450
Φ [mm]	-	-	12	10
$A_{s,min,smax}$ [mm ^{2}/m]	-	-	283	251
$A_{s,min,final}$ [mm ^{2}/m]	0	0	283	251

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]	-	-	400	251
$A_{s,applied}$ [mm ^{2}/m]	565	196	646	393
$A_{s,missing}$ [mm ^{2}/m]	-	-	-	-
Utilization [%]	0	0	62	64

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	$v_{xz,sh}$ = 17.99
$n_{y,sh}$ = 0.00	$v_{yz,sh}$ = -0.01
$n_{xy,sh}$ = 0.00	

Design forces

$$v_{max} = \sqrt{v_{xz,sh}^{2} + v_{yz,sh}^{2}} = \sqrt{17.99^{2} + -0.01^{2}} = 17.99 \text{ kN /m}$$

$$\alpha = \text{atan}\left(\frac{v_{yz,sh}}{v_{xz,sh}}\right) = \text{atan}\left(\frac{-0.01}{17.99}\right) = -0.04 \ ^\circ$$

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

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

$$A_{s,\alpha} = 646 \text{ mm}^{2}\text{/m}$$

$$d_{eff} = \frac{d_x + d_y}{2} = \frac{159 + 148}{2} = 154 \text{ mm}$$

$$\rho_{\alpha} = \min\left(\frac{A_{s,\alpha}}{d_{eff}}, 0.02\right) = \min\left(\frac{646}{154}, 0.02\right) = 0.00421$$

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

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

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

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

$$k_1 = 0.30$$

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

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

$$= \max\left(0.10 \cdot 2.00 \cdot (100.0 \cdot 0.00421 \cdot 35.00)^{1/3} + 0.30 \cdot 0.0000, 0.5857 + 0.30 \cdot 0.0000\right) \cdot$$

$$= 89.90 \text{ kN /m} \qquad (6.2.a, 6.2.b)$$

$$v_{Rd,c} > v_{max} \rightarrow \text{Utilization} = \frac{v_{max}}{v_{Rd,c}} \cdot 100 = \frac{17.99}{89.90} \cdot 100 = 20 \ \%$$

* 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]
$m_{x,sh}$ = -15.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -3.08	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Direction of crack width

No crack on bottom face.

α_{top} = 180.01 °

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]	-	-	-15.39	-
$A_{s,eq[face]}$ [mm^2/m]	-	-	646	-
$c_{\alpha[face]}$ [mm]	-	-	41	-
$A_{s,eq[other face]}$ [mm^2/m]	-	-	565	-
$c_{\alpha[other face]}$ [mm]	-	-	41	-
$\sigma_{I,c[face]}$ [N/mm^2]	-	-	2.22	-
$\sigma_{I,c[other face]}$ [N/mm^2]	-	-	-2.23	-
$\sigma_{II,s[face]}$ [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: $A_{s,eq} \leq 0$

Not cracked: $(\sigma_{I,c[bottom]} \leq f_{ctm}$ and $\sigma_{I,c[top]} \leq f_{ctm})$ or $x_{II} \leq 0$ 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°
$A_{c,eff[face]}$ [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, α+90°	Top, α	Top, α+90°
$c_{w,lim}$ [mm]	0.39	0.39	0.39	0.39
Utilization [%]	-	-	-	-

Crack width, top

LC: 'LC1SqLS'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = -15.39	$n_{x,sh}$ = 0.00
$m_{y,sh}$ = -3.08	$n_{y,sh}$ = 0.00
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = 0.00

Direction of crack width

No crack on bottom face.

α_{top} = 180.01 °

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]	-	-	-15.39	-
$A_{s,eq[face]}$ [mm^2/m]	-	-	646	-
$c_{\alpha[face]}$ [mm]	-	-	41	-
$A_{s,eq[other face]}$ [mm^2/m]	-	-	565	-
$c_{\alpha[other face]}$ [mm]	-	-	41	-
$\sigma_{I,c[face]}$ [N/mm^2]	-	-	2.22	-
$\sigma_{I,c[other face]}$ [N/mm^2]	-	-	-2.23	-
$\sigma_{II,s[face]}$ [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: $A_{s,eq} \leq 0$

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

Cracked: otherwise

Crack width

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

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

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

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

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

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

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

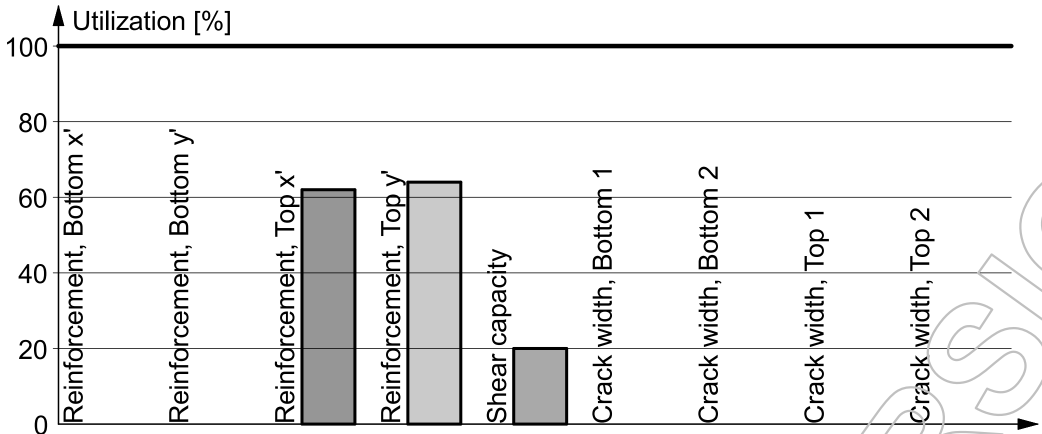
Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$A_{c,eff[face]}$ [mm²/m]	-	-	-	-
$\rho_{p,eff[face]}$	-	-	-	-
$\varepsilon_{[face]}$	-	-	-	-
$A_{c,eff[other face]}$ [mm²/m]	-	-	-	-
$\varepsilon_{[other face]}$	-	-	-	-
Φ_{dir} [mm]	-	-	-	-
s_{dir} [mm]	-	-	-	-
k_1	-	-	-	-
k_2	-	-	-	-
k_3	-	-	-	-
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]	0.39	0.39	0.39	0.39
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