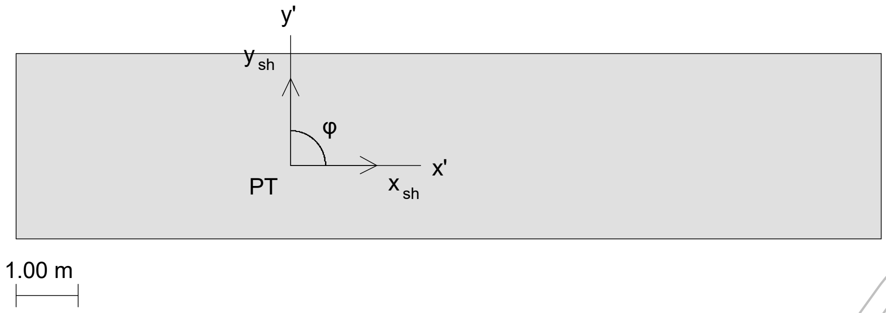
W.6.1 - PT (N19456)
Maximum of load combinations

Geometry



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

Global coordinates:
x = 9.56 m
y = 25.60 m
z = 1.19 m

Reinforcement directions:
φ = 90.00 °

Thickness:
t = 0.20 m

Concrete (EN 1992-1-1: 3.1.7)

C35/45

f_{ck} = 35.00 N/mm^2 ε_{c2} = 0.00200 ε_{cu3} = 0.0035 φ_{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 α_{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	8	45	400	126
Bottom, y'	B500C	10	35	350	224
Top, x'	B500C	8	45	400	126
Top, y'	B500C	10	35	350	224

Equivalent reinforcement

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
Quality	B500C	B500C	B500C	B500C

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Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
Diameter [mm]	8	10	8	10
Cover [mm]	45	35	45	35
c = Cover + Φ/2 [mm]	49	40	49	40
E_s [N/mm^2]	200000	200000	200000	200000
Applied, UL [mm^2/m]	126	224	126	224
$f_{sy,UL}$ [N/mm^2]	435	435	435	435
Applied, SL [mm^2/m]	126	224	126	224
$f_{sy,SL}$ [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	Minimum reinforcement:	Yes
Allowed crackwidth, bottom:	0.39 mm	Compressed reinf.:	No

Required reinforcement, bottom x'

LC: 'Stabilitet/likevekt'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh} = 0.00$	$n_{x,sh} = -18.24$
$m_{y,sh} = -0.00$	$n_{y,sh} = -121.19$
$m_{xy,sh} = -0.00$	$n_{xy,sh} = -9.71$

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot} = 0.00$	$n_{x',+} = -27.95$
$m_{y',bot} = 0.00$	$n_{y',+} = -130.90$
$m_{x',top} = 0.00$	$n_{x',-} = -27.95$
$m_{y',top} = -0.01$	$n_{y',-} = -130.90$

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 9.6.2(1))

EDUCATIONAL VERSION

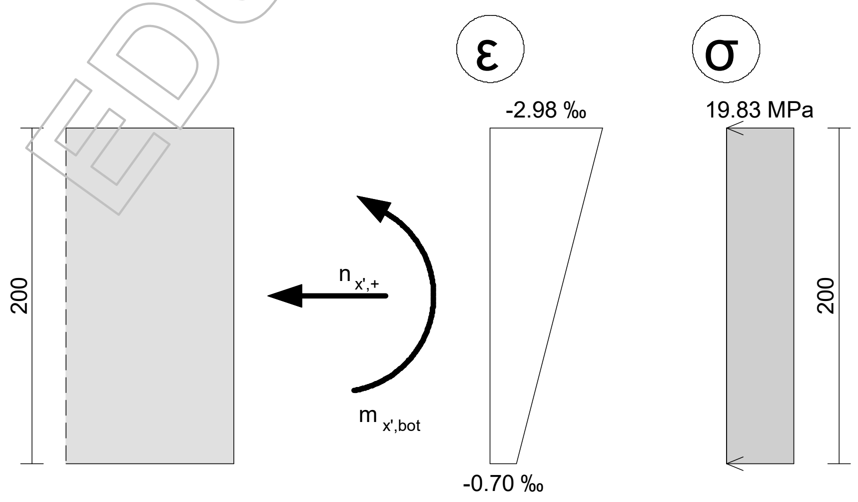
Calculation of required reinforcement from different m-n combinations

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	0.00	0.00	0.00	0.00	-0.01
$n_{[dir][face]}$ [kN/m]	-27.95	-27.95	-27.95	-27.95	-130.90	-130.90	-130.90
Case	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-0.01
$n_{[dir][face]}$ [kN/m]	-130.90
Case	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	0

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.



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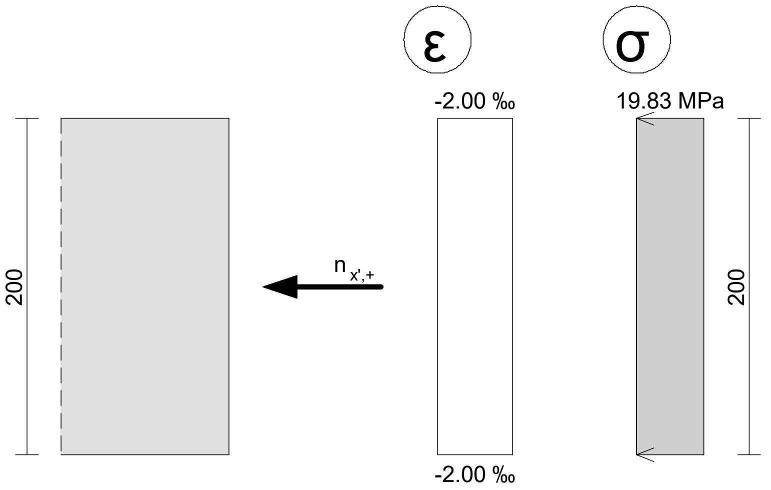
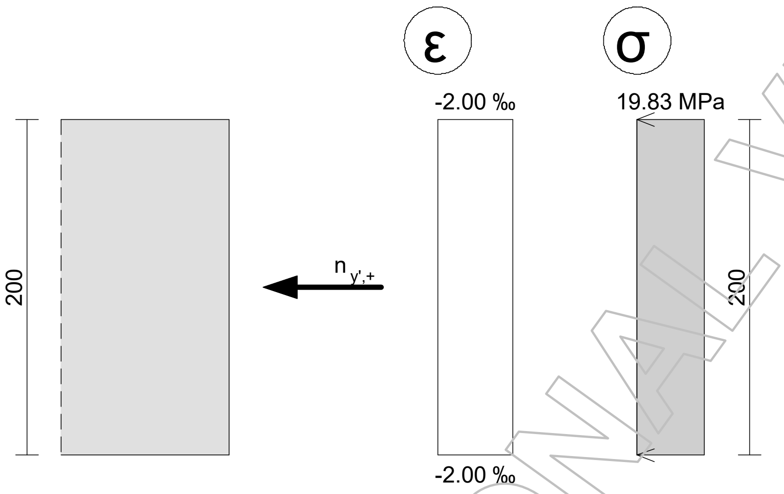
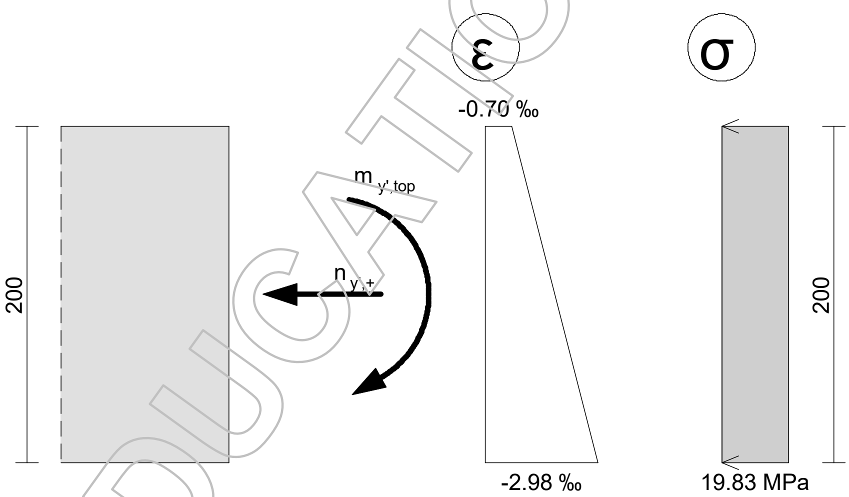






EDUCATIONAL VERSION

Minimum reinforcement

$A_{s,min,vertical} = 0.002 \cdot A_c$ (EN 1992-1-1 9.6.2(1))

$A_{s,min,horizontal} = \max(0.001 \cdot A_c, 0.25 \cdot A_{s,required,vertical})$ (EN 1992-1-1 9.6.3(1))

$s_{max,walls,vertical} = \min(3 \cdot t, 400)$ (EN 1992-1-1 9.6.2(3))

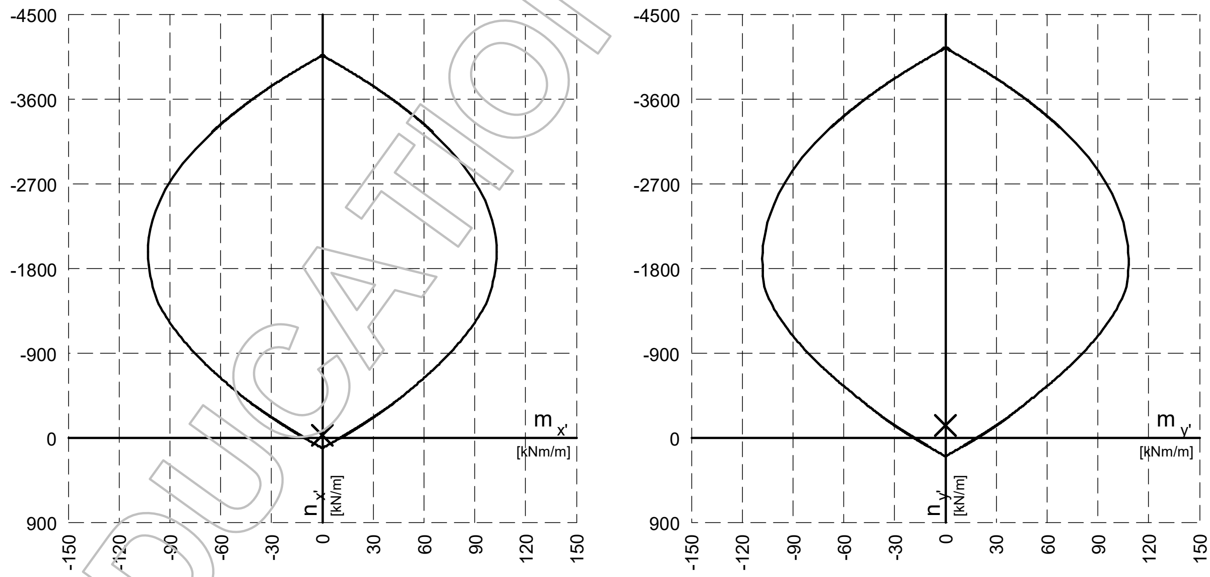
$s_{max,walls,horizontal} = 400$ mm (EN 1992-1-1 9.6.3(2))

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

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,min}$ [mm^2/m]	100	200	100	200
Type	Horizontal	Vertical	Horizontal	Vertical
s_{max} [mm]	400	400	400	400
Φ [mm]	8	10	8	10
$A_{s,min,smax}$ [mm^2/m]	126	196	126	196
$A_{s,min,final}$ [mm^2/m]	126	200	126	200

Interaction curves based on applied reinforcement



EDUCATIONAL VERSION

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]	126	200	126	200
$A_{s,applied}$ [mm^2/m]	126	224	126	224
$A_{s,missing}$ [mm^2/m]	0	-	0	-
Utilization [%]	100	89	100	89

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

Required reinforcement, bottom y'

LC: 'Stabilitet/likevekt'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = 0.00	$n_{x,sh}$ = -18.24
$m_{y,sh}$ = -0.00	$n_{y,sh}$ = -121.19
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = -9.71

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = -27.95
$m_{y',bot}$ = 0.00	$n_{y',+}$ = -130.90
$m_{x',top}$ = 0.00	$n_{x',-}$ = -27.95
$m_{y',top}$ = -0.01	$n_{y',-}$ = -130.90

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 9.6.2(1))

EDUCATIONAL VERSION

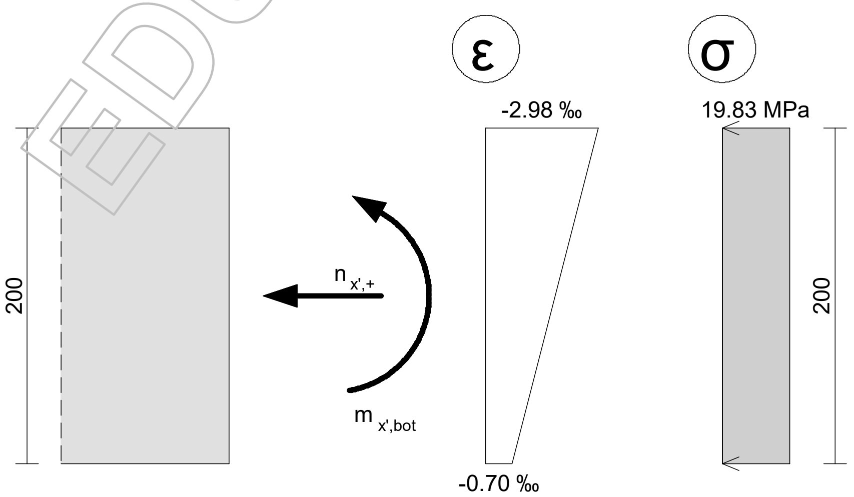
Calculation of required reinforcement from different m-n combinations

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	0.00	0.00	0.00	0.00	-0.01
$n_{[dir][face]}$ [kN/m]	-27.95	-27.95	-27.95	-27.95	-130.90	-130.90	-130.90
Case	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-0.01
$n_{[dir][face]}$ [kN/m]	-130.90
Case	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	0

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.



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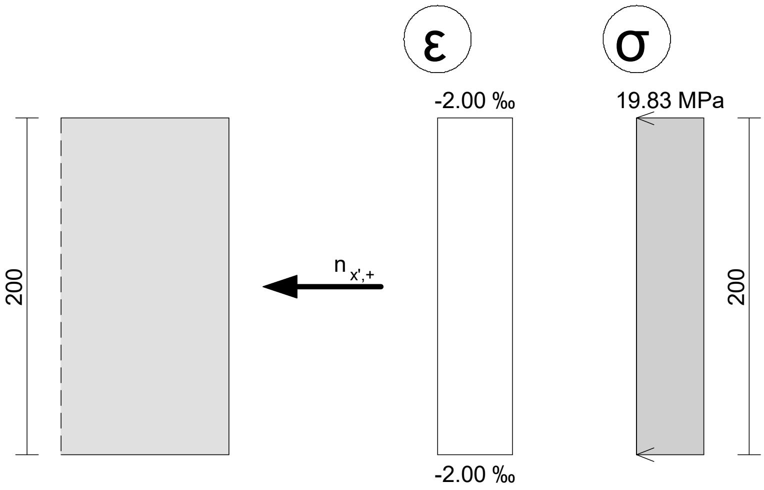
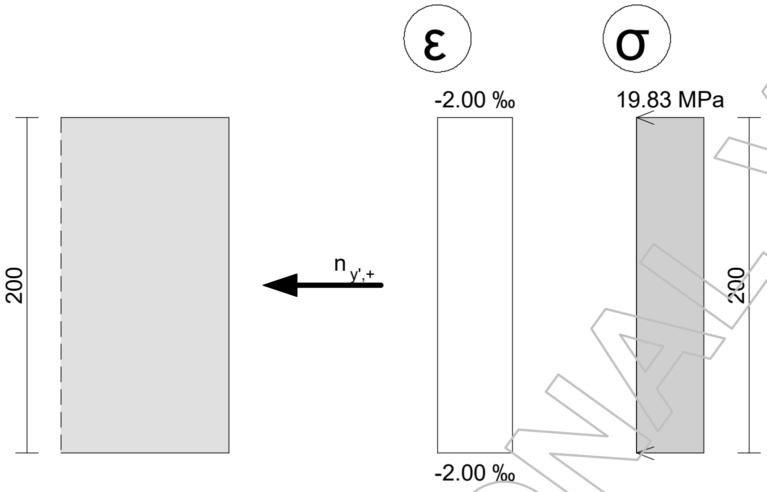
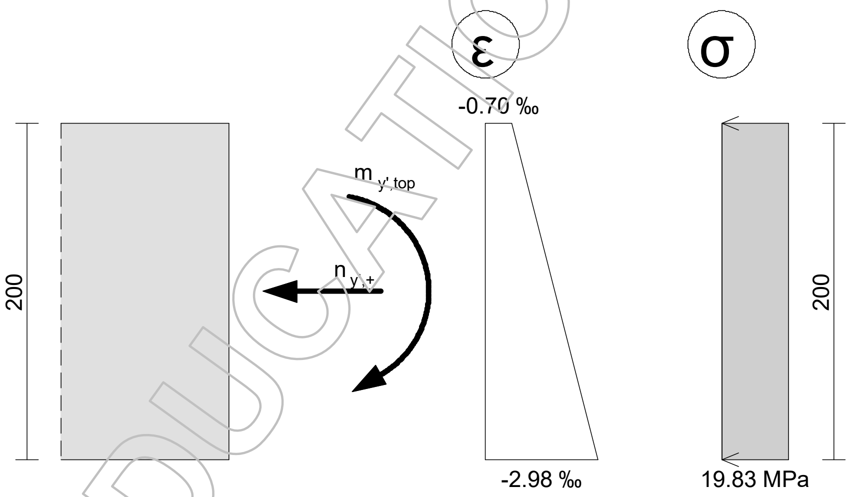






EDUCATIONAL VERSION

Minimum reinforcement

$A_{s,min,vertical} = 0.002 \cdot A_c$ (EN 1992-1-1 9.6.2(1))

$A_{s,min,horizontal} = \max(0.001 \cdot A_c, 0.25 \cdot A_{s,required,vertical})$ (EN 1992-1-1 9.6.3(1))

$s_{max,walls,vertical} = \min(3 \cdot t, 400)$ (EN 1992-1-1 9.6.2(3))

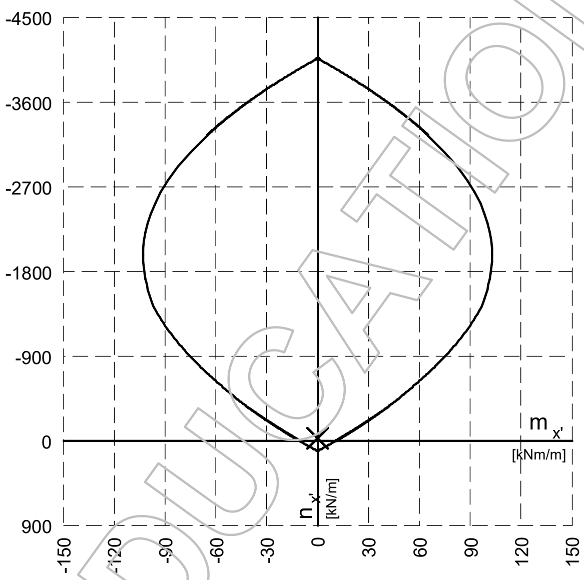
$s_{max,walls,horizontal} = 400$ mm (EN 1992-1-1 9.6.3(2))

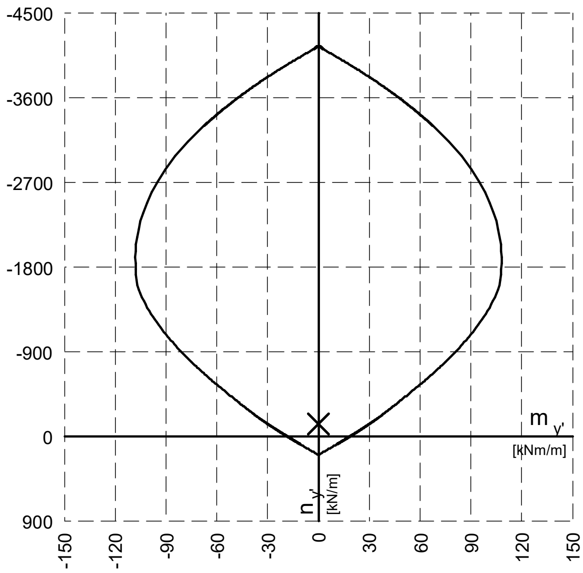
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,min}$ [mm^2/m]	100	200	100	200
Type	Horizontal	Vertical	Horizontal	Vertical
s_{max} [mm]	400	400	400	400
Φ [mm]	8	10	8	10
$A_{s,min,smax}$ [mm^2/m]	126	196	126	196
$A_{s,min,final}$ [mm^2/m]	126	200	126	200

Interaction curves based on applied reinforcement





EDUCATIONAL VERSION

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]	126	200	126	200
$A_{s,applied}$ [mm^2/m]	126	224	126	224
$A_{s,missing}$ [mm^2/m]	0	-	0	-
Utilization [%]	100	89	100	89

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

Required reinforcement, top x'

LC: 'Stabilitet/likevekt'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = 0.00	$n_{x,sh}$ = -18.24
$m_{y,sh}$ = -0.00	$n_{y,sh}$ = -121.19
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = -9.71

Design forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x',bot}$ = 0.00	$n_{x',+}$ = -27.95
$m_{y',bot}$ = 0.00	$n_{y',+}$ = -130.90
$m_{x',top}$ = 0.00	$n_{x',-}$ = -27.95
$m_{y',top}$ = -0.01	$n_{y',-}$ = -130.90

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 9.6.2(1))

EDUCATIONAL VERSION

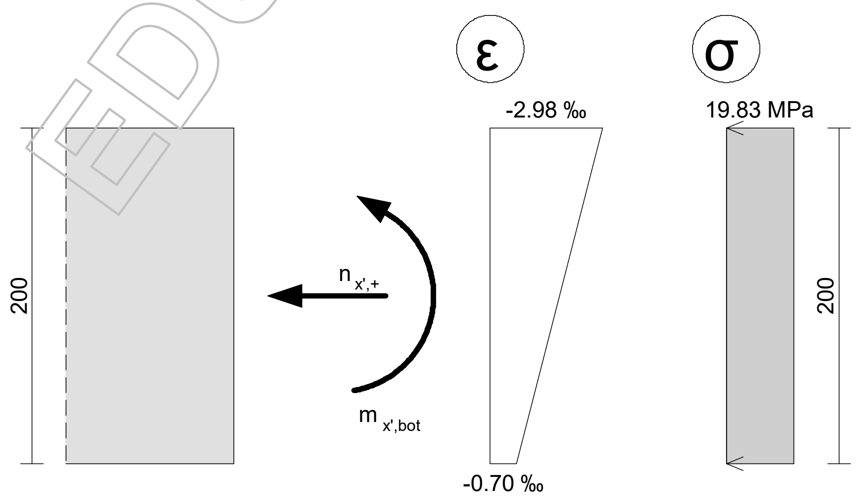
Calculation of required reinforcement from different m-n combinations

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	0.00	0.00	0.00	0.00	-0.01
$n_{[dir][face]}$ [kN/m]	-27.95	-27.95	-27.95	-27.95	-130.90	-130.90	-130.90
Case	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-0.01
$n_{[dir][face]}$ [kN/m]	-130.90
Case	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	0

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.



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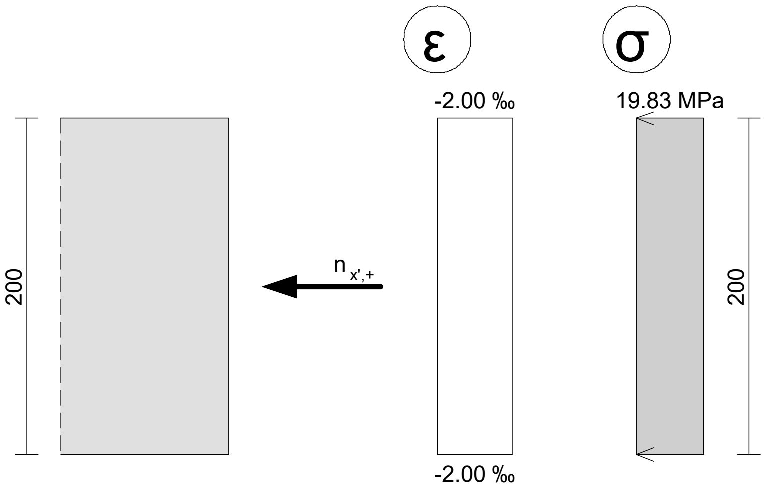

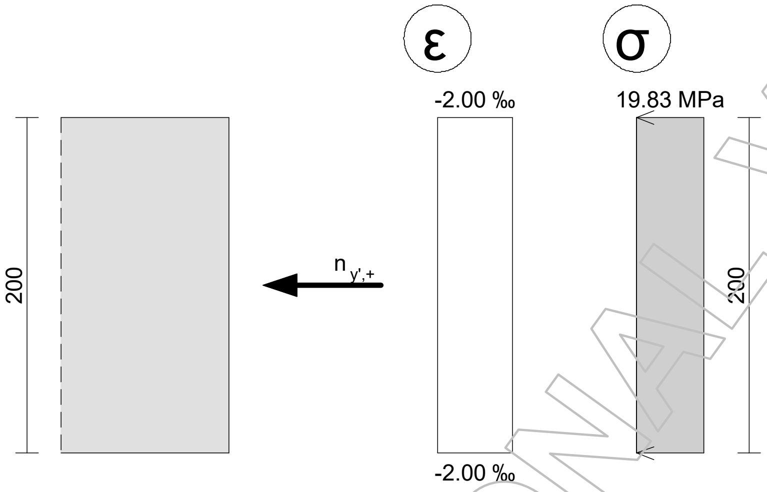

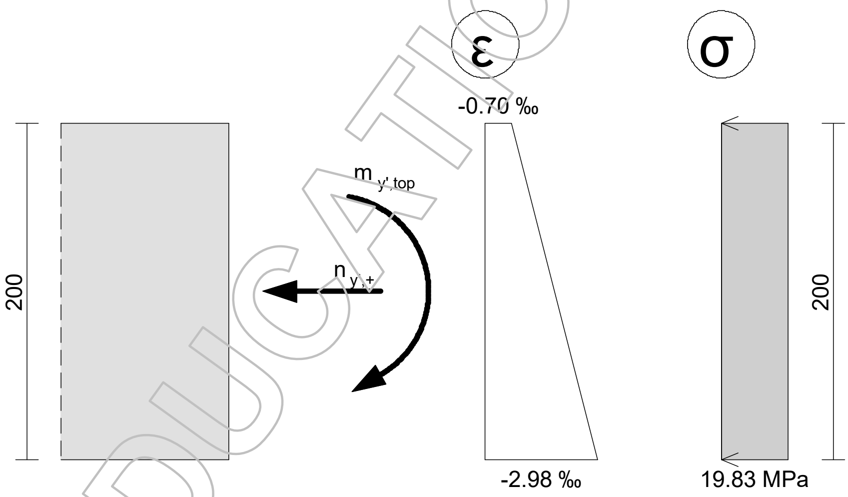

EDUCATIONAL VERSION

Minimum reinforcement

$A_{s,min,vertical} = 0.002 \cdot A_c$ (EN 1992-1-1 9.6.2(1))

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$s_{max,walls,vertical} = \min(3 \cdot t, 400)$ (EN 1992-1-1 9.6.2(3))

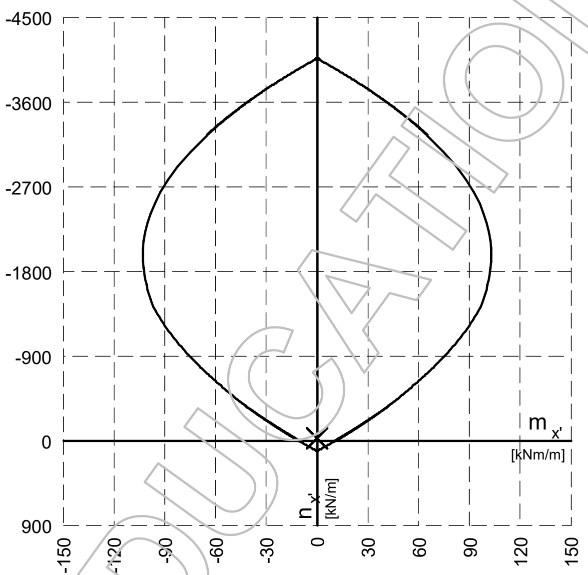
$s_{max,walls,horizontal} = 400$ mm (EN 1992-1-1 9.6.3(2))

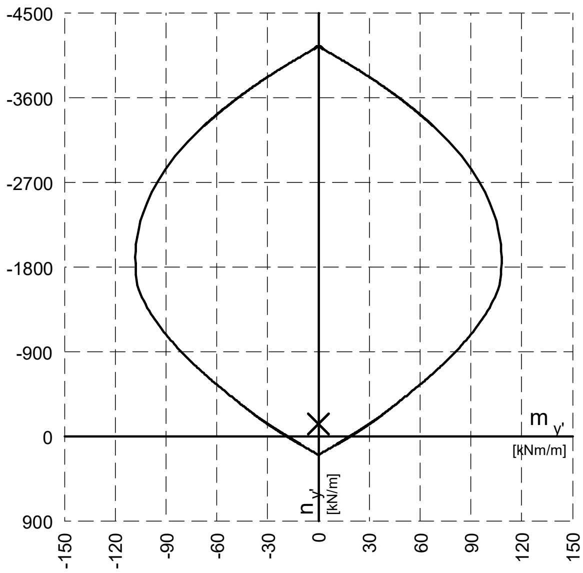
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,min}$ [mm^2/m]	100	200	100	200
Type	Horizontal	Vertical	Horizontal	Vertical
s_{max} [mm]	400	400	400	400
Φ [mm]	8	10	8	10
$A_{s,min,smax}$ [mm^2/m]	126	196	126	196
$A_{s,min,final}$ [mm^2/m]	126	200	126	200

Interaction curves based on applied reinforcement





EDUCATIONAL VERSION

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]	126	200	126	200
$A_{s,applied}$ [mm^2/m]	126	224	126	224
$A_{s,missing}$ [mm^2/m]	0	-	0	-
Utilization [%]	100	89	100	89

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

Required reinforcement, top y'

LC: 'Stabilitet/likevekt'

Internal forces

Moments [kN m/m]	Normal forces [kN /m]
$m_{x,sh}$ = 0.00	$n_{x,sh}$ = -18.24
$m_{y,sh}$ = -0.00	$n_{y,sh}$ = -121.19
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = -9.71

Design forces

Moments [kN m/m]	Normal forces [kN /m]
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$m_{y',bot}$ = 0.00	$n_{y',+}$ = -130.90
$m_{x',top}$ = 0.00	$n_{x',-}$ = -27.95
$m_{y',top}$ = -0.01	$n_{y',-}$ = -130.90

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 9.6.2(1))

EDUCATIONAL VERSION

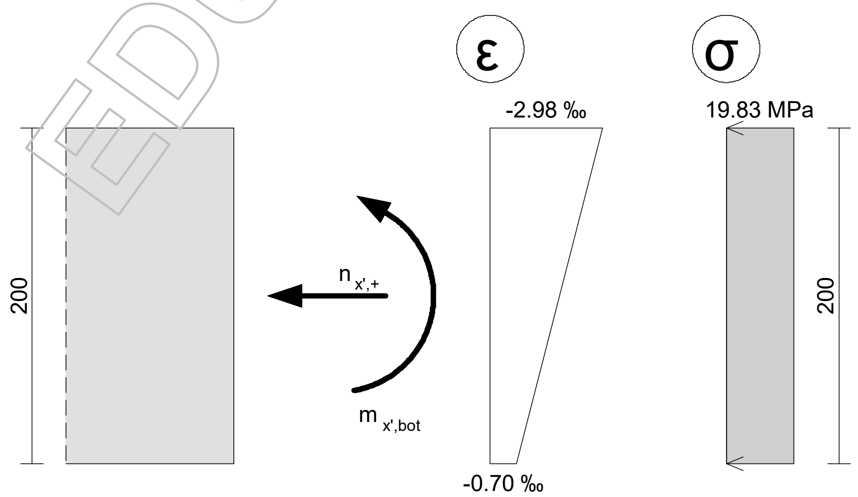
Calculation of required reinforcement from different m-n combinations

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	0.00	0.00	0.00	0.00	-0.01
$n_{[dir][face]}$ [kN/m]	-27.95	-27.95	-27.95	-27.95	-130.90	-130.90	-130.90
Case	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{sb,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0
$A_{st,x'}$ [mm ^{2}/m]	0	0	0	0	-	-	-
$A_{st,y'}$ [mm ^{2}/m]	-	-	-	-	0	0	0

Face, direction	Top, y'
Sign of n	-
$m_{[dir][face]}$ [kN m/m]	-0.01
$n_{[dir][face]}$ [kN/m]	-130.90
Case	Fully compr.
$A_{sb,x'}$ [mm ^{2}/m]	-
$A_{sb,y'}$ [mm ^{2}/m]	0
$A_{st,x'}$ [mm ^{2}/m]	-
$A_{st,y'}$ [mm ^{2}/m]	0

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.



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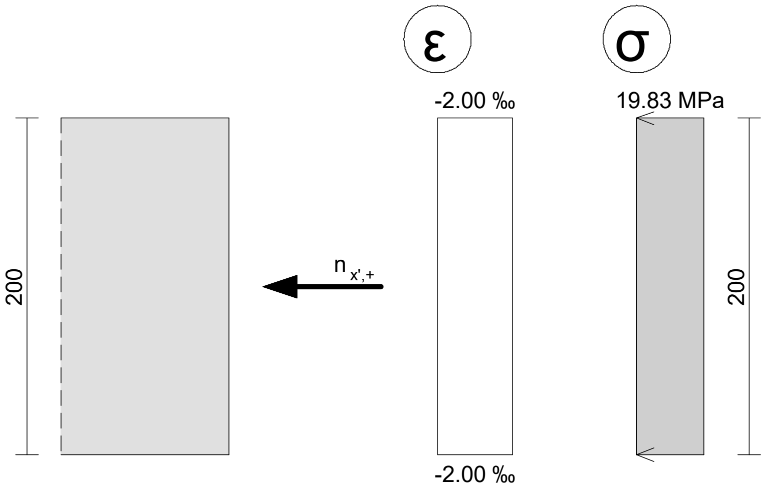

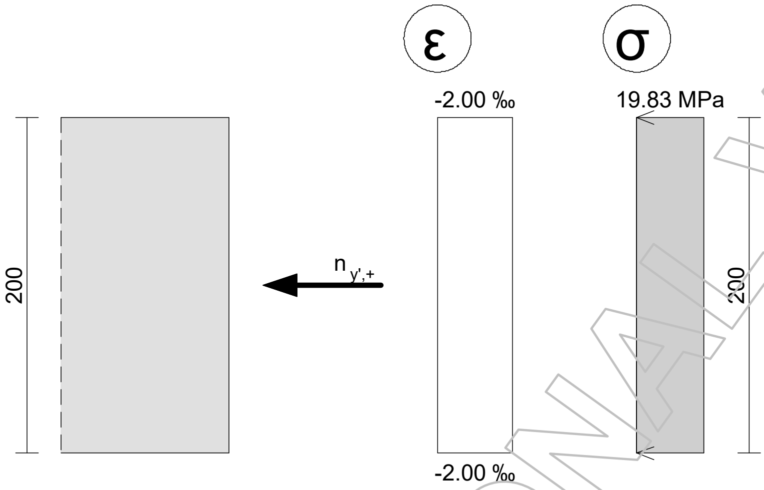

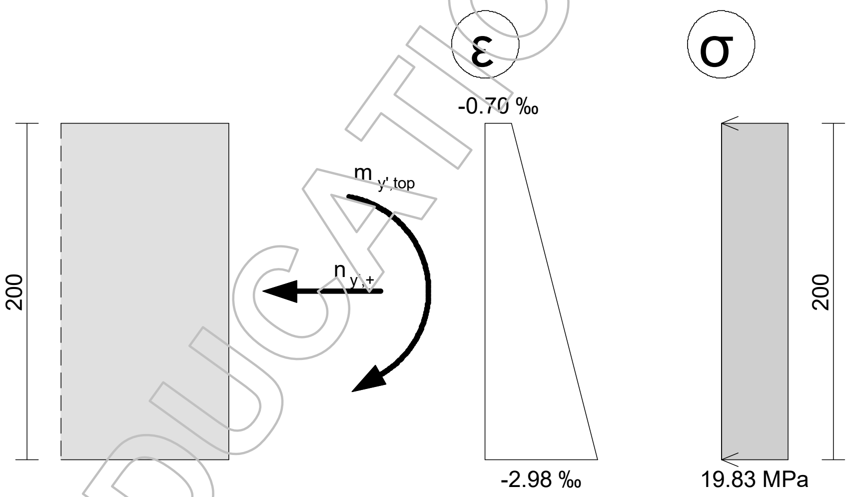

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Minimum reinforcement

$A_{s,min,vertical} = 0.002 \cdot A_c$ (EN 1992-1-1 9.6.2(1))

$A_{s,min,horizontal} = \max(0.001 \cdot A_c, 0.25 \cdot A_{s,required,vertical})$ (EN 1992-1-1 9.6.3(1))

$s_{max,walls,vertical} = \min(3 \cdot t, 400)$ (EN 1992-1-1 9.6.2(3))

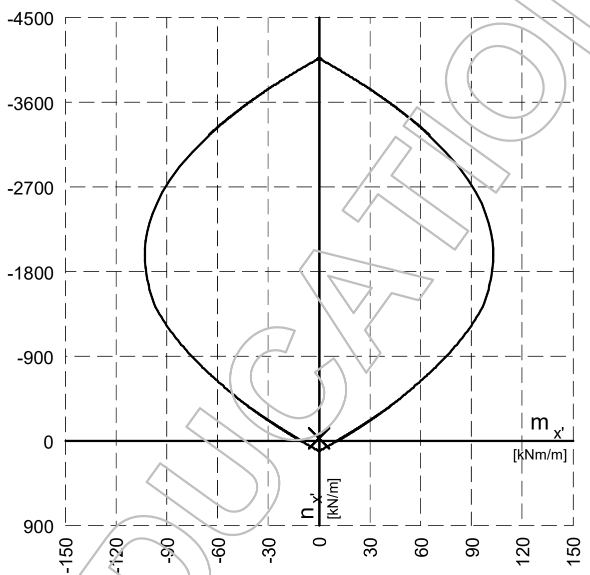
$s_{max,walls,horizontal} = 400$ mm (EN 1992-1-1 9.6.3(2))

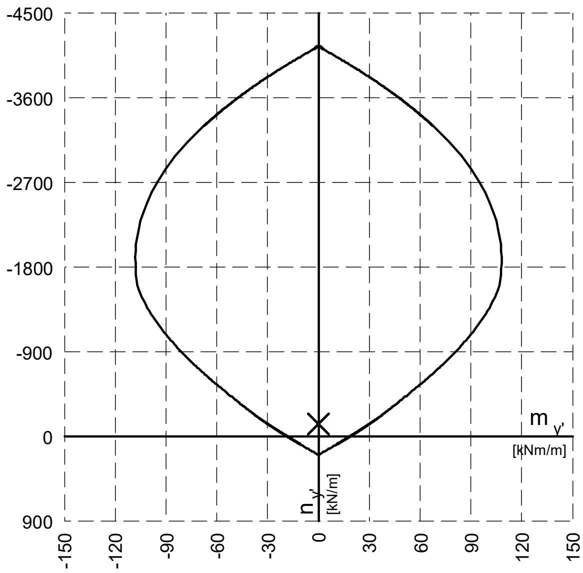
$A_{s,min,smax} = 1000 / s_{max} \cdot \Phi^2 \cdot \pi / 4$

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

Face, direction	Bottom, x'	Bottom, y'	Top, x'	Top, y'
$A_{s,min}$ [mm^2/m]	100	200	100	200
Type	Horizontal	Vertical	Horizontal	Vertical
s_{max} [mm]	400	400	400	400
Φ [mm]	8	10	8	10
$A_{s,min,smax}$ [mm^2/m]	126	196	126	196
$A_{s,min,final}$ [mm^2/m]	126	200	126	200

Interaction curves based on applied reinforcement





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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]	126	200	126	200
$A_{s,applied}$ [mm ^{2}/m]	126	224	126	224
$A_{s,missing}$ [mm ^{2}/m]	0	-	0	-
Utilization [%]	100	89	100	89

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

Shear capacity

LC: 'dom. nyttelast + vindlast'

Internal forces

Normal forces [kN /m]	Shear forces [kN /m]
$n_{x,sh}$ = -31.65	$v_{xz,sh}$ = -0.01
$n_{y,sh}$ = -217.17	$v_{yz,sh}$ = 0.00
$n_{xy,sh}$ = -12.53	

Design forces

$$v_{max} = \sqrt{v_{xz,sh}^2 + v_{yz,sh}^2} = \sqrt{-0.01^2 + 0.00^2} = 0.01 \text{ kN/m}$$

$$\alpha = \operatorname{atan}\left(\frac{v_{yz,sh}}{v_{xz,sh}}\right) = \operatorname{atan}\left(\frac{0.00}{-0.01}\right) = -14.97\ °$$

n_α = -37.78 kN /m

EDUCATIONAL VERSION

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

$$A_{s,\alpha} = 132 \text{ mm}^2/\text{m}$$

$$d_{eff} = \frac{d_x + d_y}{2} = \frac{151 + 160}{2} = 156 \text{ mm}$$

$$\rho_\alpha = \min\left(\frac{A_{s,\alpha}}{d_{eff}}, 0.02\right) = \min\left(\frac{132}{156}, 0.02\right) = 0.00085$$

$$\sigma_\alpha = \frac{n_\alpha}{t} = \frac{-37.78}{0.20} = -0.1889 \text{ N/mm}^2$$

$$\sigma_{cp,\alpha} = \min\left(-(\sigma_\alpha), 0.2 \cdot f_{cd,U}\right) = \min\left(-(-0.1889), 0.2 \cdot 19.83\right) = 0.1889 \text{ N/mm}^2 \quad *$$

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

$$k = \min\left(1 + \sqrt{\frac{200}{d_{eff}}}, 2.0\right) = \min\left(1 + \sqrt{\frac{200}{156}}, 2.0\right) = 2.00$$

$$k_1 = 0.15$$

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

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

$$= \max\left(0.10 \cdot 2.00 \cdot (100.0 \cdot 0.00085 \cdot 35.00)^{1/3} + 0.15 \cdot 0.1889, 0.5857 + 0.15 \cdot 0.1889\right) \cdot$$

$$= 95.48 \text{ kN/m} \quad (6.2.a, 6.2.b)$$

$$v_{Rd,c} > v_{max} \rightarrow \text{Utilization} = \frac{v_{max}}{v_{Rd,c}} \cdot 100 = \frac{0.01}{95.48} \cdot 100 = 0 \%$$

* 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: 'ofte forekomende'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = 0.00	$n_{x,sh}$ = -18.14
$m_{y,sh}$ = -0.01	$n_{y,sh}$ = -134.92
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = -7.13

Direction of crack width

No crack on bottom face.
No crack on top face.

Calculated by Gvozdiev method.

EDUCATIONAL VERSION

Stresses

Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
n [kN/m]	-	-	-	-
m [kN m/m]	-	-	-	-
$A_{s,eq[face]}$ [mm^2/m]	-	-	-	-
$c_{\alpha[face]}$ [mm]	-	-	-	-
$A_{s,eq[other\ face]}$ [mm^2/m]	-	-	-	-
$c_{\alpha[other\ face]}$ [mm]	-	-	-	-
$\sigma_{I,c[face]}$ [N/mm^2]	-	-	-	-
$\sigma_{I,c[other\ face]}$ [N/mm^2]	-	-	-	-
$\sigma_{II,s[face]}$ [N/mm^2]	-	-	-	-
$\sigma_{II,s[other\ face]}$ [N/mm^2]	-	-	-	-
x_{II} [mm]	-	-	-	-
Evaluation*	Not cracked	Not cracked	Not cracked	Not cracked

*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

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

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

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

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

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

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

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

Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$A_{c,eff[face]}$ [mm^2/m]	-	-	-	-

EDUCATIONAL VERSION

Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$\rho_{p,eff[face]}$	-	-	-	-
$\varepsilon_{[face]}$	-	-	-	-
$A_{c,eff[other face]}$ [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

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: 'ofte forekomende'

Internal forces

Moments [kN m/m]	Normal forces [kN/m]
$m_{x,sh}$ = 0.00	$n_{x,sh}$ = -18.14
$m_{y,sh}$ = -0.01	$n_{y,sh}$ = -134.92
$m_{xy,sh}$ = -0.00	$n_{xy,sh}$ = -7.13

Direction of crack width

No crack on bottom face.
No crack on top face.

Calculated by Gvozdiev method.

EDUCATIONAL VERSION

Stresses

Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
n [kN/m]	-	-	-	-
m [kN m/m]	-	-	-	-
$A_{s,eq[face]}$ [mm²/m]	-	-	-	-
$c_{\alpha[face]}$ [mm]	-	-	-	-
$A_{s,eq[other\ face]}$ [mm²/m]	-	-	-	-
$c_{\alpha[other\ face]}$ [mm]	-	-	-	-
$\sigma_{I,c[face]}$ [N/mm²]	-	-	-	-
$\sigma_{I,c[other\ face]}$ [N/mm²]	-	-	-	-
$\sigma_{II,s[face]}$ [N/mm²]	-	-	-	-
$\sigma_{II,s[other\ face]}$ [N/mm²]	-	-	-	-
x_{II} [mm]	-	-	-	-
Evaluation*	Not cracked	Not cracked	Not cracked	Not cracked

*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, α+90°	Top, α	Top, α+90°
$A_{c,eff[face]}$ [mm²/m]	-	-	-	-

EDUCATIONAL VERSION

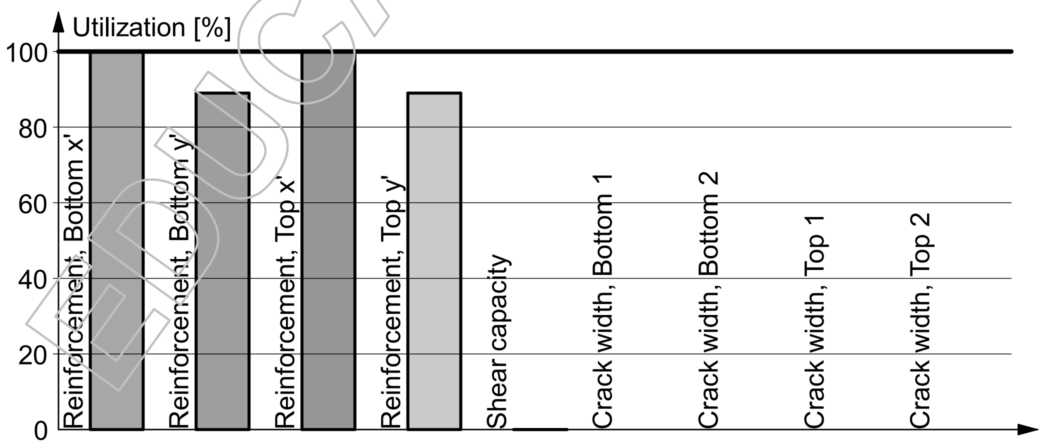
Face, direction	Bottom, α	Bottom, α+90°	Top, α	Top, α+90°
$\rho_{p,eff[face]}$	-	-	-	-
$\varepsilon_{[face]}$	-	-	-	-
$A_{c,eff[other\ face]}$ [mm^2/m]	-	-	-	-
$\varepsilon_{[other\ face]}$	-	-	-	-
Φ_{dir} [mm]	-	-	-	-
s_{dir} [mm]	-	-	-	-
k_1	-	-	-	-
k_2	-	-	-	-
k_3	-	-	-	-
k_4	-	-	-	-
$s_{r,max}$ [mm]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

Utilization

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



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