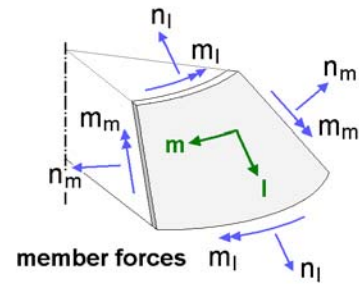
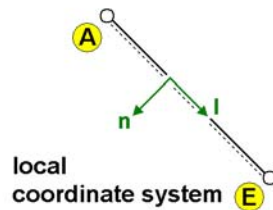
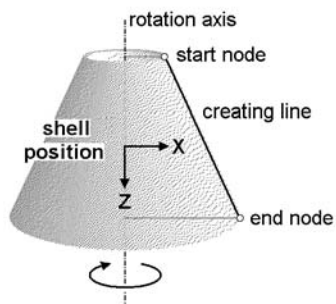


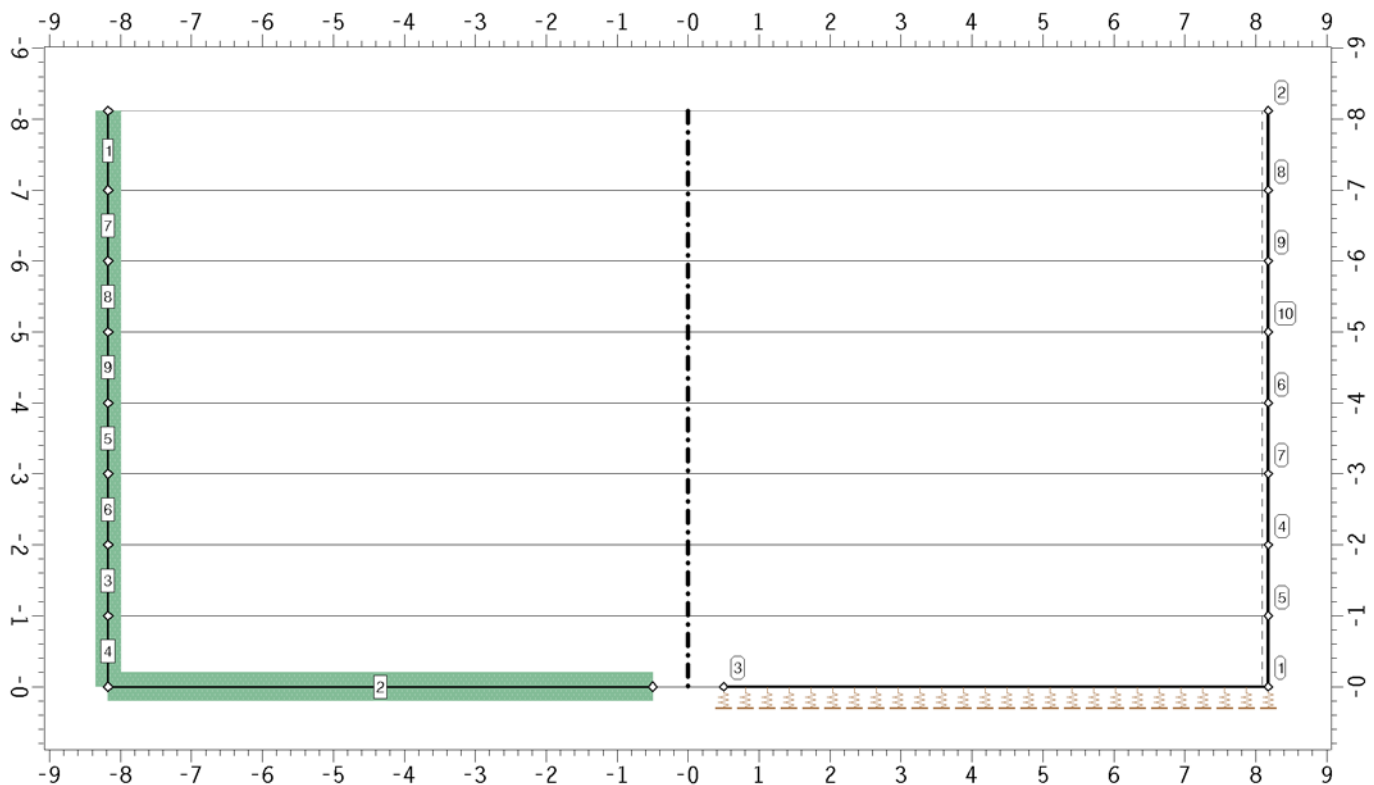
Structural Calculations of rotationally symmetrical shell structures by using the Finite Element Method



SYSTEM DESCRIPTION

System graphic

on r.h. side: node numbers, bearing information, orientation of the pos.; on l.h. side: number, thickness of the pos.



Coordinates and bearing information

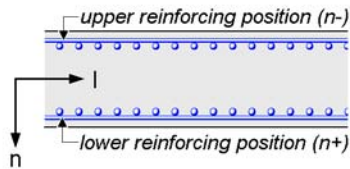
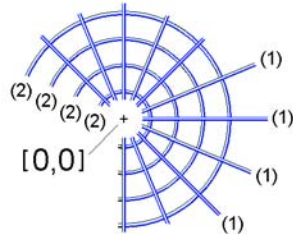
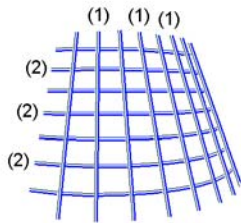
node -	X m	Z m	Cf-X MN/m ²	Cf-Z MN/m ²	Cm-Y MNm/m	designat ion -
1	8.175	0.000	-	-	-	
2	8.175	-8.120	-	-	-	
3	0.500	0.000	-	-	-	
4	8.175	-2.000	-	-	-	
5	8.175	-1.000	-	-	-	
6	8.175	-4.000	-	-	-	
7	8.175	-3.000	-	-	-	
8	8.175	-7.000	-	-	-	
9	8.175	-6.000	-	-	-	
10	8.175	-5.000	-	-	-	

Calculation values of position 1:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 2	E-modulus: 31475.81 MN/m ²	no
End node: 8	Poisson's ratio: 0.20 -	
Length: 1.12 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	
Thickn.: 35.00 cm		

Explanation of design properties



Reinforcement Layout at shells and slabs

Definition: top - bottom

Design properties of position 1:

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm	(1)above = 11.10 cm ² /m	type: orthogonal	symmetric
(2)above = 4.5 cm	(2)above = 13.20 cm ² /m	with $\alpha = 0.00^\circ$	(above as below)
(1)below = 3.5 cm	(1)below = 11.10 cm ² /m		
(2)below = 4.5 cm	(2)below = 13.20 cm ² /m		

Material properties of position 1:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 2:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 3	E-modulus: 31475.81 MN/m ²	perpendicular to shell face:
End node: 1	Poisson's ratio: 0.20 -	$C_{bn} = 10.00 \text{ MN/m}^3$
Length: 7.68 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	in shell direction:
Thickn.: 40.00 cm		no

Design properties of position 2:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm	(1)above = 11.60 cm ² /m	type: orthogonal	tensile reinforcement
(2)above = 4.5 cm	(2)above = 13.70 cm ² /m	with $\alpha = 0.00^\circ$	
(1)below = 3.5 cm	(1)below = 11.60 cm ² /m		
(2)below = 4.5 cm	(2)below = 13.70 cm ² /m		

Material properties of position 2:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Material properties of position 2:

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 3:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 4 End node: 5 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 3:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 3:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 4:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 5 End node: 1 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 4:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 4:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 5:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 6 End node: 7 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 5:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 5:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\text{‰}$ $\varepsilon_{c2u} = -3.5\text{‰}$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\text{‰}$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 6:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 7 End node: 4 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 6:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 6:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\text{‰}$ $\varepsilon_{c2u} = -3.5\text{‰}$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\text{‰}$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 7:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 8 End node: 9 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 7:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 7:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 8:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 9 End node: 10 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 8:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 8:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\%$ $\varepsilon_{c2u} = -3.5\%$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\%$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Calculation values of position 9:

Material designation: reinforced concrete C25/30

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 10 End node: 6 Length: 1.00 m Thickn.: 35.00 cm	E-modulus: 31475.81 MN/m ² Poisson's ratio: 0.20 - Temp. coeff.: 1.00 10 ⁻⁵ /K	no

Design properties of position 9:

(s.a. explanation sketch on page 2)

center distances	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)above = 3.5 cm (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 11.10 cm ² /m (2)above = 13.20 cm ² /m (1)below = 11.10 cm ² /m (2)below = 13.20 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	symmetric (above as below)

Material properties of position 9:

Verifications according to EC 2: C25/30, B500

Concrete: $\rho_c = 2200 \text{ kg/m}^3$ $f_{ck} = 25.0 \text{ MN/m}^2$ $\varepsilon_{c2} = -2.0\text{‰}$ $\varepsilon_{c2u} = -3.5\text{‰}$ $n_c = 2.00$

$E_{cm} = 31475.8 \text{ MN/m}^2$ $f_{ctm} = 2.56 \text{ MN/m}^2$

Reinforcem.: $f_{yk} = 500.0 \text{ MN/m}^2$ $f_{tk} = 525.0 \text{ MN/m}^2$ $\varepsilon_{su} = 25.0\text{‰}$ $E_s = 200000.0 \text{ MN/m}^2$

Maximum (rated) reinforcement ratio: $\max \mu = 8.0\%$

Protocol of traverses of positions

designation	(nodes) and -positions-
Shell	(2)-1-(8)-7-(9)-8-(10)-9-(6)-5-(7)-6-(4)-3-(5)-4-(1)

Description of loading structure

On the left-hand side, the relationship between the actions effects, load case file and load cases are shown in a tree structure. The right-hand side shows the characteristics of the superposition to the associated objects on the left-hand. In terms of the superposition, a load case file is equivalent to an extreme rule of the defined objects therein and can be additive or alternatively superpositioned.

Used symbols:



Action effect



Load case file



Load case

1: permanent action effect

1: dead load

2: Flüssigkeit

2: Schlamm voll

3: Schlamm halb

3: permanent load

4: Erdruchedruck

4: prestressing

5: prestressing

permanent loads

additive

fluid pressure/engine loads ($\gamma=1.35$)

alternative in group A

alternative in group A

permanent loads

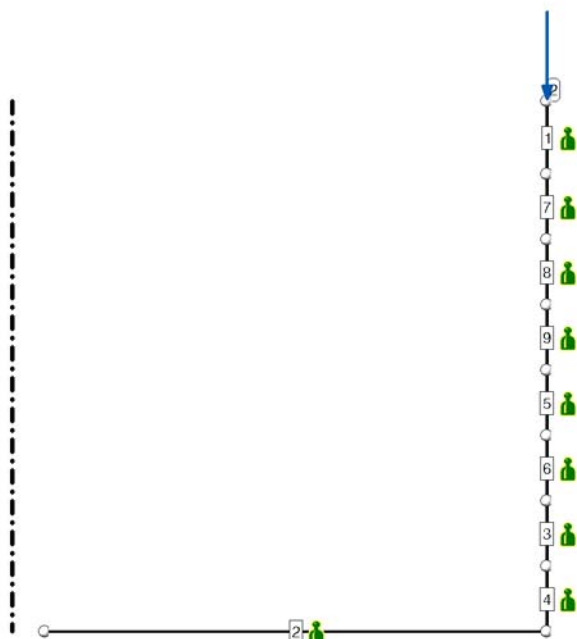
additive

prestressing

additive

LOAD PICTURES IN LOAD CASE 1: DEAD LOAD

Loaded objects in load case 1



dead loads in load case 1

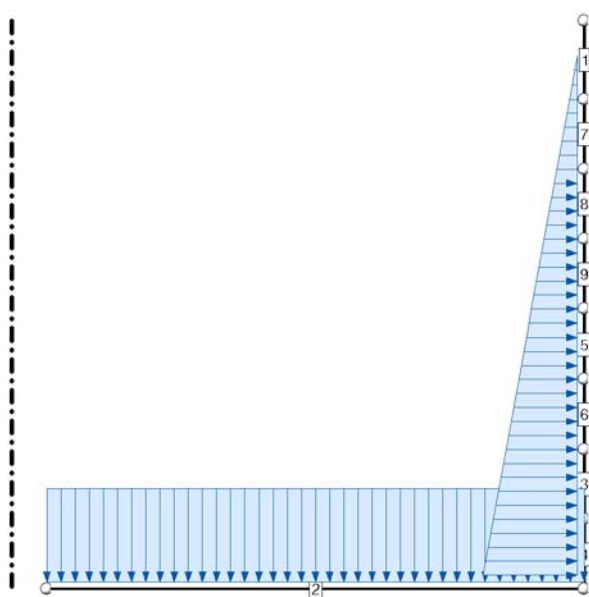
pos.	max.density	pos.	max.density	pos.	max.density
-	kN/m ³	-	kN/m ³	-	kN/m ³
2	25.000	4	25.000	7	25.000
1	25.000	5	25.000	8	25.000
3	25.000	6	25.000	9	25.000

Ring loads in load case 1

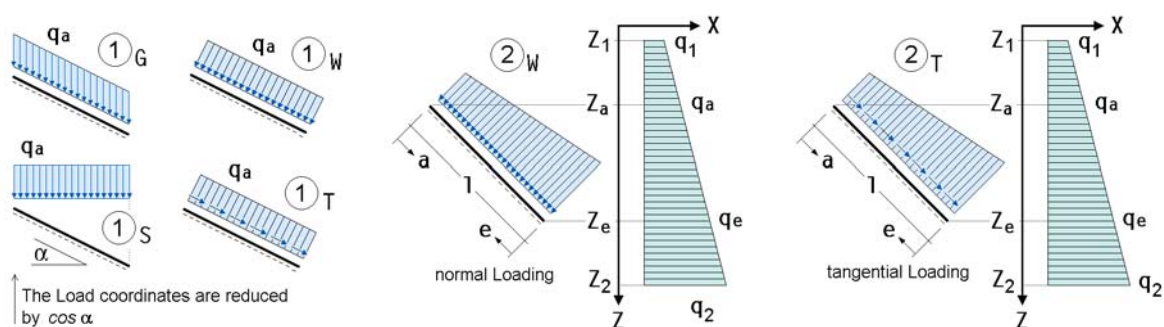
point	syst.	Px	Pz	My	length
-	-	kN/m	kN/m	kNm/m	m
2	X-Y-Z	0.000	10.000	0.000	51.365

LOAD PICTURES IN LOAD CASE 2: SCHLAMM VOLL

Loaded objects in load case 2



Explanation of load types and load directions



Area loads in load case 2

Loads depending on Z-coordinate (type 2), Z₁ and Z₂ define the load interval. Thereby the positions are u.c. partially loaded. Subscript A refers to the load distance of the start node and subscript E to the load distance of the end node. l is the loaded section.

pos.	type	q _a	q _e	a	l	e	z ₁	q ₁	z ₂	q ₂
-	-	kN/m ²	kN/m ²	m	m	m	m	kN/m ²	m	kN/m ²
1	2W	0.000	-6.820	0.500	0.620	0.000	-7.620	0.000	-0.200	-81.620
2	1G	81.620	-	-	7.675	-	-	-	-	-
3	2W	-61.820	-72.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620
4	2W	-72.820	-81.620	0.000	0.800	0.200	-7.620	0.000	-0.200	-81.620
5	2W	-39.820	-50.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620
6	2W	-50.820	-61.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620

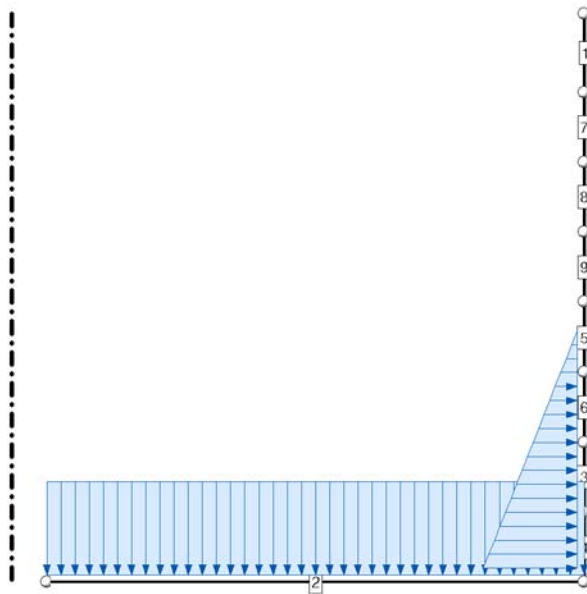
Area loads in load case 2

Loads depending on Z-coordinate (type 2), Z_1 and Z_2 define the load interval. Thereby the positions are u.c. partially loaded.
Subscript A refers to the load distance of the start node and subscript E to the load distance of the end node. l is the loaded section.

pos. -	type -	q_a kN/m ²	q_e kN/m ²	a m	l m	e m	z1 m	q1 kN/m ²	z2 m	q2 kN/m ²
7	2W	-6.820	-17.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620
8	2W	-17.820	-28.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620
9	2W	-28.820	-39.820	0.000	1.000	0.000	-7.620	0.000	-0.200	-81.620

LOAD PICTURES IN LOAD CASE 3: SCHLAMM HALB

Loaded objects in load case 3



Area loads in load case 3

Loads depending on Z-coordinate (type 2), Z_1 and Z_2 define the load interval. Thereby the positions are u.c. partially loaded.
Subscript A refers to the load distance of the start node and subscript E to the load distance of the end node. l is the loaded section.
(s.a. explanation sketch on page 7)

pos. -	type -	q_a kN/m ²	q_e kN/m ²	a m	l m	e m	z1 m	q1 kN/m ²	z2 m	q2 kN/m ²
2	1G	37.400	-	-	7.675	-				
3	2W	-17.600	-28.600	0.000	1.000	0.000	-3.600	0.000	-0.200	-37.400
4	2W	-28.600	-37.400	0.000	0.800	0.200	-3.600	0.000	-0.200	-37.400
5	2W	0.000	-6.600	0.400	0.600	0.000	-3.600	0.000	-0.200	-37.400
6	2W	-6.600	-17.600	0.000	1.000	0.000	-3.600	0.000	-0.200	-37.400

LOAD PICTURES IN LOAD CASE 4: ERDRUHEDRUCK

Loaded objects in load case 4



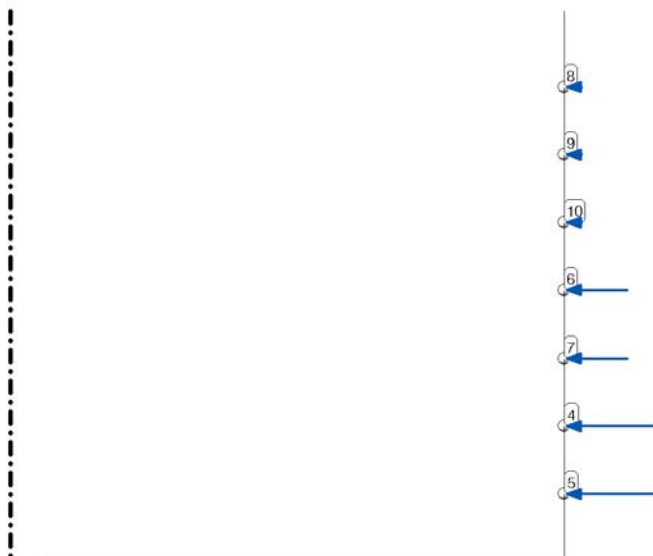
Area loads in load case 4

Loads depending on Z-coordinate (type 2), Z_1 and Z_2 define the load interval. Thereby the positions are u.c. partially loaded. Subscript A refers to the load distance of the start node and subscript E to the load distance of the end node. I is the loaded section. (s.a. explanation sketch on page 7)

pos.	type	q_a kN/m ²	q_e kN/m ²	a m	l m	e m	z_1 m	q_1 kN/m ²	z_2 m	q_2 kN/m ²
3	2W	0.000	0.488	0.970	0.030	0.000	-1.030	0.000	0.200	20.000
4	2W	0.488	16.748	0.000	1.000	0.000	-1.030	0.000	0.200	20.000

LOAD PICTURES IN LOAD CASE 5: PRESTRESSING

Loaded objects in load case 5



Ring loads in load case 5

point	syst.	Px	Pz	My	length
-	-	kN/m	kN/m	kNm/m	m
6	X-Y-Z	-80.000	0.000	0.000	51.365
7	X-Y-Z	-80.000	0.000	0.000	51.365
4	X-Y-Z	-120.000	0.000	0.000	51.365
5	X-Y-Z	-120.000	0.000	0.000	51.365
10	X-Y-Z	-20.000	0.000	0.000	51.365
9	X-Y-Z	-20.000	0.000	0.000	51.365
8	X-Y-Z	-20.000	0.000	0.000	51.365

VERIFICATIONS

meanings in case of application of superposition rule acc. to Eurocode:

Ψ_{dom}	Combination coefficient of a leading traffic load action	(leading load action)
Ψ_{sub}	Combination coefficient of a non-leading traffic load action	(accompanying load action)
γ_{sup}	Partial safety factor for unfavourable load positions	
γ_{inf}	Partial safety factor for favourable load positions	

meanings in case of application of superposition rule acc. to DIN 18800:

Ψ_{dom}	Combination coefficient of a main combination
Ψ_{sub}	Combination coefficient of a minor combination

Superposition rules of bridge construction and DIN 1055-100 behave like Eurocode.
In non-linear analysis, rules of extremization will not be considered

If verifications according to Eurocode are listed below, the following applies:
The national annex "Germany" is taken into account.

Verification 1: EC 2 Design calculation

EC 2 Design calculation: Verification of ultimate limit state according to Eurocode 2 (6.1, 6.2, 6.3)

Design options of verification 1:

Bending design calculation

- ☒ Shear design calculation (limitation of z only NA-DE)
 - ☒ z of bending design calculation
 - ☐ $z = 0.9 d \leq d - 2 c_v$
 - ☐ z aus bend. moment $\leq d - 2 c_v$
 - ☐ NO limitation of VR_{dct}
- ☒ with minimum/transverse reinforcement (bending, shear)

1: automatic (pat ds)

Rules of extremization of verification 1, type: standard, rule of superposition: Eurocode

action	Ψ_{dom}	Ψ_{sub}	γ_{sup}	γ_{inf}
1	1.00	1.00	1.35	1.00
2	1.00	1.00	1.35	0.00
3	1.00	1.00	1.35	1.00
4	1.00	1.00	1.00	1.00

Table of design positions (Verification 1)

Explanations: column (Mp), (Mw): Minimum reinforcement of slabs and/or walls (for reinforcement direction B1)
 Column (Q): transverse reinf. - minimum portions of main reinf.; column (S): shear design calc. (with 'no' resp. 'with' min. reinf. of shear)
 Column (P): if possible, avoid shear reinf. (increasing the longitudinal reinf.)
 BSt_l, BSt_q: steel quality of longitudinal, shear reinforcement; c_{v,D}: concrete cover of compression reinf.;
 ⊙: angle of compression strut (0 = minimum, * = simplified assumption);
 Description of material see: 'Material properties of position'

pos.	concrete	BSt _l	(Mp)	(Mw)	(Q)	(S)	BSt _q	c _{v,D} cm	⊙ °	(P)
1	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
2	C25/30	B500	yes	no	0.20	with	B500	2.0	45	no
3	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
4	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
5	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
6	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
7	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
8	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no
9	C25/30	B500	no	B1	0.20	with	B500	3.0	45	no

Verification 2: EC 2 Stress verification

EC 2 Stress verification: Verification of serviceability limit state according to Eurocode 2 (7.2)

Design options of verification 2:

- ☒ Check of initial reinforcement
- ☒ compressive stresses of concrete
- ☒ tensile stresses of reinforcement

Stress-strain-diagram of concrete

- ☐ according to 3.1.7 (parabola rectangle)
- ☒ according to 3.1.5 (realistic)
- ☐ linear with $\alpha = E_s/E_{cm}$

1: Standard combination

Rules of extremization of verification 2, type: standard, rule of superposition: Eurocode

action	Ψ_{dom}	Ψ_{sub}	γ_{sup}	γ_{inf}
1	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	0.00
3	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00

Table of design positions (Verification 2)

Explanations: zul $\sigma_c = fak_{\sigma c} \cdot f_{ck}$: allowable compressive stress of concrete; zul $\sigma_s = fak_{\sigma s} \cdot f_{yk}$: allowable tensile stress
 Concrete, steel quality of longitudinal reinforcement see 'Design properties of position'
 Influences of creeps and shrinks are taken into account about a modification of the stress-strain-diagram of concrete with $\varphi_{\infty,t0}$ and $\epsilon_{CS,\infty}$.

pos.	fak _{σc}	zul σ _c N/mm ²	fak _{σs}	zul σ _s N/mm ²	pos.	fak _{σc}	zul σ _c N/mm ²	fak _{σs}	zul σ _s N/mm ²
1	0.600	-15.0	0.800	400.0	6	0.600	-15.0	0.800	400.0
2	0.600	-15.0	0.800	400.0	7	0.600	-15.0	0.800	400.0
3	0.600	-15.0	0.800	400.0	8	0.600	-15.0	0.800	400.0
4	0.600	-15.0	0.800	400.0	9	0.600	-15.0	0.800	400.0
5	0.600	-15.0	0.800	400.0					

Verification 3: EC 2 Crack limitation

EC 2 Crack limitation: Verification of serviceability limit state according to Eurocode 2 (7.3)

Design options of verification 3:

- ☒ according to design code (without direct analysis)
- ☐ according to design code (direct analysis)
- ☐ according to Schießl
- ☐ according to Noakowski
- ☒ Check of initial reinforcement
- ☒ Minimum reinforcement (due to restraint)
- ☒ Control of crack width (due to load)

Stress-strain-diagram of concrete

- ☐ according to 3.1.7 (parabola rectangle)
- ☒ according to 3.1.5 (realistic)
- ☐ linear with $\alpha = E_s/E_{cm}$

1: Standard combination

Rules of extremization of verification 3, type: standard, rule of superposition: Eurocode

action	Ψ_{dom}	Ψ_{sub}	γ_{sup}	γ_{inf}
1	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	0.00
3	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00

Table of design positions (Verification 3)

Explanations:

Abbreviation of reinforcement positions: reinforcement direction 1: 1o = above, 1u = below, reinforcement direction 2: 2o = above, 2u = below

First cracking due to flexural or centric restraint (tensile restraint).

factor for recording the time of observation k_{zt} (Cracks due to restraint and load: k_{zt} for the share from restraint, k_{zt0} for the share from load)

Concrete, steel quality of longitudinal reinforcement see 'Design properties of position'

Influences of creeps and shrinks are taken into account about a modification of the stress-strain-diagram of concrete with $\varphi_{\infty,t0}$ and $\epsilon_{CS,\infty}$.

pos.	Ø of crack-distr.				crack width		cracks from load	time factors		initial cracking from	slowly hardening concrete	duration of load effect
	long.reinf. in mm				w_{ko} in mm	w_{ku}		k_{zt}	k_{zt0}			
	1o	2o	1u	2u								
1	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
2	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
3	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
4	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
5	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
6	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
7	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
8	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term
9	8	8	8	8	0.10	0.10	yes	0.65	1.00	tens.restr	no	long term

Verification 4: EC 2 Verification of tightness

EC 2 Verification of tightness: Verification of serviceability limit state

Design options of verification 4:

- ☒ Check of initial reinforcement

Stress-strain-diagram of concrete

- ☐ according to 3.1.7 (parabola rectangle)
- ☒ according to 3.1.5 (realistic)
- ☐ linear with $\alpha = E_s/E_{cm}$

1: Standard combination

Rules of extremization of verification 4, type: standard, rule of superposition: Eurocode

action	Ψ_{dom}	Ψ_{sub}	γ_{sup}	γ_{inf}
1	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	0.00
3	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00

Table of design positions (Verification 4)

Explanations: min x_D : minimum thickness of pressure zone

Concrete, steel quality of longitudinal reinforcement see 'Design properties of position'

Influences of creeps and shrinks are taken into account about a modification of the stress-strain-diagram of concrete with φ_{∞,t_0} and $\epsilon_{CS,\infty}$.

pos.	min x_D mm	pos.	min x_D mm	pos.	min x_D mm
1	30.0	4	30.0	7	30.0
2	30.0	5	30.0	8	30.0
3	30.0	6	30.0	9	30.0

Verification 5: EC 2 Fatigue design

EC 2 Fatigue design: Verification of ultimate limit state according to Eurocode 2 (6.8)

Design options of verification 5:

- ☒ Check of initial reinforcement
- ☒ Check of reinforcement
- ☒ Check of concrete

Stress-strain-diagram of concrete

- ☐ according to 3.1.7 (parabola rectangle)
- ☒ according to 3.1.5 (realistic)
- ☐ linear with $\alpha = E_s/E_{cm}$

1: Standard combination

Rules of extremization of verification 5, type: standard, rule of superposition: Eurocode

action	Ψ_{dom}	Ψ_{sub}	γ_{sup}	γ_{inf}
1	1.00	1.00	1.00	1.00
2	1.00	1.00	1.00	0.00
3	1.00	1.00	1.00	1.00
4	1.00	1.00	1.00	1.00

Table of design positions (Verification 5)

Explanations: $\Delta\sigma_{Rsk}$: fatigue range of stress for N' load cycles; t_0 : time of initial loading of concrete

Concrete, steel quality of longitudinal reinforcement see 'Design properties of position'

Influences of creeps and shrinks are taken into account about a modification of the stress-strain-diagram of concrete with φ_{∞,t_0} and $\epsilon_{CS,\infty}$.

pos.	$\Delta\sigma_{Rsk}$ N/mm ²	t_0 d	pos.	$\Delta\sigma_{Rsk}$ N/mm ²	t_0 d	pos.	$\Delta\sigma_{Rsk}$ N/mm ²	t_0 d
1	85.0	30	4	85.0	30	7	85.0	30
2	85.0	28	5	85.0	30	8	85.0	30
3	85.0	30	6	85.0	30	9	85.0	30

REGULATIONS

DIN EN 1990, Eurocode 0: Grundlagen der Tragwerksplanung;

Deutsche Fassung EN 1990:2002 + A1:2005 + A1:2005/AC:2010, Ausgabe Dezember 2010

DIN EN 1990/NA, Nationaler Anhang zur DIN EN 1990, Ausgabe Dezember 2010

DIN EN 1992-1-1, Eurocode 2: Bemessung und Konstruktion von Stahlbeton- und Spannbetonbauteilen - Teil 1-1: Allgemeine Bemessungsregeln und Regeln für den Hochbau;

Deutsche Fassung EN 1992-1-1:2004 + AC:2010, Ausgabe Januar 2011

DIN EN 1992-1-1/NA, Nationaler Anhang zur DIN EN 1992-1-1, Ausgabe Januar 2011

DAfStb-Richtlinie: Betonbau beim Umgang mit wassergefährdenden Stoffen (WU-Richtlinie)
Ausgabe Dezember 2017

NATIONAL ANNEXES OF EUROCODES

Load factors (building construction) of the National Annex

Germany

Partial safety factor for actions of permanent and transient design situation

Type of action effect	γ_{Fsup}	γ_{Finf}
permanent loads	1.35	1.00
transient loads	1.50	0.00
fluid pressure/engine loads	1.35	0.00
restraint	1.00	0.00
prestressing	1.00	1.00

Partial safety factor for actions of accidental design situation

Type of action effect	γ_{Fsup}	γ_{Finf}
permanent loads	1.00	1.00
transient loads	1.00	0.00
fluid pressure/engine loads	1.00	0.00
restraint	1.00	0.00
prestressing	1.00	1.00
accidental action effects	1.00	1.00

Partial safety factor for actions of earthquake situation

Type of action effect	γ_{Fsup}	γ_{Finf}
permanent loads	1.00	1.00
transient loads	1.00	0.00
fluid pressure/engine loads	1.00	0.00
restraint	1.00	0.00
prestressing	1.00	1.00
earthquake	1.00	1.00

Partial safety factor for actions of design of serviceability and fatigue

Type of action effect	γ_{Fsup}	γ_{Finf}
permanent loads	1.00	1.00
transient loads	1.00	0.00
fluid pressure/engine loads	1.00	0.00
restraint	1.00	0.00
prestressing	1.00	1.00

Combination coefficients

The values in Ψ_{2E} -column are the Ψ_2 -values for the earthquake design situation

Action effect	Category	Ψ_0	Ψ_1	Ψ_2	Ψ_{2E}
housing, office rooms	A, B	0.70	0.50	0.30	0.30
Assembly, salesrooms	C, D	0.70	0.70	0.60	0.60
storage rooms	E	1.00	0.90	0.80	0.80
vehicles up to 30 kN	F	0.70	0.70	0.60	0.60
vehicles up to 160 kN	G	0.70	0.50	0.30	0.30
roofs	H	0.00	0.00	0.00	0.00
snow/ice up to 1000 m alt.		0.50	0.20	0.00	0.50
snow/ice above 1000 m alt.		0.70	0.50	0.20	0.50
wind		0.60	0.20	0.00	0.00
temperature		0.60	0.50	0.00	0.00
soil settlements		1.00	1.00	1.00	1.00
other action effects		0.80	0.70	0.50	0.50

Note: Fluid pressure/engine loads, restraint or soil settlements, other action effects take no part to EN 1990 (Eurocode).

Applied design parameters of the National Annex

Germany

DIN EN 1992-1-1 (EC 2, building construction), NA Germany

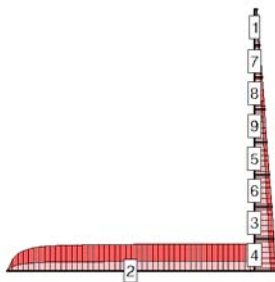
Chapter	Value	Meaning
2.4.2.4(1)	$\gamma_c = 1.50$ $\gamma_s = 1.15$ $\gamma_c = 1.50$ $\gamma_s = 1.15$ $\gamma_c = 1.50$ $\gamma_s = 1.15$ $\gamma_c = 1.30$ $\gamma_s = 1.00$	Partial safety factors for concrete and reinforcement Permanent and transient design situation Fatigue design situation Earthquake design situation Accidental design situation
2.4.2.4(2)	$\gamma_c = 1.00$ $\gamma_s = 1.00$	Serviceability limit state
3.1.6(1)P	$\alpha_{cc} = 0.85$	Reduction factor of compression strength of concrete
3.1.6(2)P	$\alpha_{ct} = 1.00$	Reduction factor of tensile strength of concrete
6.2.2(1)	$C_{Rd,c} = 0.15 / \gamma_c$ $v_{min} = 0.0525 / \gamma_c \cdot k^{3/2} \cdot f_{ck}^{1/2}$ $k_1 = 0.12$	Coeff. to calculate the resistance of shear force
6.2.2(6)	$v_V = 0.675$	Reduction factor of strength of shear force
6.2.3(2)	$\min \cot \Theta = 1.00$ $\max \cot \Theta = 3.00$	lower bound of strut gradient upper bound of strut gradient
6.2.3(3)	$\alpha_{cw} = 1.00$ $v_1 = 0.750$	Coeff. to consider the state of stress in the compress. boom Coeff. to calculate the max. design resistance of shear force
6.8.4(1)	$\gamma_{F,fat} = 1.00$	Fatigue: Safety factor of action effects

Chapter	Value	Meaning
6.8.7(1)	$k_1 = 1.00$	Fatigue: Coeff. to calculate the design strength of concrete
7.3.4(3)	$k_3 = 0.00$ $k_4 = 0.278$	Cracks: Coeff. to calculate the maximum crack distance if fracture pattern is completed Cracks: Coeff. to calculate the maximum crack distance if fracture pattern is completed
9.2.1.1(1)	$A_{s,min}$ s. NA-DE	Minimum reinforcement for beams and plates [cm ²]
9.2.2(5)	$\rho_{w,min}$ s. NA-DE	Minimum ratio of shear force reinforcement
11.3.5(1)	$\alpha_{lcc} = 0.75$	Lightw.conc.: Reduction factor of compression strength of concrete
11.3.5(2)	$\alpha_{lct} = 1.00$	Lightw.conc.: Reduction factor of tensile strength of concrete
11.6.1(1)	$C_{lRd,c} = 0.15 / \gamma_c$ $v_{l,min} = 0.0525 k^{3/2} f_{lck}^{1/2}$ $k_{l1} = 0.12$	Lightw.conc.: Coeff. to calculate the resistance of shear force
11.6.1(2)	$v_l = 0.675 \eta_l$	Lightw.conc.: Reduction factor of strength of shear force
11.6.2(1)	$v_{l1} = 0.750 \eta_l$	Lightw.conc.: Coeff. to calculate the maximum design resistance of shear force

VERIFICATION 1: SUMMARY

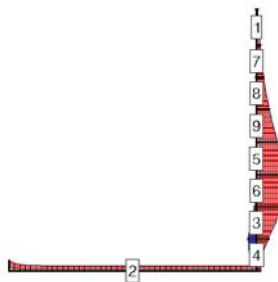
Normal force n_l

Min/Max: -133.57/0.00 kN/m



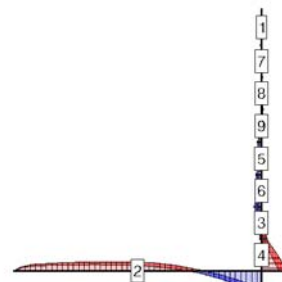
Normal force n_m

Min/Max: -720.19/221.01 kN/m



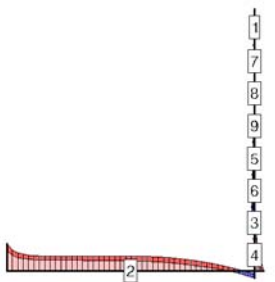
Internal moment m_l

Min/Max: -136.24/136.24 kNm/m



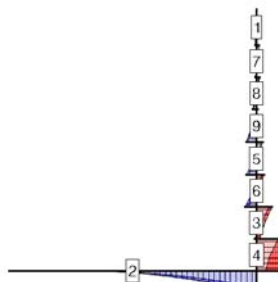
Internal moment m_m

Min/Max: -82.20/21.13 kNm/m



Shear force q_l

Min/Max: -137.71/109.42 kN/m



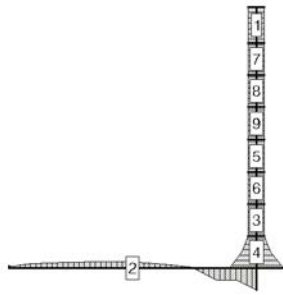
Extremal member forces

node	s	type	n _l	n _m	m _l	m _m	q _l
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
Shell travers 1: Shell 1							
2	0.00	Min	-13.50	-36.32	0.00	0.00	0.00
		Max	-10.00	10.57	0.00	0.00	0.00
8	0.56	Min	-20.11	-46.32	0.15	0.03	1.14
		Max	-14.90	-27.12	0.63	0.13	2.18
	1.12	Min	-26.73	-101.22	1.95	0.39	5.90
		Max	-19.80	-14.79	2.88	0.58	6.47
Shell travers 1: Shell 7							
8	1.12	Min	-26.73	-100.43	1.95	0.39	-14.10
		Max	-19.80	-16.32	2.88	0.58	-13.53
	1.62	Min	-32.64	-146.56	-3.42	-0.68	-6.99
		Max	-24.17	0.04	-2.26	-0.45	-6.17

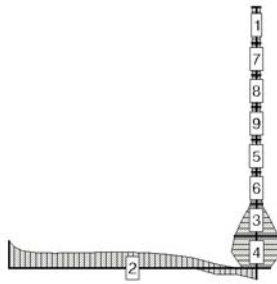
Extremal member forces

node	s	type	n _l	n _m	m _l	m _m	q _l
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
9	2.12	Min	-38.54	-199.43	-4.53	-0.91	2.98
		Max	-28.55	11.72	-3.16	-0.63	4.40
Shell travers 1: Shell 8							
9	2.12	Min	-38.54	-198.23	-4.53	-0.91	-17.02
		Max	-28.55	10.59	-3.16	-0.63	-15.60
	2.62	Min	-44.45	-263.24	-9.83	-1.97	-3.54
		Max	-32.92	10.98	-8.01	-1.60	-1.46
10	3.12	Min	-50.35	-349.89	-7.25	-1.45	14.04
		Max	-37.30	-10.12	-4.29	-0.86	17.21
Shell travers 1: Shell 9							
10	3.12	Min	-50.35	-346.95	-7.25	-1.45	-5.96
		Max	-37.30	-9.80	-4.29	-0.86	-2.79
	3.62	Min	-56.26	-457.98	-4.03	-0.81	17.14
		Max	-41.67	-48.30	0.10	0.02	21.36
6	4.12	Min	-62.17	-572.73	12.13	2.43	46.40
		Max	-46.05	-89.21	18.00	3.60	51.62
Shell travers 1: Shell 5							
6	4.12	Min	-62.17	-569.39	12.13	2.43	-33.60
		Max	-46.05	-89.44	18.00	3.60	-28.38
	4.62	Min	-68.07	-659.90	3.83	0.77	1.22
		Max	-50.42	-99.51	11.95	2.39	8.91
7	5.12	Min	-73.98	-717.67	14.06	2.81	39.95
		Max	-54.80	-83.28	24.12	4.82	50.33
Shell travers 1: Shell 6							
7	5.12	Min	-73.98	-717.33	14.06	2.81	-40.05
		Max	-54.80	-85.89	24.12	4.82	-29.67
	5.62	Min	-79.89	-720.19	4.58	0.92	-0.31
		Max	-59.17	-32.98	19.65	3.93	14.26
4	6.12	Min	-85.79	-657.59	15.74	3.15	39.17
		Max	-63.55	47.79	36.08	7.22	56.42
Shell travers 1: Shell 3							
4	6.12	Min	-85.79	-662.77	15.74	3.15	-80.83
		Max	-63.55	42.76	36.08	7.22	-63.58
	6.62	Min	-91.70	-515.11	-15.13	-3.03	-43.21
		Max	-67.93	149.97	13.64	2.73	-27.68
5	7.12	Min	-97.61	-318.84	-27.70	-5.54	-17.71
		Max	-72.30	221.01	6.72	1.34	8.45
Shell travers 1: Shell 4							
5	7.12	Min	-97.61	-327.62	-27.70	-5.54	-137.71
		Max	-72.30	218.97	6.72	1.34	-111.55
	7.62	Min	-103.51	-135.36	-82.29	-16.46	-130.85
		Max	-76.68	190.87	-50.83	-10.17	-71.14
1	8.12	Min	-109.42	-116.50	-136.24	-27.25	-133.57
		Max	-81.05	-52.93	-89.59	-17.92	-47.43
Shell 2							
3	0.00	Min	0.00	-275.31	0.00	-82.20	0.00
		Max	0.00	-97.77	0.00	-60.22	0.00
	0.18	Min	-61.60	-204.79	-18.79	-63.30	-1.17
		Max	-21.88	-72.73	-13.79	-46.38	-0.54
	0.54	Min	-103.07	-164.74	-31.92	-50.64	-2.80
		Max	-36.60	-58.50	-23.53	-37.16	-1.22
	1.61	Min	-126.59	-141.51	-42.49	-44.73	-4.95
		Max	-44.96	-50.25	-30.42	-32.99	-1.52
	3.22	Min	-131.66	-136.46	-47.67	-46.03	0.30
		Max	-46.76	-48.46	-30.30	-31.98	4.13
	5.73	Min	-133.21	-134.92	-7.87	-33.83	31.55
		Max	-47.31	-47.91	8.40	-18.06	46.65
1	7.68	Min	-133.57	-134.55	89.59	9.13	81.05
		Max	-47.43	-47.78	136.24	21.13	109.42
Minimum			-133.57	-720.19	-136.24	-82.20	-137.71
Maximum			0.00	221.01	136.24	21.13	109.42

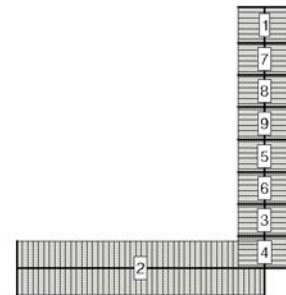
Req. reinforcement as_{b1}
Max: as_{b1o}/as_{b1u} : 8.81/8.81 cm^2/m



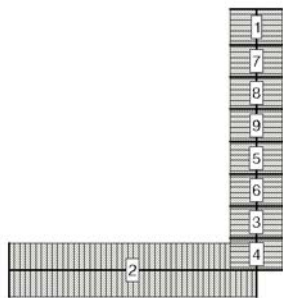
Req. reinforcement as_{b2}
Max: as_{b2o}/as_{b2u} : 3.43/3.17 cm^2/m



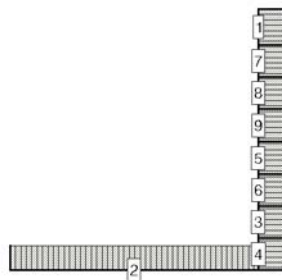
Longitudinal reinf. as_1
Max: as_{1o}/as_{1u} : 11.60/11.60 cm^2/m



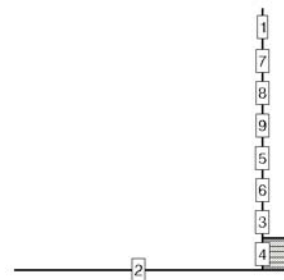
Longitudinal reinf. as_2
Max: as_{2o}/as_{2u} : 13.70/13.70 cm^2/m



Reinforcement ratio μ_s
Max: 1.39 %



Shear reinforcement as_q
Max: 10.78 cm^2/m^2

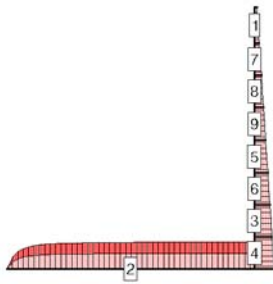


Reinforcement

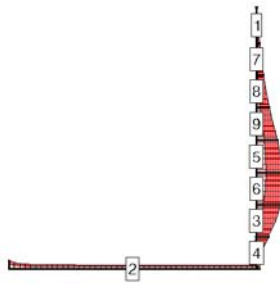
node	s	as_{1o}	as_{2o}	as_{1u}	as_{2u}	μ_s	as_q
-	m	cm^2/m	cm^2/m	cm^2/m	cm^2/m	%	cm^2/m
Shell travers 1: Shell 1							
2	0.00	11.10	13.20	11.10	13.20	1.39	0.00
8	1.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 7							
8	1.12	11.10	13.20	11.10	13.20	1.39	0.00
9	2.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 8							
9	2.12	11.10	13.20	11.10	13.20	1.39	0.00
10	3.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 9							
10	3.12	11.10	13.20	11.10	13.20	1.39	0.00
6	4.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 5							
6	4.12	11.10	13.20	11.10	13.20	1.39	0.00
7	5.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 6							
7	5.12	11.10	13.20	11.10	13.20	1.39	0.00
4	6.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 3							
4	6.12	11.10	13.20	11.10	13.20	1.39	0.00
5	7.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 4							
5	7.12	11.10	13.20	11.10	13.20	1.39	10.78
	7.62	11.10	13.20	11.10	13.20	1.39	9.55
1	8.12	11.10	13.20	11.10	13.20	1.39	9.31
Shell 2							
3	0.00	11.60	13.70	11.60	13.70	1.26	0.00
1	7.68	11.60	13.70	11.60	13.70	1.26	0.00
Minimum		11.10	13.20	11.10	13.20	1.26	0.00
Maximum		11.60	13.70	11.60	13.70	1.39	10.78

VERIFICATION 2: SUMMARY

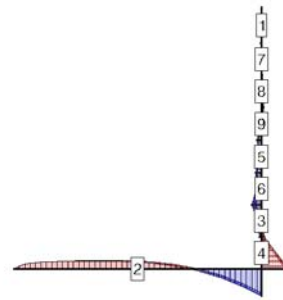
Normal force n_l
Min/Max: -110.28/0.00 kN/m



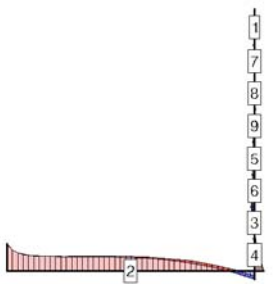
Normal force n_m
Min/Max: -718.99/60.52 kN/m



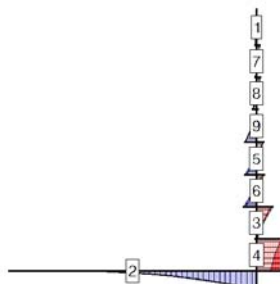
Internal moment m_l
Min/Max: -106.28/106.28 kNm/m



Internal moment m_m
Min/Max: -61.20/18.73 kNm/m



Shear force q_l
Min/Max: -122.53/81.05 kN/m



Extremal member forces

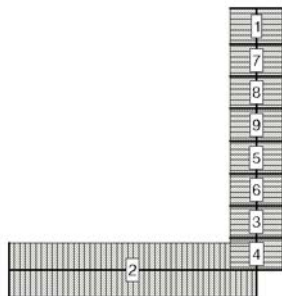
node	s	type	n1	n _m	m1	m _m	q1
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
Shell travers 1: Shell 1							
2	0.00	Min	-10.00	-24.39	0.00	0.00	0.00
		Max	-10.00	9.56	0.00	0.00	0.00
8	0.56	Min	-14.90	-45.61	0.16	0.03	1.19
		Max	-14.90	-31.48	0.51	0.10	1.92
	1.12	Min	-19.80	-99.02	1.98	0.40	5.92
		Max	-19.80	-35.63	2.65	0.53	6.33
Shell travers 1: Shell 7							
8	1.12	Min	-19.80	-97.96	1.98	0.40	-14.08
		Max	-19.80	-36.51	2.65	0.53	-13.67
9	1.62	Min	-24.17	-142.69	-3.40	-0.68	-6.99
		Max	-24.17	-35.66	-2.56	-0.51	-6.44
	2.12	Min	-28.55	-194.48	-4.53	-0.91	2.98
		Max	-28.55	-40.38	-3.56	-0.71	3.86
Shell travers 1: Shell 8							
9	2.12	Min	-28.55	-192.99	-4.53	-0.91	-17.02
		Max	-28.55	-40.82	-3.56	-0.71	-16.14
10	2.62	Min	-32.92	-257.82	-9.83	-1.97	-3.52
		Max	-32.92	-57.79	-8.65	-1.73	-2.32
	3.12	Min	-37.30	-345.83	-7.23	-1.45	14.26
		Max	-37.30	-97.27	-5.44	-1.09	16.07
Shell travers 1: Shell 9							
10	3.12	Min	-37.30	-342.56	-7.23	-1.45	-5.74
		Max	-37.30	-96.18	-5.44	-1.09	-3.93
6	3.62	Min	-41.67	-455.13	-4.00	-0.80	17.71
		Max	-41.67	-153.87	-1.65	-0.33	20.14
	4.12	Min	-46.05	-572.73	12.43	2.49	47.53
		Max	-46.05	-215.71	15.70	3.14	50.64
Shell travers 1: Shell 5							
6	4.12	Min	-46.05	-569.39	12.43	2.49	-32.47
		Max	-46.05	-214.59	15.70	3.14	-29.36
	4.62	Min	-50.42	-659.70	4.87	0.97	3.07
		Max	-50.42	-251.69	9.48	1.90	8.26

Extremal member forces

node	s	type	n ₁	n _m	m ₁	m _m	q ₁
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
7	5.12	Min	-54.80	-717.05	16.21	3.24	42.90
		Max	-54.80	-264.76	22.17	4.43	50.33
Shell travers 1: Shell 6							
7	5.12	Min	-54.80	-716.73	16.21	3.24	-37.10
		Max	-54.80	-265.89	22.17	4.43	-29.67
	5.62	Min	-59.17	-718.99	8.18	1.64	5.16
		Max	-59.17	-241.43	18.30	3.66	14.21
	6.12	Min	-63.55	-655.62	21.43	4.29	47.68
		Max	-63.55	-181.85	36.08	7.22	56.28
Shell travers 1: Shell 3							
4	6.12	Min	-63.55	-660.83	21.43	4.29	-72.32
		Max	-63.55	-186.05	36.08	7.22	-63.72
	6.62	Min	-67.93	-512.40	-4.47	-0.89	-31.89
		Max	-67.93	-83.03	13.55	2.71	-27.97
	7.12	Min	-72.30	-315.67	-10.98	-2.20	-2.53
		Max	-72.30	16.28	6.44	1.29	5.26
Shell travers 1: Shell 4							
5	7.12	Min	-72.30	-324.45	-10.98	-2.20	-122.53
		Max	-72.30	12.41	6.44	1.29	-114.74
	7.62	Min	-76.68	-132.54	-59.85	-11.97	-110.92
		Max	-76.68	60.52	-51.26	-10.25	-81.45
	8.12	Min	-81.05	-92.84	-106.28	-21.26	-110.28
		Max	-81.05	-63.28	-93.92	-18.78	-63.73
Shell 2							
3	0.00	Min	0.00	-227.31	0.00	-61.20	0.00
		Max	0.00	-131.36	0.00	-60.47	0.00
	0.18	Min	-50.86	-169.09	-13.99	-47.13	-0.77
		Max	-29.39	-97.71	-13.84	-46.58	-0.54
	0.36	Min	-73.28	-147.54	-20.27	-40.91	-1.35
		Max	-42.34	-85.26	-20.11	-40.45	-0.93
	1.43	Min	-103.32	-118.03	-30.41	-33.19	-3.00
		Max	-59.71	-68.20	-29.88	-33.19	-1.66
	2.86	Min	-108.26	-113.11	-34.00	-33.45	-0.40
		Max	-62.56	-65.36	-31.29	-32.36	2.05
	5.73	Min	-109.98	-111.40	-1.51	-22.93	32.69
		Max	-63.56	-64.37	8.31	-18.10	35.98
1	7.68	Min	-110.28	-111.09	93.92	11.62	81.05
		Max	-63.73	-64.20	106.28	18.73	81.05
Minimum			-110.28	-718.99	-106.28	-61.20	-122.53
Maximum			0.00	60.52	106.28	18.73	81.05

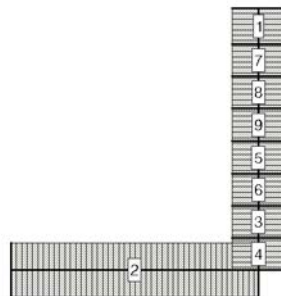
Initial reinforcement as₀₁

Max: as_{01o}/as_{01u}: 11.60/11.60 cm²/m



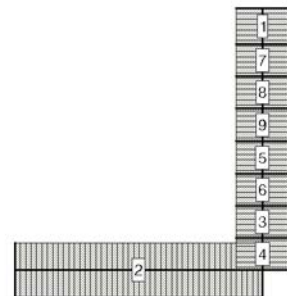
Initial reinforcement as₀₂

Max: as_{02o}/as_{02u}: 13.70/13.70 cm²/m



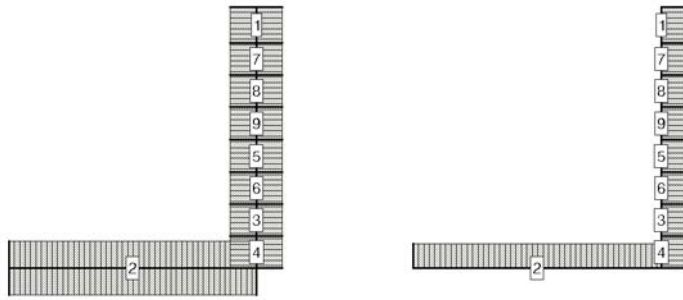
Longitudinal reinf. as₁

Max: as_{1o}/as_{1u}: 11.60/11.60 cm²/m



Longitudinal reinf. as2
Max: as2o/as2u: 13.70/13.70 cm²/m

Reinforcement ratio μ_s
Max: 1.39 %



Results of verification (reinforcement)

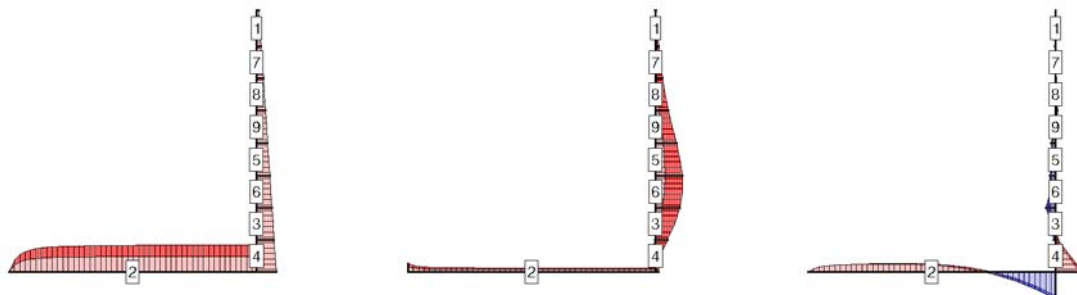
node	s	as01o	as02o	as01u	as02u	Δas1o	Δas2o	Δas1u	Δas2u	as1o	as2o	as1u	as2u	μs
-	m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	%
Shell travers 1: Shell 1														
2	0.00	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 7														
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 8														
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 9														
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 5														
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 6														
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 3														
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
5	7.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 4														
5	7.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
1	8.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell 2														
3	0.00	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
1	7.68	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
Minimum		11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.26
Maximum		11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.39

VERIFICATION 3: SUMMARY

Normal force n_l
Min/Max: -110.28/0.00 kN/m

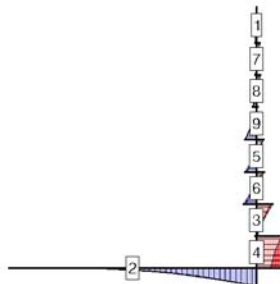
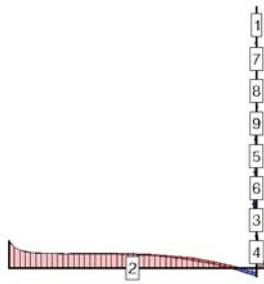
Normal force n_m
Min/Max: -718.99/60.52 kN/m

Internal moment m_l
Min/Max: -106.28/106.28 kNm/m



Internal moment m_m
Min/Max: -61.20/18.73 kNm/m

Shear force q_l
Min/Max: -122.53/81.05 kN/m



Extremal member forces

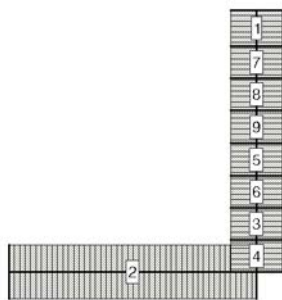
node	s	type	n _l	n _m	m _l	m _m	q _l
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
Shell travers 1: Shell 1							
2	0.00	Min	-10.00	-24.39	0.00	0.00	0.00
		Max	-10.00	9.56	0.00	0.00	0.00
8	0.56	Min	-14.90	-45.61	0.16	0.03	1.19
		Max	-14.90	-31.48	0.51	0.10	1.92
	1.12	Min	-19.80	-99.02	1.98	0.40	5.92
		Max	-19.80	-35.63	2.65	0.53	6.33
Shell travers 1: Shell 7							
8	1.12	Min	-19.80	-97.96	1.98	0.40	-14.08
		Max	-19.80	-36.51	2.65	0.53	-13.67
9	1.62	Min	-24.17	-142.69	-3.40	-0.68	-6.99
		Max	-24.17	-35.66	-2.56	-0.51	-6.44
	2.12	Min	-28.55	-194.48	-4.53	-0.91	2.98
		Max	-28.55	-40.38	-3.56	-0.71	3.86
Shell travers 1: Shell 8							
9	2.12	Min	-28.55	-192.99	-4.53	-0.91	-17.02
		Max	-28.55	-40.82	-3.56	-0.71	-16.14
10	2.62	Min	-32.92	-257.82	-9.83	-1.97	-3.52
		Max	-32.92	-57.79	-8.65	-1.73	-2.32
	3.12	Min	-37.30	-345.83	-7.23	-1.45	14.26
		Max	-37.30	-97.27	-5.44	-1.09	16.07
Shell travers 1: Shell 9							
10	3.12	Min	-37.30	-342.56	-7.23	-1.45	-5.74
		Max	-37.30	-96.18	-5.44	-1.09	-3.93
6	3.62	Min	-41.67	-455.13	-4.00	-0.80	17.71
		Max	-41.67	-153.87	-1.65	-0.33	20.14
	4.12	Min	-46.05	-572.73	12.43	2.49	47.53
		Max	-46.05	-215.71	15.70	3.14	50.64
Shell travers 1: Shell 5							
6	4.12	Min	-46.05	-569.39	12.43	2.49	-32.47
		Max	-46.05	-214.59	15.70	3.14	-29.36
7	4.62	Min	-50.42	-659.70	4.87	0.97	3.07
		Max	-50.42	-251.69	9.48	1.90	8.26
	5.12	Min	-54.80	-717.05	16.21	3.24	42.90
		Max	-54.80	-264.76	22.17	4.43	50.33
Shell travers 1: Shell 6							
7	5.12	Min	-54.80	-716.73	16.21	3.24	-37.10
		Max	-54.80	-265.89	22.17	4.43	-29.67
4	5.62	Min	-59.17	-718.99	8.18	1.64	5.16
		Max	-59.17	-241.43	18.30	3.66	14.21
	6.12	Min	-63.55	-655.62	21.43	4.29	47.68
		Max	-63.55	-181.85	36.08	7.22	56.28
Shell travers 1: Shell 3							
4	6.12	Min	-63.55	-660.83	21.43	4.29	-72.32
		Max	-63.55	-186.05	36.08	7.22	-63.72
5	6.62	Min	-67.93	-512.40	-4.47	-0.89	-31.89
		Max	-67.93	-83.03	13.55	2.71	-27.97
	7.12	Min	-72.30	-315.67	-10.98	-2.20	-2.53
		Max	-72.30	16.28	6.44	1.29	5.26
Shell travers 1: Shell 4							
5	7.12	Min	-72.30	-324.45	-10.98	-2.20	-122.53
		Max	-72.30	12.41	6.44	1.29	-114.74
	7.62	Min	-76.68	-132.54	-59.85	-11.97	-110.92

Extremal member forces

node	s	type	n _l	n _m	m _l	m _m	q _l
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
1	8.12	Max	-76.68	60.52	-51.26	-10.25	-81.45
		Min	-81.05	-92.84	-106.28	-21.26	-110.28
		Max	-81.05	-63.28	-93.92	-18.78	-63.73
Shell 2							
3	0.00	Min	0.00	-227.31	0.00	-61.20	0.00
		Max	0.00	-131.36	0.00	-60.47	0.00
	0.18	Min	-50.86	-169.09	-13.99	-47.13	-0.77
		Max	-29.39	-97.71	-13.84	-46.58	-0.54
	0.36	Min	-73.28	-147.54	-20.27	-40.91	-1.35
		Max	-42.34	-85.26	-20.11	-40.45	-0.93
	1.43	Min	-103.32	-118.03	-30.41	-33.19	-3.00
		Max	-59.71	-68.20	-29.88	-33.19	-1.66
	2.86	Min	-108.26	-113.11	-34.00	-33.45	-0.40
		Max	-62.56	-65.36	-31.29	-32.36	2.05
	5.73	Min	-109.98	-111.40	-1.51	-22.93	32.69
		Max	-63.56	-64.37	8.31	-18.10	35.98
1	7.68	Min	-110.28	-111.09	93.92	11.62	81.05
		Max	-63.73	-64.20	106.28	18.73	81.05
Minimum			-110.28	-718.99	-106.28	-61.20	-122.53
Maximum			0.00	60.52	106.28	18.73	81.05

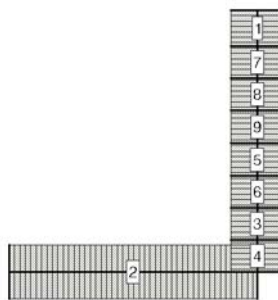
Minimum reinforcement as_{1,Min}

Max: as_{1o,Min}/as_{1u,Min}: 11.60/11.60 cm²/m



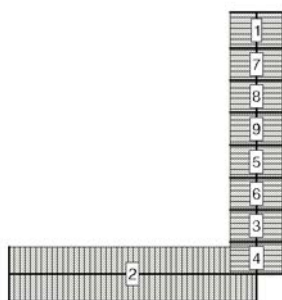
Minimum reinforcement as_{2,Min}

Max: as_{2o,Min}/as_{2u,Min}: 13.71/13.71 cm²/m



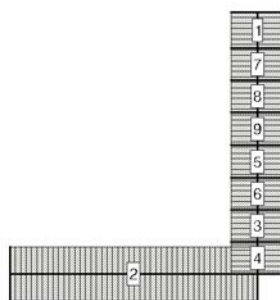
Initial reinforcement as₀₁

Max: as_{01o}/as_{01u}: 11.60/11.60 cm²/m



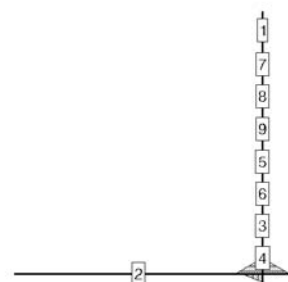
Initial reinforcement as₀₂

Max: as_{02o}/as_{02u}: 13.70/13.70 cm²/m



Additional reinforcement Δas₁

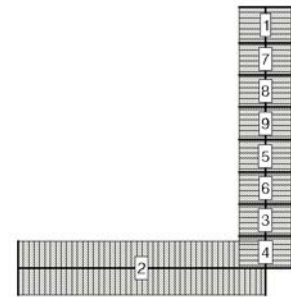
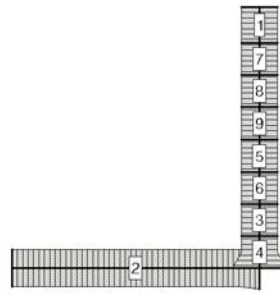
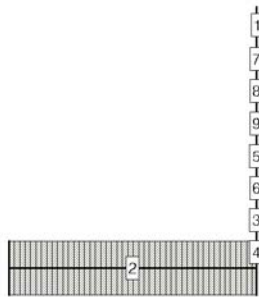
Max: Δas_{1o}/Δas_{1u}: 5.64/5.64 cm²/m



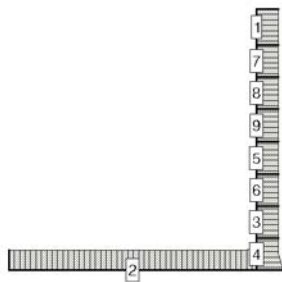
Additional reinforcement Δa_{s2}
Max: $\Delta a_{s2o}/\Delta a_{s2u}$: 0.01/0.01 cm²/m

Longitudinal reinf. a_{s1}
Max: a_{s1o}/a_{s1u} : 16.75/16.75 cm²/m

Longitudinal reinf. a_{s2}
Max: a_{s2o}/a_{s2u} : 13.71/13.71 cm²/m



Reinforcement ratio μ_s
Max: 1.71 %

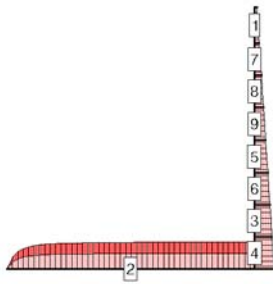


Results of verification (crack limitation)

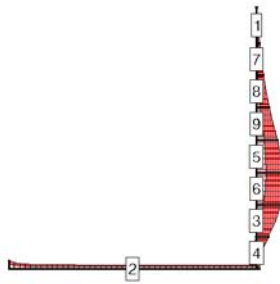
node	s	a _{sMin}	in	Lage	lo	2o	1u	2u	a _{s01o}	a _{s02o}	a _{s01u}	a _{s02u}	Δa _{s1o}	Δa _{s2o}	Δa _{s1u}	Δa _{s2u}	a _{s1o}	a _{s2o}	a _{s1u}	a _{s2u}	μ _s	
-	m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	%	
Shell travers 1: Shell 1																						
2	0.00	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
8	1.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 7																						
8	1.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
9	2.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 8																						
9	2.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
10	3.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 9																						
10	3.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
6	4.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 5																						
6	4.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
7	5.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 6																						
7	5.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
4	6.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 3																						
4	6.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
5	7.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 4																						
5	7.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
	7.62	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
1	8.12	11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	5.64	0.00	5.64	0.00	16.75	13.20	16.75	13.20	1.71
Shell 2																						
3	0.00	11.60	13.71	11.60	13.71	11.60	13.71	11.60	13.70	11.60	13.70	11.60	13.70	0.00	0.01	0.00	0.01	11.60	13.71	11.60	13.71	1.27
	7.06	11.60	13.71	11.60	13.71	11.60	13.71	11.60	13.70	11.60	13.70	11.60	13.70	0.00	0.01	0.00	0.01	11.60	13.71	11.60	13.71	1.27
1	7.68	11.60	13.71	11.60	13.71	11.60	13.71	11.60	13.70	11.60	13.70	11.60	13.70	0.00	0.01	1.65	0.01	11.60	13.71	13.25	13.71	1.31
Minimum		11.07	13.18	11.07	13.18	11.07	13.18	11.10	13.20	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.27
Maximum		11.60	13.71	11.60	13.71	11.60	13.71	11.60	13.70	11.60	13.70	11.60	13.70	5.64	0.01	5.64	0.01	16.75	13.71	16.75	13.71	1.71

VERIFICATION 4: SUMMARY

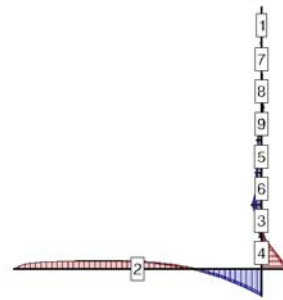
Normal force n_l
Min/Max: -110.28/0.00 kN/m



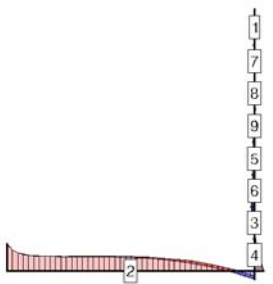
Normal force n_m
Min/Max: -718.99/60.52 kN/m



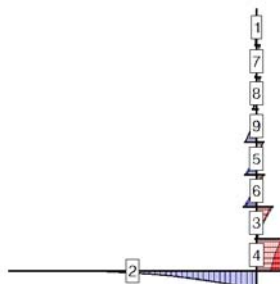
Internal moment m_l
Min/Max: -106.28/106.28 kNm/m



Internal moment m_m
Min/Max: -61.20/18.73 kNm/m



Shear force q_l
Min/Max: -122.53/81.05 kN/m



Extremal member forces

node	s	type	n1	n _m	m1	m _m	q1
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
Shell travers 1: Shell 1							
2	0.00	Min	-10.00	-24.39	0.00	0.00	0.00
		Max	-10.00	9.56	0.00	0.00	0.00
8	0.56	Min	-14.90	-45.61	0.16	0.03	1.19
		Max	-14.90	-31.48	0.51	0.10	1.92
	1.12	Min	-19.80	-99.02	1.98	0.40	5.92
		Max	-19.80	-35.63	2.65	0.53	6.33
Shell travers 1: Shell 7							
8	1.12	Min	-19.80	-97.96	1.98	0.40	-14.08
		Max	-19.80	-36.51	2.65	0.53	-13.67
9	1.62	Min	-24.17	-142.69	-3.40	-0.68	-6.99
		Max	-24.17	-35.66	-2.56	-0.51	-6.44
	2.12	Min	-28.55	-194.48	-4.53	-0.91	2.98
		Max	-28.55	-40.38	-3.56	-0.71	3.86
Shell travers 1: Shell 8							
9	2.12	Min	-28.55	-192.99	-4.53	-0.91	-17.02
		Max	-28.55	-40.82	-3.56	-0.71	-16.14
10	2.62	Min	-32.92	-257.82	-9.83	-1.97	-3.52
		Max	-32.92	-57.79	-8.65	-1.73	-2.32
	3.12	Min	-37.30	-345.83	-7.23	-1.45	14.26
		Max	-37.30	-97.27	-5.44	-1.09	16.07
Shell travers 1: Shell 9							
10	3.12	Min	-37.30	-342.56	-7.23	-1.45	-5.74
		Max	-37.30	-96.18	-5.44	-1.09	-3.93
6	3.62	Min	-41.67	-455.13	-4.00	-0.80	17.71
		Max	-41.67	-153.87	-1.65	-0.33	20.14
	4.12	Min	-46.05	-572.73	12.43	2.49	47.53
		Max	-46.05	-215.71	15.70	3.14	50.64
Shell travers 1: Shell 5							
6	4.12	Min	-46.05	-569.39	12.43	2.49	-32.47
		Max	-46.05	-214.59	15.70	3.14	-29.36
	4.62	Min	-50.42	-659.70	4.87	0.97	3.07
		Max	-50.42	-251.69	9.48	1.90	8.26

Extremal member forces

node	s	type	n _l	n _m	m _l	m _m	q _l
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
7	5.12	Min	-54.80	-717.05	16.21	3.24	42.90
		Max	-54.80	-264.76	22.17	4.43	50.33
Shell travers 1: Shell 6							
7	5.12	Min	-54.80	-716.73	16.21	3.24	-37.10
		Max	-54.80	-265.89	22.17	4.43	-29.67
	5.62	Min	-59.17	-718.99	8.18	1.64	5.16
		Max	-59.17	-241.43	18.30	3.66	14.21
	6.12	Min	-63.55	-655.62	21.43	4.29	47.68
		Max	-63.55	-181.85	36.08	7.22	56.28
Shell travers 1: Shell 3							
4	6.12	Min	-63.55	-660.83	21.43	4.29	-72.32
		Max	-63.55	-186.05	36.08	7.22	-63.72
	6.62	Min	-67.93	-512.40	-4.47	-0.89	-31.89
		Max	-67.93	-83.03	13.55	2.71	-27.97
	7.12	Min	-72.30	-315.67	-10.98	-2.20	-2.53
		Max	-72.30	16.28	6.44	1.29	5.26
Shell travers 1: Shell 4							
5	7.12	Min	-72.30	-324.45	-10.98	-2.20	-122.53
		Max	-72.30	12.41	6.44	1.29	-114.74
	7.62	Min	-76.68	-132.54	-59.85	-11.97	-110.92
		Max	-76.68	60.52	-51.26	-10.25	-81.45
	8.12	Min	-81.05	-92.84	-106.28	-21.26	-110.28
		Max	-81.05	-63.28	-93.92	-18.78	-63.73
Shell 2							
3	0.00	Min	0.00	-227.31	0.00	-61.20	0.00
		Max	0.00	-131.36	0.00	-60.47	0.00
	0.18	Min	-50.86	-169.09	-13.99	-47.13	-0.77
		Max	-29.39	-97.71	-13.84	-46.58	-0.54
	0.36	Min	-73.28	-147.54	-20.27	-40.91	-1.35
		Max	-42.34	-85.26	-20.11	-40.45	-0.93
	1.43	Min	-103.32	-118.03	-30.41	-33.19	-3.00
		Max	-59.71	-68.20	-29.88	-33.19	-1.66
	2.86	Min	-108.26	-113.11	-34.00	-33.45	-0.40
		Max	-62.56	-65.36	-31.29	-32.36	2.05
	5.73	Min	-109.98	-111.40	-1.51	-22.93	32.69
		Max	-63.56	-64.37	8.31	-18.10	35.98
1	7.68	Min	-110.28	-111.09	93.92	11.62	81.05
		Max	-63.73	-64.20	106.28	18.73	81.05
Minimum			-110.28	-718.99	-106.28	-61.20	-122.53
Maximum			0.00	60.52	106.28	18.73	81.05

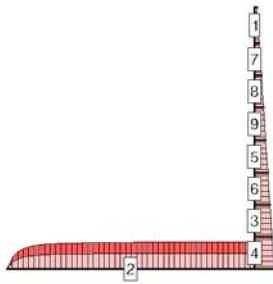
Results of verification (reinforcement)

node	s	as _{0l}	as _{0o}	as _{0u}	as _{0u}	Δas _{0o}	Δas _{0o}	Δas _{1u}	Δas _{2u}	as _{1o}	as _{2o}	as _{1u}	as _{2u}	μs
-	m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	%
Shell travers 1: Shell 1														
2	0.00	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 7														
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 8														
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 9														
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 5														
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 6														
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 3														
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
	6.62	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
5	7.12	11.10	13.20	11.10	13.20	0.00	28.77	0.00	28.77	11.10	41.97	11.10	41.97	3.03
Shell travers 1: Shell 4														
5	7.12	11.10	13.20	11.10	13.20	0.00	1.32	0.00	1.32	11.10	14.52	11.10	14.52	1.46
	7.62	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
1	8.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell 2														
3	0.00	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
1	7.68	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
Minimum		11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.26
Maximum		11.60	13.70	11.60	13.70	0.00	28.77	0.00	28.77	11.60	41.97	11.60	41.97	3.03

VERIFICATION 5: SUMMARY

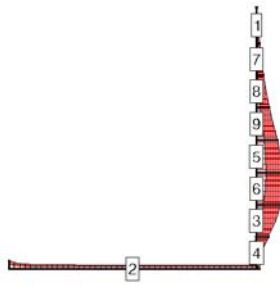
Normal force n_l

Min/Max: -110.28/0.00 kN/m



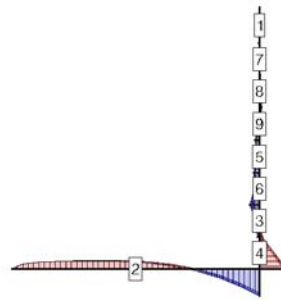
Normal force n_m

Min/Max: -718.99/60.52 kN/m



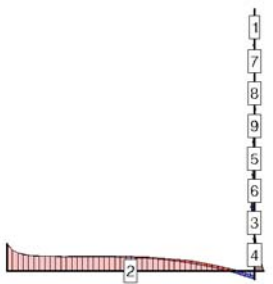
Internal moment m_l

Min/Max: -106.28/106.28 kNm/m



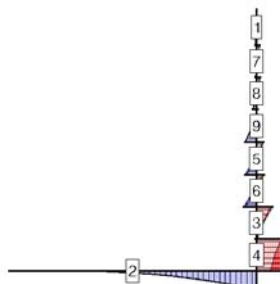
Internal moment m_m

Min/Max: -61.20/18.73 kNm/m



Shear force q_l

Min/Max: -122.53/81.05 kN/m



Extremal member forces

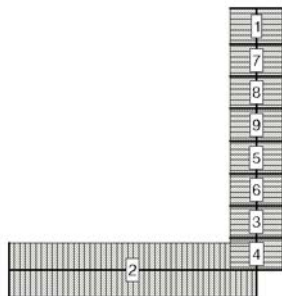
node	s	type	n1	n _m	m1	m _m	q1
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
Shell travers 1: Shell 1							
2	0.00	Min	-10.00	-24.39	0.00	0.00	0.00
		Max	-10.00	9.56	0.00	0.00	0.00
	0.56	Min	-14.90	-45.61	0.16	0.03	1.19
		Max	-14.90	-31.48	0.51	0.10	1.92
	1.12	Min	-19.80	-99.02	1.98	0.40	5.92
		Max	-19.80	-35.63	2.65	0.53	6.33
Shell travers 1: Shell 7							
8	1.12	Min	-19.80	-97.96	1.98	0.40	-14.08
		Max	-19.80	-36.51	2.65	0.53	-13.67
	1.62	Min	-24.17	-142.69	-3.40	-0.68	-6.99
		Max	-24.17	-35.66	-2.56	-0.51	-6.44
	2.12	Min	-28.55	-194.48	-4.53	-0.91	2.98
		Max	-28.55	-40.38	-3.56	-0.71	3.86
Shell travers 1: Shell 8							
9	2.12	Min	-28.55	-192.99	-4.53	-0.91	-17.02
		Max	-28.55	-40.82	-3.56	-0.71	-16.14
	2.62	Min	-32.92	-257.82	-9.83	-1.97	-3.52
		Max	-32.92	-57.79	-8.65	-1.73	-2.32
	3.12	Min	-37.30	-345.83	-7.23	-1.45	14.26
		Max	-37.30	-97.27	-5.44	-1.09	16.07
Shell travers 1: Shell 9							
10	3.12	Min	-37.30	-342.56	-7.23	-1.45	-5.74
		Max	-37.30	-96.18	-5.44	-1.09	-3.93
	3.62	Min	-41.67	-455.13	-4.00	-0.80	17.71
		Max	-41.67	-153.87	-1.65	-0.33	20.14
	4.12	Min	-46.05	-572.73	12.43	2.49	47.53
		Max	-46.05	-215.71	15.70	3.14	50.64
Shell travers 1: Shell 5							
6	4.12	Min	-46.05	-569.39	12.43	2.49	-32.47
		Max	-46.05	-214.59	15.70	3.14	-29.36
	4.62	Min	-50.42	-659.70	4.87	0.97	3.07
		Max	-50.42	-251.69	9.48	1.90	8.26

Extremal member forces

node	s	type	n ₁	n _m	m ₁	m _m	q ₁
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
7	5.12	Min	-54.80	-717.05	16.21	3.24	42.90
		Max	-54.80	-264.76	22.17	4.43	50.33
Shell travers 1: Shell 6							
7	5.12	Min	-54.80	-716.73	16.21	3.24	-37.10
		Max	-54.80	-265.89	22.17	4.43	-29.67
	5.62	Min	-59.17	-718.99	8.18	1.64	5.16
		Max	-59.17	-241.43	18.30	3.66	14.21
	6.12	Min	-63.55	-655.62	21.43	4.29	47.68
		Max	-63.55	-181.85	36.08	7.22	56.28
Shell travers 1: Shell 3							
4	6.12	Min	-63.55	-660.83	21.43	4.29	-72.32
		Max	-63.55	-186.05	36.08	7.22	-63.72
	6.62	Min	-67.93	-512.40	-4.47	-0.89	-31.89
		Max	-67.93	-83.03	13.55	2.71	-27.97
	7.12	Min	-72.30	-315.67	-10.98	-2.20	-2.53
		Max	-72.30	16.28	6.44	1.29	5.26
Shell travers 1: Shell 4							
5	7.12	Min	-72.30	-324.45	-10.98	-2.20	-122.53
		Max	-72.30	12.41	6.44	1.29	-114.74
	7.62	Min	-76.68	-132.54	-59.85	-11.97	-110.92
		Max	-76.68	60.52	-51.26	-10.25	-81.45
	8.12	Min	-81.05	-92.84	-106.28	-21.26	-110.28
		Max	-81.05	-63.28	-93.92	-18.78	-63.73
Shell 2							
3	0.00	Min	0.00	-227.31	0.00	-61.20	0.00
		Max	0.00	-131.36	0.00	-60.47	0.00
	0.18	Min	-50.86	-169.09	-13.99	-47.13	-0.77
		Max	-29.39	-97.71	-13.84	-46.58	-0.54
	0.36	Min	-73.28	-147.54	-20.27	-40.91	-1.35
		Max	-42.34	-85.26	-20.11	-40.45	-0.93
	1.43	Min	-103.32	-118.03	-30.41	-33.19	-3.00
		Max	-59.71	-68.20	-29.88	-33.19	-1.66
	2.86	Min	-108.26	-113.11	-34.00	-33.45	-0.40
		Max	-62.56	-65.36	-31.29	-32.36	2.05
	5.73	Min	-109.98	-111.40	-1.51	-22.93	32.69
		Max	-63.56	-64.37	8.31	-18.10	35.98
1	7.68	Min	-110.28	-111.09	93.92	11.62	81.05
		Max	-63.73	-64.20	106.28	18.73	81.05
Minimum			-110.28	-718.99	-106.28	-61.20	-122.53
Maximum			0.00	60.52	106.28	18.73	81.05

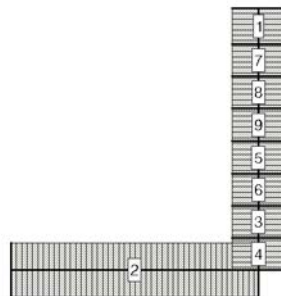
Initial reinforcement as₀₁

Max: as_{01o}/as_{01u}: 11.60/11.60 cm²/m



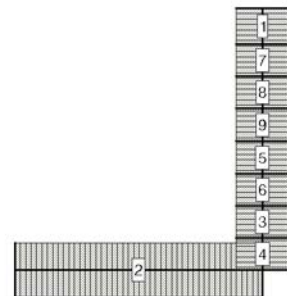
Initial reinforcement as₀₂

Max: as_{02o}/as_{02u}: 13.70/13.70 cm²/m



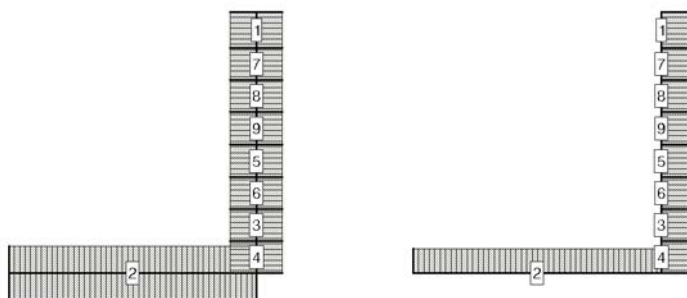
Longitudinal reinf. as₁

Max: as_{1o}/as_{1u}: 11.60/11.60 cm²/m



Longitudinal reinf. as2
Max: as2o/as2u: 13.70/13.70 cm²/m

Reinforcement ratio μ_s
Max: 1.39 %



Results of verification (reinforcement)

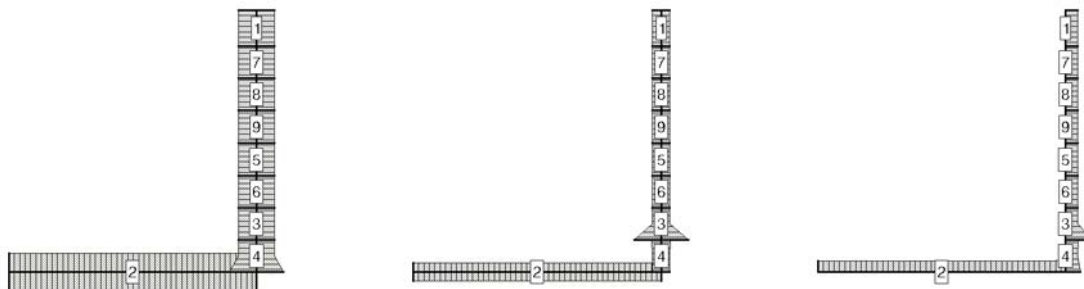
node	s	as01o	as02o	as01u	as02u	Δas1o	Δas2o	Δas1u	Δas2u	as1o	as2o	as1u	as2u	μs
-	m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	%
Shell travers 1: Shell 1														
2	0.00	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 7														
8	1.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 8														
9	2.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 9														
10	3.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 5														
6	4.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 6														
7	5.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 3														
4	6.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
5	7.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell travers 1: Shell 4														
5	7.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
1	8.12	11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.39
Shell 2														
3	0.00	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
1	7.68	11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.26
Minimum		11.10	13.20	11.10	13.20	0.00	0.00	0.00	0.00	11.10	13.20	11.10	13.20	1.26
Maximum		11.60	13.70	11.60	13.70	0.00	0.00	0.00	0.00	11.60	13.70	11.60	13.70	1.39

SUMMARY

Longitudinal reinf. as1
Max: as1o/as1u: 16.75/16.75 cm²/m

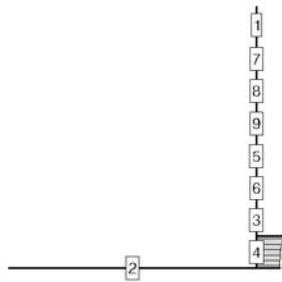
Longitudinal reinf. as2
Max: as2o/as2u: 41.97/41.97 cm²/m

Reinforcement ratio μ_s
Max: 3.03 %



Shear reinforcement as_q

Max: 10.78 cm²/m²



Reinforcement

node	s	as _{1o}	as _{2o}	as _{1u}	as _{2u}	μ _s	as _q
-	m	cm ² /m	cm ² /m	cm ² /m	cm ² /m	%	cm ² /m
Shell travers 1: Shell 1							
2	0.00	11.10	13.20	11.10	13.20	1.39	0.00
8	1.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 7							
8	1.12	11.10	13.20	11.10	13.20	1.39	0.00
9	2.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 8							
9	2.12	11.10	13.20	11.10	13.20	1.39	0.00
10	3.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 9							
10	3.12	11.10	13.20	11.10	13.20	1.39	0.00
6	4.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 5							
6	4.12	11.10	13.20	11.10	13.20	1.39	0.00
7	5.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 6							
7	5.12	11.10	13.20	11.10	13.20	1.39	0.00
4	6.12	11.10	13.20	11.10	13.20	1.39	0.00
Shell travers 1: Shell 3							
4	6.12	11.10	13.20	11.10	13.20	1.39	0.00
	6.62	11.10	13.20	11.10	13.20	1.39	0.00
5	7.12	11.10	41.97	11.10	41.97	3.03	0.00
Shell travers 1: Shell 4							
5	7.12	11.10	14.52	11.10	14.52	1.46	10.78
	7.62	11.10	13.20	11.10	13.20	1.39	9.55
1	8.12	16.75	13.20	16.75	13.20	1.71	9.31
Shell 2							
3	0.00	11.60	13.71	11.60	13.71	1.27	0.00
	7.06	11.60	13.71	11.60	13.71	1.27	0.00
1	7.68	11.60	13.71	13.25	13.71	1.31	0.00
Minimum		11.10	13.20	11.10	13.20	1.27	0.00
Maximum		16.75	41.97	16.75	41.97	3.03	10.78