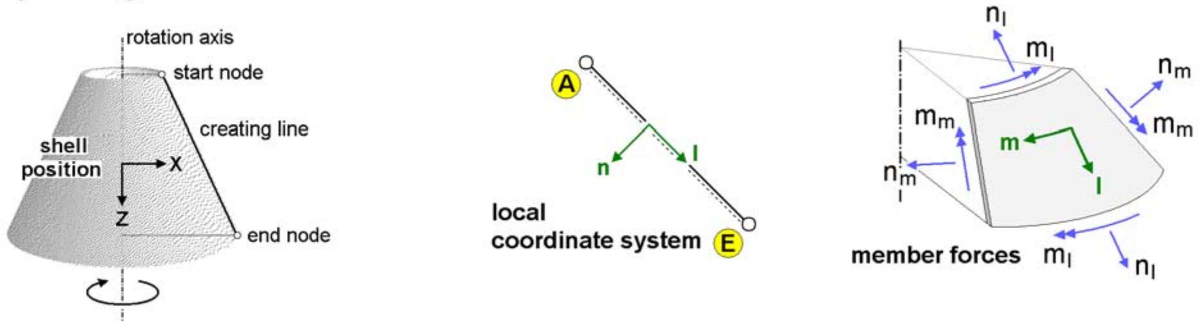
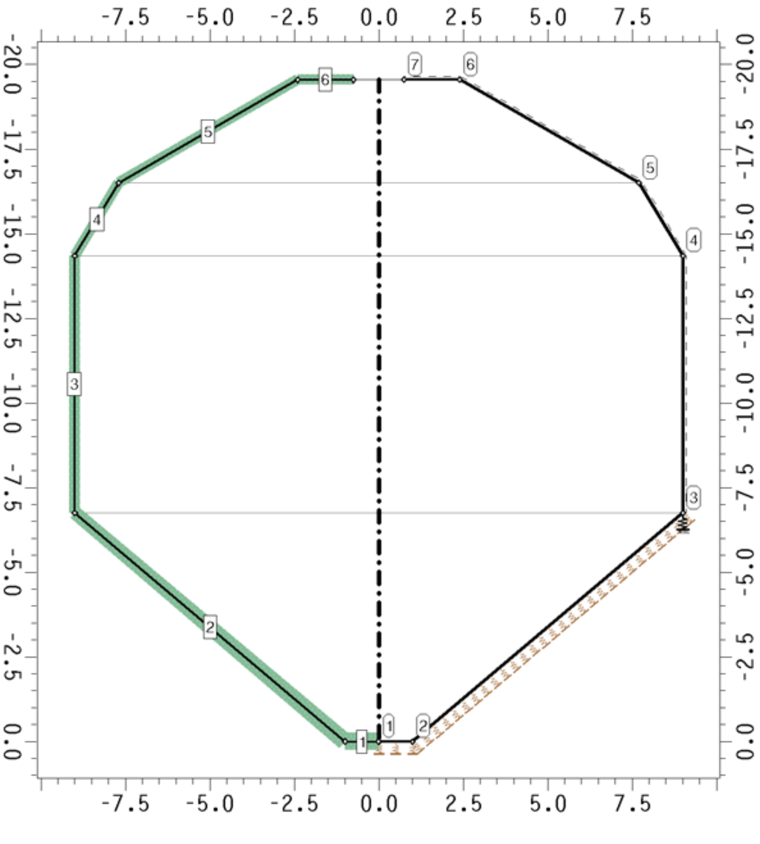
Structural Calcualtions of rotationally symmetrical shell structures by using the Finite Element Method



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

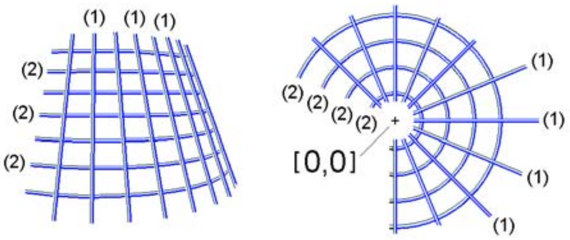
node	X	Z	Cf-X	Cf-Z	Cm-Y	designation
-	m	m	MN/m2	MN/m2	MNm/m	-
1	0.010	0.000	-	-	-	
2	1.000	0.000	-	-	-	
3	9.000	-6.750	-	1330.00	-	
4	9.000	-14.350	-	-	-	
5	7.700	-16.500	-	-	-	
6	2.400	-19.550	-	-	-	
7	0.750	-19.550	-	-	-	

Calculation values of position 1: Einlaufboden

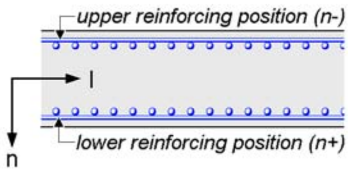
Material designation: reinforced concrete B35

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 1	E-modulus: 34000.00 MN/m2	perpendicular to shell face:
End node: 2	Poisson's ratio: 0.20 -	Cbn = 20.00 MN/m³
Length: 0.99 m	Temp. coeff.: 1.00 10-5/K	in shell direction:
Thickn.: 50.00 cm		no

Explanation of design properties



Reinforcement Layout at shells and slabs



Definition: top - bottom

Design properties of position 1:

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm	(1)top = 0.00 cm²/m	type: orthogonal	tensile reinforcement
(2)top = 4.5 cm	(2)top = 0.00 cm²/m	with α = 0.00 °	
(1)bottom= 3.5 cm	(1)bottom= 0.00 cm²/m		
(2)bottom= 4.5 cm	(2)bottom= 0.00 cm²/m		

Material properties of position 1:

Verifications according to EC 2: C20/25, BSt 500
Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00
E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²
Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Maximum (rated) reinforcement ratio: max μ = 8.0%

Calculation values of position 2: Bodenkegel

Material designation: reinforced concrete B35

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 2	E-modulus: 34000.00 MN/m2	perpendicular to shell face:
End node: 3	Poisson's ratio: 0.20 -	Cbn = 20.00 MN/m³
Length: 10.47 m	Temp. coeff.: 1.00 10-5/K	in shell direction:
Thickn.: t_A = 50.00 cm		no
t_E = 40.00 cm		

Design properties of position 2:

(s.a. explanation sketch on page 2)

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm	(1)top = 10.00 cm²/m	type: orthogonal	tensile reinforcement
(2)top = 4.5 cm	(2)top = 10.00 cm²/m	with α = 0.00 °	
(1)bottom= 3.5 cm	(1)bottom= 10.00 cm²/m		
(2)bottom= 4.5 cm	(2)bottom= 3.80 cm²/m		

Material properties of position 2:

Verifications according to EC 2: C20/25, BSt 500
Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00
E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²
Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Maximum (rated) reinforcement ratio: max μ = 8.0%

Calculation values of position 3: Zylinder

Material designation: reinforced concrete B35

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 3 End node: 4 Length: 7.60 m Thickn.: 30.00 cm	E-modulus: 34000.00 MN/m2 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)

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm (2)top = 4.5 cm (1)bottom= 3.5 cm (2)bottom= 4.5 cm	(1)top = 0.00 cm²/m (2)top = 0.00 cm²/m (1)bottom= 0.00 cm²/m (2)bottom= 0.00 cm²/m	type: orthogonal with α = 0.00 °	tensile reinforcement

Material properties of position 3:

Verifications according to EC 2: C20/25, BSt 500
Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00
E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²
Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Maximum (rated) reinforcement ratio: max μ = 8.0%

Calculation values of position 4: Galeriekegel

Material designation: reinforced concrete B35

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 4 End node: 5 Length: 2.51 m Thickn.: 30.00 cm	E-modulus: 34000.00 MN/m2 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)

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm (2)top = 4.5 cm (1)bottom= 3.5 cm (2)bottom= 4.5 cm	(1)top = 0.00 cm²/m (2)top = 0.00 cm²/m (1)bottom= 0.00 cm²/m (2)bottom= 0.00 cm²/m	type: orthogonal with α = 0.00 °	tensile reinforcement

Material properties of position 4:

Verifications according to EC 2: C20/25, BSt 500
Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00
E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²
Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Material properties of position 4:

Maximum (rated) reinforcement ratio: max μ = 8.0%

Calculation values of position 5: Kegel top

Material designation: reinforced concrete B35

Geom. characteristic values		Phys. characteristic values		elastic bedding
Start node:	5	E-modulus:	34000.00 MN/m2	no
End node:	6	Poisson's ratio:	0.20 -	
Length:	6.11 m	Temp. coeff.:	1.00 10-5/K	
Thickn.:	30.00 cm			

Design properties of position 5:

(s.a. explanation sketch on page 2)

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm	(1)top = 0.00 cm²/m	type: orthogonal	tensile reinforcement
(2)top = 4.5 cm	(2)top = 0.00 cm²/m	with α = 0.00 °	
(1)bottom= 3.5 cm	(1)bottom= 0.00 cm²/m		
(2)bottom= 4.5 cm	(2)bottom= 0.00 cm²/m		

Material properties of position 5:

Verifications according to EC 2: C20/25, BSt 500

Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00

E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²

Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Maximum (rated) reinforcement ratio: max μ = 8.0%

Calculation values of position 6: Ringplatte

Material designation: reinforced concrete B35

Geom. characteristic values		Phys. characteristic values		elastic bedding
Start node:	6	E-modulus:	34000.00 MN/m2	no
End node:	7	Poisson's ratio:	0.20 -	
Length:	1.65 m	Temp. coeff.:	1.00 10-5/K	
Thickn.:	30.00 cm			

Design properties of position 6:

(s.a. explanation sketch on page 2)

edge distance	Initial reinforcement	reinforcement direction	reinforcement arrangement
(1)top = 3.5 cm	(1)top = 0.00 cm²/m	type: orthogonal	tensile reinforcement
(2)top = 4.5 cm	(2)top = 0.00 cm²/m	with α = 0.00 °	
(1)bottom= 3.5 cm	(1)bottom= 0.00 cm²/m		
(2)bottom= 4.5 cm	(2)bottom= 0.00 cm²/m		

Material properties of position 6:

Verifications according to EC 2: C20/25, BSt 500

Concrete: ρ_c = 2200 kg/m³ f_{ck} = 20.0 MN/m² ε_{c2} = -2.0‰ ε_{c2u} = -3.5‰ n_c = 2.00

E_{cm} = 29962.0 MN/m² f_{ctm} = 2.21 MN/m²

Reinforcem.: f_{yk} = 500.0 MN/m² f_{tk} = 525.0 MN/m² ε_{su} = 25.0‰ E_s = 200000.0 MN/m²

Maximum (rated) reinforcement ratio: max μ = 8.0%

LOADING STRUCTURE

Description of loading structure

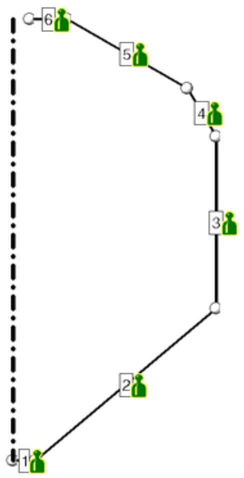
On the left-hand side, the relationship between the actions effects, load case file and load cases are shown in a tree structure. The right-hand side shows the characteristics of the superposition to the associated objects on the left-hand. In terms of the superposition, a load case file is equivalent 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 loads	**permanent loads**
1: dead load	additive
2: traffic loads	**other transient action effects**
2: Fuellung 6.75 m	alternative in group A
4: Fuellung 14.35 m	alternative in group A
3: temperature	**transient Temperature loads**
3: dt 20 K 6.75 m	alternative in group B
5: dt 20 K 14.35 m	alternative in group B

LOAD PICTURES IN LOAD CASE 1: DEAD LOAD

Loaded objects in load case 1

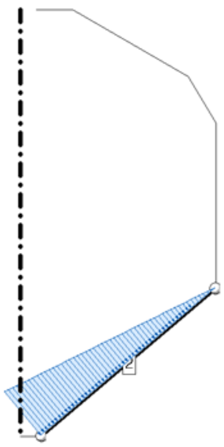


dead loads in load case 1

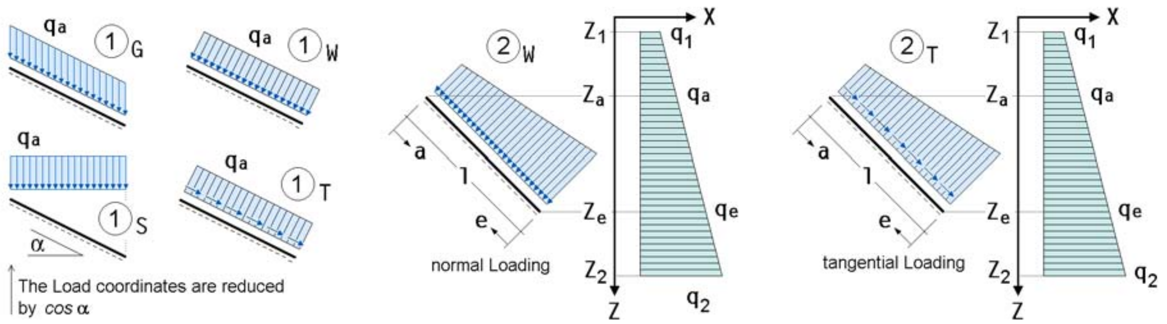
pos.	max.density	pos.	max.density
-	kN/m³	-	kN/m³
1	25.000	4	25.000
2	25.000	5	25.000
3	25.000	6	25.000

LOAD PICTURES IN LOAD CASE 2: FUELLUNG 6.75 M

Loaded objects in load case 2



Explanation of load types and load directions



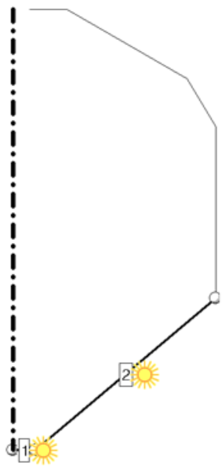
Area loads in load case 2

Loads depending on Z-coordinate (type 2), 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	q_e	a	l	e	z1	q1	z2	q2
-	-	kN/m²	kN/m²	m	m	m	m	kN/m²	m	kN/m²
2	2W	74.250	0.000	0.000	10.467	0.000	-6.750	0.000	0.000	74.250

LOAD PICTURES IN LOAD CASE 3: DT 20 K 6.75 M

Loaded objects in load case 3

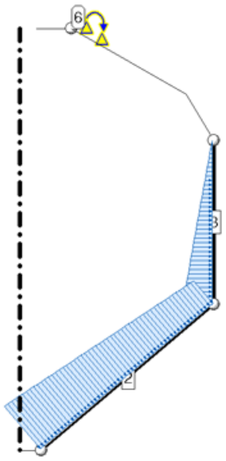


Temperature loads in load case 3

pos.	to	tu
-	°K	°K
1	0.00	20.00
2	0.00	20.00

LOAD PICTURES IN LOAD CASE 4: FUELLUNG 14.35 M

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. l is the loaded section.
(s.a. explanation sketch on page 6)

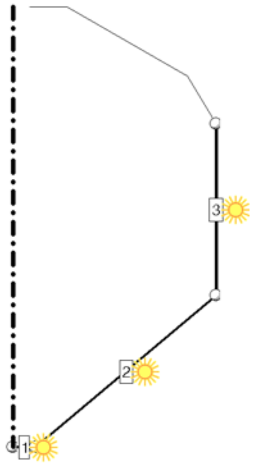
pos.	type	q_a	q_e	a	l	e	z1	q1	z2	q2
-	-	kN/m²	kN/m²	m	m	m	m	kN/m²	m	kN/m²
2	2W	157.850	83.600	0.000	10.467	0.000	-14.350	0.000	0.000	157.850
3	2W	83.600	0.000	0.000	7.600	0.000	-14.350	0.000	0.000	157.850

Restraint deformations of supported points in load case 4

point	vx	vz	φY
-	cm	cm	‰
6	0.00	1.00	0.00

LOAD PICTURES IN LOAD CASE 5: DT 20 K 14.35 M

Loaded objects in load case 5



Temperature loads in load case 5

pos.	to	tu
-	°K	°K
1	0.00	20.00
2	0.00	20.00
3	0.00	20.00

DESCRIPTION OF DEMANDED VERIFICATIONS

The following means:

Ψ_{dom} in rule of superposition DIN 1055-100: Combination coefficient of a leading traffic load action
in rule of superposition DIN 18800: Combination coefficient of a minor combination
Ψ_{sub} in rule of superposition DIN 1055-100: Combination coefficient of a non-leading traffic load action
in rule of superposition DIN 18800: Combination coefficient of a main combination
γ_{sup} Partial safety factor for unfavourable load positions
γ_{inf} Partial safety factor for favourable load positions

Rules of superposition FB101 and Eurocode are comparable with DIN 1055-100
In non-linear analysis, rules of extremization will not be considered

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
☑ z of bending design calculation
☐ $z = 0.9\ d \leq d$
☐ NO limitation of VRdct
☑ with minimum/transverse reinforcement (bending, shear)

1: Standard combination

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	0.80	1.50	0.00
3	1.00	0.60	1.50	0.00

Table of design positions (Verification 1)

Explanations: column **(M_P)**, **(M_W)**: 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;
Θ: angle of compression strut (0 = minimum);
Description of material see: 'Material properties of position'

pos.	concrete	BSt_l	(M_P)	(M_W)	(Q)	(S)	BSt_q	Θ °	(P)
1	C20/25	500	yes	B1	0.20	with	500	0	no
2	C20/25	500	yes	B1	0.20	with	500	0	no
3	C20/25	500	yes	B1	0.20	with	500	0	no
4	C20/25	500	yes	B1	0.20	with	500	0	no
5	C20/25	500	yes	B1	0.20	with	500	0	no
6	C20/25	500	yes	B1	0.20	with	500	0	no

Verification 2: EC 2 Crack limitation

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

Design options of verification 2:

☑ 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 $\alpha = Es/Ecm$

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	0.50	0.50	1.00	0.00

Table of design positions (Verification 2)

Explanations:
Abbreviation of reinforcement positions: reinforcement direction 1: 1o = top, 1u = bottom, reinforcementsrichtung 2: 2o = top, 2u = bottom
First cracking due to flexural or centric restraint (tensile restraint).
Recording the time being considered with k_{zt} (if cracks due to restraint and load: k_{zt} for the part of restraint only)
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 $\varepsilon_{cs,\infty}$.

pos.	ultimate Ø of reinf. in mm 1o	2o	1u	2u	crack width w_k in mm	cracks due to loads	time factor k_{zt}	first cracking of	slowly hardening concrete
1	8	8	8	8	0.30	yes	1.00	flex.restr	no
2	8	8	8	8	0.30	yes	1.00	flex.restr	no
3	8	8	8	8	0.30	yes	1.00	flex.restr	no
4	8	8	8	8	0.30	yes	1.00	flex.restr	no
5	8	8	8	8	0.30	yes	1.00	flex.restr	no
6	8	8	8	8	0.30	yes	1.00	flex.restr	no

NATIONAL APPENDIX OF EUROCODES

Load factors of the national appendix

EC-Standardparameter

DIN EN 1990 (EC 0)

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

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

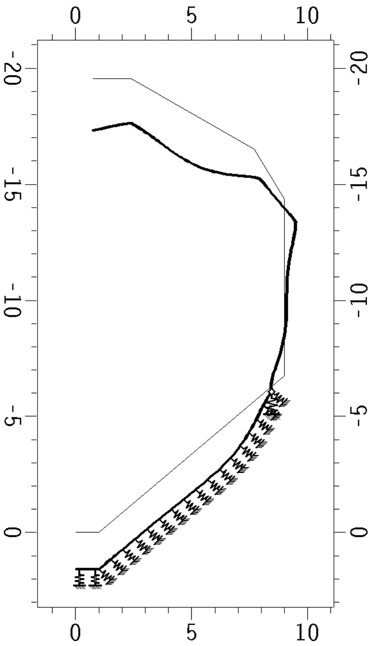
EC-Standardparameter

DIN EN 1992-1-1 (EC 2)

Chapter	Value	Meaning
2.4.2.4(1)		Partial safety factors for concrete and reinforcement
	γ_c = 1.50 γ_s = 1.15	Permanent and transient design situation
	γ_c = 1.50 γ_s = 1.15	Fatigue design situation
	γ_c = 1.50 γ_s = 1.15	Earthquake design situation
	γ_c = 1.20 γ_s = 1.00	Accidental design situation
3.1.6(1)P	α_{cc} = 1.00	Coeff. to consider the long-term influence of compression strength of concrete and the unfavourable effect due to the kind of action effect
3.1.6(2)P	α_{ct} = 1.00	Coeff. of tensile strength of concrete to calculate the bond strength
6.2.2(1)	$C_{Rd,c}$ = 0.18 / γ_c	Coeff. to calculate the resistance of shear force
	v_{min} = 0.0525/γ_c $k^{3/2}$ $f_{ck}^{1/2}$	
	k_1 = 0.15	
6.2.2(6)	v_V = 0.600(1 - f_{ck}/250)	Reduction factor of strength of shear force
6.2.3(2)	min cot Θ = 1.00	lower bound of strut gradient
	max cot Θ = 2.50	upper bound of strut gradient
6.2.3(3)	α_{cw} = 1.00	Coeff. to consider the state of stress in the compress. boom
	v_1 = 0.600(1 - f_{ck}/250)	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
6.8.7(1)	k_1 = 0.85	Fatigue: Coeff. to calculate the design strength of concrete
7.3.4(3)	k_3 = 3.40	Cracks: Coeff. to calculate the maximum crack distance if fracture pattern is completed
	k_4 = 0.425	Cracks: Coeff. to calculate the maximum crack distance if fracture pattern is completed
11.3.5(1)	α_{lcc} = 0.85	Lightw.conc.: Reduction factor of compression strength of concrete
11.3.5(2)	α_{lct} = 0.85	Lightw.conc.: Reduction factor of tensile strength of concrete
11.6.1(1)	$C_{lRd,c}$ = 0.15 / γ_c	Lightw.conc.: Coeff. to calculate the resistance of shear force
	$v_{l,min}$ = 0.0420 $k^{3/2}$ $f_{lck}^{1/2}$	
	k_{l1} = 0.15	
11.6.1(2)	v_l = 0.500 η_1 (1 - f_{lck}/250)	Lightw.conc.: Reduction factor of strength of shear force
11.6.2(1)	v_{l1} = 0.500 η_1 (1 - f_{lck}/250)	Lightw.conc.: Coeff. to calculate the maximum design resistance of shear force

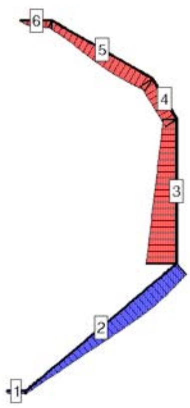
LOAD CASE 1: DEAD LOAD

Deformed system
Load case 1: dead load

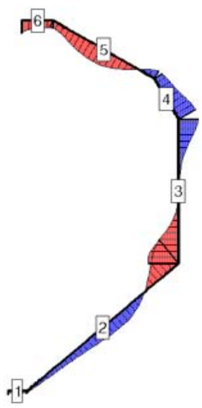


Deformations: factor: 6000.
Min/Max: ux: -8.E-2/10.E-2 mm, uz: -0.376/-0.114 mm

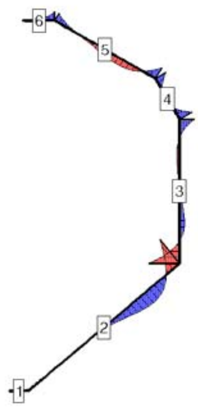
Normal force n_l
Min/Max: -102.38/59.55 kN/m



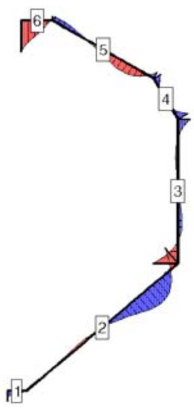
Normal force n_m
Min/Max: -129.19/82.03 kN/m



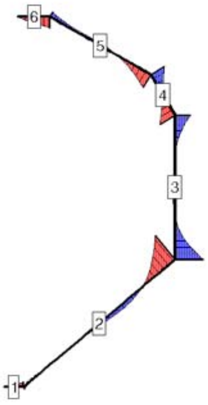
Internal moment m_l
Min/Max: -15.70/7.11 kNm/m



Internal moment m_m
Min/Max: -3.86/2.46 kNm/m

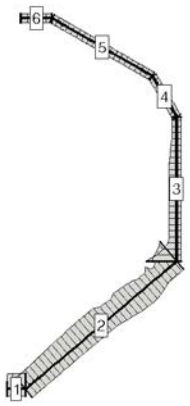


Shear force q_l
Min/Max: -23.77/21.24 kN/m

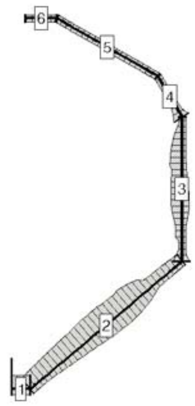


SUMMARY

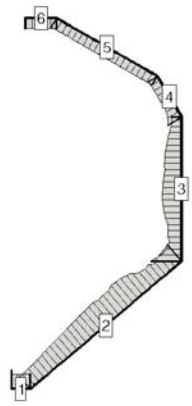
Longitudinal reinf. as1
Max: as_{1o}/as_{1u}: 29.06/15.41 cm^2/m



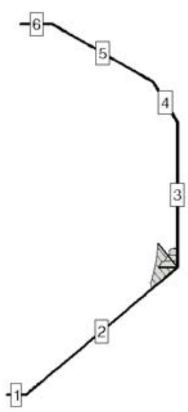
Longitudinal reinf. as2
Max: as_{2o}/as_{2u}: 35.11/15.47 cm^2/m



Reinforcement ratio μ_s
Max: 1.74 %



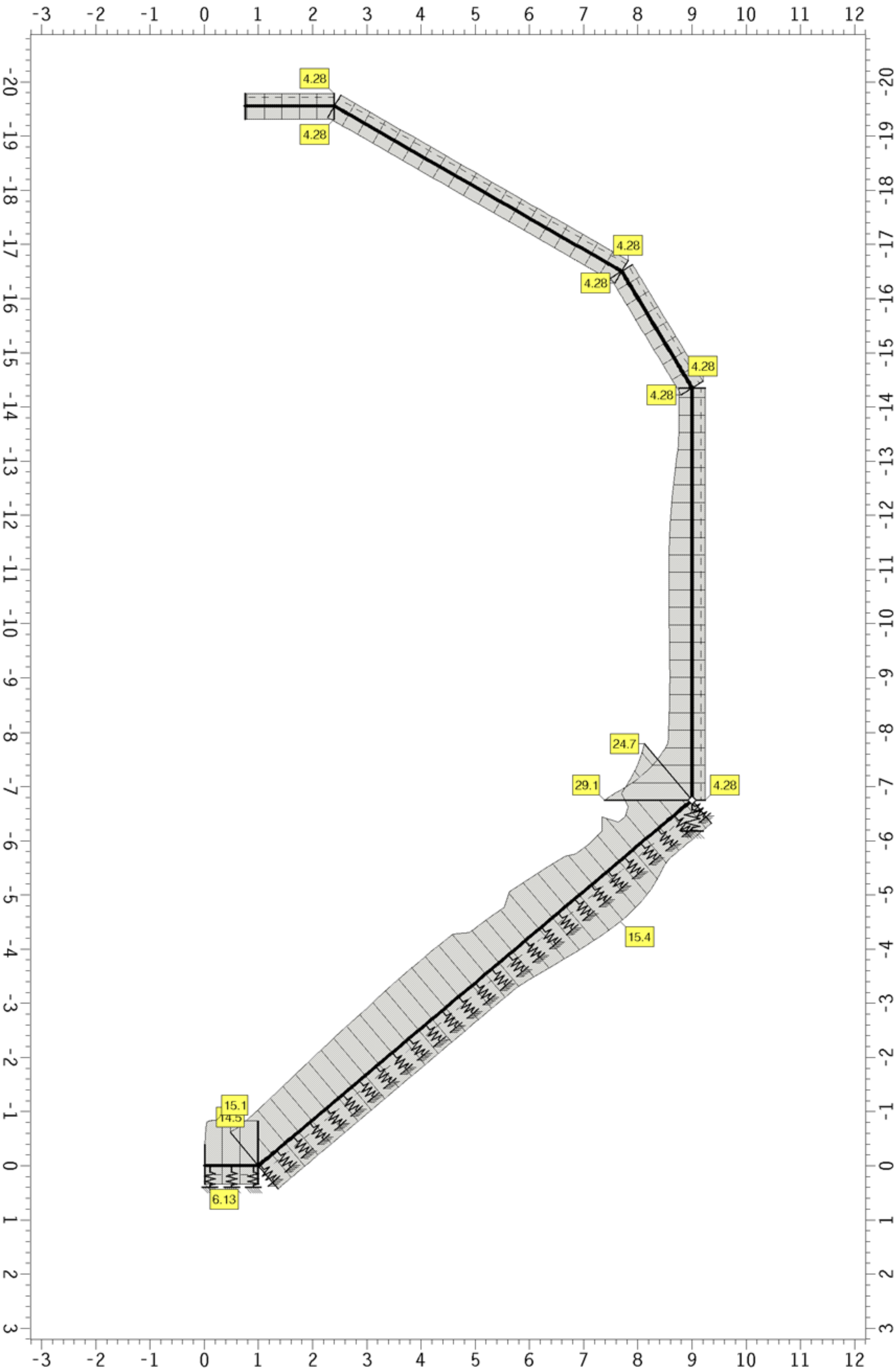
Shear reinforcement as_q
Max: 22.76 cm^2/m^2



Reinforcement

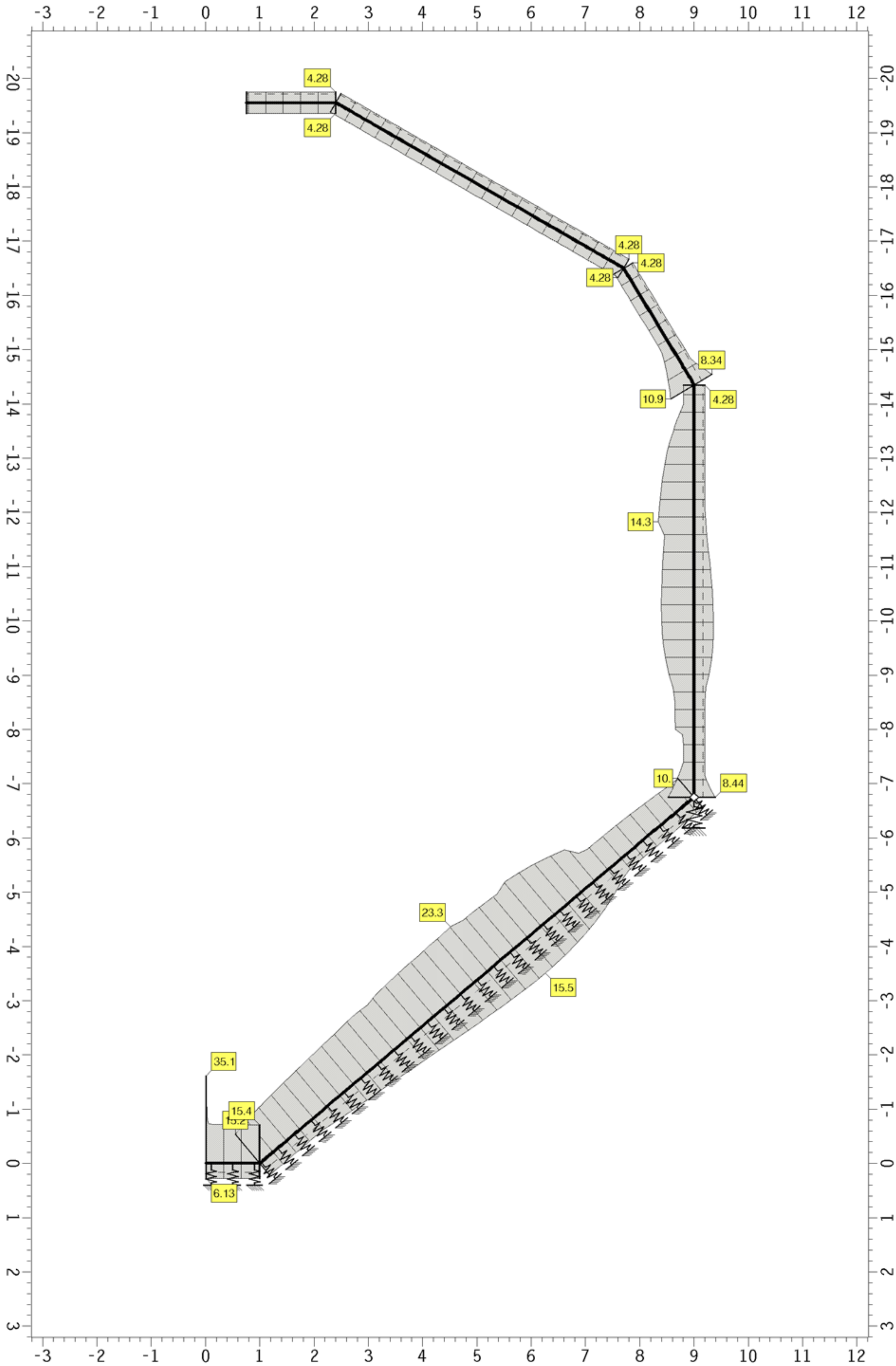
node	s	as1o	as2o	as1u	as2u	µs	asq
-	m	cm^2/m	cm^2/m	cm^2/m	cm^2/m	%	cm^2/m
Shell 1: Einlaufboden							
1	0.00	7.02	35.11	6.13	6.13	1.09	0.00
	0.01	12.65	18.58	6.13	6.13	0.87	0.00
	0.06	14.87	15.89	6.13	6.13	0.86	0.00
	0.22	15.10	15.60	6.13	6.13	0.86	0.00
2	0.99	14.87	15.45	6.13	6.13	0.85	0.00
Shell 2: Bodenkegel							
2	0.00	14.54	15.16	10.00	6.13	0.92	0.00
	1.31	14.99	18.64	10.00	6.08	1.02	0.00
	5.50	17.21	23.25	10.00	14.85	1.46	0.00
	5.76	14.11	21.99	10.00	15.18	1.38	0.00
	6.28	13.46	21.70	11.45	15.47	1.41	0.00
	6.54	13.02	21.27	12.26	15.38	1.42	0.00
	6.80	15.82	22.91	13.05	15.09	1.54	0.00
	8.01	12.98	17.37	15.41	10.33	1.32	0.00
	8.18	11.26	12.70	15.39	9.19	1.15	0.00
	8.34	11.06	11.62	15.23	7.92	1.09	0.00
	8.67	11.21	11.58	14.46	5.46	1.02	0.00
	8.83	11.53	11.54	13.80	5.45	1.02	4.29
	9.00	15.03	11.47	12.94	5.43	1.08	5.43
	9.16	10.21	11.38	11.85	5.42	0.94	6.89
	9.32	10.00	11.26	10.52	5.40	0.90	8.49
	9.49	11.99	11.13	10.00	5.39	0.94	10.22
	9.55	16.90	11.05	10.00	5.38	1.06	10.94
3	10.47	24.68	10.00	10.00	5.30	1.25	22.76
Shell 3: Zylinder							
3	0.00	29.06	10.36	4.28	8.44	1.74	13.76
	0.05	27.75	9.79	4.28	7.82	1.65	14.04
	0.40	17.96	6.22	4.28	4.28	1.09	9.10
	0.65	13.05	4.28	4.28	4.28	0.86	6.75
	0.95	9.03	4.28	4.28	4.28	0.73	5.83
	1.05	8.08	4.42	4.28	4.28	0.70	0.00
	1.15	7.74	4.60	4.28	4.28	0.70	0.00
	1.25	7.83	7.43	4.28	4.28	0.79	0.00
	2.02	7.40	8.42	4.28	4.67	0.83	0.00
	2.53	7.40	11.33	4.28	6.98	1.00	0.00
	3.04	7.52	12.73	4.28	7.82	1.08	0.00
	3.80	7.70	13.07	4.28	7.29	1.08	0.00
	4.82	7.47	11.87	4.28	5.17	0.96	0.00
	5.07	7.25	14.25	4.28	4.67	1.01	0.00
	6.09	5.56	11.94	4.28	4.28	0.87	0.00
	7.25	4.28	4.28	4.28	4.28	0.57	0.00
4	7.60	4.28	4.28	4.28	4.28	0.57	0.00
Shell 4: Galeriekegel							
4	0.00	4.28	10.94	4.28	8.34	0.93	0.00
	0.43	4.28	7.04	4.28	4.33	0.66	0.00
	0.79	4.28	4.43	4.28	4.28	0.58	0.00
5	2.51	4.28	4.28	4.28	4.28	0.57	0.00
Shell 5: Kegel top							
5	0.00	4.28	4.28	4.28	4.28	0.57	0.00
6	6.11	4.28	4.28	4.28	4.28	0.57	0.00
Shell 6: Ringplatte							
6	0.00	4.28	4.28	4.28	4.28	0.57	0.00
7	1.65	4.28	4.28	4.28	4.28	0.57	0.00
Minimum		**4.28**	**4.28**	**4.28**	**4.28**	**0.57**	**0.00**
Maximum		**29.06**	**35.11**	**15.41**	**15.47**	**1.74**	**22.76**

Boundary lines as1



Boundary lines as1, reinforcement in 1-direction: factor: 6.E-2
Max: as1o: 29.06 cm2/m, as1u: 15.41 cm2/m

Boundary lines as2



Boundary lines as2, reinforcement in 2-direction: factor: 5.E-2
Max: as2o: 35.11 cm2/m, as2u: 15.47 cm2/m