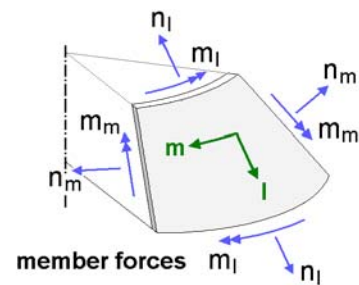
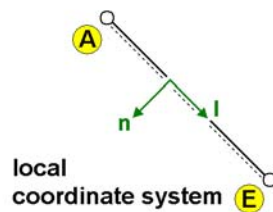
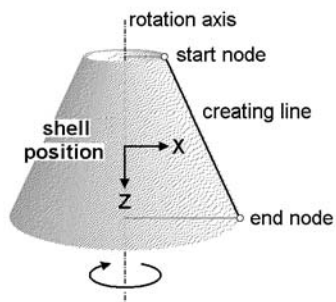


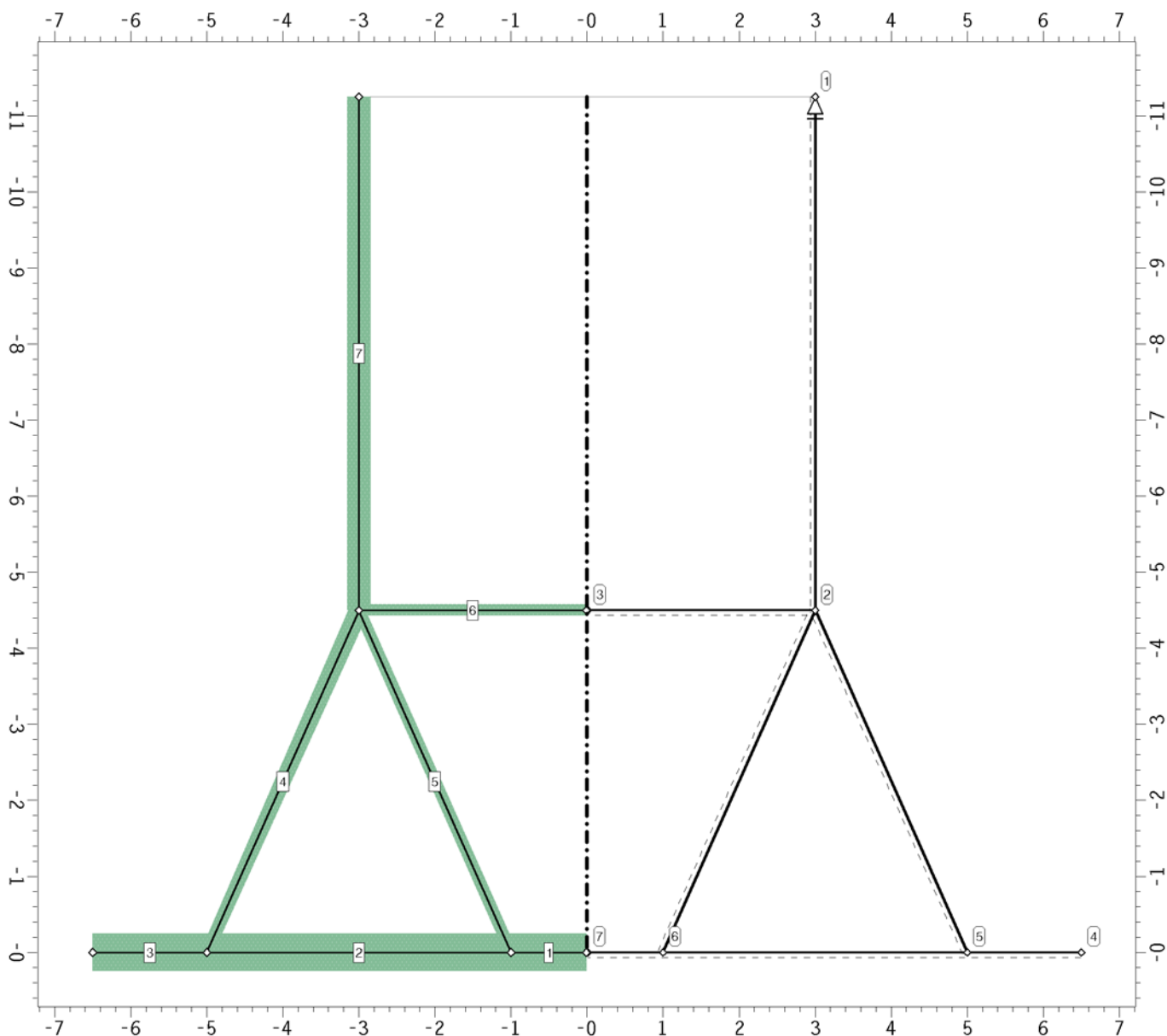
Structural Calculations of rotationally symmetrical shell structures by using the Finite Element Method



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

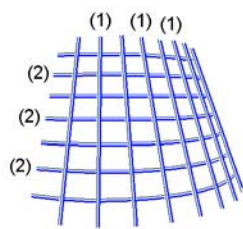
node -	X m	Z m	Cf-X MN/m ²	Cf-Z MN/m ²	Cm-Y MNm/m	designat ion -
1	3.000	-11.250	-	fest	-	
2	3.000	-4.500	-	-	-	
3	0.010	-4.500	-	-	-	
4	6.500	0.000	-	-	-	
5	5.000	0.000	-	-	-	
6	1.000	0.000	-	-	-	
7	0.010	0.000	-	-	-	

Calculation values of position 1: PLATTE INNEN

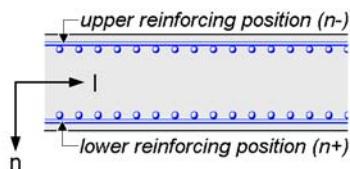
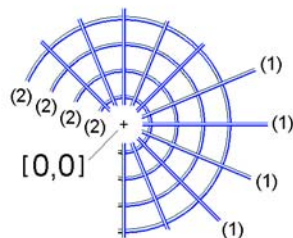
Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 7	E-modulus: 2100.00 MN/m ²	no
End node: 6	Poisson's ratio: 0.17 -	
Length: 0.99 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	
Thickn.: 50.00 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 = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement
(2)above = 4.5 cm	(2)above = 0.00 cm ² /m		
(1)below = 3.5 cm	(1)below = 0.00 cm ² /m		
(2)below = 4.5 cm	(2)below = 0.00 cm ² /m		

position 1:

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

Calculation values of position 2: PLATTE ZW. KEGELSCHA

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 6	E-modulus: 2100.00 MN/m ²	no
End node: 5	Poisson's ratio: 0.17 -	
Length: 4.00 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	
Thickn.: 50.00 cm		

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 = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement
(2)above = 4.5 cm	(2)above = 0.00 cm ² /m		
(1)below = 3.5 cm	(1)below = 0.00 cm ² /m		
(2)below = 4.5 cm	(2)below = 0.00 cm ² /m		

position 2:

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

Calculation values of position 3: BODENPLATTE AUSSEN

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 5 End node: 4 Length: 1.50 m Thickn.: 50.00 cm	E-modulus: 2100.00 MN/m ² Poisson's ratio: 0.17 - 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 = 0.00 cm ² /m (2)above = 0.00 cm ² /m (1)below = 0.00 cm ² /m (2)below = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement

position 3:

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

Calculation values of position 4: KEGELSCHALE AUSSEN

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 2 End node: 5 Length: 4.92 m Thickn.: $t_A = 25.00$ cm $t_E = 15.00$ cm	E-modulus: 2100.00 MN/m ² Poisson's ratio: 0.17 - 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 = 0.00 cm ² /m (2)above = 0.00 cm ² /m (1)below = 0.00 cm ² /m (2)below = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement

position 4:

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

Calculation values of position 5: KEGELSCHALE INNEN

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 2 End node: 6 Length: 4.92 m Thickn.: 15.00 cm	E-modulus: 2100.00 MN/m ² Poisson's ratio: 0.17 - 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 = 0.00 cm ² /m (2)above = 0.00 cm ² /m (1)below = 0.00 cm ² /m (2)below = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement

position 5:

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

Calculation values of position 6: OBERE KREISPLATTE

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 3 End node: 2 Length: 2.99 m Thickn.: 15.00 cm	E-modulus: 2100.00 MN/m ² Poisson's ratio: 0.17 - 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 = 0.00 cm ² /m (2)above = 0.00 cm ² /m (1)below = 0.00 cm ² /m (2)below = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement

position 6:

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

Calculation values of position 7: OBERE ZYLINDERSCHALE

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 1 End node: 2 Length: 6.75 m Thickn.: 30.00 cm	E-modulus: 2100.00 MN/m ² Poisson's ratio: 0.17 - 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 = 0.00 cm ² /m (2)above = 0.00 cm ² /m (1)below = 0.00 cm ² /m (2)below = 0.00 cm ² /m	type: orthogonal with $\alpha = 0.00^\circ$	tensile reinforcement

position 7:

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

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



1: dead load

2: Gleichlast

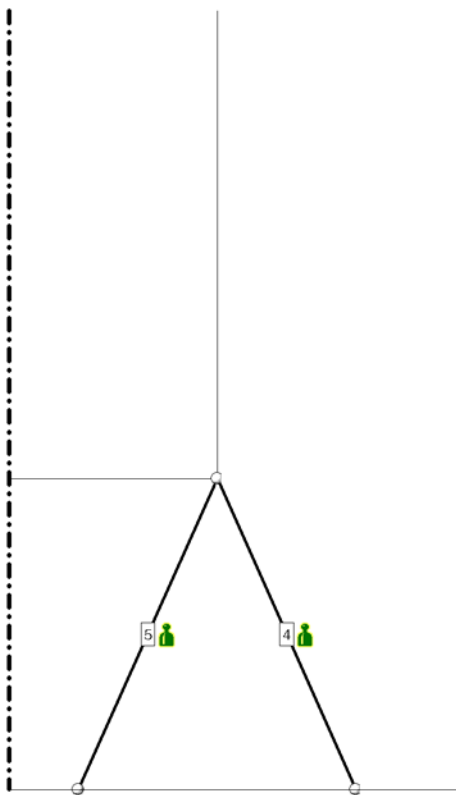
permanent loads

additive

additive

LOAD PICTURES IN LOAD CASE 1: DEAD LOAD

Loaded objects in load case 1

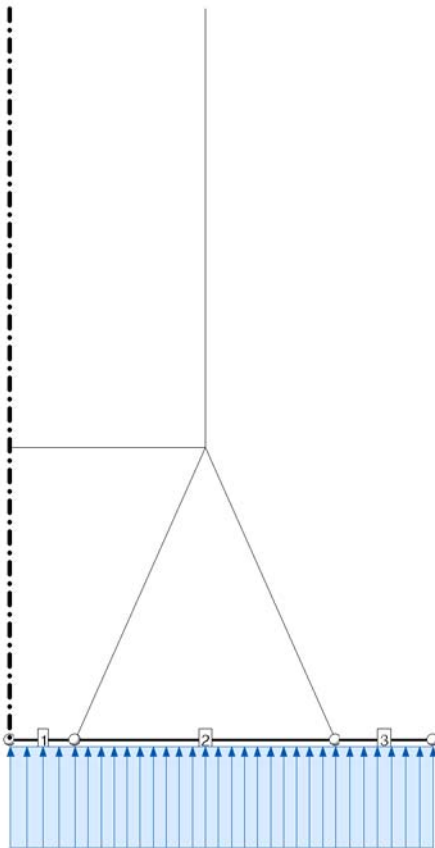


dead loads in load case 1

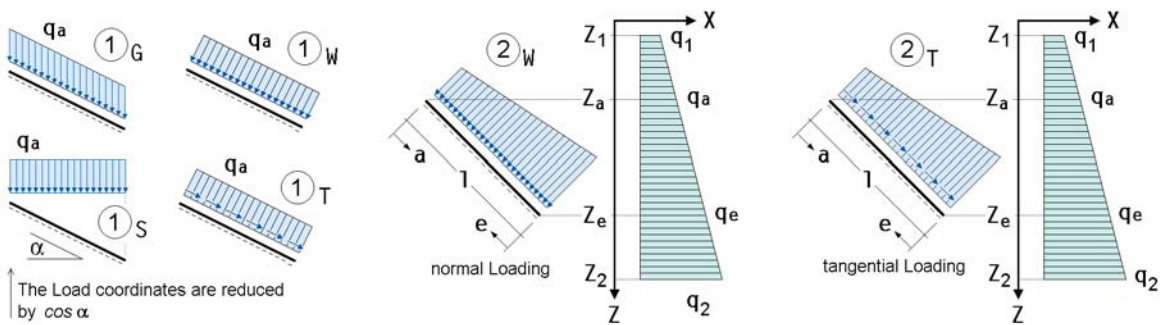
pos.	max.density
-	kN/m ³
4	2.500
5	2.500

LOAD PICTURES IN LOAD CASE 2: GLEICHLAST

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 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
1	1W	-20.000	-	-	0.990	-				
2	1W	-20.000	-	-	4.000	-				
3	1W	-20.000	-	-	1.500	-				

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: Analysis

Analysis: Analysis no Verifications

1: dead load

Rules of extremization of verification 1, type: user defined, rule of superposition: charakteristisch

LF	γ_{sup}	γ_{inf}
1	1.00	1.00

2: Gleichlast

Rules of extremization of verification 1, type: user defined, rule of superposition: charakteristisch

LF	γ_{sup}	γ_{inf}
2	1.00	1.00

3: Summe

Rules of extremization of verification 1, type: user defined, rule of superposition: charakteristisch

LF	γ_{sup}	γ_{inf}
1	1.00	1.00
2	1.00	1.00

List of beams of verification 1:

Line numbers ...							
	1	2	3	4	5	6	7

REGULATIONS

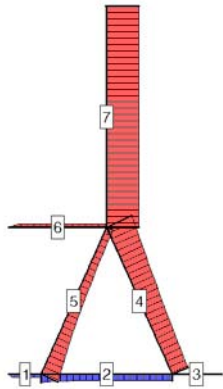
VERIFICATION 1: SUMMARY

Extremal Reactions of supported nodes (γ_F-fach)

node type	ap _x kN/m	ap _z kN/m	am _y kNm/m
1 Min	0.00	-4.45	0.00
Max	0.00	140.83	0.00
Minimum	0.00	-4.45	0.00
Maximum	0.00	140.83	0.00

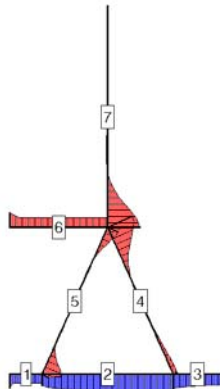
Normal force n_l

Min/Max: -140.83/35.48 kN/m



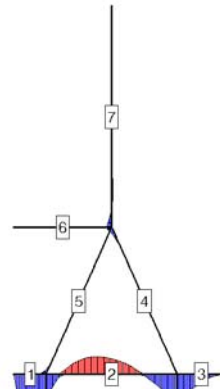
Normal force n_m

Min/Max: -47.87/25.63 kN/m



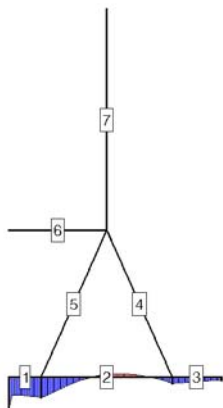
Internal moment m_l

Min/Max: -14.48/25.91 kNm/m



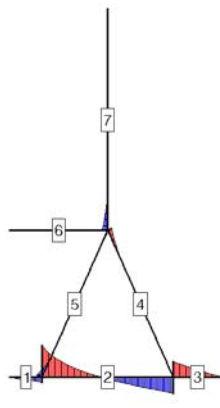
Internal moment m_m

Min/Max: -3.06/27.25 kNm/m



Shear force q_l

Min/Max: -69.48/34.12 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 1: PLATTE INNEN							
7	0.00	Min	0.00	-0.09	0.00	-0.09	0.00
		Max	0.00	20.25	0.00	27.25	0.00
	0.10	Min	-0.06	-0.06	-0.05	-0.05	0.00
		Max	12.71	12.81	14.97	15.23	1.08
6	0.99	Min	-0.06	-0.06	-0.05	-0.05	0.00
		Max	12.78	12.79	19.01	16.94	10.00
Shell 2: PLATTE ZW. KEGELSCHA							
6	0.00	Min	-0.12	-0.07	-0.05	-0.05	-69.48
		Max	35.48	16.25	22.25	17.41	0.07
	0.40	Min	-0.10	-0.08	-0.03	-0.04	-42.77
		Max	30.84	21.21	1.69	12.44	0.05
	1.00	Min	-0.10	-0.09	-11.43	-0.03	-19.74
		Max	28.37	23.65	-0.01	4.42	0.04
	1.60	Min	-0.10	-0.09	-14.48	-0.75	-4.57

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	
5	2.40	Max	27.41	24.61	0.01	-0.02	0.03	
		Min	-0.09	-0.09	-9.01	-3.06	0.02	
	3.00	Max	26.83	25.19	0.02	-0.01	10.65	
		Min	-0.09	-0.09	0.03	-1.82	0.02	
	4.00	Max	26.60	25.42	0.63	-0.00	20.15	
		Min	-0.09	-0.09	0.04	0.01	0.01	
		Max	26.39	25.63	25.53	5.14	34.12	
Shell 3: BODENPLATTE AUSSEN								
5	0.00	Min	-5.22	-0.07	-0.00	0.00	-34.50	
		Max	0.02	20.43	25.91	5.19	0.00	
4	0.75	Min	-2.10	-0.06	-0.00	0.00	-15.98	
		Max	0.01	17.23	5.74	3.51	0.00	
	1.50	Min	0.00	-0.05	0.00	0.00	0.00	
		Max	0.00	15.10	0.00	2.41	0.00	
Shell 4: KEGELSCHALE AUSSEN								
2	0.00	Min	-121.07	-40.19	-0.13	-0.02	-9.12	
		Max	3.33	0.83	3.56	0.60	0.35	
	0.49	Min	-115.78	-29.33	-0.01	-0.01	-3.42	
		Max	2.90	0.29	0.48	0.18	0.13	
	1.15	Min	-108.24	-8.51	-0.42	-0.00	-0.09	
		Max	2.32	-0.59	0.02	0.00	-0.00	
	2.30	Min	-95.52	-0.98	-0.08	0.00	-0.00	
		Max	1.41	1.72	0.00	0.00	0.18	
	5	4.92	Min	-75.53	-6.26	-0.04	-0.01	-0.11
			Max	0.03	-0.01	0.42	0.08	1.02
Shell 5: KEGELSCHALE INNEN								
2	0.00	Min	-30.17	-17.24	0.01	0.00	-2.67	
		Max	1.36	0.40	0.66	0.11	-0.03	
	0.33	Min	-30.86	-12.66	0.00	-0.01	-1.18	
		Max	1.29	0.35	0.05	0.00	-0.02	
	0.66	Min	-31.91	-5.99	-0.17	-0.04	-0.21	
		Max	1.22	0.37	-0.00	-0.00	-0.01	
	1.48	Min	-36.15	0.40	-0.06	-0.01	0.00	
		Max	1.04	1.30	-0.00	-0.00	0.19	
	3.94	Min	-62.29	-0.17	-0.16	-0.00	-0.37	
		Max	0.40	0.24	-0.00	-0.00	-0.00	
	4.27	Min	-68.50	-7.43	-0.23	-0.00	-0.00	
		Max	0.30	0.22	-0.00	0.01	0.36	
	4.60	Min	-74.79	-23.34	-0.00	-0.00	-0.00	
		Max	0.20	0.16	0.41	0.12	4.38	
	4.76	Min	-77.90	-26.98	-0.00	-0.00	0.01	
		Max	0.14	0.09	1.47	0.24	8.18	
	6	4.92	Min	-81.84	-9.87	0.00	0.00	0.02
			Max	0.09	0.00	3.24	0.39	11.56
Shell 6: OBERE KREISPLATTE								
3	0.00	Min	0.00	-20.67	0.00	-0.00	0.00	
		Max	0.00	0.30	0.00	0.00	0.00	
	0.30	Min	-14.58	-14.58	-0.00	-0.00	0.00	
		Max	0.21	0.21	0.00	0.00	0.00	
2	2.99	Min	-14.59	-14.59	-0.00	-0.00	0.00	
		Max	0.21	0.21	0.00	0.00	0.00	
Shell 7: OBERE ZYLINDERSCHALE								
1	0.00	Min	-140.83	-0.00	0.00	0.00	0.00	
		Max	4.45	0.02	0.00	0.00	0.00	
	4.50	Min	-140.83	-0.05	-0.20	-0.03	-0.54	
		Max	4.45	2.17	0.01	0.00	0.01	
	4.95	Min	-140.83	-0.01	-0.50	-0.08	-0.79	
		Max	4.45	0.82	0.01	0.00	0.02	
	5.62	Min	-140.83	-10.38	-0.89	-0.15	-0.01	
		Max	4.45	0.29	0.02	0.00	0.05	
	6.30	Min	-140.83	-36.13	-0.02	-0.00	-0.14	
		Max	4.45	0.90	0.52	0.09	5.11	
2	6.75	Min	-140.83	-47.87	-0.12	-0.02	-0.29	
		Max	4.45	1.09	4.21	0.70	11.58	
Minimum			-140.83	-47.87	-14.48	-3.06	-69.48	
Maximum			35.48	25.63	25.91	27.25	34.12	