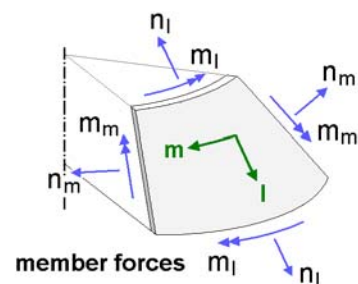
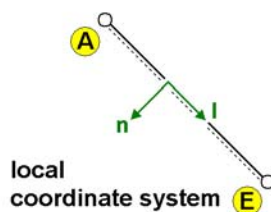
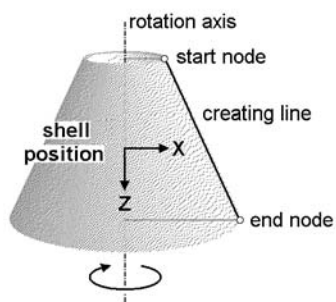


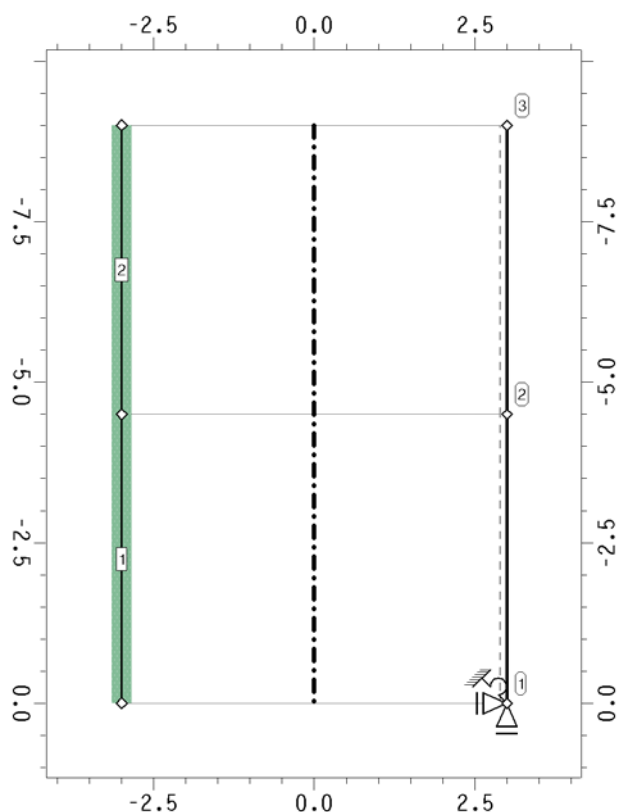
Structural Calculations of rotationally symmetrical shell structures by using the Finite Element Method



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.



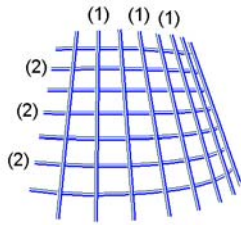
Coordinates and bearing information

node	X m	Z m	Cf-X MN/m ²	Cf-Z MN/m ²	Cm-Y MNm/m	designat ion
1	3.000	0.000	fest	fest	fest	-
2	3.000	-4.500	-	-	-	-
3	3.000	-9.000	-	-	-	-

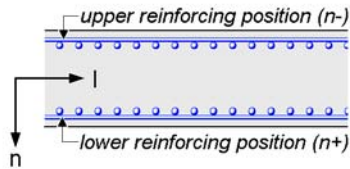
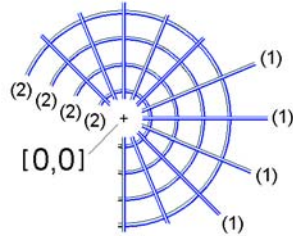
Calculation values of position 1: Shell below

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 2	E-modulus: 2100.00 MN/m ²	no
End node: 1	Poisson's ratio: 0.17 -	
Length: 4.50 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	
Thickn.: 30.00 cm		



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: Shell above

Material designation: reinforced concrete frei

Geom. characteristic values	Phys. characteristic values	elastic bedding
Start node: 3	E-modulus: 2100.00 MN/m ²	no
End node: 2	Poisson's ratio: 0.17 -	
Length: 4.50 m	Temp. coeff.: 1.00 10 ⁻⁵ /K	
Thickn.: 30.00 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: $\max \mu = 8.0\%$

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

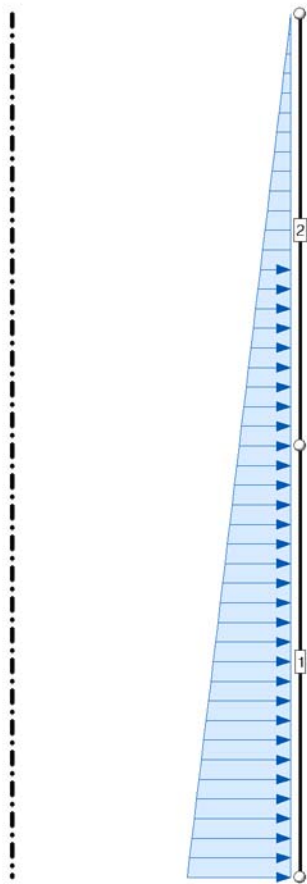
Description of loading structure

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.

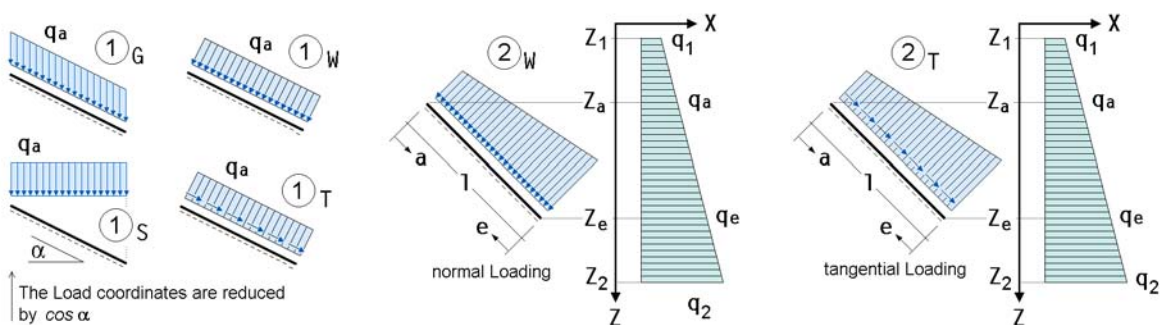


LOAD PICTURES IN LOAD CASE 1: FUELLUNG

Loaded objects in load case 1



Explanation of load types and load directions



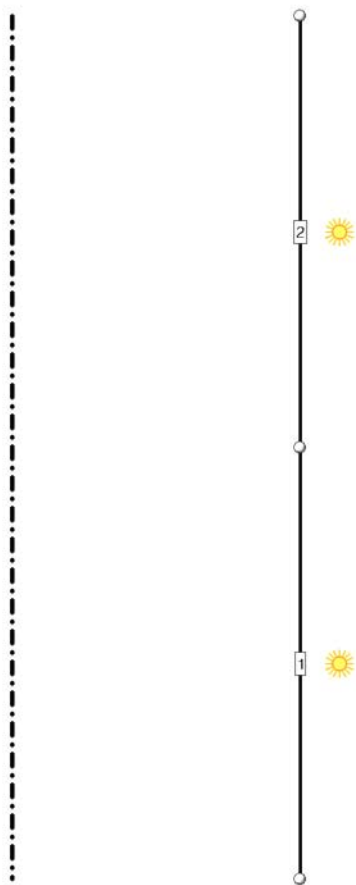
Area loads in load case 1

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	z_1 m	q_1 kN/m ²	z_2 m	q_2 kN/m ²
1	2W	-45.000	-90.000	0.000	4.500	0.000	-9.000	0.000	0.000	-90.000
2	2W	0.000	-45.000	0.000	4.500	0.000	-9.000	0.000	0.000	-90.000

LOAD PICTURES IN LOAD CASE 2: GLEICHM. TEMPERATURE

Loaded objects in load case 2

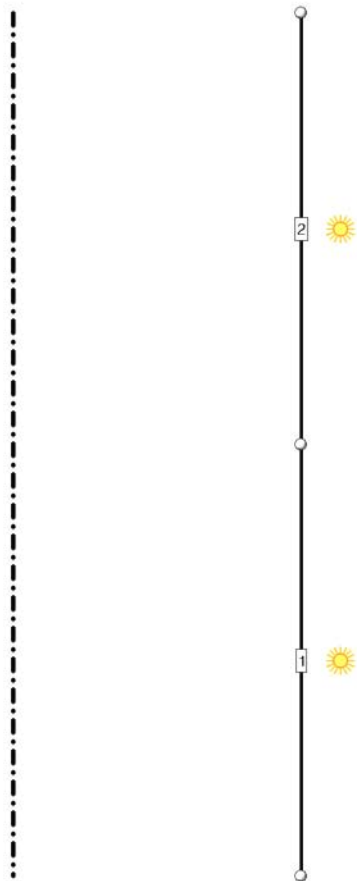


Temperature loads in load case 2

pos. -	t_o °K	t_u °K
2	10.00	10.00
1	10.00	10.00

LOAD PICTURES IN LOAD CASE 3: UNGLEICHM. TEMPERATURE

Loaded objects in load case 3



Temperature loads in load case 3

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

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: Standard combination

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

action	γ_{sup}	γ_{inf}
1	1.00	1.00

List of beams of verification 1:

Line numbers ...
1 2

REGULATIONS

VERIFICATION 1: SUMMARY

Extremal Reactions of supported nodes (γ_F -fach)

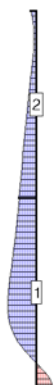
node type	apx kN/m	apz kN/m	amy kNm/m
-			
1 Min	-93.19	0.00	29.08
Max	-93.19	0.00	29.08
Minimum	-93.19	0.00	29.08
Maximum	-93.19	0.00	29.08

Normal force n_m
Min/Max: -126.01/224.73 kN/m

Internal moment m_l
Min/Max: -11.02/29.08 kNm/m

Internal moment m_m
Min/Max: -4.99/1.71 kNm/m

Shear force q_l
Min/Max: -6.41/93.19 kN/m



Extremal member forces

node	s m	type	n _l kN/m	n _m kN/m	m _l kNm/m	m _m kNm/m	q _l kN/m
Shell 1: Shell below							
2	0.00	Min	0.00	134.27	-3.70	-3.77	0.19
		Max	0.00	134.27	-3.70	-3.77	0.19
2.55		Min	0.00	224.73	-6.84	-4.29	-5.80
		Max	0.00	224.73	-6.84	-4.29	-5.80
2.85		Min	0.00	217.62	-8.71	-4.60	-6.41
		Max	0.00	217.62	-8.71	-4.60	-6.41
3.40		Min	0.00	150.15	-11.02	-4.99	0.56

Extremal member forces

node	s	type	n1	nm	m1	nm	q1
-	m		kN/m	kN/m	kNm/m	kNm/m	kN/m
1	4.03	Max	0.00	150.15	-11.02	-4.99	0.56
		Min	0.00	-25.96	-1.23	-3.36	37.60
	4.50	Max	0.00	-25.96	-1.23	-3.36	37.60
		Min	0.00	-126.01	29.08	1.71	93.19
		Max	0.00	-126.01	29.08	1.71	93.19
Shell 2: Shell above							
3	0.00	Min	0.00	43.07	0.00	-3.15	0.00
		Max	0.00	43.07	0.00	-3.15	0.00
	0.25	Min	0.00	25.91	-0.35	-3.21	-2.49
		Max	0.00	25.91	-0.35	-3.21	-2.49
	0.55	Min	0.00	17.28	-1.28	-3.36	-3.36
		Max	0.00	17.28	-1.28	-3.36	-3.36
	0.65	Min	0.00	16.76	-1.61	-3.42	-3.32
		Max	0.00	16.76	-1.61	-3.42	-3.32
	1.40	Min	0.00	33.95	-3.46	-3.73	-1.42
		Max	0.00	33.95	-3.46	-3.73	-1.42
	2.25	Min	0.00	65.52	-3.95	-3.81	-0.03
		Max	0.00	65.52	-3.95	-3.81	-0.03
2	4.50	Min	0.00	134.40	-3.70	-3.77	0.19
		Max	0.00	134.40	-3.70	-3.77	0.19
Minimum			0.00	-126.01	-11.02	-4.99	-6.41
Maximum			0.00	224.73	29.08	1.71	93.19