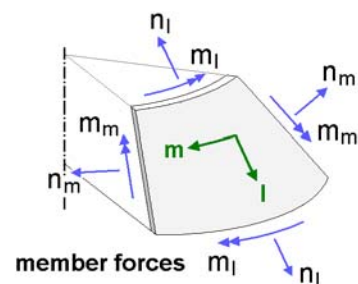
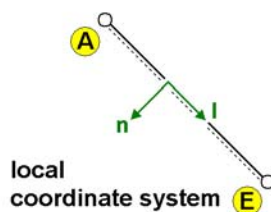
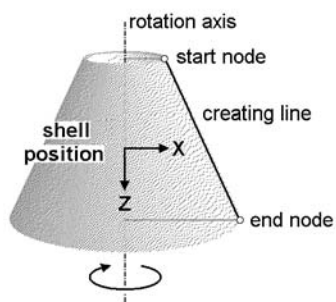


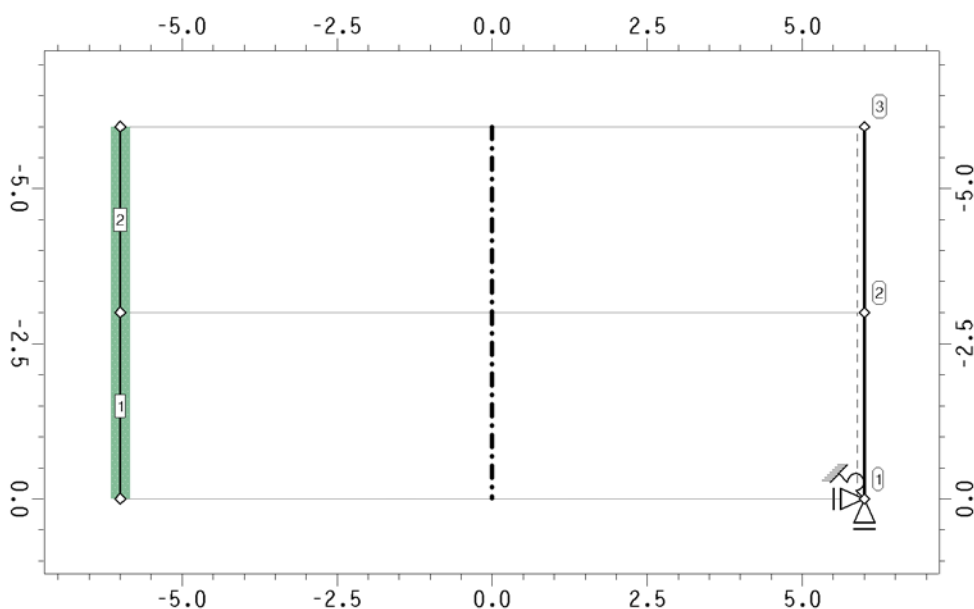
Structural Calculations of rotationally symmetrical shell structures by using the Finite Element Method



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.



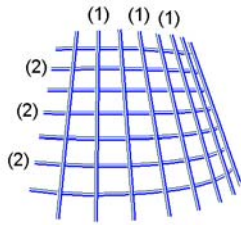
Coordinates and bearing information

node	X m	Z m	Cf-X MN/m ²	Cf-Z MN/m ²	Cm-Y MNm/m	designat ion
1	6.000	0.000	fest	fest	fest	
2	6.000	-3.000	-	-	-	
3	6.000	-6.000	-	-	-	

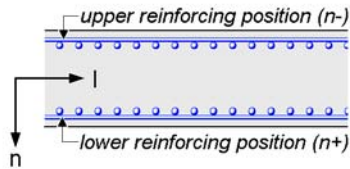
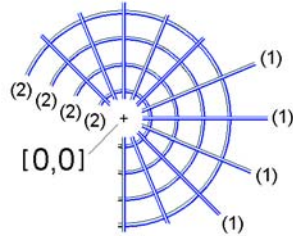
Calculation values of position 1: Shell below

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: 3.00 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 (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 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 End node: 2 Length: 3.00 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 2:

(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 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

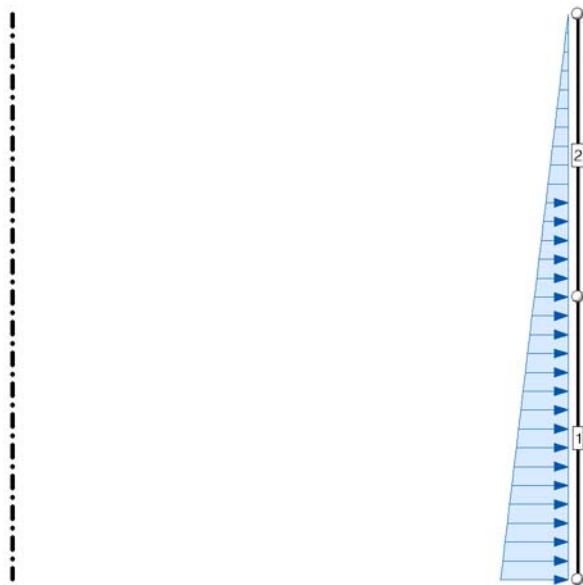
Description of loading structure

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.

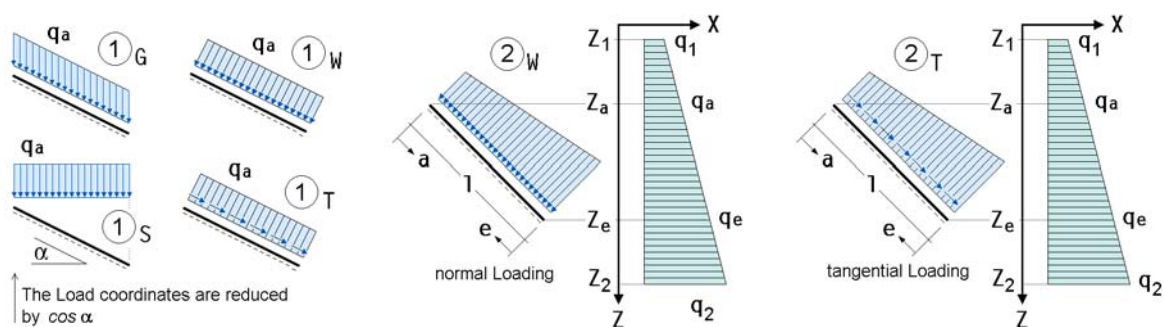


LOAD PICTURES IN LOAD CASE 1: FÜLLUNG

Loaded objects in load case 1



Explanation of load types and load directions



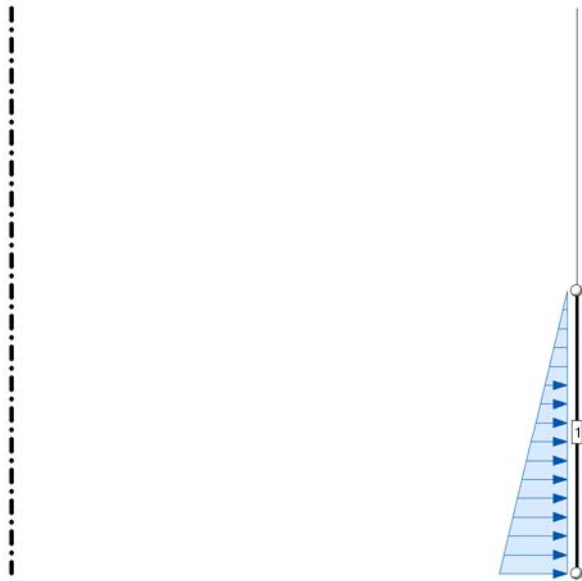
Area loads in load case 1

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	q_e	a	l	e	z1	q1	z2	q2
-	-	kN/m ²	kN/m ²	m	m	m	m	kN/m ²	m	kN/m ²
2	2W	0.000	-30.000	0.000	3.000	0.000	-6.000	0.000	0.000	-60.000
1	2W	-30.000	-60.000	0.000	3.000	0.000	-6.000	0.000	0.000	-60.000

LOAD PICTURES IN LOAD CASE 2: 1/2 FÜLLUNG

Loaded objects in load case 2



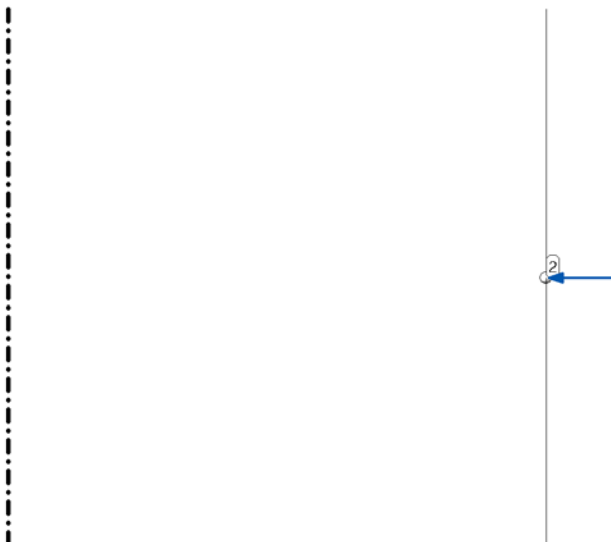
Area loads in load case 2

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. (s.a. explanation sketch on page 3)

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	-30.000	0.000	3.000	0.000	-3.000	0.000	0.000	-30.000

LOAD PICTURES IN LOAD CASE 3: QUERLAST

Loaded objects in load case 3



Ring loads in load case 3

point	syst.	Px kN/m	Pz kN/m	My kNm/m	length m
-	-				
2	r-s-t	-10.000	0.000	0.000	37.699

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)

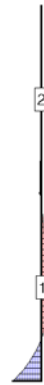
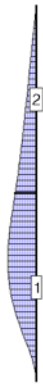
node type	apx kN/m	apz kN/m	amy kNm/m
-			
1 Min	-81.96	0.00	36.20
Max	-81.96	0.00	36.20
Minimum	-81.96	0.00	36.20
Maximum	-81.96	0.00	36.20

Normal force n_m
Min/Max: -0.00/257.24 kN/m

Internal moment m_l
Min/Max: -10.24/36.20 kNm/m

Internal moment m_m
Min/Max: -1.71/6.04 kNm/m

Shear force q_l
Min/Max: -9.68/81.96 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: Shell below							
2	0.00	Min	0.00	189.76	1.44	0.24	-9.43
		Max	0.00	189.76	1.44	0.24	-9.43
	0.25	Min	0.00	211.64	-0.95	-0.16	-9.67
		Max	0.00	211.64	-0.95	-0.16	-9.67
	1.05	Min	0.00	257.24	-8.15	-1.36	-7.24
		Max	0.00	257.24	-8.15	-1.36	-7.24
	1.50	Min	0.00	240.10	-10.24	-1.71	-1.14
		Max	0.00	240.10	-10.24	-1.71	-1.14
	2.35	Min	0.00	97.99	0.30	0.05	31.76
		Max	0.00	97.99	0.30	0.05	31.76
1	3.00	Min	0.00	-0.00	36.20	6.04	81.96
		Max	0.00	-0.00	36.20	6.04	81.96
Shell 2: Shell above							
3	0.00	Min	0.00	0.07	0.00	0.00	0.00
		Max	0.00	0.07	0.00	0.00	0.00
	0.65	Min	0.00	37.19	0.02	0.00	0.09
		Max	0.00	37.19	0.02	0.00	0.09
	1.35	Min	0.00	77.47	0.18	0.03	0.41
		Max	0.00	77.47	0.18	0.03	0.41
	2.40	Min	0.00	143.39	0.94	0.16	0.95
		Max	0.00	143.39	0.94	0.16	0.95
	2.70	Min	0.00	165.41	1.22	0.20	0.88
		Max	0.00	165.41	1.22	0.20	0.88
2	3.00	Min	0.00	189.82	1.44	0.24	0.57
		Max	0.00	189.82	1.44	0.24	0.57
Minimum			0.00	-0.00	-10.24	-1.71	-9.68
Maximum			0.00	257.24	36.20	6.04	81.96