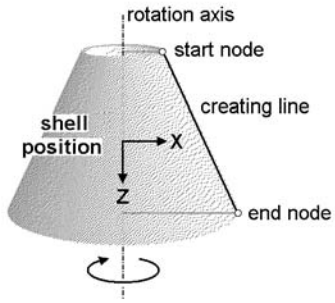
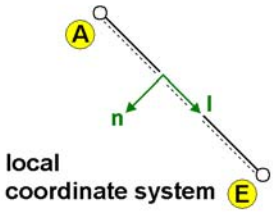
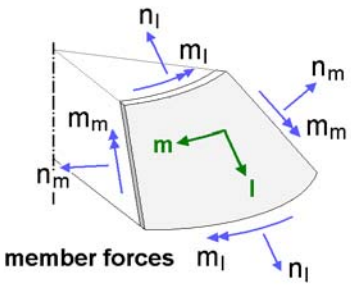
Structural Calcualtions of rotationally symmetrical shell structures by using the Finite Element Method



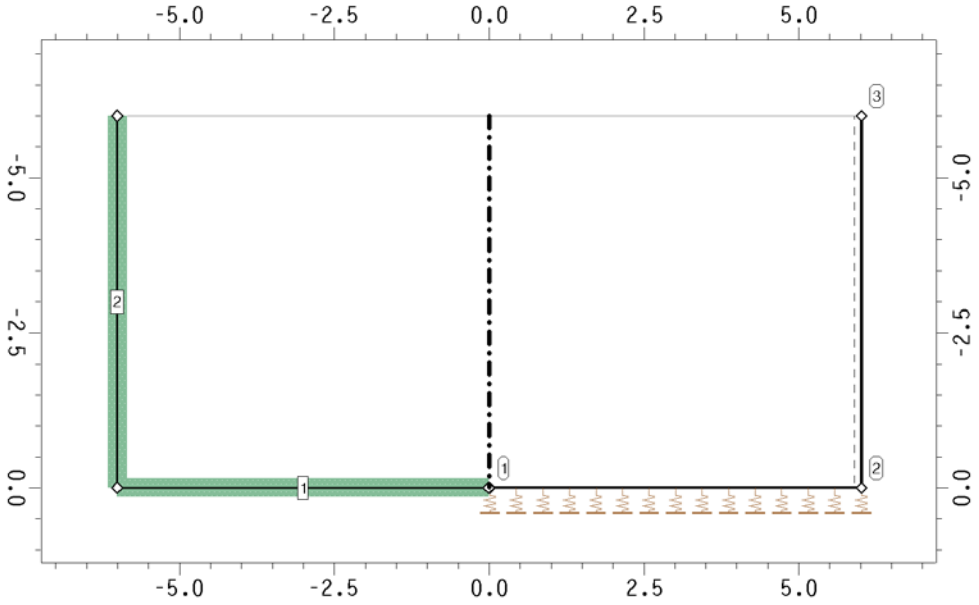




SYSTEM DESCRIPTION

System graphic

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



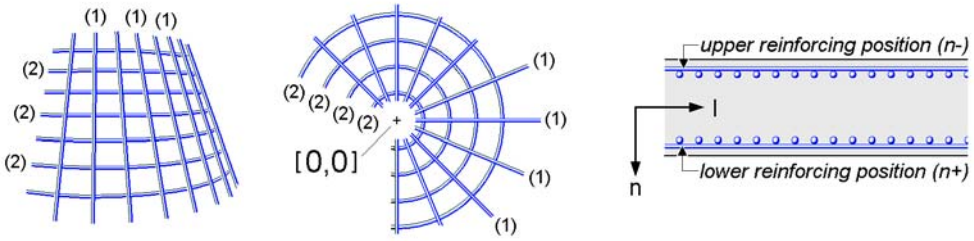
Coordinates and bearing information

node -	X m	Z m	Cf-X MN/m²	Cf-Z MN/m²	Cm-Y MNm/m	designation -
1	0.010	0.000	-	-	-	
2	6.010	0.000	-	-	-	
3	6.010	-6.000	-	-	-	

Calculation values of position 1: Gebettete Bodenplatt

Material designation: reinforced concrete frei

Geom. characteristic values		Phys. characteristic values		elastic bedding
Start node:	1	E-modulus:	2100.00 MN/m2	perpendicular to shell face:
End node:	2	Poisson's ratio:	0.17 -	Cbn = 20.00 MN/m³
Length:	6.00 m	Temp. coeff.:	1.00 10-5/K	in shell direction:
Thickn.:	30.00 cm			no



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 cm²/m (2)above = 0.00 cm²/m (1)below = 0.00 cm²/m (2)below = 0.00 cm²/m	type: orthogonal with α = 0.00 °	tensile reinforcement

position 1:

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

Calculation values of position 2: Zylinderschale

Material designation: reinforced concrete frei

Geom. characteristic values		Phys. characteristic values		elastic bedding
Start node:	3	E-modulus:	2100.00 MN/m2	no
End node:	2	Poisson's ratio:	0.17 -	
Length:	6.00 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 (2)above = 4.5 cm (1)below = 3.5 cm (2)below = 4.5 cm	(1)above = 0.00 cm²/m (2)above = 0.00 cm²/m (1)below = 0.00 cm²/m (2)below = 0.00 cm²/m	type: orthogonal with α = 0.00 °	tensile reinforcement

position 2:

Maximum (rated) reinforcement ratio: max μ = 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

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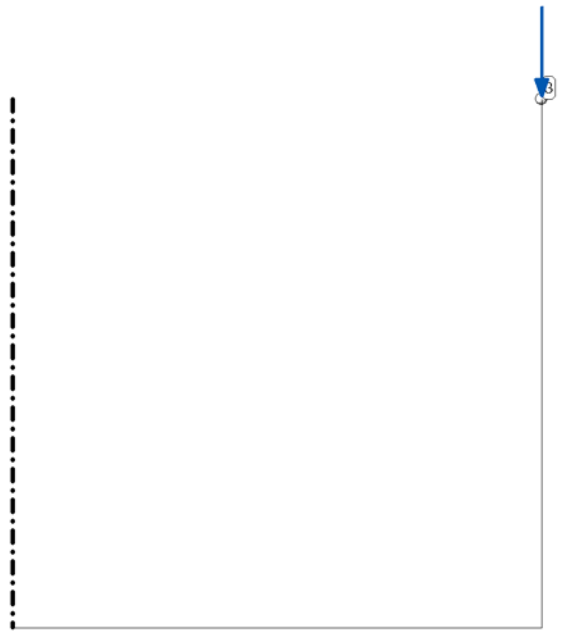
1: permanent loads	**permanent loads**
1: Ring load	additive

LOAD PICTURES IN LOAD CASE 1: RING LOAD

Loaded objects in load case 1



Ring loads in load case 1

point	syst.	P_X	P_Z	M_Y	length
-	-	kN/m	kN/m	kNm/m	m
3	r-s-t	0.000	10.000	0.000	37.762

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 listet 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

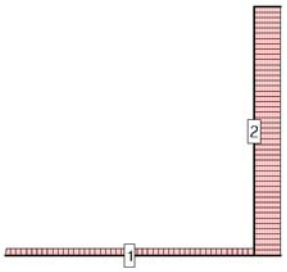
List of beams of verification 1:

Line numbers ...	
1	2

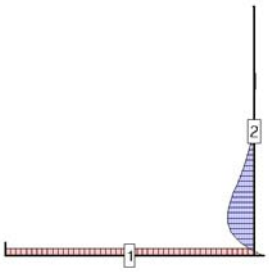
REGULATIONS

VERIFICATION 1: SUMMARY

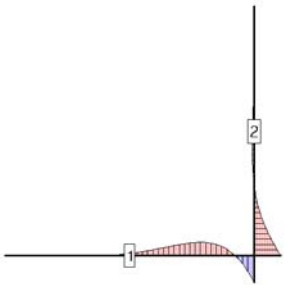
Normal force n_l
Min/Max: -10.00/0.00 kN/m



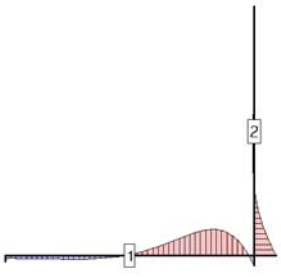
Normal force n_m
Min/Max: -5.24/10.57 kN/m



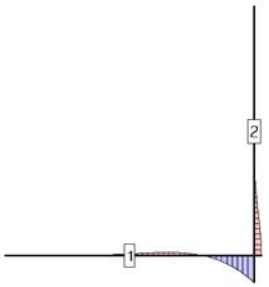
Internal moment m_l
Min/Max: -3.19/3.19 kNm/m



Internal moment m_m
Min/Max: -0.64/0.24 kNm/m



Shear force q_l
Min/Max: -2.80/10.00 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: Gebettete Bodenplatt							
1	0.00	Min	0.00	-5.24	0.00	0.14	0.00
		Max	0.00	-5.24	0.00	0.14	0.00
	0.03	Min	-2.57	-2.93	0.06	0.07	0.00
		Max	-2.57	-2.93	0.06	0.07	0.00
	0.08	Min	-2.74	-2.80	0.07	0.07	0.01

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
		Max	-2.74	-2.80	0.07	0.07	0.01
	2.50	Min	-2.77	-2.77	-0.04	0.05	-0.36
		Max	-2.77	-2.77	-0.04	0.05	-0.36
	3.90	Min	-2.77	-2.77	-1.05	-0.30	-1.21
		Max	-2.77	-2.77	-1.05	-0.30	-1.21
	4.70	Min	-2.77	-2.77	-1.63	-0.60	-0.26
		Max	-2.77	-2.77	-1.63	-0.60	-0.26
	5.00	Min	-2.77	-2.77	-1.48	-0.64	0.92
		Max	-2.77	-2.77	-1.48	-0.64	0.92
	5.55	Min	-2.77	-2.77	0.03	-0.43	4.88
		Max	-2.77	-2.77	0.03	-0.43	4.88
2	6.00	Min	-2.77	-2.77	3.19	0.24	10.00
		Max	-2.77	-2.77	3.19	0.24	10.00
Shell 2: Zylinderschale							
3	0.00	Min	-10.00	0.07	0.00	0.00	0.00
		Max	-10.00	0.07	0.00	0.00	0.00
	2.70	Min	-10.00	0.03	0.13	0.02	0.12
		Max	-10.00	0.03	0.13	0.02	0.12
	3.50	Min	-10.00	2.33	0.19	0.03	-0.01
		Max	-10.00	2.33	0.19	0.03	-0.01
	4.30	Min	-10.00	7.00	-0.01	-0.00	-0.61
		Max	-10.00	7.00	-0.01	-0.00	-0.61
	5.10	Min	-10.00	10.57	-0.96	-0.16	-1.84
		Max	-10.00	10.57	-0.96	-0.16	-1.84
	5.53	Min	-10.00	7.97	-1.90	-0.32	-2.53
		Max	-10.00	7.97	-1.90	-0.32	-2.53
	5.88	Min	-10.00	0.41	-2.84	-0.48	-2.80
		Max	-10.00	0.41	-2.84	-0.48	-2.80
2	6.00	Min	-10.00	-3.99	-3.19	-0.53	-2.77
		Max	-10.00	-3.99	-3.19	-0.53	-2.77
Minimum			**-10.00**	**-5.24**	**-3.19**	**-0.64**	**-2.80**
Maximum			**0.00**	**10.57**	**3.19**	**0.24**	**10.00**