

1 Statics according to DWA-A 143-2: 2015-07: Regularstatics MKG 26 - Egg 400/600, GW 3,50 m

Caption of static calculation: Regularstatics MKG 26 - Egg 400/600, GW 3,50 m

Host pipe state:
Verification buoyancy:
Default options according standard:

HPC II
No
Yes

1.1 Input

1.1.1 Geometry

Geometry:
Nominal diameter DN:
Mirroring horizontal:
Wallthickness liner:
Four-hinge global imperfection:

Egg shaped profile according to DIN 400/600
No
t_L 5.60 mm
WGRv/r_L 3.00 %

Type of host pipe:
Local imperfection intensity long side:
Opening angle of local imperfection:

Egg-shaped profile B:H = 2:3
w_v/r_L 0.50 %
2Φ 30.00 °

Type of annular gap:
Annular gap (const. degree of shrinkage):

Constant degree of shrinkage
w_s/U 0.400 %

1.1.2 Material

Manual definition material:
Use long-term values:
Shear stress proof conducting:

Manual definition
Yes
No

Material name:
Weight liner:
Poissons ratio:
Material is othogonal anisotropic:
E-modulus long-term, characteristic:
E-modulus short-term, characteristic:
Bending tensile strength long-term, characteristic:
Bending tensile strength short-term, characteristic:
Compressive strength long-term, characteristic:
Compressive strength short-term, characteristic:
Coefficient of thermal expansion:

UP-GF
γ_L 17.50 kN/m³
μ 0.35 [-]
No
E_L 13,000.00 N/mm²
E_K 15,600.00 N/mm²
σ_{bZ,L} 170.00 N/mm²
σ_{bZ,K} 245.00 N/mm²
σ_{D,L} 170.00 N/mm²
σ_{D,K} 245.00 N/mm²
α_T 0.00003 1/K

Safety coeff:

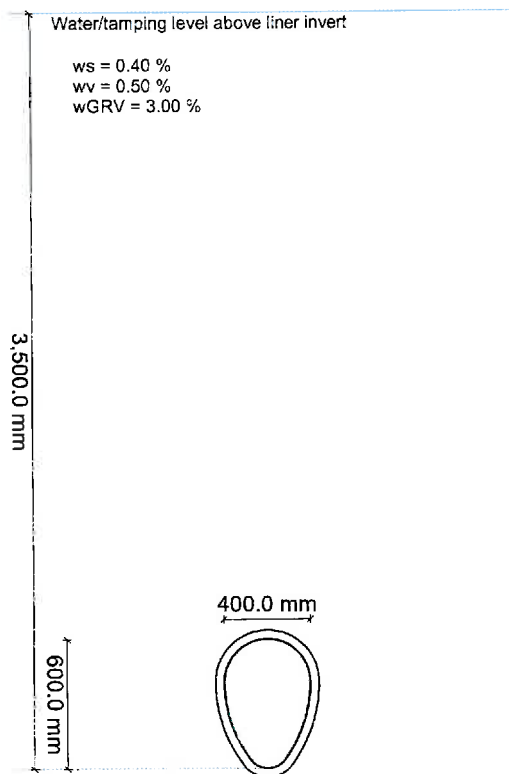
γ_M 1.35 [-]

1.1.3 Loads

Water level above liner invert:	h_w	3.50	m
Weight water:	γ_w	10.00	kN/m ³
Temperature change:	ΔT	0.00	K

Manuell definition reduction ratio for dynamic load:

Partial safety coefficient dead load:	γ_{GE}	1.35	[-]
Partial safety coefficient water pressure:	γ_w	1.50	[-]
Partial safety coefficient internal pressure:	γ_{pi}	1.50	[-]
Partial safety coefficient temperature:	γ_T	1.10	[-]

1.2 Results**1.2.1 Load host pipe state II - hW 3.50 m, Long-term**

Global imperfection according A 143-2 is understood as an increase ($w_{grv}/10$) of the entered local deformation.
Given values:

Local imperfection:	ω_v	0.50	%
Global imperfection:	$\omega_{GR,v}$	3.00	%
$\omega_v = \omega_v + \omega_v/10 = 0.50 \% + (3.00 \% / 10)$			(A 143-2 Tabelle 8)
Local imperfection:	ω_v	0.80	%

Local imperfection absolute:	w_v	4.78	mm
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Consideration of global deformation at geometry level is on the unsafe side because the height/width ratio due to expansion at springline becomes favourable against external pressure. Host pipe state II calculations would deliver more favourable results than host pipe state I.

Global imperfection:	$\omega_{GR,v}$	0.00	%
Global imperfection absolute, one side:	$W_{GR,v}$	0.00	mm
Annular gap:	ω_s	0.40	%
Annular gap absolute (const. value):	w_s	1.00	mm

1.2.1.1 Material values

liner			
Partial safety factor material:	γ_M	1.35	[-]
Poissons ratio:	μ	0.35	[-]
E-Modulus, longterm:	E_L	13,000.00	N/mm ²
E-Modulus, longterm, design:	$E_{L,d}$	9,629.63	N/mm ²
Used E-Modulus:	E	10,973.94	N/mm ²
Admissible compressive strength, long term:	$\sigma_{D,L}$	170.00	N/mm ²
Admissible compressive strength, long term, design:	$\sigma_{D,L,d}$	-125.93	N/mm ²
Admissible tensile bending strength, long term:	$\sigma_{bZ,L}$	170.00	N/mm ²
Admissible tensile bending strength, long term, design:	$\sigma_{bZ,L,d}$	125.93	N/mm ²
Admissible tensile strength, long term:	$\sigma_{Z,L}$	0.00	N/mm ²
Admissible tensile strength, long term, design:	$\sigma_{Z,L,d}$	0.00	N/mm ²

1.2.1.2 Deformation proof (Characteristic load)

Relevant diameter for percentage deformation:	d_v	500.00	mm
Annular gap absolute (const. value):	w_s	1.00	mm
Local imperfection absolute:	w_v	4.78	mm
Global imperfection absolute, one side:	$W_{GR,v}$	0.00	mm
Elastic deformation absolute:	w_{el}	13.9	mm
Relative elastic deformation:	$\delta_{v,el}$	2.78	%
Allowed elastic deformation:	$zul \delta_{v,el}$	3.00	%

The calculated elastic deformation is less than the allowed elastic deformation.

Total diameter deviation:	w	18.67	mm
Relative total deformation:	δ_v	3.73	%
Reference value total deformation:	$\delta_{v,A}$	10.00	%

1.2.1.3 Stability proof (Design values)

The decisive buckling verification of the liner is conducted, as in paragraph 7.6.4.2 (DWA-A 143-2) described, by a permitted (more accurate) variation of the calculation, according to the second order theory under consideration of the prestrain (imperfection) and the annular gap. Here is numerically tested if the elastic stability failure occurs under gamma-tuple load. In addition, in this calculation is proved if the determined stresses does not exceed the limited stresses for the single stability.

The stability proof is not necessary.

Stress analysis liner, host pipe state II - hW 3.50 m

Surface (wallthickness):	A	5.60	mm ² /mm
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outside

		compression	tensile	
Stress in element	Max σ_d	-87.18	56.95	N/mm ²
Max. allowed stress, Long term, Design:	$\sigma_{L,d}$	-125.93	125.93	N/mm ²
Utilisation stress	U_σ	69.2	45.2	%

The outside stress proof is ok.

inside

		compression	tensile	
Stress in element	Max σ_d	-71.18	74.83	N/mm ²
Max. allowed stress, Long term, Design:	$\sigma_{L,d}$	-125.93	125.93	N/mm ²
Utilisation stress	U_σ	56.5	59.4	%

The inside stress proof is ok.

The stress proof is ok.

All necessary proofs are ok.

checked by comparative calculation