1 Statics according to DWA-A 143-2: 2015-07: Regularstatics MKG 26 - Egg 600/900, GW 3,00 m

Caption of static calculation:	Regularstatics MKG 26 - Egg 600/900, GW 3,00 m

Host pipe state:	HPC II		
Verification buoyancy:	No		
Default options according standard:	Yes		

1.1 Input

1.1.1 Geometry

Geometry:	Egg shaped profile according to DIN		
Nominal diameter DN:	600/900		
Mirroring horizontal:	No		
Wallthickness liner:	t_L	7.70	mm
Four-hinge global imperfection:	w_{GRv}/r_L	3.00	%
Type of host pipe:	Egg-shaped profile B:H = 2:3		
Local imperfection intensity long side:	w_v/r_L	0.50	%
Opening angle of local imperfection:	2Φ	30.00	°
Type of annular gap:	Constant degree of shrinkage		
Annular gap (const. degree of shrinkage):	w_s/U	0.400	%

1.1.2 Material

Manual definition material:	Manual definition		
Use long-term values:	Yes		
Shear stress proof conducting:	No		
Material name:	UP-GF		
Weight liner:	γ_L	17.50	kN/m³
Poissons ratio:	μ	0.35	[-]
Material is othogonal anisotropic:	No		
E-modulus long-term, characteristic:	E_L	13,000.00	N/mm²
E-modulus short-term, characteristic:	E_K	15,600.00	N/mm²
Bending tensile strength long-term, characteristic:	$\sigma_{bZ,L}$	170.00	N/mm²
Bending tensile strength short-term, characteristic:	$\sigma_{bZ,K}$	245.00	N/mm²
Compressive strength long-term, characteristic:	$\sigma_{D,L}$	170.00	N/mm²
Compressive strength short-term, characteristic:	$\sigma_{D,K}$	245.00	N/mm²
Coefficient of thermal expansion:	α_T	0.00003	1/K
Safety coeff:	γ_M	1.35	[-]

checked by comparative calculation

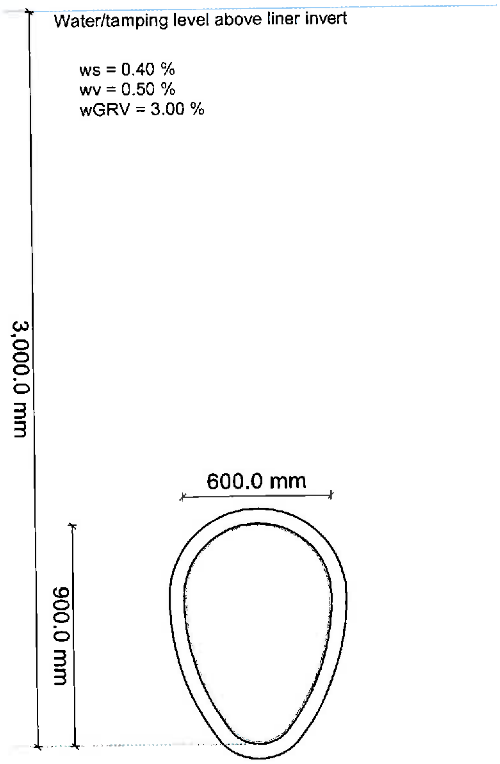
1.1.3 Loads

Water level above liner invert:	h_W	3.00	m
Weight water:	γ_W	10.00	kN/m³
Temperature change:	ΔT	0.00	K

Manuell definition reduction ratio for dynamic load:	No		
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 3.00 m, Long-term



Global imperfection according A 143-2 is understood as an increase (wgrv/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	7.17	mm

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	1.49	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/mm²
E-Modulus, longterm, design:	$E_{L,d}$	9,629.63	N/mm²
Used E-Modulus:	E	10,973.94	N/mm²
Admissible compressive strength, long term:	$\sigma_{D,L}$	170.00	N/mm²
Admissible compressive strength, long term, design:	$\sigma_{D,L,d}$	-125.93	N/mm²
Admissible tensile bending strength, long term:	$\sigma_{bZ,L}$	170.00	N/mm²
Admissible tensile bending strength, long term, design:	$\sigma_{bZ,L,d}$	125.93	N/mm²
Admissible tensile strength, long term:	$\sigma_{Z,L}$	0.00	N/mm²
Admissible tensile strength, long term, design:	$\sigma_{Z,L,d}$	0.00	N/mm²

1.2.1.2 Deformation proof (Characteristic load)

Relevant diameter for percentage deformation:	d_v	750.00	mm
Annular gap absolute (const. value):	w_s	1.49	mm
Local imperfection absolute:	w_v	7.17	mm
Global imperfection absolute, one side:	$w_{GR,v}$	0.00	mm
Elastic deformation absolute:	w_{el}	21.3	mm
Relative elastic deformation:	$\delta_{v,el}$	2.84	%
Allowed elastic deformation:	zul $\delta_{v,el}$	3.00	%

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

Total diameter deviation:	w	28.45	mm
Relative total deformation:	δ_v	3.79	%
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 seccond order theory under consideration of the prestrain (imperfection) and the annular gap. Here is numerically tested if the elastic stability failiure ocurrs under gama-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 3.00 m

Surface (wallthickness):	A	7.70	mm²/mm

outside

		compression	tensile	
Stress in element	Max σ_d	-99.71	63.07	N/mm²
Max. allowed stress, Long term, Design:	$\sigma_{L,d}$	-125.93	125.93	N/mm²
Utilisation stress	U_σ	79.2	50.1	%

The outside stress proof is ok.

inside

		compression	tensile	
Stress in element	Max σ_d	-76.65	86.98	N/mm²
Max. allowed stress, Long term, Design:	$\sigma_{L,d}$	-125.93	125.93	N/mm²
Utilisation stress	U_σ	60.9	69.1	%

The inside stress proof is ok.

The stress proof is ok.

All necessary proofs are ok.

checked by comparative calculation