Structural analysis

Project:	Preplastitev regionalne ceste R3-675
Description:	Odsek1481 Mokrice-Obrežje-Slovenska vas na delu med km 1.555 do km 2.687 DN 500; SN 10.000; PN1; HGV60
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1 Statics according to ATV-DVWK-A 127, 3rd edition

Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

1.1 Input

1.1.1 Safety factors

Safety class:	A (normal case)		
Allowable deflection:	6% (standard)		
Treatment of internal pressure:	In accordance with Footnote 39 in ATV-DVWK-A 127		
Lower safety factors for flexural compression:	No (ATV-DVWK-A 127)		
Proof for not predominantly static loading:	According to standard		
Consideration of dyn pvh*:	According to standard		
Consideration of Type A 'predeformation' in the deformation proof:	Yes		
Proof of minimum ring stiffness:	No		

1.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G2		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G3		
Calculation E3:	Proctor density		
Proctor density E3:	$D_{Pr,E3}$	90.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		

1.1.3 Load

Cover depth:	h	1.10	m
Soil density:	γ	20.0	kN/m³
Manual input of buoyant weight of soil:	No		
Additional surface load:	p_0	0.0	kN/m²
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Inner pressure, short term:	$P_{I,K}$	0.00	bar
Inner pressure, long term:	$P_{I,L}$	0.00	bar
Water fill (e.g. damming channel):	Yes		
Density of medium:	γ_F	10.0	kN/m³
Traffic load:	HLC 60 (road)		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

1.1.4 Installation

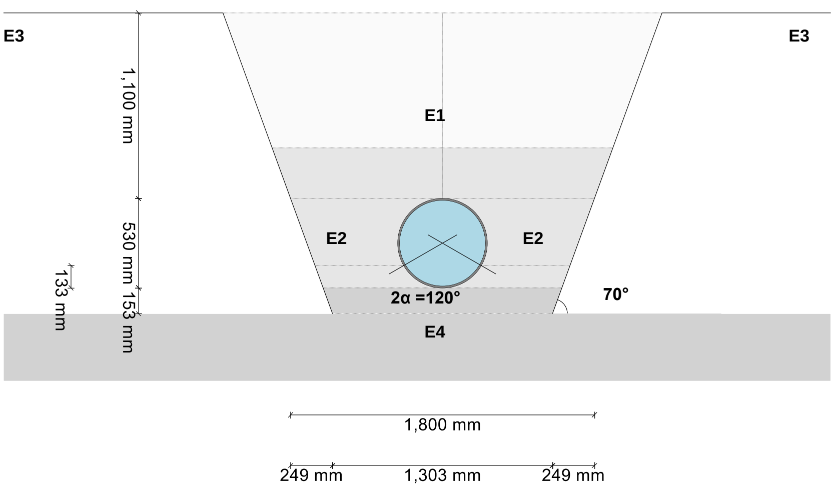
Installation:	Trench		
Trench width at pipe crown level:	b	1.80	m
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	70	°
Cover condition:	A1		

Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Height base:	h_s	0.00	m

1.1.5 Pipe with nominal stiffness

Choice of input:	Do - s		
Outer diameter:	d_a	530	mm
Wall thickness:	t	12.0	mm
Local deformation:	$\delta_{v,lokal}$	0.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Deformation at failure to Table 3 ATV:	Yes		
Creep ratio:	f_{Kriech}	2.00	[-]
Reduction factor due to temperature effect:	$A_{1,Temp}$	1.00	[-]
Reduction factor due to media attack:	$A_{2,Medium}$	1.00	[-]
Reduction factor due to dynamic loading:	$A_{3,dyn}$	1.00	[-]
Specific gravity:	γ_R	18.00	kN/m³
Poissons ratio:	v	0.30	[-]
Amplitude with 1·10^6 tests is known:	Yes		
Amplitude with 1·10^6 tests:	$2\sigma_{a,2E6}$	39.00	N/mm²
Amplitude with 1·10^8 tests is known:	Yes		
Amplitude of the pipe with 1·10^8 tests:	$2\sigma_{a,1E8}$	24.00	N/mm²

Traffic load: HLC 60 (road)



1.2 Results

1.2.0.1 Minimum trench width according to DIN EN 1610

The minimum trench width at trench sole level according DIN EN 1610 is met.

1.2.1 Section forces

1.2.2 Short term load case

1.2.2.1 Strain proof

		crown	springline	invert	
Safety coefficient outside	γ	-9.263	14.328	-7.695	[-]
Safety coefficient Inside	γ	10.028	-10.863	8.204	[-]

(Safety coefficients for flexural compressive stress are marked with a minus sign)

Required security coifficient, tensile stress by bending:	erf γ_{RBZ}	2.00	[-]
Required security coifficient, compressive stress by bending:	erf γ_{RBD}	2.00	[-]

All calculated safety coefficients of the strain proof are sufficient.

1.2.2.2 Deformation proof

Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	3.07	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the allowable deflection.

1.2.2.3 Stabilty proof, linear

Safety coefficient stability:	γ	12.57	[-]
Required security coifficient, failure by instability (buckling):	erf γ_{stab}	2.00	[-]

The buckling safety coefficients determined are sufficient.

1.2.3 Long term load case

1.2.3.1 Strain proof

		crown	springline	invert	
Safety coefficient outside	γ	-7.380	12.112	-5.868	[-]
Safety coefficient Inside	γ	8.096	-8.922	6.264	[-]

(Safety coefficients for flexural compressive stress are marked with a minus sign)

Required security coifficient, tensile stress by bending:	erf γ_{RBZ}	2.00	[-]
Required security coifficient, compressive stress by bending:	erf γ_{RBD}	2.00	[-]

All calculated safety coefficients of the strain proof are sufficient.

1.2.3.2 Deformation proof

Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	3.18	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the allowable deflection.

1.2.3.3 Stabilty proof, linear

Safety coefficient stability:	γ	11.60	[-]
Required security coifficient, failure by instability (buckling):	erf γ_{stab}	2.00	[-]

The buckling safety coefficients determined are sufficient.

1.2.3.4 stability proof, nonlinear

The nonlinear stability proof is not applicable because of VRB > 1.0 (rigid pipe) or relative vertical deformation < 6%.

1.2.3.5 Proof of safety against failure with not predominantly static loading

Inside					
Dynamic stress portion external	dyn σ_{pV}	14.387	-15.015	15.135	N/mm²
Safety coefficient external:	dyn γ	2.711	---	2.577	[-]
Necessary safety coefficient:			erf γ	1.000	[-]
outside					
Dynamic stress portion external	dyn σ_{pV}	-13.927	13.733	-14.697	N/mm²
Safety coefficient external:	dyn γ	---	2.840	---	[-]
Necessary safety coefficient:			erf γ	1.000	[-]

The determined safety coefficients are sufficient.

All necessary proofs are ok.