

Calculations according to the ATV-DVWK-A 127 leaflet, third edition, August 2000

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Cev PVC UK SN8 DN160 proizvajalca Stigma-cevni sistemi d.o.o. prenaša obremenitve Delta V = 0,67 % (Delta V max = 6 %)!

Delta V je veljaven ob pogojih izgradnje, kateri so bili uporabljeni za izracun.

Entry values:

Safeties

Safety class: A (regular case)
 Admissible deflection: 6% (regular case)
 Treatment of inner pressure: Full superimposition (ATV A127)
 Smaller safeties for compression due to bending: no (ATV A127)
 Predeformation type A: $\delta_{v,TypeA}$ 1,00 %
 Local predeformation: $\delta_{v,local}$ 0,00 %

Pipe

Description: Solid wall
 Exterior diameter: d_e 160,0 mm
 Wall thickness: s 4,70 mm

Pipe material

Material class: Thermoplast
 Density of pipe mat.: γ_P 9,50 kN/m³
 Transv. contr. value: v 0,38 [1]
 E-Modulus, short: E_{st} 3.600,00 N/mm²
 E-Modulus, long: E_{lt0} 1.750,00 N/mm²
 Stress limit for tension due to bending, short-term: $\sigma_{BT,st}$ 90,00 N/mm²
 Stress limit for compression due to bending, short-term: $\sigma_{BC,st}$ 90,00 N/mm²
 Stress limit for tension due to bending, long-term: $\sigma_{BT,lt}$ 50,00 N/mm²
 Stress limit for compression due to bending, long-term: $\sigma_{BC,lt}$ 50,00 N/mm²

Soil

E1: filling: Soil group: G1
 Proctor density: D_{PR1} 97,0 %
 E20: pipe zone: Soil group: G1
 Proctor density: D_{PR2} 97,0 %
 E3: native soil: Soil group: G2
 Proctor density: D_{PR3} 97,0 %
 E4: beneath trench: $E4 = 10 * E1$

Installation

Surcharge condition:	A4		
Bedding condition:	B1		
Bedding form:	loose		
Relative projection:	a	1,00	[1]
Bedding angle:	120°		
Trench width:	b	800	mm
Slope angle:	β	60,00	°

Load case combination 1

Description:	Spot with maximum cover		
Cover height:	h	1.200	mm
Soil density:	γ	19,60	kN/m ³
Additional surface load:	P ₀	0,00	N/mm ²
Maximum groundwater level above invert:	h _{w,max}	0	mm
Minimum groundwater level above invert:	h _{w,min}	0	mm
Internal pressure:	P _i	0,00	bar
Water filling (e.g. damming channel)	no		
Traffic load:	HLC 60 (Street)		

Load case combination 2

Description:	Spot with minimum cover		
Cover height:	h	1.000	mm
Soil density:	γ	19,60	kN/m ³
Additional surface load:	P ₀	0,00	N/mm ²
Maximum groundwater level above invert:	h _{w,max}	0	mm
Minimum groundwater level above invert:	h _{w,min}	0	mm
Internal pressure:	P _i	0,00	bar
Water filling (e.g. damming channel)	no		
Traffic load:	HLC 60 (Street)		

Proof for load case combination 1, Short term

Stress proof:

Calc. strain limit, earth and traffic I., bending tension:	$\sigma_{rech,BZ}$	90,0	N/mm ²		
Calc. strain limit, earth and traffic I., bending compress.:	$\sigma_{rech,BD}$	90,0	N/mm ²		
Tension limit due to bending because of other loads:	$\sigma_{zul,BZ}$	90,0	N/mm ²		
Compression limit due to bending because of other loads:	$\sigma_{zul,BD}$	90,0	N/mm ²		
Interior:					
		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh*,i}$	1,645	-1,070	2,876	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,029	-0,034	0,039	N/mm ²
Safety:	γ_{BTi}	53,78	---	30,87	[1]
Safety:	γ_{BCi}	---	81,56	---	[1]
Exterior:					
		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh*,a}$	-2,93	-0,75	-4,21	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,03	-0,04	N/mm ²
Safety:	γ_{BTa}	---	---	---	[1]
Safety:	γ_{BCa}	30,39	125,80	21,18	[1]

Required safety tension due to bending:	req γ_{BT}	2,50	[1]
Required safety compression due to bending:	req γ_{BC}	2,50	[1]

The determined stress safeties are larger than the required safeties.

Deflection proof:

Calculation mode:	linear			
Ratio:	$I/(A_{rad} \cdot r_m^2)$	0,00031	[1]	
Ratio:	$I/(A_{rad} \cdot r_m^2) \cdot K_q$	0,00037	[1]	
Resulting deflection coefficient:	c'_v	q_v -0,0893	q_h 0,0833	q_h^* 0,0640 [1]
Vertical diameter change:	Δd_v	0,9	mm	
Horizontal diameter change:	Δd_h	0,6	mm	
Relative vertical deflection:	δ_v	0,58	%	
Admissible deflection:	adm d_v	6,00	%	

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load	q_v	54,742	kN/m ²
Reduction factor for earth-/traffic load:	K_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,664	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	30,40	[1]
Required buckling safety:	req γ_{buckl}	2,00	[1]

The determined buckling safeties are larger than the required safeties.

Non linear stability proof:

- omitted -

Proof for load case combination 2, Short term

Stress proof:

Calc. strain limit, earth and traffic l., bending tension:		$\sigma_{rech,BZ}$	90,0	N/mm ²	
Calc. strain limit, earth and traffic l., bending compress.:		$\sigma_{rech,BD}$	90,0	N/mm ²	
Tension limit due to bending because of other loads:		$\sigma_{zul,BZ}$	90,0	N/mm ²	
Compression limit due to bending because of other loads:		$\sigma_{zul,BD}$	90,0	N/mm ²	
Interior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	1,865	-1,135	3,151	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,029	-0,034	0,039	N/mm ²
Safety:	γ_{BTi}	47,53	---	28,21	[1]
Safety:	γ_{BCi}	---	76,98	---	[1]
Exterior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-3,18	-0,76	-4,52	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,03	-0,04	N/mm ²
Safety:	γ_{BTa}	---	---	---	[1]
Safety:	γ_{BCa}	28,04	123,00	19,75	[1]
Required safety tension due to bending:		req γ_{BT}	2,50	[1]	
Required safety compression due to bending:		req γ_{BC}	2,50	[1]	

The determined stress safeties are larger than the required safeties.

Deflection proof:

Calculation mode:

Ratio:

Ratio:

linear

$I/(A_{rad} \cdot r_m^2)$ 0,00031 [1]

$I/(A_{rad} \cdot r_m^2) \cdot K_q$ 0,00037 [1]

Resulting deflection coefficient:

c'_v

q_v

-0,0893

q_h

0,0833

q_h^*

0,0640

[1]

Vertical diameter change:

Δd_v

1,0

mm

Horizontal diameter change:

Δd_h

0,7

mm

Relative vertical deflection:

δ_v

0,63

%

Admissible deflection:

adm d_v

6,00

%

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load

q_v

57,189

kN/m²

Reduction factor for earth-/traffic load:

K_{v2}

0,87

[1]

Critical buckling load (earth-/traffic load):

crit q_v

1,664

N/mm

The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.

Safety against buckling:

γ_{buckl}

29,10

[1]

Required buckling safety:

req γ_{buckl}

2,00

[1]

The determined buckling safeties are larger than the required safeties.

Non linear stability proof:

- omitted -

Proof for load case combination 1, Long term

Stress proof:

Calc. strain limit, earth and traffic l., bending tension:		$\sigma_{rech,BZ}$	74,5	N/mm ²	
Calc. strain limit, earth and traffic l., bending compress.:		$\sigma_{rech,BD}$	74,5	N/mm ²	
Tension limit due to bending because of other loads:		$\sigma_{zul,BZ}$	50,0	N/mm ²	
Compression limit due to bending because of other loads:		$\sigma_{zul,BD}$	50,0	N/mm ²	
Interior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	1,380	-0,791	2,601	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,029	-0,034	0,039	N/mm ²
Safety:	γ_{BTi}	52,40	---	28,04	[1]
Safety:	γ_{BCi}	---	88,55	---	[1]
Exterior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-2,68	-1,00	-3,95	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,03	-0,04	N/mm ²
Safety:	γ_{BTa}	---	---	---	[1]
Safety:	γ_{BCa}	27,36	78,23	18,60	[1]
Required safety tension due to bending:		req γ_{BT}	2,50	[1]	
Required safety compression due to bending:		req γ_{BC}	2,50	[1]	

The determined stress safeties are larger than the required safeties.

Deflection proof:

Calculation mode:	linear			
Ratio:	$I/(A_{rad} \cdot r_m^2)$	0,00031	[1]	
Ratio:	$I/(A_{rad} \cdot r_m^2) \cdot K_q$	0,00037	[1]	
Resulting deflection coefficient:	c'_v	q_v -0,0893	q_h 0,0833	q_h^* 0,0640 [1]
Vertical diameter change:	Δd_v	1,0	mm	
Horizontal diameter change:	Δd_h	0,6	mm	
Relative vertical deflection:	δ_v	0,62	%	
Admissible deflection:	adm d_v	6,00	%	

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load	q_v	54,276	kN/mm ²
Reduction factor for earth-/traffic load:	K_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,491	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	27,48	[1]
Required buckling safety:	req γ_{buckl}	2,00	[1]

The determined buckling safeties are larger than the required safeties.

Non linear stability proof:

- omitted -

Proof for load case combination 2. Long term

Stress proof:

Calc. strain limit, earth and traffic I., bending tension:	$\sigma_{rech,BZ}$	77,4	N/mm ²		
Calc. strain limit, earth and traffic I., bending compress.:	$\sigma_{rech,BD}$	77,4	N/mm ²		
Tension limit due to bending because of other loads:	$\sigma_{zul,BZ}$	50,0	N/mm ²		
Compression limit due to bending because of other loads:	$\sigma_{zul,BD}$	50,0	N/mm ²		
Interior:	Crown	Springline	Invert		
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	1,634	-0,889	2,914	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,029	-0,034	0,039	N/mm ²
Safety:	γ_{BTi}	46,11	---	26,03	[1]
Safety:	γ_{BCi}	---	82,16	---	[1]
Exterior:	Crown	Springline	Invert		
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-2,97	-0,99	-4,30	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,03	-0,04	N/mm ²
Safety:	γ_{BTe}	---	---	---	[1]
Safety:	γ_{BCe}	25,71	82,23	17,77	[1]
Required safety tension due to bending:	req γ_{BT}	2,50	[1]		
Required safety compression due to bending:	req γ_{BC}	2,50	[1]		

The determined stress safeties are larger than the required safeties.

Deflection proof:

Calculation mode:	linear			
Ratio:	$I/(A_{rad} \cdot r_m^2)$	0,00031	[1]	
Ratio:	$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0,00037	[1]	
Resulting deflection coefficient:	c'_v	q_v -0,0893	q_h 0,0833	q_h^* 0,0640 [1]
Vertical diameter change:	Δd_v	1,0	mm	
Horizontal diameter change:	Δd_h	0,7	mm	
Relative vertical deflection:	δ_v	0,67	%	
Admissible deflection:	adm d_v	6,00	%	

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load	q_v	56,881	kN/m ²
Reduction factor for earth-/traffic load:	κ_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,525	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	26,80	[1]
Required buckling safety:	req γ_{buckl}	2,00	[1]

The determined buckling safeties are larger than the required safeties.

Non linear stability proof:

- omitted -