

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

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Cev PVC UK SN8 DN200 proizvajalca Stigma-cevni sistemi d.o.o. prenaša obremenitve Delta V = 0,72 % (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	200,0	mm
Wall thickness:	s	5,90	mm

Pipe material

Material class:	Thermoplast		
Density of pipe mat.:	γ_P	9,50	kN/m ³
Transv. contr. value:	v	0,38	[1]
E-Modulus, short:	E_{st}	3.600,00	N/mm ²
E-Modulus, long:	E_{lt0}	1.750,00	N/mm ²
Stress limit for tension due to bending, short-term:	$\sigma_{BT,st}$	90,00	N/mm ²
Stress limit for compression due to bending, short-term:	$\sigma_{BC,st}$	90,00	N/mm ²
Stress limit for tension due to bending, long-term:	$\sigma_{BT,lt}$	50,00	N/mm ²
Stress limit for compression due to bending, long-term:	$\sigma_{BC,lt}$	50,00	N/mm ²

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 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:	$\sigma_{qv,qh,qh*,i}$	1,793	-1,272	3,004	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,036	-0,042	0,048	N/mm ²
Safety:	γ_{BTi}	49,23	---	29,49	[1]
Safety:	γ_{BCi}	---	68,48	---	[1]
Exterior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh*,a}$	-3,05	-0,53	-4,31	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,04	-0,05	N/mm ²
Safety:	γ_{BTa}	---	---	---	[1]
Safety:	γ_{BCa}	29,18	182,66	20,66	[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	1,2	mm	
Horizontal diameter change:	Δd_h	0,9	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	54,330	kN/m ²
Reduction factor for earth-/traffic load:	κ_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,559	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	28,70	[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:	$\sigma_{qv,qh,qh^*,i}$	2,029	-1,357	3,295	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,036	-0,042	0,048	N/mm ²
Safety:	γ_{BTi}	43,60	---	26,92	[1]
Safety:	γ_{BCi}	---	64,32	---	[1]
Exterior:	Crown	Springline	Invert		
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-3,31	-0,53	-4,63	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,04	-0,05	N/mm ²
Safety:	γ_{BTa}	---	---	---	[1]
Safety:	γ_{BCa}	26,89	183,83	19,25	[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: linear
 $I/(A_{rad} \cdot r_m^2)$ 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	1,3	mm	
Horizontal diameter change:		Δd_h	1,0	mm	
Relative vertical deflection:		δ_v	0,68	%	
Admissible deflection:		adm d_v	6,00	%	

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load	q_v	56,769	kN/m ²
Reduction factor for earth-/traffic load:	K_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,559	N/mm

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

Safety against buckling:	γ_{buckl}	27,47	[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 I., bending tension:		$\sigma_{rech,BZ}$	74,5	N/mm ²	
Calc. strain limit, earth and traffic I., 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:	$\sigma_{qv,qh,qh^*,i}$	1,499	-0,960	2,701	N/mm ²
Stress because of other loads:	$\sigma_{sonst,i}$	0,036	-0,042	0,048	N/mm ²
Safety:	γ_{BTi}	48,01	---	26,87	[1]
Safety:	γ_{BCi}	---	72,86	---	[1]
Exterior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-2,78	-0,82	-4,02	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,04	-0,05	N/mm ²
Safety:	γ_{BTe}	---	---	---	[1]
Safety:	γ_{BCe}	26,36	98,00	18,20	[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	1,3	mm	
Horizontal diameter change:	Δd_h	0,9	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	53,911	kN/mm ²
Reduction factor for earth-/traffic load:	K_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,397	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	25,92	[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:	$\sigma_{qv,qh,qh*,I}$	1,772	-1,081	3,032	N/mm ²
Stress because of other loads:	$\sigma_{sonst,I}$	0,036	-0,042	0,048	N/mm ²
Safety:	γ_{BTI}	42,33	---	24,90	[1]
Safety:	γ_{BCI}	---	67,47	---	[1]
Exterior:		Crown	Springline	Invert	
Stress because of earth and traffic loads:	$\sigma_{qv,qh,qh*,a}$	-3,08	-0,78	-4,38	N/mm ²
Stress because of other loads:	$\sigma_{sonst,a}$	-0,03	0,04	-0,05	N/mm ²
Safety:	γ_{BTe}	---	---	---	[1]
Safety:	γ_{BCE}	24,73	106,71	17,36	[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	1,4	mm	
Horizontal diameter change:	Δd_h	1,0	mm	
Relative vertical deflection:	δ_v	0,72	%	
Admissible deflection:	adm d_v	6,00	%	

The determined deflection is smaller than the admissible deflection.

Stability proof (linear):

Vertical total load	q_v	56,491	kN/m ²
Reduction factor for earth-/traffic load:	κ_{v2}	0,87	[1]
Critical buckling load (earth-/traffic load):	crit q_v	1,428	N/mm
The buckling proof for water pressure is omitted, as neither groundwater nor depression is present.			
Safety against buckling:	γ_{buckl}	25,28	[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 -