

## Calculations to ATV-DVWK-A 127, third edition, August 2000

Project: Letkov u Plzne  
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Nemáme autorizaci pro statické posouzení, výsledky platí pouze pro zadané hodnoty !

### Input:

#### Safety factors

Safety class:	A (normal case)	
Allowable deflection:	6% (normal case)	
A type predeformation:	$\delta_{v,TypeA}$	1,00 %
Local predeformation:	$\delta_{v,local}$	0,00 %

#### Pipe

Description:	PP Master DN500 SN12
Outside diameter:	$d_o$ 500,0 mm
Wall thickness:	$s$ 18,00 mm

#### Pipe material

Material class:	Thermoplastic
Description:	Multilyer PP- PP Master
Density of pipe material:	$\gamma_P$ 10,50 kN/m <sup>3</sup>
Transv. contr. coeff.:	$\nu$ 0,38 [1]
E-Modulus, short:	$E_{st}$ 2 900,00 N/mm <sup>2</sup>
E-Modulus, long:	$E_{lt0}$ 725,00 N/mm <sup>2</sup>
Ultimate flexural tensile stress, short-term:	$\sigma_{BT,st}$ 39,00 N/mm <sup>2</sup>
Ultimate flexural compressive stress, short-term:	$\sigma_{BC,st}$ 39,00 N/mm <sup>2</sup>
Ultimate flexural tensile stress, long-term:	$\sigma_{BT,lt}$ 17,00 N/mm <sup>2</sup>
Ultimate flexural compressive stress, long-term:	$\sigma_{BC,lt}$ 17,00 N/mm <sup>2</sup>

#### Soil

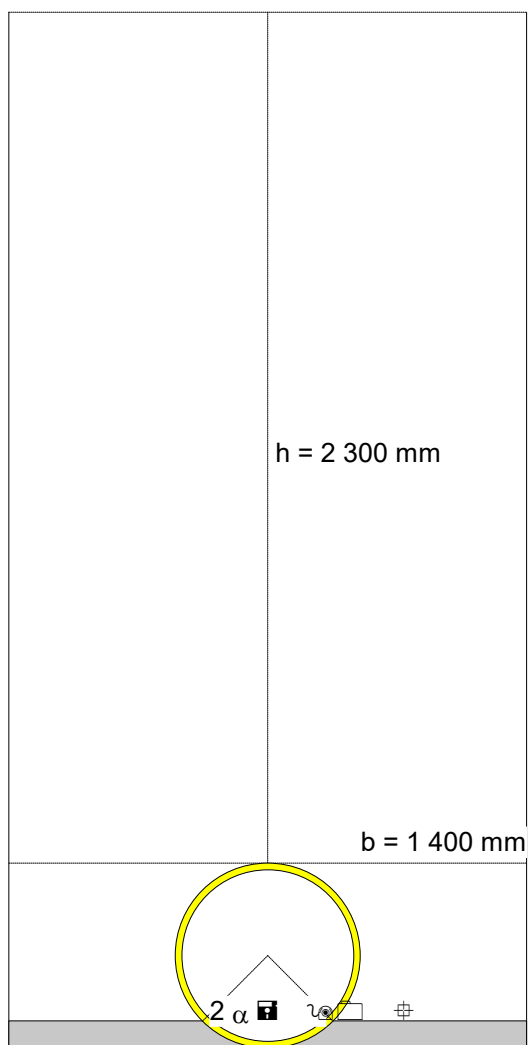
E1: Backfilling:	Soil group: G2
Value from Table 8 in ATV A127:	$D_{PR1}$ 90,0 %
E20: Pipe zone:	Soil group: G2
Value from Table 8 in ATV A127:	$D_{PR2}$ 90,0 %
E3: Native soil:	Soil group: G4
Proctor density:	$D_{PR3}$ 95,0 %
E4: Below trench	$E4 = 10 * E1$

### Installation

Trench width:	b	1 400	mm
Slope angle:	$\beta$	90,00	°
Cover condition:	A2		
Bedding condition:	B2		
Type of bedding:	loose		
Relative projection:	a	1,00	[1]
Bedding angle:	90°		

### Load case combination 1

Description:	uložení v silnici III. třídy		
Cover depth:	h	2 300	mm
Soil density:	$\gamma$	20,00	kN/m <sup>3</sup>
Additional surface load:	P <sub>0</sub>	0,00	N/mm <sup>2</sup>
Maximum groundwater level above pipe bed:	h <sub>W,max</sub>	0	mm
Minimum groundwater level above pipe bed:	h <sub>W,min</sub>	0	mm
Internal pressure:	P <sub>i</sub>	0,00	bar
Water fill (e.g. damming channel)	Yes		
Density of medium:	$\gamma_F$	10,00	kN/m <sup>3</sup>
Traffic load:	HLC 60 (road)		



## Proof for load case combination 1, Short term

### Stress proof:

Calculated ultimate flexural tensile stress, soil/traffic load:		$\sigma_{calc,BZ}$	39,0	N/mm <sup>2</sup>	
Calculated ultimate flexural compr. stress, soil/traffic load:		$\sigma_{calc,BD}$	39,0	N/mm <sup>2</sup>	
Ultimate flexural tensile stress due to other loads:		$\sigma_{all,BZ}$	39,0	N/mm <sup>2</sup>	
Ultimate flexural compressive stress due to other loads:		$\sigma_{all,BD}$	39,0	N/mm <sup>2</sup>	
Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	7,868	-8,405	10,675	N/mm <sup>2</sup>
Stress due to other loads:	$\sigma_{other,i}$	0,372	-0,416	0,733	N/mm <sup>2</sup>
Safety coefficient:	$\gamma_{BTi}$	4,73	---	3,42	[1]
Safety coefficient:	$\gamma_{BCi}$	---	4,42	---	[1]
External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-8,34	6,28	-11,20	N/mm <sup>2</sup>
Stress due to other loads:	$\sigma_{other,a}$	-0,33	0,40	-0,64	N/mm <sup>2</sup>
Safety coefficient:	$\gamma_{BTe}$	---	5,84	---	[1]
Safety coefficient:	$\gamma_{BCe}$	4,50	---	3,30	[1]
Required flexural tensile safety coefficient:		req $\gamma_{BT}$	2,50	[1]	
Required flexural compressive safety coefficient:		req $\gamma_{BC}$	2,50	[1]	

The stress safety coefficients determined are sufficient.

### Deflection proof:

Calculation method:		linear		
Ratio:		$I/(A_{rad} \cdot r_m^2)$	0,00046	[1]
Ratio:		$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0,00056	[1]
Resultant deflection coefficient:	$c'_v$	$q_v$ -0,0966	$q_h$ 0,0833	$q_h^*$ 0,0640 [1]
Vertical diameter change:		$\Delta d_v$	13,0	mm
Horizontal diameter change:		$\Delta d_h$	12,4	mm
Relative vertical deformation:		$\delta_v$	2,70	%
Allowable deflection:		all $d_v$	6,00	%

The deflection determined is less than the allowable deflection.

### Stability proof (linear):

Total vertical load	$q_v$	65,8	kN/m <sup>2</sup>
Reduction factor for soil/traffic load:	$\kappa_{v2}$	0,86	[1]
Critical buckling load (soil/traffic load):	crit $q_v$	671,2	kN/m <sup>2</sup>
The buckling proof for water pressure does not apply, as there is neither groundwater nor a vacuum.			
Buckling safety coefficient:	$\gamma_{buckl}$	10,21	[1]
Required buckling safety coefficient:	req $\gamma_{buckl}$	2,00	[1]

The buckling safety coefficients determined are sufficient.

### Non linear stability proof:

- n/a -

## Proof for load case combination 1, Long term

### Stress proof:

Calculated ultimate flexural tensile stress, soil/traffic load:		$\sigma_{calc,BZ}$	25,0	N/mm <sup>2</sup>	
Calculated ultimate flexural compr. stress, soil/traffic load:		$\sigma_{calc,BD}$	25,0	N/mm <sup>2</sup>	
Ultimate flexural tensile stress due to other loads:		$\sigma_{all,BZ}$	17,0	N/mm <sup>2</sup>	
Ultimate flexural compressive stress due to other loads:		$\sigma_{all,BD}$	17,0	N/mm <sup>2</sup>	
Internal:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,i}$	4,978	-5,268	7,662	N/mm <sup>2</sup>
Stress due to other loads:	$\sigma_{other,i}$	0,191	-0,217	0,552	N/mm <sup>2</sup>
Safety coefficient:	$\gamma_{BTi}$	4,76	---	2,95	[1]
Safety coefficient:	$\gamma_{BCi}$	---	4,48	---	[1]
External:		Crown	Springline	Bottom	
Stress due to soil and traffic loads:	$\sigma_{qv,qh,qh^*,a}$	-5,75	3,37	-8,47	N/mm <sup>2</sup>
Stress due to other loads:	$\sigma_{other,a}$	-0,17	0,21	-0,48	N/mm <sup>2</sup>
Safety coefficient:	$\gamma_{BTe}$	---	6,80	---	[1]
Safety coefficient:	$\gamma_{BCe}$	4,17	---	2,73	[1]
Required flexural tensile safety coefficient:		req $\gamma_{BT}$	2,50	[1]	
Required flexural compressive safety coefficient:		req $\gamma_{BC}$	2,50	[1]	

The stress safety coefficients determined are sufficient.

### Deflection proof:

Calculation method:		linear		
Ratio:		$I/(A_{rad} \cdot r_m^2)$	0,00046	[1]
Ratio:		$I/(A_{rad} \cdot r_m^2) \cdot \kappa_q$	0,00056	[1]
Resultant deflection coefficient:	$c'_v$	$q_v$ -0,0966	$q_h$ 0,0833	$q_h^*$ 0,0640 [1]
Vertical diameter change:		$\Delta d_v$	16,6	mm
Horizontal diameter change:		$\Delta d_h$	15,3	mm
Relative vertical deformation:		$\delta_v$	3,45	%
Allowable deflection:		all $d_v$	6,00	%

The deflection determined is less than the allowable deflection.

### Stability proof (linear):

Total vertical load	$q_v$	62,9	kN/m <sup>2</sup>
Reduction factor for soil/traffic load:	$\kappa_{v2}$	0,87	[1]
Critical buckling load (soil/traffic load):	crit $q_v$	488,5	kN/m <sup>2</sup>
The buckling proof for water pressure does not apply, as there is neither groundwater nor a vacuum.			
Buckling safety coefficient:	$\gamma_{buckl}$	7,77	[1]
Required buckling safety coefficient:	req $\gamma_{buckl}$	2,00	[1]

The buckling safety coefficients determined are sufficient.

### Non linear stability proof:

- n/a -

## Proof for load case combination 1, Long term

### Stress proof:

		Crown	Springline	Bottom	
Safety coefficient (internal):	$\gamma_i$	4,76	-4,48	2,95	[1]
Safety coefficient (external):	$\gamma_e$	-4,17	6,80	-2,73	[1]
(Safety coefficients for flexural compressive stress are marked with a minus sign)					

Required flexural tensile safety coefficient:	req $\gamma_{BT}$	2,50	[1]
Required flexural compressive safety coefficient:	req $\gamma_{BC}$	2,50	[1]

The stress safety coefficients determined are sufficient.

### Deflection proof:

Relative vertical deformation:	$\delta_v$	3,45	%
Allowable deflection:	all $d_v$	6,00	%

The deflection determined is less than the allowable deflection.

### Stability proof (linear):

Buckling safety coefficient:	$\gamma_{buckl}$	7,77	[1]
Required buckling safety coefficient:	req $\gamma_{buckl}$	2,00	[1]

The buckling safety coefficients determined are sufficient.