M Projekt CZ s.r.o.

ÚSTÍ NAD ORLICÍ - OBNOVA VODOVODU V UL. VRBENSKÉHO K.Ú. ÚSTÍ NAD ORLICÍ

E.4 Dokladová část – statika potrubí

Ústí nad Orlicí, únor 2020

Zadávací podmínky

Použité potrubí **PN 16, SN 16, De 90**
Krytí nad vrcholem potrubí: 0,8 m
Zatížení provozem: D 400
Hladina spodní vody: 0,5 m pod povrchem
Obsypový materiál: lomová prosívka 0-8
Stupeň zhutnění obsypu: 95% PS

Result

Calculation OK

Given values

Pipe type		**Pipe dimension (mm)**	90
Soil type	Sand	**Please note: the chosen pipe diameter is below 110 mm, but has been set at 110 mm for calculation purpose**	
Safety class	Normal	**Control class**	Normal
Partial coefficient - safety class	2.27	**Partial coefficient - control class**	1.50
Max. negative pressure in pipe (kPa)	Compression class Normal > 95% SP		
Installation type	Normal trench and normal up to high compaction	**Installation factor %**	1.0 %
Bedding/bedding layer	Normal levelling layer	**Bedding factor %**	2.00 %
Traffic load	Heavy traffic load	**Max. negative pressure in pipe (kPa)**	0.00
Soil cover above pipe top (m) = H	0.80	**Distance from ground level to ground-water level (m) = Hw**	0.50
Relative density - below ground-water level (kN/m³)	10.00	**Relative density - above ground-water level (kN/m³)**	20.00
Calculated diameter of pipe (mm)	90.00	**Pipe ring stiffness**	16.00

Load combination 1.1 Deformation calculation serviceability limit state

Average stress from traffic load (qtm) kN/m²	63.19	**Short-term deformation from variable load (traffic)**	1.4 %
Load factor C regarding the stiffness ratio of pipe to backfilling material (applied)	1.14	**Short-term deformation from permanent load (soil)**	0.4 %
Characteristic traffic load qtk kN/m²	72.25	**Deformation from installation**	1.0 %

(Formula 9)		(Table 2.9)	
Additional soil cover for determination of soil modulus E_{td} when influcenced by heavy road traffic load (Table 2.8)	3.00	**Average deformation**	2.8 %
delta H factor dependent on type of road traffic load	1.0	**Short-term maximum deformation (Page 42)**	**4.8 %**
Tangent modulus of backfill above ground-water E_{td} (Formula 11) - kN/m²	5376	**Long-term deformation from load (formula 16)**	2.7 %
Secant modulus of backfill above ground-water E_{sd} (Formula 12) - kN/m²	3495	**Long-term max. deformation (Formula 15)**	6.6 %
Reduction factor for ground-water influence on soil E-moduli (formula 13)	0.85		
Tangent modulus of backfill below ground-water E_{td} (Formula 11 x Formula 13) - kN/m²	4570		
Secant modulus of backfill below ground-water E_{sd} (Formula 12 x Formula 13) - kN/m²	2971		

Short-term maximum deformation (Page 42) 4.8 % < 9.0 % (Pipematerial: PE100) - OK

Load deformation 2.1 Deformation calculation ultimate limit state

Calculated ring stiffness (kN/m²)	14.00	**Calculated max. buckling pressure (kN/m²)**	949.38
Calculated tangent modulus (kN/m²)	2016.77	**Design load (kN/m²)**	110.38
Reduction factor beta	0.80	**Design buckling pressure (kN/m²)**	761.80

Buckling load combination 2.1 - q_d (Formula 20) kN/m² 110.38 < Buckling load combination 2.1 - ßxq_b (Formula 22) 761.80 - OK

Při dodržení zadávacích podmínek potrubí PN 16, SN 16, De 90 vyhoví a jeho deformace nepřesáhne hodnotu 4,8 %.
Tato deformace je počítána při prázdném potrubí bez vnitřního přetlaku.

Zadávací podmínky

Použité potrubí: **Mondial PVC-O, PN 16, SN 16, De 90**
Krytí nad vrcholem potrubí: 0,8 m
Zatížení provozem: D 400
Hladina spodní vody: 2 m pod povrchem
Obsypový materiál: lomová prosívka 0-8
Stupeň zhutnění obsypu: 95% PS

Result

Calculation OK

Given values

Pipe type	Mondial PVC-O	**Pipe dimension (mm)**	90
Soil type	Sand	**Please note: the chosen pipe diameter is below 110 mm, but has been set at 110 mm for calculation purpose**	
Safety class	Normal	**Control class**	Normal
Partial coefficient - safety class	2.27	**Partial coefficient - control class**	1.50
Max. negative pressure in pipe (kPa)	Compression class Normal > 95% SP		
Installation type	Normal trench and normal up to high compaction	**Installation factor %**	1.0 %
Bedding/bedding layer	Normal levelling layer	**Bedding factor %**	2.00 %
Traffic load	Heavy traffic load	**Max. negative pressure in pipe (kPa)**	0.00
Soil cover above pipe top (m) = H	0.80	**Distance from ground level to ground-water level (m) = Hw**	2.00
Relative density - below ground-water level (kN/m³)	10.00	**Relative density - above ground-water level (kN/m³)**	20.00
Calculated diameter of pipe (mm)	90.00	**Pipe ring stiffness**	16.00

Load combination 1.1 Deformation calculation serviceability limit state

Average stress from traffic load (qtm) kN/m²	63.19	**Short-term deformation from variable load (traffic)**	0.9 %
Load factor C regarding the stiffness ratio of pipe to backfilling material (applied)	1.14	**Short-term deformation from permanent load (soil)**	0.2 %

Characteristic traffic load qtk kN/m² (Formula 9)	72.25	**Deformation from installation (Table 2.9)**	1.0 %
Additional soil cover for determination of soil modulus E_{td} when influcenced by heavy road traffic load (Table 2.8)	3.00	**Average deformation**	2.2 %
delta H factor dependent on type of road traffic load	1.0	**Short-term maximum deformation (Page 42)**	**4.2 %**
Tangent modulus of backfill above ground-water E_{td} (Formula 11) - kN/m²	5376	**Long-term deformation from load (formula 16)**	1.8 %
Secant modulus of backfill above ground-water E_{sd} (Formula 12) - kN/m²	3495	**Long-term max. deformation (Formula 15)**	5.3 %
Reduction factor for ground-water influence on soil E-moduli (formula 13)	1.60		
Tangent modulus of backfill below ground-water E_{td} (Formula 11 x Formula 13) - kN/m²	8602		
Secant modulus of backfill below ground-water E_{sd} (Formula 12 x Formula 13) - kN/m²	5592		

Short-term maximum deformation (Page 42) 4.2 % < 9.0 % (Pipematerial: PE100) - OK

Load deformation 2.1 Deformation calculation ultimate limit state

Calculated ring stiffness (kN/m²)	14.00	**Calculated max. buckling pressure (kN/m²)**	1029.75
Calculated tangent modulus (kN/m²)	3796.28	**Design load (kN/m²)**	133.93
Reduction factor beta	0.84	**Design buckling pressure (kN/m²)**	864.72

Buckling load combination 2.1 - q_d (Formula 20) kN/m² 133.93 < Buckling load combination 2.1 - ßxq_b (Formula 22) 864.72 - OK

Při dodržení zadávacích podmínek potrubí Mondial PVC-O, PN 16, SN 16, De 90 vyhoví a jeho deformace nepřesáhne hodnotu 4,2 %.
Tato deformace je počítána při prázdném potrubí bez vnitřního přetlaku.

Zadávací podmínky

Použité potrubí: **PN 16, SN 16, De 90**
Krytí nad vrcholem potrubí: 1,5 m
Zatížení provozem: D 400
Hladina spodní vody: 0,5 m pod povrchem
Obsypový materiál: lomová prosívka 0-8
Stupeň zhutnění obsypu: 95% PS

Result

Calculation OK

Given values

Pipe type		**Pipe dimension (mm)**	90
Soil type	Sand	**Please note: the chosen pipe diameter is below 110 mm, but has been set at 110 mm for calculation purpose**	
Safety class	Normal	**Control class**	Normal
Partial coefficient - safety class	2.27	**Partial coefficient - control class**	1.50
Max. negative pressure in pipe (kPa)	Compression class Normal > 95% SP		
Installation type	Normal trench and normal up to high compaction	**Installation factor %**	1.0 %
Bedding/bedding layer	Normal levelling layer	**Bedding factor %**	2.00 %
Traffic load	Heavy traffic load	**Max. negative pressure in pipe (kPa)**	0.00
Soil cover above pipe top (m) = H	1.50	**Distance from ground level to ground-water level (m) = Hw**	0.50
Relative density - below ground-water level (kN/m³)	10.00	**Relative density - above ground-water level (kN/m³)**	20.00
Calculated diameter of pipe (mm)	90.00	**Pipe ring stiffness**	16.00

Load combination 1.1 Deformation calculation serviceability limit state

Average stress from traffic load (qtm) kN/m²	30.29	**Short-term deformation from variable load (traffic)**	0.6 %
Load factor C regarding the stiffness ratio of pipe to backfilling material (applied)	1.03	**Short-term deformation from permanent load (soil)**	0.6 %
Characteristic traffic load qtk kN/m² (Formula 9)	31.24	**Deformation from installation (Table 2.9)**	1.0 %
Additional soil cover for	1.55	**Average deformation**	2.2 %

determination of soil modulus E_{td} when influcenced by heavy road traffic load (Table 2.8)			
delta H factor dependent on type of road traffic load	1.0	**Short-term maximum deformation (Page 42)**	**4.2 %**
Tangent modulus of backfill above ground-water E_{td} (Formula 11) - kN/m²	4552	**Long-term deformation from load (formula 16)**	1.8 %
Secant modulus of backfill above ground-water E_{sd} (Formula 12) - kN/m²	2959	**Long-term max. deformation (Formula 15)**	5.4 %
Reduction factor for ground-water influence on soil E-moduli (formula 13)	0.73		
Tangent modulus of backfill below ground-water E_{td} (Formula 11 x Formula 13) - kN/m²	3338		
Secant modulus of backfill below ground-water E_{sd} (Formula 12 x Formula 13) - kN/m²	2170		

Short-term maximum deformation (Page 42) 4.2 % < 9.0 % (Pipematerial: PE100) - OK

Load deformation 2.1 Deformation calculation ultimate limit state

Calculated ring stiffness (kN/m²)	14.00	**Calculated max. buckling pressure (kN/m²)**	811.36
Calculated tangent modulus (kN/m²)	1473.00	**Design load (kN/m²)**	71.06
Reduction factor beta	0.84	**Design buckling pressure (kN/m²)**	678.88

Buckling load combination 2.1 - q_d (Formula 20) kN/m² 71.06 < Buckling load combination 2.1 - ßxq_b (Formula 22) 678.88 - OK

Při dodržení zadávacích podmínek potrubí PN 16, SN 16, De 90 vyhoví a jeho deformace nepřesáhne hodnotu 4,2 %.
Tato deformace je počítána při prázdném potrubí bez vnitřního přetlaku.

Zadávací podmínky

Použité potrubí: **Mondial PVC-O, PN 16, SN 16, De 90**
Krytí nad vrcholem potrubí: 1,5 m
Zatížení provozem: D 400
Hladina spodní vody: 2 m pod povrchem
Obsypový materiál: lomová prosívka 0-8
Stupeň zhutnění obsypu: 95% PS

Result

Calculation OK

Given values

Pipe type	Mondial PVC-O	**Pipe dimension (mm)**	90
Soil type	Sand	**Please note: the chosen pipe diameter is below 110 mm, but has been set at 110 mm for calculation purpose**	
Safety class	Normal	**Control class**	Normal
Partial coefficient - safety class	2.27	**Partial coefficient - control class**	1.50
Max. negative pressure in pipe (kPa)	Compression class Normal > 95% SP		
Installation type	Normal trench and normal up to high compaction	**Installation factor %**	1.0 %
Bedding/bedding layer	Normal levelling layer	**Bedding factor %**	2.00 %
Traffic load	Heavy traffic load	**Max. negative pressure in pipe (kPa)**	0.00
Soil cover above pipe top (m) = H	1.50	**Distance from ground level to ground-water level (m) = Hw**	2.00
Relative density - below ground-water level (kN/m³)	10.00	**Relative density - above ground-water level (kN/m³)**	20.00
Calculated diameter of pipe (mm)	90.00	**Pipe ring stiffness**	16.00

Load combination 1.1 Deformation calculation serviceability limit state

Average stress from traffic load (qtm) kN/m²	30.29	**Short-term deformation from variable load (traffic)**	0.5 %
Load factor C regarding the stiffness ratio of pipe to backfilling material (applied)	1.03	**Short-term deformation from permanent load (soil)**	0.5 %
Characteristic traffic load qtk kN/m² (Formula 9)	31.24	**Deformation from installation (Table 2.9)**	1.0 %
Additional soil cover for determination of soil modulus E_{td}	1.55	**Average deformation**	2.0 %

when influcenced by heavy road traffic load (Table 2.8)			
delta H factor dependent on type of road traffic load	1.0	**Short-term maximum deformation (Page 42)**	**4.0 %**
Tangent modulus of backfill above ground-water E_{td} (Formula 11) - kN/m²	4552	**Long-term deformation from load (formula 16)**	1.4 %
Secant modulus of backfill above ground-water E_{sd} (Formula 12) - kN/m²	2959	**Long-term max. deformation (Formula 15)**	4.9 %
Reduction factor for ground-water influence on soil E-moduli (formula 13)	1.13		
Tangent modulus of backfill below ground-water E_{td} (Formula 11 x Formula 13) - kN/m²	5158		
Secant modulus of backfill below ground-water E_{sd} (Formula 12 x Formula 13) - kN/m²	3353		

Short-term maximum deformation (Page 42) 4.0 % < 9.0 % (Pipematerial: PE100) - OK

Load deformation 2.1 Deformation calculation ultimate limit state

Calculated ring stiffness (kN/m²)	14.00	**Calculated max. buckling pressure (kN/m²)**	947.47
Calculated tangent modulus (kN/m²)	2276.46	**Design load (kN/m²)**	80.61
Reduction factor beta	0.85	**Design buckling pressure (kN/m²)**	807.52

Buckling load combination 2.1 - q_d (Formula 20) kN/m² 80.61 < Buckling load combination 2.1 - ßxq_b (Formula 22) 807.52 - OK

Při dodržení zadávacích podmínek potrubí Mondial PVC-O, PN 16, SN 16, De 90 vyhoví a jeho deformace nepřesáhne hodnotu 4,0 %.
Tato deformace je počítána při prázdném potrubí bez vnitřního přetlaku.