Kanalizacija odpadnih vod za naselje Unec, Ivanje Selo in Slivice; 1.faza Unec in Slivnica

VRSTA PROJEKTNE DOKUMENTACIJE	**PZI - projektna dokumentacija za izvedbo** **2/1 Načrt kanalizacije**
VRSTA GRADNJE	**Novogradnja - novozgrajen objekt**
ŠTEVILKA PROJEKTA	**9601_2.1**
INVESTITOR	**Občina Cerknica** Cesta 4.maja 53 1380 Cerknica
PROJEKTANT	**LUZ, d.d.** Verovškova ulica 64 1000 Ljubljana
GLAVNI IZVRŠNI DIREKTOR	**dr. Jure Zavrtanik** univ. dipl. inž. arh.
PODPIS IN ŽIG	
DATUM	februar 2026

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S/2	**NASLOVNA STRAN NAČRTA** VSE VSEBINE SO ZAJETE V PRILOŽENI PRILOGI 1C PRAVILNIKA
S/3	**IZJAVA PROJEKTANTA NAČRTA IN POOBLAŠČENEGA STROKOVNJAKA, KI JE IZDELAL NAČRT V PZI IN PID** VSE VSEBINE SO ZAJETE V PRILOŽENI PRILOGI 2C PRAVILNIKA
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T/2	**TEHNIČNO POROČILO**
T/3	**PROJEKTANTSKI POPIS**
T/4	**KOORDINATE ZAKOLIČBENIH TOČK**
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PRILOGA 1C

NASLOVNA STRAN NAČRTA

Načrt kanalizacije

PODATKI O GRADNJI		
naziv gradnje		**Kanalizacija odpadnih vod za naselje Unec, Ivanje Selo in Slivice; 1.faza Unec in Slivnica**
kratek opis gradnje		**Predmet obdelave te dokumentacije je PZI kanalizacija odpadnih komunalnih vod za naselja Unec in Slivice, ki se preko obstoječe kanalizacije priključi na ČN Rakek.**
VRSTE GRADNJE	☑	**NOVOGRADNJA - NOVOZGRAJEN OBJEKT**
označiti vse ustrezne vrste gradnje	☐	**NOVOGRADNJA - PRIZIDAVA**
	☐	**REKONSTRUKCIJA**
	☐	**SPREMEMBA NAMEMBNOSTI**
	☐	**ODSTRANITEV CELOTNEGA OBJEKTA**
	☐	**LEGALIZACIJA**
	☐	**MANJŠA REKONSTRUKCIJA**
PODATKI O PROJEKTNI DOKUMENTACIJI		
vrsta dokumentacije		**PZI (projektna dokumentacija za izvedbo gradnje)**
številka projekta		**9601**
PODATKI O NAČRTU		
strokovno področje načrta		**2/1 Načrt gradbeništva**
naziv načrta		**Načrt kanalizacije**
številka načrta		**9601/2**
datum izdelave		**februar 2026**
datum spremembe		
PODATKI O PROJEKTANTU NAČRTA		
projektant načrta (naziv družbe)		**LUZ d.d.**
naslov		**Verovškova ulica 64, 1000 Ljubljana**
odgovorna oseba projektanta načrta		**dr. Jure Zavrtanik, univ. dipl. inž. arh.**
podpis odgovorne osebe projektanta načrta		
PODATKI O IZDELOVALCU NAČRTA		
ime in priimek pooblaščenega arhitekta, pooblaščenega inženirja		**Maja Klančar, univ.dipl.inž.vod. in kom.inž.**
identifikacijska številka		**G-4066**
podpis pooblaščenega arhitekta, pooblaščenega inženirja		

PRILOGA 2C

IZJAVA PROJEKTANTA NAČRTA IN POOBLAŠČENEGA STOKOVNJAKA, KI JE IZDELAL NAČRT V PZI IN PID

PROJEKTANT NAČRTA	
projektant načrta (naziv družbe)	**LUZ d.d.**
naslov	**Verovškova ulica 64, 1000 Ljubljana**
odgovorna oseba projektanta načrta	**dr. Jure Zavrtanik, univ. dipl. inž. arh.**

IN POOBLAŠČENI STROKOVNJAK, KI JE IZDELAL NAČRT	
pooblaščeni strokovnjak	**Maja Klančar, univ.dipl.inž.vod. in kom.inž.**

IZJAVLJAVA:

da načrt

vrsta dokumentacije	**PZI (projektna dokumentacija za izvedbo gradnje)**
strokovno področje načrta	**2/1 Načrt gradbeništva**
naziv načrta	**Načrt kanalizacije**
številka načrta	**9601/2**
datum izdelave	**februar 2026**

upošteva relevantne predpise in druge normativne dokumente ter da so upoštevane ustrezne bistvene in druge zahteve.

pooblaščeni strokovnjak	**Maja Klančar, univ.dipl.inž.vod. in kom.inž.**
identifikacijska številka	**G-4066**
podpis pooblaščenega strokovnjaka	
odgovorna oseba projektanta načrta	**dr. Jure Zavrtanik, univ. dipl. inž. arh.**
podpis odgovorne osebe projektanta načrta	

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T/2 TEHNIČNO POROČILO

1. SPLOŠNO

1.1 Predmet projekta

Predmet obdelave te dokumentacije je PZI kanalizacija odpadnih komunalnih vod za naselja Unec in Slivice, ki se preko obstoječe kanalizacije priključi na ČN Rakek.

Naselja Ivanje Selo, Unec in večji del Rakeka imajo predviden kanalski sistem, ki se konča na skupni čistilni napravi velikosti 4000 PE, ki je locirana na severnem obronku Rakovskega polja. Prečiščena voda so odvaja v kraški požiralnik.

Na obravnavanem območju še ni urejenega kanalizacijskega naselja. V naselju Hribce je za novo naselje zgrajen kanalizacijski sistem, ki je priključen na MČN (mala čistilna naprava). Predvidena je prevezava komunalne odpadne vode iz MČN na nov odpadni kanal.

Faznost izvedbe projekta

Izgradnja kanalizacije za naselja Unec, Ivanje Selo in Slivice je predvidena v dveh fazah. V prvi fazi je predvidena izgradnja kanalizacije na območju naselij Unec in Slivice, vključno s povezovalnim vodom do Ivanjega Sela. V drugi fazi pa je predvidena izgradnja kanalizacije za naselje Ivanje Selo.

Predmet te projektne dokumentacije je 1.faza izgradnje kanalizacije.

1.2 Zakonske podlage in projektna izhodišča

V območju predvidenim za gradnjo je bila izdelana naslednja projektna dokumentacija:

- Idejna študija odvajanja in čiščenja komunalnih odpadnih vod za poselitvena območja na območju Občine Cerknica, ki jih je po državnem operativnem programu potrebno opremiti s kanalizacijo (Hidroinženiring, 2006)
- Operativni program odvajanja in čiščenja komunalnih odpadnih voda za območje Občine Cerknica (Hidroinženiring, 2007)
- IDZ, Kanalizacijski sistem naselja Rakek, št.proj.:60-1535-00-2010, oktober 2010 (izdelal Hidroinženiring d.o.o.)
- PZI projekt: Rekonstrukcija ceste R320 skozi Rakek, št.načrta: 3851, junij 1996, Izdelal Projekt Nova Gorica d.d.
- PZI projekt: Obnovitvena dela na cesti R320 skozi Rakek na odseku 1117 od km 0.150 do km 0.350, št.proj.:3378, januar 1995, izdelal Projekt Nova Gorica d.d.
- PZI:Cesta R1-212,odsek 1115 priključek Unec-Unec; Križišče z LC 541631 in LC 541611 v km 0,440 na Uncu; št.proj.: 11-665/18, št.načrta 11-665-3/18, avgust 2018; izdelal GIRI d.o.o., Lavričeva 9, 1000 Ljubljana
- PGD :Prestavitev sanitarne kanalizacije ob regionalni cesti Unec-Rakek z navezavo na dotočni sistem na ČN Rakek, št.proj.: 50-1942-00-2017, avgust 2017; izdelal Hidroinženiring d.o.o., Slovenčeva 95, 1000 Ljubljana

– Geodetski načrt novega stanja zemljišča gospodarska javna infrastruktura ob regionalni cesti Unec-Rakek, št.geo.načrta: GPB-29112017-UNEC, 29.11.2017; izdelal Pirc gradnje Ljubljana, Babičeva 7, 1000 Ljubljana
– PZI projekt: Obnova vodovoda na območju gradnje kanalizacije Unec, Ivanje Selo, Slivice; št.proj.: 40-2248-00-2020

Upoštevana je naslednja področna zakonodaja:

– Gradbeni zakon (GZ-1) (Ur.l. RS, št. 199/21, 105/22 – ZZNŠPP, 133/23, 85/24 – ZAID-A, 47/25 – odl. US in 75/25);
– Zakon o prostorskem načrtovanju – ZPNačrt (Uradni list RS, št. 33/07; Spremembe: 70/2008-ZVO-1B, 108/2009, 80/2010-ZUPUDPP (106/2010 popr.), 43/2011-ZKZ-C, 57/2012, 57/2012-ZUPUDPP-A);
– Zakon o urejanju prostora - ZUreP-3 (Uradni list RS, št. 199/21, 18/23 – ZDU-1O, 78/23 – ZUNPEOVE, 95/23 – ZIUOPZP, 23/24, 109/24, 25/25 – odl. US in 75/25);
– Zakon o varstvu okolja – ZVO-1 (Uradni list RS, št. 39/06 – uradno prečiščeno besedilo, 49/06 – ZMetD, 66/06 – odl. US, 33/07 – ZPNačrt, 57/08 – ZFO-1A, 70/08, 108/09, 108/09 – ZPNačrt-A, 48/12, 57/12, 92/13, 56/15, 102/15, 30/16, 61/17 – GZ, 21/18 – ZNOrg, 84/18 – ZIURKOE, 158/20 in 44/22 – ZVO-2);
– Zakon o cestah – ZCes-2 (Uradni list RS, št. 132/22, 140/22 – ZSDH-1A, 29/23 in 78/23 – ZUNPEOVE);
– Zakon o vodah - ZV-1 (Uradni list RS, št. 67/02, 2/04 – ZZdrI-A, 41/04 – ZVO-1, 57/08, 57/12, 100/13, 40/14, 56/15, 65/20, 35/23 – odl. US, 78/23 – ZUNPEOVE in 52/24 – odl. US);
– Pravilnik o pogojih za graditev gradbenih ali drugih objektov, saditev drevja ter postavljanja naprav v varovalnem progovnem pasu in v varovalnem pasu ob industrijskem tiru (Uradni list SRS, št. 2/87, Uradni list RS, št. 85/00 – ZVZP, 61/07 – ZVZelP in 30/18 – ZVZelP-1);
– Pravilnik o projektni in drugi dokumentaciji ter obrazcih pri graditvi objektov (Uradni list RS, št. 30/23);
– Splošni in posebni tehnični pogoji;
– Zakonski in podzakonski predpisi, ki bodo sprejeti v času izdelave te dokumentacije.

2. OPIS OBSTOJEČEGA STANJA

Kanalizacije za odvajanje sanitarne vode na tem področju ni. Deloma deluje kanalizacija za potrebe odvajanja meteornih vod . Sanitarne odplake se odvajajo preko greznic v ponikovalnice ali jarke.

V naselju Unec, Ivanje Selo in Slivice je izvedena naslednja infrastruktura:

- vodovod,
- elektrovodi,
- TK vodi.

Obstoječa infrastruktura je prikazana v grafičnih prilogah projekta.

3. OPIS PREDVIDENEGA STANJA

Predvidena kanalizacija iz dela naselja Unec in Slivice se preko obstoječega črpališča ČRP6 in tlačnega voda priključi na obstoječo čistilno napravo Rakek, velikosti 4000 PE, ki je locirana na severnem obronku Rakovskega polja. Del predvidene kanalizacije iz naselja Unec pa se preko tlačnega voda R1T in črpališča ČRP 1priključi na obstoječi kanal, ki v naselju Rakek.

Meteorne vode niso predmet obdelave in se rešujejo ločeno.

Dolžina gravitacijske kanalizacije znaša L=6.899,70 m in dolžina tlačne kanalizacije znaša L=2.519,7 m. Skupna dolžina kanalizacije je 9.419,4 m.

Predvideni profili cevi so dimenzij DN 250mm. Dimenzije tlačnih vodov so PE 100 d90 in d110.

Predvidena so štiri (4) mokra črpališča.

Seznam kanalov:

Ime kanala	Dolžina (m)	Dimenzija
R2(1)	1.284,6	DN 250
R2.S1	192,1	DN 250
R2.S2	72,7	DN 250
R1.S2 (1)	279,5	DN 250
R1T	1.582,4	PE100 d110
R5	120,7	DN 250
R5.1	337,8	DN 250
R5.1T	413,4	PE100 d90
R5.2	383,8	DN 250
R5.S1	292,6	DN 250
R5.S2	228,7	DN 250
R6	254,9	DN 250
R6T	350,5	PE100 d110
R6.2	179,4	DN 250
R6.2.1	17,5	DN 250
R6.S1	56,3	DN 250
R6.S2	219,1	DN 250
R6.S2.1	115,6	DN 250
R6.S3	556,5	DN 250
R6.S3.1	222,4	DN 250
R6.S3.1.1	123,5	DN 250
R6.S3.1.2	43,8	DN 250
R6.S3.1.3	88,6	DN 250
R6.S3.2	28,8	DN 250
R6.S4	368,5	DN 250
R6.S4.1	146,7	DN 250

Ime kanala	Dolžina (m)	Dimenzija
R6.S4.1T	173,4	PE100 d90
R7	866,1	DN 250
R7.S3	102,1	DN 250
R7.S2	317,4	DN 250

3.1 Opis kanalov

3.1.1 Sanitarni kanal R2(1)

Sanitarni kanal R2(1) je glavni odvodni kanal. Kanal poteka po cesti Unec in Ivanje Selo. Na kanal se priključijo še kanali R2.S2, R5, R2.S1, R1.S2 (1) in R1(2.faza). Kanal se priključi na predvideno črpališče z oznako ČRP1. Iz črpališča je predviden tlačni vod, ki prečrpava odpadno vodo na višje ležeči teren v obstoječ revizijski jašek RJ92 (kanal R3, ki je že izveden po projektu št.: 60-1535-00-2010, Kanalizacija naselja Rakek).

Kanal poteka po asfaltirani površini v glavni državni cesti RIII-640/1373 Rakek-Logatec.

Kanal R2(1) se začne v projektiranem jašku RJ43 in se zaključi s priklopom na projektirano črpališča dimenzije fi 1800 m.

Profil kanala je DN 250mm, dolžine L=1.284,59m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Vzporedno s traso kanalizacije je predviden tlačni vod R1T.

Na kanal je predviden priklop dvaindvajsetih (22) stanovanjskih objektov.

Predviden je izkop pod kotom 90º. Izkop se bo zaščitil z jeklenim opažem.

Poseg v državni cesti je podrobno opisan v poglavju: *3.4 Opis posega v regionalni cesti*.

3.1.2 Sanitarni kanal R2.S1

Sanitarni kanal R2.S1 je stranski odvodni kanal. Kanal poteka po stranski cesti naselja Unec in se priključi na proj. revizijski jašek RJ32 na kanal R2(1).

Profil kanala je DN 250mm, dolžine L=192,10 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop štirih (4) stanovanjskih objektov.

3.1.3 Sanitarni kanal R2.S2

Sanitarni kanal R2.S2 je stranski odvodni kanal. Kanal poteka po stranski cesti naselja Unec in se priključi na proj. revizijski jašek RJ40 na kanalu R2(1).

Profil kanala je DN 250mm, dolžine L=72,7 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop treh (3) stanovanjskih objektov.

Predviden je vertikalni izkop pod kotom 90º. Tam kjer se bo ob izkopu naletelo na glino bo potrebno razpiranje gradbene jame z morali 10x10cm.

3.1.4 Tlačni vod R1T

Tlačni vod R1T je odvodni tlačni vod PE 100 d110 iz ČRP1. Tlačni vod poteka po cesti Ivanje Selo, Unec in delno po Ljubljanski cesti v Rakeku. Tlačni vod se priključi na obstoječ revizijski jašek RJ92, ki je izveden po projektu št.: 60-1535-00-2010, Kanalizacija naselja Rakek.

Tlačni vod poteka po asfaltirani površini po glavni državni cesti RIII-640/1373 Rakek-Logatec. Trasa tlačnega voda poteka od ČRP1 do priključnega jaška od severa proti jugu, vzporedno s predvidenim kanalom R2(1).

Profil tlačnega voda je PE 100 d110, dolžine L=1.582,4 m. Na cca L=120,00m so predvideni čistilni jaški. Globina tlačnega voda je cca 1,30m. Projektiran tlačni vod prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov, karakterističnih prerezov in vzdolžnega profila.

Predviden je izkop pod kotom 90º. Izkop se bo zaščitil z jeklenim opažem.

Poseg v državni cesti je podrobno opisan v poglavju: *3.4 Opis posega v regionalni cesti.*.

3.1.5 Sanitarni kanal R1.S2 (1)

Sanitarni kanal R1.S2(1) je stranski odvodni kanal, ki predstavlja de kanala, ki se bo zgradil v 1.fazi in je predmet PZI projekta. Kanal poteka po stranski cesti naselja Ivanje Selo in se priključi na proj. revizijski jašek RJ3 na kanalu R2(1).

Profil kanala je DN 250mm, dolžine L=279,5 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop treh (3) stanovanjskih objektov.

3.1.6 Sanitarni kanal R5

Sanitarni kanal R5 je sekundarni odvodni kanal. Kanal poteka po cesti naselja Unec. Na kanal se v jašku RJ165 priključi tlačni vod R5.1T iz črpališča ČRP3. Kanal se priključi na predviden RJ34 na kanalu R2(1).

Profil kanala je DN 250mm, dolžine L=120,7 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop šest (6) stanovanjskih objektov.

3.1.7 Sanitarni kanal R5.1

Sanitarni kanal R5.1 je glavni odvodni kanal. Kanal poteka po cesti naselja Unec. Na kanal se priključijo kanal R5.S2, R5.2 in R5.S1. Kanal se zaključi v ČRP3 dimenzije fi1600. Iz ČRP3 je predviden tlačni vod R5.1T.

Profil kanala je PP DN 250mm, dolžine L= 337,8 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop štirinajst (14) stanovanjskih objektov.

3.1.8 Tlačni vod R5.1T

Tlačni vod R5.1T je odvodni tlačni vod PE 100 d90 iz ČRP3. Tlačni vod poteka po cesti naselja Unec., kjer se priključi na proj RJ5 (kanal R5). Vzporedno s traso poteka kanal R5.2.

Tlačni vod poteka po asfaltirani površini. Trasa tlačnega voda poteka od zahoda proti vzhodu.

Profil tlačnega voda je PE 100 d90, dolžine L= 413,05 m. Globina tlačnega voda je cca 1,30m. Na cca L=120,00m so predvideni čistilni jaški. Projektiran tlačni vod prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

3.1.9 Sanitarni kanal R5.2

Sanitarni kanal R5.2 je glavni odvodni kanal. Kanal poteka po cesti v naselju Unec inse priključi na PRJ2 na kanalu R5.1.

Profil kanala je DN 250mm, dolžine L=383,8 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop štirinajst (14) stanovanjskih objektov.

3.1.10 Sanitarni kanal R5.S1

Sanitarni kanal R5.S1 je stranski odvodni kanal. Kanal poteka po asfaltirani cesti naselja Unec od vzhoda proti severozahodu ter se priključi na RJ12 na kanalu R5.2.

Profil kanala je DN 250mm, dolžine L=292,6m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop šestih (6) stanovanjskih objektov.

3.1.11 Sanitarni kanal R5.S2

Sanitarni kanal R5.S2 je stranski odvodni kanal. Kanal poteka po asfaltirani cesti naselja Unec od vzhoda proti severozahodu ter se priključi na PRJ7 na kanalu R5.1.

Profil kanala je DN 250mm, dolžine L=228,7m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop trinajstih (13) stanovanjskih objektov.

3.1.12 Sanitarni kanal R6

Sanitarni kanal R6 je glavni odvodni kanal. Kanal R6 poteka po državni cesti prvega reda RI 212/1115 priključek Unec- Unec. Na kanal je predviden priklop kanalov R6.S3, R6.S2, R6.S3.1.3,

R7, R6.S2.1, R6.2, R6.2.1. Kanal se zaključi s priklopom na predvideno črpališče ČRP4. Iz ČRP4 je predviden tlačni vod R6T.

Profil kanala je DN 250mm, dolžine L=254,9 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila. Vzporedno s traso kanalizacije je predviden potek tlačnega voda R6T.

Na kanal je predviden priklop petih (5) stanovanjskih objektov

Predviden je izkop pod kotom 90º.Izkop se bo zaščitil z jeklenim opažem.

Poseg v državni cesti je podrobno opisan v poglavju: *3.4 Opis posega v regionalni cesti*.

3.1.13 Tlačni vod R6T

Tlačni vod R6T je odvodni tlačni vod PE 100 d110 iz ČRP4. Tlačni vod poteka po državni cesti prvega reda RI 212/1115 priključek Unec- Unec in RI 212/1116 Unec-Rakek. Trasa poteka od zahoda proti vzhodu in se priključi na obstoječ puščen odcep tlačnega voda za priključitev (izveden po PGD Prestavitev sanitarne kanalizacije ob regionalni cesti Unec-Rakek z navezavo na dotočni sistem na ČN Rakek; št. proj.: 50-1942-00-2017, avgust 2017)

Profil tlačnega voda je PE 100 d110, dolžine L= 350,50 m. Globina tlačnega voda je cca 1,30m. Projektiran tlačni vod prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Predviden je izkop pod kotom 90º vzporedno z gravitacijskim kanalom. Izkop se bo zaščitil z jeklenim opažem.

Poseg v državni cesti je podrobno opisan v poglavju: *3.4 Opis posega v regionalni cesti*.

3.1.14 Sanitarni kanal R6.2

Sanitarni kanal R6.2 je stranski odvodni kanal. Kanal poteka po cesti naselja Unec in se zaključi s priklopom na proj. RJ4 na kanalu R6.Na kanal je predviden priklop kanala R6.S1.

Profil kanala je DN 250mm, dolžine L=179.4. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop trinajstih (13) stanovanjskih objektov .

3.1.15 Sanitarni kanal R6.2.1

Sanitarni kanal R6.2.1 je glavni odvodni kanal. Kanal R6.2.1 poteka po državni cesti prvega reda RI 212/1115 priključek Unec- Unec in se zaključi s priklopom na proj.RJ2 na kanalu R6.

Profil kanala je DN 250mm, dolžine L=17,5 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop dveh (2) stanovanjskih objektov

Poseg v državni cesti je podrobno opisan v poglavju: *3.4 Opis posega v regionalni cesti*.

3.1.16 Sanitarni kanal R6.S1

Sanitarni kanal R6.S1 je stranski odvodni kanal. Kanal poteka po cesti naselja Unec in se zaključi s priklopom na proj.PRJ8 na kanalu R6.2.

Profil kanala je PP DN 250mm, dolžine L=56,35 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop treh (3) stanovanjskih objektov

3.1.17 Sanitarni kanal R6.S2

Sanitarni kanal R6.S2 je stranski odvodni kanal. Kanal poteka po cesti v naselju Unec in se zaključi s priklopom na proj.RJ11 na kanalu R6.

Na odseku kanalaR6.S2 so zahtevane posebne **naravovarstveni usmeritve:**

Pri revizijskim jaškom PRJ269 se nahaja cca 3.30 m zahodno obstoječa lipa **(drevesne naravne vrednote državnega pomena Unec-lipa (id. Št. 331))** . Ker se predvidena trasa kanalizacije približa drevesnima naravnima vrednotama Unec-lipa (parc. Št. 2118/18, k.o. Unec).

Naravovarstveni pogoji izvedbe

- Izkop naj bo čim bliže zidu**.-(projektant upošteval navodila v največji možni meri ,razvidno iz detajla 2.2.5.10-prerez A-A)**
- Drevo naj se ogradi z 2 m visoko trdno leseno ograjo, in sicer 1,5 m – 2.5 m stran od debla, da ne pride do poškodb debla in krošenj. **-(upoštevana navodila, razvidno iz detajla 3.5.5.9-prerez A-A, izvajalec bo upošteval navodila pri gradnji)**
- Popolnoma pri miru naj se pusti tista stran drevesa, ki se spušča na drugo stran škarpe.- **(upoštevana bodo navodila pri gradnji)**
- Rastišče drevesa naj se ne uporablja za manipulativne površine delovnih strojev, nanj naj se niti trajno niti začasno ne odlaga izkopanega ali drugega materiala, ne parkira vozil ali delovnih strojev, ne odlaga gradbenih kontejnerjev ali česa podobnega. **– upoštevana bodo navodila pri gradnji. Med gradnjo med RJ266, RJ267 in RJ268 mora izvajalec posebno pozornost posvetiti temu, da se na obravnavanem območje drevesa ne odlaga izkopanega materiala , drugega materiala , ne parkira strojev in drugih stvari .**
- Pri izkopu naj se previdno ravna s koreninami, ki tako med posegom, kot po njem ne smejo ostati odkrite. Treba jih je zaščititi pred izsušitvijo in mrazom ter jih čim prej spet zakriti. **– (upoštevana bodo navodila pri gradnji, ročni izkop se bo izvedel L=5,00 m pred revizijskim jaškom RJ267 in do revizijske jaška RJ266 v dolžini L=20,30m)**
- Morebitne poškodbe korenin je treba čim prej oskrbeti. To naj opravi za to usposobljen strokovnjak. Poškodovane korenine se takoj zaščiti pred izsušitvijo tako, da se jih prekrije z žakljevino, filcem ali podobno, ter se jih ohranja vlažne. Paziti je treba, da ne pridejo v stik s cementnim mlekom ali katerim drugim koreninam škodljivim sredstvom. **– (izvajalec bo upošteval navodila pri gradnji)**
- Med izvajanjem posega naj se obvesti Zavod za varstvo narave, Območna enota Ljubljana

Profil kanala je DN 250 mm, dolžine L=219,1 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop petnajstih (15) stanovanjskih objektov

3.1.18 Sanitarni kanal R6.S2.1

Sanitarni kanal R6.S2.1 je stranski odvodni kanal. Kanal poteka po cesti naselja Unec in se zaključi s priklopom na proj RJ6 na kanalu R6.

Profil kanala je DN 250mm, dolžine L=116,05 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop šestih (6) stanovanjskih objektov

3.1.19 Sanitarni kanal R6.S3

Sanitarni kanal R6.S3 je glavni odvodni kanal. Kanal poteka po cesti naselja Slivice. Na kanal je predviden priklop kanala R6.S3.1.2, R6.S3.2 in R6.S3.1. Kanal se zaključi s priklopom na proj.RJ12 na kanalu R6.

Profil kanala je DN 250mm, dolžine L=556,50 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop sedemnajstih (17) stanovanjskih objektov

3.1.20 Sanitarni kanal R6.S3.1

Sanitarni kanal R6.S3.1 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice. Na kanal je predviden priklop kanala R6.S3.1.1. Kanal se zaključi s priklopom na proj. RJ2 na kanalu R6.S3.

Profil kanala je DN 250mm, dolžine L=222,4 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop sedmih (7) stanovanjskih objektov

3.1.21 Sanitarni kanal R6.S3.1.1

Sanitarni kanal R6.S3.1.1 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice in se zaključi s priklopom na proj.RJ5na kanalu R6.S3.1.

Profil kanala je DN 250mm, dolžine L=123,5 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop petih (5) stanovanjskih objektov

3.1.22 Sanitarni kanal R6.S3.1.2

Sanitarni kanal R6.S3.1.2 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice in se zaključi s priklopom na proj.PRJ13 na kanalu R6.S3.

Profil kanala je DN 250mm, dolžine L=43,8 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop štirih (4) stanovanjskih objektov

3.1.23 Sanitarni kanal R6.S3.1.3

Sanitarni kanal R6.S3.1.3 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice in se zaključi s priklopom na proj.RJ227 na kanalu R8.

Profil kanala je DN 250mm SN16, dolžine L=88,6 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop šestih (6) stanovanjskih objektov

3.1.24 Sanitarni kanal R6.S3.2

Sanitarni kanal R6.S3.2 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice in se zaključi s priklopom na proj.RJ10 na kanalu R6.S3.

Profil kanala je DN 250mm, dolžine L=28,8 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop dveh (2) stanovanjskih objektov

3.1.25 Sanitarni kanal R6.S4

Sanitarni kanal R6.S4 je glavni odvodni kanal. Kanal poteka po cesti naselja Slivice. Na kanal je predviden priklop tlačnega voda R6.S4.1T in kanala R6.1. Kanal se zaključi s priklopom na obst. RJ (izveden po projektu PGD: Prestavitev sanitarne kanalizacije ob regionalni cesti Unec-Rakek z navezavo na dotočni sistem na ČN Rakek; št. proj.: 50-1942-00-2017, avgust 2017).

Profil kanala je DN 250mm, dolžine L=368,5 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop osemnajstih (18) stanovanjskih objektov

3.1.26 Sanitarni kanal R6.S4.1

Sanitarni kanal R6.S4.1 je stranski odvodni kanal. Kanal poteka po cesti naselja Slivice. Kanal se zaključi s priklopom na proj.ČRP5 dimenzije fi 1600 mm. Iz ČRP5 je predviden tlačni vod, ki bo prečrpaval odpadno vodo v RJ9 na kanalu R6.S4.

Profil kanala je DN 250mm, dolžine L=146,7 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop šestih (6) stanovanjskih objektov

3.1.27 Tlačni vod R6.S4.1T

Tlačni vod R6.S4.1T je odvodni tlačni vod PE 100 d90 iz ČRP5. Tlačni vod poteka po cesti naselja Slivice in se priključi na proj.RJ9 na kanalu R6.S4.

Profil tlačnega voda je PE 100 d90, dolžine L=173,4 m. Globina tlačnega voda je cca 1,30m. Na cca L=120,00 m so predvideni čistilni jaški. Projektiran tlačni vod prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov, karakterističnih prerezov in vzdolžnega profila.

3.1.28 Sanitarni kanal R7

Sanitarni kanal R7 je glavni odvodni kanal. Kanal poteka po cesti naselja Unec. Na kanal je predviden priklop kanala R7.S3 in R7.S2. Kanal se zaključi s priklopom na proj. RJ6 na kanalu R6. Kanal R7 poteka po cesti Unec pod viaduktom Hribce avtoceste A1: Unec-Postojna. Pod viaduktom je predviden izkop kotom 90º.Izkop se bo zaščitil z jeklenim opažem.

Profil kanala je DN 250mm, dolžine L=866,1 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop osemndvajsetih (28) stanovanjskih objektov

3.1.29 Sanitarni kanal R7.S2

Sanitarni kanal R7.S2 je stranski odvodni kanal. Kanal poteka po travnati površini pod stanovanjskimi objekti in delno po dovozni poti . Kanal se zaključi s priklopom na proj.RJ16 na kanalu R7.

Profil kanala je DN 250 mm, dolžine L=317,40 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop devetih (9) stanovanjskih objektov

3.1.30 Sanitarni kanal R7.S3

Sanitarni kanal R7.S3 je stranski odvodni kanal. Kanal poteka po cesti do naselja Hribce. Kanal se zaključi s priklopom na proj.RJ22 na kanalu R7.

Kanal poteka po asfaltirani površini. Trasa kanala poteka od severa proti jugovzhodu. Na proj. kanal se bo priključilo novo naselje Hribce, ki ima odpadno sanitarno vodo sedaj priključeno na MČN. Naredi se prevezava na novo zgrajeno kanalizacijo.

Profil kanala je DN 250mm, dolžine L=102,1 m. Padec kanalizacije je različen in je razviden iz vzdolžnega profila. Projektiran kanal prečka na svoji trasi obstoječe komunalne vode, kar je razvidno iz zbirnika komunalnih vodov , karakterističnih prerezov in vzdolžnega profila.

Na kanal je predviden priklop MKČN na katero je priključenih 16 stanovanjskih objektov.

3.2 Hišni priključki

Hišni priključki se praviloma izvajajo vzporedno z gradnjo kanala. Projekti hišnih priključkov niso predmet tega projekta in se izdelajo posebej.

Hišni priključki se na zahtevo upravljalca kanalizacije lahko priključujejo samo pod stropom kleti. Klet se lahko priključuje samo preko hišnega črpališča. Priključek na projektiran kanal se izvede pod kotom 45° (horizontalno), iz PVC cevi DN 160 mm. Cevi hišnega priključka se polagajo v padcu 2-5% do izven cestnega telesa, kjer se zgradi revizijski jašek Φ 800 mm (globina < 1,30 m) ali Φ 1000 mm (globina > 1,30m). Kasneje se izvede povezava z interno kanalizacijo na osnovi načrta priključka hišne kanalizacije. Vertikalni kot med osjo kanala hišnega priključka in horizontalo mora biti med 15 in 45°. Priklop na cev se izvede po priloženem detajlu.

V primeru, da zaradi prostorske stiske ne bi mogli izvesti direktnega priključka v dno javnega kanala, se izdela priključek s čistilnim kosom in cestno kapo.

Pri polaganju novega cevovoda se izvedejo hišni priključki tako, da se na predvidenih priključnih mestih vgradi odcepe. Odcep se predvidi iz PVC cevi, ki se vodotesno zaplastificira v območju spoja s poliestrsko cevjo.

Priključke z manjšim temenskim kritjem od 1,0 m je potrebno obbetonirati z betonom C 16/20.

Naknadni priključki se izdelajo tako, da se na mestu predvidene priključitve izreže odprtina na katero se nato vodotesno izvede odcep pod kotom 45°.

3.3 Predvideni objekti: črpališča

Zaradi razgibane konfiguracije terena so na območju obdelave previdena štiri črpališča za odpadne vode.

V nekaterih primerih, ko terenske razmere ne omogočajo gravitacijskega priključka objekta, bo potrebno izgraditi tudi hišna črpališča. Projekti hišnih priključkov niso predmet tega projekta in se izdelajo posebej.

Opis delovanja mokrega črpališča

Iz kanalizacijskega omrežja bo voda gravitacijsko pritekala v črpališča. V črpališče se namestijo dve potopni črpalki. Ena je delujoča, druga pa je 100% rezerva. Najprej bo delovala le ena črpalka, ki bo vzdrževala predpisani nivo vode v bazenu. V primeru da se bo gladina vode znižala do gladine izklopa se bo črpalka izklopila. V nadaljevanju ko bo gladina vode spet dosegla delovno višino se bo vklopila druga črpalka. V primeru da se bo gladina vode dvignila za 10 cm nad delovno višino se bo vzporedno vklopila še druga črpalka. Delovanje in spremljanje delovanja črpališča je omogočeno z elektroomaro in senzorji črpališča. Avtomatika črpališča je izvedena tako, da izmenično obratujeta obe črpalki.

Črpališča so mokre izvedbe, to pomeni, da so črpalke potopljene v fekalije. Dostop v črpališča je možen skozi pokrov. Notranjost črpališča se naravno prezračuje skozi odprtine. Iz črpališča vodo transportiramo v javni kanalizacijski sistem.

Črpalna komora je izdelana iz poliestrske mase, ojačane s steklenimi vlakni, ter je korozijsko odporna. Prav tako je odporno na vse obremenitve, ki nastopajo pri načinu vgradnje in tekom obratovanja.

Poliestrsko črpališče je opremljeno z zapornimi zasuni in nepovratnimi loputami, z nosilcem nivojske sonde, in plovnimi stikali.

Vsi priključki cevovodov se izvedejo na licu mesta takoj po postavitvi črpališča, tako se izogne napakam, ki bi lahko nastale pri spremembi lege cevovodov.

Priključki objekta

Za potrebe delovanja črpališč je potreben priklop na elektroenergetsko omrežje. Celoten kabelski NN dovod bo potekal v zemlji, ob trasi kanalizacije. Odjemno mesto je določeno na podlagi projektnih pogojev Elektra Ljubljana.

3.3.1 Podatki o posameznem črpališču

Črpališče ČRP1

Črpališče ČRP1 prečrpava odpadno vodo iz polovice naselja Unec in iz naselja Ivanje Selo (2.faza), preko tlačnega voda v obstoječi revizijski jašek v naselju Rakek.

Črpališče ČRP1 je predvideno v mokri izvedbi in se nahaja vzhodno, ob regionalni cesti III. reda Rakek – Logatec, št. ceste 640, št. odseka 1373, na stacionaži 2.5+410 km.. Kapaciteta črpališča je 5,5 l/s.

Črpališče bo iz poliestrske posode premera DN 1800 mm, temeljene na AB plošči iz AB C35/45. Kota terena bo znašala 502,50 m, v črpališče bo na koti 499,58 m vtekal gravitacijski kanal DN 250 mm. Na dno posode bosta nameščeni 2 črpalki.

Območje črpališča se zavaruje z zaščitno ograjo višine 2,00 m in tako onemogoča dostop nepooblačenim oseba ter ščiti območje črpališča ter zračnike. Okolica črpališča se predvidoma uredi z lomljencem 16-32 mm.

Za napajanje črpališča je predviden NN elektro priključek.

Črpališče ČRP3

Črpališče ČRP3 prečrpava odpadno vodo iz kanalov R5.2, R5.S1, R5.1 in R5.S2 v naselju Unec, preko tlačnega voda, v predvideni kanal R5.

Črpališče ČRP3 je predvideno v mokri izvedbi in je locirano v naselju Unec ob cesti nasproti objekta HŠ 97a.Kapaciteta črpališča je 2,0 l/s.

Črpališče bo iz poliesterske posode premera DN 1600 mm, temeljene na AB plošči iz AB C35/45. Kota terena bo znašala 515,10 m, v črpališče bo na koti 511,31 m vtekal gravitacijski kanal DN 250 mm. Na dno posode bosta nameščeni 2 črpalki.

Črpališče se nahaja v lokalni cesti in je povozno, tako ograja okoli objekta ni predvidena. Zračnik in elektro omarica sta umaknjena od roba lokalne ceste.

Za napajanje črpališča je predviden NN elektro priključek.

Črpališče ČRP4

Črpališče ČRP 4 prečrpava odpadno vodo iz polovice naselja Unec, Dovce in Slivice, preko tlačnega voda, v obstoječi kanal, ki poteka v pločniku ob državni cesti.

Črpališče ČRP4 je predvideno v mokri izvedbi in je locirano v naselju Unec na JV strani glavne ceste. Kapaciteta črpališča je 5,0 l/s.

Črpališče bo iz poliesterske posode premera DN 1600 mm, temeljene na AB plošči iz AB C35/45. Kota terena bo znašala 512,40 m, v črpališče bo na koti 510,51 m vtekal gravitacijski kanal DN 250 mm. Na dno posode bosta nameščeni 2 črpalki.

Območje črpališča se zavaruje z zaščitno ograjo višine 2,00 m in tako onemogoča dostop nepooblačenim in ščiti območje črpališča ter zračnike. Okolica črpališča se predvidoma uredi z lomljencem 16-32 mm.

Za napajanje črpališča je predviden NN elektro priključek.

Črpališče ČRP5

Črpališče ČRP5 prečrpava odpadno vodo iz kanala R6.S4.1, preko tlačnega voda v predviden kanal R6.S4.

Črpališče ČRP5 je predvideno v mokri izvedbi in je locirano v naselju Slivice na JV strani naselja nasproti objekta Slivice 52. Kapaciteta črpališča je 0,5 l/s.

Črpališče bo iz poliesterske posode premera DN 1600 mm, temeljene na AB plošči iz AB C35/45. Kota terena bo znašala 518,20 m, v črpališče bo na koti 515,69 m vtekal gravitacijski kanal DN 250 mm. Na dno posode bosta nameščeni 2 črpalki.

Območje črpališča se zavaruje z zaščitno ograjo višine 2,00 m in tako onemogoča dostop nepooblačenim in ščiti območje črpališča ter zračnike. Okolica črpališča se predvidoma uredi z lomljencem 16-32 mm.

Za napajanje črpališča je predviden NN elektro priključek.

3.4 Opis posega v regionalni cesti

3.4.1 Odsek trase kanalizacije R6.2.1

Odsek trase kanalizacije z oznako R6.2.1 poteka po desnem voznem pasu (gledano v smeri naraščanja stacionaže) po regionalni cesti prvega reda RI 212 odsek 1115 priključek Unec-Unec od km 0.0+500 do km 0.5+018. V km 0.5+018 se trasa priključi v revizijski jašek kanala R6.

Predviden je vertikalni izkop zaščiten z jeklenim opažem .

Pri vzdolžnem prekopu vozišča državne ceste za kanal R6.2.1 bo poškodovano več kot 1/3 vozišča. Sanacija vozišča se izvede tako, da se na območju prekopa izvede kompleten zgornji ustroj, na ostalem delu vozišča pa se odrezka obrabni sloj v celotni širini in nadomesti z novim.

3.4.2 Odsek trase tlačnega voda R6T in kanalizacije R6

Odsek trase tlačnega voda R6T in kanalizacije z oznako R6 poteka po sredini desnega voznega pasu (desni vozni pas, smer naraščanja stacionaže) po regionalni cesti prvega reda RI 212 odsek 1115 priključek Unec-Unec od km 0.5+018 do km R1212/1116 km 0.0+000.V km 0.5+018 trasa R6 in R6T zavije levo pod kotom 90° in se zaključi s priklopom na črpališče ČRP4, ki je predvideno v varovalnem pasu državne ceste. Traso tlačnega voda R6T in kanala R6 ni možno speljati izven državne ceste RI 212/1115, ker so na obeh straneh ceste obstoječi stanovanjski objekti.

Predviden je vertikalni izkop zaščiten z jeklenim opažem.

Pri vzdolžnem prekopu vozišča državne ceste za kanal R6 in tlačni vod R6T bo poškodovano več kot 1/3 vozišča. Sanacija vozišča se izvede tako, da se na območju prekopa izvede kompleten zgornji ustroj, na ostalem delu vozišča pa se odrezka obrabni sloj v celotni širini in nadomesti z novim.

Odsek tlačnega voda R6T poteka samostojno v cesti RI 212/1115 od km 0.5+264 do km 0.5+268 v dolžini L=10m, kjer zavije pred obstoječo avtobusno postajo levo (gledano v smeri naraščanja stacionaže) izven državne ceste. Trasa tlačnega voda nato poteka vzporedno z državno cesto R1 212/1116 od stacionaže km 00+00 do km 0.0+090, kjer je priklop v na obstoječ tlačni vod.

Minimalni osni odmik tlačnega voda od roba ceste na odseku, kjer trasa ne poteka v cestišču je od 2,7 m. Predviden je vertikalni izkop zaščiten z jeklenim opažem.

Sanacija vozišča se na območju stacionaže 0.5+265 (RI 212/1115) izvede tako, da se na območju prekopa izvede kompleten zgornji ustroj, na ostalem delu vozišča pa se odrezka obrabni sloj v celotni širini in nadomesti z novim.

3.4.3 Odsek trase tlačnega voda R1T

Odsek trase tlačnega voda z oznako R1T poteka po sredini desnega voznega pasu regionalne ceste tretjega reda RIII 640/1373 (gledano v smeri naraščanja stacionaže). Na Ljubljanski cesti in Trg padlih borcev je predvidena razširitev ceste po projektu Ureditev hodnika za pešce in rekonstrukcija ceste R3-640/1373 od km 0.065 do km 1.340 skozi Rakek; Izdelal: CP Inženiring d.o.o., Povšetova ulica 10, 1000 Ljubljana, št. proj. 720/08-C. Traso predvidene kanalizacije smo predvideli v sredino desnega voznega pasu predvidene razširitve ceste po zgoraj omenjenem projektu.

Zaradi razgibane konfiguracije terena potek tlačnega voda R1T in vzporednega kanala R2(1) ni možen izven regionalne ceste RIII 640/1373 Rakek-Logatec. Potek je predviden v sredini desnega voznega pasu regionalne ceste (gledano v smeri naraščanja stacionaže).

Trasa tlačnega voda R1T poteka po regionalni cesti tretjega reda RIII 640/1373 Rakek-Logatec od km 1.0+332 do km 1.5+132 samostojno po sredini desnega voznega pasu (gledano v smeri naraščanja stacionaže).

Od km 1.5+132 do km 2.5+410 pa poteka trasa tlačnega voda R1T skupaj s kanalom R2(1) po desnem voznem pasu (gledano v smeri naraščanja stacionaže). Trasa nato zavije desno do predvidenega črpališča ČRP1.

Predviden je vertikalni izkop zaščiten z jeklenim opažem.

Sanacija vozišča na celem odseku RIII 640 1373 se izvede tako, da se na območju prekopa izvede kompleten zgornji ustroj, na ostalem delu vozišča pa se odrezka obrabni sloj v celotni irini in nadomesti z novim.

3.4.4 Trasa kanalizacije z oznako R2(1)

Trasa kanalizacije z oznako R2(1) poteka skupaj s tlačnim vodom R1T po regionalni cesti RIII 640/1373 Rakek-Logatec od km 1.5+132 do km 2.5+410, kjer trasa zavije desno na travnato površino v varovalni pas, kjer se priključi na črpališče ČRP1.

Trasa kanala R2(1) in tlačnega voda R1T poteka po sredini desnega voznega pasu regionalne ceste (gledano v smeri naraščanja stacionaže).

Predviden je vertikalen izkop zaščiten z jeklenim opažem. Trasa poteka v cestni parceli.

Pri vzdolžnem prekopu vozišča regionalne ceste za tlačni vod R1T in kanal R2(1) bo poškodovano več kot 1/3 vozišča. Sanacija vozišča na celem odsek RIII 640/1373 se izvede tako, da se na območju prekopa izvede kompleten zgornji ustroj, na ostalem delu vozišča pa se odrezka obrabni sloj v celotni širini in nadomesti z novim.

Sanacija državne ceste se bo izvedla kot je predvideno v noveliranem elaboratu: Elaborat dimenzioniranja vozišče konstrukcije-novelacija, št.:DN56/20, datum 6.11.2020, izdelal Inštitut za ceste raziskovanje in razvoj , d.o.o., Viška cesta 53, 1000 Ljubljana.

3.5 Povzetek geomehanskega poročila

Izkop za izgradnjo fekalne kanalizacije se bo izvajal v zemljini 3. kategorije in hribini 4. in 5. kategorije po kategorizaciji »Splošnih in posebnih tehničnih pogojev za gradnjo cest«.

Na območju povoznih površin glavnina izkopnega materiala ne bo primerna za ponovno vgradnjo. Izkopni material 5. kategorije (trde kamnine) bo potrebno, za vgradnjo v zasip, predrobiti. Za zasip fekalnega kanala bo potrebno uporabiti kamniti zasipni material. Na utrjeni nasipni plasti mora biti izkazana nosilnost z dinamično ploščo Evd > 30 MPa.

Na odsekih, kjer globina kanala ne bo presegala 2 m, je možen široki odkop z naklonom brežine 60°. Za izkope, ki bodo globlji od 2 m in se bodo izvajali v zemljini 3. kategorije, naj se predvidi ustrezno varovanje, ublaži naklon izkopnih brežin ali izvede vmesno bermo. Izkope v hribini se lahko izvaja do končne globine v naklonu 60°.

Izboljšava temeljnih tal dna kanalov ne bo potrebna.

Predvideni gradbeni posegi pri izgradnji fekalne kanalizacije ne bodo vplivali na spremembo oziroma poslabšanje globalnih stabilnostnih razmer. V primeru globokih izkopov, več kot 2 m, bo potrebno izkopne brežine kanalov pregledati in po potrebi zagotoviti ustrezno varovanje izkopnih brežin, za preprečitev manjših lokalnih zruškov.

V primeru globokih izkopov ob posameznih stanovanjskih objektih slabše kakovosti, bo potrebno opraviti predhodni monitoring objektov in dela izvajati tako, da bo vpliv na objekte čim manjši (kampadni odkopi, varovanje brežin izkopnega kanala, statično utrjevanje zasipa).

4. HIDRAVLIČNI IZRAČUN

Hidravlična presoja kanalizacije in dimenzioniranje cevi je bilo izvedeno s pomočjo računalniškega programa SEWER+ .

Oznaka	Polnitev [%]	Max. V [m/s]	Max Q [l/s]	Min. V [m/s]	Notranji fi [mm]	i [o/oo]	L [m]	$Q_{sušni}$ [l/s]	A [ha]	T [s]	Ng
K1 - 'R2(1)'											
M1.K1.C1 (ČRP1 - RJ2)	28,40%	0,64	4,21	0,62	256	4,6	7,51	0	0	0	0,01
M1.K1.C2 (RJ2 - PRJ3)	24,10%	0,53	2,22	0,49	256	4,6	29,59	0	0	0	0,01
M1.K1.C3 (PRJ3 - PRJ4)	22,30%	0,48	1,64	0,48	256	4,6	29,5	0	0	30	0,01
M1.K1.C4 (PRJ4 - RJ8)	20,60%	0,53	1,43	0,53	256	6,7	166,38	0,12	0,6	30	0,01
M1.K1.C5 (RJ8 - RJ13)	19,50%	0,56	1,31	0,56	256	8,6	150,19	0	0	0	0,01
M1.K1.C6 (RJ13 - RJ17)	18,80%	0,63	1,31	0,63	256	12	110,41	0,04	0,13	120	0,01
M1.K1.C7 (RJ17 - RJ20)	16,80%	0,84	1,27	0,84	256	27,9	47,94	0	0	30	0,01
M1.K1.C8 (RJ20 - RJ28)	19,60%	0,54	1,28	0,54	256	7,9	251,93	0,22	1,4	30	0,01
M1.K1.C9 (RJ28 - RJ29)	17,40%	0,63	1,06	0,63	256	14,6	41,79	0	0	30	0,01
M1.K1.C10 (RJ29 - RJ30)	16,00%	0,82	1,08	0,81	256	29,9	27,25	0	0	30	0,01
M1.K1.C11 (RJ30 - PRJ32)	16,40%	0,74	1,05	0,74	256	23,3	74,56	0,17	0,96	30	0,01
M1.K1.C12 (PRJ32 - PRJ34)	14,90%	0,66	0,71	0,65	256	23,3	78,79	0,08	0,48	0	0,01
M1.K1.C13 (PRJ34 - RJ37)	16,20%	0,35	0,48	0,35	256	5,3	110,62	0,3	1,6	30	0,01
M1.K1.C14 (RJ37 - RJ40)	10,70%	0,44	0,18	0,44	256	24,5	87,08	0	0	30	0,01
M1.K1.C15 (RJ40 - RJ43)	8,60%	0,39	0,08	0,39	256	34,1	71,27	0,08	0,43	0	0,01
K2 - 'R2.S1'											
M1.K2.C1 (PRJ32 - RJ1)	11,10%	0,38	0,17	0,37	256	16,2	6,81	0	0	30	0,01
M1.K2.C2 (RJ1 - RJ2)	9,70%	0,56	0,17	0,56	256	51,9	28,31	0,17	1,04	30	0,01
K3 - 'R2.S2'											
M1.K3.C1 (RJ40 - RJ1)	9,80%	0,32	0,1	0,32	256	16,3	6,14	0	0	30	0,01
M1.K3.C2 (RJ1 - PRJ2)	8,30%	0,49	0,1	0,49	256	60,2	35,87	0,1	0,65	0	0,01
K4 - 'R1.S2 (1)'											
M1.K4.C1 (PRJ3 - RJ1)	12,70%	0,89	0,61	0,54	256	64,5	12,4	0	0	0	0,01
M1.K4.C2 (RJ1 - RJ3)	13,50%	0,75	0,61	0,44	256	37,9	38,55	0,09	0,6	0	0,01
M1.K4.C3 (RJ3 - RJ5)	12,60%	0,78	0,52	0,29	256	50,5	47,52	0	0	0	0,01
M1.K4.C4 (RJ5 - PRJ6)	12,30%	0,85	0,52	0,29	256	64	27,34	0	0	0	0,01
M1.K4.C5 (PRJ6 - PRJ7)	12,50%	0,82	0,52	0,28	256	56,4	27,86	0	0	30	0,01
M1.K4.C6 (PRJ7 - PRJ9)	12,00%	0,91	0,52	0,29	256	77,4	50,5	0	0	0	0,01
M1.K4.C7 (PRJ9 - PRJ10)	12,00%	0,91	0,52	0,27	256	79	30,64	0	0	0	0,01
M1.K4.C8 (PRJ10 - RJ11)	12,50%	0,79	0,52	0,22	256	54,4	16,35	0	0	0	0,01
M1.K4.C9 (RJ11 - PRJ12)	12,20%	0,87	0,52	0,2	256	70,4	28,34	0	0	0	0,01
K6 - 'R5.1'											
M1.K6.C1 (ČRP3 - PRJ2)	21,10%	0,52	1,5	0,51	256	6	2,9	0	0	30	0,01
M1.K6.C2 (PRJ2 - RJ3)	13,70%	0,93	0,77	0,89	256	57,6	11,11	0	0	60	0,01
M1.K6.C3 (RJ3 - PRJ7)	14,10%	0,82	0,74	0,82	256	42,2	109,5	0,22	0,9	30	0,01
M1.K6.C4 (PRJ7 - RJ9)	12,40%	0,33	0,21	0,33	256	9,6	65,59	0	0	0	0,01
M1.K6.C5 (RJ9 - RJ10)	11,10%	0,46	0,21	0,45	256	24,3	36,61	0,21	0,9	0	0,01

Oznaka	Polnitev [%]	Max. V [m/s]	Max Q [l/s]	Min. V [m/s]	Notranji fi [mm]	i [o/oo]	L [m]	$Q_{sušni}$ [l/s]	A [ha]	T [s]	Ng
M1.K6.C6 (RJ10 - RJ13)		0		0	256	51,7	87,87	0	0	0	0,01
M1.K6.C7 (RJ13 - RJ14)		0		0	256	38,4	24,2	0	0	0	0,01
K7 - 'R5'											
M1.K7.C1 (PRJ34 - RJ2)	9,30%	0,56	0,15	0,55	256	55,2	44,54	0,15	0,9	0	0,01
K9 - 'R5.2'											
M1.K9.C1 (PRJ2 - RJ4)	18,30%	0,39	0,75	0,38	256	4,8	91,51	0,2	1,02	30	0,01
M1.K9.C2 (RJ4 - RJ6)	15,50%	0,45	0,54	0,46	256	10,3	64,88	0,18	1,4	0	0,01
M1.K9.C3 (RJ6 - RJ7)	11,70%	0,7	0,37	0,69	256	48,5	21,96	0	0	30	0,01
M1.K9.C4 (RJ7 - RJ8)	12,90%	0,51	0,36	0,51	256	20,6	30,32	0,09	0,7	0	0,01
M1.K9.C5 (RJ8 - RJ12)	13,90%	0,31	0,27	0,31	256	6,3	96,5	0	0	0	0,01
M1.K9.C6 (RJ12 - RJ15)	9,40%	0,33	0,09	0,33	256	19,8	78,61	0,09	0,4	30	0,01
K10 - 'R5.S1'											
M1.K10.C1 (RJ12 - PRJ1)	9,60%	0,65	0,19	0,64	256	71,3	16,55	0	0	30	0,01
M1.K10.C2 (PRJ1 - PRJ2)	9,20%	0,71	0,18	0,72	256	97	17,11	0	0	0	0,01
M1.K10.C3 (PRJ2 - RJ3)	9,80%	0,61	0,19	0,61	256	59,7	14,63	0	0	30	0,01
M1.K10.C4 (RJ3 - RJ5)	12,50%	0,3	0,19	0,29	256	7,4	65,76	0,18	0,8	30	0,01
M1.K11.C1 (PRJ7 - RJ1)	10,30%	0,83	0,3	0,82	256	95,7	6,06	0	0	0	0,01
M1.K11.C2 (RJ1 - RJ3)	10,60%	0,76	0,3	0,76	256	76,6	46,23	0,18	0,4	0	0,01
M1.K11.C3 (RJ3 - RJ4)	8,70%	0,56	0,13	0,56	256	71	26,05	0	0	0	0,01
M1.K11.C4 (RJ4 - RJ9)	9,50%	0,44	0,13	0,44	256	34	102,35	0	0	0	0,01
M1.K11.C5 (RJ9 - RJ11)	10,90%	0,29	0,13	0,29	256	10,2	47,99	0,12	0,7	30	0,01
K12 - 'R6'											
M1.K12.C1 (ČRP4 - RJ2)	27,50%	0,83	5,03	0,82	256	8,2	7,72	0	0	60	0,01
M1.K12.C2 (RJ2 - RJ4)	24,50%	1,12	4,96	1,12	256	19,8	36,43	0,18	0	30	0,01
M1.K12.C3 (RJ4 - RJ6)	25,90%	0,81	4,18	0,81	256	9,2	57,43	0	0	60	0,01
M1.K12.C4 (RJ6 - RJ8)	21,90%	0,66	2,15	0,67	256	9,2	47,23	0,16	0,29	0	0,01
M1.K12.C5 (RJ8 - RJ11)	20,20%	0,72	1,84	0,72	256	13	79,94	0	0	30	0,01
M1.K12.C6 (RJ11 - RJ12)	18,80%	0,66	1,4	0,66	256	13	26,09	0	0	0	0,01
K14 - 'R6.2'											
M1.K14.C1 (RJ4 - PRJ1)	13,30%	0,82	0,63	0,8	256	49,1	13,85	0	0	30	0,01
M1.K14.C2 (PRJ1 - RJ2)	12,50%	0,95	0,61	0,94	256	76,3	18,34	0,25	0,7	30	0,01
M1.K14.C3 (RJ2 - RJ3)	11,80%	0,63	0,34	0,64	256	41	30,74	0	0	0	0,01
M1.K14.C4 (RJ3 - PRJ4)	11,40%	0,7	0,34	0,69	256	52,1	29,16	0	0	0	0,01
M1.K14.C5 (PRJ4 - PRJ5)	10,40%	0,91	0,34	0,89	256	112,8	10,99	0	0	0	0,01
M1.K14.C6 (PRJ5 - PRJ6)	10,40%	0,91	0,34	0,88	256	109,6	20,53	0	0	0	0,01
M1.K14.C7 (PRJ6 - RJ7)	11,10%	0,76	0,34	0,73	256	64,2	23,05	0,18	0,4	0	0,01
M1.K14.C8 (RJ7 - PRJ8)	9,20%	0,61	0,16	0,6	256	68,4	17,67	0	0	0	0,01
K16 - 'R6.S1'											
M1.K16.C1 (PRJ8 - PRJ1)	10,00%	0,48	0,16	0,48	256	35,8	6,69	0	0	0	0,01
M1.K16.C2 (PRJ1 - PRJ2)	8,60%	0,74	0,16	0,74	256	123,1	23,89	0,16	0	0	0,01
K17 - 'R6.S2'											
M1.K17.C1 (RJ11 - RJ1)	12,30%	0,76	0,46	0,75	256	50,4	9,32	0	0	60	0,01

Oznaka	Polnitev [%]	Max. V [m/s]	Max Q [l/s]	Min. V [m/s]	Notranji fi [mm]	i [o/oo]	L [m]	$Q_{sušni}$ [l/s]	A [ha]	T [s]	Ng
M1.K17.C2 (RJ1 - PRJ4)	12,90%	0,65	0,46	0,64	256	33,1	51,62	0,22	0,5	30	0,01
M1.K17.C3 (PRJ4 - PRJ5)	9,20%	0,9	0,23	0,88	256	153,6	19,14	0	0	60	0,01
M1.K17.C4 (PRJ5 - RJ7)	10,50%	0,6	0,23	0,59	256	47,4	46,46	0	0	30	0,01
M1.K17.C5 (RJ7 - RJ8)	10,10%	0,66	0,22	0,65	256	63,9	22,69	0	0	30	0,01
M1.K17.C6 (RJ8 - PRJ9)	10,40%	0,61	0,22	0,6	256	50,9	7,27	0,22	0,7	30	0,01
K18 - 'R6.S2.1'											
M1.K18.C1 (RJ6 - PRJ1)	10,40%	0,51	0,19	0,5	256	34,3	13,71	0	0	0	0,01
M1.K18.C2 (PRJ1 - PRJ3)	9,80%	0,6	0,19	0,61	256	59,2	52,55	0,19	0,4	0	0,01
K19 - 'R6.S3'											
M1.K19.C1 (RJ12 - RJ2)	19,00%	0,65	1,4	0,65	256	12,4	45,28	0	0	0	0,01
M1.K19.C2 (RJ2 - RJ6)	16,40%	0,54	0,76	0,54	256	12,4	109,84	0	0	0	0,01
M1.K19.C3 (RJ6 - RJ7)	16,00%	0,58	0,77	0,58	256	15,2	30	0,11	0,5	30	0,01
M1.K19.C4 (RJ7 - RJ10)	14,30%	0,7	0,66	0,69	256	29,3	90,7	0,18	0,7	30	0,01
M1.K19.C5 (RJ10 - PRJ13)	12,60%	0,69	0,46	0,69	256	40,1	47,12	0,21	0,8	0	0,01
M1.K19.C6 (PRJ13 - RJ14)	10,40%	0,69	0,26	0,69	256	66,7	19,95	0	0	30	0,01
M1.K19.C7 (RJ14 - PRJ15)	10,60%	0,65	0,25	0,64	256	54,1	27,92	0	0	30	0,01
M1.K19.C8 (PRJ15 - RJ16)	10,10%	0,73	0,25	0,73	256	78,4	32,18	0	0	30	0,01
M1.K19.C9 (RJ16 - RJ18)	10,50%	0,65	0,25	0,64	256	55,4	61,43	0,25	1,4	30	0,01
K20 - 'R6.S3.1'											
M1.K20.C1 (RJ2 - RJ1)	15,40%	0,54	0,64	0,53	256	14,4	30,46	0,09	0,3	0	0,01
M1.K20.C2 (RJ1 - RJ2)	14,80%	0,54	0,57	0,53	256	15,6	31,43	0,12	0,6	30	0,01
M1.K20.C3 (RJ2 - RJ3)	12,50%	0,67	0,43	0,67	256	38,4	30,19	0	0	30	0,01
M1.K20.C4 (RJ3 - RJ4)	12,10%	0,76	0,44	0,72	256	52,5	24,59	0	0	90	0,01
M1.K20.C5 (RJ4 - RJ5)	11,90%	0,79	0,44	0,78	256	60,2	13,93	0	0	60	0,01
M1.K20.C6 (RJ5 - RJ6)	9,60%	0,47	0,14	0,46	256	37	24,94	0	0	30	0,01
M1.K20.C7 (RJ6 - RJ8)	10,90%	0,32	0,14	0,32	256	12,3	36,73	0,14	0,8	30	0,01
K21 - 'R6.S3.1.1'											
M1.K21.C1 (RJ5 - PRJ1)	10,90%	0,71	0,31	0,69	256	59,6	26,83	0,18	1,2	30	0,01
M1.K21.C2 (PRJ1 - PRJ2)	8,50%	0,53	0,11	0,53	256	64,6	32,37	0,11	0,6	0	0,01
K23 - 'R6.S3.1.3'											
M1.K23.C1 (RJ8 - RJ4)	11,80%	0,29	0,16	0,28	256	8	88,62	0,15	0	0	0,01
K25 - 'R6.S4'											
M1.K25.C1 (ob.PRJ332 - RJ5)	19,60%	0,69	1,63	0,68	256	12,7	85,53	0,13	0,5	60	0,01
M1.K25.C2 (RJ5 - RJ6)	16,80%	1,01	1,53	0,99	256	40,3	31,48	0,11	0,3	60	0,01
M1.K25.C3 (RJ6 - RJ7)	17,80%	0,78	1,39	0,77	256	20,8	44,62	0,79	1.0	30	0,01
M1.K25.C4 (RJ7 - RJ9)	16,50%	0,41	0,59	0,41	256	7	59,02	0	0	0	0,01
M1.K25.C5 (RJ9 - RJ14)	16,10%	0,44	0,59	0,45	256	8,9	121,37	0,59	2,7	0	0,01
K26 - 'R6.S4.1'											
M1.K26.C1 (ČRP5 - RJ8)	12,90%	0,36	0,25	0,36	256	10	146,73	0,25	1,4	30	0,01
K28 - 'R7'											
M1.K28.C1 (RJ6 - RJ2)	21,30%	0,62	1,85	0,62	256	8,4	35,54	0	0	30	0,01
M1.K28.C2 (RJ2 - RJ9)	19,50%	0,79	1,82	0,78	256	16,7	184,26	0,35	3,4	0	0,01

Oznaka	Polnitev [%]	Max. V [m/s]	Max Q [l/s]	Min. V [m/s]	Notranji fi [mm]	i [o/oo]	L [m]	$Q_{sušni}$ [l/s]	A [ha]	T [s]	Ng
M1.K28.C3 (RJ9 - RJ13)	17,90%	0,81	1,48	0,81	256	22,3	117,19	0,2	1,3	30	0,01
M1.K28.C4 (RJ13 - RJ14)	16,00%	0,98	1,29	0,96	256	42,8	29,21	0	0	30	0,01
M1.K28.C5 (RJ14 - PRJ15)	15,40%	1,08	1,27	1,08	256	59	29,82	0	0	0	0,01
M1.K28.C6 (PRJ15 - PRJ16)	15,90%	0,99	1,27	0,97	256	43,6	54,3	0	0	0	0,01
M1.K28.C7 (PRJ16 - RJ19)	14,50%	0,93	0,92	0,93	256	50,8	62,21	0,16	0,8	0	0,01
M1.K28.C8 (RJ19 - PRJ20)	13,30%	1,03	0,79	1,02	256	77,1	14	0	0	30	0,01
M1.K28.C9 (PRJ20 - PRJ21)	12,70%	1,17	0,78	1,14	256	110,9	34,9	0	0	60	0,01
M1.K28.C10 (PRJ21 - PRJ22)	13,30%	1,03	0,79	1,02	256	77,2	32,26	0	0	30	0,01
M1.K28.C11 (PRJ22 - RJ24)	11,30%	0,68	0,32	0,67	256	50	58,36	0	0	30	0,01
M1.K28.C12 (RJ24 - RJ25)	10,50%	0,8	0,31	0,8	256	84,5	31,47	0	0	30	0,01
M1.K28.C13 (RJ25 - RJ26)	10,90%	0,76	0,33	0,74	256	69,4	28,39	0	0	30	0,01
M1.K28.C14 (RJ26 - RJ27)	11,80%	0,57	0,3	0,56	256	30,8	28,58	0,3	1,2	0	0,01
K29 - 'R7.S3'											
M1.K29.C1 (PRJ22 - PRJ1)	11,30%	0,96	0,46	0,95	256	99,8	43,17	0	0	30	0,01
M1.K29.C2 (PRJ1 - PRJ2)	11,20%	0,97	0,45	0,98	256	110,6	10,4	0	0	0	0,01
M1.K29.C3 (PRJ2 - PRJ3)	10,90%	1,06	0,45	1,05	256	136,9	18,18	0,45	1,6	30	0,01
K30 - 'R7.S2'											
M1.K30.C1 (PRJ16 - RJ2)	15,10%	0,31	0,35	0,31	256	5,2	61,52	0	0	0	0,01
M1.K30.C2 (RJ2 - PRJ3)	11,70%	0,67	0,35	0,66	256	44,6	28,5	0	0	30	0,01
M1.K30.C3 (PRJ3 - RJ4)	11,00%	0,8	0,35	0,79	256	74,8	24,2	0,35	1,8	0	0,01

5. STATIČNI IZRAČUN CEVI

Statični izračun smo izvedli za GRP cevi SN10.000 z upoštevanjem minimalne, ter maximalne globine prekritja. Glede na prometno obremenitev smo upoštevali prometno obtežbo G=26 ali 36 ton. Statični izračun je v poglavju T/4.

6. TEHNIČNA IZVEDBA

6.1 Pričetek gradnje

Pred pričetkom gradnje je potrebno zavarovati gradbišče z ustreznimi zaščitnimi ograjami, signalizacijo in ostalim, kot je navedeno v predpisih o varstvu pri gradbenem delu.

Sočasno z zakoličbo projektiranega kanala je obvezno zakoličiti trase ostalih komunalnih vodov, ki tangirajo traso projektiranih kanalov. Zakoličbo je potrebno izvajati v prisotnosti upravljavcev posameznih komunalnih vodov in upravljavca ceste. O zakoličbi je potrebno voditi zapisnik. Vanj navesti tudi ime odgovorne osebe, ki bo vršila nadzor varovanja komunalnih naprav.

Pred pričetkom je potrebno na objektih, ki so relativno blizu izkopov in večjih transportnih poti vgraditi reperje, med gradnjo je potrebno spremljati posedke.

Pred pričetkom del je potrebno območje gradbišča in neposredno bližino izkopov pregledati, ter zapisniško in s TV kamero ugotoviti in dokumentirati obstoječe stanje okolice objekta in cestnih površin, ki jih bo uporabljal v času gradnje in dokumentacijo hraniti najmanj do konca garancijskega obdobja.

Pred začetkom dela na gradbišču je potrebno izdelati varnostni načrt skladno z zakonodajo.

6.2 Izkopi

Na podlagi geomehanskega poročila, ogleda terena, ter izkušenj pri gradnji z okoliškimi objekti predvidevamo, da se bo izkop izvajal v III., IV.in V. kategoriji.

V primeru, da se pri izkopu naleti na slabo nosilna tla in brežine izkopa, je potrebno kontaktirati geomehanika in projektanta, da podata mnenje o načinu nadaljevanja del.

Strojni izkop bo možno izvajati na celotni trasi kanala.

Na mestih, kjer nastopa humus, je potrebno humus odstraniti z odrivom do 10.0 m od roba izkopa. Ne sme priti do mešanja z ostalim zemeljskim materialom.

Predvidena globina izkopa ne bo omogočala širokega izkopa. Širok odkop z naklonom izkopnih brežin do 60° bo možne za kanale do globine 2 m. Globlje izkope bo potrebno varovati ali izvajati vmesne berme za zagotavljanje začasne stabilnosti izkopnih brežin. Po vgradnji kanalizacije naj se takoj prične z zasipavanjem, da bodo izkopne brežine čim manj časa izpostavljene atmosferskim vplivom in s tem nevarnosti rušenja.

Na območju, kjer so izkopi globoki, je izkop zaščiten z Box opažem (tehnologija SBH ali Krings), ki ne sme vplivati na vgrajevanje cevi ob izvlačenju opaža. Box opaž se izvaja vzporedno z kopanjem jarka. Sestavljen je iz jeklenih panelov z vodili za razpore in z razporami. Opaž se nastavi ter se prične z izkopavanjem med stranicama opaža, opaž se z lopato rovokopača vtiska v že izkopano jamo. Opaža se ne zabija temveč se ga vtiska v izkopano jamo. Vtiska se po segmentih globine 1m. Ob izvlačenju opaža sproti zasipavamo gradbeno jamo in utrjujemo zasip.

V kolikor zaradi narave izkopa ne bo mogoče izvesti z Box opaži, se izvede zaščita jarka z jeklenimi zagatnicami tipa Larsen.

Odvečni material je potrebno sproti odvažati na začasno gradbeno deponijo.

6.3 Izbira materiala cevi

Predviden material cevi gravitacijske kanalizacije je armirani poliester (GRP), osnovna togost je SN 10000 N/m2, SIST EN 14364, razen pri ceveh, kjer je nasutje večje kot 4,5 m je predvidena nazivna togost SN 15000 n/m2, nazivni tlak je PN 1 bar. Cevi imajo na eni strani mufo iz poliestra z EPDM tesnilom. Notranji zaščitni sloj cevi iz čistega poliestra, brez polnila in ojačitve, mora imeti minimalno debelino 1,0 mm s ciljem doseganja tesnosti, kemijske in abrazijske obstojnosti in odpornosti na obrus pri visokotlačnem čiščenju. Kanalizacijske cevi morajo ustrezati zahtevam DIN 19523 in omogočati čiščenje z visokim pritiskom od 60 barov do maksimalno 100 barov.

Vgradnja cevi se izvaja po navodilih proizvajalca cevi. Pred uporabo mora biti vodotesnost javne kanalizacije preverjena v skladu s standardiziranimi postopki.

6.4 Tlačni preizkus

Standard po katerem se izvaja preizkus vodotesnosti gravitacijske kanalizacije je EN 1610. Preizkus nepropustnosti cevi in (menhole-vstopna odprtina v kanal) vstopnih odprtin v kanal in pregled jaškov je lahko opravljen z zrakom (postopek “L”) ali z vodo (postopek “W”). Postopek tlačnega preizkusa je lahko tudi točen, tako, da se del oz. deli kanalizacije preverijo z vodo, del pa z zrakom. V primeru tlačnega preizkusa z vodo, je število popravkov ponovnih tlačnih preizkusov neomejeno. V primeru negativnega končnega preizkusa z metodo tlačnega preizkusa z zrakom, je dovoljen ponoven preizkus z vodo, katerega rezultat je odločilen neglede na tlačni preizkus z zrakom. Če je v primeru preizkusa v kanalu prisotna podtalnica, lahko ima le ta vpliv na rezultate testa. Začetno testiranje se lahko prične pred zasipom kanala.

Za končne teste tlačnega preizkusa, mora biti kanal zasut (kanal mora biti razopažen). V primeru različnih metod (voda-zrak), se lahko pojavijo specifične zahteve.

6.5 Revizijski jaški

Revizijski jaški so iz poliestra ∅ 1000 mm, z minimalno debelino stene 9mm, prekriti z reducirnim kosom DN 1000/800mm na katerega se položi AB venec s pokrovom. Temelj jaška je betoniran na mestu z betonom C16/20, debelina plošče je 20 cm. Na temelj se postavi jašek iz poliestra, okrog jaška se izvede AB venec iz C16/20. Dno je izoblikovano iz poliestra, v obliki koritnice, ki usmerja odtok odpadne vode.

Pokrov jaška iz LTŽ ∅ 600 mm; EN 124 D 400, z ventilacijskimi odprtinami, protihrupnim vložkom in zaklepom je vgrajen v armiranobetonski venec. Pokrov jaška na voznih površinah ne sme biti temeljen na obodno steno jaška, ampak na utrjeno gramozno nasutje ob jašku.

Razred nosilnosti pokrovov je odvisen od lokacije jaška. V spodnji tabeli smo podrobno razdelali razrede nosilnosti v odvisnosti od lokacije jaška.

Lokacija	Razred nosilnosti	Nosilnost [kN]
Prometne površine, ki jih lahko uporabljajo izključno pešci in kolesarji, ter podobne površine, na primer zelenice.	A	15
Pločniki, peš cone (vožnja po njih le zaradi oskrbe ali v nujnih primerih) in podobne površine, parkirišča za osebna vozila.	B	125
Velja le za nastavke in pokrove za področje robnih žlebov, ki seže od robnika maksimalno 0,5 m na vozišče in 0,2 m na pločnik, ter za stranske pasove ceste	C	250
Vozišča cest (tudi peš cone, na katerem je promet z vozili ob določenem času prepovedan (npr. ob koncu delovnega časa, drugače normalen promet z vozili))	D	400

Vsi revizijski pokrovi morajo biti opremljeni s protihrupnim vložkom, na zaklep in z ventilacijskimi odprtinami. Na površinah zelenic se pokrovi jaškov dvignejo za 10 cm nad koto terena.

6.6 Vgrajevanje cevi

6.6.1 Dno jarka

Dno jarka mora biti izvedeno v zahtevanem padcu. Izogibati se je treba rahljanju zemlje v jarku. V primeru, da je zemljina zrahljana zaradi slabo opravljenega dela, je treba dodati in enakomerno utrditi primeren material. Narediti je potrebno tudi poglobitve na območju spojk.

6.6.2 Posteljica

Pri vgradnji posteljice je treba upoštevati sledeče zahteve:

- Pri vgradnji posteljice je treba upoštevati sledeče zahteve:
- naj ne vsebuje kamnitih delov, katerih zrna večja od 32 mm - v nekaterih primerih je za cevi manjšega premera priporočljivo, da so zrna še manjša
- naj bo dobro stisljiv, nekoheziven in naj zadovoljivo prenaša obtežbe
- če je zbit na 95% po standardnem Proctorjevem postopku, mora doseči minimalno nosilnost 4N/mm2.

V vodonosnih zemljinah ne sme biti finih delcev (do DN 400 - velikost zrna 8 - 16 mm, nad DN 500 - velikost zrna 16 - 32 mm).

Debelina posteljice po utrjevanju mora biti vsaj 10 cm + 0,1 x DN. Da bi dosegli zahtevani nosilni kot, najmanj 90° do 120°, je potrebno podlago zbiti (npr. z ročnim ali manjšim pnevmatičnim nabijačem). Cev mora po vsej dolžini ležati na podlagi, razen na mestih poglobitev za spojke. Pri mokrem izkopu (talna voda) je predvideno polaganje cevi na AB posteljico debeline 10 cm in sidranje cevi z poliesterskimi trakovi na posteljico, zaradi dejstva, da talna voda lahko dvigne cevi. V primeru, da se bo zasip jarka v katerega bo položena kanalizacijska cev, izvajal sproti in jarek ne bo odprt dalj časa, se ukrep sidranja cevi na AB posteljico lahko opusti.

Če pri izkopu dna jarka naletimo na slabo nosilna tla, je potrebno obvezno pridobiti mnenje geomehanika.

6.6.3 Montaža cevi

Glede na pogoje, lahko cevi do DN 500 polagamo v jarek ročno. Po potrebi uporabimo opremo za dvigovanje; priporočamo uporabo dvižnih zank. Pritrjevanja kljuk ali verig ne priporočamo, ker lahko poškodujejo konce cevi.

6.6.4 Spajanje cevi

Vse dele cevi - notranje in zunanje površine - je treba preveriti in očistiti preden jih spojimo. Utori spojk ne smejo biti onesnaženi. Na konce cevi nanesemo mazivo. Uporabljajte samo priloženo mazivo. Glede na velikost cevi je več načinov spajanja cevi:

- z rovokopačem:
- z vzvodom (drogom):
- z inštalacijskim pripomočkom

Glede na premer cevi, spojni sistem cevi omogoča naklone pod sledečimi koti:

do DN 500	α_{max}= 3°
od DN 600 do DN 900	α_{max}= 2°
od DN 1000 do DN 1400	α_{max}= 1°
DN 1600 in več	α_{max}= 0,5°

Na začetku, ko cevi spojimo, morata njuni osi sovpadati, šele nato lahko cevi ukrivimo. Glede na notranji pritisk in kotni odklon lahko dodamo betonske podpornike, ki blokirajo hidravlične sile.

6.6.5 Montaža s koleni

Kolena se spajajo na podoben način kot cevi (npr. z napenjalcem). V primeru, da montiramo koleno z topim kotom in uporabljamo rovokopač, je možno, da bo za pravilno usmerjanje sile, ki je potrebna za proces spajanja, potrebna primerna pomožna oprema.

Na mestih kjer so kolena, odcepi, reducirni kosi ali podobni elementi nastajajo hidravlične sile; količina hidravličnih sil je odvisna od oblike in tlakov v cevi. Te sile mora prevzeti zemljina preko betonskih podpornikov ali primernega utrjevanja zasipnega materiala.

6.6.6 Montaža cevi, rezanih na dolžino na lokaciji

Za rezanje cevi na želeno dolžino lahko uporabimo rezalko za kamen. Ko na odrezani strani cevi posnamemo oster rob, že lahko namestimo spojko tako, da enostavno namažemo s priloženim mazivom. Dodatna obdelava (struženje, ipd.) ni potrebna.

6.6.7 Obsip cevi

Cev mora biti zasuta v plasteh po največ 30 cm z zemljino, ki je primerna za zasip. Vsako plast je potrebno utrjevati istočasno na obeh straneh cevi, da se prepreči njeno premikanje. Za utrjevanje priporočamo uporabo lahkih vibracijskih nabijačev (maksimalna delovna teža 0,30kN) ali lahkih vibracijskih plošč (maksimalna delovna teža 1kN).

Pri materialu za zasip je treba upoštevati sledeče zahteve:

- naj ne vsebuje kamnitih delov, katerih zrna večja od 32 mm - v nekaterih primerih je za cevi manjšega premera priporočljivo, da so zrna še manjša
- naj bo dobro stisljiv, nekoheziven in naj zadovoljivo prenaša obtežbe
- če je zbit na 95% po standardnem Proctorjevem postopku, mora doseči minimalno nosilnost 4N/mm2.

6.6.8 Zasip jarka

Jarek zasipamo po plasteh in pazimo na primerno debelino plasti. Prepričati se moramo, da so cevi primerno zavarovane in da smo jih dobro utrdili. Do višine 0,3 do 1,0 m nad temenom cevi lahko material utrjujemo z srednjim vibracijskim nabijačem (največja delovna teža 0,6 kN) ali vibracijskimi ploščami (največja delovna teža 5 kN). Težja orodja za utrjevanje laho uporabimo nad 1,0 m nad temenom cevi. Vgraditi je treba tudi signalni trak.

V fazi gradnje se je potrebno izogibati prehodom težkega tovora (npr. težka mehanizacija ali vozila).

Nad zasipom 30 cm nad temenom cevi lahko uporabimo nekoherenten material iz izkopa. Če izkopani material ne ustreza, ga moramo pripeljati.

Če se v jarku pojavi talna voda, jo moramo črpati, dokler cevi niso montirane in zasute do take višine, da preprečimo dvig cevi zaradi vzgona.

Na mestih, kjer je zunanja obtežba večja od dopustne obtežbe podane v navodilih proizvajalca cevi in kjer ni dovolj nadkritja nad temenom cevi, je potrebno cevi obbetonirati.

Priporočamo, da cevi montiramo in zasipavamo sproti in ne puščamo daljših odsekov cevovoda nezasutih. S tem se izognemo neprilikam pri močnejših nenadnih padavinah in morebitnih mehanskim poškodbam cevovoda

6.7 Zaključek gradnje

Po zaključku del mora izvajalec vse poškodovane površine, ki so se med gradnjo poškodovale, povrniti v stanje pred posegom.

Po zaključku del mora izvajalec izdelati vso potrebno dokumentacijo za izvedbo tehničnega pregleda skladno z veljavno zakonodajo in dokumentacijo za predajo objekta naročniku, ki mora biti usklajena z zahtevami upravljavca kanalizacijskega sistema in objektov.

7. KRIŽANJA Z OSTALIMI KOMUNALNIMI VODI

Pred pričetkom gradnje morajo vsi upravljavci komunalnih vodov na predmetnem območju označiti trase obstoječih in predvidenih komunalnih vodov.

Trasa projektiranega meteornega kanala upošteva potek obstoječih in predvidenih komunalnih vodov.

Potek kanalizacije poteka horizontalno brez vertikalnih lomov in poteka pod drugimi komunalnimi vodi ter ima pred ostalimi vodi prednost, saj mora zagotavljati padec.

Opis križanj fekalne kanalizacije z ostalimi komunalnimi vodi:

- električni kabel, telekomunikacijski kabel, kabel javne razsvetljave:

v primeru poteka kanalizacijske cevi pod ali nad vodom, morajo biti komunalni vodi zaščiteni z zaščitno cevjo. Horizontalni odmik od obstoječih in predvidenih podzemnih napeljav naj ne bo manjši od 0,4 m

- plinovod:

v primeru poteka kanalizacijske cevi pod ali nad obstoječim oziroma projektiranim plinovodom, mora biti plinovod zaščiten z zaščitno cevjo. Horizontalni odmik od obstoječih in predvidenih podzemnih napeljav naj ne bo manjši od 0,4 m

- vodovod:
  a) v primeru poteka vodovodne cevi pod kanalizacijo, morajo biti izpolnjene naslednje zahteve:

     - vodovod mora biti vgrajen v zaščitni cevi,

     - ustji zaščitne cevi morata biti odmaknjeni od zunanje stene cevi kanalizacije, najmanj 3 m na vsako stran,

     - v primeru možnosti kontrole drenirane vode sta ustji zaščitne cevi lahko odmaknjeni od zunanje stene cevi kanalizacije, 0,8 m na vsako stran,

     - v izjemnih primerih je kanalizacija lahko zaščitena tudi drugače (PVC folija, glinen naboj), po dogovoru z upravljalcem,

     - vertikalni odmik je najmanj 0,6 m

  b) vodovod nad kanalizacijo, na območju vodoprepustnega zemljišča, morajo biti izpolnjene naslednje zahteve:

     - vodovod mora biti vgrajen v zaščitni cevi,

     - ustji zaščitne cevi morata biti odmaknjeni od zunanje stene kanalizacije, najmanj 3 m na vsako stran,

     - vertikalni odmik je najmanj 0,6 m;

  c) vodovod nad kanalizacijo, na območju vodoneprepustnega zemljišča:

     - vodovod mora biti vgrajen v zaščitni cevi (posteljici in zasipa obeh vodov niso neprepustni, zato se v primeru puščanja kanalizacije odpadna voda lahko dvigne v območje vodovoda),

     - v tem primeru vodovoda ni treba obvezno vgraditi v zaščitno cev,

     - vertikalni odmik je najmanj 0,6 m.

V primeru, da predpisanih odmikov ni mogoče doseči, se je pred vgradnjo potrebno posvetovati z upravljavci komunalnih vodov

V času gradnje je potrebno pri vseh morebitnih komunalnih vodih, ki niso vrisani v kataster in zato v projektu niso upoštevani opozoriti upravljavce le-teh, da sodelujejo pri izkopu na mestih prečkanj.

Pri ugotovljenih odstopanjih poteka obstoječih komunalnih vodov od vrisanega v načrte, ki bi ovirali gradnjo projektiranih cevovodov, se je potrebno pred montažo cevovoda posvetovati s projektantom.

8. IZVAJANJE GRADNJE IN TEHNIČNA IZVEDBA OBJEKTOV

8.1 Splošna določila

Vsa zemeljska dela se izvajajo po načrtih in detajlih, določilih tehničnih predpisov in skladno z obveznimi standardi.

Pri delih na prometnih površinah mora biti izvajanje del v skladu s cestno-prometnimi predpisi in izdanimi soglasji.

Pred začetkom del je izvajalec dolžan popolnoma očistiti teren, odstraniti rastline in objekte ter ves material transportirati na deponijo.

Na tako očiščenem terenu, izvajalec skupaj s predstavniki investitorja posname vse višinske kote terena, zakoliči in zavaruje celotno traso cevovoda oziroma objekte, ki se gradijo. Vse kote in ostale podatke vpiše v gradbeno knjigo zaradi točnega obračuna zemeljskih del. Potrebno razpiranje oziroma črpanje meteorne ali podtalne vode pri izkopih jarkov ali za objekte, je izvajalec del dolžan izvršiti na lastne stroške.

Pri vseh izkopih mora izvajalec del paziti, da poškoduje čim manj obdelovalnih površin in objektov, ker gre vsaka škoda, nastala iz naslova nestrokovnega in nesolidnega dela, ter po njegovi krivdi, na stroške izvajalca del.

Vsa zemeljska dela morajo biti izvršena pravilno in upoštevaje vse kote in detajle iz načrtov.

Predno se dela nadaljujejo, morajo biti vsa zemeljska dela sprejeta in potrjena s strani nadzornega organa ter zaradi obračuna, vpisana v gradbeno knjigo. Obračun vseh zemeljskih del se izvrši po dejansko izvršeni količini.

8.2 Izkopi

Vsi izkopi za objekte oziroma izkopi jarkov za polaganje cevovodov ali izkopi temeljev objekta morajo biti izvršeni pravilno po kotah in detajlih iz načrtov ter predpisanih padcev.

Izkopi pri objektih se vršijo po zunanjih merah temeljev in zidov, upoštevanje dodatno razširitev za 60 cm z vsake strani in naklon v odvisnosti od kategorije zemljišča ter načrta eventualnega razpiranja. Odstranitev vsipov in njihovega kasnejšega zasipavanja gre v breme izvajalca del.

Obračuni izkopov se vršijo 1 m3 izkopanega materiala v raščenem stanju ne glede na kategorijo zemljišča.

8.2.1 Planiranje terena in jarkov

Planiranje terena okoli objekta, kakor tudi dna jarkov za cevovode ali temeljev objekta, mora biti izvršeno do zahtevane točnosti po popisu del.

Planiranje in čiščenje terena po končani gradnji, zasipanje jam na gradbišču po odstranitvi vsega preostalega materiala, kakor tudi izkopa začasnih jam, se obračuna v zaključnih delih.

Obračun se vrši po 1 m2 planirane površine

8.2.2 Peščena posteljica, zasipi jarkov in zasipi ob objektih

Peščena posteljica, kakor vsi zasipi jarkov za polaganje cevovoda in zasipi ob objektih, morajo biti izvršeni z materialom in na način, kakor to predvidevajo načrti oziroma opis del.

Pri zasipanju jarkov za cevovode je obvezno potrebno uporabiti nevezan material iz izkopa, če je primeren (za prvi sloj debeline cca 20 - 30 cm nad temenom cevi, frakcije 0,02 do 16 mm).

V nasprotnem primeru je potrebno zagotoviti ustrezen material za nasip, kot je upoštevano v predmetnem projektu.

Omenjeni prvi sloj zasipa nad cevovodi sme biti komprimiran le ročno.

Preostali zasipi jarkov in zasipi ob objektih se lahko izvršijo z materialom iz izkopa in s strojnim komprimiranjem v slojih, kakor to predvidevajo načrti oziroma popis del.

Izbor materiala in način izvajanja zasipa jarkov za cevovode pod prometnimi površinami, se določi po predhodnem dogovoru z nadzornim organom in v soglasju z naročnikom.

Izračun se vrši po 1 m3 opravljenega zasipa.

8.2.3 Odvoz zemlje in preostalega materiala

Ves izkopani material se transportira na začasno deponijo, ki jo določi nadzorni organ. Tu se vrši izbor materiala za naknadno uporabo oziroma za odvoz na stalno deponijo.

Na posebno zahtevo naročnika je izvajalec del dolžan izvršiti ločitev izkopanega materiala po kategorijah.

Izračun se vrši po 1 m3 transportiranega materiala z upoštevanjem nakladanja, razkladanja in razprostiranja materiala po deponiji.

8.2.4 Cene za enoto

Cene za enoto zemeljskih del vsebujejo:

- ves porabljeni material
- vse potrebno delo
- vse transporte
- najemnino za vso potrebno mehanizacijo
- najemnino ali stroške izdelave, nameščanja in odstranjevanja vseh pomožnih odrov, platojev in opiranja za izkope v večjih globinah.

Vsa zemeljska dela, v kolikor ni drugače odločeno, se obračunavajo v raščenem stanju z upoštevanjem koeficienta razrahljivosti pri ceni za enoto.

Voziščna konstrukcija

8.3 Betonska dela

8.3.1 Splošna določila

Vsa betonska in armiranobetonska dela se izvajajo v skladu z načrti, opisi del, statičnimi izračuni ter tehničnimi predpisi in standardi.

Kvaliteta vgrajenega betona mora odgovarjati zahtevam opisa del, tehničnim predpisom in standardom glede čistoče agregata, granulacije, količine in kvalitete cementa in vode.

Cement, uporabljen za vsa dela, mora biti svež, pravilno skladiščen in zaščiten pred vodo in vlago, v skladu z navodili in predpisi za beton in armirani beton.

Agregat za pripravo betona naj bo po možnosti rečnega porekla, brez gline in mulja, zrnavosti po predpisih za predvideno marko betona.

Armatura mora biti dobro očiščena rje, blata in apna, krivljena in dimenzionirana po detajlih. Glede kvalitete mora odgovarjati veljavnim tehničnim predpisom.

Vse betonske in armiranobetonske konstrukcije morajo biti betonirane z marko betona predvideno v statičnem izračunu. V primeru, da v kakšni predračunski postavki ali statičnem izračunu MB ni določena, se izvaja z C25/30 za armirani beton oz. C8/10 za nearmirani beton.

Vgrajevanje betona v konstrukcije se mora izvajati po navodilih statika in zahtevah iz opisa del, ter v skladu s tehničnimi predpisi. Beton se vgrajuje strojno do potrebne zbitosti, tako da izpolni ves prostor med armaturo in opažem ter povsem obloži vso armaturo.

Vgrajevanje betona ni dovoljeno, dokler nadzorni organ ne pregleda vse položene armature. Pri prekinitvah betoniranja je mesta, kjer se betoniranje prekine, potrebno določiti že vnaprej. Za nadaljevanje del je stično ploskev potrebno očistiti rahlega betona, cementne kaše in prahu ter stik dobro namočiti in ga prepojiti s tanjšo plastjo mastne mešanice betona drobnejše zrnatosti.

Pri zahtevnih konstrukcijah statik določi vrstni red in način opaženja oziroma razopaženja ter mesta, kjer je betoniranje dovoljeno prekiniti.

Med betoniranjem je izvajalec dolžan vgraditi vse ostale elemente kot so podložke, čepi, škatle za prehode instalacij, kljuke potrebne za poznejšo pritrditev drugih montažnih elementov in instalacij.

V času med in po končanem betoniranju je izvajalec dolžan v skladu z začasnimi predpisi za beton in armirani beton, beton negovati in zaščititi pred vplivom nizkih oziroma visokih temperatur. Vse armiranobetonske konstrukcije, ki ostanejo vidne, se morajo v slučaju poškodbe zakrpati in zgladiti.

Obračun betonskih in armirano betonskih del se vrši za 1 m3 vgrajenega betona, obračun armature pa za 1 kg položene armature, če se obračunava posebej.

8.3.2 Pod in obbetoniranje krivin cevi

Podložni beton je treba vgraditi točno po predvidenem padcu. Pred polaganjem cevi se mora beton popolnoma strditi.

Obložni beton je treba vgraditi po polaganju in montaži cevi, tako da se popolnoma prilega cevi, podložnemu betonu in raščenemu terenu ob straneh jarka.

V posebnih primerih (sipek material, itd…) lahko izvajalec z dovoljenjem nadzornega organa izdela podlogo s pomočjo stranskega opaža. V tem primeru mora vgrajevati armirani beton boljše marke po določilih statika.

Obračun se izdela za 1 m3 vgrajenega betona.

8.3.3 Beton in armiran beton za objekte

Vgrajuje se beton in armirani beton posameznih konstruktivnih elementov objektov po načrtih, opisu del, predpisih za beton in armirani beton ter upoštevanju ustreznih standardov, kot je že opisano v splošnih določilih za betonska dela.

Obračunava se 1 m3 vgrajenega betona

8.3.4 Cene na enoto

Cene za enoto betonskih in armiranobetonskih del vsebujejo:

- ves potreben material, vključno z armaturo
- vse delo potrebno za izdelavo in vgrajevanje betona ter polaganje armature
- vse potrebne transporte
- zaščito in nego betona
- se pomožne delovne odre z dohodi, potrebne za delo pri betoniranju
- pri montažnih armiranobetonskih konstrukcijah cene vsebujejo tudi montažo

Obračun vseh betonskih in armiranobetonskih del se vrši za 1 m3 vgrajenega betona.

8.4 Tesarska dela

8.4.1 Splošna določila

Ves material, ki se uporablja za izdelavo opažev, mora biti pripravljen v odgovarjajočih merah in po kvaliteti odgovarjati ustreznim tehničnim predpisom za lesene konstrukcije in ustreznim standardom.

Opaži morajo biti izdelani točno po merah v načrtih in v vseh detajlih, z vsemi potrebnimi podporami, horizontalno in vertikalno povezavo, tako da so stabilni in sposobni prevzeti težo vgrajenega betona. Stične površine morajo biti čiste in ravne.

Opaži morajo biti izvedeni tako, da se razopaženje lahko opravi brez pretresov in poškodovanja armiranobetonskih konstrukcij oziroma opažev samih.

Obračun se vrši za napravo, postavitev in odstranitev 1 m2 opaža.

8.4.2 Opaži in odri

Vsi opaži armiranobetonskih konstrukcij (temelji, stene, nosilci, stebri, plošče ipd…), kakor tudi vsi pomični in nepomični delovni in podporni odri, se izdelujejo po načrtih in predpisih del ter v skladu z vsemi pogoji splošnih določil.

8.4.3 Cena na enoto

Cene za enoto tesarskih del vsebujejo:

- ves potreben material
- vse potrebno delo in prenose
- vse pomožne odre, v kolikor niso predvideni v predračunu

Obračun se vrši za 1 m2 izdelanega opaža, upoštevajoč notranje površine opažev, to je vidne površine konstrukcij.

8.5 Zidarska dela

8.5.1 Splošna določila

Ves material potreben za zidanje, ometavanje in ostala zidarska dela, mora biti kvaliteten in mora odgovarjati tehničnim predpisom in ustreznim standardom.

Zidanje mora biti izvršeno po načrtih in statičnem izračunu. Delo mora biti izvršeno čisto, s pravilno vezavo opeke in dobro zalitimi stiki z malto. Vrste opeke morajo biti popolnoma ravne, vse zidane površine pa popolnoma vertikalne.

Vse ometane površine morajo biti popolnoma ravne in enakomerno obdelane.

Vsa dela za izvedbo hidroizolacij, toplotnih in zvočnih izolacij, vzidav in zazidav ter ostala zidarska dela morajo biti izvršena strokovno na način, ki je predpisan v posamezni postavki del.

Obračun se vrši za mersko enoto po posamezni postavki iz predračuna.

8.5.2 Cena na enoto

Cene za enoto tesarskih del vsebujejo:

- ves potreben material
- vse potrebno delo in prenose
- vse pomožne odre, v kolikor niso predvideni v predračunu

Obračun se vrši za 1 m2 izdelanega opaža, upoštevajoč notranje površine opažev, to je vidne površine konstrukcij.

8.5.3 Cevi in stiki

Vsa dela pri montaži cevovodov je treba izvršiti točno po popisu del oziroma po navodilih proizvajalca cevi. Cevi se polaga na peščeno posteljico. V primeru slabe nosilnosti tal je potrebno izdelati poseben statični izračun. Pri jeklenih ceveh je potrebno vse zvare testirati na priznan način

8.6 Zaključna dela

Po končani gradnji kanalizacije je potrebno vse kanale in jaške očistiti gradbenih odpadkov in nečistoč. Kanalske cevi je potrebno oprati in opraviti test vodotesnosti skladno s SIST EN 1610. Po končanih testiranjih je potrebno opraviti pregled s TV kamero in posnetek predati investitorju. Pred predajo kanalizacijskega sistema upravljalcu, je potrebno geodetsko posneti vsa izvedena dela. Geodetski posnetek mora biti geolociran v državnem koordinatnem sistemu, na njem se morajo jasno videti vsi elementi kanalizacijskega sistema (višina dna jaška, kota vtoka, kota iztoka) in vsa izvedena dela. Geodetski posnetek mora biti predan investitorju v pisni in digitalni obliki.

T/3 PROJEKTANTSKI POPIS DEL

Popis del je priložen v ELABORATU POPISA DEL.

T/4 KOORDINATE ZAKOLIČBENIH TOČK

Zakoličbene točke kanalizacije

Ime	X	Y
R2(1)		
ČRP1	445366,3614	77210,3358
RJ2	445358,9149	77209,3861
PRJ3	445362,7038	77180,2606
PRJ4	445364,2198	77150,802
RJ5	445363,2877	77104,3831
RJ6	445362,7811	77064,6188
RJ7	445361,8661	77024,4619
RJ8	445361,3007	76984,4527
RJ9	445360,7816	76944,4109
RJ10	445360,486	76904,5464
RJ11	445359,8174	76864,3138
RJ12	445361,6912	76851,4998
RJ13	445368,5767	76835,8604
RJ14	445376,5618	76823,2545
RJ15	445391,5236	76808,3613
RJ16	445416,8281	76785,2861
RJ17	445445,9808	76757,6993
RJ18	445455,2616	76746,8761
RJ19	445464,1062	76730,7654
RJ20	445468,5743	76716,1307
RJ21	445476,3527	76681,4535
RJ22	445483,8386	76641,6945
RJ23	445490,107	76620,1997
RJ24	445498,2619	76605,4815
RJ25	445511,0325	76588,6244
RJ26	445532,6028	76564,5658
RJ27	445558,5823	76533,6829
RJ28	445582,304	76497,9362
RJ29	445605,0115	76462,8496
RJ30	445621,0626	76440,8274
RJ31	445646,0976	76409,2604
PRJ32	445667,1158	76382,1944
RJ33	445694,0657	76348,0306
PRJ34	445715,9561	76320,3729
RJ35	445741,2354	76289,5383
RJ36	445762,9359	76261,595
RJ37	445785,3429	76234,2332
RJ38	445810,0077	76218,7626
RJ39	445837,4305	76213,0247

RJ40	445866,9595	76208,0185
RJ41	445901,683	76202,613
RJ42	445914,6278	76199,8251
RJ43	445936,4453	76192,9006
R2.S1		
PRJ32	445667,1158	76382,1944
RJ1	445672,7354	76386,0362
RJ2	445666,3586	76413,622
RJ3	445660,2052	76446,6617
RJ4	445657,3288	76463,6509
RJ5	445657,9166	76486,1375
RJ6	445665,9767	76514,7271
RJ7	445673,7884	76540,9999
RJ8	445681,3884	76566,3999
R2.S2		
RJ40	445866,9595	76208,0185
RJ1	445865,9596	76201,9582
PRJ2	445836,5402	76181,4427
RJ3	445806,1804	76176,7934
R1.S2 (1)		
PRJ3	445362,7038	77180,2606
RJ1	445375,0976	77180,547
RJ2	445376,6673	77196,5526
RJ3	445379,9624	77218,7791
RJ4	445392,4807	77245,2228
RJ5	445404,5601	77258,927
PRJ6	445426,5814	77275,1223
PRJ7	445449,2901	77291,26
RJ8	445468,9869	77306,1598
PRJ9	445488,1146	77323,4718
PRJ10	445510,4197	77344,4758
RJ11	445516,6333	77359,6005
PRJ12	445512,8517	77387,6918
R1T		
1	445366,4544	77209,4306
2	445366,5345	77208,622
3	445358,6363	77207,3949
4	445361,8176	77180,1897
5	445363,2458	77151,8952
6	445363,1771	77124,6013
7	445362,6109	77104,3549
8	445362,4385	77079,5065
ČK	445361,9027	77061,6088
9	445361,6005	77043,6157
10	445361,2509	77024,5071

11	445361,2298	77011,1168
12	445360,5961	76984,4112
13	445360,0495	76944,5005
14	445359,8752	76924,9253
ČK	445359,7005	76908,8277
15	445359,4992	76891,6267
16	445359,1377	76864,2361
17	445361,0452	76851,3575
18	445367,9697	76835,3847
19	445376,0814	76822,7742
ČK	445392,1739	76806,6413
20	445416,3287	76784,7952
21	445445,5206	76757,2284
22	445454,6669	76746,4924
23	445463,5287	76730,5599
24	445467,7954	76715,9427
25	445469,871	76708,1479
ZR	445475,758	76680,0915
26	445480,4843	76656,428
27	445483,162	76641,6431
28	445489,4356	76619,7969
29	445497,7026	76605,0411
BL	445503,4054	76597,3258
30	445510,5222	76588,0605
31	445532,0519	76563,9986
32	445558,0342	76533,2308
33	445569,3715	76516,024
ČK	445580,8078	76498,8186
34	445590,8413	76483,79
35	445604,4772	76462,3974
36	445620,5341	76440,3674
37	445637,2497	76419,3614
ČK	445651,1182	76401,5503
38	445666,3453	76381,9791
39	445675,8689	76370,3439
40	445689,3873	76353,2932
41	445699,1322	76340,8025
42	445713,1597	76322,497
43	445725,6104	76307,6537
CK	445743,0013	76285,9281
44	445762,2543	76261,1836
45	445771,6455	76250,2812
46	445784,8814	76233,7414
BL	445802,9768	76221,9839
47	445809,5858	76218,0268

48	445837,2637	76212,4067
49	445866,4507	76207,3849
50	445887,0296	76204,2237
51	445907,0624	76200,7798
52	445916,378	76198,5227
ČK	445929,3341	76193,8562
53	445936,0759	76190,0749
54	445946,6179	76181,8779
55	445963,6778	76165,2578
56	445986,0288	76142,918
57	446007,1137	76121,4364
ČK	446013,1677	76115,4698
58	446029,836	76098,0735
59	446036,4196	76091,0151
60	446042,5577	76082,6845
61	446046,7841	76075,8985
62	446051,8611	76065,6852
63	446055,6252	76054,9021
64	446058,9748	76038,8135
65	446061,9748	76022,0488
ČK	446064,337	76009,9092
66	446068,5433	75987,5
67	446073,5837	75961,4832
68	446078,0348	75942,4975
R5.1		
ČRP3	445277,6137	76069,9076
PRJ2	445276,6946	76072,6565
RJ3	445266,2494	76068,8815
RJ4	445240,8666	76058,6637
RJ5	445220,0688	76050,4327
RJ6	445192,3688	76039,3327
PRJ7	445164,7429	76027,812
RJ8	445137,7551	76014,5332
RJ9	445104,8729	76001,127
RJ10	445069,5447	75991,5208
RJ11	445039,7955	75987,0345
RJ12	445008,7021	75986,0785
RJ13	444982,0362	75985,4244
RJ14	444957,8356	75985,2735
R5		
PRJ34	445715,6175	76320,0726
RJ1	445704,9506	76309,5264
RJ2	445675,5045	76311,8436
RJ3	445645,1269	76311,38
RJ4	445621,5696	76308,0913

RJ5	445600,6369	76301,5118
R5.1T		
ČRP3	445278,3727	76070,1846
1	445279,2841	76070,5319
2	445279,7115	76073,1622
3	445285,7545	76075,4456
4	445304,1166	76082,7521
5	445322,752	76089,8648
6	445338,3334	76095,3452
ČK	445347,7326	76104,2907
7	445356,4821	76114,516
8	445371,6538	76150,6771
9	445384,2121	76172,835
10	445399,2011	76189,647
ČK	445426,9745	76201,9953
11	445438,0885	76206,7818
12	445453,4345	76212,5722
13	445501,0777	76227,3407
14	445516,6311	76235,4819
ČK	445526,2702	76244,1267
15	445541,1293	76257,4391
16	445564,4684	76277,4859
17	445576,3304	76286,3839
18	445600,6369	76301,5118
R5.2		
PRJ2	445276,6946	76072,6565
RJ1	445322,4408	76090,4797
RJ2	445337,7967	76096,0162
RJ3	445347,6425	76105,5154
RJ4	445355,7087	76114,9413
RJ5	445370,9633	76151,0914
RJ6	445383,6795	76173,3567
RJ7	445398,2656	76189,7779
RJ8	445425,8374	76202,384
RJ9	445452,8719	76213,1624
RJ10	445471,2379	76219,006
RJ11	445500,6228	76228,033
RJ12	445515,9711	76236,2016
RJ13	445540,6321	76258,0467
RJ14	445563,9838	76278,0479
RJ15	445575,9437	76286,9639
R5.S1		
RJ12	445515,9711	76236,2016
PRJ1	445527,5477	76224,3686
PRJ2	445543,3352	76217,782

RJ3	445557,6238	76220,9424
RJ4	445582,8813	76237,7837
RJ5	445612,5055	76257,1654
RJ6	445642,8401	76264,4237
RJ7	445666,3337	76264,4726
RJ8	445689,2527	76257,5159
RJ9	445704,5823	76244,0738
RJ10	445724,2049	76227,1088
RJ11	445748,1201	76209,7314
RJ12	445763,085	76190,8845
R5.S2		
PRJ7	445164,7429	76027,812
RJ1	445167,7866	76022,5732
RJ2	445186,9797	76023,8724
RJ3	445213,8687	76026,2785
RJ4	445239,6208	76022,3261
RJ5	445260,7669	76018,8347
RJ6	445285,1269	76017,3156
RJ7	445306,131	76015,3621
RJ8	445319,3844	76005,8383
RJ9	445327,7264	75988,6572
RJ10	445336,7825	75972,2309
RJ11	445355,7051	75949,9452
R6		
ČRP4	444765,0714	75901,5342
RJ2	444770,8092	75906,7038
RJ3	444787,0213	75886,0631
RJ4	444793,532	75878,2281
RJ5	444813,3452	75856,2438
RJ6	444831,9741	75835,567
RJ7	444837,1991	75825,8621
RJ8	444862,8423	75800,2953
RJ9	444879,1531	75782,1244
RJ10	444896,1286	75754,3588
RJ11	444908,8712	75735,2342
RJ12	444927,2974	75716,7653
R6T		
CRP 4	444765,6181	75901,0292
1	444766,1652	75900,5199
2	444771,834	75906,066
3	444787,5377	75886,4797
4	444794,0405	75878,6338
5	444805,1495	75866,2508
6	444813,9031	75856,6377
7	444832,6308	75835,8773

8	444837,7321	75826,1835
ČK	444840,1097	75821,7717
9	444851,9041	75810,2366
10	444862,1831	75799,8449
11	444870,79	75790,6804
12	444878,1867	75781,6038
13	444895,4648	75753,9242
14	444908,175	75734,5856
ČK	444922,8837	75720,11
15	444927,7289	75717,4383
16	444933,555	75720,7988
17	444964,6802	75702,0336
18	444972,4837	75695,9571
19	444984,0252	75684,5762
20	445002,529	75665,7235
R6.2		
RJ4	444793,532	75878,2281
PRJ1	444803,4736	75887,8647
RJ2	444815,5365	75901,6837
RJ3	444837,7036	75922,9742
PRJ4	444859,282	75942,5869
PRJ5	444870,0866	75944,6186
PRJ6	444890,4075	75947,5118
RJ7	444904,9497	75965,3976
PRJ8	444918,7908	75976,3744
RJ9	444932,8914	75981,7002
R6.2.1		
RJ2	444770,8092	75906,7038
RJ1	444760,7621	75920,9854
R6.S1		
PRJ8	444918,7908	75976,3744
PRJ1	444923,0062	75971,1732
PRJ2	444923,7905	75947,2937
RJ3	444931,0582	75922,6051
R6.S2		
RJ11	444908,8712	75735,2342
RJ1	444916,534	75740,5363
RJ2	444922,2253	75749,6311
RJ3	444922,7611	75761,3576
PRJ4	444909,0862	75787,109
PRJ5	444912,5395	75805,9312
RJ6	444930,4623	75821,163
RJ7	444949,6814	75833,6769
RJ8	444970,2873	75843,1799
PRJ9	444975,4674	75848,2802

PRJ10	444973,0959	75866,6936
PRJ11	444968,5971	75879,4566
PRJ12	444956,3683	75892,3236
RJ13	444950,1591	75903,4362
R6.S2.1		
RJ6	444831,9741	75835,567
PRJ1	444845,0794	75839,6093
RJ2	444870,4982	75855,8427
PRJ3	444868,5037	75878,1411
PRJ4	444870,761	75896,6594
RJ5	444879,8919	75925,9826
R6.S3		
RJ12	444927,2974	75716,7653
RJ1	444917,7539	75697,8567
RJ2	444908,0289	75675,8077
RJ3	444925,9433	75652,7335
RJ4	444943,0269	75631,2577
RJ5	444961,8198	75607,8879
RJ6	444972,8472	75587,4757
RJ7	444987,06	75561,0555
RJ8	445001,24	75534,5042
RJ9	445015,3607	75508,0346
RJ10	445029,7543	75481,0305
RJ11	445027,1729	75473,5522
RJ12	445017,2927	75459,5579
PRJ13	445001,0136	75444,6444
RJ14	444987,0973	75430,3536
PRJ15	444967,9169	75410,0639
RJ16	444946,2531	75386,2741
RJ17	444924,9673	75364,7266
RJ18	444901,5181	75344,2393
RJ19	444879,3571	75334,1629
RJ20	444871,9652	75325,5917
RJ21	444860,4179	75308,673
RJ22	444848,5702	75292,7747
RJ23	444835,2841	75283,6702
R6.S3.1		
RJ2	444908,0289	75675,8077
RJ1	444894,6164	75648,4651
RJ2	444881,4433	75619,9301
RJ3	444868,3581	75592,7199
RJ4	444857,8298	75570,5016
RJ5	444853,6905	75557,2034
RJ6	444833,7686	75542,2037
RJ7	444811,3898	75533,374

RJ8	444798,9085	75531,1696
RJ9	444770,2827	75540,571
R6.S3.1.1		
RJ5	444853,6905	75557,2034
PRJ1	444856,5903	75530,5281
PRJ2	444867,212	75499,9517
PRJ3	444877,1719	75470,195
RJ4	444891,5957	75440,6304
R6.S3.1.2		
PRJ13	445001,0136	75444,6444
RJ1	445013,144	75432,54
RJ2	445010,8003	75426,3691
RJ3	444996,5316	75412,2176
R6.S3.1.3		
RJ8	444862,8423	75800,2953
RJ1	444857,4208	75792,558
RJ2	444868,5233	75764,0874
RJ3	444879,2828	75742,97
RJ4	444888,2513	75719,7307
R6.S3.2		
RJ10	445029,7543	75481,0305
RJ1	445034,542	75472,0482
RJ2	445046,9062	75458,0987
R6.S4		
ob.PRJ332	445376,8193	75393,6974
RJ2	445372,9472	75387,7426
RJ3	445354,6799	75378,442
RJ4	445334,3534	75377,1847
RJ5	445296,8033	75376,3515
RJ6	445266,1715	75369,1024
RJ7	445222,1102	75362,0398
RJ8	445196,6089	75355,3582
RJ9	445164,3271	75360,2859
RJ10	445137,8098	75371,8333
RJ11	445122,9515	75385,2025
RJ12	445103,2032	75406,9393
RJ13	445086,7281	75420,6102
RJ14	445070,3036	75434,7594
RJ15	445051,2718	75453,2001
R6.S4.1		
ČRP5	445260,2464	75236,9918
RJ2	445257,8755	75234,3936
RJ3	445246,397	75243,071
RJ4	445222,0958	75261,6501
RJ5	445200,2577	75281,4126

RJ6	445177,3825	75305,6954
RJ7	445171,0297	75314,1044
RJ8	445159,2531	75336,0182
R6.S4.1T		
ČRP5	445259,6089	75237,5287
1	445258,8866	75238,0525
2	445254,9175	75235,6457
3	445237,1837	75249,1951
4	445221,5304	75261,1158
5	445206,7066	75274,0238
CK	445200,2975	75280,119
6	445176,7137	75305,3174
7	445159,9376	75336,306
8	445155,8901	75344,1038
9	445158,1184	75353,5981
10	445164,3271	75360,2859
R7		
RJ6	444831,9741	75835,567
RJ1	444827,7408	75827,791
RJ2	444807,5323	75810,3677
RJ3	444784,0222	75793,2312
RJ4	444764,7006	75785,8397
RJ5	444748,7483	75775,4374
RJ6	444725,7146	75759,7562
RJ7	444700,5326	75751,5343
RJ8	444671,3831	75744,2392
RJ9	444642,3684	75733,2186
RJ10	444616,5202	75720,8689
RJ11	444589,8505	75707,1336
RJ12	444565,0305	75693,4583
RJ13	444538,6389	75678,774
RJ14	444513,1614	75664,4925
PRJ15	444488,499	75647,7234
PRJ16	444451,1198	75608,3396
RJ17	444437,6506	75596,7866
RJ18	444419,2696	75582,5988
RJ19	444399,6249	75574,4996
PRJ20	444385,6299	75574,0311
PRJ21	444350,9067	75577,5161
PRJ22	444318,6563	75576,7736
RJ23	444290,2548	75567,5217
RJ24	444263,888	75556,7221
RJ25	444235,4821	75543,1834
RJ26	444208,5469	75534,2143
RJ27	444181,0674	75526,3729

RJ28	444153,333	75517,8938
RJ29	444133,8682	75521,5977
RJ30	444108,6804	75536,1218
RJ31	444093,2593	75546,4837
RJ32	444067,6621	75560,4103
R7.S3		
PRJ22	444318,6563	75576,7736
PRJ1	444276,1908	75584,5649
PRJ2	444271,6384	75593,9127
PRJ3	444277,2232	75611,2166
PRJ4	444279,5531	75627,7471
RJ5	444266,0657	75630,0857
R7.S2		
PRJ16	444451,1198	75608,3396
RJ1	444454,0739	75569,8975
RJ2	444435,9371	75555,8177
PRJ3	444413,2182	75538,617
RJ4	444390,6461	75529,8907
PRJ5	444374,2493	75508,0012
PRJ6	444338,9826	75508,6304
RJ7	444331,4517	75513,7894
RJ8	444299,1811	75507,3614
RJ9	444274,6361	75502,3346
RJ10	444248,7156	75496,7695
PRJ11	444213,7481	75492,9702
RJ12	444202,3755	75496,0931

Zakoličbene točke objektov

Ime	X	Y
CRP1		
T1	445365,2011	77208,9098
T2	445367,7874	77209,1754
T3	445367,5401	77211,7637
T4	445364,9353	77211,4973
T5	445363,7648	77212,324
T6	445368,1899	77212,8314
T7	445368,7186	77208,362
T8	445364,2255	77207,8305
CRP3		
T1	445276,9101	76068,3667
T2	445276,0812	76070,6282
T3	445278,3214	76071,45

T4	445279,1561	76069,1998
CRP4		
T1	444765,0772	75903,2283
T2	444766,7755	75901,5325
T3	444765,0797	75899,8342
T4	444763,3814	75901,53
T5	444762,6409	75901,7162
T6	444765,365	75904,5014
T7	444768,126	75901,801
T8	444765,3971	75899,0205
CRP5		
T1	445260,3474	75235,3186
T2	445261,9158	75237,1353
T3	445260,0991	75238,7036
T4	445258,5307	75236,8869
T5	445257,6308	75236,8731
T6	445259,7627	75239,3873
T7	445262,9153	75236,6761
T8	445260,808	75234,1278

T/5 STATIČNI IZRAČUN KANALIZACIJE

Amiblu
Pipes designed for generations

Structural analysis

Project:	9601 PZI Kanalizacija Unec-Slivice
Description:	GRP CC pipe DN 250 PN1, SN 10.000 Trench angle 60°
Contractor:	LUZ d.d. Verovškova ulica 64 1000 Ljubljana Mrs. Maja Klančar (01) 36 02 446
Designer:	Josip Vrtarić Application Engineering Amiblu Alpe Adria d.o.o. Kralja Zvonimira 122, Zagreb, Croatia T +385 1 618 36 91 M +385 91 604 93 97 josip.vrtaric@amiblu.com www.amiblu.com
Calculation no.:	2026/17
Date:	23/02/2026

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1 Remarks

DISCLAIMER OF LIABILITY

As part of the technical service for the technical planning of projects of the Amiblu Group (hereinafter referred to as "Amiblu"), static calculations for decision-making regarding Amiblu/Flowtite/Hobas GFK pipe systems and products are regularly provided by Amiblu.

By using this free Amiblu' s technical verification service, you agree to the following terms and conditions:

1. No contractual relationship:
The use of the above mentioned Amiblu` s calculations does not constitute a contractual relationship between you and Amiblu and no consulting or information agreement is concluded. To this extent, there do not exist any contractual or quasi-contractual claims against Amiblu.

2. Requirements:
You acknowledge that the here mentioned calculations only apply to Amiblu/Flowtite/Hobas products.

3. Basis of the static calculation:
Amiblu bases the calculation according to your stated project and installation conditions and completes the missing data by itself if necessary, this to the best of its knowledge and based on the current state of knowledge and according to the requirements of the valid standards and regulations.
The trench width and installation conditions are based on the minimum requirements according to EN1610 without consideration of the trench sheet thickness (if in use). This usually represents the critical load case and is therefore on the safe side.

4. Installation specifications:
In all cases the following installation conditions must be observed for the installation of Amiblu products:

The pipe zone must be made of non-cohesive or slightly cohesive material with the quality and degree of compaction according to this calculation. The maximum grain size according to the Amiblu/Flowtite/Hobas installation instructions for buried pipes and shafts have to be observed.
To classify the bedding material, all the material in the pipeline zone has to pass through a sieve with a mesh size as specified in the installation instructions.

The pipe bedding must be at least 100 mm thick and have the specified support angle according to the static calculation. We recommend that the requirements for the pipe bedding according to EN 1610.

The degree of compaction of the pipe zone and backfill must meet or exceed the requirements of the static calculation. The installation conditions should be checked and documented. The pipe zone ends 300 mm above the pipe crown.

The quality and degree of compaction of the backfill, the existing soil and the pipeline zone must be checked and needs to meet the requirements of this static evaluation.

For the static calculation compliance with the applicable international standards and installation instructions for Amiblu/Flowtite/Hobas products is assumed. The installation instructions for Amiblu/Flowtite/Hobas can be downloaded from our homepages: http://www.flowtite.com or http://www.hobas.com or http://www.amiblu.com.

The installation conditions used for the static calculation should be compared by you or an expert engineer or the project planner with the actual conditions on site. Potential deviations may have an influence on the pipe installation.

5. Disclaimer:
The services provided are subject to Amiblu's General Conditions of Sale, insofar applicable.

The results of the calculation can only be obtained in practice if the assumptions correspond to the real construction conditions on site.

The static calculations were carried out reliably and carefully according to the professional opinion of Amiblu.

Amiblu accept liability for the static calculation carried out on the basis of customer specifications, such as e.g. contents from structural analysis forms, specifications for planning and execution, information on ground condition as well as installation and/or operation. Amiblu does not accept any liability for the correctness and completeness of the specific customer specifications.

The static calculations prepared by Amiblu are a service in the design or execution phase and usually become part of the project documentation. Amiblu assumes no liability for the applicability of the calculation results in case of deviations from the underlying assumptions.

Rev03 11/04/2023

2 List of references

DIN 4124 - Excavations and Trenches - Slopes, planking and strutting, breadths of working space: October 2002

EN 1610 - Construction and testing of drains and sewers: December 2015

EN 805 - Water Supply Requirements for systems and components outside of buildings: March 2000

EN 1992-2 - Eurocode 2: Eurocode 1: Actions on structures Part 2: Traffic loads on bridges (consolidated version): March. 2012

EN 1796 - Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): March 2013

EN 14364 - Plastics piping systems for drainage and sewerage with or without pressure – Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): Mai 2013

EN 15383 - Plastics piping systems for drainage and sewerage - Glass- reinforced thermosetting plastics (GRP) based on polyester resin (UP) - Manholes and inspection chambers: March 2013

ISO 16611 Plastics piping systems for drainage and sewerage without pressure - Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) - Dimensions, requirements and tests: June 2017

ISO 25780 - Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — Pipes with flexible joints intended to be installed using jacking techniques: Mai 2011

Worksheet DWA-A127 - Structural verification of sewer channels and pipe lines, 3. corrected Issue: August 2000

3 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 1 m

Caption of this part of the calculation:	Cover 1 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

3.1 Input

3.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
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
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

3.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

3.1.3 Load

Cover depth:	h	1.00	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
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
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

3.1.4 Installation

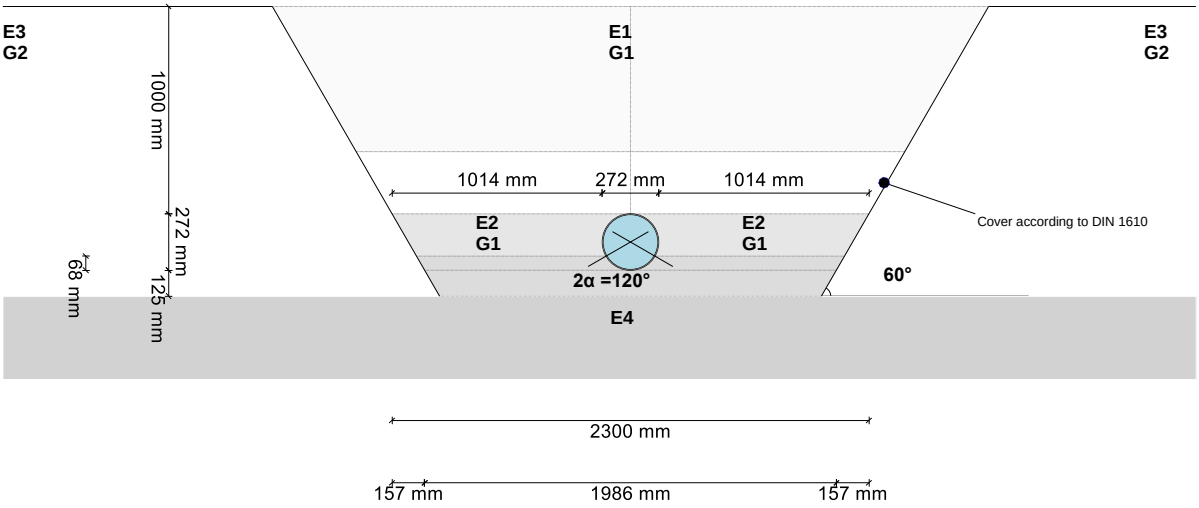
Installation:	Trench		
Trench width at pipe crown level:	b	2.30	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

3.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	272	mm
Nominal diameter:	DN	250	mm
Wall thickness:	t	6.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	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	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



3.2 Results

3.2.1 Intermediate results pipe

Inner diameter:	d_i	260.0 mm
Outer diameter:	d_a	272.0 mm
Mean radius:	r_m	133.00 mm
Wall thickness:	s	6.00 mm
Ratio radius to wall thickness:	r_m/s	22.167 [-]
Curve correction factor, internal:	α_{ki}	1.015 [-]
Curve correction factor, external:	α_{ka}	0.985 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	6.00 mm²/mm
Distance of inertia:	e	3.00 mm
Moment of inertia:	I	18.00 mm^4/mm
Outer moment of resistance:	W_a	6.00 mm³/mm
Inner moment of resistance:	W_i	6.00 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

3.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,228.1	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.869	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	8.9	4.4	N/mm²

Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$	n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$	n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$	n. def	N/mm²

3.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

3.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	250	mm
Outer diameter:	d_a	272.0	mm
Size of the bedding layer:	a	0.13	m
Minimum width at trench sole level (incl. x) according to table 1:	$min_{b,T1}$	0.67	m
Minimum clear width at trench sole level:	$min_{b,G}$	0.67	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.16	m
Required width at pipe crown level:	$min_{b,R}$	0.98	m
Trench width at pipe crown level:	b	2.30	m

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

3.2.3 Intermediate results for load case

3.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

3.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	20.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	20.00	kN/m²
Stress due to traffic load:	P_V	26.33	kN/m²
Included impact factor:	ϕ	1.50	[-]

3.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	$α_B$	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

3.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δf	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

3.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

3.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	62,732	40,000	N/m²

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	1.198	0.869	%
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	8,199.2	5,228.1	N/mm²

3.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0065	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3746	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.010	---	[-]

3.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.232	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.010	---	[-]

3.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.782	1.782	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.917	---	[-]
Concentration factor above pipe, initial value	λ_R	0.807	0.787	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.807	0.787	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.850	3.850	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.415	0.415	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.807	0.787	---	[-]
Soil concentration factor	λ_B	1.064	1.071	---	[-]

3.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	42.48	42.06	---	kN/m²
Lateral pressure	q_h	9.60	9.66	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	40.26	40.69	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

3.2.4 Section forces

3.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.196	-0.199	0.207	kNm/m
Moment due to lateral pressure	M_{qh}	-0.042	0.042	-0.042	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.129	0.148	-0.129	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.026	-0.010	0.038	kNm/m

	crown	springline	invert

Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.153	-5.649	-0.153	kN/m
Normal force due to lateral pressure	N_{qh}	-1.277	0.000	-1.277	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.090	0.000	-3.090	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-4.198	-5.634	-4.378	kN/m

3.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.194	-0.197	0.205	kNm/m
Moment due to lateral pressure	M_{qh}	-0.043	0.043	-0.043	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.130	0.150	-0.130	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.022	-0.006	0.034	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.151	-5.594	-0.151	kN/m
Normal force due to lateral pressure	N_{qh}	-1.284	0.000	-1.284	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.123	0.000	-3.123	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-4.246	-5.579	-4.423	kN/m

3.2.5 Short term load case

3.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.033	-0.023	0.050	%
Strain due to other loads	ε_{sonst}	0.002	-0.002	0.005	%
Total strain	ε	0.035	-0.025	0.055	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	41.260	---	26.366	[-]
Safety coefficient flexural compression:	γ_{BD}	---	58.264	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.046	0.004	-0.063	%
Strain due to other loads	ε_{sonst}	-0.002	0.002	-0.004	%
Total strain	ε	-0.047	0.006	-0.067	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	225.423	---	[-]
Safety coefficient flexural compression:	γ_{BD}	30.652	---	21.599	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			$I/(A \cdot rm^2)$	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00020	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	1.38	mm
Horizontal diameter change:			Δd_h	1.12	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.52	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.52	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6 Long term load case

3.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \quad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.035	-0.021	0.056	%
Strain due to other loads	ε_{sonst}	0.003	-0.003	0.009	%
Total strain	ε	0.038	-0.024	0.065	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.18	1.17	1.17	%
Safety coefficient flexural tension:	γ_{BZ}	31.197	---	17.844	[-]
Safety coefficient flexural compression:	γ_{BD}	---	47.840	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.051	-0.002	-0.073	%
Strain due to other loads	ε_{sonst}	-0.003	0.003	-0.008	%
Total strain	ε	-0.054	0.001	-0.081	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.19	1.02	1.18	%
Safety coefficient flexural tension:	γ_{BZ}	---	733.789	---	[-]
Safety coefficient flexural compression:	γ_{BD}	22.092	---	14.547	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00020	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	1.47	mm
Horizontal diameter change:			Δd_h	1.13	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.55	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.55	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\overline{S}_R$	62,732	N/m²
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0065	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,353.0	kN/m²
Total vertical load:	q_v	42.06	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	32.17	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

3.2.6.4 stability proof, nonlinear

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

3.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

4 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 3.3 m

Caption of this part of the calculation:	Cover 3.3 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

4.1 Input

4.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
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
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

4.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

4.1.3 Load

Cover depth:	h	3.30	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.00	m
Soil density:	γ_B	20.0	kN/m³
Additional surface load:	p_0	0.0	kN/m²
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
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

4.1.4 Installation

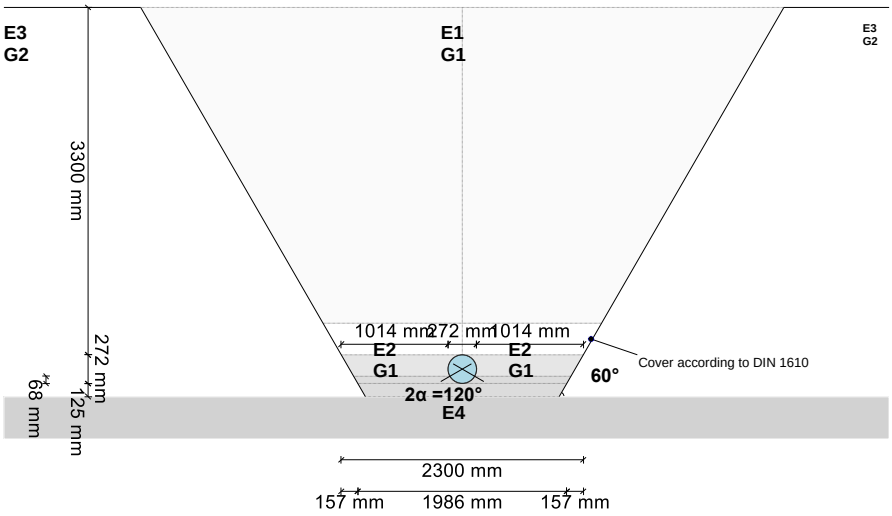
Installation:	Trench		
Trench width at pipe crown level:	b	2.30	m

Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	60	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

4.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	272	mm
Nominal diameter:	DN	250	mm
Wall thickness:	t	6.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	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	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



4.2 Results

4.2.1 Intermediate results pipe

Inner diameter:	d_i	260.0 mm
Outer diameter:	d_a	272.0 mm
Mean radius:	r_m	133.00 mm
Wall thickness:	s	6.00 mm
Ratio radius to wall thickness:	r_m/s	22.167 [-]
Curve correction factor, internal:	α_{ki}	1.015 [-]
Curve correction factor, external:	α_{ka}	0.985 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	6.00 mm²/mm
Distance of inertia:	e	3.00 mm
Moment of inertia:	I	18.00 mm^4/mm
Outer moment of resistance:	W_a	6.00 mm³/mm
Inner moment of resistance:	W_i	6.00 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

4.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,228.1	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.869	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	8.9	4.4	N/mm²
Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$		n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$		n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$		n. def	N/mm²

4.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

4.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	250	mm
Outer diameter:	d_a	272.0	mm
Size of the bedding layer:	a	0.13	m
Minimum width at trench sole level (incl. x) according to table 1:	$min_{b,T1}$	0.67	m
Minimum clear width at trench sole level:	$min_{b,G}$	0.67	m

Slope angle:	ß	60	°
Additional width for sloped trench walls:	Δb/2	0.16	m
Required width at pipe crown level:	$min_{b,R}$	0.98	m
Trench width at pipe crown level:	b	2.30	m

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

4.2.3 Intermediate results for load case

4.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

4.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	66.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	66.00	kN/m²
Stress due to traffic load:	P_V	4.63	kN/m²
Included impact factor:	ϕ	1.50	[-]

4.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	$α_B$	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

4.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	$Δ_f$	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]

If the slope angle of the trench < 90° the trench width at the middle of pipe has to be used here instead of the trench width at crown.

Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

4.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

4.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	42,624	40,000	N/m²

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.907	0.869	%
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,571.1	5,228.1	N/mm²

4.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0044	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3283	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.269	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	2.279	2.279	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.912	---	[-]
Concentration factor above pipe, initial value	λ_R	0.784	0.727	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.784	0.727	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.505	3.505	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.143	0.143	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.784	0.727	---	[-]
Soil concentration factor	λ_B	1.072	1.091	---	[-]

4.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	56.40	52.62	---	kN/m²
Lateral pressure	q_h	29.39	29.89	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	34.77	31.30	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

4.2.4 Section forces

4.2.4.1 Section forces , short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.260	-0.264	0.274	kNm/m
Moment due to lateral pressure	M_{qh}	-0.130	0.130	-0.130	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.111	0.128	-0.111	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.020	-0.008	0.036	kNm/m

	crown	springline	invert

Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.203	-7.501	-0.203	kN/m
Normal force due to lateral pressure	N_{qh}	-3.908	0.000	-3.908	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-2.668	0.000	-2.668	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-6.358	-7.486	-6.637	kN/m

4.2.4.2 Section forces , long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.243	-0.247	0.256	kNm/m
Moment due to lateral pressure	M_{qh}	-0.132	0.132	-0.132	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.100	0.115	-0.100	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.011	0.000	0.026	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.189	-6.998	-0.189	kN/m
Normal force due to lateral pressure	N_{qh}	-3.975	0.000	-3.975	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-2.402	0.000	-2.402	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-6.178	-6.982	-6.431	kN/m

4.2.5 Short term load case

4.2.5.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.021	-0.022	0.043	%
Strain due to other loads	ε_{sonst}	0.002	-0.002	0.005	%
Total strain	ε	0.023	-0.025	0.048	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	64.147	---	30.282	[-]
Safety coefficient flexural compression:	γ_{BD}	---	58.945	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.040	-0.002	-0.063	%
Strain due to other loads	ε_{sonst}	-0.002	0.002	-0.004	%
Total strain	ε	-0.042	0.000	-0.067	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	4,390.756	---	[-]
Safety coefficient flexural compression:	γ_{BD}	34.582	---	21.533	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.5.2 Deformation proof

Calculation mode:			linear		
Ratio:			$I/(A \cdot rm^2)$	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00020	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	1.21	mm
Horizontal diameter change:			Δd_h	0.96	mm
Relative vertical deformation (due to loads, elastic, Type B):			$\delta_{v,B}$	0.45	%
Predeformation (e. g. due to manufacturing, plastic, Type A):			$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):			$\delta_{v,Ges}$	1.45	%
Allowable deflection:			zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6 Long term load case

4.2.6.1 Strain proof

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \quad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.013	-0.019	0.052	%
Strain due to other loads	ε_{sonst}	0.003	-0.003	0.009	%
Total strain	ε	0.016	-0.022	0.061	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.90	0.90	0.90	%
Safety coefficient flexural tension:	γ_{BZ}	55.376	---	14.706	[-]
Safety coefficient flexural compression:	γ_{BD}	---	40.797	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.050	-0.023	-0.089	%
Strain due to other loads	ε_{sonst}	-0.003	0.003	-0.008	%
Total strain	ε	-0.052	-0.020	-0.097	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.91	0.90	0.90	%
Safety coefficient flexural tension:	γ_{BZ}	---	---	---	[-]
Safety coefficient flexural compression:	γ_{BD}	17.339	45.787	9.286	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.6.2 Deformation proof

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00020	[-]
		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]
Vertical diameter change:			Δd_v	1.28	mm
Horizontal diameter change:			Δd_h	0.87	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.48	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.48	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6.3 Stabilty proof radial, linear

Earth and traffic loads

Pipe stiffness:	$\overline{S}_R$	42,624	N/m²
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0044	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,117.4	kN/m²
Total vertical load:	q_v	52.62	kN/m²
Safety stability, radial:	$\gamma_{Stab,rad}$	21.24	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

4.2.6.4 stability proof, nonlinear

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

4.2.6.5 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

5 Appendix

Input Data for structural analysis

of application buried pipes in open trench condition, calculation acc. DWA-A 127

Please send to:
Amiblu Holding GmbH
Pischeldorfer Straße 128
A-9020 Klagenfurt
T +43 463 482424
info@amiblu.com

9601 PZI Kanalizacija Unec-Slivice	
project	
LUZ d.d.	Maja Klančar
company	contact person
Verovškova ulica 64	(01) 36 02 446
street	phone/Fax:
1000	Text input.
postcode	signature:
Ljubljana	Text input.
city	date/stamp

Pipe Details:

nominal diameter DN	250
pressure class PN	PN1
nominal stiffness SN	10000
pipe material	GRP

sewer pipe	☒
sewer pressure pipe	☐
pressure pipe	☐
potable water pipe	☐
installation in protective water area	☐
air pipe	☐
storage sewer	☐
others	Text input.

Types of native soil: acc. ATV-DVWK-A 127; DIN 18196 (please subsoil expertise ad)

		Native soil	backfilling	Pipe zone
G1	Non cohesive soils (gravel, sand) (GE, GW, GI, SE, SW, SI)	☐	☒	☒
G2	Slightly cohesive soils (GU, GT, SU, ST)	☒	☐	☐
G3	Cohesive mixed soils, silt (GÜ, GŤ, SÜ, SŤ, UL, UM)	☐	☐	☐
G4	Cohesive soils, except silts (TL, TM, TA, OU, OT, OH, UA)	☐	☐	☐
Other types of soil	Text input.	☐	☐	☐

Proctor density for native soil (Proctor density 85 – 100 %): 98 %

Foundation of pipeline

- ☒ On native soil
- ☐ very hard and rocky
- ☐ Weak soil, not stable for foundation

Soil replacement: thickness Text input. m

material Text input.

Proctor density D_{Pr} Text input. %

Specification of loads:

	Min. cover depth		Max. cover depth	
Depth of earth cover h	1,00	m	3,3	m
min. Ground water h_w above pipe invert	Text input.	m	Text input.	m
max. Ground water h_w above pipe invert	Text input.	m	Text input.	m

Other surface loads Text input. kN/m²

For pressure pipes

Short term: Text input. bar, e.g. system test pressure; hydrostatic pressure, water hammer

Long term: Text input. bar, e.g. operating pressure (OP), system pressure (PN, DP)

Traffic load

☐ no traffic

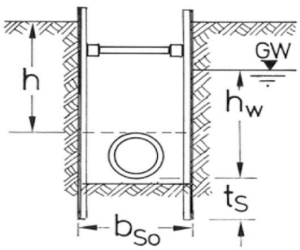
street
- ☐ HCL 60
- ☐ HCL 30
- ☒ HGV 12
- ☐ DIN EN 1991-2, TS und UDL
  - ☐ LM1-lane 3,00 m
  - ☐ LM1-lane 2,70 m
  - ☐ LM1-green field area

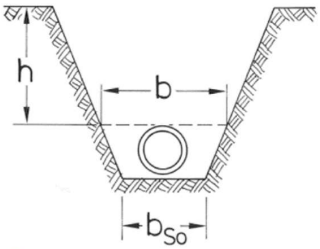
railway
- ☐ one track, UIC
- ☐ two tracks, UIC
- ☐ one track, LM 71
- ☐ two tracks, LM 71

aircraft
- ☐ BFZ 90
- ☐ BFZ 180
- ☐ BFZ 350
- ☐ BFZ 550
- ☐ BFZ 750

Other loads, e.g. special vehicle (please add load scheme with axle, wheels and wheel loads):
Text input.

Building construction:





Type of trench ☐ embankment ☐ single trench ☒ double trench [1] ☐ stepped trench [1]

[1] For special shapes add a sketch

Trench angel ☐ 90° ☒ 60° ☐ 45° ☐ Text input.

Width of trench b = 2.3 m at pipe crown

b_{So} = 1.3 m at pipe trench bottom inclusive planks

Trench planking

☒ no planks

☐ Horizontal planks, also applies to plank walls (Berlin lining)
☐ Planking with plates
☐ Vertical plank with light weight
☐ Vertical plank with boards *
☐ Vertical plank with light weight *
☐ Vertical plank with sheet piling *

bedding

☐ on native soil (acc. EN 1610)
☒ on gravel, sand
☐ on concrete [2)]

[2)] only as spezial construction in agreement with the pipe producer

bedding angle 2α

☐ 90° ☐ 120°
☐ 180°

* Depth of sheeting below pipe invert t_S = Text input. m

*thickness of plank (one-side) b_S = Text input. m

Cover condition for backfilling:

A1 ☐ Backfilling compacted in layers against the native soil (without proof of compaction degree); also applies to plank walls, Berlin lining

A2 ☐ Vertical pipe trench lining with boards that are not removed before backfilling. Lining boards or devices that are removed step by step during backfilling. Non-compacted backfilling/ backfilling with slurry (only suitable for soils of group G1).

A3 ☐ Vertical trench lining with sheet piling, light weight sheet connection, wooden planks, lining boards or devices that are not removed before backfilling.

A4 ☒ Backfilling compacted in layers against the native soil with proof of the required compaction degree to ZTVE-StB ; also applies to plank walls (Berlin lining). Cover condition A4 is not applicable to sails of group G4.

Bedding condition for pipe:

B1 ☒ Bedding compacted in layers against the native soil or in the embankment (without proof of compaction degree); also applies to plank walls, Berlin lining

B2 ☐ Vertical lining in the pipe zone with planks that reach down to the trench bottom and are not removed before backfilling and compaction. Lining boards or devices provided that the soil is compacted after the linings are removed.

B3 ☐ Vertical lining in the pipe zone with sheet piling or lightweight sheeting and compaction against the lining reaching down below the trench bottom. There is no safe calculation model for determining vertical lining with wooden planks, boards or devices that are not removed before backfilling and compaction the pipe zone.

B4 ☐ Bedding compacted in layers against the native soil or in the embankment with proof of the required compaction degree to ZTVE-StB. Bedding condition B4 does not apply to soils of group G4.

Amiblu
Pipes designed for generations

Structural analysis

Project:	9601 PZI Kanalizacija Unec-Slivice
Description:	GRP CC pipe DN 250 PN1, SN 10.000 Trench angle 90°
Contractor:	LUZ d.d. Verovškova ulica 64 1000 Ljubljana Mrs. Maja Klančar (01) 36 02 446
Designer:	Josip Vrtarić Application Engineering Amiblu Alpe Adria d.o.o. Kralja Zvonimira 122, Zagreb, Croatia T +385 1 618 36 91 M +385 91 604 93 97 josip.vrtaric@amiblu.com www.amiblu.com
Calculation no.:	2026/18
Date:	23/02/2026

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1 Remarks

DISCLAIMER OF LIABILITY

As part of the technical service for the technical planning of projects of the Amiblu Group (hereinafter referred to as "Amiblu"), static calculations for decision-making regarding Amiblu/Flowtite/Hobas GFK pipe systems and products are regularly provided by Amiblu.

By using this free Amiblu' s technical verification service, you agree to the following terms and conditions:

1. No contractual relationship:
The use of the above mentioned Amiblu` s calculations does not constitute a contractual relationship between you and Amiblu and no consulting or information agreement is concluded. To this extent, there do not exist any contractual or quasi-contractual claims against Amiblu.

2. Requirements:
You acknowledge that the here mentioned calculations only apply to Amiblu/Flowtite/Hobas products.

3. Basis of the static calculation:
Amiblu bases the calculation according to your stated project and installation conditions and completes the missing data by itself if necessary, this to the best of its knowledge and based on the current state of knowledge and according to the requirements of the valid standards and regulations.
The trench width and installation conditions are based on the minimum requirements according to EN1610 without consideration of the trench sheet thickness (if in use). This usually represents the critical load case and is therefore on the safe side.

4. Installation specifications:
In all cases the following installation conditions must be observed for the installation of Amiblu products:

The pipe zone must be made of non-cohesive or slightly cohesive material with the quality and degree of compaction according to this calculation. The maximum grain size according to the Amiblu/Flowtite/Hobas installation instructions for buried pipes and shafts have to be observed.
To classify the bedding material, all the material in the pipeline zone has to pass through a sieve with a mesh size as specified in the installation instructions.

The pipe bedding must be at least 100 mm thick and have the specified support angle according to the static calculation. We recommend that the requirements for the pipe bedding according to EN 1610.

The degree of compaction of the pipe zone and backfill must meet or exceed the requirements of the static calculation. The installation conditions should be checked and documented. The pipe zone ends 300 mm above the pipe crown.

The quality and degree of compaction of the backfill, the existing soil and the pipeline zone must be checked and needs to meet the requirements of this static evaluation.

For the static calculation compliance with the applicable international standards and installation instructions for Amiblu/Flowtite/Hobas products is assumed. The installation instructions for Amiblu/Flowtite/Hobas can be downloaded from our homepages: http://www.flowtite.com or http://www.hobas.com or http://www.amiblu.com.

The installation conditions used for the static calculation should be compared by you or an expert engineer or the project planner with the actual conditions on site. Potential deviations may have an influence on the pipe installation.

5. Disclaimer:
The services provided are subject to Amiblu's General Conditions of Sale, insofar applicable.

The results of the calculation can only be obtained in practice if the assumptions correspond to the real construction conditions on site.

The static calculations were carried out reliably and carefully according to the professional opinion of Amiblu.

Amiblu accept liability for the static calculation carried out on the basis of customer specifications, such as e.g. contents from structural analysis forms, specifications for planning and execution, information on ground condition as well as installation and/or operation. Amiblu does not accept any liability for the correctness and completeness of the specific customer specifications.

The static calculations prepared by Amiblu are a service in the design or execution phase and usually become part of the project documentation. Amiblu assumes no liability for the applicability of the calculation results in case of deviations from the underlying assumptions.

Rev03 11/04/2023

2 List of references

DIN 4124 - Excavations and Trenches - Slopes, planking and strutting, breadths of working space: October 2002

EN 1610 - Construction and testing of drains and sewers: December 2015

EN 805 - Water Supply Requirements for systems and components outside of buildings: March 2000

EN 1992-2 - Eurocode 2: Eurocode 1: Actions on structures Part 2: Traffic loads on bridges (consolidated version): March. 2012

EN 1796 - Plastics piping systems for water supply with or without pressure - Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): March 2013

EN 14364 - Plastics piping systems for drainage and sewerage with or without pressure – Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP): Mai 2013

EN 15383 - Plastics piping systems for drainage and sewerage - Glass- reinforced thermosetting plastics (GRP) based on polyester resin (UP) - Manholes and inspection chambers: March 2013

ISO 16611 Plastics piping systems for drainage and sewerage without pressure - Non-circular pipes and joints made of glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resins (UP) - Dimensions, requirements and tests: June 2017

ISO 25780 - Plastics piping systems for pressure and non-pressure water supply, irrigation, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin — Pipes with flexible joints intended to be installed using jacking techniques: Mai 2011

Worksheet DWA-A127 - Structural verification of sewer channels and pipe lines, 3. corrected Issue: August 2000

3 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 1 m

Caption of this part of the calculation:	Cover 1 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

3.1 Input

3.1.1 Safety factors

Safety class:	A (normal case)		
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)		
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		
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)		
Pipe stiffness according to set of rules:	Yes		

3.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

3.1.3 Load

Cover depth:	h	1.00	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	0.50	m
Proof of buoyancy safety:	No		
Soil density:	γ_B	20.0	kN/m³
Manual input of buoyant weight of soil:	No		
Additional surface load:	p_0	0.0	kN/m²
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
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

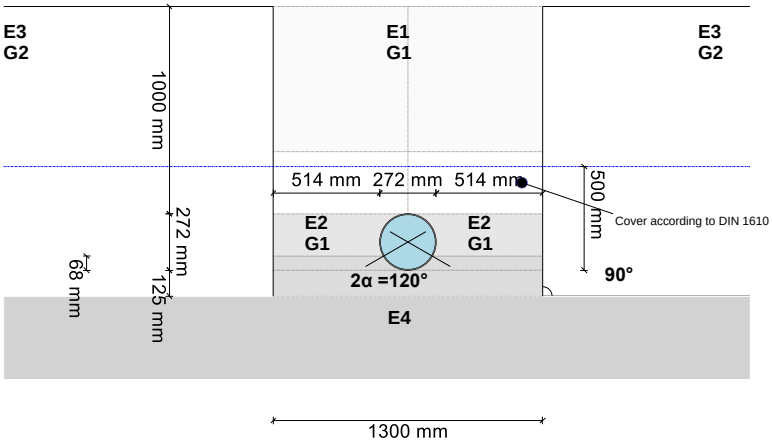
3.1.4 Installation

Installation:	Trench		
Trench width at pipe crown level:	b	1.30	m
Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	90	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

3.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	272	mm
Nominal diameter:	DN	250	mm
Wall thickness:	t	6.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	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	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



3.2 Results

3.2.1 Intermediate results pipe

Inner diameter:	d_i	260.0	mm
Outer diameter:	d_a	272.0	mm
Mean radius:	r_m	133.00	mm
Wall thickness:	s	6.00	mm
Ratio radius to wall thickness:	r_m/s	22.167	[-]
Curve correction factor, internal:	α_{ki}	1.015	[-]
Curve correction factor, external:	α_{ka}	0.985	[-]
Local predeformation:	$\delta_{v,I}$	0.00	%
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00	%
Radial cross section:	A_{rad}	6.00	mm²/mm
Distance of inertia:	e	3.00	mm
Moment of inertia:	I	18.00	mm^4/mm
Outer moment of resistance:	W_a	6.00	mm³/mm
Inner moment of resistance:	W_i	6.00	mm³/mm
Surface ratio:	κ_Q	1.2	[-]

3.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,228.1	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.869	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	8.9	4.4	N/mm²
Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$		n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$		n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$		n. def	N/mm²

3.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

3.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	250	mm
Outer diameter:	d_a	272.0	mm
Size of the bedding layer:	a	0.13	m
Minimum width at trench sole level (incl. x) according to table 1:	$min_{b,T1}$	0.77	m
Minimum width according to table 2:	$min_{b,T2}$	0.80	m

Minimum clear width at trench sole level:	$min_{b,G}$	0.80	m
Required width at pipe crown level:	$min_{b,R}$	0.80	m
Trench width at pipe crown level:	b	1.30	m

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

3.2.3 Intermediate results for load case with minimum groundwater

3.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

3.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	20.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	20.00	kN/m²
Stress due to traffic load:	P_V	26.33	kN/m²
Included impact factor:	ϕ	1.50	[-]

3.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Compaction degree according table 8:	$D_{pr,E20}$	0.95	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	$α_B$	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

3.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	$Δ_f$	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

3.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

3.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	62,732	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.448	1.198	0.869	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	8,199.2	5,228.1	N/mm²

3.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0065	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3746	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.010	---	[-]

3.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.232	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.010	---	[-]

3.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.782	1.782	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.917	---	[-]
Concentration factor above pipe, initial value	λ_R	0.807	0.787	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.807	0.787	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.850	3.850	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.415	0.415	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.807	0.787	---	[-]
Soil concentration factor	λ_B	1.064	1.071	---	[-]

3.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	42.48	42.06	---	kN/m²
Lateral pressure	q_h	9.60	9.66	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	40.26	40.69	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

3.2.4 Intermediate results for load case with maximum groundwater

3.2.4.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	κ_0	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

3.2.4.2 Load

Groundwater level above pipe invert:	h_W	0.50	m
Outer diameter:	d_a	272.0	mm
Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.23	m
Fill density under water:	γ'	11.00	kN/m³
Vertical soil stress from soil load:	P_{Erd}	17.95	kN/m²
Vertical soil stress from soil and surface load:	P_E	17.95	kN/m²
Stress due to traffic load:	P_V	26.33	kN/m²
Included impact factor:	ϕ	1.50	[-]

3.2.4.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,\sigma}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,\sigma}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,\sigma}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,\sigma}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Compaction degree according table 8:	$D_{pr,E20}$	0.95	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	α_B	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,\sigma}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,\sigma}$	230.00	N/mm²

3.2.4.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δ_f	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

3.2.4.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

3.2.4.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	63,785	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	ε_R	1.448	1.213	0.869	%
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	8,336.9	5,228.1	N/mm²

3.2.4.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0066	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3766	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.011	---	[-]

3.2.4.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.230	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.011	---	[-]

3.2.4.9 Concentration factors λR and λB

Maximum concentration factor	max λ	1.782	1.782	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.917	---	[-]
Concentration factor above pipe, initial value	λ_R	0.807	0.788	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.807	0.788	---	[-]

Concentration factor above pipe, upper limit	λ_{fo}	3.850	3.850	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.415	0.415	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.807	0.788	---	[-]
Soil concentration factor	λ_B	1.064	1.071	---	[-]

3.2.4.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	40.82	40.47	---	kN/m²
Lateral pressure	q_h	8.24	8.28	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	39.80	40.25	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

3.2.5 Section forces

3.2.5.1 Section forces with minimum groundwater, short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.196	-0.199	0.207	kNm/m
Moment due to lateral pressure	M_{qh}	-0.042	0.042	-0.042	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.129	0.148	-0.129	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.026	-0.010	0.038	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.153	-5.649	-0.153	kN/m
Normal force due to lateral pressure	N_{qh}	-1.277	0.000	-1.277	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.090	0.000	-3.090	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-4.198	-5.634	-4.378	kN/m

3.2.5.2 Section forces with minimum groundwater, long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.194	-0.197	0.205	kNm/m
Moment due to lateral pressure	M_{qh}	-0.043	0.043	-0.043	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.130	0.150	-0.130	kNm/m

Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.022	-0.006	0.034	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.151	-5.594	-0.151	kN/m
Normal force due to lateral pressure	N_{qh}	-1.284	0.000	-1.284	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.123	0.000	-3.123	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-4.246	-5.579	-4.423	kN/m

3.2.5.3 Section forces with maximum groundwater, short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.188	-0.191	0.199	kNm/m
Moment due to lateral pressure	M_{qh}	-0.036	0.036	-0.036	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.127	0.146	-0.127	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.026	-0.010	0.038	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.147	-5.429	-0.147	kN/m
Normal force due to lateral pressure	N_{qh}	-1.096	0.000	-1.096	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.055	0.000	-3.055	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	-0.680	-0.680	-0.680	kN/m
Total normal forces	ΣN	-4.668	-6.093	-4.836	kN/m

3.2.5.4 Section forces with maximum groundwater, long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm

Moment due to total vertical load	M_{qv}	0.187	-0.190	0.197	kNm/m
Moment due to lateral pressure	M_{qh}	-0.037	0.037	-0.037	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.129	0.148	-0.129	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.022	-0.006	0.034	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.145	-5.383	-0.145	kN/m
Normal force due to lateral pressure	N_{qh}	-1.102	0.000	-1.102	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-3.089	0.000	-3.089	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	-0.680	-0.680	-0.680	kN/m
Total normal forces	ΣN	-4.716	-6.048	-4.881	kN/m

3.2.6 Short term load case

3.2.6.1 Strain proof (with minimum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]

		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.033	-0.023	0.050	%
Strain due to other loads	ε_{sonst}	0.002	-0.002	0.005	%
Total strain	ε	0.035	-0.025	0.055	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	41.260	---	26.366	[-]
Safety coefficient flexural compression:	γ_{BD}	---	58.264	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]

		crown	springline	invert	

Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.046	0.004	-0.063	%
Strain due to other loads	ε_{sonst}	-0.002	0.002	-0.004	%
Total strain	ε	-0.047	0.006	-0.067	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	225.423	---	[-]
Safety coefficient flexural compression:	γ_{BD}	30.652	---	21.599	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.6.2 Strain proof (with maximum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.033	-0.022	0.049	%
Strain due to other loads	ε_{sonst}	0.001	-0.003	0.004	%
Total strain	ε	0.034	-0.026	0.053	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	42.488	---	27.187	[-]
Safety coefficient flexural compression:	γ_{BD}	---	56.711	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.045	0.005	-0.061	%
Strain due to other loads	ε_{sonst}	-0.003	0.001	-0.006	%
Total strain	ε	-0.048	0.006	-0.067	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	256.726	---	[-]
Safety coefficient flexural compression:	γ_{BD}	30.338	---	21.655	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.6.3 Deformation proof (with minimum groundwater)

Calculation mode:		linear	
Ratio:		I/(A·rm²)	0.00017 [-]
Ratio 'I/(A·rm²)·κ~Q':		I/(A·rm²)·κ_Q	0.00020 [-]

q_v	q_h	q_h^*

Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.38	mm
Horizontal diameter change:	Δd_h	1.12	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.52	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.52	%

Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.6.4 Deformation proof (with maximum groundwater)

Calculation mode:		linear	
Ratio:	I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':	$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.37	mm
Horizontal diameter change:	Δd_h	1.10	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.51	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.51	%

Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.7 Long term load case

3.2.7.1 Strain proof (with minimum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:	erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:	erf γ_{RBD}	2.00	[-]

Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:	α_{ki}	1.015	[-]

		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.035	-0.021	0.056	%

Strain due to other loads	ε_{sonst}	0.003	-0.003	0.009	%
Total strain	ε	0.038	-0.024	0.065	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.18	1.17	1.17	%
Safety coefficient flexural tension:	γ_{BZ}	31.197	---	17.844	[-]
Safety coefficient flexural compression:	γ_{BD}	---	47.840	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.051	-0.002	-0.073	%
Strain due to other loads	ε_{sonst}	-0.003	0.003	-0.008	%
Total strain	ε	-0.054	0.001	-0.081	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.19	1.02	1.18	%
Safety coefficient flexural tension:	γ_{BZ}	---	733.789	---	[-]
Safety coefficient flexural compression:	γ_{BD}	22.092	---	14.547	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.7.2 Strain proof (with maximum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.035	-0.021	0.055	%
Strain due to other loads	ε_{sonst}	0.001	-0.005	0.007	%
Total strain	ε	0.036	-0.026	0.062	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.21	1.16	1.19	%
Safety coefficient flexural tension:	γ_{BZ}	33.801	---	19.107	[-]
Safety coefficient flexural compression:	γ_{BD}	---	44.212	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.050	-0.001	-0.070	%
Strain due to other loads	ε_{sonst}	-0.005	0.001	-0.010	%
Total strain	ε	-0.055	0.000	-0.081	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.19	1.07	1.18	%

Safety coefficient flexural tension:	γ_{BZ}	---	5,769.078	---	[-]
Safety coefficient flexural compression:	γ_{BD}	21.757	---	14.656	[-]

All calculated safety coefficients of the strain proof are sufficient.

3.2.7.3 Deformation proof (with minimum groundwater)

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.47	mm
Horizontal diameter change:	Δd_h	1.13	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.55	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.55	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.7.4 Deformation proof (with maximum groundwater)

Calculation mode:			linear		
Ratio:			I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':			I/(A·rm²)·κ_Q	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.45	mm
Horizontal diameter change:	Δd_h	1.12	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.55	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.55	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

3.2.7.5 Stabilty proof radial, linear (with maximum groundwater)

Earth and traffic loads

Pipe stiffness:	$\bar{S}_R$	63,785	N/m²
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0066	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,364.2	kN/m²
Total vertical load:	q_v	40.47	kN/m²

Safety coefficient buckling (total vertical load):	γ_{qv}	33.71	[-]
Water pressure + Negative pressure			
Outer water pressure:	p_a	5.00	kN/m²
Vacuum in the pipe:	p_{I-}	0.00	kN/m²
Pipe stiffness:	S_R	40,000	N/m²
System stiffness:	V_{RB}	0.0042	[-]
Ratio radius to wall thickness:	r_m/s	22.17	[-]
Reduction factor due to local predeformation for the disruptive load at outer water pressure:	$\kappa_{a1,pa}$	1.00	[-]
Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.55	%
Predeformation sum:	δ_v	0.55	%
Reduction factor:	$\kappa_{a2,pa}$	0.90	[-]
Reduction factor:	$\kappa_{a,pa}$	0.90	[-]
Snap-trough coefficient:	$\alpha_{D,pa}$	15.355	[-]
Critical pressure:	krit p_a	553.080	kN/m²
Water pressure + vacuum in the pipe:	p_{a+I-}	5.00	kN/m²
Safety coefficient stability pressure:	$\gamma_{Stab,pa}$	110.616	[-]
Superposition			
Safety stability, radial:	$\gamma_{Stab,rad}$	25.83	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

3.2.7.6 stability proof, nonlinear (with minimum groundwater)

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

3.2.7.7 stability proof, nonlinear (with maximum groundwater)

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

3.2.7.8 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

4 Statics according to ATV-DVWK-A 127, 3rd edition: Cover 3.3 m

Caption of this part of the calculation:	Cover 3.3 m
Kind of calculation:	Nominal stiffness
Add sketch to print:	Yes

4.1 Input

4.1.1 Safety factors

Safety class:	A (normal case)
Safety stability according to table 13:	Without predeformation (2.5 / 2.0)
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
Treatment system stiffness VRB according to:	DWA-A 161:2014 (by material)
Pipe stiffness according to set of rules:	Yes

4.1.2 Soil

Soil group backfill:	G1		
Calculation E1:	Table 8 (A127)		
Soil group pipe zone:	G1		
Calculation E20:	Table 8 (A127)		
Soil group native soil:	G2		
Calculation E3:	Degree of compaction		
Compaction degree E3:	$D_{Pr,E3}$	98.0	%
E4 = 10 · E1:	Yes		
Application of silo theory:	Automatic		
K2 according to standard:	Yes		

4.1.3 Load

Cover depth:	h	3.30	m
Minimum groundwater level above pipe bed:	$h_{W,min}$	0.00	m
Maximum groundwater level above pipe bed:	$h_{W,max}$	2.80	m
Proof of buoyancy safety:	No		
Soil density:	γ_B	20.0	kN/m³
Manual input of buoyant weight of soil:	No		
Additional surface load:	p_0	0.0	kN/m²
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
Input special-purpose vehicle:	No		
Traffic load:	Street TRUCK 12		
Including horizontal loads due to traffic in the fatigue proof:	$\alpha_{qhT,dyn}$	0.00	%

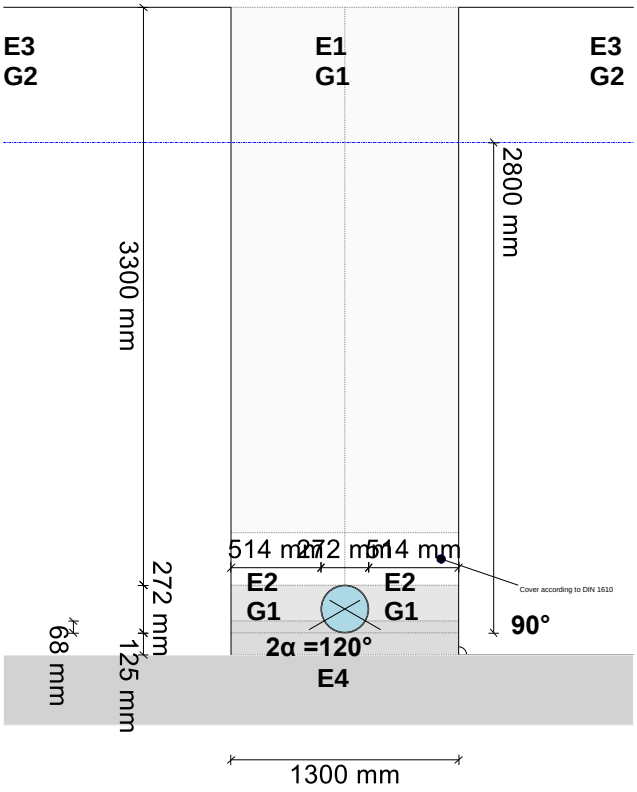
4.1.4 Installation

Installation:	Trench		
Trench width at pipe crown level:	b	1.30	m
Check minimum trench width:	Yes		
Automatic consideration of bedding layer:	Yes		
Slope angle:	ß	90	°
Cover condition:	A4		
Installation condition:	B1		
Type of bedding:	Loose		
Bedding angle:	120°		
Calculate bedding automatically:	Yes		
Set lower height base:	No		
Total height of base:	h_s	0.00	m

4.1.5 Pipe with nominal stiffness

Pipe chosen from datebase:	No		
Choice of input:	Do - s		
Outer diameter:	d_a	272	mm
Nominal diameter:	DN	250	mm
Wall thickness:	t	6.0	mm
Local predeformation:	$\delta_{v,I}$	0.0	%
A type predeformation:	$\delta_{v,A}$	1.0	%
Nominal stiffness:	SN	10,000	N/m²
Nominal pressure:	PN	1.0	bar
Relative failure strain according to standard:	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	[-]
Input of ultimate hoop tensile stress:	No		
Ultimate strain tensile strength according to standard:	Yes		
Amplitude with 2·10^6 tests is known:	No		
Amplitude with 1·10^8 tests is known:	No		
Axial compressive strength, short term:	$f_{c,ax,K}$	90.0	N/mm²
Fiber strain for axial pressure, short term:	ε_{AxK}	1.0	%

Traffic load: Street TRUCK 12



4.2 Results

4.2.1 Intermediate results pipe

Inner diameter:	d_i	260.0 mm
Outer diameter:	d_a	272.0 mm
Mean radius:	r_m	133.00 mm
Wall thickness:	s	6.00 mm
Ratio radius to wall thickness:	r_m/s	22.167 [-]
Curve correction factor, internal:	α_{ki}	1.015 [-]
Curve correction factor, external:	α_{ka}	0.985 [-]
Local predeformation:	$\delta_{v,I}$	0.00 %
Predeformation (ovalisation before load):	$\delta_{v,A}$	1.00 %
Radial cross section:	A_{rad}	6.00 mm²/mm
Distance of inertia:	e	3.00 mm
Moment of inertia:	I	18.00 mm^4/mm
Outer moment of resistance:	W_a	6.00 mm³/mm
Inner moment of resistance:	W_i	6.00 mm³/mm
Surface ratio:	κ_Q	1.2 [-]

4.2.1.1 Material properties

		short term	long term	
Specific gravity	γ_R	18.0	18.0	kN/m³
Poissons ratio	v	0.30	0.30	[-]
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,228.1	N/mm²
Creep ratio:	f_{creep}		2.00	[-]

Table 3 of ATV DVWK-A 127, footnote 34:
Determined from the momentary value and the creep ratio (2) with characteristic values for 2 years for the description of the long term behauvior. Also permitted for the long term verification for 50 years. Tests take place in accordance with DIN EN 1228 (momentary) and DIN EN 1225 (long term).

Characteristic value of relative fracture deformation	$\Delta d_{Bruch}/d_m$	15.0	9.0	%

$$\varepsilon_R = 4.28 \cdot s/d_m \cdot \Delta d_{Bruch}/d_m$$

Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.869	%

$$f_t = \frac{0.50 \cdot PN \cdot 4 \cdot 2 \cdot r_m}{h}$$

Characteristic value of hoop tensile strength	f_t	8.9	4.4	N/mm²
Amplitude for 2·10^6 load cycles:	$\Delta\sigma_{rsk,2E6}$		n. def	N/mm²
Amplitude at 5·10^6 load cycles:	$\Delta\sigma_{rsk,5E6}$		n. def	N/mm²
Amplitude for 1·10^8 cycles:	$\Delta\sigma_{rsk,1E8}$		n. def	N/mm²

4.2.1.2 Safety factors

Required safety coefficient, bending tensile stress	erf γ_{RBZ}	2.00	2.00	[-]
Required safety coefficient, bending compressive stress	erf γ_{RBD}	2.00	2.00	[-]
Required safety coefficient, instability (buckling)	erf γ_{stab}	2.50	2.50	[-]

4.2.2 Minimum trench width according to DIN EN 1610:2015-12

Nominal diameter:	DN	250	mm
Outer diameter:	d_a	272.0	mm
Size of the bedding layer:	a	0.13	m
Minimum width at trench sole level (incl. x) according to table 1:	$min_{b,T1}$	0.77	m
Minimum width according to table 2:	$min_{b,T2}$	0.90	m

Minimum clear width at trench sole level:	$min_{b,G}$	0.90	m
Required width at pipe crown level:	$min_{b,R}$	0.90	m
Trench width at pipe crown level:	b	1.30	m

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

4.2.3 Intermediate results for load case with minimum groundwater

4.2.3.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	$κ_0$	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

4.2.3.2 Load

Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	0.00	m
Vertical soil stress from soil load:	P_{Erd}	66.00	kN/m²
Vertical soil stress from soil and surface load:	P_E	66.00	kN/m²
Stress due to traffic load:	P_V	4.63	kN/m²
Included impact factor:	ϕ	1.50	[-]

4.2.3.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,σ}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,σ}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,σ}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Compaction degree according table 8:	$D_{pr,E20}$	0.95	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	$α_B$	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,σ}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,σ}$	230.00	N/mm²

4.2.3.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	$Δ_f$	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

4.2.3.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

4.2.3.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	42,624	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	$ε_R$	1.448	0.907	0.869	%

Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,571.1	5,228.1	N/mm²

4.2.3.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0044	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3283	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.3.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.269	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.3.9 Concentration factors λR and λB

Maximum concentration factor	max λ	2.279	2.279	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.912	---	[-]
Concentration factor above pipe, initial value	λ_R	0.784	0.727	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.784	0.727	---	[-]
Concentration factor above pipe, upper limit	λ_{fo}	3.505	3.505	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.143	0.143	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.784	0.727	---	[-]
Soil concentration factor	λ_B	1.072	1.091	---	[-]

4.2.3.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	56.40	52.62	---	kN/m²
Lateral pressure	q_h	29.39	29.89	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	34.77	31.30	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

4.2.4 Intermediate results for load case with maximum groundwater

4.2.4.1 Silo Theory

Soil load coefficient κ for trench load (Silo Theory):	κ	1.000	[-]
Soil load coefficient κ0 for surface load (Silo Theory):	κ_0	1.000	[-]

κ0 and κ are set to 1, because E1 is larger then E3.

4.2.4.2 Load

Groundwater level above pipe invert:	h_W	2.80	m
Outer diameter:	d_a	272.0	mm
Maximum groundwater level above pipe crown:	$h_{W,Scheitel}$	2.53	m
Fill density under water:	γ'	11.00	kN/m³
Vertical soil stress from soil load:	P_{Erd}	43.25	kN/m²
Vertical soil stress from soil and surface load:	P_E	43.25	kN/m²
Stress due to traffic load:	P_V	4.63	kN/m²
Included impact factor:	ϕ	1.50	[-]

4.2.4.3 Soil deformation moduli EB

Backfill elastic modulus under load:	$E_{1,\sigma}$	23.00	N/mm²

$$E_{3,\sigma} = \frac{40}{2} \cdot e^{-0.188(100 - D_{Pr})} \qquad 3.01$$

Native soil elastic modulus:	$E_{3,\sigma}$	13.73	N/mm²
Bedding elastic modulus (reduced):	$E_{2,\sigma}$	16.00	N/mm²
Bedding elastic modulus under load:	$E_{20,\sigma}$	16.00	N/mm²
Reduction factor for creep:	f_1	1.000	[-]
Compaction degree according table 8:	$D_{pr,E20}$	0.95	[-]
Reduction factor E20 (groundwater):	f_2	1.000	[-]
Reduction factor E20 (narrow trench):	α_B	1.000	[-]

For a ratio (trench width / outer diameter) >= 4, formula 6.03 always results in 1.0.

Bedding elastic modulus (reduced):	$E_{2,\sigma}$	16.00	N/mm²
Elastic modulus of soil under pipe:	$E_{4,\sigma}$	230.00	N/mm²

4.2.4.4 Soil stiffness values

Auxiliary value for horizontal bedding stiffness:	Δ_f	1.667	[-]
Correction factor for horizontal bedding stiffness:	ζ	1.000	[-]
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
Vertical bedding stiffness:	S_{Bv}	16.000	N/mm²

4.2.4.5 Bedding angle, effective relative projection and friction angle

Bedding angle, effective relative projection and friction angle:	2α	120	°
Height bedding from bedding angle to lower pipe ledge:	t_r	0.068	m
Calculated relative projection:	a	1.00	[-]
Effective relative projection:	a'	1.438	[-]
Internal friction angle:	φ'	30.000	°
Wall friction angle:	δ	30.000	°

4.2.4.6 Characteristic values of pipe material and ring stiffness

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Pipe stiffness	S_R	80,000	43,871	40,000	N/m²
Characteristic value of ultimate strain for edge fibers	ε_R	1.448	0.925	0.869	%
Characteristic value of Young's modulus in ring direction	$E_{R,rad}$	10,456.2	5,734.1	5,228.1	N/mm²

4.2.4.7 Stiffness ratio

System stiffness, weighted	$V_{RB,w}$	0.0083	0.0046	0.0042	[-]
Stiffness ratio	V_S	0.4039	0.3317	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.4.8 Coefficients

Ground pressure ratio (bedding)	K_2	0.400	0.400	---	[-]
Coefficient for bedding reaction pressure	K*	1.202	1.266	---	[-]
Resulting deformation coefficient	c'_h	0.0891	0.0891	---	[-]
Resulting deformation coefficient	$c'_{h,qh}$*	-0.0658	-0.0658	---	[-]
Coefficient for vertical deformation	c_v*	-0.012	-0.008	---	[-]

4.2.4.9 Concentration factors λR and λB

Maximum concentration factor	max λ	2.279	2.279	---	[-]
Coefficient for maximum concentration factor	K'	0.920	0.912	---	[-]
Concentration factor above pipe, initial value	λ_R	0.784	0.730	---	[-]
Concentration factor above pipe, under trench effect	λ_{RG}	0.784	0.730	---	[-]

Concentration factor above pipe, upper limit	λ_{fo}	3.505	3.505	---	[-]
Concentration factor above pipe, lower limit	λ_{fu}	0.143	0.143	---	[-]
Concentration factor above pipe, final value	λ_{RG}	0.784	0.730	---	[-]
Soil concentration factor	λ_B	1.072	1.090	---	[-]

4.2.4.10 Pressure distribution at pipe circumference

		short term All loads	long term Soil loads Traffic load	long term other Loads	
Total vertical load	q_v	38.55	36.19	---	kN/m²
Lateral pressure	q_h	19.14	19.46	---	kN/m²
Bedding reaction pressure (soil load)	q^*_h	24.83	22.80	---	kN/m²
Bedding reaction pressure (water filling)	q^*_{hw}	1.28	1.36	---	kN/m²

4.2.5 Section forces

4.2.5.1 Section forces with minimum groundwater, short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.260	-0.264	0.274	kNm/m
Moment due to lateral pressure	M_{qh}	-0.130	0.130	-0.130	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.111	0.128	-0.111	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.020	-0.008	0.036	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.203	-7.501	-0.203	kN/m
Normal force due to lateral pressure	N_{qh}	-3.908	0.000	-3.908	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-2.668	0.000	-2.668	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-6.358	-7.486	-6.637	kN/m

4.2.5.2 Section forces with minimum groundwater, long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.243	-0.247	0.256	kNm/m
Moment due to lateral pressure	M_{qh}	-0.132	0.132	-0.132	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.100	0.115	-0.100	kNm/m

Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.011	0.000	0.026	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.189	-6.998	-0.189	kN/m
Normal force due to lateral pressure	N_{qh}	-3.975	0.000	-3.975	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-2.402	0.000	-2.402	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	0.000	0.000	0.000	kN/m
Total normal forces	ΣN	-6.178	-6.982	-6.431	kN/m

4.2.5.3 Section forces with maximum groundwater, short term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Moment due to total vertical load	M_{qv}	0.178	-0.181	0.188	kNm/m
Moment due to lateral pressure	M_{qh}	-0.085	0.085	-0.085	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.079	0.091	-0.079	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.015	-0.006	0.026	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.138	-5.128	-0.138	kN/m
Normal force due to lateral pressure	N_{qh}	-2.546	0.000	-2.546	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-1.905	0.000	-1.905	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.098	0.000	-0.098	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	-3.808	-3.808	-3.808	kN/m
Total normal forces	ΣN	-8.105	-8.920	-8.256	kN/m

4.2.5.4 Section forces with maximum groundwater, long term

Rerounding factor (reduction moments):			r	1.000	[-]
		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm

Moment due to total vertical load	M_{qv}	0.167	-0.170	0.176	kNm/m
Moment due to lateral pressure	M_{qh}	-0.086	0.086	-0.086	kNm/m
Moment due to horizontal bedding reaction pressure	M^*_{qh}	-0.073	0.084	-0.073	kNm/m
Moment due to horizontal bedding reaction pressure (water filling)	M^*_{qw}	-0.004	0.005	-0.004	kNm/m
Moment due to dead weight	M_g	0.001	-0.001	0.001	kNm/m
Moment due to water filling	M_w	0.004	-0.005	0.006	kNm/m
Moment due to water pressure/internal pressure	M_{pw}	0.000	0.000	0.000	kNm/m
Total moments	ΣM	0.009	-0.001	0.020	kNm/m

		crown	springline	invert	
Mean radius	r_m	133.00	133.00	133.00	mm
Normal force due to total vertical load	N_{qv}	0.130	-4.814	-0.130	kN/m
Normal force due to lateral pressure	N_{qh}	-2.588	0.000	-2.588	kN/m
Normal force due to horizontal bedding reaction pressure	N^*_{qh}	-1.749	0.000	-1.749	kN/m
Normal force due to horizontal bedding reaction pressure (water filling)	N^*_{qw}	-0.104	0.000	-0.104	kN/m
Normal force due to dead weight	N_g	0.004	-0.023	-0.004	kN/m
Normal force due to water filling	N_w	0.111	0.038	0.243	kN/m
Normal force due to water pressure/internal pressure	N_{pw}	-3.808	-3.808	-3.808	kN/m
Total normal forces	ΣN	-8.005	-8.606	-8.140	kN/m

4.2.6 Short term load case

4.2.6.1 Strain proof (with minimum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]

		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.021	-0.022	0.043	%
Strain due to other loads	ε_{sonst}	0.002	-0.002	0.005	%
Total strain	ε	0.023	-0.025	0.048	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	64.147	---	30.282	[-]
Safety coefficient flexural compression:	γ_{BD}	---	58.945	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]

	crown	springline	invert

Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.040	-0.002	-0.063	%
Strain due to other loads	ε_{sonst}	-0.002	0.002	-0.004	%
Total strain	ε	-0.042	0.000	-0.067	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	4,390.756	---	[-]
Safety coefficient flexural compression:	γ_{BD}	34.582	---	21.533	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.6.2 Strain proof (with maximum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.016	-0.016	0.031	%
Strain due to other loads	ε_{sonst}	-0.004	-0.008	-0.001	%
Total strain	ε	0.011	-0.024	0.029	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	130.123	---	49.207	[-]
Safety coefficient flexural compression:	γ_{BD}	---	60.090	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.029	-0.001	-0.044	%
Strain due to other loads	ε_{sonst}	-0.008	-0.004	-0.010	%
Total strain	ε	-0.036	-0.005	-0.054	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	1.45	1.45	1.45	%
Safety coefficient flexural tension:	γ_{BZ}	---	---	---	[-]
Safety coefficient flexural compression:	γ_{BD}	39.943	312.749	26.577	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.6.3 Deformation proof (with minimum groundwater)

Calculation mode:		linear	
Ratio:		I/(A·rm²)	0.00017 [-]
Ratio 'I/(A·rm²)·κ~Q':		I/(A·rm²)·κ_Q	0.00020 [-]

q_v	q_h	q_h^*

Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.21	mm
Horizontal diameter change:	Δd_h	0.96	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.45	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.45	%

Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.6.4 Deformation proof (with maximum groundwater)

Calculation mode:		linear	
Ratio:	I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':	$I/(A \cdot rm^2) \cdot \kappa_Q$	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	0.86	mm
Horizontal diameter change:	Δd_h	0.69	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.32	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.32	%

Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.7 Long term load case

4.2.7.1 Strain proof (with minimum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:	erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:	erf γ_{RBD}	2.00	[-]

Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:	α_{ki}	1.015	[-]

		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.013	-0.019	0.052	%

Strain due to other loads	ε_{sonst}	0.003	-0.003	0.009	%
Total strain	ε	0.016	-0.022	0.061	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.90	0.90	0.90	%
Safety coefficient flexural tension:	γ_{BZ}	55.376	---	14.706	[-]
Safety coefficient flexural compression:	γ_{BD}	---	40.797	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.050	-0.023	-0.089	%
Strain due to other loads	ε_{sonst}	-0.003	0.003	-0.008	%
Total strain	ε	-0.052	-0.020	-0.097	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.91	0.90	0.90	%
Safety coefficient flexural tension:	γ_{BZ}	---	---	---	[-]
Safety coefficient flexural compression:	γ_{BD}	17.339	45.787	9.286	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.7.2 Strain proof (with maximum groundwater)

$$\varepsilon_{R,res} = \frac{|\varepsilon_{qv,qh,qh^*}| \cdot \bar{\varepsilon}_R + |\varepsilon_{sonst}| \cdot \varepsilon_{R,L}}{|\varepsilon_{qv,qh,qh^*}| + |\varepsilon_{sonst}|} \qquad (9.01d)$$

Required safety coefficient, bending tensile stress:			erf γ_{RBZ}	2.00	[-]
Required safety coefficient, bending compressive stress:			erf γ_{RBD}	2.00	[-]
Flexural tensile strength to be considered	$f_{t,fl,res}$	---	---	---	N/mm²
Flexural compressive strength to be considered	$f_{c,rad,res}$	---	---	---	N/mm²

Inside

Curve correction factor, internal:			α_{ki}	1.015	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	0.012	-0.013	0.037	%
Strain due to other loads	ε_{sonst}	-0.010	-0.016	-0.003	%
Total strain	ε	0.002	-0.029	0.034	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.90	0.90	0.92	%
Safety coefficient flexural tension:	γ_{BZ}	458.661	---	26.899	[-]
Safety coefficient flexural compression:	γ_{BD}	---	30.989	---	[-]

outside

Curve correction factor, external:			α_{ka}	0.985	[-]
		crown	springline	invert	
Strain due to earth- and trafficloads	ε_{qv,qh,qh^*}	-0.035	-0.015	-0.062	%
Strain due to other loads	ε_{sonst}	-0.015	-0.009	-0.020	%
Total strain	ε	-0.050	-0.023	-0.082	%
Ultimate outer fiber strain to be considered	$\varepsilon_{R,res}$	0.91	0.91	0.91	%

Safety coefficient flexural tension:	γ_{BZ}	---	---	---	[-]
Safety coefficient flexural compression:	γ_{BD}	18.245	38.793	11.140	[-]

All calculated safety coefficients of the strain proof are sufficient.

4.2.7.3 Deformation proof (with minimum groundwater)

Calculation mode:		linear		
Ratio:		I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':		I/(A·rm²)·κ_Q	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	1.28	mm
Horizontal diameter change:	Δd_h	0.87	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.48	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.48	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.7.4 Deformation proof (with maximum groundwater)

Calculation mode:		linear		
Ratio:		I/(A·rm²)	0.00017	[-]
Ratio 'I/(A·rm²)·κ~Q':		I/(A·rm²)·κ_Q	0.00020	[-]

		q_v	q_h	q_h^*	
Deflection coefficient for bending moments	c_v	-0.0893	0.0833	0.0640	[-]

The modifictaion of the coefficients for the moments according to ATV-DVWK-A 127 table 10a is not used, because formula 6.19a and formula 6.19b < 0.001

Resulting deformation coefficient	c'_v	-0.0893	0.0833	0.0640	[-]
Resulting deformation coefficient	c'_h	0.0891	-0.0833	-0.0658	[-]

Vertical diameter change:	Δd_v	0.92	mm
Horizontal diameter change:	Δd_h	0.63	mm

Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.35	%
Predeformation (e. g. due to manufacturing, plastic, Type A):	$\delta_{v,A}$	1.00	%
Total vertical deformation (Type A + Type B):	$\delta_{v,Ges}$	1.35	%
Allowable deflection:	zul δ_v	6.00	%

The deflection determined is less than the permissible deflection.

4.2.7.5 Stabilty proof radial, linear (with maximum groundwater)

Earth and traffic loads

Pipe stiffness:	$\overline{S}_R$	43,871	N/m²
Horizontal bedding stiffness:	S_{Bh}	9.600	N/mm²
System stiffness, weighted:	$V_{RB,w}$	0.0046	[-]
Reduction factor buckling load for earth/traffic loads:	κ_{v2}	0.87	[-]
Friction angle in bedding zone:	φ'_2	35.000	°
Critical vertical total load:	krit q_v	1,133.4	kN/m²
Total vertical load:	q_v	36.19	kN/m²

Safety coefficient buckling (total vertical load):	γ_{qv}	31.32	[-]
Water pressure + Negative pressure			
Outer water pressure:	p_a	28.00	kN/m²
Vacuum in the pipe:	p_{I-}	0.00	kN/m²
Pipe stiffness:	S_R	40,000	N/m²
System stiffness:	V_{RB}	0.0042	[-]
Ratio radius to wall thickness:	r_m/s	22.17	[-]
Reduction factor due to local predeformation for the disruptive load at outer water pressure:	$\kappa_{a1,pa}$	1.00	[-]
Relative vertical deformation (due to loads, elastic, Type B):	$\delta_{v,B}$	0.35	%
Predeformation sum:	δ_v	0.35	%
Reduction factor:	$\kappa_{a2,pa}$	0.90	[-]
Reduction factor:	$\kappa_{a,pa}$	0.90	[-]
Snap-trough coefficient:	$\alpha_{D,pa}$	15.355	[-]
Critical pressure:	krit p_a	553.080	kN/m²
Water pressure + vacuum in the pipe:	p_{a+I-}	28.00	kN/m²
Safety coefficient stability pressure:	$\gamma_{Stab,pa}$	19.753	[-]
Superposition			
Safety stability, radial:	$\gamma_{Stab,rad}$	12.11	[-]
Required safety coefficient, instability (buckling):	erf γ_{stab}	2.50	[-]

The buckling proof is fulfilled.

4.2.7.6 stability proof, nonlinear (with minimum groundwater)

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

4.2.7.7 stability proof, nonlinear (with maximum groundwater)

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

4.2.7.8 Proof of safety against failure with not predominantly static loading

According to the standard the dynamic proof is not required (e.g. traffic load > 1,5 m).

All necessary proofs are ok.

5 Appendix

Amiblu®
Sustainable Water Solutions

FLOWTITE® | HOBAS®

Input Data for structural analysis

of application buried pipes in open trench condition, calculation acc. DWA-A 127

Please send to:
Amiblu Holding GmbH
Pischeldorfer Straße 128
A-9020 Klagenfurt
T +43 463 482424
info@amiblu.com

9601 PZI Kanalizacija Unec-Slivice	
project	
LUZ d.d.	Maja Klančar
company	contact person
Verovškova ulica 64	(01) 36 02 446
street	phone/Fax:
1000	Text input.
postcode	signature:
Ljubljana	Text input.
city	date/stamp

Pipe Details:

nominal diameter DN	250
pressure class PN	PN1
nominal stiffness SN	10000
pipe material	GRP

sewer pipe	☒
sewer pressure pipe	☐
pressure pipe	☐
potable water pipe	☐
installation in protective water area	☐
air pipe	☐
storage sewer	☐
others	Text input.

Types of native soil: acc. ATV-DVWK-A 127; DIN 18196 (please subsoil expertise ad)

		Native soil	backfilling	Pipe zone
G1	Non cohesive soils (gravel, sand) (GE, GW, GI, SE, SW, SI)	☐	☒	☒
G2	Slightly cohesive soils (GU, GT, SU, ST)	☒	☐	☐
G3	Cohesive mixed soils, silt (GÜ, GŤ, SÜ, SŤ, UL, UM)	☐	☐	☐
G4	Cohesive soils, except silts (TL, TM, TA, OU, OT, OH, UA)	☐	☐	☐
Other types of soil	Text input.	☐	☐	☐

Proctor density for native soil (Proctor density 85 – 100 %): 98 %

Foundation of pipeline
- ☒ On native soil
- ☐ very hard and rocky
- ☐ Weak soil, not stable for foundation

Soil replacement: thickness Text input. m
material Text input.
Proctor density D_{Pr} Text input. %

Specification of loads:

	Min. cover depth		Max. cover depth	
Depth of earth cover h	1,00	m	3,3	m
min. Ground water h_w above pipe invert	Text input.	m	Text input.	m
max. Ground water h_w above pipe invert	Text input.	m	Text input.	m

Other surface loads Text input. kN/m²

For pressure pipes
Short term: Text input. bar, e.g. system test pressure; hydrostatic pressure, water hammer
Long term: Text input. bar, e.g. operating pressure (OP), system pressure (PN, DP)

Traffic load
☐ no traffic

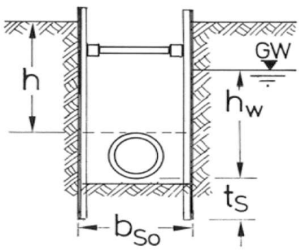
street
- ☐ HCL 60
- ☐ HCL 30
- ☒ HGV 12
- ☐ DIN EN 1991-2, TS und UDL
  - ☐ LM1-lane 3,00 m
  - ☐ LM1-lane 2,70 m
  - ☐ LM1-green field area

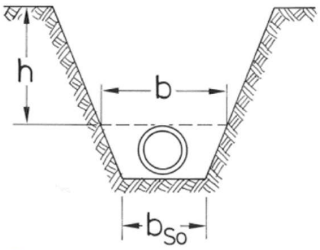
railway
- ☐ one track, UIC
- ☐ two tracks, UIC
- ☐ one track, LM 71
- ☐ two tracks, LM 71

aircraft
- ☐ BFZ 90
- ☐ BFZ 180
- ☐ BFZ 350
- ☐ BFZ 550
- ☐ BFZ 750

Other loads, e.g. special vehicle (please add load scheme with axle, wheels and wheel loads):
Text input.

Building construction:





Type of trench ☐ embankment ☐ single trench ☒ double trench [1] ☐ stepped trench [1]
[1] For special shapes add a sketch

Trench angel ☐ 90° ☒ 60° ☐ 45° ☐ Text input.

Width of trench b = 2.3 m at pipe crown

b_{So} = 1.3 m at pipe trench bottom inclusive planks

Trench planking

☒ no planks

☐ Horizontal planks, also applies to plank walls (Berlin lining)
☐ Planking with plates
☐ Vertical plank with light weight
☐ Vertical plank with boards *
☐ Vertical plank with light weight *
☐ Vertical plank with sheet piling *

bedding

☐ on native soil (acc. EN 1610)
☒ on gravel, sand
☐ on concrete [2)]

[2)] only as spezial construction in agreement with the pipe producer

bedding angle 2α

☐ 90° ☐ 120°
☐ 180°

* Depth of sheeting below pipe invert t_S = Text input. m

*thickness of plank (one-side) b_S = Text input. m

Cover condition for backfilling:

A1 ☐ Backfilling compacted in layers against the native soil (without proof of compaction degree); also applies to plank walls, Berlin lining

A2 ☐ Vertical pipe trench lining with boards that are not removed before backfilling. Lining boards or devices that are removed step by step during backfilling. Non-compacted backfilling/ backfilling with slurry (only suitable for soils of group G1).

A3 ☐ Vertical trench lining with sheet piling, light weight sheet connection, wooden planks, lining boards or devices that are not removed before backfilling.

A4 ☒ Backfilling compacted in layers against the native soil with proof of the required compaction degree to ZTVE-StB ; also applies to plank walls (Berlin lining). Cover condition A4 is not applicable to sails of group G4.

Bedding condition for pipe:

B1 ☒ Bedding compacted in layers against the native soil or in the embankment (without proof of compaction degree); also applies to plank walls, Berlin lining

B2 ☐ Vertical lining in the pipe zone with planks that reach down to the trench bottom and are not removed before backfilling and compaction. Lining boards or devices provided that the soil is compacted after the linings are removed.

B3 ☐ Vertical lining in the pipe zone with sheet piling or lightweight sheeting and compaction against the lining reaching down below the trench bottom. There is no safe calculation model for determining vertical lining with wooden planks, boards or devices that are not removed before backfilling and compaction the pipe zone.

B4 ☐ Bedding compacted in layers against the native soil or in the embankment with proof of the required compaction degree to ZTVE-StB. Bedding condition B4 does not apply to soils of group G4.

G GRAFIČNI DEL

G/1	TEHNIČNI PRIKAZI	
LIST	VSEBINA	MERILO
1	**Situacije kanalizacije**	
1.1	Situacija kanalizacije 1	M 1:1000
1.2	Situacija kanalizacije 2	M 1:1000
1.3	Situacija kanalizacije 3	M 1:1000
1.4	Situacija kanalizacije 4	M 1:1000
2	**Situacije objektov**	
2.1	Situacija črpališča: ČRP 1	M 1:50
2.2	Situacija črpališča: ČRP 3	M 1:50
2.3	Situacija črpališča: ČRP 4	M 1:50
2.4	Situacija črpališča: ČRP 5	M 1:50
3	**Hidravlična situacija**	
3.1	Hidravlična situacija 1	M 1:2000
3.2	Hidravlična situacija 2	M 1:2000
4	**Zbirnik komunalnih vodov**	
4.1	Zbirnik komunalnih vodov 1	M 1:1000
4.2	Zbirnik komunalnih vodov 2	M 1:1000
4.3	Zbirnik komunalnih vodov 3	M 1:1000
4.4	Zbirnik komunalnih vodov 4	M 1:1000
5	**Vzdolžni profili vodovoda**	
5.1	Vzdolžni profil R2(1)	1:1000/100
5.2	Vzdolžni profil R1.S2 (1), R2.S1, R2.S2	1:1000/100
5.3	Vzdolžni profil R1T	1:1000/100
5.4	Vzdolžni profil R5, R5.1	1:1000/100
5.5	Vzdolžni profil R5.1T, R5.2	1:1000/100
5.6	Vzdolžni profil R5.S1, R5.S2	1:1000/100
5.7	Vzdolžni profil R6, R6T	1:1000/100
5.8	Vzdolžni profil R6.2, R6.2.1, R6.S1	1:1000/100
5.9	Vzdolžni profil R6.S2, R6.S2.1, R6.S3	1:1000/100
5.10	Vzdolžni profil R6.S3.1, R6.S3.1.1, R6.S3.1.2, R6.S3.1.3, R6.S3.2	1:1000/100
5.11	Vzdolžni profil R6.S4, R6.S4.1, R6.S4.T	1:1000/100
5.12	Vzdolžni profil R7	1:1000/100

5.13	Vzdolžni profil R7.S3, R7.S2	1:1000/100
6	**Karakteristični prečni prerezi**	
6.1	Prečni prerez 1-1 in 2-2	M 1:50
6.2	Prečni prerez 5-5 in 5a-5a	M 1:50
6.3	Prečni prerez 6-6 in 7-7	M 1:50
6.4	Prečni prerez 8-8 in A-A	M 1:50
7	**Črpališča: tlorisi in prerezi**	
7.1	Načrt črpališča ČRP1	M 1:50
7.2	Načrt črpališča ČRP3	M 1:50
7.3	Načrt črpališča ČRP4	M 1:50
7.4	Načrt črpališča ČRP5	M 1:50
8	**Črpališča: armaturni načrti**	
8.1	Armaturni načrt črpališča ČRP1	M 1:50
8.2	Armaturni načrt črpališča ČRP3	M 1:50
8.3	Armaturni načrt črpališča ČRP4	M 1:50
8.4	Armaturni načrt črpališča ČRP5	M 1:50
9	**Detajli**	
9.1	Detajl polaganja pod kotom in detajl vertikalnega izkopa	
9.2	Detajl križanja z elektro kablovodom	
9.3	Detajl križanja z vodovodom	
9.4	Detajl križanja s TK vodom	
9.5	Detajl revizijskega jaška	
9.6	Detajl kaskadnega revizijskega jaška	
9.7	Priključevanje tlačnega voda na gravitacijsko kanalsko omrežje	
9.8	Detajl jaška s čistilnim kosom/blatnikom	
9.9	Detajl jaška z zračnikom	
9.10	Detajl direktnega priklopa na kanalizacijsko cev pod kotom 45°	
9.11	detajl direktnega priklopa na kanalizacijsko cev pod kotom 15°	