OPTIMAL SOLUTION

PECOR OPTIMA®

ViaCon® Polska

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PECOR OPTIMA® - exceptional, helically corrugated double wall pipes with smooth inside are used for building culverts and outdoor sewage system. The unique structure of PECOR OPTIMA® pipes is a result of Scandinavian long- term experience in culvert & sewage technology.

PECOR OPTIMA® system finds a broad application in civil engineering

Advantages of using system PECOR OPTIMA®

- no needs to use heavy equipment for installation
- variety of possibilities due to wide range of fittings
- fast & easy assembly (light-weighted)
- low transportation costs
- optimal strength and hydraulic parameters
- resistance to corrosion
- resistance to chemicals
- possibility to install in subzero temperatures
- available in various lengths
  (standard lengths : 6m, 7m, 8m, max. 12m)
- possibility to make bevel ends in a factory

1. Application

PECOR OPTIMA® system is widely used in civil engineering. Due to the fast assembly and very good strength and hydraulic parameters, the system has received wide recognition among designers and contractors.

PECOR OPTIMA® system is produced in ViaCon Poland factory located in Rydzyna near Leszno

Unique spiral structural wall allows to get the optimal stress distribution on the whole pipe length and ensure the proper ring stiffness on each section. Smooth inside wall of PECOR OPTIMA® pipes allows to achieve good hydraulic parameters.

Pipes are light-weighted and easy to assembly thanks to structure and raw material used for the production.

PECOR OPTIMA® pipes are manufactured of high density polyethylene, and are used as :

- **Culvert pipes PECOR OPTIMA®** – designed for roads and railways culverts, forest roads, access roads, embankments and land melioration.
- **Gravity sewage system PECOR OPTIMA® W** – designed for building non pressure sewage. PECOR OPTIMA® Watertight pipes are produced with the use of PECOR OPTIMA® culvert pipes.
- **Manholes PECOR OPTIMA® M** – used for building non pressure sewage system. PECOR OPTIMA® M manholes are produced with the use of PECOR OPTIMA® culvert pipes.
- **Retention tanks and separators PECOR OPTIMA®.**

Other applications for PECOR OPTIMA® system:

- **industrial ventilation**
- **agro-ventilation**

2. Material

Raw material which is used for the production of PECOR OPTIMA® system is high density polyethylene (HDPE).

Mechanical and physical characteristic properties are provided below:

- density: 0,942 [g/cm³]
- Young modulus [2]:
  - $E_{short\text{-}term} = 600 \div 1000$ [MPa]
  - $E_{long\text{-}term} = 150 \div 300$ [MPa]
- ultimate elongation: >800 [%]
- melt flow index MFI: 0,15 – 0,50 [g/10min] for loading 2,16 kg
- coefficient of linear thermal expansion: $\alpha = (1{,}5 \div 2{,}0) * 10^{-4}$ [1/°C]
- working temperature range : -30°C ÷ +75 [°C]

There is a mixture of polyethylene and black coloring dye stabilized on UV radiation used for PECOR OPTIMA® production. Standard PECOR OPTIMA® pipes are produced in black color.

High density polyethylene (HDPE) is characterized by a very good resistance to chemicals – see table 1

Table 1

Item.	Chemicals	Concentration	Temp. +20°C	Temp. +60°C
1	Acetone	100%	+	+
2	Methanol	100%	++	++
3	Petrol		++	+
4	Nitric acid	25%	++	-
5	Nitric acid	50%	+	-
6	Nitric acid	100%	-	-
7	Sulfuric	50%	++	++
8	Sulfuric	100%	++	++
9	Urine		++	++
10	Oil & fat		++	+
11	Mineral oil		++	+
12	Sulfide	100%	++	++

(++) – satisfactory resistance , (+) – limited resistance, (-) – dissatisfactory resistance

According to the latest PPI research (Plastics Pipes Institute) corrgated pipes produced of polyethylene can be designed on the assumption of 100 years lifetime.

3. Technical characteristic of PECOR OPTIMA® pipes

Structure of PECOR OPTIMA® pipes.

PECOR OPTIMA® pipes are produced with double wall, smooth inside and corrugated outside (figure 1). The corrugation is stiff and can interact with surrounded soil.

The corrugation size and the distance between corrugation depend on the diameter of the pipe (the bigger dimension, the larger corrugation).
Corrugation detail of PECOR OPTIMA® pipes is shown in figure 2.
The dimensions and the tolerances are presented in table 2.

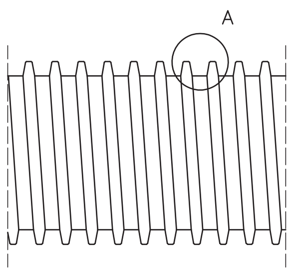


Figure 1 – View of PECOR OPTIMA® pipe

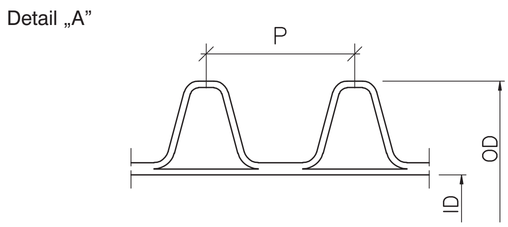


Figure 2 – Corrugation detail of PECOR OPTIMA®

Table 2

Item.	Nominal diameter DN [mm]	Outside diameter OD [mm]	Inside diameter ID [mm]	Area [mm²]	Period of corrugation P [mm]
1	200	232±2%	200±2%	0,03	25,8
2	300	357±2%	300±2%	0,07	55,5
3	400	477±2%	400±2%	0,13	74,0
4	500	593±2%	500±2%	0,20	92,0
5	600	724±2%	600±2%	0,28	108,0
6	700	824±2%	700±2%	0,38	108,0
7	800	970±2%	800±2%	0,50	140,0
8	900	1070±2%	900±2%	0,64	140,5
9	1000	1175±2%	1000±2%	0,79	142,0
10	1200	1375±2%	1200±2%	1,13	142,0
11	1400	1600±2%	1400±2%	1,54	150,0

Nominal diameters (DN) of PECOR OPTIMA® pipes refer to inside diameters (ID)

4. Strength, hydraulic parameters

Ring stiffness (SN)

Ring stiffness is parameter that characterizes strength of PECOR OPTIMA® pipes. This value is specified by the producer for each production batch. Nominal ring stiffness of PECOR OPTIMA® pipes means the minimal value that is guaranteed for each batches.

Ring stiffness test is made in our local laboratory and is to do with defining the needed strength for deforming 3% of inside dimension of pipe.
Ring stiffness test is performed in accordance with PN-EN ISO 9969

Ring stiffness of PECOR OPTIMA® pipes is much higher than declared nominal value*).

Ring stiffness significantly influences on pipes deformation in soil.

Acceptable deformation of PECOR OPTIMA® pipe is 3% (short-term deformation) ,

6% (long-term deformation)

*) in order to get more information you are welcome to contact ViaCon Poland technical department.

Standard PECOR OPTIMA® pipes are produced in the following classes of ring stiffness :

- SN 4 (4 kPa) – pipes 1400 mm
- SN 6 (6 kPa) – pipes from 300 mm to 1200 mm
- SN 8 (8 kPa) – pipes from 200 mm to 1000 mm
- there is a possibility to produce pipes in SN 10 for diameters from 300 mm to 1000 mm on special order

Hydraulic parameters

Diameters of pipe should be determined on the basis of hydraulic calculation , depending on expected volume of flow.

Water flow Q_m is calculated according to the Manning's formula :

$$Q_m = \frac{A \cdot R^{2/3} \cdot S^{1/2}}{n} \qquad [m^3/s]$$

where:

Q_m – reliable flow $[m^3/s]$

n – Manning's coefficient , assumed n= 0,012 for PECOR OPTIMA® pipes

R – hydraulic radius [m]

A – flow area $[m^2]$

S – hydraulic gradient

Figure 3 shows the reference water flow Q_m for PECOR OPTIMA® pipes with water flow at 75% height but at least 25 cm from the crown according to Polish regulations. Water-flow regulations may differ slightly depending on national standards.
Figure 4 shows the values of water flow Q_m of PECOR OPTIMA® pipes for 100% filling.

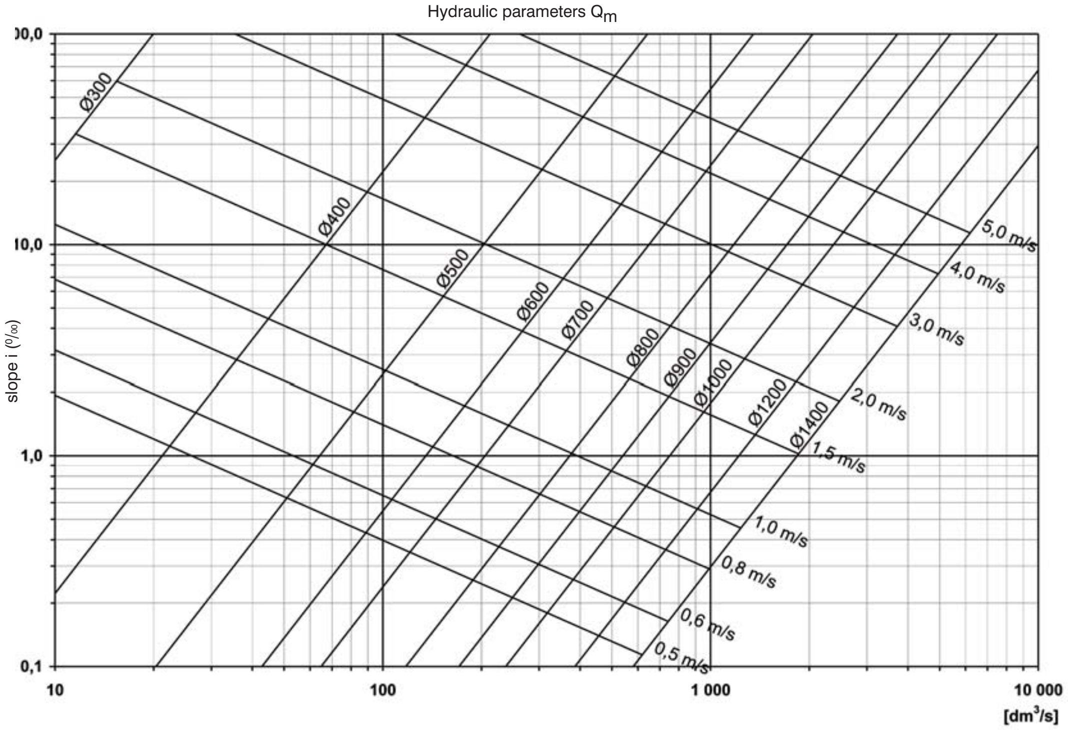


Figure 3 – Water flow Q_m for PECOR OPTIMA® pipes with water level at 75% height but at least 25 cm from the crown, according to the regulations

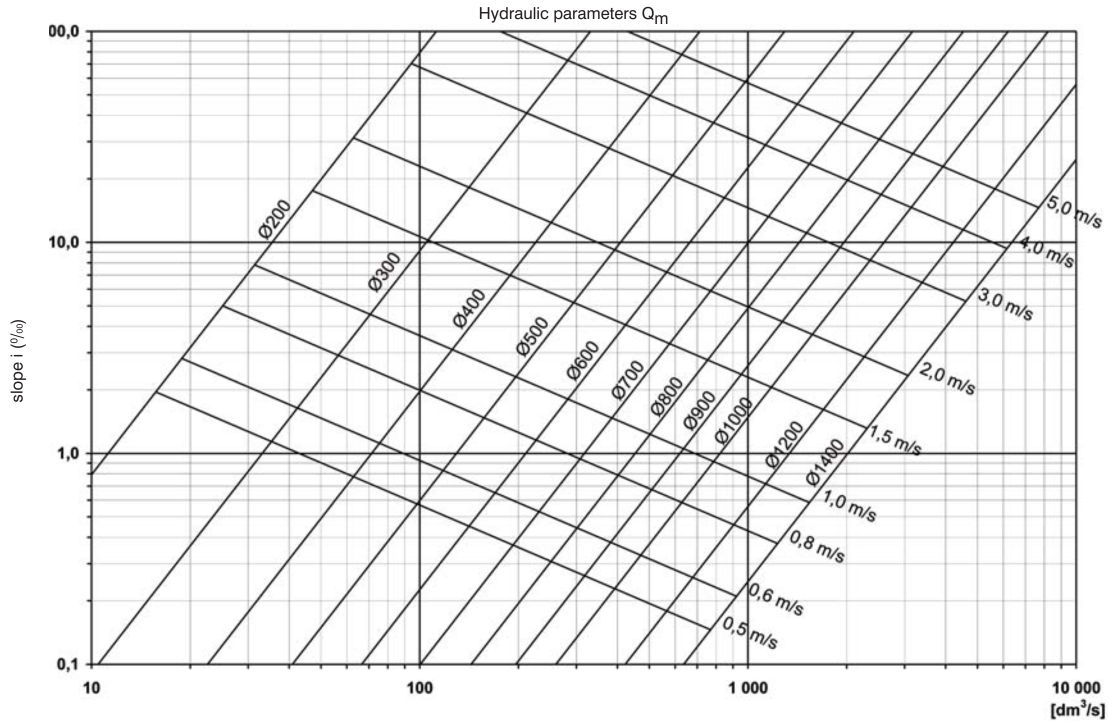


Figure 4 – Water flow Q_m for PECOR OPTIMA® pipes with water level at 100% height

The water flow with partly filling is based on efficiency curves shown in figure 5 .

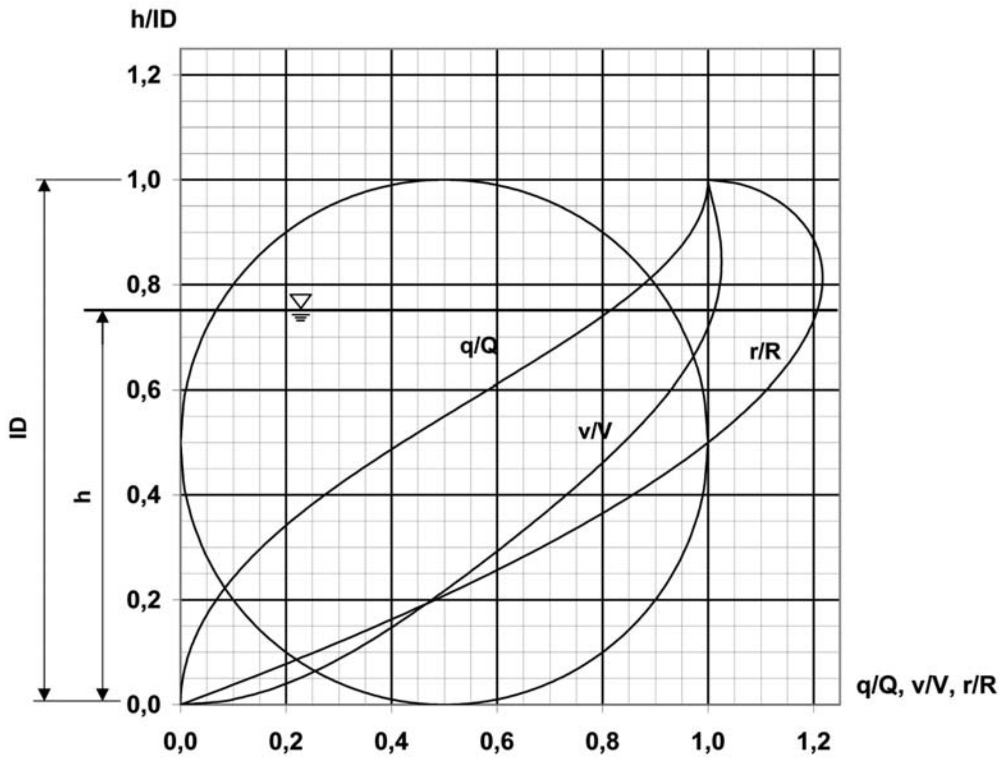


Figure 5 – Efficiency of circular section

h – partly filled height [m]

ID – fully filled height [m]

$\frac{q}{Q}$ – flow intensity for different water level

$\frac{v}{V}$ – flow velocity for different water level

$\frac{r}{R}$ – hydraulic radius ratio

5. PECOR OPTIMA® culvert pipes - application

Application

PECOR OPTIMA® pipes produced by ViaCon Poland are perfect for use in engineered structures:

- roads and railway culverts
- ecological passages (for animals)
- forestry culverts
- shaft construction
- relining of existing old culverts

PECOR OPTIMA® culvert pipes in ring stiffness SN8 can be used for each class of live load.

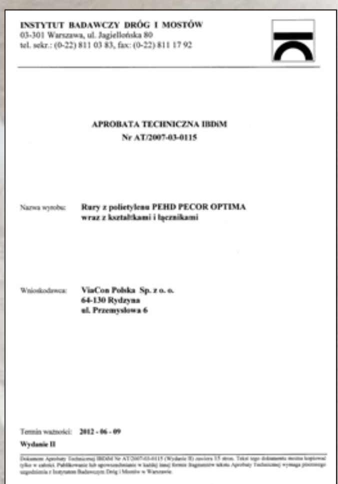
PECOR OPTIMA® pipes can be used as curved in plane and profile.

Broad range of fittings (elbows, T-pipes, reductions), which make up complete system, is used.

Technical approvals, opinions:

PECOR OPTIMA® pipes have the following documents:

- Technical Approval issued by Polish Road and Bridge Research Institute IBDiM no. AT/2007-03-115
- positive opinion from Polish Central Mining Institute (GIG) for use of pipes on subsidence areas



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APROBATA TECHNICZNA IBDiM
Nr AT/2007-03-0115

Nazwa wyrobu: Rury z polietylenu PEHD PECOR OPTIMA wraz z kształtkami i łącznikami

Wnioskodawca: ViaCon Polska Sp. z o. o.
64-130 Rydzyna
ul. Przemysłowa 6

Termin ważności: 2012 - 06 - 09

Wydanie II

GŁÓWNY INSTYTUT GÓRNICTWA

ZAKŁAD INŻYNIERII MATERIAŁOWEJ

Katowice 28.02.2007 r.

Opinia Techniczna

dotycząca spełnienia warunków stosowania na terenach objętych wpływami eksploatacji górniczej rur kanalizacyjnych i przepustowych oraz studzienek z HDPE o ściankach strukturalnych PecorOptima

Zleceniodawca: ViaCon Sp. z o.o.
64-130 Rydzyna k. Leszna, ul. Przemysłowa 6

Producent: Grupa ViaCon

Kierownik Laboratorium: (pieczątka i podpis)

Kierownik Zakładu: (pieczątka i podpis)

Egzemplarz nr 2

ZINTEGROWANY INSTYTUT NAUKOWO-TECHNOLOGICZNY

6. Section length and coupling band

Standard length for PECOR OPTIMA® pipes

The standard lengths of PECOR OPTIMA® pipes are L= 6 m, 7 m, 8 m (pipes from DN 300 mm to 1200 mm).

PECOR OPTIMA® pipes in DN 200 mm are available in length of 6,0 m.

The production process allows to make any length of pipe (max. up to 12 m, concerning pipes from DN 300 mm to 1000 mm)

Manufacturing tolerance of PECOR OPTIMA® length is +0,3% L

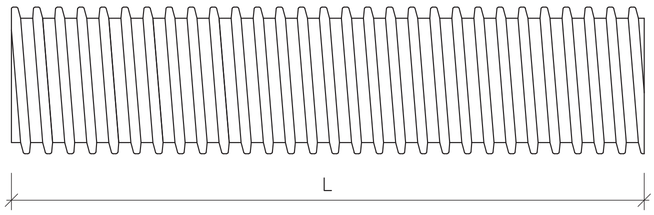


Figure 6 – PECOR OPTIMA® culvert pipe

Length of pipes should be adjusted to the culvert length. Required length of pipe should be in accordance with composed culvert. It is advisable to make the bevels at the end of pipes culvert inclination and skew angle.

Connections of PECOR OPTIMA®

PECOR OPTIMA® pipes are joined with coupling bands (figure 7). There are three types of coupling bands: full ring (figure 7a), in one connection (figure 7b), in two connections (figure 7c).

PECOR OPTIMA® pipes including coupling bands make up the sand tight system. In other cases, watertight connection is used for example for sewage system PECOR OPTIMA® W.

Figure 7a	Figure 7b	Figure 7c
(ø200 mm)	(from ø300 mm to ø500 mm)	(from ø500 mm to ø1400 mm)

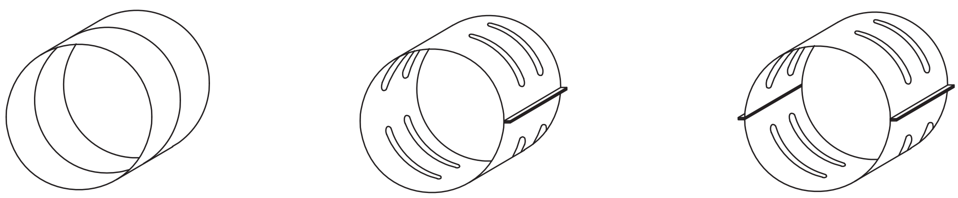


Figure 7 – Coupling bands for PECOR OPTIMA® pipes

7. Pipe end finish

Using PECOR OPTIMA® pipes enables an accurate adjustment of both ends to slope and required angle. Bevel cut can be done on one or both sides with full bevel (figure 8c) or step bevel (figure 8b). It is recommended to use vertical step of 1/3 the height of the pipe.

Figure 8a	Figure 8b	Figure 8c

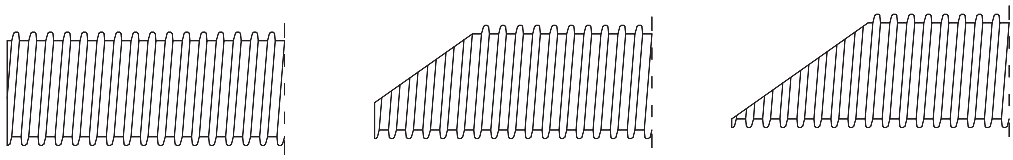


Figure 8 – End finish of PECOR OPTIMA® pipe

There are several possibilities of end finishes:

Vertical end:

- reinforced concrete head wall
- head wall made of gabions

Beveled end:

- slope paved with concrete or stone blocks placed on sand-cement mix
- slope paved with perforated concrete panels
- slope paved with stone rip rap
- reinforced concrete collar

It is recommended to pave bottom of the river. Concrete blocks, stone, gabions or other available material can be used.

Skewed (90°) end can be made for both vertical and beveled end.

Minimum allowable skew angle is 55 °.

In special cases it is necessary to make additional reinforcement in the skewed area.

Please contact ViaCon Poland technical department to get more information.

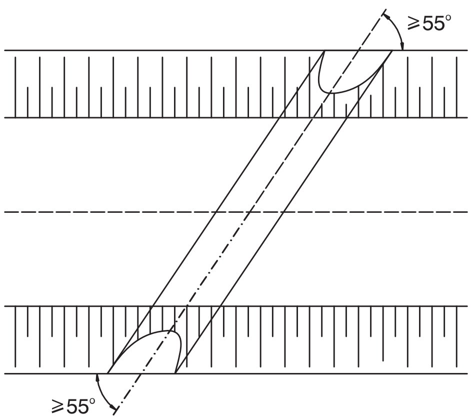
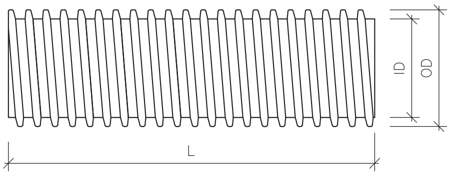


Figure 9 – Skew angle of the pipe

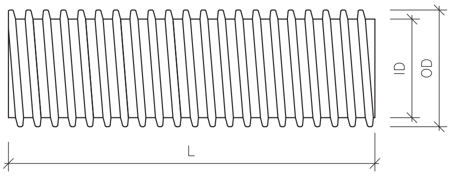
8. PECOR OPTIMA® culvert pipes

PECOR OPTIMA® - SN 4 culvert pipe



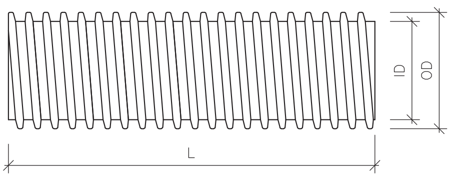
Item.	Symbol	Diameter [mm]		Length [m]
		ID	OD	L
1	PECOR OPTIMA 1400	1400	1600	6, 7, 8

PECOR OPTIMA® - SN 6 culvert pipe



Item.	Symbol	Diameter [mm]		Length [m]
		ID	OD	L
1	PECOR OPTIMA 300	300	357	Standard lengths: 6, 7, 8 m Max. length is 12 m
2	PECOR OPTIMA 400	400	477	
3	PECOR OPTIMA 500	500	593	
4	PECOR OPTIMA 600	600	724	
5	PECOR OPTIMA 700	700	824	
6	PECOR OPTIMA 800	800	970	
7	PECOR OPTIMA 900	900	1070	
8	PECOR OPTIMA 1000	1000	1175	
9	PECOR OPTIMA 1200	1200	1375	6, 7, 8

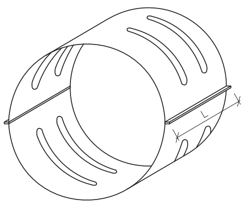
PECOR OPTIMA® - SN 8 culvert pipe



Item.	Symbol	Diameter [mm]		Length [m]
		ID	OD	L
1	PECOR OPTIMA 200	200	232	6,0
2	PECOR OPTIMA 300	300	357	Standard lengths : 6, 7, 8 m Max. length is 12 m
3	PECOR OPTIMA 400	400	477	
4	PECOR OPTIMA 500	500	593	
5	PECOR OPTIMA 600	600	724	
6	PECOR OPTIMA 700	700	824	
7	PECOR OPTIMA 800	800	970	
8	PECOR OPTIMA 900	900	1070	
9	PECOR OPTIMA 1000	1000	1175	
10	PECOR OPTIMA 1200	1200	1375	6, 7, 8

9. Fittings, coupling bands for PECOR OPTIMA® pipes

Coupling band for PECOR OPTIMA® pipes



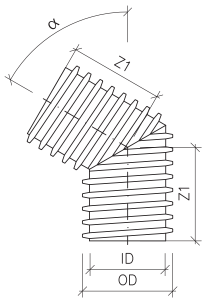
Item.	Symbol	Coupling type	Material	Length L [mm]
1	ZPO 200	full-part	HDPE	250
2	ZPO 300	one-part	HDPE	367
3	ZPO 400	one-part	HDPE	492
4	ZPO 500	two -part	HDPE	500
5	ZPO 600	two -part	HDPE	565
6	ZPO 700 OC*	two -part	steel*)	690
7	ZPO 700 TC**	two -part	steel**)	690
8	ZPO 800	two -part	HDPE	612
9	ZPO 900	two -part	HDPE	670
10	ZPO 1000	two -part	HDPE	670
11	ZPO 1200 OC*	two -part	steel*)	690
12	ZPO 1200 TC**	two -part	steel**)	690
13	ZPO 1400 OC*	two -part	steel*)	690
14	ZPO 1400 TC**	two -part	steel**)	690

*) steel zinc coated couplings

**) steel zinc coated couplings with polymer coating

PECOR OPTIMA® elbows

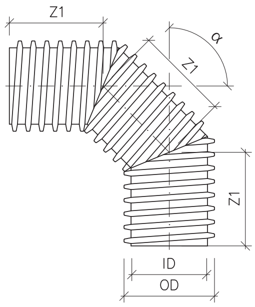
α=30°, α=45°, α=60°



Item.	Symbol	Dimension [mm]		
		ID	OD	Z1
1	KP 300/α	300	357	500
2	KP 400/α	400	477	500
3	KP 500/α	500	593	500
4	KP 600/α	600	724	750
5	KP 700/α	700	824	750
6	KP 800/α	800	970	750
7	KP 900/α	900	1070	1000
8	KP 1000/α	1000	1175	1000
9	KP 1200/α	1200	1375	-
10	KP 1400/α	1400	1600	-

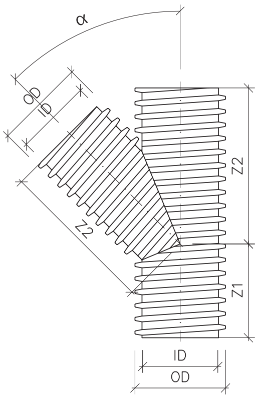
PECOR OPTIMA® elbows

α=75°, α=90°



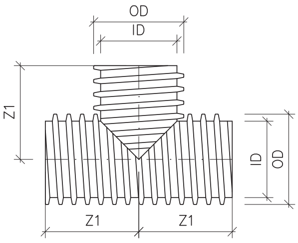
Item	Symbol	Dimension [mm]		
		ID	OD	Z1
1	KP 300/α	300	357	500
2	KP 400/α	400	477	500
3	KP 500/α	500	593	500
4	KP 600/α	600	724	750
5	KP 700/α	700	824	750
6	KP 800/α	800	970	750
7	KP 900/α	900	1070	1000
8	KP 1000/α	1000	1175	1000
9	KP 1200/α	1200	1375	-
10	KP 1400/α	1400	1600	-

PECOR OPTIMA® T-pipes α=45°



Item.	Symbol	Dimension [mm]			
		ID	OD	Z1	Z2
1	TP 300/45°	300	357	500	750
2	TP 400/45°	400	477	500	1000
3	TP 500/45°	500	593	750	1250
4	TP 600/45°	600	724	750	1250
5	TP 700/45°	700	824	1000	1500
6	TP 800/45°	800	970	1250	1750
7	TP 900/45°	900	1070	1250	2000
8	TP 1000/45°	1000	1175	1500	2000
9	TP 1200/45°	1200	1375	1500	-
10	TP 1400/45°	1400	1600	1500	-

PECOR OPTIMA® T-pipes α=90°



Item.	Symbol	Dimension [mm]		
		ID	OD	Z1
1	KP 300/90°	300	357	500
2	KP 400/90°	400	477	500
3	KP 500/90°	500	593	750
4	KP 600/90°	600	724	750
5	KP 700/90°	700	824	750
6	KP 800/90°	800	970	750
7	KP 900/90°	900	1070	1000
8	KP 1000/90°	1000	1175	1000
9	KP 1200/90°	1200	1375	-
10	KP 1400/90°	1400	1600	-

Fittings with other α angles are available.

10. PECOR OPTIMA® W sewage pipes – application

Application:

PECOR OPTIMA® W pipes are used for:

- non-pressure sewage system
- retention system
- industrial ventilation system
- agro ventilation

Standard lengths of PECOR OPTIMA® W pipes

The standard lengths of PECOR OPTIMA® W pipes are : L= 6 m, 7 m, 8 m. The production process allows to make any length of pipe. max. 12 m, due to transportation limit. For pipes from DN 300 mm to 1000 mm. PECOR OPTIMA® W pipes are connected by spigot, socket and rubber sealing ring.

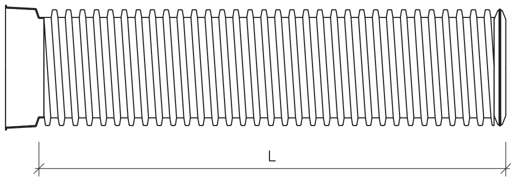


Figure 10 – PECOR OPTIMA® W sewage pipes

In order to bend or reduce the pipe, suitable fittings are used (elbows, T-pipes, reductions)

Technical approval, opinions

PECOR OPTIMA® W pipes have the following documents:

- Technical Approval issued by Polish Road and Bridge Research Institute IBDiM no. AT/2006-03-1127
- positive opinion issued Polish Central Mining Institute (GIG) for use of pipes on subsidence areas

PECOR OPTIMA® W pipes are produced according to PN-EN 13476-3:2008.

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APROBATA TECHNICZNA IBDiM
Nr AT/2006-03-1127

Nazwa wyrobu: Elementy systemu kanalizacyjnego PECOR-OPTIMA: rury, kształtki oraz studzienki

Wnioskodawca: ViaCon Polska Sp z o.o.
ul. Przemysłowa 6
64-130 Rydzyna

Termin ważności: 2011 – 09 – 14

(Zastępuje AT/2001-04-1127 i Zmianę Nr 1/2005)

GŁÓWNY INSTYTUT GÓRNICTWA

ZAKŁAD INŻYNIERII MATERIAŁOWEJ

Katowice 28.02.2007 r.

Opinia Techniczna
dotycząca spełnienia warunków stosowania na terenach objętych wpływami eksploatacji górniczej rur kanalizacyjnych i przepustowych oraz studzienek z HDPE o ściankach strukturalnych PecorOptima

Zleceniodawca: ViaCon Sp. z o.o.
64-130 Rydzyna k. Leszna, ul. Przemysłowa 6

Producent: Grupa ViaCon

Kierownik Laboratorium: (pieczątka i podpis)

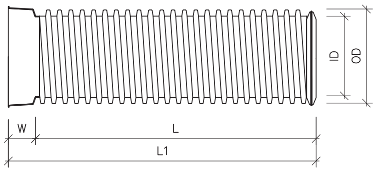
Kierownik Zakładu: (pieczątka i podpis)

Egzemplarz nr 2

ZINTEGROWANY INSTYTUT NAUKOWO-TECHNOLOGICZNY

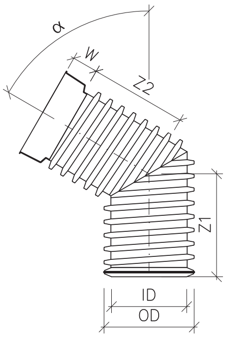
11. PECOR OPTIMA® W sewage pipes, PECOR OPTIMA® E elbows

PECOR OPTIMA® W - SN8 sawage pipes



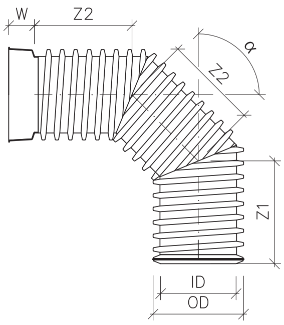
Item.	Symbol	Diameter [mm]		Dimensions [mm]		
		ID	OD	W	L	L1
1	PECOR OPTIMA W 300	300	357	115	6000	6115
2	PECOR OPTIMA W 400	400	477	130	6000	6130
3	PECOR OPTIMA W 500	500	593	180	6000	6180
4	PECOR OPTIMA W 600	600	724	210	6000	6210
5	PECOR OPTIMA W 700	700	824	265	6000	6265
6	PECOR OPTIMA W 800	800	970	270	6000	6270
7	PECOR OPTIMA W 900	900	1070	290	6000	6290
8	PECOR OPTIMA W 1000	1000	1175	335	6000	6335

PECOR OPTIMA® W elbows α=30°, α=45°, α=60°



Item.	Symbol	Diameter [mm]		Dimensions [mm]		
		ID	OD	Z1	Z2	W
1	E-KP 300/α	300	357	540	500	115
2	E-KP 400/α	400	477	545	500	130
3	E-KP 500/α	500	593	585	500	180
4	E-KP 600/α	600	724	850	750	210
5	E-KP 700/α	700	824	860	750	265
6	E-KP 800/α	800	970	860	750	270
7	E-KP 900/α	900	1070	1110	1000	290
8	E-KP 1000/α	1000	1175	1120	1000	335

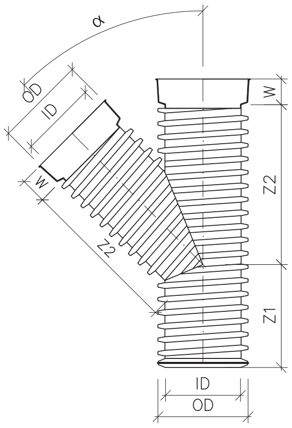
PECOR OPTIMA® W elbows α=75°, α=90°



Item.	Symbol	Diameter [mm]		Dimensions [mm]		
		ID	OD	Z1	Z2	W
1	E-KP 300/α	300	357	540	500	115
2	E-KP 400/α	400	477	545	500	130
3	E-KP 500/α	500	593	585	500	180
4	E-KP 600/α	600	724	850	750	210
5	E-KP 700/α	700	824	860	750	265
6	E-KP 800/α	800	970	860	750	270
7	E-KP 900/α	900	1070	1110	1000	290
8	E-KP 1000/α	1000	1175	1120	1000	335

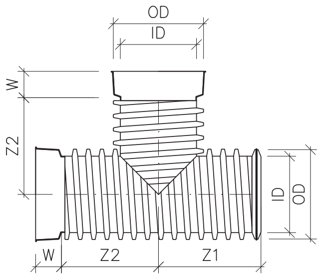
12. PECOR OPTIMA® T-pipes, reductions

PECOR OPTIMA® W T-pipes α=45°



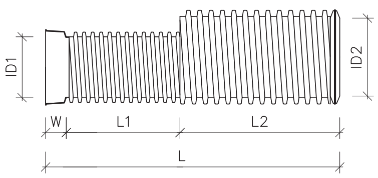
Item.	Symbol	Diameter [mm]		Dimensions [mm]		
		ID	OD	Z1	Z2	W
1	E-TP 300/α	300	357	540	750	115
2	E-TP 400/α	400	477	545	1000	130
3	E-TP 500/α	500	593	835	1250	180
4	E-TP 600/α	600	724	850	1250	210
5	E-TP 700/α	700	824	1100	1500	265
6	E-TP 800/α	800	970	1360	1750	270
7	E-TP 900/α	900	1070	1360	2000	290
8	E-TP 1000/α	1000	1175	1620	2000	335

PECOR OPTIMA® W T-pipes α=90°



Item.	Symbol	Diameter [mm]		Dimensions [mm]		
		ID	OD	Z1	Z2	W
1	E-TP 300/α	300	357	540	500	115
2	E-TP 400/α	400	477	545	500	130
3	E-TP 500/α	500	593	585	750	180
4	E-TP 600/α	600	724	850	750	210
5	E-TP 700/α	700	824	860	750	265
6	E-TP 800/α	800	970	860	750	270
7	E-TP 900/α	900	1070	1110	1000	290
8	E-TP 1000/α	1000	1175	1120	1000	335

PECOR OPTIMA® W reduction



Item.	Symbol	Diameter [mm]		Dimensions [mm]			
		ID1	ID2	L1	L2	L	W
1	E-RP 300/400	300	400	500	540	1155	115
2	E-RP 400/500	400	500	500	545	1175	130
3	E-RP 500/600	500	600	500	585	1265	180
4	E-RP 600/700	600	700	500	610	1320	210
5	E-RP 700/800	700	800	500	610	1375	265
6	E-RP 800/900	800	900	500	610	1380	270
7	E-RP 800/1000	800	1000	500	610	1400	290
8	E-RP 900/1000	900	1000	500	610	1445	335

Fittings with other α angles are available.

13. PECOR OPTIMA® M sewage manholes - application

Application

Sewage manholes PECOR OPTIMA® M are a part of sewage system PECOR OPTIMA® W.

Manholes are used for:

- non-pressure sewage system (they are integrated sewage system named PECOR OPTIMA® including PECOR OPTIMA® W pipes & PECOR OPTIMA® E fittings)
- roads dewatering
- parking places dewatering

PECOR OPTIMA® M manholes are produced in three types:

- three way pipe
- settling tank
- eccentric

There are stud couplings on the bottom part of manhole made of PECOR OPTIMA® W pipes or connector pipes made of HDPE adopted to connect sewage pipes. The bottom of the manhole PECOR OPTIMA® M is made of HDPE plate.

The whole stub pipes & bottom are connected with riser pipe by welding .

Sewage manholes PECOR OPTIMA® M are adopted to connect with cast iron or concrete cover in proper class depending on foundation place.
Figure 11 shows an example of PECOR OPTIMA® M manhole cover.

Manhole PECOR OPTIMA® M in dimensions ID= 1000 mm, 1200 mm, 1400 mm are equipped with steps.

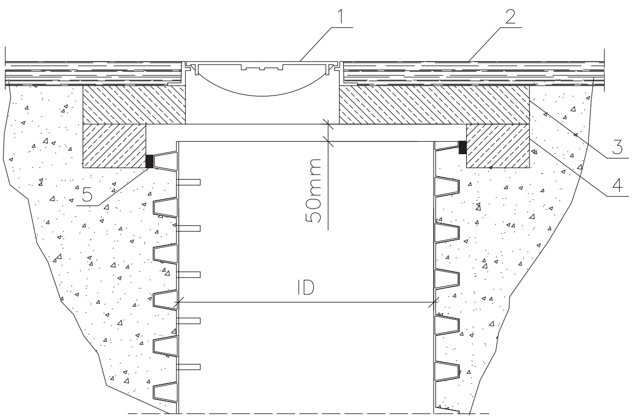


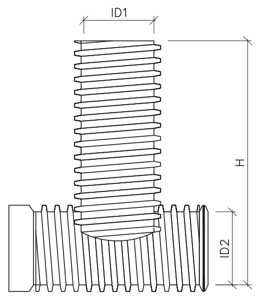
Figure 11 – PECOR OPTIMA® M - monhole cover

Description:

1 - manhole cover in proper class A15 ÷ D400
2 - surface
3 - concrete slab
4 - cover ring
5 - sealing (space between riser pipe and reinforced plate)
6 - steps

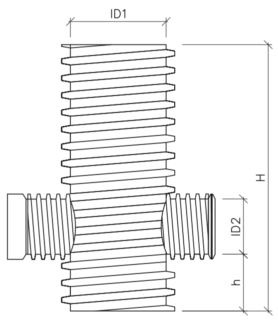
14. PECOR OPTIMA® M – types of manholes

PECOR OPTIMA® M – three ways manholes



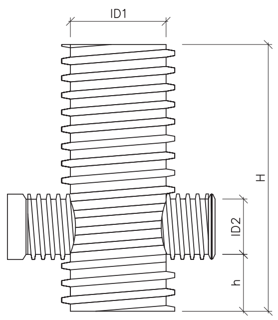
Item.	Symbol	Diameter [mm]		Height [m]
		ID1 chimney	ID2 collector	H
1	PECOR OPTIMA M 300	300	300	The height of manhole is specified in order
2	PECOR OPTIMA M 400	400	300, 400	
3	PECOR OPTIMA M 500	500	400, 500	
4	PECOR OPTIMA M 600	600	500, 600	
5	PECOR OPTIMA M 800	800	700, 800	
6	PECOR OPTIMA M 1000	1000	900, 1000	
7	PECOR OPTIMA M 1200	1200	1000, 1200	
8	PECOR OPTIMA M 1400	1400	1200, 1400	

PECOR OPTIMA® M – wells



Item.	Symbol	Diameter [mm]		Height [m]
		ID1 chimney	ID2 collector	h, H
1	PECOR OPTIMA M 400	400	300	The height of manhole is specified in order
2	PECOR OPTIMA M 500	500	300, 400	
3	PECOR OPTIMA M 600	600	300, 400	
4	PECOR OPTIMA M 800	800	300, 400, 500	

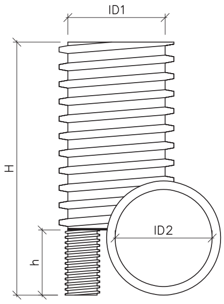
PECOR OPTIMA® M – manholes, settling tanks



Item.	Symbol	Diameter [mm]		Height [m]
		ID1 chimney	ID2 collector	h, H
1	PECOR OPTIMA M 1000	1000	300, 400, 500, 600	The height of manhole is specified in order
2	PECOR OPTIMA M 1200	1200		
3	PECOR OPTIMA M 1400	1400		

Manholes are equipped with steps

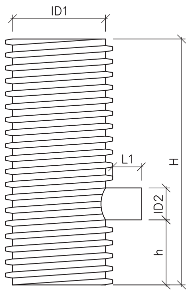
PECOR OPTIMA® M – eccentric manholes



Manholes are equipped with steps

Item.	Symbol	Diameters [mm]		Heights [m]	
		ID1 chimney	ID2 collector	h	H
1	PECOR OPTIMA M 1000	1000	700, 800, 900, 1000	0,70*ID2	The height of manhole is specified in order.
2	PECOR OPTIMA M 1200	1200	700, 800, 900, 1000, 1200		
3	PECOR OPTIMA M 1400	1400	700, 800, 900, 1000, 1200, 1400		

PECOR OPTIMA® M – street inlets



Item.	Symbol	Diameters [mm]		Heights [m]	
		ID1 chimney	OD2 stub pipe*)	L1	h, H
1	PECOR OPTIMA M 400	400	110 160 200	0,20	The height of manhole is specified in order
2	PECOR OPTIMA M 500	500			
3	PECOR OPTIMA M 600	600			

*) stub pipes can be connected with pipes of PCV, standard length of stub pipe is L= 200mm; possibility to weld stub pipes in different length

PECOR OPTIMA® M manholes in different dimensions than above, are available.

15. Cover depth

Cover depth can be described as a vertical distance between the top of the culvert and the road grade-line, including the road pavement.

For the road applications, the allowable depth of cover depends on diameter of PECOR OPTIMA® pipe, ring stiffness and is given in table 3.

Table 3

Item.	Symbol	Min. cover depth H [m]	Max. cover depth H [M]	
			SN6 (SN4*)	SN8
1	PECOR OPTIMA 200	0,30	---	15
2	PECOR OPTIMA 300	0,30	14	15
3	PECOR OPTIMA 400	0,30	14	15
4	PECOR OPTIMA 500	0,30	14	14
5	PECOR OPTIMA 600	0,50	14	15
6	PECOR OPTIMA 700	0,50	14	14
7	PECOR OPTIMA 800	0,50	14	15
8	PECOR OPTIMA 900	0,50	14	15
9	PECOR OPTIMA 1000	0,50	14	14
10	PECOR OPTIMA 1200	0,60	13	14
11	PECOR OPTIMA 1400	0,70	13	---

The minimum cover depth is specified in accordance with GDDKiA recommendations

The maximum cover depth for PECOR OPTIMA® pipe is calculated using Scandinavian method.

When the thickness of road pavement is greater than the minimum cover, the backfill thickness over the structure should be at least 0,10 – 0,15 m measured from the top of the pipe.

Cover depth for culvert under railway can be described as a vertical distance between the top of the culvert and the bottom of the railway sleeper, including the construction layers of the railroad.

The minimum cover depth for railway: $H \geq 0{,}6$ m.

16. Installation of PECOR OPTIMA® pipes

Rury PECOR OPTIMA® pipes are simple and easy to install. The assembly consists in laying pipes down in excavation and connecting them using coupling bands.
Rury PECOR OPTIMA® pipes tolerates uneven settlements of the subsoil very well. They can be successfully used on soft soils and subsidence areas.

In order to ensure the proper work of flexible pipe, several conditions must be fulfilled, i.e. concerning bedding preparation, making of aggregate foundation as well as proper backfilling of the structure. Appropriate performance of structure and its durability depends on quality of these steps. The designer should specify the load bearing capacity of the subsoil on which Pecor Optima pipe should be placed. Subsoil which does not meet the demands should be reinforced with use of geotextiles or change the soil.

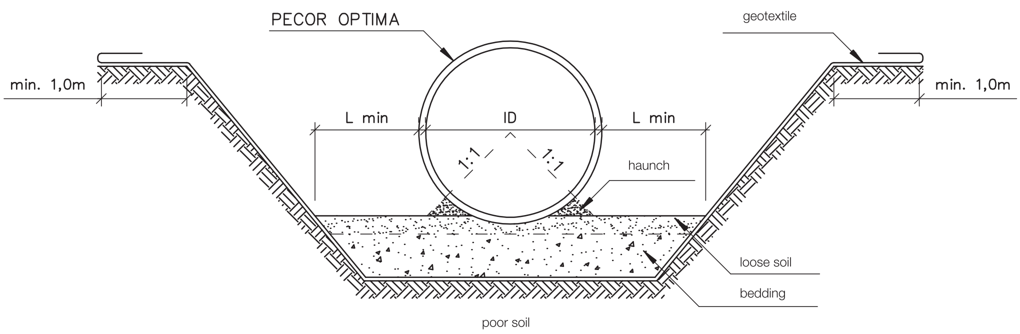


Figure 12 – Placing pipe on soft soil

Material for bedding and backfill

Graining of the bedding and backfilling material (gravel, coarse, gravel-sand mixture) depends on the corrugation type. The maximum size of grain in the vicinity (0,3 ÷ 0,5 m) of PECOR OPTIMA® pipes is 31,5 mm.

For remaining zone bigger grains can be used:

- non-uniformity index $C_u > 5{,}0$
- curvature index $1 < C_c < 3$
- permeability $k > 6$ m/24 hours

Requirements for bedding preparation :

- bedding should extend transversely to at least half of pipe's dimension, the width of excavation should be huge enough to get proper backfilling compaction
- thickness of bedding should be smaller than 20 cm; recommended 30cm
- degree of compaction should not be smaller than I_s=0,98 according to standard Proctor density
- extra layer with 5 cm of loose sand material should be made on the bedding so that the pipe corrugation can be seated on the bedding

Requirements for backfill preparation :

- backfill adjacent to pipe should exceed its perimeter by half its dimension (L_{min})
- backfill should be evenly laid in not compacted layers at maximum 30cm thick, on each side of the pipe (figure 13)
- degree of compaction of each layer should not be less than I_s=0,98 standard Proctor density, however directly near the pipe I_s=0,95 is allowed

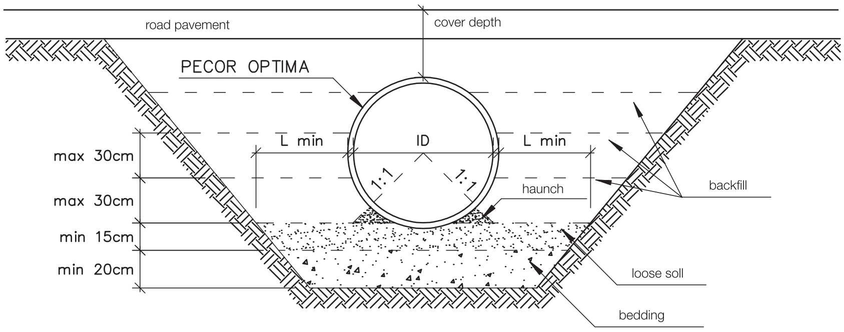


Figure 13 – Backfill and foundation for PECOR OPTIMA® pipes

Backfill compaction should be carried out using light equipment (vibrating plates or jumping jacks). Heavy equipment is not allowed until the full backfill height has been laid. Appropriate compaction in haunch area of the pipe is very important due to load bearing capacity of a culvert.

Pipe should be stabilized during backfilling in order to reach the invariable position.

For assembly PECOR OPTIMA® W pipes, please follow the same instruction as for PECOR OPTIMA® pipes. Moreover , it is necessary to check the position of rubber sealing ring and the condition, before connecting WT pipes. The rule is to insert spigot with rubber sealing ring into a socket. The rubber sealing ring and the socket must be clean. In order to make the assembly easier, the rubber sealing ring and the edge of socket should be lubricated (silicone, soap or other lubricant).

Multiple installation

In case of building multi - hole culverts , laid in two parallel lines, the most important thing is to check the distance between two pipes (detail C). The minimal distance between two pipes should allow for proper soil concentration. The distance (C) should meet the following conditions: C≥ID/2 and C≥0,50 m.

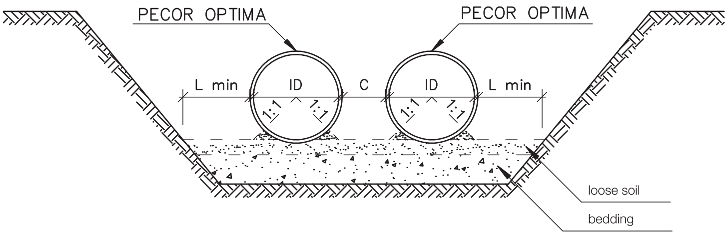


Figure 14 – Multiple installation

17. Assembly of PECOR OPTIMA® manholes

Directly under the bottom of manhole, 15 cm bedding should be prepared. The bedding material is gravel-sand mix. compacted to I_s=0,98 standard Proctor density.

Excavation should be minimum 50 cm wider than outside dimension of manhole. It is necessary to check, all joints condition: bells and rubber sealing rings before installation. Dirt must be removed and cleaned. Backfill should be evenly placed and compacted in layers maximum 30 cm thick on each side of manhole.

Use light compaction equipment in the vicinity of manhole (vibration slabs). It is not allowed to use heavy equipment.

After backfilling, the riser pipe should be cut to get the proper height of manhole. In order to avoid load transfer of concrete slab to the riser pipe, min. 50 mm gap between riser pipe an concrete slab should be kept.

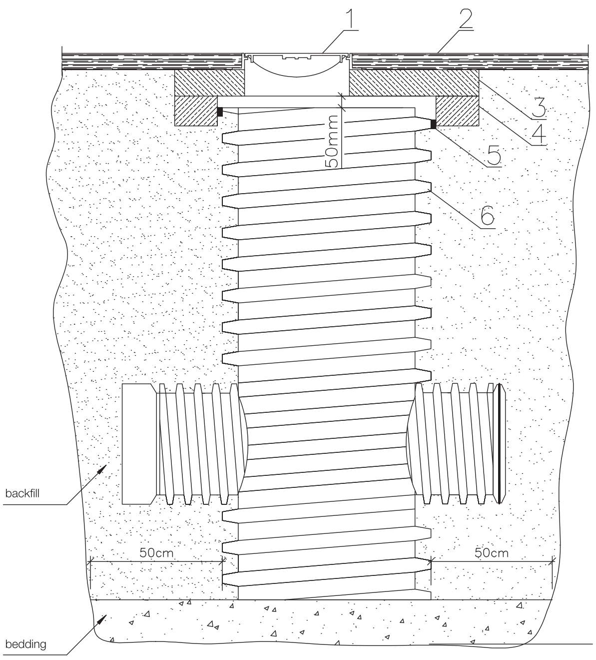


Figure 15 – Backfill for manhole

Description :

1 - manhole cover in proper class A15 ÷ D400

2 - surface

3 - concrete slab

4 - cover ring

5 - sealing (space between riser pipe and concrete slab)

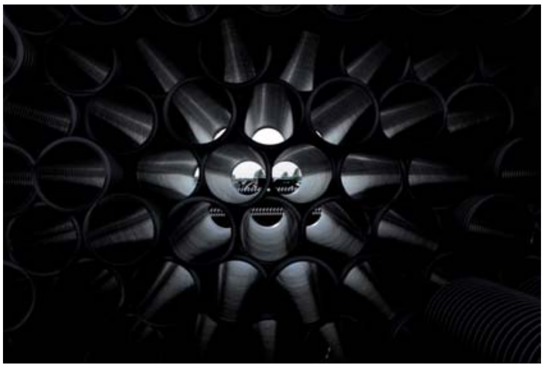
6 - riser pipe

18. Store & transport

Storage

PECOR OPTIMA® and PECOR OPTIMA® W pipes should be stored on the flat backing, in the horizontal position on the wooden shoulders, alternated with the wooden inserts and protected from rolling and deforming.

The pipes, fittings, manholes can be stored in the open air for the period 12 months max., counted from the production date without any additional protection.



Storage for the period longer than 12 months requires the protection of products from the impact of ultraviolet radiation. The occupation of the space with open fire near the stored products is prohibited. In the case of covering pipes, fittings and manholes with canvas covers not permeable to light, good ventilation for these products should be ensured.

Transport

Pipes, fittings, coupling bands and manholes should be transported by any means of transport until dimensions. The loading must be stable during driving. Pipes must be protected against scratching during transport, loading and unloading. Pipes should be carried, not push aside, throw off or dropped from the truck.

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Pecor Optima®

HelCor®

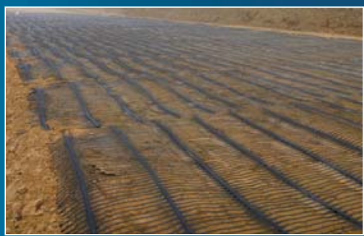
HelCor PA®

MultiPlate MP200

SuperCor®

Acrow® Temporary Bridges

Non-woven and Woven



Geogrids

Gabions

ORM System
HelCor® TC

Manholes HelCor®

Manholes Optima® M

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