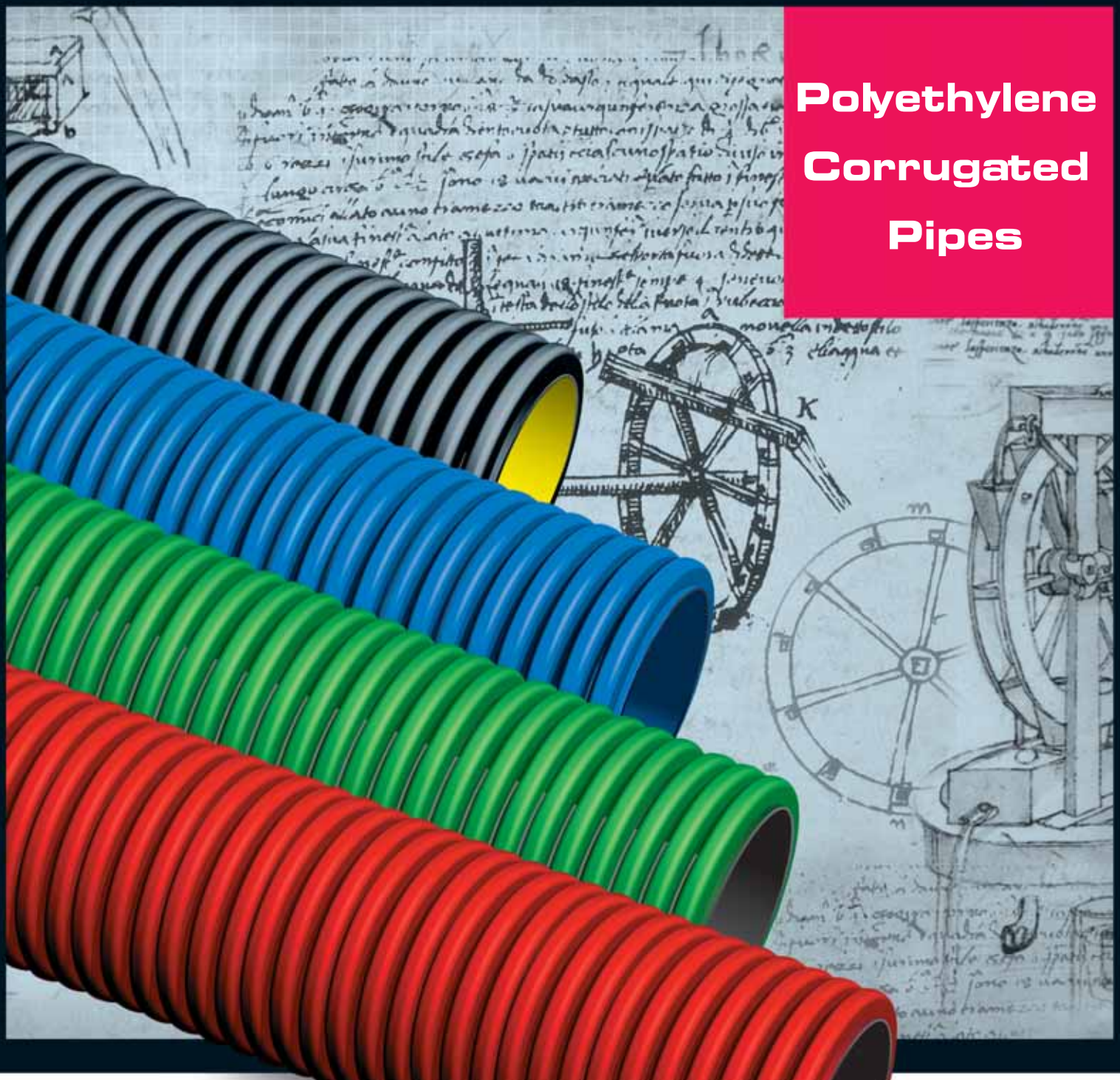
Polyethylene Corrugated Pipes



product certifications

company certifications

quality cert.
ISO 9001:2000
environmental cert.
EN ISO 14001:2004

TECHINCAL MANUAL 2006
CABLE CONDUIT AND DRAINAGE

POLIECO®
INDUSTRIE POLIECO-M.P.B. s.r.l.

INDUSTRIE POLIECO M.P.B. s.r.l.

COMPANY CERTIFICATIONS

QUALITY SYSTEM ISO 9001:2000

ENVIRONMENTAL SYSTEM EN ISO 14001:2004

PRODUCT CERTIFICATIONS

ITALIAN

FRENCH

SWISS

SPANISH

" P O L I E C O "…. a european reality enjoying continual growth

POLIECO NORTH ITALY

INDUSTRIE POLIECO-M.P.B. SRL
25046 CAZZAGO S. MARTINO (BS) - Via E. Mattei, 49
Tel. 0039 030 775 89 11 - Fax 0039 030 775 08 45 - www.polieco.com - info@polieco.com

POLIECO SOUTH ITALY

INDUSTRIE POLIECO-M.P.B. SRL
83040 CONZA DELLA CAMPANIA (AV) - Zona Industriale - Settore Sud
Tel. 0039 0827 369 72 - Fax 0039 0827 369 92

POLIECO EUROPE

POLIECO ESPAÑA S.A.
46590 ESTIVELLA VALENCIA - Poligono Bobalar Parcela, 1 - Tel. 0034 96 2628 587 - Fax 0034 96 2628 191

POLIECO FRANCE S.A.
01570 FEILLENS S.A. Sud - 2 Rue De La Loeze - Tel. 0033 3 85 23 91 60 - Fax 0033 3 85 23 91 70

POLIECO HELLAS AEBE
15351 PALLINI - Ethnikis Antistasseos, 2 - Tel. 0030 210 666 39 80 - Fax 0030 210 666 96 28

GEOPOLIECO S.A. (SWISS)
06964 DAVESCO SORAGNO - Via Ponte Di Valle, 12 - Tel. 0041 91 942 131 6 - Fax 0041 91 942 131 7

TWIN WALL CABLE CONDUIT
CORRUGATED EXTERNALLY SMOOTH INTERNALLY - **450N**

serie **-N-**

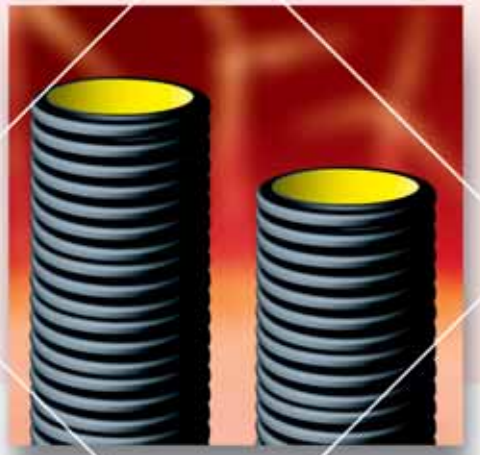
The **POLIECO** twin wall cable conduit is a high density **polyethylene** pipe, which is made to protect the cables put underground for electrical and telephone installations. It is composed of two co-extruded walls, corrugated the external one and smooth the internal one. The special co-extrusion process avoids any possibility of separation of the two walls.

- **Coils length**: 50 meters (* 25meters) ± 1%
- **Bars length**: 6 meters ± 1%
- Including jointing coupling
- **According to the norm**:
  CEI EN 50086-1 (CEI 23-39)
  CEI EN 50086-2-4/A1 (CEI 23-46/V1)
- **External colour**: red
  (other colours upon request)
- **Internal colour**: black
- Produced with polyethylene stabilized to UV rays
- 1 year warranty (from the production date printed on the pipe)

TECHNICAL FEATURES

1. **Construction:**
   Corrugated pipe externally and smooth internally, called "CAVIDOTTO" normal version from Ø 40mm to Ø 200mm
2. **Composition:**
   Neutral polyethylene: 97%
   Masterbatch pigments: 2%
   Additives: 1% - Anti UV
3. **Use:**
   Underground protection for telephone and low voltage cables.
4. **Use limits:**
   -10°C / +40°C - Flamepropagator
5. **Minimum bending radius:**
   8 times the external diameter
6. **Crush resistance:**
   (EN 50086-2-4/A1 - CEI 23-46/V1): ≥ 450 N with deformation of the external diameter equal to 5%
7. **Packaging:**
   Coils of 25 or 50 meters (OD.200mm only 25m coils) with PET or PP string (to pull the metall-thread used to pull the cables) or bars of 6 meters
8. **Accessories:**
   Jointing coupling already fitted on each coil/bar
   Seals upon request
9. **Installation:**
   In udergground trench

OD/ID	40/31	50/39	63/50	75/63	90/76	110/92	125/105	140/123	160/138	200*/170



CABLE CONDUIT IN BARS 750 Newton ENEL

ACCORDING TO THE NORM "DS4235 REV. 01/2003"

- **Length of the bars:** 6 meters ± 1%
- Including jointing coupling
- **According to the norm:**
  CEI EN 50086-1 (23-39)
  CEI EN 50086-2-4/A1 (23-46/V1)
- **External colour:** Grey
- **Internal colour:** Yellow
- **Crush resistance:** ≥ 750 N with deformation of the external diameter equal to 5%
- **Marked "ENEL"** (italian national electricity provider)
- Produced with polyethylene stabilized to UV rays
- 1 year warranty (from the production date printed on the pipe)

Available diameters:

OD/ID	110/92	125/105	160/138

TELECOM CABLE CONDUIT

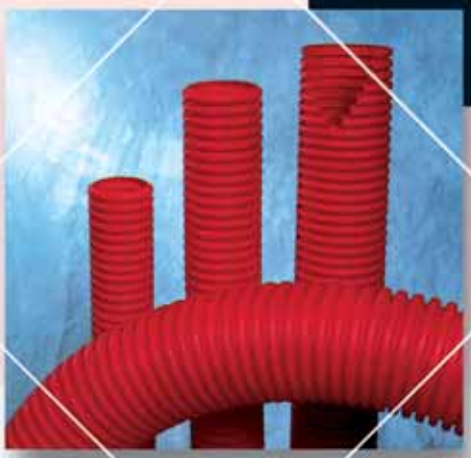
ACCORDING TO THE NORM "671 REV.2001"

- **Length of the coils:** 50 meters ± 1%
  with polyethylene string (to pull the metall-thread used to pull the cables) in PET or PP
- Including jointing coupling
- **According to the norm:**
  CEI EN 50086-1 (23-39)
  CEI EN 50086-2-4/A1 (23-46/V1)
- **External colour:** Blue
- **Internal colour:** Blue
- **Crush resistance:** ≥ 450 N with deformation of the external diameter equal to 5%
- **Marked "TELECOM"** (italian national telephone provider)
- Produced with polyethylene stabilized to UV rays
- 1 year warranty (from the production date printed on the pipe)

Available diameters:

OD/ID	50/39	63/50	125/105

CABLE CONDUIT POLIECO
SINGLE-WALL



CORRUGATED EXTERNALLY & INTERNALLY

- **Coils length**: 50 meters ± 1%
- Including jointing coupling
- **Colour**: Red (other colours upon request)
- Produced with polyethylene stabilized to UV rays
- 1 year warranty (from the production date printed on the pipe)

TECHNICAL FEATURES

1. **Construction:**
   Structured pipe, corrugated externally and internally called "CAVIDOTTO" from OD.40 mm to OD.125 mm
2. **Composition:**
   Neutral polyethylene: 97%
   Masterbatch pigments: 2%
   Additives: 1% – Anti UV
3. **Use:**
   Underground protection for telephone & low voltage cables and also as external additonal protection for gas & water HDPE pipes
4. **Use limits:**
   -10° C / + 40° C – Flamepropagator
5. **Minimum bending radius:**
   8 times the external diameter
6. **Crush resistance:** ≥ 250 N with deformation of the external diameter of 5% (internal Polieco standard SP-001 based on EN 50086-2-4/A1
7. **Packaging:**
   Coils of 50 meters fitted with PET or steel string (to pull the metall-thread used to pull the cables)
8. **Accessories:**
   Jointing coupling already fitted on each coil
   Seals upon request
9. **Installation:**
   In uderground trench

Available diameters:

OD/ID	40/31	50/39	63/50	75/63	90/76	110/92	125/105

FEATURES

- Impact resistance till -25°C.
- It resists to temperature changes from -10°C to +40°C without compromising its original features.
- Electrical insulation resistance more than 100Mohm (MW).
- Dielectric stiffness more than 800 kV/cm.
- Chemical agent resistance.
- Thanks to its flexibility is very easy to install in any type of ground, on any inclination...it allows to avoid impediments even without using bends.
- Its elasticity allows to absorb easiness the ground adjustments.
- Thank to its lightness is very easy to store, to transport and to install. The jointing between two conduits is made through a coupler, easy and quick to use and doesn't require any type of adhesive. The jointing between pipe and coupling can be done easily by sprinkling with lubricating and/or sliding stuff at the internal surface of the coupling.
- The tightness of the jointing can be assured by introducing elastomeric seals.
- Possibility of different coulors in order to identify the cables.
- Can be provided in coils of 25 or 50meters (only 25m for OD.200mm) with a polyethylene string (to pull the metall-thread used to pull the cables) or in bars of 6 meters; each coil or bar is fitted with jointing coupling.

CHEMICAL-PHYSICAL FEATURES OF POLYETHYLENE

The high density polyethylene is a thermoplastic resin of white translucent colour.
At room temperature its density is between 0,94 and 0,96 g/cm^3. The structure is about 60% crystalline, the rest is amorphous. In the range of 125-135°C, according to the density, the polyethylene is totally amorphous, and it is considered melted, even if in reality it becomes a gummy mass. When it is melted its density decreases to 0,80 g/cm^3. It is also very interesting knowing as the polyethylene behaves in relation with the chemical agents present in the laying place.
The polyethylene of Polieco cable conduit resists to the most chemical products and solvents. Only few chemicals like dechaydronaphtalene or some aromatic and halogenated hydrocarbons can melt polyethylene by high temperatures. Strong oxidizer agents like fuming nitric acid and fumic sulfurid acid can degrade the polyethylene.

MECHANICAL FEATURES

The most important features of a cable protection conduit are the crush resistance and the impact resistance.

a) Crush resistance
This is the most important, because the conduit is buried, therefore it is subject to the backfill load; moreover we had to consider the eventual load due to the trafic charge. Testing of this performance has to be made according to the norm CEI EN 50086-2-4/A1.
This standard prescribes that a sample of conduit 200mm long is compressed between two iron plates (minimum dimensions = 100 x 200 x 15 mm) in order to reduce the external diameter by 5%.
The required strength must exceed a determinate value (450 N or 750 N).
The test purpose is to declare the capability of the conduit (passed/not passed).

b) Impact resistance
Crush resistance is important for the conduit life after laying; whereas the impact resistance is very important to preserve the conduit during laying & installation. Testing of this performance simulates the casual stresses due to stones which impact on the pipe surface during the back filling operations. Thus it is important that in the soil adjacent to the conduit there are no stones with diameter bigger than 80–100mm.

The test is performed according to the norm CEI EN 50086-1 with variant CEI EN 50086-2-4/A1. The sample is cooled down to -5°C for 2 hours. The conduit is shocked by a dart of 5Kg dropped from different heights depending on the conduit nominal diameter (see chart 1).
After the test the conduit must not show any crack that allows the crossing of the water from the inside to the outside of the pipe for at least 9 out of 12 times.

1

pipe nominal diameter (mm)	dart mass (kg)	height (mm)
≤ 60	5	300
61 ÷ 90	5	400
91 ÷ 140	5	570
> 140	5	800

CABLE CONDUIT IDENTIFICATION

All cable conduits are identified thanks to an ink jet marking which is applied on the pipe surface for both packaging (coils and bars) every two meters.
The mark, which is according to the norm "CEI EN 50086-1 and CEI EN 50086-1" includes:
- manufacturer's name
- identification product code
- nominal diameter
- the letter " N " , normal type
- the referring norm
- "IEMMEQU" writing
- eventual foreign marks
- production date
- production time
- crush resistance parameter (450N or 750N)

Examples:
POLIECO 240 D40 N EN 50086-2-4/A1 IEMMEQU NF-USE TPC C 627 AENOR 030/001445 01/01/02 08:00

TRANSPORT AND STORAGE OF CABLE CONDUITS

Thanks to their structural resistance, Polieco cable conduits do not need particular care during the transport, unloading and storage.
It is advised not to lay more than 2 pallets one upon the other during the storage of the bars and not to exceed the height of 3 meters when pealing up coils. In charts n.2 and 3 are listed the volume for coils and number of pallets for bars.

COILS

2

diameter mm	length m	volume in total m^3/coil
40	50	0,14
50	50	0,18
63	50	0,33
75	50	0,47
90	50	0,77
110	50	1,04
125	50	1,39
140	50	1,62
160	50	2,09
200	25	1,67

BARS

3

diameter mm	nr. pcs /pallet	m /pallet	pallets /truck	total m/truck
–	–	–	–	–
–	–	–	–	–
63	72	432	32	13824
75	46	276	32	8832
90	33	198	32	6336
110	105	630	8	5040
125	77	462	8	3696
140	60	360	8	2880
160	46	276	8	2208
200	30	180	8	1440

THE LAYING TECHNIQUE

For the conduit installation it is essential to know which kind of trench is the most suitable.

The trench selection is made according to the ground and the forecasted stresses present.

TRENCH CLASSIFICATION

Trench classification is based on the geometrical dimensions (as the depth H and the width B of the trench) and according to the diameter of the conduit to lay (see chart 4). These two methods describe the normal kinds of trenches: narrow trench, wide trench or endless trench (embankment trench). The following chart (4) reports the trench width (B) according to the nominal conduit diameter (DN) or trench depth (H) for each kind of trench.

TRENCH TYPE	B	
NARROW TRENCH	≤ 3 DN	< H/2
WIDE TRENCH	> 3 DN	< H/2
	< 10 DN	< H/2
ENDLESS TRENCH	≥ 10 DN	≥ H/2

4

DN = nominal diameter of the conduit.
B = trench width measured at the top of the conduit.
H = backfilling height measured from the top of the conduit

The narrow trench is the best choice for conduit installation because part of the load is discharged on the walls of the trench. This kind of trench must be used as much as possible, according to the ground nature.

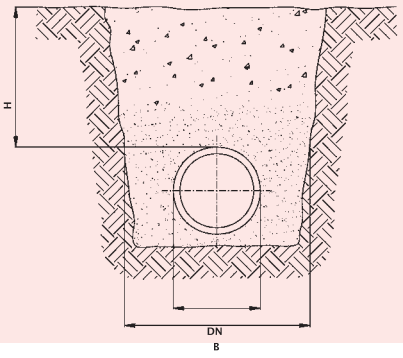


Fig. 1 – Narrow trench

The wide trench is adopted when the ground is mostly composed of sand and gravel. Here the conduit is subjected to a higher stress than the one in the narrow trench and only a small part of the total load is discharged on the walls.

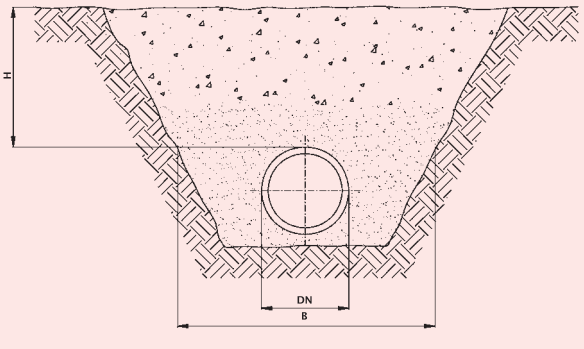


Fig. 2 – Wide trench

TRENCH WIDTH

The width is determined according to the trench depth and the conduit diameter.
The trench width should be enough to permit the jointing between couplings and conduits and sufficient working space.
Anyway the more narrow the trench is the more efficient it is.
If the trench contains more than one conduit, there must be enough space for the saddles.

TRENCH BOTTOM

The trench bottom is generally made with sand to provide the conduit with a continuous and flat base. Because of its mechanical stresses resistance, for Polieco conduit is not necessary to build the trench bottom through concrete or similar.
Instead it is necessary to prepare niches at fixed distances to ease the jointing among bars or coils.

BEDDING AND SIDEFILL

When needed, the bedding must be realized before than the trench bottom is fully stabilized. The material for the bedding has to be sand mixed with small gravel, or gravel or small stones with a diameter of 10–15 mm.
The bedding must be accurately compacted in order to assure the uniform load distribution along the conduit. The filling on the sides of the conduit shall be accurately executed with good compaction materials like sand. Organic, peat, muddies and clay grounds must be avoided because of their high water content which obstructs the compaction.

TRENCH BACKFILL

The backfilling of the trench and generally in all kinds of excavation, is the most important part of the installation of a conduit. It must be correctly performed so that the conduit and the backfill interact perfectly. In this way the conduit can react to the ground deformations caused both by its adjustments and by the weight of the backfill. The right interaction is obtained by backfilling the trench through layers as shown in figure 3.
The first layer is the conduit sidefill to reach the top of the conduit. The material is the same of the bedding and the compaction is made only along the sides of the conduit.
The second layer, 15–20cm high, is made by the same bedding material. Again, the compaction is made only along the sides of the conduit and not above to avoid damages resulting from the dynamic stresses caused by compaction.
The remaining part of the backfill can be made with excavated material laid in 30cm layers. The backfill material must have a maximum particle size of 10cm and no plant-fragments. The layer compaction shall be always accurate and all material which obstacles an optimal compaction must be removed. On the top of all this it has to remain some free space to fill with a last layer of organic ground.

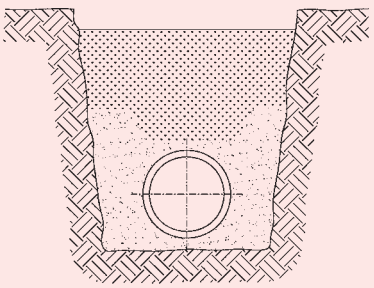
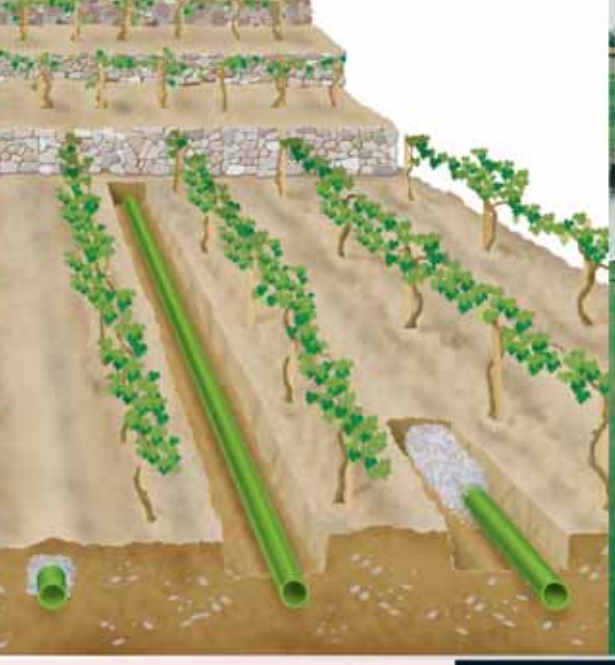
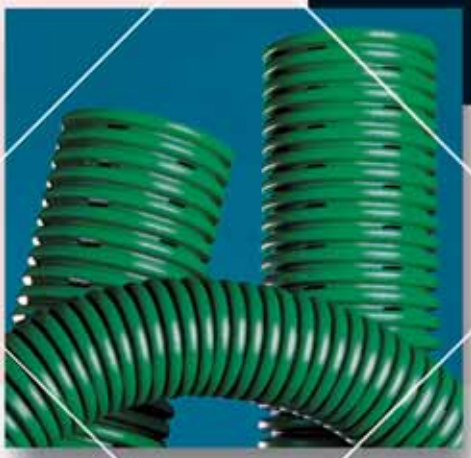


Fig. 3 – Trench backfilling by following layers



DRAINAGE PIPE
"POLIDREN"



SLOTTED PIPE IN COILS
STANDARD CRUSH RESISTANCE

- **Coils length**: 50 meters (* 25meters) ± 1%
- Including jointing coupling
- **External colour**: Green
- **Internal colour**: Black
- Produced with high density polyethylene stabilized to UV rays
- **Slotting option**: 360°
- 1 year warranty (from the production date printed on the pipe)

TECHNICAL FEATURES

1. **Construction:**
   Drainage twin-wall pipe corrugated externally and smooth internally, called "POLIDREN" (from Ø 63 mm to Ø 200 mm)
2. **Composition:**
   Neutral polyethylene: 97%
   Masterbatch green pigments: 2%
   Additives: 1% – Anti UV
3. **Use:**
   Farmland drainage, civil engineering and sport projects
4. **Use limits:**
   -10° C / + 40° C – Flamepropagator
5. **Minimum bending radius:**
   8 times the external diameter
6. **Crush resistance:**
   ≥ 300 N with deformation of the external diameter of 5% (internal Polieco standard based on EN 50086-2-4/A1)
7. **Packaging:**
   Coils of 50 meters (OD.200mm 25meters)
8. **Accessories:** Jointing coupling already fitted on each coil
9. **Installation:** In uderground trench

Available diameters:

DN	63	90	110	125	140	160	200*
Slots on the circumference (nr.)	3	6	3	3	3	3	6
Average slot length (mm)	10	9	14	17	15	18	19
Slot width (mm)	2	2	2	2	2	2	2
Collection surface (cm^2/m)	≥60	≥100	≥60	≥60	≥60	≥60	≥100

DRAINAGE TWIN-WALL PIPE

HIGH RESISTANCE "DRENOSEWER"

SLOTTED PIPE IN BARS WITH HIGH CRUSH RESISTANCE

- **Bars length**: 6 meters ± 1%
- Including jointing coupling
- **External colour**: Black
- **Internal colour**: White
- Produced with high density polyethylene stabilized to UV rays
- **Slotting options**: 360° or 220°
- 1 year warranty (from the production date printed on the pipe)

TECHNICAL FEATURES

1. **Construction:**
   Drainage twin-wall pipe corrugated externally and smooth internally, called "DRENOSEWER" (from Ø 110mm to Ø 200mm)
2. **Composition:**
   Neutral polyethylene: 97%
   Masterbatch black pigments: 2%
   Additives: 1% - Anti UV
3. **Use:**
   Drainage and percolate collection
4. **Use limits:**
   -10° C / + 40° C - Flamepropagator
5. **Minimum bending radius:**
   8 times the external diameter
6. **Crush resistance:**
   ≥ 450 N with deformation of the external diameter of 5% (internal Polieco standard based on EN 50086-2-4/A1)
7. **Packaging:** Bars of 6 meters
8. **Accessories:** Jointing coupling already fitted on each bar
9. **Installation:** In uderground trench

Available diameters:

	Slotting 360°					Slotting 220°				
DN	110	125	140	160	200	110	125	140	160	200
Slots on the circumference (nr.)	3	3	3	3	6	2	2	2	2	4
Slot length (mm)	19	20	17	16	21	19	20	17	16	21
Slot width (mm)	2	2	2	2	2	2	2	2	2	2
Collection surface (cm^2/m)	≥70	≥70	≥70	≥50	≥100	≥50	≥50	≥40	≥40	≥70

DRAINAGE PURPOSE

The artificial ground drainage is made by a network of narrow underground ducts called drains. These are buried in the ground with different extent of permeability to collect and expel the water in excess.
This system avoids to set a special form of the ground surface.
Drainage is essential for grounds where water infiltrations can produce heavy damage both in agriculture and in civil engineering projects.

To build a correct drainage network it is necessary to identify the underground water infiltrations. Often it is necessary make a survey of the surface and underground hydrology also with help of meteorological, hydrometrical and phreatical data.
Moreover it is very important to know the physical and chemical characteristic of the ground, fist of all the permeability coefficient and the depth of the first impermeable layer.

DRAINAGE IN CIVIL ENGINEERING PROJECTS

80% of cracks in buildings, works of art and manufactured products is caused by underground water infiltrations.
The major part of damages are suffered by roads. Almost all slots, which damages the road surface, have origin from water infiltrations which produce instability of the underground layers substaining the road.
Restoring of the bituminous road-coating are useless if the infiltrations are not eliminated deeply with an appropriate drainage of the underground water.

Drainage pipes can and must be put in place according to specific circumstances. For example a motorway (or a busy road) consists of an impermeable roadway, side embankments and a traffic divider which is generally permeable. The rainwater filters through the permeable surface and is absorbed by the roadbed foundation. If not drained the water will compromise the road stability.
In this case the drainage pipe has to be laid lengthwise, along the edge of the roadway and in the centre of the traffic divider (see fig.4).

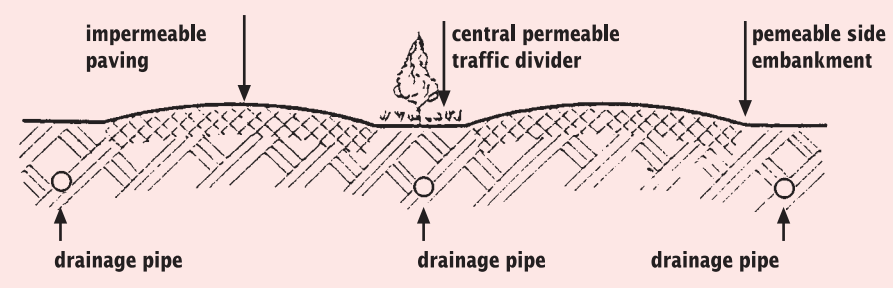


Fig. 4 – Drain allocation along a motorway

In the case of roads cut into a hill-side, part cut in the hill-side and part built on a fill, is used the interception drainage technique. The pipe has to be laid along the side cut in the hill to avoid infiltrations between the impermeable surface and the fill (see fig.5).

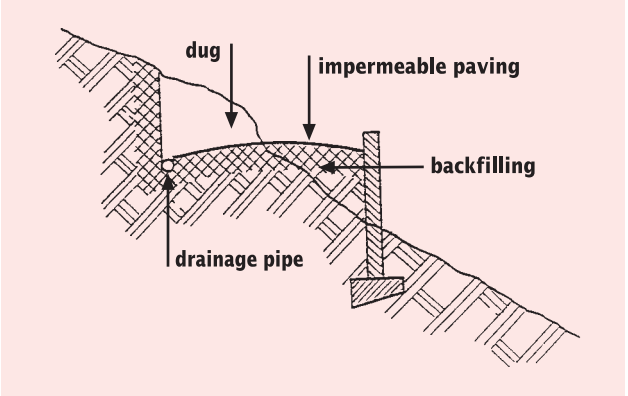
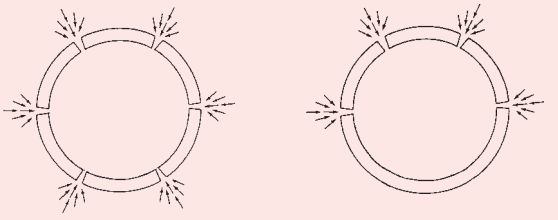


Fig. 5 – Drain allocation along a road cut into a hill-side

DRAINAGE WITH HDPE PIPES "POLIDREN" AND "DRENOSEWER"

The main characteristic of drainage pipes is the ability to collect the water in excess and evacuate it.
To fulfil the first task it is necessary that pipes have slots so that water can enter into the pipe and to carry away the water the pipe must have an adequate section with a sufficient slope and without obstacles so that water flows.
The best drainage pipes in commerce are the Polieco twin-wall pipes made with high density polyethylene corrugated externally and smooth internally called POLIDREN (green coils) and DRENOSEWER (black bars).
The drainage pipes are able to pick up the water thanks to the slots into the corrugations (perpendicular to the pipe axis).
By POLIDREN, as shown in the chart, slots are at 360°, placed every 120 degrees each slot from the next, for diameters from 110 to 160mm, and every 60 degrees for diameter 90mm.
By DRENOSEWER we can have two versions: one with slotting at 360° and the other at 220°, so that the bottom part of the pipe does not have slots, as shown in figure n. 6.
All slots have the same width of 2mm in order to avoid the introduction of particle of a size which might obstruct the pipe in short time.
The choice of slotting perpendicular to the pipe axis and not lengthwise or diagonal has been made because in this way the slot is cut in the invert of the corrugation so that the two corrugation's peaks avoid the obstruction of the slot from the surrounding materials.
Combination of the length and the width acts in such a way that the pipe works like a filter and divides water from the lime in suspension.
The pipe walls thickness and corrugation structure guarantee a high crush & deformation resistance due to the adjustments of the ground.

Fig. 6 – Standard slotting



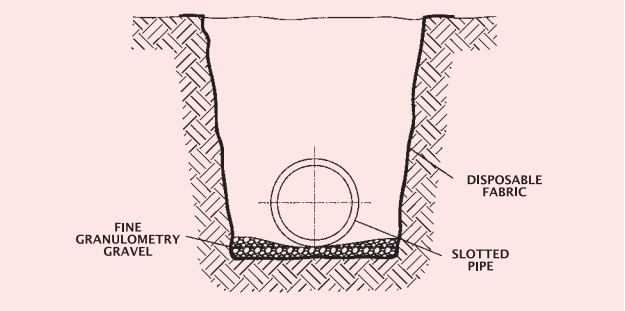
"DRENOSEWER" 360°
"POLIDREN" 360°

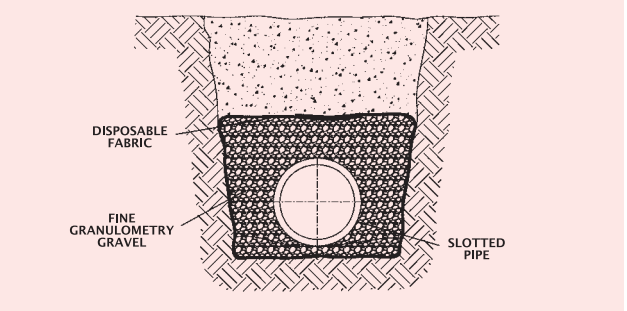
DRENOSEWER 220°

DRAINAGE PIPE LAYING

For a correct and effective laying of a slotted piping it is necessary to act according to following indications:
- to cover the trench walls with a layer of disposable fabric;
- to realize a trench-bed with selected material (fine gravel with granulometry 3-5mm) for a bed thickness of 10 cm, to avoid the direct resting of the corrugations on the deepest level of the digged trench;
- fill the trench around the pipe walls till 40 cm over the top of the pipe, with selected material (fine gravel with granulometry 3-5 mm); then close the two strips pf disposable fabric over this covering level;
- ultimate the backfilling of trench using the same ground digged at the beginning.

It is important to effect a good compaction with special machines and to do not pass during the laying works over the trench area with excavator machines or any other heavy machines or vehicles.





PROJECTING OF A DRAINAGE NETWORK SYSTEM

To project properly a drainage network system it is necessary to have a certain range of basal data and knowledges to oneself; those are reachable through studies and verifications to apply case by case. To define a good size of a drainage network, it is necessary to understand and to locate the origin of the water infiltrations, to control the drainage capability of the ground, to determine the ground permeability coefficient (K) and the depth of the first impermeable layer. It is always necessary to get a complet plot of the tract of the land, on which are present the land heights and the extisting constructions & infrastructures (roads, irrigations networks, waterways and inhabited places, etc..). The frist step by projecting a drainage network, is to define the "flow to drain".
The water excesses inside the ground can be originated by:
- rains;
- water-bearings stratums;
- irrigations.

In this chapter we will speak only about water originated by meteoric events.
Rainwaters are classified according to the different final destination:
a) superficial waters, which flow only on the ground surface;
b) underground waters, which flow under the ground surface;
c) combinated flowing waters, which flow part on and a part under the ground surface.

Combinated flowing waters constitutes a small supplying to the water-beraings stratums: it beginns with the beginning of the rain and means a temporary stratum raising for a period corresponding to the rain duration which caused it. Depth waters, normally filtered towards far sites (sprign-waters, rivers, lakes) are destinated to come again out on the ground surface, because they are always in movement together with the water-bearings stratums.

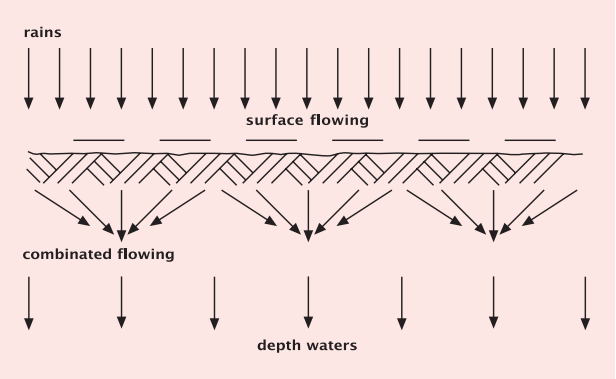


Fig. 7 – Water flowing plan

The calculation of the water quantity which has to be evacuated by the drainage piping system is definied according to the "combinated flowing": indeed, either the superficial flowing waters or the depth waters – thanks to the fact that they are not stagnant – normally they do not decrease the mechanical ground stability. The water quantities referred to each destination, are different according to the ground structure and granulometry; with a certain approximation, we can say that 5% of the rains constitutes the superficial flowing water and 95% percolates in the ground (of this quantity, 25% goes to the "depth waters" and 70% to the combinated flowing which can be intercepted by the drainage piping system. By this numbers, the drainage network should be sized for a flowing capacity equal to 70% of the rain waters. After this calculation, it can be definied the diameter of the drainage pipes to lay according to the formula of Visser:

$$d = 0{,}0209 q^{0{,}375} A^{0{,}375} J^{-0{,}375} \qquad (Visser)$$

d: internal diameter of the drainage pipe (cm),
q: specific water flow to drain (mm/day),
A: ground surface interested by the underground drainage network (m^2),
J: drainage pipe slope (%).

Furthermore to the flowrates, it is necessary also to define the "filling rate" (maximum level that can be reached by the water inside the pipes) and calculate the slopes to be used, in relation the height sequence of the ground and to the collectors level to which the piping are connected; all this is necessary to guarantee a regular water flowing.

The flowing speedness must be enough to guarantee the elimination of eventual sediments inside the drainage piping (speedness of 0,5 m/sec are normally recommended). To obatain it, pipes can be laid with a slope particularly different from the external ground slope. Another interesting evaluation refers to the distance between each one of the drainage pipes. The most used formula to calculate this doistance is that of Hooghoudt–Donnan.

$$L = \sqrt{\frac{8KDh}{q} + \frac{4Kh^2}{q}} \qquad \textit{(Hooghoudt-Donnan)}$$

q: flow to drain (mm/day),
D: drainage pipes distance from the impermeable layer (m),
h: stratum maximum elevation possible in relation with the drainage pipes flat (m),
K: soil permeability coefficient (mm/day).

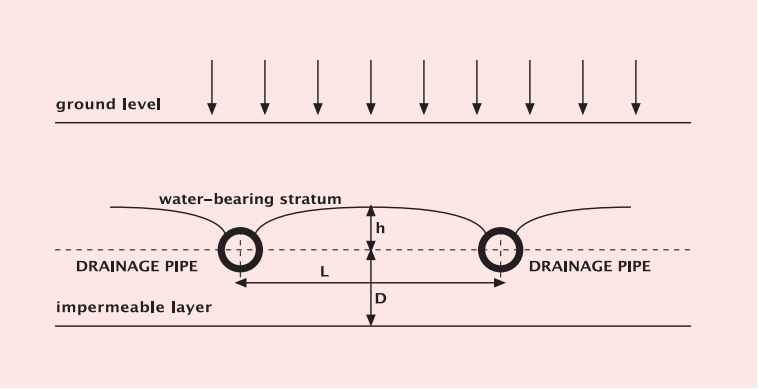


Fig. 8 – Optimal distance between drainage pipes

PLANIMETRIC VIEWS OF POSSIBLE DRAIN PLANS

Drainage pipe networks are normally laid in parallel (see figure 9) and end into a surface canal or into a collector that flows into a surface canal. To ease the maintenance operations we suggest to install manholes along the drainage line and where the drainage pipe end in the collector.

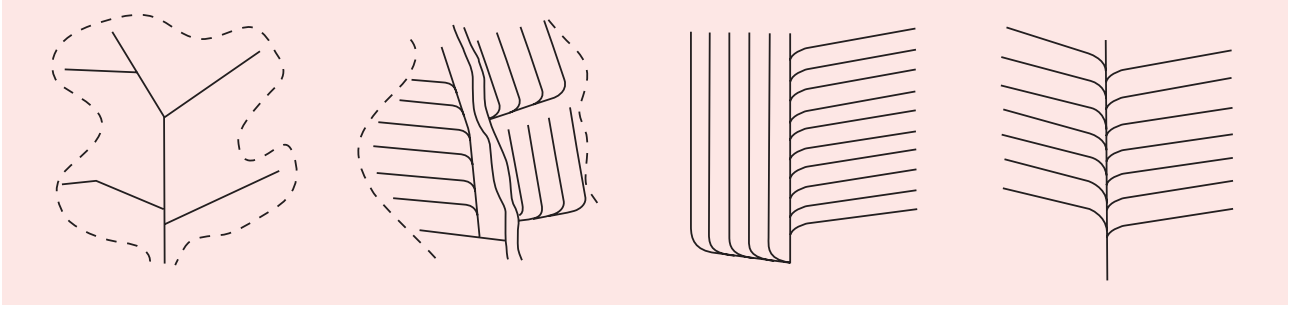


Fig. 9 – Some typical drainage pipes schemes

INDUSTRIE POLIECO M.P.B. s.r.l.

Cazzago S. Martino (Bs) Italy - Via E. Mattei, 49
Tel. +39.030.7758911 - Fax +39.030.7750845
www.polieco.com - info@polieco.com