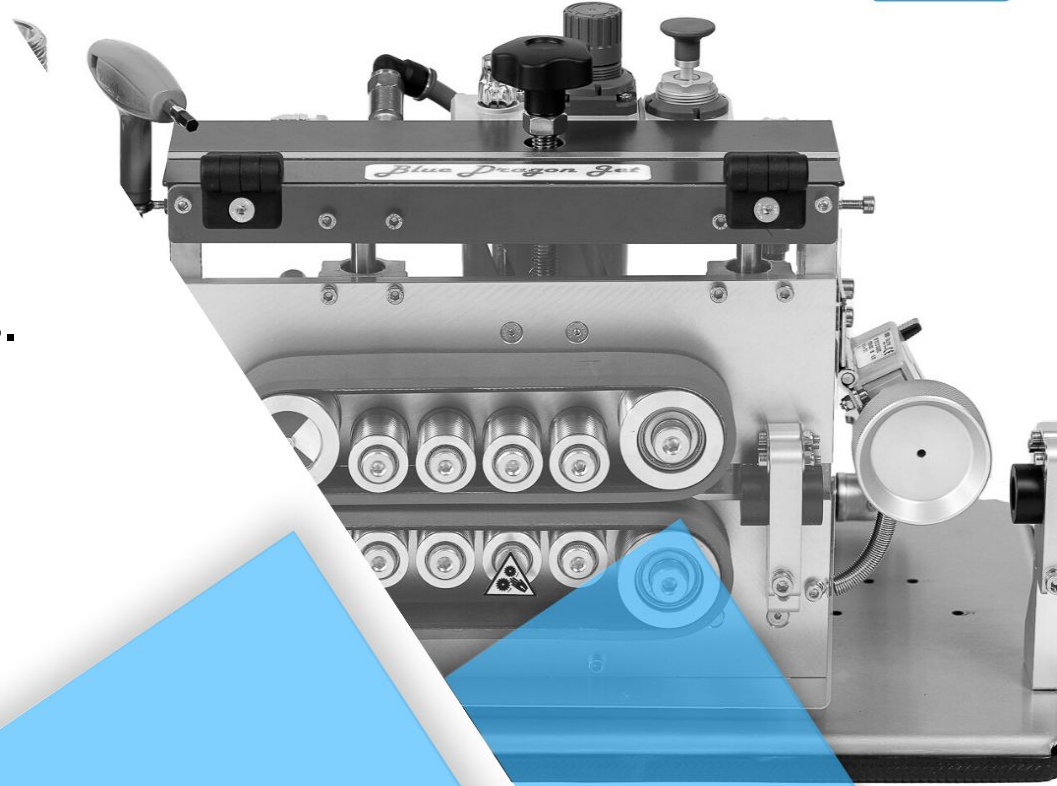


The construction of modern telecommunications networks.

Using the fibre-optic cable blowing technique

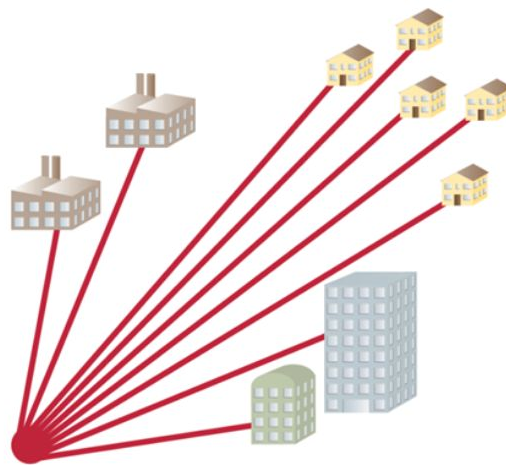




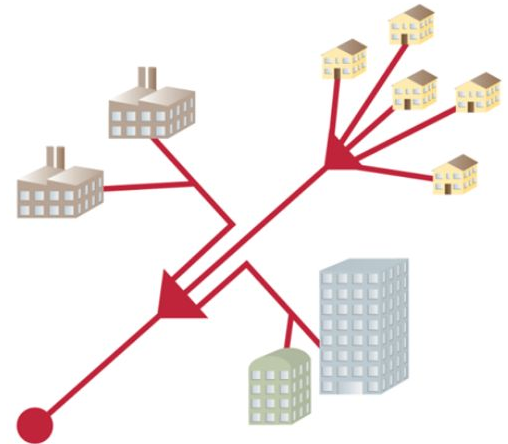
Types of telecommunications networks



Backbone network



Distribution network



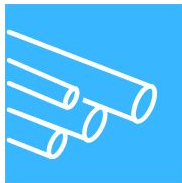
Access network



CONSTRUCTION OF TELECOMMUNICATIONS NETWORKS



DESIGN AND OBTAINING PERMITS



FOR THE CONSTRUCTION OF A CABLE DUCT



INTRODUCING CABLES INTO THE DUCT



CONNECTING ACTIVE EQUIPMENT



CONSTRUCTION OF TELECOM DUCT SYSTEMS AND CABLE MICRO-SEWERAGE SYSTEMS



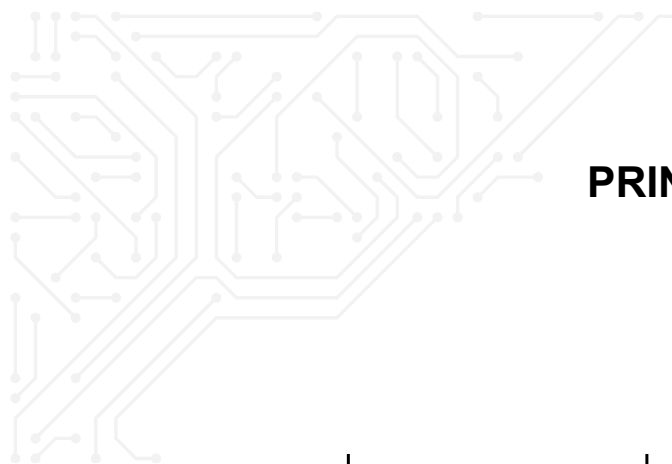
PRIMARY TELECOM DUCT SYSTEM



SECONDARY TELECOM SYSTEM



MICRO-TELECOM SYSTEM



PRINCIPLES OF TELECOM SYSTEM CONSTRUCTION

Over the entire length of the section, pipes must not cross or entangle with each other.

Vertical and horizontal pipe undulation should not exceed 0.2-0.3%.

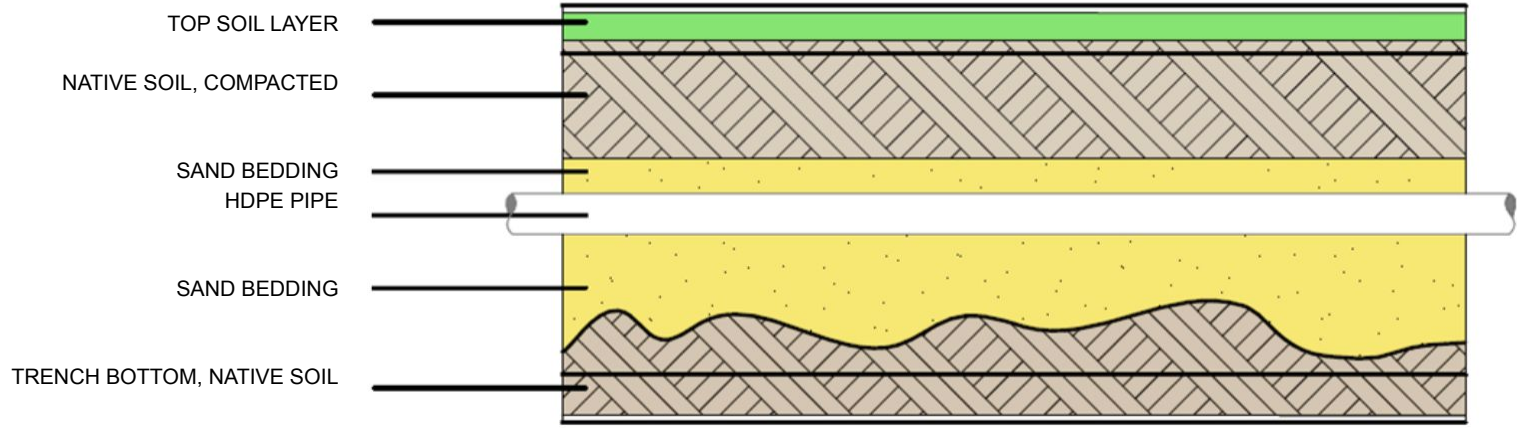
Over the entire length of the section, pipes must not be joined.

The trench bottom must be flat and hard, and the first backfill layer of approx. 30 cm should consist of sand or sifted, fine soil.

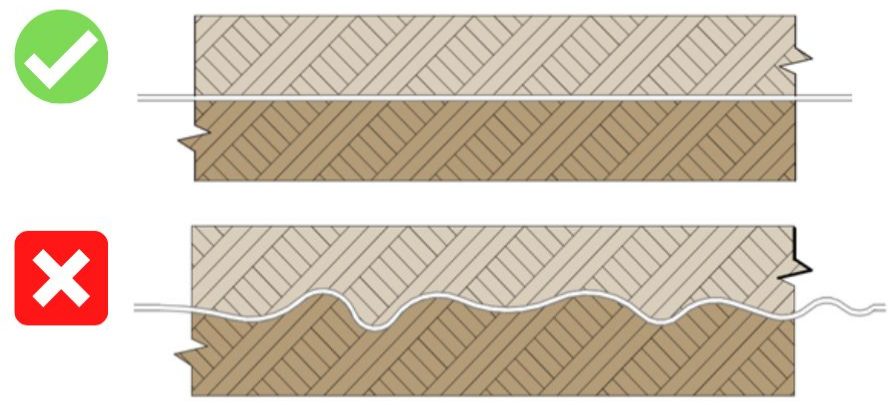
The soil after backfilling the trench must be compacted.

A warning/signaling tape should be placed above the pipes at half the depth.

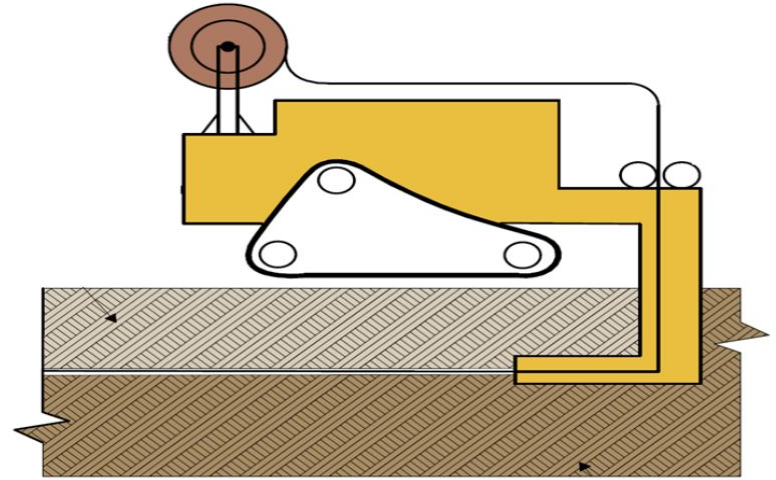
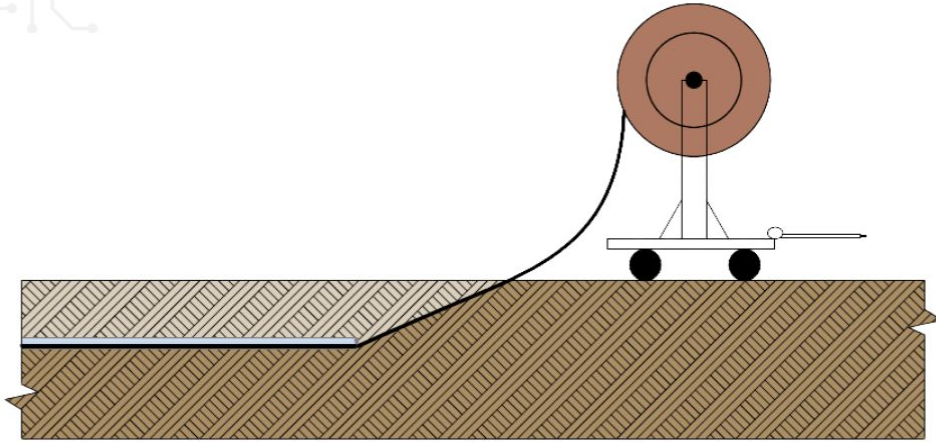




**Correct installation of
a cable duct pipe in
the ground**



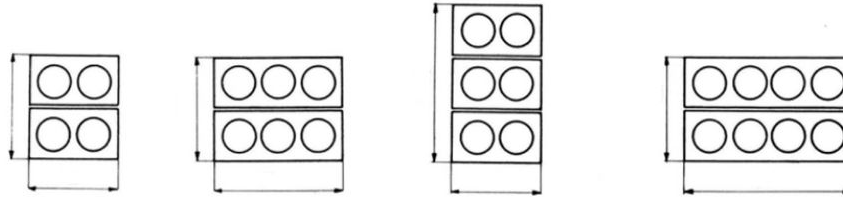
Principles of cable duct construction



Rules for constructing cable duct systems

Concrete prefabricated elements are still encountered. Currently, they are mostly made of high-density polyethylene HDPE, polypropylene PP, or less frequently polyvinyl chloride PVC. Pipes are manufactured in 6 m lengths as straight, socketed, corrugated, double-walled (corrugated outside, smooth inside), and longitudinally split. The most common diameters range from 60 to 160 mm. Standard is DN 100-DN 110 mm.

PRIMARY DUCT PIPES



CONCRETE PREFABRICATED ELEMENTS

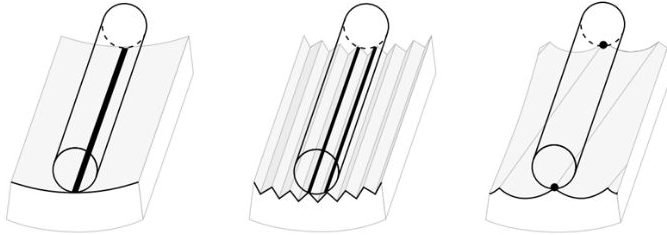


SMOOTH PLASTIC PIPES



CORRUGATED PLASTIC PIPES

Materials for the construction of sewerage systems



Smooth pipe

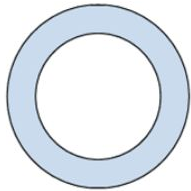
Contact surface for
 $1 \text{ m} \geq 200 \text{ mm}^2$

Grooved pipe

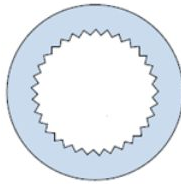
Contact surface for
 $1 \text{ m} = 200 \text{ mm}^2$

TeleRohr System

Contact surface for
Vogelsang RSR
 $1 \text{ m} = 1.76 \text{ mm}^2$



Smooth pipe



Grooved pipe

Secondary duct pipes should be made of virgin HDPE material, which excludes the presence of impurities that increase friction. Pipes can have various internal surface finishes:

- homogeneous smooth pipes
- smooth pipes with a sliding layer
- homogeneous grooved pipes
- grooved pipes with a sliding layer
- Vogelsang system grooved pipes (internal grooves arranged spirally, with direction change)

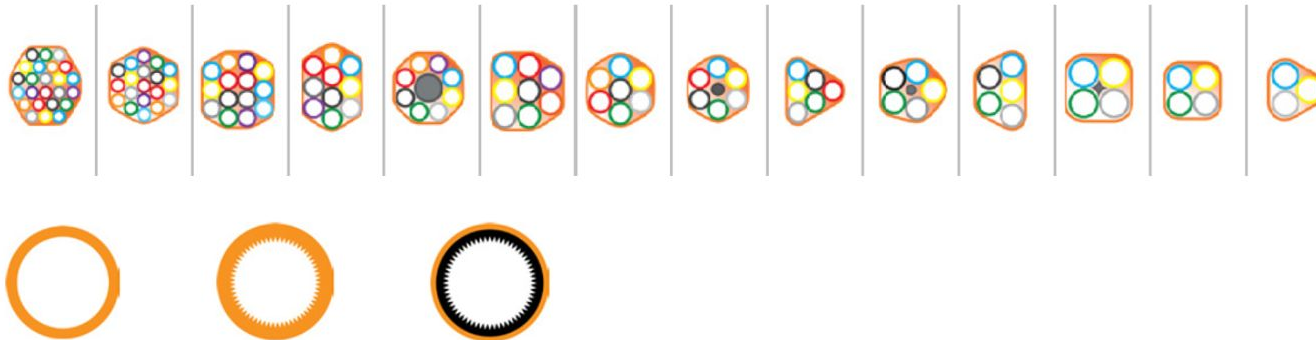


Materials for the construction of sewerage systems

Micro-duct pipes are made of high-density polyethylene HDPE. Just like secondary ducts, they have various internal surface finish variants:

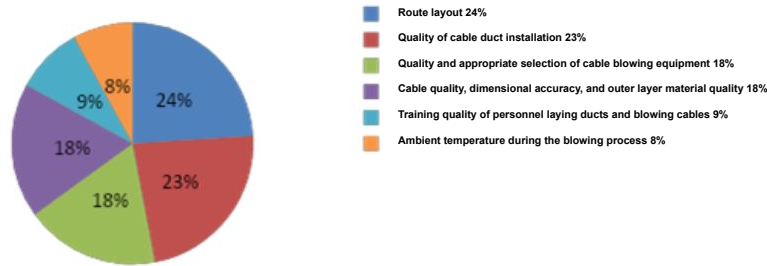
- homogeneous smooth pipes
- smooth pipes with a sliding layer
- homogeneous grooved pipes
- grooved pipes with a sliding layer

An important parameter for micro-ducts is the wall thickness. Tubes for direct burial or in bundles bound only with a thin foil have thicker walls, above 1.5 mm. For tubes to be installed in a secondary duct, walls below 1.5 mm are provided. Tubes delivered individually can have different colors over their entire surface or have longitudinal lines of different colors for easy identification in bundles. Thick-walled tube bundles usually contain tubes of the same diameters. The arrangement of tubes in bundles can vary greatly, so that they take on a flat, triangular, oval, or polygonal shape. Bundles containing even over twenty tubes are encountered. Often, the bundle also contains a copper tracer wire and/or a ripcord to facilitate tearing the foil wrapping the bundle. Thin-walled tubes are sometimes delivered in prefabricated bundles inside secondary ducts. They also contain even over 20 tubes of small diameters. Bundles with tubes of various diameters are often encountered. Micro-ducts can be arranged tightly or loosely in the secondary duct.



MOST COMMON MISTAKES IN CONSTRUCTION SIDE

Factors affecting the blowing range of fiber optic cables



Factors affecting the blowing range of fiber optic cables

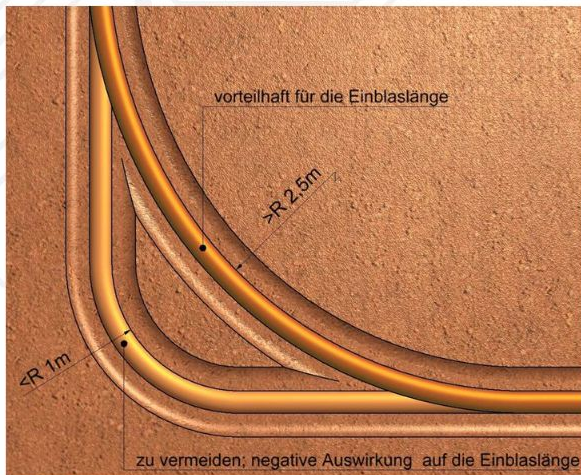
1. Route layout 24%
2. Quality of cable duct installation 23%
3. Quality and appropriate selection of cable blowing equipment 18%
4. Cable quality, dimensional accuracy, and outer layer material quality 18%
5. Training quality of personnel laying ducts and blowing cables 9%
6. Ambient temperature during the blowing process 8%

- Errors at the design stage
- Errors during pipe storage and transport
- Errors during trench excavation for protective pipes
- Errors during pipe laying in the trench
- Errors when joining pipes and micro-ducts
- Errors during duct backfilling

Errors at the design stage

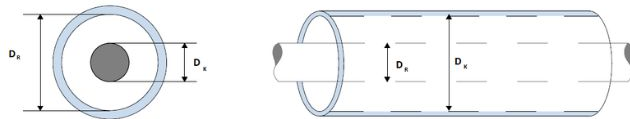
Incorrect route design

The most common route design error is designing bends without considering the minimum bending radius, which should be greater than 2.5 m. The use of bends smaller than 1.5 m drastically reduces the blowing distance.



Źródło Gabocom

Incorrect selection of cable diameter relative to duct diameter



Optimal conditions occur when the cable diameter is 60% of the inner diameter of the tube.

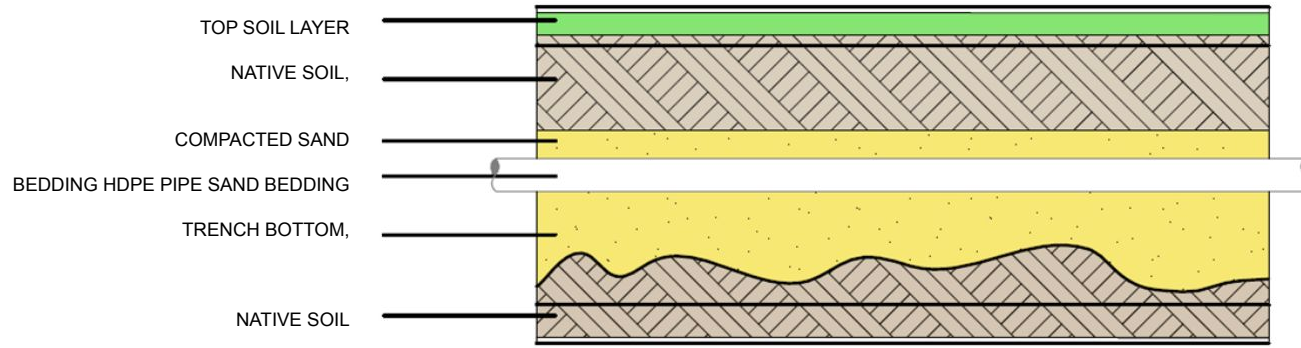
speed pipeØ	min. Kabel Ø in mm	empfohlener Kabel Ø in mm	max. Kabel Ø in mm
7x0.75	1.8	3.8	4.0
7x1.5	1.0	2.3	2.7
10x1.0	2.5	6.2	6.5
10x2.0	1.8	4.0	4.6
12x1.1	3.0	8.0	8.0
12x2.0	3.0	6.2	6.8
14x1.3	4.0	9.0	9.5
14x2.0	3.0	8.0	8.7
16x2.0	6.5	9.8	10.4

Źródło Gabocom

Errors during the storage and transport of pipes

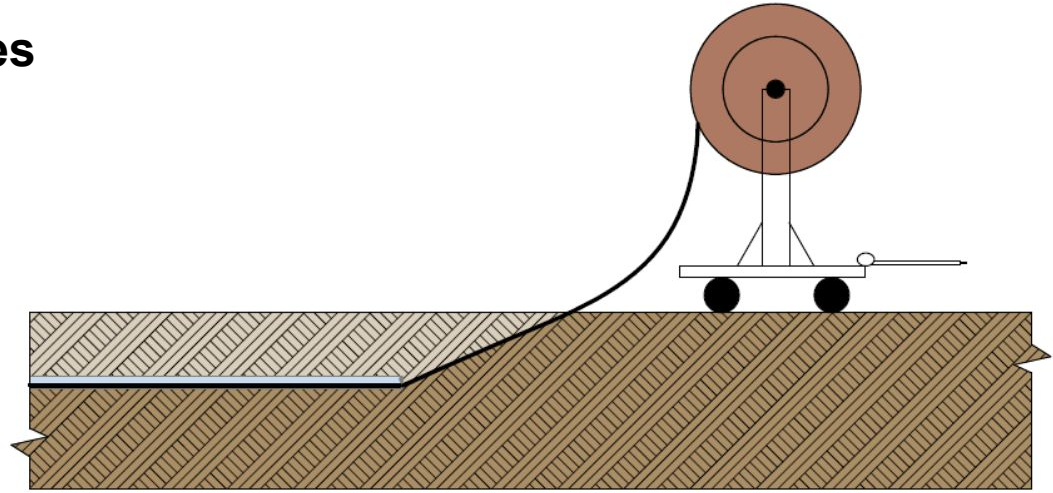


Errors during trench excavation for protective pipes



A trench excavated manually or by an excavator is difficult to do incorrectly. It is important that the trench bottom is flat and runs in a straight line, both vertically and horizontally. Stones, rubble, or roots must not be left at the bottom of the trench. It is best if it is smoothed and slightly hardened (compacted). When changing the direction of the trench, remember to maintain the minimum radii provided by the pipe manufacturer.

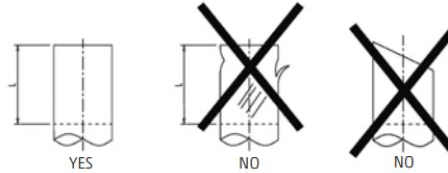
errors when laying pipes in a trench



Errors when joining pipes and micro-ducts

Errors when joining pipes and micro-ducts

The general rule is not to join protective pipes between manholes or handholes. However, in practice, such joints do occur. The most common mistake is inaccurate pipe cutting. Ordinary knives or, even worse, saws must never be used for cutting. Special knives or cutters must be used for cutting. It is important that the cut is made perfectly perpendicular to the pipe axis. Then the joined sections will meet without any gap. It is very important that the ends of the pipes are deburred after cutting, meaning the sharp outer and inner edges of the pipe are chamfered. Special tools must be used for deburring. Special care must be taken so that filings or plastic chips do not get inside the pipe during deburring. In the case of micro-ducts, this can make cable blowing completely impossible. Equally important when joining are appropriate connectors. They must ensure a strong and tight connection. It is unacceptable for the connector to cause a reduction in the inner diameter of the conduit.

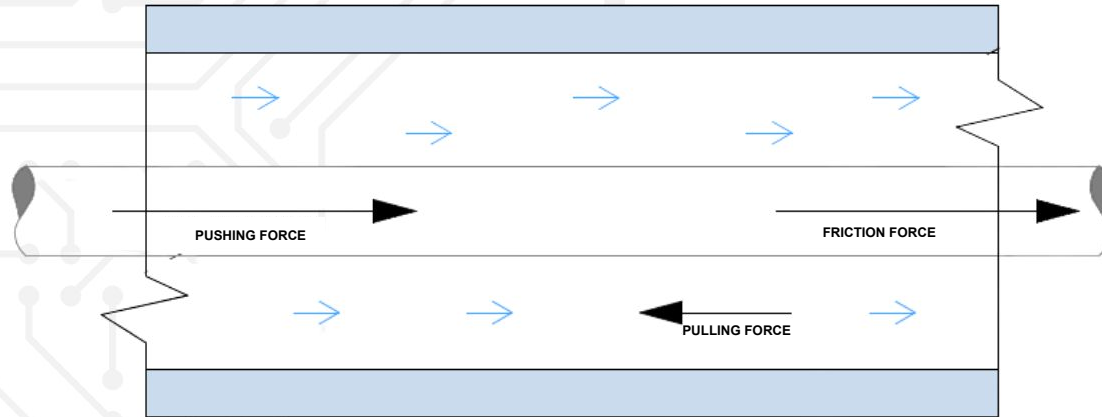


When backfilling the duct system, care must be taken not to cause displacement of the buried pipes. The first layer of soil in direct contact with the pipes must be free of stones, rubble, and the like. It is best if it is sifted sand or soil. Do not forget to place a warning tape in the trench at the appropriate depth. Special caution must also be exercised in the case of mechanical soil compaction in the trench to avoid crushing the tubes lying at the bottom.

Errors during duct backfilling



Forces acting on a cable in a pipe



$$F_{\text{tarcia}} \leq F_{\text{ciągnięcia}} + F_{\text{pchająca}}$$

The cable moves inside the pipe until the friction force balances the sum of the pulling and pushing forces.

Siła tarcia w prostej rurze

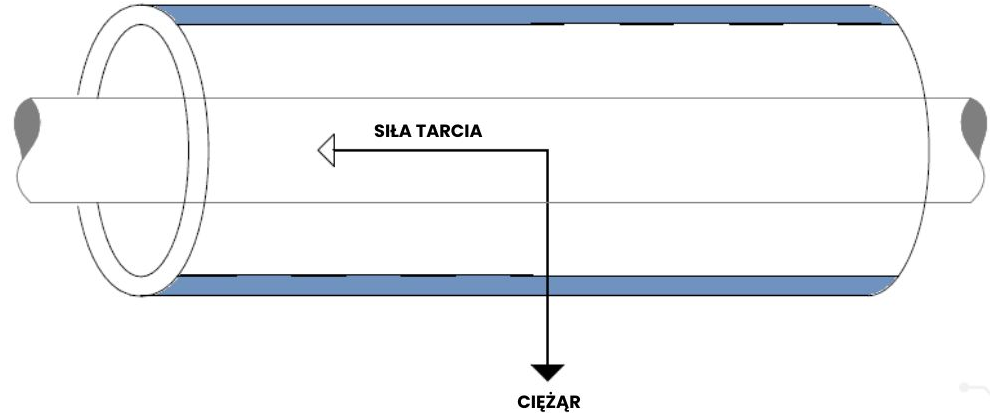
$$F_{\text{tarcia}} = m l \mu$$

m - ciężar właściwy kabla [N/m]

l - długość kabla [m]

μ - współczynnik tarcia

Dla przeciętnego kabla o ciężarze właściwym 2 N/m daje to siłę około 300 N przy długości kabla 2000 m

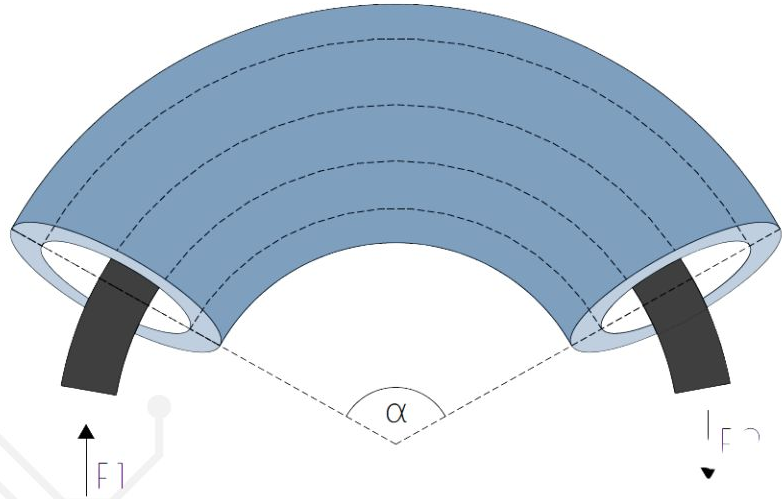


Frictional force in a pipe bend

$$F_2 = F_1 e^{\mu\alpha}$$

$$F_2 = F_1 e^{\mu\alpha}$$

- F_1 - force before the bend
- F_2 - force after the bend
- e - Euler's number (approx. 2.71)
- μ - coefficient of friction
- α - angle defining the size of the bend



cable blowing

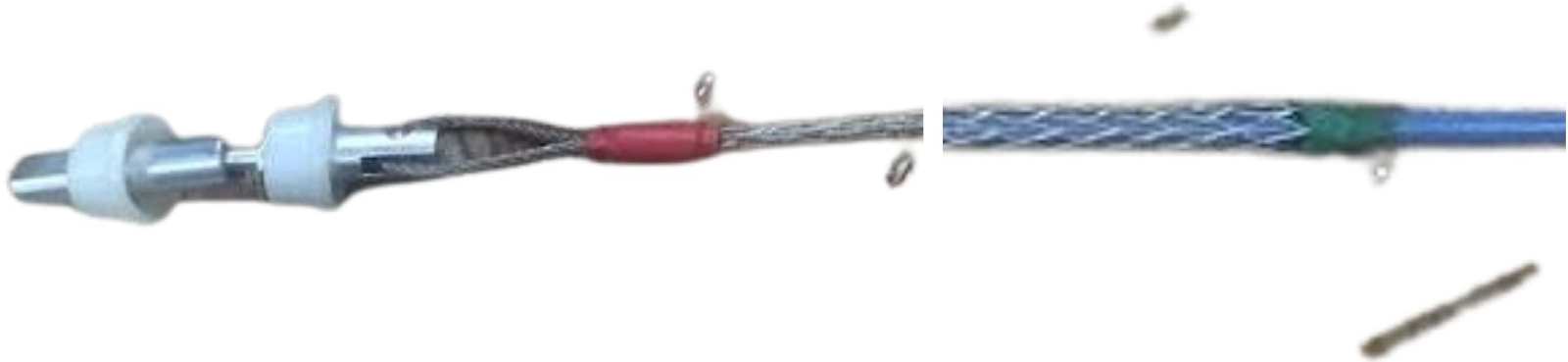
PISTON METHOD

The piston method is used only for installation in protective ducts with internal diameters greater than 28 mm (outer diameter 32 mm). The piston must be attached to the end of the cable using a dedicated pulling grip (cable stocking) for fiber optic cables. After placing the grip onto the cable, tightly wrap the last few centimeters with soft adhesive tape to secure it against slipping off, taping the end of the grip directly onto the cable.

The piston should be fitted with soft plastic/rubber sealing discs with a diameter matched to the inner diameter of the duct. The piston should move freely inside the duct without resistance. If necessary, the outer diameter of the seal can be trimmed. Before inserting the piston with the cable into the duct, pour in about ½ liter of cable blowing lubricant. After inserting the piston with the cable into the duct and pushing it in for a few meters, pour in another portion of lubricant, approximately 1 liter per 1 km of the planned route. Then connect the duct with the cable to the blowing machine head.

With the drive tracks (belts, wheels, rollers) raised, begin slowly introducing compressed air while monitoring the cable speed so it does not exceed 120–130 m/min. If there are many bends at the beginning of the route, limit the speed to a maximum of 60 m/min. When the cable speed drops below 30 m/min, engage the drive feeder. The optimal speed is 60–120 m/min. The pushing force must not exceed the limit determined during the crash test. Make sure that the piston popping out at the other end of the duct does not hit any crew members.

Blowing cables using the PISTON METHOD



COMPRESSORS



For duct pipes with outer diameter $D = 32 \text{ mm}$ to $D = 50 \text{ mm}$, large compressors with a capacity of $8\text{--}11 \text{ m}^3/\text{min}$ and an operating pressure of $8\text{--}10 \text{ bar}$ are required.

For duct pipes with diameters of $12 \text{ mm}\text{--}20 \text{ mm}$, a compressor with a working pressure of 15 bar and a capacity of up to $2 \text{ m}^3/\text{min}$ is required.



For pipes with diameters of $7 \text{ mm}\text{--}12 \text{ mm}$, a compressor with 15 bar pressure and a capacity of $1 \text{ m}^3/\text{min}$ is sufficient.



For microducts with diameters up to 7 mm , compressors with $10\text{--}12 \text{ bar}$ pressure and a capacity of 0.1 to $0.5 \text{ m}^3/\text{min}$ are sufficient.



Classification of fiber blowing machines

1. BY APPLICATION:

- Blowing machines for traditional cables, with an outer diameter over 10 mm
- Blowing machines for microcables, with an outer diameter under 10 mm
- Blowing machines for microduct bundles

2. BY FEEDER TYPE:

- Track feeder (caterpillar drive)
- Roller feeder
- Belt feeder
- Toothed wheel (gear) feeder
- Blowing heads without feeders

3. BY DRIVE TYPE:

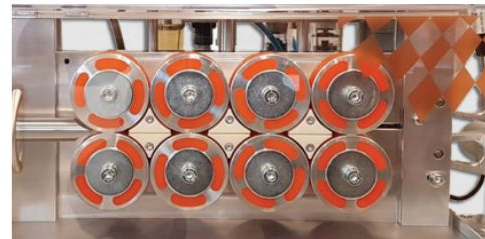
- Pneumatic motor drive
- Hydraulic motor drive
- Electric motor drive
- External drive (e.g., cordless drill)



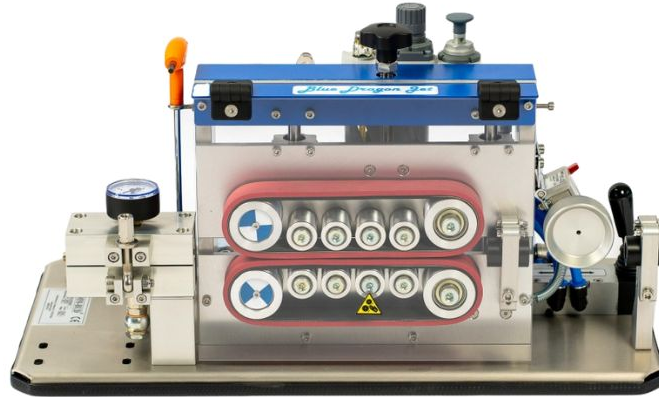
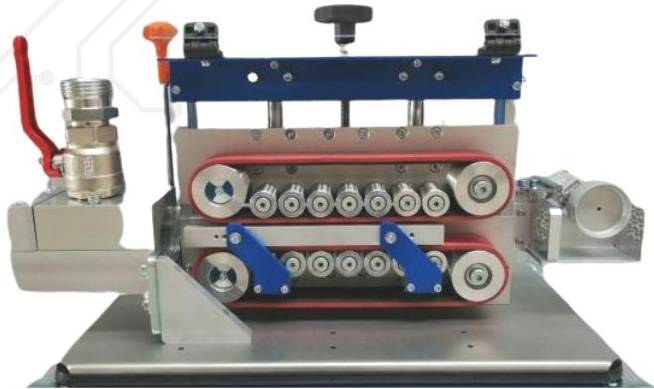
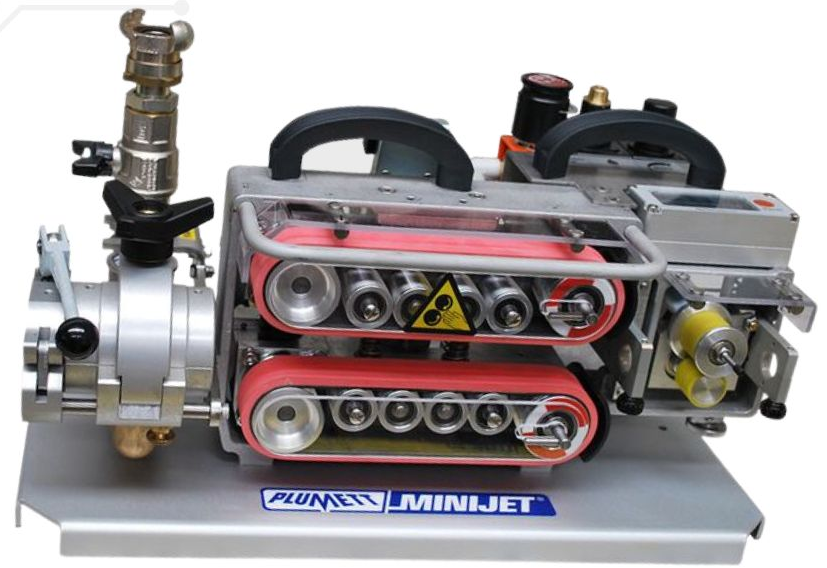
Machines with a caterpillar feeder



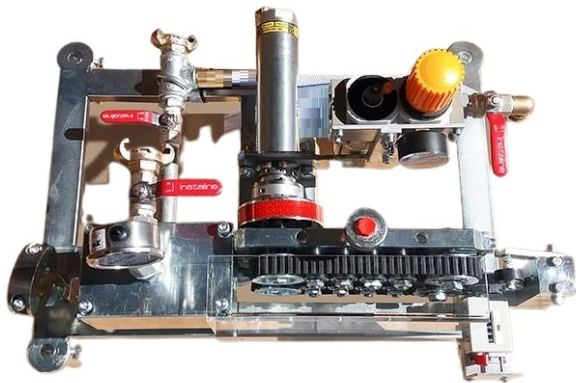
Machines with a roller feeder



Machines with a belt feeder



Machines with a belt feeder



Cable blowing

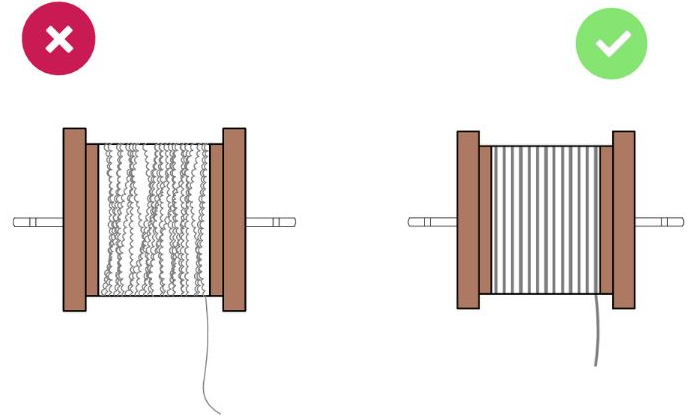
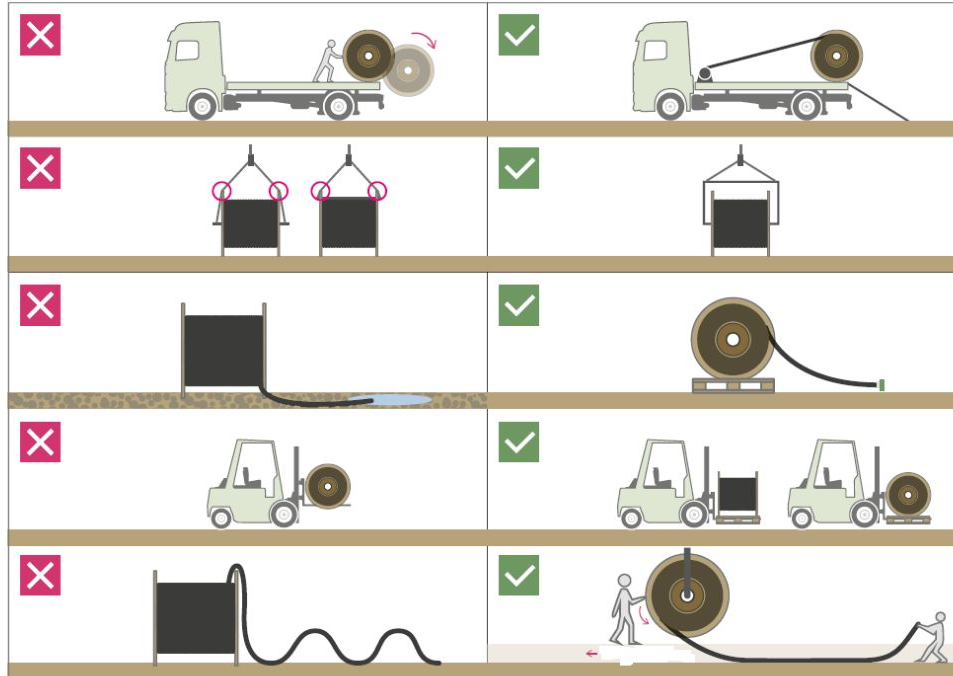
A critical procedure that must be performed before **EVERY** cable blowing operation is the so-called Crash Test—determining the pushing force that will cause cable failure (buckling/bending). So far, cable manufacturers only provide the maximum permissible pulling tension, even though very few fiber optic cables are installed using the pulling method. Therefore, the maximum allowable compressive force must be determined on-site by the operator.

In the blowing head, clamp a short section of duct pipe capped at the end (1.5 m for HDPE 32, 40, and 50 mm pipes, and 1 m for microducts). Insert a 3–4 m cable sample into the machine feeder and set the drive to low power (depending on the drive type: by adjusting pressure on pneumatic or hydraulic motors, or using the power potentiometer for electric motors).

Next, start the feeder so that the cable strikes the capped end of the duct at maximum speed. Repeat this procedure several times, gradually increasing the motor power each time until the cable buckles. The maximum allowable pushing force will be the setting from the last test that caused no damage to the cable.

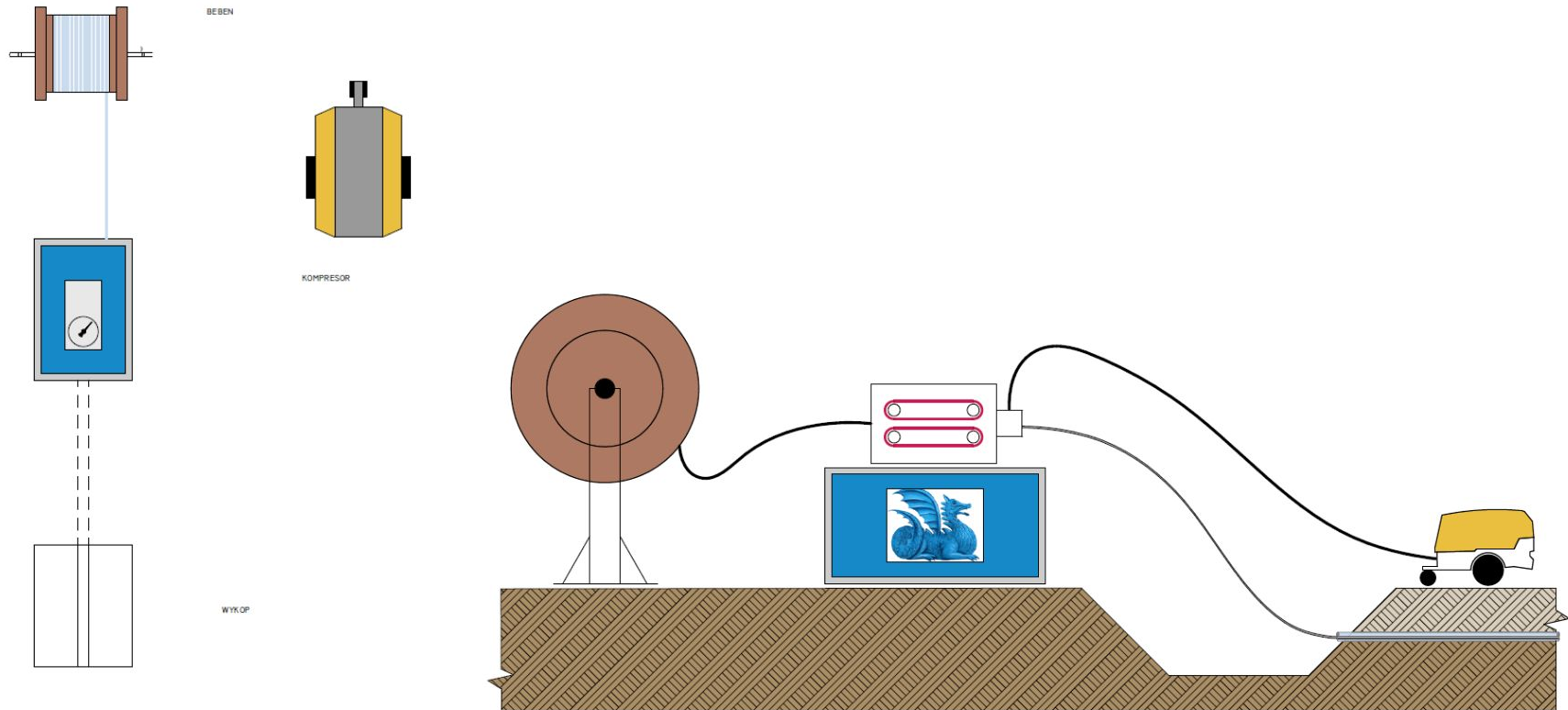
2. Mistakes during cable storage and transportation

MOST COMMON MISTAKES IN CABLE BLOWING



3. Mistakes in jobsite setup (worksite layout)

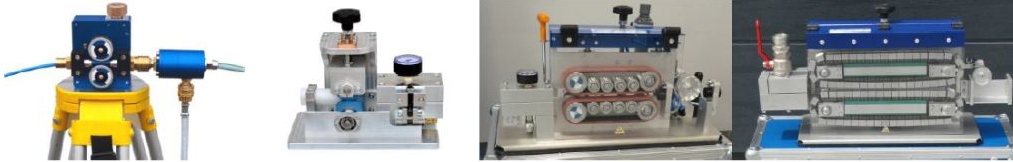
MOST COMMON MISTAKES IN CABLE BLOWING



4. Mistakes in equipment selection for cable blowing

Select the appropriate blowing machine:

- a. Microducts up to 12 mm – BDJ Budget
- b. Ducts up to 20 mm – BDJ Mini, BDJ Standard
- c. Ducts up to 50 mm – BDJ Max, BDJ Hydro, BDJ Hydro Chain
- d. Microduct bundle blowing – BDJ Multitube, BDJ Multitube Belt



Select the appropriate compressor:

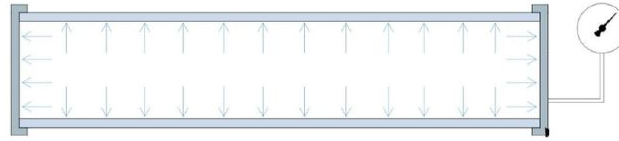
- a. For duct pipes $D = 32$ mm to $D = 50$ mm, large compressors with an output of 8–11 m³/min and working pressure of 8–10 bar are required.
- b. For pipes with diameters of 12 mm–20 mm, a compressor with 15 bar pressure and output up to 2 m³/min is required.
- c. For pipes with diameters of 7 mm–12 mm, a compressor with 15 bar pressure and output of 1 m³/min is sufficient.
- d. For microducts with diameters up to 7 mm, compressors with 10–12 bar pressure and output of 0.1 to 0.5 m³/min are sufficient.



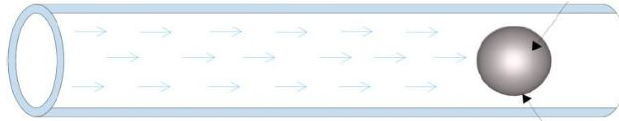
MOST COMMON MISTAKES IN CABLE BLOWING

MOST COMMON MISTAKES IN CABLE BLOWING

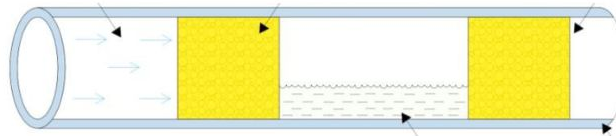
➤ No pressure



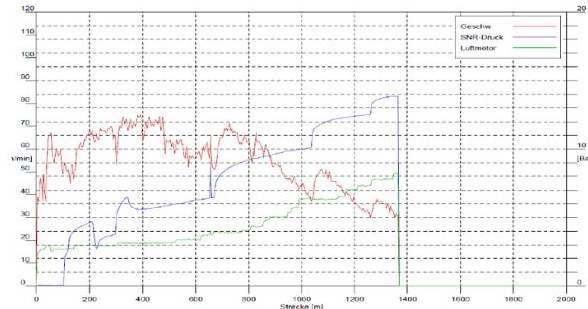
➤ No duct calibration



➤ Lack of lubrication



➤ Incorrect metering of blowing air pressure



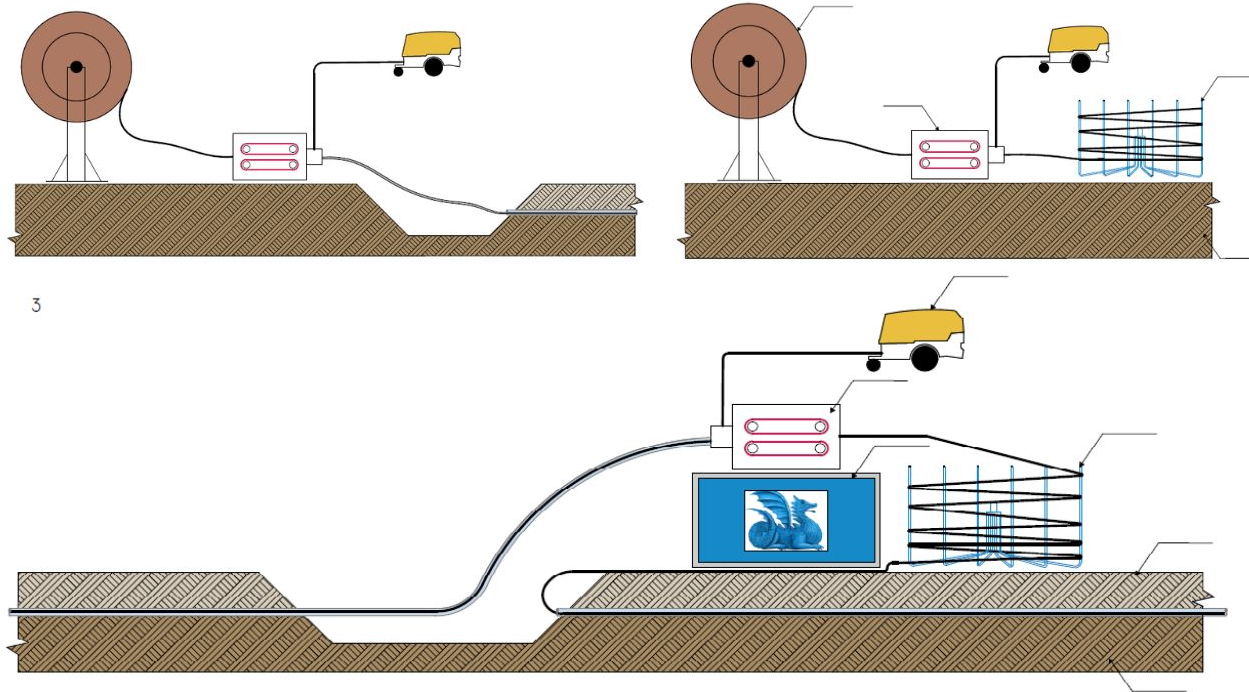
MOST COMMON MISTAKES IN CABLE BLOWING

Useful information on cable blowing techniques



Center blowing (mid-span blowing)
Figure-eighting the cable

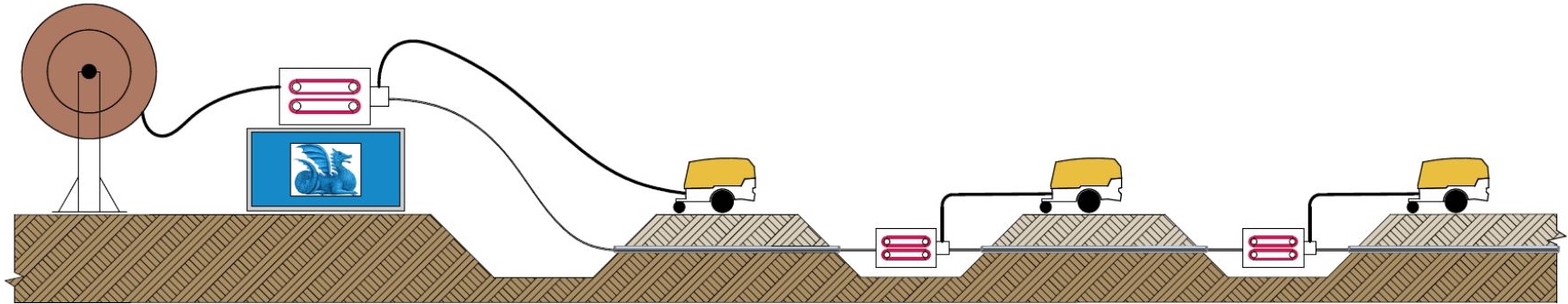
Useful information on cable blowing techniques



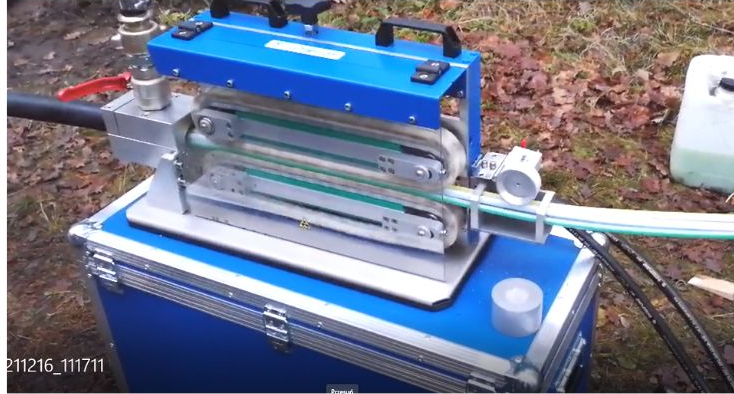
**Center blowing
Using a Twister**

Useful information on cable blowing techniques

CASCADE BLOWING

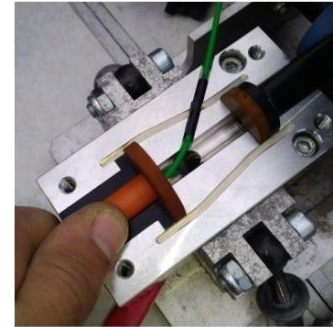
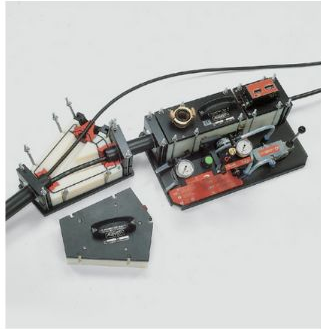
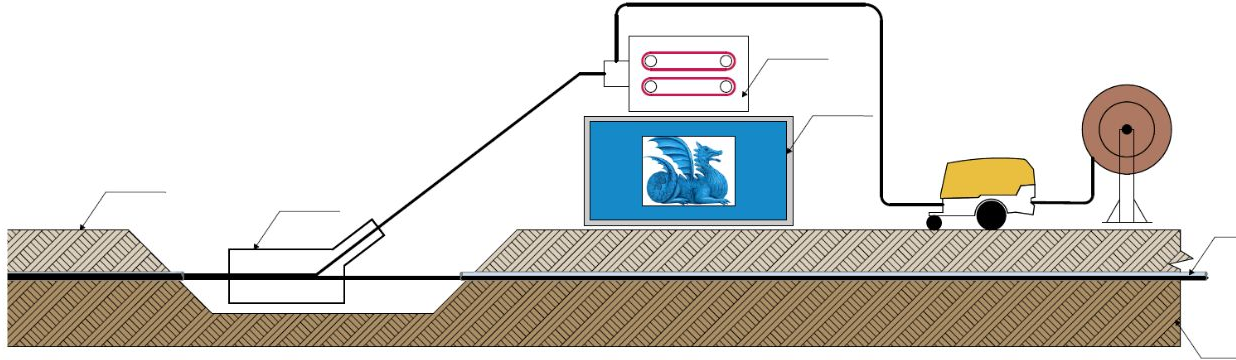


Useful information on cable blowing techniques



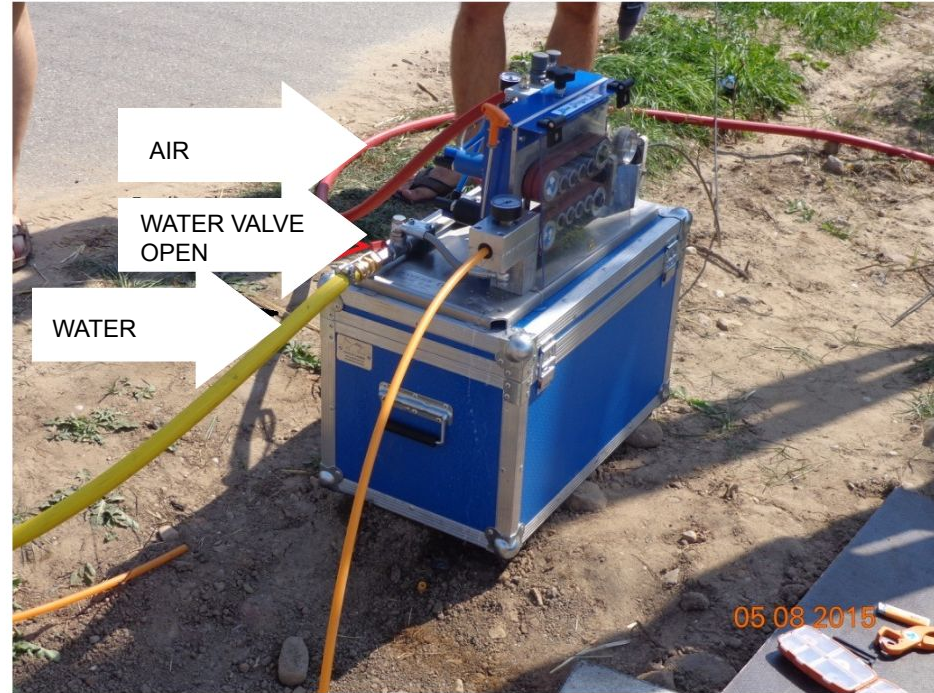
MICRODUCT BLOWING

Useful information on cable blowing techniques



Blowing a cable/microduct into an occupied duct (overblowing).

Useful information on cable blowing techniques



“WATER” BLOWING



Thank you for your attention