

**Europacable**  
**Technical newsletter**  
**Pulling and blowing**  
**a cable in a duct**

**January 2023**

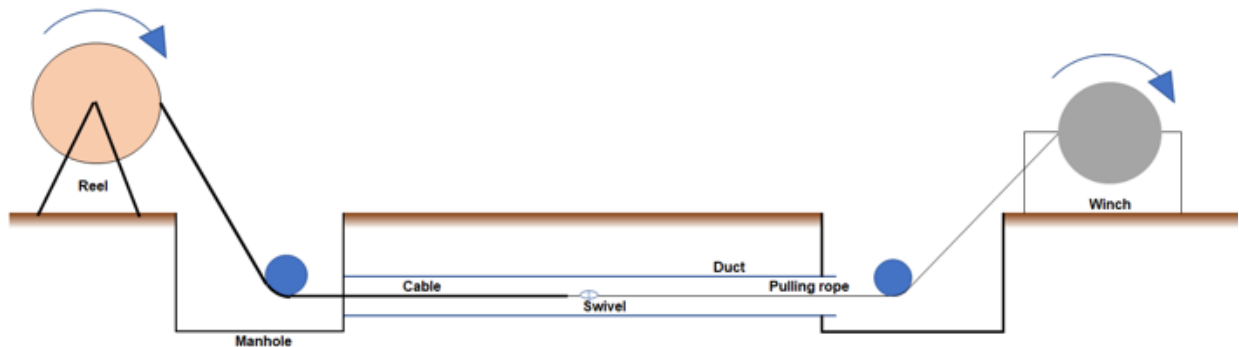


## Executive summary

The installation of optical fibre cable in duct is becoming the most popular installation method in the FTTH networks; from pulling to air jetting the network builder has the choice but the trend to reduce the size of the OF cables is giving more and more consideration to the microcables and associated microducts. We review the main differences between pulling and blowing a cable in a duct and the impact on the cable designs. Also, the optical fibre diameter evolution from 250 to 200 and now 180µm will accelerate the adoption of microcables and the installation by blowing.

### Ducts - Pulling

Very rapidly (in the 80's) the installation in duct by pulling becomes very popular as the OF cable was considered very fragile and must be protected in the ground. Pulling has been the first technology for installing OF cables in duct. It means the cable must be reinforced to cope with the necessary tensile force.



The quality of the duct is of particular importance; the coefficient of friction between the duct and the cable must be as low as possible using appropriate high-quality material (i.e., HDPE). Also, the route and the possible windings are critical to achieve long distance pulling. Very rapidly the capstan effect will make the tension very high at the cable far end following the exponential law:



$$T_{out} = T_{in} \times e^{\mu\theta}$$

$T_{in}$ : tension at the entry  
 $\mu$ : coefficient of friction

$T_{out}$ : tension at the exit  
 $\theta$ : rotation angle

This makes obvious that the installation condition is a key factor for a good cable installation: all the small bends will have a cumulative effect causing the tension in the cable reaching very rapidly the maximum allowed tension. Keep in mind the bends, the windings and the slopes.

In a horizontal straight section of a route the tension build-up will evolve linearly following:

$$T_{out} = T_{in} + W \times \mu \times L$$

W: Linear weight of the cable (N/km)

$\mu$ : coefficient of friction

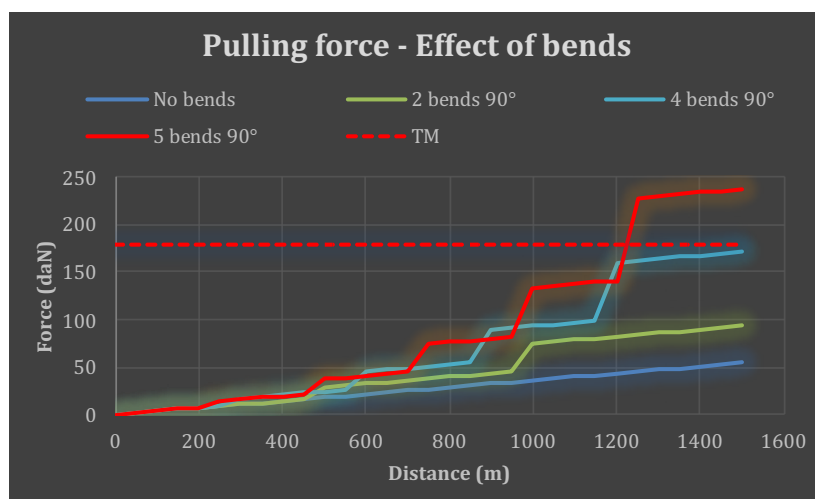
L: Length of the route segment

The main cable parameters to take into consideration to appreciate the pulling tension performance of a cable are:

- The mass of the cable (kg/km)
- The diameter of the cable (mm)
- The stiffness of the cable (Nx $m^2$ )
- The coefficient of friction between the cable and the duct
- The inner diameter of the duct (mm)

A simplified numerical exemple is given in the next graph considering:

- L: 1550 m
- Dc: 12 mm
- Coefficient of friction: 0.3
- Linear weight: 120 daN/km
- TM: 180 daN



Such a cable cannot be installed when more than 4 bends 90° are present!

## Optical fibre cable design for pulling

Keeping in mind what has been said in the [Newsletter “Optical reliability”](#), we have to consider both the optical and mechanical reliability. During installation, the cable will face severe stress, possibly several hours long. Also, after installation the cable part exposed to the maximum pulling tension will remain under stress and could never totally relax. Nevertheless, the installation tension is considered a short-term tension compared to the expected more than 25 years lifetime.

So, it is not a surprise that the optical fibre cables, originally for pulling in duct, were mechanically reinforced and were taking also advantage of the loose tube design offering a significant fibre overlength.

It is important that the tension during installation never exceeds the maximum rated installation load  $TM$  with a maximum fibre strain less than 0.5%. Always refer to the cable datasheet before installation. It is also a common practice to rate the cables using the ratio  $TM / W$ . A minimum ratio 1.5 is recommended but greater than 2 is much better.

The use of FRP (composite) strength members, aramid and/or glass yarns is very common in cable design to guarantee the mechanical performance of the cable.

## From pulling to blowing

The optical fibres cables are very lightweight compared to metallic (copper) telecom cables; the possibility to blow an optical fibre cable inside a duct has been instigated from the early 80's using the drag force generated by a high-speed airflow inside the duct. This force reduces the friction of the cable against the inner wall of the duct and consequently reduce considerably the exponential tension build-up (the principal cause of limitation in case of pulling).

The theory says that this drag force is:

$$F_{Dg} \div D_c \times D_d \times \Delta p$$

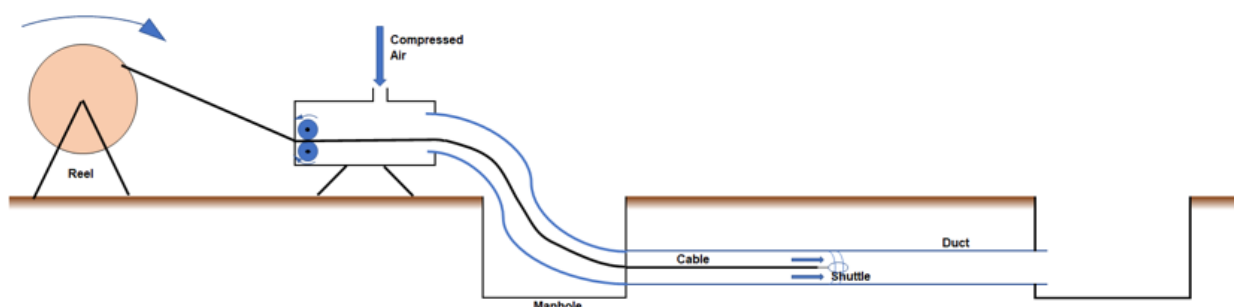
$F_{Dg}$  : the drag force

$D_c$  : the cable diameter

$D_d$  : the duct inner diameter

$\Delta p$  : the pressure difference along the duct

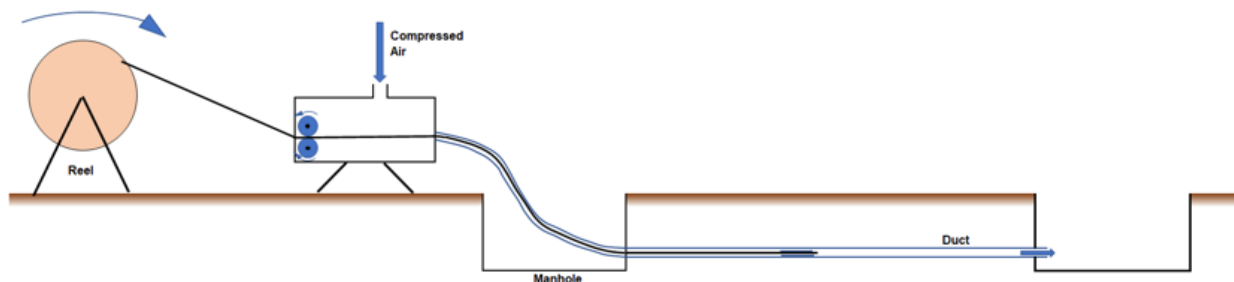
At the beginning, blowing and pulling have been combined by using a shuttle attached to the far end of the cable during installation: the air pressure at the rear of the shuttle is causing a “pulling force” at the cable head. No more need of a pulling rope!





## And to pushing and blowing

Very rapidly the high potential of the blowing technology has been investigated opening the door to the microcables and microducts world. The virtuous spiral of “diameter decrease => weight decrease => tensile force decrease” generates a new family of optical fibre cable, the so-called microcables. At the end no shuttle, no pulling rope needed! Just the combination of a pushing force (to force the cable to enter the microduct) with the drag force generated by the rapid air flow injected into the microduct is responsible for the microcable going forward. The cable stress becomes now very low and the limiting stress is now the compressive force (buckling effect at the entrance of the duct).



## Impact on the cable design

The main driver for the cable design is the cable diameter reduction: the tube diameter of the legacy loose cable has been reduced from typically 2.0-3.0mm down to ~1.5mm for the microloose designs and even further down ~1.3mm for the micromodules. Today the introduction of the 200µm and 180µm fibres has caused a further unit diameter decrease and allows to maximize the fibre count per cable mm<sup>2</sup> or per occupied microduct. Today it is possible to install a 288f cable in an 8/10mm microduct!

Installation of cables into microducts with air jetting technology is fast and reliable. This technology is currently used in many different countries worldwide and at several different points in the network whatever it is backbone or access. It offers a lot of advantages and flexibility from the central office to the distribution nodes and finally to the final subscriber.

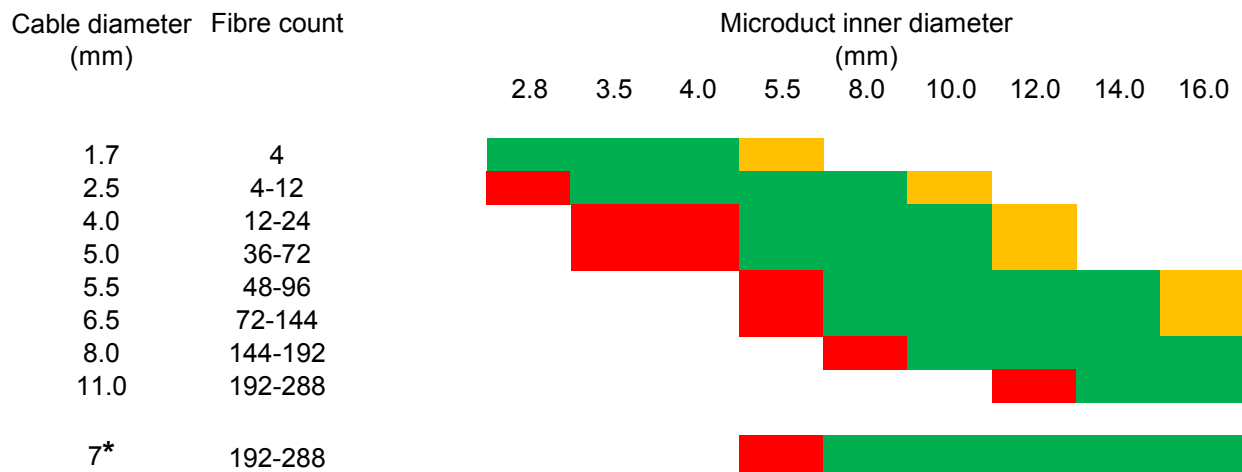
## FAQ

### How far can a cable be pulled ?

Difficult to answer this question as it depends so much on several different parameters: when all the parameters are well under control, 2000m is possible. Nevertheless, it is wise to limit the distance between accessible manholes to ~1000 -1200m and even less if the route presents a lot of bends.

### Is it the same in the case of air jetting ?

Installation over similar distance is easily achieved by blowing microcables but remember that the sizes of the microcable and of the microduct must match each other: if the size of the microduct is too small, the air velocity is reduced and the drag force is not efficient. If too large, the pushing force at the entry of the microduct must be reduced to prevent the cable from buckling. The percentage of occupation of the cable in a microduct should be below 65% ( $\text{cable OuterDiam}^2 / \mu\text{duct InnerDiam}^2$ ). Here under a table presenting the size compatibility of microcables and microducts.



\* microcables with reduced fibre coating

## What about lubricating ?

The coefficient of friction between the cable and the duct is a key factor. So, using lubricant can be a good idea, but always check the compatibility between all the materials in contact. Be sure to apply the lubricant in the right quantity and avoid local excess quantity.

## Should I test the microduct before cable installation ?

Yes: the microducts could have been damaged during or after installation; the connectors must be watertight; always blow an appropriate gauge to detect detrimental shape reduction.

## Is a microcable robust ?

A microcable is supposed to be installed in a microduct that is sometime also installed in a main duct. So globally it makes a very robust solution.

**It is good practice to take care of the the microcable management in accessible manholes where the microcables are sharing the space with other cables.**

## Good to know

The blowing technology is very efficient to install microcable but remember it can also be used to uninstall a cable when needed. It is a guarantee to manage the network with a high degree of flexibility and a future proof outlook.

## References

This document is part of a suite of Newsletters; we encourage you to read all these documents for a better global view.

IEC TR 62691 – Guide to the installation of optical fibre cables

IEC 60794-5-10: Family specification for outdoor microduct optical fibre cables, microducts and protected microducts for installation by blowing.

Cassidy, S.A., Reeve, M.H., "A typically new approach to the installation of optical fibre using the viscous flow of air", Proceedings of the 32th International Wire and Cable Symposium (1983)

Griffioen, W., "Installation of optical cables in duct" , 1993 Published by Plumettaz SA (CH)

Griffioen, W., "Understanding of cable in duct installation: do's and don'ts", Proceedings of the 60th International Wire and Cable Symposium (2011)

**For further information please contact:**

Alberto Lampasona, Director Public Affairs, [a.lampasona@europacable.eu](mailto:a.lampasona@europacable.eu)

**About Europacable**

Europacable is the voice of Europe's leading wire and cable producers. High-quality, sustainable power and telecommunication cables, produced by our members in Europe, empower electrification and digitalization of our societies. Founded in 1991, Europacable represents the largest cable makers in the world providing global technology leadership, as well as highly specialized small- and medium sized businesses from across Europe.

With our future being ever more electrified and digitalised, cable technology will be the core backbone of Europe's energy and telecommunication infrastructures. Sustainable, low-carbon manufacturing and high-performance cables are essential to achieve Europe's climate neutrality objectives by 2050. Europacable is committed to the principles of free enterprise and fair trade. Our members employ over 80.000 people of which more than 50% in Europe, generating a worldwide turnover over € 70 billion in 2021. [www.europacable.eu](http://www.europacable.eu)



**[www.europacable.eu](http://www.europacable.eu)**

*The information provided in this document reflects the best knowledge of Europacable experts at the moment of its publication and is provided as an informative tool to assist the readers in the assessment and use of Optical fibre cables and components. The content of the document is not legally binding and is not intended as a substitute for user's or manufacturer's own assessment and decision-making.*

*Readers of this document are encouraged to seek information on specific matters regarding Optical cables and components from the manufacturer or provider and to consider the Technical Standards relating to the selected products.*

*A binding interpretation of the relevant legislation is of the exclusive competence of the European Court of Justice and Europacable and its members decline all liability for any measures taken or not taken on the basis of the content of this information leaflet which is intended for general information only.*