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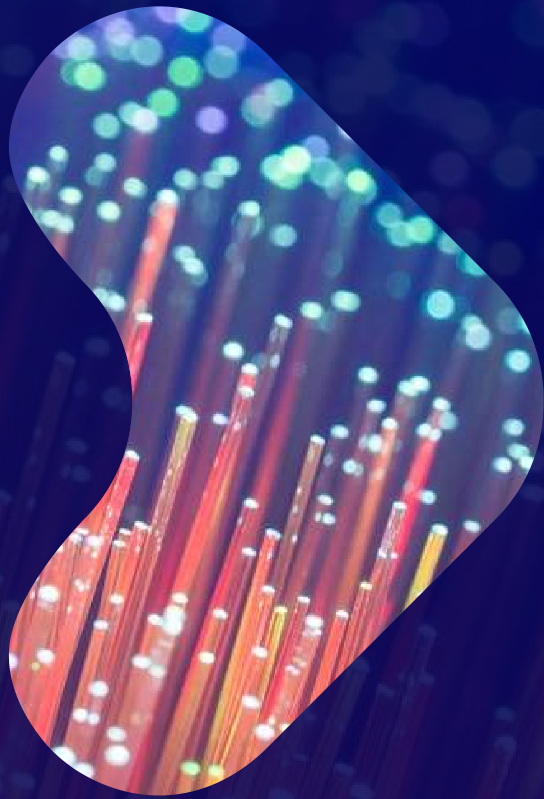
Installation of Optical Fiber Cable by Blowing/Jetting



APPLICATION NOTE

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ABSTRACT
This application note discusses fiber optic cable installation by blowing technique, the factors effecting blowing performance and best practices.

KEYWORDS
Fiber optic cable, Micro-ducts, Cable blowing/jetting

1.0 Introduction

1.1 Optical fiber cables for telecommunication application have been installed in pipes/ducts for many years. The installation process is influenced by local conditions, local climate, customer's existing procedures, and customer requirements. There are two basic methods of cable installation in a preinstalled duct – Pulling method and Blowing method. The cable installation method is selected based on site conditions and availability of machinery & resources. Table 1 shows a comparison between the two installation methods.

Table 1 : Comparison between Pulling and Blowing methods

Pulling Method	Blowing Method
Pulling rope pre-installed	No pulling rope to install
Equipment and manpower at two sides	Equipment and manpower at one side
High sidewall forces on cables and ducts may lead to cable damage	Forces on cable and duct can be monitored and controlled and minimal chance of cable damage
Mainly manual pulling is practiced.	Large compressor and/or hydraulic power pack at one side
Machine pulling needs one hydraulic power pack	Preferred for duct route with multiple bends and undulations
Mainly used for straight duct route	Preferred for long distance (over 2km) installation
Suitable for short distance (few 100m) installation	

Overall, blowing method is preferred over traditional pulling method due to savings in manpower & installation time and improved installation efficiency, particularly in longer ducts with multiple bends and undulations. In this application note, cable installation by blowing method and its best practices are explained.

Blowing Method

Cable installation by using high speed air flow combined with additional mechanical pushing force is called as "blowing or jetting". Cable blowing is the process of installation of optical fiber cable into a pre-installed duct. Compressed air is injected in the duct inlet after few hundred meters of cable is pushed into the duct. Compressed air flows at high speed through the duct and along the cable. The pushing force is applied mainly near the cable inlet by a pushing device. Standard optical fiber cables (like uni-tube, multi-tube, unarmored & armored), microduct cables, and micro-ducts can be installed by using this method. It is possible to install microduct cable using blowing method in continuous lengths of more than 1000 meters depending upon the duct route. There are two methods for blowing which are discussed below.

Method 1: High air speed blowing

This method requires pushing the cable with tractor mechanism by traction rollers in blowing device for a few hundred meters and then introducing compressed air to make the cable inside the ducts remain in floating condition, which reduces friction between the cable outer surface and duct inner wall by reducing area of contact as shown below in Figures 1 and 2.

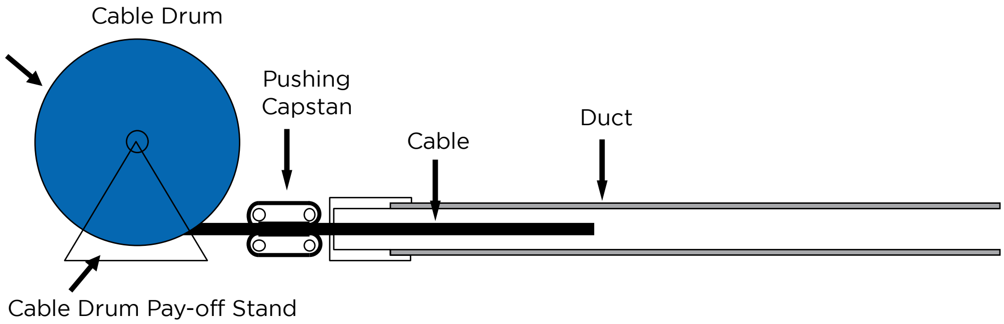


Figure 1

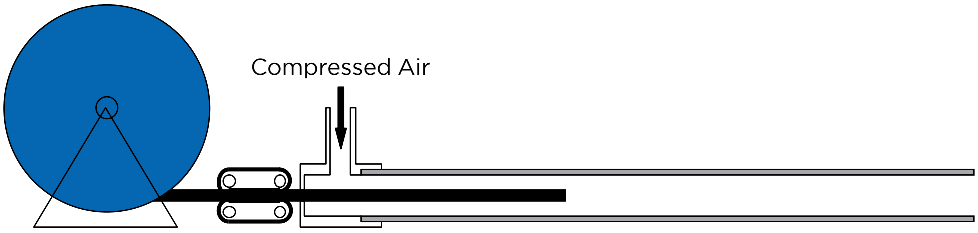


Figure 2

Method 2: Push/Pull (Piston) blowing

In this type of blowing unit, an air-tight piston is attached to the front of the cable. The air pushes this piston, and the piston "pulls" the cable as shown in Figure 3. Installers should be aware that a pulling force exists in piston blowing, and the pulling force shouldn't cross the maximum cable tension. This method is preferred for larger size ducts (32/40mm and 42/50mm) and in "straight" trajectories to achieve longer cable blowing distance.

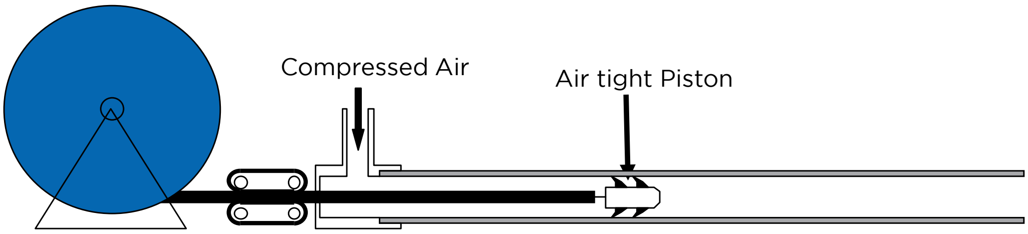


Figure 3

Key Parameters of Blowing Method

The following three major parameters and their combined effects control how far a cable can be blown in a duct.

- Duct Fill Ratio (cable to duct size ratio)
- Coefficient of Friction (between cable outer surface and duct inner wall)
- Cable Stiffness (related to cable flexibility & undulations in duct route)

Duct Fill Ratio (DFR)

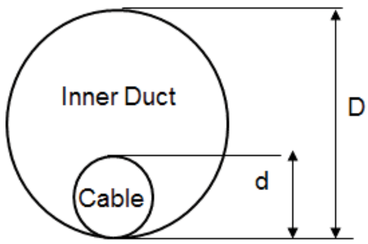
The ratio between cable and duct size is known as 'Duct Fill Ratio' or 'Fill Ratio'. There are two methods to calculate DFR.

a) The ratio between cross sectional area of cable and inner space of the duct.

$DFR = d^2/D^2 \times 100$

Where,
d= cable diameter
D= duct inner diameter

For optimum blowing performance DFR to be kept between 35 to 65%.



b) The ratio between cable diameter and duct inner diameter.

$DFR = d/D \times 100$

For optimum blowing performance DFR to be kept between 30 to 80%.
For conventional cable of diameter ≥10 mm: 30 to 50%
For micro cable of diameter 1-9 mm: 30 to 80%

Higher DFR helps to achieve longer blowing distance particularly in straight route. Higher DFR also prevents cable buckling effect (cable forming a helix inside the duct) particularly for cables with low stiffness. However, high DFR may result in shorter blowing distance in the route having multiple bends. Therefore, an optimized DFR needs to be maintained to achieve best blowing performance.

Coefficient of Friction (CoF)

Coefficient of Friction can be termed as the drag force (sliding friction) generated during cable blowing due to area of contact between cable and duct inner wall because of mass of the cable and gravity. CoF mainly depends on elevation, bending in duct route, undulations in duct and properties of cable outer jacket materials. Generally stiffer materials like Polymide, high density polyethylene (HDPE) give better blowing results as compare to low density polyethylene (LDPE) and flame retardant material like low smoke zero halogen (LSZH). CoF can be reduced by using lubricants during blowing of cable. Blowing with lubricants increases efficiency approximately by 50 %. CoF is also influenced by quality of ducts i.e. inner wall material of duct (smooth & ribbed). Generally blowing distance in ribbed inner wall duct will be more as compared to smooth inner wall due to less area of contact between cable outer surface & duct inner wall. Various factors that influence CoF, are summarized in Table 2.

Table 2 : Factors influencing CoF

Component	Important Parameters/ Characteristics	How to reduce CoF
Cable	Weight , Stiffness, Construction	Use of materials with low stiffness
Duct	Material of construction and design	Quality of duct (use of virgin HDPE materials), Inner surface (smooth/ribbed), Low friction lining, Pre-lubrication
Duct Route	Straightness, Number of bends, Bend Straight radii, Elevations, Cleanliness	Straight laying of ducts, no deformations and/or kinks and maintain minimum bend diameter >30 x Outer cable diameter (or as specified in cable design sheet)
Blowing Equipment	Temperature of compressed air, Presence of moisture in compressed air	Use of after cooler and water separator in warm and humid climate
Lubricant	Quality and Quantity of lubricants, Method of application of lubricants	The lubricant material should not react with cable outer sheath (don't use soap water, kerosene, diesel), Apply right quantity by sponge or lubricator as suggested by the supplier

Cable Stiffness or flexibility

Stiffness or flexibility of cable also plays an important role in blowing performance. Stiffness depends on cable design construction i.e. metallic or non- metallic, central tube or multi-tube, outer jacket material, etc. Stiffer cable can achieve more blowing distance in straight trajectory and flexible cable can achieve more blowing distance in difficult trajectory or route with multiple bends and grading. Stiffer cable is preferable as it can blow fast through undulation in ducts and avoids buckling of cable inside the ducts.

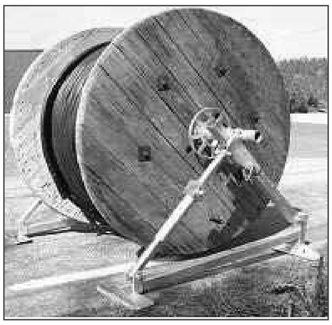
Blowing Method

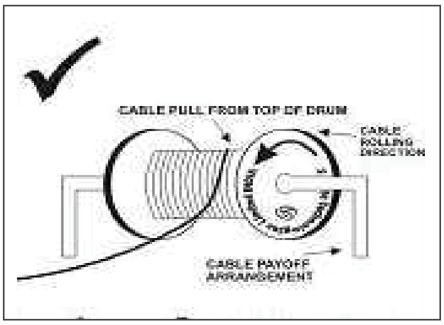
Cable Crash Test

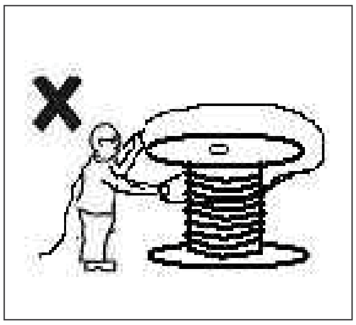
Prior to cable blowing it is important to perform the crash test to determine the maximum pushing force that can be applied on cable. Higher pushing force by tractor mechanism can damage cable outer sheath and cable buckling at entry point. This test involves pushing the cable from blowing head into 5 to 10 meters of a duct that is sealed at the other end. When the cable stops after hitting the sealed end of the duct then blowing head must stop pushing the cable such that there is no damage to the cable outer jacket and no cable buckling at entry point. This process is repeated with an increase in push force until cable jacket damage is witnessed. The maximum permissible push force will be the highest push force without any damage to the cable jacket. This test ensures that the tractor will not damage the cable during installation in case of sudden stoppage of blowing.

Cable drum pay-off

This feature is very important in a blowing set up to ensure cable is smoothly pushed inside the duct through the blowing unit. It is always recommended to use cable reel pay off during cable installation. The cable drum should be kept level to avoid cable rubbing against the drum flanges. The cable drum orientation should be such that the natural payoff direction is towards the pulling direction. To eliminate possible cable contact with the ground, cable payout should be from the top of the drum. Figure 4 shows a cable drum in a cable drum pay-off and figure 5 shows the do's and don'ts of cable unwinding.





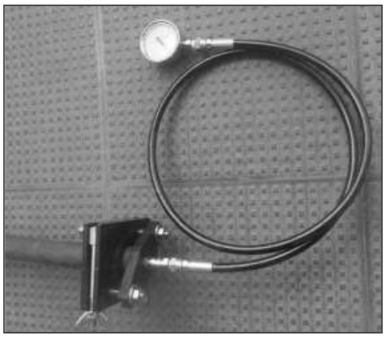


Duct Integrity Test (DIT)

The purpose of DIT is to prove that the installed ducts are ready to use for blowing from one manhole to the other. DIT should be performed before blowing to avoid sudden surprises like missing section of ducts, improper coupling, and kink and blockage in ducts. The DIT is carried out with the help of compressed air and a suitable go-gauge sponge and mandrel of appropriate size, which is pushed inside from one end with pneumatic pressure and is thrown outside from the other end. The three steps outlined below should be performed to conduct integrity.

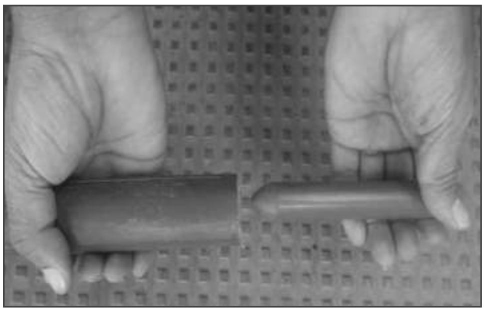
a) Step 1: Air pressure test

Duct continuity is verified by introducing compressed air from one end of the duct, and checking if air comes out from the other end of the duct. If no air emerges then fault point has to be identified and corrected before proceeding further. Duct leakage is verified with compressed air by attaching the compressed air unit head to one end of the duct, and attaching the pressure gauge to the other end of the duct. Compressed air at pressure of 10 bar is applied at the first end for 10 - 15 minutes and air pressure drop at the other end of the duct is measured. If the pressure reading remains the same (not reducing to zero) at other end or 5-10 minutes then there is no leakage in the duct. If the pressure reading drops to zero then there is leakage in coupler (that join two ducts), and duct is punctured. Figure 6 shows a pressure gauge fixed at one end of the duct to monitor air pressure.



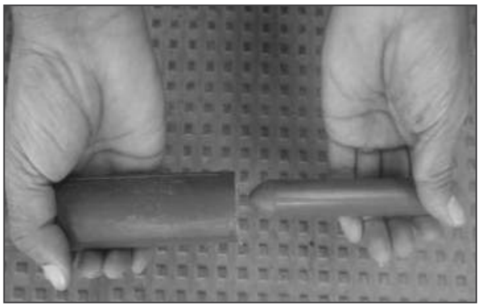
c) Step 2 : Shuttle test

The kink in the installed ducts is located by shuttle test. A suitable shuttle of size 70-80% of duct inner diameter is passed through the duct with the help of compressed air. If the shuttle comes out from the other end then the duct has no blockage and it is considered ready for cable blowing. If the shuttle does not come from the other end, then the duct is either kinked or blocked. To identify the blockage or kinked location, a transmitter is passed through the duct which will get stuck behind the shuttle and then the blockage point in the duct is tracked with the help of receiver. The blocked portion of the duct is dug out and replaced. Figure 7 and 8 show a shuttle being inserted in a duct.



d) Step 3: Sponge Test

Very often mud and water are found inside an underground duct. In this test a sponge double the size of duct inner diameter is passed through by compressed air to clean the duct. Figure 9 and 10 show a sponge being inserted in a duct.



Cable cap

A metal cap is fixed at the head of cable as shown in figure 11, to seal the cable end so that jelly or other elements of the cable will not damage the duct inner wall and cable blowing will be smooth.

beyond tomorrow

About STL - Sterlite Technologies Ltd

STL is an industry-leading integrator of digital networks.

We design and integrate these digital networks for our customers. With core capabilities in Optical Interconnect, Virtualized Access Solutions, Network Software and System Integration, we are the industry's leading end-to-end solutions provider for global digital networks. We partner with global telecom companies, cloud companies, citizen networks and large enterprises to deliver solutions for their fixed and wireless networks for current and future needs.We believe in harnessing technology to create a world with next generation connected experiences that transform everyday living. With intense focus on end-to-end network solutions development, we conduct fundamental research in next-generation network applications at our Centre of Excellence. STL has a strong global presence with next-gen optical preform, fibre and cable manufacturing facilities in India, Italy, China and Brazil, optical interconnect capabilities in Italy, along with two software-development centres across India and one data centre design facility in the UK