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Applications
Engineering Note

Air-Assisted Cable Installation Techniques

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Introduction

Placing optical fiber cables in duct systems using air-assisted installation techniques presents different installation requirements than traditional pulling. In return, these techniques enable installation of much longer cable lengths to take advantage of long manufactured lengths (up to 12 kilometers or approximately 7.5 miles). Installing long cable lengths often reduces labor and material expenses.

Jetting and blowing are two common air-assisted cable installation techniques. Both methods require pushing the cable with a tractor mechanism while blowing compressed air into a pre-installed duct around the cable being installed. Both rely on air flow to help “float” the cable inside the duct, minimizing sidewall pressures to reduce friction between the cable and the duct.

Jetting and blowing differ, though, in how pulling force is applied to the cable. Jetting uses a reaction head (or parachute) attached to the cable. A differential pressure across the reaction head creates a pulling force on the cable. Blowing does not use a reaction head. Instead, the pulling force on the cable is due to fluid drag of air rushing along the cable. This pulling force is distributed along the cable length.

Corning Optical Communications field trials have confirmed that a single jetting device can install 1500 to 2100 meters (5000 to 7000 feet) of optical fiber cable under good conditions. Longer lengths can be achieved by cascading devices (i.e., providing mid-assist) throughout the cable run. All cables suitable for traditional pulling are suitable for jetting. AE Note 96 provides additional guidance for blowing cables.

General Considerations

In typical (non air-assisted) cable pulling operations, the friction between the cable and duct wall, especially from the contact at bends and/or elevation changes, results in the pulling tension increasing exponentially as the cable length pulled into the duct increases. Air-assisted installations minimize these contact forces.

Regardless of whether a cable is pulled or jetted, cables which tend to conform to a set curve (e.g. wound on a reel), will generate more side force, and more drag, than a dielectric cable of like size. This is observed in reduced jetting distances for armored cables relative to dielectric cables and for cold cables relative to warm ones. Further, both of these effects worsen as cable diameters increase.

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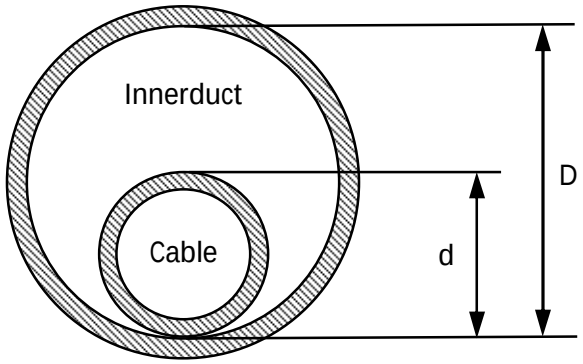
When preparing for an air-assisted installation, the following parameters should be considered:

Cable and duct size (i.e., fill ratio)
Cable type (armor or dielectric)
Ambient temperature/humidity
Maximum hydraulic pressure of the tractor mechanism
Cable bend radius
Duct type and condition
Duct lubrication

Fill Ratio

When pulling cables, the fill ratio is calculated using areas, or d/D. For optimum performance when blowing or jetting cables, Corning Optical Communications recommends using simple diameters to calculate the fill ratio, with a target range being 50% to 80%.



$$\text{Fill Ratio} = \frac{d}{D} x100$$

Note:
d = Cable Diameter
D = Innerduct Diameter

In general, higher cable-to-duct fill ratios achieve longer installation distances for air-assisted installations. This is due to the cable's ability to be pushed through the duct without forming a helically-shaped wave within the duct. However, performance on high fill ratios can be hindered by the inability of the cable to bend through turns along the cable route.

Hydraulic Pressure on Tractor

When installing cables in lower fill ratio applications, regard to the maximum hydraulic pressure (i.e., the pushing force) applied to the tractor mechanism should be observed to safeguard against damaging the cable. If the maximum pushing force is used, smaller diameter cables are

more prone to buckle at the duct entry point if obstructions are encountered. The maximum pushing force is typically determined by on-site testing, but general guidance is available from manufacturers of specific equipment.

Bend Radius

The minimum cable-bending radius should be considered during any optical cable installation. This bend radius is based on the cable construction and is calculated to provide the smallest bend the cable can be subjected to before cable or fiber damage may result. The radius of conduit bends, cable guides, sheaves and capstans should be equal to or greater than the cable minimum bending radius.

Historically, minimum bend radius of optical fiber cables has been ≥ 15 times the outer diameter of the cables during installation. However, it is recommended that the minimum bend radius specifications for the particular cable in question be confirmed prior to installation. This information can be found on the specific Corning Optical Communications' cable product information sheet.

Duct Type and Condition

Duct type is an important consideration when using an air-assisted installation method. Variation in achievable distances will be seen based on the type of duct selected. For example, corrugated innerduct will tend to reduce the performance relative to smooth wall or ribbed type ducts due to the disruption of airflow within the duct.

Duct integrity and cleanliness are also important. The innerduct should be clear of mud, water, and other obstructions that will reduce the effectiveness of the air assisted technique. Innerduct tension is important since an over tensioned installation may result in necking of the innerduct. Partial collapse of the innerduct will also have the same effect. Nail holes and poorly installed couplings will reduce effectiveness and installation distance, since air leakage will occur, thereby reducing the “floating” ability of the conveying airflow.

Duct Lubrication

Duct lubrication is another parameter to consider. Manufacturers of air-assisted installation equipment offer lubricants designed especially for these types of installations. Formulations vary considerably depending on specific installation technique. Installation contractors should contact the equipment manufacturer for the recommended duct lubricant and the cable manufacturer to determine the compatibility of the lubricant and the cable sheath. Given the proper lubricant, the coefficient of friction between the cable outer sheath and the duct wall can be minimized for a variety of cable sheathing materials. Minimizing the friction will allow for longer installation lengths. Over lubricating is a common practice, as most air-assisted installations require $1/10^{th}$’s of an ounce compared to multiple pints that may be used when pulling a cable.

The duct and equipment manufacturers should always be consulted for specific installation guidance, including lubrication.

For more information or questions, please contact Corning Optical Communications Customer Service at 1-800-743-2671.

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