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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. 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. It should be noted that the terms Jetting and Blowing are commonly used with reference to each of these techniques on an inter-changeable basis, so it is good to clarify the intended use. Also, Corning recommends that only a “bullet” is attached to the end of the cable that is the same diameter of the cable.

Corning Optical Communications field trials have confirmed that a single air-assisted 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 micro-duct 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.

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

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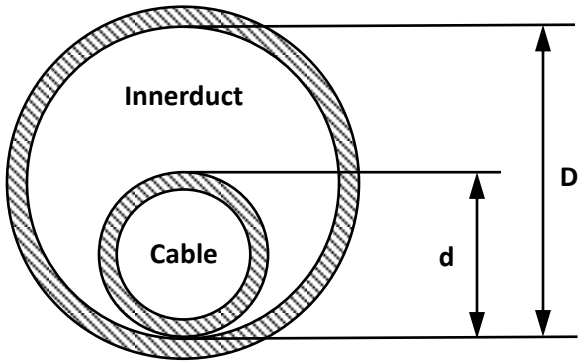
Maximum hydraulic pressure of the tractor mechanism
Cable bend radius
Duct type and condition – proof duct
Duct lubrication
Air Compressor and Cooler

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%.



$$Fill\ Ratio(\%) = \frac{Outer\ Diameter\ of\ Cable\ (d)}{Inner\ Diameter\ of\ Duct\ (D)} \times 100$$

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 crash testing, but general guidance is available from manufacturers of equipment on procedures and operation of their specific products.

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.

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. The duct system should be proofed using a plastic ball or steel mandrel with a diameter equal to 80% fill ratio prior to start of installation.

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 instructions for use. 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.

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

Air Compressor

Guidance from manufacturers of equipment is available on selection of a compatible air compressor for air assisted installation. An air cooler/dryer at the discharge of the air compressor is recommended to maintain cool temperature of the duct and cable. Maintaining cool air temperature and low humidity in the duct is critical to achieve maximum jetting or blowing distance and speed and will reduce the risk of damaging cable.

Procedures and videos can be obtained from the jetting or blowing machine manufacturer on operation and methods & procedures of their equipment, i.e. Crash Test. On-site support and training is usually available from these companies. These machines can be used on a wide range of cables available on the market. Selecting the correct machine for the application should also be considered, including the correct compressor and cooler that is appropriate for the jetting/blowing machine. Major factors that are critical for machine selection are the cable outside diameter, type of cable, and inside diameter of the duct.

Air-Assisted Installation Checklist

- ☐ MBD: Refer to the cable specification for the Minimum Bend Diameter (MBD) of the cable being installed. At all times during the installation the MBD must be maintained.

- ☐ Fill Ratio: The recommended fill ratio is between 50% to 80%

$$Fill\ Ratio(\%) = \frac{Outer\ Diameter\ of\ Cable}{Inner\ Diameter\ of\ Duct} \times 100$$

- ☐ Reel Bolts: Hand tighten reel bolts prior to starting, and again when reel is stopped during installation. Tighten bolts at the beginning, middle of reel, and when about 75% is off the reel. Refer to AEN165 for additional cable reel handling information:

- ☐ Bullet on cable: correct size helps jump over couplings – Corning recommends using a bullet on the end of the cable, and not a parachute.

- ☐ Compressor with cooler or separate cooler attached to the compressor used increases jetting performance and ensures temperatures are within the operating range of the cable installed. This is especially important when the ambient temperature is above 60 degrees Fahrenheit.

- ☐ Duct proofed: Using a mandrel or plastic ball that is 80% of the inside diameter of the duct helps ensure that there are no obstructions. Install a capture device on the end to catch the plastic ball, i.e.: wire mesh grip taped on the end. Sponges will not proof a duct since they can get past a partial obstruction.

- ☐ Sponge with lube performed: lubricate the duct, use the blowing machine manufacturer's recommended lubricant and quantity per 1,000 ft of duct that is applicable for each size duct. Do not over lubricate. Pooling lubricant in the duct can cause cable obstruction and damage.

- ☐ Crash Test: Perform the blowing machine manufacturer crash test, consult with equipment manufacturer if this has not been provided. This will allow the blowing machine to stop the mechanical drive in the event the cable stops due to some obstruction.

- Cable pay off the top of reel: This helps installer to have control and manage the pay-off, do not pay cable from the bottom of the reel which can cause loosening of the windings and loss of control.

- Cable on outside reel flange: cut at one foot from hole and allow to squirt out during placing and cut off squirted cable during placing as necessary. Failure to do this can damage the inner wraps of the cable on the reel if cable squirts inside the reel.

- Cable Payoff Reel: Ensure cable is clean when entering the jetting machine. Control cable paying off the reel – maintain back tension to not allow cable wraps not to loosen and cross each other. If any cable defect noticed, record length mark and take pictures. Notify Corning.

- Plug Ducts: After ducts are installed, they should be plugged to stop water entry into them. This can save time later when the cable is installed, and water must be blown out. Also plug ducts after cable is installed.

- Pulling Cable: Do not pull at all when jetting/blowing. Combining pulling and air assisted installation methods is not recommended.

- Follow jetting machine manufacturer's procedures of the machine being used for cable installation.

Additional information on Corning Optical Communications recommendations can be found in AEN175, AEN165, and AEN173.

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