OSP® HOW-TO NETWORK SOLUTIONS™
Reprinted with permission from the January 2011 Issue of OSP® magazine.

Avoiding a Costly Crush

Four Fundamentals of Safe Fiber Optic Cable Placement

By: Matt Fitzgerald and Gerry Harvey

Figure 1: End cap color guidelines.

Driven by the American Recovery and Reinvestment Act of 2009 (ARRA) and Broadband Stimulus, the demand for outside plant cable is likely to surge in 2011 to 2012. With more and more miles of cable being deployed under the constraints of tight deadlines, installers will be under increased pressure to place cable quickly but safely. Meanwhile, with many Americans still out of work, this surge of demand in the cable installation space is likely to draw less experienced or even untrained installers into the fiber optic cable installation business. All of these factors add up to one message. Now is the right time for contractors, consultants, engineering firms and end users to evaluate and refresh their understanding of safe fiber optic cable placement fundamentals.

Four Steps to Live By

Step 1: Choose an experienced, reputable supplier.

A successful fiber optic cable installation begins long before the cable is even delivered by selecting a reputable fiber optic cable supplier and installation team. An established, experienced, high-quality supplier can provide specific fiber optic cable installation guidelines that enable the installation to go much smoother.

These manufacturers have conducted environmental and mechanical tests specifically designed to ensure the cable will survive both the rigors of installation and a lifetime of exposure to the elements common in the outside plant environment. Each cable design must successfully complete these tests as part of the internal design and qualification process.

The goal of construction is to maintain the integrity of the cable, protecting the underlying optical fiber. Guidelines provided by the supplier or relevant industry standards will ensure that this is accomplished. Cable suppliers may also be able to provide a list of preferred or certified installers, helping to eliminate the risks associated with using an untrained crew.

Step 2: Inspect the cable and reel.

Once the vendor is selected and the cable is procured, the next step to ensure a successful cable installation is proper receipt and handling of the cable reel. Every optical fiber in each reel should be tested from the factory, and the attenuation recorded on a cable data sheet that is shipped with the reel or otherwise made available by the supplier.

Before beginning the installation, make sure all fibers have been tested and conform to the specified performance requirements. It may be a good idea to test each fiber on the reel with an Optical Time Domain Reflectometer (OTDR) before beginning cable placement. In some cases, this may be a warranty requirement, so save any OTDR traces that indicate abnormalities or yield unexpected results.

Check general reel integrity for signs of excessive weathering or damage. The thermal wrap should stay in place until cable placement. For wooden reels, ensure the hub bolts are tightened, and verify all nails, bolts or screws on the inside surface of the flanges are fully clenched or counter-sunk to avoid damage to the cable during payoff.

Avoid These Mistakes

Figure 2: The wheel on this cable feeding sheave, designed for installation of power cable, has a diameter of less than one inch, far below the minimum bend diameter of typical outside plant cables.

Figure 3: Lip roller designed for power cable.

Figure 4: Cable vault entry or exit at severe angles.

Make sure the cable has a good traverse, free of crossovers, loops or excessive slack. Verify the print statement is correct and legible. In some cases, bulk reels are direct-shipped with a colored vinyl cap on the end of the cable to provide guidance for tensile capability and minimum bend diameter. (See Figure 1.)

Step 3: Choose the proper installation hardware.

There is a lot of hardware that looks like it might be useful for cable installation but is not designed for fiber optic cables. Fiber cables have design limits, especially around tension and bend. Small sheaves and wheels designed for power cables, for example, may seem like convenient tools to redirect the cable while entering or exiting handholes, pedestals and vaults. However, these small wheels may cause the fiber optic cable to experience bend conditions that are just too tight for the design. This can cause excessive crushing forces inside the cable, resulting in splintering of the central strength member, crushed buffer tubes and, ultimately, broken fibers. These small wheels can cause cable damage even at relatively low tensions.

Furthermore, the cable can be damaged, even at angles less than 90 degrees. If the tension is high enough to cause the cable to conform to a portion of the radius of the wheel, even for a short time, the entire cable passing over the wheel will experience a bend that is below the cable's rating, and damage is likely to occur. This damage may be contained entirely within the cable, with little or no indication on the outer jacket. (See Figures 2 and 3.)

> "With more and more miles of cable being deployed under the constraints of tight deadlines, installers will be under increased pressure to place cable quickly but safely."

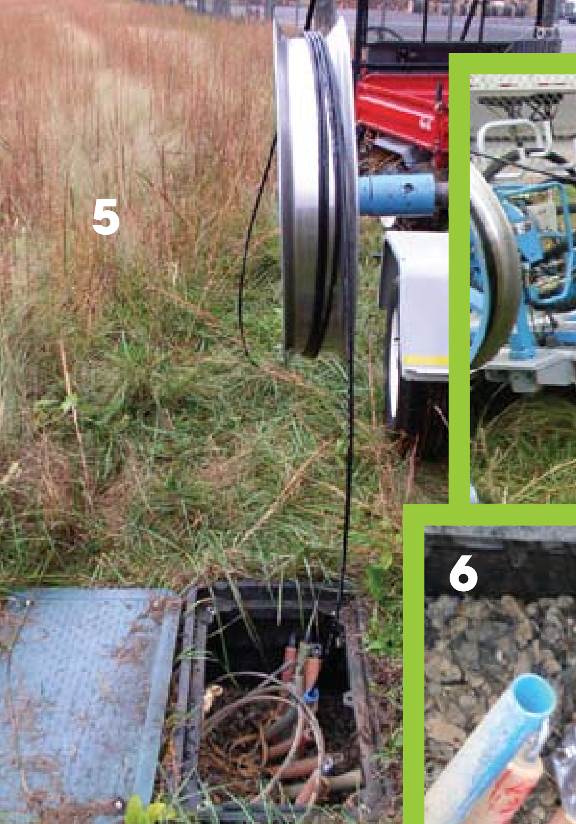
Similar to the cable feeding sheave in Figure 2, the lip roller shown in Figure 3 is designed for power cable. These devices are typically rated for 10,000 lbf or greater and are comprised of small rollers. While the lip roller will avoid dragging the cable across a sharp edge, the diameters are insufficient for placing fiber optic cable and will subject the cable to compressive forces under load that will collapse the buffer tubes and break fibers.

Ensure all equipment used for installation is calibrated and well maintained. For cable pulling into ducts, a breakaway swivel is necessary in order to control both the tension and the torsion on the cable. For jetting applications, broken or out-of-calibration gauges on the jetting equipment will fail to detect tension spikes that may damage the cable. Also, ensure the tracks of the jetting equipment firmly engage the cable and are not prone to slipping during installation.

Step 4: Control the cable installation to avoid common mistakes.

This step contains 5 common errors made in many cable placements. Put these on the top of your checklist BEFORE you begin the installation process:

Common Mistake 1: Paying off the cable. It is imperative that the cable is controlled during payoff, span routing and takeup. For the payoff, it is necessary to ensure that the cable feeds off the reel and into the aerial run or duct bank smoothly and with minimal back tension. Some amount of back tension may be desired to prevent the payoff reel from freewheeling. For duct installations, place the cable reel in line with the intended direction of deployment, in order to prevent the cable from rubbing excessively against the reel flange. This will help protect



Acceptable Methods

Figure 5: Midspan cable takeup with takeup equipment appropriately placed in line with the duct.

Figure 6: Subduct coupled onto installed duct base.

Figure 7: Controlling cable bend radius with subduct extension.

Figure 6 is an inset of Figure 7.

the cable jacket and print statement, and avoid any potential tight bends the cable might otherwise experience from pulling across the edge of the flange.

For aerial installations, the key is positioning corner blocks with sufficient radius to control bend. Small single cable stringing blocks are not appropriate for offset or corner pulls. For the subduct run, it should be racked appropriately and the pull tension calculated so that tension is not exceeded.

Common Mistake 2: Entering and exiting ducts. The condition of the subduct is important to the placing of the cable. Oftentimes, one contractor has placed the subduct, and another is responsible for placing the cable. There are some simple proofing tests if the cable is being jetted that will ensure that the duct is continuous, unobstructed and ready for safe placing. A lubricated foam plug is blown through the subduct and its passage is timed for normal travel. Completing this step will ensure that the pathway is clear and capable of supporting the greatest length of cable placement.

Wherever the cable enters or leaves the duct infrastructure, it is necessary to control the bend radius. This is best accomplished with a wheel or piece of subduct that maintains the proper bend radius. This is where the selection of appropriate hardware will really pay off. Most cable damage occurs at transition points into and out of ducts, due to failure to control cable bend radius, especially at the cable takeup.

When the cable exits the subduct, whether below grade or from the pedestal, it is imperative that the cable not rub against the wall of the subduct at an angle under tension, as this will affect the cable structure. This can occur when the amount of subduct length is too short, and the duct cannot provide the proper cable bend radius control. (See Figure 4.) Whenever possible, it is best to position the pulling equipment in line with the duct. (See Figure 5.)

If the pulling equipment cannot be positioned over the duct and in line, then the safest way to control the pull is to couple a piece of split subduct (~ 3 ft to 6 ft) to the installed base, which maintains the bend radius. (See Figures 6 and 7.)

> "Most cable damage occurs at transition points into and out of ducts, due to failure to control cable bend radius, especially at the cable takeup."

To add a bit more description to this minimum bend radius, a bend radius of 15x the cable outer diameter (OD) translates to 30x the cable OD for the diameter of the roller or guide. This is the minimum bend typically specified by many outside plant cable suppliers. Some industry specifications are even more restrictive. For example, the TIA specification ICEA 640, "Standard for

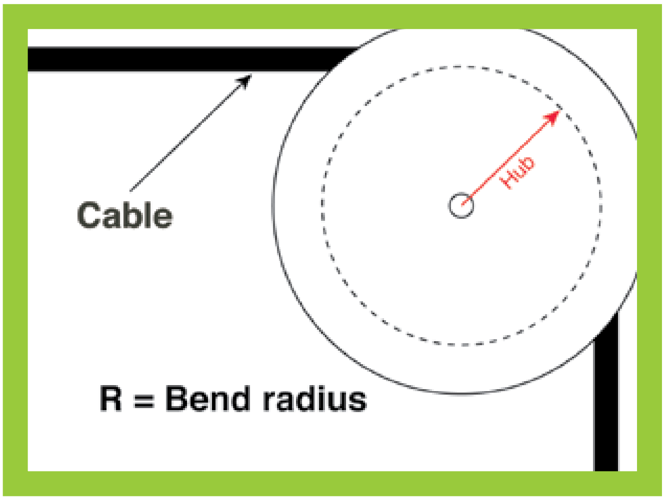


Figure 8: Hub OD must be 30x cable OD.

Optical Fiber Outside Plant Communications Cable," specifies that 40x the cable OD be maintained during installation. In addition, the location to measure is not the OD of the sheave but to the hub of the guide where the cable rides. (See Figure 8.) Even if the tension is not expected to reach the maximum-rated tension, this is critical to allow for any type of tension excursion that may occur.

Common Mistake 3: Handling the cable at midspan points. With the advent of fiber-to-the-home (FTTH), fiber optic cable is being installed and handled with significantly more midspan coiling of slack. If the cable cannot be placed in one continuous run, it will be necessary to bring the cable up, and position the cable for subsequent placing. This cable must be managed in a figure 8 to avoid cable twisting and kinking. After forming the figure 8, the cable is flipped to allow access to the cable end and the smooth payoff of the cable section. This process ensures that the cable is not damaged by twisting during the subsequent installation.

In the formation of the figure 8, it is important to provide sufficient labor force to manage the cable length, ensuring the cable is coiled properly and pays off in smooth form. Also, start the figure 8 some distance away from the reel, and do not force the cable, particularly one that has parallel strength elements and a preferential bend.

Common Mistake 4: Jetting cable. Cable jetting is an efficient way to place long lengths of cable in subduct. Each manufacturer has specific instructions that are important to follow. Of specific note is the increase in 2-inch subducts, particularly in rural FTTx deployments and for traffic control. A simple crash test should be performed to ensure that the cable pusher does not exert too much force on the cable which could cause the cable to fold over or staple within the duct structure.

The greatest stapling risk is with smaller, all-dielectric cables that have a < 0.5-inch OD, but it can occur even with armored cables. In addition, handhole or access points are being designed with greater separations: 3,000 to 5,300 ft in length in some instances. Designers should evaluate the route and infrastructure and ensure that cable tensions are not exceeded for the cable placement process.

Common Mistake 5: Direct burial. For direct burying the cable, it is rare that the cable is plowed in one continuous length. Typically, there are a series of driveway or road crossings such that the cable is required to be placed in a figure 8. Follow those guidelines as mentioned previously. The cable should pay off in a linear fashion over the tractor and down to the plow chute. Cable guide rollers should provide an adequate transition to the plow. For multiple cables, the plow chute should have segments to allow for separate paths to ensure that cable(s) do not twist around one another and lay in even form.

Save Yourself from a Crush

These guidelines highlight the critical steps for the safe fiber optic cable placing operation. Please locate the cable manufacturer's specific installation procedures, which will detail more fully all of the steps required for a safe cable installation. In addition, a thorough understanding of placing equipment and tools is required. By adhering to these fundamentals and being mindful of the limits of the optical cable, a safe cable installation can be assured.

Matt Fitzgerald is a Product Line Manager at Corning Cable Systems. He has over 19 years of experience in product line management and cable quality. For more information, email matt.fitzgerald@corning.com or visit www.corning.com/cablesystems.

Gerry Harvey is a Senior Projects Manager at Corning Cable Systems. He has more than 25 years of experience in OSP engineering/construction and fiber optic cable and cable assembly manufacturing. For more information, email gerry.harvey@corning.com or visit www.corning.com/cablesystems.