

## **Installation/Handling Considerations for Tuff Coat vs Crush Resistant MDU Drop Cable**



Tuff Coat Drop Cable



Crush Resistant Drop Cable

Unlike installation procedures associated with traditional outside plant (OSP) feeder & distribution cables; a detailed, standardized installation practice for Multi-dwelling Units (MDU) drop cables is difficult to capture in a single concise document. The primary hurdle is that this application does not lend itself to a "one-size-fits-all" approach. The diversity of design, construction, and vintage of different MDU structures create a variety of installation challenges that create unique situations and must be addressed on a case-by-case basis.

The specific installation methodology pursued by a service provider engaged in MDU applications will be dictated by the operational strategy and logistical priorities of the service provider. Tradeoffs involving material cost, inventory management, and installer training will have to be considered and integrated with established objectives to develop the deployment plan appropriate for each system. Manufacturers have responded to customer desires for "right-sizing" products to application requirements by offering a tiered set of products to address many of the key MDU application challenges. This has resulted in a portfolio of MDU drop cable products to select from and creates a situation whereby the specific installation practices and limits will depend upon the product selected for use. While a detailed installation procedure for each and every MDU building design is not practical; there are a number of proven general installation principles associated with fiber optic cables that should be integrated into drop cable installation practices in MDU structures and should be considered for every installation. Adherence to these methods will minimize re-work and will ultimately translate into improved long term reliability of the network. These basic fiber-optic installation principles have withstood the test of time and should be considered during the conduct of any MDU drop cable installation. The concepts described easily serve as a foundation which may be adapted into specialized procedures necessary for specific MDU designs.

These principles may be divided into three basic elements:

1. When pulling the drop into position, the cable's jacket and strength elements should be physically coupled together to properly counteract the stresses applied by pulling on the cable.
2. If staples are used for cable attachment to building structures; then, use only round crown staples properly sized for the cable design being used in the application.
3. Attention must be given to the radius of all routing bends and any residual tension that could pull the cable into an even smaller bending configuration over time.

Uncontrolled tight bends create "point loads", potential kinking events, and/or localized stress that can impact performance and limit the long-term system reliability.

A more detailed discussion of each of these principles will now be provided for clarity.

### **Drop Cable Pulls - Importance of Cable Jacket and Strength Elements Coupling**

All fiber optic cables are designed with strength components that are intended to provide tensile strength to the entire cable as it is pulled into its desired installation location. The number and material composition of the strength components of each cable design depends upon the application and is engineered appropriately. To properly protect the cable from unwanted mechanical stresses during cable pulling operations all cable installation practices recommend positively engaging the cable's strength elements before applying any pulling force on the cable.

A pulling grip is typically used for larger fiber optic cables to achieve this objective; however, this practice is not commonly used or practical for drop cable installations. To minimize the potential for installation damage, a functional alternative to the pulling grip should be implemented to insure the drop cable's strength components are used as designed. If the installer believes the drop cable may be exposed to significant tension after examining the intended installation route; then, considerations should be made to take positive measures to insure the cable jacket and strength elements are properly coupled together for the pull. The simplest method to accomplish this objective is to tie a knot in the pull-end of the cable before starting the installation (See Figure 1). The knot allows the entire cable structure to work together as a unit, minimizes independent jacket stretch, and creates an easily identified, localized condition that is removed after the cable is installed.

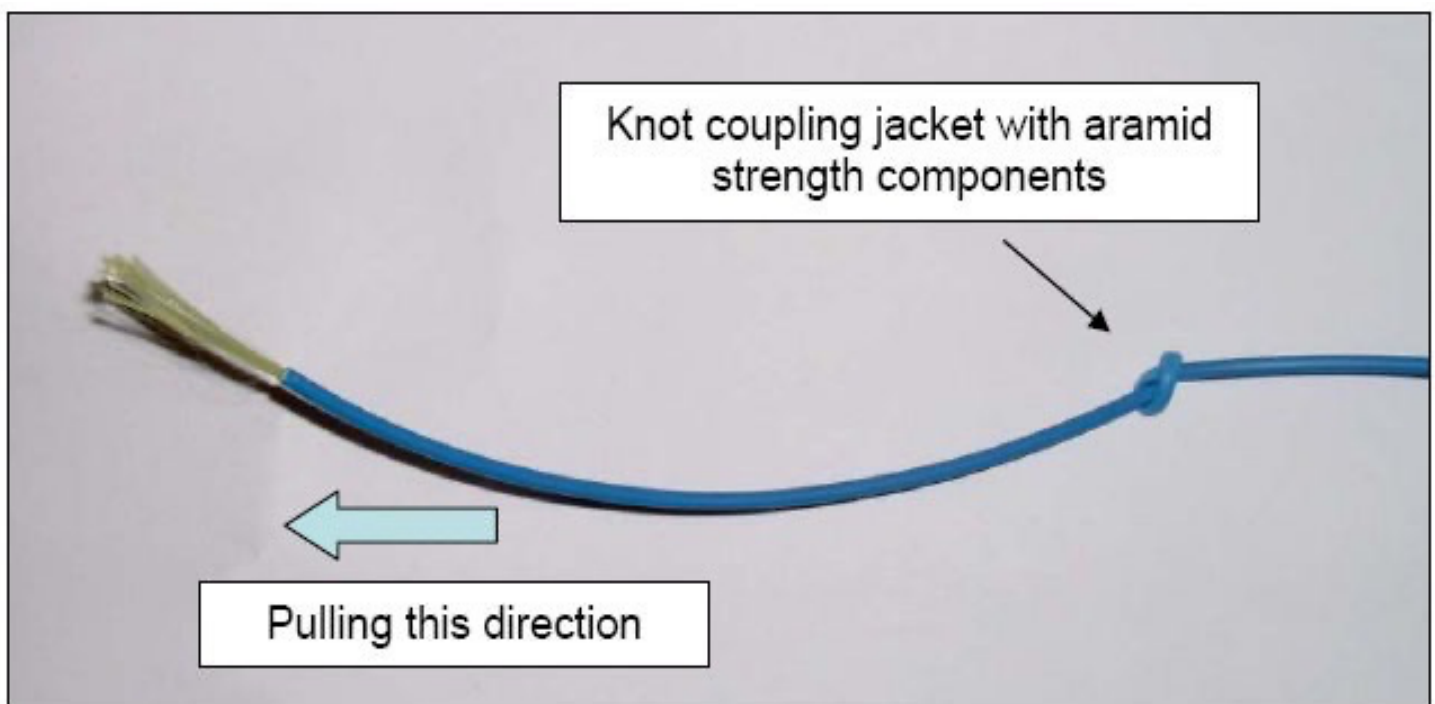


**Figure 1 - Cable prepared for pulling with knot on "pull-end"**

The functionality of this recommendation is best explained by describing the adverse condition being prevented. The mechanism the knot prevents also occurs for small interconnect (one or two fibers) sized and low fiber count (cables with < 6 fibers) when these cables must be pulled into place in cable routes in excess of 25 feet that contain several bends. This type of installation may require a significant amount of pulling force to be applied to the cable in order to move the cable over/around barriers and into the

desired location. Performance issues are created in these situations if the cable jacket and strength elements are not coupled during the pulling operation. These small cables are usually pulled by hand directly off the reel by grasping the cable jacket and pulling the cable into place. If the cable’s internal strength elements, which are part of the cable core are not effectively coupled prior to pulling the cable; then, the cable jacket and cable strength elements will move independently from each other. This condition allows the cable jacket to stretch independently from the cable core and become relatively longer in length than the cable core. When the drop cable has been pulled into its desired position, and the pulling force is removed, the cable jacket will relax and attempt to return to its “un-stretched” configuration. Unfortunately, the cable core may be pulled back with the jacket in an uncontrolled manner as the jacket contracts causing the cable core to “bunch-up” under the jacket. Ultimately, this bunching action creates fiber bending that may induce unacceptable attenuation loss. Many MDU installations, by their nature, are expected to have routing conditions similar or more severe than the application described above. Therefore, there is a reasonable expectation for higher tensions pulling tensions necessary for installation. The recommendation to insure cable strength component coupling is a necessary measure to address this situation.

**General Drop Cable Routing Considerations - Routing Bends and Staples**

A variety of application challenges are anticipated for MDU deployments due to the seemingly limitless configuration options created by different architectural designs and styles. Drop cables designed and built to meet different durability performance standards will be the order of the day to assist deployment economics. New cable performance standards which replicate anticipated installation forces must augment existing cable tests. Above all, the selected solution must include a balanced combination of optical fiber bend-insensitivity, a cost effective cable design that meets the rigours of the application, and definition/adherence to appropriate installation practices. An unbalanced approach adds unnecessary expense and ultimately reduces the effectiveness of MDU FTTH deployments in general.

To address this application diversity, Priority provides a bi-level product family solution for the MDU space. Having this tiered level of product offerings allows Priority to provide a variety of solutions to match up with the diverse variety of MDU designs that exist today and are being built in the future. This product family includes Crush Resistant and Tuff Coat Bend Free cable designs. This approach enables operators to properly engineer their systems and maintain a cost conscious approach. The differences between products create real value that is significant to the installer and system operator.

Product selection will be based on a number of factors which are expected to include cost, available routing paths, and aesthetics.

|                                                                                 | 2.9mm OD MDU Tuff Coat |
|---------------------------------------------------------------------------------|------------------------|
| Average number of 90 degree bends to generate induced attenuation of 0.1 dB     | 5                      |
| Average number of round crown staples to generate induced attenuation of 0.1 dB | 20                     |

**Table 1: Bend Protection**

## Drop Cable Attachment with Staples

Cable attachment to building structures using a staple-type fastener is an installation practice that has been used for decades with copper-based cable products. Historically, optical cable manufacturers have advised against the practice of staple attachment of fiber optic cables due to performance issues created by stapling. Advances in optical fiber and optical cable technology have resulted in the availability of an optical drop cable product that can be installed using staples. However, some precautions and installation practice recommendations are necessary to optimize the performance of drop cable performance with staples. There are two basic staple designs used with commercially available staple guns. One type of staple is a "Flat Crown" design and the other type is a "Round Crown" design. The visual differences between the two types are evident in Figure 2. The round crown staple is the recommended staple design for use in attaching optical drop cables. The flat crown staple should not be used as it applies a much more severe crushing force on the cable.

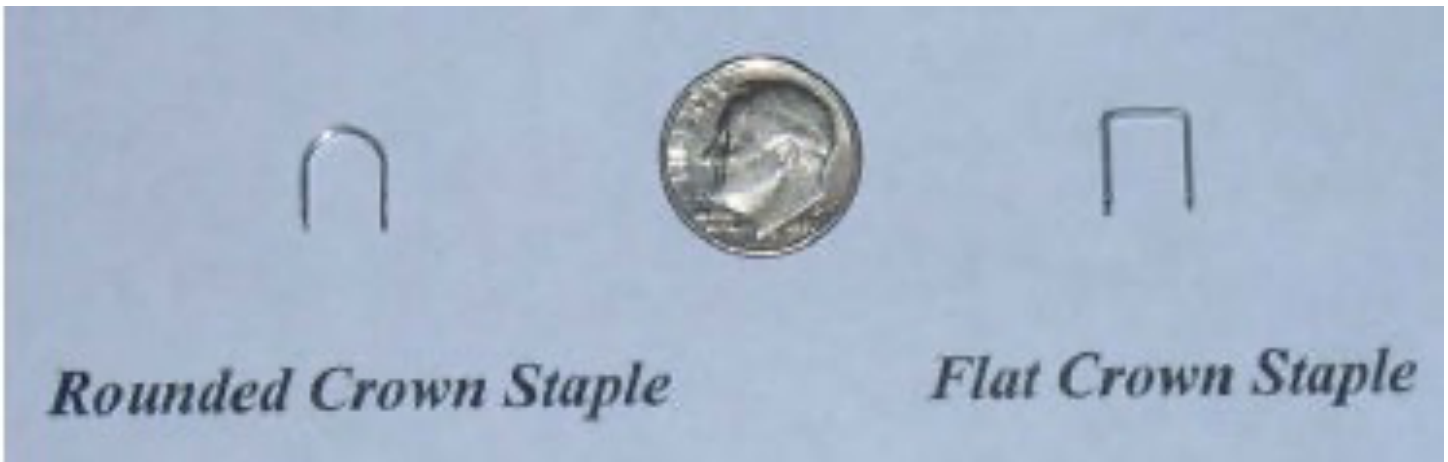


**Figure 2 - Round Crown Staple vs. Flat Crown Staple**

When installed using manufacture's recommendations the performance difference between the round crown staples and flat crown staples can easily be observed by visual inspection. When properly sized, the curved contour of the round crown staple matches the outer diameter of the drop cable. The cable is held in place with an appropriate amount of force and the cable's outer jacket is not severely deformed (See Figure 3). Comparing the same cable with an equivalent sized flat staple the performance difference is obvious. The crown of the flat staple is driven into the outer jacket of the cable and visually deforms it (See Figure 4). The compressive force and deformation of the outer jacket would also cause some movement of the cable core components. This may cause some induced attenuation and signal loss. This condition is avoided when round crown staples are used per recommended practices.

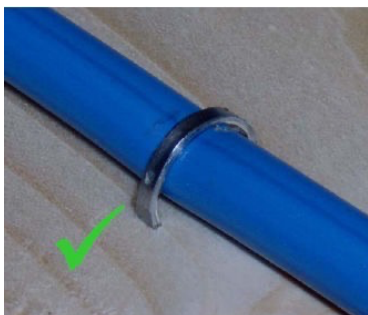


**Figure 3 - Drop Cable with Round Crown Staple**



**Figure 4 - Drop Cable with Flat Crown Staple**

Drop cable attachment using staples is necessarily a universal MDU installation method; however, this method is anticipated for use in new construction applications where drop cables will typically be run similar to copper wiring in and around wall framing. Also, in retro-fit applications of pre-existing structures staples may be used to secure cables in attic spaces or to attach cable to available hallway or ceiling space. A round crown staple, used per manufacturer's established practice, is recommended for use in all these applications. A flat crown staple should not be used in any case.

### **Drop Cable Bends - Radius and Residual Tension Severity Factors**

Handling studies consistently demonstrate that cable routing bends create the most significant contribution to the overall signal attenuation experienced in a drop cable route. Nevertheless, there are measures that can be taken to control and minimize these effects. Taking an active role in proper bend radius management and minimizing residual cable tension will directly improve network performance and overall long-term system reliability.

Factors directly controlled by the installation technician include:

1. Drop cable design used for each installation – Crush Resistant or Tuff Coat
2. Route selection (if multiple options are available)
3. Staple placement at corners (if staples are used for cable attachment in the route)
4. Manner in which cable routing bends for "non-pulled" placements are managed (areas with relatively open access, like framing bays, where the cable can be placed and attached)
5. Attention given to minimizing residual tension on any cable sections pulled into place The first factor, drop cable product selection is a choice at the discretion of the service provider.

The choice to either standardize on a single design or provide options for different applications will be driven by cost, logistics, and technical objectives. The technical necessity for selecting either a Tuff Coat drop cable or a Crush Resistant drop cable depends upon both the complexity of the available cable route as well as the experience and installation guidance provided to the technician performing the work. The Tuff Coat cable is quite capable and can be used in a variety of applications including placement in framing, being jetted through micro-duct, or placement behind decorative molding. However, installation of the Tuff Coat cable requires a degree of "handling finesse" in some situations that is not required for the Crush Resistant drop cable design. These handling differences between the Tuff Coat and Crush Resistant cables become evident when routing drop cable in particularly aggressive bending conditions. The performance difference involves how unacceptable fiber bends are prevented when using each design. Due to its heavier, more ruggedized design, the construction of the Crush Resistant cable prevents the optical fiber from being placed in a compromising bend configuration. This "self-limiting" feature of the Crush Resistant drop cable is completely independent from the experience/training of the installation technician. The design/construction of the Tuff Coat cable is not sufficient to prevent a compromising bend configuration in all cases by itself. For particularly aggressive bending conditions, technician verification/intervention would be necessary to avoid creating an unacceptable bending condition.

The Crush Resistant product provides an extra measure of protection; however, the cost of this cable is higher than the Tuff Coat cable.

The second factor is straight forward. The number, size, and shape of the obstructions in each cable route will have a direct influence on the ease of installation. For example, square shapes such as 90 degree corners are typically the most severe and are more challenging than sweeping bends. When multiple paths are available, consideration should be given to making the installation in the route that is most advantageous to the installer.

The third and fourth factors, both related to staple placement at corners, are additional considerations that demonstrate how installation practice can dictate the severity of bending imposed during the installation process. The recommended practice is to place two staples for each corner (one at the entry to the corner and the other at the exit of the corner). Each staple should be a minimum of 2 cm (approximately 0.75 inches) from the corner. This practice prevents the staple gun from being pushed into the corner and creates a sweeping bend that does not create excessive bending stress on the optical fiber contained in the drop cable (See Figure 5). Also care should be taken to minimize any force that pulls the cable against the staples.

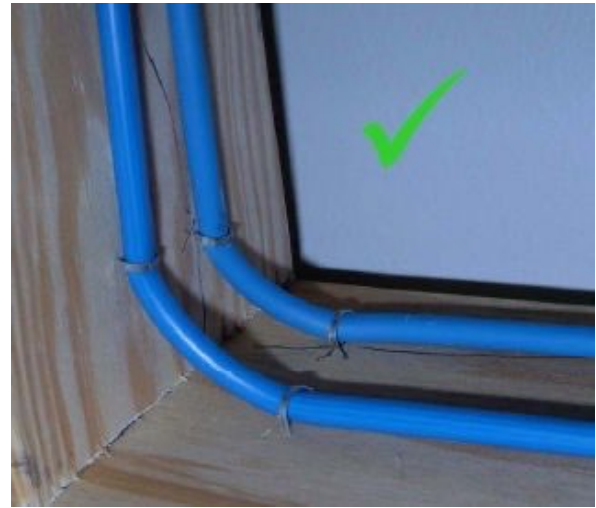
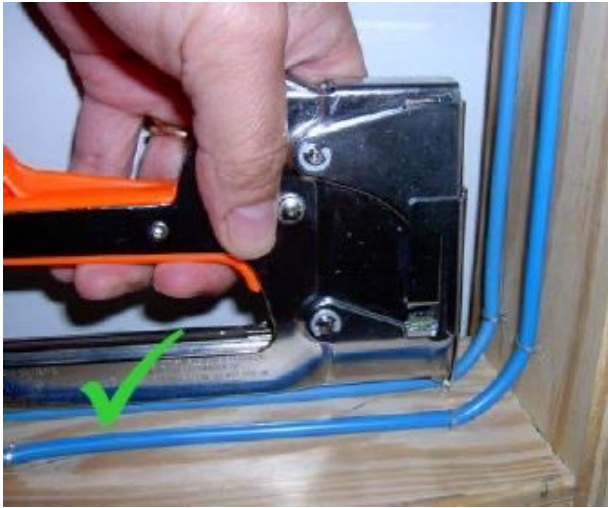


**Figure 5 - Recommended method for stapling drop cable in a 90° bend**

A practice that should be avoided is to secure the drop cable with a single staple that is placed as close to the corner as possible. This method would be done by pushing the staple gun as close to the corner as possible and inserting a single staple to hold the cable in place (See Figure 6). This practice creates a much tighter bend than the two staple method and creates a much greater stress on the cable and the fiber contained within the cable.



**Figure 6 - Incorrect Procedure for Stapling Drop Cable in Corners**

The fifth factor involves the influence of residual tension creating bending problems in a cable route. The most common location for generating a tension induced bending issue would be where a cable passes over a 90 degree corner (what is frequently termed as an “outside 90”). At moderate loading (several pounds) the cable structure protects the fiber and does a reasonable job of bend management (See Figure 7).

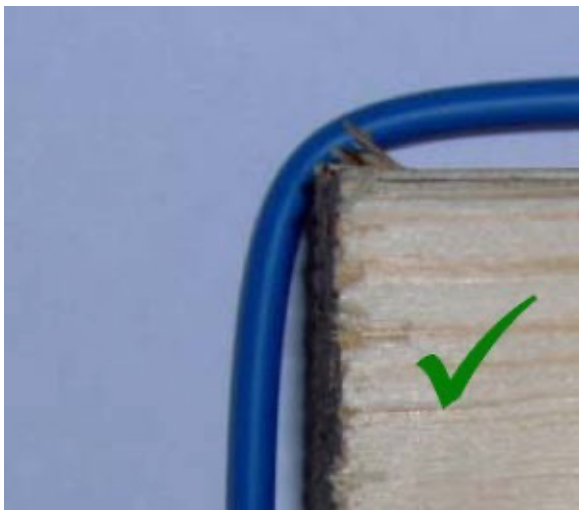


**Figure 7 - Outside 90° Bend with Low Residual Tension**



**Figure 8 - Outside 90° Bend with High Residual Tension (Not Recommended)**

When excessive loading is applied to a cable that passes over an outside 90 several problematic conditions occur. First, the cable tightly conforms to the 90° angle of the corner and significantly reduces the overall bend radius. Second, the applied stress flattens out the cable at the corner which further reduced the bend radius control capability of the cable structure. Third, the reduction in bend radius and shift in load distribution to the corner creates a concentrated loading condition in a confined area (See Figure 8). Each of these factors increases the potential for network issues.

## Summary

The MDU installation environment can be quite complex and product solutions must provide flexibility, adaptability, and options. The diversity of design, construction, and vintage of different MDU structures create a variety of installation challenges that create unique situations and must be addressed on a case-by-case basis. Specific product selection will be based on a number of factors which are expected to include cost, available routing paths, and aesthetics. A tiered product offering enables installers/operators to construct and maintain systems that meet the requirements. The basic principles presented in this document should apply to many of these applications and should be taken into consideration when installing drop cable.