

# Underground Installation of Optical Fiber Cable by Pulling

## Authors

Prasanna Pardeshi and Sudipta Bhaumik

## Issued

July 2015

## Abstract

This application note discusses underground fiber optic cable installation by pulling technique, the factors effecting pulling performance & best practices.

## Keywords

Fiber optic cable, Underground installation, Cable pulling



## Introduction

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. Machine pulling needs one hydraulic power pack	Large compressor and/or hydraulic power pack at one side
Mainly used for straight duct route	Preferred for duct route with multiple bends and undulations
Suitable for short distance (few 100 meters) installation	Preferred for long distance (over 2 km) installation

Pulling procedure is necessary and unavoidable in certain areas such as the small areas, small patches where blowing set up is not able to be accommodated. In this application note, cable installation by pulling method and its best practices are explained.

## Pulling Method

Cable installation into a pre-installed underground ducts/pipes by manual pulling or by puller machine is called as “Pulling Method”. In this method, cable is pulled through duct/pipes with the help of pre-installed rope inside the duct/pipes.

Optical fiber Cable pulling in underground horizontal duct routes requires some special considerations. These considerations are familiar to the installers who are specialize in optical fiber cabling installation, but may be unknown to the contractor who has dealt primarily with copper cabling. Failing to follow such a procedure can result in fiber/cable damages or high optical power losses after installation.

Optical fiber cable pulling is generally preferred in access networks where underground ducts/ pipes are not continuous for more than 200 to 300 meters and cable needs to be stored in coil form at each manhole/handhole available at every 200 to 300 meters.

If cables are pulled into conduit or inner duct, the ‘Duct Fill Ratio’ to be maintained below 65%. The ratio between cross sectional area of the cable and inner space of the duct is known as ‘Duct Fill Ratio (DFR)’ or ‘Fill Ratio’.

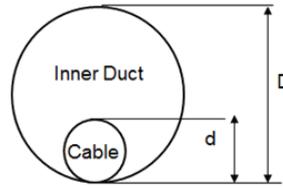


$$DFR = \frac{d^2}{D^2} \times 100$$

Where,

d= cable diameter

D= duct inner diameter



## Cable Pulling Guidelines and Best Practices

### Duct Route Survey

Conduct the duct route survey and inspect the route for manhole, coiling, splicing locations. Ensure there are no sharp bends or slopes that exceed the minimum bend radius of the cable (refer cable supplier specification sheet). Identify and attain the potential problems during route survey. Identify the cable reel location/pulling location. Ensure the duct continuity is thorough and clear for the pulling length patch.

### Pulling Rope

Ensure cable pulling rope is available in the duct. If pulling rope is not available inside the ducts then first install the pulling rope with the help of rodder as shown in Figure 1. Push the rodder rod through one end of the duct/pipe and as the rodder rod reaches to other end of the duct/pipe, tie the pulling rope with the rodder rod at other end and reel back the rodder rod.

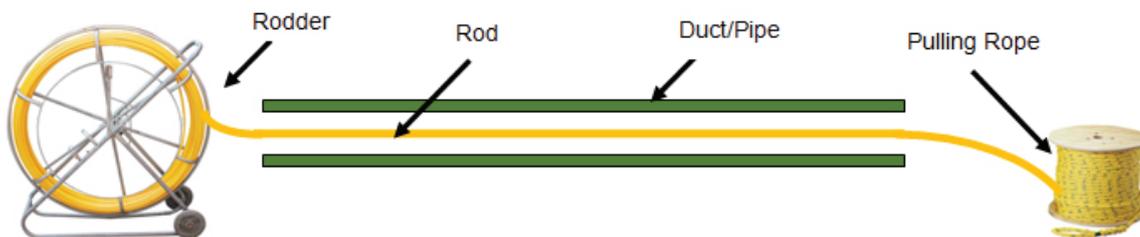


Figure 1 Pulling rope installation by rodder

### Cable Pulling Grip

Cable pulling grip shall be fixed at the head of the cable as shown in below figure 2. The function of this grip is to provide effective grip over cable sheath which is very useful during cable pulling. A wrap of plastic tape shall be wrapped around the grip which has been pulled tight over the cable.

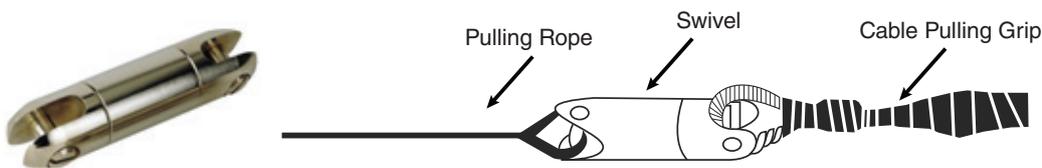


Figure 2 Wire mesh cable pulling grip



### Breakaway Swivel

It is strongly recommended to use breakaway swivel during manual pulling installation where pulling tension is not controlled. During manual pulling, applied pulling tension higher than the cable tensile rating can damage the cable and negatively impact its lifetime. Breakaway swivels are available with different tensile rating and can be placed in between cable and pulling rope. The main function of breakaway swivel is to break the swivel device if excess tension applied during cable pulling. For example, if cable rated tensile is 2700N and breakaway swivel having 2500N tensile strength is fixed, when the cable pulling tension goes above 2500N, the swivel will break so that excess pulling tension will not have any impact on cable.



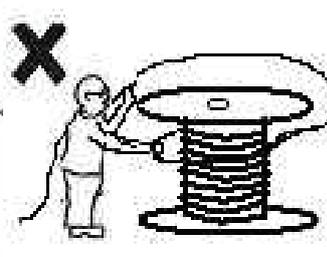
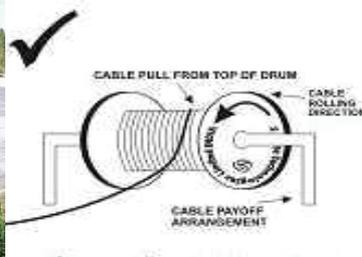
**Figure 3 Swivel**

### Cable reel pay-off

This feature is very important in optical fiber cable installation set-up to ensure cable is smoothly reel off. It is always recommended to use cable reel pay off during cable installation. The cable reel should be kept in level to avoid cable rubbing against the reel flanges. The cable reel 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 reel. Figure 4 shows a cable reel in a cable reel pay-off and figure 5 shows the do's and don'ts of cable unwinding.



**Figure 4**



**Figure 5**

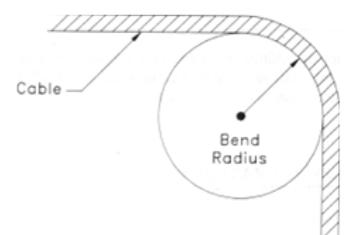
**Figure 4 Cable reel pay-off**

**Figure 5**

### Cable Handling

All optical fiber cables are sensitive to damage during shipping, handling, and installation. Some of the important parameters that need special attention during cable pulling installation are:

**Cable bending radius:** Optical fiber cables are designed with a minimum bending radius. The cable should never be bent below its minimum bending radius. Doing so can result in bending losses and/or fiber breaks in the cable. Generally the minimum bending radius of a fiber cable under load is  $20 \times D$ , where  $D$  is the diameter of cable.



**Figure 6**



- **Cable Pulling Tension:** Optical fiber cables are designed with a maximum tensile strength. The cable should never be pulled beyond its maximum tensile strength. Exceeding the cable's pulling tension provided by Sterlite in the Cable Data Sheet / Specification, can alter cable and fiber performance and shorten its in-service lifetime.
- **Cable Twist:** Cable twist can develop stress on the fibers and therefore need to be avoided. Tension on the cable and pulling ropes can cause cable twisting. Use a swivel pulling eye to connect the pulling rope to the cable prevents pulling tension causing twisting forces on the cable as shown in figure 3. Unroll the cable off the reel loaded on pay-off or reel jack instead of manually taking out as shown in figure 4. When reel-off the cable for pulling, stored in "figure-8" shape on the ground to prevent twisting. The figure 8 puts a half twist in one side of '8' and takes it out on the other side to prevent generation of twists in cable.



**Figure 7 Cable stored in 'fig-8' shape**

### **Cable Lubricants**

Use of cable lubricants to reduce co-efficient of friction between cable outer surface and duct inner surface is recommended to pull cable in a duct route having multiple bends, elevation and undulations. The lubricant material should not react with cable outer sheath (don't use soap water, kerosene, diesel). Apply right quantity of lubricant as suggested by the supplier.

For additional information refer Sterlite application note titled "Underground Installation of Optic Fiber Cable Placing"(issue- November' 2014).

