Application Note

Buried Installation of Optic Fiber Cable

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Abstract
Buried cable is a kind of communications cable which is especially designed to be buried under the ground without any kind of extra covering, sheathing, or piping to protect it. This cable is built to specific tolerances to heat, moisture, conductivity, and soil acidity. Unlike standard telecommunications cables, which have only a thin layer of insulation and a waterproof outer cover, Buried Cable may consist of multiple layers of sheathing or jacketing, reinforced by metallic-banded, shock absorbing gel, wrapped thread-fortified waterproof tape, etc. This Applications Note describes the placement of optical cables as buried cable in the outside plant portion of the communications network.

Keywords
Plowing, Trenching

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2. Introduction

Buried plant is usually placed into a narrow trench or plowed directly in the ground. Sometimes a fiber cable is placed in an open trench with several empty sub-ducts for use when future service demands require more cable infrastructure.

A general description of placing fiber cables will be presented in this Note. The Direct buried cable placing methods described in this document are intended as guidelines. National, state, local, and corporate specifications, regulations, and industry recommendations normally take precedence over these. It is impossible to cover all the conditions that may arise during a placing operation. Individual company practices for placing fiber optic cable should supersede any conflicting instructions in this document whenever they do not exceed the cable's optical and mechanical performance specifications. This note is not intended as a replacement for instructions or operations described by the manufacturer's procedures for the materials and equipment being used.

3. Advantages of Buried Plant

Construction of buried plant is popular because it provides three major advantages over other types of communications plant construction when used in properly suited areas.

1. It provides a fast installation procedure.
2. It is economical both in initial investment in infrastructure and it provides good flexibility in being able to place new plant in a more timely manner to closely match new service demands.
3. It is the least disruptive to surface conditions along the right-of-way.

Buried construction is well suited for use in the following conditions:

- Soils with low clay content.
- Compatible granular soils.
- Free from medium or large size rocks.
- Free of frozen soil and/or debris.
- Right-of-way with few crossing utilities, roadways, or underground obstacles.
- Right-of-way that crosses open land, free from buildings, and large expanses of paved areas.

Special techniques such as directional drilling and boring may need to be used to cross roads, railroad tracks, or paved areas. Areas that have rocky or frozen soil may need to be pre-ripped in advance of attempting to place cable using a plow.

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4. General Procedure

Buried cable is placed directly in the ground, without being encased in a conduit system. It is commonly placed with several feet of soil cover over the cable with the depth of cover depending upon the type of soil, surface loads, and applicable regulations. Generally, one or two cables are placed in an open trench dug by a trencher or plowed directly into the soil.

If the cable is placed with a trencher, a narrow trench is dug and covered with a bed of fine granular soil, several inches thick to serve as a protective bed for the cable to cushion it from any sharp rocks at the floor of the trench. The cable is then covered with the same granular material to a depth of approximately 6 inches. The granular backfill provides good cushioning of the cable with protection from stones that could migrate into the cable from years of surface loading and climatic conditions. The remainder of the trench is normally backfilled with clean soil, usually the original soil excavated from the trench. The surface is compacted, usually, with a roller or flat plate soil compactor. Occasionally, if the applicable construction regulations permit, a large rubber tire or track from a tractor mounted backhoe or trencher is run over the backfilled trench to compact the soil.

Plowing is often used to place buried cable. The process is well suited for some soils, such as granular, rock free soil. The plowing operation usually requires a large tractor type vehicle to pull the plow through the soil. The tractor is usually a large diesel powered, tracked vehicle, although rubber tires are used on some vehicles. The plow share must be properly designed to feed the cable through the share and into the soil without violating its minimum bending radius. The share must provide a smooth entry for the cable and no sharp edges to damage the cable. Most plow trains are arranged with the front end of the tractor modified to carry the cable reel. The cable is passed over the top of the tractor to the plow share with its pathway controlled by a series of rollers on top of the tractor that capture the cable and keep it safe and aligned with the plow as it passes over the tractor. The cable is tended by an operator to feed it into the top of the plow under zero tension.

If plowing is attempted in difficult soil, it may be necessary to use a second tractor, in tandem with the primary tractor power unit. Rocky, frozen, or poor quality soils may need to be ripped in advance of the plowing operation.

Buried optical cable needs to have a robust design to resist damage during its service lifetime. Since buried cable is generally laid in the trench or placed using heavy machinery, the difference in cable handling due to the jacket stiffness is not too significant during cable placement, but will be noticed during reel handling and splicing operations. Armoring is recommended for standard size buried fiber cables. Depending upon the quality of the soil and the amount of rocks encountered, it may be necessary to use an armored dual-jacket cable as opposed to a single-jacket armored cable. ***Table 1*** provides a comparison between armored single- and dual-jacketed cables.

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Single Jacket	Dual Jacket
• Suitable for direct burial and underground applications. • Cable is lighter and easier to install. • Cable is more flexible, easier to prepare. • Metallic armoring requires the cable to be properly bonded and grounded.	• Suitable for direct burial and underground applications. • Extra protection for direct buried applications. • Cable is heavier than single jacket cable. • Best rodent protection. • Most robust design, good crush and impact resistance. • Metallic armoring requires the cable to be properly bonded and grounded. • Extra weight makes cable more difficult to place. • Requires more time and is more difficult to prepare for splicing.

Table 1– Comparison between Single and Dual Jacketed Cable

Table 2 provides a tabular summary of the types of applications served by various forms of buried optical plant.

Underground Plant	Urban	New Suburban	Old Suburban	Campuses	Rural
• Trenched Standard Fiber Cable		●		●	●
• Trenched Micro-Ducts		●		●	●
• Plowed Standard Fiber Cable		●		●	●
• Plowed Micro-Ducts		●		●	●

Table 2– Commonly Used Forms of Buried Plant for Various OSP Applications

● = Used often in this application

● = Can be used in the application under certain circumstances

Buried cables are generally terminated and spliced in handholes[1] or pedestals. Underground/buried interconnection usually occurs in a manhole or occasionally in a handhole.

It is possible to bury unoccupied lengths of sub-ducting or conduit in a narrow trench or with an adjacent buried fiber cable. Unfortunately the distance that an optical cable can be confidently pulled into trenched sub-ducting (3/4 to 2-inches in diameter) is limited and is dependent that the sub-duct is placed under slight tension to keep it as straight as possible once it is backfilled with soil. Larger diameter conduits can be trenched alone or with one or two optical cables then lined with innerduct to serve as pathways for individual standard size optical cables or with micro-ducts to house micro-duct cables. Finally, composite duct-like units of grouped multiple sections of micro-duct are manufactured in long lengths. These composite, multi-unit lengths of ducting can be trenched alone or with one or two optical cables to serve as pathways to jet micro-duct cables when future service demands require.

The buried placing methods described in this document are intended as guidelines. Most fiber optic cables are usually ordered in lengths as calculated by an OSP (Outside Plant) Engineer to match the span they will occupy. Their lengths are determined by measuring the distance between selected splice point plus the excess cable length required for splicing and slack storage for maintenance. In addition, extra length should be included in the ordered length to be available if errors are made during the construction operation. If the excess splice length is not known, the splicing foreman should be consulted. Never cut a fiber cable without first consulting the OSP Engineer responsible for the job.

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5. Precautions

5.1 Cable Handling

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

- **Cable bending radius:** Optical fiber cables are designed with a minimum bending radius and maximum tensile strength. The cable should never be bent below its minimum bending radius. Doing so can result in bending losses and/or breaks in the cable's fibers. **Generally the minimum bending radius of a fiber cable under load is 20 × D, where D is the diameter of cable; the minimum bending radius of a fiber cable under no load is 15 × D.**
- **Cable Placing Tension:** Optical cables are designed with a maximum tensile strength. The cable should never be loaded beyond its maximum tensile strength. Exceeding this value provided by Sterlite in the Cable Data Sheet / Specification, can alter cable and fiber performance and shorten its service lifetime.

5.2 LED and Laser Precaution

LED and Laser beams used in testing fiber optic cable and transmission systems are invisible to the human eye and can seriously damage the eye. Viewing these beams directly may not cause any pain and the iris of eye does not close automatically as it does while viewing a bright light. As a result the eye may not react to protect itself, causing serious damage to result to the retina.

5.3 Material Safety

Fiber optic splicing and termination processes often use various chemical cleaners. The safety instructions developed for these substances should be followed. If there is confusion in the usage of these products, ask their manufacturer for a Material Safety Data Sheet (MSDS). Remember the following instructions while working with these chemicals.

- ⚠ Always work in well-ventilated areas.
- ⚠ Avoid skin contact with these cleaning materials as much as possible.
- ⚠ Avoid using chemicals that causes allergic reactions.
- ⚠ Isopropyl alcohol, used as a cleaner, is flammable and should be handled carefully.

[1] A handhole is a dielectric structure providing access to small underground systems and buried plant. Its top opens to store splice closures and spare cable. It is small in size, too small for a worker to enter. The National Electrical Code covers handhole specifications.

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Primary treatments for exposure to Isopropyl alcohol or Hexane in cleaning fibers or cables are presented in **Table 3**.

Type of Exposure	Hexane		Isopropyl	
	Effect of Exposure	Emergency Treatment[2]	Effect of Exposure	Emergency Treatment[2]
Inhalation	Irritation of the respiratory tract, cough.	Maintain respiration, bed rest.	Irritation of the upper respiratory tract.	Move victim to area containing fresh air. Administer artificial respiration if breathing is irregular.
Ingestion	Nausea,Vomiting, Headache.	Do not induce vomiting, immediately seek medical assistance.	Drunkenness and vomiting.	Have victim drink water and milk. Seek medical assistance.
Contact with Skin	Irritation.	Wipe off affected area and wash with soap and water.	Harmless to skin.	Wipe off affected area of skin and wash with soap and water.
Contact with Eyes	Irritation.	Wash eyes with plenty of water for 15 minutes.	Irritation.	Wash eyes with plenty of water for 15 minutes.

Table 3– Primary Treatments for Hexane and Isopropyl Exposure

5.4 Safety During Installation

Manhole/Underground Vault Safety:

- Explosive gases or vapors might be present in manholes or handholes due to gas leaking from nearby pipelines, tanks, or the soil. Before entering any manhole test its atmosphere with an approved test kit for flammable, explosive, and poisonous gases.
- Avoid usage of any device that produces a spark or flame in or near a manhole.

Working Safely:

- To minimize the risks of an accident in the work area, follow the existing rules for setting up warning signs, barricades, manhole guards, and cones.
- Ensure that the tools and equipment used for the cable installation are in proper working order. Improperly functioning equipment may damage cable or cause injury to personnel.
- Be careful when working near electrical hazards, if electric lines are passing through or near the right-of-way where installation is being performed.
- Bond all metallic components in the cable and buried system together. At all points where anyone may come in contact with the metallic components of the buried cable system, ground the bonded metallic components to a proper earth ground to avoid electric hazards produced by power lines or any other means.

[2] Seek Emergency treatment for inhalation, ingestion, severe contact with skin, and contact with eyes.

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5.5 Personal Protective Equipment

Placing optical cable and jetting micro-duct cable require sophisticated operations and use equipment that many placing crews may not be experienced with. As a result, Sterlite recommends using a placing crew that is familiar with and has experience with the cable being placed and the procedures and equipment being used. Approved personal safety equipment, such as hard hats, safety shoes, safety glasses, reflective traffic vests, and gloves shall be used for all outside plant construction activities.

5.6 Traffic Safety

All applicable federal, state, and local departments of transportation regulations and codes shall be met including the use of safety equipment such as reflective safety vests, warning signs, barricades, and lighting if work is being performed during non-daylight hours. All traffic control requirements shall be met.

5.7 Placing Equipment

Most of the equipment used is more sophisticated than conventional placing equipment. High pressures are used to drive hydraulic motors as well as the use of high pressure air lines. If a failure occurs to a high pressure hose or connection, it is potentially dangerous to those working around the equipment.

Therefore, the placing crew needs to read, understand, and be familiar with all operating procedures as well the safety issues outlined by the placing equipment manufacturer.

The depth of plow should be kept constant, if possible. Changing depth while plowing is likely to kink and damage the cable. Extreme care is required to make the plowed depth of cover change as gentile as possible.

5.8 Cable Protection and Reel Handling

- While loading or unloading cable reels, care must be taken to prevent collision with other reels, or damage to the reel or cable.
- The reel should not be rolled a long distance. If it is necessary to roll the reel, it should be rolled on both flanges in the direction indicated by the arrow on the flange.
- The reel should never be stored on its side (do not store a reel flat on one flange).
- Cable reels should always be stored on a flat surface with blocks placed under the flanges to prevent rolling in either direction.
- The cable on the reel should be covered at the factory with a UV/thermal wrap until just prior to installation to protect it from exposure to the sun and high temperatures.
- The reel should never be dropped (i.e. off of a flatbed truck).

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6. Preparation for Cable Placing

6.1 Pre-Construction Survey

One of the most important steps in the engineering and placement of optical cable is the pre-construction site survey. During this visit the placing supervisor and/or OSP engineer will be able to observe any unusual situations that require special attention. The proposed placing route will be evaluated for it ability to support the planned placing procedure. One of the main objectives of the survey is to discover all potential pit-falls in the proposed placing operation so they may be accounted for in the final procedure used.

General Issues

- If possible, select a route that has good quality, rock-free soil; thatis in an open area with few crossing utilities or surface obstacles.
- Before any visit is made to a prospective construction site, an up-to-date plot plan showing the location of existing utilities shall be obtained from each of the utilities that will affect the construction operation. The plot plan shall be noted with details characterizing each utility and phone numbers to call if there are problems.
- Select a route that provides easy access for workers, equipment, and materials.
- The placing route shall have a spacious and safe staging area convenient to the job site.
- The staging area shall be a location in which cable reels can be unloaded and stored prior to use. It shall also be a location at which fiber measurements can be made. It shall be secure from vandalism and theft.
- The job site and staging area shall be protected from both pedestrian and vehicular traffic.
- Buried splice locations shall be selected on the basis of their ability to serve as a good cable branching points, near obstacles for which the cable must be hand fed, and locations spaced at distances convenient with respect to cable availability.
- The pre-construction survey of must include an inspection of the respective handhole, pedestal, and manhole locations. In addition, there must be sufficient space on the ground surface adjacent to these splice locations to support the splicing operation.
- Placing operations in all types of plant (aerial, buried, and underground) are normally easier when done downhill. Try to configure the placing operation downhill.
- All splice locations and points where human contact may result in exposure to metallic components in the cable, splice closure, or buried infrastructure need to be properly bonded and grounded to an earth ground.
- Sufficient space must be provided around the start of the cable placement location (manhole or handhole) to provide a starting point for the plow. The plow share must start at full burial depth for the cable. A trench (starting pit) approximately 6-inches deeper than the cable depth and about 8 feet long should be provided aligned with the cable route. The plow will start the plowing operation from inside the starting pit. Each buried cable will have its own starting pit.
- If cable pulling is required, the placing operation shall be arranged to have the cable enter the most difficult bends first (bends with the largest central angle), as early in the placing operation as possible. This will allow the cable placing loads to be as low as possible.
- New construction must follow the National Electric Safety Code; OSHA Safety Requirements; and state, local, and federal guidelines.

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- All placing operations require constant high quality communications for the entire placing operation. Radios are the most common means of communications for placing operations. The pre-construction survey should ensure that the radios will work properly in the entire construction area.
- Underground and buried utilities should be marked on the ground surface so the construction crew can easily determine where it is safe to work. Most areas have a "Call before You Dig" phone number to call for contractors to use to avoid damaging underground utilities during construction. If required, call on the designated phone number before digging that connects contractors to their local one call center. Each state has different rules and regulations concerning digging.
- It may be necessary to dig exploratory holes along the right-of-way to sample the soil to be encountered.
- Rocky soils and heavily cohesive soils may need to be pre-ripped in advance of plowing. It may also be necessary to use multiple tractor units arranged in tandem to provide sufficient power to plow the intended communications plant.
- Portions of the right-of-way that may need surface restoration need to be noted during the pre-construction survey.
- All locations where buried plant crosses obstructing facilities need to be visited during the pre-construction survey. Crossing utilities and roadways are usually traversed by tunneling or directional boring; although with special planning, secondary roads can be trenched. For plowed plant, the plowing operation is continued to a tunneling trench that runs parallel to the obstruction and is intended as support for the tunneling or boring operation. Cable and/or ducting is unreeled and pulled through the tunnel under the obstruction into a tunneling trench at the far side of the obstruction. It is recommended that a splice handhole, pedestal, or manhole be placed close to and on the far side of a crossing obstruction, allowing a trench to be dug from the tunneling trench to the splice location.

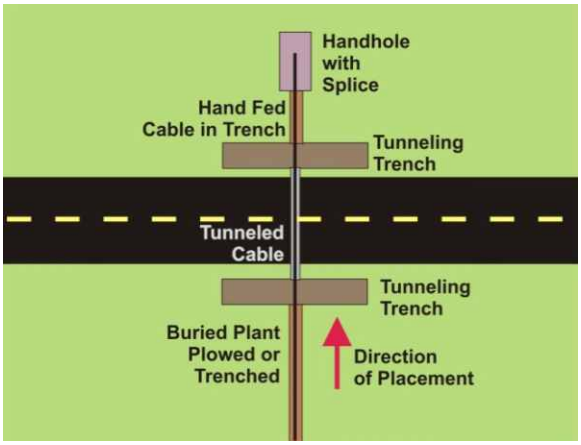

Figure 1– Tunneled Crossing Obstructions

- Travel the entire length of the right-of–way to look for features that may present a problem for the placing operation such as streams, gullies, trees, or any unrecorded structures.
- The plan developed as a result of the pre-survey along with comments shall be summarized in drawings made available to the placing crew.
- Cables and sub-duct (if required) shall be delivered to a staging area designated in the pre-placement survey by the service provider or contractor installing the cable.
- All Sterlite cables are shipped with loss information on each fiber. The information is provided electronically or as a hard copy attached to the cable reel.

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The cable on each reel needs to be inspected for damage it is received. As a precaution and to avoid costly extra cable removal operations, all fibers should be measured on the reel using an OTDR. Measurements on Optical fiber cables should be made and if discrepancies are found with respect to the factory "as shipped" test results on the cabled fiber, contact Sterlite Technical Team for further assistance.

6.2 Cable Staging

- New cables, sub-ducts, and micro-ducts will be staged at selected in safe, convent to the right-of-way locations prior to their installation.
- Staging locations shall be safe from vandalism and free of pedestrian and vehicular traffic interaction. If possible, the staging area shall be flat and covered with an all-weather surface that will not become a problem in wet or stormy weather.
- The staging location shall be large enough to store the reels and placing equipment and materials being used in the construction operation.
- Reels shall be stored on the edge of both of their flanges with access to the side of the reel for the pre-construction testing of the cable on the reel.
- The thermal wrap shall be kept on the cable reel as long as possible to provide thermal and solar protection to the cable as long as possible.
- Pre-Construction measurements shall be made on all fibers in each new cable reel at the staging location to confirm that they have survived shipment undamaged.

7. Tools and Materials

Buried cable placement is characterized by plowing or trenching cables underground. It may also include placing several spare sub-ducts for future use with the buried cable. Standard size fiber cables are normally placed as buried cable; they are also placed in any of the spare sub-ducts (innerducts) that are inside ducts that were installed with the buried cable. Micro-duct cables can be placed into micro-ducts which are housed directly in the innerducts. Placing equipment is specially tuned to be effective for placing standard fiber cables or the even smaller micro-duct cables. Procedures are used to keep bending and tensile stresses under the threshold values that could begin to be a problem if violated.

The following sections are intentionally generic in tools and material application. Sterlite does not intend for the following tools and materials list to supplant the individual's tools and materials as defined by their company's practices. The following generic list is offered only as an overview of the tools and material required for pulling cable into ducts

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Buried Cable Placing Equipment	
Plowing and Trenching Equipment	
 Vibrating Plow	 Vibrating Plow with Reel Carrier
 Rubber Tire Trencher	 Chain Type Trencher
Micro-Duct Cable Placing Equipment	
Jetting and Pushing Equipment	
Buried Cable Placing Equipment	
 Strand Arnco Dura-Line Plumett Cable Jet	 GMP Air Stream
 Dura-Line Air-Trak MD	 Arnco Dura-Line Plumett SuperJet
 Arnco Dura-Line Plumett Mini Jet	 Cable Reel Trailer (Plumett)

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Pulling Equipment

Portable Capstan Winch (GMP)

Trailer mounted Capstan Winch (GMP)

Cable Placing Truck (Canada)

Side take-off winch with slip clutch (Condux)

Support Equipment

Pull Line

Rodding Cord

Buried Cable Placing Equipment

Duct Cutter

Fiberglass Duct Rodder

Duct Lubricant

Pulling Eyes for Sub-Ducts

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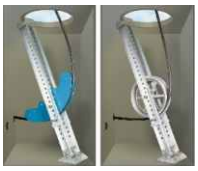
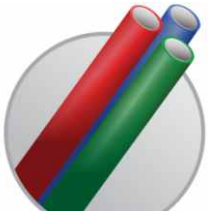
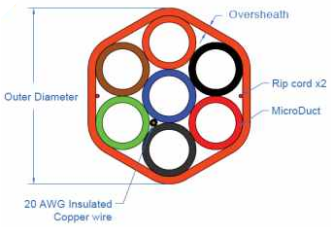
 Pull Line	 Rodding Cord
  Duct Plugs	 Pneumatic Missiles (“Pigs” or “Birdies”)
 Ball Bearing Swivels	 Large Diameter Splittable Sheave and Quadrent Block
  Manhole Sheave and Quadrent Block (GMP)	 Pulling Frame in Manhole
Buried Sub-and Micro-Duct	 Innerduct ENDOT
Buried Cable Placing Equipment	
 Micro-Ducts	 Multi-Unit Micro-Duct

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7.1 Innerduct and Micro-Ducts

Buried installations are often combined with duct installations to go under obstacles like roads, driveways, etc. At the transition point between the direct-buried section and the conduit, the cable must be unreeled. In such cases use the figure-eight configuration to prevent kinking or twisting. Standard communications conduit systems are generally made from formations of 3.5 inches to 4 inches in diameter single-bore conduit that is often arranged into multiple duct conduit systems. Innerduct is often smooth wall polyethylene tubing ranging from 25mm to 50mm in diameter which houses standard fiber optic cable. Micro-ducts are small bore polyethylene tubes ranging in diameter from 5 mm to 14 mm which houses micro-duct cables.

7.2 Lubricant

Generally, lubricant is not required to place buried cable. The following section is included to cover placement of cables in sub-ducts placed with buried cables.

As always, the encasing conduit, sub-duct, innerduct, or micro-duct must be lubricated prior to the start of any pulling operation. Once the pulling operation begins, lubrication must continue to be applied to the plant being placed as it is placed.

The cable manufacturer's recommended minimum bend diameter shall be maintained. If no minimum bend diameter is recommended, use the minimum diameters listed below.

Cable under no load, Minimum bend radius $\geqslant$ 15 × Cable Diameter
Cable under load, Minimum bend radius $\geqslant$ 20 × Cable Diameter

7.3 Winches

Generally, winches are not required to place buried cable. The following section is included to cover placement of cables in sub-ducts placed with buried cables.

Most standard size optical cables have a maximum cable placing force of 2700N or greater (some cables have higher loads and some lower, consult the cable specification provided by Sterlite to determine the maximum placing load for each cable). Fiber optic cable winches tend to be smaller than the line truck bed winches used for copper cables. Capstan winches are popular. Some of these winches are stand alone, using portable power packs (electric and hydraulic) and some are truck or trailer mounted using the hydraulic power take-off from the support truck for power. Fiber winches should all have or be coupled to cable tension monitoring systems to ensure that the maximum cable tension is not violated. Slip clutches are often used for side take-off winches on line trucks.

7.4 Cable Blowing and Pushing Engine

The micro-duct system is based on the use of a combination of smaller diameter sub-ducts and more compact optical cables using more efficient placing methods and equipment specifically tuned to micro-ducts and micro-cables. It is possible to use equipment similar to that used to place micro-duct cable to place standard size optical cables; it is specially tuned to the standard diameter optical cables and innerduct.

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8. Buried Cable Placing Methods

All buried cable routes should be marked with signs or markers to clearly identify the route as an optical communications cable and warning contractors of the impending danger if they dig along this route.

Figure 2– Fiber Optic Marking Tape and Warning Sign

8.1 Trenched Construction

Buried cable placement is done using a trencher or excavator to dig a narrow trench for the entire length of the cable route. The trench is lined with a bed of fine, granular soil to provide a gentle cushion for the cable. After the trench has been dug, the cable may be laid out along the side of the trench. If unoccupied sub-ducts or conduits are being placed with the buried cable they may also be assembled and laid alongside of the buried cable for eventual placement onto the trench. The cable shall be laid out with sufficient extra cable at the splice locations to satisfy splicing length requirements, maintenance requirements, and spare length to compensate for any splicing problems. The cable shall be carefully lifted into the open trench, being careful not to violate its minimum bend radius limit. If sub-ducts are to be placed alongside the buried cable, they should be placed next to the cable with several inches space between the two entities. The sub-duct should be placed under slight tension to remove any undulations and keep it as straight as possible. Cross-over's between individual items being placed is not permitted.

The buried cable (and sub-duct) should be covered with a lift of select granular soil to a depth 4 to 6 inches above its top surface. The remainder of the trench should be filled in two lifts with good quality soil containing no debris or large rocks. A plastic warning tape shall be buried between the two top layers of soil backfill alerting future construction forces to the presence of the buried cable, see ***Figure 3***. The filled trench shall be compacted with a compactor or using the rubber tire or track from the excavator.

If a below ground crossing obstacle is encountered, a trench exposing the obstacle should be carefully dug, if necessary by hand. The buried cable is then either passed under or over the obstacle.

In some cases, a roadway can be cut with a very narrow slot to lay the cable into. This slot should be prepared with a bed of select granular soil before the cable is placed. The remainder of the slot should be filled with the same select granular soil. The road surface should be patched after a week or two to fill in the slot to settle.

Often surface obstacles are breached using directional drilling or tunneling. A starting pit needs to be prepared for the drilling or tunneling operation. The excavated trench for the buried cable should be brought to the starting pit. The buried cable is then hand fed through the tunnel casing. Normally, it is advisable to locate a splice point on the far side of such a crossing.

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8.2 Plowed Construction

Buried cable placement can also be done using a plow (either vibrating or static) being pulled by a tractor. The tractor is usually a large diesel powered, tracked vehicle, although rubber tires are used on some vehicles. The plow share must be properly designed to feed the cable into the soil without violating its minimum bending radius. The share must provide a smooth entry for the cable and have no sharp edges to damage the cable. Most plow trains are arranged with the front end of the tractor carrying the cable reel. The cable is passed over the top of the tractor to the plow share with its pathway controlled by a series of rollers positioned on top of the tractor to capture the cable and keep it safe and in line with the plow as it passes over the tractor. The cable is tended by an operator to feed it into the top of the plow under zero tension.

If plowing is attempted in difficult soil, it may be necessary to use a second tractor, pulling in tandem with the primary tractor. Rocky, frozen, or poor quality soils may need to be ripped in advance of the plowing operation.

The cable reel is loaded on the tractor and the cable is passed through the guide rollers over the top of the tractor. The cable is hand tended as it passes smoothly into the top of the plow share; it should enter the share under no tension with a small slack loop above the share. At the start of each cable reel placement sufficient cable slack shall be carefully pulled through the plow share to account for sufficient extra cable at the splice locations to satisfy splicing length requirements, maintenance requirements, and spare length to compensate for any splicing problems.

A starting pit for the plow must be dug in alignment with the cable alignment. It provides a starting point for the plowing operation for each cable. The plow share must start at full burial depth for the cable. A starting pit approximately 6-inches deeper than the cable depth and about 8 feet long should be provided at the starting portion of each cable length. The plow will start the plowing operation from inside the starting pit.

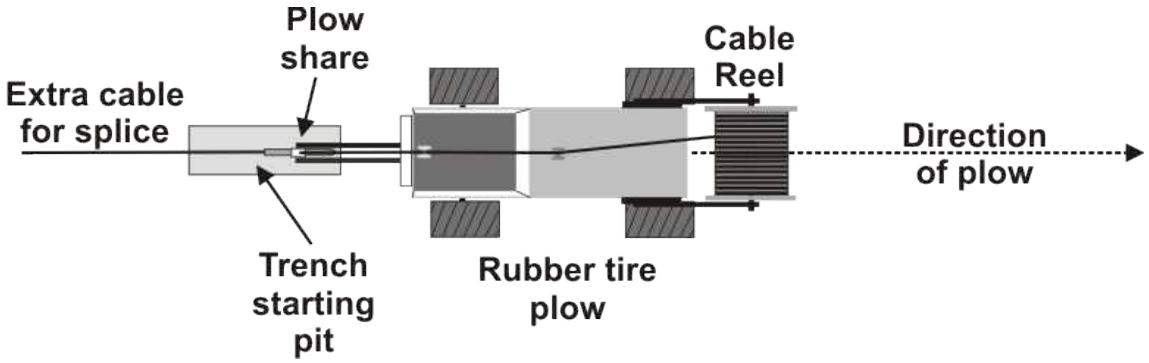

Figure 3– Plow Starting Pit

If a crossing obstacle is encountered, it should be hand excavated and the cable laid over the top of the obstacle or hand fed under the obstacle. If the cable needs to be hand fed under the obstacle, the obstacle should be near the start or end of the cable reel. If the obstacle is early in the cable length, it shall be hand fed before plowing is started; if it occurs later in the cable length, it shall be hand fed after plowing is completed.

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Application Note

Cable plowing should be started slowly and if things continue to work properly, the process can be increased in speed. **It is imperative that the plowing operation be kept at a nearly constant depth. If the plow share rotates sharply up or down from changes in plow depth or surface gullies, it will crush the cable and fibers will be damaged.**

In some cases, a very narrow slot can be cut into a roadway with a rock saw. The cable can be laid into this slotted trench after the trench is prepared with a bed of select granular soil. The remainder of the slot should be filled with the same select granular soil.

Often surface obstacles are breached using directional drilling or tunneling. A starting pit needs to be prepared for the drilling or tunneling operation. The plow placing the buried cable should be brought to the starting pit. The buried plant is then hand fed through the tunnel casing. Normally, it is advisable to locate a splice point on the far side of such a crossing.

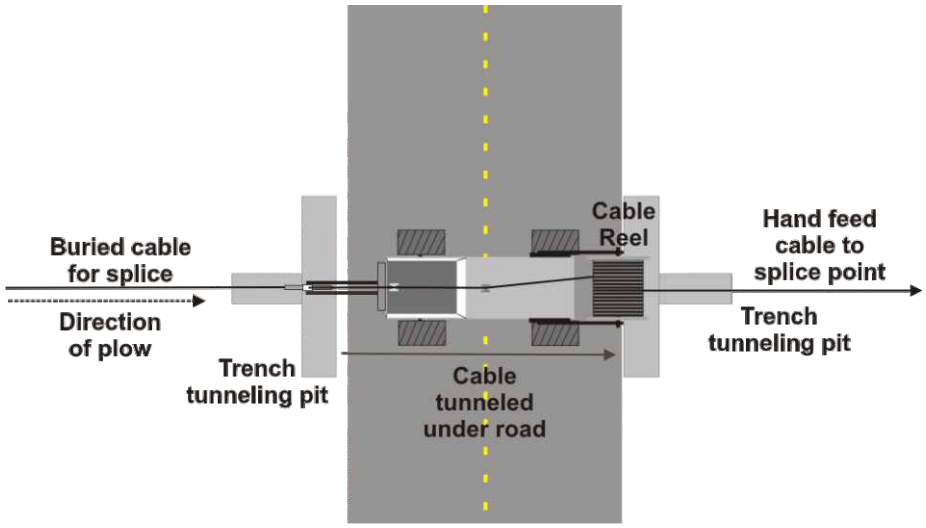

Figure 4– Plowed Road Crossing

9. Manhole or Handhole Housekeeping

9.1 Cable Coiling

Spare cable from the cable placing operation should be stored in splice manholes or hand holes in a neat coil wrapped with a radius greater than the minimum bend radius of the cable. Forms for the cable coiling operation can be commercially purchased.

Cable coils should be stored in a safe location, away from the normal work operations. The cable coils should be cable tied in place.

9.2 Racking Cable and Innerduct

The cable must be properly terminated in a splice closure. The proper clamping of the central strength member is necessary to provide a positive stop to prevent central strength member (CSM) pistoning. In addition, the jacket must be properly secured to prevent jacket retraction or cable slippage.

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Application Note

If possible, when racking cables in intermediate hand holes, the innerduct should be continuous through the handhole. The innerduct will provide the cable with an extra layer of protection during future work activities. Form the innerduct and enclosed cable to the sides of the handhole, being careful to maintain the cable's minimum bend radius. Once the cable and innerduct are formed along the handhole walls in a safe location, secure them to the handhole using plastic cable ties. Pulling slack innerduct from adjacent handholes is not recommended.

Expressing micro-duct cable buffer tubes through a splice closures is not recommended. The buffer tubes shall be opened in the splice closure and the express fibers shall be stored in the closure's splice trays or routed in furcation tubing through the closure. If the buffer tubes are expressed through the splice closure, an increase in attenuation may occur at colder temperatures.

Additional Information

If there are additional questions on this topic or other fiber optic issues, please contact Sterlite Technologies at:

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