

Installation of Corning Cable Systems Self-supporting (Figure-8) Aerial Cable

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1. General

1.1 Corning Cable Systems self-supporting (Figure-8) optical fiber cable greatly simplifies the task of placing fiber optic cable on an aerial plant. It incorporates both a steel messenger and the core of a standard optical fiber cable into a single jacket of “Figure-8” cross-section (Figure 1). The combination of strand and optical fiber into a single cable allows rapid one-step installation and results in a more durable aerial plant.

1.2 This procedure provides general guidance for the installation of self-supporting cable. It is not intended to be a comprehensive summary of the steps and procedures required for successful placement, as each installation will be influenced by local conditions. It is assumed that the reader is experienced in aerial cable placement.

1.3 This procedure contains references to specific brand-name tools in order to illustrate a particular method. Such references are not intended as product endorsements – other manufacturer’s equivalent tools can be used.

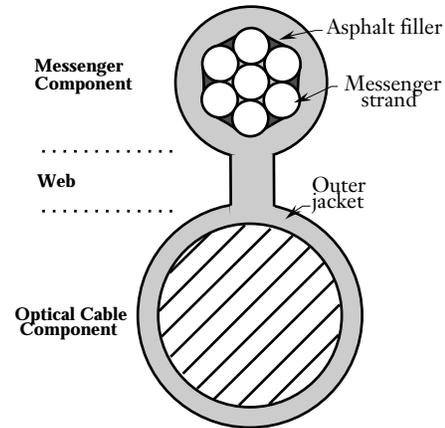


Figure 1

Definitions

1.4 Because of the nature of self-supporting cables, this practice employs terms in ways with which the reader may be unfamiliar. These are defined below:

CABLE refers to the entire Figure-8 product including the messenger and cable components.

MESSENGER COMPONENT and **CABLE COMPONENT** describe the two halves of the Figure-8 cable.

DEAD-END POLE is a utility pole on which the messenger component is tensioned and terminated into a dead-end fixture.

MESSENGER SPAN refers to the length of continuous messenger component tensioned between two dead-end poles.

INTERMEDIATE POLES are those between dead-end poles where the cable is supported in tangent clamps.

1.5 This issue deletes obsolescent information.

2. Safety Precautions

2.1 This section discusses some basic safety considerations applicable to aerial cable installations. This section is not intended to provide a comprehensive guide to safety pre-cautions and not all items mentioned will apply to every installation. In all cases, your company’s procedures and precautions should take precedence over the recommendations in this document.



CAUTION: Before starting any aerial cable installation, all personnel must be thoroughly familiarized with all applicable Occupational Safety and Health Administration (OSHA) regulations, the National Electrical Safety Code (NESC), state and local regulations, and your company safety practices and policies. Failure to do so can result in life-threatening injury to employees or the general public.



WARNING: To reduce the chance of accidental injury:

- Before work begins, all personnel must be thoroughly familiar with the operation of all equipment and procedures to be used during the installation.
- Before use, all equipment, especially safety gear, must be inspected and tested for proper operation. Replace or repair as necessary.
- Arrange or secure any loose articles to be taken aloft so that they cannot fall.
- Personnel going aloft must wear a safety harness or body belt and safety strap at all times. Additional safety gear, including insulated or lineman’s gloves, eye protection, hard hats, and other protective clothing should be worn as necessary.
- Before climbing a pole, it should be inspected for significant deterioration, insect nests, and other potential safety hazards. If work near power lines is required, appropriate caution should be exercised.
- Read the entire procedure before starting a Figure-8 cable installation. Thoroughly understand the procedure, its precautions, and the tools and equipment required before starting work.

2.2 Laser Handling Precautions



WARNING: The laser light used to transmit information over optical fiber cables can cause severe eye damage. Because this light is invisible, it will not cause the iris to involuntarily contract as it does when viewing a bright visible light, and no pain is felt as the retina is burned. NEVER LOOK INTO THE END OF A FIBER WHICH MAY HAVE A LASER COUPLED TO IT.

SHOULD ACCIDENTAL EYE EXPOSURE TO LASER LIGHT BE SUSPECTED, ARRANGE FOR AN EYE EXAMINATION IMMEDIATELY.

3. Cable Handling Precautions



CAUTION: Like any fiber optic cable, Figure-8 cable is sensitive to damage during handling and installation. Such damage can degrade the cable’s performance to the extent that replacement is necessary. In order to avoid damaging the cable, the following precautions should be observed during handling and installation.

Maximum Pulling Tension

3.1 The maximum tension at which Figure-8 cable can be pulled depends on whether the force is applied to the messenger or cable component. Both of these figures are listed on each cable’s specification sheet .

MAXIMUM PULLING TENSION (MESSENGER): Because of its unique construction, Figure 8 cable can be pulled by its messenger component at much higher tensions than typical fiber optic cables. For standard Figure-8 cable, this figure is 9000 N (2,000 lbs).

MAXIMUM PULLING TENSION (CABLE): When pulling force is applied to the cable component (as in the case of duct installations as described in Section 10), Figure-8 cable has a lower maximum pulling tension than standard cables. For standard Figure-8 cable, this figure is 2025 N (450 lbs).

Exceeding the maximum tension when pulling by either component risks severe damage to the cable. Methods of attaching the pull line to either component are discussed in Section 6. If the cable is to be pulled mechanically, use of a tension-limiting device or a break-away swivel in the pull line is recommended. Avoid surges and jerks during pulling by using properly adjusted reel brakes.

Maximum Installation Tension (Span Tensioning)

3.2 The maximum tension at which Figure-8 cable can be installed for a given span length may be determined from your company’s standard engineering practices for self-supporting copper cable taking into account the appropriate size strand and cable weight or from Corning Cable Systems’ Application Note G-CI-009. Please contact Corning Cable Systems Engineering Services at 1-828-327-5000 for sag and tensioning requirements for special applications.

Minimum Bend Radius

3.3 Excessively sharp bends can damage fibers within fiber optic cable and render the cable useless. The minimum bend radii for both tensioned and no-tension conditions are stated on the cable specification sheet. These values can also be determined using Table 1.

Table 1

Minimum Bend Radius					
Cable Component Diameter		Minimum Bend Radius (No Tension)		Minimum Bend Radius (Under Tension)	
Millimeters	Inches	Centimeters	Inches	Centimeters	Inches
6.0 -10.0	1/4 - 3/8	10.0	4	15.0	6
10.0 - 15.0	3/8 - 9/16	15.0	6	22.5	9
15.0 - 20.0	9/16 - 13/16	20.0	8	30.0	12
20.0 - 23.0	13/16 - 7/8	23.0	9	34.5	13 1/2
23.0 - 25.0	7/8 - 1	25.0	10	37.5	15

Notes: Use of the above figures may result in cosmetic wrinkling of the cable jacket. Although this wrinkling will not affect performance, it can be eliminated by using a bend radius 20 times the cable component diameter. The minimum bend radius of any Figure-8 cable with a cable component diameter of less than 25 mm (1 in) can be maintained with a 50 cm (20 in) diameter wheel.

During all phases of installation it is crucial that the minimum bend radius not be violated. Carefully select equipment and procedures which will maintain this radius throughout the cable route.

Rated Crush Strength

3.4 The rated crush strength for each type of Figure-8 cable is stated on its respective cable specification sheet. For standard armored and non-armored Figure-8 cables, the maximum rated crush strength is 220 N/cm.

Uncontrolled Twisting

3.5 Uncontrolled twisting can damage any fiber optic cable. To prevent such damage during a pull, place a pulling swivel between the pulling line and the pulling grip (see step 6.7). Whenever a cable is dereeled for subsequent pulling, "figure-eight" the cable as outlined in steps 5.2 - 5.5.

Equipment Inspection

3.6 All equipment to be used during handling and installation should be inspected for features which might damage the cable. Examples of dangerous features are nails, broken flanges on cable reels, and damaged blocks.

Cable Care And Inspection

3.7 Leave cable reel lagging, the protective boards nailed between the flanges of the reel, intact until the reel arrives at the installation site. Upon removal of the lagging, inspect the cable jacket for signs of damage. If the lagging has been previously removed, secure the cable end(s) during transit to prevent damage. Cable reels should be stored vertically on their flanges and chocked to prevent rolling.

3.8 Determine if your company requires that the cable be tested for optical continuity prior to installation. These tests can be done with an OTDR or attenuation test set.

3.9 Do *not*, under any circumstances, make unplanned cuts in the cable. Unplanned cuts mean additional splices, which are costly in monetary and attenuation terms. Any departure from the planned installation should be approved by the construction supervisor.

4. Planning and Preparation

4.1 Prior to beginning an aerial cable installation, careful planning and preparation are necessary. Representatives of each organization potentially affected by the installation (utilities, street department, police, etc.) should be present during the route survey. Approval by all necessary parties should be secured before detailed planning begins. A few of the issues to be considered are listed in the following paragraphs. Planning should be undertaken jointly by construction and engineering personnel. Hardware requirements should also be considered at the planning stage.

Route Selection And Planning

4.2 Installation costs will be minimized by using existing poles whenever possible. The ability of existing poles to accept new Figure-8 cable and the need for modification should be determined using your company's normal criteria for installing an

additional cable with a dedicated messenger. Ideally, the guying of the cable plant should remove all lateral stress, leaving the poles to support only the weight of the cable and associated hardware. Sufficient clearance for new cable along the right of way should be confirmed during the route survey.

Cable Placement

4.3 Several factors should be considered when deciding where on a pole to place Figure-8 cable. Like other fiber optic cables, Figure-8 cable weighs less than equivalent copper cables and will tend to sag less over a given aerial span. Because of this, it should occupy the uppermost available communications space on a pole in order to maintain adequate clearance.

4.4 On joint-use poles, care must be taken to ensure sufficient clearances between Figure-8 cable and electrical power and other cables. The necessary clearance should be determined on a case-by-case basis by referring to the current National Electrical Safety Code (NESC), appropriate local codes and your company's standards.



WARNING: *Notwithstanding the fact that NESC spacing is observed, there is still a danger of flashover (arcing) from a power line to the metallic messenger which may cause electrocution to installers of the cable. A safety meeting should be held between all involved parties to discuss a plan of action concerning the proper clearances required to ensure a safe outside plant installation.*

Installation Planning

4.5 Planning the actual installation should take place only after a thorough route survey. The installation method to be used will be largely dictated by the cable route. Both the *moving reel (drive-off)* and *stationary reel* methods of aerial cable installation are outlined in this procedure, as well as conditions requiring use of one, the other, or both. Duct and direct burial placement are also discussed. With the proper hardware, any of these methods can be used to install Figure-8 cable.

4.6 Examine the ability of existing dead-end poles to withstand the temporary stresses of installation. Because it is impossible to tension each of the messenger spans along the route simultaneously, a dead-end pole will be subjected to an unbalanced load as the messenger is tensioned on one end of the cable run before the other. This temporary unbalanced loading can be relieved by temporary guy wires where required. Determine whether temporary guying is needed according to your company's standard route engineering guidelines.

Splice Locations And Cable Slack Requirements

4.7 Select splice locations during the route survey and make plans for slack and splice closure storage. Splice locations should be placed to allow for the longest possible continuous cable spans and a minimum number of splices. The splice points should be chosen to facilitate the later splicing operation and should be easily and conveniently accessible to a splicing vehicle.

4.8 The amount of slack cable component at each splice point

must be sufficient to reach from the pole's height to the planned splicing vehicle location on the ground. An additional 5 meters (16 ft) should be added onto this figure to allow for closure requirements (Figure 2). This slack should be allowed for when planning the route and ordering cable. Leave sufficient slack at each future drop point to allow for splicing.

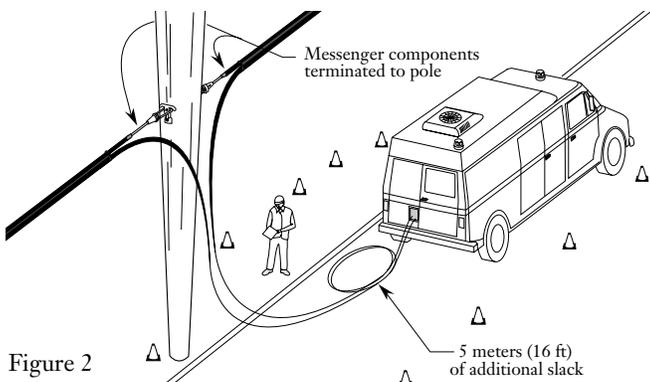


Figure 2

4.9 Because of its configuration, Figure-8 cable is not well suited to the use of "repair" slack. Movement of slack along the pole line is discussed in Section 9, which describes how to make emergency restorations of damaged Figure-8 cable.

5. Figure-8 Cable Aerial Plant

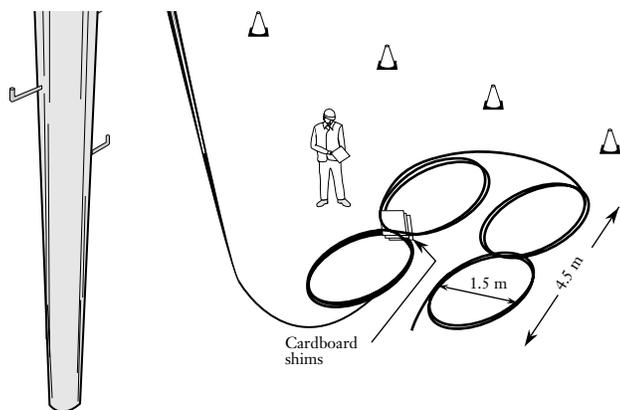
5.1 This section provides a general overview of the elements of an integrated messenger aerial plant installation:

- Figure-eighting cable
- Separating Figure-8 cable components
- Dead-ends
- Grounding requirements
- Support hardware types and installation
- Cable twist
- Slack storage
- Splice closures
- Slack spans

Figure-Eighting Cable

5.2 Whenever cable is unreeled for subsequent pulling, it should be coiled in a "figure-eight" configuration as in Figure 3. This procedure will prevent damage due to twisting of the cable. The figure-eight coil should measure at least 4.5 m (15 ft) by 1.5 m (5 ft) and be protected from passersby.

Figure 3



5.3 When long lengths of cable need to be unreeled, there is a

danger that the weight of the figure-eight coil may damage the cable on the bottom. This can be prevented by adding support shims at the crossover to spread the weight out (cardboard works well) or by spreading the cable out into several figure-eight coils as shown in Figure 3.

5.4 In order to pull from a figure-eight coil, it is sometimes necessary to turn it over to expose the cable end. This task usually requires at least three persons, one at the center and one at each end.

5.5 Figure-eighting can be used in order to pull in both directions from a central location or to make a transition from the moving reel (drive-off) installation method to the stationary reel installation method. This makes it possible to use the relatively quick and uncomplicated moving-reel technique on that portion of a cable route accessible by vehicles and the more involved stationary reel method where vehicle access to the pole line is not possible.

Separating Figure-8 Cable Components

5.6 Figure-8 cable components must be separated for splicing and termination operations. While short lengths of Figure-8 cable components may be separated by scoring the web with a cable knife and pulling the two components apart, this task is made easier and safer for both the cable and personnel by using a web-splitting tool (General Machine Products® model # 8273C Web Splitter, or equivalent).

5.7 To use the tool, place the pliers-based device over the messenger component with the blade penetrating the cable web. Pull it along the cable to cut the web (Figure 4). Long lengths (e.g., 150 m [500 ft] or more) of cable can be separated easily with this tool.

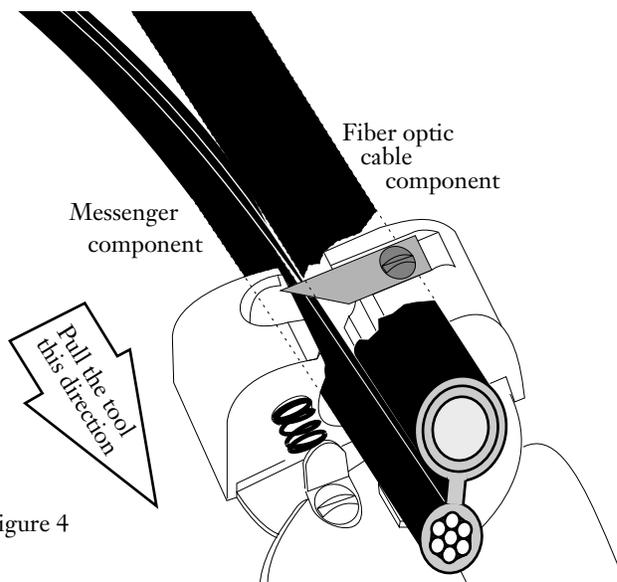


Figure 4

Dead-ends

5.8 Dead-end poles are the anchor points for a tensioned messenger span. The messenger strand is terminated into dead-end fittings which engage pole fixtures and maintain the tensile loading of the span. This procedure describes two basic types of dead-end fittings, strandvises and strand grips (wrap type).

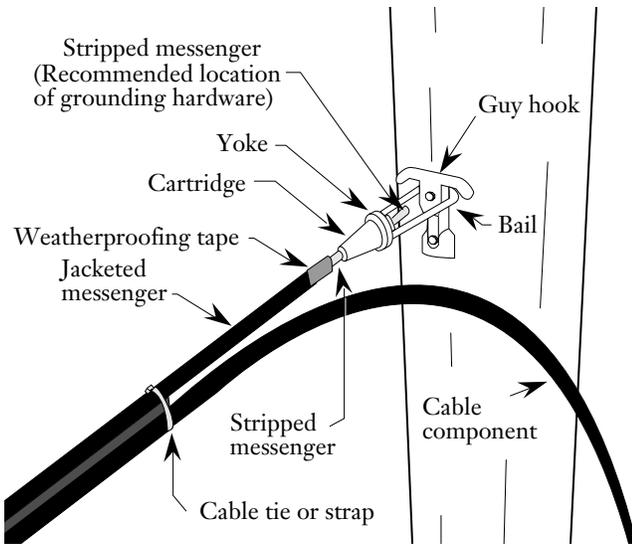
Strandvisé Dead-end

5.9 The strandwise type dead-end (Figure 5) uses a spring-type compression sleeve to grip the bare messenger strand. This sleeve cartridge attaches to the yoke and bail to produce a fitting which can be hung on guy hooks.

Figure 5

Notes: A key arrangement in the side of the cartridge sleeve allows removal of the messenger from the strandwise. The bail and yoke can be reused, but the used cartridge should be discarded.

If applicable, ensure that your company's policy concerning dead-end and pole line hardware in corrosive environments such as coastal areas are followed.



5.10 Prepare the dead-end pole by installing the guy hook. To install a strandwise dead-end on a Figure-8 cable:

- Determine and mark the point where the strandwise will be mounted on the Figure-8 cable's messenger component:
 - If you are installing the dead-end at the end of a cable span or providing slack for a future splice point (e.g., prior to beginning a moving reel installation) allow for the appropriate slack requirements.
 - If the dead-end is being assembled on a tensioned cable at its installation level, ensure that the span is properly tensioned according to Section 8. Provide support to the cable extending beyond the dead end location to prevent damage from bending and or tensioning to the cable component once the messenger is cut.
- Separate the two cable components with a web splitter or cable knife, starting about 27.5 cm (11 in) before the point where the messenger will enter the strandwise. The component separation lengths may vary with the strandwise type and are best determined by holding the strandwise you are using alongside the cable.
- Determine the messenger component strip length required to fit both the messenger component into the strandwise and provide sufficient length for a bonding / grounding clamp to bond/ ground the exposed end(s) of the strand. At least 7.5 cm (3-in) of stripped messenger should extend out of the strandwise. Cut the messenger strand to length with a pair of bolt cutters.

- Strip the jacket from the messenger component by running a cable knife along the strand, removing a strip of the jacket. Pull the remaining jacket away from the strand. Use care during this step to minimize damage to the anti-corrosive zinc coating of the strand.
- Slide the stripped strand into the assembled strandwise cartridge and assemble per its manufacturer's instructions.
- Apply weather-resistant cable ties (Thomas & Betts TYZ series TY-RAPS or equivalent) or a cable strap outboard of the separation between components to prevent the split from propagating down the web.
- Apply weather proofing tape (Scotch® 2228 rubber mastic or equivalent) around the strand at the point where the jacket is stripped off of the messenger in order to seal the jacket.

Strand Grip (Wrap-type) Dead-end

5.11 The strand grip consists of spirally formed high strength steel wires which are applied to the bare messenger strand in two wraps (Figure 6). The portion of the wires between the two legs form an eye when installed. This type of dead-end can be used to terminate a messenger strand onto guy hook. Follow the strand grip manufacturer's instructions during its application to the Figure-8 cable. Step 5.12 details how to prepare the cable for this device.

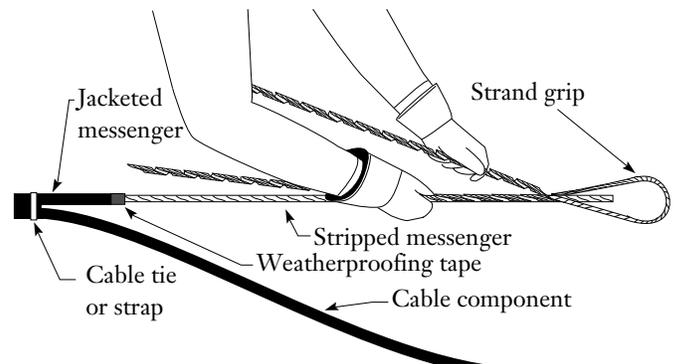


Figure 6

5.12 Prepare the dead-end pole and Figure-8 cable as described in 5.10 a) - b). After these steps are complete:

- Determine the cable splitting and stripping lengths by holding the grip up alongside the cable. Mark the points where the messenger should be stripped and the components separated in order to place the eye at the pole fixture (refer to 5.10 c).
- Strip the jacket as described in step 5.10 d).
- Assemble the strand grip on the stripped section of strand according to its manufacturer's instructions.
- Apply weather resistant cable ties (or a cable strap) and tape as described in steps 5.10 f) and g).

Note: Strand grips are fairly easy to remove, but should not be reused.

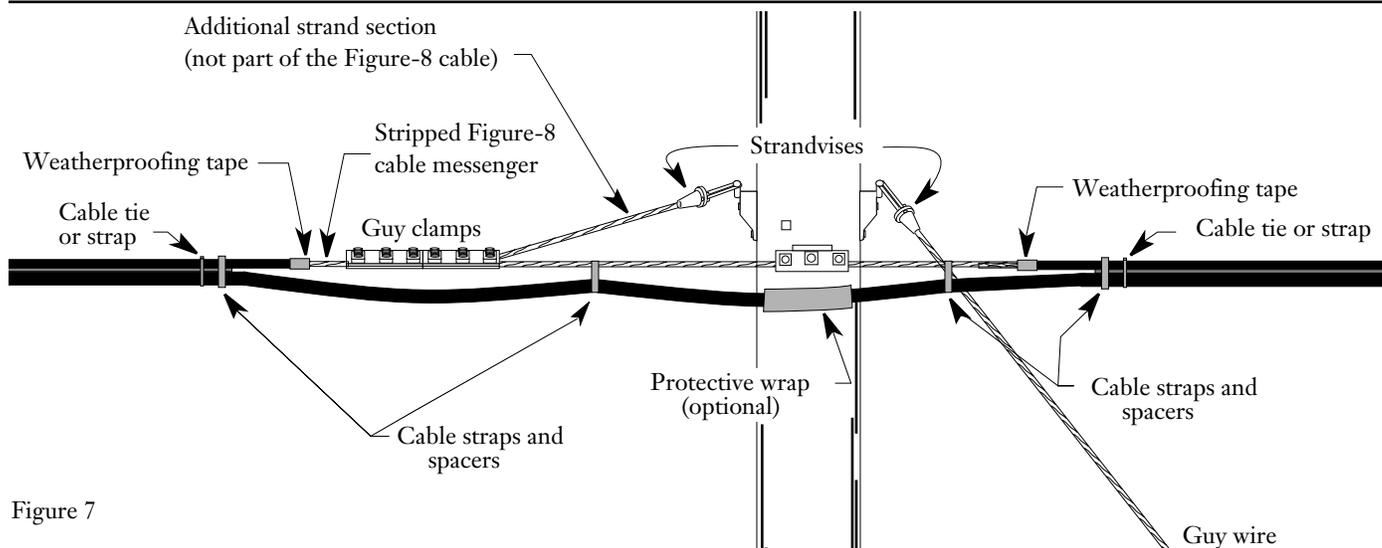


Figure 7

False Dead-ends

5.13 False dead-ends are frequently used to eliminate unbalanced loading of poles, either intermediate or dead-end. Different types of false dead-ends utilize various combinations of strandvises, strand grips and guy clamps to apply tension to the messenger without terminating it.

Note: The possible configurations of false dead-ends are too numerous to detail in this procedure, but all utilize hardware and installation techniques similar to those discussed in this procedure. One possible arrangement is depicted in Figure 7. By using elements of the methods already discussed, each can be adapted for use with integrated messenger cable. Follow your company's standard false dead-ending procedures for steel messengers.

Grounding Requirements

5.14 As with any cable containing conductive elements, Figure-8 cable must be electrically grounded. Grounding dissipates and limits voltage accumulation by the cable, thus reducing the danger of electrical shock and outside plant damage. Grounding interval requirements vary widely, especially on joint use pole lines, and the standard route engineering procedures of your company or the concerned utility must be followed. Procedures for grounding each of the cable's conductive elements are discussed below.

Messenger Component

5.15 Electrical continuity of the strand must be established by bonding messenger spans together at dead-end poles. This may be done in two ways:

- Leave sufficient strand past the dead-end fitting so that the two strands can be placed in a bonding clamp (Reliable 438 ACL or equivalent) (Figure 8).
- Jumper between the two strands with No. 6 AWG wire bonded to each strand by one of the above clamps.

Electrical continuity between parallel strands should also be established at each dead-end pole using the latter method.

5.16 Actual grounding of the messenger is usually done at dead-end poles by jumpering between the stripped messenger strand and a grounded guy wire at a dead-end pole.

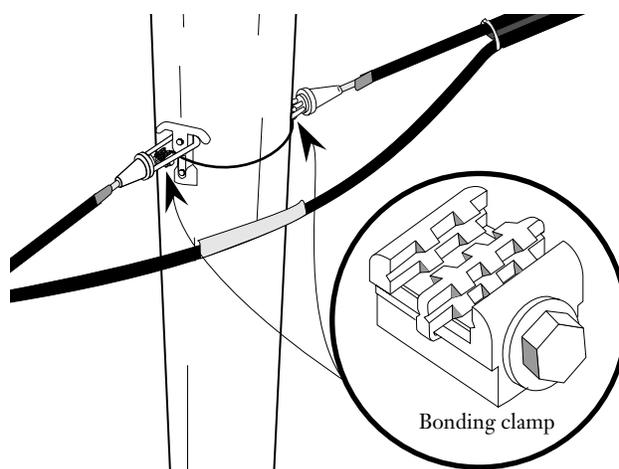


Figure 8

5.17 Where grounding of the messenger strand at an intermediate pole is required, electrical contact with the messenger is made with a C or D type connector on the jacketed strand and a No. 6 AWG ground wire. This connector has teeth which penetrate the jacket and contact the strand when compressed. Again, grounding interval requirements vary widely, especially on joint use pole lines, and the standard route engineering procedures of your company or the concerned utility must be followed.

Cable component

5.18 Corning Cable Systems recommends that metallic central members and armor sheath (if present) be grounded at each splice point. Most splice closures provide an internal means for bonding the central members and the steel tape to a ground lug which can be attached to a ground wire outside the splice closure. Use the specific instructions provided by the closure manufacturer. Follow your company's recommended procedures if shorter grounding intervals are required.

5.19 If electrical continuity is not established between the cable component's metallic central member, armor, and the messenger strand, there is a possibility of an electrical potential existing between them. At a minimum, these components should be electrically connected at each splice point. Follow your company's recommended procedures if shorter bonding intervals are required.

Support Hardware Types and Installation

5.20 The type of cable support hardware installed at each pole in a Figure-8 cable aerial plant is determined by several factors. The primary factor in hardware selection is the amount of "pull," if any, present at a pole. This figure, measured in feet, (meters) can be found by using a pull finder or by calculating the distance as outlined in step 5.21.

Determining "Pull"

5.21 "Pull" at a pole can be determined by the following method (Figure 9 a):

- 1) Measure 100 feet (30.48 m) away from the pole *along* both intended cable span directions. Mark these distances by stakes or other means.
- 2) Measure the distance between the two 100-foot (30.48 m) marks.
- 3) Mark the mid point of the distance found in 2). *The distance from this midpoint to the pole is the "pull" present at the pole.*

Figures 9 b and c illustrate methods which can be used when physical barriers prohibit the use of the above method. The calculated "pull" value will be the same with all three methods.

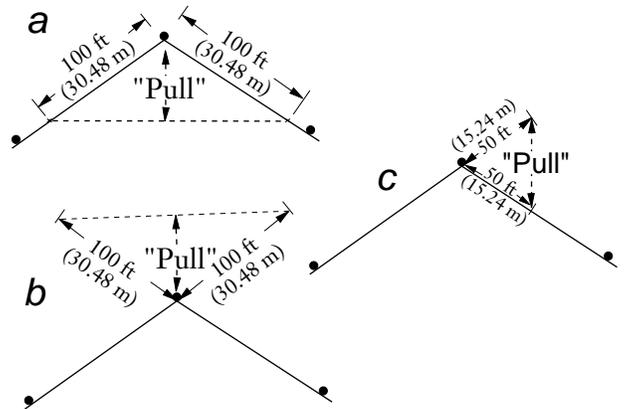


Figure 9 Pull determination

5.22 Acute angles resulting from "tight" turns in the cable route can present "pull" figures which can require dead-ending of the strand component of Figure-8 cable. Figure 10 illustrates intersection angles which produce the maximum rated "pull," for the three tangent clamps discussed in this section: *C-cable clamps, straight suspension clamps, and corner clamps.*

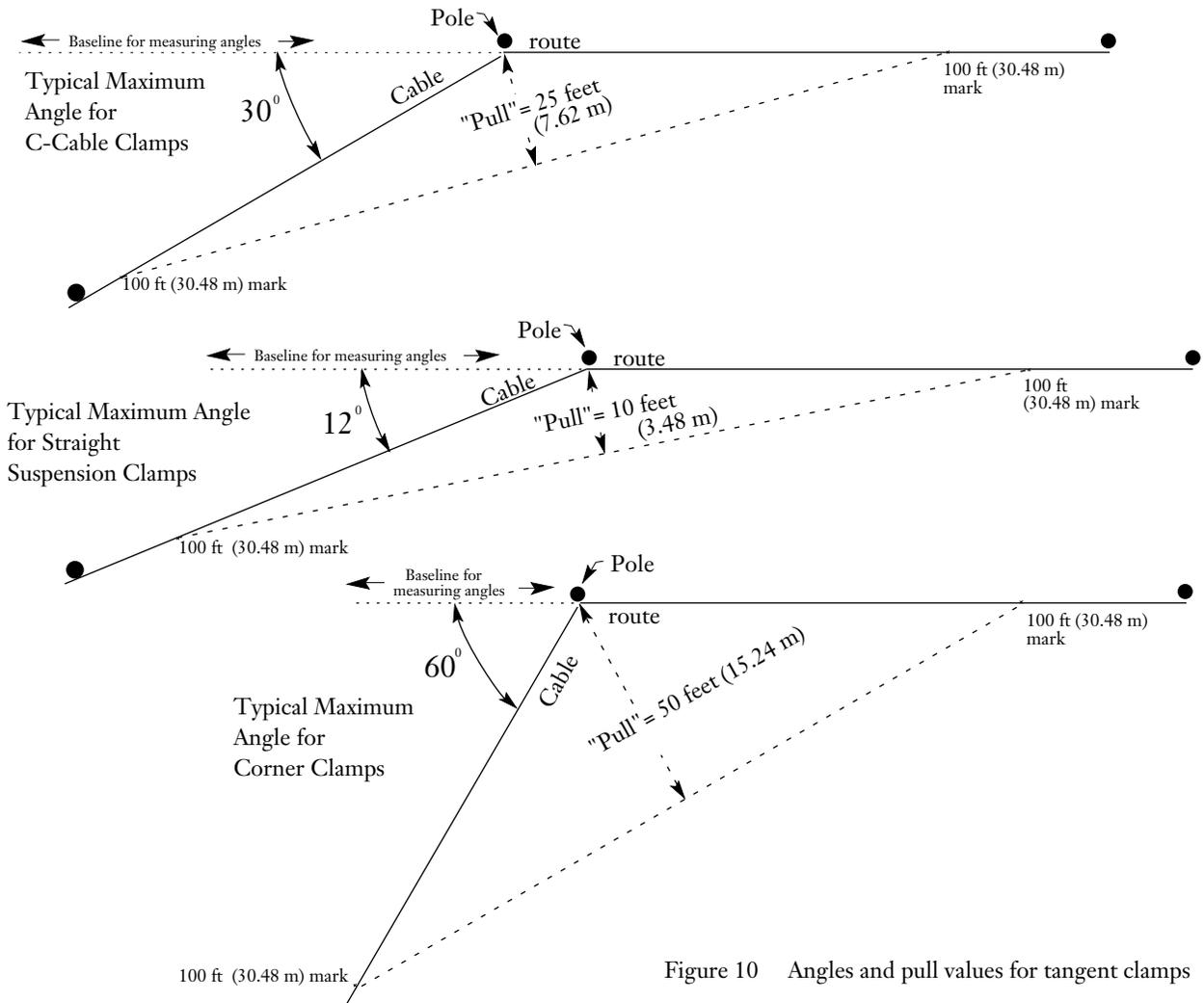


Figure 10 Angles and pull values for tangent clamps

Tangent clamps

5.23 Tangent clamps are used to support the cable's weight at intermediate poles where no significant tension is applied. They are typically of a 3-bolt configuration with the central bolt mounting the fixture to the pole and the outer two bolts used to compress the clamp onto the messenger component. Tangent clamps are widely available from cable hardware suppliers. **Check the manufacturer's "pull" tolerances and strand size accommodation before selecting a particular clamp.**

C-CABLE CLAMP

5.24 The C-cable clamp (Stanley Flagg® part # PA 422 or equivalent) is specially designed to support Figure-8 configuration cable and is the clamp best suited for use with Corning Cable Systems Figure-8 cable. It can be used on intermediate poles with a "pull" of up to 25 feet (7.62 m). Unlike other tangent clamps, the C-cable clamp features a serpentine clamp jaw which accommodates a Figure-8 configuration cable without requiring separation of the two components (Figure 11).

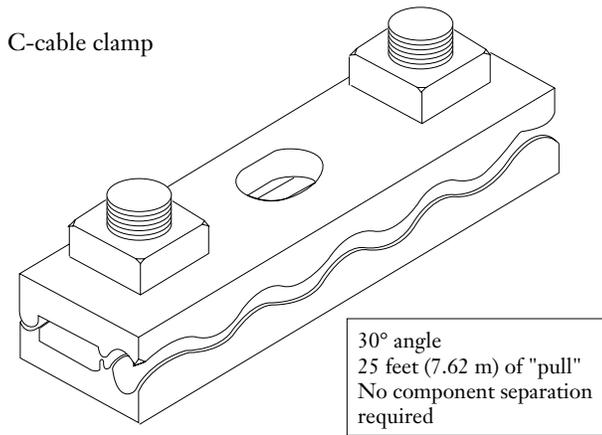


Figure 11

STRAIGHT SUSPENSION CLAMP

5.25 The straight suspension type tangent clamp (Figure 12) has several limitations when used with Figure-8 cable:

- a) The straight clamp can only be used on intermediate poles with a "pull" of 10 feet (3.05 m) or less. Refer to the respective manufacturer's specifications for actual "maximum "pull" values.

Straight suspension

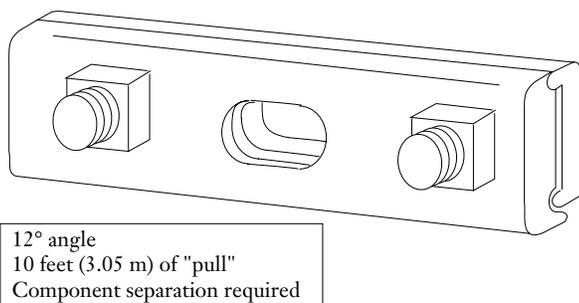


Figure 12

- b) The straight clamp jaw of this design will *not* accommodate Figure-8 configuration cable unless the two components are separated and installed with the cable component passing below the clamp (Figure 13). To use a straight suspension clamp with Figure-8 cable:

- 1) Separate the two cable components for approximately 60 cm (24 in).
- 2) Maintain component separation by standard cable spacer straps placed about 12.5 cm (5 in) inboard of the separations. These dimensions are approximate and should be adjusted to accommodate specific hardware.
- 3) Place weather resistant cable ties (Thomas & Betts® TYZ series TY-RAPS® or equivalent) or cable straps around the cable just outboard of the separated section to prevent the split from propagating down the web (Figure 13).

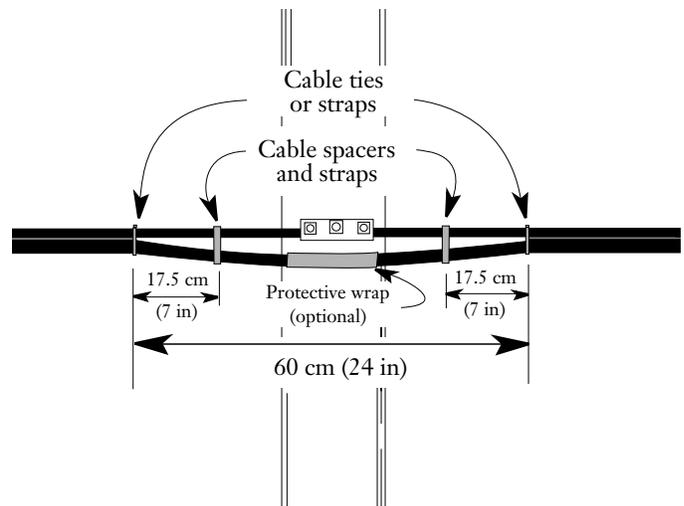


Figure 13

CORNER SUSPENSION CLAMP

5.26 The corner suspension clamp differs from the straight suspension clamp only in that the ends of the clamp jaw are beveled, allowing its use on intermediate poles with a pull of up to 50 feet (15.25 m) (Figure 14). Cable component separation and installation procedures are identical to those outlined for the straight suspension clamp in step 5.25.

Corner suspension clamp

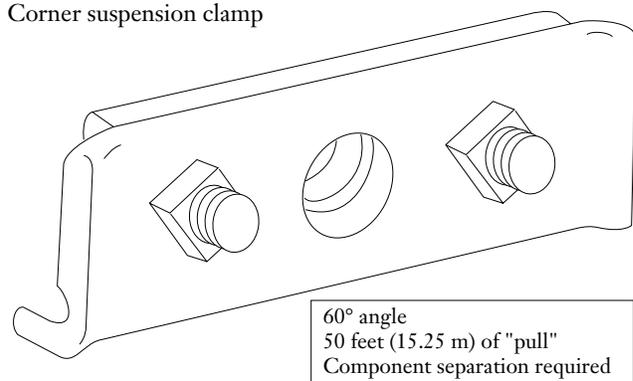


Figure 14

Cable Twist

5.27 Because Figure-8 cable has a non-symmetrical cross-section it can exhibit airfoil characteristics during certain wind loading and icing situations. To prevent this potentially damaging situation, twist should be applied to the cable between poles. Corning Cable Systems recommends twisting the cable so that it makes one 360° revolution every 6-9 meters (20 - 30 ft).

Note: No twist is required for SSW type Figure -8 cable.

5.28 Apply the twist to the cable as it is moved from its temporary support hardware into the permanent fittings after tensioning and dead-ending. For pole lines of equal spacing, the twist can be applied in alternating directions at every other pole. In this way, two pole spans are twisted simultaneously. Where pole spans vary, the twist may need to be applied at each pole to maintain the same pitch.

Slack Storage

5.29 Slack cable can be distributed throughout the cable route (see steps 4.7 - 4.8). At locations like splice points and future drop points, the messenger component serves no purpose. The cable will be smaller, lighter and easier to handle if the messenger is removed. Slack cable being left for a future drop point can be coiled at the top of the pole (Figure 15, top), lashed to adjacent span, or placed in an enclosure at the top or base of the pole.

Slack cable with the messenger strand removed can easily be run down the pole to a splice point under a U-guard (Figure 15, lower).

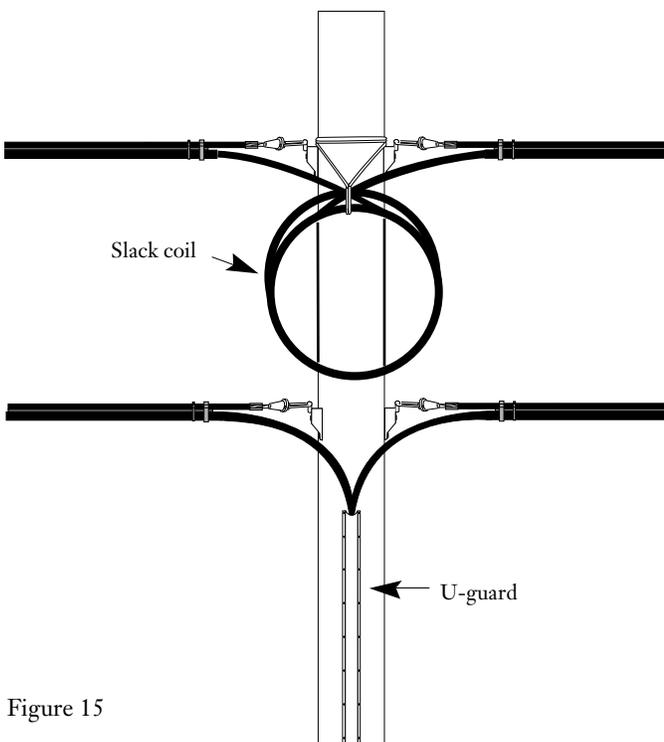


Figure 15

Splice Closures

5.30 Splice closures should be mounted according to their manufacturer's suggestions but, in general, can be placed on the pole, lashed to the span (Figure 16), placed in a pedestal, or buried.

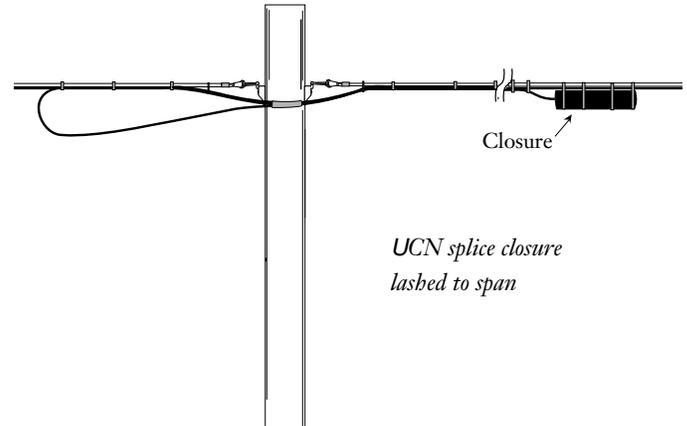


Figure 16

5.31 Entry of Figure-8 cable into splice closures is no different from that of any other cable once the messenger component is removed. At the point where the closure seals around the cable component, make the cable component as round as possible by removing the remaining web and trimming the jacket with a standard cable knife.

Slack Spans

5.32 Slack spans are generally placed at the ends of a cable route. The installation of Figure-8 cable in a slack span differs from a standard installation only in the reduced tension at which the cable is placed. The primary difficulty introduced by the slack span is in relieving the unbalanced load placed on the intermediate poles where this transition in tension takes place. Typically this is done with a dead-end (steps 5.8 - 5.12) and guy wire installed at this pole.

6. Stationary Reel Installation Method

6.1 In the stationary reel method of aerial cable installation, the cable is pulled along the cable route through temporary support hardware installed for this purpose (see Figure 17). When the cable is in place between splice points, the messenger component is tensioned and terminated at each dead-end pole along the route. The cable spans are then lifted out of the temporary support hardware, twisted and placed in tangent clamps at each intermediate pole. Multiple cables can be installed simultaneously by using multiple-cable hardware during the pull.

6.2 The stationary reel method is generally slower and more costly than the moving reel method, but can be used anywhere since it doesn't require an unobstructed right of way or vehicular access to the pole line. Higher costs are imposed by the difficulty of coordinating the pulling operation over the length of the route.

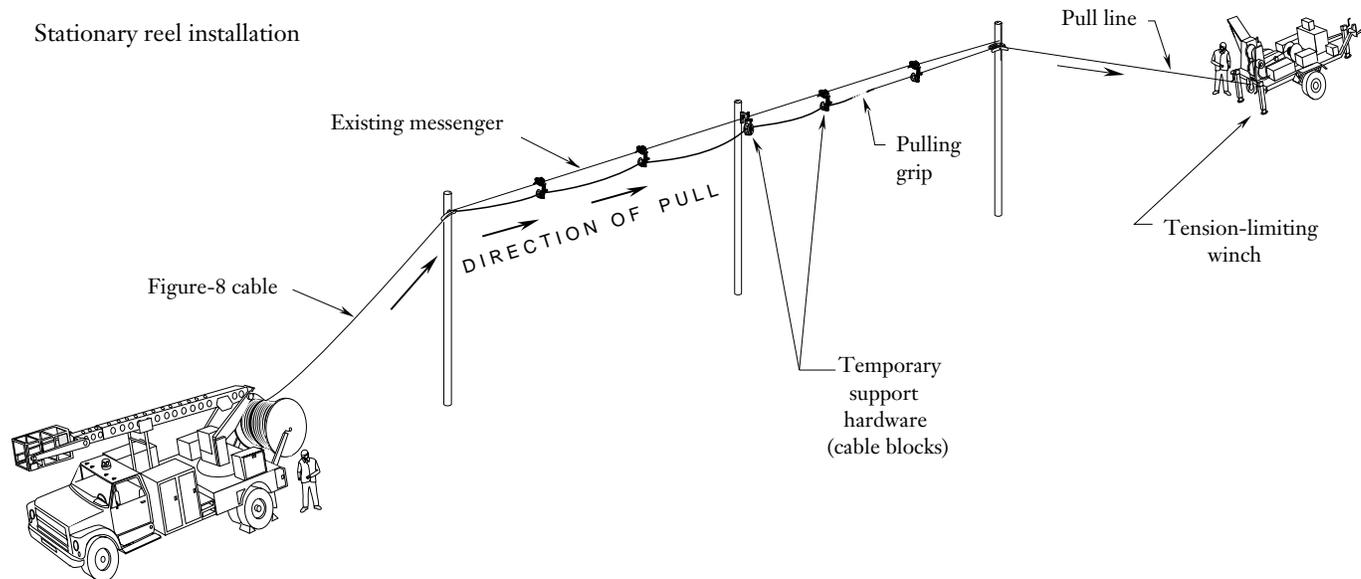


Figure 17

Determine the cable reel and pull locations, each of which can be at any point along the route. The location of the cable reel and any subsequent intermediate pull points must be determined during the route survey. Some of the factors to consider are:

- a) Where significant elevation change occurs along the route, it is usually best to pull downhill.
- b) The cable reel location should be accessible by the reel carrying truck, but as removed from passers-by as possible.
- c) By using the figure-eight coiling procedure, cable from one reel can be pulled in both directions from a central point. The route can be subdivided into shorter pulls to:
 - keep the pulling tension below the cable’s rated strength
 - avoid pulling across sharp turns
 - provide cable slack at designated points to allow for future drops.
 - compensate for insufficient hardware or personnel to cover the entire route.

- d) Installation time will be minimized if reels can be set up for continuous pulls in both directions from a splice point.
- e) To prevent damage to the cable during payout: keep the cable reel level to avoid cable contact with the reel flanges; orient the cable reel so that the natural payout direction is directly towards the first pole; pay out the cable from the top of the reel as shown in Figure 17 to eliminate possible cable contact with the ground.

Temporary Support Hardware

6.4 Temporary support hardware must be selected and placed so as to maintain the cable’s minimum bend radius throughout the route and to prevent the cable’s entanglement on obstructions in the right-of-way.

CABLE BLOCKS (Figure 18) - Various types of cable blocks, for either single or multiple cables, can be installed at poles or on an existing messenger to support the cable and are especially useful where the pole line crosses streets or other obstructions where adequate ground clearance is vital. Some blocks (e.g., K blocks) can be lifted on and off the messenger using a cable block lifter on a liftup stick.

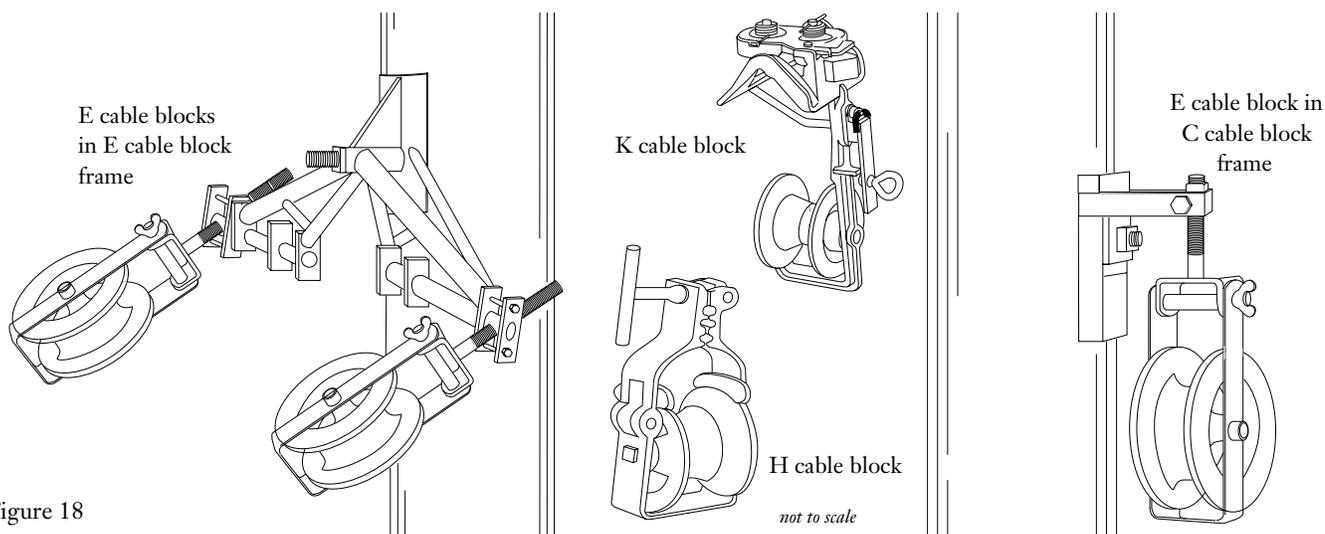


Figure 18



CAUTION: Due to the small pulley size in E cable blocks, observe the following limitations when using them with Figure-8 cable:

Two E cable blocks in an E cable block frame: 40 foot " (12.2 m) pull," (maximum combined angle of 20°).

Single E cable blocks - 20 foot (6.1 m) "pull" (maximum angle of 10°).

Use of E cable blocks at greater pull ratings and angles will exceed the Figure-8 cable's minimum bend radius and can result in

CORNER BLOCKS - Corner blocks (Figure 19) of a sufficient radius are used to maintain minimum cable bend radius as the route changes direction. Available in 45° and 90° configurations, corner blocks can be fitted to pole brackets, set-up brackets or strand crossover brackets and used on single or multiple-cable pulls. When mounted vertically, they provide bend radius/friction protection at horizontal bends; when mounted horizontally, they perform the same function for vertical bends such as those at the first pole of a pull or where the route changes grades.

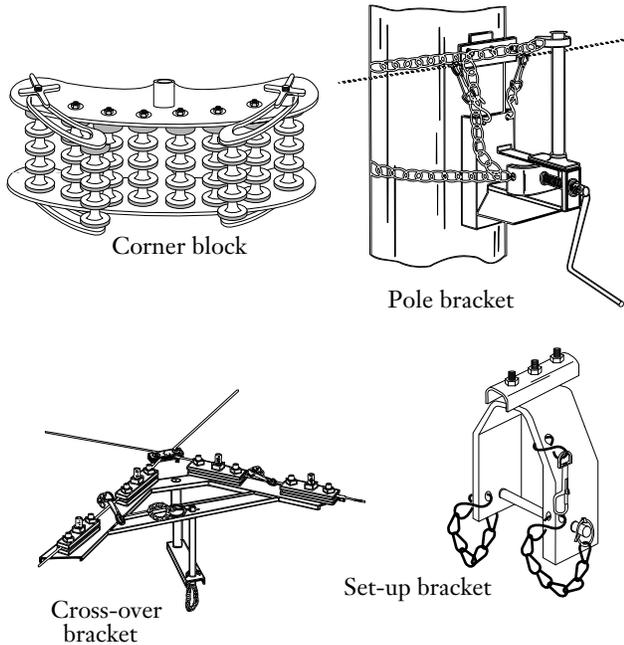


Figure 19

CABLE CHUTE GUIDE- This device (Figure 20) performs basically the same function as a horizontally mounted corner block but should be used on single cable pulls only.

Cable chute guide

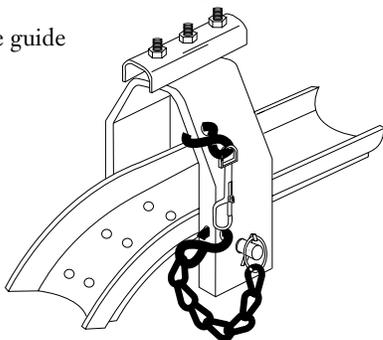


Figure 20

J-HOOKS - Although producing more friction than rolling hardware, Figure-8 cable can be pulled across J-shaped hooks (Figure 21) of at least 3.75 cm (1.5-in) radius installed on intermediate poles. Check all J-hooks to make sure they are free of rough edges or burrs which could damage the cable. Maintain tension on the cable during placement to prevent excess slack which could result in the minimum bend radius being exceeded.

J-hook

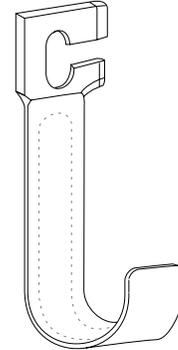


Figure 21

Application of a Pulling Grip To Figure-8 Cable

6.5 Pull the Figure-8 cable through the route by a pull line or tape attached to the messenger component with a properly sized Kellems® grip and break-away swivel. Step 6.6 outlines how to apply a pulling grip to the messenger component.

6.6 To install a pulling grip on the messenger component:

- a) Select an appropriately-sized pulling grip for the diameter of the messenger component.
- b) Separate the cable component from the portion of the messenger component which will be held in the pulling grip. There is no need to remove the residual web from the messenger component.
- c) Cut the separated cable component off at an angle so that the transition from Figure-8 cable to messenger is tapered (Figure 22).

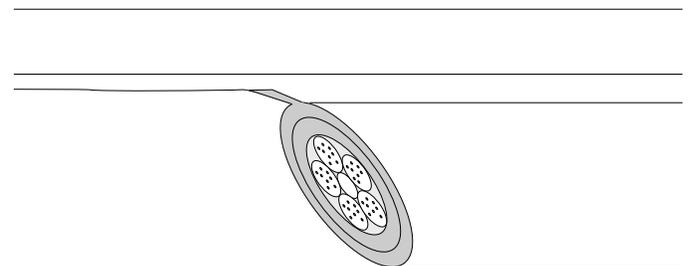


Figure 22

- d) Inspect the pulling grip for damage - broken wires, kinks, rust, etc. Smooth out the mesh as necessary by pulling along the length of the grip with a gloved hand.
- e) Slide the grip over the jacketed messenger component by alternately expanding and contracting the mesh. For safety, wear gloves during this step. When finished, the end of the messenger component should extend into the basket portion of the pulling grip.

- f) Smooth the grip down over the messenger component and tighten it by tugging on the pulling eye.
- g) Starting before the cable component cutback point, wrap towards the pulling eye with Scotch® Type 88 tape or equivalent. Wrap the tape tightly enough so that the mesh of the grip is clearly visible through the tape. Upon reaching the basket, cut the tape and tuck the end inside the grip.
- h) Removal of the grip is a straightforward reversal of the above process. After removal, smooth out the mesh, inspect for damage, and store in a dry place for reuse.

6.7 If you are using a non-swivelling grip, install a break-away swivel between the grip and the pulling line in order to prevent cable damage due to twisting (Figure 23).

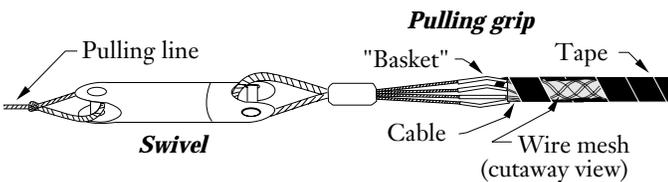


Figure 23

Pull Line Placement

6.8 Once the temporary support hardware is in position, place the pull line by walking it out at ground level along the cable route and lifting it into position in the temporary hardware. This can be done in two distinct stages, or simultaneously by lifting the pulling line up into each piece of hardware as it is passed while walking the pulling line out along the cable route.

Note: *This same procedure may be used to place Figure-8 cable into temporary support hardware for short sections of a cable route, eliminating pulling lines and rolling hardware. However, maintaining the cable's minimum bend radius is more difficult when the cable is lifted up into each piece of hardware than when it is pulled through a prepared route.*

6.9 Once the pulling line is in place, attach it to the cable's swivel and grip assembly. The cable is now ready to be pulled into place.

Pulling Operation

6.10 The pull can be accomplished by hand or by using a cable pulling winch. In both cases, care must be taken not to exceed the cable's rated pulling strength. Use a tension-monitoring or limiting winch, or install a break-away swivel between the pulling line and the cable.

6.11 During the pull, sufficient personnel should be on hand to monitor the entire pull route. Two-way communication, usually over walkie-talkies, should be established between the pull point, the cable reel location, and each of the route observers.

6.12 Start the pull very slowly as the cable is drawn from the reel at ground level up through the temporary support hardware located atop the first pole. Once the cable end is past the first pole, the pulling speed can be gradually and steadily increased. If sufficient support hardware is in place, pulling speeds on the order of 45 meters (150 ft) per minute can be achieved. This may require the placement of rolling support hardware at intervals as close as 15 meters (50 ft).

6.13 Observers at the pull point, reel location and along the pull route must be alert for any condition which might cause cable damage and be able to stop the pull immediately if any damaging conditions are observed:

- Avoid exceeding the cable's rated pulling strength and bending the cable beyond its minimum bend radius.
- Control the unreeling of the cable either by hand or with a cable reel brake in order to prevent free-running or jerking of the cable.
- At the pull point, winch or hand-pull the cable so as to prevent either free-running or jerking of the cable. If either is observed, the pull must be halted until the cause is eliminated.
- Excessive oscillation or galloping of the cable can be damaging. Reduce the pulling speed or add additional temporary support hardware to minimize these conditions.

6.14 When the cable reaches the pull point, do not allow it to engage the winch unless the winch maintains the cable's minimum bend radius.

6.15 Pull the amount of cable specified in the route plan and pull plan. This amount should include all slack requirements as outlined in paragraphs 4.7 and 4.8.

6.16 When the cable has been pulled into place as specified by the route plan:

- a) Install a dead-end on one end of the first messenger span to be tensioned as outlined in steps 5.9 -5.11.
- b) Proceed to Section 8 for instructions on tensioning and terminating the messenger component. The sequence in which the messenger spans are tensioned and dead-ended is unimportant as long as a central pole is not converged upon from both directions.
- c) Twist and secure the Figure-8 cable in the tangent clamp on each intermediate pole as described in 5.27 - 5.28.

7. Moving Reel Installation Method

7.1 In the moving reel or drive-off method, the cable is payed off of a moving vehicle as it drives along the pole line. As the vehicle passes each pole, the cable is raised into place and into a J-hook or block fitting for temporary support. This procedure progresses down the pole line until a dead-end pole is reached. At this point the messenger component of the cable is tensioned and terminated into a dead-end fitting. The cable between dead-ends is then lifted out of the temporary fittings at each of the intermediate poles, twisted and placed in permanent clamp fittings.

7.2 In most cases, the drive-off method is the fastest and least expensive method of installing aerial cable. Pole-mounted hooks are the only temporary support devices required and fewer personnel are required than by other methods. It does, however, require vehicular access to the placement side of the pole line and a right-of-way clear of tree limbs, guy wires, and other obstructions.

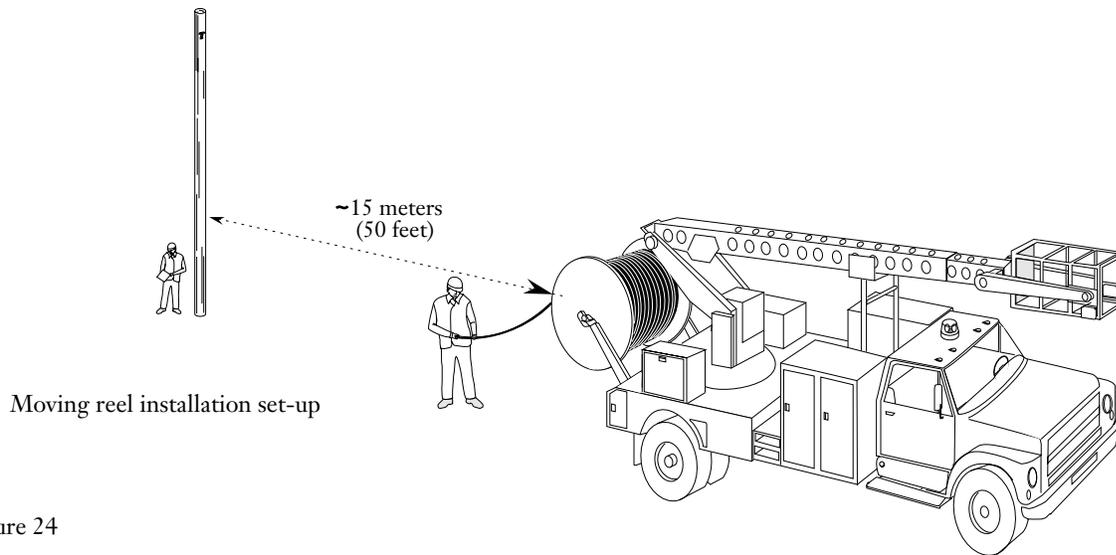


Figure 24

7.3 Begin the installation with the reel-carrying vehicle about 15 meters (50 ft) from the pole and facing away from it down the pole line (Figure 24). The cable must pay off the top of the reel towards the rear of the vehicle.

7.4 Pull off the necessary amount of slack as specified in paragraph 4.8, and cut the messenger component at the point where the cable is to be dead-ended. Prepare the messenger component and install the dead-end as specified in Section 5.

7.5 With either a bucket or handline, lift the dead-end fitting to the top of the pole and mount on the pole fixture. Be careful to maintain the cable's minimum bend radius throughout this operation. Removing the messenger component from the slack cable may be necessary to prevent the weight of the messenger from sharply bending the cable as it is lifted. It may also be necessary to pay out additional length as the cable is lifted.

7.6 Slowly drive the reel-carrying vehicle down the placement side of the pole line, paying out cable off the back of the truck. Once the reel is approximately 15 meters (50 ft) past each pole, lift the cable up the pole and place it in a J-hook or block fitting (Figure 25). If necessary, the Figure-8 cable can be lifted into additional support hardware hung on existing messengers

to provide temporary support until the cable is tensioned and dead-ended at the far end of the messenger span.



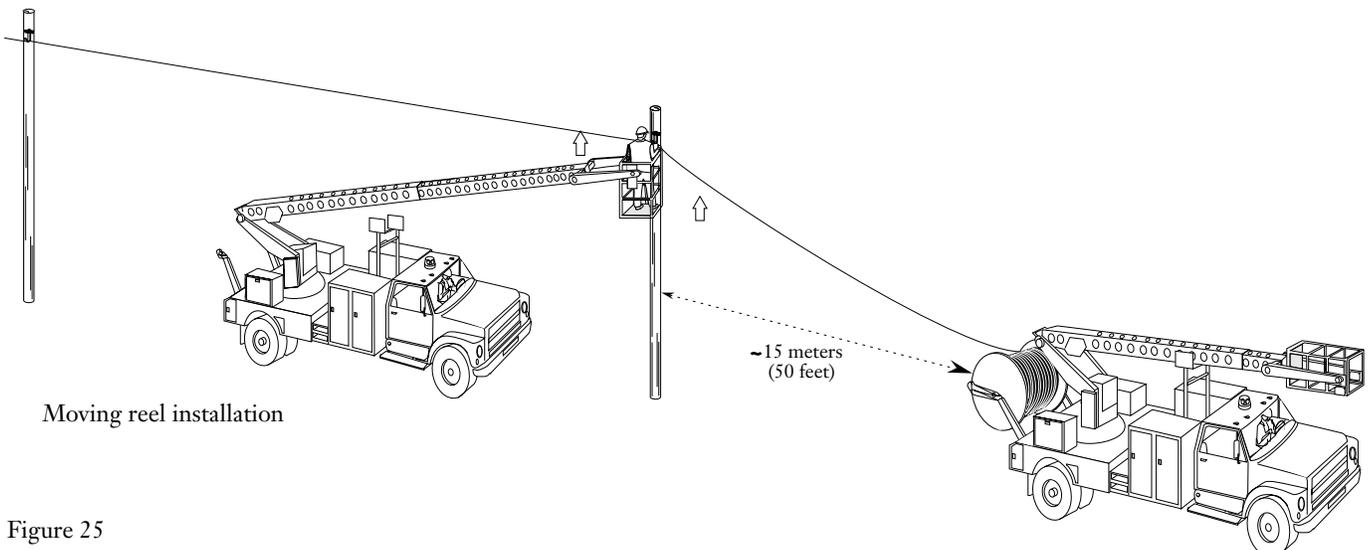
CAUTION: Monitor the entire installation process for any situation which could result in cable damage or injury to the crew. Communications between crew members must be effective enough to immediately stop the operation if problems arise.

7.7 Once the cable reel reaches the end of the messenger span, lift the cable to its assigned position on the dead-end pole.

7.8 Tension and terminate the cable into the dead-end as described in Section 8.

7.9 After the cable span is properly tensioned and secured into dead-ends at both ends of the cable span:

- Lift the Figure-8 cable out of the hooks / blocks at each intermediate pole.
- Apply cable twist as described in steps 5.27 - 5.28 and secure the cable in the tangent clamp on each pole as described in Section 5.



Moving reel installation

Figure 25

8. Messenger Tensioning

General

8.1 After the proper amount of cable has been placed in temporary support hardware between the dead-end poles, the messenger component must be properly tensioned before it is permanently secured into cable clamps on intermediate poles and at all dead-end fixtures.

8.2 With a dead-end fitting already in place on one end of the span, the messenger is tensioned by pulling on its opposite "free" end with a chain hoist (come-along), using the set up shown in Figure 26.

8.3 Once the entire messenger span is under the required tension, the "free" end of the messenger component is terminated into a dead-end as described in Section 5.

 **CAUTION:** Proper measuring of messenger tension is critical for a safe installation of aerial plant. Please read and understand all of this section before attempting to apply tension to the Figure-8 cable.

Tensioning Operation

Note: Before beginning this stage of the installation, any pole modifications or additional temporary / permanent guying must be completed, as must the installation of the dead-end and tangent clamp pole fixtures (see Section 5).

8.4 Proceed to the end of the cable run which does not have a dead-end fitting already in place from the cable installation procedure. Pull out all messenger component slack between the dead-end poles.

8.5 Clamp a "Chicago grip" onto the jacketed messenger component. The "Chicago grip" (Klein Tools® type 1659-5AT or equivalent) (Figure 27) is specifically designed for use on a jacketed messenger, with a oval cross-section serpentine jaw, rather than a sawtooth jaw which could damage the jacket.

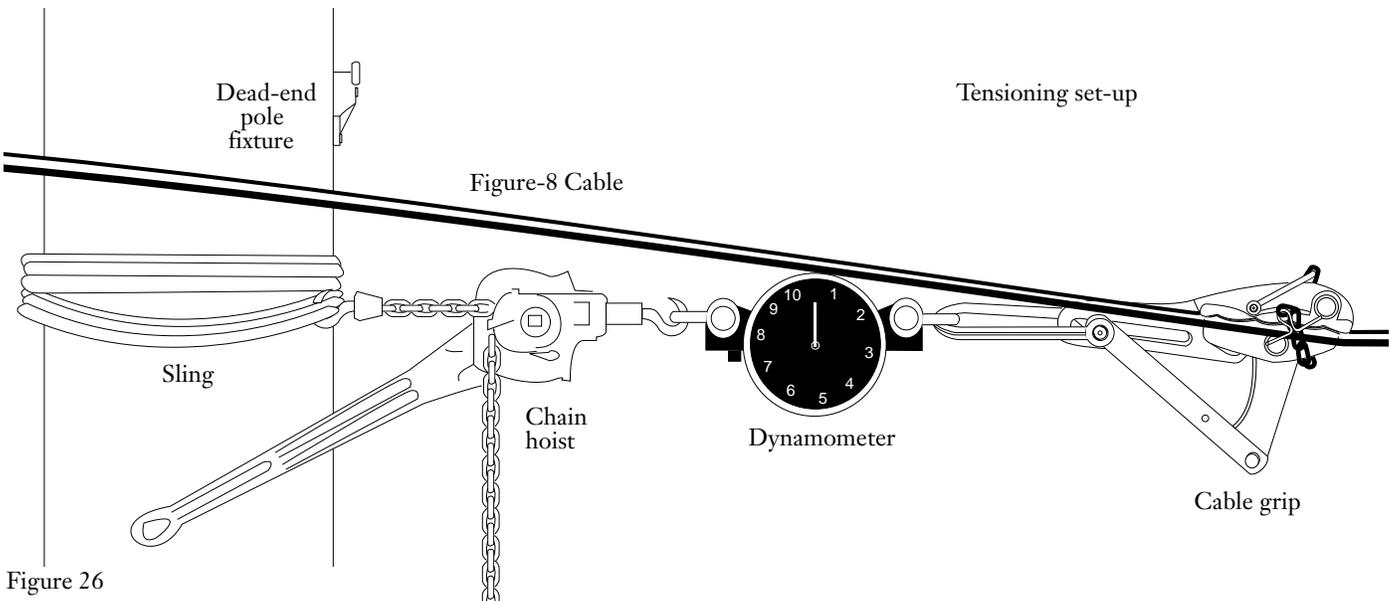


Figure 26

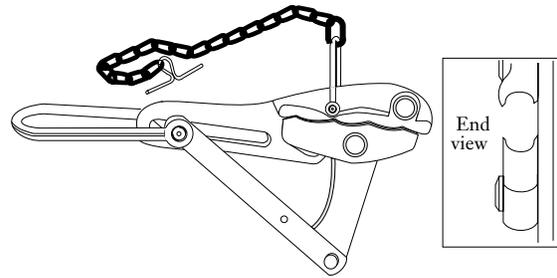


Figure 27

8.6 During the tensioning operation, tension should be monitored at the dead-end pole by an in-line dynamometer (Figure 26). Subsequent measurements can also be made mid-span using the same set up as shown in Figure 26.

8.7 Set up the grip, chain hoist, in-line dynamometer, and other hardware as shown in Figure 26. Typically, the chain hoist is strapped to the dead-end pole. Specific operation of the chain hoist should follow manufacturer's recommendations.

8.8 Apply tension to the cable messenger with the chain hoist. Best results are obtained by initially overtensioning the messenger with the chain hoist, and then backing off until the desired tension is achieved. During the tensioning operation, stay within the limits of maximum pulling tension for the messenger and the strength of the poles themselves. For long messenger spans under high tension, it may be necessary to use two chain hoist/cable grip set-ups in succession to obtain the necessary tension.

 **CAUTION:** As the messenger component is placed under tension, weaknesses in the cable plant can cause failure of pole fittings, support hardware or even the poles themselves.

The risk of death or injury due to such failures is best minimized by keeping all but essential personnel clear of the tensioning operation. Nobody should be allowed to climb intermediate poles as the messenger span they support is being placed under tension. If possible, passers-by on the ground should be kept away from the poles during this operation.

8.9 The proper installation tension of the messenger span can be determined from your company's installation procedures for standard "Figure-8" self-supporting cable of the same strand size. In addition, Corning Cable Systems Field Engineering (1-800-743-2671) can answer specific questions about tensioning.

8.10 The tension can be initially monitored at the dead-end pole with the dynamometer shown in Figure 26. Subsequent measurements must be made with a mid-span dynamometer or other method approved by your company. Messenger tension must be measured not only at the dead-end pole, but as specified for various lengths and conditions described below:

a) Straight messenger spans without a change in grade:

Fewer than 11 poles:	Measure the tension near the middle of the messenger span.
11 to 21 poles:	Measure the tension at a point 2/3 of the messenger span length from the tensioning pole, then at a point 1/3 of the distance.
Over 21 poles:	Measure the tension at a point 3/4 of the messenger span length from the tensioning pole, then at points 1/2 and 1/4 the distance.

b) Messenger spans with grade changes or turns: Begin measuring tension at the far side of the corner or grade change most distant from the tensioning pole. Follow with measurements at each corner or grade change, working towards the tensioning pole.

8.11 If measurements show that the required tension is not present throughout the span, it will be necessary to tension the wire from intermediate poles. Use the same procedure as at the dead-end pole, working towards the tensioning dead-end. As each section is tensioned, install the messenger in the support hardware as described in Section 5.



CAUTION: *Intermediate poles generally are not configured for lateral stress. If significant intermediate tensioning is required, perform it in gradual steps, repeating the process until the required tension is reached.*

8.12 Once the entire messenger span is under the required tension, terminate the messenger into a dead-end as described in Section 5. The dead-end should be placed on the messenger where it reaches the pole fixture, unless allowance is being made for grade changes or turns as described in step 8.13.

Tensioning Across Turns And Grade Changes

8.13 Within the hardware limitations discussed in Section 5, a messenger span may extend across turns and grade changes in the pole line. Since Corning Cable Systems Figure-8 cable is normally placed in the permanent support hardware after tensioning, any change in pole line direction complicates the process. Three possible cases are discussed below.

- CABLE ON OUTSIDE OF TURN:** Place the cable in the permanent support hardware on the corner pole as described in Section 5. Tighten the hardware only enough to prevent the cable from falling out during tensioning. Do not twist the cable until after tensioning.
- CABLE ON INSIDE OF TURN:** As the messenger in this situation is tensioned, the cable will naturally tend to pull inside of the corner pole. A vertically mounted corner block will keep separation to a minimum.



CAUTION: *Temporary support hardware used to restrain a cable being tensioned will be subjected to a significant portion of the messenger's tensile loading and should be mounted accordingly.*

Tension the cable in stages:

- Tension the cable to the degree planned from the dead-end pole.
- While monitoring the tension, use a Type E strand shifter to move the cable from the temporary support hardware at the inside turn to the cable's permanent support hardware on the pole.
- As the cable is pulled out to the pole, tension will increase. Take care not to exceed the maximum pulling tension of the cable messenger or the capacity of the poles and hardware. It may be necessary to relieve tension by backing off with the chain hoist at the dead-end pole.

Continue this process until the cable is in place on the pole at the inside turn.



CAUTION: *Do not allow personnel on the inside turn pole while tension is being increased at the dead-end pole. When personnel are sent up the inside turn pole, they must stay on the pole side of the cable.*

- CABLE ON THE POLE AT A GRADE CHANGE:** The procedure used to tension the messenger across a change of grade is similar to that used on an inside turn. The cable will pull up or down, depending on the direction of the grade change, rather than horizontally as is the case on an inside turn. Temporary support hardware should be mounted accordingly.

9. Emergency Restoration and Route Reconfiguration

Emergency Restoration

9.1 Compared to conventional fiber optic cable, the use of Figure-8 cable slack for emergency restoration is limited by several factors:

- The messenger component is normally cut to length between dead-end poles.
- The messenger component is frequently separated and removed from the slack cable to ease handling and storage.
- In those cases where the slack cable does still have its messenger component, moving the slack to the damage point may be a time consuming operation better suited to route reconfiguration than restoration.

9.2 Except for the increased difficulty of moving slack along the pole line, restoration procedures for Figure-8 cable differ little from those used in conventional lashed aerial installations. This section outlines two possible restoration procedures for Figure-8 cable.

Cable Component Damage Only

9.3 If the messenger component is intact, separate and remove the damaged length of cable component and deal with its restoration just as you would with a conventional cable by splicing in a new section of cable:

- a) Cut out the damaged cable component section, plus an additional 3 meters (10 ft) on either side.
- b) Splice in the replacement length of new cable using fusion or mechanical splicing.
- c) Protect the splice points with cable closures.
- d) The replacement cable section can either be lashed to the messenger component (see SRP-005-010, *Fiber Optic Cable Placing - Lashed Aerial*), or suspended beneath it with TYZ series Ty-Raps at 45 cm (18 in) intervals. Secure the closure to the cable per your company's normal practices (see step 5.30).

9.4 For a more detailed description of this type of repair, see the documentation supplied with the emergency restoration kit for fiber optic cable.

Damage to Both Components

9.5 If a Figure-8 cable is completely severed, or the messenger strand is damaged beyond safe re-use or reinforcement, it will be necessary to restore a continuous messenger and replace the damaged cable component:

- a) Cut out the damaged section of messenger and splice in an appropriate length of replacement strand with strand connectors. The replacement strand must match the size and grade of the original messenger component.

Available in a range of sizes, strand connectors are 3-section, wrap-applied devices similar to the strand dead-ends (see steps 5.11 - 5.12). Follow the connector manufacturer's instructions and/or your company's practices. Properly installed strand connectors have the same rated breaking strength as the original messenger component.

Note: *Strand connectors may also be used to reinforce weakened messenger components which have slightly damaged strands; apply the connector over the weak area, rather than cutting it out.*

- b) Re-tension the restored messenger.
- c) Repair the cable component and install it on the strand as described in step 9.3.

Route Reconfiguration

9.6 If changes must be made to an existing Figure-8 cable aerial plant (e.g., due to highway widening, etc.) "repair slack" can be used to reconfigure a cable route without introducing additional fiber splice points.

- *If the messenger component was left intact on the stored slack, shift the slack as needed while rerouting the cable. Restore a continuous messenger between dead-end poles by splicing the*
- *If the messenger component was separated and removed from the stored slack (as is more common), shift the slack as needed while rerouting the cable. Use strand connectors to splice in the necessary length of replacement strand of the same grade and size.*

10. Special Applications of Figure-8 Cable

Duct Placement

10.1 Although Figure-8 cable is intended for aerial placement, it can easily be pulled into ducts where required. The procedures to be used follow closely those outlined in SRP-005-011, *Fiber Optic Cable Placement - Duct*, with the following stipulations:

- a) In typical ducts, space limitations may dictate pulling-in only the cable component. The cable component of standard Figure-8 cable has a rated pulling strength of 2000N (450 lbs). This figure must not be exceeded (see Paragraph 3.1). Use a Kellems® grip on the separated cable component as described in SRP-005-003, *Installing a Wire Mesh Pulling Grip on Fiber Optic Cable*.
- b) Where duct space allows, pull in Figure-8 cable by the messenger component. Do not exceed the maximum pulling tension of the messenger.

c) Use the following formula to compute duct fill ratios for both components:

$$\text{cross sectional area} = 4.4 (a^2 + b^2)$$

where a is the cable component diameter and b is the messenger component diameter

Treat the cable as two cables being pulled simultaneously.

Direct Burial

10.2 Where required, cable can be trench-buried as discussed in SRP-005-012, *Fiber Optic Cable Placement-Direct Buried*.

*Special Note:
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Corning Cable Systems
PO Box 489
Hickory, NC 28603-0489 USA
For US and Canada 1-800-743-2673
International 828-901-5000
FAX: 828-901-5973
<http://www.corning.com/cablesystems>