All Dielectric Self Supporting (ADSS) Fiber Optic Cable Installation

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The practices contained herein are designed as a guide. Since there are numerous practices which may be utilized, Prysmian has tested and determined that the practices described herein are effective and efficient. The recommended practices are based on average conditions.

In addition, the materials and hardware referenced herein appear as examples, but in no way reflect the only tools and materials available to perform these evaluations.

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ALL DIELECTRIC SELF-SUPPORTING (ADSS) FIBER OPTIC CABLE INSTALLATION

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1.0 GENERAL

1.1 The methods described in this procedure for installation of All Dielectric Self-Supporting (ADSS) fiber optic cables are intended to be used as guidelines by design engineers and outside plant construction personnel. This guide is generic yet contains sufficient specific information applicable for most installations of ADSS cable. Local conditions, existing engineering and customer procedures and requirements must be considered. The IEEE Guide to the Installation of Overhead Transmission Line Conductors provides additional relevant information about installation practices.

1.2 Prysmian incorporates the National Electric Safety Code (NESC) loading requirements for heavy, medium, and light loading conditions in their sag/tension tables. Special tables can be generated based on specific customer installation requirements, which may include minimum separation and clearance, sag requirements, and loading conditions.

1.3 It is assumed personnel using the information presented in this document have experience in planning, engineering and/or placement of ADSS fiber Optic Cable.

1.4 Prysmian ADSS fiber optic cables meet or exceed IEEE 1222–2011 “Standard for Testing and Performance for All-Dielectric Self-Supporting (ADSS) Fiber Optic Cable for Use on Electric Utility Power Lines”.

1.5 If the cable is installed on structures with transmission lines exceeding 69 kV, make sure the ADSS space potential exposure has been calculated to determine it complies with the cable’s performance. Standard jackets have a space potential exposure compatibility up to 12 kV (low pollution area) and track resistant jacketed cables have a compatibility up to 25 kV (low pollution area).

2.0 PRECAUTIONS

2.1 The following are suggested precautions which should be observed when working with fiber optic cables. Before starting any aerial fiber optic cable installation, all personnel must be thoroughly familiar with Occupational Safety and Health Act (OSHA) regulations. Each individual company’s safety precautions for ADSS fiber optic cable installations should be reviewed before work begins and practiced during the entire installation process.

2.2 Before installation begins, the cable reels should be carefully inspected for any imperfections such as nails and broken flanges which might cause damage to the cable as it is payed out. Precautions should be taken to protect stored reels from possible damage by vandals or other sources when left unattended. Cable reels should be transported in an upright position, on the flanges only. Never lay the cable reel on its side.

2.3 Fiber optic cable is a high capacity transmission medium which can have its transmission characteristics degraded when subjected to excessive pulling force, sharp bends, and crushing forces. These losses may not be immediately revealed after installation. For these reasons extra care must be taken during the entire installation process.

2.4 Whenever cable from the reel is placed on pavement or other surfaces, it should be protected with barricades or cones to prevent possible vehicular or pedestrian traffic damage. Prior to pulling cable off of reel, the capboard covering the inside end must be removed and the inside end should be loosened.

2.5 Fiber optic cables are susceptible to performance degradation due to tight bending. The minimum bend radius of each cable is specified relative to the cable’s diameter. Prysmian requires the cable not be exposed to a bend radius smaller than 20 times the cable diameter during installation and after installation should not be exposed to a bend radius smaller than 10 times the cable diameter.

2.6 A “figure-eight” configuration should be used when the cable is removed from the reel and piled on the ground. This prevents kinking and twisting of the cable which could cause damage. Fiber optic cable should not be coiled in a continuous direction except for lengths of 30 meters (100 ft) or less. The preferred sized for the “figure-eight” is about 4.5 meters (15 ft) in length with each loop 1.5 meters (5 ft) to 2.4 meters (8 ft) in diameter.

Note: Figure 8 machines should not be used without specific approval from Prysmian. Many Figure 8 machines do not control the cable bend radius and can cause cable damage. Specifically, the End-Again machine is not approved.

2.7 During the installation process, the cable should not experience sags, bends or twists that produce a bend radius smaller than the specified minimum bend radius. Failure to observe proper handling procedures during cable placement can void Prysmian’s warranty and result in permanent damage to the transmission characteristics of the cable.

2.8 Do not cut the cable under any circumstances without prior approval of the engineer responsible for the project. Splice locations are determined in the initial system design by the project engineer. Introducing new splices can potentially degrade the transmission characteristics of the system.

2.9 Temporary or permanent guys should be installed at any location where the self-supporting cable is tensioned to avoid placing an unbalanced load on the support poles.

2.10 Wire mesh grips are intended for pulling the cable into place and are not intended for tensioning the cable in place. Do not use split wire mesh grips to tension or to hold cable under tension.

2.11 All safety practices of the Power Utility and the Installation Contractor must be followed. These safety procedures will take precedence over any information contained in this document.

3.0 INSTALLATION EQUIPMENT

3.1 The type and construction of the reel support determines the method and tools for handling. Reel construction requires they be mounted on an axle or be supported by the reel flange. The equipment used must be rated for the maximum load and be able to lift the reel. When the reel stand is not self-loading, a crane, forklift or some other method of lifting must be available to lift the reel onto its stand.

3.2 The reel support design employed must incorporate an adjustable brake to supply the necessary back tension to properly control cable placement. The cable may be pulled directly from the reel support when employing slack stringing methods that apply minimal tension to the reel of cable.

3.3 Capstan and reel type pulling machines with approved adjustable tensioners may be used to install the ADSS fiber optic cable.

3.4 The pulling and braking system employed should operate smoothly to prevent any jerking or bouncing of the cable during placement. The system should be controllable and able to maintain a constant and even tension on the cable during the installation process. Pullers and tensioner should be equipped with tension indicator and limiting devices. Tensioner wheels should be controlled so that a constant back tension is maintained at all pulling speeds. A braking system to maintain proper cable tension when the pulling is stopped is also required.

3.5 Sheave diameters larger than those specified in Paragraph 2.5 are recommended at the payoff reel position and the take-up or winch location. A sheave diameter larger than the minimum required offers the advantage of reducing the load applied to the cable.

3.6 The depth and flare of grooves in the sheaves used during the placing process are not critical, however, there are recommended guidelines which should be followed. The grooves should have depth 25% greater than the cable diameter with a flare angle of 15 to 20 degrees from vertical. This will facilitate the passage of grips and swivels and contain the cable within the groove. The material and finish of the grooves should be such that it does not mar the surface of the cable.

3.7 The travelers or sheaves used should be in good working order and properly lubricated. The cable release should work smoothly with minimal pressure. They should be lined so as to not cause abrasion of the cable jacket. A plastic lining of neoprene or urethane is recommended.

3.8 Tangent supports with a protective pad can be used as a replacement for stringing blocks. These supports are mounted directly on the pole and open from the top. The protective pads can be removed and the top closed and secured for stringing. During stringing and pulling of the cable, the angle of change cannot exceed 10 degrees.

3.9 At places where elevation change may occur, it is recommended appropriate sheaves be used.

3.10 Wire mesh grips or pulling eyes can be used to pull the cable into place through the travelers or sheaves. The mesh grip or pulling eye must be used in conjunction with a double swivel link to minimize cable twisting which may be introduced by the pull rope. The load rating of the swivel link shall not exceed the maximum pulling tension rating of the cable (normally 600 LB). The pull rope must be well matched to the cable diameter and cable weight. The pull rope should also be torque balanced, have a high dielectric strength, and low elongation.

4.0 PRE-SURVEY

4.1 A pre-survey of the fiber cable route is very important in planning for an aerial optical fiber cable project. During the pre-survey the nature and extent of work required along the proposed route should be determined before cable placement begins. Each section of the route must be prepared properly before cable installation begins.

4.2 One of the objectives of the pre-survey is to determine where each reel of fiber optic cable is to be placed. Slack locations and cable storage requirements must also be considered along with splice locations. The pre-survey will verify construction methods, special tools required, or possibly require a revision of preliminary splice locations.

4.3 Grade changes or line angle changes from straight and horizontal should be noted in order to plan ordering of proper installation hardware.

4.4 The characteristic of the ground along the route also needs to be evaluated. Trees or other obstructions which could hinder placing operation should be noted. Clearance issues over roadway, driveways, etc. need to be taken into account before cable placement begins.

4.5 The setup locations for reels and vehicles should be evaluated and ease of vehicle accessibility to the cable route considered.

4.6 A good pre-survey should reveal clearances and separations on joint-use poles eliminating the need to rectify any issues when the cable is being placed. It will also qualify the condition and size of the existing poles and anchors to be used and reveal the need for any new poles before placement operations begin.

5.0 INSTALLATION METHODS

There are two primary methods used for placing ADSS cable. Both of these methods are very similar to those used to place most aerial cables. The first method is called the *stationary reel method* and the second is called the *moving reel method*, or the “Drive-off Method.” The moving reel method is typically not recommended.

5.1 The Stationary Reel Method is illustrated in Figure 1 below.

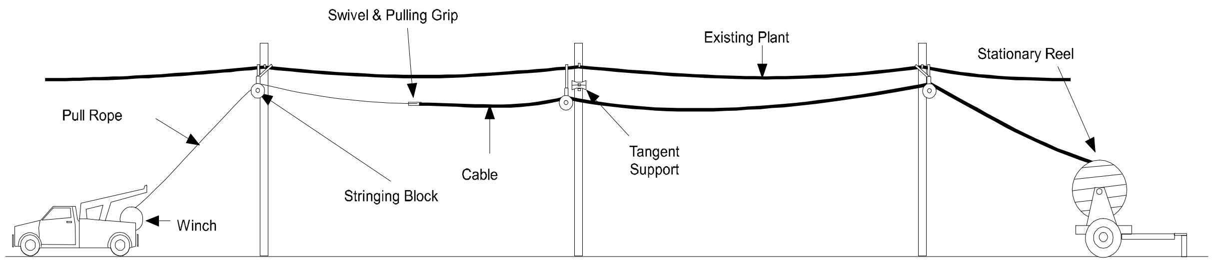

Figure 1 - Stationary Reel Method of Cable Deployment

5.1.1 The *stationary reel method* is used in urban areas where there is no vehicle access. The reel is placed on a reel stand or reel trailer at one end of the pull run. A braking device applies minimal braking tension to prevent overrun. Cable reel trailers should be disconnected from their towing vehicles, have the reel leveled and the trailer wheel securely chocked.

5.1.1 Holes are drilled in all poles along the cable run and line pole hardware is attached to the poles at the engineered height. At dead-end and tangent locations, down guys are placed at the correct position according to local engineering practices.

5.1.2 The travelers or sheaves are placed just above or just below the location of the installed pole line hardware at each pole location. The travelers must have a soft neoprene or similar material liner to cushion the cable from the bare metal of the traveler. The liner or insert must be smooth and show no signs of wear and tear. It is unacceptable for a traveler to have sections of cushion missing or worn through at the bottom of the groove.

The diameter of these supports must meet the minimum bend radius specs for the cable in any location where the cable will be bent more than 20 degrees. ***The cable warranty is void if these limits are not observed.***

Please note if the pulling tension is greatly reduced during a pull, the natural sag of the cable will usually produce angles larger than 20 degrees at each support point. Thus, extreme caution must be used if pulling through small diameter supports.

Traveler Installation: Each structure in the pulling segment must have a traveler installed and a pulling rope threaded (reeved) through it. Each traveler must be balanced so that the rope, and the following ADSS cable, ride at the bottom of the neoprene insert's groove. It is important to tie up the traveler at each angle so the pulling rope and ADSS cable enter and exit the traveler smoothly (See below Figures 2 & 3). If the cable enters at an angle, it increases the chance of jumping from the traveler groove into space between the traveler and the yoke holding the traveler to the pole. This would cause severe damage to the cable.

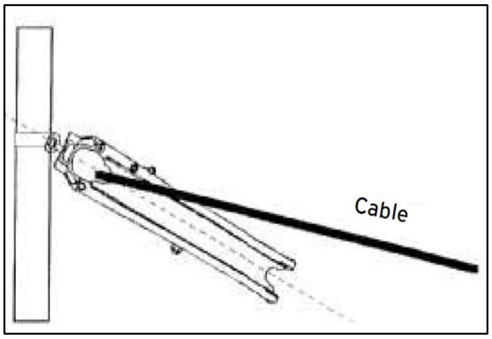

Figure 2 - Incorrect Traveler

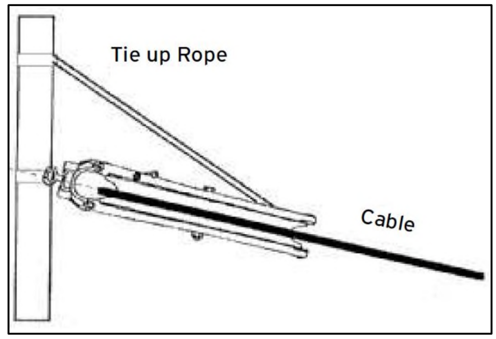

Figure 3 - Correct Traveler

5.1.3 It is extremely important that the pulling rope and the ADSS cable have the same diameter and approximate weight. This will allow the travelers to float at the same level with the pulling rope as they will when the ADSS cable enters the travelers. The pulling line should be all dielectric and not susceptible to internal, electrical static charge build up. The pulling rope should never be allowed to drape over distribution lines or slump between pole attachments. It should have constant tension throughout the entire pulling operation. Once in place, it is attached to the ADSS cable with a break-away swivel and pulling grip.

5.1.4 The ADSS cable shall be attached to the pulling rope using a double swivel eye and woven wire grip. The double swivel eye insures the ADSS cable will not see an induced torque as the pulling line enters and exits each traveler. A ‘flag’ shall be attached just behind the swivel eye on the ADSS cable jacket. This flag should stay straight through each traveler. If the flag starts to flip over the cable, it shows the swivel eye is not working properly and the pulling operation should be stopped and oil or fix the swivel. The woven wire grip shall be of sufficient length on the cable jacket to insure even loading of the cable strength members. The edges of the woven wire grip should be taped smooth so the grip does not damage the neoprene inserts of the travelers as it passes through.

The ADSS cable is pulled through the entire section using the puller and tensioner. Care must be taken to avoid over tensioning the cable as well as excessive sagging which may introduce bends smaller than the minimum bend radius. Several pulling stages may be required to place the cable through the entire system.

5.1.5 Once the entire cable has been pulled into place, each dead-end to dead-end section can be sagged and tensioned and support hardware applied according to the installation requirements.

5.2 The Drive-off method is illustrated in Figure 4 below:

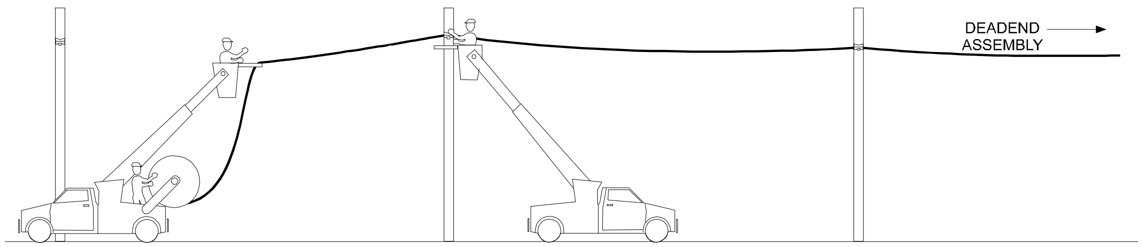

Figure 4 - Drive Off Method of Cable Deployment

5.2.1 The Drive-off Method of cable placement is primarily used during the construction of new lines where there is a clear right-of-way and with no obstructions to vehicles.

5.2.3 The reel of cable is placed on a reel trailer or a truck equipped with a reel carrier. The cable should pay off the top of the reel for reel trailers and the bottom of the reel for trucks equipped with a reel carrier. The reel trailer or reel equipped truck should have a braking device, set on minimum. The brake is used to prevent overrun of the reel when stopping at the support poles.

5.2.4 Holes will have to be drilled at the poles to mount the support hardware. At dead-end and tensioning locations, down-guys of the correct loading size will need to be placed per local engineering practices.

5.2.5 The travelers and sheaves are placed above or below the pole mounting hardware at each pole location.

5.2.6 With the cable deadended at the starting location and minimum tension applied to the reel brake, the reel of cable is transported along the construction route while the cable is played out.

5.2.7 As the reel passes a pole location, the trailer or truck must be stopped while the cable is placed into the traveler or sheave.

5.2.8 The reel then travels to the next pole where the process is repeated. This continues until the cable is completely deployed or a deadend is reached.

5.2.9 With the cable deployed, each span must be sagged and tensioned with supporting hardware installed. Each section starts at a dead-end location and slack worked back towards the opposite end.

6.0 INSTALLATION OVERVIEW

6.1 Large diameter sheaves should be used at the first position and final position where the reel and puller/tensioners are located. The angle between the reel or puller and the sheave a the first and last pole should be minimized. The location of the tensioner/puller and reel relative to the structure should be selected to obtain a pulling slope of 75º to 80° for good practice. This ratio will minimize the load on the cable, traveler, sheave, and pole. It may be necessary to place temporary guys to prevent overloading support poles. The reel must be placed in-line with the first two poles of the run to prevent twisting of the cable or damage caused by abrasion from the sides of the travelers or sheaves.

6.2 Anchors and pole hardware must be rated above the expected environmental load of the cable, plus a safety factor. In installations where aeolian vibration could be an issue, the safety factor should be increased. At locations where the cable is tensioned to achieve proper sag, the pole may require a temporary down-guy and anchor to prevent overloading.

6.3 The travelers or sheaves are normally attached directly to the support pole. The pole attachment hardware must be consistent with the working load and rating of the travelers and sheaves.

6.4 The pulling grip shall be rated above the maximum anticipated pulling tension. Follow the manufacturer’s installation instructions. When properly installed, no special preparation of the cable end or aramid yarns is required. A matching clevis type swivel should be used to help prevent twisting of the cable during pull-in. The swivel should be of the type that has a break-away tension less than the cable’s rated maximum pulling tension to prevent over tensioning.

6.5 Aeolian vibration is a resonant vibration caused by low velocity wind blowing across a cylindrical cable under tension. This vibration can cause severe degradation of the support hardware. Vibration dampers can be very effective in controlling Aeolian vibration on ADSS cable. Both resonant and interference type vibration control systems will work when properly applied.

6.6 Splice locations require additional cable to accommodate lowering to the ground with enough slack to allow splicing inside a splicing van or trailer.

6.7 All slack cable storage locations require the installation of cable storage brackets. The cable storage bracket insures the proper bend radius for the stored fiber optic cable and provides for horizontal storage and tiering of multiple cables and loops. Figure 5 below illustrates slack cable storage.

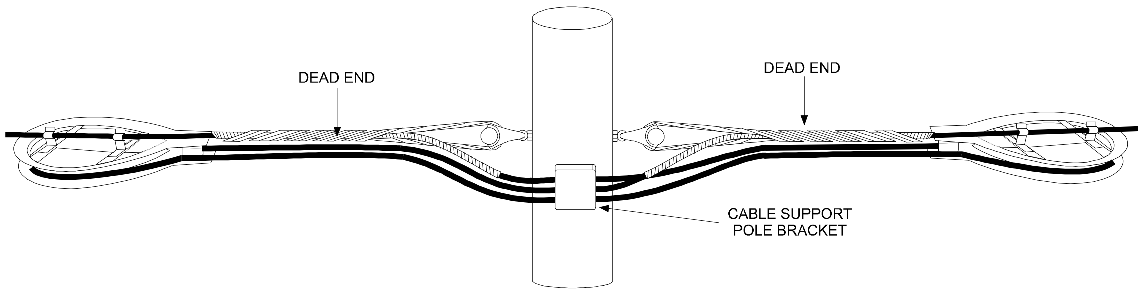

Figure 5 - Cable Slack Storage

7.0 CABLE SUPPORT HARDWARE

There are two general types of ADSS cable support hardware: dead ends and tangent assemblies. Hardware manufacturer's installation instructions should take precedence over the guidelines below. Note the selection of hardware depends on the cable diameter and span distance. The selection of dead-ends also depends on the maximum installation tension and maximum rated cable load. PLP is the recommended hardware supplier.

7.1 Deadend assemblies are normally used at the point of cable termination or where the cable angle is greater than 30°. See Figure 6 below for illustration of a Deadend Assembly.

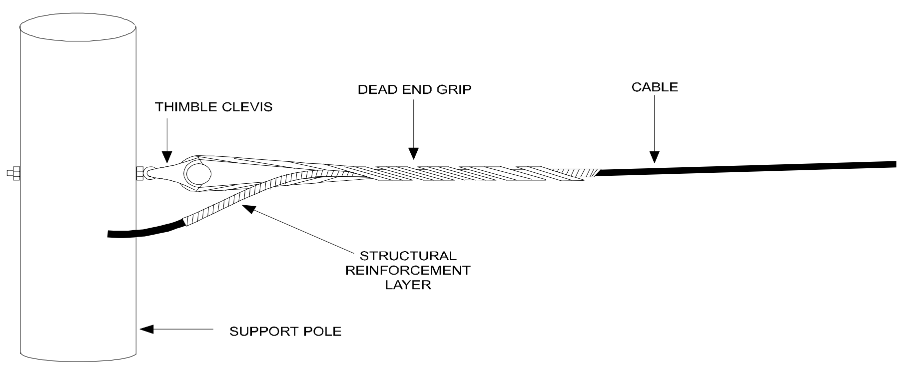

Figure 6 - Deadend Assembly

7.2 The Structural Reinforcement Layer (SRL) is a subset of armor rod that is the first layer applied to the ADSS cable. They are spiraled in a precise twist lay to match the diameter and load of a specific cable. They are normally grouped together in a sub-set of four to five rods and have grit applied to the inside for slip resistance.

7.3 The Deadend Grip consists of a set of armor rods which have been formed in a double spiral with a loop at one end. Its precise twist is designed to very closely match the diameter of the SRL as it is applied over the cable. The length of the deadend grip is dependent upon the maximum load. It also has grit applied to the inside for slip resistance.

7.4 The Thimble Clevis is made of cast aluminum or steel and is used to maintain the set diameter of the deadend loop.

7.5 The deadend hardware is assembled in the following manner:

1. The SRL rod is assembled on the cable first. The end with the color band is assembled towards the end of the span. Wind on one set of rods at a time. The rods should be placed close together so there is sufficient room for all.

2. The tips of the SRL rods should align at the end. Do not force the rods or use tools to install them. Forcing the rods or using tools may damage the cable jacket.

3. Align the color band on the deadend with the color band on the SRL and wind one leg of the deadend on approximately two feet.

4. Insert the thimble clevis into the loop.

5. Align the color band on the second deadend leg with the color band on the first deadend. Wind the second deadend leg over the SRL for approximately two feet. Continue winding the deadend legs over the SRL until both legs are snapped in place.

6. Connect the thimble clevis to the hardware (or to the extension link and then the hardware) mounted on the pole.

7.6 Tangent hardware is normally installed after the span has been tensioned. Figure 7 below illustrates a front and side view of a Tangent Support. To install the cable, open the hinged top and insert the bottom pad. Place the cable on the pad, then position the top pad over the cable, close the top and tighten the bolt to hold the cable in place.

The maximum span distance and maximum angle/degree of offset specified by the hardware supplier should not be exceeded. The maximum angle of change is typically 20 degrees; however, this is limited to 10 degrees if the cable is pulled through the tangent support. *Note that cable cannot be pulled through suspensions.*

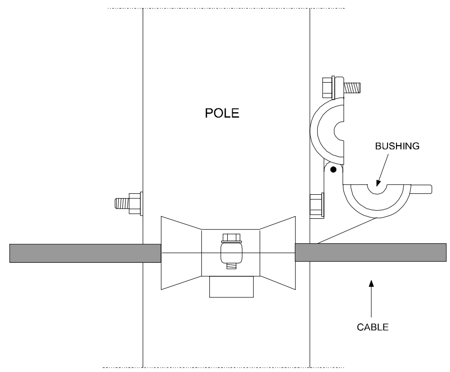

Figure 7 - Tangent Support

7.7 Suspensions: Suspensions are also installed after the span has been tensioned. Suspensions are hung from the pole using shackle. The maximum angle of change for suspensions is typically 30 degrees. Suspensions without support rods should not be used on span exceeding 600 feet. Suspensions with support rods may be used on spans up to 1200 feet.

Figure 8 – Suspension

7.8 Armor Grip Suspension (AGS): Used for any span length with an angle change, either horizontal or vertical, less than 30°. An AGS Suspension or Suspension with support rods shall be used for in-line structures if the span is greater than 600 feet. Suspensions with support rods are limited to 1200 feet.

Figure 9 – Armor Grip Suspension

7.10 Corona Rings: Typically used for applications above 230 kV to protect cable from discharge off of dead-end or armor rod suspension hardware.

8.0 SAGGING AND TENSIONING

8.1 Upon completion of placing the entire run of cable, sagging and tensioning can now be started. Sagging and tensioning the run is worked progressively from one end of the run towards the opposite end. Normally the slack is worked back in the direction of the reel in order to recover as much cable as possible. Sagging and tensioning should be conducted according to the cable manufacturer's recommendations for the cable just installed. Direct tension stringing from the reel at cable installation stringing tensions is not recommended.

8.2 The cable run is broken down into subsections for sagging and tensioning purposes. The last structure at each end of a section being sagged and tensioned is a deadend assembly. Remove all excess slack cable out of the section of the run being prepared for sagging and tensioning. To remove the slack, reverse the tensioner and pull the cable back towards the reel, being careful not to exceed the minimum bending radius for the cable under tension.

8.3 Once the slack is removed install a temporary deadend on the cable approximately 2 deadend assembly lengths away from the support pole. This deadend will be used as a tensioning grip to achieve proper span sag and tension prior to installing the permanent deadend assembly.

8.4 Attach the tensioning device: a chain hoist or power winch and a dynamometer between the pole and the temporary deadend. Begin to apply tension to the span.

8.5 The cable is normally tensioned from deadend to deadend along the span back to the reel. Once the spans are properly sagged and deadends attached, the suspension or tangent hardware is installed and attached to the poles by working back to the deadend one span at a time.

8.6 Once the permanent deadends are installed and the hardware attached to the poles, the pulling device can remove the tension and the temporary deadends removed from the cable. When the next permanent deadend is installed on the adjacent span, make sure the loop formed between the two deadends maintains the minimum bend radius for the cable. Repeat this operation until all spans are sagged and tensioned.