

INSTALLATION PROCEDURE FOR OPGW FIBER OPTIC CABLES

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1. PURPOSE

The procedure describes the recommendations for installation and delivery of OPGW fiber optic cables.

2. SCOPE

This document covers the installation of OPGW fiber optic cables, including transport, accessory assembly, verification of optical transmission characteristics and final certification.

3. REFERENCES

- Quality Assurance Manual

4. GENERAL

In general, the system and the equipment used for installation of the OPGW Cable are similar to those used for installation of the standard ground wire cable.

However, since there is an optical fiber core, special care should be taken to avoid any damage to the fibers by observing the minimum bending radius at all times. Therefore, specific components and machinery are used for the OPGW cable: pullers, tensioners, anti-twisting counterweights, swivels, pulling grips, pulley-blocks, self-gripping clamps, pulling ropes, pulling cables, etc.

5. PROCEDURES

5.1. Line survey

Prior planning for installation of the OPGW cable is performed by monitoring the line, taking into account the following parameters:

5.1.1. Reel length

The OPGW reel lengths are determined based on the following considerations: position of the tension towers, tower access, distance between supports and crossings of other lines, roads, railways, routes, services and other obstacles.

5.1.2. Splices

The splice point locations depend on the maximum available length of OPGW and on the tower locations and accessibility.

5.2. Transport, loading, unloading and storage

The following procedures are recommended to prevent damage to the cable during handling, transport, and storage:

- a) The reels must be transported in the vertical position with the cable ends fixed to prevent the cable from slackening. All of the staves and/or safeguards should be maintained until the reels are situated for immediate installation.
- b) After transport, the reels should be inspected to verify that they have not been damaged and that the staves and/or safeguards are not broken.
- c) The reels should never, under any circumstances, be thrown from the truck during unloading, nor should they be moved by uncontrolled rolling.
- d) Loading and unloading are performed so that the reel remains in vertical position and the reel flanges are not damaged.
- e) The reels can be moved by rolling a short distance while ensuring that there are no objects that may damage the staves. The direction in which the reel turns should be the same as that in which the cable is wound during manufacture.
- f) The reel should not be stored on its side under any circumstances.
- g) The ends of the cable should be sealed to prevent water penetration.
- h) The reels should be stored on flooring that is strong enough to prevent sinking.
- i) The reels should be stored to facilitate handling and loading. They should be located far from any activity that may damage them.

5.3. Installation preparation

5.3.1. Equipment positioning

5.3.1.1 Reel

The reel should be placed at the selected site (with the space required for its location) so that the cable end pulls from the top of the reel and is aligned with the planned direction of pull.

The reel must be located 2 or 3 metres from the tensioner. The lifting components usually used are hydraulic jacks and a bar with the suitable dimensions is inserted through the reel arbour hole. The reel must be located at a height of 4 to 6 inches (10 to 15 cm) from the ground.



Location of tensioner and drum

5.3.1.2 Puller and tensioner

The puller and tensioner must be placed at a minimum distance from the tower equal or greater than 2 times the height of the tower.

The tensioner as well as the puller should be placed so they are aligned with the conductors. The maximum acceptable deviation angle is 30°. ($\alpha < 30^\circ$, see Figure 1)

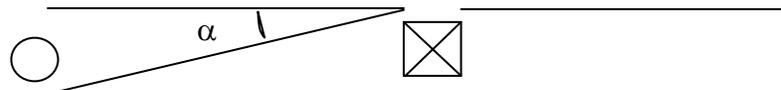


Figure 1

If it is not possible to achieve this angle, the puller and/or the tensioner can be placed close to the following tower, using an additional pulling line of suitable length and tensile rating.

If an installation is done in a way which allows the cable to move backward (back-tracking) on any of the pulleys, special care must be taken. Back-tracking is not allowed on any pulley where the cable is in contact for 90° or more (a right-angle turn or sharper). If a turn of 90° or sharper is required, two pulleys must be used, in order to reduce the angle at each pulley.

The tensioner, as well as the puller, should be positioned at a distance of at least twice the height of the support to which the cable is fastened.

In the first groove of the tensioner, the first groove or pulley the cable will pass through must be perpendicular to the axis of the drum. In the tensioner, double armour OPGW will enter from the right and leave from the left for left-hand lay sense (and from the left and leave from the right for right-hand lay sense) .

The tensioner must be equipped with a dynamometer (i). Reels must be protected with material that does not damage the outer layer of the OPGW cable.

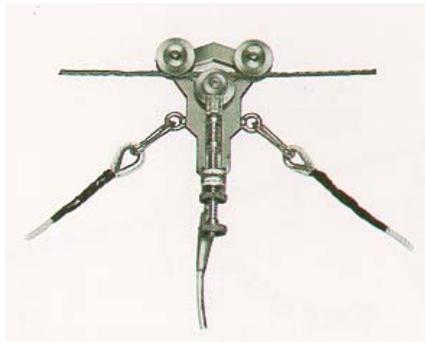
The puller must also be equipped with a dynamometer ¹(i) with automatic disconnection to prevent over tensioning of the cable (see 5.4.1.3).

The pulling cable must be joined to the OPGW cable by a swivel and a pulling grip.

The minimum diameter of the reels used for coiling the OPGW cable during installation should be at least 80 times the diameter of the OPGW cable; however, the diameter need not exceed 59 inches (1500 mm). For example: the tensioner reels for a 0.5" (12.7mm) cable should have a diameter of approximately 40 inches (1016mm).

The breaking device and puller should be suitably connected to the ground by a system of moveable rollers such as that shown in the following picture.

The grounding connection in the photo shown below should not apply any pressure or deform the OPGW cable.

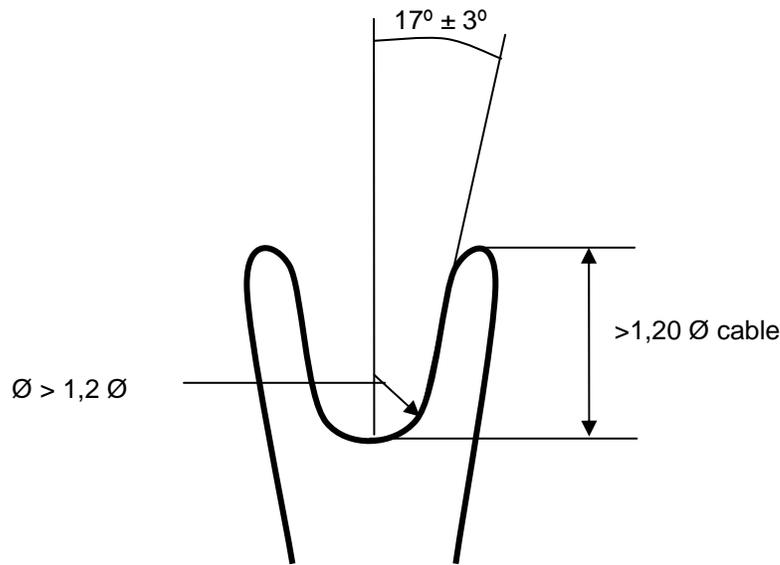


Ground connection of the OPGW cable at the tensioner outlet.

¹ It is compulsory to perform the calibration of the dynamometer, at least once a year.

5.3.1.3 Pulleys

Pulleys must have a large enough diameter to meet the minimum bend radius rating of the cable. The pulley groove should be shaped as shown in the figure below.



The tower pulleys should have a minimum diameter of at least 0.8 metres in the following cases:

- In all towers with a change in laying direction equal to or greater than 15 degrees.
- In the first and in the last tower of a single installation.
- If the distance between the towers is greater than 1968 feet (600 m).

In all the other cases, pulleys with a diameter of 24 inches (0.6 m) can be used.

The pulleys must be in good conditions. The pulley groove should be protected with neoprene or other similar material.

In case of sharp angles, the pulley must be placed so that the cable always passes through the center of the groove.

If the angles are greater than 45 °, a dual pulley system must be used in order to increase the bending radius during the installation. The diameter of each pulley should be at least 0.6 m.

5.3.1.4 Anti-twisting devices

When a single or double layer OPGW cable is installed, an anti-twisting system is required to compensate the inherent effect of torque of the OPGW cable. This device is always positioned at the pulling head of the OPGW cable and equipped with two counterweights placed at a distance that is at least 10 feet (3 meters) one from the other. In this way, when one counterweight goes through the pulley the other remains active

Another anti-twisting device is installed at the end of the OPGW cable just prior to leaving the tensioner.

The weight of the anti-twisting devices must be high enough to prevent OPGW cable rotation. The minimum values recommended for each counterweight are as follows:

- | | |
|----------------------|------------------|
| - Spans \leq 1000' | 26.4 lbs (12 kg) |
| - Spans 1000 – 2300' | 33 lbs (15 kg) |
| - Spans > 2300' | 44 lbs (20 kg) |

For installation lengths longer than 13,000' (4km), these values should be increased by 11 lbs (5 kg).

After the counterweights have been installed, they should not be removed until the cable is secure and cannot rotate.

Special precaution must be taken in order to not rotate the cable inside the counterweights, due to unsuitable or incorrect tightening, during the tightening process, special attention must be taken on using the appropriate clamp size and correct installation procedure to prevent damaging the OPGW cable.

5.3.1.5 Auxiliary components

Use swivels that are specifically designed for OPGW cables. They must be of suitable size relative to the cable to be installed and must be in optimal condition.

The pulling grip for OPGW cable stringing must be at least 59 inches (1.5 m) long and be specifically designed for stringing OPGW cables. It must have the proper dimensions and be in optimal condition.

The clamps used during the stringing and sagging operations must be specifically designed for OPGW cables and must be compatible with the OPGW cable diameter.

If preformed fittings are used, these should be specifically designed for the OPGW cable to be installed. The diameter as well as the length and material of these components must be suitable for the OPGW cable.

The torque wrenches used must be reliable and calibrated on a regular basis. If a fall or accidental damage occurs, the calibration must be verified.

5.3.1.6 Pulling rope

The pulling rope must be specifically designed for cable stringing. When stringing is performed on a power line that is out of service, metallic rope/cable is recommended. The minimum breaking load must be 11,000 lbs. This value can be higher depending upon the OPGW cable

mechanical characteristics and it must be at least equal to 2.5 times the maximum stringing load (see 5.4.3.1).

If an old ground cable must be used as a pulling rope, ensure that it is not damaged and that its weight is lower than the OPGW cable one that is going to be installed.

The pulling cable must be joined to the optical cable by a swivel and a pulling grip. The swivel is necessary to prevent any twisting of the cable when stringing is performed.

Installation equipment



Fig 1. Tensioner



Fig 2. Puller



Fig 3. Swivel



Fig 4. Pulley



Fig 5. Pulling grip



Fig 6. Anti-twisting devices

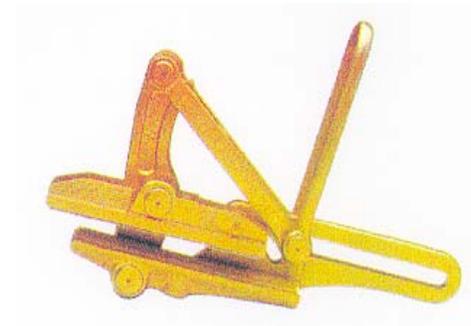


Fig 7. Clamp

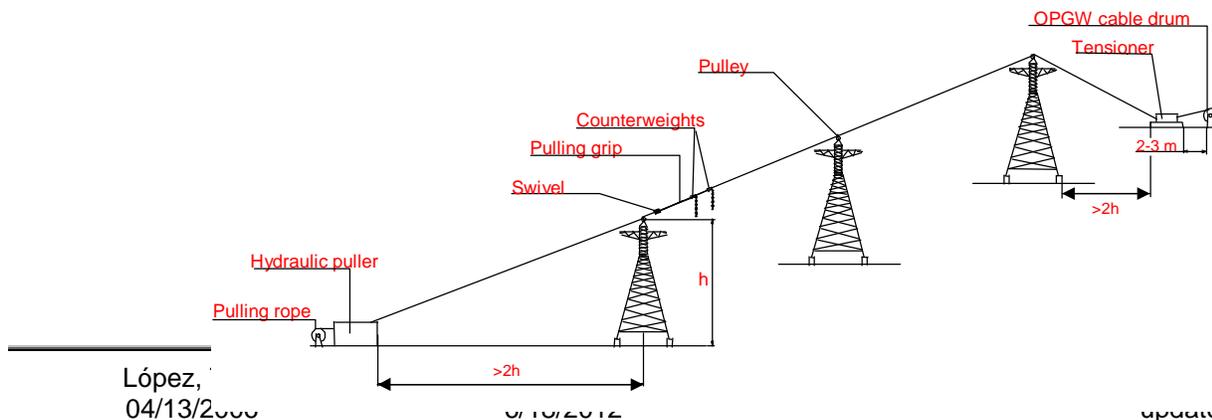


Fig 8. Pulling rope

5.4 Installation of OPGW cables

5.4.1 Important considerations during cable stringing.

The general method of installation is shown in Figure 2.



As a rule, install one reel of OPGW cable is installed at a time. In case of any difficulties, contact PRYSMIAN to obtain the correct guidelines to proceed with the OPGW cable installation.

5.4.1.1 Basic controls

Strict controls must be established during installation to ensure that it is performed correctly, without excess tension, twist of the OPGW, unsuitable compression, with correct sagging to assure the fibers or the aluminium tube are not damaged.

The tensioner and the puller should be placed at a distance from the first tower pulley which is equivalent to at least twice the height of the pulley (see fig. 2).

Intermediate control points should be established, with the necessary precautions that are required at critical points during installation (beginning/end of drum, angles, etc.).

During installation, the OPGW cable should not contact (strike or graze) any objects other than the pulleys.

The pulleys must be free to rotate in the correct direction; they must be free of obstacles that could prevent the proper pulley alignment.

The minimum bending radius must be controlled during all installation operations.

Ensure that the metal part of the pulleys do not make contact with the cable to prevent it from being damaged.

5.4.1.2 Stringing speed

PRYSMIAN recommends an installation speed about 60 m/min, depending always on the environmental conditions and the topology of the overhead line. The supervisors for the installation must assure that all PRYSMIAN recommendations are fully applied during the installation process.

5.4.1.3 Pulling tension

The recommended pulling tension shall be lower than 1.5 times the weight of 1 km (3280') of OPGW cable length.

In cases where higher pulling tensions are required (i.e. live installations,...), contact PRYSMIAN to determine the maximum permissible pulling tension for the installation.

5.4.1.4 Minimum bending radius

The minimum bending radius is as follows:

- On tensioner reels 40 times the cable diameter
- During installation 15.75 inches (400 mm)
- After installation 20 times the cable diameter

5.4.1.5 Communications during stringing

The personnel located at the puller, the tensioner, the pulley crossings, and the cable ends must be in communication at all times.

5.5 Sagging of the cable

Generally, the methods used to obtain the correct sag values of the OPGW cables are the same used for conventional ground wire cables. The specific recommendations are as follows:

Pulling is performed by using a preformed fitting or tension clamp (in intermediate spans) or by pulling the cable end. It is important that clamps are specified to the OPGW cable diameter.

Sagging of the cable and installation of fittings are always performed after stringing. At this time, the attachment fittings are installed to prevent damage to the OPGW cable.

The installer is responsible for any damage to the OPGW cable that may occur due to failure of following the proper procedures.

If the tension and sags are different from the expected values, the stringing or sagging should be halted. PRYSMIAN should be consulted in order to safely continue the installation operations.

5.6 Installation of fittings and accessories

The fittings (tension clamps, suspensions, earthing clamps, dampers, etc.) should be installed in accordance with the manufacturer's instructions and using the appropriate tools. Special attention must be taken on using appropriate clamps designed for the OPGW cable diameter.

When bringing the OPGW cable down the tower for splicing, a coil should be placed near the top of the tower. The coil should contain at least 3 loops and have a diameter of 1 meter (3.3 feet). An additional coil should be placed every 20m (66') as the cable progresses down the tower. An additional coil should be placed next to the splice case.

5.7 Personnel training

All personnel who participate in the installation of the OPGW cable must be properly trained and informed of handling problems and installation procedures for the OPGW cable.

It is responsibility of the installer to assure the personnel are properly trained.

5.8 Supervision

It is essential that the OPGW be supervised by technically competent personnel. This is critical for safety reasons, and to avoid any damage to the cable, which would void the warranty.

It is recommended that the supervisor also log all of the hardware used for the installation (type and location). This is important for ensuring that the correct hardware has been installed.

5.9 – Splice Points

After installation and optical measurements are taken to verify the OPGW cable meets the

customer's requirements, the OPGW cable will be spliced. The splice boxes should have a device for properly securing the center strength element (multitube configuration) or core tube (central tube designs) PRYSMIAN recommends the use of joint boxes specially designed for the correct jointing of OPGW, which can be obtained from approved hardware suppliers..

5.10 – Transmission testing during the installation phases

Prior to, as well as during the installation phases, the transmission characteristics of the fiber optic cables are verified in order to ensure proper installation and be sure that the final tests are within the specified range of tolerances.

5.10.1 – Measurements before OPGW cable installation

Prior to OPGW cable installation, the optical attenuation performance should be verified using an OTDR.

The attenuation values at the specified wavelengths shall be recorded and saved on an electronic diskette.

5.10.2 - Measurements after installation

After cable installation, prior to the splicing, the attenuation of each fiber shall be measured using an OTDR. These measurements are compared with those obtained prior to installation (see section 5.11.1.) to ensure the cable complies with the requirements and there are not any issues.

The attenuation values shall be recorded and saved on an electronic diskette.

5.10.3 – Splices measurement

After splicing, each splice is measured using bi-directional OTDR measurements to ensure that the attenuation values are within the specified criteria. The attenuation values shall be recorded and saved on an electronic diskette.

5.11 – Final acceptance test

After installation, final measurements of the transmission characteristics shall be performed and recorded.

5.12 – Environment

5.12.1 – Withdrawal of special waste (toxic and dangerous)

If any type of special waste such as oil, grease, solvents, saturation of gloves or rags, etc. are produced during cable installation, they must be disposed of in accordance to government and local regulations.

5.12.2 – Withdrawal of non-special or inert waste

- If there are excess materials or waste such as aluminium, optic fiber, plastic, wood, iron, etc., whenever possible, this should be sent to an authorized recycler or a controlled dumping ground.

- Regardless of the amount, the waste should never be abandoned. Moreover, the area should be cleaned when the work is finished.

6.- APPLICABLE PROCEDURES

Code	Document
SIG-07-PE-PA-008	INSTALLATION OF Prysmian EWJ and EWMJ SPLICE BOXES