

INSTALLATION PROCEDURE FOR OPGW FIBER OPTIC CABLES

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1. - PURPOSE

Describe the system used for installation and delivery of OPGW fibre optic cables.

2. - SCOPE

This document covers all the activities usually performed by PRYSMIAN for on-site installation of OPGW fibre optic cables, including transport, installation, 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 with optical fibre are similar to those used for installation of the standard ground wire cable.

Nevertheless, since there is an optical fibre core, special care should be taken to avoid any damage to the fibres 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. – Survey of the line

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

5.1.1. – Length of each drum

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

5.1.2.- Splices

The position of the splices depends on the maximum available length of OPGW, on the position of the towers and the tower access.

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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 drums should always be transported in vertical position with the cable ends fixed to prevent cable from slackening. All of the staves and/or safeguards should be maintained until the drums are situated for immediate installation.
- b) After the transport, the drums should be inspected to verify that they have not been damaged and that none of the staves and/or safeguards are broken.
- c) The drums should never, under any circumstances, be thrown from the lorry during unloading, nor moved by uncontrolled rolling.
- d) Loading and unloading are performed so that the drum remains in vertical position and the sides of the drum are not damaged.
- e) The drums can be moved by rolling a short distance ensuring that there are no objects that may damage the staves. The direction in which the drum turns should be the same as that in which the cable is wound during manufacture.
- f) The drum should not be stored on its side under any circumstances whatsoever.
- g) The ends of the cable should be sealed to prevent water penetration.
- h) The drums should be stored on flooring that is strong enough to prevent sinking.
- i) The drums should be stored to facilitate handling and loading. They should be located far from any activity that may damage them.

5.3. – Preparation for installation

5.3.1. – Positioning the equipment

5.3.1.1 Drum

The drum is placed at the selected site (with the space required for its location) so that the cable outlet is on the upper part and aligned with the planned laying direction.

The drum must be located at a distance of 2 or 3 metres from the tensioner. The lifting components usually used are hydraulic jacks and a bar with the suitable dimensions inserted in the central opening of the drum. The drum must be located at a height of 10 to 15 cm from the ground.

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Location of tensioner and drum

5.3.1.2 Puller and tensioner.

Either the puller and the 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 aligned with the conductors. The maximum acceptable deviation angle is 30° . ($\alpha < 30^\circ$ see Figure 1)

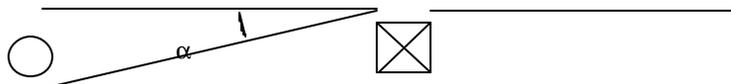


Figure 1

If it is not possible to achieve this angle, the puller and/or the tensioner are placed close to the following tower, using an additional pulling cable of the required length.

90° or less retracking of the optic cable is not allowed.

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

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In an installation with retracking, the smallest angle must be more than 90° and the final pulley should be placed at a distance equal to 2 times the height of the tower.

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

The tensioner must be equipped with a dynamometer (i). Its 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 in case of over tension on the cable (see 5.4.1.3).

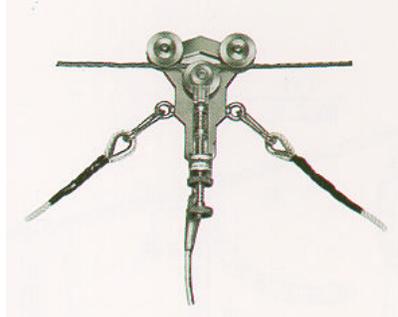
The pulling cable should be joined to the OPGW cable by a swivel and a pulling grip.

The minimum diameter of the reels (where the OPGW is to be coiled) used during the installation should be at least 80 times the diameter of the OPGW cable, with no need of exceeding 1500mm. For example, the tensioner reels for a 15mm cable should have a diameter of approximately 1.2 metres.

Either the breaking device and the puller have to be suitably connected to the ground by a system of moveable rollers such as that shown in the following picture. This also applies to the OPGW cable and the pulling cable, if it is a metal one.

The grounding connection in the photo here bellow has not to apply any pressure or deform the OPGW cable.

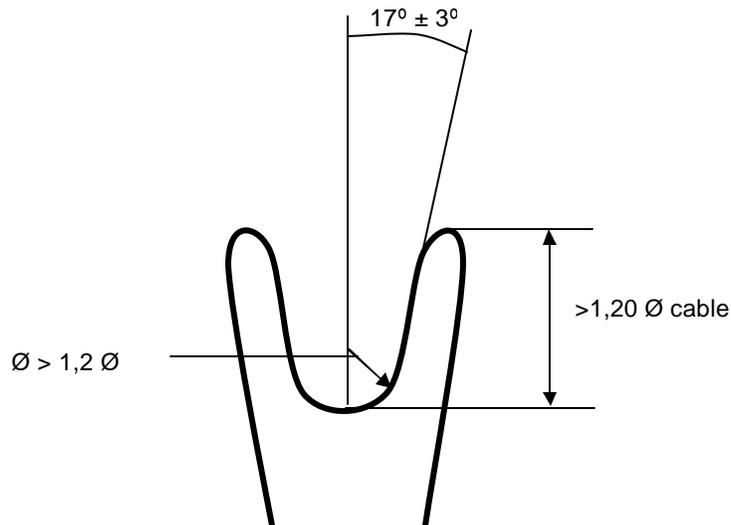
¹ It is compulsory to perform the calibration of the dynamometer, at least once a year. The PRYSMIAN supervisor could demand the Certificate of Calibration. This certificate will be emitted by an independent official laboratory.



Ground connection of the OPGW cable at the tensioner outlet.

5.3.1.3 Pulleys

It is recommended the use of adapted pulleys.



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.

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- In the first and in the last tower of a single installation.
- If the distance between the towers is greater than 600 metres.

In all the other cases pulleys with a diameter of 0.6 m can be used.

The pulleys have to be under good use 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 3 meters one from the other. In this way that when one counterweight goes through the pulley the other is operative.

Another anti-twisting device is installed at the end of the OPGW cable just before it leaves the tensioner.

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

- Spans \leq 300 m 12 kg
- Spans 300 m - 700 m 15 kg
- Spans > 700 m 20 kg

For Installation length longer than 4000 metres these values should be increased by 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 tightening process special attention has to be taken on using the appropriate clamp range and correct installation procedure, in order to not damage the OPGW cable.

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5.3.1.5 Auxiliary components

The swivel are specifically designed for OPGW cables. They are of the suitable size for the cable to be installed and in optimum condition for use.

The pulling grip for OPGW cable stringing must be at least 1.5 metres long and specifically designed for stringing OPGW cables. Moreover, it should be of the suitable dimensions and in optimum condition for use.

The clamps used during stringing and sagging operations have to be specifically designed for OPGW cables and must be suitable for 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 have to be specifically designed for cable stringing. When stringing is performed on a power line that is out of service we recommend the rope to be a metallic one. The minimum breaking load must be 5000 kg. This value can be higher depending upon the OPGW cable mechanical characteristics and at least equal to 2.5 times the maximum stringing load (see 5.4.3.1).

If an old earth 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.

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Installation equipment



Fig 1. Tensioner



Fig 2. Puller



Fig 3. Swivel



Fig 4. Pulley



Fig 5. Pulling grip

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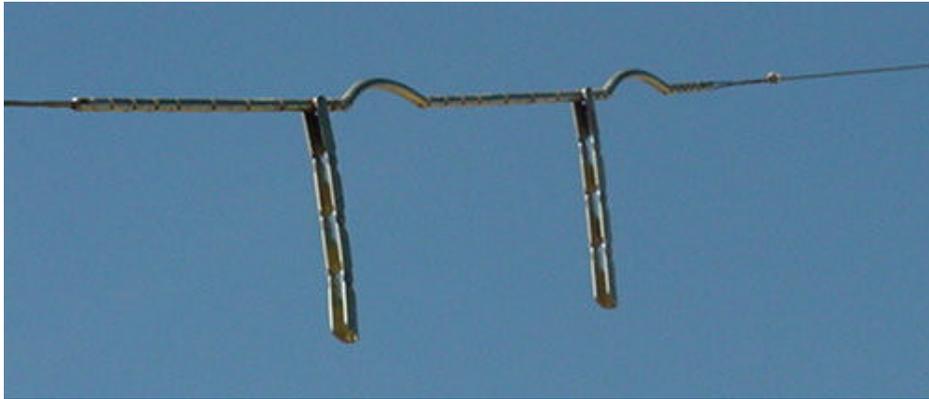


Fig 6. Anti-twisting devices



Fig 7. Clamp



Fig 8. Pulling rope

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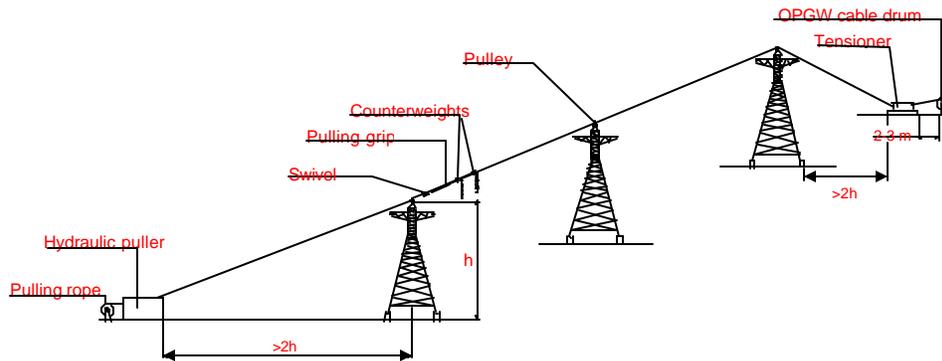
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5.4 Installation of OPGW cables

5.4.1 Important factors to be taken into account during stringing

The general method of installation is shown in Figure 2.



As a rule, one drum at a time of OPGW cable is installed. In case of any difficulties, contact PRYSMIAN TELECOM. We will give 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, regulating a correct sagging. Neither the fibres nor the aluminium tube will be 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 strike nor graze any objects other than the pulleys.

No obstacles must prevent the pulleys from rotating in the correct way.

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

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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 (or the technical responsible) for the installation will take care 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 (kg) of 1 km OPGW cable length.

In case that higher pulling tensions are required (i.e. live installations,...), further information should be asked to PRYSMIAN supervisor or PRYSMIAN Telecom Cables y Sistemas España S.L. in order to know the maximum permissible pulling tension for such particular installation.

5.4.1.4 Minimum bending radius

The minimum bending radius are as follows:

- | | |
|-----------------------|-----------------------------|
| - on tensioner reels | 40 times the cable diameter |
| - during installation | 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 are in communication at all times by communication system.

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:

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Pulling is performed by a preformed fitting or tension clamp (in intermediate spans) or with the pull jacket at the end. Special attention must be taken on using appropriate clamps adapted to the OPGW cable diameter.

Sagging of the cable and fittings installation are always performed after stringing. At this time, the attachment fittings are also 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 cause by incorrect application of the previous points.

If the tension and sags are different from the expected values, the stringing or sagging should be halted. The PRYSMIAN supervisor and the project leader will 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 adapted to the OPGW cable diameter.

From the top of the tower, OPGW falls down, it is necessary to introduce a cable loop of three spires of 1 m diameter in the top of the tower and each 20 m from the top. Finally the cable must be conducted till the joint box place.

5.7 Personnel training

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

It is responsibility of the installer to assure the correct instruction to the whole personnel involved in the installation works.

5.8 Supervision

Over requisition, PRYSMIAN offers the service of a supervisor that will be responsible for ensuring compliance with all of the points indicated in this document as well as all required standards applicable to the specific installation.

The supervisor will communicate to PRYSMIAN Telecom Cables y Sistemas España, S.L. any non-conformity detected in the cable or cable installation procedures.

If a situation occurs that is not covered in the present installation procedure, whenever this

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occurs with an OPGW cable, the Supervisor will determine whether or not the action is correct.

The supervisor will request the installer to provide a descriptive list of the components to be used for installation. Moreover, he will verify that these components are sufficient and adequate.

To place the supervision on record, the PRYSMIAN supervisor will register all of the items indicated in point 5 of this document in Q-09-F-PA-004 format.

5.9 - Splices

After stringing and the optical measurements taken to verify it meets the customer's requirements, the OPGW cable will be spliced

The joint boxes used should have a device for fixing properly the centre element (multitube configuration) or the aramid yarns (nomotube configuration). PRYSMIAN recommend to use the PRYSMIAN joint boxes specially designed for the correct jointing of OPGW cables (Q-09-PE-PA-004 "Installation of EWJ and EWMJ splice boxes")

5.10 – Transmission test during the installation phases

Prior to as well as during the installation phases, the transmission characteristics of the fibre 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, each optical fibres is verified using OTDR.

The attenuation values recorded are registered in during installation phase" and saved on an electronic diskette. This computer register is kept by PRYSMIAN.

5.10.2 - Measurements after installation

After the cable has been installed, and prior to the splices, each of the cable fibres is verified once again using OTDR. These new values are compared with those obtained in 5.11.1. in order to ensure the absence of any problems.

The attenuation values recorded are registered saved on an electronic diskette. This computer register is kept by PRYSMIAN. The measurements are suitable identified and referenced.

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5.10.3 – Splices measurement

After splicing, each joint is optically verified using OTDR in order to ensure that the attenuation values are within the required values.

The attenuation values recorded are registered and on electronic format. This computer register is kept by PRYSMIAN.

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5.11 – Final acceptance test

After installation, a final measurement of the transmission characteristics is and the values are duly recorded. A copy of this is submitted to the customer. These measurements are also recorded and kept by PRYSMIAN.

5.12 – Safety and hygiene

The supervisor designated by PRYSMIAN is responsible for compliance with the general safety and hygiene standards for PRYSMIAN cables or the requirements stipulated by contract, if any.

5.13 – Environment

5.13.1 – 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, proceed as follows:

- Place in heavy-duty carboys or steel drums, indicating what type of waste it is.
- If installation is performed in the Community of Catalonia, contact the Quality and Environment Department. This department will furnish the data for the administrator in charge of such waste. Another option is to contact the Waste Committee of the Autonomous Government of Catalonia directly (tel. +34 93 567 33 00).
- If the installation is located outside of the Community of Catalonia, contact the Town Council or Community in this location so that such bodies can provide information on the administrators authorized to treat this waste.
- Such waste must not be abandoned, mixed with other waste, or sent to the dumping ground.

5.13.2 – Withdrawal of non-special or inert waste

- If there are excess materials or waste such as aluminium, optic fibre, 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.

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6. – APPLICABLE FORMATS**7.- APPLICABLE PROCEDURES**

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

8.- MODIFICATIONS TO THE PREVIOUS REVISION

Point 5.6: down lead cable in the jointing towers

Point 5.9.: fixing the centre element (multitube configuration) or the aramid yarns (monotube configuration)

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