

## Installation Guidelines for Optical Ground Wire (OPGW) Cables



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**GENERAL:**

OPGW is usually installed on the top of pole of the electric power aerial wire.(on the Power transmission line towers/poles) The following disadvantages should be considered: vibration caused by wind, hurricane, ice thickness, unsteady operation caused by temperature, and possible thunder attack, short circuit etc. Therefore, detailed engineering program should be formulated according to different structures of OPGW and specific route conditions. According to design requirement, OPGW should be allotted correctly; every tray of optical fiber cable should be installed in the appointed part of route and should be laid according to engineering chart operation file.

**1. PURPOSE:**

This Manual outlines the general recommendations for the selection of methods, equipment, and tools that have been found to be practical for the stringing of the Optical Ground Wire (OPGW).

**2. REFERENCE:**

IEEE 524, Drum handling & Quality Assurance Manual

**3. PRECAUTION:**

Care must be taken to avoid damaging the OPGW during handling and stringing operations. Avoid sharp bends to the cable and take precautions to prevent crushing the OPGW during placement. The transmission quality of the optical fibers can potentially be degraded if the OPGW is subjected to excessive pulling tensions or excessively small bend diameters. Always observe the recommended values for Maximum Stringing Tensions and Minimum Bend Radius. More information about these values is contained in the 7.3 and 7.4.

OPGW cable reels should always be transported and handled in an upright position. Never lay a reel of cable on its side. It is recommended that each reel of OPGW be tested prior to installation and after installation to ensure that fiber damage has not occurred during shipping and after installation to ensure that fiber damage has not occurred during stringing operations. All cable protective packaging (wood lagging or Polypropylene sheet) must remain in place on all reels until placed on a pay-out rack and the rack is in position for cable stringing.

#### **4. INSTALLATION PREPARATION OF OPGW:**

##### **4.1 Survey of the line**

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

##### **4.2 Length of each drum**

The OPGW drum length is 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.

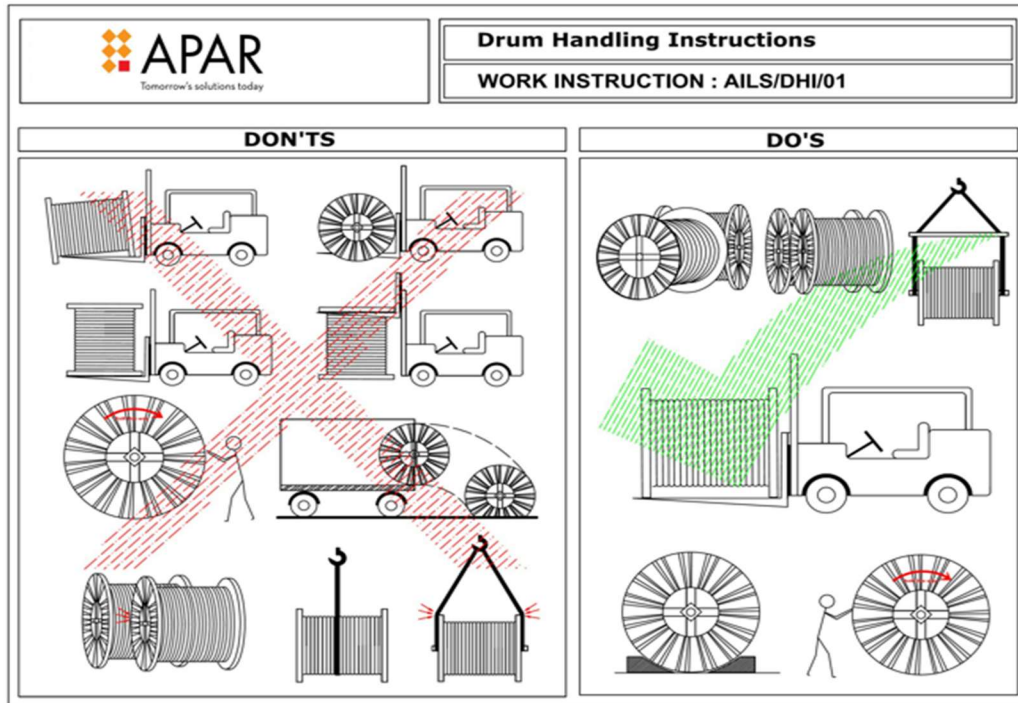
##### **4.3 Splices**

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

#### **5 TRANSPORT, LOADING, UNLOADING AND STORAGE:**

The following procedures are recommended to prevent the cable from suffering damage 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 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 or safeguards is broken.
- c) The drums should never, in any case, be thrown from the lorry during unloading, or 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 the drum turns should follow the instruction of the mark on the drum.
- f) In any case the drum should not be stored horizontally.
- g) The ends of the cable should be sealed to prevent water penetration.
- h) The drums should be stored to facilitate handling and loading, and should be located on a safe place where they will not be damaged.



**Fig. 1 - Handling of OPGW cables**

**6 PREPARATION OF INSTALLATION:**

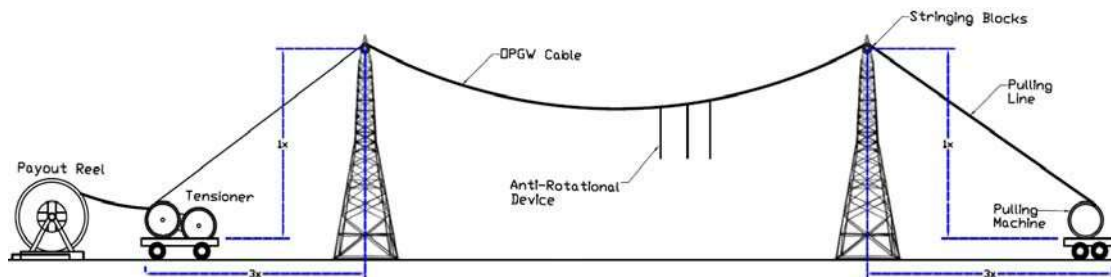
**6.1 POSITIONING THE EQUIPMENT:**

**6.1.1 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 meters 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.



**Fig 2 - Stringing Set-up at Site**

**6.1.2 PULLER AND TENSIONER:**

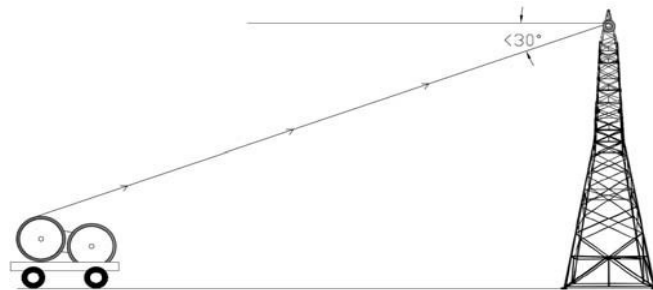


**Fig.3 – Puller & Tensioner**

APAR recommends using the controlled tension stringing method of installation.

The puller and the tensioner must be placed at a minimum distance from the tower equal or more than twice of the tower's height.

The tensioner as well as the puller should be placed aligned with the conductors. The maximum acceptable deviation angle is 30°. (a < 30 ° see Figure 4)



**Fig. 4 Location of Puller and drum**

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.

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. In the installation with retracing, the smallest angle must be more than 90° and the final pulley should be placed at a distance equal to twice of the tower's height.

In the tensioner, the first groove that the cable will pass through must be perpendicular to the axis of drum.

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 14.00mm cable should have a diameter of approximately 1.12 meters.

Either the braking device or the puller has to be suitably connected to the ground by a system of moveable rollers such as that shown in the figure 5.

This also applies to the OPGW cable and the pulling cable, if it is a metal one.



**Fig. 5 - Ground connection of the OPGW cable at the tensioner outlet**

### **6.1.3 PULLEYS:**



**Fig 6- Pulleys**

The tower pulleys should have a minimum diameter of at least 0.8 meters 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 600 meters.

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.

#### **6.1.4 ANTI-TWISTING DEVICES:**



**Fig. 7- 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 meters 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.

#### **6.1.5 AUXILIARY COMPONENTS:**



**Fig 8 – Swivel**

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 meters 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.

**6.1.6 PULLING ROPE:**



**Fig. 9 - Pulling Rope**

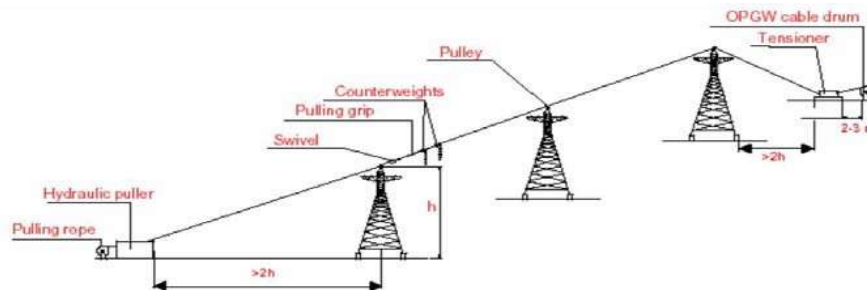
The pulling rope have to be specifically designed for cable stringing. When stringing is performed on a power line that is out of service we recommend the rope to be a metallic one. The minimum breaking load must be 5000 kg. This value can be higher depending upon the OPGW cable mechanical characteristics and at least equal to 2.5 times the maximum stringing load (refer pulling tension & bend radius)

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.

**7.1 INSTALLATION OF OPGW CABLE:**

The general Method of installation is shown as below:



**Fig. 10 - Schematic View of installation Process**

## **7.2 BASIC CONTROL:**

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 fibers nor the aluminum or stainless steel 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.

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.

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

## **7.2 STRINGING SPEED:**

The maximum permissible stringing speed is 40 meters per minute. It always depends on the stringing conditions and must be reduced to avoid damages to the optical fibers, the tube and the OPGW cable. Higher speeds create a potential hazard of greater damage in case of a malfunction.

## **7.3 PULLING TENSION:**

It is recommended to use a bull-wheel type tensioner with round (not "V" type) polyurethane lined contact grooves. The tensioner should have two bull-wheels, each with multiple grooves to minimize cable damage. The tensioner should be capable of maintaining the required tensions at various pulling speeds. Positive braking systems are necessary for pullers and tensioners to maintain the tension when pulling is stopped. Minimum diameter of the bull wheels should not be less than  $70 \times D$  (diameter of the OPGW).

The recommended pulling tension shall be lower than 1.5 times the weight (kg) of 1 km OPGW cable length. Maximum OPGW recommended stringing tension is 20% (at tensioner) of the rated breaking strength.

In case that higher pulling tensions are required (i.e. live installation), further information should be asked to APAR engineer in order to know the maximum permissible pulling tension for such particular installation.

## **7.4 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

### 7.5 COMMUNICATIONS DURING STRINGING

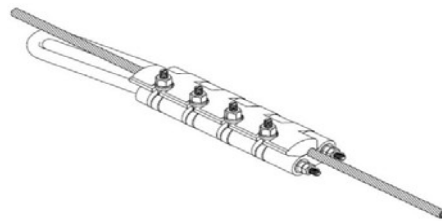
The personnel located at the puller, the tensioner, the pulley crossings and the cable ends are in communication at all times by communication system.

### 7.6 SAGGING METHODS

The methods and procedures for sagging the OPGW are the same as those for normal overhead ground wires. For determining sags, the installer should use the sag-tension design information provided by the utility or APAR.

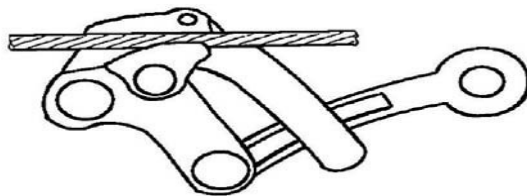
Sagging and tensioning should be conducted from dead-end to dead-end. Care should be taken to avoid sagging the cable around angles greater than 30 degrees.

A temporary grip is installed on the OPGW for tensioning. The grip must be designed to hold the OPGW without damage, and in particular not pinch the cable or crush the aluminum pipe. APAR can provide a come-along, sometimes called a pocketbook grip, that can be attached anywhere along the length of an OPGW. Figure 11 illustrates a satisfactory come-along design.



**Fig. 11 – Come - along (Pocketbook Grip)**

Some types of gripping devices that might damage the OPGW such as Chicago grip or Kito grip are strictly prohibited to use for OPGW, as shown in Figures 12 A & B.



**Fig. 12 A – Chicago Grip**



**Fig. 12 B – Kito Grip**

**Note :** Always use the proper cable pulling equipment and tools to prevent stressing the cable, as this could cause damage or failure.

## **7.7 INSTALLATION OF FITTINGS AND ACCESSORIES:**

The OPGW will also use special attachment hardware, including dead ends, suspension clamps, and wire fittings such as grounding clamps. The hardware is designed to provide the necessary holding strengths and prevent deformation of the fiber unit which could potentially damage the optical fibers.

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.

## **7.8 SPLICE:**

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 center element (multitude configuration).

Note : After Fibre Splicing –

- Protect the splice joints with suitable waterproofing materials to prevent water ingress, which could damage the fibers over time.
- Test the fiber optic links using an optical time-domain reflectometer (OTDR) to ensure that there is no significant signal loss or issues with the fiber.

## **7.9 TRANSMISSION TESTS DURING 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.

- a) Measurements before OPGW cable installation  
Prior to OPGW cable installation, each optical fibers is verified using OTDR. The attenuation values recorded are registered in during installation phase
- b) Measurements after installation  
After the cable has been installed, and prior to the splices, each of the cable fibers is verified once again using OTDR. These new values are compared with those obtained in a) in order to ensure the absence of any problems

## **7.10 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 APAR.

## **7.11 LEGAL NOTICES:**

PLEASE READ THESE LEGAL NOTICES CAREFULLY.

### **Disclaimer:**

This guide provides suggestions for methods, equipment and tools that have been found practical based on field-testing. These guidelines are meant to provide procedures that will help provide a high quality, trouble-free installation so that the OPGW Cable once installed, will perform its intended function.

Failure to follow these guidelines may cause a hazardous condition or result in premature failure.

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**WARNING:** Use appropriate safety procedures.

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