Incab

OPGW Installation

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PURPOSE AND LEARNING OBJECTIVES

This course will teach the proper method to install OPGW cable in a safe manner, as well as the cable characteristics which will define the equipment requirements.

After this class, you will be able to:

1. Identify cable specifications that define the equipment requirements.
2. Understand the correct stringing method for OPGW.
3. Specify the required equipment for the installation:
    - Bullwheel tensioner
    - Reel Stand
    - Puller
    - Pulling Rope (“Line”)
    - Pulling Grips (“Shocks”) & swivel
    - Stringing Blocks (“Sheaves”)
    - Grips for Sagging & Clipping-In
    - Anti-Rotation Device (ARD)
4. Understand how to setup an OPGW installation with safe working methods.

Incab University “School of Excellence in Fiber Optics”
Agenda

- Introduction
- Learning Objectives
- Presentation
- Q&A (Technical questions only)
- Let’s start!

Part 1

Stringing

OPGW Installation - Stringing

Safety

- All applicable federal, state, local, industry, and your own company's safety rules and practices must be followed while shipping, handling, or storing OPGW.
- Cable manufacturer guidelines do *not* supersede any established safety rules, policies, procedures, or practices.
- The safety needs of the general public and your own personnel supersede all other considerations.

Safety is essential!

OPGW Installation - Stringing

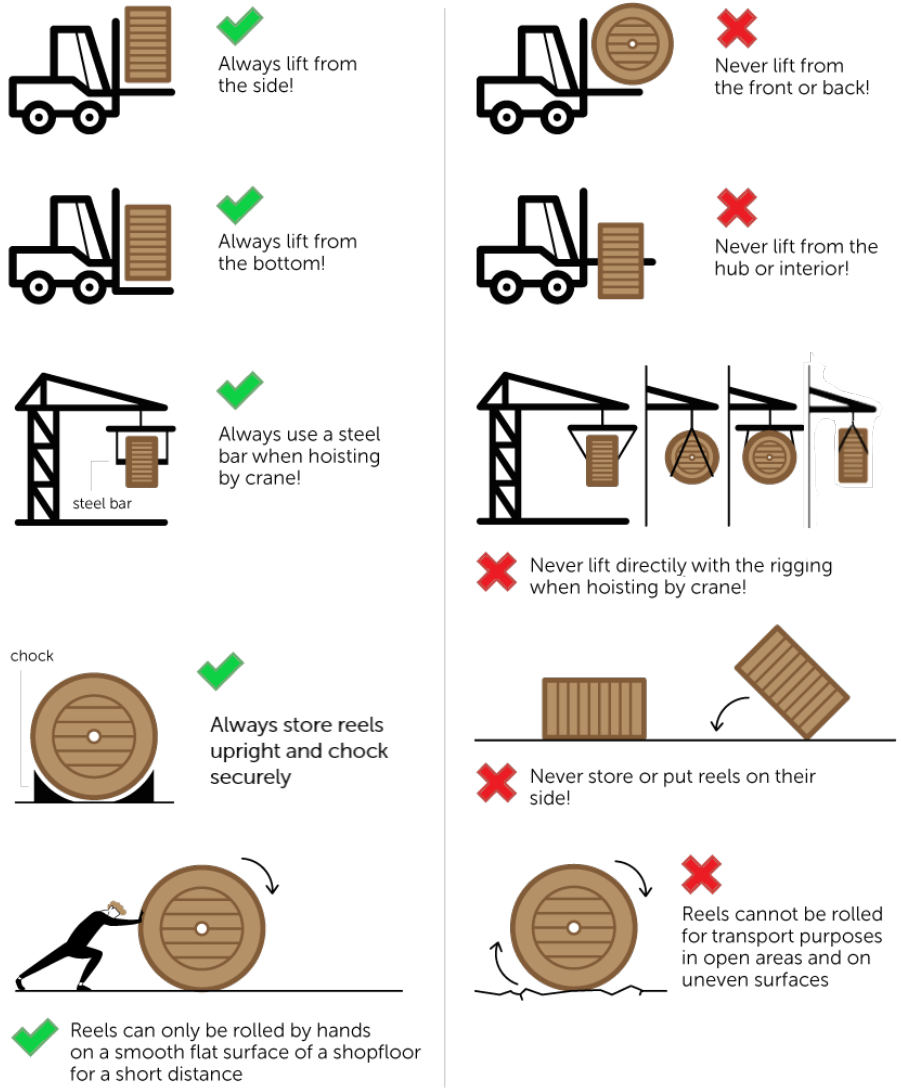
Reel Handling

Quick review of reel handling:

always ✓

never ✗

Comment: Wood lagging versus reel wrap



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Check the Pull!

This is your last chance to check the pull for "gross conceptual error" (= potential for problems)

Pull must not exceed the maximum pull-in tension = 20% RBS!

- Per IEEE 524 (and Incab) = 20% RBS
- Must confirm with the cable supplier! Some allow only 15% RBS or less

Pull also must not exceed the maximum allowed horizontal line angle change!

Let's look at each…

OPGW Installation - Stringing

Review the Cable Datasheet

Product Datasheet

OPGW S 48U (2x24) 15.0mm 105kA2·s 103kN

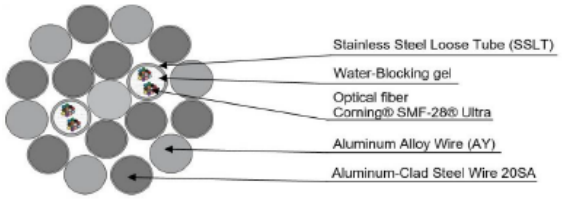
Order information

Design	Part number
OPGW S 48U (2x24) 15.0mm 105kA2·s 103kN	0113-67572

Features

- ACS wires are highly corrosion-resistant
- Aluminum alloy wires provide conductivity for fault current
- Optical ground wire shields high-voltage conductors from lightning strikes

Design



Design element	Material	Count	Diameter Metric (mm)	Diameter Customary (inches)
Center member	AY wire	1	3.00	0.1181
1st stranded layer	20% ACS wire/SSLT	4/2	3.00	0.1181
2nd stranded layer	20% ACS wire/AY-wire	6/6	3.00	0.1181

Technical Specifications

Mechanical	Metric	Customary
Cable diameter	15.0 mm	0.591 in
Cable unit weight	641 kg/km	0.431 lb/ft
Rated breaking strength (RBS) (without SSLT's)	103.8 kN	23 332 lb
Maximum rated design tension (MRDT) (80% RBS) with 0% fiber strain	82.1 kN	18 460 lb
Zero fiber strain margin (ZFSM) (80% RBS)	82.1 kN	18 460 lb
Cross-sectional area of ACS wire	74.0 mm²	0.115 in²
Cross-sectional area of AY wire	49.5 mm²	0.077 in²
Cable total cross-sectional area	123.4 mm²	0.191 in²
Modulus of Elasticity, initial	96.0 kN/mm²	13 926 ksi
Modulus of Elasticity, final	115.9 kN/mm²	16 813 ksi
Temperature coefficient of linear expansion	14.93 E⁻⁶/°C	8.29 E⁻⁶/°F
Southwire Sag10™ coefficient chart number	1-1461	-
Lay direction of outer layer	Left	-

The cable datasheet provides important information that you will need.
This is an example.

We will show you how these are used in a moment

Cable Diameter

Cable rated breaking strength (RBS)

If you don't have the datasheet, check with the cable manufacturer!

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Maximum Pull-In Tension

- **Check the estimated pulling tension (reference: IEEE 524)**
  - Step 1. $T_{\text{Payoff}} \approx \frac{1}{2}$ Design tension, 60°F Initial, unloaded
  - Step 2. $T_{Max\ (Pulling\ end)} \approx \frac{T_{\text{Payoff}}}{0.98^N}$ where N = number of structures

- **What does this mean exactly?**
  - Each stringing block (a.k.a. sheave or pulley) will add a little friction to the pull
  - Consequently, the tension on the payoff side < tension on the pulling side
  - The difference will be a factor of 1.5 at 20 structures and almost 2 at 30 structures

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Maximum Pull-In Tension, Example

- **Example (customary units):**
  - 19,500 ft pull through 30 structures
  - Cable RBS = 20,000 lb ➔ 20% RBS = 4,000 lb.
  - Design tension is 3,000 lb.
  - Estimated tension at payoff = 1,500 lb.
  - Estimated maximum tension = 1.8 * 1,500 = 2,700 lb.
  - 2,700 lb < 4,000 lb so OK!

Tip: Alternate method for estimating the pull-in tension can be found at the Wagner-Smith web site: https://wagnersmith.com/line-pull-calculator/

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Maximum Pull-In Tension, Example

- **Example (metric units):**
  - 5,945 m pull through 30 structures
  - Cable RBS = 89.0 kN (9,070 kg) ➔ 20% RBS = 17.8 kN (1,814 kg)
  - Design tension is 13.3 kN (1,360 kg)
  - Estimated tension at payoff = 6.7 kN (680 kg)
  - Estimated maximum tension = 1.8 * 6.7 = 12.1 kN (or 1.8 * 680 = 1,224 kg)
  - 12.1 kN < 17.8 kN so OK! (or 1,224 kg < 1,814 kg so OK!)

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Maximum Horizontal Line Angle Change

- **Verify the maximum amount of horizontal line angle change that is allowed. Incab guidelines are:**
  - Types C (plain center SSLT), CA (aluminum-clad center SSLT) and AP (aluminum pipe): ≤ 270° total, 1 ≥ 90°
  - Type S (stranded SSLT): ≤ 360° total, 2 ≥ 90°

Notes:

- Ignore angles ≤ 5°
- (2) These are guidelines only, *not* laws.

- **Other suppliers could be more or less restrictive. You must check!**
- **Check with the cable manufacturer if you have a problem situation!**

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Controlled Tension Stringing Only!

- Only the Controlled Tension Method of stringing is approved to install OPGW
- This method consists of using a bullwheel tensioning device at the payoff end of the pull to maintain constant cable tension during stringing
  - Reference: IEEE 524

Let's review each piece of equipment

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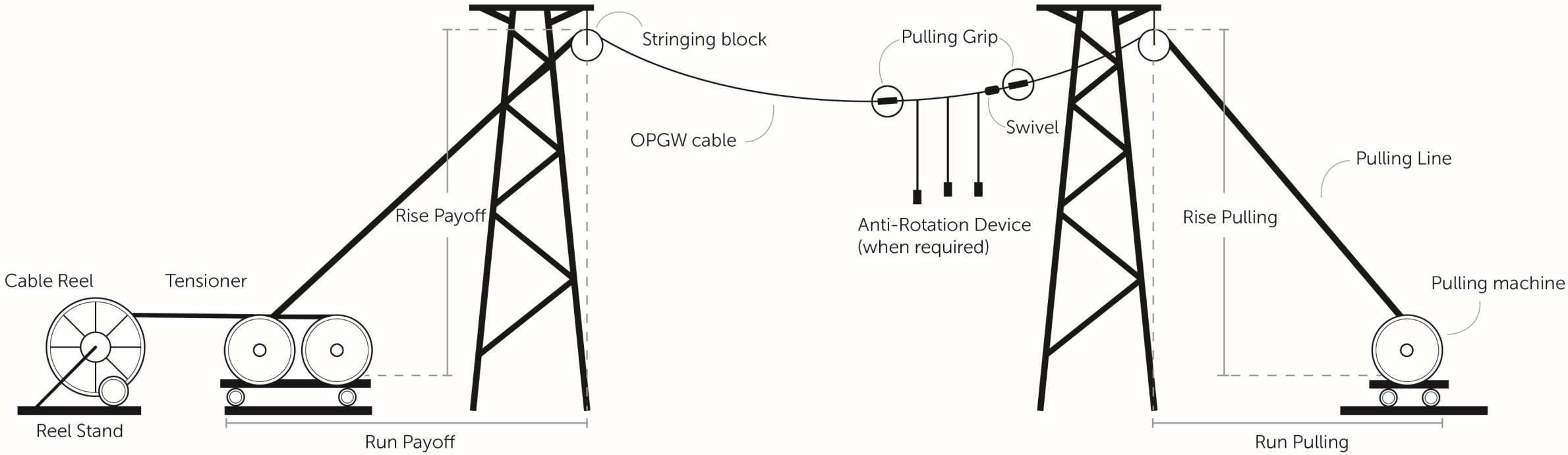
Controlled Tension Stringing



Typical Set-up for Controlled Tension Stringing

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Equipment – Bullwheel Tensioner

- **Requirements:**
  - Must be capable of maintaining constant tension and speed
  - Grooves must be neoprene lined and in excellent condition
    - clean
    - no scratches, gouges, or grooves worn into the surface

- **Tip: Use the mental "Bloody Hand Test"**

- Also, note that in the US and many other countries, conductor is right-hand lay and OPGW is left-hand lay

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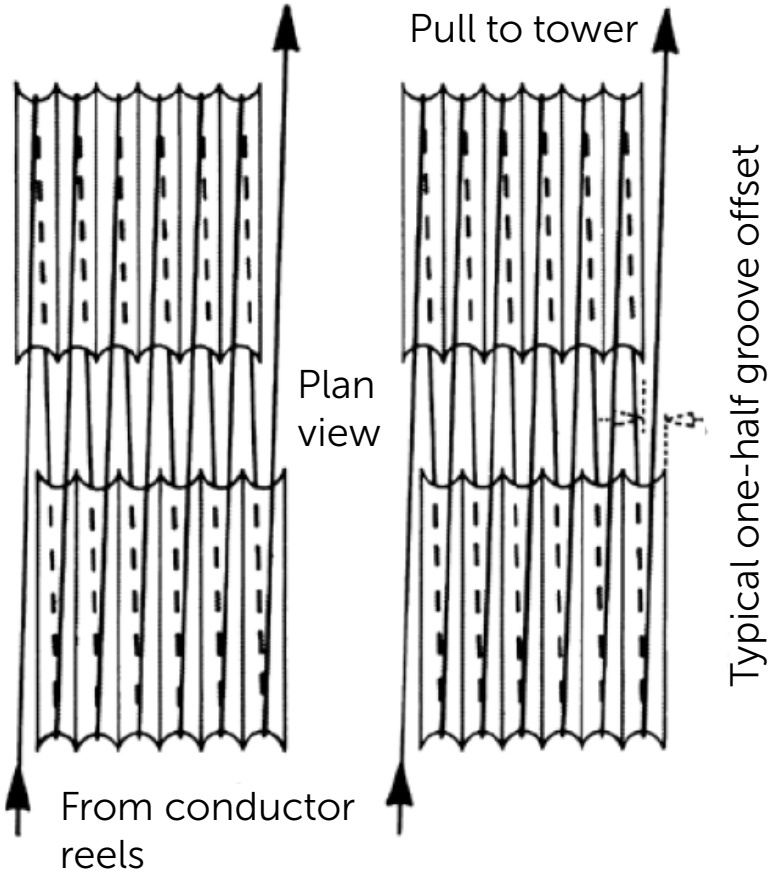
Bullwheel Reeving for Right-Hand Lay Conductor



Notice that the **conductor** is going **left to right** and that the **offset** of the front set of wheels is to the **left** relative to the back set

OPGW Installation - Stringing

Bullwheel Reeving for Left-Hand Lay OPGW

- **In theory, reeving and offset should be opposite for OPGW vs conductor**
  - So, reeving right to left and offset to the right
  - To prevent "de-stranding", unravelling, or birdcaging
- **But reality (in my experience) has shown…**
  1. ≈ 50% (or more?) of tensioners, not possible or practical to reave opposite or change the offset
  2. The requirement often overlooked or ignored

➔ **Never seen an actual problem caused by incorrect reeving or offset**
- Because ACS and AY wires used in OPGW? Good wire preforming?

➔ **You must check with the cable manufacturer on this point!**

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Equipment – Reel Stand

- **Requirements:**
  - Must be capable of supporting the gross reel weight
  - Must rotate smoothly so that the cable pays off smoothly
  - Must provide light, constant back tension
    - No "free spin"
    - 50 - 100 lbs back tension = "hand tight"

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Equipment – Puller

- **Requirements:**
  - Must have sufficient working capacity for the pull
    - Torque and tension
    - Volume for pulling line
  - Must operate smoothly when starting and stopping pulls
    - Free of "chatter“
    - Free of any sudden jerking or bouncing of the OPGW

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Pulling Rope or Line

- **Requirements:**
  - Should use high quality, braided pulling rope/line
    - About same diameter as the OPGW
    - Sufficient strength
    - No-torque type is best

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What about using an existing shield wire to pull in OPGW?

- Can use existing shield wire or OPGW, *but* ….
  - ➢ Must be carefully inspected before the pull
    - Drones, assessment equipment (such as Kinectrics)
    - Look for broken strands and corrosion
      - ➔ If the cable breaks during pull-in, you will have **disaster!**
  - ➢ Must also monitor the cable during the pull
    - Broken strands on old cable could damage the sheaves which could damage your new OPGW

So, is it worth the risk to use an old cable to pull in new OPGW?

In terms of safety and your investment in your new OPGW, isn't it better to pull out the old cable and install a good quality pulling rope?

OPGW Installation - Stringing

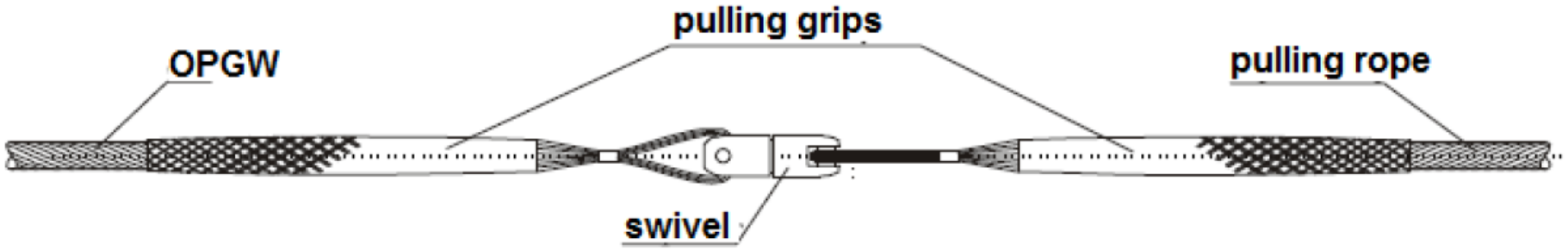
Pulling Grip

- **Requirements:**
  - Must use high quality, woven wire pulling grips
    - "Kellums" type
    - 1 sized for the OPGW, 1 for the pulling rope
    - Strong enough for the pull
    - Must pass freely through the blocks!

OPGW Installation - Stringing

Swivel

- Must use high quality, ball bearing, double-axis swivel
  - ➢ To minimize the transfer of torque between pulling rope and OPGW
  - ➢ Strong enough for the pull
  - ➢ Must pass freely through the blocks!



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Stringing Blocks (“Sheaves”, “Travelers”, “Pulleys”)

- **Requirements:**
  - Stringing blocks are the single most important tool used during stringing!
- **Absolutely essential that they:**
  - ➢ Rotate freely
  - ➢ Have smooth, clean bearing surface

Tip: Recall the mental "Bloody Hand Test"

OPGW Installation - Stringing

Stringing Blocks (“Sheaves”, “Travelers”, “Pulleys”)

- Un-lined aluminum blocks work great!
  - **Note:**
    - Preferred by **Incab** based on 25+ years of field experience!
    - But some OPGW manufacturers may not approve!

- Lined with neoprene or urethane is OK, but with OPGW these have a greater tendency to ride out of the groove, especially at angles ➔ Must be careful!
  - **Note:**
    - Some OPGW manufactures only permit lined blocks

- Never, ever use un-lined steel blocks!

OPGW Installation - Stringing

Stringing Blocks (“Sheaves”, “Travelers”, “Pulleys”)

Tip:

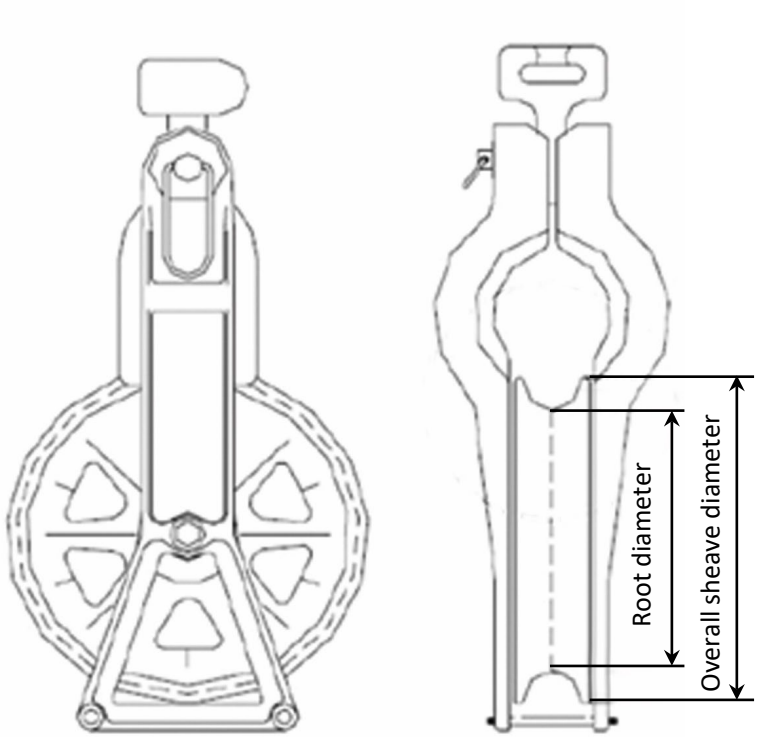
Plastic "Aerial Buddy" blocks from Jameson are great for OPGW

24" size is good for most cables and most angles (Gotta check!)

OPGW Installation - Stringing

Sizing The Blocks

- **Sizing:** Default = 40 x cable OD, or…
- First, Last, and Angles ≥ 45°
  - Aluminum pipe (Type AP) = 40 x cable OD
  - Center SSLT (Type C or CA) = 40 x cable OD
  - Stranded SSLT (Type S) = 30 x cable OD
- All Other Structures
  - Aluminum pipe (Type AP) = 35 x cable OD
  - Center SSLT (Type C or CA) = 35 x cable OD
  - Stranded SSLT (Type S) = 25 x cable OD
- **Measured "bottom of groove" (not overall)**



Warning!
Some manufacturers may be more restrictive (= larger blocks)

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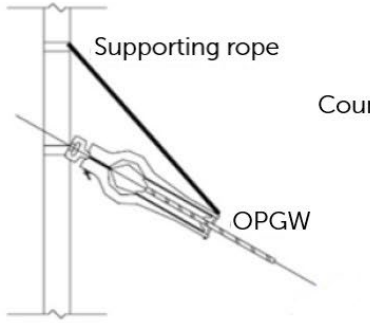
Stringing the Blocks (continued)

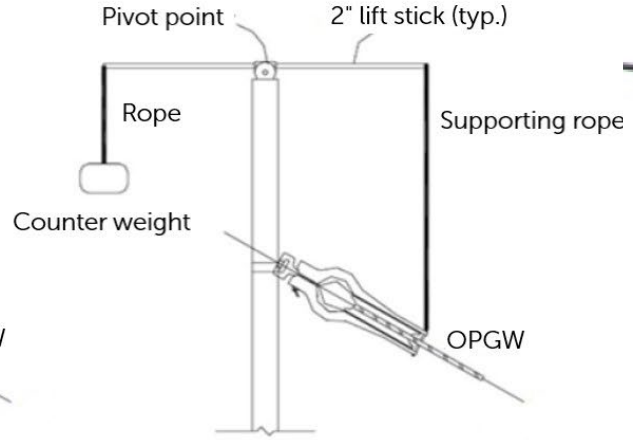
- Blocks Need Support at Angles ≥ 30°

Improperly supported sheave

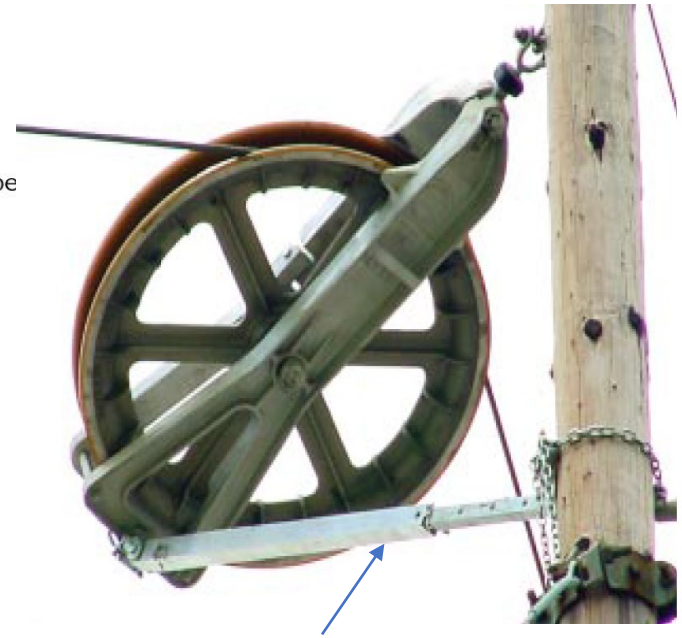


Properly supported sheave

(Can also be from underneath ➔)



Best supported sheave



Support from underneath block

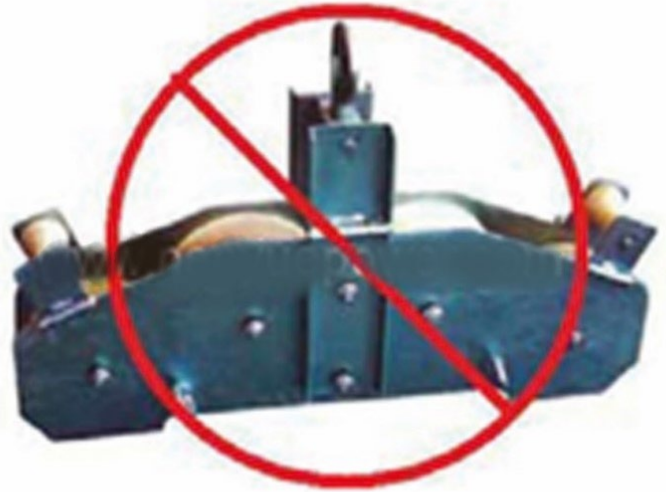
The OPGW and the block must be in the same plane during the pull!

➔ If they aren't, then the cable can ride up and out of the block!

OPGW Installation - Stringing

Beware of “bad” Stringing Blocks

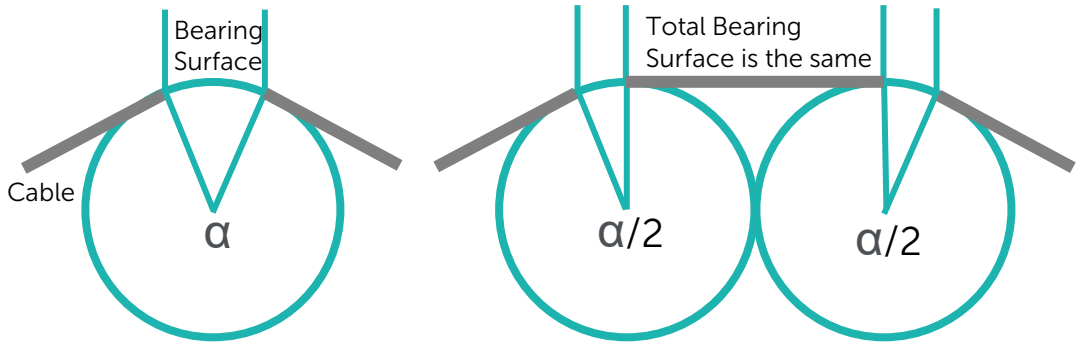
- Never, ever use anything that looks like this or try “ganging” two or more smaller blocks to replace one large one!



OPGW Installation - Stringing

Beware of “bad” Stringing Blocks

- If a given diameter isn’t large enough, it doesn’t have enough bearing surface
  - If you “gang” blocks you’re just dividing the same area across those blocks
    - Thus, it doesn’t matter how many blocks you use, there still won’t be enough total bearing surface area!



OPGW Installation - Stringing

Beware of “bad” Stringing Blocks

- **Exception (sort of):** When multiple blocks are needed to physically traverse a structure

  ➔ Even in this situation, each block must still have sufficient bearing surface, so each must still be the correct minimum size!

OPGW Installation - Stringing

Grips for Sagging & Clipping-In

Requirements: You have two good choices, plus one in a special situation

1. "Pocketbook" type come along
   - More expensive (around $500), longer lead time (2 - 4 weeks)
   - For one diameter only
   - Can be used indefinitely ***if*** kept in good condition

2. Formed wire grips
   - Fairly cheap (< $100), often from stock
   - For a range of OD's
   - Can only be used 3x max (initial + 2 re-applies)!
   - Some grip manufacturers don't approve of their use as a tool!

3. Deadend (desperation or emergency situation)
   - bolted - but, shear-head bolts will have to be replaced
   - u-bolt or wedge - difficult to later move
   - formed wire - Can't use as a deadend after use as tool

OPGW Installation - Stringing

Beware of “bad” Grips for Sagging & Clipping-In

Never use one of these:

Or any tool with an elliptical (oval) or triangular shaped groove

OPGW Installation - Stringing

Anti-Rotation Device (ARD)

- When to use?

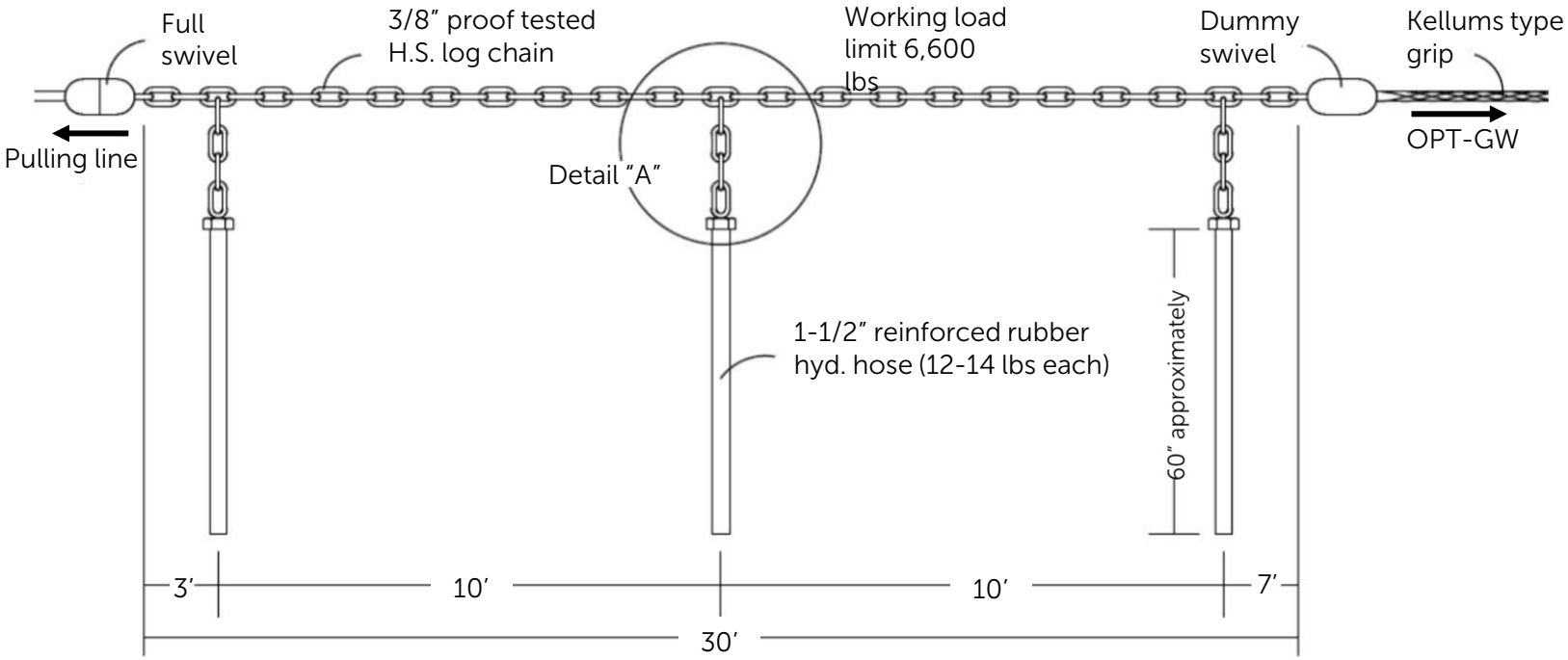
- For Incab, follow these guidelines
  - Type AP (aluminum pipe) = Always use
  - Type C or CA (center SSLT) = Pulling distance > 15,000 ft (4,500 m)
  - Type S (stranded SSLT) = Not required

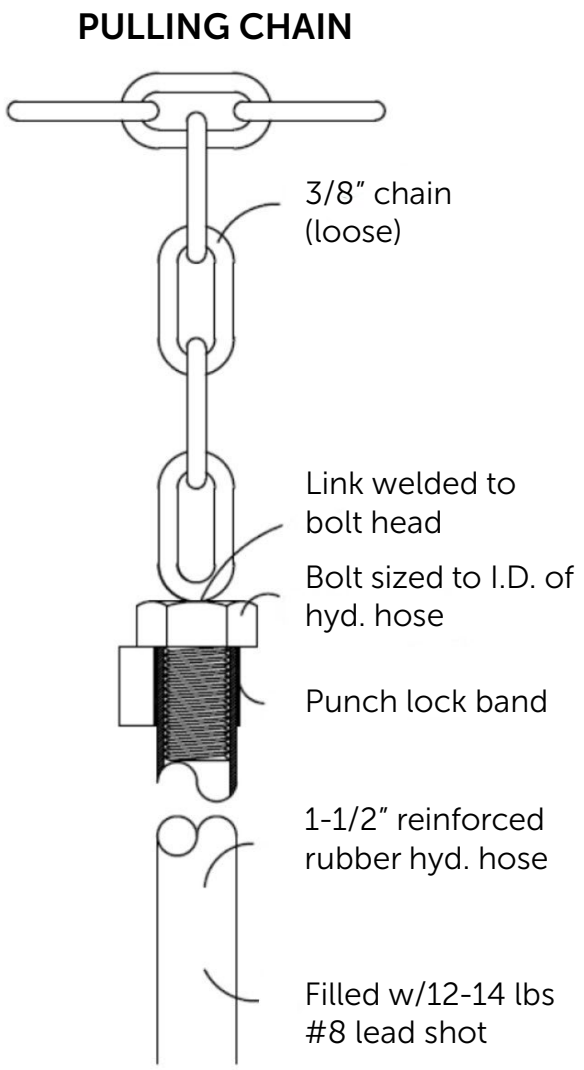
- Important Notes:
  - Some OPGW suppliers require ARD on *all* their cables
  - Suppliers recommend different dimensions and weights for the ARD's for their cables ➔ You have to check!

OPGW Installation - Stringing

Typical Field Fabricated ARD

When needed, can fabricate as follows:





Detail "A"

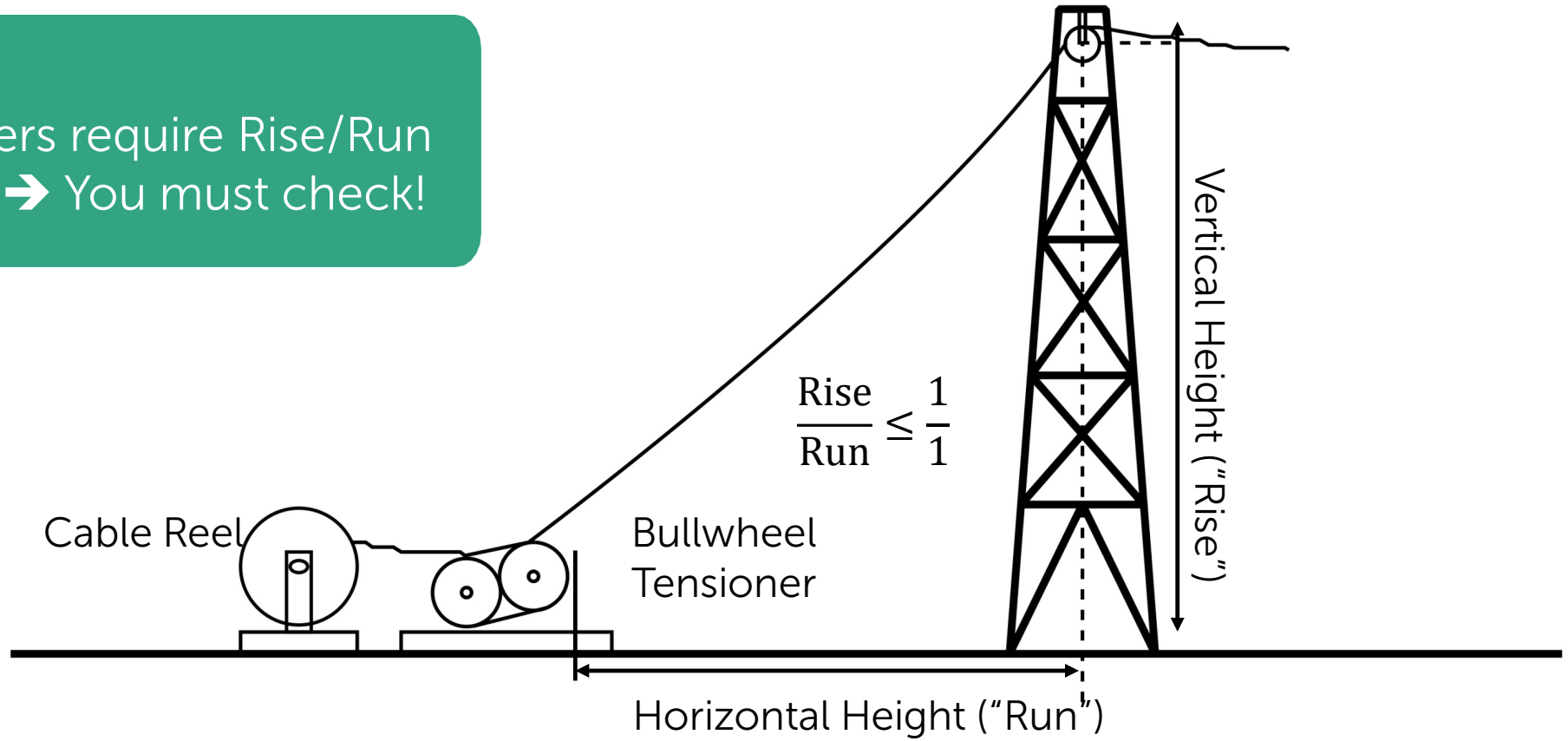
See also our installation guidelines

➔ Commercially available ones are also OK (Example: Slingco)

OPGW Specific Issues

Pull Set Up

Caution!
Some suppliers require Rise/Run of 1/3 or 1/4 ➔ You must check!



OPGW Specific Issues

Pulling Speed

- **Pull at a speed that the OPGW goes smoothly through the blocks!**
  - Guidelines (*not* laws):
    - When using an ARD, then about 1 - 3 mph (1.6 - 5 km/hr)
      - Slow down at each structure and watch to make sure the ARD passes through the block smoothly and clears it, and then smoothly accelerate
    - When not using ARD, then about 3 - 5 mph (5 - 8 km/hr)
      - "Slow and steady wins the race"
    - Also, smoothly start and stop the pull
    - Conditions during the pull (angles, terrain, weather) may require a lower speed.
- **Remember:** Smooth! (No one likes a jerk…including your OPGW)

OPGW Installation - Stringing

Temperature and Time Limits

- Temperature range for stringing: -22°F to 122°F (-30°C to 50°C)

- Sagging: Not more than 18 hours after stringing (pull-in)
  - Better to bring up to sag and install first and last deadends immediately
  - Unsecured cable is vulnerable
  - Too long in blocks can distort sagging ("excess" elongation)

- Clipping-In: Not more than 48 hours
  - Unsecured cable is vulnerable
  - Secure longer spans

- Damper Placement: Not more than 24 hours after clipping-in or 54 hours after sagging
  - But, typically done in conjunction with clipping-in

Part 2

Splice Prep

OPGW Installation – Splice Preparation

Just kidding! The previous slide was fake

- We are not going to cover splice preparation today because:
  1. There is too much variation in the process from one design type to another
  2. There is too much variation in the recommendations of both cable and enclosure manufacturers
  3. We are out of time!

- For now, just know that:
  A. Splice prep is the next step in the installation process
  B. The challenge is to access the fibers without damaging them, either during the process itself or leaving them vulnerable to damage during operations

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Thank you

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