



Incab

# OPGW Engineering 201 Accessories

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# Registered Continuing Education Program

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Registered Continuing Education Program

## **PURPOSE STATEMENT / COURSE DESCRIPTION**

OPGW Engineering 201 – Accessories will teach attendees about accessories that are used with OPGW to complete a system. Special attention will be given to dead-ends and suspensions since these are especially critical.

## Registered Continuing Education Program

# LEARNING OBJECTIVES

### After this class you will be able to:

1. Identify the **three basic OPGW dead-end types** and state the advantages/disadvantages of each.
2. Understand “**tension coupling**” and its importance to dead-end functionality.
3. Identify the **two basic types of OPGW suspensions** and state the advantages/disadvantages of each.
4. Know when to use a single suspension, a double suspension, and a “running dead-end.”
5. Identify the **two types of vibration dampers for OPGW** and state the advantages/disadvantages of each.
6. Identify the **three basic types of splice enclosures** and know the considerations that go into selecting a good one.
7. Identify other important items that your project might need.

# Incab University "School of Excellence in Fiber Optics"

Learning Hub



[INCABAMERICA.COM](https://www.incabamerica.com)

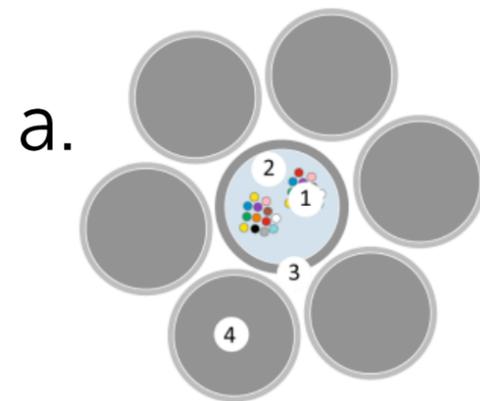
## Webinar Rules

- Introduction and sound check
- Presentation: 60 min
- Use chat for questions during presentation
- Q&A (NB! Technical questions only)
- Let's start!

# OPGW – Quick Review

## The Three Types Used Today

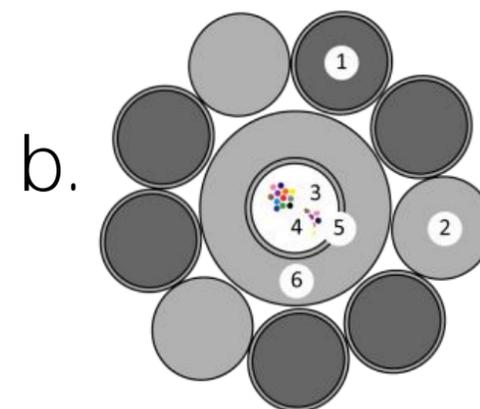
### Center Tube Designs



#### OPGW C

##### CABLE DESIGN:

1. Optical fiber
2. Stainless steel tube filled with water-blocking gel
3. & 4. Stranded wires (aluminum-clad steel wires and/or aluminum alloy wires)

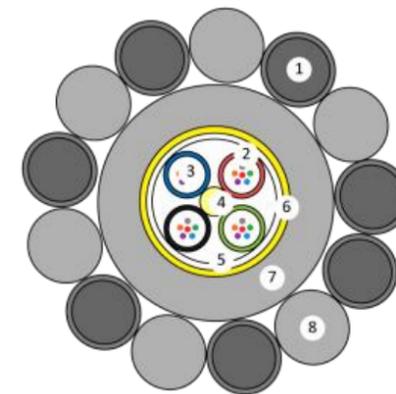


#### OPGW CA

##### CABLE DESIGN:

1. Aluminum-clad steel wires
2. Aluminum alloy wires
3. Water-blocking gel
4. Optical fiber
5. Stainless steel loose tube (SSLT)
6. Aluminum cladding applied to SSLT

### Aluminum Pipe Design

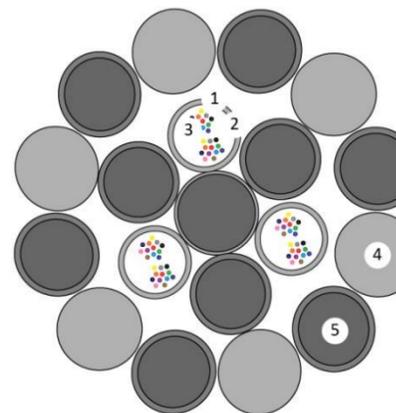


#### OPGW AP

##### CABLE DESIGN:

1. Aluminum-clad steel wires
2. Plastic buffer loose tube filled with water-blocking gel
3. Optical fiber
4. Central strength member (FRP)
5. Water-swellable tape
6. Thermal barrier
7. Aluminum pipe
8. Aluminum alloy wires

### Stranded Design



#### OPGW S

##### CABLE DESIGN:

1. Stainless steel loose tube (SSLT)
2. Water-blocking gel
3. Optical fiber
4. Aluminum alloy wires
5. Aluminum-clad steel wires

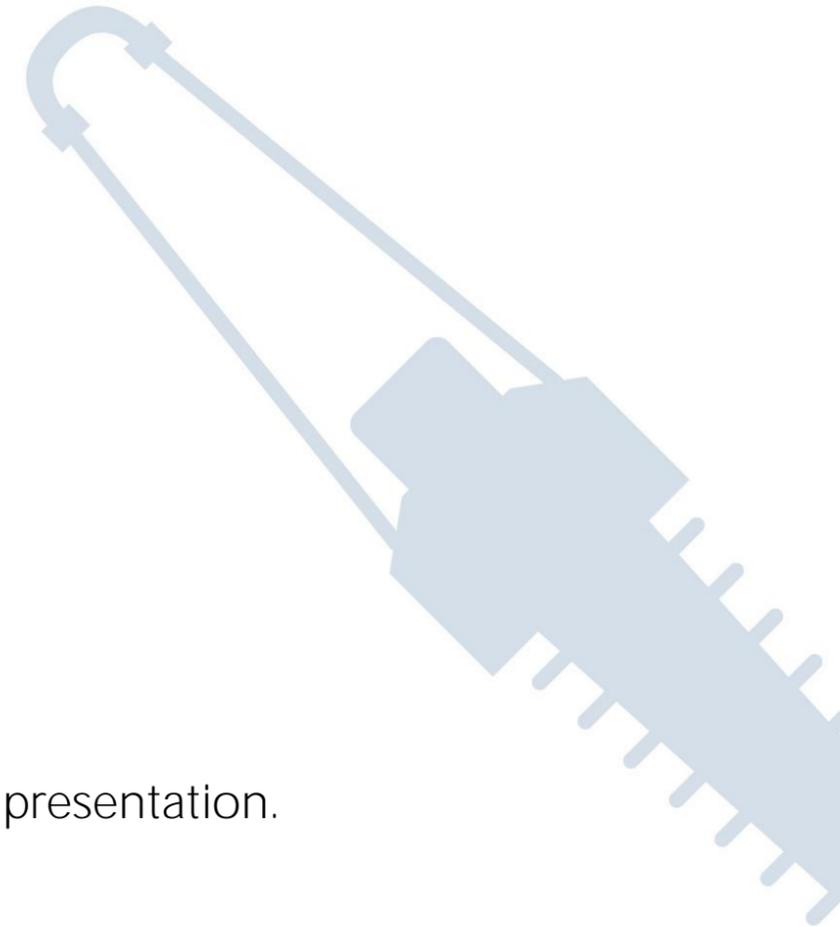
# OPGW Accessories

## General

- OPGW suspension clamps, dead-ends, comealongs, etc. are specially designed to limit radial pressure on the cable
  - Cannot use compression fittings, or standard clamps for conventional overhead groundwire or conductor
  - Very limited diameter range, means you must carefully select
- Typical lead-time is 6-8 weeks, so you must plan accordingly

### Notes:

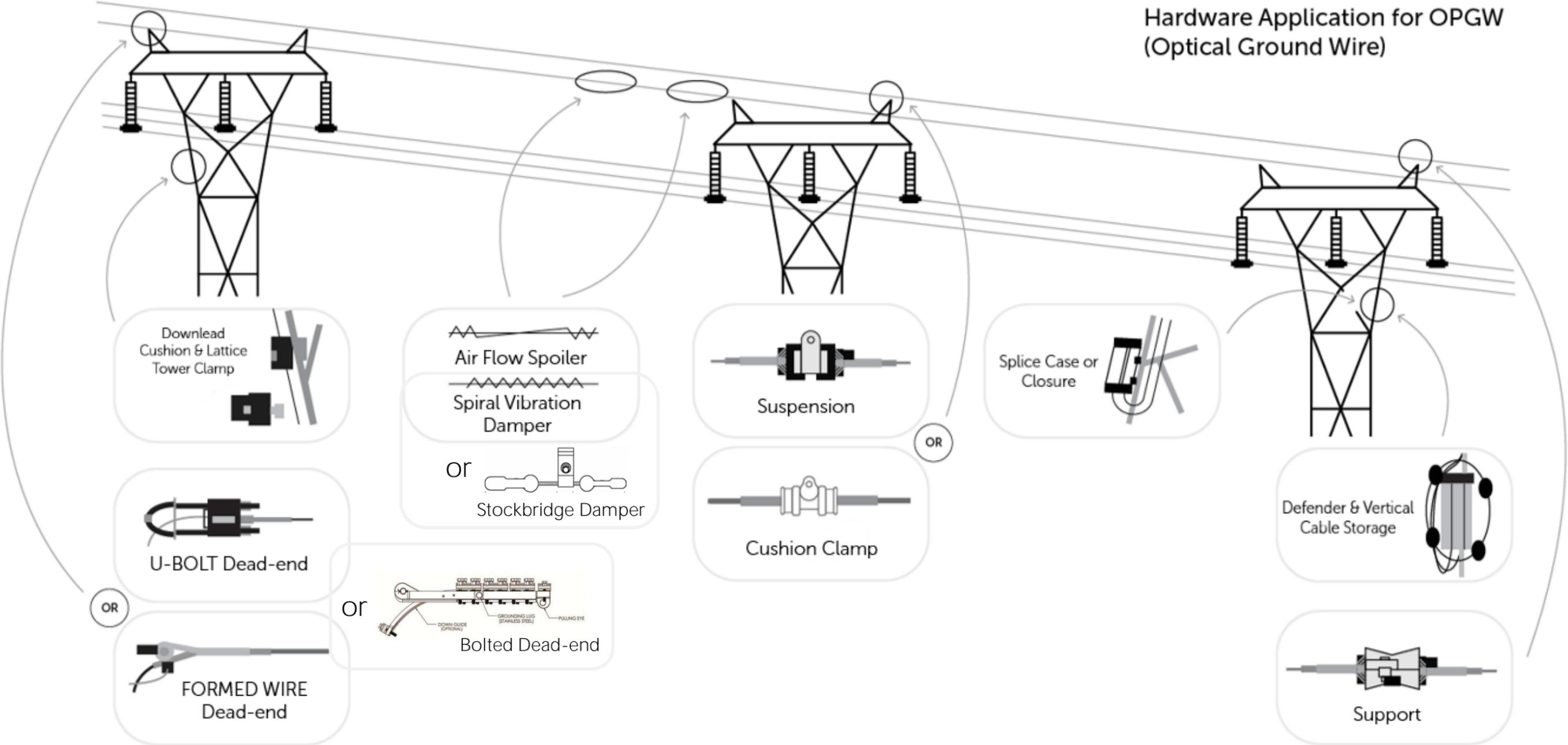
1. I have shamelessly copied and pasted pictures from various suppliers that I found on-line for this presentation. I offer my appreciation for those that do not mind this, and my apologies for those that do.
2. A ✓ beside an item means that it has earned the much coveted “Mike Riddle Preferred Item” rating.



# OPGW Accessories

# System Overview. Major Accessories

Hardware Application for OPGW  
(Optical Ground Wire)



# OPGW Engineering - Accessories

## A Lot to Think About!

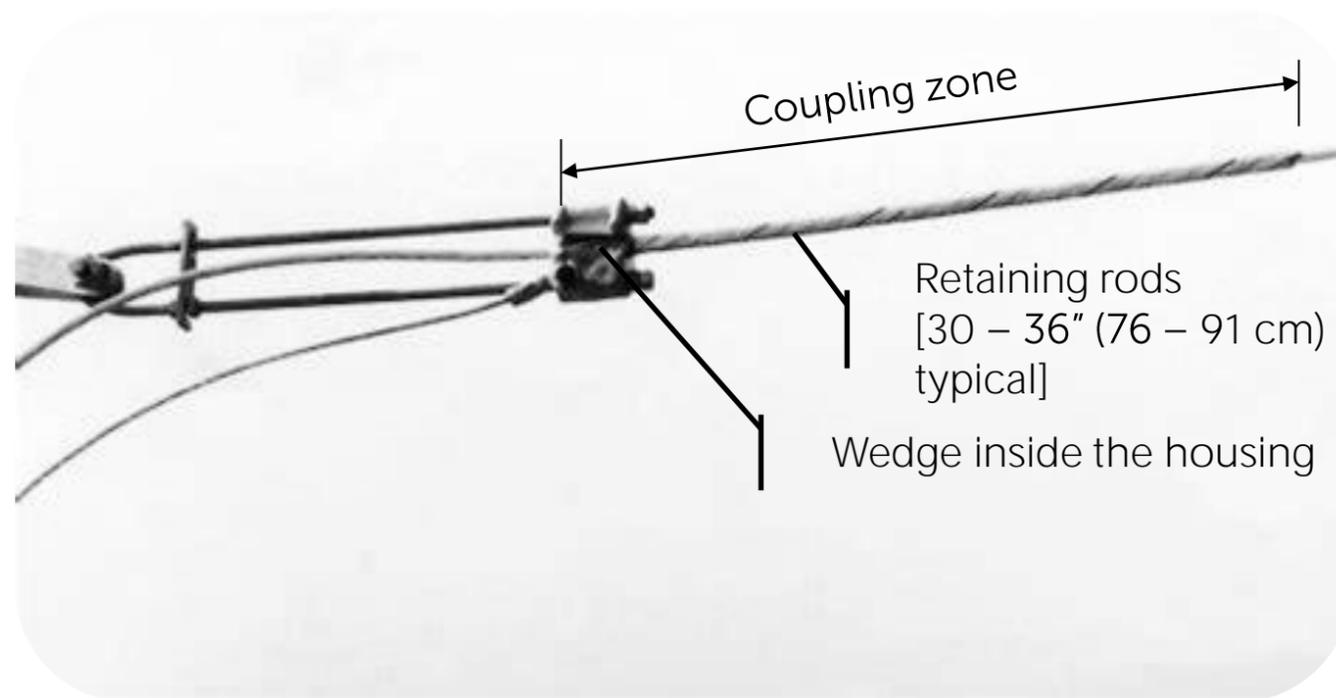
- **Dead-ends.** Three basic options: Wedge (2 “flavors”) vs. Bolted vs. Formed Wire
- **Suspensions.** Two basic options: “AGS” (armor grip suspension) vs. Bolted
  - Plus, “no rod” variants of the bolted concept
- **Double Suspensions.** Two basic options: AGS vs. Bolted
- **Connection options.**
- **Grounding.** Two options: Copper vs. aluminum
- **Dampers.** Two options: SVD’s (spiral vibration dampers) vs. Stockbridge
- **Downlead clamps.** Two options: Aluminum vs. plastic
  - Consider: mounting options
- **Splice enclosures.** Lots of options!
  - Consider: Bullet resistance? Cable storage
- Other important items you may need:
  - Protecting against galloping
  - Bird flight diverters
  - Marker balls
  - Repair rods

**Feeling anxious? Relax! We’ll break these down so that you can make informed choices!**

## OPGW Accessories

# Dead-ends. Wedge Type

### ✓ Wedge Type a.k.a "U-bolt"



### Advantages:

- Balances installation time and tension coupling
- Good value
- Good availability

### Disadvantages:

- None (in terms of performance)?
- One supplier (in USA)

Note: This design was derived from one used for securing wire rope cables on bridges. It's very strong!

## OPGW Accessories

# Dead-ends. Variant of Wedge Type

### ✘ Sliding Wedge Type



#### Advantages:

- Claimed easier to install(?)

#### Disadvantages:

- No rods to protect the cable
- Much shorter "coupling zone"  
(Stress concentrates near the mouth)
- Problems under "real world" conditions  
(Leading to slippage)
- Limited sources
- Expensive
- Requires a special tool to remove

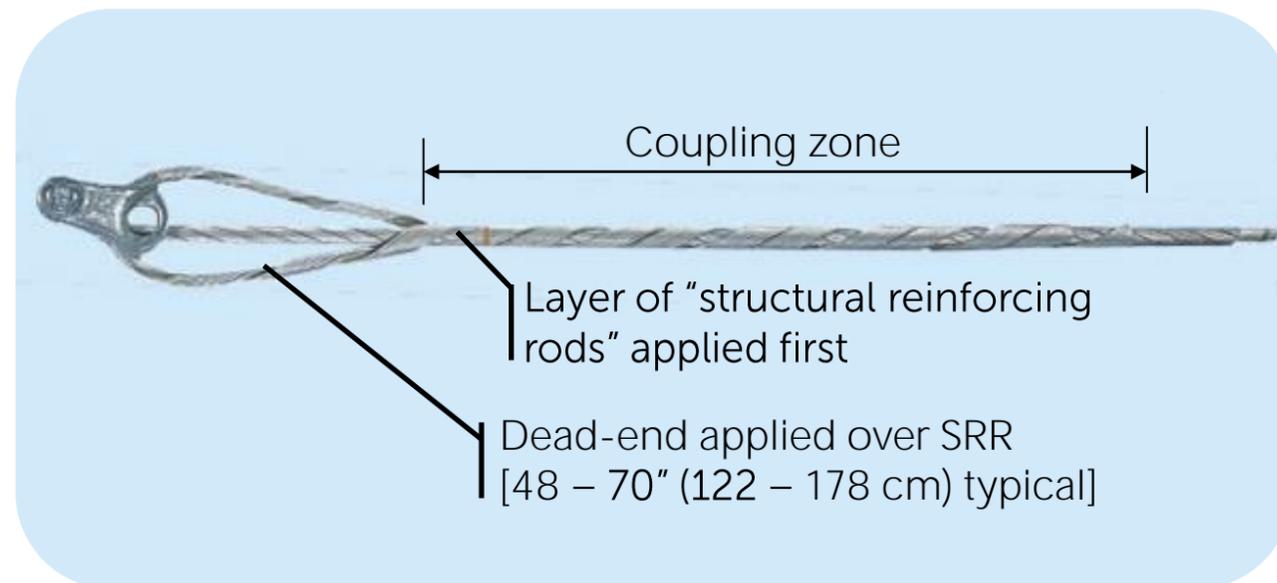


Suggest you avoid this type

## OPGW Accessories

# Dead-ends. Formed Wire Type

Formed Wire, similar design concept as a guy grip



### Advantages:

- Very inexpensive
- Excellent availability
- Multiple sources
- Best tension coupling

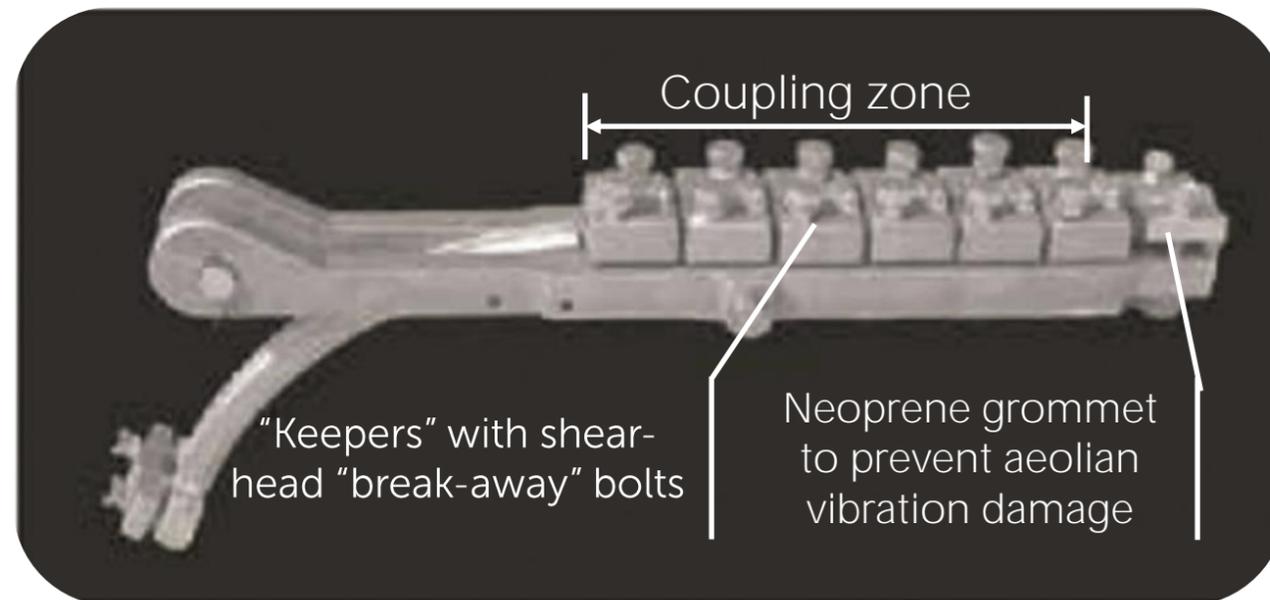
### Disadvantages:

- Quite long (may not be able to install from a pole)
- Length makes installation harder
- Takes the longest to install

## OPGW Accessories

# Dead-ends. Bolted Type

### Bolted



### Advantages:

- Claimed faster to install ← Highly debatable! Consider:
  - (1) All bolts on one side must be loosened  $\approx 0.5$  inches (12.7 mm)
  - (2) All bolts on the other side must be fully loosened  $\approx 1.0$  inch (25.4 mm)
  - (3) Cable must be positioned in the center groove
  - (4) Bolts must then be initially tightened in a crisscross pattern
  - (5) Bolts must then be tightened again in a crisscross pattern
  - (6) Bolts must then be fully tightened in a crisscross pattern
- Multiple sources
- Good availability

### Disadvantages:

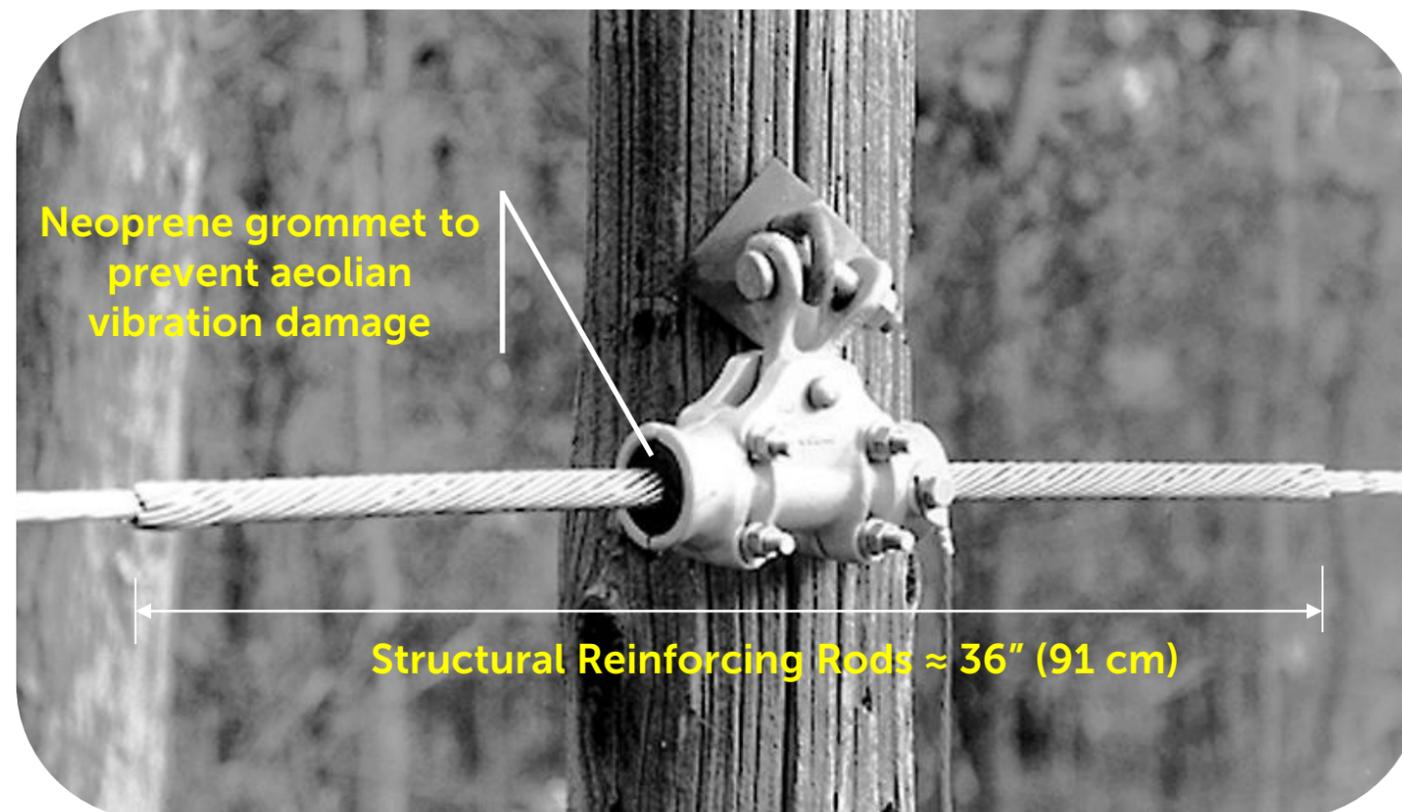
- Worst tension coupling [ $\approx 10 - 12$  inches (25.4 – 30.5 cm)]
- Expensive
- Many (most?) crews will NOT tighten the bolts as above
  - ➔ Won't have full holding strength!
  - ➔ What if bolts shear off prematurely?

## OPGW Accessories

# Suspension Clamps – Bolted

➔ General: All suspension clamps should use armor rods! (more in a moment)  
– Standard units good for line angles  $\leq 30^\circ$

✓ Bolted (Example: PLP “Cushion Clamp”)



### Advantages:

- Balances the support function with ease of installation
- Economical
- Good availability
- Multiple sources

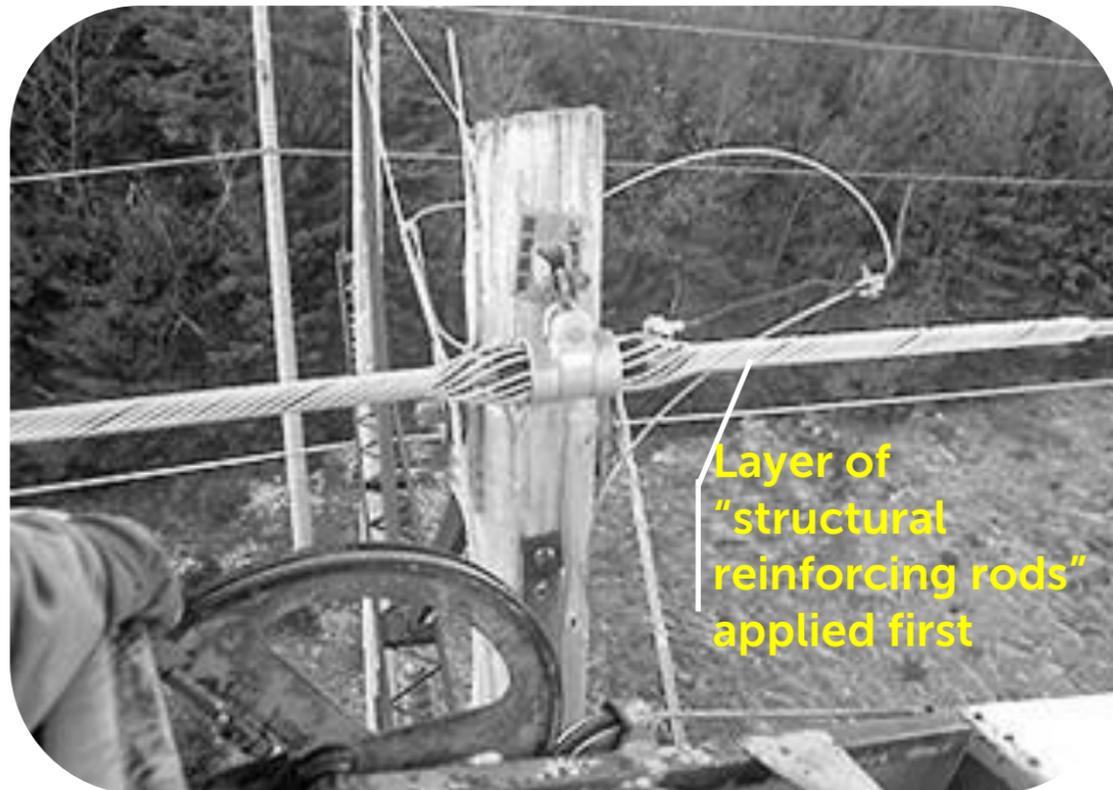
### Disadvantages:

- None

## OPGW Accessories

# Suspension Clamps – AGS

### Armor Grip Suspension (“AGS”) type



### Advantages:

- The best support for the cable
- Economical
- Good availability
- Multiple sources
- Option to use single layer version for use on Stranded SSLT (Type S) cable (Must use standard dual layer for use on Aluminum Pipe (Type AP) or Center SSLT (Types C and CA))

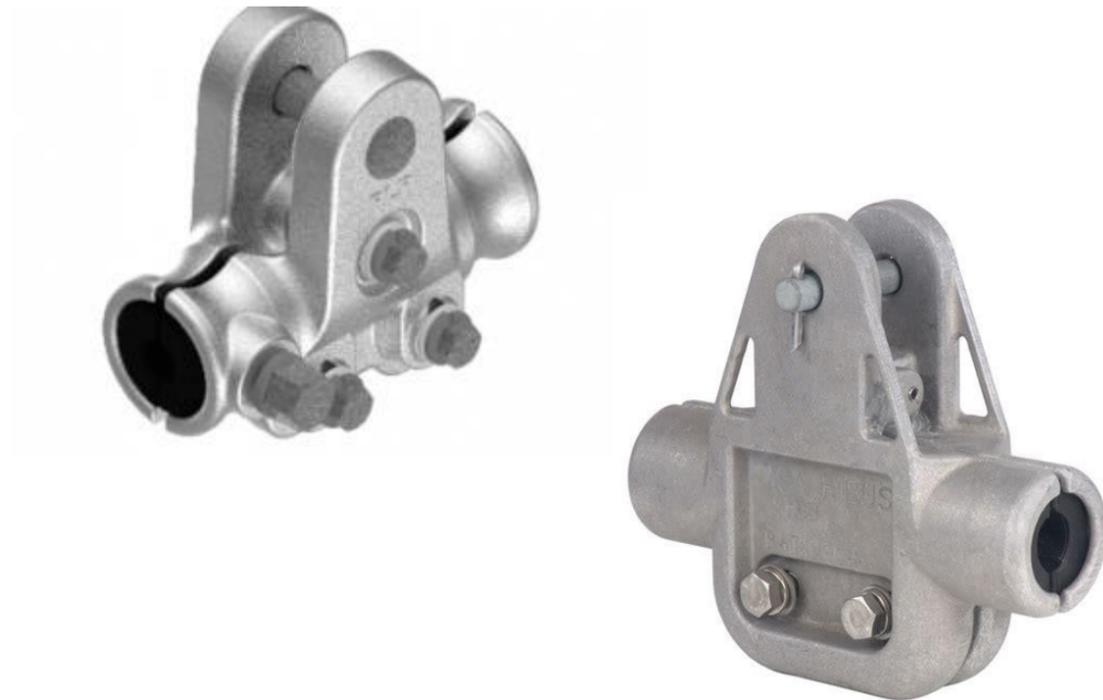
### Disadvantages:

- Takes longer to install, especially the dual layer type

## OPGW Accessories

# Suspension Clamps

What about the newer “no rod” type designs?



Consider:

- 75% of lightning strikes at or near a structure (EPRI Red Book)
- Rods provide additional protection for the cable! (Cheap insurance)
- Some limit line angle change  $\leq 20^\circ$ !
- Save  $\approx$  \$10 + 10 minutes/unit
  - ➔ Cable is around \$1/ft, so maybe save 2%
  - ➔ System is supposed to last 40 years!
- From the archives: In the 1970's/1980's a rod-less conductor clamp became popular for a few years... until they started to fail after about 5 - 10 years

Conclusions:

- I will not use these

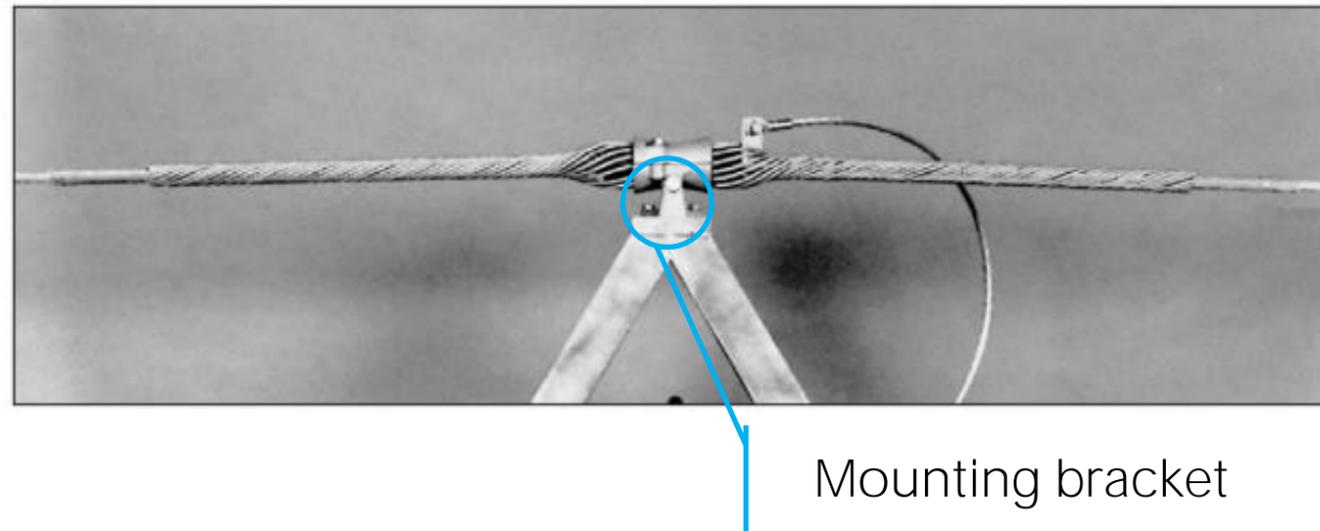


Suggest you avoid this type

## OPGW Accessories

# Tangent Supports

Special situation in some parts of the USA and world



Notes:

→ Requires a bracket with dimensions as specified in ANSI C29.7-1986, Class 57

→ The bracket can be hard to find. Here are two possibilities:

- Maclean Power Systems #TMB-1
- Lindsey Manufacturing #2121

→ Strongly prefer suspensions because they articulate (move).

- It only takes a little to alleviate tension imbalance (span differentials + wind/ice loading)
- Trunnion supports cause the support/cable to bear the differential

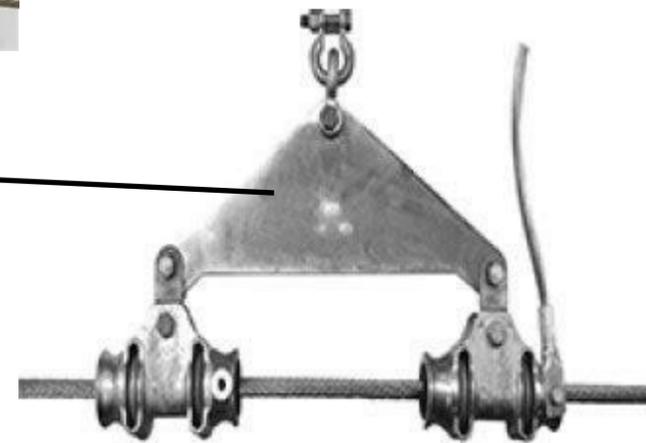
## OPGW Accessories

# Double Suspension Clamps



AGS type

Yoke plate



Bolted type (PLP Cushion Clamp)

Consider:

- Good for horizontal line angles of  $30^{\circ}$  -  $60^{\circ}$
- Same options as for single suspensions
- Might cost the same or even be slightly cheaper to double dead end ("running dead end") without splicing

# OPGW Accessories

## Connection Options

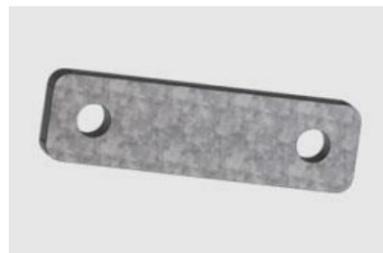
All of the preceding accessories require pole line hardware to attach to the structure

### Dead-ends

Typical options: Clevis-eye extension link  
*or* extension link + anchor shackle



or



+



### Suspensions

Typical options: Y-clevis eye/*y*-clevis eye 90 *or*  
*clevis eye or anchor (or two)*, depending upon  
orientation



Y-clevis eye

or



Y-clevis eye 90



or



or



+





## OPGW Accessories

# Connection Options, continued

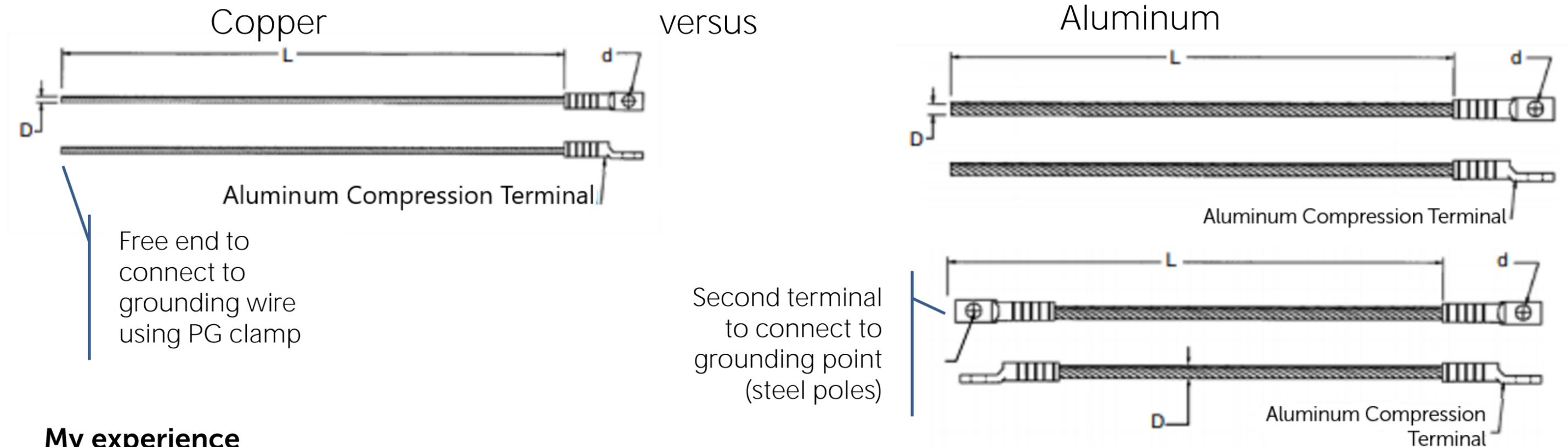
**Which option to use? Guidelines, in descending order of importance:**

- You must verify the hardware fits with the accessory!
- You must verify the assembly is consistent with the orientation of the attachment point (if this gets overlooked, an anchor shackle can fix it)
- What your company already stocks
- Price and availability
- What you like

In case you are wondering: "What about cotter pin versus bolt+nut+cotter pin?" In my experience, cotter pin alone works just fine.

## OPGW Accessories

# Grounding (a.k.a. "Bonding") Options



### My experience

Either copper or aluminum can be used, but...

- More reports of breakage (fatigue caused by wind induced movement) with aluminum
- Zero reports of "galvanic corrosion" with copper (inhibitor is used with the terminal)

## OPGW Accessories

# Vibration Dampers

### ✓ Spiral Vibration Damper (SVD)

Length



### Advantages

- Highly effective!
- Very economical
- Simple protection plans. Typically:
  - 2/span up to 800 ft (244 m)
  - 4/span up to 1,600 ft (488 m)
  - 6/span up to 2,400 ft (732 m)
- Easy to install
  - Also, can "nest" 2 or 3 together

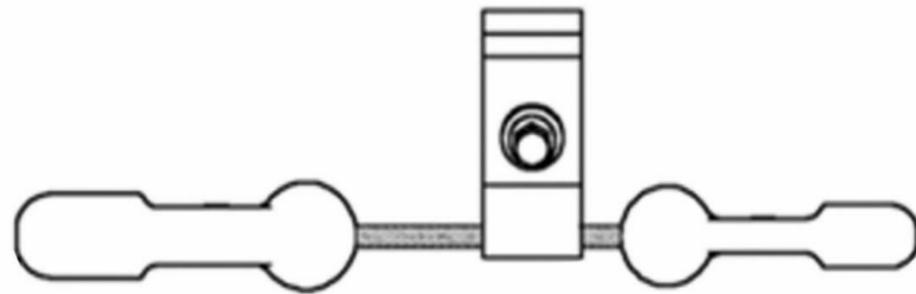
### Disadvantages

- Limited to OD's < 0.75 inches (19 mm)

## OPGW Accessories

# Vibration Dampers

### Stockbridge Damper



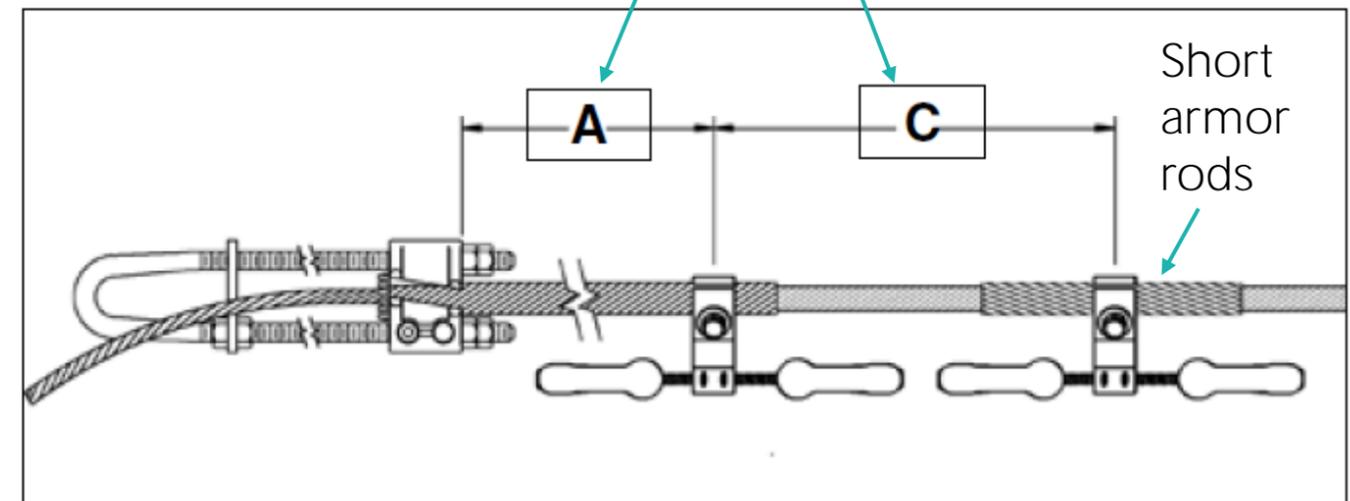
Typical "4R" Stockbridge damper

### Advantages

- Effective on all cable sizes
- Only choice if OD > 0.75 inches (19 mm)

### Disadvantages

- Cost
- More complicated protection plans
- May have to install over rods
- Sensitive to placement
  - Not effective if placed at incorrect location



2 dampers required at dead-ends and at AGS suspensions



OPGW Accessories

## Vibration Dampers – Additional Info

**Regardless of the type of damper you plan to use**

- It is best to coordinate a damper analysis and protection plan with both the cable and the damper suppliers
- Beware any terrain conducive to smooth laminar wind flow!  
(50 – 100% more dampers!!)
  - River crossings
  - Canyon crossings
  - Very flat terrain, unbroken by trees, buildings, etc.



## OPGW Accessories

# Vibration Dampers – Additional Info

**These are VERY general guidelines for when dampers are needed**

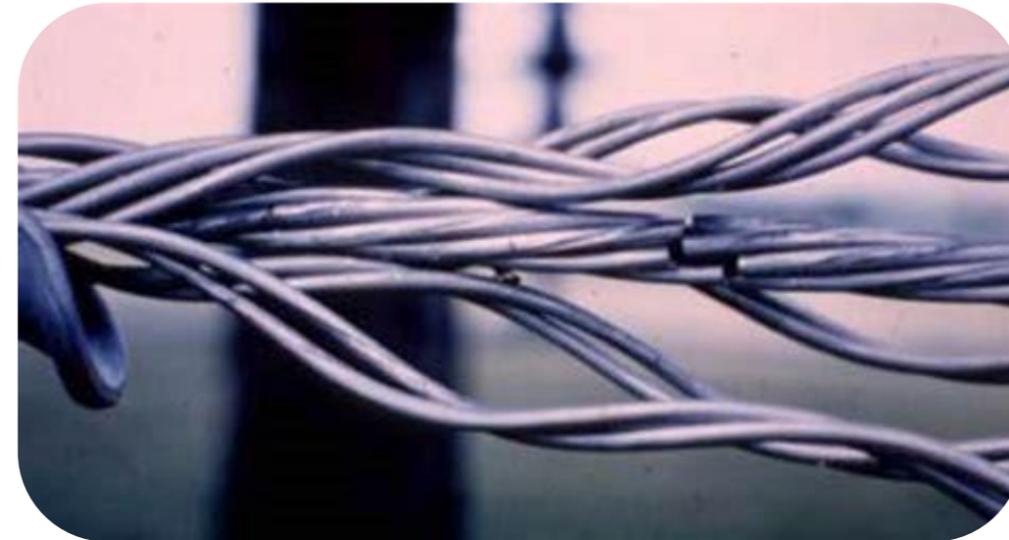
Benchmark: Final “everyday” (no ice, no wind) tension at 60°F (16°C):

- Tension < 10% RBS = Dampers not required
- Tension 10 – 15% = Dampers a good idea (cheap insurance)
- Tension 15 – 20% = Dampers required
- Tension 20 – 25% = Should “double up”
  - Also, critical to confirm protection plan with both the cable and the damper suppliers
- Tension > 25% = “Danger Zone!”
  - In the USA you would be outside the NESC!
  - Don’t go here!

Comment: These are good guidelines for any aerial, metallic cable

OPGW Accessories

# Vibration Dampers – Fatigue Damage



Good primer on aeolian vibration in T&D World: <https://www.tdworld.com/resources/white-papers/whitepaper/20970197/managing-aeolian-powerline-vibrations-the-basics>

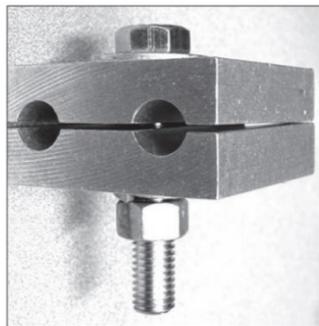
## OPGW Accessories

# Downlead Clamps (DLC's)

At splice points, DLC's are used to guide the OPGW down the structure to the splice enclosure

Two basic types

Aluminum



Plastic (typically urethane)



Both types work fine. I prefer the aluminum ("metal for metal"...for ADSS, "plastic for plastic")

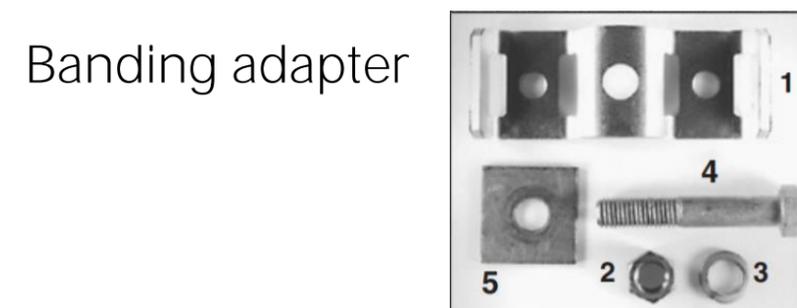
## OPGW Accessories

# Downlead Clamps. Mounting Options

There are mounting options for all structure types



- Wood poles



- Steel poles (very common)
- Wood poles
- Concrete poles

Lattice tower adapters. Lots of different designs



Note: You can also just use a bolt for metal and concrete poles if a nut or similar female interface is included (i.e. specified by you)

## OPGW Accessories

# Splice Enclosures

There are lots of splice enclosures on the market today! (Could be a separate webinar)

### Dome Types



Today's most popular type

### "Clam Shell" Types



A classic design that still works great!

### Cast Type



A very old design (late 80's), but lingers on

OPGW Accessories

## Splice Enclosures – Which Type to Use

- Dome type offers the best seal → Prevents leaks!
- Cast type offer the worst seal (anecdotal evidence of lots of leaks) and are not well-suited for prepping in a controlled environment
  - Either: Mount first, but then optical core exposed during splicing
  - Or: Slice in controlled environment, but then heavy and hard to mount

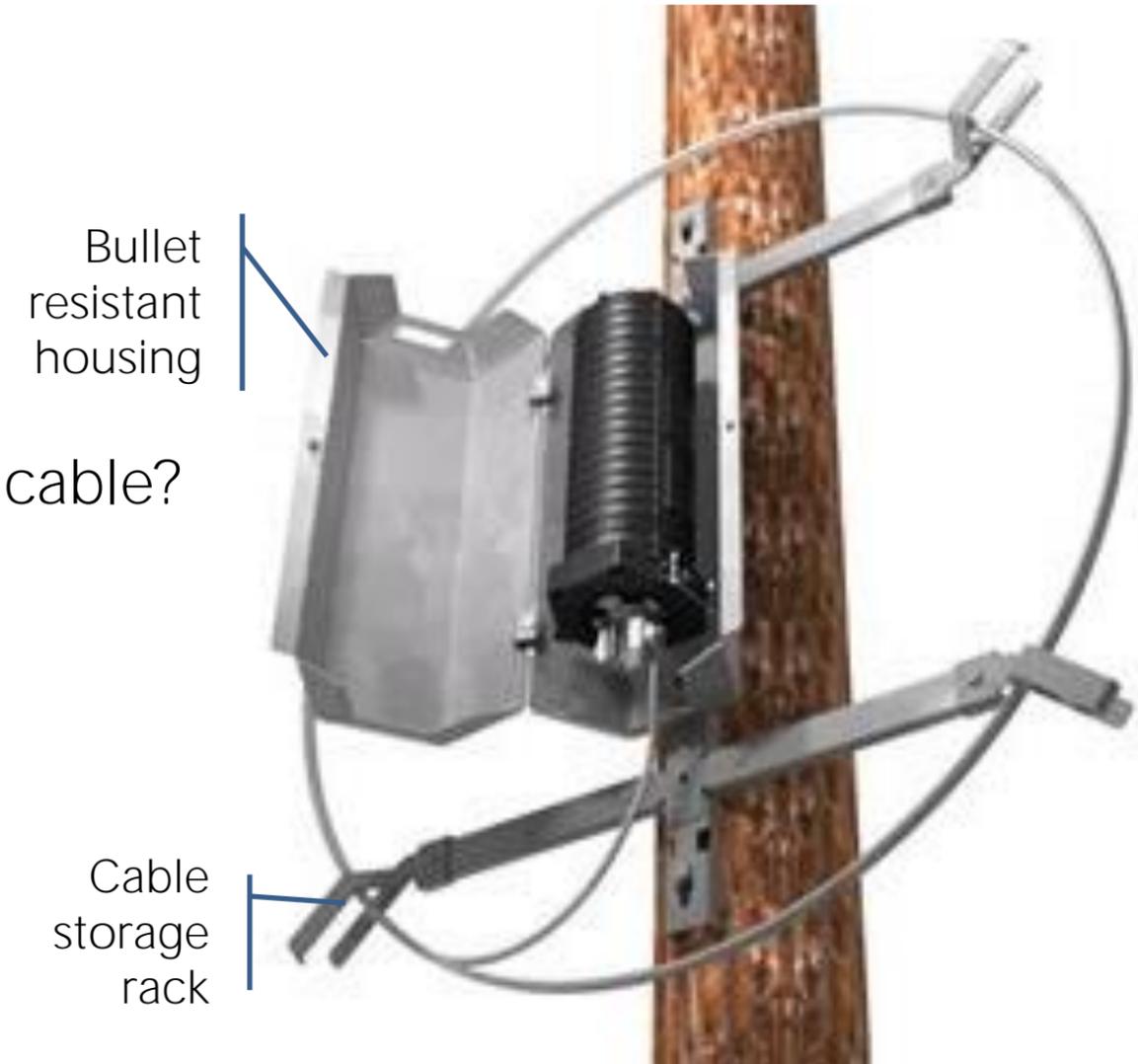
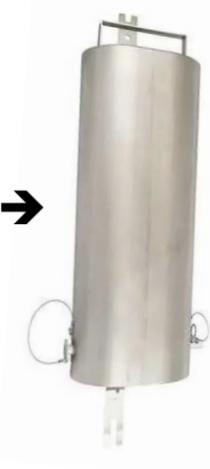
**Remember: Water and fiber don't mix!**

## OPGW Accessories

# Splice Enclosures – Other Considerations

- Splice trays.
  - 24-fiber trays coordinate well with most of today's OPGW designs.
  - Use what you (or your splice techs) like
- Cable storage. Can you ever have too much spare cable?
- Bullet resistance. In areas where that's needed.

Another bullet resistant housing design →



## OPGW Accessories

# Galloping Mitigation

**Galloping is a form of wind-induced motion that is very damaging**

- Low frequency, high amplitude (contrasting with aeolian vibration: high frequency, low amplitude)
- Can mitigate with:  
PLP "Air Flow Spoilers".
  - Works by varying the cross-section of the cable relative to the wind
  - Thereby disrupts the lift that the wind would otherwise create
  - I consider these the *only proven* mitigation method



PLP has an excellent primer on galloping:

[https://preformed.com/images/pdfs/Energy/Transmission/Motion\\_Control/Air\\_Flow\\_Spoiler/Conductor\\_Galloping\\_Basics-EN-ML-1166.pdf](https://preformed.com/images/pdfs/Energy/Transmission/Motion_Control/Air_Flow_Spoiler/Conductor_Galloping_Basics-EN-ML-1166.pdf)



A PLP Air Flow Spoiler hard at work

**Various other claimed solutions exist with questionable effectiveness and reliability**

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## Bird Diverters

**Birds, especially large migratory species, can hit aerial cables for various reasons that include one of the following:**

- Juveniles that have not yet developed good flight control
- Flying While under the Influence (FWI)
- Texting while flying



A small flock attends a safety briefing about aerial cables

# OPGW Accessories

## Bird Diverters

### Mitigation measures include:

- Education. But, birds are known to shun webinars, plus there is a language barrier
- Shotguns. But, these have highly adverse side effects to both the bird and the cable
  - I do *not* recommend this mitigation measure!



Bird-Flight Diverter – Visible to most birds (except swans, raptors, owls) and all humans



Swan-Flight Diverter – Visible only to swans and humans



PLP Bird, Swan, Raptor, or Owl Flight Diverters. Very effective. No known side effects to either bird or cable! As the names imply, you must use the one designed for the kind of bird that you want to protect. Consult PLP for detailed information

## OPGW Accessories

# Marker Balls

**Because aircraft (UFO's too) and OPGW don't mix**

Use where needed.

Application comments.

- Must factor the added weight into your sag and tension calculations for design and into your stringing tables or charts!
  - Both PLS-CADD and Southwire Sag10 can do this
- It is best to install marker balls over armor rods!



## OPGW Accessories

# Marker Balls and Aeolian Vibration

- You must treat the sub-spans created by marker balls like they are separate spans for purposes of aeolian vibration protection!
  - Example: 1,000 ft span (305 m) with 2 marker balls with even spacing
  - Creates three sub-spans of 333 ft (102 m)
  - Standard SVD protection is 2/span up to 800 ft (244 m)
  - Therefore, need a total of 6 for this span
- This is very important because the balls are heavy enough to create a vibration “node”.



Stockbridge damper installed to protect the sub-span

(Notice that the ball is installed over rods)

## OPGW Accessories

# Repair Rods

**If your OPGW gets damaged, then repair rods may be a solution.**

- A special set of armor rods to restore both strength and conductivity.
- General guideline: Good for up to 50% of the cable RBS.
- Best to double check with BOTH the repair rod supplier and the cable manufacturer!

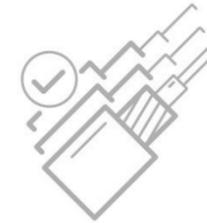


# ACES: Advanced Cable Engineering System

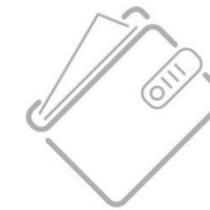
## OPGW Configurator

- Our Advanced Cable Engineering System (ACES) is a unique software tool to help engineers select the optimal OPGW design along with the associated accessories, including dead-ends, suspensions, down leads, splice enclosures, and dampers
- ACES OPGW will also help engineers and planners prepare cost estimates, generate a complete bill of materials, determine reel lengths, and plan logistics

ACES was developed by Incab in partnership with Preformed Line Products, and we very much appreciate their assistance.



optimal cable selection



cost estimates



specifications generation



design calculations

[Start ACES](#)



Incab

# Thank you!

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