Incab

OPGW Accessories

Mike Riddle
President

January 18, 2024

RCEP COMPLIANT

- Incab America has met the standards and requirements of the Registered Continuing Education Program.
- Credit earned on completion of this program will be reported to RCEP.net.
- Certificates of Completion will be issued to all participants via the RCEP.net online system.
- As such, it does not include content that may be deemed or construed to be an approval or endorsement by the RCEP.

ENGINEERING
RCEP
REGISTERED CONTINUING EDUCATION PROGRAM

PURPOSE AND LEARNING OBJECTIVES

This course teach attendees about accessories that are used with OPGW to complete a system.

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”
Agenda

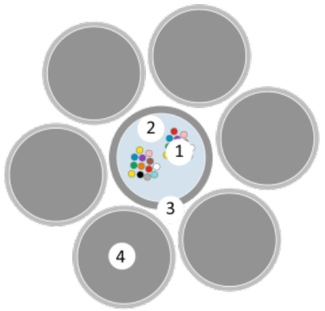
- Introduction
- Learning Objectives
- Presentation
- Q&A (Technical questions only)
- Let’s start!

OPGW – Quick Review

The Three Types Used Today

Center Tube Designs

a.

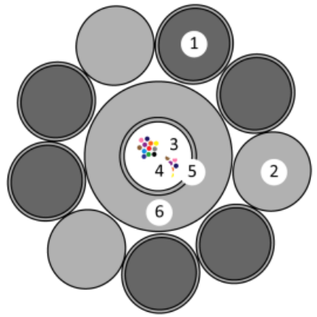


OPGW C

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)

b.

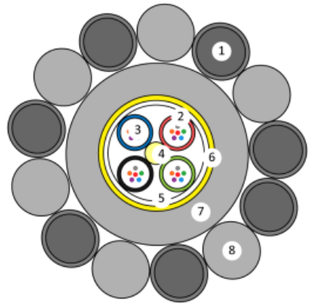


OPGW CA

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

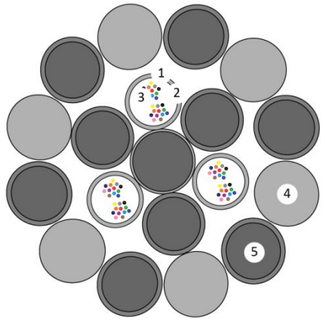


OPGW AP

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

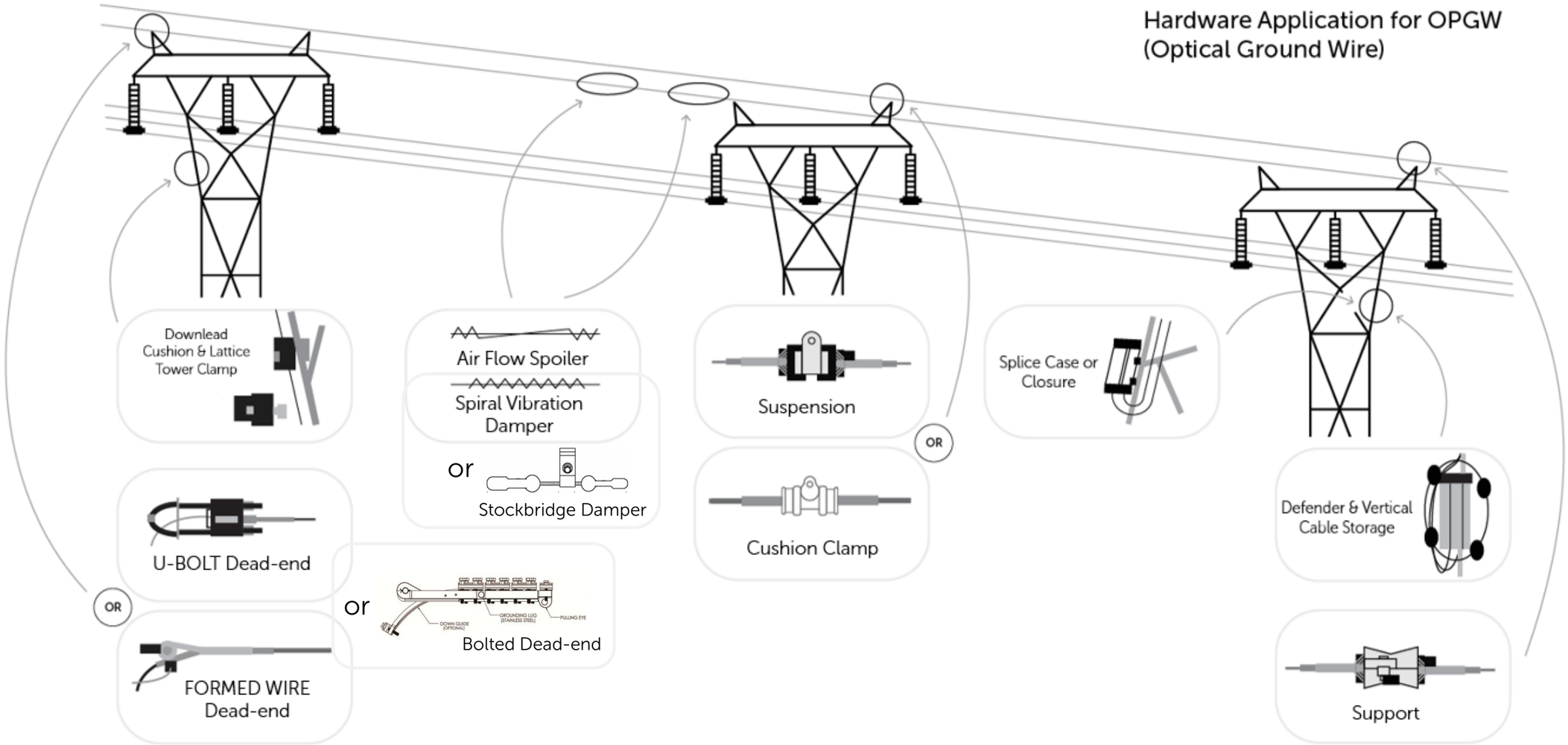
Notes:

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



OPGW Accessories

A Lot to Think About!

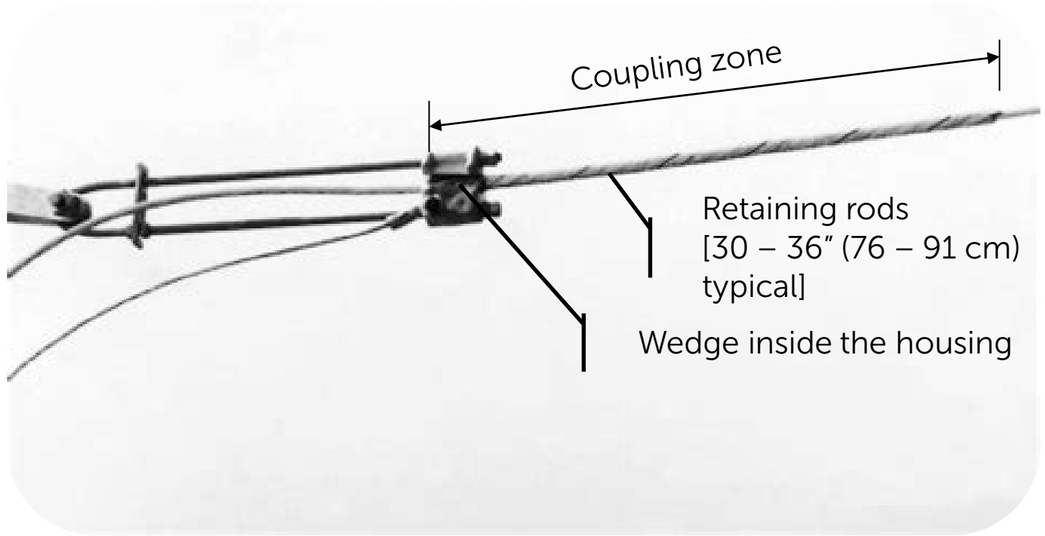
- **Dead-ends:** Three basic options: Wedge (2 “flavors”) vs. Bolted vs. Formed Wire
- **Suspensions:** Two basic options: “AGS” (armor grip suspension) vs. Bolted
  - Plus, “no rod” variants of the bolted concept
- **Double Suspensions:** Two basic options: AGS vs. Bolted
- **Connection options**
- **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!

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!

Dead-ends

Variant of Wedge Type

❌ **Sliding Wedge Type**

WARNING
CONTROVERSIAL TOPIC

Suggest you avoid this type

Advantages:

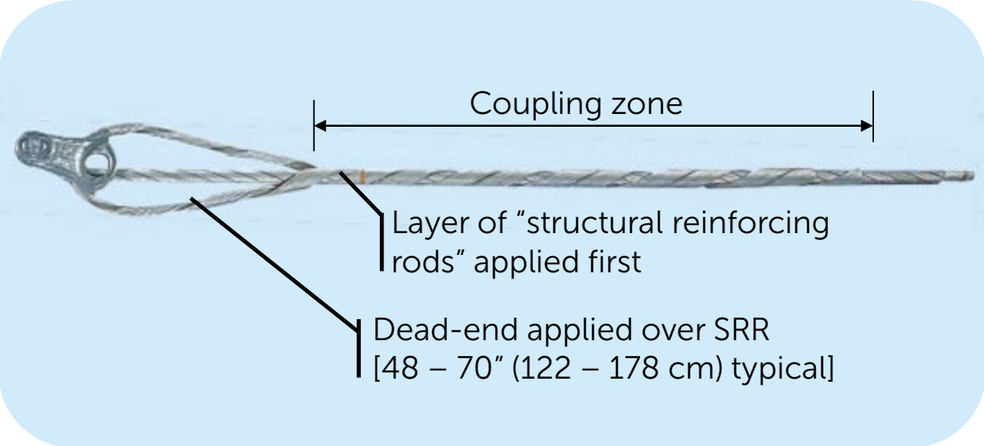
- Claimed easier to install(?)

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

Dead-ends
Formed Wire Type

Formed Wire, similar design concept as a guy grip



Advantages:

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

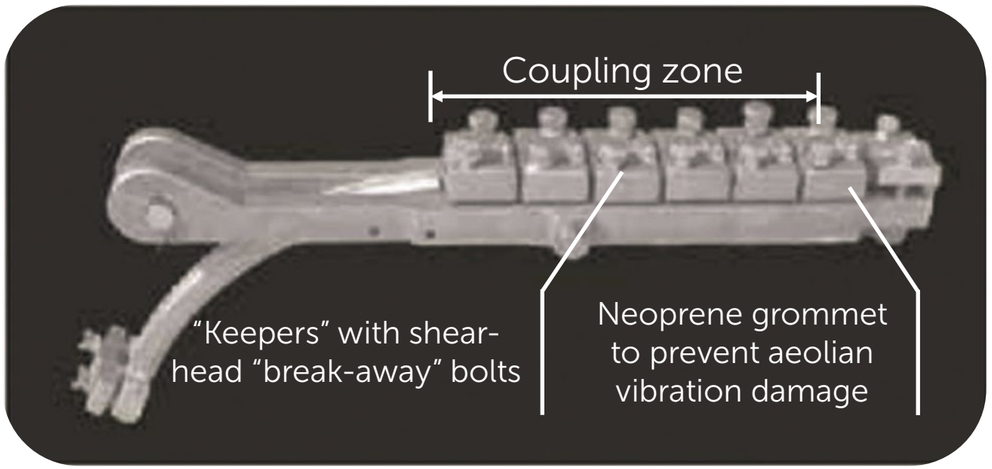
Disadvantages:

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

Dead-ends
Bolted Type

Advantages:
- Claimed faster to install ← Highly debatable! Consider:
  1. All bolts on one side must be loosened ≈ 0.5 inches (12.7 mm)
  2. All bolts on the other side must be fully loosened ≈ 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

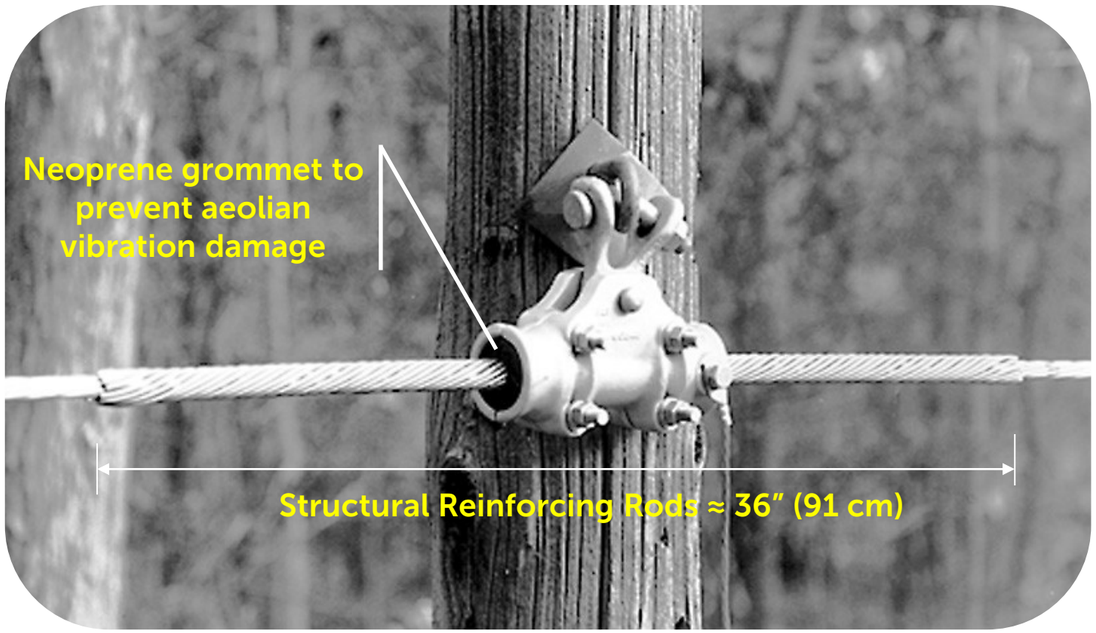
Disadvantages:
- Worst tension coupling [≈ 10 – 12 inches (25.4 – 30.5 cm)]
- Expensive
- Many (most?) crews will NOT tighten the bolts as above
  - Won't have full holding strength!
  - What if bolts shear off prematurely?



Suspension Clamps
Bolted

➔ General: All suspension clamps should use armor rods! (more in a moment)
— Standard units good for line angles ≤ 30°

✓ **Bolted (Example: PLP “Cushion Clamp”)**



Advantages:

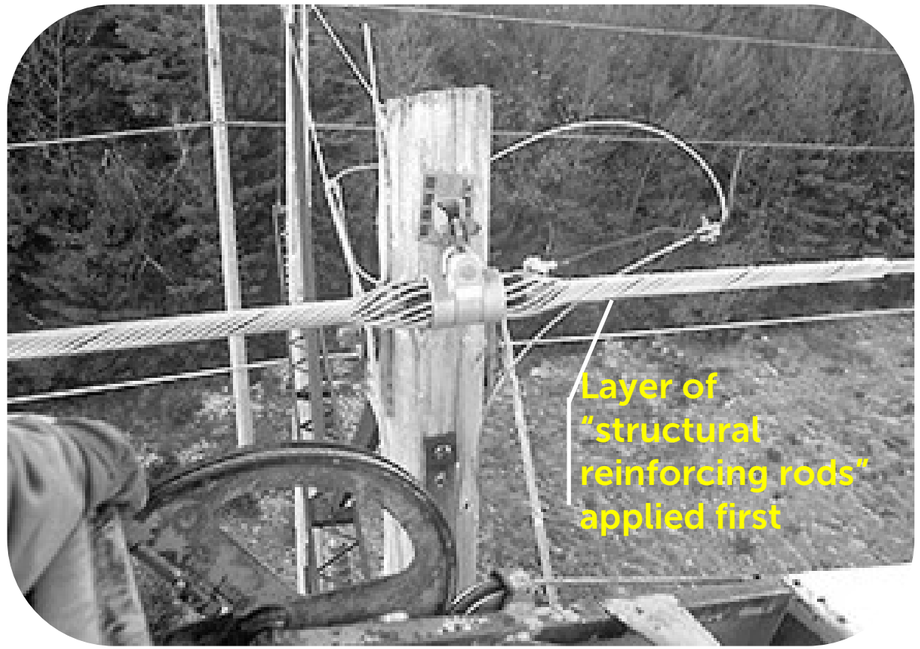
- Balances the support function with ease of installation
- Economical
- Good availability
- Multiple sources

Disadvantages:

- None

Suspension Clamps

Armor Grip Suspension “AGS” Type



Advantages:

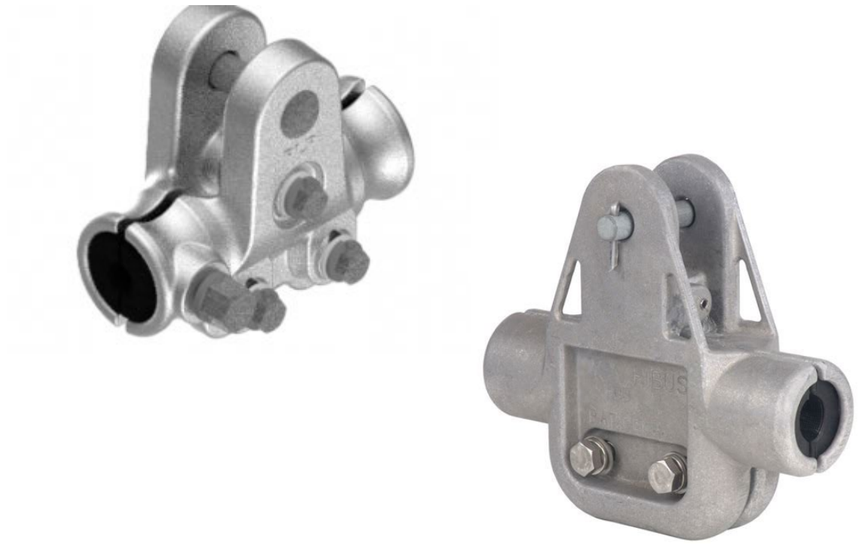
- The best support for the cable
- Economical
- Good availability
- Multiple sources
- Option to use single layer version for use on Stranded SSLT (Type S) cable
  (Must use standard dual layer for use on Aluminum Pipe (Type AP) or Center SSLT (Types C and CA)

Disadvantages:

- Takes longer to install, especially the dual layer type

Suspension Clamps

What about the newer “no rod” type designs?



WARNING

CONTROVERSIAL TOPIC

Suggest you avoid this type

Consider:

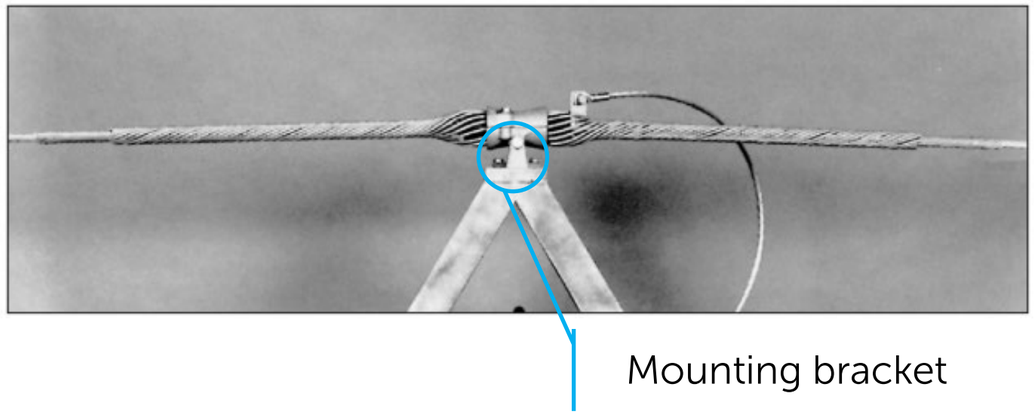
- 75% of lightning strikes at or near a structure (EPRI Red Book)
- Rods provide additional protection for the cable! (Cheap insurance)
- Some limit line angle change ≤ 20^0!
- Save ≈ $10 + 10 minutes/unit
  - ➔ Cable is around $1/ft, so maybe save 2%
  - ➔ System is supposed to last 40 years!
- From 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

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:

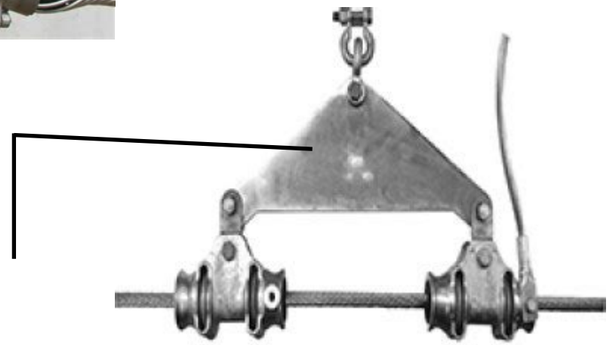
- Maclean Power Systems #TMB-1
- Lindsey Manufacturing #2121

➔ 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

Double Suspension Clamps

AGS type



Bolted type (PLP Cushion Clamp)

Consider:

- Good for horizonal line angles of 30° - 60°
- Same options as for single suspensions
- Might cost the same or even be slightly cheaper to double dead end (“running dead end”) without splicing

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

or

Y-clevis eye

Y-clevis eye 90

or

or

+

Connection Options

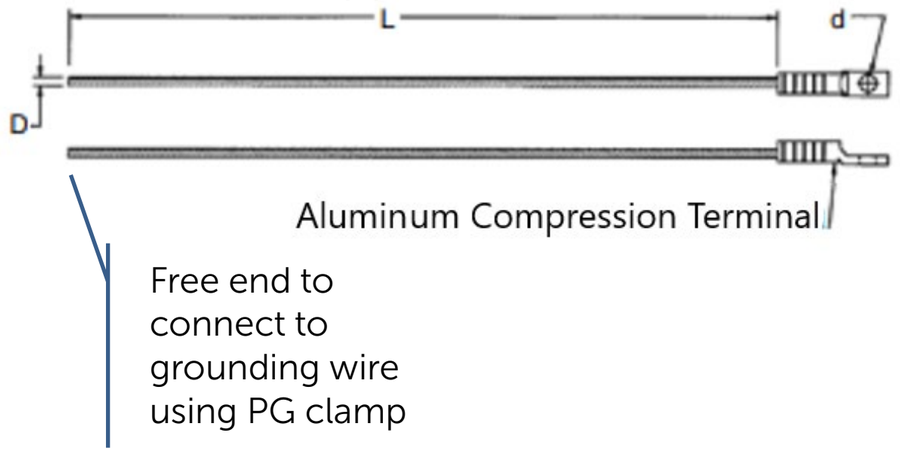
Which option to use? Guidelines, in descending order of importance:

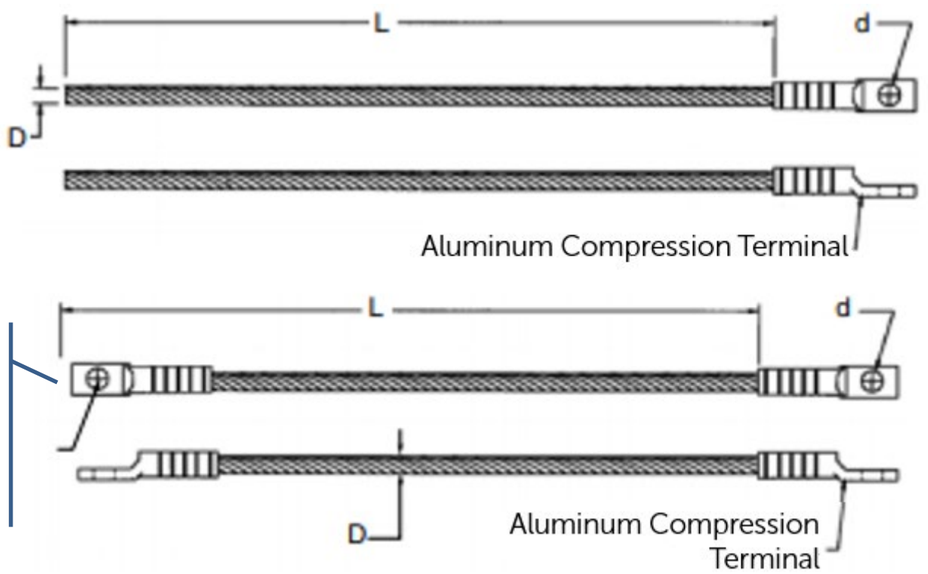
- **You must verify the hardware fits with the accessory!**
- You must verify the assembly is consistent with the orientation of the attachment point (if this gets overlooked, an anchor shackle can fix it)
- What your company already stocks
- Price and availability
- What you like

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

Grounding (a.k.a. “Bonding”) Options

Copper versus Aluminum





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)

Vibration Dampers

Spiral Vibration Damper

✓ **Spiral Vibration Damper (SVD)**

Length

Damping section

Two SVD's "nested"

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

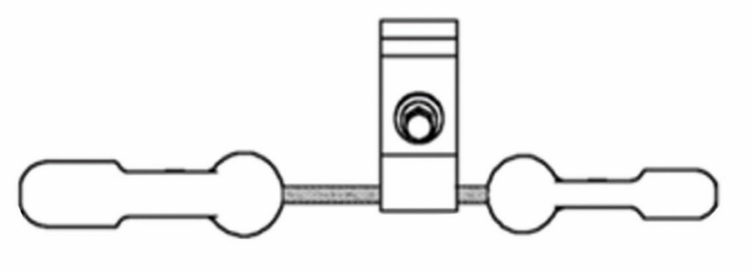
- Also, can "nest" 2 or 3 together

Disadvantages

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

Vibration Dampers

Stockbridge Damper



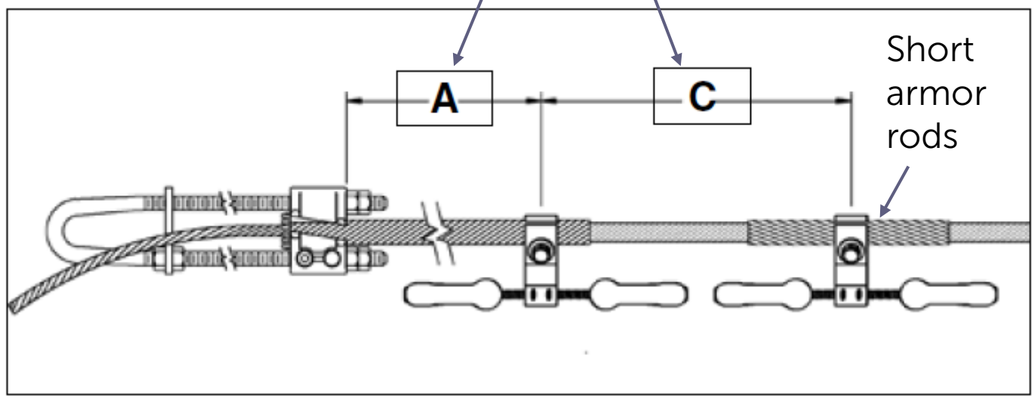
Typical “4R” Stockbridge damper

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 each required at dead-ends and at AGS suspensions

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.

Vibration Dampers

Additional Info

These are VERY general guidelines for when dampers are needed

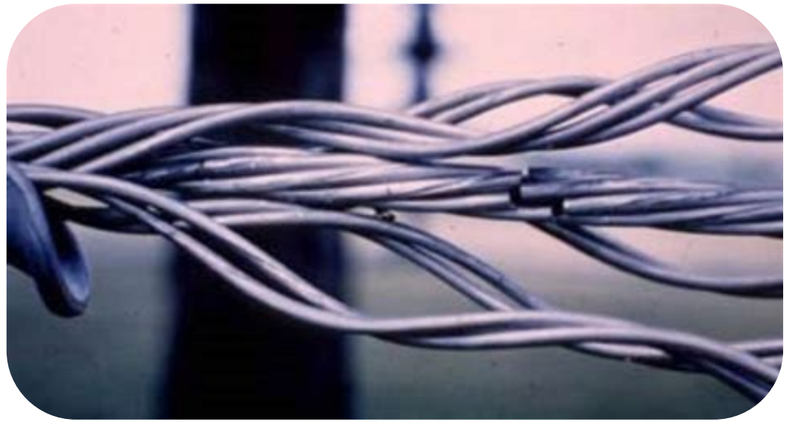
Benchmark: Final “everyday” (no ice, no wind) tension at 60°F (16°C):

- 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

Vibration Dampers

Fatigue Damage



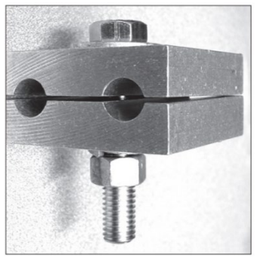
Good primer on aeolian vibration in T&D World: https://www.tdworld.com/resources/white-papers/whitepaper/20970197/managing-aeolian-powerline-vibrations-the-basics

Downlead Clamps (DLC's)

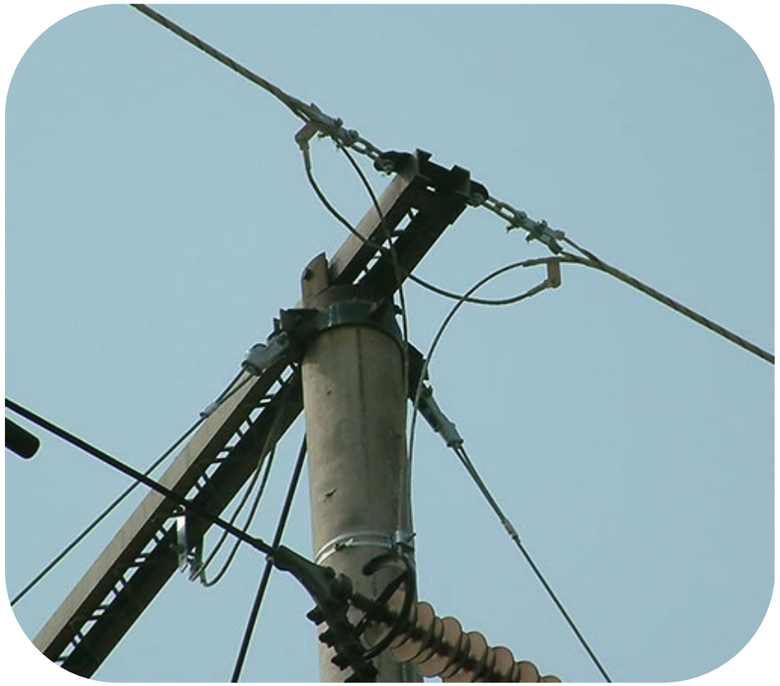
At splice points, DLC's are used to guide the OPGW down the structure to the splice enclosure

Two basic types

Aluminum



Plastic (typically urethane)



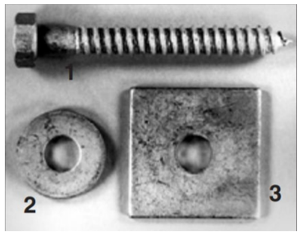
Both types work fine. I prefer the aluminum ("metal for metal"…for ADSS, "plastic for plastic")

Download Clamps

Mounting Options

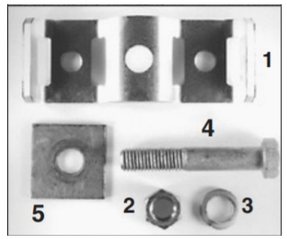
There are mounting options for all structure types

Lag screw



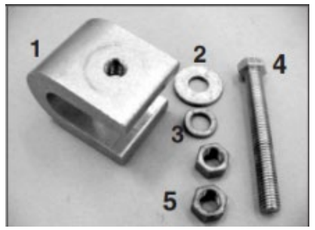
- Wood poles

Banding adapter



- 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)

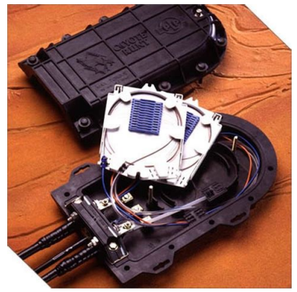
Splice Enclosures

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

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: Splice in controlled environment, but then heavy and hard to mount

Remember: Water and fiber don't mix!

Splice Enclosure
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 ➔

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

A PLP Air Flow Spoiler hard at work

Various other claimed solutions exist with questionable effectiveness and reliability

Bird Diverters

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

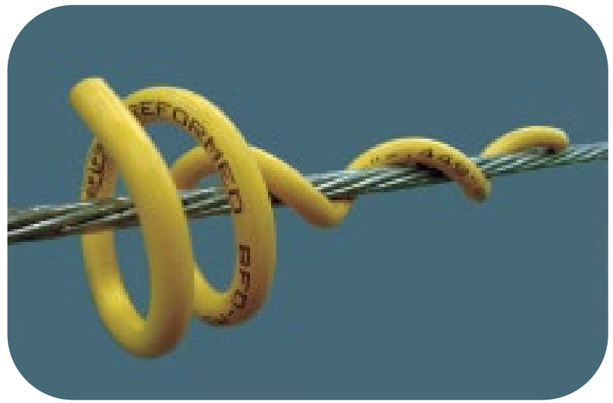
- Juveniles that have not yet developed good flight control
- Flying While under the Influence (FWI)
- Texting while flying

A small flock attends a safety briefing about aerial cables

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

Marker Balls

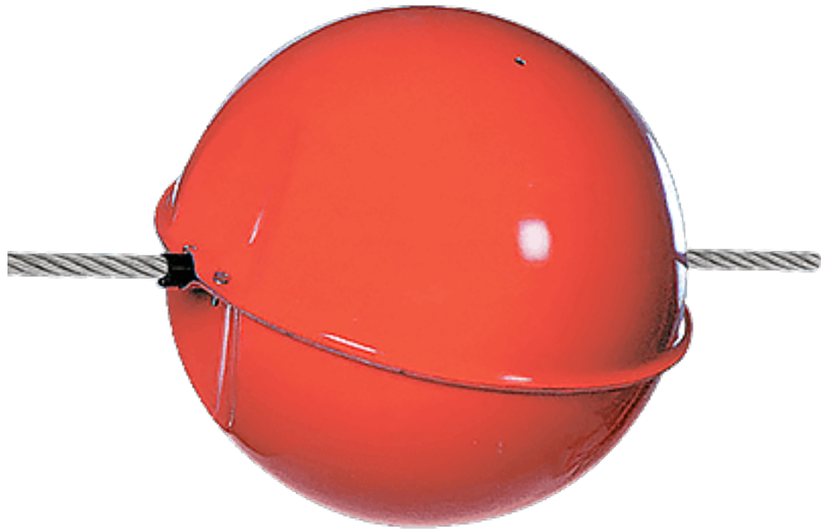
Because aircraft (UFO's too) and OPGW don't mix

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!**



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)

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!

OPGW Accessories

Closing Thought

- Your OPGW cable and all accessories used on it must work together as a system
    - So, have both the cable manufacturer and the accessories manufacture(s) work together and agree that system

Incab

Thank you!

INCABAMERICA.COM