Incab

ADSS Engineering 101

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President

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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 STATEMENT / COURSE DESCRIPTION

Registered continuing education program

- ADSS Engineering 101 will teach you **eight** important design elements of all-dielectric self-supporting cable (ADSS)

- How the tubes and optical core should be made, and why this "how" is important to long-term performance.

- We will conclude with a primer on sag and tension data for ADSS and how to determine when a track-resistant jacket is necessary.

LEARNING OBJECTIVES

After this class, you will be able to:

1. Explain the meaning and importance of each of the eight (8) design elements of all-dielectric, self-supporting (ADSS) cable
2. Explain how the tubes and optical core should be made, and why this “how” is important to long-term performance.
3. Outline how to obtain sag and tension data for an ADSS cable.
4. Explain how to determine when a track-resistant jacket is necessary for an ADSS cable.

Incab University "School of Excellence in Fiber Optics"
Agenda

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

Review

Fiber Optic Cable Basics

- Let's begin by reviewing some basics of optical fiber and loose tubes.
- The principles behind these are the same whether they are in ADSS, OPGW or other types of fiber optic cable.

Cable Basics

Fiber

- "Low Water Peak" SM = Overwhelmingly most used fiber type today!
  - ITU-T G.652D
  - Corning SMF family
  - Generally splice compatible
  - Good for about 60-90 miles

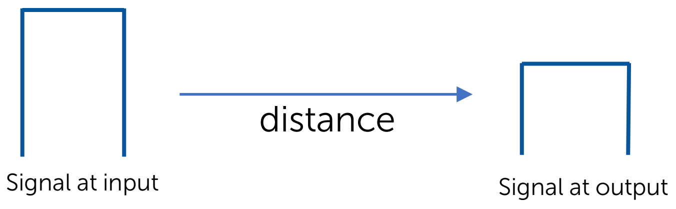
- Non-Zero Dispersion Shifted (NZDS)
  - ITU-T G.655
  - Corning LEAF and OFS TrueWave RS ZWP
  - Generally not splice compatible (the «progressive lenses» analogy)
  - Good for up to about 250 miles
  - A must when using DWDM to boost bandwidth

- Multimode
  - 50 µm (= "micron") or 62.5 µm
  - ITU G.651.1 & ISO/IEC 11801 OM1 (62.5) and OM2 – OM5
  - Premises or short distances (typically 2 km or less) for local area networks (LAN)

Cable Basics

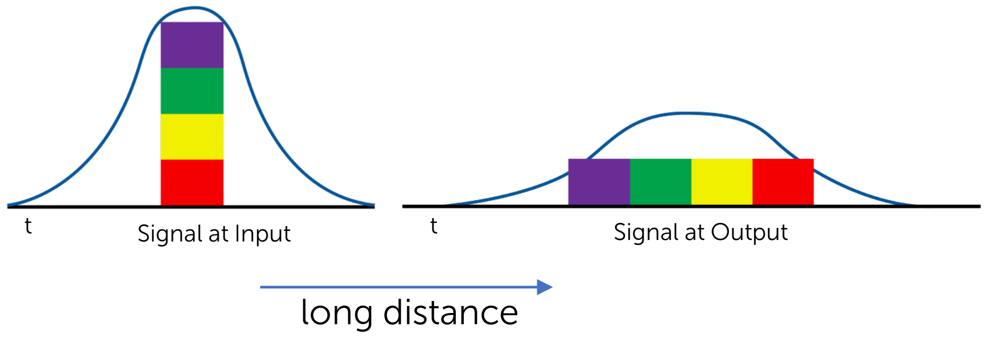
Fiber – Performance Specifications

Attenuation: The loss of power over distance (dB/km)



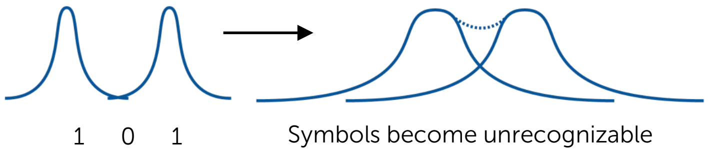
The single most important fiber performance spec for the user

(**Chromatic) Dispersion:** Corruption ("spreading out") of a signal over distance due to component wavelengths travelling at different speeds



Dispersion

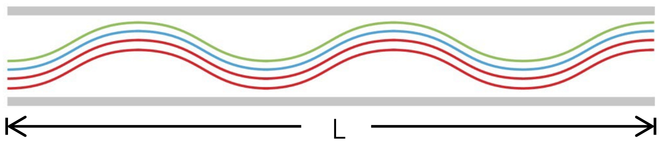
As a pulse travels down a fiber, dispersion causes pulse spreading.
This limits the distance and the bit rate of data on an optical fiber.



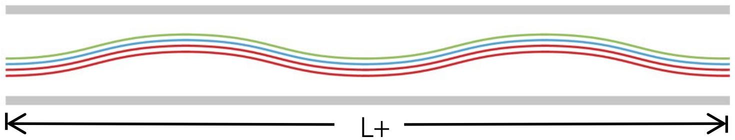
Cable Basics

Protecting the Fiber – Loose Tubes

- Loose tubes allow the fibers to move in response to changes in elongation which result from changes in temperature plus ice and wind loading



Loose Tube – No Tension



Loose Tube – Elongated By Tension

- Fibers need room to move freely

$$\frac{L_{\text{fibers}}}{L_{\text{tubes}}} \approx 1.0025 \text{ (or more)}$$

- Fibers begin to straighten out

$$\frac{L_{\text{fibers}}}{L_{\text{tubes}}}$$ ⇒ lowers, until it is 1
⇒ Then there is strain (tension) on the fibers

- EFL = Excess Fiber Length = the “extra” fiber per unit length of tube or cable (from stranding)
  General Rule: Higher is better

  Stranding a tube increases “EFL” because of the helix imparted to it (≈2.5% to EFL)

Distance required to complete 1 revolution of a tube around the diameter of what’s underneath (typically, the center element)

- Zero Fiber Strain Margin = the point where the fibers begin to experience strain. Expressed in %RBS

Cable Basics

Protecting the Fiber – Loose Tubes

- If a tube is «overfilled», then the fibers will not have the sinusoidal shape they should have and they will also lose the ability to move freely

  ➔ Overfilled tube = Bad!

- «Bundling» or «binder threads» can reduce freedom of movement, but splicing techs often prefer these over ring or band marking
  - Today's manufacturing processes yield EFL that is:
    - Consistent. Each fiber has the same amount of EFL
    - Well-coordinated. All fibers "in phase"

    ➔ So, bundling works well…the bundle itself moves as a unit

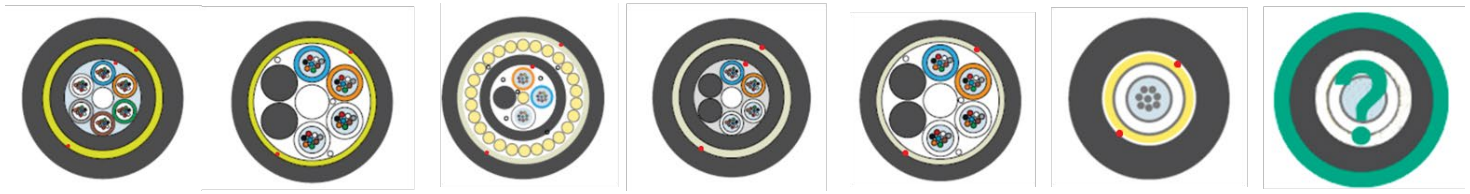
Cable Basics
ADSS Cable

- All Dielectric Self-Supporting
  - "Dielectric" = No metallic components
  - "Self-Supporting" = Designed to support its own weight

- Technical Standards
  - US IEEE 1222
  - Internationally, 60794-4-20

- Classification By Span Length That You Will Often Hear:
  - Short, Medium, Long
  - What do these really mean?

ADSS Design Considerations



- Jacket Configuration
    - Double vs. Single
- Jacket Material
    - High Density Polyethylene (HDPE) vs. Medium Density PE (What about Low Density PE?)
- Strength Material
    - Aramid (Kevlar) vs. Fiberglass (or Fiberglass Reinforced Plastic (FRP) rods)
- Core Design
    - Dry vs. Flooded (gel-filled = "Wet")
- Tube Design
    - Dry vs. Flooded
- Fibers per tube
    - 12 vs. 24 (and others)
- Tube Material
    - Polybutylene Terephthalate (PBT) vs. Polypropylene (PP)
- Outer jacket adhesion to the strength element
    - Coupled vs. De-coupled

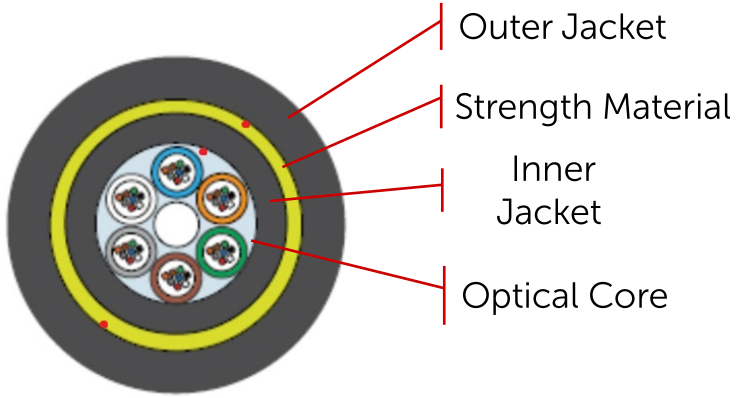
Feeling anxious? Relax! We'll break these down so that you can make informed choices!

ADSS Design Considerations

Jacket Configuration

Double Jacket

- Traditional design
- **Advantages**
  - Highest reliability. Inner jacket protects optical core
  - Long spans. Over 1,600 ft (549 m) possible
- **Disadvantages**
  - More expensive (≈ 5 – 25% depending on fiber count)
  - Increased diameter and weight (≈ 10 – 20%)

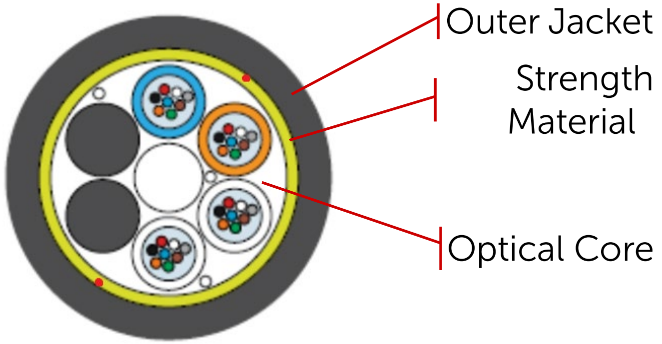


ADSS Design Considerations

Jacket Configuration

Single

- Newer design type (but, still around for over 20 years)
- **Advantages**
  - Reduced diameter and weight
  - Less expensive
- **Disadvantages**
  - Lower reliability
  - Reduced span lengths/loading conditions.
    - Less than 650 ft. (200 m)



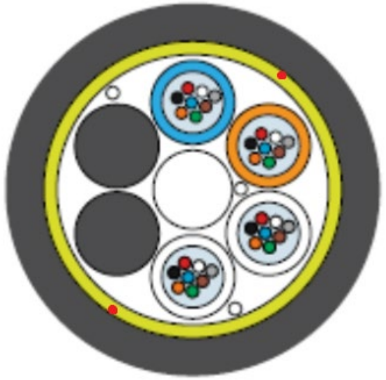
ADSS Design Considerations

Jacket Configuration

What choice to make?

- **Double** – If *any* of the following applies
  - Spans > 600 ft (180 m)
  - NESC Heavy (or similar) or extreme ice/wind loading
  - Fiber count > 144
  - Highest reliability needed

- **Single** – If *all* of the following apply
  - Spans ≤ 600 ft (180 m)
  - Light or Medium (or similar) w/o extreme ice/wind loading
  - Fiber count ≤ 144
  - Good reliability is "good enough"



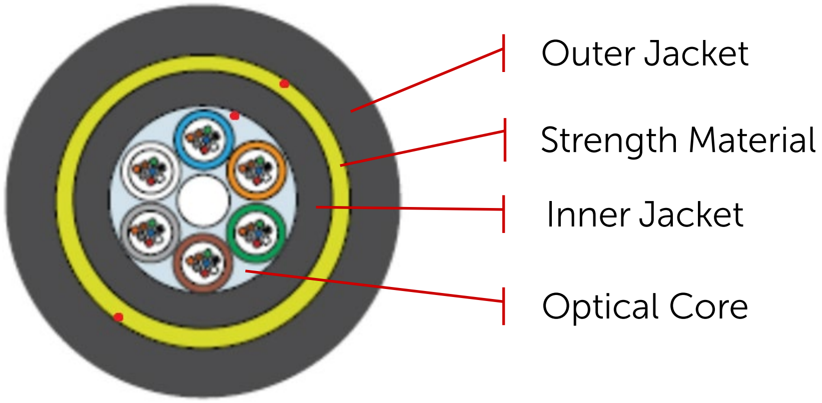
The optimal choice depends on your project details

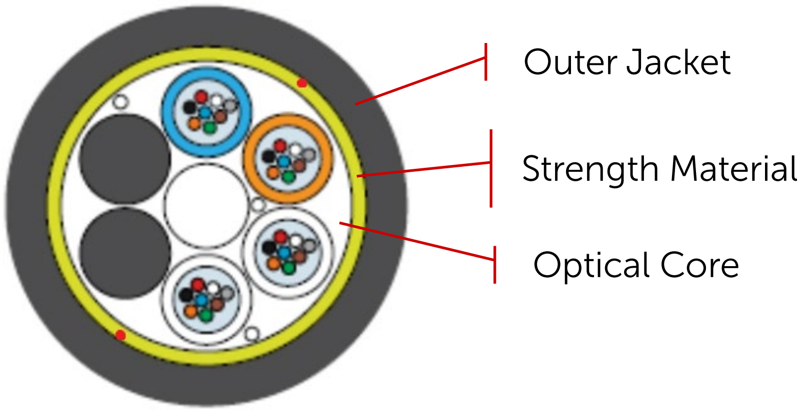
ADSS Design Considerations

Jacket Material

High density polyethylene (HDPE)

- **Advantages**
    - Tough and durable
- **Disadvantages**
    - Susceptible to cracking
    - Makes splice prep harder
    - More expensive



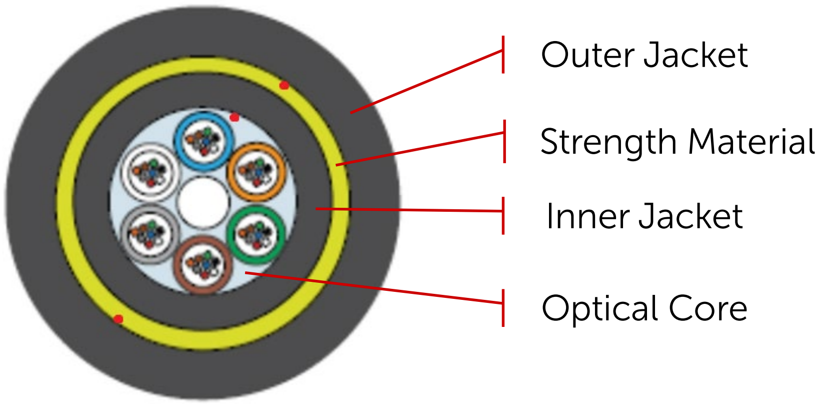


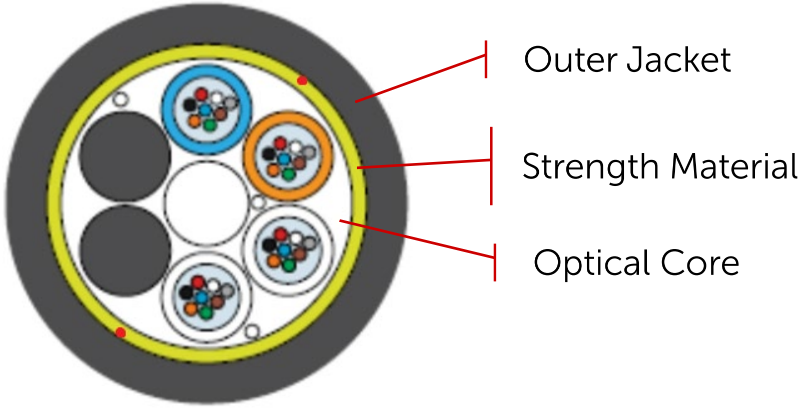
ADSS Design Considerations

Jacket Material

Medium density polyethylene (MDPE)

- **Advantages**
  - Tough and durable
  - Easier to remove during splice prep
  - Less expensive than HDPE
- **Disadvantages**
  - Not as tough and durable as HDPE





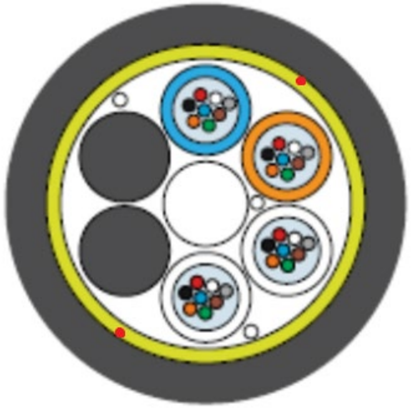
Low density polyethylene (LDPE)

- Well-suited for <u>inner-jacket only</u>

ADSS Design Considerations

Jacket Material

- **High density polyethylene (HDPE)**
  - Special applications and for track-resistant
- ✓ **Medium density polyethylene (MDPE)**
  - Best overall choice for outer jacket.
    - Balances toughness and durability with cost and ease of splice prep
- **Low density polyethylene (LDPE)**
  - Well-suited for inner-jacket only.
    - Facilitates splice prep



ADSS Design Considerations

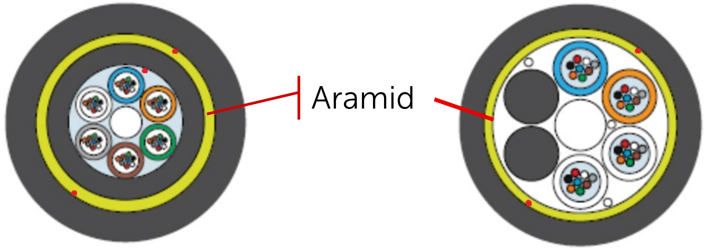
Strength Material

Aramid ("Kevlar®" is specific to DuPont who invented it)

- The original and most used strength material

- **Advantages**
  - High strength-to-weight ratio (5x greater than steel!)
  - Thermal stability (way above and below range for ADSS)
  - Can easily limit fiber strain at Maximum Rated Design Tension (MRDT = MRCL) to ≤ 0.2% (best maximum limit)

- **Disadvantages**
  - More expensive than fiberglass
  - Can become conductive with water (jacket breach) plus high electric field



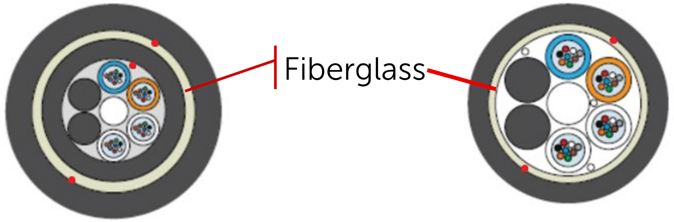
ADSS Design Considerations

Strength Material

Fiberglass yarn

- **Advantages**
  - Less expensive
  - Rodents (including squirrels) don't like to chew on it
    - Gets a grade of "C"

- **Disadvantages**
    - Lower strength and thermal stability compared to aramid
      - Must use more to achieve a given strength
      - This drives up overall diameter (≈ 10 – 20%)
    - Usually, higher fiber strain at MRDT, 0.3 – 0.4%

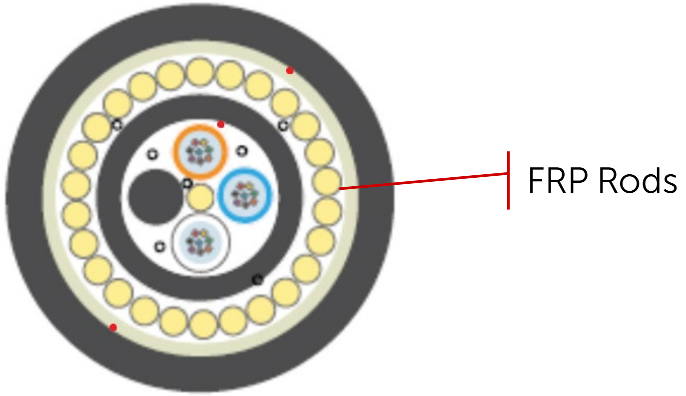


ADSS Design Considerations

Strength Material

Fiberglass Reinforced Plastic Rods (FRP)

- **Advantages**
  - Rodents (including squirrels) don't like to chew on it ("A")
  - Very high crush resistance
  - Versatile. Can also direct bury underground
  - Hoped for shotgun resistant, but unfortunately, <u>no</u>
- **Disadvantages**
  - Expensive
  - Largest diameter and weight (must have inner-jacket)
  - Relatively shorter spans
  - May be harder to splice prep (removing the rods)



ADSS Design Considerations

Context for Considering Rodent Resistance

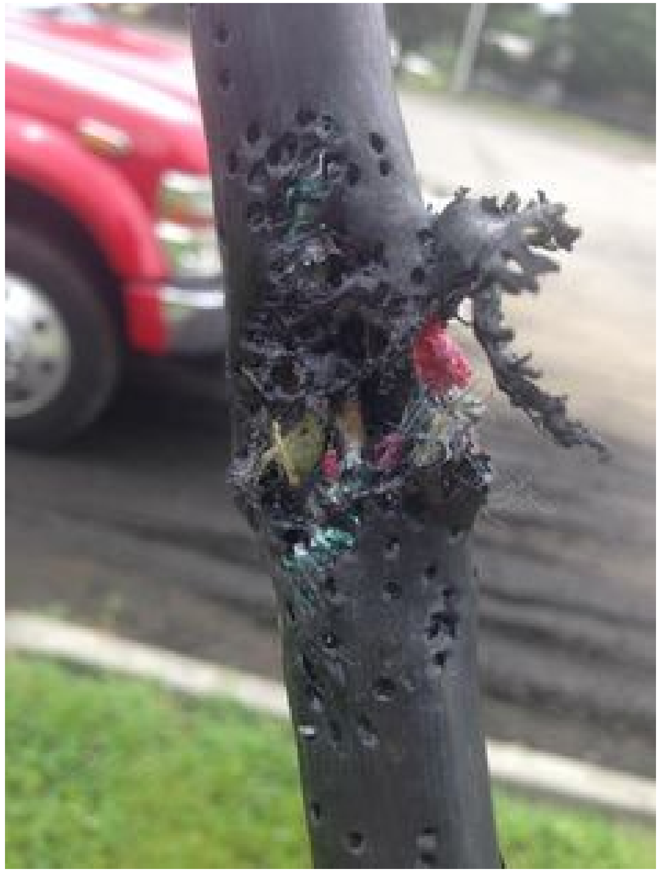
Per a UTC survey (2017)…

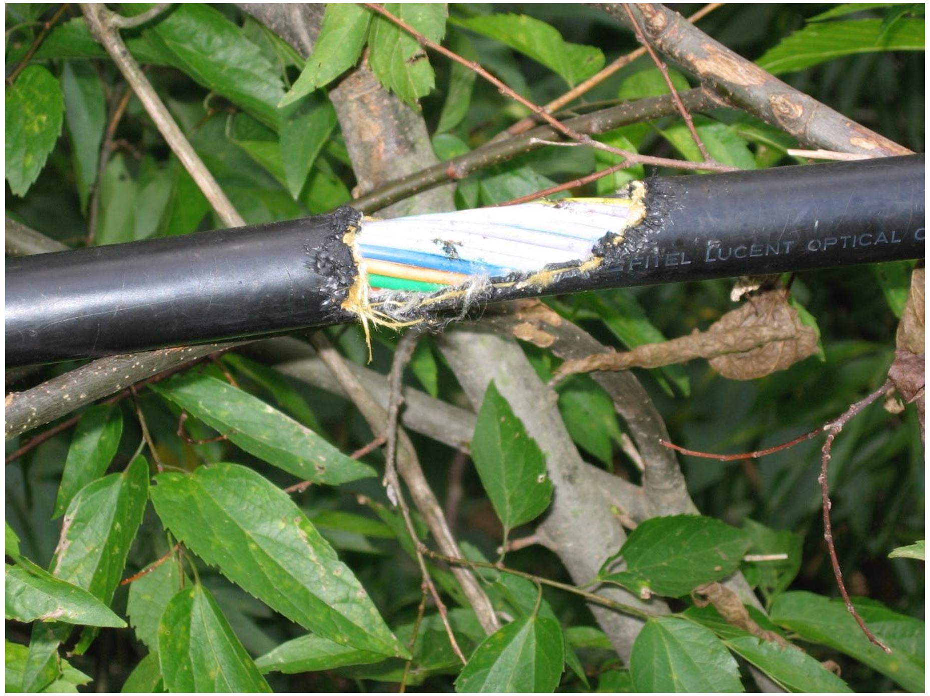
- The **#1 field problem** with ADSS has been **shotgun damage**
- The **#2 problem** has been **rodent damage**, in particular **squirrels**

Enjoy the next slide!

ADSS Design Considerations

“Critter Cable Killers”

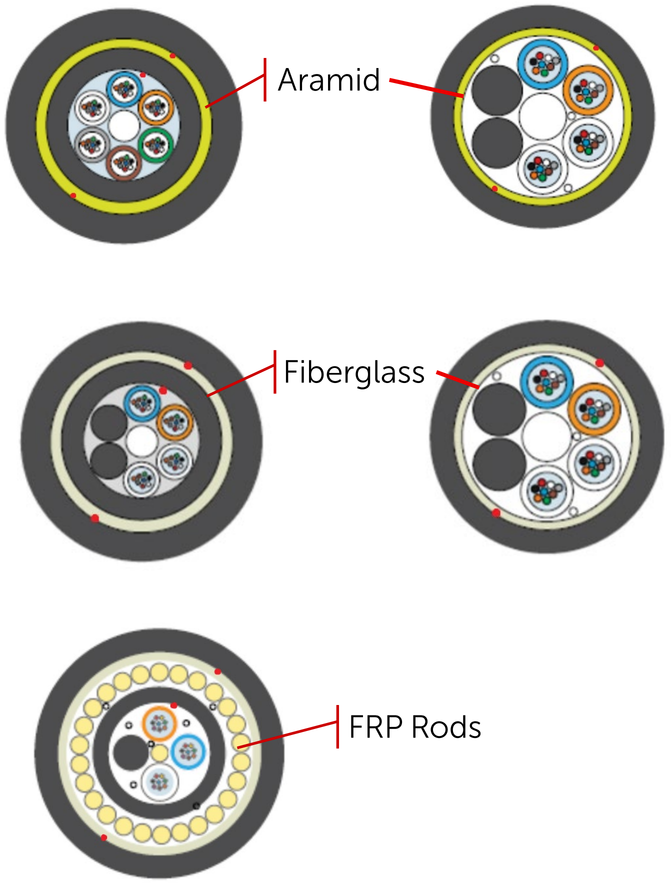




ADSS Design Considerations

Strength Material: What Choice to Make?

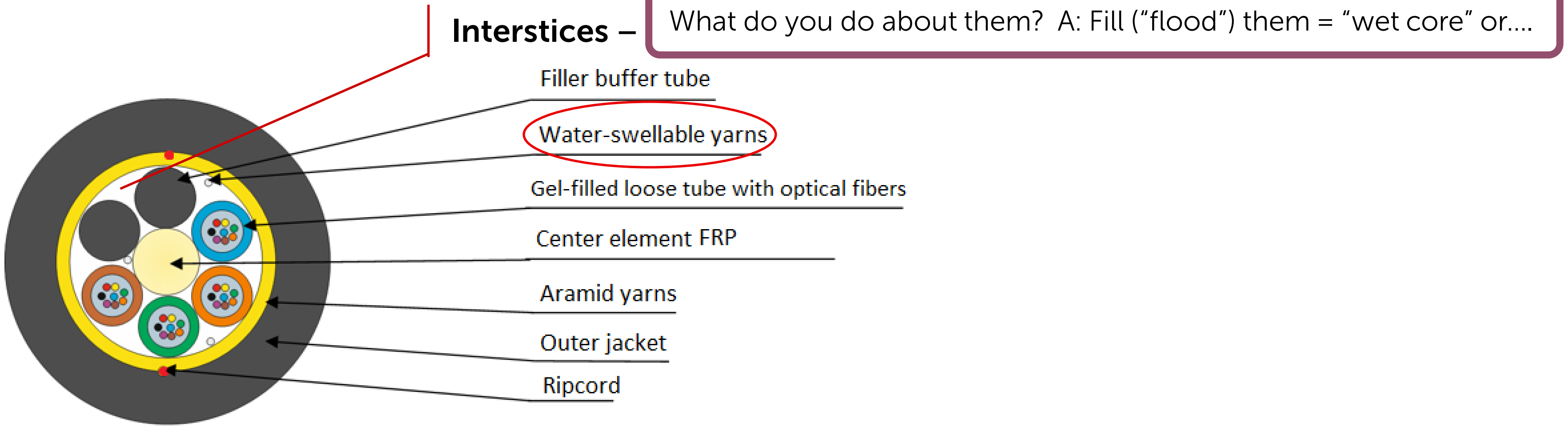
- ✓+ **Aramid**
  - The "default" choice. Fiberglass or FRP should be used in special situations
- ✓ **Fiberglass yarn**
  - Use when rodents are only possibly a problem or just a minor problem
    - Can combine with rodent deterrent additive to enhance protection ("B")
  - Use when spans are short to medium, and cost must be cut to the bone
    - FTTH round drop cables?
- ✓ **FRP rod**
  - Use when rodents are a known problem and spans short to medium
    - You must confirm sag and tension characteristics are suitable
    - Can combine with rodent deterrent additive to enhance protection ("A+")
  - Excellent for use in FTTH flat drop cables



The optimal choice depends on your project details

ADSS Design Considerations

Core Design



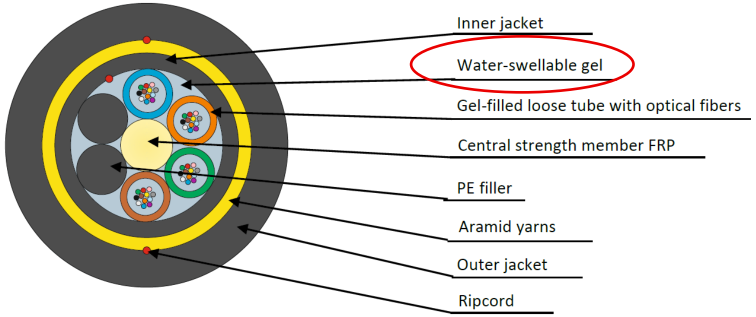
Dry – water-swellable yarns using “super absorbing polymer” (SAP) absorb water that penetrates cable

- Newer, but over 20 years use

- **Advantages**
  - Much less messy splice prep
  - Lowers unit weight a little
- **Disadvantages**
  - * Water gets *inside* the cable *before* it gets absorbed

ADSS Design Considerations

Core Design



Flooded or "Wet" – Gel is used to fill the interstices of the optical core

- Original design, but replaced in the US with dry core

- **Advantages**
  - Keeps water 100% out of the optical core!
  - Slightly cheaper (≈ 5 - 10%)

- **Disadvantages**
  - Messy splice prep
    - Context: ≈ 6 ft (2 m) or more of core must be prepped

ADSS Design Considerations

Core Design: What Choice to Make

✓ **Dry**

- The default choice in the USA and some countries

Flooded or “Wet”

- Used in many countries outside the USA
- Technically, flooded is better, but USA splice techs hate it

ADSS Design Considerations

Tube Design

Dry – Water-swellable yarns using "super absorbing polymer" (SAP) absorb water that penetrates the tubes

- Newer (≈ 10 – 15 years)

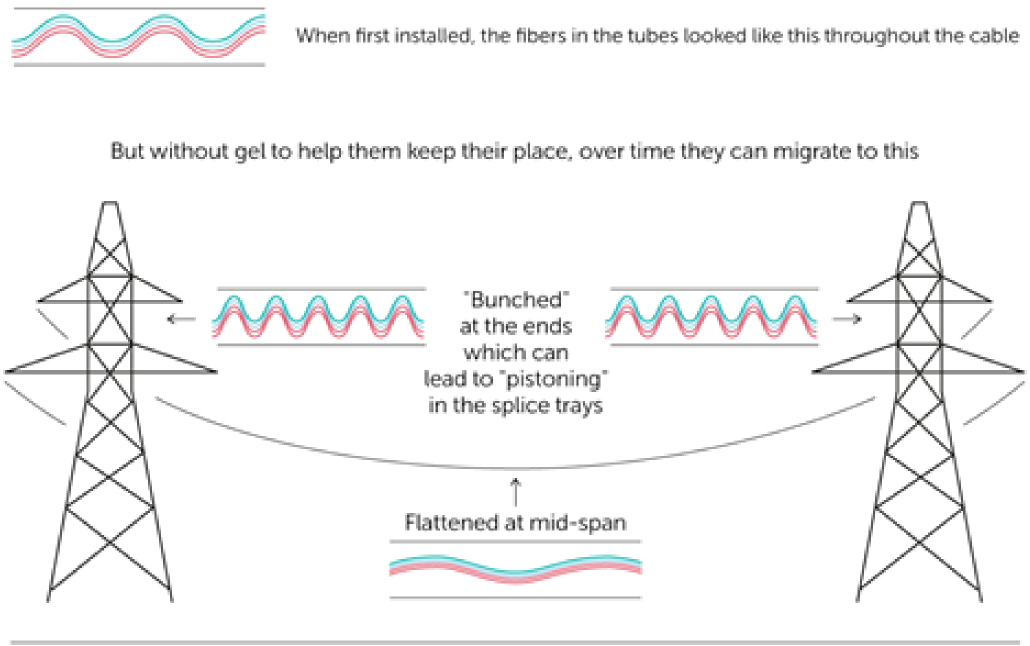
- **Advantages**
  - Less messy splice prep 🡐 Debatable based on anecdotes from some splice techs (SAP residue)
  - Lowers unit weight a little 🡐 Weight savings may be trivial

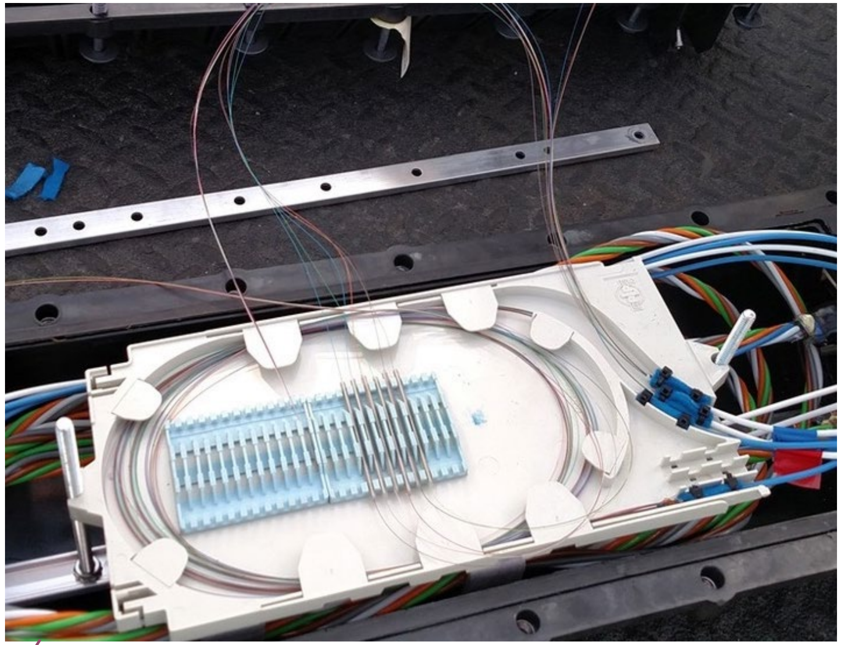
- **Disadvantages**
  - Water gets *inside* the tube *before* it gets absorbed
  - Yarn alone does *not* help the fibers keep their sinusoidal shape
  - Yarn alone does *not* help the fibers move in unison with the tube during changes in elongation (tension)
    - Fibers will tend to flatten in the middle of spans and "bunch up" at the ends
    - This can result in "piston-ing" inside the splice enclosures
  - More expensive (≈ 5 - 10%)

Controversial Topic

ADSS Design Considerations

Tube Design – Migration and Bunching Illustrated





Fiber Migration – Can lead to "piston-ing"

Controversial Topic

ADSS Design Considerations

Tube Design

Flooded or "Wet" – Gel is used to fill the buffer tubes

- Original design, still the most common around the world

- **Advantages**
  - Keeps water 100% out of the tubes!
  - Less expensive
    - Gel helps the fibers keep their sinusoidal shape
    - Gel helps the fibers move in unison with the tube during changes in elongation (tension)
      - So, the fibers will stay where they should be and resist "piston-ing" (pushing out of tubes)
    - Gel helps the tubes resist deformation
    - Improves tube and cable crush resistance

- **Disadvantages**
  - Perceived to be messy during splice prep and to add time. But…
    - Only about 8 – 24 inches (20 – 52 cm) of tube needs to be prepped, so really not very messy
    - Cleaning the fibers adds about 15 seconds per tube

Controversial Topic

ADSS Design Considerations

Tube Design: What Choice to Make

Dry

- If used, should only be used in underground cables or ones to be lashed

✓ **Flooded or "Wet"**

- The best choice for an aerial cable such as ADSS

But, a cable supplier must be responsive to what customers want, so…

- We do supply dry tubes for "short" and "medium" span ADSS
    - Up to about 600 ft (183 m) and NESC Medium loading
      [Ice = ¼-inch (6.5 mm); Wind = 4 lb/ft^2 (190 Pa); K = 0.2 lb/ft (2.90 N/m)]

Controversial Topic

ADSS Design Considerations

Fiber Per Tube

12-fibers per tube

  - Industry standard practice for decades

- **Advantages**
  - Everyone and everything is used to it
  - Better facilitates “taps” than 24-fibers per tube

- **Disadvantages**
  - Increases cable diameter and weight, especially at higher fiber counts
  - More expensive (≈ 10 - 50%)
  - More time for splice prep

ADSS Design Considerations

Fiber Per Tube

24-fibers per tube

- Newer. Increased use as total fiber count has increased

- **Advantages**
    - Decreases cable diameter and weight, especially at higher fiber counts
    - Less expensive
    - Reduces time for splice prep
    - Coordinates very well with most splice trays

- **Disadvantages**
    - Need to confirm your splice trays can hold 24-fibers (many do, but some only hold 12)
    - Less conductive to taps as 12-fibers
    - May not work as well with some FTTH network architectures

ADSS Design Considerations

Fiber Per Tube

Other Counts

- Example, a 48-fiber cable could be 4 x 12, 2 x 24, but also 3x16, 6x8, 8x6, or 12x4 per tube

- **Advantages**
  - At ≤ 48-fibers, 8 or 6-fibers per tube can reduce overall cable diameter
  - Facilitates taps and mid-span access which may be helpful in a FTTH project

- **Disadvantages**
  - Not the norm
    - May not be in stock or have longer lead time
    - May increase cable cost
    - At > 48-fibers, 8 or 6-fibers per tube will increase overall cable diameter and weight

ADSS Design Considerations

Fiber Per Tube: What Choice to Make?

- ✓ **12-fibers per tube**
- ✓ **24-fibers per tube**
- **Others** (8 or 6) 🡐 May be appropriate in some cases, especially a FTTH project

The optimal choice depends on your project details

ADSS Design Considerations

Tube Material

Polybutylene Terephthalate (PBT)

- **Advantages**
  - High crush resistance (≈ 60% greater in cable with PBT vs cable with PP) and durability
    - Helps the cable work well with deadends
  - High tensile strength
  - Excellent temperature performance
  - "Clean" cuts when removing tube during splice prep

- **Disadvantages**
  - Stiffer, so more susceptible to being kinked during splice prep
  - Should use "slitting" type tool for mid-span access
    - "Shaving" type tools do *not* work well, unless used with a heat gun
  - Need to be reasonably careful during splice prep
  - More expensive

Controversial Topic

ADSS Design Considerations

Tube Material

Polypropylene (PP)

- **Advantages**
  - Very flexible, so tubes less likely to kink during splice prep
  - Splice techs often like PP a lot
  - Mid-span access is readily achieved using a "shaving" type tool
  - Less expensive

- **Disadvantages**
  - Much lower crush resistance and tensile strength
  - Not as durable as PBT
  - <u>Much</u> lower temperature resistance, especially at low temperatures [-4^{0}F (-20^{0}C)]
    - Should *not* be used in areas where the temperature can get this cold
  - Tends to tear and leave jagged edges when removed during splice prep

Controversial Topic

ADSS Design Considerations

Tube Material: What Choice to Make?

- ✓ **Polybutylene Terephthalate (PBT)**
- **Polypropylene (PP)**

➔ **In our experience, PBT gives the best overall long-term performance, especially in ADSS**

- Some manufacturers will disagree with us

But, recall that a cable supplier must be responsive to what customers want, so...

- We plan to start supplying PP tubes for "short" and "medium" span ADSS later this year
  - Up to about 600 ft (183 m) and NESC Medium loading [Ice = ¼-inch (6.5 mm); Wind = 4 lb/ft^2 (190 Pa); K = 0.2 lb/ft (2.90 N/m)]

Controversial Topic

ADSS Design Considerations

Outer Jacket Adhesion

Coupled

- The outer jacket will have **adhesion** (“sticky”) to the strength material (aramid, fiberglass, or FRP rod) **- ranging from light to heavy**

- **Advantages**
    - Ensures that the tension in the strength material transitions smoothly through the jacket to the deadend
        - Prevents jacket failures!
        - Permits the use of shorter deadends

- **Disadvantages**
    - Makes removing the outer jacket less easy
        - Some splice techs will complain
        - Can be mitigated by having two rip cords under the outer jacket

Controversial Topic

ADSS Design Considerations

Outer Jacket Adhesion

De-Coupled

- The outer jacket will not have adhesion to the strength material (aramid, fiberglass, or FRP rod)
  - There may even be a tape applied specifically to prevent adhesion

- **Advantages**
  - Makes splice prep easier by making it easier to remove the outer jacket

- **Disadvantages**
  - Disrupts the smooth transition of the tension in the strength material through the jacket to the deadend
    - Can lead to stress concentrations
    - Stress concentrations can lead to jacket failures
      - Often mitigated by using longer deadends
        - But, this will increase their cost!
        - And, this may mean that the deadends cannot be installed from the pole
          - Therefore, requiring a bucket truck or other means to install them (more cost!)

Controversial Topic

Outer Jacket Adhesion

Comparisons

Maximum Loaded Tension		Required Rod Lengths for ADSS Deadends				
		Coupled Design		De-Coupled Design		Difference
lb	kN	in	mm	in	mm	%
2500	12	41	1050	48	1219	116
4000	20	51	1300	80	2032	156
7500	35	67	1700	104	2642	155

A jacket tear in a lab on a known de-coupled ADSS cable design

A jacket tear in the field on an ADSS cable believed to be de-coupled design

Controversial Topic

Outer Jacket Adhesion

What Choice to Make?

✓ **Coupled – But, for the USA market, we do light only**

De-coupled

We think coupled designs ensure long-term reliability for ADSS!

- Some cable manufacturers will disagree with us
- Most accessories manufacturers will agree with us

Note: De-coupled designs are fine for underground or lashed types of cables

Controversial Topic

Observation

What about splice prep considerations?

We have seen splice prep considerations drive cable design in four areas:

1. **Dry vs. flooded core**
2. **Dry vs. flooded tube**
3. **PP vs. PBT tubes**
4. **De-coupled vs. adhesion between outer jacket and strength material**

In each of these, the cable's long-term reliability has been sacrificed to make splice prep easier, faster, or less messy

➔ Is this really what we all want?

Controversial Topic

Observation

What about splice prep considerations?

Context for viewing splice prep considerations

- **Splice prep** is on the order of a few **hours**
- Cable **operation** is on the order of a few **decades**

Thus, when there is a **conflict** between **reliability** and **ease of splice prep**, we think **reliability** should drive cable design, especially for ADSS

"The tail should *not* wag the dog"

Don't you agree?

Controversial Topic

Best Practices

Tubes and the Optical Core

Tubes

- The tube fabrication process should include continuous in-line excess fiber length (EFL) monitoring and control
- Recall: "Consistent" and "Well-coordinated"

Optical Core. Comprised of the tubes stranded around a center FRP rod.

- The core should be stranded using a conservative lay length

  Lay length is critical to:

    - Maximize the zero-fiber strain margin (ZFSM)
    - Minimize fiber strain at maximum rated design tension (MRDT)

- The core should also be stranded using reverse-oscillating lay (ROL)
  - ROL is when the lay direction reverses every few inches (cm)
  - ROL facilitates splice prep and mid-span access

Important Considerations

Two More Design Considerations

What about sag and tension characteristics?

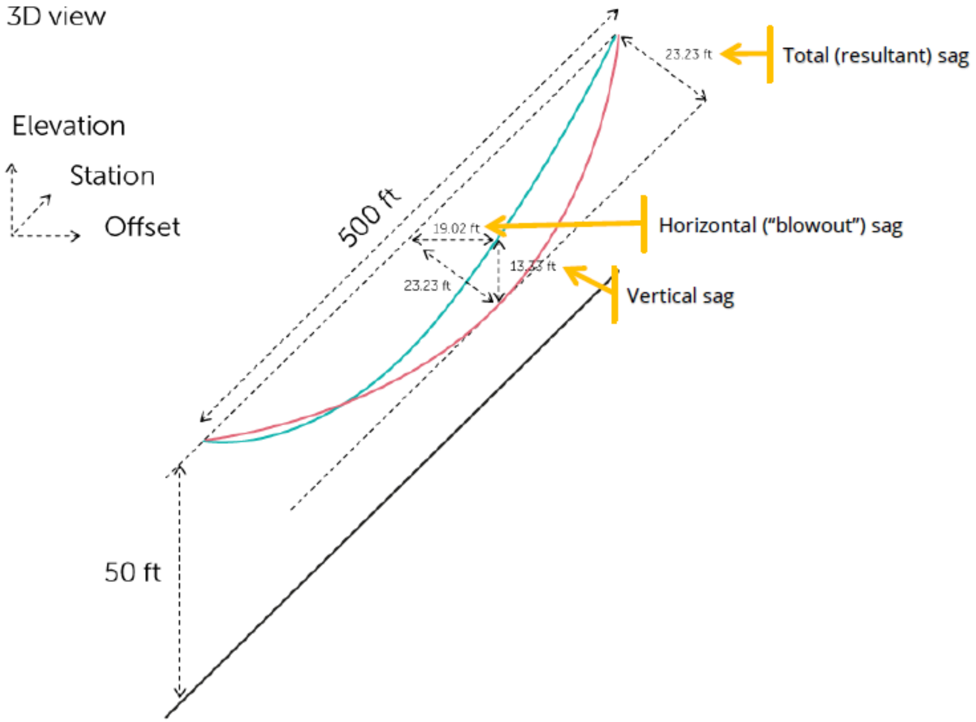
When is a track-resistant jacket necessary?

Let's (quickly) review each

ADSS Specific Issues

Sag and Tension (a primer only)

- ADSS sag and tension characteristics are quite different from those of OPGW or other metallic cables
  - OPGW and metal cables. Strength is required to control sag
  - ADSS. Strength is required to control fiber strain
  - Plus:
    - **Horizontal blowout** during wind loading can be significant and **must be checked**!
    - **Vertical sag** under ice loading can exceed ground clearance and **must be checked**!
      - It's a myth that ice won't accumulate on ADSS! (See next slide)
- Industry convention is to have sag be **1.0 - 1.5% of span length** at "everyday" tension (= no ice or wind loading)



ADSS Specific Issues

Sag and Tension comment

If someone tells you:

- "Snow and ice don't accumulate on ADSS in the field"
- Please show them these pictures:

Sag and Tension

Check Your Fiber Strain!

Cable suppliers have a design policy on fiber strain

- “Best Practice” is **zero fiber strain to MRDT** (a.k.a. “MRCL”).
  - This is Incab’s policy

- Acceptable alternates (low risk, but non-zero) might be:
  - Zero fiber strain at nominal (unloaded) tension (“everyday”)
  - Limited fiber strain at maximum (loaded) tension (MRDT)
    - Best, ≤ 0.2% (if you are going to allow some fiber strain)
    - Not too bad, ≤ 0.3%
    - Risky, ≤ 0.4% ← Greater than this is just plain crazy!

You should have a fiber strain limit in your specs

Sag and Tension Data

Two Sources

1. Manufacturer-provided charts
   - Make sure these cover all your loading criteria

2. Generate your own data using Power Line® Systems PLS-CADD or Southwire™ Sag10®
   - For PLS-CADD, you will need a "wire" file. Ask the cable manufacturer or check their library at:
     www.powline.com/files/cables
   - Sag10® may not be suitable for all ADSS cable manufacturers' products

Note: Generating sag and tension data is thoroughly explained in ADSS Engineering 102

Sag and Tension Data

Two Tips

A. ADSS sag charts are not temperature related because of the cable's very low thermal coefficient of expansion
   - Industry practice is to ignore temperature effects

B. We offer an online tool to generate ADSS sag and tension data (ACES CATS)
   - It is available free on our website
   - It can work with anyone's cable

ADSS Specific Issues

Electric Field Guidelines

- **Standard polyethylene jacket (MDPE or HDPE) is limited to < 12 kV space potential**
  - PE degrades in a strong electric field which leads to tracking on the jacket
  - Jacket burns through, and the breech leads to mechanical or optical failure

- **For > 12 kV space potential, need track-resistant jacket, and…**
  - Corona at the tips of the accessories can damage the jacket
    - Solution: "**Corona Coils**" must be used at the ends of all armor rods
  - Caution: Could have induction issues with pulling line during installation

- **Maximum space potential is 25 kV**
  - **But, there are ways to get around this**

Note: For a full treatment of ADSS in HV applications, see our ACES SPOT webinar

ADSS Specific Issues

Electric Field Guidelines

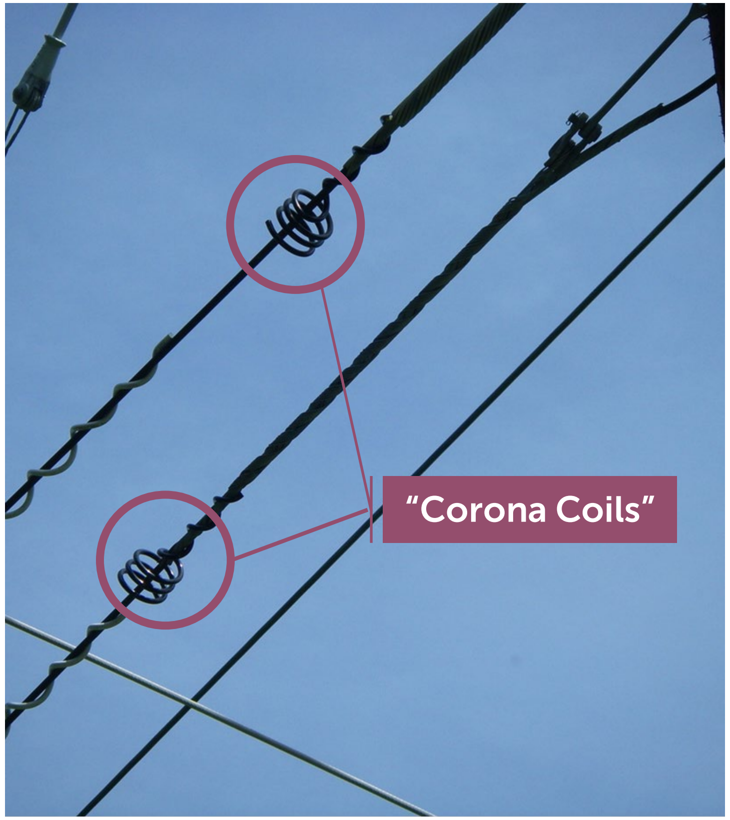
General guidelines

- < 35 kV = No danger
- 35 kV – 138 kV = **Likely no danger**, unless you install the cable "close" (within inches or cm) to the phase conductors
  - Supplier can help you check this
- 138 kV – 200 kV = **Possibly dangerous**. Should check.
  - Supplier should help you
- ≥ 230 kV = **Absolutely dangerous.** Must use track-resistant jacket and corona coils
  - Supplier can help you verify this and confirm placement details

ADSS Specific Issues

Electric Field Related Problems

Here’s the corona problem

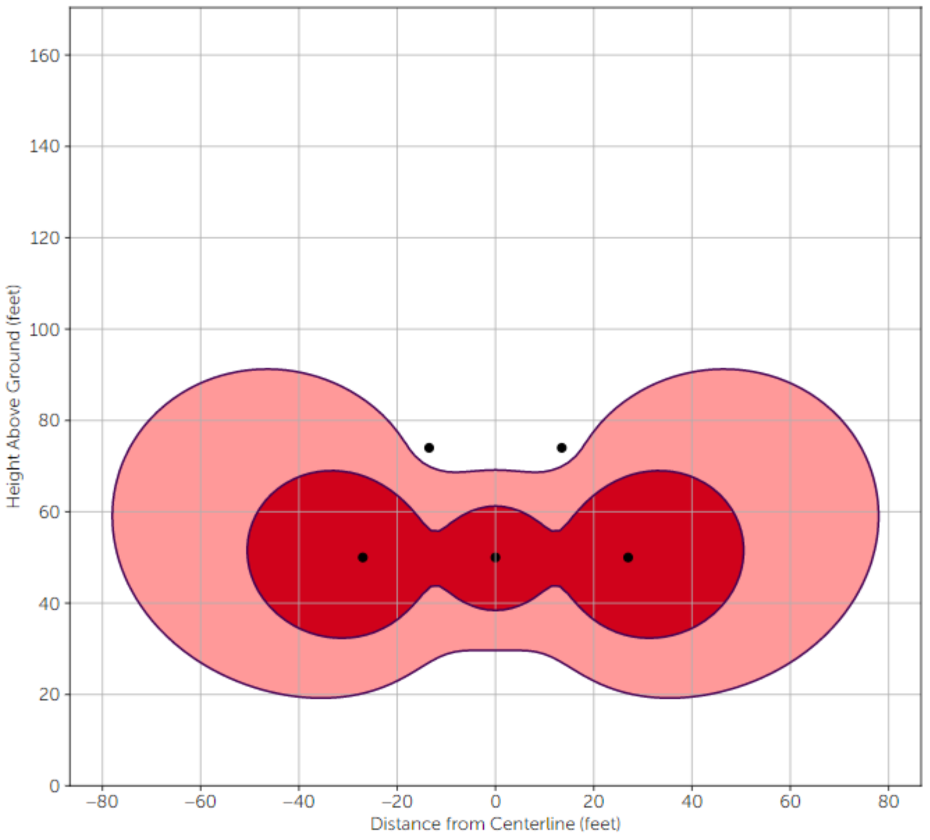


Here’s the corona solution

ADSS Specific Issues

Space Potential Analysis

Results



Space Potential (kV)

- 0–12 kV
- 12–25 kV
- above 25 kV

- For zones with electric field **up to 12 kV** it's possible to use ADSS with standard jacket
- For zones with electric field **between 12 kV and 25 kV** it is advisable to use ADSS with track-resistant jacket
- For zones with electric field **above 25 kV** the use of ADSS cable is not recommended

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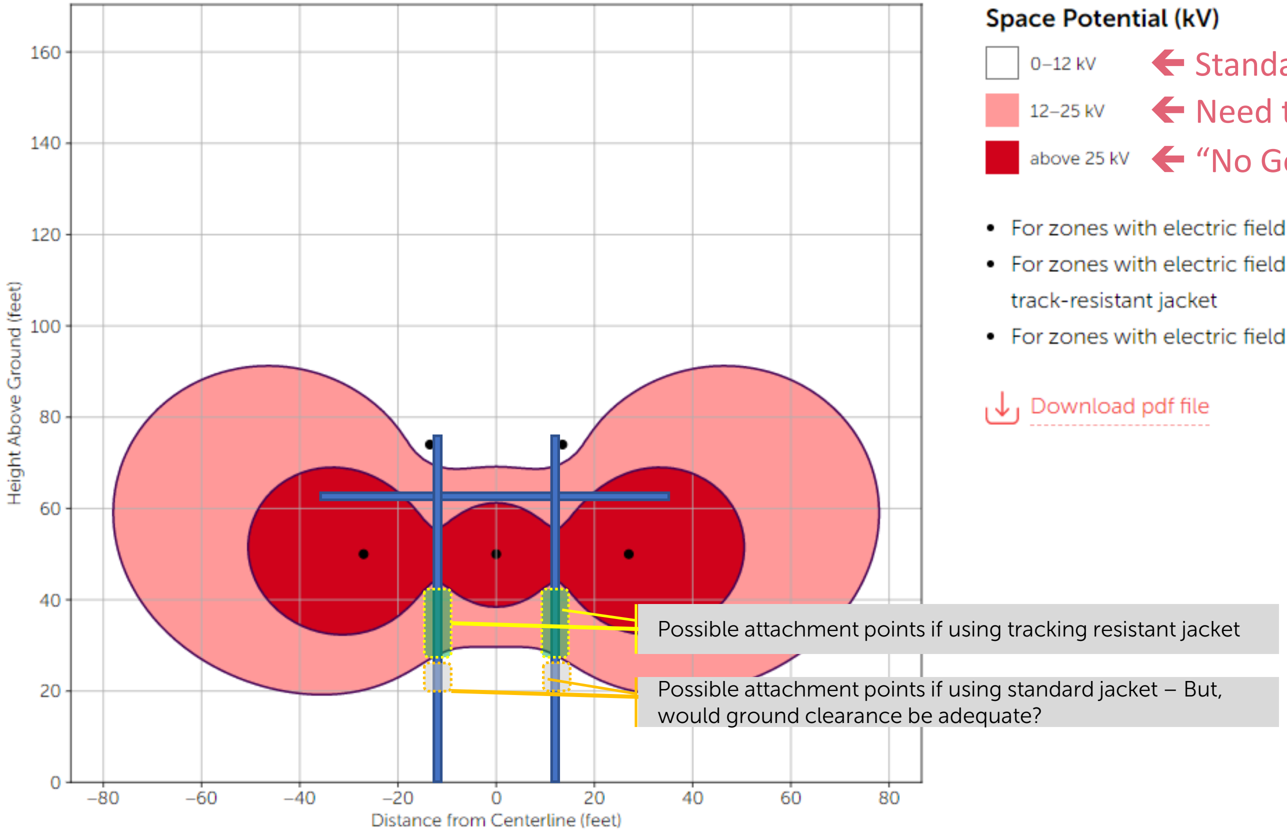
ADSS Specific Issues

Applying Space Potential Analysis

Results



Example: 345 kV H-frame transmission line

Space Potential (kV)

- 0–12 kV ← Standard jacket is OK
- 12–25 kV ← Need tracking resistant jacket
- above 25 kV ← "No Go" for any ADSS

- For zones with electric field **up to 12 kV** it's possible to use ADSS with standard jacket
- For zones with electric field **between 12 kV and 25 kV** it is advisable to use ADSS with track-resistant jacket
- For zones with electric field **above 25 kV** the use of ADSS cable is not recommended

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ADSS Specific Issues

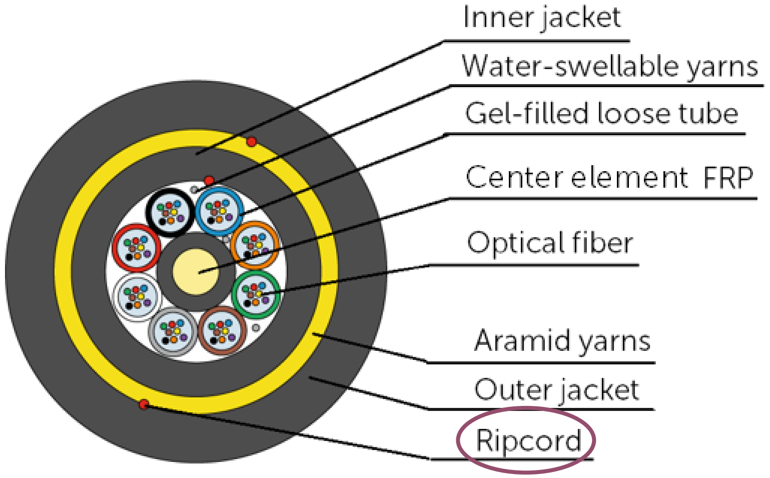
Rip Cords and Splice Prep Tools

“Rip Cords” – Used to cut through the jacket(s) to remove it (them)

- Two rip cords under the outer jacket helps a lot, **especially if the cable is a coupled design**

- A good jacket stripping tool is also an option

- Rip cords will vary by supplier, so you should <u>specify exactly what you want</u>
  - Incab’s standard is to put two (2) under the outer jacket and one (1) under an inner jacket
  - Some customers want two (2) under each jacket
  - Some suppliers have only one (1) under the outer jacket
  - Some suppliers omit them altogether unless you ask



Incab

Thank you

Questions?

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