Advanced Conductor Technologies

Christopher P. Soderman
Director – Transmission Line Engineering
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Purpose of Advance Conductors

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- With increased line loadings identified in the early 2000s, the industry became concerned with thermal rating of transmission lines and clearances to ground and other nearby objects

- Many solutions have been developed over the years to combat these issues and unlock additional capacity on the transmission system

Aluminum Conductor Steel Reinforced (ACSR)

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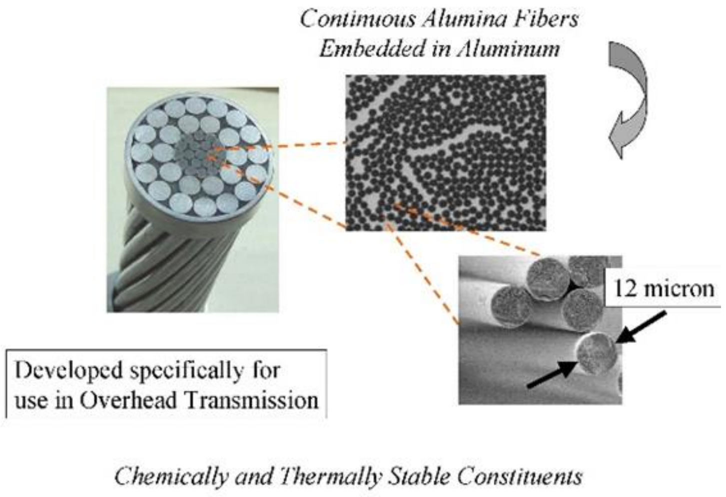
- The default conductor for many utilities across the country, first installed in the early 20th century
- Originally designed to maximize strength and conductivity taking advantage of the skin effect limiting current to outer layers
- Maximizes balance of strength of steel core to minimize sags and save money on aluminum
- Outer layers of aluminum are hardened through mechanical means, limiting the long term operating temperature to 93°C to avoiding annealing and weakening of conductor

Aluminum Conductor Steel Supported (ACSS)

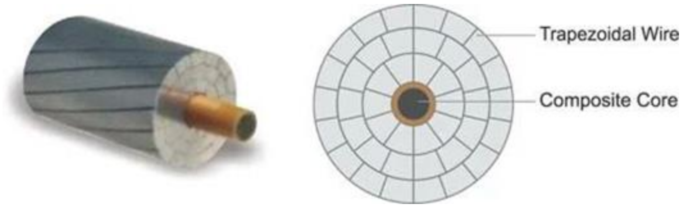
- Relies on composite performance of aluminum and steel
- In this case, the aluminum is fully annealed and all the tension is supported by the steel core
- Steel expands less with increased temperature than aluminum, thus reducing sag at higher temperatures
- Steel core provides low expansion under tension loads (wind and ice)

Aluminum Conductor Composite Reinforced (ACCR)

- Developed by the 3M Corporation in early 2000s
- Uses doped aluminum to provide thermally resistant aluminum (sustained temperatures as high as 240°C)
- Core relies on strong alumina fibers suspended in an aluminum-zirconium matrix
- Very sensitive to bending; requires special installation wheels and deadend grips

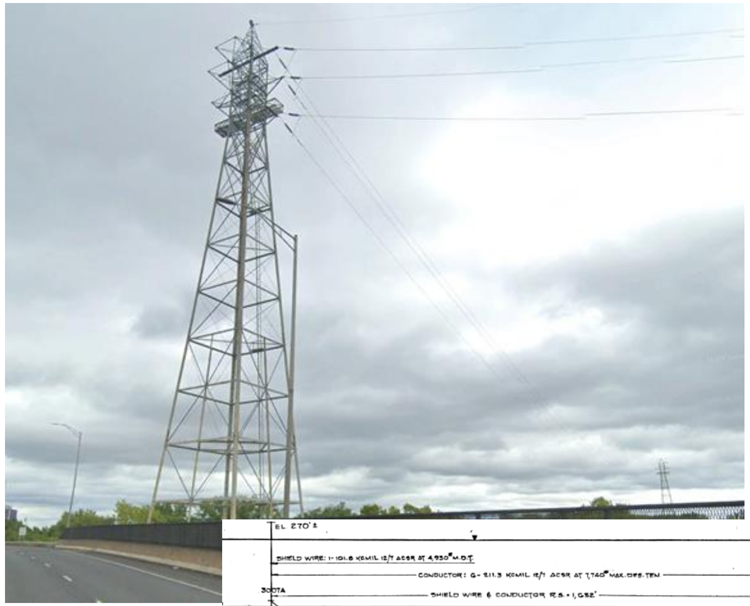


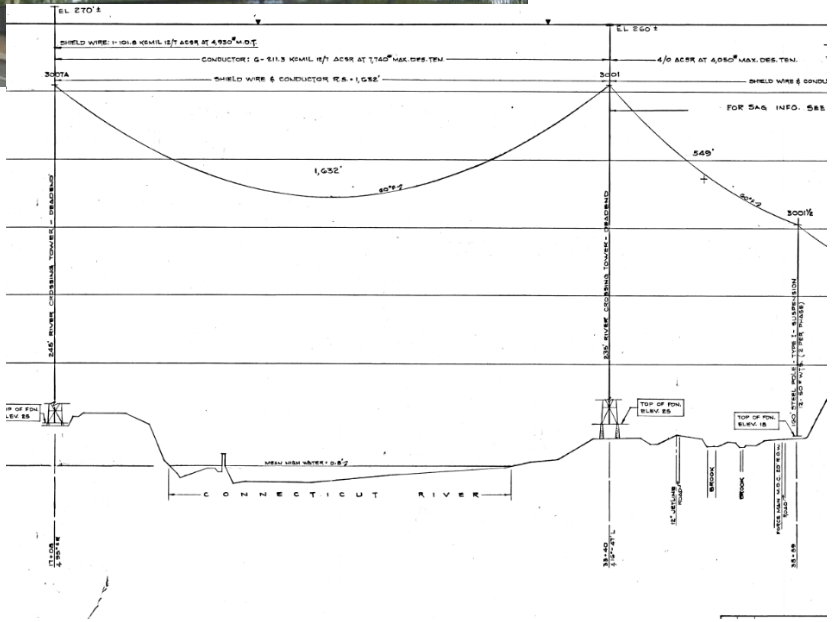
Aluminum Conductor Composite Core (ACCC) / TS Conductor



- Carbon fiber composite core technologies
- Low expansion with increased temperatures (mated with fully annealed aluminum)
- Low modulus of elasticity resulting to **increased elongation** under tension loads (wind and ice)
- Very flexible using standard installation reels
- High maximum tensile load/rated breaking strength, allowing for increased tension for special circumstances

Application Discussion – Where do these technologies fit?

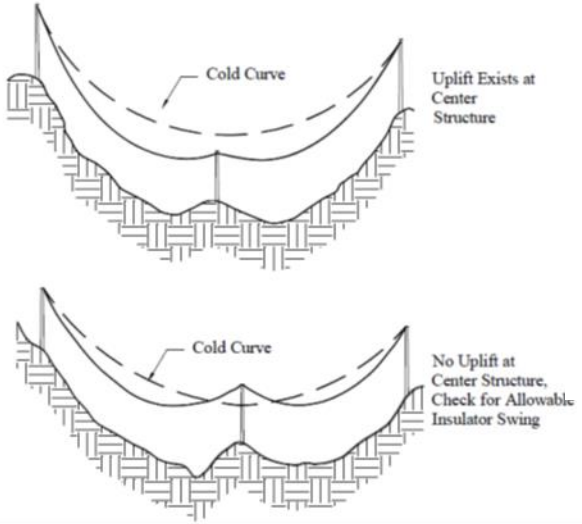


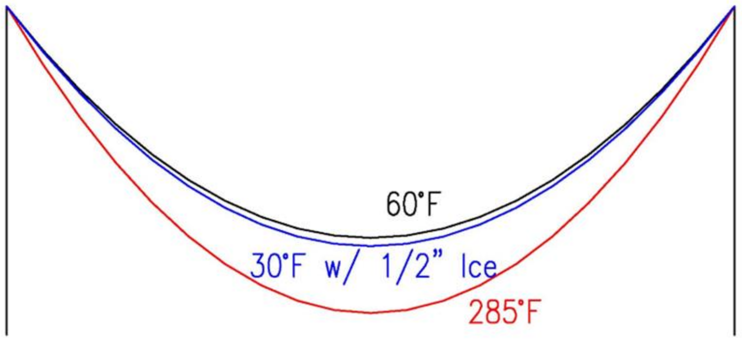


- On long spans, ACCR, ACCC and TS conductors offer the ability for increased tensions to have lower sag and therefore short structures
- Ability to reuse/reconfigure existing structures to keep project costs down
- Typically, long span conductor attachments are taller than neighboring structures, eliminating concerns with uplift

Application Discussion – Where is ACSS better?

- Short span transmission lines, particularly in up-and-down rolling terrain
  - Short spans (less than 600 feet) limit savings in sag differentials
  - Increased tensions to limit sag with composite core technologies will lead to structures in uplift requiring more expensive structures
  - The entire range of conductor sags must be considered (difference between minimum sag and maximum sag)





Sag & Tension Comparison		ACSS	ACCC		ACCR	TS Conductor
		EHS Steel	ULS	ULS AZR		Max Core
Conductor Size	kcmil	1272	1582	1582	1272	1619
Diameter	inch	1.382	1.345	1.345	1.35	1.382
Weight	#/foot	1.631	1.5629	1.5661	1.326	1.63238
Weather Case	Cable Condition					
Rule 250B	Max Sag	14.46	14.05	14.06	13.05	14.47
Uplift	Initial	9.32	8.08	9.61	8.85	9.69
200°C	Max Sag	20.03	14.08	19.23	24.77	13.94
120 MPH Wind	Max Sag	17.20	16.81	16.83	15.88	17.00
NH Ice (1.5")	Max Sag	19.53	19.66	18.91	17.73	19.06
Maximum Difference		**10.71**	**11.58**	**9.62**	**15.92**	**9.37**
Summer LTE Rating	Amps	2906	3172	3118	2976	3231

“Best” conductor for a project depends on the situation

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- ACSS strikes the right balance between performance and cost for most applications
  - Low sag under ice and wind conditions, which are typically more challenging design conditions in New England than hot summer days

- Composite core technologies are useful in specific circumstances
  - Typically useful for long spans (e.g. river crossings) where cost savings from shorter towers can offset higher conductor costs
  - Eversource has ACCR at several crossings of the Connecticut River and is evaluating the use of TS Conductor for the proposed rebuilds of two crossings south of Middletown, CT

- All conductor types provide significantly higher capacity than ACSR
  - Older transmission lines typically use smaller-diameter ACSR
  - All newer conductor types (ACSS, ACCC, etc.) provide substantially higher capacity
  - But, is it wise to install new, more expensive conductors on aging structures?

Questions?