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Applications Engineering Note

Sag and Tension - General

AEN 14, Revision 5

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Introduction

Planning for aerial cable installation includes taking into account proper clearances, cable types and properties, and the mechanical stress loading on the cable. Planning for proper clearances requires knowing the "sag" characteristics of the proposed installation. Understanding the expected mechanical (tensile) loads placed on an aerial installation is important to ensure that safe operating conditions are not exceeded and cable lifetime is not shortened.

Clearance requirements for aerial cables are defined in Section 23 of the National Electrical Safety Code® (NESC®). State and local authorities have adopted some editions and some parts of this code. Additionally, some countries outside of the United States have adopted all or part of this code. To determine the legal status of the NESC in any particular country, state, province, or locale, the authority having jurisdiction should be contacted.

Basics

The following installation methods are commonly used throughout the industry:

Dedicated messenger - The application of a steel messenger installed aerially followed by lashing one or more cables to it.

Overlash - The practice of lashing a new cable to a pre-existing aerial installation. In this application, consideration must be given to the existing cable as well as to the new cable being installed. Overlashing can be used with existing dedicated messenger or figure-8 applications; however, overlashing to a figure-8 cable may require additional considerations.

Figure-8 - Self-supporting aerial cables consisting of an optical fiber cable core and integrated stranded steel messenger. Both the cable and the messenger share a common outer jacket resulting in a figure-8 shape. In some countries, the messenger may also consist of a dielectric material.

All-dielectric, self-supporting (ADSS) - A self-supporting aerial cable containing no metallic elements. A dielectric aramid yarn is used, typically by stranding it around the optical fiber cable core, providing the necessary tensile strength for aerial applications.

Additional terms used with respect to aerial installation are listed below for clarification and understanding:

Span length - The straight line-of-sight distance between consecutive poles.

Tension – Axial tensile force applied to the messenger or other cable strength member(s). This value is affected by the amount of cable sag, and by the mechanical and environmental loading. It is inversely proportional to amount of sag.

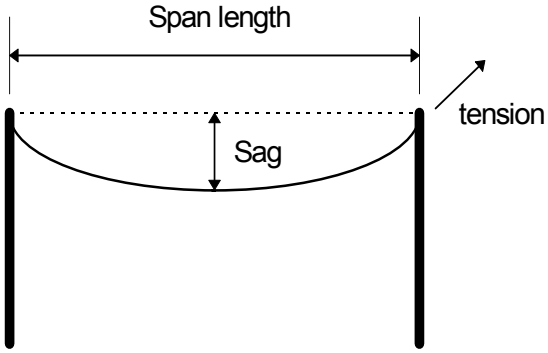

Figure 1

Sag - Defined by various texts (IEEE Std 100-1996, IEEE Std 524-1992, NESC) as the vertical distance between the cable and an imaginary horizontal line extending between the points where the cable is attached to the poles. This measure assumes a zero elevation difference between the pole attachment points. Many sag and tension algorithms will compute sag as the total displacement due to ice and wind loading and cable weight. This value for sag is the combination of vertical sag and horizontal displacement. Unless otherwise stated, sag is referenced to the midpoint of the span.

Loading - The amount of mechanical load seen by the cable. This is a combination of the installation tension required to achieve a given sag, the weight of the cable, the weight of any ice loading on the cable, and the wind pressure felt by the cable, if any.

Ruling span – The term commonly used in the aerial cable industry when referring to a series of cable spans with differing lengths, but all of which experience the same changes in tension with respect to variations in temperature and loading. In the past, sag and tension calculations were performed manually using such references as Martin's Tables. For a series of differing length spans, computations would be based on a somewhat longer than average span, known as the ruling span. A common formula used was

$$\text{Ruling Span} = \text{Average Span} + 2/3(\text{Longest Span} - \text{Average Span})$$

Today with computer solutions, calculations can be performed for multiple span lengths with ease. Corning Cable Systems routinely specifies maximum span lengths, vice ruling span, for given sag and environmental conditions.

Discussion

When pondering an aerial installation, the following are important considerations:

- Cable size and type - This includes cable type, cable diameter, weight, strength member type and location, armoring (if used), and fiber count.
- Span lengths

- Allowable sag - This is typically set at 1% (of span length) or based on a given installation tension.
- Messenger type - Dedicated messenger, overlash, figure-8, or ADSS
- Environmental conditions - Geographic location, NESC loading area, ice and wind conditions, etc.
    - Application of extreme wind, as applicable.

Corning Cable Systems has developed sag and tension algorithms that allow sag to be calculated for a variety of cable/messenger combinations and environmental loading conditions. The algorithms can also be used to determine an installation tension, also known as stringing tension, based on a desired sag and/or environmental limitations.

Environmental conditions are the main factors in determining the maximum loading on the cable. While NESC specifies three standard conditions (heavy, medium, and light), these conditions are not always the minimum requirement. Many municipalities and utility companies have adopted NESC standards as their minimum requirements; however, customer should always specify what additional environmental conditions, if any, they would like incorporated into the sag and tension calculations. Such conditions might include a maximum ice thickness that could form on the cable, the lowest temperature expected for that ice condition, and an expected wind speed to which the cable might reasonably be subjected. The accuracy of the calculations is based on a proper estimate of actual environmental conditions the cable will experience.

The NESC gives a guideline for extreme wind loading conditions to be used if pole heights are above 18 m (60 ft). The wind speed and expected temperature is required for these calculations. Some utilities in coastal regions require extreme wind to be considered, as their aerial installations are more likely to be subject to the wind force of gales, hurricanes, or similar ocean borne storms. A similar situation may apply to high mountain ridges or large river valleys where terrain can play an important factor in wind velocity. In these cases, specific meteorological data may be required to provide an accurate calculation of extreme wind loading.

Sag and tension calculations have been used in the copper cable industry for years. Sag and tension calculations continue to be a best engineering estimate of expected loading on a cable for a given set of installation and environmental conditions. Corning Cable Systems will work with customers to look at minimum requirements for a location, as set by the applicable regulating body. Additional customer requirements or restrictions on clearance, in addition to any environmental factors, may be considered as well.

Corning Cable Systems Applications Engineers can assist with sag and tension calculations on a case-by-case basis. To request help, complete the information sheet attached at the end of this note. Your request can be handled by facsimile at (828) 901-5533 addressed to Applications Engineering, or by phone at (828) 901-5000 or (800) 743-2671.

REFERENCES

T.Dugan, Mechanics of Aerial CATV Plant, Proceedings of the National Cable Television Association; May 18-20, 1987.

National Electrical Safety Code, 1997 Edition, The Institute of Electrical and Electronic Engineers, Inc.

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Donald G. Fink and H. Wayne Beaty, Standard Handbook for Electrical Engineers, 12th Edition, McGraw-Hill Inc., 1997.

IEEE Std 100-1996, The IEEE Standard Dictionary of Electrical and Electronics Terms, 6th Edition, The Institute of Electrical and Electronic Engineers, Inc., 1996.

IEEE Std 524-1992, IEEE Guide to the Installation of Overhead Transmission Line Conductors, The Institute of Electrical and Electronic Engineers, Inc., 1992.

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Applications Engineering Note

Sag and Tension Case Form

Fax to: Corning Cable Systems Engineering Services
Attn: Applications Engineering

Fax: 828-901-5533
Voice: 828-901-5000
800-743-2671

Project Information

Project Identifier		Company Name	
Project Location		Point of Contact	

Installation Details

Length of Span			Installation Type (circle one)	Dedicated Figure 8	Overlash ADSS
Installation Basis (circle one)	Tension	Sag	Installation Value (Force/distance/		

Messenger Details (ex. ¼" EHS, 5/16" UG)

Messenger Type	

Cable Details (ex. ALTOS,single-armor,60 fiber, GRP central member)
Note: In an overlash application, Cable 1 is the existing application, Cables 2 and 3 are new.

Cable	Product Line	Armoring	Fiber Count	Central Member
1				
2				
3				

Temperature Details

Installation		Minimum		Maximum	

Ice Loading Conditions (Select NESC Condition or enter details)

NESC Loading		Ice Thickness		Adder	
❑ Heavy		Wind with Ice		Ice Density	
❑ Medium		Temperature with Ice			
❑ Light					

Extreme Wind Loading Conditions (optional)

Wind Speed/Wind Force	
Temperature with Wind	

Corning Cable Systems recommends that any questions with regard to completing this form be directed to Applications Engineering to ensure results are correct for the desired application.