Span Length Recommendations for Optical Fiber Cable in Aerial Innerduct

Contents **Section**

1. General

1.1 This document describes aerial storm load requirements, fiber stress criteria, and span length recommendations for OFS optical fiber cables installed in aerial innerduct.

1.2 OFS optical fiber cables are available in a variety of different jacket constructions in both loose tube and central tube designs. Two of the popular designs include Fortex™ DT and AccuRibbon® DC cables.

1.3 OFS MiDia® FX *plus* and DuctSaver® FX cables are designed specifically for blown cable applications in underground plant. In general, they are not intended for lashed aerial applications or use in aerial innerduct.

2. Precautions

2.1 OFS optical fiber cables are designed to meet the rigors of aerial, buried, and underground conduit installations. However, care must be exercised during installation to ensure that the maximum rated cable load (MRCL) is not exceeded and the minimum cable bend diameter is not violated.

2.2 The MRCL for standard OFS optical fiber cables is 600 pounds (2700 N)[1]. This is the maximum tensile force that may be applied to the cable during short-term installation conditions, e.g., during installation in conduit or innerduct. For

[1] Note that there are some exceptions to the 600 lb MRCL for special application cables, e.g., micro-cables and drop cables.

long-term conditions, the maximum allowable cable tension is 180 pounds (810 N).

2.3 Cable minimum bend diameters[2] for OFS cables are defined for both dynamic and static conditions. The dynamic condition applies during installation to a cable that may be exposed to the MRCL, e.g., while pulling the cable around a sheave or capstan. The static condition applies to a cable that is exposed only to low tension, e.g., an installed cable that may be exposed to long-term residual tension. Cable minimum bend diameters are expressed as a multiple of the cable outside diameter (OD) and are also dependent on the fiber count as shown in Table 1. Minimum bend diameters are also defined for slack storage coils and are included in Table 1.

Table 1 – Cable Minimum Bend Diameters

Cable Type	**Fiber Count**	**Minimum Bend Diameter**		**Minimum Storage Coil Diameter**
		Static	**Dynamic**	
Loose Tube Cables				
Fortex *Fortex* DT	≤ 432	20 × OD	30 × OD	20 × OD (but no less than 12")
AccuTube®	≤ 864	30 × OD	30 × OD	30 × OD
Central Tube Cables				
LightPack® LXE *AccuRibbon* LXE *AccuRibbon* DC	≤ 216	20 × OD	40 × OD	18" (46 cm)
AccuRibbon LXE *AccuRibbon* DC *AccuRibbon DuctSaver*	≥ 240	30 × OD	40 × OD	40 × OD

3. Aerial Storm Load and Fiber Stress

3.1 Aerial cable plant must be designed to meet the strength requirement specified by National Electric Safety Code (NESC), i.e., the maximum storm-load tension of the support messenger must not exceed 60% of its rated breaking strength. Three storm-load districts — heavy, medium, and light — are delineated by the NESC as shown in Figure 1. For each district, the NESC defines the expected ice, wind, and thermal loads as summarized in Table 2. These rules are intended to safeguard the public. In the simplest terms, aerial plant designed to meet the NESC storm load conditions is not supposed to fall.

[2] Some cable manufacturers specify minimum bend radius rather than minimum bend diameter. Minimum bend diameter can be converted to minimum bend radius by dividing the minimum bend diameter by two. For example, the minimum bend radii for Fortex™ DT cables containing ≤ 432 fibers are 10 × OD and 15 × OD, respectively, for static and dynamic conditions.

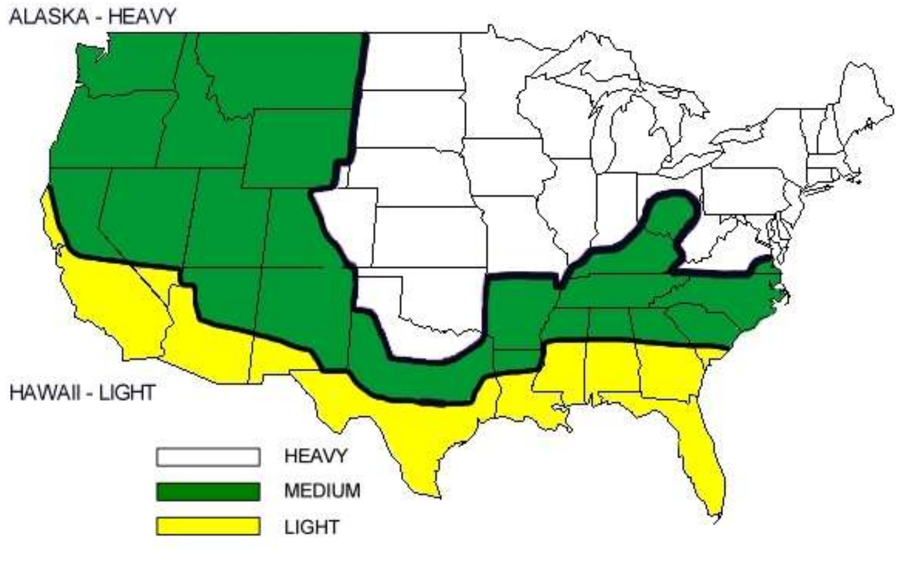

Figure 1 - NESC Loading Map of the United States

Table 2 – NESC Ice, Wind, and Temperature Conditions			
	Storm-Load Region		
Load Condition	**Heavy**	**Medium**	**Light**
Radial Thickness of Ice	0.5 inch	0.25 inch	0
Horizontal Wind Pressure	4 lb/ft^2	4 lb/ft^2	9 lb/ft^2
Temperature	0 °F	15 °F	30 °F
Added Load	0.3 lb/ft	0.2 lb/ft	0.05 lb/ft

3.2 Because innerduct has a larger outside diameter than the fiber optic cable, the strand/innerduct/cable composite structure will be exposed to higher loads than a cable lashed directly to the strand. For example, in the heavy load region, the NESC specifies a storm load of 0.5” of radial ice thickness and a horizontal wind pressure of 4 lb/ft^2. The actual load is a function of the cable diameter, i.e., the transverse load on a large diameter cable will be higher that that on a small diameter cable. In the heavy load region, the transverse load on a 0.5” diameter cable lashed to a 6.6M strand is 0.91 lb/ft. Under the same conditions, the transverse load on a 1.0” nominal-diameter innerduct structure is 1.48 lb/ft. The storm load on the composite innerduct structure is about 60% higher than the storm load on cable lashed directly to the strand.

3.3 The aerial innerduct structure will also be subjected to the weight of water that may accumulate in the innerduct. Assuming the space between the cable and innerduct is full of water, the additional vertical load is 0.33 lb/ft for a 0.5” diameter cable in the 1.0” nominal diameter innerduct. Adding the weight of water in the storm load calculation increases the total transverse load to 1.76 lb/ft.

3.4 In addition to the NESC strength requirement, aerial fiber-optic cable plant must also be designed to minimize fiber stress. This requires a *stiffness design* for aerial fiber-optic cables. Unlike the strength design, the stiffness design is intended to limit the strain, or elongation, of the optical fibers. Since the innerduct does not add much tensile stiffness to the composite structure, the axial strain of the strand/innerduct/cable structure will be significantly higher than that of the cable lashed directly to the strand. Consequently, the maximum allowable span lengths for the optical cable in aerial innerduct will be less than those permitted for optical cable lashed directly to the strand.

3.5 Fiber stress is also dependent on temperature. Maximum fiber stress occurs under the combined conditions of high transverse load and high temperature. In the heavy and medium storm load regions, the highest transverse load occurs under the combined loads of ice and wind; therefore, the maximum temperature is assumed to be 32 °F. For the light storm load region, ice load is not specified and the transverse load is due only to wind. In this case, the maximum temperature is assumed to be 100 °F. Furthermore, since this high temperature condition may occur throughout the United States, the high temperature and high wind condition is applied to all storm load regions. The condition that causes the highest fiber stress is used as the ruling condition for determining maximum allowable span lengths. The storm load conditions for the stiffness design are summarized in Table 3.

Table 3 – Ice, Wind, and Temperature Conditions

	Storm-Load Region		
Load Condition	**Heavy**	**Medium**	**All**
Radial Thickness of Ice	0.5 inch	0.25 inch	0
Horizontal Wind Pressure	4 lb/ft^2	4 lb/ft^2	9 lb/ft^2
Temperature	32 °F	32 °F	100 °F

4. Span Length Recommendations

4.1 Both the NESC strength requirement and the stiffness requirement must be evaluated in the determination of maximum recommended span lengths. As mentioned above, the NESC limits the maximum strand tension to 60% of its rated breaking strength. For the stiffness design, the limiting criterion is fiber stress, which is not allowed to exceed 12,500 psi under storm load conditions. Giving consideration to both of these requirements, the maximum recommended span lengths for OFS cables in 1-inch and 1.25-inch nominal-diameter aerial innerduct are given in Tables 4 and 5.

Table 4 – Maximum Recommended Span Lengths (ft) for OFS Cables Installed in 1" Nominal-Diameter Aerial Innerduct			
Strand Designation	**Storm-Load Region**		
	Heavy	**Medium**	**Light**
Central Tube Cable			
6.6M (1/4" EHS)	150	150	150
6M (5/16")	225	225	225
10M (3/8")	300	300	300
Loose Tube Cable			
6.6M (1/4" EHS)	200	600	600
6M (5/16")	250	400	400
10M (3/8")	300	800	800

Table 5 – Maximum Recommended Span Lengths (ft) for OFS Cables Installed in 1.25" Nominal-Diameter Aerial Innerduct			
Strand Designation	**Storm-Load Region**		
	Heavy	**Medium**	**Light**
Central Tube Cable			
6.6M (1/4" EHS)	100	100	100
6M (5/16")	175	175	175
10M (3/8")	225	225	225
Loose Tube Cable			
6.6M (1/4" EHS)	125	400	500
6M (5/16")	175	350	375
10M (3/8")	200	700	700

For additional information please contact your sales representative. You can also visit our website at www.ofsoptics.com or call 1-888-FIBERHELP (1-888-342-3743) from inside the USA or 1-770-798-5555 from outside the USA.

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