Corning Cable Systems
Engineering Services Department
800 17th Street NW
PO Box 489
Hickory, NC 28603-0489
t 800 743-2671
f 828 901-5533
www.corning.com/cablesystems

Applications Engineering Note

Effects of Using an End-Again or Other Figure-Eighting Machines With Corning Cable Systems' Fiber Optic Cables

AEN 121, Revision 2

Revised March 25, 2008

This Applications Engineering Note addresses Corning Cable Systems' position on the use of figure-eight machines when installing fiber optic cables with a central tube construction or loose tube construction.

CCS's position is to not use automated figure-eight machines when installing fiber optic cables with a central tube design or any loose tube cable having one or more layers of corrugated steel armor. If using automated figure-eight machines with non-armored loose tube cables, one must still exercise extreme care to not exceed the cable's design limits.

With respect to armored loose tube designs, the combination of machine brand, principle of operation (twisting cable around drum or drum around cable), operating speed, ambient temperature, tension, bend radius and cable design can easily exceed cable design limits and can cause damage to the cable including zippering, sheath twisting and strength element failures (see Figure 1).

(Figure 1)
Zippering of Armored Loose Tube Cable

With respect to central tube designs, figure-eight machines can damage the cable in three different ways: violation of bend radius under tension, violation of bend radius under no tension, and the torsional effects due to the preferential bend of the cable and the twisting motions of the cable as it goes through the machine.

A typical figure-eighting machine usually violates at least one, if not all, of these conditions during use. The figure-eight machine violates the idle bend radius because the drum used to prepare the cable for figure-eighting is typically too small; especially for larger diameter cables. During automated figure-eight operation, the cable passes through a series of wheels to place the cable in a figure eight. Again, the radii of the system of wheels exceed the minimum bend radius causing damage to the cable.

These first two ways of damaging the cable are easily understood and corrected. The third way, damage via torsional effects and bending unlike the first two is completely due to the construction of the cable.

Central tube cables have the strength members along opposite sides of the cable. The figure-eight machine places tension on these strength members as the cable (and thus strength members) twist onto the drum. Furthermore, the cable naturally bends as the cable is placed on the drum. The simultaneous forces of increased tension due to twisting as well as increased tension due to bending can cause the strength members to protrude through the jacket.

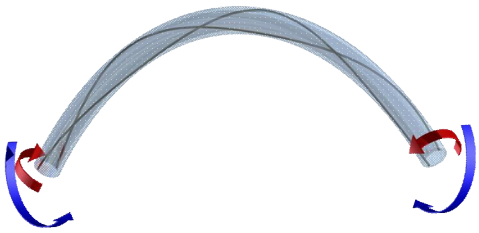

Figure 2: Torsional and Bending Tension Of Cable

As the cable diameter increases, the tension placed on the cable and its strength members increases.

The relationship between the diameter of the cable and either type of tension is not linear, in fact the relationship is cubic (T_t or $T_b \alpha D_{cable}^3$).

Even though the cable diameter increases by less than 20% from a 24 fiber to a 216 fiber cable, the tension increases by 83%. The dramatic increase in tension due to an increase in diameter is the reason why a smaller central tube cable will fail less often than a larger central tube cable when using a figure-eighting machine.

Now the question arises, "Why does this type of damage typically not occur in standard loose tube non-armored construction cable?" The answer is simply that the central strength member is in the center of the cable where the diameter is close to zero. Therefore the torsion experienced by the central strength member is minimal and almost non-existent relative to central-tube designs. In a loose tube constructed cable, the only part of the cable experiencing tension is the PE jacket which will stretch and contract with ease. For these reasons, the central strength member will not buckle or break when twisted.

In summary, CCS's position is to not use automated figure-eight machines when installing fiber optic cables; specifically with armored loose tube cable or cables with a central tube design. If a figure-eight machine is used with non-armored loose tube cable, then extreme care must still be taken to not exceed the design limits of the cable including tension, bend radii, etc. Manually creating figure-eights provides for safe, temporary storage of cable during installation. Always reference the cable's associated Standard Recommended Procedure for detailed instructions.

For any additional information, visit http://www.corning.com or contact Corning Cable Systems at 800-743-2671.