Is Fiber Optic Cable Fragile?

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ABSTRACT

Communications grade optical fibers are very sensitive to bending, impact and tension. These forces can adversely affect fibers optical performance immediately and can also reduce the expected lifetime through the mechanisms of macro and micro bending. The objective of the cable manufacturer is to "package" those fragile glass fibers in such a way that they will survive the rigors of installation and the installed environment without suffering performance or life expectancy loss. This objective has been far exceeded by today's cable designs and in fact fiber optic cables are "NOT FRAGILE" but are more rugged than coaxial cables used in CATV systems.

TENSILE FORCE

Figure 1

A cable when put under a tensile load will have a tendency to stretch. The plastic material having a elasticity greater then that of glass will increase in length as compared to the glass fibers. The cable design must allow for that stretch without putting stress on the fibers which could, depending on the magnitude of the stress, cause reduced performance or premature failure. A laboratory test which is generally used to prove that a cable design will withstand a given load without damaging the cable is the Electronic Industries Association 455-33A (EIA 455-33A).

The test set-up is shown in Figure 2.

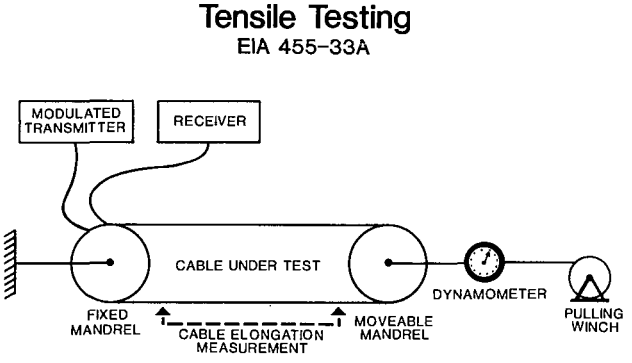


Figure 2

Typical limits for fiber optic cables are 600 pounds force during installation and 250 pounds force installed. Coaxial cables are typically specified at 200 pounds force for .500 inch size and around 400 pounds force for .750 inch size.

Although fiber cables are obviously specified significantly higher than coaxial cables, there is one difference in their installation which may reduce the significance of the difference. That is, fiber cable installed lengths are generally on the order of magnitude of 2-6 km (6,000 to 20,000 ft.) rather than the typical coaxial length of 2000 ft. or less. Obviously then, the weight from the long lengths of cable and the frictional forces developed during installation (whether aerial or duct) can generate greater actual installation tension for fiber cables than for coaxial cables. Under some aerial installations of fiber cable, can generate 600 lbs/f after 1 km of pull. Therefore, when pulling long lengths of fiber cable, tension monitoring is a must.

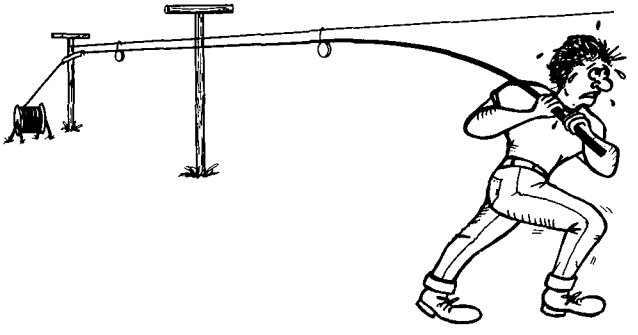


Figure 3

IMPACT AND CRUSH

Between the factory floor and finished installation many unforeseen accidents can happen to the cable. Sufficient ruggedness is built-in to protect the fibers under most conditions.

Figure 4

The Electronic Industries Association 455-25 (EIA 455-25) test apparatus for crush resistance is shown in figure 5. The hydraulic apparatus puts a significant crushing load on a small section of cable under test with no measurable performance degradation.

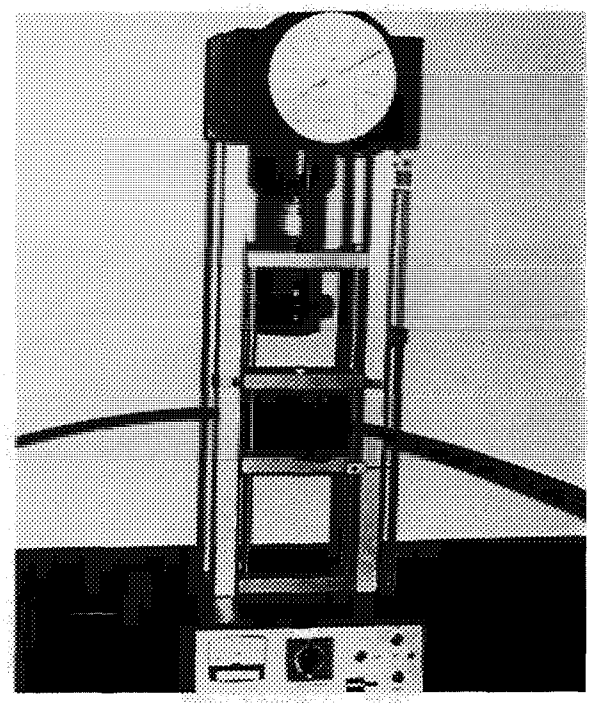


Figure 5

Obviously to people in the CATV installation business impact and crush resistance is coaxial cables weakest link. We all are familiar with dented cable. Fiber cable is very rugged in this respect and with reasonable care during shipping and installation no damage to the fibers should occur.

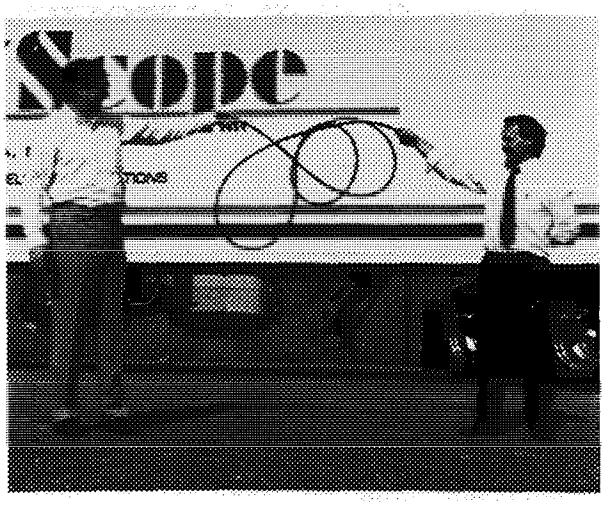


Figure 6

BENDING

Figure 7

Fiber cables generally act more elastically in the bending mode than do coaxial cable. Therefore they are less susceptible to buckling and kinking. However because of macro and micro bending characteristics the performance and life of the fibers inside the cable can be affected even though no observable deformation to the cable is done. Strict adherence to the minimum bend radius specifications is important

But again fiber cable demonstrates a considerable edge over coax in specified minimum bend radius.

Fiber Optic Cable	7"
1/2" Coaxial	8"
3/4" Coaxial	10"

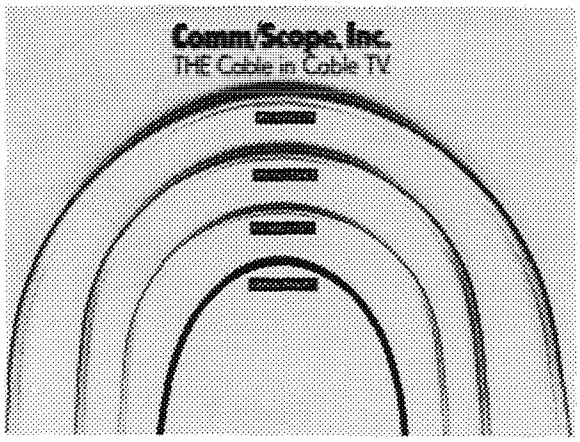
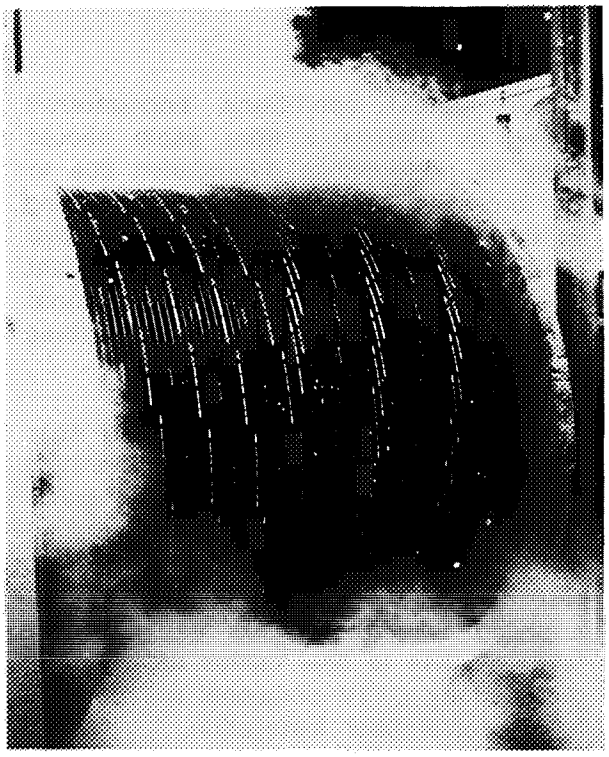


Figure 8

TEMPERATURE

Like all CATV outside plant, fiber optic cable will see extreme environmental changes during its life.



Environmental Test Chamber

Figure 9

Environments include the tropics to the arctic; the mountains to the deserts; swamps; industrial pollution, acid raid, seacoast salt and beneath the streets of major cities. The materials and cable designs chosen must be carefully and extensively tested to assure adequate performance.

The Electronic Industries Association tests that evaluate how the fiber optic cables will react under various environmental conditions can be found as follows:

a) Fiber optic cable bend test at high and low temperature (EIA 455-37).
b) Fiber optic cable twist test (EIA 455-85).
c) Fiber optic cable jacket elongation and tensile strength (EIA 455-89).
d) Fiber optic cable external freezing test (EIA 455-98).
e) Fiber optic cable cyclic testing (EIA 455-104).

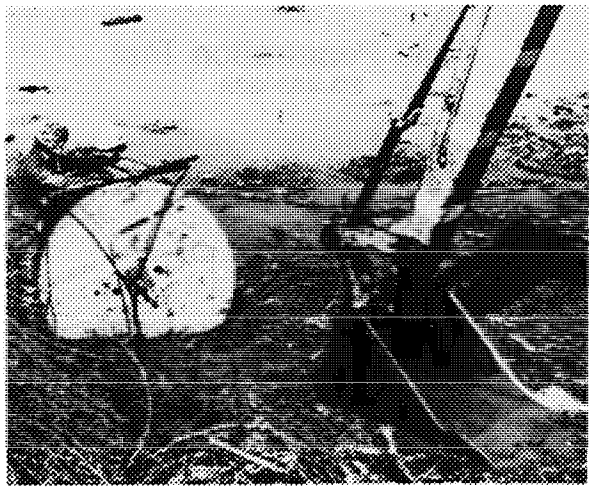


Figure 10

WATER

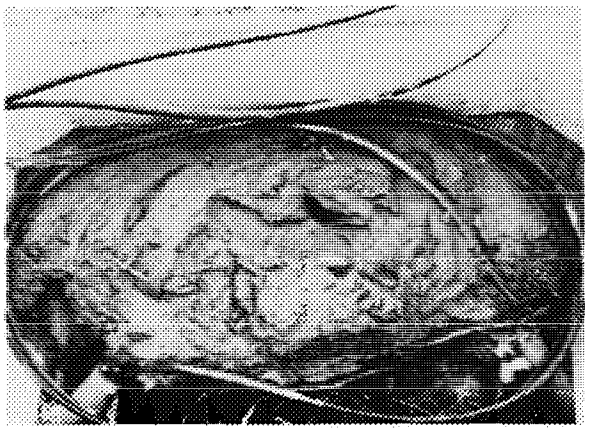


Figure 11

As with any cable water ingress will be detrimental to performance. Optical cables are filled with grease like materials to prevent water entry and there is an Electronic Industries Association 455-82A (EIA 455-82A) test which is performed on samples of finished cable to prove the performance of the filling material.

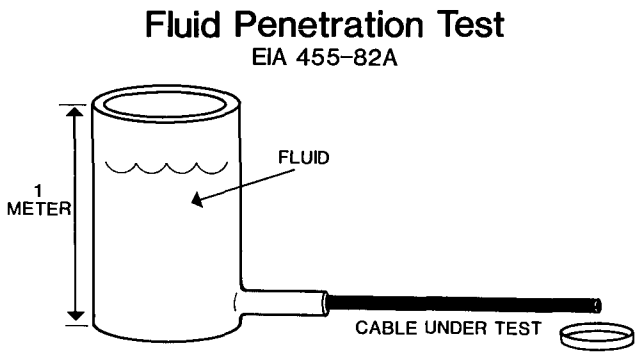


Figure 12

THE BOTTOM LINE

The end result is that cable manufacturers have been very successful at developing cable packages that protect the fragile fibers during manufacturing, shipping, installation and service life. Under typical conditions encountered during its lifetime a fiber cable should show no performance degradation due to the forces we have talked about. As long as the fiber remains inside the protective cable, it is as resistant or more resistant to harmful forces than the traditional coaxial trunk and distribution cables widely used in CATV.

We have intended to demystify fiber optic cable by effectively demonstrating that CATV construction and service crews who have customarily dealt with coaxial cables should unequivocally have no reservations about handling fiber cables. Applying the same rules and common "street" sense to fiber cables as is widely practiced by CATV personnel will produce a successful fiber installation.