OPTICAL CABLE CORPORATION

Tight-Buffered, Tightbound Cable Construction Provides Excellent Moisture Resistance

Optical Cable Corporation's tight-buffered B-Series and BX-Series Breakout Cables, D-Series and DX-Series Distribution Cables, and G-Series and GX-Series Subgrouping Cables offer excellent moisture protection over loose-tube gel-filled type cable constructions. They are suited for outdoor use. These tight-buffered, tightbound indoor/outdoor cables have demonstrated long-term survival in wet environments.

The basic mechanical failure mechanism for optical fibers is the slow to rapid growth of any glass imperfections in the fiber caused by the fiber being under stress. This "fatigue" phenomenon can be accelerated with the presence of moisture (H20) molecules at the glass surface of the fiber. The greater the concentration of the water molecules (OH - ions) at the glass surface, and the greater the stress applied to the glass, the more rapidly the surface imperfections will grow. This accelerated fatigue in the presence of OH- ions is similar to "stress corrosion."

The speed of imperfection or "crack growth" in optical fibers is also very dependent on the size of the flaws in the fiber. To insure that no flaws greater than a predetermined size are present in finished fiber, fiber manufacturers subject their fibers to a brief elongation or stress, a process called proof testing.

All manufacturers of fiber optic cables intended for use outdoors must address the issue of protecting the fiber's glass surface from the presence of moisture. This is because the 250 μm primary fiber coating provides only a 62.5 μm-thick layer of UV-cured acrylate material as basic protection over the fiber's glass surface. This UV-cured acrylate material is not chosen by the fiber manufacturers for its optimal resistance to water or its minimal porosity. It is in fact chosen primarily because of its fast processing speed, since a primary cost driver for fiber manufacturers is the draw speed, which is steadily increasing. The very thin UV-cured acrylate layer is porous to water molecules and will permit concentration of OH- ions at the fiber surface, if the fiber is immersed in water.

All plastic materials are porous to varying degrees. The general category of thermoplastic materials commonly used in cable constructions will to some extent absorb water; however, thermoplastic materials certainly do not act as a complete water block. Only materials like metals or glass can provide a true "hermetic" seal. Plastic materials are generally characterized with parameters such as water absorption, and absorption of other common solvents such as oils, gasoline, kerosene, etc. This being the case, water molecules cannot be eliminated from the glass surface of any fibers incorporated in a cable having plastic jackets. The issue is to minimize the concentration of water molecules at the glass surface so that stress crack growth effects are minimized.

There are two different design approaches to water and moisture protection in fiber optic cables. The loose-tube gel-filled cables (or slotted-core cables) must prevent water from reaching the 250 μm coated fibers. The approach is to "waterproof" the cable by "filling" the empty spaces in the cable with gel,theoretically preventing water from reaching the 250 μm coated fibers. To insure that this is accomplished, the "filled" cables are generally subjected to a hosing test to show that water will not flow through a short section (one meter) of cables. Unfortunately, the gel filling in the cables can never be 100% and, in fact, is generally in the 85% to 90% range. This, plus the fact that gels can move, flow, and settle, leaves an uncertainty of the filling level of any particular point of a loose-tube gel-filled cable. This uncertainty of the filling is highlighted by the routine practice of water-blocking the loose-tube gel-filled cables at the entrance to splice housings to keep water from migrating from the cable into the splice housing. The loose-tube gel-filled structures, with the uncertainty of the filling and the 250 μm coated fibers, are at risk in the presence of water and stress to suffer fiber fatigue and breakage over time.

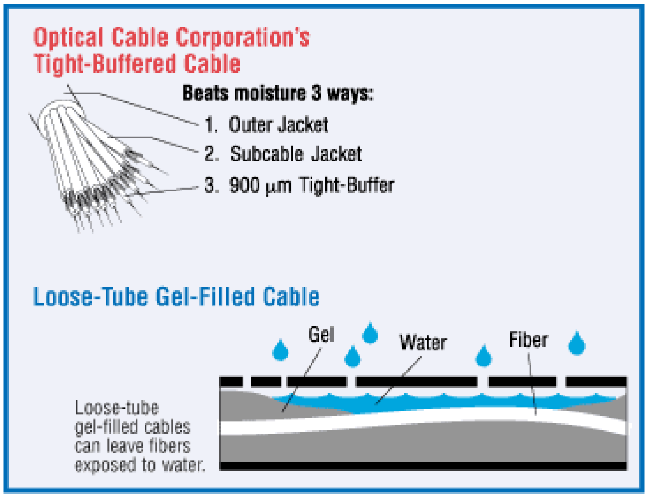
The tight-buffered, tightbound indoor/outdoor cables manufactured by Optical Cable Corporation utilize an entirely different design approach to deal with the moisture issue. Rather than attempting to be “waterproof,” they are designed to be water tolerant.

Recognizing the porosity of plastic materials and the inherent impossibility of waterproofing a cable, the moisture protection is concentrated at the fiber surface where it is most needed.

Optical Cable Corporation’s tight-buffer systems consist of extremely low moisture absorption coefficient materials at the fiber coating. This provides a buffer system thickness of 387 μm over the glass, more than six times as thick as the 62.5 μm coating found in the loose-tube gel-filled cables.

Buffer materials are low-porosity plastics with excellent moisture resistance. This construction very effectively minimizes the water molecule and OH- ion concentration level at the glass surface and virtually eliminates the stress corrosion phenomenon. The tight-buffered design also has the great advantage of being a solid, non-flowing, non-moving structure. The same level of protection remains in place all along the fiber, regardless of installation conditions, environment, or time.

The balance of the tight-buffered, tightbound cable designs is such that it minimizes the open spaces available in the cable structure in which water can reside. Even if an outer cable jacket is cut, or water otherwise enters the cable structure, only a very small percentage of the cross-sectional area is open to water. This eliminates the other water-related failure mechanism, freezing, and expansion in the cable structure, causing stress on the fiber which could lead to failure. Optical Cable Corporation’s tight-buffered, tightbound cables have been deliberately pumped full of water and frozen in a temperature chamber, and they show no damage and virtually no change in attenuation.



Optical Cable Corporation’s excellent tight-buffered, tightbound cable construction results from extensive developmental efforts funded by the U.S. Government in the late 1970s and early 1980s. These efforts led to the highly successful military tactical fiber optic cable products offered by Optical Cable Corporation. These cables have been subjected to complete military qualification testing for outdoor field use. The same design approach, and many of the same materials, are used in our indoor/outdoor cables offered for commercial use. In 1978, the same technology was used for the first telephone installation field trial in central Pennsylvania. Twenty-two miles of tight-buffered fiber optic cable was installed outdoors, half aerially and half directly buried. This cable system was in continuous use for more than 20-years without cable degradation or failures. This system was finally retired when their multimode electro-optics became obsolete.

The technology and construction of Optical Cable Corporation’s tight-buffered, tightbound indoor/outdoor fiber optic cables offer a truly exceptional design for protection against moisture and for long-term survivability in outside-plant type applications.