Optical Fiber Cable Design

Optical fiber cables are designed to **protect fragile (vongur) fibers**, maintain signal quality, and ensure mechanical strength.

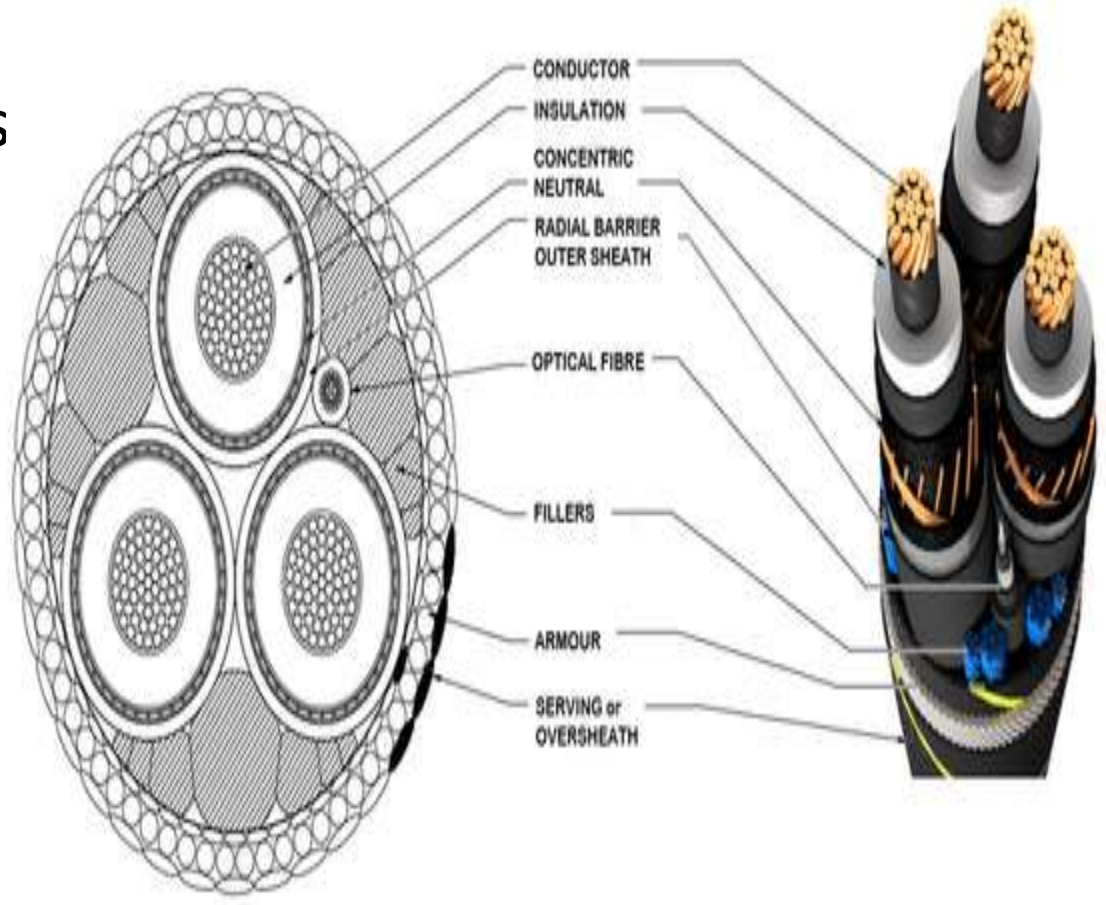
Fiber Buffering

- Buffering is the first layer of protection applied to the fiber to prevent microbending and physical damage.
  - **Tight Buffering:** A thick layer of plastic (like PVC) is applied directly onto the fiber coating.
    - It is used for indoor cables where flexibility and durability are needed.
    - **Example:** A patch cord used to connect a computer to a wall outlet.
  - **Loose-Tube Buffering:** The fiber sits loosely inside a larger, hard plastic tube which is often filled with a water-resistant gel.
  - This allows the fiber to move slightly when the cable expands or contracts due to temperature.
  - **Example:** Outdoor trunk lines buried underground.

PVC-এর পূর্ণরূপ হলো **Polyvinyl Chloride**। অপটিক্যাল ফাইবার নেটওয়ার্কিং এবং ক্যাবল ডিজাইনের ক্ষেত্রে এটি একটি অত্যন্ত গুরুত্বপূর্ণ পলিমার বা প্লাস্টিক উপাদান, যা মূলত ফাইবারের সুরক্ষা নিশ্চিত করতে ব্যবহৃত হয়।

Cable Strength and Structural Members

- To prevent the fiber from being stretched or crushed during installation, strength members are added to the cable.
  - **Central Strength Member:** A rod made of steel or fiberglass (FRP) placed in the center of the cable to provide rigidity.
  - **Aramid Yarns (Kevlar):** Strong synthetic fibers wrapped around the buffer tubes to provide high tensile strength, allowing the cable to be pulled through conduits without breaking.
  - **Example:** Long-haul undersea cables use multiple layers of steel wire armor to withstand extreme ocean pressure.



DFB Laser vs. Fabry–Pérot Laser

- The primary difference lies in how they achieve single-frequency (single-wavelength) operation.
- Fabry–Pérot (FP) Laser: This laser uses two mirrors at the ends of the semiconductor material.
  - Light bounces back and forth between them, but this often results in multiple "modes" or wavelengths being emitted.
  - This causes more dispersion (spreading) over long distances.
- Distributed Feedback (DFB) Laser: Instead of simple mirrors, a DFB laser has a Bragg Grating etched directly into the semiconductor.
  - This grating acts like a highly specific filter that only allows one precise wavelength to be amplified.
- Comparison: If an FP laser is like a flashlight emitting a broad beam, a DFB laser is like a high-precision pointer emitting a single, pure color.
  - This makes DFB lasers essential for high-speed WDM systems.

Fabrication of Fiber Couplers

Fiber couplers are passive components used to split or combine light signals.

1. Fused Biconical Taper (FBT) Method

- **Process:** Two or more fibers are stripped of their coatings, placed side-by-side, and twisted together.
  - They are then heated (usually with a flame) until they soften and are pulled or "tapered" until they fuse together.
- **Mechanism:** As the fiber cores get thinner, light "leaks" from one fiber into the other.
- **Example:** A **3 dB Coupler** created this way will take 10 mW of input power and split it into two 5 mW outputs.

2. Polished Fiber Method

- **Process:** Two fibers are partially embedded in separate glass blocks.
  - The cladding of each fiber is polished away until it is very close to the core.
  - The two polished surfaces are then pressed together with an index-matching oil between them.
- **Mechanism:** Light moves between the fibers through "evanescent wave coupling."
- **Example:** This method is often used to create **Wavelength Selective Couplers** that can separate two different colors of light, such as 1310 nm and 1550 nm signals.