Exploration of Fibre Optic : A Systemic Review

Akhilesh Kumar Chauhan [1], Dr. Shailesh Kumar Singh [2]
M.Sc. Physics [1], Head of Department [2]
Monad University, Hapur [1,2]

Abstract Communication is an important part of our daily lives. The communication process involves the generation, transmission, reception and interpretation of information. As the demand for various types of communication such as voice, image, video and data communication increases, the demand for large transmission capacity also increases. This demand for large capacity has driven the rapid development of light wave technology; the global industry has developed. An optical or optical wave communication system is a system that uses light waves as a transmission carrier. The optical communication system mainly includes three parts. Transmitter, receiver and channel. In optical communication, the transmitter is a light source, the receiver is a light detector, and the channel is an optical fiber. In optical communications, the channel, the fiber, plays an important role because it transmits data from the transmitter to the receiver. Therefore, here we will mainly discuss fiber optics.

Keywords- Data Communication, Transmission, Optical Communication

1. Introduction

Fiber optic, or optical fiber, refers to the means and technology associated with the transmission of information such as light pulses along fiber, fiberglass or plastics. The fiber optic cable can contain a variable number of these fiberglass, from a few to a few hundred. About the glass pulp there is another layer of glass called paint. The layer known as the protective tube protects the outer layer, and the coating layer acts as the final protective layer of the individual strand.

1.1 How fiber optics works

Optical fibers transmit data in the form of optical particles, or photons that pulse through the fiber optic cable. The fiberglass and lining contain a different refractive index that doubles the light at a given angle. When light signals are sent through a fiber optic cable, the pulp and coating are reflected in a series of zigzag reflexes, which adhere to a process called total internal reflection. Light signals do not move at light speed due to dense glass layers, but they travel about 30% slower than the speed of light. To renew or increase the signal throughout its journey, the transmission of fiber optics sometimes requires rewiring devices at long intervals to renew the signal by switching it to an electrical signal, processing that electrical signal and reselling the optical signal.

1.2 Types of fiber optic cables

Multimode fiber and single-mode fiber are the two main types of fiber optic cable. Single-mode fibers are used for longer distances because of a smaller diameter than the basic fiberglass, which reduces the attenuation potential, which reduces signal strength. The smaller slot isolates the light in a single package, providing a more direct path and allowing the signal to move further. Single fibers also have a much larger bandwidth than multi-media fibers. The light source used for individual-mode fibers is a laser. Single-mode fibers are generally more expensive because they require precise calculations to produce laser light in a smaller slot.

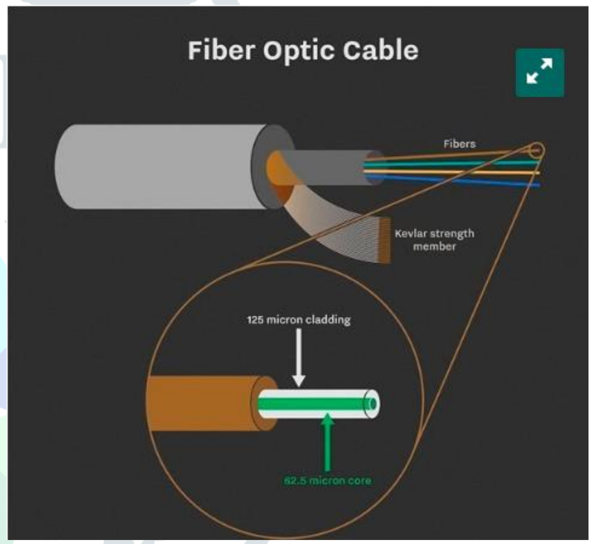

Fig 1. Fiber Optic Cable

Multi-track fibers are used for shorter distances because the larger opening of the main part allows the optical signals to bounce back and reflect more on the road. Larger diameter allows multiple pulses of light to be transmitted over the cable at the same time, increasing data transfer. This also means that there is a greater possibility of loss of signal, reduction or overlap. Multi-mode fiber optic LED is often used to generate light pulse.

While copper cables have been a traditional choice for telecommunications and cable networks for years, fiber optics have become a common alternative. Most long-distance lines for phone companies are now made from fiber optic cables. Optical fibers carry more information than traditional copper cables, due to increased bandwidth and higher speeds. Since glass does not conduct electricity, optical fibers are not subject to electromagnetic interference and signal losses are minimized.

1.3. SYNTHESIS OF OPTICAL- FIBER

This Chapter is devoted to the description of the optical cable installation methods. Each type of optical fiber cable has a specific strain limit, and special care and arrangements may be needed to ensure successful installation without exceeding it.

Some of the most difficult situations for the installation of optical fiber cables are in underground ducts. The condition and geometry of duct routes are of great importance. Damage caused by overloading during installation may not be immediately apparent but can lead to failure later in its service life. Also, aspects related to bending during the installation may require special consideration. Consideration should also be given to factors of time and disturbance. Installation equipment may be required to run for long periods of time and the time of day, noise levels, and traffic disruption should be taken into account. There are many types of cable installation (underground duct, trenchless, mini-trench, aerial, submarine) are described. Clause 2 deals with additional safety precautions when installing optical cables. In a top-down approach -a large piece of material is cut down to small pieces through different means such as lithography and electrophoresis. In order to obtain a reliable end-to-end network, all different network nodes shall be evaluated using the same methods and metrics. A network node should be able to fulfill its optical functionalities, including the ability to be reconfigured, in all conditions of the environment, in which the node will reside.

2. Background

1. Zlatanov (2017) study of the field of applied science and engineering is defined as the design and application of optical fibers in the name of fiber optics. Optical fibers typically include a transparent nucleus surrounded by transparent cladding material with a low refractive index. The light is kept in essence by the overall internal reflection phenomenon which causes the fiber to act as a waveguide. Fibers that support multiple propagation paths or transverse modes are called multi-mode fibers (MMFs), while single-mode fibers (SMF) are called fibers. Multi-mode fibers generally have a wider base diameter and are used for short-distance communications and for applications that must transmit high capacity. Single-mode fibers are used for most communication links that are longer than 1,000 meters (3,300 feet) in length. An important aspect of fiber optic communication is the extension of optical fiber cables so that losses from joining two different cables are reduced to a minimum. Fiber optic fiber connections are often proven to be more complex than wire or cable wiring and involve fine fiber pruning, perfect alignment of fiber fibers, and connection of these alignment fibers. For applications that require a constant connection, the mechanical link connecting the fiber ends can be used mechanically or fusion using heat can be used to merge the fibers together. Temporary or semi-permanent connections are made by specialized optical fiber connectors.

2. Massa (2000) study of Fiber optics are an important building block in communications infrastructure. High bandwidth and low attenuation capabilities make it ideal for Gigabit transmission and more. In this module, you will be provided with the basic components that make up the fiber optic communication system. You will be familiar with the different types of fibers and their applications, light sources, detectors, couplers, splitters, wavelength division multipliers and modern devices used in the latest high-bandwidth communications systems. Attention will also be given to system performance standards, such as energy budgets and elevation time.

3. Liu et al. (2018) they demonstrate experimentally the manufacture of long-range helical networks (HLPG) in the reduced fiber index produced by the CO2 laser. HLPG manufacturer is sensitive to temperature with high sensitivity up to 244 m / ° C.

4. A. A. Krylov *et al*.(2016) For the first time, the spread of femtosecond pulses was studied numerically and experimentally in basic hollow-core fibers with a coating layer based on discrete cylindrical filaments manufactured to deliver ultra-low-power pulses in the near-1.55 μm.

5. J. Wen *et al*. (2018) study of the orbital angular momentum amplifier (OAM) has been studied for all high purity fibers and broadband spectrum gain based on a built-in conical spiral vortex (VBC). Active and passive fibers are manufactured in several ways (FMF), which have similar geometric parameters. VBC is designed and manufactured which uses single mode fiber and passive FMF. VBC can create the first OAM order at 1480-1640 nm and its purity up to 91%. Then, the vortex amplification system is created from all fibers for the first time, and OAM is amplified first class using this system with a low gain (ΔG) difference. The gain exceeds 22 dB at 1549 nm, and its total width at half the maximum is about 40 nm: 1519-1559 nm. This is a full fiber amplification OAM system that has a simple structure and low cost applicable to optical communication fields.

6. Geng *et al.* (2014) propose of they are reporting two types of parallel adaptive fiber optics applications, Wave Tip/ Tilt Corrector, in the fiber coupling and directional beam fields, respectively.

7. Shi et al. (2018) they experimentally demonstrate the generation of radial polarized pulses using the broadband mode coupler. The laser can work at 1032 nm or 1040 nm with a spectrum width of 10 nm.

8. J. Fu *et al.* (2017) study of a new Mach-Zehnder (MZI) interference test is proposed and tested based on a pair of long-range fiber (LPG) networks on ECOF. Two similar GLPs are manufactured with a maximum attenuation of about 3dB at ECOF using high frequency CO2 laser to form MZI in fiber. The peak resonance dependencies of the temperature and axial deformity were studied. The experimental results showed that temperature and axial temperature sensitivities were 64.3 pm/°C and 0.4 pm/με respectively.

9. X. Zhao *et al.* (2018) they study of manufacture long-term spiral fiber mesh in six mode fiber with CO2 laser. Network mode conversion from LP01 mode to LP21 mode is performed with high efficiency. Status and detection coupling properties are checked.

10. Li *et al.* (2015) they proposed to illustrate the reception and transmission of laser lasers using a two-component adaptive fiber optics (AFOC) matrix under simulation disturbances. The laser beam coupling efficiency is improved from free space to polarization, while maintaining fiber, with correct tilt / tilt deflection. In accordance with the principle of optical reciprocity, the simultaneous tilt / tilt errors of concurrent synchronous laser beams are compensated in phase. The mean association efficiency of AFOC increases from 0.61 without limitation to 0.85 under control and from 0.57 to 0.85 to another. The mean deviation of the center point decreases with the pattern of diffraction consisting of two authentic joint packets in the remote field from 17.5 µrad to 2.35 µrad, and the average error value decreases from 6.59 to 1.35 µrad. The 30 Hz bandwidth is achieved to control tilt / tilt correction through a balanced slope based on a computer-based stochastic and a refresh rate of 1.15 kHz. The results indicate the potential value of the AFOC matrix in fiber coupling applications, laser contacts and beam projection.

3. Mathematical modelling

Fiber Optic Loss Calculations

The system loss can be expressed as follows:

$$Loss = \frac{P_{out}}{P_{in}} \qquad (8.1)$$

Where P_{in} is the power input for fiber and P_{out} is the energy available in the fiber output. For convenience, optical fiber loss is typically expressed in terms of decibels (dB) and can be calculated using Equation 8.2a.

$$\boldsymbol{Loss_{dB} = 10 log \frac{P_{out}}{P_{in}}} \qquad (8\text{-}2a)$$

Often, optical fiber loss is also expressed in terms of the number of decibels per kilometer (dB / km)

The 100 m length fiber contains a pin = 10 µW and Pout = 9 µW. Find the loss in dB / km. Of equation 8.2 and since

$$\mathrm{Loss_{dB}} = 10\ \log\left(\frac{9\mu W}{10\mu W}\right) = -0.458\ dB$$

the loss is

$$\mathrm{Loss}\ \left(\frac{dB}{Km}\right) = \frac{-0.458dB}{0.1km} = -4.58dB/Km$$

∴ The negative sign implies loss.

4. Conclusion

• Fiber optic cable has a limited bend radius (approximately 30 mm). Therefore, if they bend more, it may cause signal loss. Recently, however, anti-bending fibers have been introduced which have higher bending resistance.

• Unlike copper UTP cables with standard Rj-45 sockets and connectors (most), fiber optic cables have many types of connectors, and this lack of standardization can add confusion.

• By bending a common fiber optic cable, it may cause some signal leakage and can be used for hacker information. Therefore, even though it may be difficult to do so, they are not completely tamper-proof.

• Single mode cables and their associated optical components (active components) are very expensive. Although multimode cables/optics are less expensive, they are not even close to the cost of copper UTP cables/ports. In addition, multimode cables have limitations in terms of distance to support higher bandwidths (such as 1 Gbps and 10 Gbps).

• There is an outdoor cable, but it needs to be well shielded. This shielding makes them less flexible/flexible everywhere and adds to the cost of the cable.

• Fiber optic cables cannot be terminated directly to the network/fiber switch. They need a complete set of active/passive components such as SFP modules, fiber patch cords, and appropriate connectors and couplers. All of these components increase the cost of implementing fiber optic networks at each location.

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