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A REVIEW OF ATTENUATION IN OPTICAL DEVICES

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Abstract: A review of attenuation in fiber optic has been proposed in the research work. Attenuation is a measure of the loss of signal strength or light power that occurs as light pulses propagate through a run of multimode or single-mode fiber. Measurements are typically defined in terms of decibels or dB/km. There are several researches that have been made in the field of attenuation in optical devices. Such existing work is also described in the proposed work. In the research work the attenuation in different cases is calculated. Along with this the comparative analysis of attenuation is also provided in different scenarios. The research work would be helpful in the future time to know about the influencing factor of attenuation in optical devices.

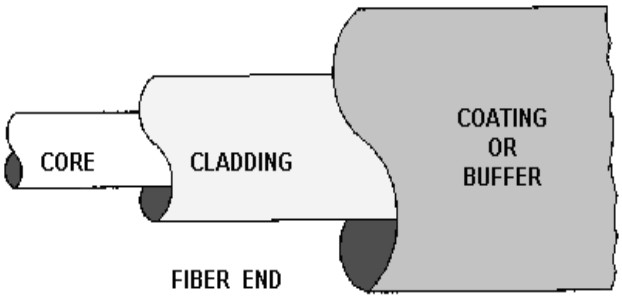
Keywords: Optical Devices, Fiber optic, Attenuation

[1] INTRODUCTION

Light is used in optoelectronics and optical fiber for data transmission through the optical fiber interferometers, optical fiber lasers, sensors, modulator and optical fiber demodulator. The term 'light' in fiber optic transmission even if commonly used, is not always specific. Light defines only the electromagnetic radiation from the visual range of 380-780 nm, while in many applications like optical fiber transmission, the electromagnetic radiation from near infrared range (850 nm, 1310 nm and 1550 nm) is used.

Fiber is an integral part of modern day data communication infrastructure and can be found along roads, in buildings, industries, hospitals and machinery. The fiber itself is a strand of silica based glass and its dimensions similar to those of a human hair that are surrounded by a transparent cladding. Light can be transmitted along the fiber over long distances at very high data rates providing an ideal medium for the transport of information.

The basic structure of an optical fiber consists of three parts that are core, cladding and the coating or buffer. The basic structure diagram of an optical fiber is shown in figure 1.1. The core is made of dielectric material with cylindrical shape. Dielectric material conducts no electricity. Light propagates principally along the core of the fiber. The core is generally made of glass. The core is described with its parameter that is its radius 'a' and refractive index ɳ. The core is surrounded by a layer of a material called



the cladding. Even light will propagate along the fiber core without the layer of cladding material, the cladding does perform some essential functions that are responsible for total internal reflection in the core.

Figure 1 Structure of an optical fiber

[2]OPTICAL FIBER TYPES

We will represent now different types of optical fibers applied in telecommunications, computer data communication networks and other applications. Fiber Optic waveguides can be divided into various categories considering:

a) Structure (cylindrical, birefringence, planar, strip)
b) Number of modes (single mode or multimode fiber)

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c) The refractive index profile (step index or graded index fiber)
d) Material (glass, plastic, semiconductor)
e) Dispersion (Dispersion shifted fiber, Non zero dispersion shifted fiber, Dispersion flattend fiber)
f) Signal processing ability (passive component- data transmission, active component-amplifier)
g) Polarization (classic, polarization maintaining/preserving fibers)

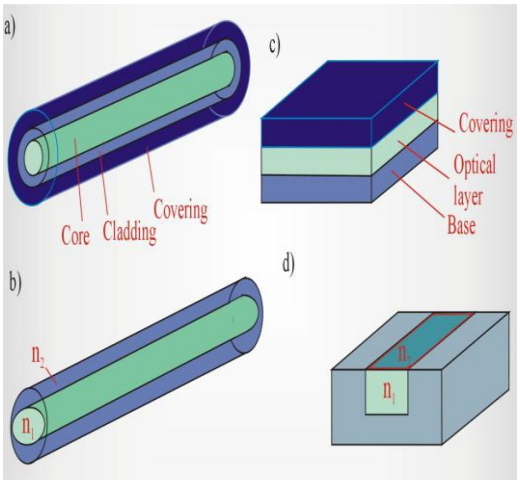

Figure 2 Different types of optical waveguide

[3] LITERATUE REVIEW

There are several researches that have been made in the field of attenuation in optical devices. Such existing work is also described in the proposed work.

In 2014 Mehul G.Patel, et al[1] proposed research work on Soliton Transmission in Fiber Optics for Long.

They stated that Multi terabit per sec., ultrahigh speed optical data transmissions over several thousands of kilometers on fibers are becoming reality. The group velocity dispersion imposes relentless limit on information carrying capacity of optical communication systems

In 2014, Alla Abbas Khadir et al[2] stated the achieving Optical Fiber Communication Experiments. They described the recent findings as optical fiber communication technology have made immense progress, where has been regularly exploring new technologies has greatly enhanced communications ability in the traditional sense,

In 2014 Xue-zhao Zheng et al[3] discussed a Measurement Method for Dispersion in Optical Fiber Communication with Long Distance.

He concluded his argument by saying that the dispersion exists in optical fiber in the telecommunication. It is an important optical characteristic in the optical fiber and will broaden optical pulse. Mode dispersion plays a major role in multimode fiber, while chromatic dispersion is the main mechanism broadening in single mode fiber that also called intramodal dispersion. Now, single mode fiber is widely used, so it is somewhat important to test the dispersion characteristics of it

S.K. Raghuwanshi, et al[4] stated the Experimental Characterization of Fiber Optic Communication Link for Digital Transmission System. paying attention on the experimental results characteristic of optical communication link and of their components.

They stated that an optical fiber is a cylindrical structure made from a transparent material like glass and consist of a core of refractive index n1 at the center of fiber, surrounded by a cladding of refractive index n2.

In 2014 Hao Ziqiang et al[5] provided the theoretical analysis on the transient characteristics of EDFA in optical fiber communication.

While as a representative, Erbium doped laser amplifier has become an important components indispensable in optical fiber communication for its high output power, high pumping efficiency, polarization-independent and small crosstalk between signals, etc.

2014 Francis Idachaba, et al[6] proposed the Future Trends in Fiber Optics Communication.

According to them the Fiber optic communication systems are important telecommunication infrastructure for worldwide broadband networks. Broad bandwidth signal transmission with low delay is a key requirement in present day applications.

In 2012 Mohammed Yousef Al Gawagzeh et al[7]released a research paper on analysis of Opposing Stream Effect on the Non-uniform Optical Fiber Communication Lines. In this paper they defined the expression for definition the opposing stream effect in optical fiber lines with N heterogeneities.

In 2014 Dr. K.A.Lathief Similarly et al[8] stated the attenuation measurement in Optical Fiber Communication. They discussed that an Optical Time Domain Reflectometer (OTDR) unite a laser source and a detector to provide an interior view of the optical fiber link. The laser source sends a signal into the fiber where the detector receives the light reflected from core-cladding interface of the fiber link

In 2013 Pulkit Berwal et al[9] made the development in the Field of Optical Fiber Communication. They focused on the latest research and development in the field of optical fiber communication system network.

In 2018, Jianxiang Wen, et al. [10] wrote on All-Fiber OAM Amplifier. This Amplifier works with high purity along with broadband spectrum gain. present Amplifier is related to fuse taper VBC. FMF is short form of Active and passive few-mode fibers. It carries same geometric parameters. A VBC has been formulated with use of a single-mode fiber. A

In 2016, Xiaohui Liu , et al. [11] proposed Fiber optic pressure. They also considered temperature monitoring structure. This system is very applicable for downhole application. There presented a pressure and temperature monitoring structure. This structure is related to fiber Bragg grating and extrinsic Fabry-Perot interferometer. This system has been launched for downhole application. system has been considered passive by electronic means. This structure carries no electronics downhole. present system is capable to control downhole pressure and temperature in continue flow. It works devoid of making oil production well. It has been revealed in this experiment that there would be error by system. error would be if temperature is less than 1 °C with 0.03 MPa pressure. It has been set-up in production well. This system is also manage downhole P&T. This management is for a year. It lies at 140°C temperature with highest 50 MPa pressure.

In 2016, Junfeng Jiang , et al. [12] described development of optical fiber temperature sensor. This sensor is applicable in aviation business. Temperature has been considered an essential parameter to manage applications. This parameter is applicable in aviation business. They launched a series of optical fiber temperature sensors. such sensors are capable in order to complete several needs. such requirements are related to interference. such requirement are also involves pressure-based optical fiber temperature sensor. such sensors have capability to integrate with optical fiber MEMS pressure sensor. Their series also includes micro-interferometer-based optical fiber medium temperature sensor. They require no particular assembly procedure. such sensors carry compact system. After that sensors provide best output. It would allow us a panorama of promising application.

In 2017, Di Yang , et al. [13] reviewed An optical fiber comprehensive analysis system. This system is efficient for spectral-attenuation. Along with this, it is also capable for geometry parameters measurement. They proposed a quickly geometry parameters measurement on G652, G655, G657, GI50, GI62.5 fibers. Than with this system they achieved accuracy within 1percent for spectral-attenuation measurement. Along with this they also minimize repetition of geometry parameters testing .their complete testing procedure cost was below twenty seconds. This cost don't involves pretreatment and position time. With best knowledge of them, they proposed a system that was very vast integrated fiber measurement.

In 2011, Roman Kruglov , et al. [14] wrote on Gbit/s short-reach transmission. This transmission executes on 35 m huge-core graded-index polymer optical fiber. They have demonstrated robust 10 Gbit/s short-reach transmission. This carries low cost elements with DMT modulation. With help of this system it is possible to create reliable high-speed short-reach interconnects. such are capable to make combination with fiber ribbons.

In 2017, Liyun Ding , et al. [15] wrote on Fiber optic sensor. This sensor is related to polarization-based absorption of grapheme. Here Grapheme is mentioned to indicate polarization-based optical absorption in feasible spectral range. It indicates more absorption for s-polarized light as compare to p-polarized light. researchers of this study have designed more effort on it. They revealed a fact. fact is that their special property is capable to use in designing of a fiber optic sensor. Their system performs in same method as SPR fiber optic sensor.

Thus, such sensors have dependency on several techniques. Several simulation has reveals that grapheme layer of 5 nm are appropriate for fiber optic sensor. It has been designed to get best sensing performance.

In 2017, Jianan Fu , et al. [16] wrote on Mach-Zehnder interferometer in embedded-core optical fiber. A novel MZI related to pair of long period fiber gratings in an ECOF has been presented with experiment. Two LPGs that carries similarity with peak attenuation of nearly 3dB have been made-up. It has been fabricated in an embedded-core hollow optical fiber. It has been made-up with use of high-frequency CO 2laser. High-frequency CO 2laser is utilized to create an in-fiber MZI. They studied dependences of resonant peak on temperature. They also reviewed axial strain based resonant peak. Their Experiment has indicated sensitivities of temperature and axial strain.

In 2017, Konstantin Hicke, et al. [17] proposed Condition monitoring of industrial infrastructures. They have utilized distributed fiber optic acoustic sensors. DAS is capable to work like a brilliant tool for real-time condition monitoring. It is applicable when there is a diversity of industrial as well as civil set-up. present review has portrayed a subset of their current research activities. It also investigated here usability of Distributed fiber optic acoustic sensing related to C-OTDR. Particularly their application-oriented research has been proposed here with objective at acoustic. They provide review on Vibration condition monitoring of pipelines and piping systems. .

In 2017, Liu Nianyun, et al. [18] reviewed Strain measurement of spiral bevel gear. They have utilized optical fiber gratings. They proposed a spiral bevel gear strain measurement with use of optical fiber gratings. High-speed and heavy-duty SBG has been considered a key element of power dealing of intersection axes. Their dynamic mechanical properties significantly manipulate execution efficiency of machine. With creation of strain detecting system related to FBG demodulation, it has been carried out real-time measurements of distributed strain in SBG. It has been done at several torqueses along with different rotation speed. Their experiment has indicated a complete strain waveform from gear-in to gear-out. They have verified feasibility of measuring strain of SBG. It was possible with use of optical fiber gratings.

In 2017, Yujia Zhao , et al. [19] Provided a novel fiber Michelson interferometer. This novel is related to cascaded twin core fiber and side-hole fiber. interferometer has fabricated by fusing TCF and SHF. interferometer is capable to calculate curvature and temperature. It is possible to monitor wavelength change of interferometer spectrum. This experimental has investigated sensor's spectral responses to curvature. It locates at several bending directions. present Experiment indicates bending sensitivities of sensor. sensitivities are at bending direction of 0° and 180°. interferometer's temperature sensitivity has been considered 10.37 pm/°C.

In 2017, B. C. Yao , et al. [20]did research on partially reduced graphene oxide based FRET on fiber-optic interferometer. This research has been done for biochemical detection. An all-fiber graphene oxide (GO) that is related to`FRET concept has been proposed here. define technique carries both good selectivity and high sensitivity. They work with detection limits of 1.2 nM, 1.3 μM and 1 pM, for metal ion, dopamine and single-stranded DNA (ssDNA), respectively.

In 2015, Jianxiang Wen, et al. [21]wrote on Spun-Related Effects on Optical Properties of Spun Silica Optical Fibers. consequences on optical characteristic of silica optical fibers due to effects associated with Spun have been considered experimentally. such consequences are considerable in case of highly spun (short pitch length) fibers. such fibers are described at high rotation pace along with a tiny drawing rate. Spun fibers of different pitch lengths are formed by them. After forming spun fibers of different pitch lengths their examination is done by them. From this examination it is come in to notice that with decrease in pitch length MFD, cutoff wavelength and PMD decreases. But if reduction of 1.5 mm in pitch length is done, fiber deficit increases considerably. consequences of spun and annealing on Verdet constant of spun fibers are also considered by them. It is make known by their experimental results that Verdet constant is directionally proportional to spun

rate. One of significant outcomes is that after annealing increase of Verdet constant of spun fibers is inversely proportional to pitch length. In general an increase in Verdet constant is observed, because of spun and annealing processes. In a spun fiber it could reach about 4.5% at wavelength of 1550 nm with 1.0 mm pitch.

In 2013, Feng WenMagneto [22]-optic four-wave mixing in fibers: Theory and experiment. They put forward a complete magneto-optic four-wave mixing theory in linearly birefringent fibers for guided optical waves . A progress of 1.2 dB is secured in a magnetically controllable 2R parametric regeneration experiment.

In 2010,Hua Bai , et al. [23] wrote on Surface-enhanced Raman scattering optical fiber sensor using biconical taper fiber. A fresh surface-enhanced Raman scattering (SERS) optical fiber sensor in that biconical taper fiber is utilized is suggested. For its manufacture first of all contraction in multi-mode fiber is done. After that its waist is layered with silver colloid. Raman spectrum for R6G dye solution is obtained whose detection sensitivity is up to 10-9M.

In 2008,Zhi-Yong Dai, et al. [24] wrote on Landslide monitoring based on high-resolution distributed fiber optic stress sensor. A landslide monitoring application that uses a high-resolution distributed fiber optic stress sensor is make known by them. intra-stress distribution and change in landslide bodies is examined by use of sensors. Whenever there is a possibility of landslides, an early warning is given by them . In this article rule of distributed fiber optic stress sensing and intra-stress monitoring method for landslides were briefly described by them. Firstly evaluation of distributed polarization mode that is incorporated in polarization-maintaining fiber is carried out. After that, they planned distributed fiber stress sensor that has a stress calculating variety of 0-15 Mpa, spatial resolution 10 cm and measuring range 0.5 km. At last an innovative study of warning system is carried out.

In 2002, M.C.J. Large, et al. [25] Explained Single-mode micro structured polymer optical fiber. Firstly they create a single-mode micro structured polymer optical fiber (MPOF). After that they described guiding characteristics. By means of multiple expansion practice it is come in to notice that huge confinement losses are encountered by all of modes excluding original mode, that is considered as foundation of single mode transmission in micro structured fibers. After that additional benefit of MPOF in comparison with both conventional polymer optical fibers and glass micro structured fiber were considered. It is noticed that in upcoming era a lot of researches could be done in sector of micro structured polymer fibers

In 2008, Masahito Morimoto, et al. [26] presented review on R=1mm 90°-Bent Multi-Mode Optical Fiber. In this paper, they have searched bending losses and polarization dependent losses of 90° light beam deflection for multi-mode optical fibers (MMF). They have applied small-radius 90°-bent optical fibers. such optical fibers carry low refractive index UV curable resin.

In 2017, C. B. et al. [27] stated highly sensitive fiber-optic Fabry-Perot geophone with graphene-coated PMMA membrane. They put forward an extremely responsive fiber-optic Fabry-Perot interferometric geophone (FFPG) by means of graphene that is layered with PMMA crust. After that they illustrate it. In this mechanical power of crust is improved with help of graphene coating. If a comparison is designed among sensitivity of conventional electrical geophone and it is found that sensitivity of latter one is much higher. This type of all new optical geophone having tiny price, high sensitivity, electromagnetic interference immunity, uncomplicated manufacture and strong arrangement, should be probably utilized in oil/gas exploration and seismic wave detection.
In 2017, Zinan Wang , et al. [28] did research Towards ultra-long-distance distributed fiber-optic sensing. Because of exceptional benefits of Distributed fiber-optic sensing (DFOS), it is gaining huge consideration in both academic research and industrial applications. In this article we also talk on

latest improvement in DFOS at University of Electronic Science and Technology of China (UESTC), principally on ultra-long-distance Brillouin optical time-domain analysis (BOTDA) and phase-sensitive optical time-domain reflectometry (Φ-OTDR). We also talk on research advancement and real-life applications.

In 2017, Lingxia Chen , et al. [29] provided a comparison of clinic based dosimeters based on silica optical fiber and plastic optical fiber for in-vivo dosimeter. At Galway Clinic, creation and evaluation of 4 sensors that are based on silica optical fiber and plastic optical fiber for clinical in-vivo dosimeter is done on site. After that such 4 sensors are exposed to radiation having beam energies of 6 MV and 15 MV at different dose rates in order to find out primary consequences. radiation source that is utilized for this work is modern clinical linear accelerator (Linac). If a comparison is designed among new test results, it is found that sensors based on silica optical fiber show better sensitivity to incident radiation beam in comparison to sensors based on plastic optical fiber as soon as both are exposed to identical irradiation conditions. It is noticed that amount of intensity produced from sensor based on silica fiber is 5 times greater than in comparison to sensor based on plastic optical fiber.

In 2006, Clark Kinlin, et al[30] Proposed Asian Optical Fiber Communication & Optoelectronic Exposition & Conference. following topics were dealt with: advanced optical communication network; radio-over-fiber network; optical heterodyne OPESK system; polarisation mode dispersion on a single mode fiber; ultrafast bit and byte addressing; all optical memory; microring resonators; token-based optical burst switching ring network; GMPLS Testing; Kerr nonlinearity; optical ASK-DPSK system; optical ASK-DQPSK system; CAD for photonics devices and circuit; ion-exchanged glass waveguide technology; fiber optical communication; PPM receiver; deep space communication; SOA based fiber ring laser; photonic crystal waveguide; fiber grating laser module package; PMD distribution measurement by an OTDR with polarimetry; deep-blue organic light emitting device; optical fiber Raman temperature sensor; and integrated network management system for 3TNET..

In 1999, D.J. DiGiovanni , et al. [31] discussed about Specialty of optical fiber. A considerable viable achievement is obtained by a no of equipments that are fiber-based in previous 10 years. This includes equipments like fiber lasers, amplifiers, filters, sensors, and gyroscopes. Main objective of this conversation is of fibers that facilitate such devices.

In 2015, Tong Wang, et al.[32] put forward a new single fiber optical tweezers based on GIMMF: Simulation and experiment. On basis of a graded-index multimode fiber (GIMMF), fresh single fiber optical tweezers is put forward by them. Its length is arbitrary (when length is huger than 5mm). Large light field intensity are spread by optical fiber tweezers based on GIMMFs. Particles are easily captured by them. optical fiber tweezers applies GIMMF with arbitrary length is presented in this article .They guarantee fabrication of optical tweezers based on GIMMF uncomplicated, suitable and repeatability.

In 2010, René-Jean Essiambre, et al. [33] explained Fiber capacity limits: Information theory meets optical communication and fiber physics. In order to find out primary limit of fiber capacity, it is essential that we collectively use concepts of information theory, nonlinear dynamics and optical physics. A synopsis of an approach to estimate fiber capacity is presented.

[4] PROBLEM FORMULATION

Several problems are faced due to attenuation in fiber optics. There is need of repeater in order to regenerate the signals. The attenuation in fiber optics has been influenced by increase in distance, number of joints and number of connectors. However there are several other factors that results in attenuation but our research focus on three factors

1. Distance
2. Number of joints
3. Number of connectors

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However there have been several researches regarding fiber optic performance. But the simulation of attenuation in different circumstances is the major concern of this research.

Usually performance and cost get increase when wavelength increases. Multimode and single-mode fibers are using various fiber types or sizes. For example, single-mode fiber uses 9/125 um and multimode uses 62.5/125 or 50/125. The different size fibers have different optical loss dB/km values. Fiber loss is depending heavily on operating wavelength. Practical fibers are having minimum loss at 1550 nm and the highest loss at 780 nm with all physical fiber sizes.

[5]PROPOSED WORK

This research has been divided in three sections

1. Study and investigation of performance influencing factors in case of fiber optics and study of existing researches in related field.
2. Analysis of the influencing factors in case of attenuation in case of optical links. Here the data related to attenuation in different cases would be collected. In this research attenuation in case of wavelengths of 1310 nm, 1550 nm has been simulated.
3. Performing simulation of the attenuation in different cases and perform comparative analysis of attenuation in different scenarios.

Algorithm to find attenuation

1. Get n as number of connectors
2. Get C as attenuation for one optical connector (dB)
3. Get c number of splices in elementary cable section
4. Get J attenuation for one splice (dB)
5. Get M system margin (patch cords, cable bend, unpredictable optical attenuation events, and so on, should be considered around 3dB)
6. Get a attenuation for optical cable (dB/Km)
7. Get L total length of the optical cable
8. Calculate total attenuation **TA = n x C + c x J + L x a + M**
9. Stop

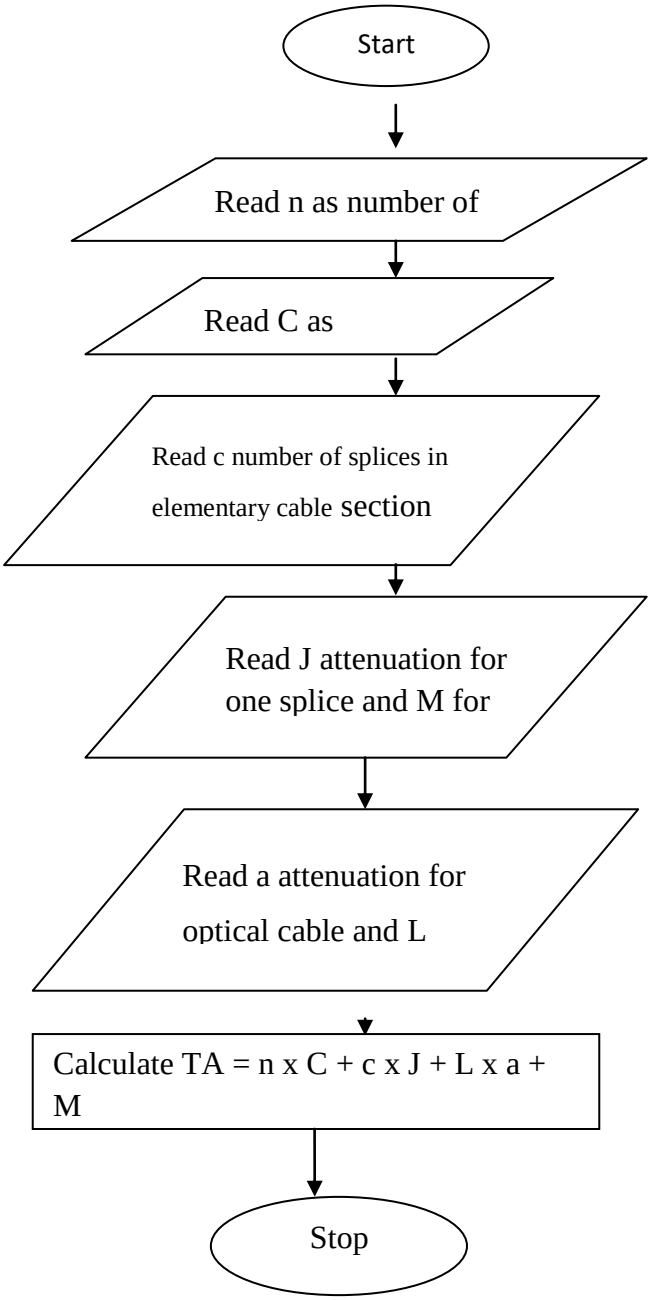

Fig 3 Flowchart for Attenuation Calculation

[6] CONCLUSION

In the research work the investigation of performance influencing factors in case of fiber optics has been made. Attenuation is a measure of the loss of signal strength or light power that occurs as light pulses

propagate through a run of multimode or single-mode fiber. In this research attenuation in case of wavelengths of 1310 nm, 1550 nm has been simulated. It has been simulated with respect to distance, joints, and connectors. In the research work the attenuation in different cases is calculated. Along with this the comparative analysis of attenuation is also provided in different scenarios.

[7]FUTURE SCOPE

The research work would provide the study of the existing researches related to fiber optics. It would provide the need, scope and working of fiber optics. It also investigates the performance influencing factors of fiber optical devices. The research is based on performance influencing factors of fiber optics in which one is attenuation. This research has considered the attenuation due to increase in distance, number of joints and number of connectors. The research work would also provide the comparative analysis of impact on attenuation considering defined factors in the research work.

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