SPLICING OF MULTIPLE FIBRES USING RIBBON SPLICER BY ELECTRIC ARC METHOD

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ABSTRACT

In the field of optical communication, the term splicing is used for soldering two ends of the fibre permanently which is damaged to perform the communication via a light. In this paper, fusion splicing of the bunch of cable (single to 12) is done simultaneously at a time using single ribbon splicer machine instead of splicing of one fibre individually. Hence, parallelly many fibres can be spliced in less than a minute. Experimental result shows performance of the ribbon splicer.

Keywords: splicing; soldering; optical fibre

INTRODUCTION

Fibre optics communication have gained tremendous popularity because of its speed, accuracy, immunity against noise. The term used as optics in fibre deals with the light propagation through thin glass fibres [1]. It is the physical mode of communication from transmitter to receiver.It uses light as a propagating media from sender to receiver. Fibre optics plays an important role in the field of communication to transmit voice, video, text, digital data signals from one place to another. Fibre cable network can be used under sea, College, universities, offices, industrial plants etc use fibre optic within their LAN (Local Area Network) systems. In general, for any line communication, transmission media has a requirement of both the joining and terminating. Proper fibre-to-fibre connection is required so that there is very low loss with minimum signal distortion [2]. Fibre joining is analogous to the electrical wiring joints done at home. In general, at our home if we have to join the wire either of electric or telephone line, the broken edges are twisted together or we either solder the broken edges of wire to join the wire together. But in case of OFC, two fibre cables are joined together by a method, known as splicing. Hence, Splicing is the method in which broken fibre ends are joined permanently. Splicing is nothing but a sort of noble name of “soldering”. Once Fibre cables are damaged or cut, network will be interrupted. Since optical fibre cable is made up of glass and if these cables are broken or damaged it requires repairing. It requires specialized splicing technique to join the damaged optical cable because the cable of optical fibre is composed of glass[3]. Splicing is costly method of repairing the fibre. It requires costly machines and technician to repair. The sophisticated term of splicing is used with fibre optics since these cables carry light signal and not the electrical signal. The OFC consists of core through which the light propagates. Hence to perform joining of the OFC cables it requires proper core-to-core alignment so that light can pass through it without any leakage. There are various modes of the fibre like single mode and multimode.In case of single mode only one light ray is used to send the data. The core has a diameter of 9µm (.009 millimetre). It has higher bandwidth and lower attenuation. Attenuation is the reduction in the intensity of light. In single mode optical fibre cable (OFC) data can be transferred to a fairly long distance of approximately 50 to 60 km. Data travels in the form of light signals. multimode Fibres allows more than one modes like two three or more than that propagate along the Fibre. The core of multimode OFC has a diameter of 50 or 62.5µm (1µm= 0.001). It has lower bandwidth and higher attenuation. The multimode OFC transfer the data upto 10 – 15 km, which is quite low as compared to single

mode OFC [4,5]. The multiple beams from a light source move through the core in different paths, so it is named as multimode. The light beams move within the cable depend on the structure of the core. Multimode can further be divided into step index and graded index. In step index fibres, the light rays propagate in zig-zag manner It has a core of constant/uniform density of glass. In graded index fibre, the light rays, propagate in the form of skew rays or helical rays inside the core of the fibre They will not cross the Fibre axis. The glass density of core is non-uniform[6]. There is a parabolically decrease in the densities of core from the axis of the Fibre to its surface.

In this paper, method of splicing multiple fibre using Multiple V-groove using Ribbon splicing is discussed. It results in splicing of maximum 12 fibres at a time in less than a minute. Earlier method of splicing used splicing of single cables which is broken or damaged at a time[7]. This paper suggests fast method of splicing with very less attenuation and results are also very accurate.

RESEACH METHOD:

Multiple V-groove method of Splicing:

Fusion slicing is used for fusing fibre ends. This method is achieved by an electric arc method. It is a method that uses heating method to melt two optical Fibres at the end faces together, to form a single long fibre. The source of heat is an electric arc[8], but it can be a laser beam, or a gas flame, or a tungsten filament through which current is passed.Auto voltage selection from 100 to 240 V AC or 10 to 15 V DC with ADC-18, 14.8 V DC with BTR-09 battery.

Experimental set up of fusion splicing:

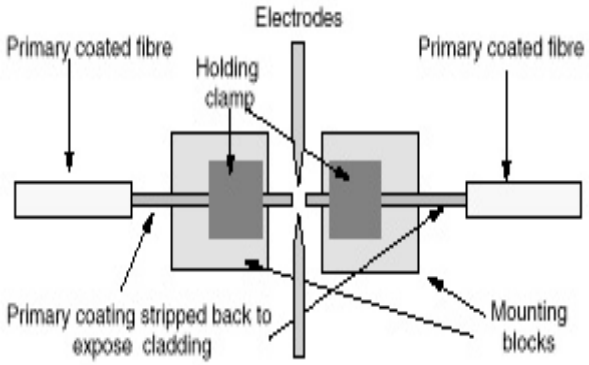

Figure 2 Method of fusion splicing

1. *Fibre Preparation:* First take the damaged fibre to be spliced of size-9/125 µm [9]. On the cable of fibre it is written weather it is designed as single mode or multimode. Based on it, fibre machine which is used for splicing, the necessary settings are done for splicing.

2. *Prepare the fibre cable for splicing*: For preparing the cable to be spliced break all the fibre at damaged area into two parts using Plier. Now prepare each end perfectly so that both broken parts of the fibre can be joined/spliced perfectly at core-to-core without any losses.

3. Take a Round cutter and put the fibre inside its round jaws a distance of around 3 to 4 inches away from the cable end to remove its jacket part. Rotate it twice or thrice times around the cable. A round cut mark is formed on the cable. Now push the jacket with hand finger towards fibre end to remove it.

Discard the jacket of the fibre in dustbin. Finally you are left with hair type thin long fibres of different colours (in set of 12 bunches of multiples of 12 like 24, 36 fibres). This fibre is now used for splicing

4. *Placing the protection sleeve over the fibre:*Take a 60mm protection sleeve and put the single hair-like red colour fibre chosen inside it. Move it around 4 inches backward from the end of the fibre[10]. Protection sleeve contains inner tube (Hot -melt glue) and strength member .The hot-melt adhesive inner tube bonds to both the fibre and the heat shrinkable outer tube to encapsulate the fusion splice joint and provides vibration damping and an environmental seal, protecting the Fibre from damage and contaminants and strength member (stainless steel, ceramic or non-metallic) provides additional rigidity to prevent misalignment, micro bending or breakage of the Fibre.

5. *Stripping the fibre:* Take the stripping tool and put all hair like single fibre inside its first slot. This will remove the buffer and now you are left with the tube/cladding inside the jacket [11]. Again take stripper and put the tube part inside the second slot of the stripper. This will give the cladding part**.** Again take stripper and put the cladding part inside the third slot of the stripper. This will give the core part with jelly above it. You will find a transparent sticky jelly after above the core. Don't touch this jelly directly with hands. Take a clean dry tissue and use it to clean the jelly Again take a tissue with few drops of alcohol on it and make it wet and clean the core again so that no dust is left above core. It is necessary to clean the fibre so that the dust cannot enter inside the protection sleeve which can result in future fibre break and attenuation. Don't touch the bare fibre with hands. The glass of fibre can cut the fingertip.

6. *Cleaving the fibre*. Take the precise cleaver and place the cleaned thin hair like core of the fibre inside it. The round diamond blade cutter is suitable for cutting the fibre at 412 (suitable for 60 mm protection sleeve if used) or at 10 (suitable for 30 mm protection sleeve if used) written inside the machine as a standard[12]. Exactly 90 degree of cleaving is done in which core part of the fibre in the machine is kept horizontally and machine blade cut fibre end vertically. This give very accurate cut. It involves three steps. Place the fibre in the cleaver. Adjust the blades. Finally cleave it by pressing the cap above.

7. *Operation with splicing machine.* Optical fibre splice machine used for fusion splice: The machine has two steps of operation. Firstly, it aligns the fibre i.e. core-to-core alignment and then it has two electrodes inside it which performs fusion of the fibre. It is shock resistance, dust resistance, and rain resistance. It is easy to handle. It performs total splicing operation in less than a minute. It produces high quality of spliced fibres with an attenuation loss less than 0.1db/km. The main disadvantage of this machine is that it is very costly.

RESULTS:

Splicer Machine of FUJIKURA 70R is capable of splicing 12 fibres at a time. It has fixed V-Groove with multiple slots for placing the fibre. If performs splicing at 11 second of bunch of 8 fibres at a time, along with tube heating in 18 sec.

Table 1: Specifications of ribbon splicer and single fiber splicer

Specification	**Ribbon Splicer (Fujikura 70R)**	**Single Fibre Splicer (Fujikura 62S)[13]**
Model Name		
Applicable fibres	SMF(G.652/657), MMF(G.651), DSF(G.653), NZDSF(G.655)	Single-mode (G.652 & G.657), Multimode (G.651.1), DS (G.653), CS (G.654), NZDS (G.655 & G.656) and Erbium-doped fibre
Fibre count	Single to 12	single
Splice loss	0.05dB (SM), 0.02dB(MM), 0.08dB(DS) and 0.08dB(NZDS) Measured by cut-back method relevant to ITU-T and IEC standards	0.02 dB with SM, 0.01 dB with MM, 0.04 dB with DS, 0.04 dB with NZDS, measured by cut-back method relevant to ITU-T standards
Splice mode / heating mode	Total 100 splice modes / 30 heating modes	100 pre-set and user programmable modes
Power supply	Battery operated	Auto voltage selection from 100 to 240 V AC or 10 to 15 V DC with ADC-18, 14.8 V DC with BTR-09 battery[14]
Magnification	2 axis CMOS camera with 4.73" colour LCD. X / Y (35 - 90X magnification, automatically change depending on fibre count), or both X and Y simultaneously	320X for single X or Y view, or 200X for X and Y view
Weight	2.5kg (including battery)	2.5 kg (5.5 lbs) with AC adapter ADC-18; 2.7 kg (5.95 lbs) with BTR-09 battery
Cladding dia. / Sheath dia	Single : 125µm / 160µm to 3mm by fiber holder system Ribbon : 125µm / Ribbon fiber thickness 0.25 to 0.4mm	80 µm to 150 µm
Splicing timing	11sec with SM FAST, 15sec with SM AUTO / 18sec with FP-04(T) sleeve	ULTRA FAST mode 6 seconds; SM FAST mode 7 seconds; SM AUTO mode 10 seconds with SM fiber

Table 2: Ribbon splicing of different types of fibers

Cable type (1-12 cables at a time)	Arc duration (seconds)	Attenuation (in db)
Single mode (SM)G.652/657	11.25	0.04
Multimode (MM)G.651	11.50	0.03
DSF G.653	10.6	0.08
NZDSF G.655	10.5	0.09

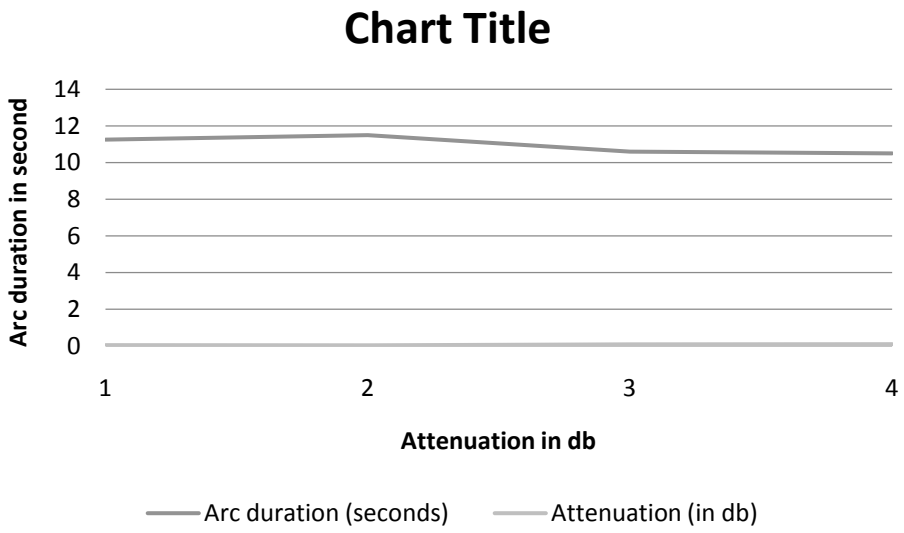

Figure 3 Graphical representation of total time taken in seconds with attenuation of ribbon splicing

CONCLUSION:

The splicing operation using multiple V- groove splicing using ribbon splicer has better performance compared to single splicer machine which is capable of joining only two fibres at a time. Ribbon splicer with less attenuation increase the speed of splicing operation hence able to complete splicing operation in very less time.

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