



# Manufacture of Light Propagation Instruments on Fiber Optic Cables

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**Abstract.** Practical activities can help teachers deliver material because students are directly involved and observing. In addition, practical activities also help students understand concepts. This research aims to make teaching aids to understand the concept of light propagation on fibre optic cables in schools. The method used is the experimental method, namely analyzing, designing, making, and testing the props made. Testing of teaching aids is done by finding the value of the Numerical Aperture (NA) of the optical fibre used by varying the distance of the screen from the laser light source (L) to the laser light capture diameter (D). The results showed that the measured average numerical aperture (NA) for single-mode fiber optic cables was 0.1. This corresponds to the NA magnitude for single-mode cables ranging from 0.05 to 0.4. Light propagation props on fiber optic cables are suitable for use in optical practicum activities at school. It is expected that teachers cannot only make teaching aids but must innovate in making them as long as the learning objectives can be achieved.

**Keywords:** Manufacture of Light · Fiber Optic Cables · Numerical Aperture

## 1 Introduction

Technological developments can not be avoided even humans tend to follow them. Technology has a very important role in human life in the military, education, economics, communication, information, and so on. In the field of communication, for example, humans can interact remotely. Communication that can be done with technology today is not only in the form of text and voice messages but can already communicate face to face. According to Aceto, G. et al [1]. The main supporting information and communication technology are truly changing the world. Technology in the field of communication in its transmission using the internet.

The internet is a fast-growing computer network consisting of millions of corporate, educational, and government networks that connect hundreds of millions of computers

and their users in more than 200 countries [6]. Two media are used by the internet in data transmission, namely wired and wireless, each of which has advantages and disadvantages [3]. Cables are often used in urban areas. This is to avoid interference with wireless use. Cables that are often used today are Fiber Optic (FO) cables made from fibre. Optical fibre is a transmission medium that uses light media as a conduit of information (data), offering greater data rates over longer distances and various other advantages [10]. FO cable has the advantage of a faster data transmission speed than copper cable (Fig. 1).

FO cable is a type of cable whose main material is made of glass fibre and plastic that uses light as the transmission medium in data transmission. The realization of the FO cable used today is an extraordinary form in physics. The light propagating through fibre optic fibre is a wave and a particle. In principle, light propagating through the optical fibre is based on Snell's law. Physics is one of the subjects that discusses how light propagates through a medium and how it refracts and reflects (Fig. 2).

The optical material in physics lessons in practical activities still uses simple tools such as a light source from a flashlight, various types of lenses, and several other tools. In addition, the use of practicum tools that students at school have used in understanding a concept still tends to be monotonous and lacks innovation in the tools used.

Practical activities can help teachers deliver the material because students are directly involved and observing. The practicum tools used as learning media must be by the learning objectives. Students can use fiber optic cables connected to laser light to understand light propagation on optical fibre. In practical activities, students can look for the fibre optic cable's acceptance angle and numerical aperture (NA). The numerical aperture (NA) is a value that has no units that characterize the range of angles at which the system can receive or emit light [12]. The size of the numerical aperture of fibre can determine how strongly the fibre guides light and how resistant it is to losses caused by bending [4].

Practising using fibre optics to understand the concept of light propagation on optical fibres will certainly provide a different experience for students. In addition to understanding the process of light propagation in fibre, students also know that the cables are made of copper and glass fibre. Based on the description above, the title of this research is "Making Light Propagation Props on Fiber Optic Cables."

## 2 Method

The method used is the experimental method, namely analyzing, designing, making, and testing the props made.

### 1) Tools and Materials

- a. Visual Fault Locator
- b. Single-mode Fiber Optic Cable
- c. Precision Rail 50 cm
- d. Precision Rail Feet
- e. Clamp Rider
- f. Support Pole (Visual Fault Locator, Fiber Optic Cable End, Light Capture Screen)



**Fig. 1.** Props and Materials

## 2) Tool Assembly Way

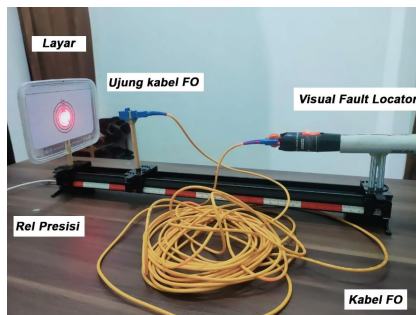
- a. Prepare tools and materials
- b. Install precision rail legs and clamped stacks
- c. Install support poles for visual fault locators, fibre optic cable ends, and light capture screens.
- d. Install the visual fault locator and connect the fibre optic cable from the visual fault locator to the end support pole of the fibre optic cable

## 3) Steps to Use Tool

- a. Assemble tools and materials according to existing instructions
- b. Position the light capture screen at the very end of the zero point on the precision rail
- c. Set the end support pole of the fibre optic cable (output) between the light capture screen and the visual fault locator.
- d. Turn on the visual fault locator and do the practicum.

## 4) Practical Steps Using the Tool

- a. Turn on the light source (visual fault locator)
- b. Adjust the distance of the optical fibre light output support pole with the light capture screen.
- c. Make sure the light caught on the screen is 10 mm in diameter
- d. Repeat the above steps for diameters 20 mm, 30 mm, 40 mm, and 50 mm.
- e. Record the data obtained in the following table:



**Fig. 2.** Design of Light Propagation Props on Fiber Optic Cables

**Table 1.** Data Collection of Experimental Results

| No. | D (cm)  | L (cm) | 2L (cm) | Reception Angle | Numerical aperture |
|-----|---------|--------|---------|-----------------|--------------------|
| 1   | 1.00    |        |         |                 |                    |
| 2   | 2.00    |        |         |                 |                    |
| 3   | 3.00    |        |         |                 |                    |
| 4   | 4.00    |        |         |                 |                    |
| 5   | 5.00    |        |         |                 |                    |
|     | Average |        |         |                 |                    |

### 3 Results and Discussion

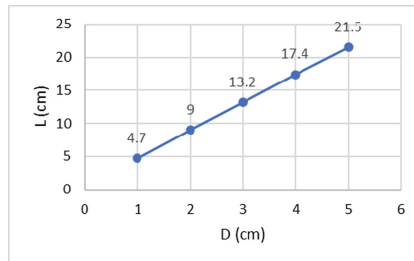
The experimental data using teaching aids are followed by data analysis to determine the numerical aperture (NA) value can be seen in the Table 2.

From the results of experiments conducted, the distance from the screen to the laser light source (L) is directly proportional to the diameter of the laser light capture on the screen (D) as shown in the graphic below (Fig. 3).

To get a laser light capture diameter on the screen of 1 cm, the distance between the capture screen and the laser light output is adjusted to obtain a distance of 4.7 cm. Likewise, the diameters of 2 cm, 3 cm, 4 cm, and 5 cm each get a distance of 9 cm, 13.2 cm, 17.4 cm, and 21.5 cm. Next, look for the acceptance angle and numerical aperture (NA), and based on the results of the data analysis above, it is found that the diameter captured by the screen starts from 1 cm, 2 cm, 3 cm, 4 cm, and 5 cm, resulting in values with insignificant differences as well as with Numerical aperture (NA) value. The average numerical aperture (NA) value obtained in the experimental results is 0.11. Usually, the size of the NA in a single-mode cable generally is in the range of 0.05 to 0.4. The NA value obtained is included in the NA value for single-mode FO cables (Table 1).

**Table 2.** Experimental data using visual aids

| No. | D (cm)  | L (cm) | 2L (cm) | Reception Angle | Numerical aperture |
|-----|---------|--------|---------|-----------------|--------------------|
| 1   | 1.00    | 4.70   | 9.40    | 6.051           | 0.105              |
| 2   | 2.00    | 9.00   | 18.0    | 6,333           | 0.110              |
| 3   | 3.00    | 13.2   | 26.4    | 6.504           | 0.113              |
| 4   | 4.00    | 17.4   | 34.8    | 6,560           | 0.114              |
| 5   | 5.00    | 21.5   | 43.0    | 6,617           | 0.115              |
|     | Average |        |         | 6,413           | 0.111              |



**Fig. 3.** Graphics Distance of the screen with Laser light source (L) to Laser light capture diameter (D).

## 4 Conclusion

The results showed that the measured average numerical aperture (NA) for single-mode fiber optic cables was 0.1. This corresponds to the NA magnitude for single-mode cables ranging from 0.05 to 0.4. Light propagation props on fiber optic cables are suitable for use in optical practicum activities at school. It is expected that teachers cannot only make teaching aids but must innovate in making them as long as the learning objectives can be achieved.

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