Optical Connector for 5G Base Station

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In recent years, mobile communication systems are shifting from the 4th generation, which mainly focuses on mobile phone services, to the 5th generation mobile communication system (5G), which enables high-speed, low-latency and high-capacity with multiple connections of various devices. The 5G offers improved services at autonomous vehicles, industrial equipment, security and medical care. The 5G deployment has begun in each country, and a lot of base stations start building. In this paper, we report on the development of a filed-assembly optical connector that can realize 5G optical fiber network wiring with high quality and less capital investment.

1. Introduction

1.1 Development Background

A typical example of optical fiber wiring from the central office to a 5G base station is shown in Figure 1. The construction of an optical fiber network requires optical fiber connections, and field -assembly optical connectors[1)2)] and waterproof optical connectors[3)], which are also used in FTTH. 5G is becoming an urgent issue, and the construction of base stations is being actively carried out around the world. In order to construct an optical fiber network quickly, good quality construction is required so that there is no backtracking. In addition, it is necessary to reduce the capital investment required for construction per worker because many workers need to work in parallel. In addition, since workers who do not usually assemble optical connectors in the field have more opportunities to do so, simple work is required. In this paper, we report on the development of a field-assembly optical connector that is easy to assemble with good quality and minimal investment.

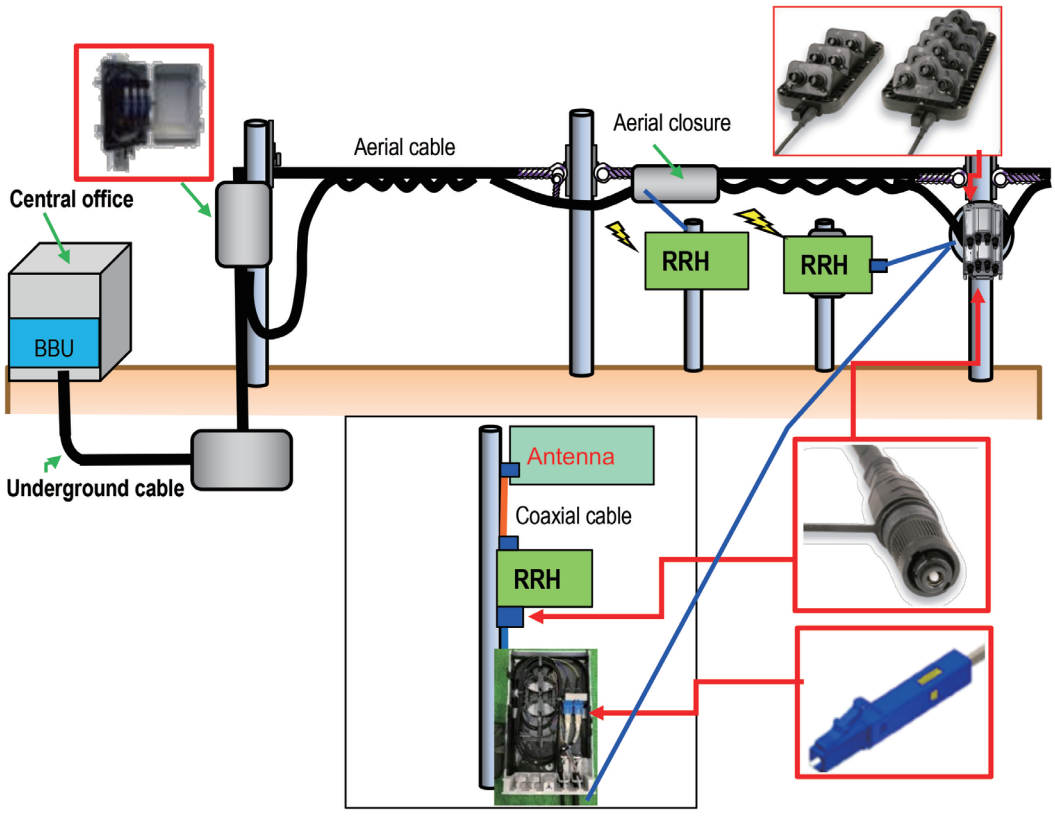

Fig.1. Typical example of optical fiber wiring.

1 Fiber Optics Network Product R&D Department Optical Cable Systems Division Telecommunication Systems Business Unit
2 Fujikura Fiber Optics Vietnam
3 Global Business Development Department Optical Cable Systems Division Telecommunication Systems Business Unit

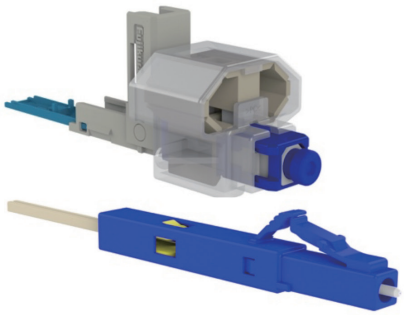

Fig.2. Field-assembly connector.

Fig.3. Water proof optical connector plug.

1.2 Field-assembly Optical Connectors Overview

The basic structure and features of the field-assembly optical connector are shown below. The field -assembly optical connector has a mechanical splice at the rear of the connector mating part and a cable clamp further back. The optical fiber is fixed inside the connector and the ferrule end face is polished to high precision. The mechanical splice is filled with refractive index matching material to stabilize the splice loss. When splicing an optical fiber, a wedge is inserted into the mechanical splice to create a gap in the mechanical splice, the optical fiber is inserted into the gap, and the optical fiber is fixed and spliced by removing the wedge. To secure the cable, a cable sheath is secured to the cable clamp in advance, and after a series of operations, the cable clamp is secured to the connector housing.

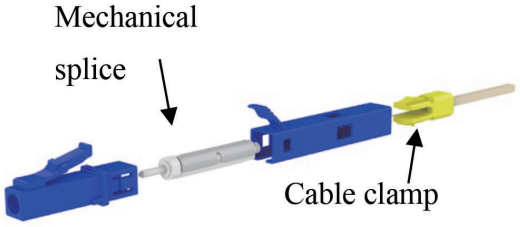

Fig.4. Field-assembly optical connector configuration.

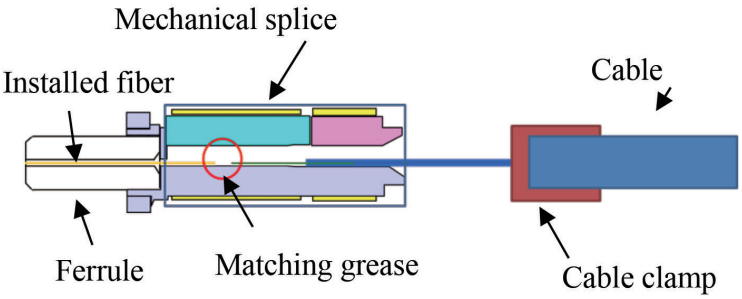

Fig.5. Schematic of field-assembly optical connector.

1.3 Field-assembly optical connector assembly flow

As shown in the assembly flow of the field-assembly optical connector in Fig. 6, before inserting the optical fiber into the field-assembly optical connector, the coating of the optical fiber must be removed and the end face must be cleaved to a mirror end face. These operations require two special tools: a fiber stripper and a fiber cleaver. In addition, these special tools must be maintained in good condition at all times, and it is necessary to educate the operator on how to manage the tools.

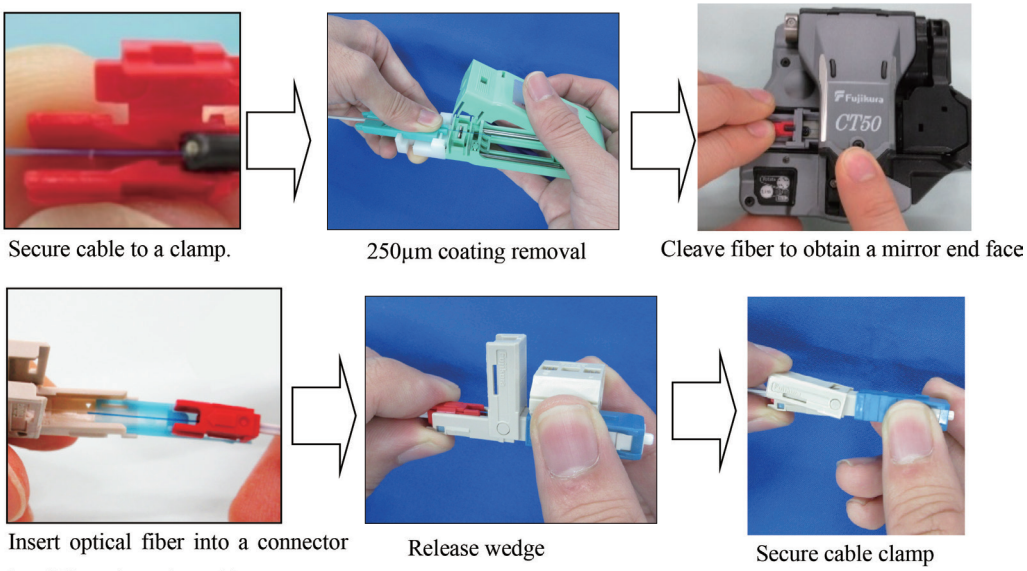

Fig.6. Field-assembly optical connector assembly flow.

2.1 Development of the fiber stripper

The use of plastic for the blade of the fiber stripper, which used to be a metal blade, and the simplification of the structure have made it possible to manufacture the stripper with only one injection-molded part, thereby making it economical. In addition, since there is no need to worry about the blade rusting, stable coating removal is possible and maintenance is not required, enabling high-quality.

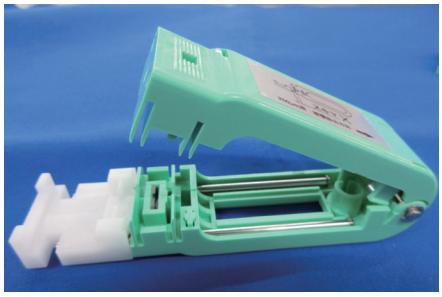

Fig.7. Fiber stripper (Metal blade).

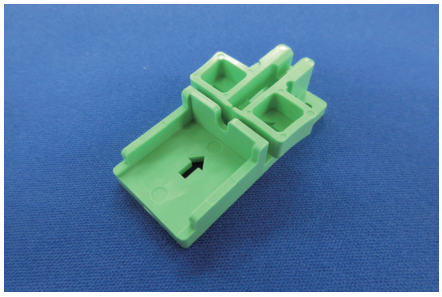

Fig.8. Fiber stripper (Plastic blade).

2.2 Development of the fiber cleaver

In the field-assembly optical connector, it is important to cleave the optical fiber to a mirror end face because insertion of an optical fiber without a mirror end face causes a gap at the connection point of the optical fiber and degrades the loss characteristics. If the maintenance of the fiber cleaver is inadequate, excessive stress might be exerted on the fiber while it is not sufficiently scratched, resulting in a ripple shaped end face. In the developed cleaver, a structure is adopted to scratch the fiber while applying constant tensile stress to the fiber, thereby achieving a fail-safe structure that prevents the fiber from being breaking when the scratch is insufficient. As a result, the tool is always in good condition, and the installation can be done easily without providing training to installers. In addition, the use of diamond abrasives for the scratching blade has achieved economic efficiency.

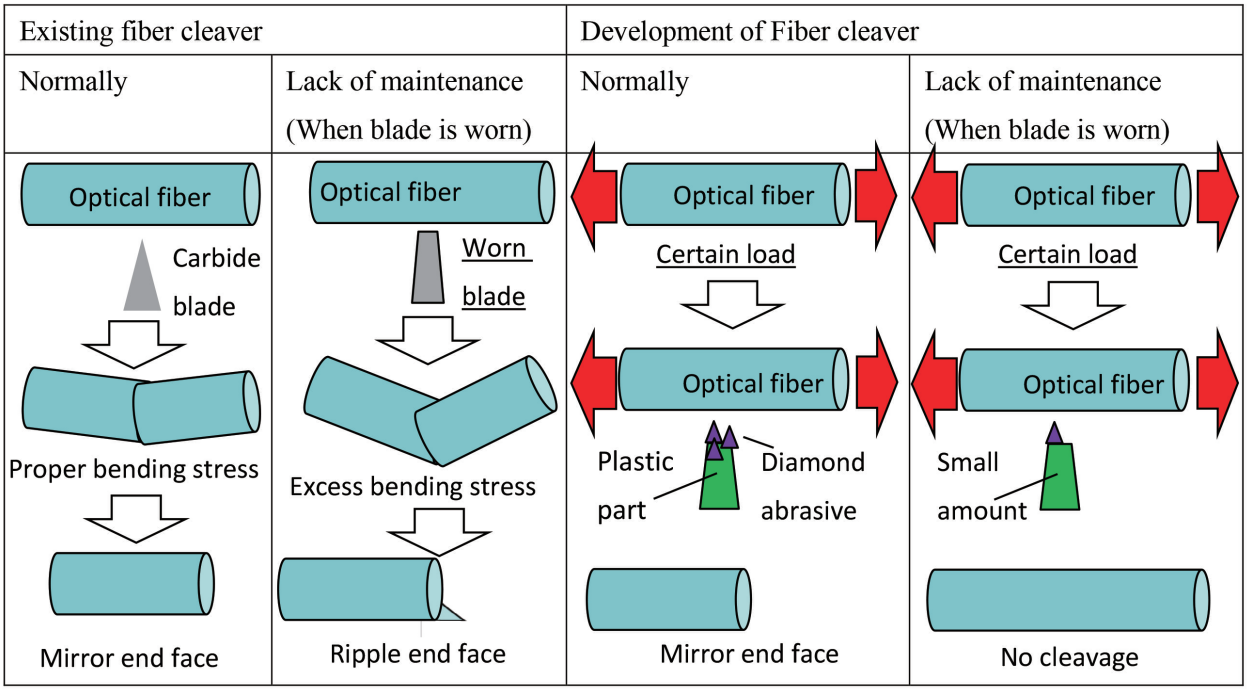

Fig.9. Fiber cleaving principle.

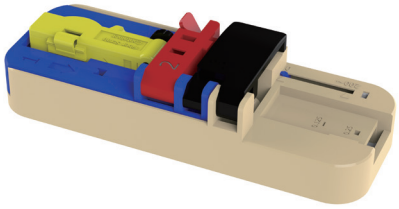

Fig.10. Fiber cleaver (developed).

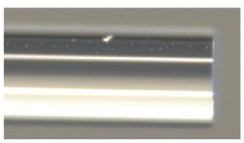

Fig.11. Cleaved end face (good end face).

Fig.12. Cleaved end face (Ripple end face).

3. Characteristics of Field-assembly Optical Connectors

3.1 Initial optical properties

The evaluation results of the connection loss and return loss of the field-assembly optical connector are shown in Figs. 13 and 14. The measurement wavelengths are 1.31μm and 1.55μm. An average connection loss of 0.21 dB was achieved. In addition, a return loss of more than 40 dB has been achieved.

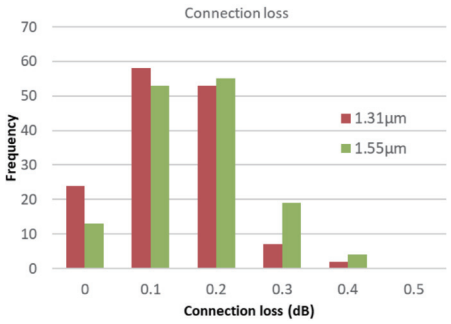

Fig.13. Connection loss.

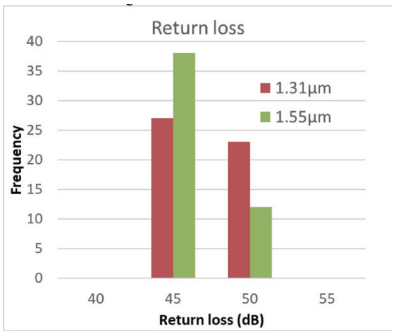

Fig.14. Return loss.

3.2 Reliability test

Table 1 summarizes the reliability test result of the field-assembly optical connector. Since this connector is intended to be used outdoors, high temperature tests and temperature cycle tests were conducted. The variation of the connection loss was less than 0.2dB in all the tests. From these results, it was confirmed that the connector has stable reliability characteristics.

Table 1. Reliability test.

Item		Test condition		Result	
				1.31um (dB)	1.55um (dB)
Mechanical performance	Fiber retention	20N 1min	Δ≦0.2 dB	Δ≦0.01	Δ≦0.01
	Twist test	15N 180°	Δ≦0.2 dB	Δ≦0.01	Δ≦0.01
	Flex test	5N 10times	Δ≦0.2 dB	Δ≦0.13	Δ≦0.06
Temperature performance	Change of temperature	-40～+70℃ 10 cycles	Δ≦0.2 dB	△≦0.10	△≦0.09
	Composite temperature humidity cyclic test	-10～65℃ 93% 10cycles	Δ≦0.2 dB	△≦0.09	△≦0.10
	Dry heat	85℃ 96 hours	Δ≦0.2 dB	△≦0.10	△≦0.10
	Cold	-40℃ 96 hours	Δ≦0.2 dB	△≦0.08	△≦0.03

4.Conclusion

As shown in this report, we have developed a field-assembly optical connector with good quality, minimal capital investment, easy installation, and confirmed that the characteristics are good. We will continue to develop products with simple workability and high functionality to contribute to the construction of 5G networks.

References

1) K.Takizawa, et al. : Development of New Mechanical Splice and Field-Installable Connector for FTTH, 52th IWCS,2003
2) D.Saito, et al.: Development of Field-Installable Optical Connector for FTTH, 54th IWCS,2005
3) D.Takeda Water Proof Optical Connector for FTTH,65thIWCS2016,