Underground Communication Facilities Technologies Enabling Lifecycle Cost Reductions

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Abstract

Underground communication facilities need to be economical, durable, and flexible to adapt to shifts in demands for services. This article describes our work on underground communication facilities technologies and related peripheral technologies focusing on efforts to reduce the lifecycle cost to meets these needs.

1. Background

Broadband services require underground communication facilities that are in good condition to ensure service reliability. Future underground communication facilities must support the flexible deployment of various types of broadband services and have long-term durability as well as having low maintenance and management costs. Therefore, we are developing highly cost-effective and high-performance facilities that can reduce lifecycle costs, including construction, maintenance, repair, and updating costs, as well as improving the durability and effectiveness of cable accommodation.

2. Conduit facilities technologies

This section describes conduit facilities technologies including a conduit system for improving cable accommodation efficiency and the utilization of existing facilities (free space or short access systems), conduit protection techniques that take into consideration environmental conditions, and a water-blocker for installing multiple cables.

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2.1 Free-space conduit system (ordinary conduit section)

This conduit system can accommodate cables according to demand by using a large diameter tube in ordinary conduit sections. Traditionally, multiple pipes with a diameter of 75 mm each that accommodate just one cable have been used for installing multiple cables. However, we are now developing and introducing a free-space conduit system that uses 150-mm diameter tubes, which should lead to a faster service response. This system enables high-density accommodation of optical cables and the use of long spans (inner space utilization technique) by making free use of the available space in the pipe and enables reductions of 10% in construction costs and 20% in operating costs by reducing the width of the trenches that need to be dug and the road occupation fee by using a single pipe (outer pipe technique) (**Fig. 1**).

(1) Inner space utilization technique

Laying cables over long spans using 75-mm diameter pipes has been difficult because of the limited tensile force that can be applied to the new cable without damaging its outer surface by rubbing against the previously installed cables. The free-space conduit system with one 150-mm diameter pipe uses up to six flexible polyethylene pipes each 36 mm in diameter to protect the cable's outer surface and each pipe can accommodate optical cables with up to 1000 cores. As a result, we can increase both the total number of cables that can be accommodated and the distance over which they can be installed.

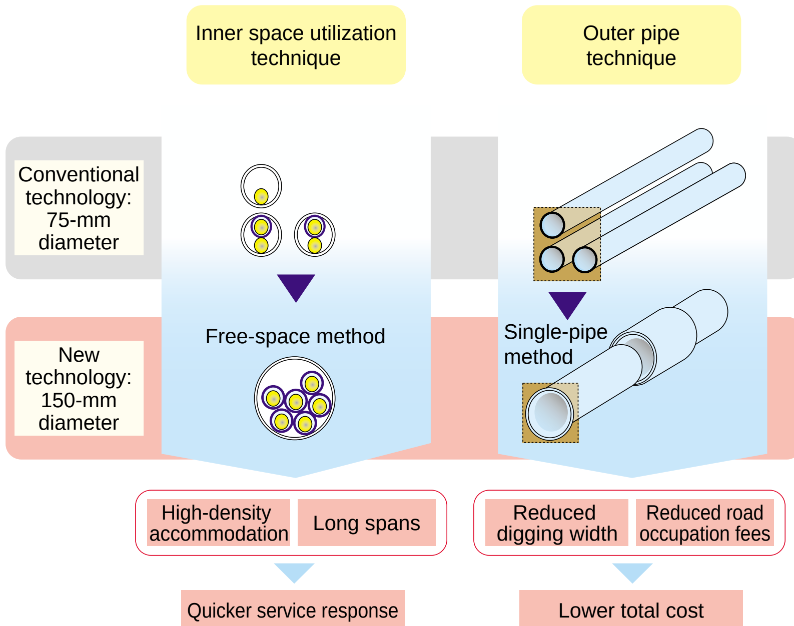

Fig. 1. Concept of 150-mm-diameter conduit method.

(2) Outer pipe technique

With an aim of applying it for general-purpose use, we evaluated the performance and compared the cost of various pipes. We selected and are using a free access vinyl pipe (diameter: 150 mm), which has a track record of actual usage in utility holes for power cables and communication cables.

(3) Metallic cable accommodation technique

We are developing a way to accommodate multiple metallic or optical cables to extend the applicability of the 150-mm diameter free-space conduit method to the expansion or relocation of existing facilities.

2.2 Free-space conduit system (bridge conduit section)

For bridge conduit sections, we have achieved cost reduction and simplification by using a fiber reinforced plastic (FRP) pipe. A photograph of a free-space bridge conduit is shown in **Fig. 2**. By utilizing some of the features of FRP pipe (it is light, having approximately half the unit weight of hard vinyl pipe, and has a high stiffness equivalent to that of steel pipe), we made a lightweight long-span (5 m) bridge conduit. In addition, we simplified the structure of the expansion/contraction joint by utilizing the characteristic that FRP's coefficient of thermal expansion is as small as one-fifth that of vinyl tube.

Weather-proofing of conduits has also been greatly improved by using FRP pipe and supporting hardware with fine PET (polyethylene terephthalate) particles applied to it. This is contributing to a reduction in maintenance and management costs from the viewpoint of lifecycle cost. Furthermore, our bridge conduit sections feature earthquake resistance that conforms to the latest road bridge technical standards (**Fig. 3**).

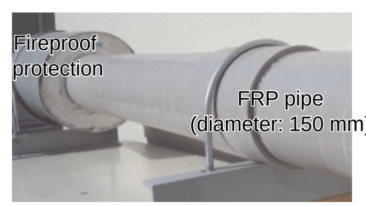

Fig. 2. 150-mm-diameter bridge conduit.

We expect this technology to enable us to reduce construction costs by 20% and operating costs by 55%.

2.3 Short access method

We have developed a short access method for underground cable conduits to enable a quick response to requests for optical services. It enables us to effectively utilize existing facilities by using a branch pipe to add a new branch from an existing cable conduit in which a cable has already been installed [1].Thus, it should greatly reduce the costs

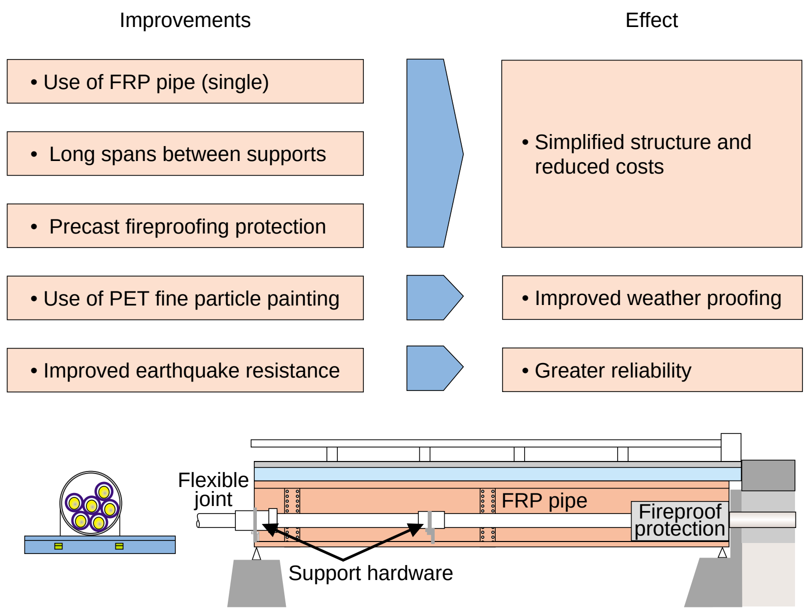

Fig. 3. Concept of 150-mm-diameter bridge conduit technologies.

of adding more conduits at the branch point in handholes.

2.4 Water-blocker for installing multiple cables

To prevent water from flowing into manholes through the gaps around conduits, water must be blocked at the end of manhole ducts. The conventional method of blocking water for multiple cable installation uses water-blocking foam material as a gap filler. However, there have been problems. For example, it is difficult to install and remove and it takes much time to do so, and since there is only a small gap between cables, a cable may be damaged when it is removed. We have developed a new water blocker that does not damage cables during installation or removal (**Fig. 4**). It consists of an outer sheath rubber portion (non-expandable) and a tubular portion that expands when wet. This water blocker can be applied to multi-cable installations with cables of various outer diameters because the water-expanding rubber part can be opened using a cutter on site.

2.5 Recycled conduit protector

If there is a danger of a conduit being damaged when the road is dug up or the pavement is cut because there is not enough earth above the conduit, then the conduit can be protected by a metal pipe, by concrete, or by a steel or ceramic plate. As an alternative to protective concrete, we have developed a "recycled conduit protector" using recycled material

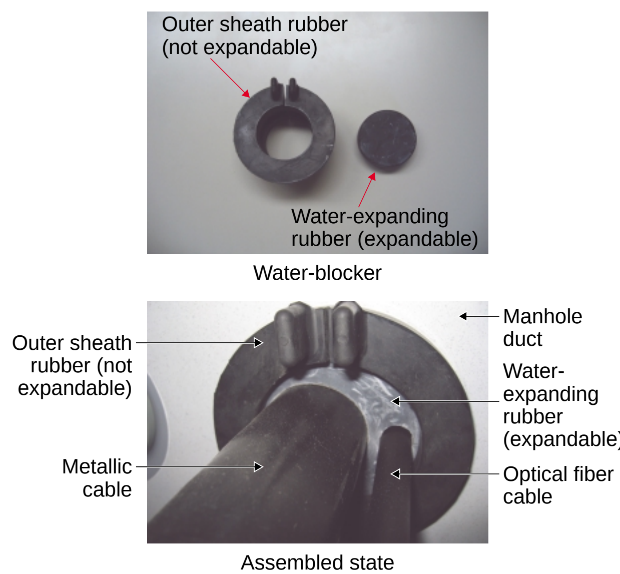

Fig. 4. Water-blocker for installing multiple cables.

obtained from scrap optical fiber cables [2]. In practical use, this conduit protection method has achieved a considerable improvement in work effectiveness and approximately 50% cost reduction while keeping the same level of reliability and durability as conventional conduit protection methods using concrete. It also helps to reduce industrial waste, because almost all of the scrap material from optical fiber cables is reused.

3. Manhole facilities technology

In this section we describe iron manhole covers for use in snowy regions developed from the viewpoint of reducing maintenance and management costs and preventing snowplow accidents from occurring during snow removal work. Accidents caused by snowplow blades hitting iron manhole covers, which can damage both the cover and vehicle or injure the driver, occur frequently in snowy regions (**Fig. 5**). Therefore, there is a need for an iron cover that does not affect snow removal work, has durability against blade impacts, and does not need frequent replacement. The manhole cover that we have recently developed is made of ductile cast iron, like existing iron covers, has a tapered holder structure that enables integration of the top cover and the frame, and has a sloping structure at the outer edge of the holding frame to alleviate the impact of a collision. The concept of this cover is shown in **Fig. 6**. Its main features are:

- Impact-alleviation properties of the holding frame:
  A slope formed at the outer edge relieves the shock of collision from snow removal work from any direction.
- Impact-alleviation properties of the top cover:
  The top cover also has a slope at the outer edge to relieve the shock of collision with a snowplow blade.
- Improved durability:
  For the paving material around the iron cover, we chose an epoxy resin material that has high adhesiveness, is durable against chipping and cracking, and is easy to use for immediate pavement repairs. It is greatly improving the durability of the pave-

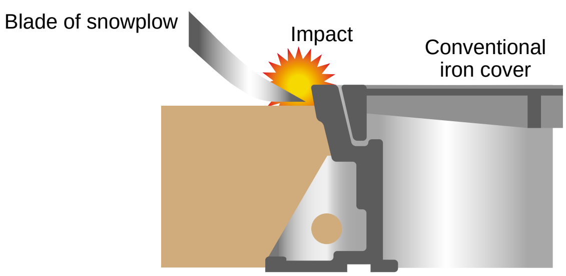

Fig. 5. Example of iron cover being damaged during snow removal work.

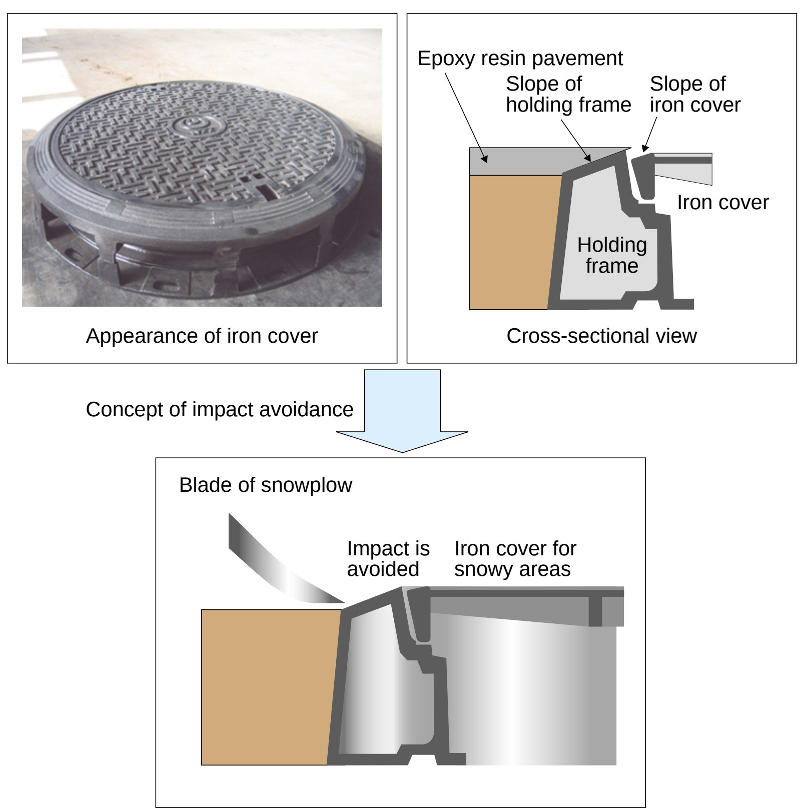

Fig. 6. Structure of iron manhole cover designed for snowy regions.

ment around the iron cover.

These improvements let us greatly extend the replacement cycle of iron covers in snowy regions, so we can expect the lifecycle costs to be drastically reduced.

5. Future plans

In the future, we will continue to develop underground communication facilities technologies by identifying business needs in order to improve the cost performance of equipment.

References

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