Underground Distribution Conduit Technology for Delivering IP Services (Free Access Method)

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Abstract

We have developed the Free Access method for delivering IP (Internet protocol) services to buildings. It utilizes existing metal pipes already installed in lead-in conduits and riser conduits to a customer building when further laying of fiber-optic cables is not possible. New lead-in conduits can be branched from any desired location on an underground distribution conduit, providing entry space for fiber-optic cables. This method makes effective use of existing facilities and reduces construction costs.

1. Introduction

As telecommunication demands grow in volume and variety, IP (Internet protocol) services, such as NTT's B-FLET'S continue to expand year after year. However, increased competition in the telecommunications field has resulted in the need for technology for constructing telecommunications facilities economically and has led to requests for effective utilization of existing facilities. At the NTT Access Network Service Systems Laboratories, to solve problems concerning underground distribution conduit technology for IP services, we are trying to develop methods for:

(1) Inserting a reversible pipe into an existing conduit to obtain cable housing space,
(2) Using a branch pipe of an existing distribution conduit for branching and building lead-in pipes,
(3) Laying pipes next to existing pipes to increase the number of pipes economically.

This article describes method (2), namely, underground distribution conduit technology that effectively utilizes existing facilities. We call it the Free Access method.

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2. Current state of underground distribution conduits

Numerous modifications have been made to the available underground distribution conduit types to reduce work costs and improve compatibility with services. As a result, three different types are being used today (**Fig. 1**). Our Free Access method is applicable to distribution conduits built using SUD (subscriber underground distribution) type 1 installed with a single cable per pipe.

A survey of major cities in western Japan indicated that virtually all existing distribution conduits have diameters of either 50 or 75 mm. Rigid PVC (polyvinylchloride) pipes and metal pipes were found to be relatively common, accounting for approximately 50% and 40%, respectively (**Fig. 2**).

3. Free Access method

The Free Access method enables new lead-in conduits to be branched from any desired location to relieve bottlenecks in the customer's lead-in conduits and riser conduits. By effectively utilizing existing distribution conduits, this method can reduce conduit expansion costs from the hand hole to the branching location (**Fig. 3**).

3.1 Usage conditions

To effectively utilize a broad array of stock, there must be a wide range of usage that is not limited to any distribution conduit type. Existing conduits

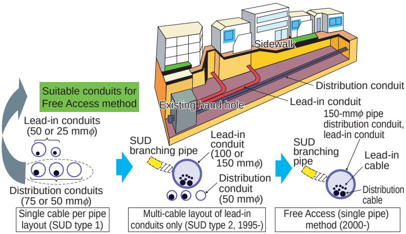

Fig. 1. Types of underground distribution conduits.

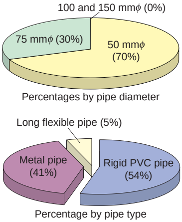

Fig. 2. Distribution of conduits (in 25 urban buildings in western Japan).

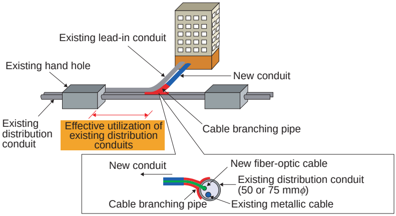

Fig. 3. Concept of Free Access method.

Table 1. Suitable conduit types for free access method.

Suitable conduit types		Pipe diameter (mm)
Rigid PVC pipe		50, 75
Metal pipe	Coated steel pipe	50, 75
	Asphalt-coated steel pipe	
	Cast iron pipe	75 (No specifications for 50)
Long flexible pipe		50 (No specifications for 75)

where the Free Access method can be used are shown in **Table 1**. Except for anticorrosive steel pipes, it can be used for virtually all conduits.

Table 2 shows how fiber-optic cables can installed in combination with the main existing cables. The diameter of cables already housed in the conduit determines how many new fiber-optic cables can be laid. For example, if 400 pairs of metal cable are already housed in a 50-mmϕ conduit, it is physically impossible to lay 100 cores of new fiber-optic cables. Therefore, application of this method requires a complete study of existing cable specifications.

Underground distribution conduits are common in urban shopping districts, and since the cable laying distance is relatively short, the cables are typically laid manually. As a result, considering the traction force for manual cable laying (approx. 196 N max.), for a single distribution conduit connecting two hand holes, the number of branching points is set to one for a 50-mmϕ distribution conduit diameter and at most two for a 75-mmϕ one. For a 75-mmϕ conduit, up to two fiber-optic cables can be added if the number of existing cables is at most 100 pairs.

Table 2. Combinations of multi-cable installations.

Newly laid cables / Existing cables			Fiber-optic cables			
		No. of cores	8	40	100	200
Metal cables	Quantity (pairs)	Outer diameter (mm)	8	10.5	12.5	16
	100	18.5	◎	◎	◎	◎
	200	24	◎	◎	◎	◎
	400	33	◎	◎	○	○

◎ : Suitable for 50 and 75-mmϕ conduits
○ : Suitable for 75-mmϕ conduits only
[dashed box] Two fiber-optic cables can be laid only in 75 mmϕ conduits.

Table 3. Guaranteed performance.

Cable laying performance	The cable will pass smoothly through the joint section and curved section of the branching pipe.
Load resistance	The pipe will not be damaged by the dead weight of dirt and other objects or automobile weight equivalent to T-25*.
Shock resistance	The pipe will not be damaged by mechanical shovels or other unexpected shocks (for metal pipes).

* T25: For automobile loads used in roads, bridges, and other structures, T25 stands for a large-sized vehicle load having a total vehicle mass of 25 tf (=250 kN).

3.2 Branching structure

When the branching section is housed in an existing distribution conduit, the structure must allow safe cabling work without constraining the expansion capabilities for newly laid cables or damaging existing cables. The performance (guaranteed performance) taken into account in developing the branching structure is shown in **Table 3**. The attachment to rigid PVC pipes uses branching technology from 150 mmϕ pipes already standardized in the current SUD type 2 (**Fig. 4**). Also, the branching section of metal pipes uses already-established layout technology for split pipes and cut pipes. Part of the metal pipe is removed and the split branching pipe is then affixed and joined to make a structure connected by a split joint (**Fig. 5**). Although the joint structures are different for the branching sections of long flexible pipes, the connection method is identical to that metal pipes.

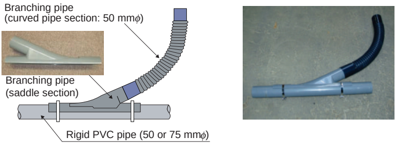

Fig. 4. Branching structure for rigid PVC pipes.

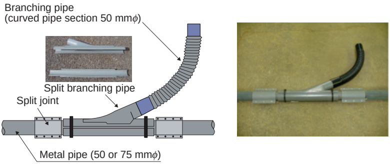

Fig. 5. Branching structure for metal pipes.

3.3 Protection of branching section

In underground distribution conduit areas, metal pipes are typically used when there are numerous buried objects and sufficient burial depth is not available or when the pipes might be subjected to unexpected shock from backhoes or other mechanical shovels due to frequent construction work by nearby companies. Whenever a branching section is installed in a metal pipe, the strength of that section is reduced. Protection must be used to reinforce this section and provide shock resistance. This protection is provided by protective fittings made from recycled fiber-optic cables (recycled protective fittings are used for branching conduits) (**Fig. 6**). The parts of fiber-optic cables that can be recycled are the sheathes (polyethylene), slot rods (polyethylene), and aluminum wrapping (aluminum). These are mixed, shredded, and then bonded to form a polyethylene compound.

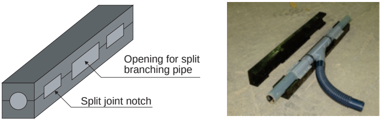

Fig. 6. Recycled protective fitting for branching conduit.

4. Conclusion

With the shift from the existing telephone network consisting primarily of metal cables to an IP network consisting primarily of fiber-optic cables, the technology described here will contribute to the quick response time and economic viability of fiber-optic services. This branching technology can be used not only to relieve bottlenecks in lead-in conduits, but also to eliminate steps in the process of moving obstructions. Plans are being made to standardize this technology. We are continuing to promote the effective utilization of NTT infrastructure facilities, perform research and development of maintenance and control technologies that will likely become mainstream in the future, and contribute to the generation of viable business.

Reference

[1] Y. Tamai, N. Segawa, and J. Tamamatsu, “Adapting Recycling to NTT Infrastructure Facilities Having Discarded Fiber-optic Cable,” NTT Technical Journal, Vol. 15, No. 6, pp. 42-45, 2003 (in Japanese).

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