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SERIES L: CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical fibre cable elements for microduct blowing-installation application

Recommendation ITU-T L.79

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Optical fibre cable elements for microduct blowing-installation application

Summary

Recommendation ITU-T L.79 describes characteristics, construction and test methods for microduct fibre units and microduct cables to be used with the blowing installation technique. The cable characteristics required for a cable to perform appropriately are described. Also, a method is described for determining whether or not the cable has the required characteristics. The required conditions may differ according to the installation environment; detailed test conditions must be agreed upon between a user and a manufacturer for the environment in which a cable is to be used.

Source

Recommendation ITU-T L.79 was approved on 7 July 2008 by ITU-T Study Group 6 (2005-2008) under Recommendation ITU-T A.8 procedure.

FOREWORD

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Introduction

Air blowing installation methods are based on viscous drag acting upon a cable while forcing a continuous high-speed airflow along it with a compressor. The velocity of the moving air propels the cable and makes it advance at a typical speed supported by the equipment. New generation cabling techniques, based on microduct cables, microduct fibre units and microduct systems, offer the possibility of branching without the need for splices. These techniques are extremely flexible and make it possible to grow in accordance with demand. This gives rise to the concept of "fibre on demand", which involves the pre-installation of a multi-microduct system and then the subsequent, incremental installation of fibre based on individual customer demand.

To support this "fibre on demand" approach, a fibre cable product must allow the installation of only a few fibres at a time. Cable products should take up the smallest possible amount of the service provider's right-of-way (i.e., fit the smallest microduct) so that there is plenty of space to add fibre for future customers. Therefore, usually only a small number of the fibres that are installed are used immediately. Also state-of-the-art fibre technology can be adopted.

When using blowing techniques, there is no pulling force at the front end of the cable; airflow exerts a distributed force along the entire cable. In addition, connection to a pulling cord is not needed.

Generally, the blowing force is an order of magnitude lower than the typical force involved in other installation methods, for example pulling techniques, thus reducing installation hazards. Additionally, with this technique, bends in a duct run are much less of a concern than with pulling techniques, so the installation speed increases and longer lengths of cable can be installed. Cables are installed virtually without stress, leaving the cable relaxed in the duct once the installation has been completed.

Recommendation ITU-T L.79

Optical fibre cable elements for microduct blowing-installation application

1 Scope

This Recommendation:

– refers to microduct fibre units and microduct cables to be used for telecommunications networks with blowing installation techniques;

– deals with mechanical and environmental characteristics of microduct fibre units and microduct cables. The optical fibre dimensional and transmission characteristics, together with their test methods, should comply with [IEC 60793-2-10], [ITU-T G.652], [ITU-T G.653], [ITU-T G.654], [ITU-T G.655], [ITU-T G.656] and [ITU-T G.657] which deal with multi-mode graded index optical fibres and single-mode optical fibres, respectively;

– deals with fundamental considerations related to optical fibre cable from mechanical and environmental standpoints;

– acknowledges that some optical fibre cables may contain metallic elements, for which reference should be made to [b-ITU-T Handbook] and other L-series Recommendations;

– recommends that microduct fibre units and microduct cables should be provided with end-sealing and protection during delivery and storage, as used for metallic cables.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

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[ITU-T G.651.1] Recommendation ITU-T G.651.1 (2007), *Characteristics of a 50/125 µm multimode graded index optical fibre cable for the optical access network*.
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[ITU-T G.652] Recommendation ITU-T G.652 (2005), *Characteristics of a single-mode optical fibre and cable*.
<http://www.itu.int/rec/T-REC-G.652>

[ITU-T G.653] Recommendation ITU-T G.653 (2006), *Characteristics of a dispersion-shifted single-mode optical fibre and cable*.
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[ITU-T G.654] Recommendation ITU-T G.654 (2006), *Characteristics of a cut-off shifted single-ode optical fibre and cable*.
<http://www.itu.int/rec/T-REC-G.654>

[ITU-T G.655] Recommendation ITU-T G.655 (2006), *Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable*.
<http://www.itu.int/rec/T-REC-G.655>

[ITU-T G.656] Recommendation ITU-T G.656 (2006), *Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport*.
<http://www.itu.int/rec/T-REC-G.656>

[ITU-T G.657] Recommendation ITU-T G.657 (2006), *Characteristics of a bending loss insensitive single mode optical fibre and cable for the access network*.
<http://www.itu.int/rec/T-REC-G.657>

[ITU-T L.1] Recommendation ITU-T L.1 (1988), *Construction, installation and protection of telecommunication cables in public networks*.
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[ITU-T L.10] Recommendation ITU-T L.10 (2002), *Optical fibre cables for duct and tunnel application*.
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[ITU-T L.12] Recommendation ITU-T L.12 (2008), *Optical fibre splices*.
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[ITU-T L.26] Recommendation ITU-T L.26 (2002), *Optical fibre cables for aerial application*.
<http://www.itu.int/rec/T-REC-L.26>

[ITU-T L.35] Recommendation ITU-T L.35 (1998), *Installation of optical fibre cables in the access network*.
<http://www.itu.int/rec/T-REC-L.35>

[ITU-T L.43] Recommendation ITU-T L.43 (2002), *Optical fibre cables for buried application*.
<http://www.itu.int/rec/T-REC-L.43>

[ITU-T L.59] Recommendation ITU-T L.59 (2004), *Optical fibre cables for indoor applications*.
<http://www.itu.int/rec/T-REC-L.59>

[IEC 60189-1] IEC 60189-1 (2007), *Low-frequency cables and wires with PVC insulation and PVC sheath – Part 1: General test and measuring methods* .
<http://webstore.iec.ch/webstore/webstore.nsf/artnum/038026>

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[IEC 60793-1] IEC 60793-1 (2001), *Optical fibres – Part 1: Generic specifications*.
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[IEC 60793-1-32] IEC 60793-1-32 (2001), *Optical fibres – Part 1-32: Measurement methods and test procedures – Coating strippability*.
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[IEC 60793-2-10] IEC 60793-2-10 (2007), *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres.*
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[IEC 60794-1-1] IEC 60794-1-1 (2001), *Optical fibre cables – Part 1-1: Generic specification – General*.
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[IEC 60794-2] IEC 60794-2 (2002), *Optical fibre cables – Part 2: Indoor cables – Sectional specification*.
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3 Definitions

This Recommendation defines the following terms (the definitions for other terms are given in [ITU-T G.650.1], and [ITU-T G.651.1] apply):

3.1 blown-in element: A blown-in element consists of optical fibre(s), sheath and other materials and is inserted into the microduct by continuous high-speed airflow force. Some of the characteristics of this element are described in clause 6.5.

3.2 hybrid protected microduct cable: A hybrid protected microduct cable is a bundle containing both microducts and optical fibre cable. They are combined and surrounded by a tight or loose protective sheath, perhaps with another optional protective layer such as a humidity shield.

3.3 microduct: A microduct is a small, flexible lightweight tube with an outer diameter typically less than 16 mm. Some of the characteristics of this element are described in clause 6.2. Plastic microducts are sized to allow the fibre unit to be blown freely into the duct, and the inner surface of the microduct is designed to minimize sliding friction with the blown-in element (see clause 3.1).

3.4 microduct cable: This is an optical fibre cable that can be installed in a microduct with the blowing technique.

3.5 microduct fibre unit: This is a group of fibres (with a count starting at one) that can be installed in a microduct with the blowing technique.

3.6 parent blowing duct: There are three kinds of parent blowing ducts: outer protective ducts, protected microducts and hybrid protected microduct cable.

3.7 protected microduct: This kind of duct comprises a number of microducts that are loosely or tightly packed together and jacketed, in much the same way as an optical cable without the fibre (small guide tubes running through a network of protective tubes typically made of polyethylene, with a typical external diameter of 25 to 63 mm).

4 Abbreviations and acronyms

None.

5 Environmental conditions

The required characteristics depend strongly on the environmental conditions at the location where the optical cables are installed. Therefore, it is important to know these conditions.

5.1 Underground

5.1.1 Conduits and tunnels

The environmental conditions of conduits and tunnels are described in [ITU-T L.10].

5.1.2 Direct buried

The environmental conditions for buried applications are described in [ITU-T L.43].

5.2 Aerial

The environmental conditions for aerial applications are described in [ITU-T L.26].

5.3 Indoor

The environmental conditions for indoor applications are described in [ITU-T L.59].

6 Cable construction

6.1 Fibre protection

6.1.1 Primary coated fibre

Primary coated fibres must comply with the relevant ITU-T G.65x-series Recommendations.

6.1.2 Buffered fibre

When using a tight or semi-tight buffer (loosely applied), the following characteristics are required:

– A tight buffer should be easily removable over a length of 15 to 25 mm for fibre splicing.
– A semi-tight buffer should be easily removable over a length of 300 to 2000 mm for fibre splicing.
– With a tight buffer, the nominal diameter should be between 300 and 1000 µm, based on an agreement between the user and supplier. The tolerance should be ±100 µm.

– With a semi-tight buffer, the nominal diameter should be between 300 and 1300 μm, based on an agreement between the user and supplier. The tolerance should be ±100 μm.

6.1.3 Further protection

When a buffered fibre requires further protection, a sheath that includes one or two non-metallic strength members can be used. The sheath should be made of a suitable material.

6.2 Protected microducts

Duct systems to blow blown-in elements inside have been designed to optimize blowing distances and provide additional protection from the environment. Different kinds of protected microducts are considered, with alternative materials and properties, depending on the installation environment.

For example, if rodent protection is needed, fibreglass yarn or corrugated laminated steel can be used in the outer duct.

6.2.1 Outdoor protected microducts for duct installation

These microducts can be made of polyethylene, with an optional low friction anti-static inner surface to deal with the presence of water (usually with aluminium foil for water protection).

Vendors can supply them with drum sizes holding up to 4 km.

Inner duct counts may vary from one to more than 20 microducts. These inner microducts are coloured to facilitate identification.

6.2.2 Outdoor protected microducts to be directly buried

These microducts can be made of polyethylene: two sheaths of polyethylene (the outer one made of high density polyethylene), with a low friction anti-static inner surface, and prepared for the presence of water (usually with aluminium foil for water protection).

Alternatively, they can consist of a bundle of microducts loosely pre-installed in a protective duct of the type commonly used as an empty protected duct. Vendors can supply them using drum sizes up to 4 km.

Inner microduct counts may vary from 1 to more than 20. These inner microducts are coloured to facilitate identification.

6.2.3 Aerial protected microducts for outdoor installations

These microducts, usually made of polyethylene, can either be used singly or enclosed in a larger duct. The ducts that are suspended are usually self-supporting with a typical installation span of up to 70 m. Different reinforcing elements or materials such as steel, fibreglass or aramid yarns may be used to improve the mechanical characteristics.

Inner microduct counts may vary from one to more than 12. These inner microducts are coloured to facilitate identification.

The suspension element can be metallic or dielectric, and the whole system should be waterproof.

6.2.4 Indoor protected microducts

They are usually made of halogen-free, flame-retardant material, with a low friction anti-static inner surface.

Vendors can supply them using drum sizes up to 3 km.

Inner duct counts may vary from one to more than 15 microducts. These inner microducts should have individual markings for identification.

6.3 Microducts

The microducts shall be able to resist the pressure differences needed during installation with a blowing technique. They shall be circular and uniform in cross-section throughout their length and the inner surface shall have a low friction coefficient. The inner and outer diameters shall be specified.

Microducts are intended for benign installation within ducts or as components within a protected duct as described in clause 6.2. In all cases it shall be possible to identify each individual microduct throughout its length.

Microducts can also be put into the interstices of ducts containing other cables.

6.4 Hybrid protected microduct/cable

They consist of microducts, optical fibre cables and protective sheaths, perhaps with some other optional protective layer such as a humidity shield. The materials and configuration that can be used for microducts are described in clause 6.3. The requirements, configuration, characteristics and test methods of an optical fibre cable that is used for this unit are described in [ITU-T L.10], [ITU-T L.26], [ITU-T L.43] and [ITU-T L.59], and depend on the environment in which they are used.

6.5 Blown-in elements

The key mechanical design issues related to the blown-in elements are diameter, weight, stiffness and elasticity, robustness, surface friction and element memory (element memory is an attribute relating to the cable's ability to return to its original shape, i.e., straight, after being bent). Although the blown element is effectively pulled into the duct by an air stream during installation, there are circumstances under which compressive axial forces can occur, and hence the possibility of buckling the blown-in element. Buckling can cause jams in the duct and possible damage to the fibre being installed.

These elements must also be able to bend around corners, as typical installations will contain bends. Thus, the element bending stiffness must be sufficiently high to minimize the risk of buckling, but not so high as to prevent cornering during installation.

Another key property of these elements is its surface characteristics. The goal is to maximize viscous air drag on these elements and minimize friction with the duct. Although these elements shall be designed to minimize sliding friction inside the duct, its surface will contribute to drag.

Regarding the fibre itself, any of the current ITU-T Recommendations may be considered – from [ITU-T G.651.1] to [ITU-T G.657].

Different methods may be used to ensure correct fibre identification (typically, by colouring fibres).

Finally, the element must be robust to the presence of gases or liquids (water) in the duct.

6.5.1 Microduct fibre unit

These units differ from microduct optical fibre cables in that they provide less protection to the fibres that they contain.

Microduct fibre units do not utilize strength members as traditional fibre cables do, and therefore the stiffness of the entire element is achieved through the intrinsic stiffness of the fibres themselves, as well as of the materials coating the fibres. Here the small cross-sectional geometry of the blow-in element plays a beneficial role in achieving a balance between flexibility and stiffness.

The attenuation of an installed microduct fibre unit at the operational wavelength(s) shall not exceed values agreed between the customer and supplier.

There shall be no fibre splice in a delivery length unless otherwise agreed between the customer and supplier.

It shall be possible to identify each individual fibre throughout the length of the microduct fibre unit.

Fibre units normally have fibre counts ranging from one to 12 fibres, and will typically have an outside diameter of between 1.0 and 1.5 mm. They may consist of single fibres or a ribbon (made of two or four fibres).

6.5.2 Microduct cable

Microduct cables may consist of fibres, groupings of fibres, strength members, water blocking materials, sheaths and other appropriate materials.

The attenuation of the installed cable at the operational wavelength(s) shall not exceed values agreed between the customer and supplier.

There shall be no fibre splice in a delivery length unless otherwise agreed by the customer and supplier.

It shall be possible to identify each individual fibre throughout the length of the optical fibre microduct cable.

Microduct cables can have fibre counts ranging from 4 to 192 fibres, with a typical outside diameter of 1.5 mm to 9.2 mm. They may consist of single fibres or a ribbon (made of two or four fibres).

7 Test methods

7.1 Test methods for cable elements

7.1.1 Tests applicable to optical fibres

This clause describes optical fibre test methods related to splicing. Methods for testing the mechanical and optical characteristics of optical fibres are described in [ITU-T G.650.1], [ITU-T G.651.1] and [IEC 60793-1].

7.1.1.1 Dimensions

[IEC 60189-1] shall be used for measuring buffered fibres, tubes and cable diameters. This method can be employed to measure the thickness of a cable sheath.

7.1.1.2 Coating strippability

[IEC 60793-1-32] shall be used for measuring the strippability of primary or secondary fibre coatings.

7.1.1.3 Compatibility with filling material

When fibres come into contact with a filling material, the stability of the fibre coating and the filling material should be tested after accelerated aging.

The stability of the coating stripping force shall be tested in accordance with method E5 of [IEC 60794-1-2].

Dimension stability and coating transmissivity should be examined by using a test method agreed upon by the user and supplier.

7.1.2 Tests applicable to tubes

7.1.2.1 Tube kink

Method G7 of [IEC 60794-1-2] shall be used for measuring the kink characteristics of a tube.

7.2 Methods for testing mechanical characteristics

The methods for testing the mechanical characteristics of each product are divided into two categories as shown in Table 1. In the table, "recommended" means that a test should be performed. "Optional" means that a test will be performed if agreed between a manufacturer and a customer. As regards the test methods, reference shall be made to [IEC 60794-1-2] and [IEC 60794-2].

Table 1 – Mechanical test methods applied for each product

	Protected microducts and microducts	Hybrid protected microduct cable	Microduct fibre unit and microduct cable
Tensile strength	Recommended	Recommended	Recommended
Bending	Recommended	Recommended	Recommended
Flexing	Recommended	Optional	Optional
Crushing	Recommended	Recommended	Recommended
Torsion	Recommended	Recommended	Recommended
Impact	Recommended	Recommended	Recommended
Kink	Recommended	Recommended	Recommended
Vibration	Optional	Optional	Optional
Repeated bending	Recommended	Recommended	Recommended
Repeated bending at low temperature	Optional	Optional	Optional

7.2.1 Tensile strength

This test method applies to optical fibre cables installed under all environmental conditions.

Measurements are made to examine the behaviour of the fibre attenuation as a function of the load on a cable during installation.

The test should be carried out in accordance with method E1A of [IEC 60794-1-2].

The amount of mechanical decoupling of the fibre and cable can be determined by measuring the fibre elongation with optical phase shift test equipment, together with cable elongation.

This method may be non-destructive if the tension applied is within the operational values.

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.2 Bending

This test method applies to optical fibre cables installed under all environmental conditions.

The purpose of this test is to determine the ability of optical fibre cables to withstand bending around a pulley, as simulated by a test mandrel.

This test shall be carried out in accordance with method E11A of [IEC 60794-1-2].

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.3 Flexing

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method E8 of [IEC 60794-1-2].

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.4 Crushing

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with method E3 of [IEC 60794-1-2].

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.5 Torsion

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method E7 of [IEC 60794-1-2].

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.6 Impact

This test method applies to optical fibre cables installed under all environmental conditions.

This test shall be carried out in accordance with method E4 of [IEC 60794-1-2].

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.7 Kink

This test method applies to optical fibre cables installed under all environmental conditions.

This test should be carried out in accordance with method E10 of [IEC 60794-1-2].

The test conditions should be identical to those of [IEC 60794-2-10].

7.2.8 Vibration

This subject is for further study.

7.2.9 Repeated bending

This test shall be carried out in accordance with method E6 of [IEC 60794-1-2].

The test conditions shall be identical to those of [IEC 60794-2-10].

7.2.10 Repeated bending at low temperature

This test should be carried out in accordance with method E11A of [IEC 60794-1-2].

The test conditions should be identical to those of [IEC 60794-2-10].

7.3 Test methods for environmental characteristics

This clause recommends appropriate tests and test methods for verifying the environmental characteristics of optical fibre cables.

7.3.1 Temperature cycling

This test method applies to optical fibre cables installed under all environmental conditions.

Testing involves temperature cycling to determine the stability of the attenuation of a cable in the presence of ambient temperature changes, which may occur during storage, transportation and operation.

This test shall be carried out in accordance with method F1 of [IEC 60794-1-2].

7.3.2 Vibration

This subject needs further study.

7.4 Test methods for fire safety

This clause recommends appropriate tests and test methods for verifying the fire safety characteristics of products for indoor applications. In this clause, if the word (optional) follows the test title, it means that the test is not mandatory.

7.4.1 Flame retardant characteristics

This test shall be carried out in accordance with method [IEC 60332-1] or [IEC 60332-3-24], unless there is an agreement between the manufacturer and user.

7.4.2 Toxic gases characteristics (optional)

This test shall be carried out in accordance with method [IEC 60754-1] or [IEC 60754-2], unless there is an agreement between the manufacturer and user.

7.4.3 Smoke characteristics

This test shall be carried out in accordance with method [IEC 61304-1] or [IEC 61304-2], unless there is an agreement between the manufacturer and user.

Appendix I

Chinese experience

(This appendix does not form an integral part of this Recommendation)

I.1 Product types of microducts

Product types of microduct includes outer protective ducts, microducts, microduct bundles, protected microducts, hybrid protected microduct cable, etc.

Their main specifications are shown in Table I.1.

Table I.1 – Main specifications and arrangements of microduct

Duct type			Example of maximum capacity of sub-ducts or micro-cables	Layout purpose
Duct type	**Outer/inner diameter (mm)**	**Material**		
Large ducts	110/100	PVC PE	3 × 40/33 small ducts, 4 × 34/28 small ducts	Backbone conduit, or conduit from telecom central office.
	100/90	PVC PE	2 × 40/33 small ducts, 3 × 34/28 or 32/26 small ducts	Backbone conduit.
	75/65	PVC PE	2 × 32/26 small ducts	Branching conduit to distribution point, or feeder conduit to a great number of users.
Small ducts (i.e., outer protective ducts)	63/54	HDPE	10 × 10/8 microducts, 20 × 7/5 microducts	Installed into large ducts, or used solely for directly-buried applications. Generally, this is a type of duct with a special solid polymer lubricant as inner lining, such as silicon core tube.
	50/41	HDPE	7 × 10/8 microducts, 14 × 7/5 microducts	
	46/38	HDPE	6 × 10/8 microducts, 12 × 7/5 microducts	
	40/33	HDPE	5 × 10/8 microducts, 7 × 8/6 microducts, 10 × 7/5 microducts, 4 groups of 4/3 microduct bundles	
	34/28	HDPE	3 × 10/8 microducts, 7 × 7/5 microducts	
	32/26	HDPE	3 × 10/8 microducts, 6 × 7/5 microducts	

Table I.1 – Main specifications and arrangements of microduct

<table>
<tr><th colspan="3">Duct type</th><th rowspan="2">Example of maximum capacity of sub-ducts or micro-cables</th><th rowspan="2">Layout purpose</th></tr>
<tr><th>Duct type</th><th>Outer/inner diameter (mm)</th><th>Material</th></tr>
<tr><td rowspan="9">Microducts</td><td>16.0/13.5</td><td>HDPE</td><td>Maximum 1 × Φ10.5 microduct cable</td><td rowspan="9">Installed into the parent blowing duct. Generally, this is a type of duct with a special solid polymer lubricant as inner lining, such as silicon core tube.</td></tr>
<tr><td>14.0/11.5</td><td>HDPE</td><td>Maximum 1 × Φ8.9 microduct cable</td></tr>
<tr><td>12.0/10.0*</td><td>HDPE</td><td>Maximum 1 × Φ7.8 microduct cable</td></tr>
<tr><td>10.0/8.0*</td><td>HDPE</td><td>Maximum 1 × Φ6.2 microduct cable</td></tr>
<tr><td>8.0/6.0</td><td>HDPE</td><td>Maximum 1 × Φ4.6 microduct cable, or used to blow fibre units</td></tr>
<tr><td>7.0/5.5*</td><td>HDPE</td><td>Maximum 1 × Φ4.2 microduct cable, or used to blow fibre units</td></tr>
<tr><td>5.0/3.5*</td><td>HDPE</td><td>Maximum 1 × Φ2.7 fibre units</td></tr>
<tr><td>4.0/3.0</td><td>HDPE</td><td>Maximum 1 × Φ2.3 fibre units</td></tr>
<tr><td>3.5/2.5</td><td>HDPE</td><td>Maximum 1 × Φ1.9 fibre units</td></tr>
<tr><td>Microduct bundles and protected microducts</td><td colspan="3">Main types are 1, 2, 4, 7, 12, 19, 24 apertures.</td><td>Installed into large ducts, the microduct cables can also be used alone for directly buried applications.</td></tr>
<tr><td>Hybrid protected microduct/cable</td><td colspan="3">Types of the hybrid protected microduct/cable should be determined according to the diameter of microducts and the number of members inside.</td><td>Installed into large ducts, or used alone for directly buried applications.</td></tr>
<tr><td colspan="5">NOTE 1 – The microducts noted with * are often used.
NOTE 2 – The capacity of microducts is calculated according to the ratio of the cross-section of the microduct cable to the inner aperture of the microduct. The appendix specifies 60% as the maximum ratio.</td></tr>
</table>

I.2 Blowing performance test for micro-cable or fibre unit in microduct

I.2.1 Method A: Blowing test through microduct on drum

Sample length: Not less than 500 m.

Microduct drum diameter: To be 1000 mm for micro-cable, to be 500 mm for fibre unit.

Microduct diameter when sample is micro-cable: To be determined according to the ratio of the cross-section of the micro-cable to the inner aperture of the microduct. Generally, 45% to 60% are specified as reasonable ratios.

Microduct diameter when sample is fibre unit: To be determined according to the dimension of the fibre unit and the maximum blowing force that it can support. Generally, the reasonable microduct diameter range is from 2.5 mm to 6.0 mm.

Blowing pressure: 8 to 12 bar.

Relative humidity in microduct: 4% to 6%.

Number of tests: Three times.

Performance requirements: In order to evaluate the blowing performance of blowing products, in the test process the installation length, installation speed and blowing pressure shall be recorded corresponding to installation time. Generally speaking, as for microduct cable, the average installation speed shall be not less than 25 m/min, installation length in 20 minutes shall be not less than 500 m. As for fibre units, the average installation speed shall be not less than 20 m/min, installation length in 25 minutes shall be not less than 500 m.

I.2.2 Method B: Blowing test through microduct on field (simulated)

Test method: The microduct shall be laid out according to one of a), b) and c) in Figure I.1. Sufficient access to both ends of the microduct shall be provided. The microduct shall then be positioned for the duration of the tests. Air shall then be blown into the microduct through the blowing head for 20 minutes to condition the reference test route. Then the microduct cable or microduct fibre unit shall be installed into the microduct at up to the maximum speed specified, until the microduct cable or microduct fibre unit is blown out of the other end of the microduct.

Sample length: Not less than 1200 m for microduct cable, 600 m for microduct fibre unit.

Microduct diameter when sample is microduct cable: To be determined according to the ratio of the cross-section of the microduct cable to the inner aperture of the microduct. Generally, 45% to 60% are specified as reasonable ratios.

Microduct diameter when sample is microduct fibre unit: To be determined according to the dimensions of the microduct fibre unit and the maximum blowing force that it can support. Generally, reasonable values for the microduct diameter are 2.5 mm to 6.0 mm.

Blowing pressure: 8 to 12 bar.

Relative humidity in microduct: 4% to 6% (only relevant for microduct fibre units).

Number of tests: Three times.

Performance requirements: In order to evaluate the blowing performance of blowing products, in the test process the installation length, installation speed and blowing pressure shall be recorded corresponding to installation time. Generally speaking, for microduct cable, the average installation speed shall be not less than 35 m/min, installation length in 35 minutes shall be not less than 1200 m. For microduct fibre unit, the average installation speed shall be not less than 25 m/min, installation length in 24 minutes shall be not less than 600 m.

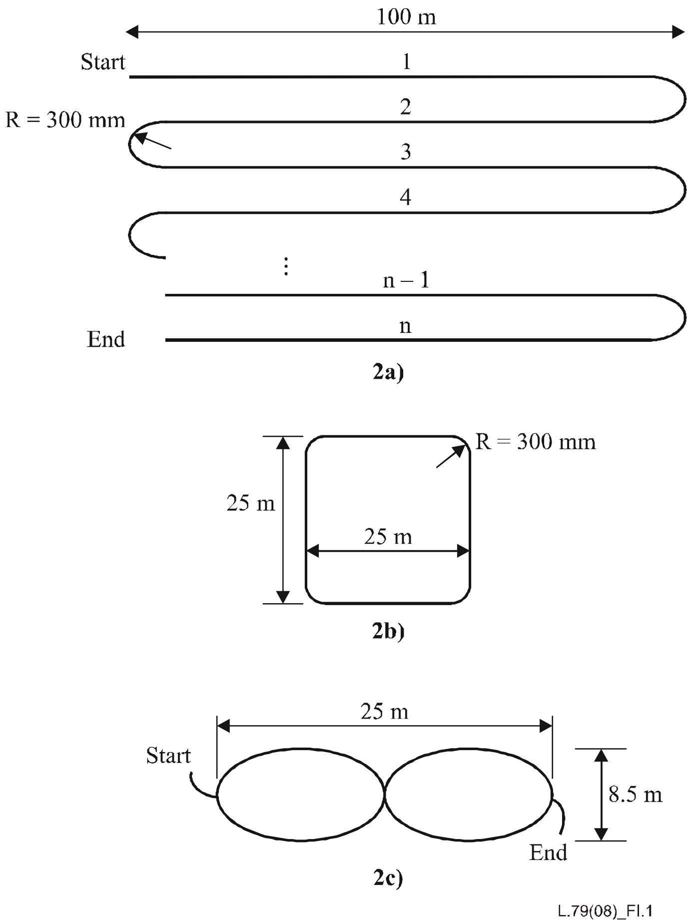

Figure I.1 – Test set-up for blowing performance in the field (simulated)

I.3 Layout location selection for microduct

The best layout location should be selected according to Table I.2, taking local conditions into account.

Table I.2 – The priority of layout location selection for microduct

Sequence number	Layout region	Layout location for microduct
1	Super highway	1) Central reservation (median strip) 2) Road shoulder 3) Inside safety guardrail 4) Roadside ditch
2	Ordinary highway	1) Invariable highway: road shoulder, the belt between the roadside ditch and the edge of highway, the roadside ditch 2) Variable highway: within 200 m of the highway; avoiding the influence of inclines, changes in direction or width, etc.
3	City street	1) Footway footpath (sidewalk) 2) Slow lane 3) Fast lane
4	Other region	1) Suitable topography and consistent geology 2) Convenient access for blowing machines

Burying depth

The burying depth for parent microduct should be determined according to the characteristics of the soil and environment around layout regions. The main specifications are shown in Table I.3.

Table I.3 – The requirements of burying depth for parent microduct

Number	Characteristics of soil and layout regions	Burying depth (m)
1	Ordinary soil, hard soil	≥1.0
2	Half stone-like soil (for example stonebrash and efflorescent stone, etc.)	≥0.8
3	Full stone-like soil and quicksand	≥0.6
4	Suburb, village and small town	≥1.0
5	City street	≥0.8
6	Through railroad or highway from underside	≥1.0 (from roadbed)
7	Central reservation (median strip) and road shoulder of highway	≥0.8
8	Groove, ditch and pond	≥1.0
9	River	Same as optical fibre cable under river

Bibliography

[b-ITU-T Handbook] ITU-T Handbook (1991), *Outside Plant Technologies for Public Networks*. <http://www.itu.int/publ/T-HDB-OUT.05-1992/en>

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