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SERIES L: ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

Optical fibre cables – Guidance and installation technique

Microduct technology and its applications

Recommendation ITU-T L.162

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ITU-T L-SERIES RECOMMENDATIONS

ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION, INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT

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Recommendation ITU-T L.162

Microduct technology and its applications

Summary

Recommendation ITU-T L.162 describes the solutions for indoor and/or outdoor installation of microducts in various conditions: directly into the trench, existing pipes, aerial applications and access to buildings. There is broad interest in this technology by telecommunication installation companies and operators for the deployment of optical networks, because it helps in the reutilization and optimization of the space inside existing pipes (e.g., large ducts), as well as the minimization of civil works, the social impact and the cost of the plant. The same technology approach may be utilized for new microduct plant installations.

These solutions can be applied in all segments of the telecommunications networks when existing infrastructure is available for reuse or when it is necessary to create a new infrastructure.

The required solution of microducts may differ according to the dimensions and the conditions of existing pipes and the dimensions of microcables to be laid.

History

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Infrastructure optimization, microcable, microduct, miniaturization, subduct.

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FOREWORD

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Introduction

The development of cables characterized by smaller diameters, but with the same fibre counts as traditional cables, has permitted the realization of new infrastructures, called microducts, with the goal of existing space optimization. When the operator considers laying new cables, it is recommended to evaluate the possibility of re-utilizing previously-occupied infrastructures. This technique is called subducting.

As much of the cost for the construction of a ducted network is related to civil works, telecommunication installation companies and operators are evaluating whether existing infrastructure (ducts from telecom operators, municipalities, power companies, the public lighting system, sewers, water and gas pipes) can be reutilized for the deployment of the future networks. Similarly, laying microducts in new plants can minimize the impact of civil works.

One of possible solutions is using microducts and microcables.

Other possibilities are associated with direct burial, aerial or semi aerial applications of microducts. Some particular microduct infrastructures can simplify the laying procedure.

However, it is important to remember the existence of other solutions to avoid civil works, for example, the replacement of copper cables with fibre cables and low fibre-count cables with high fibre-count cables.

Recommendation ITU-T L.162

Microduct technology and its applications

1 Scope

This Recommendation provides general information about features of microduct technology and requirements concerning its application in all segments of the telecommunications networks, with particular attention to the access network and access to buildings. This technology is mainly applied in underground installations but can also be used in aerial applications.

This Recommendation provides:

– some application criteria about situations in which applying subducting techniques is needed;

– advice about technical features of the components used in microduct infrastructures;

– advice about subducting operating procedures;

– some application criteria for microduct entering the building.

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.

[ITU-T L.156] Recommendation ITU-T L.156 (2003), *Air-assisted installation of optical fibre cables*.

3 Definitions

3.1 Terms defined elsewhere

None.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 microcable: An optical fibre cable that is suitable for installation into a subducting microduct.

3.2.2 microduct: A small, flexible tube with enough wall thickness to provide the mechanical protection required by the application, with outer and inner diameter defined according to the dimension and the condition of existing duct and the diameter of microcable.

3.2.3 microduct infrastructure: A complex of two or more microducts assembled in different configurations.

3.2.4 optical fibre element: Any of several types of fibre units, micromodules, buffered fibre, etc. intended for installation in a manner similar to microcable. Refer to [b-ITU-T L.108].

3.2.5 pipe/conduit: Existing infrastructure (empty or occupied with other cables) designed to accommodate the microtubes by means of subducting technique.

3.2.6 subducting: A technique that re-utilizes existing infrastructure to lay microducts, in order to optimize the space.

3.2.7 subducting microduct: Microduct appropriate for use within subducting technique.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

FTTx Fiber To The x, with "x" being the home, the antenna, etc.

HDPE High Density Polyethylene

ID/OD mm ID value is the inner diameter of the microduct, and OD value is the outer diameter of the microduct (given in mm)

5 Conventions

None.

6 Microcable technology

The microcable is a compact optical fibre cable with a small diameter and construction enabling air-blown installation in microducts.

The cable allows the deployment of currently required fibre count, thus the microcable provides a lower initial investment. Together with the microduct it allows for the flexibility to install and upgrade to the latest fiber technologies after the initial installation.

Microcables can have 288 fibres or more. Microcables have outer diameters appropriate for use in microducts with diameters typically less than 16 mm.

Typically, they have a central strength member, some loose tubes containing fibres, a ripcord and an outer jacket often made of high density polyethylene (HDPE) for outdoor use, and flame retardant materials for indoor applications. The cable could be all dielectric or not, depending on the field application.

The microcable remains flexible and provides reduced resistance when passed through the ducting, making it is easy to handle and install.

Typically, the microcable can be used in operating temperatures of −30°C / +70ºC.

It is recommended to lay a microcable inside a microduct by using a blowing technique, according to [ITU-T L.156]. In appropriate applications, it is also possible to pull/push microcables directly.

For additional information on this technology, refer to [b-IEC 60794-5], [b-IEC 60794-5-10], [b-IEC 60794-5-20], [b-IEC 60793-1-1], [b-ITU-T G.650.1], [b-ITU-T G.652], [b-ITU-T G.655], [b-ITU-T G.656], [b-ITU-T G.657] and [b-ITU-T L.108].

7 Microduct features

7.1 Single microduct

The function of single microduct is the protection of a single fibre optic microcable. It is typically made of HDPE. The type of HDPE used should be suitable for general use without risks for health and guarantees the required rigidity, easy handling and other mechanical parameters (pressure resistance greater than 10 bar). The dimensions of microducts, used for outdoor subducting, should depend on the dimension and the condition of exiting pipes as well as the dimension of the microcable. Examples of dimensions are 10-12 mm (inner-outer diameter).

Generally the inner and outer layers of the microduct are of the same material. However, the inner layer could be chiseled, not smooth, or otherwise profiled or be of a different material to minimize the friction of the cable during laying.

Microducts should be single coloured or striped in order to facilitate their identification in the field. Microducts with transparent stripes or transparent microducts with identifying coloured stripes should be used so that the operator can check the presence of cables inside. Microducts exposed to sunlight should be protected against UV degradation; this is of particular importance for the transparent section. (See Figure 7.1).

Figure 7.1 – Examples of single microducts

The single microduct should be protected to prevent rodent attacks when laid directly in ducts placed inside galleries of public services or multi-purpose tunnels, bridges or viaducts. Such protection may include a single layer of glass yarn or steel armour, together with an outer sheath of HDPE or other material. Specialized outer sheaths such as polyamid or polyethylene with anti-rodent chemical additives could also be considered.

7.2 Microducts infrastructure

Microduct infrastructure is a complex of two or more microducts assembled in different configurations. A microduct infrastructure can be used when the number of microducts to be laid in existing pipe is more than two. The number and the dimension of microducts of the infrastructure change according to the dimension of the existing pipe and the type of cable inside it. Various kinds of microduct infrastructures can be used.

7.2.1 Flat infrastructure

In the flat infrastructure, microducts are adjacently or tangentially joined with bridges side-by-side. These are also called flat bundle ducts. The flat infrastructure can be used when existing pipe is occupied by other utility cables by using the small unoccupied space (see clause 9). The guiding effect inside the duct is better than with the single microducts which may have twists and bends. Flat bundles may also be effective in microtrenching applications.

The flat infrastructure can contain some microducts, individually over-sheathed with a thin-wall bridge. The bridges should allow the folding of the microducts into a compact aggregate or flat configuration. (See Figure 7.2).

Figure 7.2 – Example of flat infrastructure of microducts

Microducts are connected with bridges which increases the flexibility of the infrastructure. The bridge should be easily removable to enable branching-off the microducts and utilization of standard connectors.

The flat infrastructure's bridge should be made of plastic material which guarantees the required rigidity and other mechanical parameters. The bridge can be different colours, commonly transparent or orange.

Each microduct of the infrastructure should have the features described in clause 7.1.

7.2.2 Bundle Infrastructure

In the bundle infrastructure, microducts are preinstalled in a sheath in a loose way. Typically, the bundle infrastructure can be used when the existing pipe is empty.

The bundle infrastructure can contain some number of microducts, according to the dimension of the existing pipe.

The bundle's sheath should be made of plastic material which guarantees the required rigidity and other mechanical parameters and it can be different colours. (See Figure 7.3).

Each microduct of the infrastructure should have the features described in clause 7.1.

Figure 7.3 – Example of bundle structure of microducts

7.3 Microduct accessories

7.3.1 Microduct end caps

End caps should always be used during the laying, storage and transportation of microducts or microduct infrastructure in order to assure their closing and avoid the penetration of water or dust. They should be removable and reusable, with diameter matched to the microduct.

7.3.2 Microduct connectors

Microduct connectors are sleeves for splicing two microducts. They should guarantee tensile strength and pressure more than 15 bar. Further, they should be reusable and removable. Straight connectors are used to join microducts with the same diameters and so called "reducers" for microducts of different size.

In order to support pneumatic and hydraulic strength, the cut end of the microduct should be perfectly perpendicular.

7.4 Factory-assembled microduct products

Factory-assembled microduct products are HDPE conduits with fibre optic microcable pre-installed.

The conduits can be installed via open trench, plowing or directional drilling, eliminating the need to pull in or jet in the fibre. The pre-installed cables experience minimal stress during installation, reducing the possibility of damage from handling.

Other factory-assembled products may include fibre assemblies. Conduit is manufactured by continuously extruding HDPE loosely over the fibre assembly with no adhesion between the conduit and fibre. Optical fibers are placed in buffer tubes that contain an absorbent yarn which delivers water blocking 'on demand'. Color-coded buffer tubes stranded around a dielectric central member using the reverse oscillating lay (ROL) stranding technique can facilitate easy mid-span fiber access.

Single or multiple cables may be pre-installed.

8 Microduct and microcable protection system

It is mandatory to provide an effective protection solution for the microducts and microcables laid in handholes, manholes or in other critical places, where optical fibres pass through, in order to protect the telecommunication infrastructure from rodent attacks and accidental damage; this is to prevent catastrophic events such as network blackouts. See clause 7.1.

It is mandatory to use pipe – microduct sealing elements (sealing between pipe and microducts), in order to ensure both the seal against the entry of liquids and gases and to avoid slipping, and microduct split elements to protect the branch of microducts. Connector boxes and cable boxes are recommended.

Microduct – microcable sealing elements should be used for maintenance activity to realize the connection of microducts and to avoid slipping and pressure sealing.

According to plant topology, approximately 20 to 25 metres of extra length of microcable for future maintenance should be left in a manhole or handhole. It is recommended to protect the extra microcable against damage with an appropriate box.

9 Principle of microducts installation in existing pipe

In order to subduct existing pipe, it is recommended to use microducts according to the dimension of microcable and the number of microducts needed.

All microducts shall be closed with appropriate end caps (described in clause 7.3.1.) during the laying.

The principles of subducting of existing infrastructure with microducts are a function of the following parameters:

– diameter and type of existing pipe;
– available space in occupied pipe (filling ratio). (See Figure 9.1).

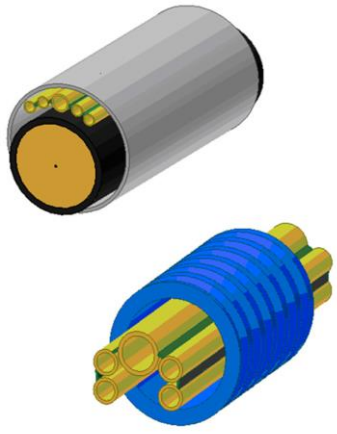

Figure 9.1 – Examples of subducting technique using microducts

Generally, the number of microducts for subducting is defined by the conditions of the existing pipe (crushing, ovalization, etc.) and the dimensions and types of existing cables in the partially occupied infrastructure.

Video inspection systems are useful for locating and checking the status of the existing infrastructure (telcos, power, street lighting, sewer, etc.) before pulling or blowing microducts and microcables.

During the laying of microducts in existing infrastructure, splices between microducts should be avoided, except:

– inside the manhole according to plant topology (typically after laying at least 100 m in urban area and 250 m in suburban area);
– when changing between microducts of different dimensions; and
– for maintenance activity.

In existing infrastructure where there are both occupied and empty pipes, it is recommended to lay the microduct infrastructure in empty pipes first. In general, saturation of existing tubes is to be avoided in order to guarantee reliability and facilitate maintenance operations.

Microducts should be laid with traditional techniques and tools or by blowing technique.

When microduct infrastructures are laid, it is recommended to equally distribute the tensile strength on all microducts of the infrastructure.

Microcable should be laid in microduct with blowing technique, and only one microcable should be laid in each microduct. Multiple microcables or micro-elements can be installed if the microduct dimensions allow it, either upon initial installation or by later overblowing.

10 Principle of microduct installation through walls entering the building

A very important part of the microduct installation applies to underground passage of microduct through the walls of buildings, especially if natural gas pipelines are nearby. This is associated with the risk of gas penetration through the walls of buildings and the risk of explosion. In this case, the gas tightness of the building structure is very important.

In case of classical cable construction and classical cable pipes (ducts) entering the building, the cable pipe is usually terminated at some distance (1 to 2 m) from the building wall, and the bare cable passes through the wall. The purpose of such treatment is related to the importance of safety aspects, in order to prevent the passage of natural gas to the building via cable duct. This solution is called "gas break".

Using "gas break" solution is not possible in the case of microducts and microcables, due to the limited strength parameters of microcables which cannot be installed without tube protection unless a cable type change is made. Therefore, it is recommended to use microducts when crossing the wall and in particular a thick-walled type.

Microcable should be sealed to the microduct both in the cable chamber adjacent to the building as well as inside the building.

The installation of empty (spare) microducts that do not contain microcables, should also be sealed in the cable chamber, inside the building. The distance between the point of microduct entry to the building and sealing element placement should not exceed 5 m.

11 Principle of microducts installation in the building

The microducts technology can also be used inside buildings.

The characteristics and size of this system of microducts are different from those of microducts used for outside cable installations, however fibres or bundles of fibres can also be blown inside the tubes after their installation.

Both single microducts as well as microduct bundles used inside buildings should be protected with a sheath made of low-fire-hazard material.

12 Microducts installation in the long-haul network

Microducts and microcables can be also used in long-haul networks both within subducting techniques as well as independent installation. In the case of long-haul network, it is particularly important to obtain long range of duct blowing that reduces the number of connectors.

Another important aspect of the microduct and microcables installation in long-haul networks is associated with proper risk assessment of using such a technique.

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