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1. DUCTS

Ducts are especially designed to blow or pull in micro-, mini- or bundled- glass-fibre-cables, mechanically or in air stream, and designed to be directly buried or installed into existing ducts (subducting).

1.1. GENERAL CHARACTERISTICS

- special low-friction inner coating for maximum blowing lengths
- **Packaging:** without drum, fastened with plastic binders, protected by stretched **Material:** high-density polyethylene (HDPE), with a low-friction grooved inner layer or with foil
- UV stabilized
- Pressure-tight up to a minimum of 10 bar internal pressure
- **Life span:** microducts offered in compliance with these specifications must be capable to withstand the typical service condition for a period of twenty-five (25) years without detriment to the operation characteristics.
- **Printed in black,** printing scheme repeated each 1m: RUNE MD< outer diameter > / < inner diameter > < month of production > / < year of production > 0000m (example: RUNE MD18/14 3/2023 0927m)

These minimum technical specifications relate to the manufacture, testing, delivery and storage of microducts and associated equipment. Microducts are intended for blowing of mini fibre optic cable with application in existing telecommunication pipes for the purpose of better utilization of space in existing pipes and protection of fibre optic cables.

The preferred type of microduct for RUNE project is HDPE microduct 18/14 with 18mm outer diameter, 14mm inner diameter and 2mm wall thickness. Microduct must be tested to support the air pressure necessary for blowing of the mini cables.

In case of use of existing underground infrastructure (e.g. existing telecommunication pipes), subducting must be done by using microducts according to the infrastructure owner regulation. Prospected types of microducts for subducting of existing underground infrastructure are: 12/10 and 10/8 but other dimensions can be requested in some cases. The same quality standards must be applied as for microduct 18/14.

The inner sliding layer must be made of a material that provides a small coefficient of friction when the fibre optical cable is blown into the microduct and with grooved inner structure to provide a lower coefficient of friction. The basic characteristics of this material are:

- it is firmly imprinted in the HDPE layer
- has the same physical and mechanical characteristics as the HDPE layer
- is equally distributed along the inner wall of the pipe
- do not react with water (cleaning pipes with water must be possible)
- keeps the same characteristics throughout the entire life span
- makes cable blowing or pulling easier

1.2. REFERENCE

Microducts intended for installation directly in the ground “Direct Bury”, must have a minimum wall thickness of 2 mm. If the microducts are intended for installation in existing telecommunication pipes “Direct install” the wall thickness may be 1 mm.

Dimensions of microducts, the nominal value of the outer and inner diameter, the minimum outer diameter, the minimum inner diameter and the minimum wall thickness are given in the following Table 1:

Nominal outer/inner diameter (mm)	Outer diameter (mm)	Minimum inner diameter (mm)	Minimum wall thickness (mm)
18/14	18,0 ^{+0,1/-0,05}	13,9	2,0
16/12	16,0 ^{+0,1/-0,05}	11,9	2,0
14/12	14,0 ^{+0,1/-0,05}	11,9	1,0
12/10	12,0 ^{+0,1/-0,05}	9,9	1,0
12/8	12,0 ^{+0,1/-0,05}	7,9	2,0
10/8	10,0 ^{+0,1/-0,05}	7,9	1,0

The mechanical characteristics must correspond to those given in the following Table 2:

Nominal outer/inner diameter (mm)	Friction coefficient max.	Max pull force (N)	Crush pressure (bar)	Weight approximately (g/m)	Bending radius min. (mm)
18/14	0,12	800	35	132	220
16/12	0,12	700	35	132	200
14/12	0,12	450	20	120	140
12/10	0,12	400	20	50	180
12/8	0,12	400	20	64	120
10/8	0,12	225	25	42	150

Dimensions inspection

The following dimensions are checked on selected delivery samples:

- the outer and inner diameter are measured using a measuring instrument with precision of 0.1 mm,
- the wall thickness is measured in four points on the circumference of the microduct using a calibrator with a precision of 0.1 mm.

Friction coefficient inspection

A microduct segment with installed mini cable is wrapped around a drum of the appropriate diameter for a 450° angle. At one end, the load is fastened while the other end is connected to an adequate mechanism. By using this mechanism, the mini cable is inserted into microduct and the extent of the pulling force is recorded. The subject procedure is repeated several times, each time a new microduct and mini cable is used. The relevant retraction force is the same as the arithmetic mean of all measurements. The coefficient of friction is proportional to the relationship of the pulling force and the gravitational force caused by the weight connected to the other end. The resulting friction

coefficient value must be less than given in Table 2. When performing this test, no friction reducing agents may be used.

Compression test

The 200m long microduct sample must be loaded with a constant force in duration of 60s. The deformation after the force termination (after 20s) must not exceed 15%. The force size is in function of the nominal thickness of the wall ($F = 310 \times s$; s = wall thickness in mm).

Constant internal pressure and crush pressure tests

The continuous pressure test is performed on microduct samples of 1m length. One end of the microduct is closed while the other end is placed under a pressure of 15 bar. Within the period of 2 hours no damage to microduct must be present. Afterwards, air pressure in the interior of the microduct is continuously increased. The pressure at which the microduct cracks is called the crush pressure and it must be greater than given in Table 2.

Bending test

A microduct sample of 1m length is wrapped around a $12 \times D$ diameter roller (D = outer diameter of microduct) in 3-turn cycles. No visible damages or deformations of the microduct shall be apparent after these tests.

1.3. MICRODUCT 18/14MM PE

Description

- Supply length: up to 1000m, but max. 50 kg per coil
- Outer diameter: 18mm
- Inner diameter: 14mm

1.4. MICRODUCT 16/12MM PE

Description

- Supply length: up to 1000m, but max. 50 kg per coil
- Outer diameter: 16mm
- Inner diameter: 12mm

1.5. MICRODUCT 14/12MM PE

Description

- Supply length: up to 1000m, but max. 50 kg per coil
- Outer diameter: 14mm
- Inner diameter: 12mm

1.6. MICRODUCT 12/10MM PE

Description

- Supply length: up to 2000m, but max. 50 kg per coil
- Outer diameter: 12mm
- Inner diameter: 10mm

1.7. MICRODUCT 12/8MM PE

Description

- Supply length: up to 2000m, but max. 50 kg per coil
- Outer diameter: 12mm
- Inner diameter: 8mm

1.8. MICRODUCT 10/8MM PE

Description

- Supply length: 2000m, but max. 50 kg per coil
- Outer diameter: 10mm
- Inner diameter: 8mm

2. DUCT EQUIPMENT

2.1. GENERAL CHARACTERISTICS

Connector for the tensiled or detachable connection of microduct pipes/ducts; pressure-tight up to a minimum of 12 bar internal pressure. Directly buried or installed in existing ducts of larger diameter (subducting). Must not contain metallic parts.

Microduct end stop connector is used to keep microduct networks free of debris by sealing the system.

Central part of the connector must be transparent to allow visual inspection of the cable presence.

- **Packaging:** bags or card boxes of 100
- UV stabilized

2.2. TYPES OF CONNECTORS

- a) Duct connector for PE 18 mm outer diameter
- b) Duct connector for PE 16 mm outer diameter
- c) Duct connector for PE 10 mm outer diameter

2.3. TYPES OF MICRO DUCT END STOP CONNECTORS

- a) Micro duct end stop connector for PE 18 mm outer diameter
- b) Micro duct end stop connector for PE 16 mm outer diameter
- c) Micro duct end stop connector for PE 10 mm outer diameter