IEC 60794-3-40

Edition 2.0 2022-04

INTERNATIONAL STANDARD

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Optical fibre cables – Part 3-40: Outdoor cables – Family specification for cables for storm and sanitary sewers

Câbles à fibres optiques – Partie 3-40: Câbles extérieurs – Spécification de famille pour les câbles destinés aux évacuations d'eaux sanitaires et pluviales

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OPTICAL FIBRE CABLES –

Part 3-40: Outdoor cables – Family specification for cables for storm and sanitary sewers

FOREWORD

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IEC 60794-3-40 has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics. It is an International Standard.

This second edition cancels and replaces the first edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) this document follows the new structure for family specifications: symbols and abbreviations were included in Clause 3, and Clause 4 became the General requirements with 4.1 Optical fibres, 4.2 Cable element and 4.3 Optical fibre cable construction;
b) Annex D has been removed as it is part of IEC TR 62691;
c) this document has been streamlined by cross-referencing IEC 60794-1-1, IEC 60793-2, IEC 60794-3 and the IEC 60794-1-2x series;
d) the fibre strain allowance for tensile tests was updated;

e) characteristics Table 5, Table 6, Table 7 were moved to the Annex A (informative).

The text of this International Standard is based on the following documents:

Draft	Report on voting
86A/2189/FDIS	86A/2191/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60794 series, published under the general title *Optical fibre cables*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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OPTICAL FIBRE CABLES –

Part 3-40: Outdoor cables – Family specification for cables for storm and sanitary sewers

1 Scope

This part of IEC 60794 is a family specification that covers sewer cables and conduits for installation by blowing and/or pulling in man accessible and non-man accessible storm and sanitary sewers. Systems built with components covered by this document are subject to the requirements of sectional specification IEC 60794-3.

Sewer cable and conduit constructions need to meet the different requirements of the sewer operating companies and/or associations regarding chemical, environmental, operational, cleaning and in general maintenance conditions.

Preferential applications, describing sewer cable characteristics versus methods of installation is reported in Annex A and Annex B for non-man accessible sewers.

Clause 5 describes characteristics of sewer cables and conduits for installation by blowing, pulling or other means in storm and sanitary sewers.

Detail specifications can be prepared on the basis of this family specification.

It is important that acceptance criteria are interpreted with respect to this consideration. The number of fibres tested is representative of the sewer cable and is agreed between the customer and the supplier.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60793-2, *Optical fibres – Part 2: Product specifications – General*

IEC 60794-1-1, *Optical fibre cables – Part 1-1: Generic specification – General*

IEC 60794-1-2, *Optical fibre cables – Part 1-2: Generic specification – Basic optical cable test procedures – General guidance*

IEC 60794-1-21, *Optical fibre cables – Part 1-21: Generic specification – Basic optical cable test procedures – Mechanical tests methods*

IEC 60794-1-22, *Optical fibre cables – Part 1-22: Generic specification – Basic optical cable test procedures – Environmental tests methods*

IEC 60794-1-23, *Optical fibre cables – Part 1-23: Generic specification – Basic optical cable test procedures – Cable element test methods*

IEC 60794-1-215, *Optical fibre cables – Part 1-215: Generic specification – Basic optical cable test procedures – Environmental test methods – Cable external freezing test, Method F15*

IEC 60794-3:2014, *Optical fibre cables – Part 3: Outdoor cables – Sectional specification*

IEC 60794-5, *Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing*

IEC 60794-5-10, *Optical fibre cables – Part 5-10: Family specification – Outdoor microduct optical fibre cables, microducts and protected microducts for installation by blowing*

IEC 60811-501, *Electric and optical fibre cables – Test methods for non-metallic materials – Part 501: Mechanical tests – Tests for determining the mechanical properties of insulating and sheathing compounds*

IEC TR 62362:2020, *Selection of optical fibre cable specifications relative to mechanical, ingress, climatic or electromagnetic characteristics – Guidance*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms, definitions, symbols and abbreviated terms given in IEC 60794-1-1 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

4 General requirements

4.1 Optical fibres

The optical fibre shall conform to the requirements of IEC 60793-2. The fibre type shall be agreed between the customer and supplier. The cabled fibre shall conform to IEC 60794-3.

4.2 Cable element

The cable elements shall conform to IEC 60794-3.

4.3 Optical fibre cable and conduit construction

4.3.1 General

In addition to the constructional requirements of sectional specification IEC 60794-3, the following considerations apply to the sewer cables and/or conduits.

The tests of this specification are intended to assess the performance of cables and conduits, as manufactured and under agreed ageing and performance-limit tests. These tests are not intended to define end-of-life performance. See IEC 60794-3:2014, 6.1.

The materials in the cable or conduit shall not present a health hazard within its intended use.

The clamping systems and accessories associated with cables and conduits of this document are not specified herein. Such parts shall be agreed between the customer and the installer depending on the installation technique.

Annex C shows examples of conduits and sewer cables.

4.3.2 Conduits

If used, conduits shall conform to the installation and system design considerations of 4.3.3.

Conduits shall be able to resist pressure differences needed for installation by blowing and outside pressure due to sewer cleaning operations. Conduits shall be circular and, if needed, corrugated in cross-section throughout their length. The material shall withstand all possible chemical attacks by the sewer liquid itself. Such chemicals hazards shall be agreed between customer and supplier as well as the geometric dimensions, for example inner- and outer-diameter, overall minimum wall thickness, of the conduit.

NOTE For instance stainless steel conduits have shown reliable performance.

4.3.3 Sewer cables

A sewer cable in accordance to this document should be suitable for installation in man accessible storm and sanitary sewers and non-man accessible sewers and lateral sewer systems, by installation methods as agreed between customer and supplier. Common installation methods include

– blowing and/or pulling into a conduit, previously fixed to the sewer wall or, for laterals, placed in between the lateral sewer wall and the in-liner system, and
– direct installation into the sewer duct, according to the following applications:
  - drilling and screwing to the inner wall;
  - spanning between manholes, etc. similarly to aerial cables;
  - laying on the ground of the sewer.

The size and installation of the sewer cable shall be such that it does not restrict the flow of sewer fluid or create obstacles to flow of any debris within the sewer pipe, as agreed between customer and supplier.

Sewer cables installed without conduit into sewer systems shall be so constructed to withstand chemical attacks by the sewer liquid. Such chemical hazards shall be agreed between customer and supplier, using 5.5.3.3.9 as guidance.

4.3.4 Rodent protection

Rodent protection is generally needed but there is presently no standard test to measure the level of rodent protection. Rodent protection can be provided by the cable or by the duct.

5 Details of family requirements and test conditions for optical fibre cable and conduit

5.1 Cable for installation within conduits (previously fixed to the sewer wall)

The cable construction shall confirm to IEC 60794-3, IEC 60794-5 or IEC 60794-5-10, as appropriate.

5.2 Cable for direct installation into the sewer duct

The cable construction shall confirm to IEC 60794-3.

5.3 Conduit construction

The conduit construction shall conform to the performance required for the sewer environment as compatible with the performance intent of cables of IEC 60794-3 and of IEC 60794-5 and IEC 60794-5-10 as applicable to microducts. Specific attributes to be considered in conduit construction are:

- materials;
- conduit dimensions – inner and outer diameter;
- moisture barrier types (if used) – materials, metallic tapes, etc.;
- for corrugated conduit (metallic) – metal tape thickness, corrugation depth and pitch, overlap requirements;
- for inner tubes (if used) – tube materials, tube dimensions.

The performance attributes shall be agreed between customer and supplier.

5.4 Operating conditions

The operating conditions of cables within sewers may be different from those of general cables of IEC 60794-3. Different operating regimes, if applicable, shall be agreed between customer and supplier. Consideration shall also be given to any operating regimes occurring when the cable exits the sewer system. Typical considerations include

- temperatures of sewer fluids, especially high temperatures,
- normal operating temperature ranges that may be less severe than those usual for IEC 60794-3 cables, especially the low temperature extreme,
- chemical exposure, as covered in 5.5.3.3.9, and
- other special conditions, as agreed between customer and supplier.

5.5 Mechanical and environmental tests

5.5.1 Conduits

5.5.1.1 Conduit tests (select applicable tests)

Tests listed in Table 1 are those relevant to IEC 60794-3, 60794-5 and 60794-5-10 as applicable for conduits.

Table 1 – Conduit tests applicable

Characteristics	IEC 60794-3:2014 (IEC 60794-5-10:2014)[a]	Family requirements	Test methods	Remarks
Pressure withstand	(6.1, Table 3)	5.5.1.2.2	IEC 60794-1-22, method F13	If external pressure resistance is required, IEC 60794-1-22, method F10, may be used, as agreed between customer and supplier.
Tensile performance	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.3	IEC 60794-1-21, method E1	
Crush	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.5	IEC 60794-1-21, method E3A	
Impact	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.6	IEC 60794-1-21, method E4	
Repeated bending	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.7	IEC 60794-1-21, method E6	
Torsion	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.8	IEC 60794-1-21, method E7	
Kink	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.4	IEC 60794-1-21, method E10	
Bend	Clause 9, Table 3 (Bend) (6.1, Table 3)	5.5.1.2.9	IEC 60794-1-21, method E11B	

Characteristics	IEC 60794-3:2014 (IEC 60794-5-10:2014)[a]	Family requirements	Test methods	Remarks
Bending under tension	Clause 9, Table 3	5.5.1.2.10	IEC 60794-1-21, method E18A, procedure 1	
Ageing	Clause 9, Table 3 (6.1, Table 3)	5.5.1.2.11	IEC 60794-1-22, method F9	

[a] IEC 60794-3 or IEC 60794-5-10 as applicable.

5.5.1.2 Details of family requirements and test conditions for conduits

5.5.1.2.1 General

Tests shall be selected from those of Table 1 and the following hereinafter described.

5.5.1.2.2 Pressure withstand

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the conduit.

b) Test conditions:

– Method: IEC 60794-1-22, method F13

– Apply an air pressure of 2,5 x the specified installation pressure at standard ambient temperature, per IEC 60794-1-2, for 30 min.

– Apply an air pressure of 1,3 x the specified installation pressure and maintain at 40 °C, or other elevated temperature as specified, for 24 h.

5.5.1.2.3 Tensile performance

a) Family requirements

Under visual examination without magnification, there shall be no damage and the outer diameter shall not change by more than 10 %.

b) Test conditions

Method: IEC 60794-1-21, method E1

Sample length under tension: ≥ 50 m, per method E1. Taking into account the measurement accuracy and end effects, shorter lengths may be used by agreement between the customer and the supplier.

Tensile load on sample: installation load (T_M). Other loads may be applied in accordance with particular user conditions.

Diameter of test pulleys: 1 m but not less than the minimum loaded bending diameter specified for the conduit.

T_M: equivalent to weight of 1 km of conduit.

5.5.1.2.4 Kink

a) Family requirements

Under visual examination, without magnification, there shall be no kink to the conduits.

b) Test conditions

Method: IEC 60794-1-21, method E10

Minimum diameter: 20 times the outer diameter of the conduit.

5.5.1.2.5 Crush

a) Family requirements

Under visual examination, without magnification, there shall be no damage to the conduit. There shall be no residual deformation greater than 15 % of the conduit diameter, no splitting or permanent damage after removing load. The imprint of the plates on the conduit surface is not considered as mechanical damage.

b) Test conditions

Method: IEC 60794-1-21, method E3A

Sample length: 250 mm

Load (plate/plate):

– Un-armoured conduit: 1,5 kN

– Armoured conduit: 2,2 kN

Duration time: 60 s

Recovery time: 1 h

5.5.1.2.6 Impact

a) Family requirements

Under visual examination, without magnification, there shall be no splitting or permanent damage to the conduit. There shall be no residual deformation greater than 15 % of the conduit diameter. The imprint of the striking surface on the conduit is not considered damage.

b) Test conditions

Method: in analogy of IEC 60794-1-21, method E4

Striking surface curvature radius: 300 mm minimum (flat hammer)

Impact energy:

– Un-armoured conduit: 10 J

– Armoured conduit: 20 J to 30 J, depending on particular user conditions

Recovery time: 1 h

Number of impacts: one in 3 different places spaced not less than 500 mm apart

5.5.1.2.7 Repeated bending

a) Family requirements

Under visual examination, without magnification, there shall be no splitting, collapse, or other damage to the conduit sample. If the conduit has metallic armour, there shall be no cracks greater than 5 mm in length. The conduit sample shall exhibit no reduction in outer diameter greater than 15 %.

b) Test conditions

Method:	IEC 60794-1-21, method E6
Bending diameter:	40 × OD
Load:	Adequate to assure uniform contact with the mandrel
Number of cycles:	25

5.5.1.2.8 Torsion

a) Family requirements

Under visual examination, without magnification, there shall be no splitting or other damage to the conduit sample. The conduit sample shall exhibit no reduction in outer diameter greater than 15 %.

b) Test conditions

Method:	IEC 60794-1-21, method E7
Maximum gauge length:	2 m

5.5.1.2.9 Bend

a) Family requirements

Upon dissection, the outer and inner diameter of the conduit sample shall show, under visual examination without magnification, no damage after the test. If the conduit has a metallic armour, there shall be no cracks. The conduit sample shall exhibit no reduction in outer diameter greater than 15 %.

b) Test conditions

Method:	IEC 60794-1-21, method E11B
Diameter of mandrel:	40 × OD
Number of cycles:	3

5.5.1.2.10 Bending under tension

a) Family requirements

Upon dissection, the outer and inner diameter of the conduit sample shall show, under visual examination without magnification, no damage after the test. If the conduit has a metallic armour, there shall be no cracks. The conduit sample shall exhibit no reduction in outer diameter greater than 15 %.

b) Test conditions

Method:	IEC 60794-1-21, method E18A, procedure 1
Diameter of mandrel:	40 × OD or the minimum bending diameter of the conduit, whichever is smaller
Tension:	T_M, the rated installation tension
Bend angle:	90°
Test distance:	100 × OD
Number of cycles:	10

5.5.1.2.11 Ageing

a) Family requirements

After ageing, the following tests shall be applied.

- Under visual examination, without magnification, there shall be no splitting or other damage to the conduit sample.
- Following the material tensile and elongation tests of IEC 60811-501, the conduit material shall retain a minimum of 85 % of the before-ageing values.
- The conduit sample shall pass the bending test of 5.5.1.2.9.

b) Test conditions

Method:	IEC 60794-1-22, method F9
Temperature:	85 °C
Duration:	168 h

5.5.2 Cable for installation within conduits (previously fixed to the sewer wall)

5.5.2.1 General

Cables installed in conduits within sewers follow the intent of IEC 60794-3. In some cases, cable systems are designed to follow the intent of IEC 60794-5 and IEC 60794-5-10. In these cases, refer to IEC 60794-5-10 for guidance on agreement between the manufacturer and customer.

5.5.2.2 Tests applicable

Table 2 – Optical fibre cable – Tests applicable

Characteristics	IEC 60794-3:2014	Family requirements	Test methods	Remarks
Tensile performance	Clause 9, Table 3	5.5.2.3.2	IEC 60794-1-21, method E1	
Crush	Clause 9, Table 3	5.5.2.3.6	IEC 60794-1-21, method E3A	
Impact	Clause 9, Table 3	5.5.2.3.7	IEC 60794-1-21, method E4	
Repeated bending	Clause 9, Table 3	5.5.2.3.3	IEC 60794-1-21, method E6	
Torsion	Clause 9, Table 3	5.5.2.3.4	IEC 60794-1-21, method E7	
Kink	Clause 9, Table 3	5.5.2.3.9	IEC 60794-1-21, method E10	
Bend	Clause 9, Table 3	5.5.2.3.5	IEC 60794-1-21, method E11A	
Bending under tension	Clause 9, Table 3	5.5.2.3.10	IEC 60794-1-21, method E18A, procedure 1	
Blowing	---	According to DS	IEC 60794-1-21, method E24	Requirements will vary by duct, cable and installation.
Ageing	Clause 9, Table 3	5.5.2.3.11	IEC 60794-1-22, method F9	
Coating adhesion stability	Clause 8, Table 2	5.5.2.3.12	IEC 60794-1-22, method F9 IEC 60794-1-23, method G10A, G10B or G10C, as applicable.	
Temperature cycling	Clause 9, Table 3	5.5.2.3.8	IEC 60794-1-22, method F1	
Water penetration	Clause 9, Table 3	5.5.2.3.13	IEC 60794-1-22, method F5B or F5C	
Freezing	---	5.5.2.3.14	IEC 60794-1-215, method F15A or F15B	In the case where some part of a cable or cable in conduit might freeze.

5.5.2.3 Details of family requirements and test conditions for sewer cable tests

5.5.2.3.1 General

Tests shall be selected from those of Table 2 and the following hereinafter described.

Attenuation measurements shall be made at room temperature except as specified in particular tests.

Attenuation measurements shall be made at 1 550 nm for single-mode fibres and 1 300 nm for multimode fibres, or at the operational wavelength specified by the customer.

For L-band operation, the measurements shall be measured at 1 625 nm and shall be a value agreed between customer and supplier.