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TECHNICAL REPORT

colour inside

Optical fibre cables –
Guide to the installation of optical fibre cables

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FOREWORD

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IEC 62691, which is a technical report, has been prepared by subcommittee 86A: Fibres and cables, of IEC technical committee 86: Fibre optics.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
86A/1415/DTR	86A/1426/RVC

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

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A bilingual version of this publication may be issued at a later date.

OPTICAL FIBRE CABLES –

Guide to the installation of optical fibre cables

1 Scope

Optical fibre cabling provides a high performance communications pathway whose characteristics can be degraded by inadequate installation. This technical report provides guidance to assist the user and installer with regard to the general aspects of the installation of optical fibre cables covered by the IEC 60794 series of specifications, and the particular aspects of the 'blowing' technique.

Optical fibre cables are designed so that normal installation practices and equipment can be used wherever possible. They do, however, generally have a strain limit rather lower than metallic conductor cables and, in some circumstances, special care and arrangements may be needed to ensure successful installation.

It is important to pay particular attention to the cable manufacturer's recommendations and stated physical limitations and not exceed the given cable tensile load rating for a particular cable. Damage caused by overloading during installation may not be immediately apparent but can lead to failure later in its service life.

This guide does not supersede the additional relevant standards and requirements applicable to certain hazardous environments, e.g. electricity supply and railways.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60794-3-40, *Optical fibre cables – Part 3-40: Outdoor cables – Family specification for sewer cables and conduits for installation by blowing and/or pulling in non-man accessible storm and sanitary sewers*

IEC 60794-3-50, *Optical fibre cables – Part 3-50: Outdoor cables – Family specification for gas pipe cables and subducts for installation by blowing and/or pulling/dragging in gas pipes*

IEC 60794-3-60, *Optical fibre cables – Part 3-60: Outdoor cables – Family specification for drinking water pipe cables and subducts for installation by blowing and/or pulling/dragging/floating in drinking water pipes*

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

IEC/TR 62470, *Guidance on techniques for the measurement of the Coefficient Of Friction (COF) between cables and ducts*

ISO/IEC 24702, *Information technology – Generic cabling – Industrial premises*

ISO/IEC TR 29106, *Information technology – Generic cabling – Introduction to the MICE environmental classification*

ITU-T Recommendation K.25, *Protection of optical fibre cables*

ITU-T Recommendation L.35, *Installation of optical fibre cables in the access network*

ITU-T Recommendation L.38, *Use of trenchless techniques for the construction of underground infrastructures for telecommunication cable installation*

ITU-T Recommendation L.57, *Air-assisted installation of optical fibre cables*

ITU-T Recommendation L.61, *Optical fibre cable installation by floating technique*

ITU-T Recommendation L.77, *Installation of optical fibre cables inside sewer ducts*

3 Installation planning

3.1 Installation specification

The successful installation of an optical fibre cable can be influenced significantly by careful planning and assisted by the preparation of an installation specification by the user. The installation specification should address the cabling infrastructure, cable routes, potential hazards and installation environment and provide a bill of materials and technical requirements for cables, connectors and closures.

The installation specification should also detail any civil works, route preparation (including drawpits, ductwork, traywork and trunking) and surveying that are necessary, together with a clear indication of responsibilities and contractual interfaces, especially if there are any site or access limitations.

Post installation requirements for reinstatement, spares, ancillary services and regulatory issues should also be addressed.

3.2 Route considerations

Whilst optical fibre cables are lighter and installed in longer lengths than conventional metallic cables, the same basic route considerations apply.

Route planning and cable handling methods must carefully take into account the specified minimum bending radius and maximum tensile loading of the particular optical fibre cable being installed so that fibre damage, giving rise to latent faults, can be avoided.

Some of the most difficult situations for the installation of optical fibre cables are in underground ducts and the condition and geometry of duct routes is of great importance. Where the infrastructure includes ducts in poor condition, excessive curvature, or ducts already containing cables or access points with abrupt changes of direction, the maximum pull distance will be reduced accordingly.

Provision of long cable lengths in underground duct or aerial situations may involve installation methods that require access to the cable at intermediate points for additional winching or blowing effort, or “figure 8” techniques, these sites should be chosen with care. Consideration should also be given to factors of time and disturbance. Installation equipment may be required to run for long periods of time and the time of day, noise levels, and vehicular traffic disruption should be taken into account.

Because the condition of underground ducts intended for optical fibre cable is of particular importance, care should always be taken to ensure that ducts are in sound condition and as clean and clear as possible. Consideration can also be given to the provision of a sub-duct system, either in single or multiple form, to provide a good environment for installation, segregation of cables, extra mechanical protection and improved maintenance procedures. Sub-ducts can be more difficult to rope and cable than normal size ducts, particularly over long lengths, and the diameter ratio between the cable and subduct should be considered. Note that in ducts or subducts, bundles of microducts can also be installed, e.g. by pulling or blowing.

For overhead route sections, a very important consideration is the need to minimise in-service cable movement. Movement of the cable produced by thermal changes, cable weight, ice loading, wind, etc. may have a detrimental effect. A stable pole route, with all poles set as rigidly as possible, is therefore an important element in reducing possible movement and consideration should be given to purpose-designed, optical fibre-compatible, pole top fittings and attachments.

Although optical fibre cables are generally light in weight, their addition to an existing suspension member can take the optical fibre beyond its recommended strain limit and the added dip and extension should be calculated before installation.

Where it is planned for long lengths of optical fibre cable to be directly buried or ploughed, those sections involving ploughing can, with advantage, be pre-prepared using specialised slitting or trenching equipment.

3.3 Cable installation tension considerations

The potential for providing very long lengths of optical fibre cable can lead to the need for confidence that a particular installation operation will be successfully achieved, particularly in underground ducts, and a good indication can be provided, in some cases, by calculating the maximum cable tension. This maximum tension can be compared with the stated mechanical performance of the cable and, where these values are close, consideration can be given to methods for providing a greater margin of safety such as an alternative cable design, shortening the route, changing the route or direction of cabling, provision of intermediate winches, or by taking special precautions at particular locations. Calculation considerations are indicated in the clauses which follow.

Cable tensions in overhead installations where the cable is lashed or clipped to a messenger strand or other supporting members are generally minimal. Rollers or similar types of hangers are used to support the cable at frequent intervals such that it does not sag during the installation process. Rollers, quadrant blocks, or other guides should be used when the cable line changes direction in order to minimize cable tensions and support the cable's minimum bend radius. If cables are pulled from the end, many of the same considerations for pulling into ducts are present, though generally with lower tensions. Changes in elevation may increase the tension, and must be considered. Moving reel installation methods generally exhibit minimal cable tension, but jerking of the cable due to reel inertia and movements must be guarded against. See the further discussion in 4.5. Considerations for self-supporting cables (figure-8 or ADSS, for example) are addressed in 4.5.

Cable tensions in ploughing or trenching are generally minimal, much smaller than the rated tension of the cable. Momentary tensions and jerking due to cable reel inertia when paying off cables, which result in tensions in the immediate area being installed, should be considered. In ploughing, frictional tension through the plough chute must be considered, but is generally small. See also 3.6.

3.4 Cable tension predictions – duct installations

It should be noted that the tension calculations for duct installations are of necessity inexact since the actual geometry and characteristics of the ducts are seldom well known. The calculations, therefore, should be utilized with regard to experience and empirical data from similar installations.

Two sets of equation are presented below. The first, presented in 3.5.2, is used to calculate cable tension in pulling applications. The second, presented in 3.5.3, is used to calculate cable tension in cable pushing and blowing applications; it may also be used for pulling. Note that the first set, for pulling only, is much simpler and neglects cable weight in Equation 3. The second equation, for any of the duct installation methods, comprises very complex equations involving much more data, including amplitude and frequency of innerduct undulations. Much of this sort of data are generally not known and must be estimated from cable experiments and empirical data from similar installations.

3.5 Maximum cable tension

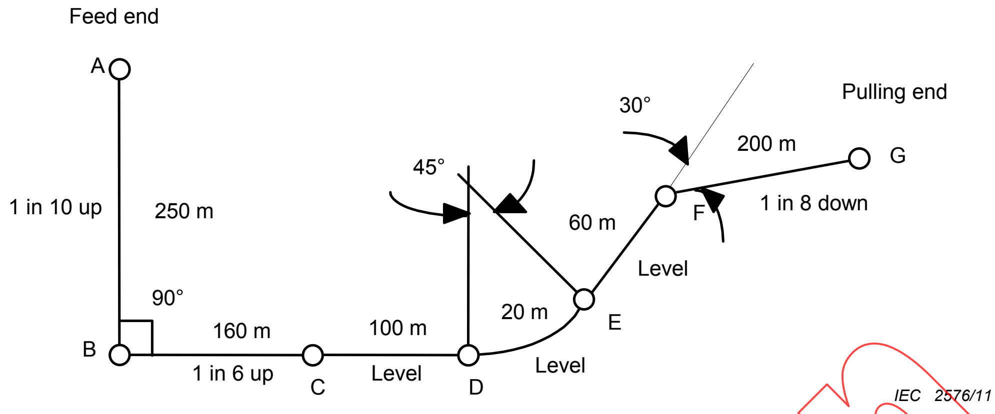
3.5.1 General

The following main contributory functions need to be considered when calculating cable tensions:

– the mass per unit length of cable;
– the diameter of the cable;
– the stiffness of the cable;
– the coefficient of friction between cable sheath and surfaces with which it will come in contact;
– the inner diameter of the duct;
– deviations (bends and undulations) and inclinations.

3.5.2 Total cable tension – pulling applications

Using the routes and common tension formulae in Figure 1 as an example:



T is the tension at end of section (N);

T_i is the tension at beginning of section (N);

μ is the coefficient of friction (between cable and duct or guide);

l is the length of section (m);

w is the cable specific mass (kg/m);

θ is the inclination (radians, + up, – down) or deviation (radians, horizontal plane);

g is the acceleration due to gravity (9,81 m/s²);

$T = Ti + \mu lwg$ *Equation 1 (for straight sections)*

$T = Ti + lwg\,(\mu \cos\theta + \sin\theta)$ *Equation 2 (for inclined sections)*

$T = Ti\, e\mu\theta$ *Equation 3 (for deviated sections and bends)*

Figure 1 – Cable tension calculations (equations. 1 through 3)

The resulting total tension calculations are shown in Table 1:

Table 1 – Calculation for total tension

Section	Length	Tension at beginning of section T_i	Inclination	Deviation	Equation	Tension at end of section (cumulative) *T*
	m	N	rad	rad		N
A	–	0	–	–	–	0
A – B	250	0	0,100	–	2	1 460
B	–	1 460	–	1,571	3	3 464
B – C	160	3 464	0,165	–	2	4 484
C	–	4 484	–	–	–	4 484
C – D	100	4 484	–	–	1	4 980
D	–	4 980	–	–	–	4 980
D – E	20	4 980		0,785	3	7 669
E	–	7 669	–	–	–	7 669
E – F	60	7 669	–	–	1	7 967
F	–	7 967		0,524	3	10 628
F – G	200	10 628	– 0,124	–	2	11 390