DRAFT TANZANIA STANDARD

(Draft for comments only)

Optical fibres - Part 1-31: Measurement methods and test procedures - Tensile strength
Optical fibres –
Part 1-31: Measurement methods and test procedures – Tensile strength

Fibres optiques –
Partie 1-31: Méthodes de mesure et procédures d’essai – Résistance à la traction

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.
## CONTENTS

- **FOREWORD** ........................................................................................................... 4
- **INTRODUCTION** ...................................................................................................... 6
- 1 **Scope** .................................................................................................................. 7
- 2 **Normative references** ......................................................................................... 7
- 3 **Terms and definitions** ......................................................................................... 7
- 4 **Hazards** .............................................................................................................. 7
- 5 **Apparatus** ........................................................................................................... 8
  - 5.1 **General** ........................................................................................................... 8
  - 5.2 **Gripping the fibre at both ends** ..................................................................... 8
  - 5.3 **Sample support** ............................................................................................. 8
  - 5.4 **Stretching the fibre** ....................................................................................... 8
  - 5.5 **Measuring the force at failure** ...................................................................... 9
  - 5.6 **Environmental control equipment** ................................................................ 9
- 6 **Sample preparation** ........................................................................................... 10
  - 6.1 **Definition** ...................................................................................................... 10
  - 6.2 **Sample size and gauge length** ..................................................................... 10
  - 6.3 **Auxiliary measurements** .............................................................................. 11
  - 6.4 **Environment** .................................................................................................. 11
- 7 **Procedure** .......................................................................................................... 11
  - 7.1 **Preliminary steps** .......................................................................................... 11
  - 7.2 **Procedure for a single specimen** .................................................................. 11
  - 7.3 **Procedure for completing all samples for a given nominal strain rate** .......... 12
- 8 **Calculations** ....................................................................................................... 12
  - 8.1 **Conversion of tensile load to failure stress** .................................................. 12
  - 8.2 **Preparation of a Weibull plot** ...................................................................... 13
  - 8.3 **Computation of Weibull parameters** ............................................................ 13
- 9 **Results** ................................................................................................................ 14
  - 9.1 **Details to be reported** ................................................................................. 14
  - 9.2 **Details to be recorded** .................................................................................. 15
- 10 **Specification information** ................................................................................ 15

**Annex A (informative) Typical testing apparatus of tensile strength under dynamic loading** ....................................................................................................................... 16
**Annex B (informative) Guidelines on gripping the fibre** ........................................ 18
**Annex C (informative) Guidelines on stress rate** .................................................... 22

**Bibliography** ........................................................................................................... 24

**Figure 1** – Bimodal tensile strength Weibull plot for a 20 m gauge length test set-up at 5 %/min strain rate .................................................................................................................. 10
**Figure A.1** – Capstan design ...................................................................................... 16
**Figure A.2** – Translation test apparatus .................................................................... 16
**Figure A.3** – Rotating capstan apparatus ................................................................... 17
**Figure A.4** – Rotating capstan apparatus for long lengths ..................................... 17
**Figure A.5** – Ganged rotating capstan tester ............................................................ 17
**Figure B.1** – Gradual slippage .................................................................................. 18
Figure B.2 – Irregular slippage ................................................................. 18
Figure B.3 – Sawtooth slippage ............................................................... 19
Figure B.4 – Acceptable transfer function ............................................... 19
Figure B.5 – Typical capstan .................................................................... 20
Figure B.6 – Isostatic compression ............................................................. 20
Figure B.7 – Escargot wrap ....................................................................... 21
Figure C.1 – System to control stress rate ................................................ 22
Figure C.2 – Time variation of load and loading speed ................................ 23
INTERNATIONAL ELECTROTECHNICAL COMMISSION

OPTICAL FIBRES –
Part 1-31: Measurement methods and test procedures –
Tensile strength

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60793-1-31 has been prepared by subcommittee 86A: Fibres and cables of IEC technical committee 86: Fibre optics.

This third edition cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

a) correction of Formulae (3b) and (4b) and renumbering of formulae.
The text of this International Standard is based on the following documents:

<table>
<thead>
<tr>
<th>FDIS</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>86A/1908/FDIS</td>
<td>86A/1926/RVD</td>
</tr>
</tbody>
</table>

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

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

A list of all parts in the IEC 60793 series, published under the general title Optical fibres, 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 “http://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.
INTRODUCTION

Failure stress distributions can be used to predict fibre reliability in different conditions. IEC TR 62048 shows mathematically how this can be done. To complete a given reliability projection, the tests used to characterize a distribution are controlled for the following:

- population of fibre, for example coating, manufacturing period, diameter;
- gauge length, i.e. length of section that is tested;
- stress or strain rates;
- testing environment;
- preconditioning or aging treatments;
- sample size.

This method measures the strength of optical fibre at a specified constant strain rate. It is a destructive test, and is not a substitute for proof-testing.

This method is used for those typical optical fibres for which the median fracture stress is greater than 3.1 GPa (450 kpsi) in 0.5 m gauge lengths at the highest specified strain rate of 25 %/min. For fibres with lower median fracture stress, the conditions herein have not demonstrated sufficient precision.

Typical testing is conducted on "short lengths", up to 1 m, or on "long lengths", from 10 m to 20 m with sample size ranging from 15 to 30.

The test environment and any preconditioning or aging are critical to the outcome of this test. There is no agreed upon model for extrapolating the results for one environment to another environment. For failure stress at a given stress or strain rate, however, as the relative humidity increases, failure stress decreases. Both increases and decreases in the measured strength distribution parameters have been observed as the result of preconditioning at elevated temperature and humidity for even a day or two.

This test is based on the theory of fracture mechanics of brittle materials and on the power-law description of flaw growth (see IEC TR 62048). Although other theories have been described elsewhere, the fracture mechanics based on power-law theory is the most generally accepted.

A typical population consists of fibre that has not been deliberately damaged or environmentally aged. A typical fibre has a nominal diameter of 125 mm, with a 250 mm or less diameter acrylate coating. Default conditions are given for such typical populations. Non-typical populations might include alternative coatings, environmentally aged fibre, or deliberately damaged or abraded fibre. Guidance for non-typical populations is also provided.

\[1\] kpsi = kilopounds per square inch.
1 Scope

This part of IEC 60793 provides values of the tensile strength under dynamic loading of optical fibre samples. The method tests individual lengths of uncabled and unbundled glass optical fibre. Sections of fibre are broken with controlled increasing stress or strain that is uniform over the entire fibre length and cross section. The stress or strain is increased at a nominally constant rate until breakage occurs.

The distribution of the tensile strength values of a given fibre strongly depends on the sample length, loading velocity and environmental conditions. The test can be used for inspection where statistical data on fibre strength is required. Results are reported by means of statistical quality control distribution. Normally, the test is carried out after temperature and humidity conditioning of the sample. However, in some cases, it can be sufficient to measure the values at ambient temperature and humidity conditions.

This method is applicable to categories A1, A2, and A3, and classes B and C optical fibres.

The object of this document is to establish uniform requirements for the mechanical characteristic: tensile strength.

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 60793-1-20, Optical fibres – Part 1-20: Measurement methods and test procedures – Fibre geometry

3 Terms and definitions

No terms and definitions are listed in this document.

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

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

4 Hazards

This test involves stretching sections of optical fibre until breakage occurs. Upon breakage, glass fragments can be distributed in the test area. Protective screens are recommended. Safety glasses shall be worn at all times in the testing area.