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Fourth edition
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Reinforcement yarns — Determination of linear density

Fils de renfort — Détermination de la masse linéique

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 1889 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.

This fourth edition cancels and replaces the third edition (ISO 1889:1997), of which it constitutes a minor revision. The main changes are as follows:

— the scope has been broadened to include all reinforcement-fibre yarns;

— the normative references have been updated;

— the reference to ISO 1886 which was in the first footnote on page 3 has been removed (ISO 1886 has been withdrawn without replacement).

Reinforcement yarns — Determination of linear density

1 Scope

This International Standard specifies a method for the determination of the linear density of glass-fibre, carbon-fibre, aramid-fibre and any other reinforcement-fibre yarns.

It is applicable to all types of yarn, including single yarns, double and cabled yarns, textured yarns, rovings and staple-fibre yarns.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 1887, *Textile glass — Determination of combustible-matter content*

ISO 3344, *Reinforcement products — Determination of moisture content*

ISO 10548:2002, *Carbon fibre — Determination of size content*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
linear density
⟨of a yarn⟩ mass per unit length of the yarn, with or without size

NOTE The unit generally used is the tex, which corresponds to 1 g per kilometre of yarn.

4 Principle

A yarn test specimen of known length, with or without size, is weighed and the mass per unit length calculated.

In the case where the yarn must be desized, this is done by extraction and drying (in the case of aramid fibre), by calcination (in the case of glass fibre) or by extraction or pyrolysis (in the case of carbon fibre).

In the case of carbon-fibre yarns, the linear density of the desized yarn may also be calculated from the linear density of the sized yarn and the size content determined in accordance with ISO 10548. However, the result obtained in this way will include a small error due to the inherent error involved in determining the size content.

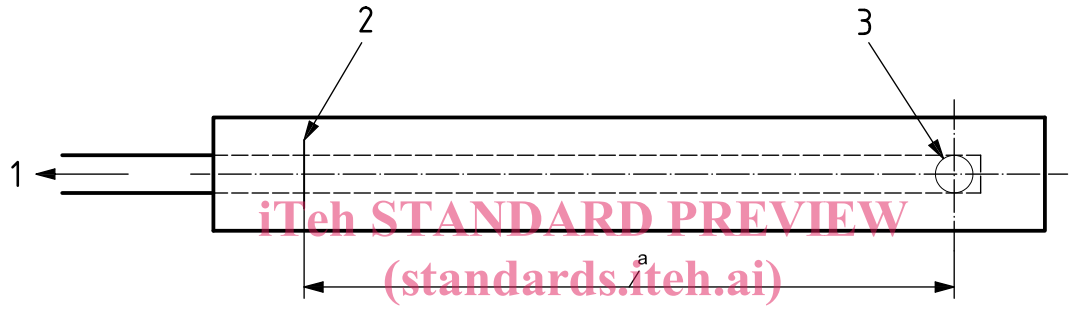
5 Apparatus

5.1 Apparatus for determinations on sized yarn

5.1.1 Spool, preferably with a circumference of 1 m. The spool is generally fitted with a traversing system to wind the yarn in thin layers. It may also include a tensioning system to tension the yarn while a test specimen is being taken.

The spool shall be calibrated in such a way that, for all specimen lengths, the actual length obtained is accurate to ± 0,3 %. The calibration of the spool shall take into consideration the required specimen length, the type of yarn and the type of material. This calibration shall be carried out with a particular tension in the yarn, and the operator shall be made aware of this tension.

For specimens < 5 m in length (in the case of certain carbon and aramid yarns and for glass rovings of 2 000 tex or greater), replace the spool by other equipment enabling specimens to be cut to the required length with the required accuracy. A sketch of such equipment is shown in Figure 1.



Key

1 tension
2 cutter blade
3 guide bar

[a] 2,50 m or less, depending on specimen length required.

Figure 1 — Equipment for cutting test specimens up to 5 m in length

5.1.2 Specimen holder, to hold the specimen before weighing and, if necessary, to hold the specimen in an oven and/or a muffle furnace.

5.1.3 Forced-circulation oven, with an air-change rate of 20 to 50 times per hour and capable of maintaining a temperature of (105 ± 3) °C.

5.1.4 Analytical balance, capable of weighing to 0,1 mg.

5.1.5 Suitable tool, e.g. scissors or knife.

5.1.6 Stoppered weighing bottle, for weighing aramid yarn.

5.1.7 Desiccator, containing a suitable drying agent (e.g. silica gel).

5.1.8 Stainless-steel tweezers, for handling the specimens.

5.2 Additional apparatus for determinations on desized yarn

5.2.1 For glass fibre

Refer to ISO 1887, but essentially: **muffle furnace**, capable of maintaining a temperature of (625 ± 20) °C.

5.2.2 For carbon fibre

Refer to ISO 10548, but essentially: **Soxhlet extractor** (method A), or **pyrolysis equipment** with a supply of nitrogen (method C).

5.2.3 For aramid fibre

Soxhlet extractor plus **solvent** (e.g. dichloromethane).

6 Test specimens

The determination is based, in principle, on the measurement of the linear density of one specimen per elementary unit[1)] or laboratory sample[2)]. Table 1 gives the length of yarn to be taken as a function of its nominal linear density.

Table 1

Type of yarn	**Nominal linear density,** Tt (tex)	**Length of specimen** (m)
Glass	Tt < 25	500
	25 < Tt < 45	200
	45 < Tt < 280	100
	280 < Tt < 650	50
	650 < Tt < 2 000	10
	2 000 < Tt	5
Carbon	Tt < 50	Length such that the mass is > 0,25 g
	50 < Tt < 125	5
	125 < Tt < 250	2
	250 < Tt	1
Aramid	—	Length such that the mass is between 3 g and 10 g

The product specification or the person requesting the determination may stipulate that the determination be performed on a (specified) higher number of specimens which are generally taken from adjacent positions in the elementary unit or laboratory sample.

Moreover, it may be stipulated that the determination be repeated at different places within the elementary unit or laboratory sample.

1) The elementary unit is the smallest normally commercially available entity of a given product.

2) A laboratory sample is a part of the elementary unit from which the specimen(s) will be selected for the test. A laboratory sample is taken when it is impractical to bring the elementary unit into the test laboratory.

7 Conditioning and test atmosphere

If the determination is to be carried out on a desized specimen, conditioning is not necessary. In other cases, ensure that the elementary units or laboratory samples to be examined are at a temperature defined in ISO 291 before beginning the test.

Carry out the determination itself in a standard atmosphere as defined in ISO 291.

For aramid yarns, use the atmosphere at (20 ± 2) °C and (65 ± 5) % relative humidity.

8 Procedure

8.1 Effect of sizing

NOTE In the designation of a yarn, the linear density is generally that of the dry, desized yarn. However, linear density may be measured with or without size. Therefore, it is important to verify on which basis the yarn specification is written so as to provide clear instructions to the operator for the test procedure.

On the other hand, glass and carbon-fibre yarns contain a very small amount of moisture. If the amount does not exceed 0,2 %, measured in accordance with ISO 3344, the determination may be made on the undried, sized yarn.

8.2 Preliminary operations

Using the spool (or alternative equipment as specified in 5.1.1), take the specimen in accordance with the instructions in Clause 6 from a yarn which shows no visible signs of damage. For yarn from a package, it is recommended that the outer layers, which may be partially damaged, be first removed.

Remove the specimen from the spool and fold it so that it can be placed on the balance (5.1.4) or in the weighing bottle (5.1.6) without difficulty.

8.3 Determination with desized specimen

8.3.1 General

If a specimen holder (5.1.2) or weighing bottle is used to weigh the specimen, stabilize its mass by bringing it to the temperature used to dry the specimen. Allow it to cool in the desiccator (5.1.7) until it reaches room temperature. Then proceed as described in 8.3.2, 8.3.3 or 8.3.4, depending on the type of yarn being examined.

Take care to avoid any loss of material whenever handling the specimen.

8.3.2 Glass yarns or rovings

Lay the specimen flat on a suitable support, and place the support in the muffle furnace (5.2.1) set at (625 ± 20) °C.

Calcinate for $\left(20^{+10}_{0}\right)$ min, taking care that the specimen does not touch the muffle.

Allow the specimen to cool in the desiccator.

Weigh the specimen to the nearest 1 mg.

8.3.3 Carbon yarns

8.3.3.1 **Extraction method** (ISO 10548:2002, method A)

Extract for 2 h using a Soxhlet extractor and a solvent such as methylethylketone, tetrahydrofuran, acetone, dichloromethane or dichloroethane.

Dry at (105 ± 3) °C for $\left(90^{+10}_{0}\right)$ min.

Allow the specimen to cool in the desiccator.

Weigh the specimen to the nearest 1 mg.

8.3.3.2 **Pyrolysis method** (ISO 10548:2002, method C)

Pyrolyse in an oven at (450 ± 5) °C in a stream of nitrogen for $\left(15^{+10}_{0}\right)$ min.

Allow to cool in the desiccator.

Weigh the specimen to the nearest 1 mg.

8.3.4 Aramid yarns

Extract for 4 h using a Soxhlet extractor and a solvent such as dichloromethane.

Dry at (105 ± 3) °C for $\left(30^{+10}_{0}\right)$ min.

Allow to cool in the desiccator.

Weigh the specimen to the nearest 1 mg.

8.4 Determination on a sized specimen

The procedure described provides for the drying of glass-fibre or carbon-fibre specimens if the product specification requires it (see the Note in 8.1). For aramid-fibre yarns, drying is not required.

If the moisture content at the point where the specimen is taken is less than 0,2 %, proceed directly to weighing the specimen taken in 8.2.

If it is necessary to dry the specimen for the determination, place the specimen in the oven (5.1.3) at (105 ± 3) °C for $\left(60^{+10}_{0}\right)$ min, subsequently allowing it to cool in the desiccator until it reaches room temperature.

Weigh the specimen to the nearest 1 mg.

Take care to avoid any loss of material whenever handling the specimen.

If a specimen holder or weighing bottle is used to weigh the specimen, allow its mass to stabilize at the oven temperature and then leave to cool in the desiccator until ambient temperature is reached. Then proceed to drying the specimen.