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Geosynthetics — Wide-width tensile test

Géosynthétiques — Essai de traction des bandes larges

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 221, *Geosynthetics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 189, *Geosynthetics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 10319:2015), which has been technically revised.

The main changes are as follows:

- the term "load" changed to "force" in all instances;
- difference between strain and elongation clarified in Clause 3 and Figure 1 modified accordingly;
- difference between tensile strength at first and second peak clarified in Clause 3 and 9.2;
- illustration of suitable jaws and grips introduced in Figure 3;
- testing of metallic products limited to woven steel wire meshes in 6.4.6;
- testing products narrower than 200 mm introduced in 6.4.7;
- testing at lower or higher temperatures introduced, with the related conditioning in 7.3 and the related procedure added in Annex A;
- formulae for strain calculation introduced in 9.1;
- formulae for tensile strength of products narrower than 200 mm introduced in 9.2;
- test report requirements updated in Clause 10.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Geosynthetics — Wide-width tensile test

1 Scope

This document specifies an index test method for the determination of the tensile properties of geosynthetics (polymeric, glass and metallic), using a wide-width strip. This document is applicable to most geosynthetics, including woven geotextiles, nonwoven geotextiles, geocomposites, knitted geotextiles, geonets, geomats and metallic products. It is also applicable to geogrids and similar open-structure geotextiles, but specimen dimensions will possibly need to be altered. It is not applicable to polymeric or bituminous geosynthetic barriers, but it is applicable to clay geosynthetic barriers.

This document specifies a tensile test method that covers the measurement of tensile force, elongation characteristics and includes procedures for the calculation of secant stiffness, maximum load per unit width and strain at maximum force. Singular points on the tensile force-extension curve are also indicated.

Procedures for measuring the tensile properties of both conditioned and wet specimens are included in this document.

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.

ISO 554, *Standard atmospheres for conditioning and/or testing — Specifications*

ISO 3696, *Water for analytical laboratory use — Specification and test methods*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 9862, *Geosynthetics — Sampling and preparation of test specimens*

ISO 9863-1, *Geosynthetics — Determination of thickness at specified pressures — Part 1: Single layers*

ISO 10318-1, *Geosynthetics — Part 1: Terms and definitions*

ISO 10321, *Geosynthetics — Tensile test for joints/seams by wide-width strip method*

EN 10223-3, *Steel wire and wire products for fencing and netting — Part 3: Hexagonal steel wire mesh products for civil engineering purposes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 10318-1and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

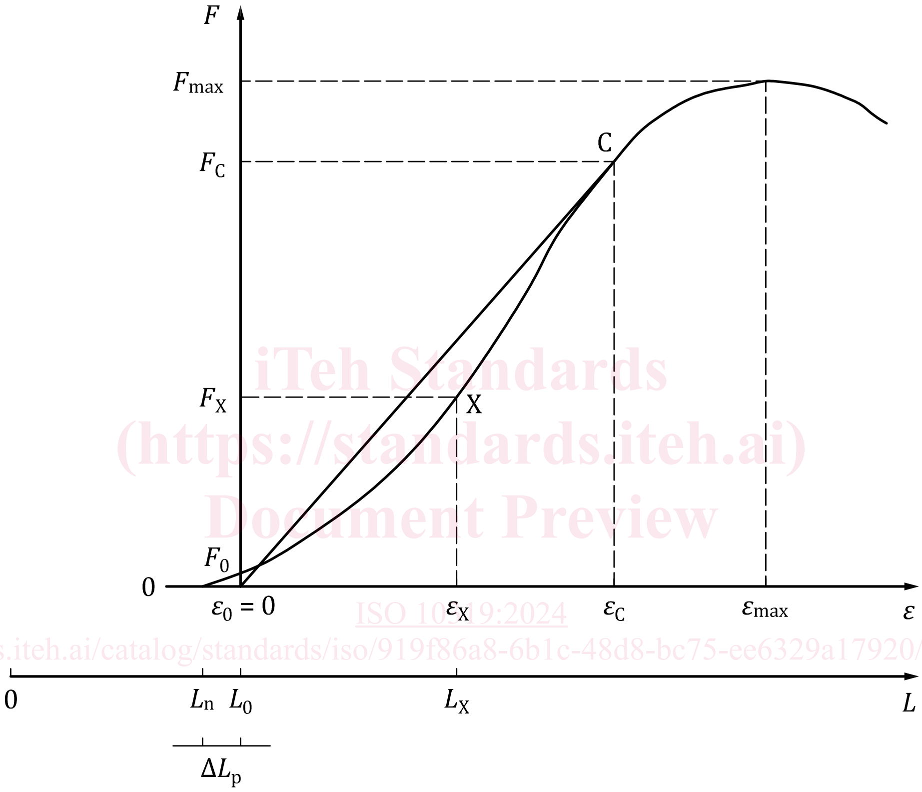
— IEC Electropedia: available at https://www.electropedia.org/

3.1
nominal gauge length
L_n
initial distance between two reference points located on the specimen parallel to the applied force direction

Note 1 to entry: The nominal gauge length is normally 60 mm (30 mm on either side of the specimen symmetrical centre).

3.2
elongation at pre-tension force
ΔL_p
measured increase in gauge length (mm) corresponding to an applied pre-tension force of 1 % of the expected *maximum tensile force* (3.4)

Note 1 to entry: The elongation at pre-tension force is indicated in Figure 1.



Key

F	tensile force, in kN
F_{max}	maximum tensile force, in kN
F_0	pre-tension force, in kN
F_c	tensile force for secant stiffness calculation at point C
F_x	tensile force at strain ε_x
C	selected point for the stiffness calculation
ε	tensile strain, in per cent
ε_0	tensile strain at pre-tension force set as the origin of the abscissa, in per cent
ε_{max}	tensile strain at maximum tensile force, in per cent
ε_x	tensile strain corresponding to the generic length L_x, in per cent
ε_c	tensile strain for secant stiffness calculation at point C, in per cent
L	length, equal to the distance between the two reference points measured during the test, in mm
L_n	nominal gauge length, in mm

L_0 true gauge length, in mm

L_x generic length measured during the test, in mm

ΔL_p elongation at pre-tension force, in mm

Figure 1 — Typical tensile force–strain curve

3.3
true gauge length
L_0
nominal gauge length (3.1) in millimetres plus the *elongation at pre-tension force* (3.2) in millimetres

3.4
maximum tensile force
F_{max}
maximum value obtained during a test

Note 1 to entry: The maximum tensile force is expressed in kilonewtons (kN).

3.5
tensile strain
ε
increase in *true gauge length* (3.3) of a specimen during a test divided by true gauge length

Note 1 to entry: Tensile strain is expressed as a percentage of the true gauge length.

3.6
tensile strain at maximum tensile force
ε_{max}
tensile strain (3.5) exhibited by the specimen under *maximum tensile force* (3.4)

Note 1 to entry: Tensile strain at maximum tensile force is expressed in per cent.

3.7
tensile strain at nominal tensile strength
ε_{nom}
value at the nominal *tensile strength* (3.9) as defined by the manufacturer

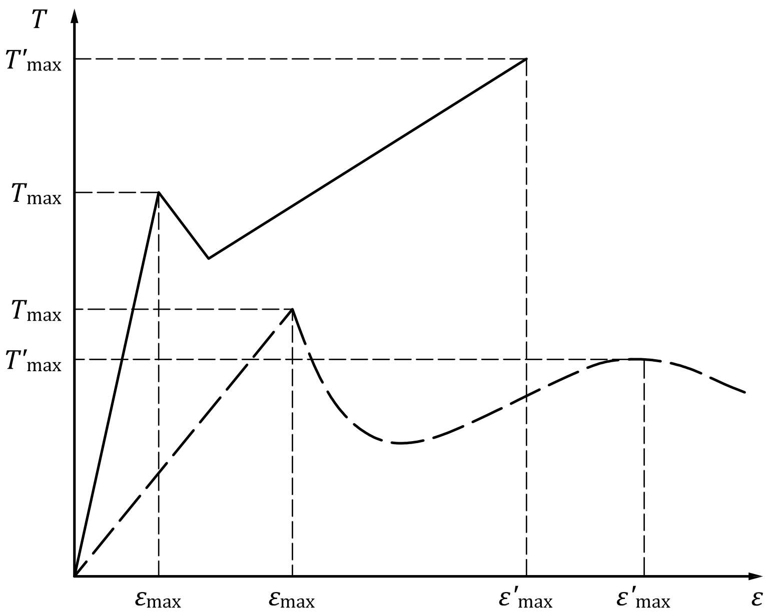
3.8
secant tensile stiffness
J
ratio of tensile force per unit width to an associated value of strain

Note 1 to entry: Secant tensile stiffness is expressed in kilonewtons per metre (kN/m).

3.9
tensile strength
T_{max}
maximum force per unit width observed during a test in which the specimen is stretched to rupture

Note 1 to entry: Tensile strength is expressed in kilonewtons per metre (kN/m).

Note 2 to entry: For products exhibiting a second peak on the tensile force per unit width-strain curves, the tensile strength is defined as the highest value between the two peaks, as shown in Figure 2.



Key

T_{max} tensile strength at first peak, in kN/m

ε_{max} tensile strain at first peak, in per cent

T'_{max} tensile strength at second peak (kN/m)

ε'_{max} tensile strain at second peak, in per cent

Figure 2 — Typical tensile force per unit width-strain curves of two geosynthetics showing a second peak

3.10
strain rate
strain at maximum force, divided by the duration of the test, i.e. the time to attainment of *maximum tensile force* (3.4) from pre-tension force

Note 1 to entry: Strain rate is expressed in percentage per minute.

3.11
tensile strength at second peak
T'_{max}
maximum force per unit width observed during a test in which the specimen is stretched to rupture, at the second peak observed on the tensile force per unit width–strain curve, occurring at a higher strain than that corresponding to the first peak

Note 1 to entry: Tensile strength at second peak is expressed in kilonewtons per metre (kN/m).

3.12
tensile strain at second peak
ε'_{max}
tensile strain (3.5) exhibited by the specimen at the second peak observed on the tensile force per unit width–strain curve, occurring at a higher strain than that corresponding to the first peak

Note 1 to entry: Tensile strain at second peak is expressed in per cent.

3.13
pre-tension force
F_0
tensile force equal to 1 % of the expected *maximum tensile force* (3.4), applied at the beginning of the test

Note 1 to entry: The pre-tension force is expressed in kilonewtons (kN).

3.14
tensile strain at pre-tension force
ε_0
tensile strain (3.5) corresponding to the pre-tension force, set as the origin of the abscissa in Figure 1, in per cent

Note 1 to entry: Tensile strain at pre-tension force is equal to zero based on Formulae (1) and (2), as shown in Figure 1.

4 Principle

A specimen is held across its entire width in a set of clamps or jaws (see Figure 3) of a tensile testing machine operated at a constant cross-head speed. A longitudinal force is applied to the specimen until the specimen ruptures. The type of jaws used are selected according to the type and tensile strength of the tested product; compressive hydraulic jaws [Figure 3 a), c), d)] and capstan grips [Figure 3 b), e), f)] may be used. For capstan grips, it can be useful to wind the specimen in an "S-shape" scheme around the capstan clamps or in a "B-shape" scheme, as shown in Figure 3 f).

The tensile properties of the specimen are calculated from machine scales, dials, autographic recording charts or an interfaced computer. A constant test speed is selected so as to give a strain rate of (20 ± 5) % per minute in the true gauge length of the specimen, except for products that exhibit a low strain, i.e. less than or equal to 5 %. For these products, e.g. glass, the speed is reduced so that the specimen breaks in (30 ± 5) s.

The basic distinction between the current method and other methods for measuring tensile properties of products is the width of the specimen. In the current method, the width is greater than the length of the specimen, as some geosynthetics have a tendency to contract (neck down) under tensile force in the gauge length area [see Figure 3 c)].

Greater width reduces the contraction effect of such products and provides a relationship closer to the expected product behaviour in the field, as well as a standard for comparison of geosynthetics.

For information on strain, extension measurements are made by means of an extensometer, which follows the movement of two reference points on the specimen. These reference points are situated on the specimen symmetry axis, which is parallel to the applied tensile force, and are separated by a distance of 60 mm (30 mm on each side of the specimen symmetry centre). This distance can be adapted for some types of geosynthetics, like geogrid, in order to include at least one row of nodes or internal junctions.

5 Reagents

The usual laboratory apparatus and, in particular, the following shall be used.

— Use only reagents of recognized analytical grade and only distilled water or water of equivalent purity.

— Distilled water, for wet specimens only, conforming to Grade 3 of ISO 3696.

— Non-ionic wetting agent, for wet specimens only.

— The wetting agent used shall be a general purpose polyoxyethylene glycol alkyl ether at 0,05 % volume.

6 Apparatus

The usual laboratory apparatus and, in particular, the following shall be used.

6.1 Tensile testing machine (constant cross-head speed), conforming to ISO 7500-1, Class 1 or better, in which the rate of increase of specimen length is uniform with time, fitted with a set of clamps or jaws which are sufficiently wide to hold the entire width of the specimen and equipped with appropriate means to limit slippage or damage.

NOTE 1 It is useful if one clamp is supported by a free swivel or universal joint to compensate for uneven distribution of force across the specimen.

Compressive jaws or capstan grips should be selected according to the type and tensile strength of the tested product.

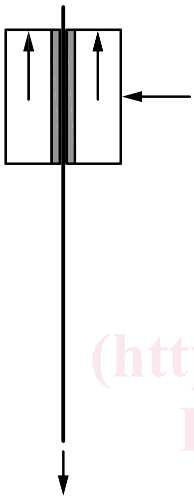
Jaw faces that limit slippage of the specimen shall be chosen, especially in stronger geosynthetics. Examples of jaws that have been found satisfactory are shown in Figure 3.

NOTE 2 The type of selected clamp can affect the obtained results.

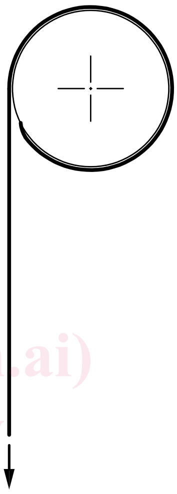
6.2 Extensometer, capable of measuring the distance between two reference points on the specimen without any damage to the specimen or slippage. Care should be taken to ensure that the measurement represents the true movement of the reference points.

NOTE Suitable extensometers are mechanical, optical, infrared or other types, all with an electrical output.

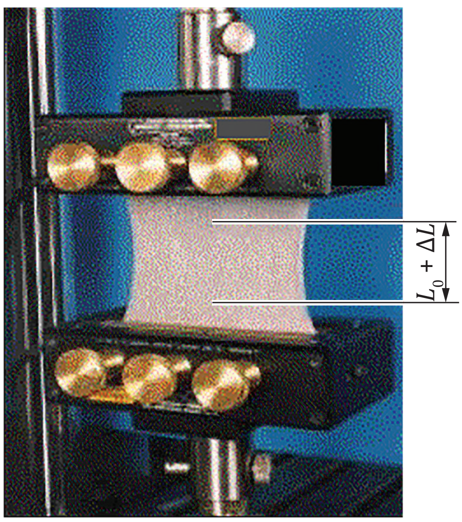
The extensometer shall be capable of measuring to an accuracy of ±2 % of the indicated reading. If any irregularity of the stress-strain curve due to the extensometer is observed, this result shall be discarded and another specimen shall be tested.



a) Friction by lateral pressure (hydraulic or mechanic compressive jaws)



b) Capstan or roller clamps friction on circular tube



c) Example of hydraulic jaws for low-strength products

d) Example of hydraulic jaws for high-strength products