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Geosynthetics — Wide-width tensile test

Géosynthétiques — Essai de traction des bandes larges

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 documents 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).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT), see the following URL: Foreword — Supplementary information.

The committee responsible for this document is ISO/TC 221, *Geosynthetics.*

This third edition cancels and replaces the second edition (ISO 10319:2008), which has been technically revised.

Geosynthetics — Wide-width tensile test

1 Scope

This International Standard describes an index test method for the determination of the tensile properties of geosynthetics (polymeric, glass, and metallic), using a wide-width strip. This International Standard 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 might need to be altered. It is not applicable to polymeric or bituminous geosynthetic barriers, while it is applicable to clay geosynthetic barriers.

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

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

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.

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 — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

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

ISO 10318, *Geosynthetics — 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 engineering purposes*

3 Terms and definitions

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

3.1
nominal gauge length
initial distance, normally 60 mm (30 mm on either side of the specimen symmetrical centre), between two reference points located on the specimen parallel to the applied load direction

3.2
elongation at preload
measured increase in gauge length (mm) corresponding to an applied load of 1 % of the maximum load

Note 1 to entry: The elongation at preload is indicated as SA in Figure 1.

3.3
true gauge length
L_0
nominal gauge length (3.1) in millimetres plus the *elongation at preload* (3.2) in millimetres

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

Note 1 to entry: The maximum load 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 load
ε_{max}
tensile strain (3.5) exhibited by the specimen under maximum tensile load

Note 1 to entry: Tensile strain at maximum tensile load is expressed in percent.

3.7
tensile strain at nominal strength
ε_{nom}
strain at the guaranteed strength as defined by the manufacturer

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

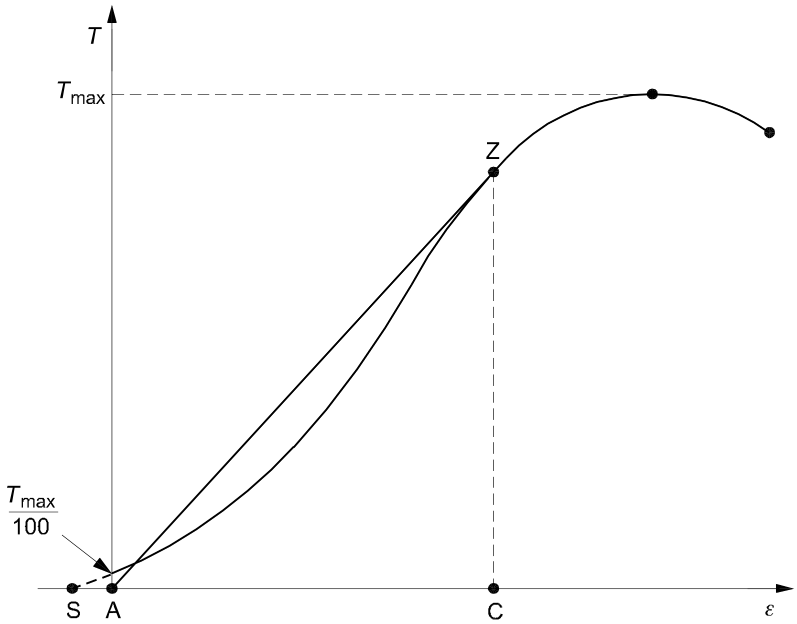
Note 1 to entry: Tensile secant stiffness is expressed in kilonewtons per metre (kN/m).

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).

3.10
strain rate
strain at maximum load, divided by the duration of the test, i.e. the time to attainment of maximum tensile load from preload

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



Key

T load/unit width, in kN/m

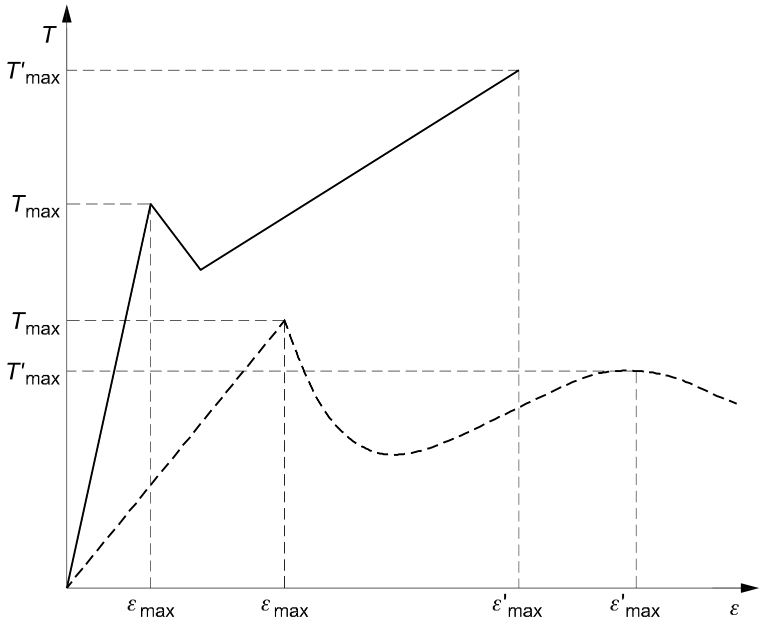
ε strain, in %

AC strain for secant stiffness

AZ secant

SA elongation at preload

Figure 1 — Typical load per unit width/strain curve



Key

T_{max} tensile strength (kN/m)

ε_{max} tensile strain (%)

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

ε'_{max} tensile strain (%) at second peak

Figure 2 — Typical tensile load per unit width — strain — curves of two geocomposites second peak-values marked by "'", e.g. T'_{max}, ε'_{max}

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 displacement speed, and a longitudinal force is applied to the test specimen until the specimen ruptures. The tensile properties of the test 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 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 fabrics 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 load in the gauge length area.

The greater width reduces the contraction effect of such fabrics and provides a relationship closer to the expected fabric behaviour in the field, as well as a standard for comparison of geosynthetics.

When information on strain is required, 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 load, 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 geogrid in order to include at least one row of nodes or internal junctions.

5 Apparatus and reagents

5.1 Tensile testing machine (constant rate of extension), complying with ISO 7500-1, Class 2 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. One clamp may be supported by a free swivel or universal joint to compensate for uneven distribution of force across the specimen.

Compressive jaws should be used for most materials, but for materials where the use of these grips gives rise to excessive jaw breaks or slippage, capstan grips may be used.

It is essential to choose jaw faces that limit slippage of the specimen, especially in stronger geosynthetics. Examples of jaw faces that have been found satisfactory are shown in Figure 3.

5.2 Extensometer, capable of measuring the distance between two reference points on the specimen without any damage to the specimen or slippage, care being taken to ensure that the measurement represents the true movement of the reference points.

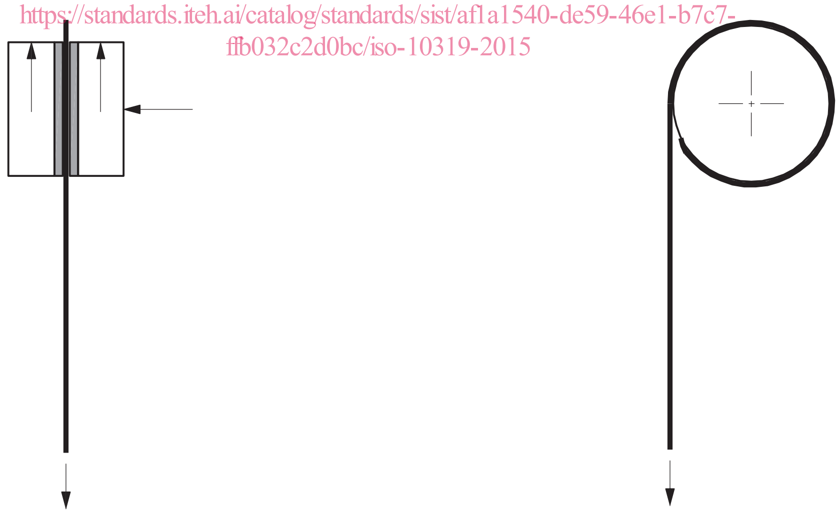
EXAMPLE Mechanical, optical, infrared or other types, all with an electrical output.

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.

5.3 Distilled water, for wet specimens only, complying with Grade 3 of ISO 3696.

5.4 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.



a) friction by lateral pressure (hydraulic or mechanic)

b) capstan or roller clamps friction on circular tube

Figure 3 — Examples of jaw faces for tensile testing of geosynthetics

6 Test specimens

6.1 Number of test specimens

Cut a minimum of five test specimens in both machine direction (MD) and cross machine direction (CMD).

6.2 Preparation of test specimens

Prepare the test specimens in accordance with ISO 9862.

6.3 Dimensions

6.3.1 Nonwoven geotextiles, knitted geotextiles, geonets, geomats, clay geosynthetic barriers, drainage composites, and other products

Prepare each finished test specimen to a nominal 200 mm ±1 mm width and of sufficient length to ensure 100 mm between the jaws, with the length dimension being designated and parallel to the direction in which the tensile force is applied. For some materials, the use of a cutting knife or scissors can affect the structure. In such cases, thermal cutting or other techniques can be used, and this shall be reported in the test report (see Clause 10) Where appropriate and for monitoring any slippage, draw two lines running the full width of the test specimen jaw faces, perpendicular to the length dimension and separated by 100 mm [except for capstan grips — see Figure 3b)].

6.3.2 Woven geotextiles

For woven geotextiles, cut each specimen approximately 220 mm wide and then make fringes by removing an equal number of threads from each side to obtain the 200 mm ±1 mm nominal specimen width.

NOTE This helps to maintain the specimen integrity during the test. When the specimen integrity is not affected, the specimens can be initially cut to the finished width.

6.3.3 Geogrids with one axis

For geogrids with one axis, prepare each specimen at least 200 mm wide and sufficiently long to ensure at least 100 mm between the jaws. Cut all ribs at least 10 mm from any node. Where the nodes are not separated by at least 10 mm, the specimens should be prepared two ribs wider than required for the test and, after clamping in the jaws, the outer rib on each side of the specimen should be severed. The test result (strength) shall be based on the unit of width associated with the number of intact ribs. The test specimen shall contain at least one row of nodes or cross-members, excluding the nodes of cross-members held in the jaws (see Figure 4). Products of pitch [i.e. the distance between the start of one rib (load bearing element) and the start of the next rib] less than 75 mm shall contain at least four complete tensile elements (ribs) in the width direction. Products of pitch greater than 75 mm and less than 120 mm shall contain at least two complete tensile elements in the width direction. For products of pitch greater than 120 mm, single ribs may be tested.

The reference points for the extensometer shall be marked on a central row of tensile elements that will be subjected to testing and shall be at least 60 mm apart. The reference points shall be marked at the centre point of a rib and shall be separated by at least one node or cross-member. Where necessary, the two reference points may be separated by more than one row of nodes or cross-members, in order to achieve the minimum separation of 60 mm apart. In this case, the requirement to mark the reference points at mid-rib shall be maintained and the gauge length shall then be an integral number of pitches of the grid. Measure the nominal gauge length to an accuracy of ±1 mm.

6.3.4 Geogrids with two axes and four axes

For geogrids with two or four axes, prepare each specimen at least 200 mm wide and sufficiently long to ensure at least 100 mm between the jaws. Cut all ribs at least 10 mm from any node. The test specimen shall contain at least one row of nodes or cross-members, excluding the nodes of cross-members held in the jaws (see Figure 5 and Figure 8).

Products of pitch less than 75 mm shall contain at least four complete tensile elements (ribs) in the width direction. Products of pitch greater than 75 mm and less than 120 mm shall contain at least two complete tensile elements in the width direction. For products of pitch greater than 120 mm, single ribs may be tested.

The reference points for the extensometer shall be marked on a central row of tensile elements that will be subjected to testing and shall be at least 60 mm apart. The reference points shall be marked at the centre point of a rib and shall be separated by at least one node or cross-member. Where necessary, the two reference points may be separated by more than one row of nodes or cross-members, in order to achieve the minimum separation of 60 mm apart. In this case, mark the reference points at mid-rib or on nodes and the gauge length shall then be an integral number of pitches of the grid. Measure the nominal gauge length to an accuracy of ±1 mm.

6.3.5 Geogrids with three axes

For geogrids with three axes prepare each specimen at least 200 mm wide and sufficiently long to ensure at least 100 mm between the jaws. The specimens are cut and the width of the specimen is measured as shown in Figure 6 and Figure 7.

The reference points for the extensometer shall be marked at the centre point of a node and shall be separated by at least one node or cross-member. Where necessary, the two reference points may be separated by more than one row of nodes or cross-members, in order to achieve the minimum separation of 60 mm apart. In this case, the requirement to mark the reference points at mid-rib shall be maintained and the gauge length shall then be an integral number of pitches of the grid. Measure the nominal gauge length to an accuracy of ±1 mm.

6.3.6 Metallic geotextile related product

For most metallic products the preparation of specimens can be done by methods already defined for geogrids

Specifically for testing double twisted, hexagonal, steel wire mesh product, the sample should be tested in accordance with EN 10223-3, except that the extension shall be measured using an extensometer.

The reference points for the extensometer shall be marked at the centre point of the double twists and shall be separated by a distance of at least 60mm. Measure the nominal gauge length to an accuracy of ±1mm (see Figure 9).

Note that results obtained in these tests might not be directly comparable to those obtained if tested in accordance with ISO 10319.