INTERNATIONAL STANDARD

ISO 10319

First edition
1993-04-15

Geotextiles — Wide-width tensile test

Géotextiles — Essai de traction des bandes larges

Reference number
ISO 10319:1993(E)

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.

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.

International Standard ISO 10319 was prepared by Technical Committee ISO/TC 38, *Textiles*, Sub-Committee SC 21, *Geotextiles*.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Geotextiles — Wide-width tensile test

1 Scope

This International Standard describes an index test method for determination of the tensile properties of geotextiles and related products, using a wide-width strip. The method is applicable to most geotextiles, including woven fabrics, nonwovens, geocomposites, knitted fabrics and felts. The method is also applicable to geogrids, but specimen dimensions may need to be altered.

This tensile test method 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.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 554:1976, *Standard atmospheres for conditioning and/or testing — Specifications.*

ISO 3301:1975, *Statistical interpretation of data — Comparison of two means in the case of paired observations.*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods.*

ISO 7500-1:1986, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines.*

ISO 9862:1990, *Geotextiles — Sampling and preparation of test specimens.*

3 Definitions

3.1 nominal gauge length

(1) For measurement with an extensometer, the initial distance, normally 60 mm (30 mm on either side of the specimen's symmetrical centre), between two reference points located on the specimen parallel to the applied load.

(2) For measurement by jaw displacement, the initial jaw separation distance, normally 100 mm.

3.2 extension at preload: Measured increase in gauge length, expressed in millimetres, corresponding to an applied load of 1 % of the maximum load (SA in figure 1).

3.3 true gauge length: Nominal gauge length plus the extension at preload.

3.4 maximum load: Maximum tensile force, expressed in kilonewtons, obtained during a test (see point D in figure 1).

3.5 strain: Increase in true gauge length of a specimen during a test, expressed as a percentage of the true gauge length.

3.6 strain at maximum load: Strain, expressed in percentage, exhibited by the specimen under maximum load.

3.7 secant stiffness: Ratio of load per unit width, in kilonewtons per metre, to a given value of strain. For example, at point B in figure 1, secant stiffness = BC/CA.

3.8 tensile strength: Maximum strength per unit width, in kilonewtons per metre, observed during a test in which the specimen is stretched until it breaks.

3.9 strain rate: Percentage increase in true gauge length at maximum load, divided by the duration of the test, i.e. the time to attainment of maximum load from preload level.

4 Principle

A test specimen is held across its entire width in the jaws of a tensile testing machine operated at a given rate of strain, and a longitudinal force 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. The rate of strain is fixed at (20 ± 5) % per minute for all geotextiles and related products.

Most geotextiles can be tested by this method. However, some modification of techniques may be necessary for particular geotextiles, e.g. strong geotextiles, meshes or geotextiles made from glass fibre, to prevent them from slipping in the jaws or being damaged as a result of being gripped in the jaws.

The basic distinction between the present method and other methods for measuring tensile properties of fabrics is the width of the specimen. In the present method, the width is greater than the length of the specimen, as some geotextiles 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 expected fabric behaviour in the field, as well as a standard for comparison of geotextiles.

The basic test, for all kinds of geotextiles and geogrids, uses test specimens of 200 mm width and of 100 mm length (see 6.3.3 for details on preparation of geogrid specimens). 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 geogrids in order to include at least one row of nodes (see 6.3.3).

Measurement of the extension of the test specimen is carried out by means of an extensometer. Alternatively, extension may be measured by jaw displacement if a calibration trial shows no significant difference between jaw displacement and extensometer results. The significance of the difference is determined by a Student *t*-distribution at significance level of 95 %, as defined in ISO 3301. In such a case, the nominal gauge length is the distance between the jaws and is fixed at 100 mm.

5 Apparatus and reagents

5.1 Tensile testing machine (constant rate of extension), complying with ISO 7500-1, in which the rate of increase of specimen length is uniform with time, fitted with 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 Compressive jaws should be used for most materials, but for materials where the use of these grips gives rise to excessive jaw breaks or slippages, capstan grips may be used.

It is essential to choose jaw faces that limit slippage of the specimen, especially in stronger geotextiles. Examples of jaw faces that have been found satisfactory are shown in figure 2.

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. Examples of extensometers include mechanical, optical, infrared or electrical devices.

The accuracy of the extensometer shall comply with ISO 7500-1. 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; see ISO 3696.

5.4 Nonionic wetting agent, for wet specimens only.

6 Test specimens

6.1 Number

Cut a minimum of five test specimens in both the machine direction and the cross direction.

6.2 Selection

Select test specimens in accordance with ISO 9862.

6.3 Dimensions

6.3.1 Prepare each finished test specimen to a nominal 200 mm ± 1 mm width (excluding fringes when applicable, see 6.3.2), 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. 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 2 c)].

6.3.2 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. This helps to maintain the specimen integrity during the test.

NOTE 2 When specimen integrity is not affected, the specimens may be initially cut to the finished width.

6.3.3 For geogrids, prepare each specimen at least 200 mm wide and sufficiently long to ensure a length of at least 100 mm. The test specimen shall contain at least one row of nodes or cross-members, excluding the nodes or cross-members held in the jaws (see figure 3), and, for products of pitch less than 75 mm, at least five complete tensile elements in the width direction. Products of transverse pitch ⩾ 75 mm shall contain at least two complete tensile elements in the width direction.

If the test is to be used as a reference test for the seam/joint strength test (see ISO 10321[1)]), the specimen width shall be a minimum of 200 mm and contain at least five complete tensile elements.

The reference points for the extensometer shall be marked on a central row of tensile elements that will be subjected to test 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. 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 ± 3 mm.

6.3.4 For knitted fabrics, geocomposites or others, preparation of the specimen by cutting with a knife or scissors can affect the fabric structure. In such cases, thermal cutting can be used and shall be reported in the test report (clause 10).

6.3.5 When the values of both the wet maximum load and the dry maximum load are required, cut each test specimen at least twice as long as is usually required. Number each test specimen and then cut each specimen crosswise into two halves, one for determining the dry maximum load, and the other for determining the wet maximum load. Each portion shall be marked with the specimen number. Thus each paired break is performed on a test specimen containing the same threads.

For geotextiles which shrink excessively when wet, the tensile strength shall be determined from the maximum load, in wet conditions, and the initial width measured to an accuracy of ± 1 mm, after conditioning but before wetting (see clause 7).

7 Conditioning atmosphere

7.1 The test specimens shall be conditioned and the test conducted in one of the atmospheres defined in ISO 554. The test specimens are considered to have been conditioned when the change in mass of the test specimen in successive weighings, made at intervals of not less than 2 h of conditioning, does not exceed 0,25 % of the mass of the test specimen.

NOTE 3 Conditioning and/or testing at a specified relative humidity may be omitted if it can be shown that the results are not affected by this omission.

7.2 Specimens to be tested in the wet condition shall be immersed in water maintained at a temperature of (20 ± 2) °C [or (23 ± 2) °C, or (27 ± 2) °C]. The time of immersion shall be at least 24 h and shall be sufficient to wet the test specimens thoroughly, as indicated by no significant change in maximum load or strain following a longer period of immersion. To obtain thorough wetting, it may be necessary to add up to a maximum of 0,05 % of a nonionic neutral wetting agent (5.4) to the water.

8 Test procedure

8.1 Setting up the machine

Adjust the distance between the jaws at the start of the test to give a test specimen length of 100 mm ± 3 mm, except for geogrids and for geotextiles mounted on capstan grips. Select the force range of the testing machine such that the break occurs between 30 % and 90 % of full-scale force. Set the machine so as to induce a strain rate of 20 % ± 5 % per min in the gauge length. Test conditioned specimens in an atmosphere as specified in clause 6. For wet specimens, carry out the test within 3 min of removal from the water.

If capstan grips are used, the separation between the centres of the capstans at the beginning of each test shall be kept to a minimum. The use of capstan grips shall be recorded in the test report.

8.2 Insertion of test specimen in the jaws

Mount the test specimen centrally in the jaws. Take care that in both the machine direction and cross direction tests the specimen length is parallel to the direction of application of force. Where appropriate, do this by having the two lines, which were previously

1) ISO 10321:1992, *Geotextiles — Tensile test for joints/seams by wide-width method*

drawn 100 mm apart across the width of the test specimen (see 6.3.1), positioned as closely as possible adjacent to the inside edges of the jaws.

8.3 Installation of the extensometer

Fix the reference points on the specimen 60 mm apart (30 mm on each side of the specimen's symmetry centre), and set the extensometer, without causing any damage to the specimen. Ensure that there is no slippage of the reference points during the test.

8.4 Measurement of tensile properties

Start the tensile testing machine and continue running until the specimen ruptures. Stop the machine, record and report the maximum load to an accuracy of 0,2 % of the full-scale reading, and strain to the first decimal place; reset to the initial gauge position.

The decision to discard the results from a break shall be based on observation of the specimen during the test, on the inherent variability of the geotextile and on the provision of 5.2. In the absence of other criteria for rejecting a jaw break, any break occurring within 5 mm of the jaws, which results in a value below 50 % of the average value of all other breaks, shall be discarded. No other break results shall be discarded, unless the test is known to be faulty.

NOTE 4 It is difficult to determine the precise reason why certain specimens break near the edge of the jaws. If a jaw break is caused by damage to the test specimen by the jaws, the results should be discarded. If, however, it is merely due to randomly distributed weaknesses in the test specimen, it is a legitimate result. In some cases, it may also be caused by a concentration of stress in the area adjacent to the jaws because they prevent the test specimen from contracting in width as the load is applied. In these cases, a break near the edge of the jaws is inevitable and should be accepted as a characteristic of the particular method of test.

Special procedures are required for the testing of specimens made from specific materials (e.g. glass fibre, carbon fibre) to minimize any damage that may be caused by the jaws. If a test specimen slips in the jaws, or if more than one quarter of the specimens break at a point within 5 mm of the edge of the jaw, then

a) the jaws may be padded;

b) the test specimen may be coated under the jaw face area; or

c) the jaw face may be modified.

If any of the modifications listed above are used, state the method of modification in the test report.

8.5 Measurement of strain

Measure the increase in true gauge length of the test specimen at any specified load by means of a suitable recording device.

9 Calculations

9.1 Tensile strength

Calculate the tensile strength α_f, expressed in kilonewtons per metre, directly from the data obtained from the tensile testing machine, using equation (1).

$$\alpha_f = F_f c \qquad \dots (1)$$

where

F_f is the recorded maximum load, in kilonewtons;

c is obtained from equation (2) or equation (3) as appropriate:

For nonwovens, closely woven fabrics or similar materials,

$$c = 1/B \qquad \dots (2)$$

where B is the specimen nominal width, in metres.

For coarse-woven geotextiles, geomeshes, geogrids or similar open-structure materials,

$$c = N_m/N_s \qquad \dots (3)$$

where

N_m is the minimum number of tensile elements within a 1 m width of the product being tested;

N_s is the number of tensile elements within the test specimen.

9.2 Strain at maximum load

Record the strain, in percent, at the maximum load (see figure 1).

9.3 Secant stiffness

To calculate the secant stiffness, J_{sec}, expressed in kilonewtons per metre, at a specified strain, determine the load at that specified strain (point B in figure 1) and apply equation (4).

$$J_{sec} = \frac{Fc \times 100}{\varepsilon} \qquad \dots (4)$$

where

F is the determined load at strain ε, in kilonewtons;

ε is the specified strain, in percent;

c is obtained from equation (2) or equation (3) as appropriate.

10 Test report

The test report shall include the following information:

a) reference to this International Standard;

b) all relevant data for complete identification of the specimen tested;

c) the mean tensile strength, in both the machine direction and cross direction, and, if required, the individual values, expressed as in clause 9;

d) if applicable, the mean strain at the maximum load in both the machine direction and cross direction and, if required, the individual values, expressed as in clause 9;

e) the mean secant stiffnesses corresponding to strains of at least the following percentages: 2 %, 5 % and 10 %, and the individual values, if required;

f) the standard deviation or coefficient of variation of any of the properties determined;

g) the condition of the test specimen, i.e. wet or dry;

h) the number of specimens tested in each direction;

i) the manufacturer and model of the tensile testing machine;

j) the type of jaw, including the dimensions of the jaws and the type of jaw faces used, type of deformation-measuring system and initial jaw separation;

k) a typical load-strain curve with the yield points, if required;

l) details of any deviations from the specified procedure;

m) strain rate, in percent per minute, reported to the nearest percent;

n) the standard atmosphere used.

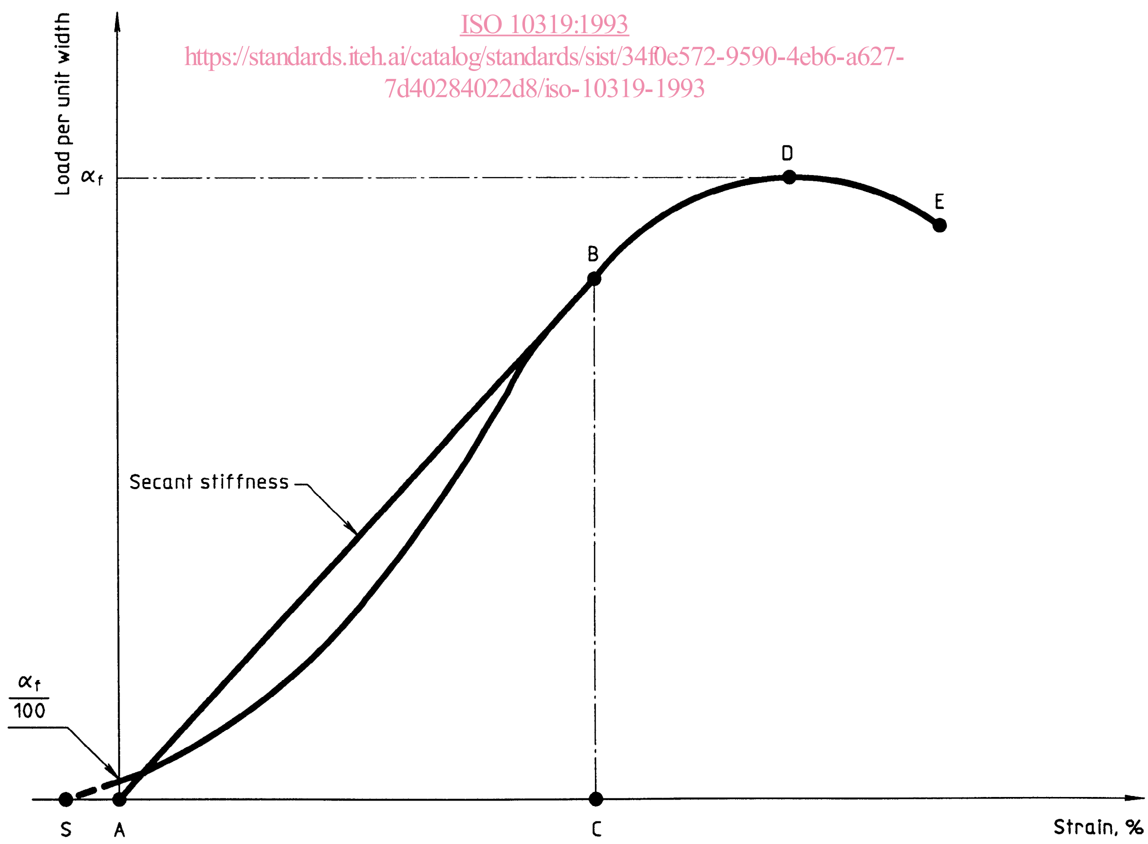
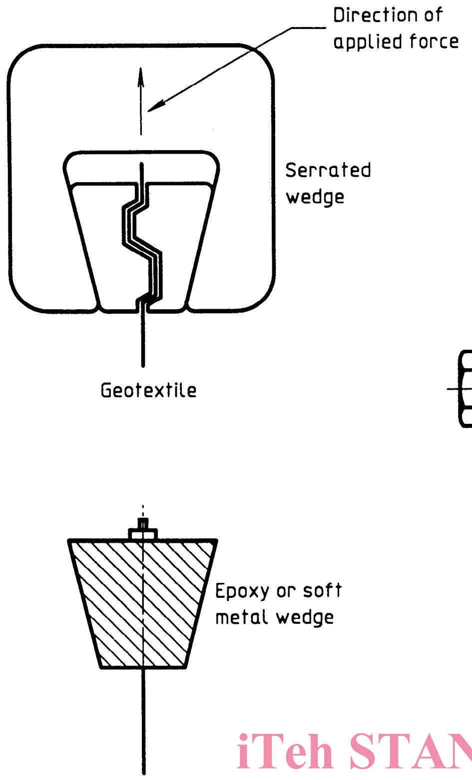
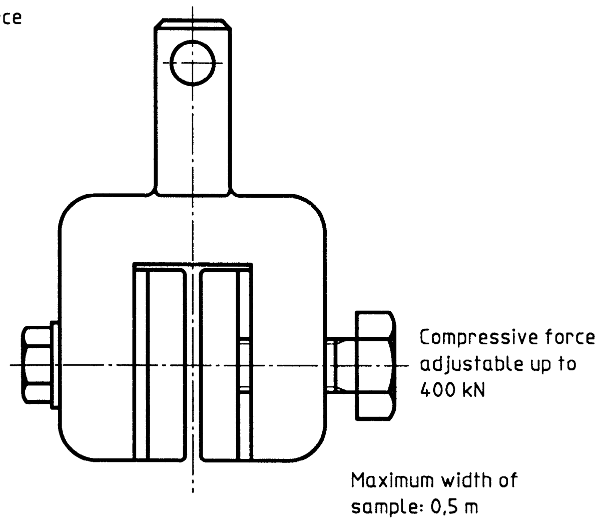


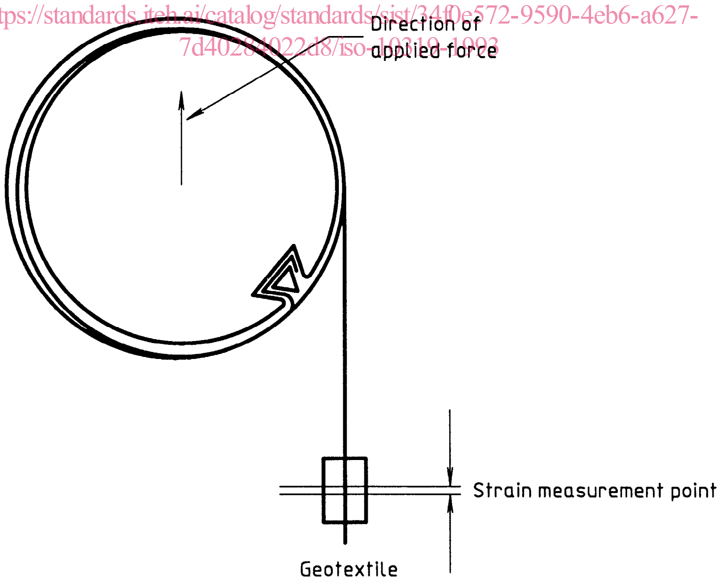
Figure 1 — Typical load-strain curve



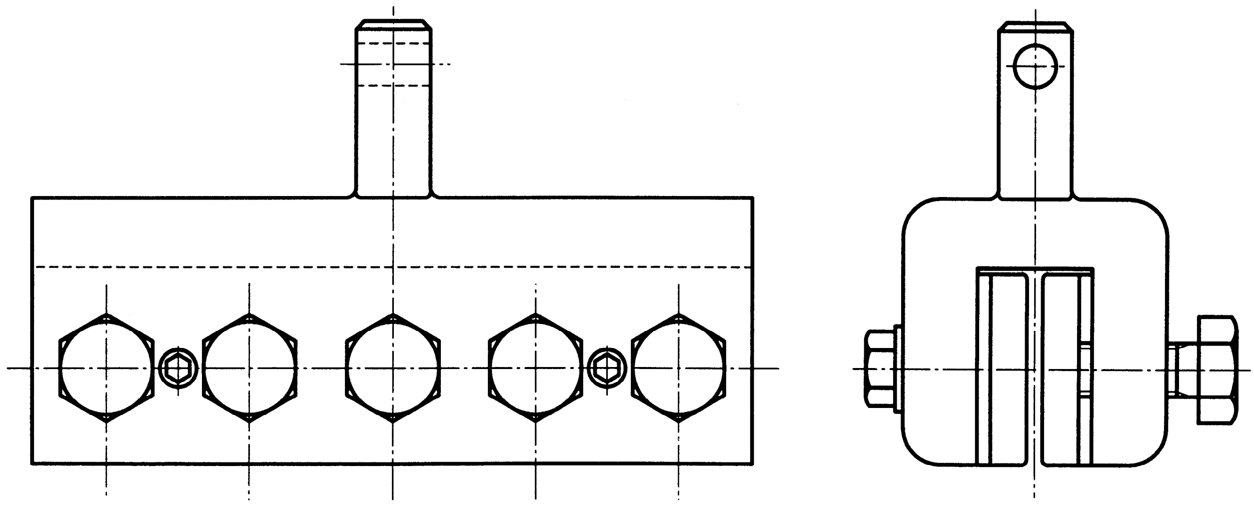
a) Wedge jaws



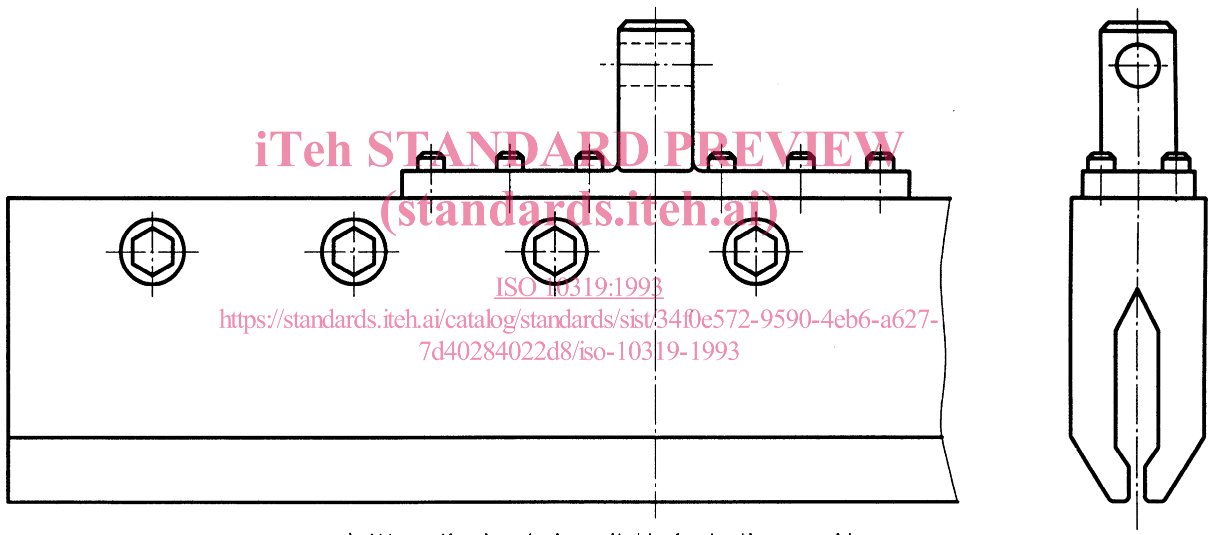
b) Compressive block jaws



c) Capstan



d) Jaw design suitable for testing geogrids



e) Alternative jaw design suitable for testing geogrids

Figure 2 — Examples of jaw faces for tensile testing of geotextiles