INTERNATIONAL STANDARD

ISO 13431

First edition
1999-08-01

Geotextiles and geotextile-related products — Determination of tensile creep and creep rupture behaviour

Géotextiles et produits apparentés — Détermination du comportement au fluage en traction et de la rupture au fluage en traction

Reference number
ISO 13431:1999(E)

PDF disclaimer

This PDF file may contain embedded typefaces. In accordance with Adobe's licensing policy, this file may be printed or viewed but shall not be edited unless the typefaces which are embedded are licensed to and installed on the computer performing the editing. In downloading this file, parties accept therein the responsibility of not infringing Adobe's licensing policy. The ISO Central Secretariat accepts no liability in this area.

Adobe is a trademark of Adobe Systems Incorporated.

Details of the software products used to create this PDF file can be found in the General Info relative to the file; the PDF-creation parameters were optimized for printing. Every care has been taken to ensure that the file is suitable for use by ISO member bodies. In the unlikely event that a problem relating to it is found, please inform the Central Secretariat at the address given below.

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 734 10 79
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 member bodies casting a vote.

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

International Standard ISO 13431 was prepared by the European Committee for Standardization (CEN) in collaboration with ISO Technical Committee TC 38, *Textiles*, Subcommittee SC 21, *Geotextiles*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Throughout the text of this standard, read "...this European Standard..." to mean "...this International Standard...".

Annex ZZ provides a list of corresponding International and European Standards for which equivalents are not given in the text.

Foreword

The text of EN ISO 13431:1999 has been prepared by Technical Committee CEN/TC 189 "Geotextiles and geotextile-related products", the secretariat of which is held by IBN, in collaboration with Technical Committee ISO/TC 38 "Textiles".

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2000, and conflicting national standards shall be withdrawn at the latest by February 2000.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

1 Scope

This Standard specifies a method for determining the tensile creep and creep rupture behaviour of geotextiles and geotextile-related products in an unconfined situation.

Application of this standard is limited to those products and applications where the risk of collapse of a structure due to premature failure or to strain/time variation of the reinforcement under constant load is of essential importance.

As the test is carried out over a long period of time and the procedure is complex, it is therefore recommended that the test is not considered to be a routine quality control test. The results of the test may not be representative of the performance of the products when subject to soil pressures.

2 Normative References

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate points in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 963	Geotextiles and geotextile-related products - Sampling and preparation of test specimens.
EN ISO 10319	Geotextiles - Wide-width tensile test (ISO 10319:1993)
ISO 554	Standard atmospheres for conditioning and/or testing - Specifications.

3 Definitions

For the purposes of this standard the following definitions apply:

3.1 tensile strength: Maximum load per unit width, in kilonewtons per metre, developed in a specific material subjected to an external tensile load, when measured in accordance with EN ISO 10319.

3.2 preload: Force, in kilonewtons per metre, equal to 1% of the tensile strength, but not more than 10% of the tensile creep load, applied to the specimen to enable the gauge length and strain zero to be determined under reproducible conditions.

3.3 nominal gauge length: Initial distance between two reference points located on the specimen parallel to the applied load before the application of the preload. The gauge length should be set to be completely clear from the clamping devices. The gauge length should be a representative part of the specimen, e.g. for grid structures the gauge length should be a whole number of meshes or ribs.

3.4 technically representative width (TRW): A small width, that exhibits tensile strength/ strain characteristics per unit width, under identical test conditions, within ± 5% for tensile strength and ± 20% for strain at the maximum load, of the values measured in accordance with EN ISO10319.

3.5 tensile creep strain: Time dependent change in tensile strain of a specimen subject to a constant tensile load.

3.6 tensile creep rupture: Tensile failure of a specimen subject to a constant tensile load, which is less than the tensile strength.

NOTE: In some materials tensile creep rupture is preceeded by an increasing rate of strain.

3.7 tensile creep load: Constant tensile static load per unit width, in kilonewtons per metre, applied to the specimen.

NOTE: The tensile creep load is usually expressed as a percentage of the tensile strength of the sample. The tensile creep load includes the preload and, if applicable, any load due to the loading device.

3.8 loading time: Time, in seconds, required to apply the full tensile creep load.

3.9 creep time: Time elapsed from the end of the loading time.

3.10 time to creep rupture: Time elapsed from the end of the loading time until tensile creep rupture of the specimen.

3.11 initial strain: Change in the gauge length (strain), in percent, measured on the specimen at (60 ± 5) s after the end of the loading time.

3.12 lateral contraction: Decrease in the width of the specimen during the tensile test, expressed as a percentage of the width of the specimen under preload, measured at the centre of the gauge length (see figure 2).

4 Specimens

4.1 Sampling

Take a sample and prepare specimens in accordance with EN 963.

4.2 Number of specimens

For the determination of tensile creep behaviour (see clause 5), cut four specimens from the sample.
For the determination of tensile creep rupture (see clause 6), cut twelve specimens from the sample.

4.3 Dimensions of specimens

4.3.1 The size of the specimens is determined:

- to suit the dimensions of the apparatus being used;
- to suit the accuracy of the measuring equipment being used;
- to comply with the technically representative width;
- to allow the minimum gauge length to be established within the grips such that there is a distance of not less than 20mm between either end of the marked gauge length and the grips.

4.3.2 The minimum gauge length of the specimens shall be (see figure 1):

- not less than 200 mm;
- for geogrids not less than two full elements;
- for all samples, such length as will enable the measurement of the gauge length to an accuracy of ± 0,1 %.

4.3.3 The width of the specimens shall be:

- for products which exhibit significant lateral contraction (≥10%), when tested in accordance with EN ISO 10319 (see figure 2): 200 mm;
- for geogrids: not less than three full elements;
- for all other materials: a technically representative width.

NOTE: The size of the specimens has a major influence on the feasibility and the accuracy of the test. The loads required are dependent upon the width of the specimen.

4.4 Conditioning

Condition the test specimens in a standard atmosphere for testing defined in ISO 554, until the change in mass between successive readings made at intervals of not less than 2 h does not exceed 0,25 % of the mass of the specimens.
Tests shall be carried out under the same conditions.

NOTE: 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. As this test is carried out over a long period of 1 000 h, the omission of humidity control should be based upon experimental evidence from tests carried out over a similar period of time on similar samples of the same polymer.

5 Determination of tensile creep behaviour

5.1 Principle

The specimens are loaded with a constant static force, in constant ambient conditions of temperature and humidity.

The load is distributed evenly across the specimen width.

The elongation of the specimen is recorded continuously or is measured at specific time intervals. The load is maintained for a period of 1000 h. If the specimen fails before 1000 h the time to rupture is recorded.

Specimens from the sample shall first be tested in accordance with EN ISO 10319 to determine the tensile strength and the TRW of the sample.

5.2 Apparatus

5.2.1 General

A schematic representation of suitable equipment is shown in figures 3 and 4.

The apparatus shall consist of a device to grip the specimen without slipping, a loading system and a system to measure the change in gauge length with time.

5.2.2 Specimen grips

The grips shall be wide enough to hold the specimen firmly across the full width. The grips shall hold the specimen without slippage and in a way which does not cause any damage to the specimen, which can in turn result in failure of the specimen in the grips.

The grips shall be fixed to the loading system in such a way that the load is applied to the specimen without any eccentricity, i.e. by using a universal joint or spherical seating.

5.2.3 Loading system

The loading frame shall be stiff enough to support the loads without apparent deformation.

The loading frame shall be insulated from vibrations from outside sources.

The loading frame shall not be susceptible to the disturbance caused by the failure of other specimens in the frame, in adjacent frames or by any other means.

The tensile creep load shall be constant within ±1%.

The tensile creep load may be applied using weights acting directly or through a system of levers, or by the use of mechanical, hydraulic or pneumatic systems. The loading system shall be calibrated before each test to demonstrate that the required load is being applied to the specimen.

> NOTE**:** Special attention may be needed to ensure that the tensile creep load is constant when using loading systems other than dead loads, e.g. the angle of lever systems should be kept nearly constant to ensure that the applied creep load remains within the accuracy specified.

The loading system shall be capable of applying the preload to the specimen.

The loading system shall allow the specimen to be loaded smoothly, such that the full tensile creep load is applied in not more than 60 s.

5.2.4 Strain measuring system

The change in the gauge length or strain, shall be measured between two parallel lines across the full width of the specimen or between two points on the central axis of the specimen in the loaded direction.

The change in the gauge length may be measured with any apparatus which is able to measure the change with an accuracy of ± 0,1% of the gauge length; a mechanical, electrical or optical apparatus is normally used.

> NOTE 1: Extreme care should be taken to ensure the reproducibility of the readings and the long-term stability of the apparatus. The apparatus may be connected to a continuous reading system or data logger, or the changes in length can be measured at the specific time intervals given in 5.3.

> NOTE 2: Extreme care is needed when marking the reference points or lines on the specimen, to avoid any displacement or distortion during the test.

5.3 Procedure

5.3.1 Determine the wide-width tensile characteristics of the sample in accordance with EN ISO 10319, including the strain to rupture and lateral contraction of the specimens.

5.3.2 Evaluate the validity of using a specimen of a technically representative width (TRW) less than 200 mm, if so required. The procedure for the evaluation of the validity of tests using specimens with a TRW of less than 200 mm is described in the examples given in clause 7. Determine the tensile strength and strain at the maximum load of the TRW-specimens.

5.3.3 Carry out the test at four load levels selected from the following range:

5%, 10%, 20%, 30%, 40%, 50%, 60% of the measured tensile strength.

Load each specimen with one of the selected loads, such that each specimen is loaded with a different tensile creep load.

5.3.4 Prepare the specimens for the tensile creep test and mount the specimens in the test apparatus. For woven geotextiles, the procedure described in EN ISO 10319 for the preparation of specimens shall be used.

Mark on the specimens the reference lines or points to give the required gauge length.

Apply the preload and measure the gauge length to within ± 0,1%.

Assemble and fix in place the strain measurement system and set it to zero, if applicable.

Smoothly apply the full tensile creep load (see 5.3.3) within not more than 60 s.

The zero time for the test is the time at which the full tensile creep load is applied to the specimen.

5.3.5 Measure the change in the gauge length to within ± 0,1%, at the following times, after the full tensile creep load has been applied:

1, 2, 4, 8, 15, 30 and 60 min;
2, 4, 8 and 24 h;
3, 7, 14, 21 and 42 days (42 days = 1 008 h).

Alternatively continuous measurement or measurement at similar or more frequent time intervals may be used, provided that the first reading is taken within 1 min of the application of the full tensile creep load and that the final reading is taken at 1000 h or later from the start of the test.

6 Determination of tensile creep rupture

6.1 Principle

The specimens are loaded with a constant static force, in constant ambient conditions of temperature and humidity.

The load is distributed evenly across the specimen width.

The load is maintained until the specimen ruptures.

The time to rupture is determined by means of a timing device which is stopped when the specimen ruptures.

6.2 Apparatus

6.2.1 General

A schematic representation of suitable equipment is shown in figures 3 and 4, omitting the strain measuring system and adding an automatic timing device.

The apparatus shall consist of a device to grip the specimen without slipping, a loading system and a system to record the time to rupture.

6.2.2 Specimen grips

The grips shall be wide enough to hold the specimen firmly across the full width. The grips shall hold the specimen without slippage and in a way which does not cause any damage to the specimen, which can in turn result in failure of the specimen in the grips.

The grips shall be fixed to the loading system in such a way that the load is applied to the specimen without any eccentricity, i.e. by using a universal joint (see figure 4).

6.2.3 Loading system

The loading frame shall be stiff enough to support the loads without apparent deformation.

The loading frame shall be insulated from vibrations from outside sources.

The loading frame shall not be susceptible to the disturbance caused by the failure of other specimens in the frame, in adjacent frames or by any other means.

The tensile creep load shall be constant to within ± 1%.

The tensile creep load may be applied using weights acting directly or through a system of levers, or by the use of mechanical, hydraulic or pneumatic systems. The loading system shall be calibrated before each test to demonstrate that the required load is being applied to the specimen.

> NOTE: Special attention may be needed to ensure that the tensile creep load is constant when using loading systems other than dead loads, e.g. the angle of lever systems should be kept nearly constant to ensure than the applied creep load remains within the accuracy specified.

The loading system shall allow the specimen to be loaded smoothly, such that the full tensile creep load is applied within not more than 60 s.

6.2.4 Time recording system

The accuracy of the time recording system shall be ±1%. It shall be capable of being set to zero at the time when the full tensile creep load is applied and of recording automatically the time at which tensile creep rupture occurs

6.3 Procedure

6.3.1 Determine the wide-width tensile characteristics of the sample in accordance with EN ISO 10319, including the strain to rupture and lateral contraction of the specimens.

6.3.2 Evaluate the validity of using a specimen of a technically representative width (TRW) less than 200 mm, if required. Determine the tensile strength and strain at the maximum load of the TRW specimens.

6.3.3 Carry out the test at four load levels selected from a range between 50% and 90% of the measured tensile strength.

Load each of the four selected load levels on three specimens, i.e. test a total of 12 specimens.

> NOTE: It is recommended to choose first four logarithmically equally spaced times such as 100 h, 500 h, 2000h and 10000 h, to estimate the load level likely to lead to rupture at 100 h and to perform three parallel tests. From the results, make an estimate of the load likely to lead to rupture in 500 h. Then proceed to the other two load levels.

6.3.4 Prepare the specimens for the tensile creep rupture test and mount the specimens in the test apparatus. For woven geotextile specimens, the procedure described in EN ISO 10319 for the preparation of specimens shall be used.

Smoothly apply the full tensile creep load within not more than 60 s.

The zero time for the test is the time at which the full tensile creep load is applied to the specimen.

6.3.5 Record the time at which tensile creep rupture occurs.

7 Calculations (for use of TRW specimens)

When using specimens with a TRW less than 200 mm, samples with a coarse weave or geogrids, the way in which the specimen width is determined, is important. The number of tensile elements per metre width is determined as follows:

Lay the sample, a full roll width if possible, on a flat surface and smooth out any wrinkles and creases. Using a rule, at least 1,5 m long, measure the width corresponding to the number of tensile elements present in approximately one metre, the actual width to be measured to the nearest millimetre. Use the number of elements to calculate the number of tensile elements per metre width to within 0,1 units. Record the number of tensile elements in the specimen.

When using specimens where the resolution of the fabric structure into individual tensile elements is not practical and a TRW of less than 200 mm is to be used, the following procedure shall be followed:

Specimens of the geotextile shall be prepared at a width of less than 200 mm but greater than 50 mm, using the method of specimen preparation described in EN ISO 10319. Determine the tensile strength and strain at maximum load on specimens 200 mm wide and the reduced width using the procedure described in EN ISO 10319. Calculate the tensile strength and strain at maximum load for both the 200 mm and the reduced-width specimens.

EXAMPLE 1:

A geogrid has 43 ribs or tensile elements in a width of 986 mm. Therefore the number of tensile elements per metre width is 43,6 per metre.

A specimen for a wide-width tensile test has eight tensile elements, representing a nominal width of :

$$(8 / 43,6) \times 1000 \approx 183,5 \text{ mm}$$

The mean specimen strength was determined to be 10,8 kN with a mean strain at maximum load of 12,8%, lateral contraction 0%.
The tensile strength per metre width is:

$$(1000 / 183,5) \times 10,8 \approx 58,9 \text{ kN/m}$$

A TRW specimen of three tensile elements represents a specimen width of:

$$(1000 \times 3) / 43,6 \approx 68,8 \text{ mm}$$

The mean tensile strength of 10 TRW specimens is determined to be 4086 N with a mean strain at the maximum load of 13,4%. Hence the tensile strength per unit width is:

$$(43,6 / 3) \times 4086 \approx 59,4 \text{ kN/m}$$

Therefore, as the tensile strengths of the wide-width tensile test and the TRW specimens deviate by less than 5% and the strain at maximum load deviates less than 20%, the use of TRW specimens for the tensile creep test is allowed.

EXAMPLE 2:

For 200 mm wide specimens, the tensile strength was determined to be 220,4 kN/m and the strain at maximum load was 10,7%.
For 60 mm wide specimens, the tensile strength was determined to be 213,4 kN/m and the strain at maximum load was 15,2%.
The tensile strength measured using the 60 mm wide specimens is within 5% of the strength measured using the 200 mm wide specimens, but the strain at maximum load measured using the 60 mm wide specimens differs more than 20% from that measured using the 200 mm wide specimens, and therefore the use of 60 mm wide specimens as the TRW is not permitted.

8 Test report

The test report shall include the following information:

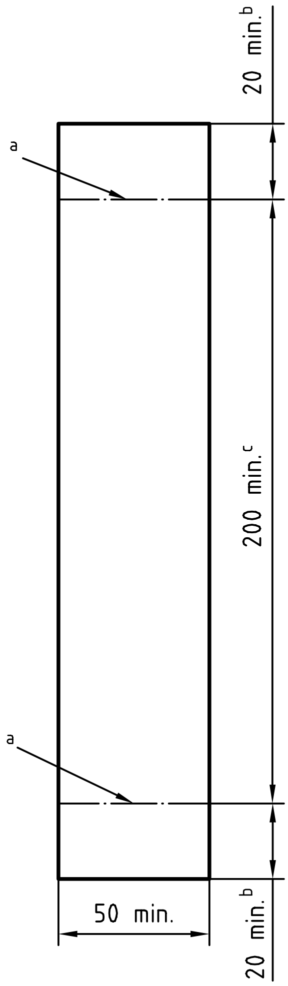
- for both test procedures:
  a) number and year of publication of this standard;
  b) identification of the sample, date of receipt;
  c) conditioning atmosphere;
  d) dates between which the tests were carried out;

e) mean wide-width tensile test strength, strain(s) and lateral contraction of the specimens;
f) details of the justification for the use of Technically Representative Width specimens for the tensile creep test (if applicable);
g) dimensions, tensile strength specified by the manufacturer, mean tensile strength and strain(s) of the specimens used for tensile creep testing (if applicable);
h) atmosphere in which the test was carried out;
i) description of the loading system, the grips and the extensometry apparatus;
j) tensile creep loads used (in kilonewtons per metre) and as a percentage of the tensile strength reported in e);
k) table of the results of the creep strain versus time measurements;
l) details of any deviations from the above procedures.

- for the determination of the tensile creep behaviour:
  m) nominal gauge length;
  n) Graphs of the creep strain versus log time for each specimen, for each tensile creep load and if applicable for each temperature The graph shall include all data points.

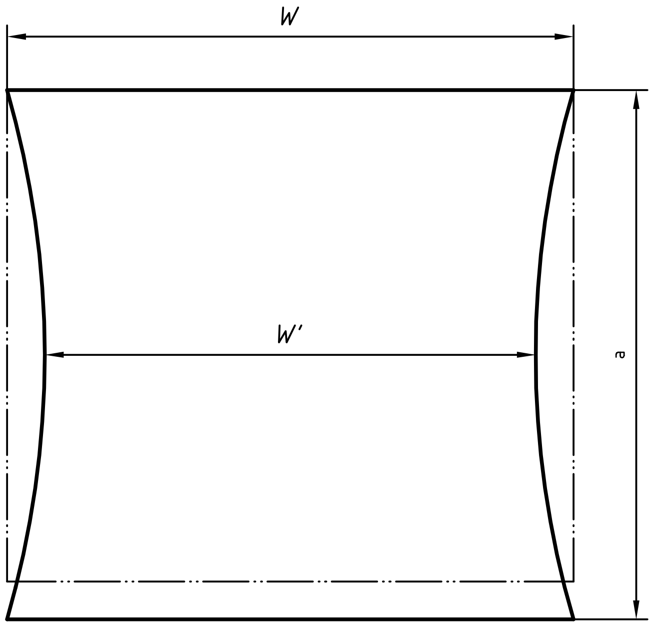
- for the determination of the tensile creep rupture:
  o) times to tensile creep rupture for each specimen (in a table);
  p) graph of tensile creep loads against time to rupture (on a logarithmic time scales) for each temperature, if applicable, and a regression line and lower 95% confidence limit.

Dimensions in millimeter



a) marks
b) distance to grips
c) gauge length
d) distance to grips

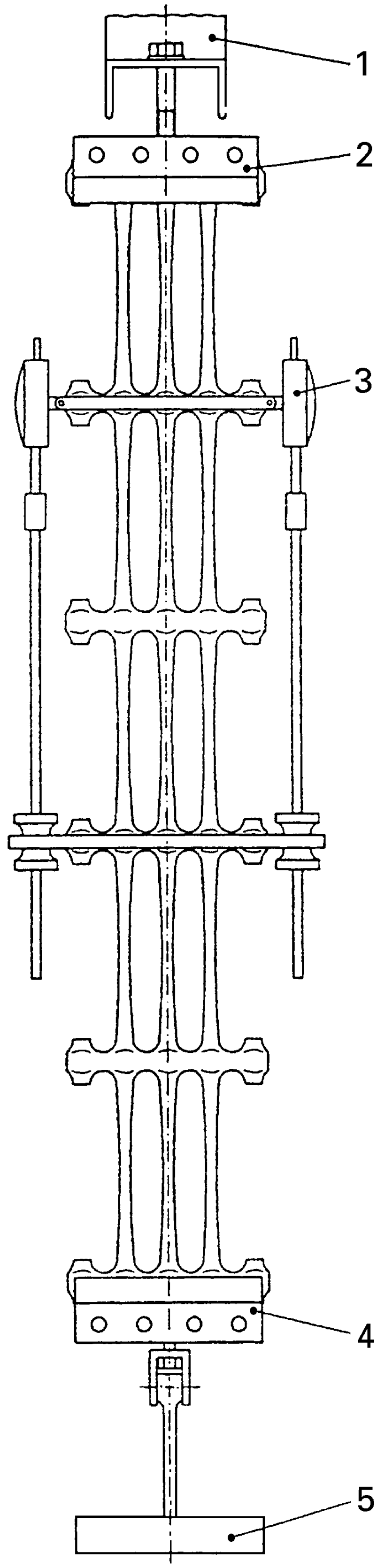
Figure 1: Specimen details



a)gauge length

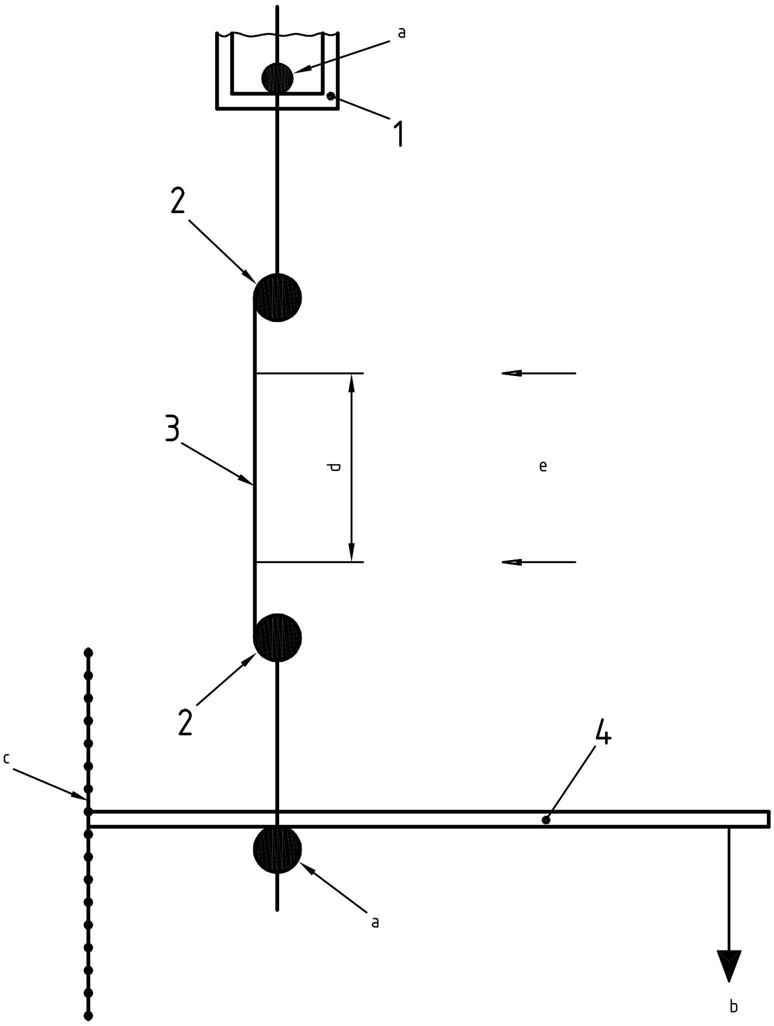
NOTE: To use a specimen less than 200 mm wide the value of the lateral contraction shall not be more than 10%, where:
Lateral contraction in % = ((W-W')/(W)).100

Figure 2: Definition of contraction



1 rigid support frame
2 upper jaw
3 dial gauge
4 lower jaw
5 weights

Figure 3: Tensile creep recording apparatus



1 rigid support frame
2 specimen grips
3 specimen
4 load support lever

a) spherical seating
b) load
c) adjustable fulcrum to allow load to be kept constant during the test
d) gauge length
e)remote extensometry apparatus

Figure 4: Typical lever arm loading system

Annex ZZ
(informative)

Corresponding International and European Standards for which equivalents are not given in the text

At the time of publication of this International Standard, the edition of the following document was 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 edition of the document indicated below. Members of ISO and IEC maintain registers of currently valid International Standards.

EN 963 ISO 9862:1990, *Geotextiles — Sampling and preparation of test specimens.*

ICS 59.080.70

Price based on 15 pages