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IS 13162-5 (1992): Geotextiles - Methods of Test, Part 5: Determination of Tensile Properties Using a Wide Width Strip [TXD 30: Geotextiles and Industrial Fabrics]

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# Indian Standard

## **GEOTEXTILES** — METHODS OF TEST

PART 5 DETERMINATION OF TENSILE PROPERTIES USING A WIDE WIDTH STRIP

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**BUREAU OF INDIAN STANDARDS** MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG NEW DELHI 110002

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**Price Group 3** 

#### FOREWORD

This Indian Standard (Part 5) was adopted by the Bureau of Indian Standards after the draft finalized by the Geotextiles Sectional Committee had been approved by the Textile Division Council.

Tensile characteristics of geotextiles are of particular importance if the geotextile has to perform the reinforcing function. The test methods for these characteristics depend on the type of geotextile that is woven or nonwoven. Among the popular tests are the strip tensile test, the grab test and the wide width strip tensile test. The methods for strip tensile test and grab test as given in IS 1969: 1985 are equally important for geotextiles.

This standard prescribes wide width strip tensile test. Most geotextiles can be tested by this methods. Some modification of techniques may be necessary for particular geotextiles, for example 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 this method and other methods for measuring tensile properties of fabrics, is the width of the specimen. This width by contrast is greater than the length of the specimen. Some geotextiles have a tendency to contract (neck down) under load in the gauge length area. The width of the specimen specified in this method reduees the contraction effect of those fabrics and provides a closer relationship to expected fabric behaviour in the field and a standard comparision of geotextiles.

This standard is based on draft international standard ISO/DIS 10319 Geotextiles - Wide width tensile test.

In reporting the results of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2: 1960 'Rules for rounding off numerical values (*revised*)'.

## Indian Standard

# **GEOTEXTILES — METHODS OF TEST**

#### PART 5 DETERMINATION OF TENSILE PROPERTIES USING A WIDE WIDTH STRIP

#### **1** SCOPE

1.1 This standard (Part 5) prescribes 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, non-wovens, layered fabrics, knitted fabrics and felts. The method is applicable to geogrids but thespecimen dimensions may need to be altered.

**1.2** This method covers the measurement of load elongation characteristics and includes procedures for calculation of secant stiffness, maximum load per unit width, strain at maximum load and equivalent strain at maximum load.

**1.3** Procedures for measuring the tensile properties of both conditioned and wet specimens are included.

**1.4** The measuring device can be either mechanical, optical or infra-red. In any case it shall not damage the sample.

#### 2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	Title
1070:1977	Water for general laboratory use (second revision)
1969 : 1985	Methods for determination of breaking load and elonga- tion of woven textile fabrics (second revision)
6359:1 <b>9</b> 71	Method for conditioning of textiles
13162 (Part 3): 1991	Geotextiles – Methods of Test: Part 3 Determination of thickness at specified pressures

#### **3 DEFINITIONS**

**3.0** For the purpose of this standard, the following deficitions shall apply.

#### 3.1 Extension at Preload

The extension corresponding to an applied load equal to 1 percent of the maximum load or 350 N which ever is less.

#### 3.2 Maximum Load

The maximum tensile force (in kN) obtained during a test (see Point D in Fig. 1).



FIG. 1 TYPICAL LOAD-STRAIN CURVE

#### 3.3 Secant Stiffness

The ratio of change in load per unit width to a stated value of strain (in kN/m) for example in Fig. 1 the percentage secant stiffness is (BC/CA).

#### 3.4 The Gauge Length

The distance between the two reference points of the sample. They are placed on the sample symmetry axis which is parallel to the applied load and are 6 cm apart (3 cm on each side of the sample symmetry center). This distance can be adapted for the geogrids in order to include an entire number of nodes in the gauge length.

#### 3.5 Increase in Gauge Length

The measured extension minus the extension at the preload.

#### 3.6 Strain

The increase in gauge length of a specimen during a tensile test expressed as a percentage of the initial nominal gauge length.

#### 3.7 Strain at Maximum Load

The percentage strain corresponding to the maximum load (see Point D in Fig. 1).

#### 3.8 Tensile Strength (kN/m)

The maximum resistance to deformation per unit width developed for a specific material when subjected to tension by one external force.

#### 3.9 Strain Rate

Strain rate of testing is defined as the speed of the jaws expressed as a percentage of the initial jaw separation. The initial jaw separation shall be as defined in 8.1.1.

When testing with capstan grips, the strain rate shall be defined on the basis of the increase in gauge length at maximum load divided by the duration of the test.

#### **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, applying a longitudinal force 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  $\pm$  5 percent per minute for all geotextiles and related products, if constant rate of extension tensile testing machine is used. In case of constant rate of traverse tensile testing machine, the rate of traverse shall be 20  $\pm$  5 mm per minute.

#### **5** APPARATUS AND REAGENTS

#### 5.1 Tensile Testing Machines

A constant rate of extension (CRE) or a constant-rate-of-traverse (CRT) tensile testing machine as specified in IS 1969: 1985 shall be used.

5.2 Jaws which are sufficiently wide to hold the entire width of the specimen and with appropriate means to limit slippage or damage.

**5.2.1** Compressive grips will be used for most materials. For materials where the use of compressive grips gives rise to excessive jaw breaks or slippage, capstan grips may be used.

5.2.2 When capstan grips are used, the reason for their use and the separation between the centre of the capstan at the beginning of each test should be kept to a minimum. The use of capstan shall be specified in the report.

NOTE — It is stressed that it is essential to choose jaw faces that limits the slippage of the geotextile that may occur especially for stronger geotextiles. Examples of number of jaw faces that have been found satisfactory is given in Fig. 2 (a) to 2 (c). Other grips which limits slippage may also be acceptable. Examples of jaw designs suitable for testing geogrids are given in Fig. 3 (a) and (b).

#### 5.3 Extensiometer

**5.3.1** Extensiometer may also be used for testing in place of CRE or CRT tensile testing machines. The extensiometer shall be able to follow two reference points on the sample without any damage or slippage. Examples of extensiometers include mechanical, optical, infra-red or electrical devices.

**5.3.2** Care should be taken to ensure that the measurement represents the true movement of the reference points.

5.3.3 If any irregularity of the stress-strain curve due to the extensiometer is remarked, this result shall be discarded and another specimen shall be tested.

#### 5.4 Distilled Water

For wet specimens only (see IS 1070: 1977).

#### 5.5 Non-Ionic Wetting Agent

For wet specimens only.

#### **6 TEST SPECIMENS**

#### 6.1 Number of Test Specimens

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

#### 6.2 Selection of Test Specimen

6.2.1 The specimens shall be selected as specified in IS 13162 (Part 3): 1991.



FIG. 2 EXAMPLES OF JAWS FACES FOR TESTING GEOTEXTILES

#### 6.3 Dimensions of Test Specimens

**6.3.1** Prepare each finished test specimen 200 mm wide (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 for which the breaking load is being measured. Where appropriate and for slippage control, draw two lines running the full width of the test specimen, perpendicular to the length dimension and separated by 100 mm (except for capstan grips) [see Fig. 2(c)].

**6.3.2** For woven geotextiles cut each specimen 220 mm wide and then remove an equal number of threads from each side to obtain the 200 mm, nominal specimen width.

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

**6.3.3** For geogrids the specimen shall be of at least 200 mm width and sufficiently long to ensure a length of at least 100 mm. The test specimen shall contain at least 5 complete tensile elements with the width and at least one row of nodes or cross-members excluding the nodes or cross-members by which the test specimen is held in the jaws (see Fig. 4).

**6.3.3.1** The reference points shall be marked on a central row of tensile elements that are subjected to test and shall be at least 60 mm apart. The reference points shall be mounted at the central point of a rib and shall be separated by at least one node or cross member. If necessary, in order to achieve the minimum separation of 60 mm, the two reference points can be separated by more than one row of nodes or cross-members. In this case, the requirement to mount the reference points at mid-rib shall be maintained and the gauge length shall then be

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FIG. 3 EXAMPLES OF JAW DESIGN SUITABLE FOR TESTING GEOGRIDS



#### NOTES

1 The nodes and ribs on lines C and D are those by which the specimen is to be held in the jaws of the clamps.

2 Width W is greater or equal to 200 mm.

3 The gauge length shall be equal to or exceeded 60 mm and shall enclose at least one low cross-members. If it is necessary more rows or cross-members can be included in the gauge length until it exceeded 60 mm. The gauge length is always measured from mid rib to mid rib.

4 Cut all ribs at least 10 mm from any node.

#### FIG. 4 SPECIMENS OF GEOGRIDS

an integral number of pitches of the grid. Measure the gauge length within  $\pm 3$  mm.

**6.3.4** When both the wet maximum load and the dry maximum load are required, cut each test specimen at least twice the required length. Number each test specimen and then cut crosswise into two parts, one for determining the dry maximum load, and the other for determining the wet maximum load, each portion shall bear the specimen number. In this manner, each paired break is performed on test specimens containing the same threads.

NOTE — For geotextiles which shrink excessively when wet, the tensile strength is determined from the maximum load in wet conditions and the initial width before wetting.

#### **7 CONDITIONING ATMOSPHERE**

7.1 The test specimens shall be conditioned and the test conducted in the standard atmosphere for testing textiles as prescribed in IS 6359 : 1971.

#### NOTES

1 The test specimens may be considered to have been conditioned when the change in mass of the test specimen in any two successive weighings made at intervals of not less than 2 h does not exceed 0.25 percent of the original mass of the test specimen.

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

7.2 Test specimens to be tested in the wet condition shall be immersed in water, maintained at a temperature of  $27 \pm 2^{\circ}$ C. The time of immersion shall be sufficient to wet out the test specimens thoroughly, as indicated by no significant change in maximum load or stain following a longer period of immersion, and at least 24 hours. To obtain thorough wetting, it may be necessary to add not more than 0.05 percent of a nonionic neutral wetting agent (see 5.5) to the water.

#### **8 PROCEDURE**

#### 8.1 Setting up of Machine

8.1.1 Adjust the distance between the jaws at the start of the test to give a length of 100  $\pm$  3 mm except for geogrids and for geotextiles when using capstan grips. Select the force range of the testing machine such that the break occurs between 30 percent and 90 percent of full scale force. Set the machine to a rate of strain or rate of traverse as given in 4.1. Test the conditioned specimens in the atmosphere specified in 7.

**8.1.2** For wet test specimens perform the test within 3 minutes after removal from the water.

#### 8.2 Insertion of Test Specimen in Jaws

**8.2.1** Mount the test specimen centrally in the jaws. Take care that the specimen length in the

machine direction and cross direction tests, respectively, is parallel to the direction of application of force. Where appropriate do this by having the two lines, which were previously drawn 100 mm apart across the width of the test specimen positioned as close as possible adjacent to the inside edges of the upper and lower jaws.

#### 8.3 Installation of the Tensile Testing Machine on the Extensiometer

Place the reference points on the sample. Ensure that there will be no slippage of the points during the mounting of test specimens or during testing.

#### 8.4 Measurement of Tensile Properties

**8.4.1** Start the tensile testing machine and continue running the test until the specimen ruptures. Stop the machine and reset to the initial gauge position. Record and report the maximum load to an accuracy of 0.2 percent of the full scale and strain to the first decimal place.

**8.4.2** The decision to discard a break shall be based on observation of the specimen during the test upon the inherent variability of the geotextile and the provision of **5.4**. 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 percent of the average of all other breaks shall be discarded. No other break shall be discarded unless the test is known to be faulty.

NOTES

1 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, due to randomly distributed weak place, 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 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.

2 Special procedures are required for the preparation of test specimens made from specific materials (glass fibre, carbon, composite geotextiles, etc), to minimize damage in 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 gauge length of the test specimen at any stated load by means of a suitable recording device.

#### 9 CALCULATIONS

#### 9.1 Tensile Strength

Calculate the tensile strength (kN/m) directly from the information obtained from the tensile testing machine using the formula:

$$a_{\rm f} = F_{\rm f} \times C \qquad \qquad \dots (1)$$

where

- $a_{\rm f}$  = the tensile strength in kN/m of width;
- $F_{I}$  = the observed maximum load (in kN); and
- C = value obtained from formulae (2) or (3) given below as appropriate.

For nonwovens or close woven fabrics or similar materials:

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

where

B = specimen width in metres, or

For coarse woven fabrics, meshes, grids or similar materials:

$$C = N_{\rm m}/N_{\rm s} \qquad \dots (3)$$

where

- $N_{\rm m}$  = the minimum number of tensile elements within 1 m width of the product being tested; and
- $N_{\rm s}$  = the number of tensile elements within the test specimen.

#### 9.2 Strain at Maximum Load

Record the strain in percentage at the maximum load (see Fig. 1).

#### 9.3 Secant Stiffness

To calculate the secant stiffness, determine load for a specified strain, (see Point B in Fig. 1) and use the following formula:

$$J_{\text{sec}} = \frac{(F \times C \times 100)}{E}$$

where

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- $J_{\text{sec}}$  = the secant stiffness in (kN/m) at the specified strain E;
  - F = the determined load at strain E (in kN);
  - E = the corresponding percentage strain; and
  - C = value obtained from formulae (2) or (3) given in 9.1 as appropriate.

#### **10 TEST REPORT**

The test report shall include the following information:

- a) Identification of the sample tested;
- b) The mean tensile strength in both the machine direction and cross direction (see 9.1);
- c) If applicable, the mean strain at the maximum load in both the machine direction and cross direction (see 9.2);
- d) The mean secant stiffness corresponding to the strain of 2, 5 and 10 percent, if required;
- e) The standard deviation or coefficient of variation of any of the properties determined;
- f) The condition of the test specimens, that is wet or dry;
- g) The number of test specimens tested in each direction;
- h) The make and model of 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 load-strain curve with the yield points;
- m) Details of any deviations from the specified procedure; and
- n) Strain rate reported to 1 percent accuracy.

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