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INTERNATIONAL STANDARD ISO 5081

H-36-25

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

Textiles — Woven fabrics — Determination of breaking strength and elongation (Strip method)

Textiles — Tissus — Détermination de la force de rupture et de l'allongement de rupture (Méthode sur bande)

First edition — 1977-03-15

UDC 677.017.424.2 + 677.017.426 **Ref. No. ISO 5081-1977 (E)**

Descriptors : textiles, woven fabrics, tests, tension tests, determination, tensile strength, elongation at fracture, test specimens, test equipment.

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5081 was developed by Technical Committee ISO/TC 38, *Textiles*, and was circulated to the member bodies in February 1976.

It has been approved by the member bodies of the following countries :

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Textiles — Woven fabrics — Determination of breaking strength and elongation (Strip method)

1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard specifies a method, known as the "strip" method, for the determination of the breaking strength and elongation at break of woven textile fabrics (except woven elastic fabrics).

NOTE — The determination of breaking strength using the "grab" method is given in ISO 5082[1]. There is no simple relationship between results given by strip tests and those given by grab tests because the amount of assistance provided by the adjacent yarns depends on the type of weave, construction, mobility of yarns, and other factors.

1.2 The method is applicable to unimpregnated fabrics and to fabrics that have been impregnated with sizing or stiffening materials but not to fabrics coated with rubber or plastics.[2]

1.3 The method provides for the determination of the breaking strength and elongation at break of specimens in equilibrium with the standard atmosphere for testing, and of specimens in the wet state.

1.4 The method authorizes the use of the following types of testing machine in common use for measuring breaking strength and elongation of fabrics :

a) constant-rate-of-specimen-extension (CRE) (see clause 5 and annex A, clause A.1);

b) constant-rate-of-traverse (CRT) (see clause 5 and annex A, clause A.2);

c) constant-rate-of-load (CRL) (see clause 5 and annex A, clause A.3).

The three types of testing machine do not necessarily give the same results for the same fabric. The type of tester to be used must, therefore, be agreed upon by all parties interested in the test results, and must be reported. As it has been found that the breaking strengths obtained on different types of tester agree best when the time-to-break is the same, the method provides for testing at specific times-to-break (see 4.2), and rates of extension, traverse, or loading are not specified.

NOTE — When the time-to-break has been the same, excellent experimental agreement has been reported between results obtained with CRE and CRT testers, but results given by CRL testers have in some cases been reported to differ somewhat from the other results.

2 REFERENCES

ISO 139, *Textiles — Standard atmospheres for conditioning and testing.*

ISO 2602, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

3 DEFINITIONS

For the purpose of this International Standard the following definitions apply.

3.1 breaking strength : The maximum tensile force observed during a test in which the specimen is stretched until it breaks.

3.2 elongation (extension) : The increase in length of a specimen during a tensile test, expressed in units of length, for example centimetres, millimetres, etc.

1) ISO 5082, *Textiles — Woven fabrics — Determination of breaking strength (Grab method).* (At present at the stage of draft.)

2) The determination of breaking strength and elongation at break of fabrics coated with rubber or plastics is dealt with in ISO 1421, *Rubber-coated and plastics-coated fabrics — Determination of breaking strength and elongation at break.*

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3.3 elongation % (extension %) : The increase in length of a specimen during a tensile test, expressed as a percentage of the nominal gauge length.

NOTE — In a tensile test, the elongation % (extension %) is calculated on the basis of the nominal gauge length of a pre-tensioned specimen.

3.4 elongation at break : The elongation produced by the breaking force (i.e. by the maximum force applied during a determination of breaking strength).

3.5 nominal gauge length : The length of a specimen under specified pre-tension, measured from nip to nip of the jaws of the holding clamps in their starting position.

3.6 strip test : A breaking strength test in which the full width of the specimen is gripped in the jaws.

3.7 time-to-break : The interval, measured in suitable units such as seconds, during which the specimen is under a (generally increasing) tension, i.e. absorbing the energy supplied before the breaking force is reached.

NOTE — Time-to-break does not include the time required to remove slack from the specimen. On machines supplied with an autographic recorder, the time-to-break is indicated by the time elapsing after the pen registers the initial force sustained by the specimen until the pen registers the maximum force.

4 PRINCIPLE

4.1 Breaking strength and elongation

An increasing force is applied (until break occurs) by a suitable mechanical means that indicates the maximum force and the elongation at break. The testing machine is operated at such a rate that the average time-to-break of a group of specimens falls within specified time limits. Elongation when a specified force is applied or the force required to produce a specified elongation (or both) may be reported if desired.

4.2 Time-to-break

Unless otherwise agreed upon by the parties interested in the test results, the specified period for the average time-to-break shall be either 20 ± 3 s or 30 ± 5 s.

5 APPARATUS

5.1 Tensile testing machine meeting the following requirements :

5.1.1 *Type*

The type of machine shall be one of those described in annex A, as mutually agreed upon by the parties interested in the test results.

5.1.2 *Machine requirements*

The tensile testing machine shall include a pair of clamps suitable for gripping the specimen, a means of elongating the specimen at suitable rates, and a force-indicating mechanism which will indicate (or record) continuously the force applied to the specimen and the accompanying elongation. An autographic recorder is desirable for the determination of elongation at a specified force.

5.1.3 *Accuracy of recorder*

The dynamic response rate of the recorder shall be sufficiently rapid to ensure that the steepest part of the force/elongation curve is recorded accurately. The maximum error of the indicated force at any point in the range in which the machine is used shall not exceed 1 %. Any error in indicated clamp separation shall not exceed 1 mm. Before the test verify the accuracy of the graduated scale of the apparatus.

5.1.4 *Gauge length*

The testing machine shall be capable of testing specimens that have a nominal gauge length of 200 mm or, in the case of fabrics that have an elongation at break greater than 75 %, 100 mm.

5.1.5 *Jaws*

The central points of the two jaws of the machine shall be in the line of pull, the front edges shall be at right angles to the line of pull, and their clamping faces shall be so aligned as to maintain specimens in a plane. The jaws of the clamps shall be capable of holding the specimens without slippage and without causing apparent damage, and shall have gripping faces of width at least 60 mm. The gripping faces of the jaws shall, preferably, be smooth and flat, but when the specimens under test cannot be satisfactorily held with unlined flat-faced jaws, jaws with lined or engraved or corrugated faces may be used. (Lining materials suitable for use with both smooth jaws and corrugated jaws include paper, felt, leather, plastics, and sheet rubber.)

5.1.6 *Rates of operation*

All testing machines shall include facilities for producing such different constant rates of operation as will allow specimens to be fractured in the applicable average times-to-break, i.e. unless otherwise agreed (see 4.2) 20 ± 3 s or 30 ± 5 s. Different rates can be obtained most readily by means of a continuously variable drive, but satisfactory results can be obtained by means of a series of steps, provided that the latter are small enough. The ratio between the rates produced by consecutive steps should not exceed 125 : 100.

5.2 Equipment in which specimens can be immersed in water preparatory to wet testing (see 8.4).

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5.3 Equipment for cutting specimens and for fraying them down to the required width.

5.4 Stop-watch or **interval-timer.**

5.5 Distilled or de-ionized water for wetting out specimens.

5.6 Wetting agent or **surfactant,** non-ionic.

6 ATMOSPHERES FOR TESTING

6.1 Standard atmosphere for testing

The standard temperate atmosphere for testing has a relative humidity (RH) of 65 ± 2 % at a temperature of 20 ± 2 °C. The standard tropical atmosphere for testing has the same relative humidity and a temperature of 27 ± 2 °C. (See ISO 139.)

6.2 Pre-conditioning atmosphere

Suitable atmospheres and procedures for pre-conditioning are specified in ISO 139.

NOTE — Air at 20 °C and 65 % RH has a water vapour pressure of 1 515 Pa* and when heated to 47 ± 2 °C will produce an atmosphere having an RH of 12,3 % to 16,7 %. Air at the maximum permissible limits of 22 °C and 67 % RH has a vapour pressure of 1 700 Pa and when heated to 50 °C has an RH in the range of 14,3 % to 19,4 %. If it is desired to keep the RH below 10 % and not to exceed a temperature of 50 °C, the original air must have a water vapour pressure below 1 230 Pa (equivalent to 53 % RH at 20 °C or 30 % RH at 27 °C).

7 SAMPLES

7.1 Both bulk samples and laboratory samples shall be taken in one or the following ways, as appropriate :

a) according to the directions given in the relevant material specification;

b) if directions for sampling are not included in the material specification, according to the procedures approved by ISO for textile products;

c) if neither a) nor b) is applicable, according to the method given in annex B.

7.2 Laboratory samples shall be conditioned as follows :

7.2.1 Except in the case of heat-sensitive materials, the laboratory samples from which specimens are to be taken shall be pre-conditioned by exposing them for at least 12 h to freely moving air in the special atmosphere for pre-conditioning as given in 6.2.

7.2.2 After pre-conditioning (when relevant), the samples shall be brought to moisture equilibrium for testing by exposing them for at least 24 h (48 h in the case of samples of tightly woven material) to the appropriate standard atmosphere for testing as given in 6.1.

8 SPECIMENS

8.1 General

From each laboratory sample two sets of test specimens shall be cut, one set in the warp direction and the other in the weft direction. Unless otherwise agreed by the parties interested in the test results, each set shall consist of at least five specimens, except that if a higher degree of precision is required, more specimens shall be tested.[1] The specimens shall be as representative of the sample as possible. No two specimens shall contain the same longitudinal threads, and no warp direction specimen shall be cut from nearer either selvedge than one-tenth of the width of the test sample. An example of cutting specimens to meet the above conditions is given in the figure, annex C. Additional specimens shall be used for adjusting the time-to-break of the testing machine. All specimens shall be cut and tested in the standard atmosphere for testing.

8.2 Dimensions

The width of each test specimen shall be 50 mm excluding any fringe) and its length shall be such as to provide a nominal gauge length of 200 mm, except that for fabrics that have an elongation at break greater than 75 % the nominal gauge length may be reduced to 100 mm. Test specimens having widths other than the preferred width of 50 mm may be tested if given in the material specification or as agreed between the interested parties. In the case of fabrics containing few threads per centimetre the width of the specimen shall be as wide as to accommodate at least 20 threads. This shall be stated in the test report.

* 1 Pa = 1 N/m^2

1) The parties interested in the test results are referred to ISO 2602.

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8.3 Preparation of specimens

Each specimen shall be cut with its length parallel to the warp or the weft of the fabric and sufficiently wide to allow the necessary fringes, and threads shall be removed in approximately equal numbers from each of the long edges of the cut strip until the width of the specimen is as specified in 8.2. The width of the fringes shall be such that during testing no longitudinal threads escape from the fringes. For the majority of fabrics fringes of about 5 mm or 15 threads will be sufficient. Fabrics of very open weave may require up to 10 mm. For very closely woven fabrics a much narrower fringe may be satisfactory.

For fabrics which cannot be frayed in this manner, warp and weft specimens shall be cut along lines 50 mm apart and parallel to the appropriate thread direction. In some fabrics the thread direction cannot be determined except by tearing, but the specimen shall not be reduced to the specified width in this way.

8.4 Wet test specimens

8.4.1 When the wet breaking strength of the fabric is required in addition to the dry breaking strength, strips of the appropriate width and at least twice as long as the specimens required for a dry test shall be cut. Each end of each strip, shall be numbered, frayed down (when relevant), and then each specimen shall be cut crosswise into two parts, one for determining the dry breaking strength and the other for determining the wet breaking strength. (This ensures that each pair of specimens contains the same longitudinal yarns.) For fabrics which shrink excessively when wet, the initial length of test specimens for the determination of wet breaking strength must be greater than that of specimens for dry breaking strength tests.

8.4.2 The wet test specimens shall be laid on the surface of distilled or de-ionized water at a temperature between 17 and 30 °C, until they sink under their own weight, but if this period exceeds 2 h they shall be forcibly immersed in the water for at least a further 1 h.

When complete wetting of specimens that are normally resistant to wetting is essential, an aqueous solution containing not more than 1 g of a non-ionic wetting agent per litre may be used instead of the water.

9 PROCEDURE

9.1 Checking of apparatus

Check the testing machine to ensure that the distance between the clamps is equal (to within 1 mm) to the relevant nominal gauge length (see 5.1.4). Check also that the clamps are properly aligned and parallel (to ensure that the subsequent application of force to the specimen will not cause any angular deflection of either clamp). Ensure that the appropriate standard atmosphere for testing prevails (see 6.1), and that the recording mechanism is operating properly.

9.2 Mounting of specimens

Mount a specimen centrally in the testing machine so that the longitudinal axis of the specimen is at right angles to the edges of the clamps after pre-tensioning (see 9.3). In the case of tests on wet specimens, mount them immediately after removal from the water.

9.3 Pre-tensioning

9.3.1 Unless the use of a lower tension is necessary (see 9.3.2) apply either of the following tensions :

a) a tension equal to 1 ± 0,25 % of the probable breaking strength;

b) the tension given in table 1 appropriate to the mass per unit area of the fabric under test.

TABLE 1 — **Pre-tensioning of specimens**

Mass, g/m^2	Force, N
Up to and including 150	2
Over 150 up to and including 500	5
Over 500	10

9.3.2 If the tension chosen in terms of 9.3.1 elongates the specimens by more than 0,5 %, use a lower tension that is acceptable to the parties interested in the test results.

NOTE — If, owing to the construction of the testing machine or for other reasons, no pre-tension is applied, this shall be stated in the test report [11 i)].

9.4 Preliminary test

Use an additional specimen (see 8.1) and after pre-tensioning (if relevant), set the moving clamp in motion at a rate estimated to result in an average time-to-break as specified. In the case of tests on wet specimens, ensure that the test is completed within 120 s of removal of the specimen from the water.

After the specimen has been broken, note

a) the maximum force recorded;

b) the elongation at break;

c) the time-to-break.

Return the moving clamp to its zero position, remove the ends of the broken specimen, and repeat the above procedure on two more additional specimens.

If the average time-to-break of the first three preliminary tests does not fall within the applicable limits, i.e. unless otherwise agreed (see 4.2) 20 ± 3 s or 30 ± 5s, discard the results and, using a suitably different rate of traverse of the moving clamp, repeat the procedure described above. Continue in this way until the average time-to-break is within the applicable limits.

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9.5 Final tests

9.5.1 Using the final rate of operation established in accordance with 9.4, test the required number of specimens (see 8.1). For each specimen note the maximum force recorded and the elongation at break.

9.5.2 Discard the result on any specimen that slips in the clamp or breaks in the clamp or within 5 mm of the edge of the clamp, if there is reason to believe that the machine has operated in a faulty manner. Otherwise, accept the result provided that the breaking strength is not lower than the lowest result and/or that the elongation at break is not higher than the highest result obtained on specimens from the same sample which break in a normal manner.

When results are discarded, repeat the test on a replacement test specimen taken (if practicable) from the same part of the test sample as the discarded specimen.

10 EXPRESSION OF RESULTS

10.1 Units (all tests)

Express the breaking strength in newtons. Record the observed elongation in millimetres.

10.2 Calculation of average breaking strength and elongation at break

For each set of warp and weft direction specimens calculate (separately) the following :

a) average breaking strength, using the formula :

$$\overline{F} = \frac{\Sigma F_i}{n}$$

where

$\overline{F}$ is the average breaking strength, in newtons;

ΣF_i is the sum of the observed values of breaking strength, in newtons;

n is the number of observations.

Express the average breaking strength to a precision of 1 %.

b) percentage elongation of individual specimens, using the formula :

$$E_i = \frac{100\,\Delta L}{L}$$

where

E_i is the percentage elongation at break of an individual specimen;

ΔL is the observed elongation at break, in millimetres;

L is the nominal gauge length of the specimen, in millimetres.

c) average percentage elongation at break, using the formula :

$$\overline{E} = \frac{\Sigma E_i}{n}$$

where

$\overline{E}$ is the average percentage elongation at break;

ΣE_i is the sum of the calculated percentage elongations at break as obtained in 10.2 b);

n is the number of observations.

Round off the average elongation at break to the nearest 0,2 % when the average elongation does not exceed 10 %, to the nearest 0,5 % when it is over 10 % and below 50 %, and to the nearest 1 % when it is 50 % or greater.

11 TEST REPORT

The test report shall state that the test was performed in accordance with this International Standard and shall also include the following particulars :

a) the date of the test;

b) the value of breaking strength of each specimen, and the average breaking strength of each laboratory sample, in newtons (warp and weft directions separately);

c) the observed value of percentage elongation at break of each specimen, and the average percentage elongation at break of each laboratory sample (warp and weft directions separately);

d) the time-to-break (either 20 ± 3 s or 30 ± 5 s);

e) the sampling scheme used;

f) the number of specimens tested of each laboratory sample;

g) the width of the specimens and the gauge length;

h) the type (whether CRT, CRE or CRL) and capacity of the testing machine used;

i) details of any deviation from the specified test procedure;

j) state of the specimens (conditioned or wet).

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ANNEX A

TYPES OF TESTING MACHINE

A.1 CONSTANT-RATE-OF-SPECIMEN-EXTENSION TYPE OF TESTING MACHINE

A.1.1 Principle

The specimen is elongated at a predetermined constant rate which is such that the average time-to-break will fall within the specified limits.

A.1.2 Testing machine

A constant-rate-of-extension testing machine shall comply with the requirements given in clause 5. After the first 2 s of the operation the rate of increase in the distance between the clamps shall be uniform to within 5 %. The testing machine shall be capable of operating at such different constant rates of elongation that, regardless of the extent of elongation, the specimen is elongated to breaking point within the applicable time limits.

A.2 CONSTANT-RATE-OF-TRAVERSE TYPE OF TESTING MACHINE (Pendulum or spring weighing mechanism)

A.2.1 Principle

The specimen is subjected to an increasing force by the moving clamp traversing at a constant rate which is such that the average time-to-break will fall within the specified limits.

A.2.2 Testing machine

A constant-rate-of-traverse testing machine with a pendulum or a spring type weighing mechanism shall comply with the requirements given in clause 5. The machine shall be capable of operating at such different constant rates of traverse that, regardless of the strength of the specimen, the breaking point is reached within the applicable time limits.

A.3 CONSTANT-RATE-OF-LOAD TYPE OF TESTING MACHINE

A.3.1 Principle

The specimen is subjected to a force that increases at a predetermined constant rate which is such that the average time-to-break will fall within the specified limits.

A.3.2 Testing machine

A constant-rate-of-load tensile testing machine shall comply with the requirements given in clause 5. After the first 2 s of the test operation, the rate of increase of force per unit time shall be uniform to within 10 %. The machine shall be capable of applying a range of constant rates of loading such that, regardless of the strength of the specimen, the breaking force (maximum force) required can be applied within the applicable time limits.

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ANNEX B

SUGGESTED PROCEDURE FOR SAMPLING

B.1 BULK SAMPLE (number of pieces from a shipment or lot)

Take at random from the shipment or lot the appropriate number of pieces shown in table 2. Ensure that no piece that shows signs of damage or dampness incurred during transit is included in the sample.

TABLE 2 — **Bulk sample**

Number of pieces in shipment or lot	Number of pieces in bulk sample, minimum
3 or less	1
4 to 10	2
11 to 30	3
31 to 75	4
76 or more	5

B.2 NUMBER OF LABORATORY SAMPLES

From each piece in the bulk sample, cut (from a position taken at random but at least 3 m from an end of the piece) a laboratory sample of length at least 1 m and of full width. Ensure that areas that are creased or that have visible faults are not included in a sample, and roll each sample on a tube.

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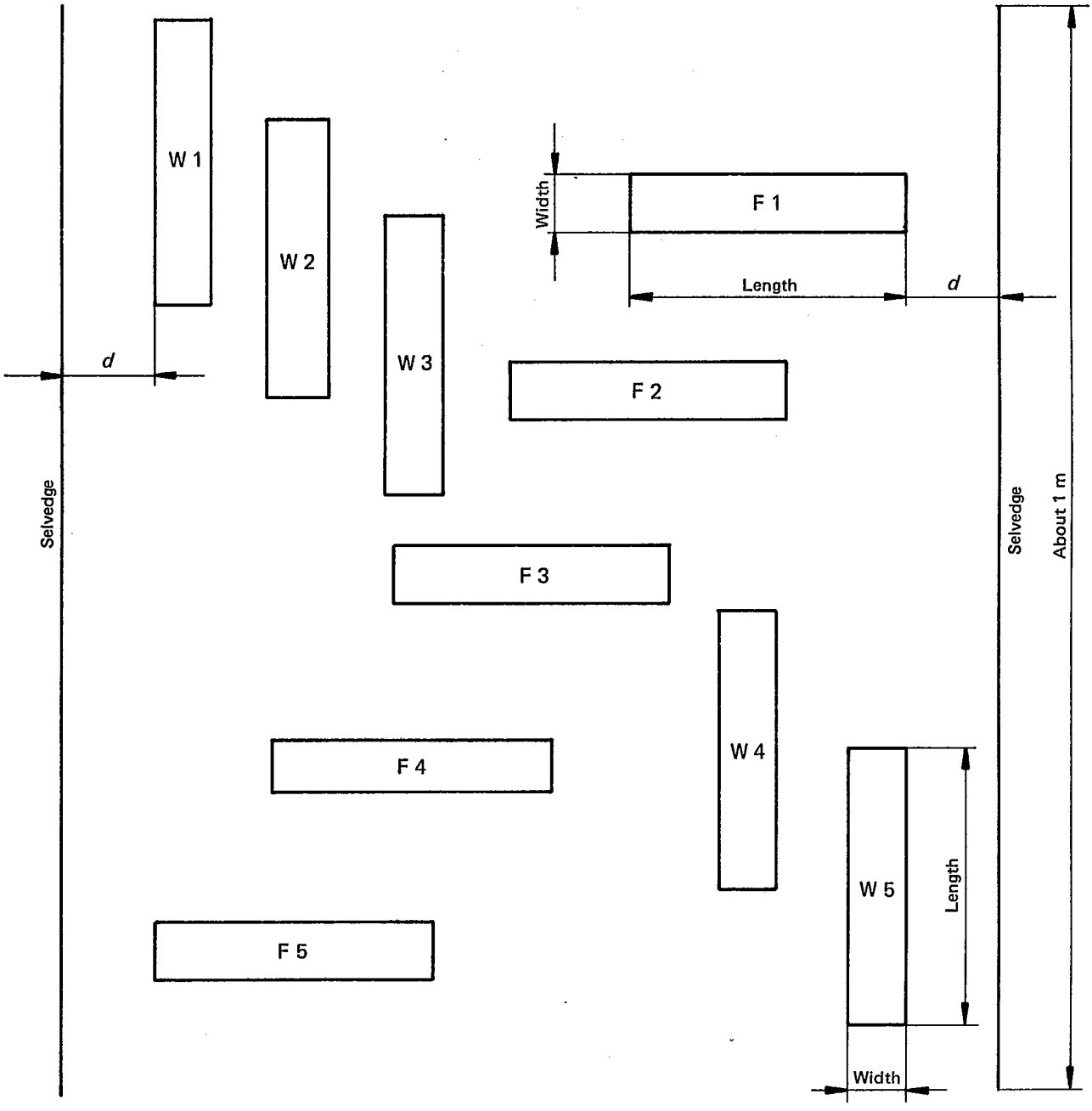
ANNEX C

EXAMPLE OF CUTTING SPECIMENS



d = at least one-tenth of width of sample
W : warp direction F : weft direction

FIGURE 1 — **Example of cutting specimens**

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