International Standard (ISO) 6383/2

Plastics — Film and sheeting — Determination of tear resistance —
Part 2: Elmendorf method

Plastiques — Film et feuille — Détermination de la résistance au déchirement — Partie 2: Méthode Elmendorf

First edition — 1983-09-01

UDC 678.5/.8-416 : 620.176.245

Ref. No. ISO 6383/2-1983 (E)

Descriptors: plastics, tests, tear strength, tear tests, test specimens.

O 6383/2-1983 (E)

Price based on 6 pages

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

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 6383/2 (formerly ISO/DIS 6824) was developed by Technical Committee ISO/TC 61, *Plastics*, and was circulated to the member bodies in February 1980.

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

Australia	Germany, F.R.	Philippines
Austria	Hungary	Poland
Belgium	India	Portugal
Brazil	Ireland	Romania
Canada	Israel	South Africa, Rep. of
China	Italy	Spain
Czechoslovakia	Japan	Switzerland
Egypt, Arab Rep. of	Korea, Rep. of	United Kingdom
Finland	Mexico	USA
France	Netherlands	USSR

The member body of the following country expressed disapproval of the document on technical grounds:

Sweden

Plastics — Film and sheeting — Determination of tear resistance — Part 2: Elmendorf method

0 Introduction

ISO 6383 consists of the following parts:

Part 1: Trouser tear method.

Part 2: Elmendorf method.

1 Scope and field of application

1.1 This part of ISO 6383 specifies a method of determining the force required to propagate a tear through a specified distance and from a specified slit, cut in a test specimen of thin flexible plastic sheeting or film, under specified conditions of loading.

The upper limit of thickness that can be tested depends on the tearing force of the material in relation to the capacity of the testing machine.

Materials that can be tested according to this method include flexible poly(vinyl chloride) (PVC) and polyolefin films, but variable elongation and oblique tearing effects on the more extensible films may cause poor reproducibility of test results. This method may not be suitable for testing more rigid materials such as rigid PVC, nylon and polyester films.

1.2 The tear resistance test specified by this method is applied to specimens cut from semi-finished and finished products. The test is suitable for the control of production and manufactured products as well as for acceptance or rejection testing under specifications for semi-finished and finished products, provided that it has been demonstrated that the data for a particular material are acceptably reproducible.

1.3 There is no direct linear relationship between tearing force and specimen thickness. Data from this method are expressed as tearing force in newtons, with specimen thickness also reported. Only data obtained at the same thickness should be compared because sets of data from specimens of dissimilar thickness are generally not comparable.

2 References

ISO 291, *Plastics — Standard atmospheres for conditioning and testing.*

ISO 4591, *Plastics — Film and sheeting — Determination of average thickness of a sample and average thickness and yield of a roll by gravimetric techniques (gravimetric thickness).*

ISO 4593, *Plastics — Film and sheeting — Determination of thickness by mechanical scanning.*

3 Definition

For the purpose of this part of ISO 6383, the following definition applies.

tear resistance: The force, in newtons, required to tear a test specimen by the specified method.

4 Principle

A test specimen having a specified precut slit is subjected to a tearing force generated by the energy stored in a pendulum of specified dimensions. The energy expended in tearing the specimen is used to calculate the tear resistance of the specimen.

5 Apparatus

The test machine shall be of the Elmendorf type (an example of a suitable test machine is shown diagrammatically in figure 1), comprising the following.

5.1 Stationary jaw, accurately aligned with a movable jaw carried on a pendulum, preferably formed by a sector of a circle, free to swing on ball bearings or other substantially frictionless bearings. Each jaw shall have a clamping surface of not less than 25 mm in the horizontal direction [dimension *b* (see

figure 1)] and not less than 15 mm in the vertical direction (dimension *c*). The thickness of the fixed portion of each jaw shall be between 9 and 13 mm (dimension *a*). When the pendulum is in the initial position, ready for the test, the jaws shall be separated by a distance of 2,8 ± 0,3 mm and so aligned that the test specimen clamped in them lies in a plane perpendicular to the plane of oscillation of the pendulum, with the edges of the jaws gripping the test specimen in a horizontal line, a perpendicular to which through the axis of suspension of the pendulum (i.e. the distance between the axis and the top edges of the clamping jaws) is 104 ± 2 mm long and makes an angle of 27,5° ± 30' with the plane of the test specimen.

5.2 Means for holding the pendulum in a raised position and for releasing it without imparting shock.

5.3 Means for determining the energy expended by the pendulum in tearing a specimen. This usually consists of a circumferential scale on the pendulum which indicates against a pointer. The machine shall be accurately calibrated (allowing for friction and windage losses) to enable the scale reading to be used to give the force required to tear the standard test specimen in newtons, with an accuracy to within 1 % . This calibration shall be periodically checked. Annexes A and B give instructions for the adjustment and calibration of the apparatus.

5.4 Incremental masses, to add to the pendulum to increase the tearing force capacity of the machine.

5.5 Suitable measuring equipment, to measure the thickness of the material being tested by the methods specified in ISO 4591 and ISO 4593.

6 Test specimens

6.1 The test specimen shall have the shape and dimensions shown in figures 2 or 3. The preferred or referee specimen shall be the constant-radius specimen (figure 2) because of better reproducibility (see 8.5).

6.2 The test specimen may be cut from the sample using templates and a sharp knife. Special attention shall be given to the cutting of the 20 ± 0,5 mm slit, which shall be free of nicks and ragged edges.

NOTE — Some testing machines have a permanent and integral knife by which the slit can be cut into the test specimen after mounting in the jaws of the machine. In such cases, the sharpness of this knife and its ability to cut the slit to the correct dimensions should be frequently checked.

6.3 Unless otherwise specified by the specification for the material being tested, five test specimens [or five groups of test specimens (see the note)] shall be tested in each principal direction of the film sample, cut from positions evenly spaced across the width of the sample.

NOTE — In the case of films of low tear strength, it is permissible to test a group of two or more test specimens simultaneously in order to meet the requirements of 8.3. Cut the individual test pieces for each group adjacent to each other, but space the groups approximately evenly across the width of the sample. However, certain specimens in

the same sandwich may tear obliquely in opposite directions, which may lead to falsely high results. When this testing behaviour is encountered, single specimens must be tested even though scale readings may be in the range below 20. For thin film, it is recommended that single specimens and a lower capacity tester be used rather than several specimens and a higher capacity machine.

6.4 When testing film in the machine (longitudinal) direction, test specimens shall be oriented so that their width is cut in the longitudinal direction and, similarly, specimens for transverse tear strength determinations shall be cut with their width in the transverse direction.

7 Conditioning

Unless otherwise specified by the specification for the material being tested, test specimens shall be preconditioned and tested in atmosphere 23/50 as specified in ISO 291, except that when material is known not to be sensitive to humidity, atmosphere 23 may be used.

8 Procedure

8.1 Determine the thickness of the material being tested by the method specified in ISO 4591 and ISO 4593.

NOTE — ISO 4593 is not suitable for use with embossed film and sheeting.

8.2 Check that the Elmendorf apparatus is level. Lift and arrest the pendulum, set the indicating mechanism to the starting position and gently release the pendulum. Check that the pointer indicates zero and adjust if necessary according to the manufacturer's instructions.

8.3 Carry out a few tests by the procedure specified in 8.4 to check whether augmenting weights are required or a number of test specimens need to be tested simultaneously (see the note to 6.3) so that on any test the energy of the pendulum absorbed in tearing lies between 20 and 80 % of the total energy of the pendulum. Check the zero setting and adjust according to the manufacturer's instructions each time that augmenting weights are fitted or removed.

8.4 Lift and arrest the pendulum of the machine and set the indicating mechanism to its starting point. Carefully position the test specimen, or group of test specimens, in the jaws of the grips so that the slit is centrally disposed between the fixed and movable jaws of the machine and tighten the clamps firmly (see the note). Carefully release the pendulum and read from the scale the force expended in tearing the specimen or group of test specimens.

NOTE — When the machine is fitted with an integral slitting knife, clamp the specimen as in 8.4 and then operate the knife to produce the slit (see the note to 6.2).

8.5 When constant-radius test specimens (see figure 2) are used, reject any tests in which the line or tear deviates outside the constant radius section and test additional specimens to replace those rejected.

When rectangular test specimens (see figure 3) are used, reject any tests in which the line of tear deviates more than 10 mm from the line of the slit, except when the tear is following a specific line of an embossed pattern, and test additional specimens to replace those rejected. When the tear deviation consistently exceeds 10 mm, use the constant-radius test specimens.

9   Calculation and expression of results

9.1   From the scale readings, determine, according to the machine manufacturer's instructions, the force in newtons required to tear each test specimen, taking account of any use of augmenting weights and groups of specimens torn simultaneously. Record this force in newtons as the tear resistance of each test specimen.

9.2   Calculate the arithmetic mean tear resistance in each principal direction of the film or sheeting.

9.3   If required, calculate the standard deviation for each set of results.

10   Test report

The test report shall include the following:

a)   a reference to this part of ISO 6383;

b)   complete identification of the material tested including type, source, manufacturer's code, form, principal dimensions and previous history;

c)   thickness of the material and method of measuring thickness;

d)   the standard atmosphere of ISO 291 used for conditioning and testing;

e)   type of test specimen used;

f)   the number of specimens tested, including the number in each group if appropriate;

g)   the mean tear resistance in each principal direction;

h)   individual test results and standard deviation, if required;

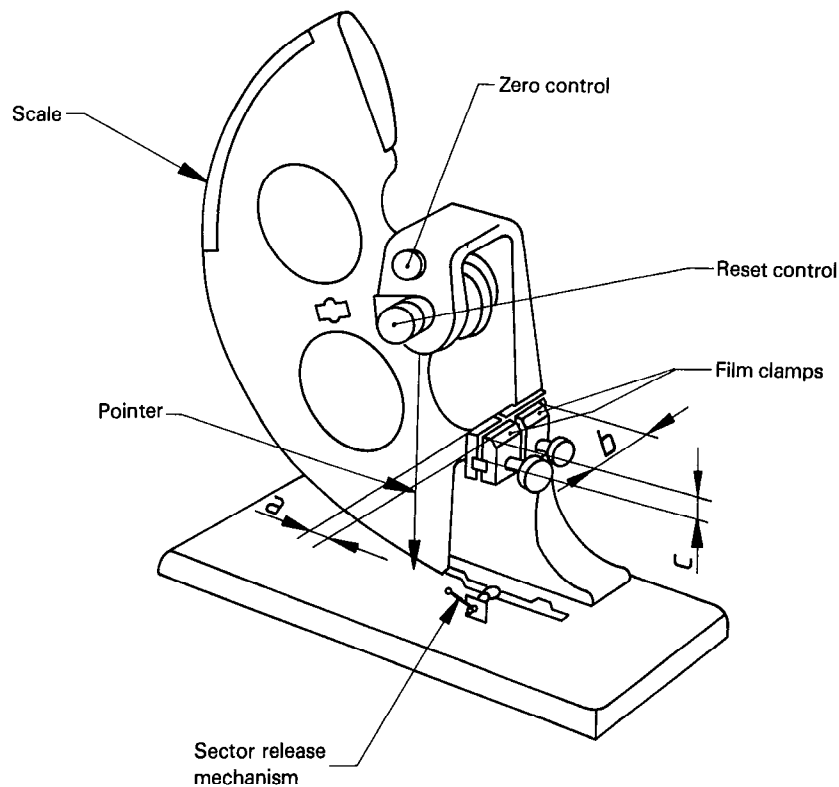j)   any operational details not specified in this part of ISO 6383 that may have had an influence upon the result.

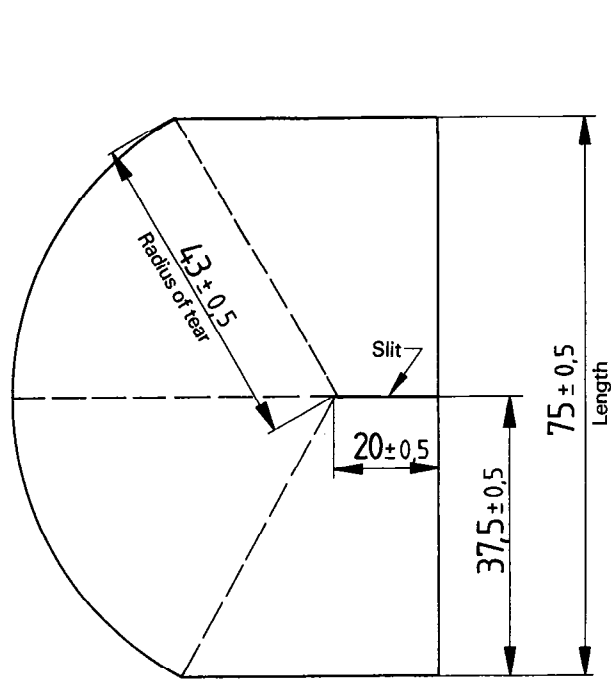**Figure 1 — Elmendorf tear test apparatus**

Dimensions in millimetres

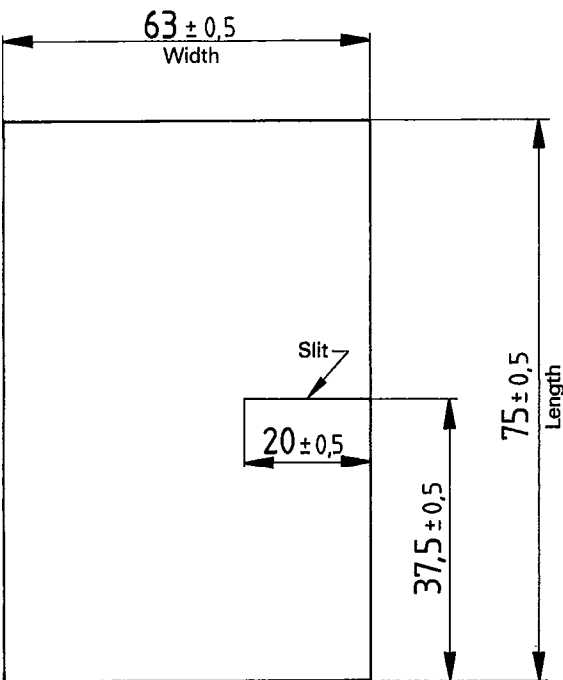**Figure 2 — Constant-radius test specimen**

Figure 3 — Rectangular test specimen

Annex A

Adjustment and maintenance of the instruments

(This annex does not form part of the Standard.)

Follow the procedure described below for each of the pendulum/additional weight combinations used.

A.1 Inspection

Check the following items and make any necessary adjustments.

a) Check that the pendulum shaft is not bent.

b) Check that the distance between clamps is 2,8 ± 0,3 mm and that when the pendulum is in its initial position, the clamps are in alignment.

c) Check that the knife fitting is secure, and that the cutting edge is sharp and undamaged. The blade shall be situated midway between, and at right angles to, the top of the clamps.

d) Ensure that the pointer is undamaged and rigidly attached to the sleeve.

A.2 Levelling

Mount the instrument on a rigid bench and, if possible, firmly attach it to the bench.

With the pendulum clamp closed, adjust the level of the instrument so that the pendulum hangs vertically and the index marks on the pendulum and base coincide. With the stop depressed, displace the pendulum slightly and after it comes to rest, check that the index marks still coincide.

A.3 Zero adjustment

After levelling, operate the instrument several times with clamps empty and closed to ascertain whether the pointer registers zero. If zero is not registered, move the adjustable pointer stop.

A.4 Pendulum friction

Make a reference mark on the stop mechanism 25 mm to the right of the edge of the pendulum catch. Raise the sector to its initial position and set the pointer so that it does not meet the pointer stop when the instrument is operated.

When the sector is released and the pendulum stop held down, the sector should make at least 35 complete oscillations before the edge of the sector which engages with the catch no longer passes to the left of the reference mark. Otherwise, clean, oil or adjust the bearing.

A.5 Tearing length

Adjust the position of the knife. Check that the tearing length is 43,0 ± 0,5 mm. If this is not so, adjust the dimensions of the guillotine or template used.

Annex B

Calibration of the instrument

(This annex does not form part of the Standard.)

Calibration of the instrument may be checked by measuring the work done by the pendulum in raising various attached weights. The indicated scale reading is then compared with the amount of work done. Many tear testers are provided with a threaded hole to aid the attachment of weights.

The position of the centre of gravity of the attached weights should be known.

Set up the instrument and check it as specified in annex A. With various weights attached, operate the instrument without a test piece in position and determine the scale reading and height above a horizontal datum surface of the centre of gravity of the additional weight corresponding to this scale reading.

Calculate the correct scale readings Y from the formula

$$Y = \frac{9,81 \times m \times (h - H)}{0,086 \times P}$$

where

Y is the correct scale reading (scale units);

m is the mass, in kilograms, of the added weight;

h is the height, in metres, above the datum surface of the centre of gravity of the attached weight;

H is the height, in metres, of the centre of gravity of the attached weight above the datum surface with the pendulum in the initial position;

P is the pendulum factor, i.e. theoretically the number of sheets torn simultaneously for which the pendulum scale has been calibrated to give a direct tearing resistance reading in millinewtons, commonly 8, 16 or 32.

For routine calibration checks, an alternative procedure is to prepare a graph giving $(h - H)$ for different scale readings. It is then only necessary to determine the scale reading for a given added weight, to read off the corresponding value of $(h - H)$ and to calculate the error using this value.

Calculated and indicated scale readings should agree to within ± 1 %. If they do not, the fault should, if possible, be found and remedied. Otherwise, prepare a correction chart and adjust the results accordingly.