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Flexible cellular polymeric materials — Determination of fatigue by constant-load pounding

*Matériaux polymères alvéolaires souples — Détermination de la fatigue par
indentation à charge constante*

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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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3385 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*.

This third edition cancels and replaces the second edition (ISO 3385 : 1982), of which it constitutes a minor revision.

ISO 3385:1989

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International Organization for Standardization

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Flexible cellular polymeric materials — Determination of fatigue by constant-load pounding

1 Scope

This International Standard specifies a method for the determination of loss in thickness and loss in hardness of flexible cellular materials intended for use in upholstery.

This test method provides a means of assessing the service performance of flexible cellular materials of the latex and polyether urethane types used in load-bearing upholstery.

The measured loss in thickness and loss in hardness are related to, but are not necessarily the same as, the losses likely to occur in service.

The method is applicable both to standard size test pieces cut from stock material and to shaped components.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated 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 standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 2439 : 1980, *Polymeric materials, cellular flexible — Determination of hardness (indentation technique)*.

3 Principle

Repeated indentation of a test piece by an indenter smaller in area than the test piece, the maximum load reached during each cycle being kept within specified limits.

4 Apparatus

Pounding test machine, having the following parts.

4.1 Plane platen, capable of fully supporting the test piece, and suitably vented with holes approximately 6 mm in diameter at approximately 20 mm pitch in order to allow air to escape from the test piece.

4.2 Indentor, having an overall diameter of $250 \text{ mm} \pm 1 \text{ mm}$ with a $25 \text{ mm} \pm 1 \text{ mm}$ radius at its lower edge, provided with a device for applying a maximum force of $750 \text{ N} \pm 20 \text{ N}$ during one loading cycle. The indentor shall be rigidly fixed to its guide and its surface shall be smooth but not polished.

By means of a crank or other suitable mechanism, the machine shall be capable of oscillating either the platen (4.1) carrying the test piece, or the indentor support mounting (4.3), towards the other in a vertical direction at a rate of (70 ± 5) strokes per minute. The amplitude of the stroke shall be adjustable.

4.3 Indentor support mounting, such that the indentor force is carried by it except at that part of the stroke when the mounting and platen are closest together; at this point the full force of the indentor shall be supported by the test piece. The indentor shall be free to be lifted in its mounting to prevent overloading of the test piece. Means shall be provided whereby at any stroke the time can be controlled during which the full force is exerted by the indentor. This time shall be no more than 25 % of the total duration of each cycle.

4.4 Force measuring device, whereby the load applied to the test piece by the indentor can be measured. A suitable method consists in mounting the platen upon load cells.

NOTE — Where adjustment is manual, the indentor is attached to the lower end of a shaft which passes through a vertical guide above the platen carrying the test piece. Adjustment of the vertical position of the indentor relative to the platen controls the length of time at any stroke that the full force of the indentor is supported by the test piece. A suggested arrangement is shown diagrammatically in figure 1.

A suggested method of securing automatic adjustment is shown in figure 2, whereby the length of time during which the test piece supports the indentor is controlled directly by the time during which the valve is open.

5 Test pieces

5.1 Shape and dimensions

Test pieces shall be right parallelepipeds having sides of length $380 \text{ mm} \pm 20 \text{ mm}$ and a thickness of $50 \text{ mm} \pm 2 \text{ mm}$. Tests may also be carried out on components that do not comply with these dimensions subject to agreement between the interested parties.

5.2 Samples showing orientation

If the products show an orientation of the cellular structure, the direction in which the indentation is to be carried out shall be agreed upon between the interested parties. Normally, testing is carried out in that direction in which the finished product will be stressed under service conditions.

5.3 Number

Three test pieces shall be tested.

5.4 Conditioning

Test pieces shall not be tested less than 72 h after manufacture unless it can be demonstrated that, at either 16 h or 48 h after manufacture, the compression stress-strain characteristics obtained do not differ by more than $\pm 10\%$ from those obtained after 72 h. Testing is permitted at either 16 h or 48 h if, at the selected time, the above criterion has been satisfied.

Prior to the test, the test pieces shall be stored for at least 16 h at either

23 °C \pm 2 °C, 50 % \pm 5 % relative humidity, or

27 °C \pm 2 °C, 65 % \pm 5 % relative humidity.

This period can form the latter part of the period following manufacture.

6 Procedure

Measure the thickness d_1 of one of the test pieces and its hardness index as specified in ISO 2439.

Place the test piece concentrically under the indenter, adjust the stroke to be equal to the thickness of the test piece and adjust the relative positions of the indenter and platen until the specified load of 750 N \pm 20 N is applied. Adjustment of the indenter mass may be required.

NOTE — In the case of the manually adjusted arrangement shown in figure 1, the correct setting is achieved when the indenter is just lifted in its mounting. In the case of the arrangement shown in figure 2, these adjustments are automatic. However, slight movement of the indenter in its mounting may not be clearly visible, but provided that the valve is operated at each stroke, the conditions of the test are satisfied.

As the foam softens during the test, it is necessary, if automatic adjustment is not provided, that the indenter position be adjusted manually sufficiently frequently to maintain the above test load of 750 N \pm 20 N.

Run the machine for 80 000 continuous load cycles and then remove the test piece from the machine and allow to rest in an unstrained state for 10,0 min \pm 0,5 min.

Remeasure the thickness d_2 of the test piece as specified in ISO 2439 and then carry out the measurement of hardness index at 40 % \pm 1 % indentation as specified in sub-clause 7.2 (method A) of ISO 2439 : 1980, including the preliminary indentation procedure specified in sub-clause 7.1 of that International Standard, except that the 40 % \pm 1 % indentation level shall be calculated using the original thickness measurement d_1 .

Repeat the whole procedure, from the measurement of the original thickness and hardness index at the beginning of this clause, for the two remaining test pieces.

7 Expression of results

7.1 Loss in thickness

The percentage loss in thickness Δd given by the formula

$$\Delta d = 100 \times \frac{d_1 - d_2}{d_1}$$

where

d_1 is the original thickness;

d_2 is the final thickness.

Express the result as the median of the values obtained for the three test pieces.

7.2 Loss in hardness

The loss in hardness ΔH is given by the formula

$$\Delta H = H_1 - H_2$$

where

H_1 is the original hardness;

H_2 is the final hardness.

Express the result as the median of the values obtained for the three test pieces.

NOTE — This method of expressing hardness loss results as absolute rather than percentage losses has been selected because analysis of experimental data shows that the variability of results is reduced by this method of expression. The commonly used percentage loss is related to the absolute loss by the following formula :

$$\text{Percentage hardness loss} = 100 \times \frac{H_1 - H_2}{H_1}$$

8 Test report

The test report shall include the following information :

- a reference to this International Standard;
- a description of the material;
- the conditioning used;
- the size and shape of the component tested, if different from the standard test piece;
- the predominant direction of the cellular structure, if any;
- the median percentage thickness loss after pounding;
- the median hardness loss after pounding.

NOTE — An example of how to express briefly the dynamic fatigue characteristics determined in accordance with this International Standard is as follows :

ISO 3385/median percentage thickness loss/median hardness loss.