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Incorporating corrigendum August 2014

BSI Standards Publication

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

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National foreword

This British Standard is the UK implementation of EN ISO 3385:2014. It supersedes BS EN ISO 3385:1995 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PRI/24, Testing of rigid and flexible cellular materials.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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31 August 2014	Implementation of CEN Correction Notice 6 August 2014: ISO committee reference in EN Foreword corrected

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EUROPÄISCHE NORM

EN ISO 3385

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ICS 83.100

Supersedes EN ISO 3385:1995

English Version

Flexible cellular polymeric materials - Determination of fatigue by constant-load pounding (ISO 3385:2014)

Matériaux polymères alvéolaires souples - Détermination de la fatigue par indentation à charge constante (ISO 3385:2014)

Weich-elastische polymere Schaumstoffe - Bestimmung der Ermüdung im Dauerschwingversuch mit Stoßbelastung unter konstanter Kraft (ISO 3385:2014)

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Ref. No. EN ISO 3385:2014 E

Foreword

This document (EN ISO 3385:2014) has been prepared by Technical Committee ISO/TC 45 "Rubber and rubber products" in collaboration with Technical Committee CEN/TC 249 “Plastics” the secretariat of which is held by NBN.

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of an identical text or by endorsement, at the latest by January 2015, and conflicting national standards shall be withdrawn at the latest by January 2015.

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Endorsement notice

The text of ISO 3385:2014 has been approved by CEN as EN ISO 3385:2014 without any modification.

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information.

The committee responsible for this document is ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 4, *Products other than hoses*.

This fourth edition cancels and replaces the third edition (ISO 3385:1989), which has been technically revised.

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 load-bearing applications such as upholstery.

It provides a means of assessing the service performance of flexible cellular materials based on rubber latex or polyurethane used in load-bearing upholstery.

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

This international Standard is not intended to function as a detailed engineering design specification for fatigue apparatus.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2439:2008, *Flexible cellular polymeric materials — Determination of hardness (indentation technique)*

3 Principle

Repeated indentation of a test piece by an indentor smaller in area than the test piece, the maximum load reached during each cycle being kept within specified limits. The typical loading cycle is shown in Figure A.1.

4 Apparatus

4.1 Pounding test machine of either Type A (see 4.2) or Type B (see 4.3), having the following parts.

4.1.1 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.

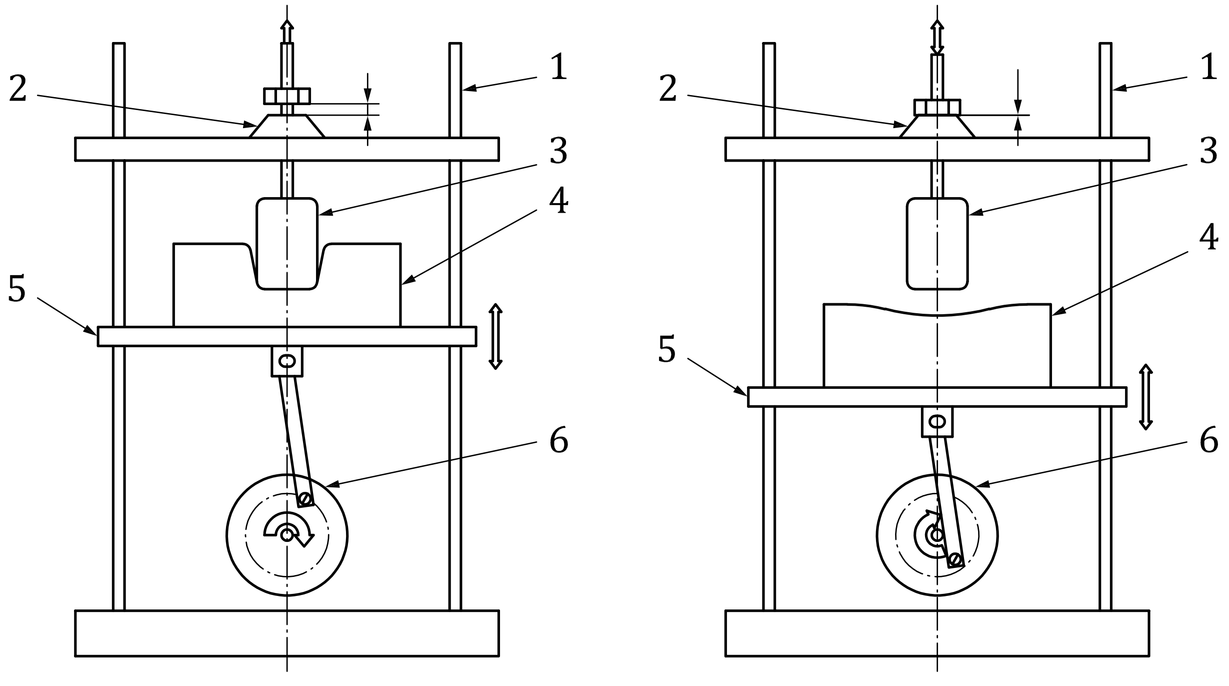
4.1.2 Indentor, having an overall diameter of 250 mm ± 1 mm with a 25 mm ± 1 mm radius at its lower edge, provided with a device for applying a maximum force of 750 N ± 20 N during the loading cycle. The indentor shall be rigidly fixed to its guide and its surface shall be smooth but not polished.

The machine shall be capable of oscillating either the platen (4.1.1) carrying the test piece, or the indentor towards the other in a vertical direction at a rate of (70 ± 5) strokes per minute. The amplitude of the stroke shall be adjustable.

The indentor shall be linked to a re-settable counting device which displays the number of compression cycles performed during the test.

4.1.3 Indentor drive mechanism, capable of applying the maximum force of 750 N ± 20 N for no more than 10 % of the total duration of each cycle.

4.2 Machine Type A, in its simplest form the mechanism comprises a crank drive and suspended weight. The weight shall be supported throughout the loading cycle 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; this shall not be for more than 10 % of the full machine cycle. This type of device is shown schematically in Figure 1 a) and Figure 1 b). The moving platen (5) shall be fitted with appropriate means to locate the test piece and prevent its lateral movement during the test.



a) Full loading point **b) Zero load point**

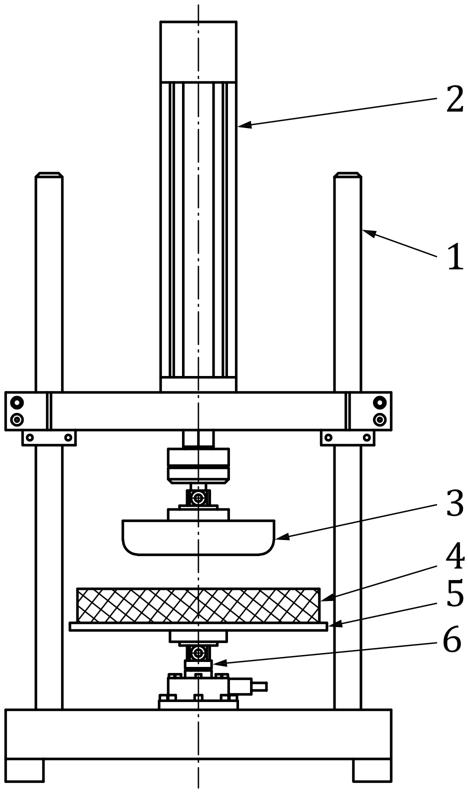
Key

1 load frame
2 indentor mounting
3 indentor
4 test piece
5 moving platen
6 drive shaft/cam

Figure 1 — Example of an arrangement of machine Type A with manual adjustment

4.3 Machine Type B, a fully controlled device driven by electro-, pneumatic or hydraulic mechanism, equipped with load cell and means to provide the necessary indentation frequency and peak force. The generic form of machine Type B is illustrated schematically in Figure 2. Figure 3 is an outline drawing of one of the commercially available machines, but is not meant to exclude other machines that comply with the essential requirements.

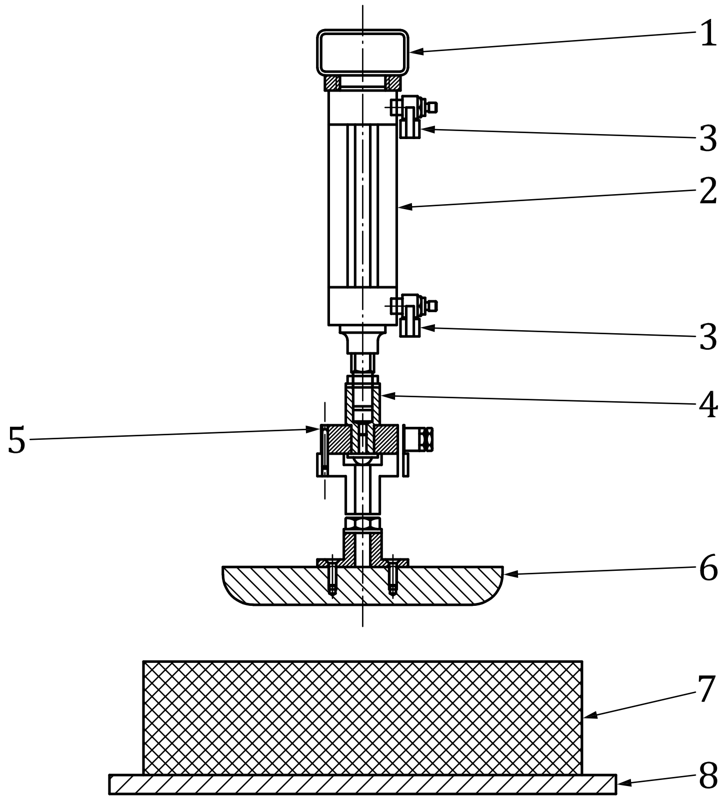
The apparatus shall be capable of measuring the maximum force with a precision of ±1 %. Compliance with specified limits shall be provided by graphical or other visual display.



Key

1 load frame
2 actuator (electro-mechanical, pneumatic or servo-hydraulic)
3 indentor
4 test piece
5 support platen
6 load cell

Figure 2 — Examples of diagrammatic arrangements of machine Type B with fully automatic adjustment — a) Generic design



Key

1 beam
2 electromechanical, pneumatic or hydraulic cylinder
3 flow control valve
4 load cell adapter
5 load cell
6 indentor
7 test piece
8 base plate

Figure 3 — Examples of diagrammatic arrangements of machine Type B with fully automatic adjustment — b) Example of one commercially available apparatus

Type B machines shall be equipped with a force-measurement device, whereby the maximum load applied to the test piece by the indentor during every cycle shall be measured. The maximum force shall be controlled within 750 N ± 20 N tolerance throughout the full duration of the pounding process.

The support platen (5) or base plate (8) (as appropriate) shall be fitted with appropriate means to locate the test piece and prevent its lateral movement during the test.

5 Test pieces

5.1 Shape and dimensions

Test pieces shall be right parallelepipeds having sides of length 380 mm ± 20 mm and a thickness of 50 mm ± 2 mm. Tests may also be conducted on components that do not comply with these dimensions subject to agreement between the interested parties.

5.2 Samples showing orientation

Normally, testing shall be conducted in that direction in which the finished product will be stressed under service conditions. If materials show cell structure orientation, the direction in which the indentation is applied may be agreed between the interested parties.

5.3 Number

Three test pieces shall be tested.

5.4 Conditioning

5.4.1 Material shall not be tested less than 72 h after manufacture, unless at either 16 h or 48 h after manufacture it can be demonstrated that the result does not differ by more than ±10 % from that obtained after 72 h. Testing is permitted at either 16 h or 48 h if, at the specified time, the above criterion has been satisfied.

5.4.2 Prior to the test, the test pieces shall be conditioned, undistorted, for at least 16 h in one of the specified atmospheres as follows:

a) 23 °C ± 2 °C, 50 % ± 5 % relative humidity, or

b) 27 °C ± 2 °C, 65 % ± 5 % relative humidity.

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

6 Procedure

6.1 Testing shall be conducted in a climate controlled atmosphere as specified in 5.4.

6.2 Perform all measurements on the same surface of the test specimen.

6.3 Measure the thickness, d_1, and its hardness index as specified in ISO 2439:2008, Method A.

6.4 Machine Type A: Place the test piece concentrically under the indentor, adjust the stroke to be equal to the thickness of the test piece with a tolerance of ±10 % and adjust the relative separation of the indentor and platen, until the specified load of 750 N ± 20 N is applied. The correct loading is achieved when the indentor is just lifted in its mounting and is completely unsupported.

As the foam softens during pounding, it is necessary for the indentor position to be continuously adjusted during the test sequence to maintain the above test load of 750 N ± 20 N.

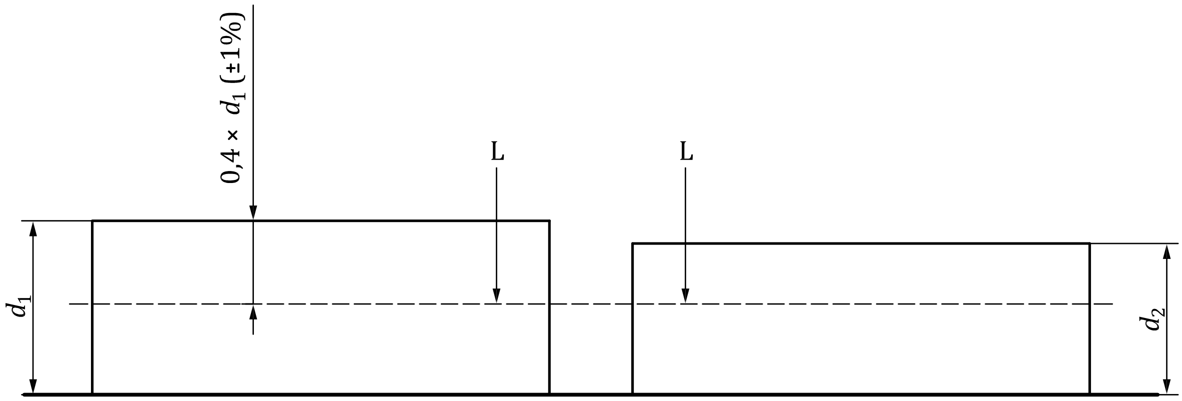
6.5 Machine Type B: Place the test piece concentrically under the indentor and set the indentor speed to provide an indentation frequency of (70 ± 5) strokes per minute in a way that approximates to a triangular or sinusoidal travel-time sequence.

Apply contact between indentor and specimen and, within the first 10 preliminary loading cycles, bring peak load and dwell time under control within specified limits. The maximum allowed force of 770 N shall not be exceeded at any time during the test. The dwell time at peak load shall not exceed 10 % of the full period time of the indentation cycle throughout the whole test.

During the test, ensure that the peak load of 750 N ± 20 N is constantly within tolerance by appropriate adjustment e.g. of the stroke or test speed. The indentor shall be completely discharged in each loading cycle of the test.

6.6 Run the machine for 80 000 continuous load cycles and then remove the test piece from the machine and allow it to rest in an unstrained state for 10 min ± 0,5 min, before performing fresh measurements on the fatigued area as described in 6.7.

6.7 Re-measure the thickness d_2 of the test piece as specified in ISO 2439 and then carry out the measurement of hardness index at (40 ± 1) % indentation as specified in Subclauses 7.2 and 7.3 (method A) of ISO 2439:2008, except that the (40 ± 1) % indentation level shall be calculated using the original thickness measurement d_1. This requirement is illustrated schematically in Figure 4.



a) Test piece before fatigue test

b) Test piece after fatigue test

Key

L indentation level

d_1 thickness of the test piece before fatigue test, expressed in millimetres

d_2 thickness of the test piece after fatigue test, expressed in millimetres

Figure 4 — Schematic representation of hardness re-test procedure

6.8 Repeat the whole procedure, from the measurement of the original thickness and indentation hardness, for the remaining test pieces.

7 Expression of results

7.1 Loss in thickness

The percentage loss in thickness, Δd (%), is given using Formula (1):

$$\Delta d\,(\%) = 100 \times \frac{d_1 - d_2}{d_1} \quad (1)$$

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 (N), is given using Formula (2):

$$\Delta H\ (\mathrm{N}) = H_1 - H_2 \tag{2}$$

where

H_1 is the original hardness (N);

H_2 is the final hardness (N).

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

7.3 Percentage hardness loss

The percentage hardness loss, ΔH (%), is given by Formula (3):

$$\Delta H\ (\%) = 100 \times (H_1 - H_2)/H_1 \tag{3}$$

where

H_1 is the original hardness (N);

H_2 is the final hardness (N).

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

8 Precision

An ITP study was conducted in 2012 under the supervision of experts from Germany and Japan, using procedural details contained in this International Standard. The results of this study are presented as Annex B.

Additional information from a UK study using machine Type B is contained in Annex C. This study was conducted in 2008 following the requirements of ISO 3385:1989.

9 Test report

9.1 The test report shall include the following information:

a) a reference to this International Standard;

b) a description of the material;

c) the conditioning used;

d) the size and shape of the component tested, if different from the standard test piece;

e) the predominant direction of the cellular structure, if any;

f) the type of machine used (Type A or B);

g) the median percentage thickness loss after pounding;

h) the median hardness loss after pounding;

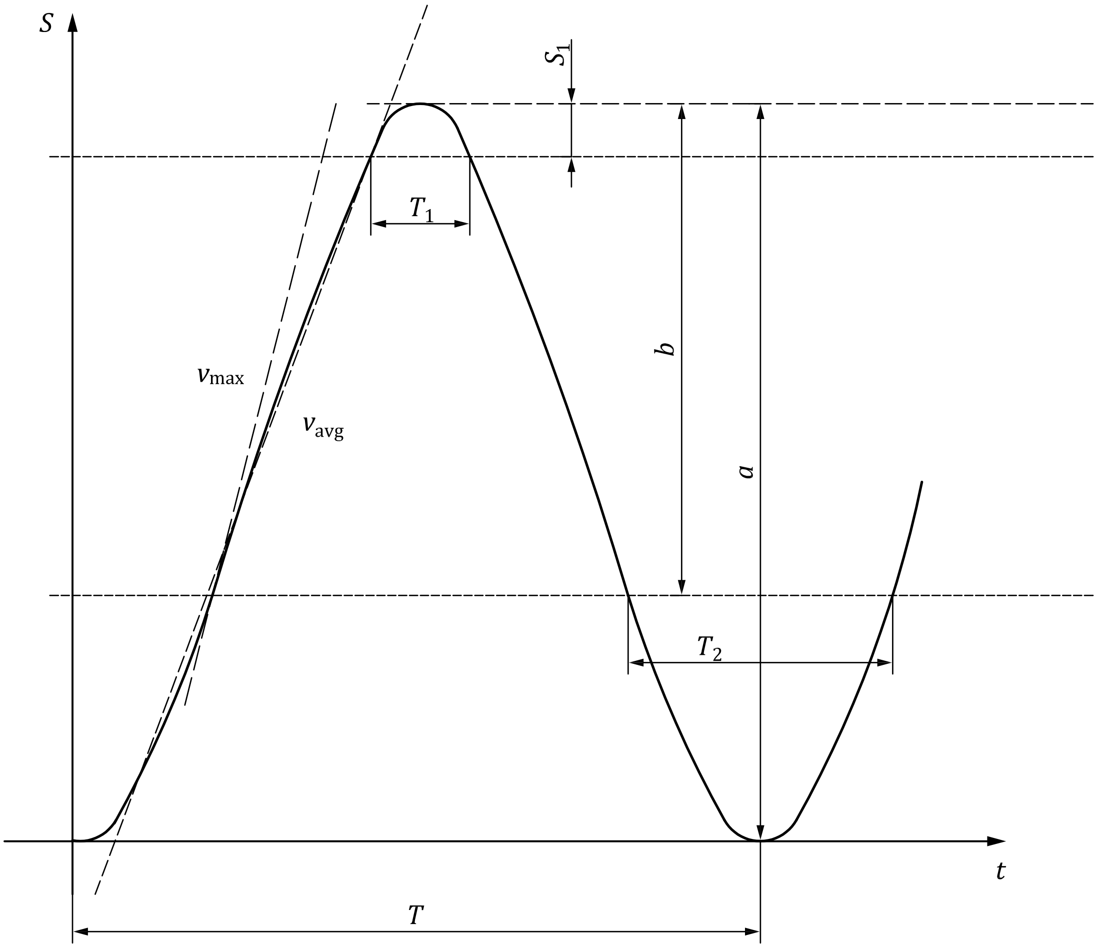
i) the median percentage hardness loss after pounding.

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

EXAMPLE ISO 3385 median percentage thickness loss median percentage hardness loss after pounding.

Annex A
(informative)

Typical loading cycle



Key

S	indentor stroke
S_1	indentor travel unsupported by mounting
t	time axis
T	time for one complete load cycle
T_1	dwell time at full loading
T_2	dwell time at zero load
v_{avg}	average indentor speed
v_{max}	maximum indentor speed
a	Indentor stroke = specimen thickness.
b	Indentor contact.

Figure A.1 — Graphical representation of loading cycle: manually adjusted machine

Annex B
(informative)

Precision

B.1 General

An interlaboratory test program (ITP) for the precision evaluation of the pounding fatigue test machines Type A and Type B described in this International Standard for flexible cellular foam was planned and conducted in 2012 and the calculation was carried out in accordance with ISO/TR 9272. Ten different laboratories from two countries participated in Type B testing [seven laboratories used Type B b) (see Figure 3) and other three used Type B a) (see Figure 2)] in this ITP but only one laboratory used Type A machine.

Two samples with two different levels of hardness were prepared for this ITP as shown in Table B.1 and sent out to each laboratory which had been requested to do the test as soon as the samples arrived. The test was carried out in two different days at one week's interval. Each sample comprised triplicate test pieces for each day (n = 3).

The precision results as determined by this ITP may not be applied to acceptance or rejection testing for any group of materials or products without documentation that the results of this precision evaluation actually apply to the products or materials tested.

Table B.1 — Flexible cellular foam sample

	Sample A	**Sample B**
Hardness level according to ISO 2439 (Average N)	Low (140 N)	High (300 N)
NOTE Each sample was conditioned and tested according to this International Standard.		

B.2 Precision results

The precision results are summarized and given in Table B.2. This result was obtained using outlier deletion procedures as described in ISO/TR 9272, therefore the number of laboratories in Table B.2 is given after the outliers were deleted. Table B.3 is for information only since only one laboratory's data are shown.

Repeatability: The repeatability, r, of the test method has been established as the appropriate value tabulated in Table B.2 for each material. Two single test results that differ by more than the value shall be considered suspect and suggest that some appropriate investigative action be taken.

Reproducibility: The reproducibility, R, of the test method has been established as the appropriate value tabulated in Table B.2 for each material. Two single test results that differ by more than the value shall be considered suspect and suggest that some appropriate investigative action be taken.

Table B.2 — Precision for Type B a) and Type B b)

Sample	Item	Mean	Within laboratory			Between laboratories			Number of laboratories
			s_r	r	(r)	s_R	R	(R)	
A	Δd (%)	3,36	0,15	0,43	13	0,51	1,43	43	8
	ΔH (N)	46,5	4,65	13,2	28	7,14	20,2	44	10
	ΔH (%)	33,3	0,87	2,45	7	2,91	8,25	25	8
B	Δd (%)	1,55	0,12	0,33	21	0,21	0,59	38	7
	ΔH (N)	65,7	2,36	6,70	10	11,4	32,3	49	8
	ΔH (%)	21,9	0,86	2,44	11	3,30	9,30	43	8

Notation used:

s_r is the repeatability standard deviation;

r is the repeatability, in measurement units;

(r) is the repeatability, in percent (relative);

s_R is the reproducibility standard deviation;

R is the reproducibility, in measurement units;

(R) is the reproducibility, in percent (relative).

Table B.3 — Precision for Type A

Sample	Item	Mean	Within laboratory			Number of laboratories
			s_r	r	(r)	
A	Δd (%)	3,6	0,6	1,6	44,0	1
	ΔH (N)	54,1	7,4	20,8	38,5	1
	ΔH (%)	38,4	2,8	7,9	20,6	1
B	Δd (%)	1,2	0,1	0,2	17,2	1
	ΔH (N)	85,2	5,6	15,6	18,4	1
	ΔH (%)	30,2	2,0	5,5	18,4	1

Notation used:

s_r is the repeatability standard deviation;

r is the repeatability, in measurement units;

(r) is the repeatability, in percent (relative).

Annex C
(informative)

Precision study — Machine Type B

C.1 General

A precision study was commissioned by the UK during 2008. A total of 18 different grades of flexible polyurethane foam with widely divergent physical properties and chemistry were tested to ISO 3385:1989 using a Type B machine at a nationally accredited independent test laboratory. Hardness loss and height loss were measured in triplicate for each of the 18 materials. Results are shown in Table C.1.

Table C.1 — Precision results

Foam	Hardness loss %				Deviation from median %		Hardness loss *N*				Deviation from median %	
	i	ii	iii	median			i	ii	iii	median		
1	7,7	6,5	6,4	6,5	1,5	18,5	57	57	53	57	7,0	0
2	2,4	2,4	2,3	2,4	4,2	0	31	29	32	31	6,5	3,2
3	2,1	2,8	3,0	2,8	25,0	7,1	30	33	35	33	9,1	6,1
4	5,4	6	6,4	6	10,0	5,7	38	36	35	36	2,8	5,6
5	2,5	3,4	3,6	3,4	26,5	5,9	22	23	22	22	0	4,5
6	1,0	0,5	1,2	1,0	50,0	20,0	25	20	25	25	20	0
7	20,4	14,1	15,0	15,0	6,0	36,0	81	72	72	72	0	12,7
8	4,0	3,8	3,7	3,8	2,6	5,3	37	34	40	37	8,1	8,1
9	2,8	2,5	2,0	2,5	20,0	12,0	20	19	20	20	5	0
10	3,8	3,5	3,2	3,5	8,6	8,6	27	24	25	25	4	8
11	4,9	3,9	3,1	3,9	25,6	20,5	31	29	27	29	6,9	6,9
12	3,6	3,3	2,8	3,3	15,2	9,1	37	34	34	34	0	8,8
13	3,8	2,8	2,6	2,8	7,1	35,7	36	32	38	36	11,1	5,6
14	3,5	4,3	3,8	3,8	7,9	13,2	39	35	37	37	5,4	5,4
15	4,4	4,4	5,1	4,4	0	15,9	44	46	41	44	6,8	4,5
16	4,6	4,1	4,2	4,2	2,4	9,5	62	58	69	62	6,5	11,3
17	4,4	4,6	4,1	4,4	7,3	4,5	50	50	55	50	0	10,0
18	4,7	3,8	3,0	3,8	21,1	23,7	54	51	49	51	3,9	5,9

C.2 Precision results

As required by ISO 3385:1989, the median height loss and median hardness loss were identified. This was done for each of triplicate data sets representing the 18 different foam grades.

Individual height loss measurements (in millimetres, mm) deviated from the median value by, on average, 13,7 %.

Individual hardness loss measurements (in newtons, N) deviated from the median value by, on average, 5,8 %.

Bibliography

[1] ISO/TR 9272, *Rubber and rubber products — Determination of precision for test method standards*

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