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Paper and board — Stylus contact method —

Part 1: Determination of surface roughness

Papiers et cartons — Méthode par contact avec stylet —

Partie 1: Détermination de la rugosité de surface

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Foreword

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This document was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 2, *Test methods and quality specifications for paper and board*.

A list of all parts in the ISO 24118 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Paper and board — Stylus contact method —

Part 1: Determination of surface roughness

1 Scope

This document specifies a test method for the determination of the surface roughness of paper and board using a stylus contact method. It is applicable to all papers and boards except tissue paper.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 186, *Paper and board — Sampling to determine average quality*

ISO 187, *Paper, board and pulps — Standard atmosphere for conditioning and testing and procedure for monitoring the atmosphere and conditioning of samples*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
surface roughness
R
value indicating a deviation of height from the mean line

3.2
average surface roughness
R_a
arithmetic average of the absolute values of the *surface roughness* (3.1)

4 Principle

For surface roughness measurement, the specimen with the stylus under the contact force is scanned horizontally at a constant speed and surface height is measured. Precision data are available in Annex B. Annex A provides further information.

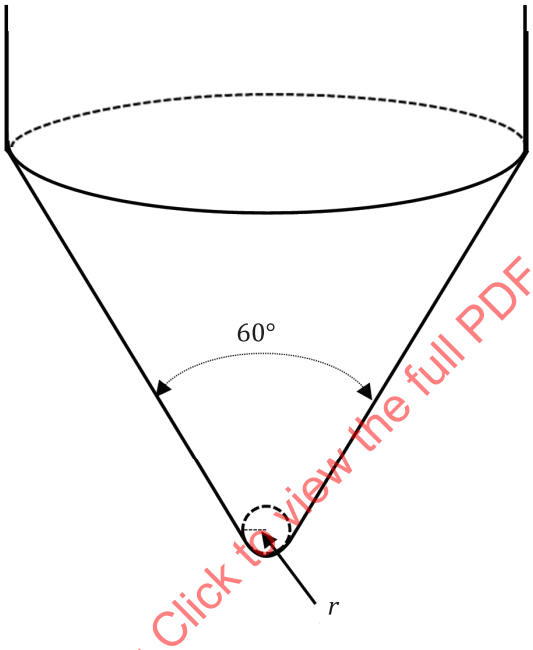
5 Apparatus

5.1 Surface roughness - Testing apparatus

The surface roughness measurement should have an accuracy of ±1 % or less of the full scale of 0,4 m within a surface measurement travel distance of 30 mm, and an overall accuracy of ±1 % or less of the full scale.

5.2 Stylus

A conical shape whose radius of the curvature of the tip is 0,5 mm ± 0,025 mm. The material made of stainless steel specified in ASTM A681-08:2015 (P21 or equivalent) is recommended.



Key

r (0,5 ± 0,025) mm

Figure 1 — Geometry of a stylus tip

5.3 Drive unit

Drive unit for advancing the test piece beneath the stylus with constant traversing speed of 1,0 mm/s ± 0,05 mm/s.

5.4 Specimen holder

Used to place and fix the test piece on the horizontal metallic plate during the testing.

6 Sampling

If the tests are being made to evaluate a lot, the sample shall be selected in accordance with ISO 186. If the tests are performed on another type of sample, verify that the test pieces taken are representative of the sample received.

7 Conditioning of samples

Condition the samples in accordance with ISO 187 and keep them in the standard atmosphere throughout the test. Conditioning shall be performed prior to the preparation of test pieces.

8 Preparation of the test pieces

Prepare the test pieces in the same atmospheric conditions as those used to condition the sample. Cut at least 10 test pieces for the machine direction (MD) testing and another 10 sheets for the cross direction (CD) testing. Test pieces should have a minimum size of 100 mm ± 5 mm in length and 60 mm ± 5 mm in width.

The test area shall be free from folds, wrinkles, holes, watermarks or defects not inherent in the sample. Do not handle the part of the test piece that will become part of the test area.

9 Procedure

Carry out the test in the same atmospheric conditions as those used to condition the samples.

— Place the instrument on a solid and vibration-free table.

— Place the test piece on the specimen holder.

— Set stylus to contact force 50,0 mN ± 0,25 mN.

— Start the test and record the data until it scans at least 30 mm, then stop the test. Record the roughness reading during a run of 5 mm ± 0,01 mm to 25 mm ± 0,01 mm while the surfaces are moving uniformly over one another.

— Repeat the test at least 10 times in both CD and MD.

10 Calculation

Surface roughness, average surface roughness and M are calculated according to Formulae (1), (2) and (3).

$$R_i = h_i - \bar{h} \tag{1}$$

$$R_a = \frac{1}{N}\sum_1^N |R_i| \tag{2}$$

$$M = \frac{1}{N}\sum_1^N \left| |R_i| - R_a \right| \tag{3}$$

where

R_i is the surface roughness at point i, in µm;

h_i is the height at point i, in µm;

$\bar{h}$ is the height average (mean line), in µm;

N is number of data points from 5 mm to 25 mm;

R_a is the average surface roughness, arithmetic average of the absolute values of the roughness, in µm;

M is the mean absolute deviation from R_a, in µm.

11 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 24118-1:2023;

b) the date and place of testing;

c) all details necessary for the complete identification of the sample;

d) the conditioning atmosphere used;

e) the number of test pieces;

f) R_a and M results of each test piece with the grand average of the 10 test pieces in both MD and CD, reported to three significant figures, respectively;

g) the standard deviation of the 10 individual R_a and M results, reported to three significant figures for each direction MD and CD;

h) the coefficient of variation in % to first decimal place for each direction MD and CD;

i) any departure from this document and any circumstances that can have affected the results.

Annex A
(informative)

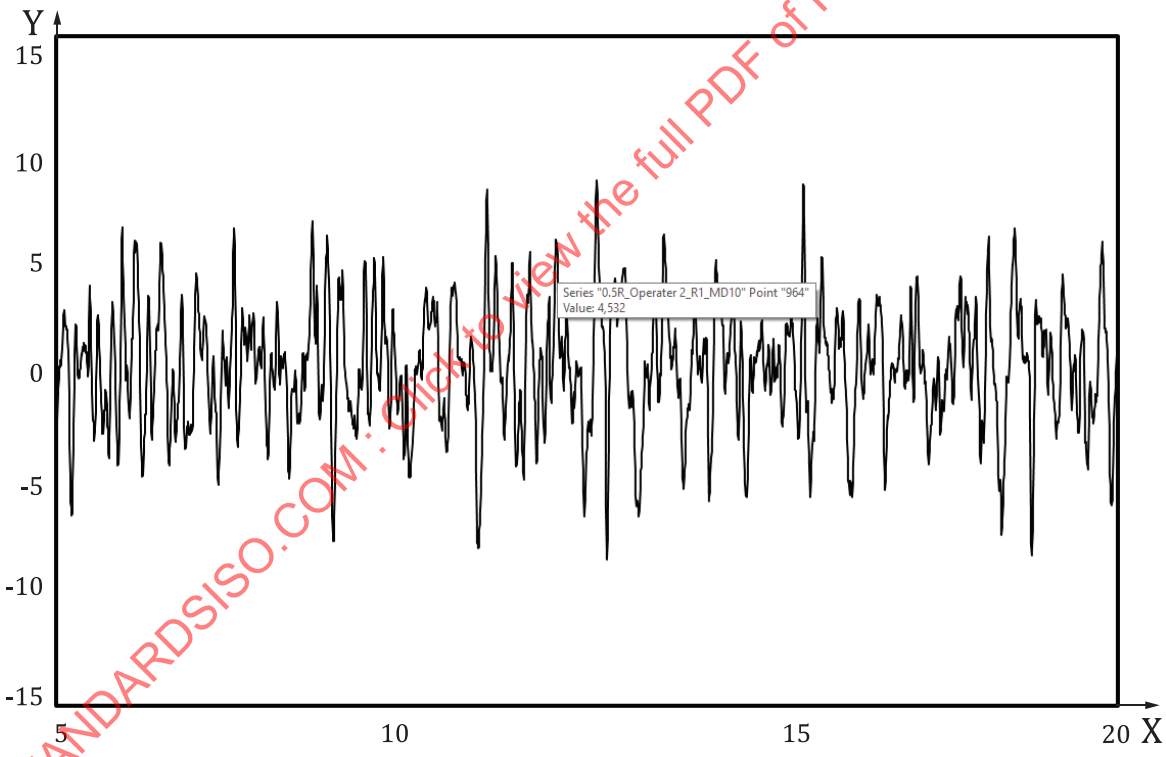
Measurement principle of surface roughness

A.1 General

For surface roughness measurement, the specimen with the stylus under the contact force is scanned horizontally at a constant speed and roughness is measured during the scanning.

A.2 Determination of surface roughness – Example

One example of surface roughness profiles of printing paper sample in the machine direction (MD) is shown in Figure A.1.



Key

X scan length, mm

Y roughness (R), µm

NOTE From the surface roughness profile data, the M is determined using Formula (3).

Figure A.1 — Surface roughness profile of a paper sample

Table A.1 shows a raw data of scan length and surface roughness of paper sample.

Table A.1 — Surface roughness profile data

Scan length mm	Roughness µm
0	Excluded
0,11	
0,12	
0,13	
…	
5,13	-2,93
5,14	-2,38
5,15	-2,22
5,16	-1,82
5,17	-1,01
…	⋮
14,99	2,19
15,00	3,08
15,01	2,72
15,02	1,42
15,03	-0,55
…	⋮
24,96	-1,20
24,97	-0,74
24,98	-0,03
24,99	0,64
25,00	1,20
…	Excluded
26,09	
26,10	
26,11	
26,12	

Table A.2 shows an example of test report of surface roughness.

Table A.2 — Example of test report

Test run	MD		CD	
	R_a, µm	M, µm	R_a, µm	M, µm
1	2,27	1,43	2,72	1,67
2	2,15	1,37	2,83	1,65
3	2,51	1,52	2,71	1,74
4	2,39	1,50	2,84	1,68
5	2,46	1,51	2,53	1,55
6	2,56	1,54	2,66	1,71
7	2,31	1,44	2,78	1,62
8	2,83	1,60	2,78	1,75
9	2,59	1,62	2,62	1,61
10	2,60	1,50	2,73	1,67
Avg.	2,47	1,50	2,72	1,67
Std.	0,20	0,08	0,10	0,06
C_V, %	7,9	5,1	3,5	3,7

Annex B
(informative)

Precision

B.1 General

Printing (CODE 1), base (CODE 2), newsprint (CODE 3), liner (CODE 4) and kraft (CODE 5) papers were submitted to test according to the current standard in five different laboratories. Repeatability and reproducibility were determined according to ISO 5725-2. Tables B.1 and B.2 provide the interlaboratory results.

B.2 Results

Table B.1 — Interlaboratory results of R_a

Sample		Mean R_a µm	Number of laboratories p	Repeatability standard deviation S	Repeatability limit r	Repeatability coefficient of variation $C_{V,r}$ %	Reproducibility standard deviation S_R	Reproducibility limit R	Reproducibility coefficient of variation $C_{V,R}$ %
Code 1	MD	2,37	5	0,213 4	0,591	9,0	0,270 8	0,750	11,4
	CD	2,63	5	0,187 9	0,521	7,1	0,244 0	0,676	9,3
Code 2	MD	2,83	5	0,296 1	0,820	10,5	0,326 8	0,905	11,5
	CD	3,04	5	0,249 9	0,692	8,2	0,266 4	0,738	8,8
Code 3	MD	2,26	5	0,190 5	0,528	8,4	0,308 0	0,853	13,6
	CD	2,49	5	0,169 3	0,469	6,8	0,285 8	0,792	11,5
Code 4	MD	3,94	5	0,513 9	1,424	13,0	0,646 4	1,790	16,4
	CD	4,20	5	0,743 5	2,059	17,7	0,855 8	2,371	20,4
Code 5	MD	3,75	5	0,288 9	0,800	7,7	0,388 5	1,076	10,3
	CD	4,35	5	0,321 6	0,891	7,4	0,396 1	1,097	9,1

MD: machine direction
CD: cross direction