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Paper and board — Testing of cores —

Part 4: Measurement of dimensions

Papier et carton — Essais des mandrins —

Partie 4: Mesurage des dimensions



Reference number
ISO 11093-4:1997(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 11093-4 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*, Subcommittee SC 3, *Dimensions and grammages of paper, board and pulp products*.

ISO 11093 consists of the following parts, under the general title *Paper and board — Testing of cores*:

- *Part 1: Sampling*
- *Part 2: Conditioning of test samples*
- *Part 3: Determination of moisture content using the oven drying method*
- *Part 4: Measurement of dimensions*
- *Part 5: Determination of characteristics of concentric rotation*
- *Part 6: Determination of bending strength by the three-point method*
- *Part 7: Calculation of flexural modulus by the three-point method*
- *Part 8: Determination of natural frequency and flexural modulus by experimental modal analysis*
- *Part 9: Determination of flat crush resistance*

Annexes A, B and C of this part of ISO 11093 are for information only.

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Paper and board — Testing of cores —

Part 4: Measurement of dimensions

1 Scope

This part of ISO 11093 specifies test methods for the determination of the internal diameter, the external diameter, the wall thickness and the length of paper and board cores.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 11093. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 11093 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards

ISO 3599:1976, *Vernier callipers reading to 0,1 and 0,05 mm.*

ISO 3611:1978, *Micrometer callipers for external measurement.*

ISO 11093-1:1994, *Paper and board - Testing of cores - Part 1: Sampling.*

ISO 11093-2:1994, *Paper and board - Testing of cores - Part 2: Conditioning of test samples.*

3 Definitions

For the purposes of this part of ISO 11093, the following definitions apply.

3.1 internal diameter, d : Dimension of the internal width of the cylindrical core. (See figure 1.)

3.2 external diameter, D : Dimension of the external width of the cylindrical core. (See figure 1.)

3.3 wall thickness, s : Distance between the inner and outer surfaces of the core. (See figure 1.)

3.4 length, l : Distance between the two end faces of the core. (See figure 1.)

3.5 deformations: Visual surface changes which can affect test results. Examples of these are seams, lap joints and cutting burrs.

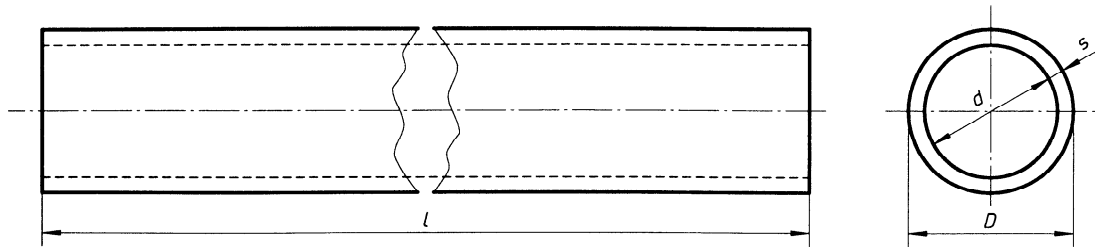


Figure 1 — Diagram of a core showing dimension lines

4 Sampling

Samples shall be taken in accordance with ISO 11093-1.

NOTE — For the purpose of measuring the length, the specimen constitutes the test piece.

5 Conditioning

Test pieces shall be conditioned in accordance with ISO 11093-2.

6 Measurement of internal diameters

6.1 General

Four methods of measuring the internal diameter are available. They are of differing accuracy and speed. The method used shall be compatible with the type of core being measured and shall be specified.

Method A: Internal tri-point micrometer (see figure A.1)

Method B: Internal vernier calliper (see figures B.1 and B.2)

Method C: Calibrated step mandrel

Calculated

6.2 Method A

6.2.1 Apparatus

An internal tri-point micrometer equipped with a ratchet and accurate to at least 0,025 mm. The instrument shall also be fitted with a slip arrangement such that the measuring force cannot exceed the following:

Internal diameter up to 100 mm: $(4,5 \pm 0,2) \text{ N}$

Internal diameter over 100 mm: $(9,0 \pm 0,3) \text{ N}$

6.2.2 Procedure

Avoiding any obvious deformations, insert the tri-point micrometer at least 10 mm from the end of the test piece. Take two measurements, to the nearest 0,025 mm,

approximately 60° apart. Repeat the procedure at the other end of the test piece. Average the four readings and report to the nearest 0,025 mm.

6.3 Method B

6.3.1 Apparatus

A vernier calliper accurate to at least 0,1 mm (see ISO 3599).

6.3.2 Procedure

Avoiding any obvious deformations, insert the calliper into the test piece such that the measuring faces are aligned axially and radially. Take two measurements, to the nearest 0,1 mm, 90° apart. Repeat the procedure at the other end of the test piece. Average the four readings and report to the nearest 0,1 mm.

6.4 Method C

6.4.1 Apparatus

A solid round mandrel with the external diameters within the tolerance range for the diameter to be measured. The mandrel is stepped over its length and graduated in increasing diameters of 0,1 mm with a diameter tolerance of $\pm 0,01$ mm and each step having a minimum length of 50 mm.

An example of a solid mandrel is given in figure 2.

6.4.2 Procedure

Insert the mandrel into the test piece until a push fit is obtained and note the graduation at this point. Repeat this procedure at the other end of the test piece. Average the two results and report to the nearest 0,1 mm.

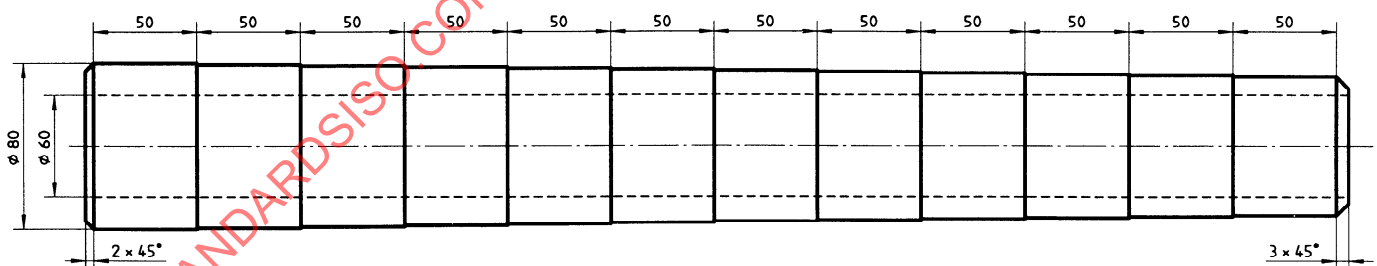


Figure 2 — Example of a calibrated step mandrel

6.5 Calculation

Measure the external diameter D and the wall thickness s of the test piece as detailed in clauses 7 and 8. Calculate the internal diameter d using the formula:

$$d = D - 2s \quad \dots(1)$$

7 Measurement of external diameters

7.1 General

Three methods of measuring the external diameter are available. They are of differing accuracy and speed. The method used shall be reported and should be compatible with the type of core being measured.

Method D: External micrometer (see figure C.1)

Method E: External vernier calliper (see figure B.1)

Method F: Flexible tape

7.2 Method D

7.2.1 Apparatus

A micrometer accurate to at least 0,025 mm (see ISO 3611). In addition, the micrometer anvil and spindle faces shall be flat and have a diameter between 6,00 mm and 8,00 mm. The ratchet drive should allow a measuring force between the following values:

External diameter up to 150 mm: 4 N to 12 N

External diameter over 150 mm: 4 N to 14 N

7.2.2 Procedure

Avoiding any obvious deformations, position the micrometer round the test piece at least 10 mm from the end. Ensure that the faces of the anvil and spindle are radially aligned to the test piece. Close the micrometer and record the measurement to the nearest 0,025 mm. Rotate the test piece through approximately 120° and repeat the measurement. Rotate the test piece through a further 120° and repeat the measurement. Repeat the above procedure at the other end of the core. Average the six readings and report to the nearest 0,025 mm.

7.3 Method E

7.3.1 Apparatus

A vernier calliper accurate to at least 0,1 mm (see ISO 3599).

7.3.2 Procedure

Avoiding any obvious deformations, position the calliper as shown in figure 3. Close the vernier, ensuring no deformation of the surface, and record the measurement to the nearest 0,1 mm. Rotate the test piece through approximately 120° and repeat the measurement. Rotate the test piece through a further 120° and repeat the measurement. Repeat the above procedure at the other end of the core. Average the six readings and record to the nearest 0,1 mm.

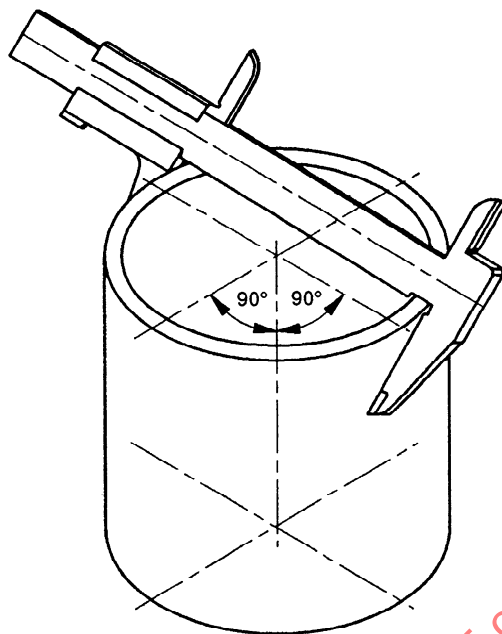


Figure 3 — Position of vernier calliper

7.4 Method F

7.4.1 Apparatus

A flat, fully flexible, metal tape graduated in millimetres.

NOTE — A more accurate result can be obtained using a circumferential tape with a vernier scale with 0,1 mm graduations.

7.4.2 Procedure

Wrap the tape around the test piece at least 10 mm from the end, ensuring that the tape is flat on the surface and avoids any obvious deformations. The tape shall be perpendicular to the lengthwise axis of the test piece. Record the measurement to the nearest millimetre.

If the tape used does not allow a direct reading of the diameter, the following formula shall be used:

$$D = \frac{c}{\pi} \quad \dots(2)$$

where

c is the circumference, in millimetres;

D is the external diameter, in millimetres.

8 Measurement of wall thickness

8.1 General

Three methods of measuring the wall thickness are available. They are of differing accuracy and speed. The method used shall be compatible with the type of core being measured and shall be reported.

Method G: External micrometer (see figure C.1)

Method H: External vernier calliper (see figure B.1)

Calculated

8.2 Method G

8.2.1 Apparatus

A micrometer accurate to at least 0,025 mm (see ISO 3611). In addition, the anvil shall be replaced by a cylindrical anvil where the length of the anvil shall be parallel to the spindle face. The dimensions of the anvil and spindle shall be in the following ranges:

Anvil diameter:	8,0 mm to 9,5 mm
Anvil length:	7,0 mm to 9,0 mm
Spindle face diameter:	6,0 mm to 8,0 mm

The ratchet drive shall allow a measuring force in the range 4 N to 14 N.

8.2.2 Procedure

Avoiding any obvious deformations, position the micrometer anvil inside the test piece at least 10 mm from the end and ensure that the spindle face is parallel to the lengthwise axis of the test piece. Close the micrometer and record the measurement to the nearest 0,025 mm. Rotate the test piece through 90° and repeat the measurement. Repeat the procedure at the other end of the core. Average the four measurements and record to the nearest 0,025 mm.

8.3 Method H

8.3.1 Apparatus

A vernier calliper accurate to at least 0,1 mm (see ISO 3599).

8.3.2 Procedure

Avoiding any obvious deformations, position the vernier calliper with one face inside the test piece. Ensure that the faces of the vernier calliper are parallel to the lengthwise axis of the test piece. Close the faces, ensuring no deformation of the test piece surface, and record the measurement to the nearest 0,1 mm. Rotate the test piece through approximately 120° and repeat the measurement. Rotate through a further 120° and repeat the measurement. Repeat the procedure at the other end of the core. Average the six readings and record to the nearest 0,1 mm.

8.4 Calculation

Measure the external diameter D and the internal diameter d of the test piece as detailed in clauses 6 and 7. Calculate the wall thickness s using the formula:

$$s = \frac{D - d}{2} \quad \dots(3)$$

9 Measurement of length

9.1 Apparatus

A flexible metal tape graduated in millimetres and fitted with a hook at one end. The hook shall be at a right angle to the tape face and not less than 10 mm high. For lengths of less than 500 mm, it is permissible to use an external vernier calliper conforming to ISO 3599.

9.2 Procedure

Avoiding any obvious deformations, insert the tape into the test piece. With the hook held firmly against the end face of the test piece and ensuring that the tape is parallel to the longitudinal axis, record the measurement to the nearest millimetre. Rotate the test piece through 120° and repeat the measurement. Rotate through a further 120° and repeat the measurement. Repeat the above procedure at the other end of the core. Average the six measurements and record to the nearest millimetre.

NOTE — Where it is not practical to measure the inside length, it is permissible to measure the outside length, the procedure being the same.

10 Test report

The test report shall include the following particulars:

- a) reference to this part of ISO 11093;
- b) type and designation of the cores tested;
- c) place and date of sampling;
- d) place and date of testing;
- e) measurement method used for each dimension;
- f) individual values, in millimetres, separately for internal diameter, external diameter, wall thickness and length: values being recorded in ascending order with any mean or standard deviation, if calculated;
- g) deviations, if any, from the method specified;
- h) date and signature.

Annex A (informative)

Example of a micrometer

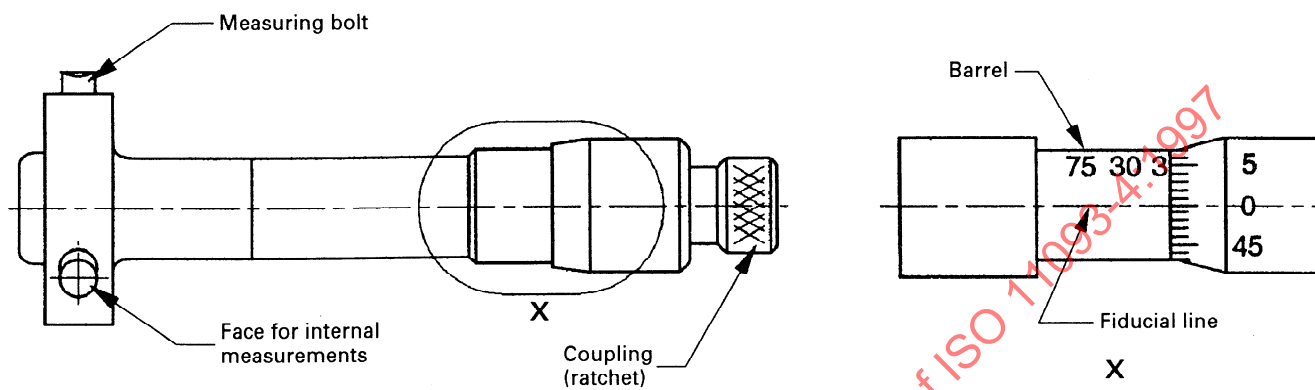


Figure A.1 — Example of an internal tri-point micrometer

Annex B (informative)

Examples of vernier callipers

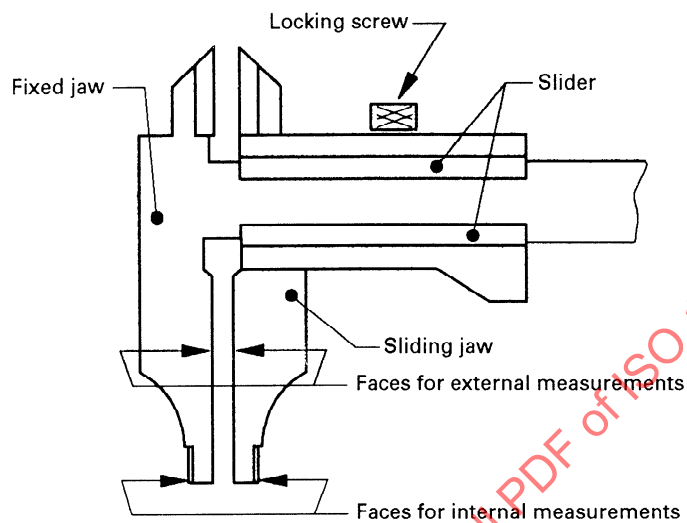


Figure B.1 — Type having internal and external measuring jaws

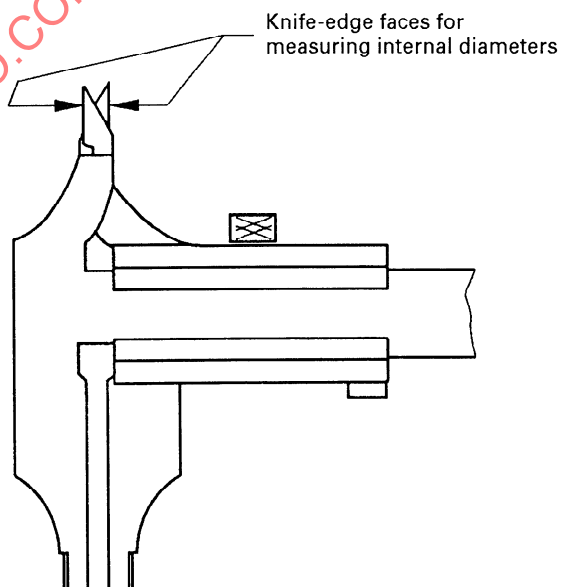


Figure B.2 — Type having jaws with knife-edge points

Annex C (informative)

Other examples

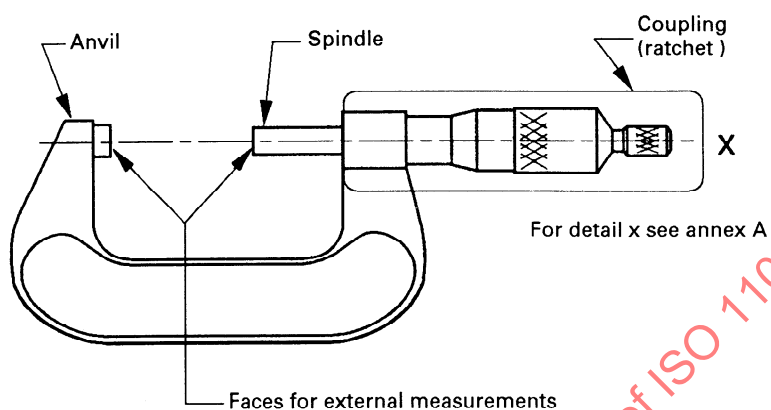


Figure C.1 — Example of external micrometer

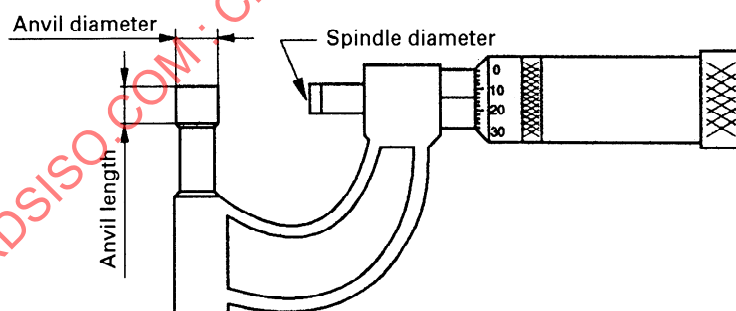


Figure C.2 — Example of wall-thickness micrometer