
**Paper and board — Determination
of roughness/smoothness (air leak
methods) —**

**Part 3:
Sheffield method**

*Papier et carton — Détermination de la rugosité/du lissé (méthodes
du débit d'air) —*

Partie 3: Méthode Sheffield

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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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

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*.

This third edition cancels and replaces the second edition (ISO 8791-3:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

- editorial changes have been made;
- precision data has been added as [Annex D](#).

A list of all parts in the ISO 8791 series can be found on the ISO website.

Paper and board — Determination of roughness/smoothness (air leak methods) —

Part 3: Sheffield method

1 Scope

This document specifies a method for the determination of the roughness of paper and board using the Sheffield apparatus.

This document is applicable to papers and boards which have Sheffield roughness values between 10 ml/min and about 3 000 ml/min. It is not suitable for soft papers which allow the lands of the test head to indent the surface, or for high air-permeance papers which allow a significant flow of air through the sheet, or for papers which will not lie flat during the test.

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 terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

Sheffield roughness

measure of the rate at which air flows between flat circular lands and the surface of a sheet of paper or board under specified conditions

Note 1 to entry: The roughness is expressed in millilitres per minute.

Note 2 to entry: The Sheffield unit is not defined, since it has been found that the scale units (Sheffield units) on different instruments can correspond to different air flows, and there is no precise physical definition. This document requires that the flowmeters be calibrated to give a flow rate in millilitres per minute.

4 Principle

A test piece is clamped between a flat plate and two flat concentric annular lands. Air is supplied at a specified pressure to the space between the two lands, and the rate of air flow between the lands and the test piece is measured. The air flow rate is a measure of the roughness of the test piece.

5 Apparatus

The apparatus, an example of which is shown in Figure 1, shall consist of an air supply (5.1), an air pressure control (5.2) and air flow-measuring device (5.4), a test assembly (5.5) which houses a measuring head (5.5.1) fitted with test lands, a flat plate (5.5.2), and a mechanical device for bringing the lands into contact with the flat plate under a defined load.

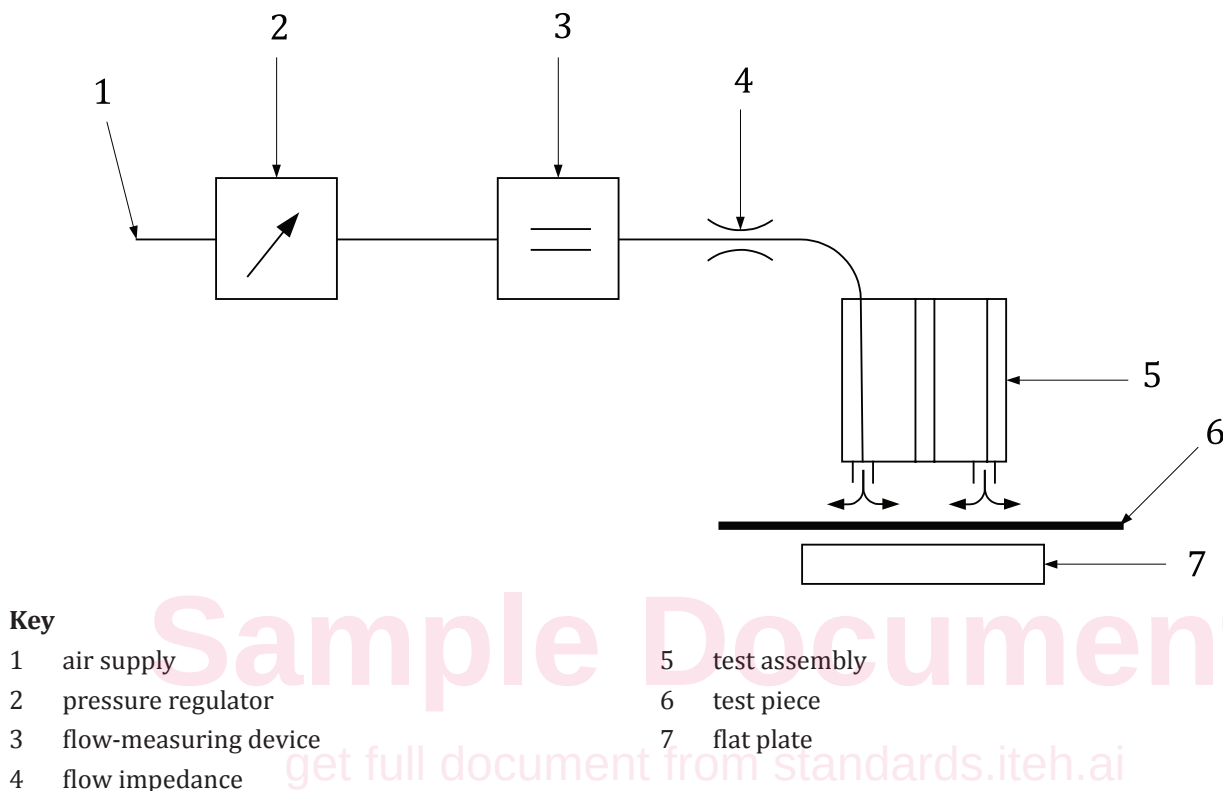


Figure 1 — Example of Sheffield apparatus

5.1 Air supply, free of water, oil and other contaminants, at a pressure of 420 kPa to 950 kPa. A small compressor using laboratory air is preferred to external compressed air.

5.2 Pressure-regulating device, consisting of a primary regulator to reduce the pressure to between 205 kPa and 210 kPa, and another regulator to adjust the pressure at the measuring head to 10,3 kPa (variable-area flowmeters) or 9,85 kPa (electronic flowmeters).

5.3 Pressure manometer, with a range from 0 kPa to 20 kPa to enable the air pressure at the measuring head to be set to the specified pressure within 2 % of the nominal value.

5.4 Flow-measuring device, of either a variable-area or an electronic type. The air flow shall be measurable to an accuracy of ± 5 % of the measured value.

5.4.1 Variable-area flow-measuring device, consisting of three variable-area flowmeters, each having a tapered glass column containing a metering float suspended by the air flow in the column (see Reference [7]). The three columns shall be chosen such that they enable measurement to be made on a continuous scale of flow rate from 10 ml/min to 3 000 ml/min, with some overlap of scales between columns. Each column shall be provided with a means of adjusting the flow rate (float-position knob)

and a means of span calibration (calibrating knob). This type of instrument shall operate at a supply pressure of 10,3 kPa.

At air flow rates greater than 1 200 ml/min, the pressure drop in the Sheffield system is substantial and, to ensure the reproducibility of results, it is necessary that the tubing used to connect the flowmeter to the measuring head be carefully controlled with a length of $1,50 \text{ m} \pm 0,01 \text{ m}$ and an internal diameter of $6,25 \text{ mm} \pm 0,25 \text{ mm}$. For the same reason, openings in valves and other fittings on the instrument shall not be changed from those provided by the instrument manufacturer.

5.4.2 Electronic flow-measuring device, for measuring the air flow to the test assembly (measuring head). The inlet pressure to the measurement device shall be controlled at 9,85 kPa.

NOTE The 9,85 kPa pressure is the typical pressure measured downstream of variable-area flow tubes that have been calibrated using the zero and span adjustment air bleeds to atmosphere.

5.5 Test assembly.

5.5.1 The measuring head, together with a dead weight, shall have a mass of $1\,640 \text{ g} \pm 2 \text{ g}$, shall have two concentric annular lands made of, or coated with, a corrosion-resistant material and be designed to contact the test piece. The annular lands shall have a total area of $97 \text{ mm}^2 \pm 3 \text{ mm}^2$; each land shall have a width of $0,380 \text{ mm} \pm 0,010 \text{ mm}$. The outer diameters of the outer and inner lands shall be $47,70 \text{ mm} \pm 0,03 \text{ mm}$ and $34,37 \text{ mm} \pm 0,03 \text{ mm}$, respectively.

The test assembly, an example of which is shown in [Figure 2](#), shall include a detachable measuring head mounted so that it can be brought into contact with a test piece placed on an optically flat plate.

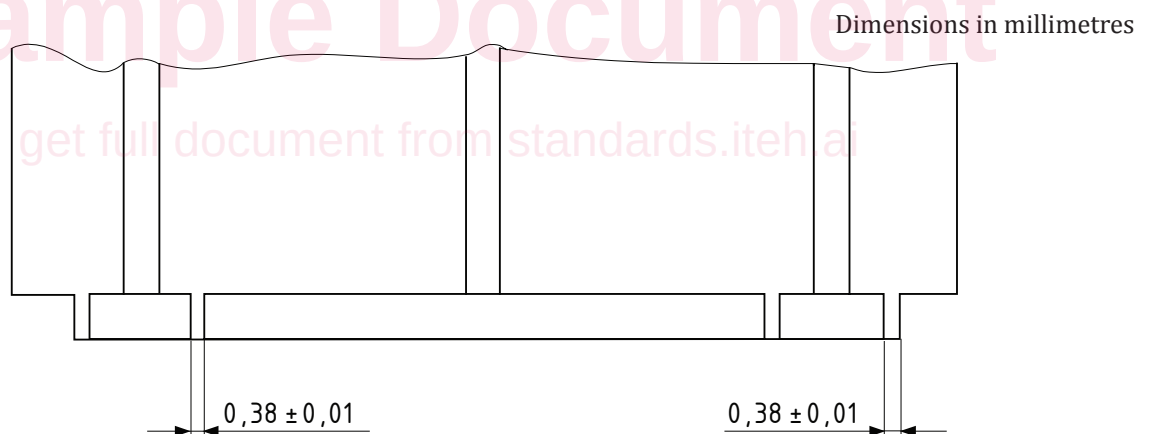


Figure 2 — Example of test assembly

The measuring head shall be connected to the air supply with an airtight seal and the air shall be fed into the gap between the two measuring lands through a narrow hole bored through the material of the measuring head. This can act as impedance in the measurement air line (see [Figure 1](#), Key 4). The central space inside the inner land shall be vented to the atmosphere.

The test assembly shall have a suitable coupling through which the chosen flowmeter is connected to the tube leading to the measuring head. The tube, connecting the measuring head to the instrument, and the tube connectors have internal diameters that provide resistance to the air flow. Alteration of these components from those provided by the manufacturer may change the calibration and operation of the instrument.

5.5.2 The flat plate is usually glass and shall be free from surface flaws. The measuring lands shall be machined and the supporting plate shall be sufficiently flat so that, when the measuring lands are in contact with the plate in the absence of any test piece, the air flow rate does not exceed 10 ml/min.