INTERNATIONAL STANDARD

ISO 4330

Third edition
1994-12-15

Photography — Determination of the curl of photographic film and paper

Photographie — Détermination de l'incurvation des films et papiers photographiques

Reference number
ISO 4330:1994(E)

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.

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 4330 was prepared by Technical Committee ISO/TC 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 4330:1987), of which it constitutes a technical revision. It has been modified to include photographic paper and provides a method of measuring the degree of cupping.

Annex A of this International Standard is for information only.

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Introduction

Curl is a basic property of photographic film and paper which can influence acceptability in many applications. High curl can lead to problems in printing, projection and handling.

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Photography — Determination of the curl of photographic film and paper

1 Scope

This International Standard specifies methods for determining and expressing quantitatively the curl characteristics of unprocessed and processed photographic film and paper in sheet, roll, or strip forms.

It specifies three measuring methods: method A involves the determination of curl when the specimen is held in a vertical position, methods B and C with the specimen in a horizontal position. Values for the three methods are not comparable because of the differences in specimen configuration and size.

These methods are not intended for use in determining the curl characteristics of photographic materials during processing or drying.

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 curl: Departure from physical flatness and characterized with respect to curl direction (L, T, D or C), curl sign (+ or −) and curl value. This flatness defect is evident by a tendency of film or paper to coil into a cylindrical shape.

2.2 curl direction: Means of identifying by letter L, T, D or C the direction of curl about a specific axis of a specimen corresponding to that of the sample from which it is taken.

L represents "lengthwise curl" about the axis perpendicular to the length or machine direction of the specimen for rolls or to the longer specimen dimension for sheets. An alternative approach when the machine direction is not known is to reference the curl direction to a film notch, if present.

T represents "transverse curl" about the axis parallel to the length or machine direction of the specimen.

D represents "diagonal curl" about the diagonal of the specimen.

C represents "cupping" when all four corners of the specimen are raised and bent towards the centre of the specimen.

See figure 1.

2.3 curl sign: Mathematical sign, + or −, used to indicate the direction of curl which, if toward the emulsion (sensitized) side (emulsion-in) is + or, if toward the base (emulsion-out), is −. The sign is always plus for materials sensitized on both surfaces.

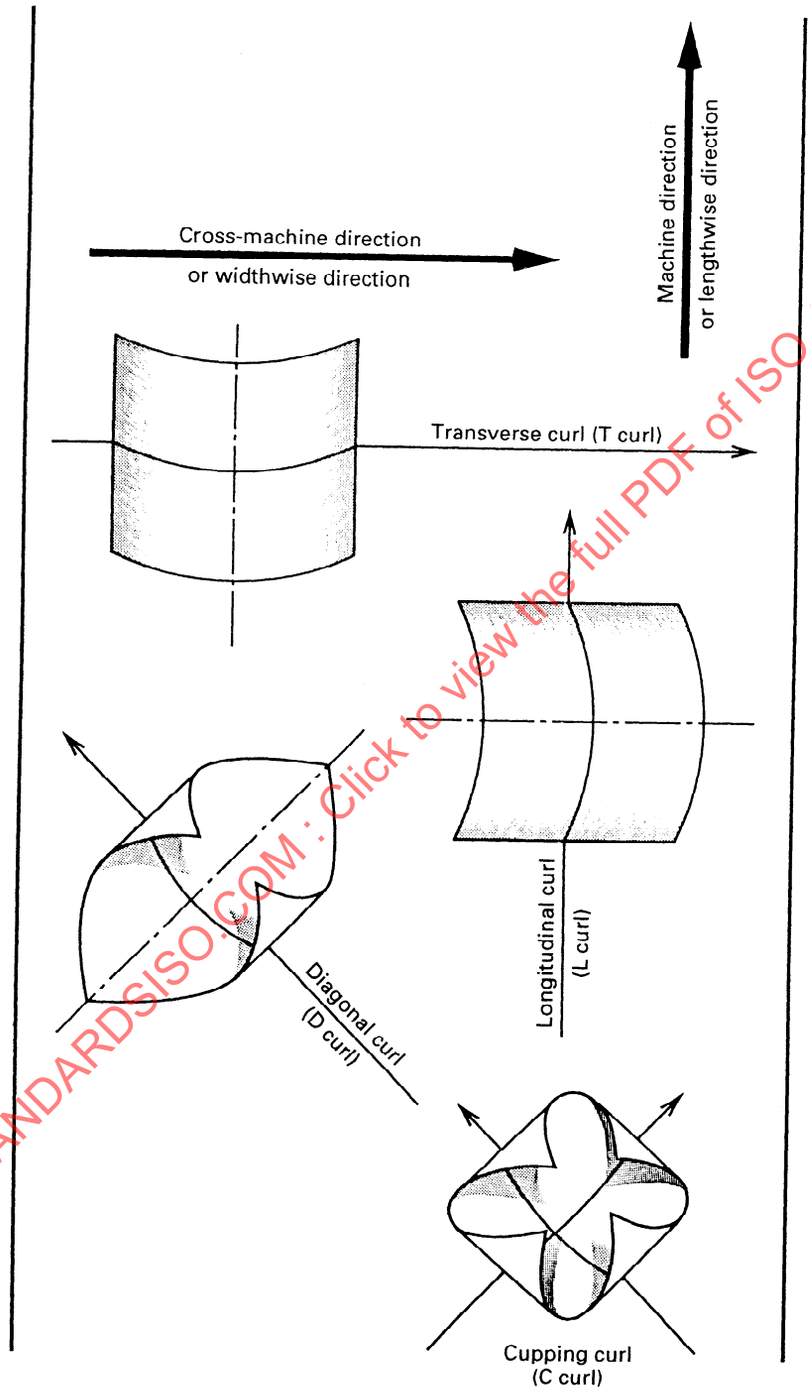


Figure 1 — Curl direction

3 Sampling and conditioning

3.1 Selection of samples

Material intended for curl tests shall be representative of the whole of the samples being tested, exhibit no obvious physical defects, be handled in the same manner as in actual use, and be treated uniformly. When different materials are to be compared, they shall have been subjected to the same relative humidity history for similar times. The machine direction shall be indicated, if known, by crayon or ink marking.

3.2 Handling of specimens

Prepare specimens under controlled relative humidity conditions, and then separate them into groups which are to be subjected to different atmospheric conditions. Wear cotton or other suitable gloves or use pincers while handling specimen. Moisture from hands or fingers will reduce accuracy of test data. The operator shall take care not to breathe on the specimens.

3.3 Conditioning of specimen

Condition specimens at the chosen relative humidity until practical moisture equilibrium has been reached. In most instances, this time will be about 2 h for photographic films, one day for photographic fibre-base papers and 7 days for RC (resin coated) papers.[1)]

Excessive conditioning times may result in a curl decrease due to relaxation effects.

Suspend the specimens freely by means of a hook or a rod through a hole close to the centre of one edge, and separate enough to prevent contact with each other. Hang square specimens with the axis of curl vertical to avoid producing distortion. An alternative method of support is to place specimens horizontally on net-covered or screen-covered racks spaced so that there is free circulation of air.

3.4 Test conditions

A temperature of 23 °C ± 2 °C is specified. Relative humidities of 15 %, 30 %, 50 %, 70 % and 85 % are suggested but are not mandatory. Tests can be conducted in glove boxes or in conditioned rooms; the latter are preferable since they can provide better humidity control.

Curl value may be influenced by the moisture history of the material. This may be standardized by an initial preconditioning step at 50 % relative humidity.

4 Test method A

4.1 Field of application

This method is intended mainly for samples of film or paper in sheet form or in rolls which do not show cupping but curl in only L, T or D directions.

4.2 Specimen size

Prepare at least three square specimens measuring from 50 mm × 50 mm to 100 mm × 100 mm from each sample to be tested. Alternatively, circular specimens measuring from 50 mm to 100 mm in diameter can be used. Indicate the machine direction, if known.

For analytical purposes, or for specimens which show cupping or varying curl along the length or width, specimens measuring 50 mm × 5 mm can be used, with specimen cut in both the L and T directions.

4.3 Unit of curl measurement

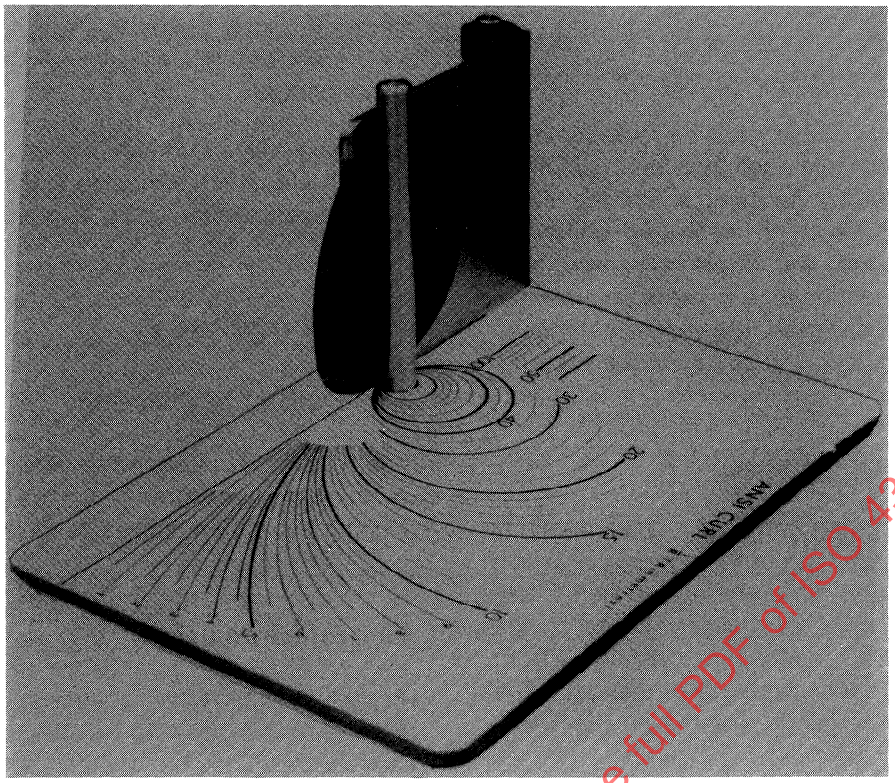
The curl values are expressed as $1/R$, where R is the radius of curvature in metres.

4.4 Apparatus

4.4.1 Curl board template, marked off with curves corresponding to various values of reciprocal radius. It may be one of several formats (see figure 2).

4.4.2 Specimen clamp, consisting of two vertical members of which the one facing the concave side of the specimen shall be approximately 3 mm in radius. In no case shall this radius exceed the radius of the curled specimen.

1) At relative humidities of 70 % and above, films and papers sometimes undergo an irreversible change in curl with time. For this reason, the conditioning time must be standardized for comparison purposes.



NOTE — Arrange the clamp to hold the edge of the film on a line normal to the curves making up the measuring template. These curves may be computed as defined in 4.3.

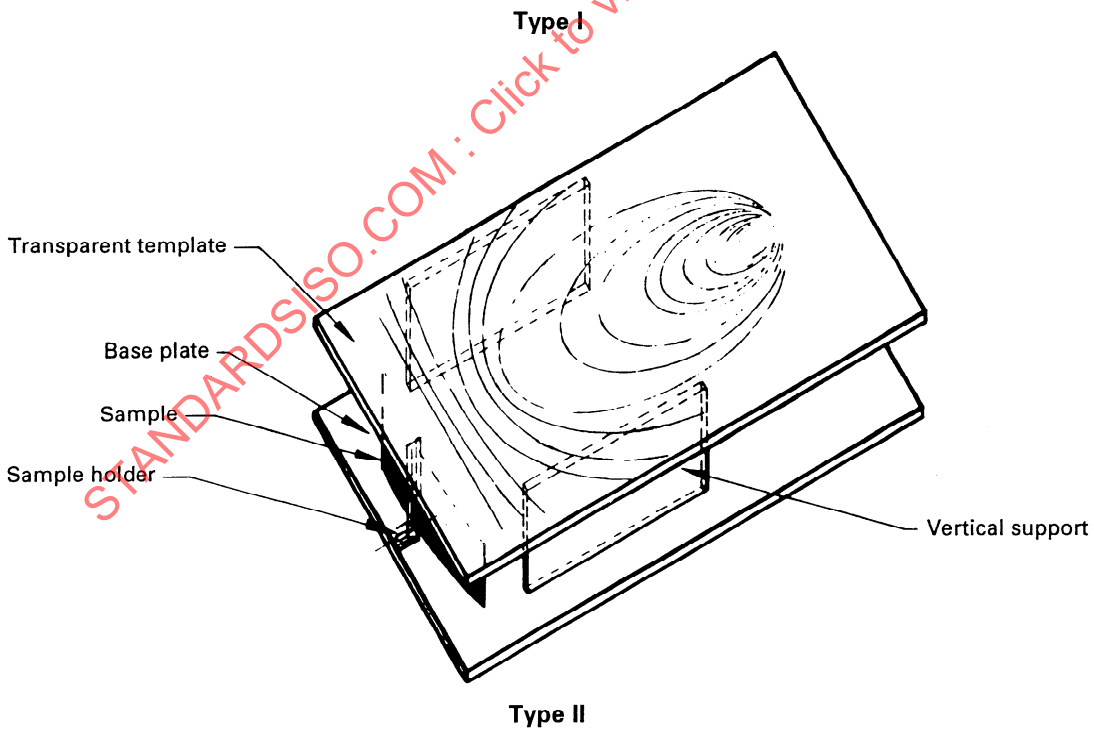


Figure 2 — Curlboard templates for measuring curl in accordance with test method A

4.5 Procedure

At the end of the conditioning period and without removing the specimens from the conditioned atmosphere, secure each specimen above or below the template by clamping so that the axis of curl is vertical. At least 10 mm of film should be held within the clamp. Films of low stiffness may require a larger clamped area to avoid drooping due to gravity. Note the curl value of the curve most nearly coinciding with the curl of the specimen.

5 Test method B

5.1 Field of application

This method is intended for long lengths of film in roll form. It provides a means for measuring curl as it is found in use.

The curl is measured only in the cross-direction. It is purely a practical type of measurement and is not intended to distinguish the factors which cause curl.

5.2 Specimen size

Test specimens in standard widths (for example, 8 mm, 16 mm, 32 mm, 35 mm, 70 mm, 105 mm, etc.). Select at least 3 specimens from each sample to be tested. The specimen length should be at least six times the film width.

5.3 Apparatus

5.3.1 Suitable depth or height gauge, graduated in millimetres, that can read the edge curl of film strips (see figure 3).

5.4 Procedure

Place the strips to be measured on a horizontal surface at the end of the conditioning period without removing them from the conditioning atmosphere. If necessary, hold the strip down at each end.

Measure the edge curl using the depth or height gauge. The precision required with this method depends upon the film width. As a guide, readings can be made to the nearest 0,20 mm for 35 mm, 0,04 mm for 16 mm, and 0,02 mm for 8 mm film. Sensitivity for 8 mm film is not as high as for wider film and it is very difficult to make readings to a precision of 0,02 mm.

Widthwise film curl can be measured either concave side up or convex side up, depending on the type of device used. A depth gauge and a height gauge are shown in use in figure 3.

The height gauge illustrated can measure film in either configuration, but depth gauges are limited to concave-up measurements. Such measurements may be converted trigonometrically into units of reciprocal radius.[2)]

Make three measurements in this manner along the specimen length and take the arithmetic mean as the film curl. Do not make measurements closer than 100 mm to the ends of the specimen.

6 Test method C

6.1 Field of application

This method is intended for film or paper (in sheet form or microfiche). It provides a means of measuring curl in either the width direction or length direction of the sample. This is a practical type of measurement and combines the effects of curl with gravity. This occurs when photographic material is placed on a horizontal surface.

6.2 Specimen size

Test specimens in standard distribution microfiche or sheet sizes. Select at least three specimens from each sample to be tested.

6.3 Procedure

Place the sheets to be measured concave side upward on a table at the end of the conditioning period and without removing them from the conditioned atmosphere. Measure the distance between each of the four corners of the specimen and the table in millimetres to the nearest millimetre.

2) The relationship between the height of the edge curl (H), the radius (R) and the film width (W) is given by the formula

$$1/R = (1 - \cos\frac{90W}{\pi R})\frac{1}{H}$$

where the cosine value is in degrees.

For small curl values, this can be approximated by $1/R \approx 8H/W^2$

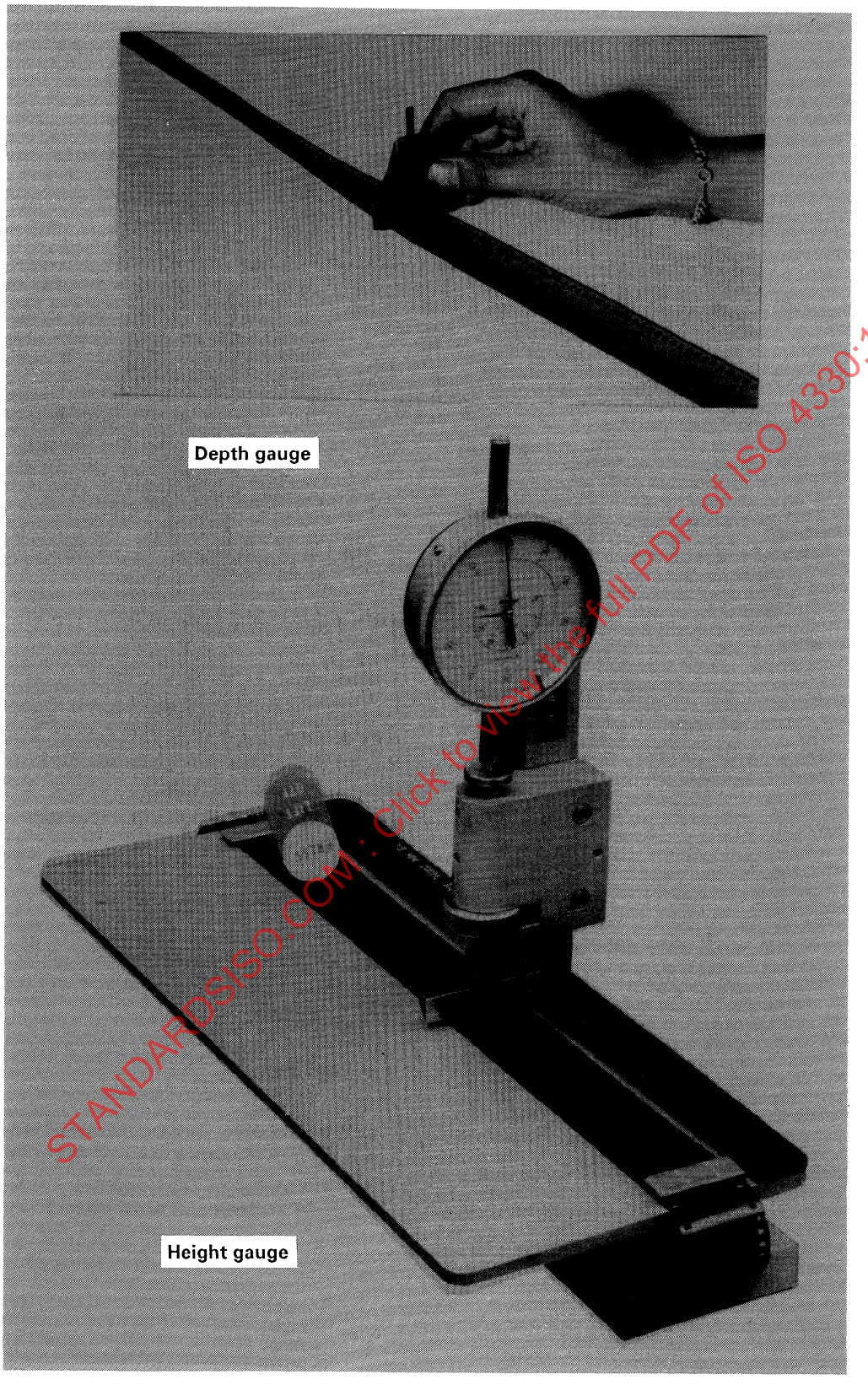


Figure 3 — Devices for reading edge curl of film strips for test method B

Calculate the mean of these four measurements[3]. Designate the direction of curl as L, T or D, or indicate as C[4]. The results obtained are influenced by the specimen dimensions. Results between samples can only be compared if the specimen sizes are identical.

7 Test report

7.1 Test data

The test report shall include the following information:

a) reference to this International Standard;

b) sample name and number;

c) description of specimen (thickness, type of substrate, unprocessed or processed);

d) conditioning time, temperature, and relative humidity;

e) test method (method A, B, or C);

f) average curl value, curl sign, and curl direction (length, transverse, diagonal or cupping), and precision of curl value;

g) position in the roll for rolls or dimensions of specimen for sheets.

7.2 Significance

Values obtained by methods A, B and C should not be compared. Curl is very dependent upon the specimen dimensions and these differ for each method. Moreover, method A is read vertically and is not affected by gravity. Consequently, it represents a measure of the inherent property. Methods B and C are read horizontally and are influenced by gravity and stiffness. Since method C is used for material in sheet form which may have large dimensions, the specimens may show more distortion than observed in methods A and B. Because of these distortions and the possible large effect of gravity, the curl in method C may not assume the arc of a circle and consequently curl is not expressed in units of $1/R$.

Whether or not the curl values determined by this International Standard are considered high for a given type of photographic material depends on the particular application. The acceptable value may also depend on the camera, processing machine, printer or viewer used, as well as on the size of the sample and whether it is raw or processed.

3) In microfiche applications, the maximum height of one of the edges may be critical in causing transport problems.

4) Difficulty can be experienced in measuring the average curl value of distorted samples.

Annex A
(informative)

Bibliography

[1] CURRENT, I.B., Equipment for testing some physical characteristics of sensitized materials, *Photographic engineering,* Vol. 5, No. 4 (1954), pp. 227-283.