

INTERNATIONAL STANDARD

**ISO
5000**

Second edition
1993-12-01

Continuous hot-dip aluminium/silicon-coated cold-reduced carbon steel sheet of commercial and drawing qualities

*Tôles en acier au carbone laminées à froid, revêtues par immersion à
chaud en continu d'une couche d'aluminium-silicium, de qualité
commerciale et pour emboutissage*



Reference number
ISO 5000:1993(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 5000 was prepared by Technical Committee ISO/TC 17, *Steel*, Sub-Committee SC 12, *Continuous mill flat rolled products*.

This second edition cancels and replaces the first edition (ISO 5000:1980), of which it constitutes a technical revision.

Annexes A and B form an integral part of this International Standard.

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Continuous hot-dip aluminium/silicon-coated cold-reduced carbon steel sheet of commercial and drawing qualities

1 Scope

1.1 This International Standard specifies the characteristics of cold-reduced carbon steel sheet of commercial and drawing qualities coated by a continuous hot-dip aluminium/silicon alloy coating process.¹⁾ This product is used principally for heat-resisting applications and also where corrosion resistance and heat are involved. The coating mass may be specified in accordance with table 2.²⁾ This coating system normally produces a minimum layer of alloy. The coating mass is expressed as the total coating on both surfaces in grams per square metre. The coating mass specified should be compatible with the desired service life, thickness of the base metal and with forming requirements involved. A designation system (see clause 4) includes the coating designation, coating condition and quality.

1.2 Aluminium/silicon-coated steel sheet is produced in thicknesses from 0,40 mm to 3,0 mm inclusive and in widths of 600 mm to 1 500 mm (see clause 7) in coils and cut lengths. Aluminium/silicon-coated sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

NOTE 1 Values of total theoretical thickness for coating mass are given in annex A. A method for the determination of coating mass is given in annex B.

1.3 Commercial quality aluminium/silicon-coated steel sheet (quality 01) is intended for general fabricating purposes where sheet is used in the flat, or for bending or moderate forming.

1.4 Drawing quality aluminium/silicon-coated sheet (qualities 02, 03 and 04) is intended for drawing or severe forming. It is furnished according to the requirements of this International Standard, or, with agreement when ordered, to fabricate an identified part, in which case the mechanical properties in table 3 do not apply. The use of grade 04 minimizes strain ageing.

Drawing qualities are identified as follows:

02	Drawing quality
03	Deep drawing quality
04	Deep drawing quality special killed

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 6892:1984, *Metallic materials — Tensile testing*.

ISO 7438:1985, *Metallic materials — Bend test*.

3 Definition

For the purposes of this International Standard, the following definition applies.

1) This product is sometimes known as type 1.

2) Theoretical thicknesses for coating mass given in annex A are for information only.

3.1 continuous hot-dip aluminium/silicon-coated cold-reduced steel sheet: A product obtained by hot-dip coating cold-reduced sheet coils on a continuous aluminium/silicon alloy coating line to produce either aluminium/coated coils or aluminium/coated cut lengths. The aluminium/silicon alloy used for coating normally has between 5 % and 11 % silicon added to promote better adherence and heat resistance.

4 Designation system

The as-produced hot-dip aluminium coatings are designated AS (aluminium/silicon), as shown in table 2. The coating mass designation follows the AS and three spaces are allocated for coating mass designation. If only two spaces are required, such as for designation "80", then the "80" is preceded by a "0" to fill computer space and is shown as "080". Since this product is normally skin passed, designation "S" is used to indicate the coating condition. The numbers 01, 02, 03 and 04 are common to other standards, indicating the qualities of commercial, drawing, deep drawing and deep drawing special killed.

An example of a complete designation, including coating mass, coating condition and quality is AS080S01. This is composed by combining the following:

AS:	Aluminium/silicon coating
080:	Coating mass designation (see table 2)
S:	Skin passed
01:	Commercial quality

5 General information

5.1 Skin-pass

This is a light cold rolling of the aluminium/silicon-coated steel sheet. This product is normally skin-passed. The purposes of skin-passing are one or more of the following:

- to produce a higher degree of surface smoothness and to improve appearance (this process may adversely affect the ductility of the base metal);
- to minimize temporarily the occurrence of conditions known as stretcher strain (Lüder's lines) or fluting during fabrication of finished parts;
- to control shape.

5.2 Strain ageing

Aluminium/silicon-coated steel sheet tends to strain age, and this may lead to the following:

- surface marking from stretcher strain (Lüder's lines) or fluting when the steel is formed;
- a deterioration in ductility.

Because of these factors, it is essential that the period between final processing at the mill and fabrication be kept to a minimum. Rotation of stock, by using the oldest material first, is important. Stocking of such steels for extended periods of time should be avoided and should not exceed six weeks for optimum performance. For skin-passed sheet, reasonable freedom from stretcher strain can be achieved by effective roller levelling immediately prior to fabrication at the purchaser's plant.

5.3 Mill passivation

A chemical treatment may be applied to aluminium/silicon-coated steel sheet to minimize the hazard of wet storage stains during shipment and storage. However, the inhibiting characteristics of the treatment are limited and if a shipment is received wet, the material shall be used immediately or dried.

5.4 Oiling

The aluminium/silicon-coated steel sheet as produced shall be oiled to prevent marring or scratching of the soft surface during handling or shipping and to minimize the hazard of wet storage stains. Sheet which is not oiled shall be subject to an agreement between the producer and purchaser. When the aluminium/silicon-coated sheet has received a passivating treatment, oiling will further minimize the hazard of wet storage stains.

6 Conditions of manufacture

6.1 Steelmaking

The processes used in making the steel and in manufacturing aluminium/silicon coated sheet are left to the discretion of the manufacturer. When requested, the purchaser shall be informed of the steelmaking process being used.

6.2 Chemical composition

The chemical composition of the steel (cast analysis) would not be expected to exceed the values given in table 1.

Table 1 — Chemical composition, %

Quality		C	Mn	P	S
Designation	Name	max.	max.	max.	max.
01	Commercial	0,15	0,60	0,05	0,05
02	Drawing	0,12	0,50	0,04	0,04
03	Deep drawing	0,10	0,45	0,03	0,03
04	Deep drawing special killed	0,08	0,45	0,03	0,03

6.3 Chemical analysis

6.3.1 Cast analysis

A cast analysis of each cast of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus and sulfur. When requested, this analysis shall be reported to the purchaser or his representative.

6.3.2 Verification analysis

A verification analysis may be made by the purchaser to verify the specified analysis of the semi-finished or finished steel and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to verification analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between manufacturer and purchaser at the time of ordering.

6.4 Coating mass

The coating mass shall conform to the requirements presented in table 2 for the specific coating designation. The coating mass is the total amount of the aluminium/silicon alloy, including both sides of the sheet, expressed in grams per square metre (g/m^2) of sheet. Methods of checking that the material complies with this International Standard are given in 8.2.1, 9.2 and annex B. Procedures other than those covered in annex B shall be permitted by agreement between manufacturer and purchaser.

Table 2 — Mass of coating (total both sides)

Qualities for mass of coating	Coating designation	Minimum coating mass limits	
		Triple-spot test check limits g/m^2 (of sheet)	Single-spot test check limits g/m^2 (of sheet)
Commercial	AS300	300	240
	AS200	200	150
Commercial and drawing	AS150	150	115
	AS120	120	90
	AS100	100	75
	AS080	80	60
	AS060	60	45
	AS040	40	30

NOTE — Because of the many variables and changing conditions that are characteristic of continuous aluminium/silicon coating, the mass of coating is not always evenly divided between the two surfaces of an aluminium/silicon-coated sheet; neither is the aluminium/silicon coating evenly distributed from edge to edge. However, it can normally be expected that not less than 40 % of the single-spot check limit will be found on either surface.

6.5 Weldability

The product is suitable for welding if appropriate welding methods and procedures are used, with special attention to the heavier coatings.

6.6 Application

Aluminium/silicon-coated steel sheet shall be identified for fabrication by the name of the part or by the intended application. Steel sheet of drawing qualities (02, 03 and 04) may be produced to make an identified part, which shall be previously agreed upon between manufacturer and purchaser. In this case, the part name, the details of fabrication, and special requirements (freedom from stretcher strain or fluting, coating performance requirements) shall be specified and the mechanical properties of table 3 do not apply.

6.7 Mechanical properties

Except when ordered to an identified part as explained in 6.6, at the time that the steel is made available for shipment, the mechanical properties shall be as stated in table 3 when they are determined on test pieces obtained according to the requirements of 8.1 (mechanical tests). Prolonged storage of the sheet can cause a change in mechanical properties (increase in hardness and decrease in elongation),

leading to a decrease in drawability. To minimize this effect, quality 04 should be specified.

7 Dimensional tolerances

Dimensional tolerances applicable to aluminium/silicon-coated steel sheet shall be as given in tables 5 to 12.

8 Sampling

8.1 Mechanical tests

8.1.1 Tensile test

When ordered according to mechanical properties, one representative sample for the tensile test required in table 3 shall be taken from each lot of sheet for shipment. A lot consists of 50 tonnes or less of sheet of the same quality rolled to the same thickness and condition.

8.1.2 Bend test (when specified)

One representative sample for the bend test (quality 01) shall be taken from each lot of sheet for shipment.

A lot consists of all sheet of the same quality rolled to the same thickness and condition.

8.2 Coating tests

8.2.1 Mass of coating

The manufacturer shall make such tests and measurements as he deems necessary to ensure that the material produced complies with the values in table 2. The purchaser may verify the mass of coating by use of the following sampling method.

Three specimens shall be cut, one from the mid-width position, and one from each side not closer than 25 mm from the side edge. The minimum specimen area should be 2 000 mm².

8.2.2 Bend test (when specified)

One representative sample shall be taken from each lot of sheet for shipment. The specimens for the coated bend test shall be taken not closer than 25 mm from the side edge. The minimum specimen width shall be 50 mm.

Table 3 — Mechanical properties (see 6.7)

Base metal quality		R_m 1) N/mm ²	A min. 2) %		180° bend mandrel diameter, for all thicknesses
Designation	Name		$L_o = 50$ mm	$L_o = 80$ mm	
01	Commercial	—	—	—	1a
02	Drawing	430	24	23	Does not apply
03	Deep drawing	410	26	25	
04	Deep drawing special killed	410	29	28	

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

a = thickness of bend test piece

1 N/mm² = 1 MPa

1) Minimum tensile strength for qualities 02, 03 and 04 would normally be expected to be 260 N/mm². All tensile strength values are determined to the nearest 10 N/mm².

2) For material up to and including 0,6 mm in thickness, the elongation values in the table shall be reduced by 2. For thicknesses up to 3,0 mm, use either $L_o = 50$ mm or $L_o = 80$ mm.

9 Test methods

9.1 Mechanical tests

9.1.1 Tensile test (base metal)

The tensile test shall be carried out in accordance with ISO 6892. Transverse test pieces shall be taken mid-way between the centre and edge of the sheet as rolled. Since the tensile test is for the determination of properties of the base metal, ends of test pieces shall be stripped of the coating to measure base metal thickness for calculation of cross-sectional area.

9.1.2 Bend test (base metal) (when specified)

The transverse bend test piece (quality 01), stripped of coating shall withstand being bent through 180° in the direction shown in figure 1, around the inside diameter as shown in table 3, without cracking on the outside of the bent portion. The bend test shall be performed at ambient temperature and is described in ISO 7438. Small cracks on the edges of test pieces, and cracks which require magnification to be visible, shall be disregarded.

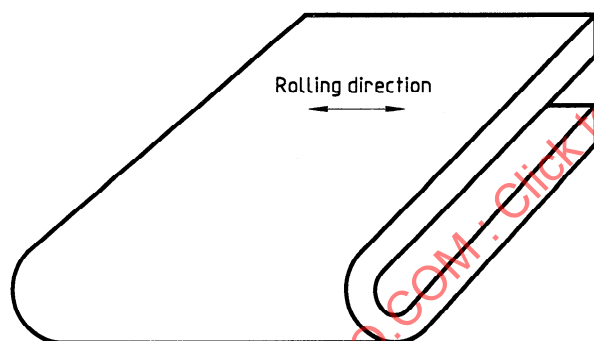


Figure 1 — Transverse bend test piece (after bending)

9.2 Coating tests

9.2.1 Triple-spot test

The triple-spot test result is the average coating mass found on the three specimens taken according to 8.2.1. The test is normally carried out by stamping out a known area of sheet and calculating the coating mass from the loss in mass after removing the aluminium coating. (See annex B.) Procedures other than those covered in annex B should be permitted upon agreement by manufacturer and purchaser.

9.2.2 Single-spot test

The single-spot test result shall be the minimum coating mass found on any one of the three specimens used for the triple-spot test. Material which has been slit from wide coil shall be subject to a single-spot test only.

9.2.3 Bend test (coating)

Bend test pieces taken after coating (before additional processing) shall withstand being bent through 180° in either direction without flaking of the coating on the outside of the bend. The radius of the bend is determined by the number of pieces of the same thickness (or mandrel equivalent) as shown in table 4. Flaking of coating within 7 mm from the edge of the test piece shall not be cause for rejection.

10 Retests

If a test does not give the specified results, two more test pieces shall be taken at random from the same lot. Both retests shall conform to the requirements of this International Standard, otherwise, the lot shall be rejected.

11 Resubmission

11.1 The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to a suitable treatment (selection, heat treatment) which, on request, will be indicated to the purchaser. In this case, the tests should be carried out as if they applied to a new batch.

11.2 The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another grade.

12 Workmanship

The aluminium/silicon-coated steel sheet in cut lengths shall be free from laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing. Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove defective portions, as can be carried out on the cut-length product.

Table 4 — Coating bend test requirements

Coating designation	180° bend mandrel diameter, for			
	$e < 1,25$		$e \geq 1,25$	
	Commercial quality	Drawing quality	Commercial quality	Drawing quality
AS300	2a	—	3a	—
AS200	2a	—	3a	—
AS150	2a	2a	3a	3a
AS120	1a	1a	2a	2a
AS100	1a	1a	2a	2a
AS080	1a	1a	2a	2a
AS060	1a	1a	2a	2a
AS040	1a	1a	2a	2a

e = thickness of steel sheet, in millimetres
 a = thickness of bend test piece, in millimetres

13 Inspection and acceptance

13.1 While not usually required for products covered by this International Standard, when the purchaser specifies that inspection and tests for acceptance be observed prior to shipment from the manufacturer's works, the manufacturer shall afford the purchaser's inspector all reasonable facilities to determine that the steel is being furnished in accordance with this International Standard.

13.2 Steel that is reported to be defective after arrival at the user's works shall be set aside, properly and correctly identified and adequately protected. The supplier shall be notified in order that he may properly investigate.

14 Coil size

When aluminium/silicon-coated steel sheet is ordered in coils, a minimum inside diameter (I.D.) or range of acceptable inside diameters shall be specified. In addition, the maximum outside diameter (O.D.) and maximum acceptable coil mass shall be specified.

15 Marking

Unless otherwise stated, the following minimum requirements for identifying the steel shall be legibly stencilled on the top of each lift or shown on a tag attached to each coil or shipping unit:

- a) the manufacturer's name or identifying brand;
- b) the number of this International Standard;

- c) the designation (coating, coating mass, coating condition and quality of the base metal);
- d) the order number;
- e) the product dimensions;
- f) the lot number;
- g) the mass.

16 Information to be supplied by the purchaser

To specify adequately requirements under this International Standard, inquiries and orders shall include the following information:

- a) the number of this International Standard;
- b) the name and designation of the material;

EXAMPLE

Aluminium/silicon-coated steel sheet, commercial quality, AS120S01 (see 1.3 and 4).

- c) the dimensions of the product (the thickness includes the coating) and the quantity required;
- d) the application (name of part), if possible (see 6.6);
- e) for drawing qualities (02, 03 and 04), whether ordered according to mechanical properties (see 6.7) or to fabricate an identified part (see 6.6);
- f) mill passivated, if required (see 5.3);

- g) not oiled, if required (see 5.4);
- h) the coil size requirements (see clause 14);
- i) the report of the cast analysis, if required (see 6.3.1);
- j) details of fabrication or special requirements (fluting or coating performance) (see 6.6);

- k) inspection and tests for acceptance prior to shipment from the producer's works, if required (see 13.1).

NOTE 2 A typical ordering description is as follows:

International Standard ISO 5000, aluminium/silicon coated steel sheet, drawing quality, designation AS120S02, 1,0 x 1 200 mm x coil, 20 000 kg, exhaust pipe tubing, # 6201.

Table 5 — Thickness tolerances for coils and cut lengths

Values in millimetres

Specified widths	Thickness tolerances ^{1) 2)} , over and under, for specified thicknesses							
	0,4 up to and including 0,6	over 0,6 up to and including 0,8	over 0,8 up to and including 1,0	over 1,0 up to and including 1,2	over 1,2 up to and including 1,6	over 1,6 up to and including 2,0	over 2,0 up to and including 2,5	over 2,5 up to and including 3,0
600 up to and including 1 200	0,06	0,08	0,09	0,10	0,12	0,14	0,16	0,19
Over 1 200 up to and including 1 500	0,07	0,09	0,10	0,11	0,13	0,15	0,17	0,20
1) Tolerances apply to the total thickness.								
2) Thickness is measured at any point on the coated sheet not less than 25 mm from a side edge.								

Table 6 — Width tolerances for coils and cut lengths, not resquared

Values in millimetres

Specified widths	Tolerance
Up to and including 1 500	$\begin{smallmatrix} +7 \\ 0 \end{smallmatrix}$

Table 7 — Length tolerances for cut lengths not resquared

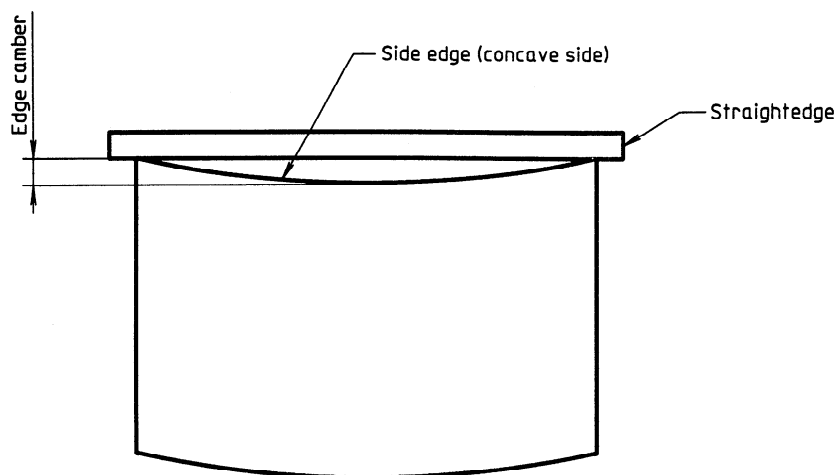
Specified lengths	Tolerance
Up to and including 3 000	$\begin{smallmatrix} +20 \\ 0 \end{smallmatrix}$ mm
Over 3 000 up to and including 6 000	$\begin{smallmatrix} +30 \\ 0 \end{smallmatrix}$ mm
Over 6 000	$\begin{smallmatrix} +0,5 \\ 0 \end{smallmatrix}$ %

Table 8 — Camber tolerances for coils and cut lengths (see figure 2)

Form	Camber tolerance
Coils	20 mm in any 5 000 mm length
Cut lengths	0,4 % x length

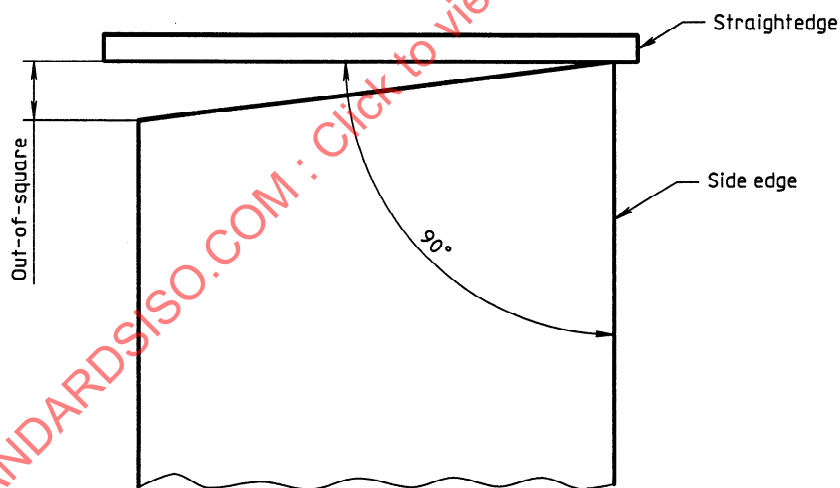
Table 9 — Out-of-square tolerance for cut lengths, not resquared (see figure 3)

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1,0 % x width



NOTE — Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge.

Figure 2 — Measurement of camber



NOTE — Out-of-square is the greatest deviation of an end edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown. It can also be measured as one-half the difference between the diagonals of the cut-length sheet.

Figure 3 — Measurement of out-of-square

Table 10 — Out-of-square tolerances for resquared sheet (see figure 3)

Values in millimetres

Specified lengths	Specified widths	Out-of-square tolerance
Up to and including 3 000	Up to and including 1 200	+2 0
	Over 1 200	+3 0
Over 3 000	All widths	+3 0
NOTE — When measuring material ordered to resquared tolerances, consideration may have to be given to extreme variations in temperature.		

Table 11 — Standard flatness tolerances for cut lengths

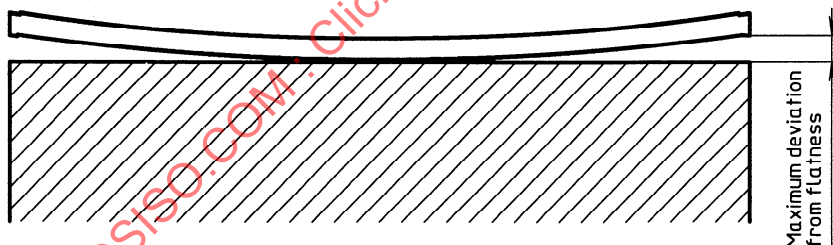
Values in millimetres

Specified thicknesses	Specified widths	Flatness tolerance ¹⁾
Up to and including 0,7	Up to and including 1 200	15
	Over 1 200 up to and including 1 500	18
Over 0,7 up to and including 1,2	Up to and including 1 200	12
	Over 1 200 up to and including 1 500	15
Over 1,2	Up to and including 1 200	10
	Over 1 200 up to and including 1 500	12
NOTE — These tolerances are only applicable to sheet up to and including 5 000 mm length when their thickness is 3,0 mm or less. This table also applies to sheet cut to length from coils by the customer when adequate flattening procedures are performed. Tolerances for sheet exceeding 5 000 mm in length are subject to agreement.		
1) Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness (see figure 4).		

Table 12 — Special flatness tolerances for cut lengths, roller levelled

Values in millimetres

Specified thicknesses	Specified widths	Specified lengths	Flatness tolerance ¹⁾
Up to and including 2	Up to and including 1 200	Up to and including 2 500	9
	Over 1 200	Over 2 500	15
Over 2 up to and including 3,0	Up to and including 1 200	Up to and including 2 500	8
	Over 1 200	Over 2 500	13
NOTE — Tolerance for sheet exceeding 5 000 mm in length are subject to agreement.			
1) Maximum deviation from a flat horizontal surface. With the sheet lying under its own weight on a flat surface, the maximum distance between the lower surface of the sheet and the flat horizontal surface is the maximum deviation from flatness (see figure 4).			

**Figure 4 — Measurement of flatness**