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**INTERNATIONAL STANDARD****3573**

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INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

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## Hot-rolled carbon steel sheet of commercial and drawing qualities

*Tôles en acier au carbone laminées à chaud, de qualité commerciale et pour emboutissage*

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**Descriptors:** iron and steel products, hot-rolled products, metal plates, carbon steels, cupping, specifications, chemical composition, mechanical properties, mechanical tests, dimensions, tolerances (mechanics).

Price based on 13 pages

## FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up 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.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3573 was drawn up by Technical Committee ISO/TC 17, *Steel*, and was circulated to the Member Bodies in April 1975.

It has been approved by the Member Bodies of the following countries

Austria	Hungary	Romania
Belgium	Iran	South Africa, Rep. of
Brazil	Ireland	Spain
Bulgaria	Italy	Sweden
Canada	Japan	Switzerland
Czechoslovakia	Korea, Dem. P. Rep. of	Turkey
Denmark	Korea, Rep. of	United Kingdom
Finland	Mexico	U.S.A.
France	Netherlands	U.S.S.R.
Germany	New Zealand	Yugoslavia

The Member Body of the following country expressed disapproval of the document on technical grounds :

Australia

# Hot-rolled carbon steel sheet of commercial and drawing qualities

## 1 SCOPE AND FIELD OF APPLICATION

1.1 This International Standard applies to hot-rolled carbon steel sheet of commercial and drawing qualities.

### NOTES

1 Hot-rolled sheet up to but not including 3 mm in thickness is commonly known as "sheet". Hot-rolled sheet 3 mm and over in thickness is commonly known as either "sheet" or "plate".

2 Steel sheet that is to be subjected to subsequent rerolling is not covered by this International Standard.

Hot-rolled steel sheet is suitable for many applications where the presence of oxide or scale, or normal surface imperfections disclosed after removal of oxide or scale, are not objectionable. It is not suitable for applications where surface is of prime importance.

1.2 Commercial quality sheet (HR1) is intended for general fabrication purposes where sheet is used in the flat or for bending, moderate forming, and welding operations. It is commonly produced in the range of thickness 1,2 to 12,5 mm inclusive, and widths 600 mm and over in coils and cut lengths.

NOTE — Approximate conversions into inches are given in the annex, for information only.

1.3 Drawing quality sheet (HR2, HR3, HR4) is intended for drawing or severe forming, including welding. It is commonly produced in the range of thicknesses 1,6 to 12,5 mm inclusive, and widths 600 mm and over in coils and cut lengths. Drawing quality sheet is furnished to all the requirements of this International Standard, or, by agreement when ordered, to fabricate an identified part, in which case the mechanical properties in table 2 do not apply. Drawing qualities are identified as follows :

**HR2** : Drawing quality

**HR3** : Deep drawing quality

**HR4** : Deep drawing quality special killed

1.4 Hot-rolled sheet less than 600 mm wide may be slit from wide sheet and will be considered as sheet.

## 2 REFERENCES

ISO 82, *Steel — Tensile testing.*

ISO/R 85, *Bend test for steel.*

ISO 86, *Steel — Tensile testing of sheet and strip less than 3 mm and not less than 0,5 mm thick.*

ISO/R 87, *Simple bend testing of steel sheet and strip less than 3 mm wide.*

## 3 DEFINITIONS AND OTHER INFORMATION

**3.1 hot-rolled steel sheet** : A product obtained by rolling heated steel through a continuous-type or reversing-type strip mill to the required sheet thickness. The product has a surface covered with oxide or scale resulting from the hot-rolling operation.

**3.2 hot-rolled descaled steel sheet** : Hot-rolled steel sheet from which oxide or scale has been removed, commonly by pickling in an acid solution. Descaling may also be performed by mechanical means such as grit blasting. Some increase in hardness and some loss of ductility may result from descaling.

As a deterrent to rusting, a coating of oil is usually applied to hot-rolled descaled steel sheet, but sheet may be furnished not oiled if required. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals.

**3.3 skin pass** : A light cold-rolling of hot-rolled steel sheet or hot-rolled descaled steel sheet. The purposes of skin passing are one or more of the following :

- to minimize temporarily the occurrence of the condition known as stretcher strain (Lüder's lines) or fluting during fabrication of finished parts;
- to minimize the appearance of coil breaks;
- to control the shape.

Some increase in hardness and some loss of ductility will result from skin passing.

**3.4 mill edge** : A normal side edge produced in hot-rolling. Mill edges may contain some irregularities such as cracked or torn edges or thin (feathered) edges.

**3.5 edge trimmed** : A normal edge obtained by shearing, slitting, or trimming a mill edge product.

**3.6 surface condition**

Oxide or scale on hot-rolled steel sheet is subject to variations in thickness, adherence and colour. Removal of the oxide or scale by pickling or blast cleaning may disclose surface imperfections not readily visible prior to this operation. Also, after drawing, imperfections may be visible which were not apparent in the flat sheet.

**4 CONDITIONS OF MANUFACTURE**

**4.1 Steelmaking**

The processes used in making the steel and in manufacturing hot-rolled sheet are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

**4.2 Chemical composition**

The chemical composition (cast analysis) shall not exceed the values given in table 1.

TABLE 1 – Chemical composition (cast analysis) %

Quality		C max.	Mn max.	P max.	S max.
Designation	Name				
HR1	Commercial	0,15	0,60	0,05	0,05
HR2	Drawing	0,12	0,50	0,04	0,04
HR3	Deep drawing	0,10	0,45	0,03	0,03
HR4	Deep drawing special killed	0,08	0,45	0,03	0,03

**4.3 Chemical analysis**

**4.3.1 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 sulphur. On request, this analysis shall be reported to the purchaser or his representative.

**4.3.2 Verification analysis**

A verification analysis may be made by the purchaser to verify the specified chemical composition 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 verifi-

cation analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

**4.4 Weldability**

This product is normally suitable for welding if appropriate welding conditions are selected. For underscaled steel, it may be necessary to remove the scale or oxide depending upon the welding method.

**4.5 Application**

It is desirable that hot-rolled steel sheet be identified for fabrication by name of the part or by the intended application. Hot-rolled steel sheet of drawing qualities (HR2, HR3, HR4) may be produced to make an identified part within a properly established breakage allowance which shall be previously agreed upon between the interested parties. In this case, part name, details of fabrication, and special requirements such as freedom from stretcher strains or from fluting shall be specified and the mechanical properties in table 2 do not apply.

**4.6 Mechanical properties**

Except when ordered to an identified part, as explained in 4.5, at the time that the steel is made available for shipment, the mechanical properties shall be as given in table 2 when they are determined on test pieces obtained in accordance with the requirements of clause 7.

Prolonged storage of the sheet can cause a change in the mechanical properties (increase in hardness and a decrease in elongation), leading to a decrease in drawability. To minimize this effect, quality HR4 should be specified.

**5 DIMENSIONAL TOLERANCES**

Dimensional tolerances applicable to hot-rolled steel sheet shall be as given in tables 3 to 13 inclusive.

**6 SAMPLING**

**6.1 Tensile test**

One representative sample for the tensile test required in table 2 shall be taken from each lot of sheet of shipment. A lot consists of 50 tonnes or less of sheet of the same quality rolled to the same thickness and condition.

**6.2 Bend test**

One representative sample for the bend test (applicable only to HR1) 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.

TABLE 2 — Mechanical properties<sup>1)</sup> (see 4.6)

Quality		$R_m$ , max. 2) N/mm <sup>2</sup>	A min. % <sup>3)</sup>				180° bend mandrel diameter			
Designation	Name		$e < 3$		$3 \leq e < 6$		$e \geq 6$			
			$L_o = 80$ mm	$L_o = 50$ mm	$L_o = 5,65 \sqrt{S_o}$	$L_o = 50$ mm	$L_o = 5,65 \sqrt{S_o}$	$e < 3$	$3 \leq e < 6$	$6 \leq e < 9$
HR1	Commercial	—	—	—	—	—	1 a	2 a	3 a	4 a
HR2	Drawing	430	25	26	28	29	—	—	—	—
HR3	Deep drawing	370	28	29	32	33	—	—	—	—
HR4	Deep drawing special killed	390	28	29	32	33	—	—	—	—

1)  $R_m$  = tensile strength

A = percentage elongation after fracture

$L_o$  = gauge length of test piece

$S_o$  = original cross-sectional area of gauge length

$e$  = thickness of steel sheet, in millimetres

$a$  = thickness of bend test piece

1 N/mm<sup>2</sup> = 1 MPa

2) Minimum tensile strength for qualities HR2, HR3 and HR4 would normally be expected to be 270 N/mm<sup>2</sup>. All tensile strength values are determined to the nearest 10 N/mm<sup>2</sup>.

3) The non-proportional test piece with a fixed original gauge length (50 mm, up to 6 mm thick sheet and 200 mm for 6 mm and thicker) can be used in conjunction with a conversion table. In case of dispute, however, only the results obtained on a proportional test piece will be valid for material 3 mm and over in thickness.

4) By agreement between the interested parties.

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## 7 MECHANICAL TESTS

### 7.1 Tensile test

The tensile test shall be carried out in accordance with ISO 82 and ISO 86. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

### 7.2 Bend test (applicable only to HR1)

The transverse bend test piece shall withstand being bent through  $180^\circ$ , in the direction as shown in figure 1, around an inside diameter as shown in table 2, without cracking on the outside of the bent portion. The bend test is to be carried out at ambient temperature and as described in ISO/R 85 and ISO/R 87.

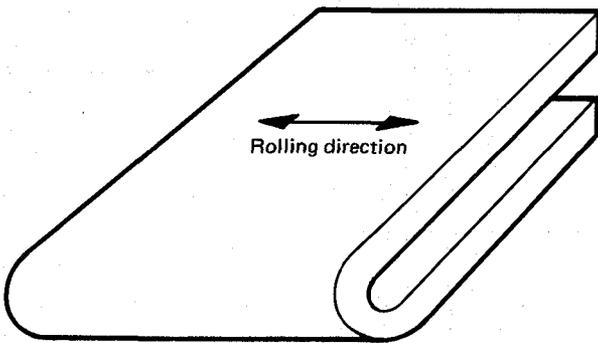


FIGURE 1 — Transverse bend test piece (after bending)

## 8 WORKMANSHIP

The surface condition shall be that normally obtained in a hot-rolled or hot-rolled descaled product.

The 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 such portions as can be carried out on the cut length product.

## 9 INSPECTION AND ACCEPTANCE

**9.1** 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.

**9.2** 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.

## 10 COIL SIZE

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

## 11 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 quality designation;
- d) the order number;
- e) the product dimensions;
- f) the lot number;
- g) the mass.

## 12 INFORMATION TO BE SUPPLIED BY THE PURCHASER

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

- a) the number of this International Standard;
- b) the name and quality of the material (for example, hot-rolled steel sheet, deep drawing quality HR3) (see 1.2 and 1.3);
- c) the dimensions of the product and the quantity required;
- d) the application (name of part), if possible (see 4.5);
- e) for drawing qualities HR2, HR3 and HR4, whether ordered to mechanical properties or to fabricate an identified part (see 4.5 and 4.6);
- f) whether pickling or descaling by grit or shot blasting is required (material so specified will be oiled unless ordered not oiled) (see 3.2);
- g) the type of edge (see 3.4 and 3.5);
- h) whether skin passing is required (see 3.3);
- i) the report of the cast analysis, if required (see 4.3.1);
- j) limitations on masses and dimensions of individual coils and bundles, if applicable (see clause 10);

k) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 9.1).

used for warehouse resale, edge trimmed, furnish report of cast analysis, maximum lift mass 4 000 kg.

2) International Standard ISO 3573, hot-rolled steel sheet, deep drawing quality HR1, 2,5 × 1 200 mm × coil, 50,000 kg, ordered to mechanical properties, pickled and oiled, mill edge, coils 600 mm minimum I.D., 1 500 mm maximum O.D., maximum coil mass 15 000 kg.

NOTE – Typical ordering descriptions are as follows :

1) International Standard ISO 3573, hot-rolled steel sheet, commercial quality HR1, 3 × 1 200 × 2 440 mm, 10 000 kg, to be

TABLE 3 – Thickness tolerances for coils<sup>1)</sup> and cut lengths (including descaled sheet).

Values in millimetres

Specified widths	Thickness tolerances <sup>2)</sup> , over and under, for specified thicknesses								
	up to and including 1,60	over 1,60 up to and including 2,00	over 2,00 up to and including 2,50	over 2,50 up to and including 3,00	over 3,00 up to and including 4,00	over 4,00 up to and including 6,00	over 6,00 up to and including 8,00	over 8,00 up to and including 10,00	over 10,00 to 12,50 inclusive
600 up to and including 1 200	0,17	0,18	0,20	0,21	0,23	0,27	0,30	0,33	0,36
Over 1 200 up to and including 1 500	0,19	0,20	0,22	0,23	0,25	0,28	0,31	0,36	0,38
Over 1 500 up to and including 1 800	0,21	0,22	0,24	0,25	0,26	0,29	0,33	0,38	0,41
Over 1 800	–	–	0,26	0,27	0,28	0,30	0,38	0,43	0,46

1) The values specified do not apply to the uncropped ends for a length  $l$  of a mill edge coil.

Length  $l$  would be calculated using the formula :

$$\text{Length } l \text{ in metres} = \frac{90}{\text{Thickness in millimetres}}$$

provided that the result was not greater than 30 m.

2) Thickness is measured at any point on the sheet not less than 40 mm from a side edge.

**TABLE 4 – Width tolerances for coils and cut lengths  
(including descaled sheet), mill edge**

Values in millimetres

Specified widths	Tolerance <sup>1)</sup>
Up to and including 1 200	+ 30 0
Over 1 200 up to and including 1 500	+ 35 0
Over 1 500	+ 40 0

1) The values specified do not apply to the uncropped ends for a length *l* of a mill edge coil.

Length *l* would be calculated using the formula :

$$\text{Length } l \text{ in metres} = \frac{90}{\text{Thickness in millimetres}}$$

provided that the result was not greater than 30 m.

**TABLE 5 – Width tolerances for coils and cut lengths  
(including descaled sheet), cut edge, not resquared**

Values in millimetres

Specified widths	Tolerance
Up to and including 1 200	+ 6 0
Over 1 200 up to and including 1 500	+ 8 0
Over 1 500	+ 10 0

**TABLE 6 – Length tolerances for cut lengths  
(including descaled sheet), not resquared**

Values in millimetres

Specified lengths	Tolerance
Up to and including 3 000	+ 20 0
Over 3 000 up to and including 6 000	+ 30 0
Over 6 000	+ 0,5 % 0

TABLE 7 — Camber tolerances for coils and cut lengths  
(including descaled sheet), not resquared

Form	Camber tolerance
Coils	25 mm in any 5 000 mm length
Cut lengths	0,5 % × length

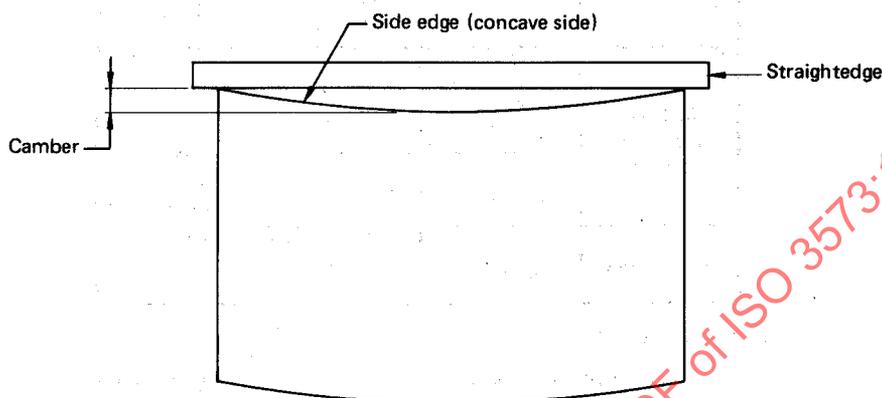


FIGURE 2 — Measurement of camber

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

TABLE 8 — Out-of-square tolerances for cut lengths  
(including descaled sheet), not resquared

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

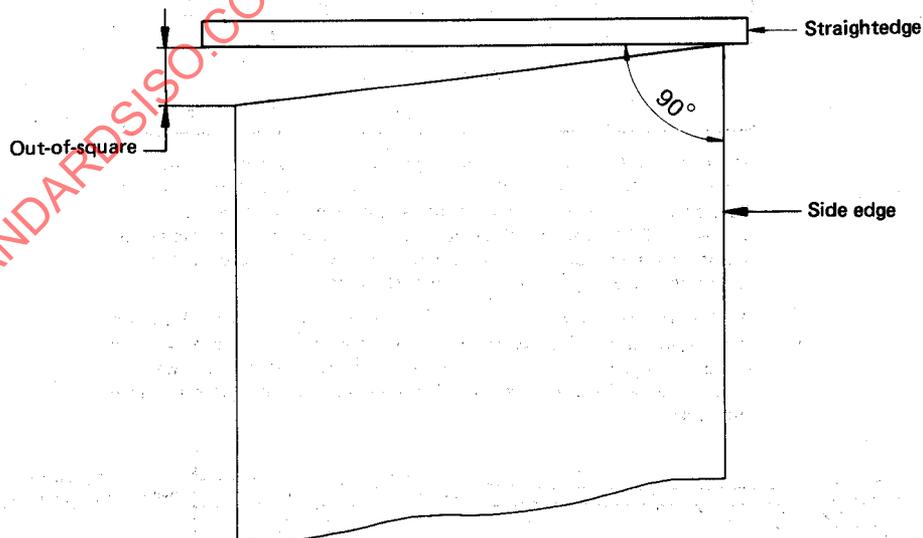


FIGURE 3 — Measurement of out-of-square

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 in figure 3. It can also be measured as one-half the difference between the diagonals of the cut length sheet.

TABLE 9 – Out-of-square<sup>1)</sup> tolerances for resquared<sup>2)</sup> sheet

Values in millimetres

Specified lengths	Specified widths	Out-of-square tolerance	
		Up to and including 5 mm in thickness	Over 5 mm in thickness
Up to and including 3 000	Up to and including 1 200	+ 2 0	To be subject to an agreement between the interested parties
	Over 1 200	+ 3 0	
Over 3 000	All widths	+ 3 0	

- 1) See figure 3.
- 2) When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature.

TABLE 10 – Standard flatness tolerances<sup>1)</sup> for cut lengths (including descaled sheet)

Values in millimetres

Specified thickness	Specified widths	Flatness tolerance <sup>2)</sup>
Up to and including 2	Up to and including 1 200	18
	Over 1 200 up to and including 1 500	25
	Over 1 500	30
Over 2	Up to and including 1 200	15
	Over 1 200 up to and including 1 500	20
	Over 1 500	25

1) These tolerances are only applicable to sheet up to and including 5 000 mm length when their thickness is 6 mm or less. Tolerances for sheet having a thickness over 6 mm and a length exceeding 5 000 mm shall be subject to agreement. This table also applies to sheet cut to length from coil by the purchaser when adequate flattening procedures are performed.

2) 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).

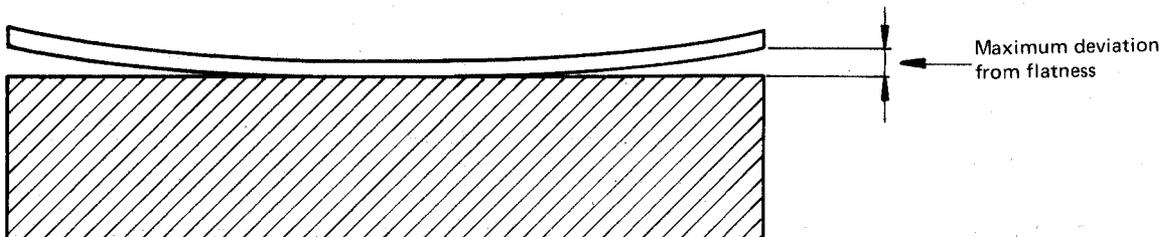


FIGURE 4 – Measurement of flatness

TABLE 11 – Special flatness tolerances<sup>1)</sup> for cut lengths,  
roller levelled (including descaled sheet)

Values in millimetres

Specified thicknesses	Specified widths	Specified lengths	Flatness tolerance <sup>2)</sup>
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 to 6, inclusive	Up to and including 1 200	Up to and including 2 500	8
	Over 1 200	Over 2 500	13

1) Tolerances for sheet over 6 mm in thickness or over 5 000 mm in length shall be subject to agreement.

2) 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<sup>1)</sup> for cut lengths,  
stretcher levelled (including descaled sheet)

Values in millimetres

Specified thicknesses	Specified widths	Specified lengths	Flatness tolerance <sup>2)</sup>
Up to and including 2	Up to and including 1 200	Up to and including 2 500	5
	Over 1 200	Over 2 500	8
Over 2 to 6, inclusive	Up to and including 1 200	Up to and including 2 500	3
	Over 1 200	Over 2 500	6

1) Tolerances for sheet over 6 mm in thickness or over 5 000 mm in length shall be subject to agreement.

2) 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).

When hot-rolled sheet is specified to stretcher levelled standard of flatness and not resquared, the allowance over specified dimensions in width and length given in table 13 apply. Under these conditions, the allowances for width and length are added by the manufacturer to the specified width and length and the new tolerances given in tables 4, 5 and 6 apply on the basis of the new size established. The camber tolerances in table 7 do not apply.

When sheet is not to have grip or entry marks within the specified length, the purchaser should specify "grip or entry marks outside specified length". When sheet may have grip or entry marks within the specified length, the purchaser should specify "grip or entry marks inside specified length".

TABLE 13 – Width and length allowances<sup>1)</sup> for cut lengths, stretcher levelled (including descaled sheet)

Values in millimetres

Specified lengths	Allowances over specified dimensions		
	Widths	Lengths	
		Grip or entry marks outside specified length	Grip or entry marks inside specified length
Up to and including 3 000	19	100	75
Over 3 000 up to and including 4 000	25	100	75
Over 4 000	32	125	100

1) Allowances for sheet exceeding 6 mm thickness or length exceeding 5 000 mm shall be the subject of agreement.

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