International Standard ISO 3573

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

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 : steels, unalloyed steels, iron-and steel products, hot rolled products, sheet metal, specifications, chemical composition, mechanical properties, dimensional tolerances, tests, mechanical tests, marking.

Price based on 9 pages

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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 3573 was prepared by Technical Committee ISO/TC 17, *Steel*.

This second edition cancels and replaces the first edition (ISO 3573-1976), table 3 of which has been technically revised.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

Printed in Switzerland

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 fabricating 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 in widths of 600 mm and over, in coils and cut lengths.

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 thickness 1,6 to 12,5 mm inclusive, and in widths of 600 mm and over, in coils and cut lengths. Drawing quality sheet shall be 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 6892, *Metallic materials — Tensile testing.*

ISO 7438, *Metallic materials — Bend test.*

3 Definitions

3.1 hot-rolled steel sheet : A product obtained by rolling heated steel through a continuous-type strip mill to the required sheet thickness and tolerances. 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.

3.3 skin pass : A light cold-rolling of hot-rolled steel sheet or hot-rolled descaled steel sheet.

3.4 mill edge : A normal side edge without any definite contour 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. Normal processing does not necessarily provide a definite positioning of the slitting burr.

4 Other information

4.1 Descaling

Some increase in hardness and some loss of ductility may result from descaling, if mechanical means such as grit blasting is used.

The purchaser should state whether descaling is required.

4.2 Skin pass

The purpose of skin passing is one or more of the following :

a) to minimize temporarily the occurrence of the condition known as stretcher strain (Lüder's lines) or fluting during fabrication of finished parts;

b) to minimize the appearance of coil breaks;

c) to control the shape.

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

The purchaser should state whether skin passing is required.

4.3 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.

4.4 Oiling

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.

5 Conditions of manufacture

5.1 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.

5.2 Chemical composition

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

5.3 Chemical analysis

5.3.1 Cast analysis

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

5.3.2 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 between the manufacturer and purchaser at the time of ordering.

5.4 Weldability

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

5.5 Application

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

5.6 Mechanical properties

Except when ordered to an identified part, as explained in 5.5, 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 8.

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.

Table 1 — Chemical composition (cast analysis)

Values as percentages by mass

Quality		Carbon (C) max.	Manganese (Mn) max.	Phosphorus (P) max.	Sulfur (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

Table 2 — Mechanical property requirements for hot-rolled carbon steel sheet[1)]

Quality		R_m max.[2)] N/mm²	A min.[3)4)] (%)				180° bend mandrel[4)] diameter	
			$e < 3$		$3 < e < 6$			
Designation	Name		$L_o = 80$ mm	$L_o = 50$ mm	$L_o = 5{,}65\sqrt{S_o}$	$L_o = 50$ mm	$e < 3$	$3 < e < 6$
HR1	Commercial	—	—	—	—	—	1a	2a
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 for test piece

S_o : original cross-sectional area of gauge length

e : thickness, in millimetres, of steel sheet

a : thickness of the bend test piece

1 N/mm² = 1 MPa

2) Minimum tensile strength for qualities HR2, HR3 and HR4 would normally be expected to be 270 N/mm². All tensile strength values are determined to the nearest 10 N/mm².

3) The non-proportional test piece with a fixed original gauge length (50 mm) up to 6 mm inclusive thick sheet 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) For materials over 6 mm in thickness, values for bend and elongation are subject to agreement between the manufacturer and purchaser.

6 Dimensional tolerances

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

When hot-rolled sheet is specified to stretcher levelled standards of flatness and not resquared, the allowances 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 shall specify "grip or entry marks outside specified length". When sheet may have grip or entry marks within the specified length, the purchaser shall specify "grip or entry marks inside specified length".

7 Sampling

7.1 Tensile test

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

7.2 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 designation rolled to the same thickness and condition.

8 Mechanical property tests

8.1 Tensile test

The tensile test shall be carried out in accordance with ISO 6892. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

8.2 Bend test (applicable only to HR1)

The transverse bend test piece shall withstand being bent through 180°, in the direction shown in figure 1 and around an inside diameter as given in table 2, without cracking on the outside of the bent portion. The bend test shall be carried out at ambient temperature and in accordance with ISO 7438.

Small cracks on the edges of test pieces, and cracks not visible to the naked eye shall be disregarded.

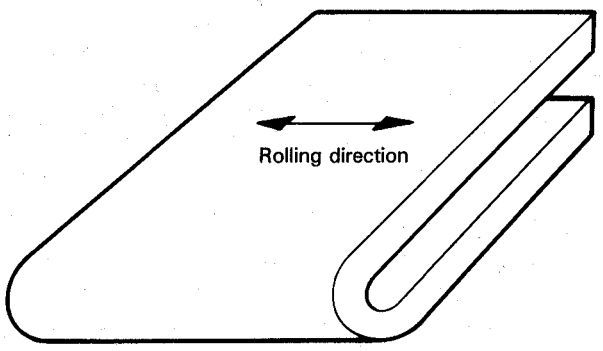

Figure 1 — Transverse bend test piece (after bending)

9 Retests

9.1 Machining and flaws

If any test piece shows defective machining or develops flaws, it shall be discarded and another test piece substituted.

9.2 Elongation

If the percentage of elongation of any test piece is less than that specified in table 2 and if any part of the fracture is outside the middle half of the gauge length as scribed before the test, the test shall be discarded and a retest shall be carried out.

9.3 Additional tests

If a test does not give the specified results, two more tests shall be carried out at random on the same lot. Both retests shall conform to the requirements of this International Standard; otherwise, the lot may be rejected.

10 Resubmission

10.1 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. Tests shall be carried out as if they apply to a new batch.

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

11 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 amounts of laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing.

Processing for shipment in coils does not afford the manufacturer opportunity to observe readily or to remove defective portions as can be carried out on the cut length product.

12 Inspection and acceptance

12.1 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.

12.2 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.

13 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.

14 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.

15 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 quantity required;

d) the application (name of part), if possible (see 5.5);

e) for drawing qualities HR2, HR3 and HR4, whether ordered to mechanical properties or to fabricate an identified part (see 5.5 and 5.6);

f) whether pickling or descaling by grit or shot blasting is required (material so specified will be oiled unless ordered not oiled) (see 4.1);

g) the type of edge (see 3.4 and 3.5);

h) whether skin passing is required (see 4.2);

i) the report of the cast analysis, if required (see 5.3.1);

j) limitations on mass and dimensions of individual coils and bundles, if applicable (see clause 13);

k) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 12.1).

NOTE — Typical ordering descriptions are as follows :

EXAMPLE 1: ISO 3573, hot-rolled steel sheet, commercial quality HR1, 3 mm × 1 200 mm × 2 440 mm, 10 000 kg, to be used for warehouse resale, edge trimmed, report of cast analysis required, maximum lift mass 4 000 kg.

EXAMPLE 2: ISO 3573, hot-rolled steel sheet, deep drawing quality HR3, 2,5 mm × 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.

Table 3 — Thickness tolerances for hot-rolled steel sheet (including descaled sheet), for coils[1] and cut lengths

Values in millimetres

Specified width, b	Thickness tolerance[2] for specified thickness, e								
	$e < 2,0$	$2,0 < e < 2,5$	$2,5 < e < 3,0$	$3,0 < e < 4,0$	$4,0 < e < 5,0$	$5,0 < e < 6,0$	$6,0 < e < 8,0$	$8,0 < e < 10,0$	$10,0 < e < 12,5$
$600 < b < 1\,200$	± 0,17	± 0,18	± 0,20	± 0,22	± 0,24	± 0,26	± 0,29	± 0,32	± 0,35
$1\,200 < b < 1\,500$	± 0,19	± 0,21	± 0,22	± 0,24	± 0,26	± 0,28	± 0,30	± 0,33	± 0,36
$1\,500 < b < 1\,800$	± 0,21	± 0,23	± 0,24	± 0,26	± 0,28	± 0,29	± 0,31	± 0,34	± 0,37
$b > 1\,800$	—	± 0,25	± 0,26	± 0,27	± 0,29	± 0,31	± 0,35	± 0,40	± 0,45

1) The values specified do not apply to the uncropped ends for a length, l, of a mill edge coil. The length, l, in metres, may be calculated from the equation

$$l = \frac{90}{e}$$

where e is the thickness, in millimetres, provided that the result was not greater than 20 m, inclusive of both ends.

2) Thickness is measured at any point on the sheet not less than 40 mm from a side edge. (Measurement on an untrimmed edge sheet nearer to an edge than 40 mm and on a trimmed edge sheet nearer to an edge than 25 mm and values of tolerances are subject to negotiation between the purchaser and supplier.)

Table 4 — Width tolerances for hot-rolled steel sheet (including descaled sheet), for mill edge coils and cut lengths

Values in millimetres

Specified width, b	Tolerance[1]
$b < 1\,200$	$+\ 30\ 0$
$1\,200 < b < 1\,500$	$+\ 35\ 0$
$1\,500 < b < 1\,800$	$+\ 40\ 0$
$b > 1\,800$	$+\ 50\ 0$

1) The values specified do not apply to the uncropped ends for a length, l, of a mill edge coil. The length, l, in metres, may be calculated from the equation

$$l = \frac{90}{e}$$

where e is the thickness, in millimetres, provided that the result was not greater than 20 m, inclusive of both ends.

Table 5 — Width tolerances for hot-rolled steel sheet (including descaled sheet) cut edge, not resquared coils and cut lengths

Values in millimetres

Specified width, b	Tolerance
$b < 1\,200$	$+\ 6\ 0$
$1\,200 < b < 1\,500$	$+\ 8\ 0$
$b > 1\,500$	$+\ 10\ 0$

Table 6 — Length tolerances for hot-rolled steel sheet (including descaled sheet), not resquared

Values in millimetres

Specified length, l	Tolerance
$l < 3\,000$	$+\ 20\ 0$
$3\,000 < l < 6\,000$	$+\ 30\ 0$
$l > 6\,000$	$+\ 0{,}5\ \%\ \times\ l\ 0$

Table 7 — Camber[1] tolerances for hot-rolled steel sheet (including descaled sheet), not resquared

Form	Camber tolerance
Cut length, l	$0{,}5\ \%\ \times\ l$
Coil	25 mm in any 5 000 mm length

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

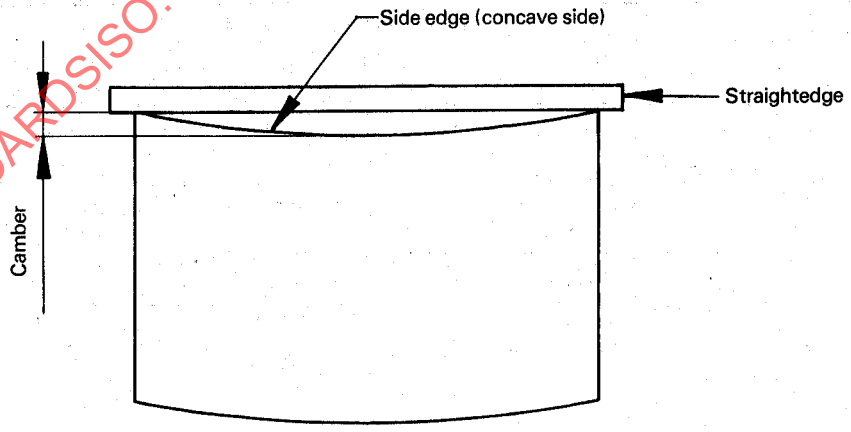

Figure 2 — Measurement of camber

Table 8 — Out-of-square[1] tolerances for hot-rolled steel sheet for cut lengths (including descaled sheet), not resquared

Dimensions	Out-of-square tolerance
All thicknesses and all sizes	1,0 % × b[2]

1) 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.

2) b is the width.

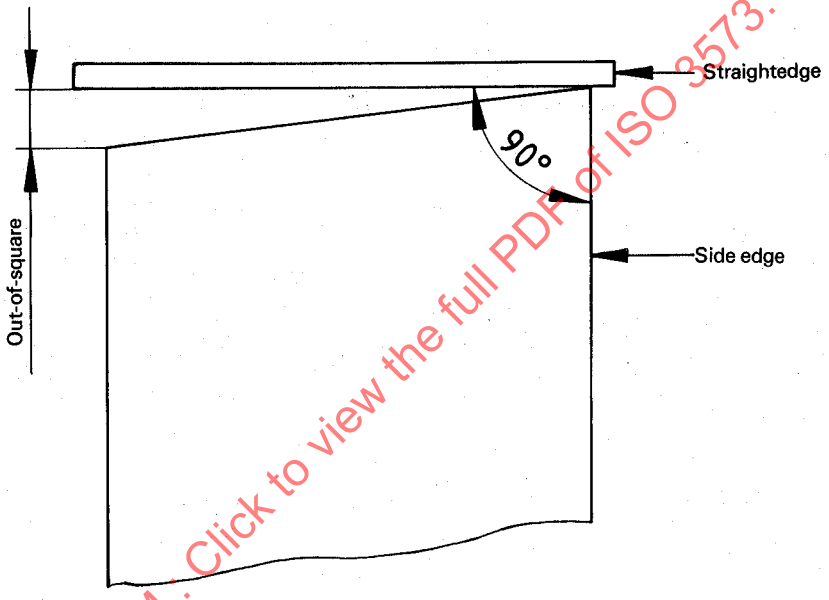

Figure 3 — Measurement of out-of-square

Table 9 — Out-of-square[1] width, and length tolerances for hot-rolled steel sheet, resquared[2]

Values in millimetres

Specified length, l	Specified width, b	Tolerance[3]
		Thickness, e < 6 mm
l < 3 000	b < 1 200	2
	b > 1 200	3
l > 3 000	All widths	3

1) See figure 3.

2) When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature.

3) Tolerances for thicknesses over 6 mm are subject to agreement between the manufacturer and purchaser.