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Hot-rolled steel sheet of structural quality

Tôles en acier de construction laminées à chaud

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 4995 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This fourth edition cancels and replaces the third edition (ISO 4995:1993), which has been technically revised.

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Hot-rolled steel sheet of structural quality

1 Scope

1.1 This International Standard applies to hot-rolled steel sheet of structural quality in the grades and classes listed in Tables 1 and 2, usually without the use of microalloying elements. The product is intended for structural purposes where particular mechanical properties are required. It is generally used in the delivered condition and is intended for bolted, riveted or welded structures. This product is produced on a wide strip mill, not a plate mill.

1.2 This product is commonly produced in thicknesses from 1,6 mm to 6 mm and widths of 600 mm and over, in coils and cut lengths.

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

NOTE 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".

1.4 This International Standard does not cover steels intended for boilers or pressure vessels, or steels designated as commercial quality or drawing qualities (covered in ISO 3573^[1]) or steels to be re-rolled to cold-reduced products, or steels designated as weathering steels, having increased atmospheric corrosion resistance.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

3 Terms and definitions

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

3.1

microalloying elements

elements, such as niobium, vanadium, titanium, etc., added singly or in combination to obtain higher strength levels combined with better formability, weldability and toughness as compared with non-alloyed steel produced to equivalent strength levels

3.2

hot-rolled steel sheet

a product obtained by rolling heated steel through a continuous-type or reversing-type wide strip mill to the required sheet thickness

NOTE The product has a surface covered with oxide or scale resulting from the hot rolling operation.

3.3 hot-rolled descaled steel sheet
hot-rolled steel sheet from which oxide or scale has been removed, commonly by pickling in an acid solution

NOTE Descaling may also be performed by mechanical means such as grit blasting. Some change in properties may result from descaling.

3.4 mill edge
a normal side edge without any definite contour produced in hot-rolling

NOTE Mill edges may contain some irregularities such as cracked or torn edges or thin (feathered) edges.

3.5 sheared edge
a normal edge obtained by shearing, slitting or trimming a mill edge product

NOTE Normal processing does not necessarily provide a definite positioning of the slitting burr.

4 Conditions of manufacture

4.1 Steelmaking

Unless otherwise agreed by the interested parties, 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 (heat analysis) shall conform to the requirements given in Tables 1 and 2.

4.3 Chemical analysis

4.3.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer in order to determine the percentage of all elements listed in Tables 1 and 2. On request, this analysis shall be reported to the purchaser or his representative.

4.3.2 Product analysis

A product analysis may be made by the purchaser in order to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to product analysis. For killed steel, 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 non-descaled steel, it may be necessary to remove the scale or oxide depending upon the welding method. As the carbon content increases above 0,15 %, spot welding becomes increasingly difficult.

4.5 Application

It is desirable that hot-rolled steel sheet be identified for fabrication by the name of the part or by the intended application. Proper identification of the part may include visual examination, prints or description, or a combination of these.

Table 1 — Chemical composition (heat analysis)

Content levels in percent by mass

Grade	Class ^{a, b}	Method of deoxidization ^{c, d}	C max.	Mn max.	Si max.	P max.	S max.
HR235	B	E or NE	0,18	1,20	Not applicable	0,035	0,035
	D	CS	0,17	1,20	Not applicable	0,035	0,035
HR275	B	E or NE	0,21	1,20	Not applicable	0,035	0,035
	D	CS	0,20	1,20	Not applicable	0,035	0,035
HR355	B	NE	0,21	1,60	0,55	0,035	0,035
	D	CS	0,20			0,035	0,035

^a Class B steels are intended for use in welded structures or structural parts, subjected to normal loading conditions.

^b Class D steels are to be used for welded structures or structural parts where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary.

^c E = Rimming; NE = Non-rimming; CS = Aluminum killed.

^d The nitrogen content is controlled; normally, it should not exceed 0,009 % for E or NE steels or 0,015 % for CS steels.

Table 2 — Limits on additional chemical elements ^a

Content levels in percent by mass

Element	Heat analysis max.	Product analysis max.
Cu ^b	0,20	0,23
Ni ^b	0,20	0,23
Cr ^{b, c}	0,15	0,19
Mo ^{b, c}	0,06	0,07
Nb ^d	0,008	0,018
V ^d	0,008	0,018
Ti ^d	0,008	0,018

^a Each of the elements listed in this table shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis may be reported as "< 0,02 %".

^b The sum of copper, nickel, chromium, and molybdenum shall not exceed 0,50 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

^c The sum of chromium and molybdenum shall not exceed 0,16 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

^d Heat analysis greater than 0,008 % may be supplied upon agreement between producer and consumer.

4.6 Mechanical properties

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 in accordance with the requirements of clause 7.

NOTE Either R_{eH} or R_{eL} may be specified, but not both.

4.7 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 grit blasting may disclose surface imperfections not readily visible prior to this operation.

4.8 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 forming lubricant and shall be easily removable using degreasing chemicals. On request, the manufacturer shall advise the purchaser which type of oil has been used.

Table 3 — Mechanical properties

Grade ^a	R_e min. ^b N/mm ²		R_m min. (information only) N/mm ²	A min. % ^c			
				$e < 3$		$3 \leq e \leq 6$	
				R_{eH}	R_{eL}	$L_o = 50$ mm	$L_o = 80$ mm
HR235	235	215	330	20	18	23	22
HR275	275	255	370	17	15	20	18
HR355	355	335	450	15	13	19	16

R_e = yield stress
 R_{eH} = upper yield stress
 R_{eL} = lower yield stress
 R_m = tensile strength
A = percentage elongation after fracture
 L_o = gauge length on test piece
 S_o = original cross-sectional area of gauge length
 e = thickness of steel sheet, in millimetres
1 N/mm² = 1 MPa

^a Formerly designated as grades Fe37, Fe44 and Fe52.
^b Either R_{eH} or R_{eL} shall be specified and the measured value shall meet the minimum requirement. The yield stress values can be measured by 0,5 % elongation proof stress (proof stress under load) or by 0,2 % offset when a definite yield phenomenon is not present.
^c For thicknesses up to 3 mm, use either $L_o = 50$ mm or $L_o = 80$ mm. For thicknesses from 3 mm to 6 mm use either $L_o = 5,65 \sqrt{S_o}$ or $L_o = 50$ mm. 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.

5 Dimensional tolerances

5.1 Dimensional tolerances applicable to hot-rolled steel sheet of structural quality shall be as given in Tables 4 to 12 inclusive.

5.2 Restricted thickness tolerances are given in Table 5.

Table 4 — Normal thickness tolerances for hot-rolled sheet steel (including descaled sheet), coils and cut lengths

Values in millimetres

Specified widths	Thickness tolerances ^a for specified thicknesses ^b					
	1,6 ≤ 2,0	> 2,0 ≤ 2,5	> 2,5 ≤ 3,0	> 3,0 ≤ 4,0	> 4,0 ≤ 5,0	> 5,0 ≤ 6,0
600 ≤ 1 200	± 0,17	± 0,18	± 0,20	± 0,22	± 0,24	± 0,26
> 1 200 ≤ 1 500	± 0,19	± 0,21	± 0,22	± 0,24	± 0,26	± 0,28
> 1 500 ≤ 1 800	± 0,21	± 0,23	± 0,24	± 0,26	± 0,28	± 0,29
> 1 800	—	± 0,25	± 0,26	± 0,27	± 0,29	± 0,31

The values specified do not apply to the uncropped ends for a length "l" of a mill edge coil. The total length "l" would be calculated using the following formula:

$$\text{Total length "l" in meters} = \frac{90}{\text{Thickness in mm}}$$

provided that the result was not greater than 20 m.

^a For grade HR355 increase the thickness tolerances by 10 % applying normal rounding off procedures.

^b Thickness is measured at any point on the sheet not less than 25 mm from a sheared edge and 40 mm from a mill edge. Points closer than these are subject to negotiation.

6 Sampling

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 grade and class rolled to the same thickness and condition.

7 Mechanical property tests

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.

Table 5 — Restricted tolerances for hot rolled sheet steel (including descaled sheet) coils and cut lengths

Values in millimetres

Specified width	Thickness tolerances ^a for specified thicknesses ^b					
	1,6 ≤ 2,0	> 2,0 ≤ 2,5	> 2,5 ≤ 3,0	> 3,0 ≤ 4,0	> 4,0 ≤ 5,0	> 5,0 ≤ 6,0
600 ≤ 1 200	± 0,13	± 0,14	± 0,15	± 0,17	± 0,19	± 0,21
> 1 200 ≤ 1 500	± 0,14	± 0,15	± 0,17	± 0,18	± 0,21	± 0,22
> 1 500 ≤ 1 800	± 0,14	± 0,17	± 0,19	± 0,21	± 0,22	± 0,23
> 1 800	—	± 0,20	± 0,21	± 0,22	± 0,23	± 0,25

The values specified do not apply to the uncropped ends for a length, "l", of a mill edge coil. The total length "l" would be calculated using the following formula:

$$\text{Length "l" in meters} = \frac{90}{\text{Thickness in mm}}$$

provided that the result was not greater than 20 m.

^a For grade HR 355 increase the thickness tolerances by 10 % applying normal rounding off procedures.

^b Thickness is measured at any point on the sheet not less than 25 mm from a sheared edge and 40 mm from a mill edge. Points closer than these are subject to negotiation.

Table 6 — Width tolerances for coils and cut lengths (including descaled material), mill edge

Values in millimetres

Specified width	Tolerance
≤ 1 500	+20 0
> 1 500	+25 0

The values specified do not apply to the uncropped ends for a length, "l", of a mill edge coil. The total length "l" would be calculated using the following formula:

$$\text{Length "l" in meters} = \frac{90}{\text{Thickness in mm}}$$

provided that the result was not greater than 20 m.

**Table 7 — Width tolerances for coils and cut lengths
(including descaled material), sheared edge, not resquared**

Values in millimetres

Specified width	Tolerance
$\leq 1\ 200$	+3 0
$> 1\ 200 \leq 1\ 500$	+5 0
$> 1\ 500$	+6 0
NOTE For resquared material more restrictive tolerances are subject to negotiation.	

**Table 8 — Length tolerances for cut lengths
(including descaled material) not resquared**

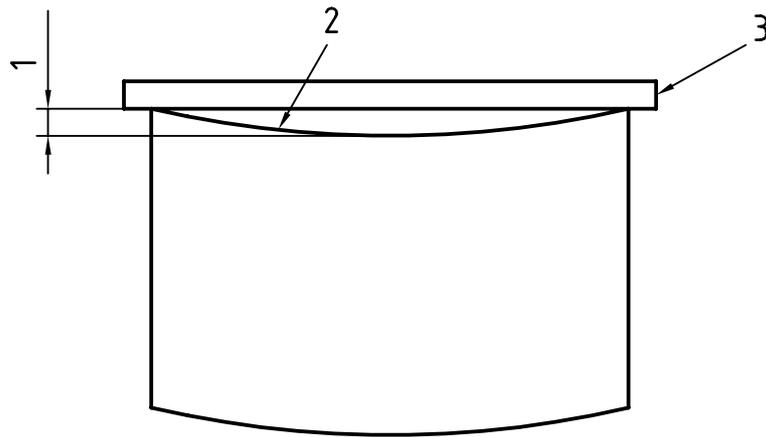
Values in millimetres

Specified length	Tolerance
$\leq 2\ 000$	+10 0
$> 2\ 000 \leq 8\ 000$	+ 0,5 % \times length 0
$> 8\ 000$	+40 0
NOTE For resquared material more restrictive tolerances are subject to negotiation.	

Table 9 — Camber tolerances for coils and cut lengths (including descaled material), not resquared

Values in millimetres

Form	Camber tolerance
Coils	25 mm in any 5 000 mm length
Cut lengths	0,5 % \times length
NOTE For resquared material more restrictive tolerances are subject to negotiation. The values specified do not apply to the uncropped ends of a mill edge coil for a total length of 7 metres. Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straight edge as shown in Figure 1.	



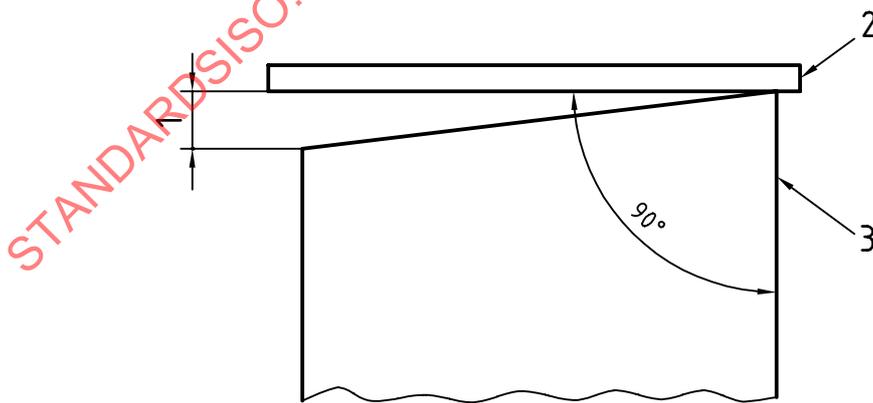
- Key**
- 1 Edge camber
 - 2 Side edge (concave side)
 - 3 Straightedge

Figure 1 — Measurement of camber

Table 10 — Out-of-square tolerance for cut lengths (including descaled material), not resquared

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

NOTE Out-of-square is the greatest deviation of an edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in Figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet. For resquared material more restrictive tolerances are subject to negotiation.



- Key**
- 1 Out-of-square
 - 2 Straightedge
 - 3 Side edge

Figure 2 — Measurement of out-of-square

Table 11 — Out-of-square tolerance for resquared material (including descaled material)

Values in millimetres

Specified length	Specified width	Out-of-square tolerance ≤ 6 mm thickness
≤ 3 000	≤ 1 200	+2 0
	> 1 200	+3 0
> 3 000	All widths	+3 0

NOTE Out-of-square is the greatest deviation of an edge from a straight line at right angles to a side and touching one corner, the measurement being taken as shown in Figure 2. It can also be measured as one-half the difference between the diagonals of the cut length sheet. When measuring material to resquared tolerances, consideration may have to be given to extreme variations in temperature.

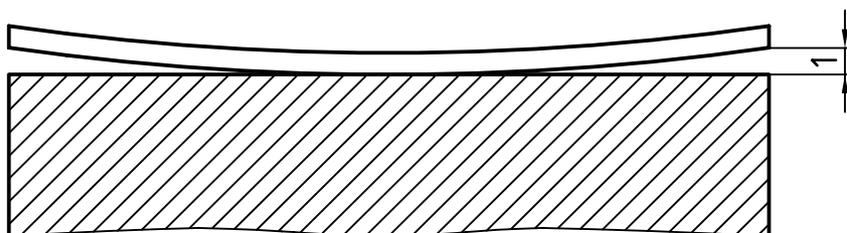
Table 12 — Standard flatness tolerances for cut lengths (including descaled material)

Values in millimetres

Specified thicknesses	Specified widths	Flatness tolerances ^a	
		HR 235 and HR 275	HR 355
≤ 2	≤ 1 200	26	32
	> 1 200 ≤ 1 500	31	38
	> 1 500	38	45
> 2	≤ 1 200	22	27
	> 1 200 ≤ 1 500	29	34
	> 1 500	35	42

NOTE 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 as shown in Figure 3.

^a These tolerances are only applicable to sheet ≤ 5 000 mm length. Tolerances for sheet having a length exceeding 5 000 mm shall be subject to agreement. This table also applies to sheet cut to length from coil by the customer when adequate flattening procedures are performed.



Key

- 1 Maximum deviation from flatness

Figure 3 — Measurement of flatness

8 Retests

8.1 General

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

8.2 Machining and flaws

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

8.3 Elongation

If the percentage elongation of any test piece is less than that specified in Table 3 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 Resubmission

9.1 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 shall be carried out as if they applied to a new batch.

9.2 The manufacturer has the right to present the rejected products for fresh examination for compliance with the requirements for another grade or class.

10 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 the final product or 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.

11 Inspection and acceptance

11.1 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.

11.2 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.

12 Coil size

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