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Hot-rolled steel sheet in coils of structural quality and heavy thickness

Tôles fortes en acier de construction laminées à chaud en bobines

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Reference number
ISO 13976:1998(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 13976 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

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Hot rolled steel sheet in coils of structural quality and heavy thickness —

1 Scope

1.1 This International Standard applies to hot-rolled steel sheet of structural quality in the grades listed in tables 1 and 3, 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. The product is produced on a wide strip mill.

1.2 This product is commonly produced in the range of thicknesses, greater than 6 mm to 25 mm and widths of 600 mm and over, in coils.

1.3 This International Standard does not cover steels intended for boilers or pressure vessels, or steels designated as commercial quality or drawing qualities, or steels rolled to cold-reduced products, or steels designated as weathering steels, having increased atmospheric corrosion resistance or those products rolled on a plate mill.

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

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

3 Definitions

For the purposes of this International Standard, the following 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 in coils: A product obtained by rolling heated steel through a continuous-type or reversing-type wide strip mill to the required sheet thickness. The product has a surface covered with oxide or scale resulting from the hot rolling operation.

3.3 hot-rolled descaled steel sheet in coils: Hot-rolled steel sheet from which oxide or scale has been removed by pickling in an acid solution or by mechanical means such as grit blasting. Some change in properties may result from descaling.

3.4 mill edge: A normal 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 sheared edge: 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 Conditions of manufacture

4.1 Steelmaking

Unless otherwise agreed upon 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.

Table 1 — Chemical composition (heat analysis)

Grade	C max. %	Mn max. %	P max. %	S max. %	Si max. %	N max. %
HR 185	0,16	1,5	0,035	0,035	0,40	0,015
HR 235	0,17	1,5	0,035	0,035	0,40	0,015
HR 275	0,18	1,5	0,035	0,035	0,40	0,015
HR 295	0,21	1,5	0,035	0,035	0,55	0,015
HR 355	0,22	1,5	0,035	0,035	0,55	0,015

Table 2 — Additional limits on chemical elements

Element	Cu ¹⁾ max. %	Ni ¹⁾ max. %	Cr ^{1), 2)} max. %	Mo ^{1), 2)} max. %	Nb max. %	V ³⁾ max. %	Ti max. %
Heat analysis	0,40	0,40	0,30	0,12	0,008	0,008	0,008
Product analysis	0,43	0,43	0,34	0,13	0,008	0,008	0,008

NOTE — 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 %.

1) The sum of copper, nickel, chromium and molybdenum shall not exceed 1 % on the 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.

2) The sum of chromium and molybdenum shall not exceed 0,32 % 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.

3) Analysis greater than 0,008 % may be supplied after agreement between producer and consumer.

4.3 Chemical analysis

4.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer in order to determine compliance with the requirements given in tables 1 and 2. When requested, at the time of ordering, 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 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 verification 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 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. When the carbon content rises above 0,15 %, welding becomes increasingly difficult.

4.5 Application

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

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 in clause 7.

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 blast cleaning 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 unoiled if required. The oil is not intended as a forming lubricant and shall be easily removable with degreasing chemicals. On request the manufacturer shall advise the purchaser which type of oil has been used.

5 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel sheet in coils of structural quality heavy thickness shall be as given in tables 4 and 5. These tolerances also apply to descaled material.

Camber shall not exceed 25 mm in any 5 000 mm of length (see figure 1).

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

Table 3 — Mechanical properties

Grade	R_e min. 1) N/mm ²	R_m min. N/mm ²	A min.		180° Bend 2)
			$L_0 = 5,65 \sqrt{S_0}$	$L_0 = 50 \text{ mm}$	
HR 185	185	290	16	15	1a
HR 235	235	340	23	22	1a
HR 275	275	410	20	18	3a
HR 295	295	470	19	18	3a
HR 355	355	490	19	18	3a
R_e = yield stress; R_m = tensile strength; A = percentage elongation after fracture; L_0 = gauge length on test piece; S_0 = original cross-sectional area of gauge length; e = thickness of bend test piece; 1 N/mm ² = 1 MPa					
1) Either R_{eh} or R_{el} shall be measured and either value shall meet the minimum requirement. The yield stress values can be measured by 0,5 % total elongation proof stress (proof stress under load) or by 0,2 % offset when a definite yield phenomenon is not present. 2) The bend test is carried out only when specified. The bend mandrel diameters in this table are for test pieces prepared for laboratory testing. Conditions during fabrication may be more severe and may not simulate those apparent during laboratory testing.					

Table 4 — Thickness tolerances for heavy thickness hot rolled sheet in coils

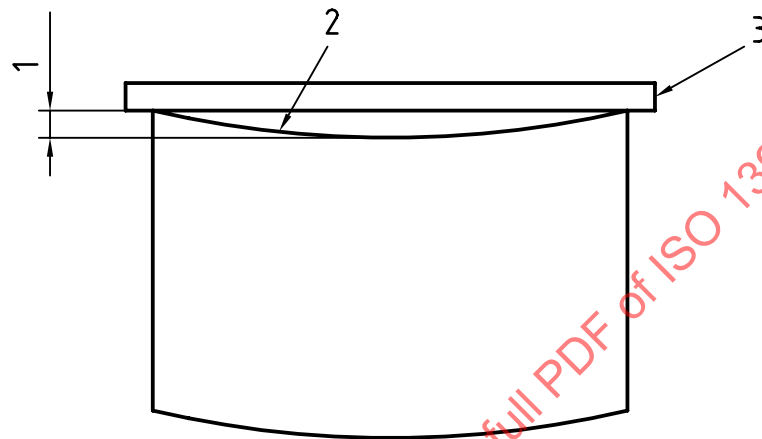
Dimensions and tolerances in millimetres

Specified widths	Thickness tolerances for specified thicknesses 1)				
	$> 6,00 \leq 8,00$	$> 8,00 \leq 10,00$	$> 10,00 \leq 12,50$	$> 12,50 \leq 16,00$	$> 16,00 \leq 25,00$
$> 600 \leq 1\,200$	$\pm 0,29$	$\pm 0,32$	$\pm 0,35$	$\pm 0,38$	$\pm 0,40$
$> 1\,200 \leq 1\,500$	$\pm 0,30$	$\pm 0,33$	$\pm 0,36$	$\pm 0,39$	$\pm 0,42$
$> 1\,500 \leq 1\,800$	$\pm 0,31$	$\pm 0,34$	$\pm 0,37$	$\pm 0,40$	$\pm 0,44$
$> 1\,800$	$\pm 0,35$	$\pm 0,40$	$\pm 0,43$	$\pm 0,48$	$\pm 0,50$
The values specified do not apply to the uncropped ends for a length, l , of a mill edge coil. The length, l , would be calculated using the following formula: $\text{length, } l, \text{ in metres} = \frac{90}{\text{thickness in millimetres}}$ provided that the result was not greater than 20 m inclusive of both ends.					
1) Thickness is measured at any point on the sheet not less than 40 mm from a side edge for untrimmed material and not less than 25 mm from the edge for trimmed material.					

Table 5 — Width tolerances for heavy thickness hot rolled sheet in coils

Dimensions and tolerances in millimetres

Specified widths	Mill edges		Trimmed edges	
$> 600 \leq 1\,200$	+ 28	0	+ 5	0
$> 1\,200 \leq 1\,500$	+ 38	0	+ 6	0
$> 1\,500 \leq 1\,800$	+ 45	0	+ 8	0
$> 1\,800$	+ 50	0	+ 10	0

**Key**

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

Figure 1 — Measurement of camber**6 Sampling****6.1 Tensile test**

One representative sample for the tensile test shall be taken from each lot of material for shipment. A lot consists of all sheet of the same grade and class rolled to the same thickness and condition.

6.2 Bend test (when specified)

One representative sample for the bend test shall be taken from each lot of material for shipment. A lot consists of all sheet of the same grade and class rolled to the same thickness and condition.

7 Mechanical property tests**7.1 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 the edge of the sheet as rolled.

7.2 Bend test (when specified)

The transverse bend test piece shall withstand being bent through 180°, in the direction shown in figure 2, around an outside diameter as shown in table 3, without cracking on the outside of the bent portion. The bend test shall be carried out at ambient temperature and as specified in ISO 7438.

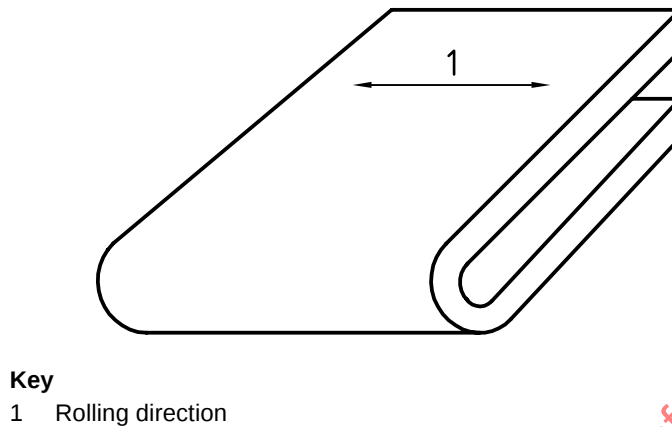


Figure 2 — Transverse bend test piece (after bending)

8 Retests

8.1 Machining and flaws

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

8.2 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.

8.3 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.

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 lot.

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

10 Workmanship

The surface condition shall be that normally obtained for this product. Processing for shipment in coils does not afford the manufacturer the opportunity of readily observing or removing imperfect portions as would be the case 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 manufacturer shall be notified in order that he may properly investigate.

12 Coil size

When hot-rolled 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 the maximum acceptable coil mass shall be specified.

13 Marking

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

- a) the manufacturer's name or identifying brand;
- b) reference to this International Standard, i.e. ISO 13976;
- c) the grade and class designations;
- d) the order number;
- e) the product dimensions;
- f) the lot number;
- g) the mass.

14 Information to be supplied by the purchaser

To adequately specify requirements according to this International Standard, inquiries and orders shall include the following information.

- a) reference to this International Standard, i.e. ISO 13976;
- b) the name, quality, and grade of the material (for example, hot-rolled steel sheet in coils, structural quality, grade HR275);
- c) the dimensions of the product and the quantity required;
- d) the application (name of part) if possible (see 4.5);