INTERNATIONAL STANDARD

ISO 13976

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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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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition (ISO 13976:1998), which has been technically revised.

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

1 Scope

1.1 This International Standard applies to hot-rolled carbon/manganese 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 referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 148:1983, *Steel — Charpy impact test (V-notch)*

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

3 Terms and definitions

For the purposes of this document, 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 in coils
product obtained by rolling heated steel (billet or slab) through a continuous-type mill to the required strip thickness and tolerances

NOTE 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 the surface of 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 increase in hardness and some loss of ductility may result from descaling.

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

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 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. %
HR185	0,16	1,5	0,030	0,035	0,40	0,015
HR235	0,18	1,5	0,030	0,035	0,40	0,015
HR275	0,18	1,5	0,030	0,035	0,40	0,015
HR295	0,21	1,5	0,030	0,035	0,55	0,015
HR325	0,18	1,6	0,030	0,035	0,55	0,015
HR355	0,22	1,5	0,030	0,035	0,55	0,015

Table 2 — Limits on additional chemical elements

Element	Cu [a] max. %	Ni [a] max. %	Cr [a,b] max. %	Mo [a,b] max. %	Nb max. %	V [c] max. %	Ti max. %
Heat analysis	0,20	0,20	0,15	0,06	0,008	0,008 [c]	0,008
Product analysis	0,23	0,23	0,19	0,07	0,018	0,018	0,018

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 %.

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

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

[c] Where residual V levels greater than 0,008 % occur due to high levels of V in natural ores, such material may be supplied after agreement between the producer and consumer.

4.3 Chemical analysis

4.3.1 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements of 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 Product analysis

A product 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 product analysis. For killed steels, the sampling method shall be agreed upon between the interested parties at the time of ordering. The product analysis tolerances shall be in accordance with Table 3.

Table 3 — Product analysis tolerances

Element	Maximum of specified element, %	Tolerance over maximum specified, %
Carbon	> 0,15 to ⩽ 0,40	0,04
Manganese	> 1,15 to ⩽ 1,65	0,05
Phosphorus	⩽ 0,04	0,010
Sulfur	⩽ 0,06	0,010
Silicon	> 0,30 to ⩽ 0,60	0,05
Nitrogen	⩽ 0,030	0,005

NOTE The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis. For example: for Grade HR295, the following product analysis values are within these tolerances: C 0,25 %, Mn 1,55 %, P 0,040 %, S 0,045 %, Si 0,60 %, 0,020 %.

4.4 Weldability

This product is 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. 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 the 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 4, when they are determined on test pieces obtained in accordance with the requirements in Clause 6.

4.7 Surface condition

Designation AR describes the as-rolled 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.

NOTE If AR and DO are omitted, it also means that the delivery will be as-rolled.

4.8 Oiling

Designation DO describes the descaled and oiled condition. As a deterrent to rusting, a coating of oil is usually applied to hot-rolled descaled steel sheet. The oil is not intended as a drawing or 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. Hot-rolled descaled steel sheet may be ordered not oiled, if required, in which case the supplier has limited responsibility if oxidation occurs.

5 Dimensional tolerances

5.1 Dimensional tolerances applicable to hot-rolled steel sheet in coils of structural quality heavy thickness shall be in accordance with Tables 5 and 6. These tolerances also apply to descaled material.

5.2 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 4 — Mechanical properties

Grade	R_e [a] min. N/mm²	R_m min. N/mm²	A [b] min, %			
			$L_o = 5{,}65\sqrt{S_o}$	L_o = 50 mm for sheet thickness		
				6-12 mm	> 12-19 mm	> 19-25 mm
HR185	185	290	19	20	23	26
HR235	235	400	19	20	23	26
HR275	275	410	16	17	20	22
HR295	295	470	15	16	19	21
HR325	325	490	15	16	19	21
HR355	355	490	15	16	19	21

R_e = 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;

1 N/mm² = 1 MPa

a 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.

b In case of dispute, only the results obtained on a 50 mm test piece will be valid.

Table 5 — Thickness tolerances for heavy thickness hot-rolled sheet (including descaled) in coils

Dimensions and tolerances in millimetres

Specified widths	Specified thicknesses [a]				
	> 6,00 ⩽ 8,00	> 8,00 ⩽ 10,00	> 10,00 ⩽ 12,50	> 12,50 ⩽ 16,00	> 16,00 ⩽ 25,00
600 ⩽ 1 200	± 0,29	± 0,32	± 0,35	± 0,38	± 0,40
> 1 200 ⩽ 1 500	± 0,30	± 0,33	± 0,36	± 0,39	± 0,42
> 1 500 ⩽ 1 800	± 0,31	± 0,34	± 0,37	± 0,40	± 0,44
> 1 800	± 0,35	± 0,40	± 0,43	± 0,48	± 0,50

NOTE 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.

a Thickness is measured at any point on the sheet not less than 40 mm from a side edge for mill edge material and not less than 25 mm from the edge for sheared material.