INTERNATIONAL STANDARD

ISO 5951

Fourth edition
2008-08-15

Hot-rolled steel sheet of higher yield strength with improved formability

Tôles en acier laminées à chaud à limite d'élasticité et aptitude au formage accrues

Reference number
ISO 5951:2008(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

Published in Switzerland

Contents

Page

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 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 5951 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 5951:2001), which has been technically revised.

Hot-rolled steel sheet of higher yield strength with improved formability

1 Scope

1.1 This International Standard applies to all grades of continuously hot-rolled steel sheet of higher yield strength with improved formability. The steel is killed, made according to a fine grain practice and has a suitable chemical composition, including microalloying elements, to provide improved formability. The product is intended for the fabrication of parts requiring better formability than is provided by normal high yield strength steel sheet. It is generally used in the delivered condition.

1.2 Because of the combination of higher strength and improved formability, it is possible to obtain savings in mass along with better weldability.

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

1.4 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".

1.5 This International Standard does not cover steel intended for boilers or pressure vessels, steels designated as commercial quality or drawing quality (covered in ISO 3573), steels designated as weathering steels, having increased atmospheric corrosion resistance, or lower yield strength steels having less formability compared with those in this International Standard (covered in ISO 4995 and ISO 4996).

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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 16160, *Continuously hot-rolled steel sheet products — Dimensional and shape tolerances*

ISO 20805, *Hot-rolled steel sheet in coils of higher yield strength with improved formability and heavy thickness for cold forming*

3 Terms and definitions

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

3.1
microalloying element
element, such as niobium, vanadium, titanium, 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
product obtained by rolling heated steel through a continuous hot strip mill or other hot rolling processes that produce a coiled product to the required sheet 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
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 can result from descaling.

3.4
mill edge
normal 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
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

4.2.1 For all grades, the chemical composition (heat analysis) shall conform to the requirements in Tables 1 and 2.

4.2.2 The steel covered by this International Standard shall contain microalloying elements. The chemical composition may be agreed between the interested parties at the time of enquiry and ordering.

Table 1 — Chemical analysis (heat analysis)

Mass fractions in percent

Element	Heat analysis max.
Carbon	0,15
Manganese	1,65
Phosphorus	0,025
Sulfur	0,030
NOTE 1 As the form of sulfide inclusions may have a certain influence on the cold forming properties of the products, manufacturers may, at their discretion, influence the form of inclusions by adding certain elements, such as Ce or Ca, or may choose a very low sulfur content for these steels. NOTE 2 These steels shall also contain one or more of the following microalloying elements: vanadium, titanium or niobium. Other alloying elements may be present but are not required.	

Table 2 — Limits on additional chemical elements

Mass fractions in percent

Element	Heat analysis max.	Product analysis max.
Copper	0,20	0,23
Nickel	0,20	0,23
Chromium	0,15	0,19
Molybdenum	0,06	0,07

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 the contents of carbon, manganese, phosphorus and sulfur, and the content of other elements giving the specified mechanical strength and formability. 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 to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. 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 Tables 2 and 3.

Table 3 — Product analysis tolerances

Mass fractions in percent

Element	Maximum of specified element	Tolerance over maximum specified
Carbon	0,15	0,03
Manganese	1,65	0,05
Phosphorus	0,025	0,010
Sulfur	0,030	0,010
NOTE The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis. For example, for all grades in this International Standard, the following product analysis values are within these tolerances: C 0,18 %, Mn 1,70 %, P 0,035 %, S 0,040 %.		

4.4 Weldability

This product is normally suitable for welding when appropriate welding conditions are selected. For undescaled 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. 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 in accordance with the requirements of Clause 7. Any additional property requirements specified or required are subject to agreement between the interested parties at the time of enquiry and ordering. Such additional requirements may include characterization or prescribed values for properties such as impact for sheet over 6 mm in thickness (see 7.2).

Table 4 — Mechanical properties

Grade	R_e min [a]	R_m min	A min. [b, c]			
		(information only)	$e < 3$ mm		3 mm $\leqslant e \leqslant$ 6 mm	
	MPa	MPa	L_o = 50 mm	L_o = 80 mm	$L_o = 5{,}65\sqrt{S_o}$	L_o = 50 mm
HSF325	325	410	22	20	25	24
HSF355	355	420	21	19	24	23
HSF420	420	480	18	16	21	20
HSF490	490	540	15	13	18	17
HSF560	560	610	12	10	15	14

R_e = yield strength

R_m = tensile strength

A = percentage elongation after fracture

e = thickness of steel sheet, in millimetres

L_o = gauge length on test piece

S_o = original cross sectional area of gauge length

1 MPa = 1 N/mm²

[a] The yield strength can be measured either by 0,5 % elongation proof stress $R_{t0,5}$ (proof stress under load) or by 0,2 % offset $R_{p0,2}$ when a definite yield phenomenon is not present.

[b] For thicknesses from 3 mm to 6 mm, use either L_o = 50 mm or L_o = 80 mm. For thicknesses of 3 mm and over, use $L_o = 5{,}65\sqrt{S_o}$ or L_o = 50 mm. In case of dispute, only the results obtained on a 50 mm test piece will be valid.

[c] For material over 6 mm in thickness, values for elongation are subject to agreement between the manufacturer and the purchaser.

4.7 Surface condition

4.7.1 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.

4.7.2 The steel shall be supplied as rolled or pickled and oiled as requested by the purchaser at the time of enquiry and ordering.

4.8 Oiling

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 should be easily removable with degreasing chemicals. The product may be ordered not oiled, if required, in which case, the supplier has limited responsibility if oxidation occurs.

5 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel sheet of higher yield strength with improved formability shall be as given in ISO 16160. These tolerances also apply to descaled material. Tolerances on coiled material with thicknesses over 6 mm shall be as given in ISO 20805.

6 Sampling — Tensile test

One representative sample for the tensile test required in Table 4 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 Mechanical property tests

7.1 Tensile test

The tensile test shall be carried out in accordance with ISO 6892-1. Transverse test pieces shall be taken midway between the centre and edge of the sheet as rolled.

7.2 Impact test

While not usually specified, if so agreed at the time of ordering, impact tests may be specified for material over 6 mm in thickness. The test piece shall be in the longitudinal direction and the test shall be carried out in accordance with ISO 148-1.

8 Retests

8.1 Machining and flaws

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

8.2 Elongation

If the percentage elongation of any test piece is less than that specified in Table 4, 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.