INTERNATIONAL STANDARD

ISO 4996

Fifth edition
2014-12-15

Hot-rolled steel sheet of high yield stress structural quality

Tôles laminées à chaud en acier de construction à haute limite d'élasticité

Reference number
ISO 4996:2014(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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This fifth edition cancels and replaces the fourth edition (ISO 4996:2007), which has been technically revised.

Hot-rolled steel sheet of high yield stress structural quality

1 Scope

This International Standard applies to hot-rolled steel sheet of high yield stress structural quality with 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 structures that may include bolting, riveting and welding.

Because of the combination of higher strength and microalloy composition, it is possible to obtain savings in mass, along with better formability and weldability as compared with steel sheet without microalloying elements. The product is produced on a wide strip-mill, not a plate mill.

This International Standard does not cover steels intended for boilers or pressure vessels, steels designated as commercial quality or drawing quality (covered by ISO 3573), steels to be re-rolled to cold-reducing products, steels designated as weathering steels, having increased atmospheric corrosion resistance, or steels having improved formability properties compared with those in this International Standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

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

3.2
hot-rolled steel sheet
product obtained by rolling heated steel through a continuous-type or reversing-type wide strip-mill to the required sheet thickness, the product having 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 1 to entry: Descaling may also be performed by a mechanical means such as grit blasting. Some changes in properties may result from descaling.

3.4 Edges

3.4.1
mill edge
normal side edge without any definite contour produced in hot rolling

Note 1 to entry: Mill edges may contain some irregularities such as cracked or torn edges or thin (feathered) edges.

3.4.2
sheared edge
normal edge obtained by shearing, slitting or trimming a mill edge product

Note 1 to entry: Normal processing does not necessarily provide a definite positioning of the slitting burr.

3.5
aluminum killed
steel which has been deoxidized with aluminum sufficient to prevent the evolution of gas during solidification

3.6
lot
50 t or less of sheet of the same grade and class rolled to the same thickness and condition

4 Dimensions

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

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

5 Conditions of manufacture

5.1 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.

5.2 Chemical composition

The chemical composition (heat analysis) shall not exceed the values given in Tables 1 and 2.

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat shall be made by the manufacturer in order to determine compliance with the requirements given in Tables 1 and 2. On request, at the time of ordering, this analysis shall be reported to the purchaser or the purchaser’s representative. Each of the elements listed in Table 2 shall be included in the report of the heat analysis.

Table 1 — Chemical composition (heat analysis)

Mass fractions in percent

Grade	C max.	Mn max.	Si max.	P max.	S max.
HS355	0,20	1,60	0,50	0,035	0,035
HS390	0,20	1,60	0,50	0,035	0,035
HS420	0,20	1,70	0,50	0,035	0,035
HS460	0,20	1,70	0,50	0,035	0,035
HS490	0,20	1,70	0,50	0,035	0,035
Each grade contains one or more microalloying elements with the following restrictions: Ti – 0,10 % max., Nb – 0,08 % max., V – 0,10 % max.. The amounts of these elements are subject to agreement between the manufacturer and purchaser. In the absence of an agreement, the amounts shall be at the discretion of the manufacturer. In all cases, the sum of Ti, Nb, and V shall be less than or equal to 0,22 %. In no case shall Nb, V or Ti be less than 0,005 %.					

Table 2 — Limits on additional chemical elements

Mass fractions in percent

Element	Heat analysis max.	Product analysis max.
Cu[b]	0,20	0,23
Ni[b]	0,20	0,23
Cr[bc]	0,15	0,19
Mo[bc]	0,06	0,07

[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 is 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.

5.3.2 Product analysis

A product 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. The sampling method shall be agreed between the manufacturer and purchaser at the time of ordering. The product analysis tolerances shall be in accordance with Table 2 and Table 3.

Table 3 — Product analysis tolerances

Mass fractions in percent

Element	Range of specified element	Tolerance over maximum specified
C	≤0,15	0,03
	>0,15 ≤ 0,40	0,04
Mn	≤0,60	0,03
	>0,60 ≤ 1,15	0,04
	>1,15 ≤ 1,70	0,05
NOTE The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis. For example, for Grade HS490, the following product analysis values are within these tolerances: C 0,24 %, Mn 1,75 %, P 0,045 %, S 0,045 %, Si 0,54 %.		

Table 3 *(continued)*

Element	Range of specified element	Tolerance over maximum specified
P	≤0,04	0,010
S	≤0,04	0,010
Si	≤0,30	0,03
	>0,30 ≤ 0,50	0,04
N	≤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 HS490, the following product analysis values are within these tolerances: C 0,24 %, Mn 1,75 %, P 0,045 %, S 0,045 %, Si 0,54 %.		

5.4 Weldability

The 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. As the carbon content increases above 0,15 %, spot welding becomes increasingly difficult.

5.5 Application

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

5.6 Mechanical properties

At the time that the steel is made available for shipment, the mechanical properties shall be as stated in Table 4, if they are determined on test pieces obtained in accordance with the requirements of Clause 7.

5.7 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.

5.8 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 of the type of oil used. Hot-rolled descaled sheet may be ordered not oiled, if required, in which case the supplier has limited responsibility if oxidation occurs.

Table 4 — Mechanical properties

Grade	R_e min. [a] MPa	R_m min. (information only) MPa	A min., % [b]			
			$e < 3$		$3 \le e \le 6$	
			$L_o = 50$ mm	$L_o = 80$ mm	$L_o = 5{,}65\sqrt{S_o}$	$L_o = 50$ mm
HS355	355	430	18	16	22	21
HS390	390	460	16	14	20	19
HS420	420	490	14	12	19	18
HS460	460	530	12	10	17	16
HS490	490	570	10	8	15	14

R_e = yield strength – may be either R_{eL} or R_{eH}, but not both

R_{eH} = upper yield strength

R_{eL} = lower yield strength

R_m = tensile strength

A = percentage elongation after fracture

L_o = initial gauge length on test piece

S_o = original cross-sectional area of gauge length

e = thickness of steel sheet, in millimetres

1MPa = 1N/mm2

[a] The yield strength values can be measured by 0,5 % elongation proof strength (proof strength under load) or by 0,2 % offset when a definite yield phenomenon is not present.

[b] 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.

6 Dimensional and shape tolerances

Dimensional and shape tolerances applicable to hot-rolled steel sheet of high yield stress structural quality shall be as given in ISO 16160. These tolerances also apply to descaled material.

7 Tensile test sampling

One representative sample for the tensile test required in Table 4 shall be taken from each lot of sheet for shipment.

8 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.

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 shall be substituted.