INTERNATIONAL STANDARD

ISO 4996

Third edition
1999-09-15

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 4996:1999(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.

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.

International Standard ISO 4996 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee 12, *Continuous mill flat rolled products*.

This third edition cancels and replaces the second edition (ISO 4996:1991) which has been technically revised.

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Hot-rolled steel sheet of high yield stress structural quality

1 Scope

1.1 This International Standard applies to hot-rolled steel sheet of high yield stress structural quality in the grades and classes listed in Tables 1 and 2, 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 bolted, riveted or welded structures.

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.

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 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 steel intended for boilers or pressure vessels, steels designated as commercial quality or drawing qualities (ISO 3573, *Hot-rolled carbon steel sheet of commercial and drawing qualities*), steels to be rerolled 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 document.

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, this publication 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 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 Descaling may also be performed by mechanical means such as grit blasting. Some changes in properties may result from descaling.

3.4
edges

3.4.1
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.

3.4.2
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.

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

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 Table 1.

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 Table 1. When requested, at the time of ordering, this analysis shall be reported to the purchaser or to 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 aluminum killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

Table 1 — Chemical Composition (heat analysis) %

Grade	Class[a]	Method of deoxidation[b]	C max.	Mn max.	Si max.	P max.	S max.
HS355	C	NE	0,20	1,60	0,50	0,040	0,040
	D	CS	0,20	1,60	0,50	0,035	0,035
HS390	C	NE	0,20	1,60	0,50	0,040	0,040
	D	CS	0,20	1,60	0,50	0,035	0,035
HS420	C	NE	0,20	1,70	0,50	0,040	0,040
	D	CS	0,20	1,70	0,50	0,035	0,035
HS460	C	NE	0,20	1,70	0,50	0,040	0,040
	D	CS	0,20	1,70	0,50	0,035	0,035
HS490	C	NE	0,22	1,70	0,50	0,040	0,040
	D	CS	0,22	1,70	0,50	0,035	0,035

NOTE 1 Nitrogen content is controlled; normally it should not exceed 0,009 % for NE steel or 0,015 % for CS steel.

NOTE 2 Each grade includes at least one microalloying element such as vanadium, titanium, niobium, etc.

[a] Class C steels are to be used in cases where, owing to conditions and the general design of the structure, some resistance to brittle fracture is necessary. Class D steels are to be used in cases where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary.

[b] NE = non-rimming; CS = aluminum killed.

4.4 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.

4.5 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 and class specified. 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 2, if they are determined on test pieces obtained in accordance with the requirements of 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 not oiled, if required. The oil is not intended as a drawing or forming lubricant and should 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 unoiled, if required, in which case, the supplier has limited responsibility if oxidation occurs.

Table 2 — Mechanical Properties

Grade	R_e min.[a] N/mm^2	R_m min. (information only) N/mm^2	A min.[b] %			
			$e < 3$ mm		$3 \leqslant e \leqslant 6$ mm	
			$L_o = 50$ 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

NOTE R_e yield stress – may be either R_{eL} or R_{eH} but not both;

R_{eH} upper yield stress;

R_{eL} lower yield stress;

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.

1 N/mm^2 = 1 MPa

[a] 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.

[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.

5 Dimensional tolerances

5.1 Dimensional tolerances applicable to hot-rolled steel sheet of high yield stress structural quality shall be as given in Tables 3 to 11 inclusive.

5.2 Restricted thickness tolerances are given in Table 4.

Table 3 — Normal thickness tolerances for hot-rolled sheet steel (including descaled sheet), coils and cut lengths

Values in millimetres

Specified width	Thickness tolerance, for specified thickness					
	⩽ 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

NOTE 1 The values specified do not apply to the uncropped ends for a total length l of a mill edge coil. The total length l would be calculated using the following formula:

$$\text{total length } l \text{ in metres} = \frac{90}{\text{Thickness in mm}} \text{ provided that the result was not greater than 20 m.}$$

NOTE 2 Thickness is measured at any point on the sheet not less than 25 mm from a trimmed edge and 40 mm from an untrimmed edge. Points closer than these are subject to negotiation.

NOTE 3 For specified strength levels of R_e = 360 N/mm^2 and greater, increase the thickness tolerances by 10 % applying normal rounding off procedures.

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

Values in millimetres

Specified width	Thickness tolerance, for specified thickness					
	⩽ 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

NOTE 1 The values specified do not apply to the uncropped ends for a total length l of a mill edge coil. The total length l would be calculated using the following formula:

$$\text{total length } l \text{ in metres} = \frac{90}{\text{Thickness in mm}} \text{ provided that the result was not greater than 20 m.}$$

NOTE 2 Thickness is measured at any point on the sheet not less than 25 mm from a trimmed edge and 40 mm from an untrimmed edge. Points closer than these are subject to negotiation.

NOTE 3 For specified strength levels of R_{eL} = 360 N/mm^2 and greater, increase the thickness tolerances by 10 % applying normal rounding off procedures.

Table 5 — Width tolerances for coils and cut lengths (including descaled material), mill edge

Values in millimetres

Specified widths	Tolerance
⩽ 1 500	$^{+20}_{-0}$
> 1 500	$^{+25}_{-0}$
NOTE The values specified do not apply to the uncropped ends for a total length l of a mill edge coil. The total length l would be calculated using the following formula: total length l in metres $= \frac{90}{\text{Thickness in mm}}$ provided that the result was not greater than 20 m.	

Table 6 — Width tolerances for coils and cut lengths (including descaled material), sheared edge, not resquared

Values in millimetres

Specified widths	Tolerance
⩽ 1 200	$^{+3}_{-0}$
> 1 200 ⩽ 1 500	$^{+5}_{-0}$
> 1 500	$^{+6}_{-0}$
NOTE For resquared material more restrictive tolerances are subject to negotiation.	

Table 7 — Length tolerances for cut lengths (including descaled material), not resquared

Values in millimetres

Specified lengths	Tolerance
⩽ 2 000	$^{+10}_{-0}$
> 2 000 ⩽ 8 000	$^{+0,5\ \% \times \text{length}}_{-0}$
> 8 000	$^{+40}_{-0}$
NOTE For resquared material more restrictive tolerances are subject to negotiation.	

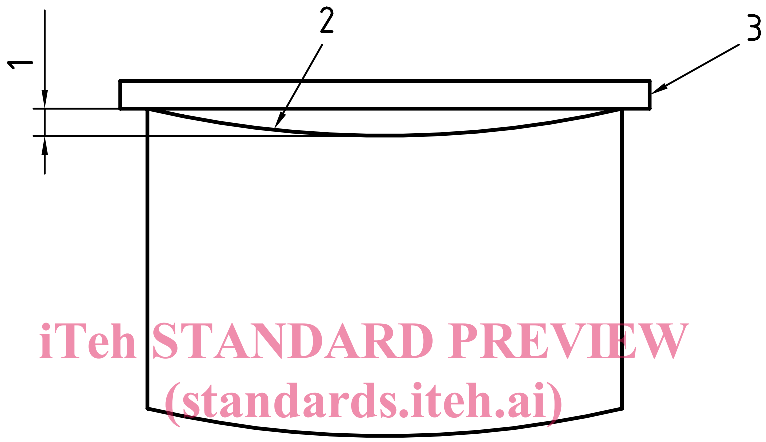
Table 8 — Camber tolerances for coils and cut lengths (including descaled material), not resquared

Form	Camber tolerance
Coils	25 mm in any 5 000 length
Cut lengths	0,5 % × length

NOTE 1 For resquared material more restrictive tolerances are subject to negotiation.

NOTE 2 The values specified do not apply to the uncropped ends of a mill edge coil for a total length of 7 metres.

NOTE 3 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 (see Figure 1).



Key

1 Edge camber

2 Side edge

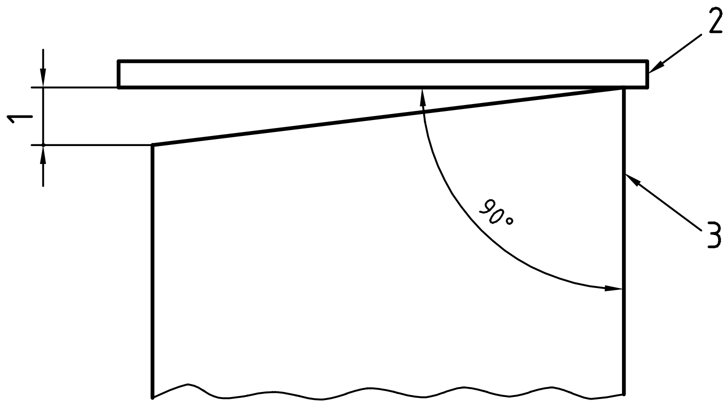
3 Straight edge

Figure 1 — Measurement of camber

Table 9 — 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.



Key

1 Out-of-square

2 Straight edge

3 Side edge

Figure 2 — Measurement of out-of-square