INTERNATIONAL STANDARD

ISO 6316

Second edition
1993-11-01

Hot-rolled steel strip of structural quality

Feuillards laminés à chaud en acier de construction

Reference number
ISO 6316:1993(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 6316 was prepared by Technical Committee ISO/TC 17, *Steel*, Sub-Committee SC 12, *Continuous mill flat rolled products*.

This second edition cancels and replaces the first edition (ISO 6316:1982), which has been technically revised.

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Hot-rolled steel strip of structural quality

1 Scope

1.1 This International Standard applies to hot-rolled steel strip of structural quality in the grades and classes listed in tables 1 and 2, usually 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. This product is rolled on a narrow strip mill.

1.2 This product is commonly produced in thicknesses from 0,65 mm to 12 mm inclusive and widths up to 600 mm exclusive, in coils and cut lengths.

1.3 This International Standard does not cover strip steels designated as commercial quality or drawing qualities (covered in ISO 6317[1]) or steels intended for boilers or pressure vessels, or steels to be rerolled to cold-reduced products, or steels designated as weathering steels, having increased atmospheric corrosion resistance.

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

ISO 6892:1984, *Metallic materials — Tensile testing.*

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 strip: A product obtained usually by rolling heated steel (billet or slab) through a continuous-type mill to the required strip thickness and tolerances. The product has a surface covered with oxide or scale resulting from the hot-rolling operation.

3.3 hot-rolled descaled steel strip: Hot-rolled steel strip from the surface of which oxide or scale has been removed, commonly by pickling in an acid solution. Descaling may also be performed by mechanical means such as grit blasting. Some change in properties may result from descaling.

As a deterrent to rusting, a coating of oil is usually applied to hot-rolled descaled steel strip, but strip may be furnished not oiled 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.

3.4 mill edge: A normal side edge produced without any definite contour in hot rolling. Mill edges may contain some irregularities such as cracked or torn edges or thin (feathered) edges.

A square mill edge can be produced by hot-edge rolling (with the corners not as square as a square-edge bar).

3.5 edge trimmed: A normal edge obtained by shearing, slitting or trimming a mill-edge product.

1) ISO 6317:1982, *Hot-rolled carbon steel strip of commercial and drawing qualities.*

Normal processing does not necessarily provide a definite positioning of the slitting burr.

4 Conditions of manufacture

4.1 Steelmaking

The processes used in making the steel and in manufacturing hot-rolled strip 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 (cast analysis) shall conform to the requirements in table 1.

4.3 Chemical analysis

4.3.1 Cast analysis

A cast analysis of each cast of steel shall be made by the manufacturer to determine the percentage of carbon, manganese, phosphorus and sulfur. 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 semi-finished or finished steel, 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 manufacturer and purchaser at the time of ordering.

4.4 Weldability

This product is normally 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 hot-rolled steel strip 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.

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, when 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 strip 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.

Table 1 — Chemical composition (cast analysis), %

Grade	Class[1) 2)]	Method of deoxidation[3) 4)]	C max.	Mn max.	Si max.	P max.	S max.
HR235	B D	E or NE CS	0,18 0,17	1,20 1,20	Not applicable Not applicable	0,035 0,035	0,035 0,035
HR275	B D	E or NE CS	0,21 0,20	1,20 1,20	Not applicable Not applicable	0,035 0,035	0,035 0,035
HR355	B D	NE CS	0,21 0,20	1,60	0,55	0,035 0,035	0,035 0,035

1) Class B steels are intended for use in welded structures or structural parts, subjected to normal loading conditions.

2) Class D steels are to be used for welded structures or structural parts where, owing to loading conditions and the general design of the structure, a high resistance to brittle fracture is necessary.

3) E = Rimming NE = Non-rimming CS = Special killed

4) The nitrogen content is controlled; normally, it should not exceed 0,009 % for E or NE steel or 0,015 % for CS steel.

5 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel strip of structural quality shall be as given in tables 3 to 7 inclusive.

It has not been practicable to formulate flatness tolerances for hot-rolled steel strip.

6 Sampling

6.1 Tensile test

One representative sample for the tensile test required in table 2 shall be taken from each lot of strip for shipment. A lot consists of 50 tonnes or less of strip 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 strip for shipment. A lot consists of all strip 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. Longitudinal test pieces shall be used.

7.2 Bend test (when specified)

The transverse bend test piece shall withstand being bent through 180°, in the direction as shown in figure 1, around an inside diameter as shown in table 2, 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.

Table 2 — Mechanical properties

Grade	R_e min.[1]	R_m min. (information only)	A min. % [2] [3]				180° bend mandrel diameter[3] [4]
			$e < 3$		$3 \leqslant e \leqslant 6$		
	N/mm²	N/mm²	$L_o = 50$ mm	$L_o = 80$ mm	$L_o = 5{,}65\sqrt{S_o}$	$L_o = 50$ mm	
HR235	235	330	20	18	23	22	$2a$
HR275	275	370	17	15	20	18	$3a$
HR355	355	450	15	13	19	16	$3a$

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

a = thickness of bend test piece

e = thickness of steel strip, in millimetres

1 N/mm² = 1 MPa

1) The yield strength can be measured either by 0,5 % total 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.

2) 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 inclusive, 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.

3) For material over 6 mm in thickness, values for bend and elongation are subject to agreement between the manufacturer and purchaser.

4) The bend test is carried out only when specified (see 7.2). The bend mandrel diameters in table 2 are for test pieces prepared for laboratory testing. Conditions during fabrication may be more severe, and may not simulate those during laboratory testing.

Small cracks on the edges of test pieces and cracks which require magnification to be visible shall be disregarded.

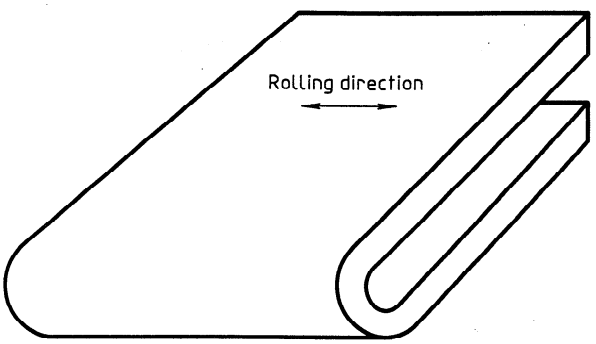


Figure 1 — Transverse bend test piece (after bending)

7.3 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 specimen shall be in the longitudinal direction and the test shall be carried out in accordance with ISO 148 for the Charpy V-notch test.

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 2 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 batch.

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 in a hot-rolled or hot-rolled descaled product.

The steel strip in cut lengths shall be free from amounts of laminations, surface flaws and other imperfections that are detrimental to subsequent appropriate processing.

Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove defective portions as can be carried out 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 strip 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 top of each lift or shown on a tag attached to each coil or shipping unit:

a) the manufacturer's name or identifying brand;

b) the number of this International Standard;

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

a) the number of this International Standard;

b) the name, quality, grade and class of the material (for example, hot-rolled steel strip, structural quality, grade HR235 class D);

c) the dimensions of the product and the quantity required;

d) the application (name of part) if possible (see 4.5);

e) whether pickling or descaling by grit or shot blasting is required (material so specified will be oiled unless ordered not oiled) (see 3.3);

f) the type of edge (see 3.4 and 3.5);

g) whether cropped ends are required;

h) the report of the mechanical properties and/or the cast analysis, if required (see 4.3.1 and 4.6);

i) limitations on masses and dimensions of individual coils and bundles, if applicable (see clause 12);

j) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 11.1).

NOTE 1 A typical ordering description is as follows:

International Standard 6316, hot-rolled steel strip, structural quality, grade HR235, class D, 3 × 200 × 1 600 mm, 40 000 kg, for part No. 2345, roof support, mill edge, furnish report of mechanical properties, maximum lift 1 000 kg.

Table 3 — Thickness tolerances for coils and cut lengths

Values in millimetres

Grade	Specified widths	Thickness tolerances[1], over and under, for specified thicknesses							
		up to and including 1,5	over 1,5 up to and including 2,0	over 2,0 up to and including 4,0	over 4,0 up to and including 5,0	over 5,0 up to and including 6,0	over 6,0 up to and including 8,0	over 8,0 up to and including 10,0	over 10,0 up to and including 12,0
HR235 and HR275 (including descaled strip, coils)	10 up to 100 exclusive	0,12	0,14	0,15	0,16	0,17	0,18	0,19	—
	100 up to 600 exclusive	0,14	0,16	0,17	0,18	0,19	0,20	0,22	0,27
HR355 (including descaled material)	10 up to 100 exclusive	0,13	0,15	0,17	0,18	0,19	0,20	0,21	—
	100 up to 600 exclusive	0,15	0,18	0,19	0,20	0,21	0,22	0,24	0,30

The values specified do not apply to the uncropped ends of a mill-edge coil within 7 m inclusive of both ends.

1) Thickness is measured at any point on the strip not less than 20 mm from a side edge for mill-edge strip and not less than 10 mm from a side edge for edge-trimmed strip. Measurements shall not be made on top of the shear burr.

Table 4 — Width tolerances, over and under for coils and cut lengths (including descaled material), mill edge

Values in millimetres

Specified widths	Tolerance[1) 2)]
Up to and including 50	0,8
Over 50 up to and including 100	1,2
Over 100 up to and including 200	1,6
Over 200 up to and including 400	2,0
Over 400 up to 600 exclusive	2,5

1) The values specified do not apply to the uncropped ends of a mill-edge coil within 7 m inclusive of both ends.

2) By agreement, material can be ordered with only plus tolerances, in which case the value in the table is doubled.

Table 5 — Width tolerances, over and under, for hot-rolled steel strip (including descaled strip), edge trimmed, not resquared coils and cut lengths

Values in millimetres

Specified widths	Tolerance[1)]	
	Specified thicknesses	
	Up to and including 3	Over 3
Up to and including 100	0,3	0,4
Over 100 up to and including 200	0,5	0,6
Over 200 up to and including 400	0,7	0,8
Over 400 up to 600 exclusive	0,5	1,0

1) By agreement, material can be ordered with only plus tolerances, in which case the value in the table is doubled.

Table 6 — Length tolerances for hot-rolled steel strip (including descaled strip), not resquared

Values in millimetres

Specified lengths	Tolerance over, nothing under[1)]
	Specified widths up to 600 exclusive
Up to and including 1 500	25
Over 1 500 up to and including 3 000	30
Over 3 000 up to and including 6 000	40
Over 6 000 up to and including 9 000	65
Over 9 000 up to and including 12 000	85
Over 12 000	100

1) Closer tolerances are subject to agreement.

Table 7 — Camber tolerances for coils and cut lengths (including descaled material)

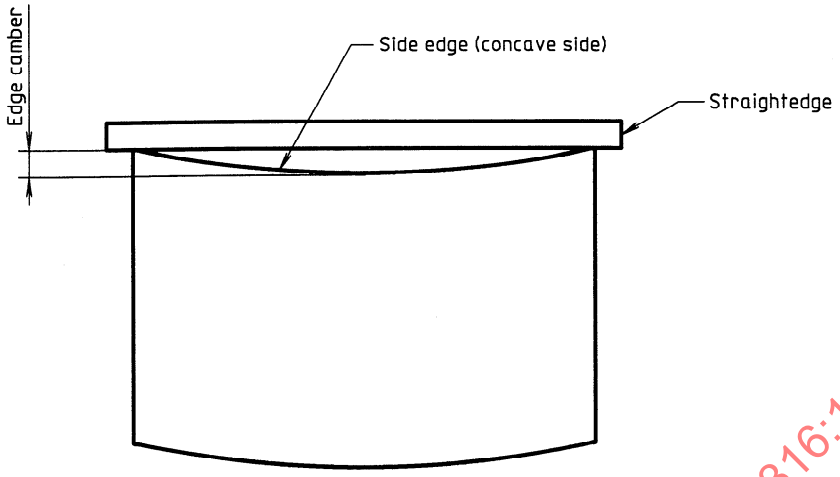
Values in millimetres

Form	Camber tolerances[1) 2)]
Coils	20 for widths $\geq 10 < 40$ in any 2 000 length
Cut lengths	10 for widths $\geq 40 < 600$ in any 2 000 length

1) In those cases where it is not practical to measure the tolerance as given in the table, the following formula may be used:

$$\text{New tolerance} = \frac{(\text{non-standard } l)^2}{(\text{standard } l)^2} \times \text{tolerance in this table}$$

2) The values specified do not apply to the uncropped ends of a mill-edge coil within 7 m inclusive of both ends.



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

Figure 2 — Measurement of camber