INTERNATIONAL STANDARD

ISO 5952

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Continuously hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance

Tôles en acier de construction laminées à chaud en continu à résistance améliorée à la corrosion atmosphérique

Reference number
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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 5952 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 5952:2005), which has been technically revised.

Continuously hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance

1 Scope

1.1 This International Standard applies to continuously hot-rolled steel sheet (see 3.2) of structural quality with improved atmospheric corrosion resistance, also known as weather-resistant structural steel. It is produced in the grades and classes listed in Table 1. The product is intended for applications where requirements are for mechanical properties and increased resistance to atmospheric corrosion. It is generally used in the delivered condition and is intended for bolted, riveted or welded structures.

1.2 This product is commonly produced in the range of thicknesses 1,6 mm up to and including 12,5 mm and widths of 600 mm and over, in coils and cut lengths.

1.3 Hot-rolled sheet less than 600 mm wide can 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”.

1.4 This International Standard does not cover the following steel qualities:

— steels intended for boilers or pressure vessels, or steels designated as commercial quality or drawing qualities (see ISO 3573);

— steels produced on reversing mills and designated with improved atmospheric corrosion resistance (see ISO 4952);

— steels designated with structural quality (see ISO 4995), or high yield strength structural quality (see ISO 4996);

— steels designated with higher yield strength with improved formability (see ISO 5951).

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*

3 Terms and definitions

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

3.1
improved atmospheric corrosion resistance
a characteristic achieved by intentional addition of a certain number of alloying elements, such as P, Cu, Cr, Ni, etc., providing a chemical composition which promotes the formation of a protective oxide layer on the product

NOTE The degree of corrosion resistance is based on data acceptable to the purchaser.

3.2
hot-rolled steel sheet
product obtained by rolling heated steel through a continuous-type wide strip mill to the required sheet thickness

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 by pickling in an acid solution or by mechanical means such as grit blasting

NOTE Some change in properties can result from mechanical descaling.

3.4
mill edge
normal edge without any definite contour produced during hot rolling

NOTE Untrimmed 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 1 Normal processing does not necessarily provide a definite positioning of the slitting burr.

NOTE 2 Material is normally supplied as described in 3.4 and 3.5. Other edges may be supplied as agreed upon.

4 Surface characteristics

4.1 Surface condition

Oxide or scale in 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.

4.2 Oiling

As a deterrent to rusting, a coating of oil is usually applied to hot-rolled, descaled steel sheet, but sheet may be furnished unoiled, if required. The oil is not intended as a forming lubricant and shall be easily removable with degreasing chemicals.

When requested, the manufacturer shall advise the purchaser which type of oil has been used.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed upon, 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

5.2.1 The chemical composition (heat analysis) shall conform to the values given in Table 1, unless otherwise agreed between the interested parties.

5.2.2 When selecting the grade or chemical composition to be used, attention should be directed to the appropriate welding procedure to be followed (see 5.4).

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer 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 his or her representative.

Table 1 — Chemical composition (heat analysis) (normal standard compositions, see 5.2)

Values in percent

Grade	Class[a]	Method[b]	C	Mn	Si	P	S	Cu	Ni	Cr	Mo	Zr
HSA 235W	B D	NE CS	0,13 max.	0,20 to 0,60	0,100 to 0,40	0,040 max.	0,035 max.	0,25 to 0,55	0,65 max.	0,40 to 0,80		
HSA 245W	B D	NE CS	0,18 max.	1,25 max.	0,15 to 0,65	0,035 max.	0,035 max.	0,30 to 0,50	0,05 to 0,30	0,45 to 0,75	[c]	[c]
HSA 355W1	A D	NE CS	0,12 max.	1,00 max.	0,20 to 0,75	0,06 to 0,15	0,035 max.	0,25 to 0,55	0,65 max.	0,30 to 1,25		
HSA 355W2	C D	NE CS	0,16 max.	0,50 to 1,50	0,50 max.	0,035 max.	0,035 max.	0,25 to 0,55	0,65 max.	0,40 to 0,80	0,30 max.	0,15 max.
HSA 365W	B D	NE CS	0,18 max.	1,40 max.	0,15 to 0,65	0,035 max.	0,035 max.	0,30 to 0,50	0,05 to 0,30	0,45 to 0,75	[c]	[c]

NOTE Each grade can contain one or more microalloying elements, such as vanadium, titanium, niobium, etc.

[a] Class A steels satisfy only moderate loading conditions.

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

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

Class D steels are to be used for structures or structural parts 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 — aluminium killed (0,020 % minimum total aluminium)

[c] The total content of Mo, Nb, Ti, V and Zr is not to exceed 0,15 %.

5.3.2 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 and deviation limits shall be agreed upon between the interested parties at the time of ordering. See Table 2.

Table 2 — Product analysis tolerances

Values in percent

Element	Maximum of specified element,	Tolerance over maximum specified,
Carbon	⩽0,15 0,15 to 0,18	0,03 0,04
Manganese	⩽0,60 > 0,60 to 1,50	0,03 0,05
Phosphorous	0,15	0,01
Sulfur	0,035	0,010
Copper	0,55	0,03
Nickel	0,65	0,03
Chromium	1,25	0,04
Molybdenum	0,30	0,01

5.4 Weldability

This product is suitable for welding if appropriate welding conditions are selected. See the recommendations given in IIS/IIW 382-71 as an example.

5.5 Application

It is desirable that the specified product be identified for fabrication by 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.

5.6 Mechanical properties

At the time that the steel is made available for shipment, the mechanical properties shall be as stated in Table 3 when they are determined on test pieces obtained according to the requirements of Clause 8. Any additional property requirements specified or required are subject to agreement before ordering.

5.7 Corrosion resistance

The resistance of these steels to atmospheric corrosion is due to the formation of a protective oxide layer. The formation of this protective layer depends not only on chemical composition, such as the distinctive differences between the analyses of the various grades, but also on a number of factors such as surrounding atmosphere, design, etc., over which the steel producer has no control. See Annexes A and B for information on estimating the corrosion resistance and cautions concerning the use of these steels.

6 Dimensional tolerances

Dimensional tolerances applicable to hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance shall be as given in ISO 16160.

7 Tensile test sampling

One representative sample for the tensile test required in Table 3 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.

8 Tensile test requirements

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.

Table 3 — Mechanical properties

Grade	Class[a]	R_e[b] min. MPa	R_m MPa		A[c] min %					
			Nominal thickness		$e < 3$ mm		$3 \geqslant e \leqslant 6$ mm		$e > 6$ mm	
			<3 mm	≥3 mm	$L_o = 50$ mm	$L_o = 80$ mm	$L_o = 5{,}65\sqrt{S_o}$ mm	$L_o = 50$ mm	$L_o = 5{,}65\sqrt{S_o}$ mm	$L_o = 200$ mm
HSA 235W	B and D	235	360 to 510	340 to 470	20	18	24	22	24	17
HSA 245W	B and D	245	400 to 540		20	18	24	22	24	17
HSA 355W1	A and D	355	510 to 680	490 to 630	15	15	20	19	24	18
HSA 355W2	C and D	355	510 to 680	490 to 630	18	15	20	22	24	18
HSA 365W	B and D	365	490 to 610		15	12	17	19	21	15

R_e = yield strength

R_m = tensile strength

A = percentage elongation after fracture

L_o = gauge length on test piece

e = thickness of steel sheet, in millimetres

S_o = original cross-sectional area of gauge length

1 MPa = 1 N/mm^2

a Class A steels satisfy only moderate loading conditions.

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

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

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

While not usually specified, if so agreed at the time of ordering, impact tests may be specified for material of Class C or D, 6 mm and over in thickness.

The test pieces shall be in the longitudinal direction and the test shall be carried out in accordance with ISO 148-1 for the Charpy V-notch test.

b 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.

c For thicknesses up to 3 mm, use either $L_o = 50$ mm or $L_o = 80$ mm. For thicknesses of 3 mm inclusive to 6 mm inclusive, use $L_o = 5{,}65\sqrt{S_o}$ or $L_o = 50$ mm. For thicknesses of 6 mm and over, use $L_o = 5{,}65\sqrt{S_o}$ or $L_o = 200$ 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.

9 Retests

9.1 Machining and flaws

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

9.2 Elongation

If the percentage of elongation of any tested piece is less than that specified in Table 3 and 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 conducted.

9.3 Additional tests

If a test does not give the specified results, two additional tests shall be taken at random from the same lot. Both retests shall conform to the requirements of this International Standard; otherwise, the lot shall be rejected.

10 Resubmission

The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he or she has subjected them to a suitable 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.

The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another grade.

11 Workmanship

The surface condition shall be that normally obtained in a hot-rolled product. The material cut in lengths shall be free from any laminations, surface flaws and other imperfections that are detrimental to the final product or to subsequent appropriate processing.

Processing for shipment in coils does not afford the manufacturer the opportunity of readily observing or removing imperfect portions, as would be the case on the cut-length product.

12 Inspection and acceptance

12.1 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.

12.2 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 supplier shall be notified in order that he or she may properly investigate.

13 Coil size

When hot-rolled steel sheet is ordered in coils, a minimum or range of acceptable inside diameters (ID) shall be specified. In addition, the maximum outside diameter (OD) and maximum acceptable coil mass shall be specified.

14 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) manufacturer's name or identifying brand;

b) a reference to this International Standard, i.e. ISO 5952:2011;

c) the grade and class designation;

d) the order number;

e) the product dimensions;

f) the lot number;

g) the mass.

15 Information to be supplied by the purchaser

To adequately specify requirements in this International Standard, enquiries and orders shall include the following information:

a) a reference to this International Standard, i.e. ISO 5952:2011;

b) name, quality, grade and class of material (for example, hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance, grade HSA 355W1, Class A);

c) dimensions of product and quantity required;

d) application (name of part) if possible (see 5.5);

e) pickling (or descaling by grit or shot blasting), if required (material so specified will be oiled unless it is ordered unoiled) (see 3.3 and 4.2);

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

g) ends cropped, if required;

h) if required, report of heat analysis and/or mechanical properties (see 5.3.1 and 5.6);

i) if necessary, additional requirements (see 5.6);

j) limitations on mass and dimensions of individual coils and bundles, if applicable (see Clause 13);

k) inspection and tests for acceptance prior to shipment from the manufacturer's works, if required (see 12.1);

l) restricted thickness tolerances, if required.

A typical ordering description is as follows.

International Standard ISO 5952:2011 hot-rolled steel sheet of structural quality with improved atmospheric corrosion resistance, grade HSA 355W1, Class A, 3 × 1 200 mm × 2 440 mm restricted thickness tolerance, 40 000 kg, for Part No. 32154, formed channels for outdoor parking garage.

Annex A
(informative)

Guidelines for estimating the atmospheric corrosion resistance of low-alloy steels

A.1 Scope

This annex presents a method for estimating the atmospheric corrosion resistance of low-alloy weather-resistant steels from chemical composition data.

The method utilizes predictive equations based on the steel composition to calculate indices of atmospheric corrosion resistance.

As many indices have been used around the world, it is necessary to consider the different environments and the chemical composition of the steel when choosing an index. As any index may be inappropriate based on the above, it is necessary for the purchaser and supplier to decide on the type of index to use and the requirement levels of that index for the expected environment.

A.2 Terminology

Low-alloy steels means iron-carbon alloys containing greater than 1 % but less than 5 %, by mass, of total alloying elements.

NOTE Most “low-alloy weather-resistant steels” contain additions of both chromium and copper, and can also contain additions of silicon, nickel, phosphorus, or other alloying elements which enhance atmospheric corrosion resistance.

A.3 Procedure

A.3.1 Equations for predicting the corrosion penetration of low-alloy steels after 15,5 years of exposure to various atmospheres, based on the chemical composition of the steel, were published by Legault and Leckie [9]. The equations are based on extensive data published by Larrabee and Coburn [10].

A.3.2 For use with these guidelines, the Legault-Leckie equation for an industrial atmosphere (Kearny, N.J.) was modified to allow calculation of an atmospheric corrosion resistance index based on chemical composition. The modification consisted of deletion of the constant and changing the signs of all the terms in the equation. The modified equation for calculation of the atmospheric corrosion resistance index (I) is given below. The higher the index, the more corrosion resistant is the steel.

$$I = 26{,}01\ (\%\ \mathrm{Cu}) + 3{,}88\ (\%\ \mathrm{Ni}) + 1{,}20\ (\%\ \mathrm{Cr}) + 1{,}49\ (\%\ \mathrm{Si}) + 17{,}28\ (\%\ \mathrm{P}) - 7{,}29\ (\%\ \mathrm{Cu})\ (\%\ \mathrm{Ni}) - 9{,}10\ (\%\ \mathrm{Ni})\ (\%\ \mathrm{P}) - 33{,}39\ (\%\ \mathrm{Cu})^2$$

A.3.3 The predictive equation should be used only for steel compositions within the range of the original test materials in the Larrabee-Coburn data set. These limits are as follows:

Cu 0,012 to 0.51 %
Ni < 0,05 to 1,1 %
Cr < 0,10 to 1,3 %
Si < 0,10 to 0,64 %
P < 0,01 to 0,12 %

A.3.4 The minimum acceptable atmospheric corrosion index should be a matter of negotiation between the manufacturer/supplier and the purchaser.

Annex B
(informative)

Additional information for the use of steel with improved atmospheric corrosion resistance

The corrosion-inhibiting effect of the auto-protective oxide layer relates to the nature of its constituents and to the particular distribution and concentration of alloying elements in it. The resistance to atmospheric corrosion resistance depends on weather conditions giving a succession of dry and wet periods for the forming of the auto-protective oxide layer of the base metal. The protection afforded depends on the environmental and other conditions prevailing at the site of the structure.

Provisions should be made in the design and fabrication of the structure, for the auto-protective oxide layer on the surface to form and regenerate itself unimpeded. It is the responsibility of the designer to include corrosion of unprotected steels in his or her calculation and, as far as is necessary, to compensate for this by increasing the thickness of the product.

Conventional surface protection is recommended when the content of particular chemical substances in the air is significant. It is absolutely necessary where the structure is in contact with water for long periods, is permanently exposed to moisture, or is to be used in a marine atmosphere. Before painting, the products should be descaled. Under comparable conditions, the susceptibility to corrosion of steel with improved atmospheric corrosion resistance under painting is less than that for conventional structural steels.

The surface of structures which are not exposed to the elements, but may be subject to the build-up of condensation, should be appropriately ventilated. Otherwise, a suitable surface protection is necessary. Generally valid statements on the corrosion process cannot be made, due to the extent to which the process depends on the prevailing climatic conditions and the details of the structure.

Bibliography

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[2] ISO 4952, *Structural steels with improved atmospheric corrosion resistance*

[3] ISO 4995, *Hot-rolled steel sheet of structural quality*

[4] ISO 4996, *Hot-rolled steel sheet of high yield stress structural quality*

[5] ISO 5951, *Hot-rolled steel sheet of higher yield strength with improved formability*

[6] ASTM A606, *Standard Specification for Steel, Sheet and Strip, High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, with Improved Atmospheric Corrosion Resistance*[1)]

[7] EN 10025-5, *Hot rolled products of structural steels — Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance*[1)]

[8] JIS G 3125, *Superior Atmospheric Corrosion Resisting Rolled Steels*[1)]

[9] LEGAULT, R.A. and LECKIE, H.P., *Effect of Composition on the Atmospheric Corrosion Behaviour of Steels Based on a Statistical Analysis of the Larrabee-Coburn Data Set*, Corrosion in Natural Environments, ASTM STP 558, ASTM 1974, pp. 334-347

[10] LARRABEE, C.P. and COBURN, S.K., *The Atmospheric Corrosion of Steels as Influenced by Changes in Chemical Composition*, First International Congress on Metallic Corrosion, Buttterworths, London, 1962, pp. 276-285

[11] IIS/IIW 382-71, Guide to the welding and weldability of C-Mn steels and C-Mn microalloyed steels

1) This document is recognized by ISO/TC 17/SC 12 to cover a subject similar to that of this International Standard. This information is given for the convenience of users of this International Standard and constitutes neither an endorsement of the document by TC 17/SC 12 or ISO, nor a statement regarding its degree of equivalence with this International Standard.

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