
**Steel sheet, cold-reduced, of higher
yield strength with improved
formability**

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

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Contents

	Page
Foreword.....	iv
Introduction.....	v
1 Scope.....	1
2 Normative references.....	1
3 Terms and definitions.....	1
4 Dimensions.....	1
5 Conditions of manufacture.....	2
5.1 Steelmaking.....	2
5.2 Chemical composition.....	2
5.3 Chemical analysis.....	2
5.3.1 Heat analysis.....	2
5.3.2 Product analysis.....	3
5.4 Mechanical properties.....	3
5.5 Application.....	4
5.6 Weldability.....	4
5.7 Surface condition.....	4
5.8 Surface finish.....	4
5.9 Oiling.....	4
5.10 Dimensional and shape tolerances.....	4
6 Sampling — Tensile test.....	4
7 Test methods — Tensile test.....	4
8 Retests.....	5
8.1 Machining and flaws.....	5
8.2 Elongation.....	5
8.3 Additional tests.....	5
9 Resubmission.....	5
10 Workmanship.....	5
11 Inspection and tests.....	5
12 Coil size.....	6
13 Marking.....	6
14 Information to be supplied by the purchaser.....	6
Bibliography.....	7

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 (see 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 (see 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 voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document 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 13887:2011), which has been technically revised.

Introduction

With the combination of higher strength and improved formability derived from the tests outlined in this document, it is possible to obtain savings in mass along with better weldability.

References [4] and [5] may be reviewed for comparison with this document. The relationship between the standards might only be approximate; therefore, the respective standards should be consulted for actual requirements. Those who use these documents will need to determine which specifications address their needs.

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Steel sheet, cold-reduced, of higher yield strength with improved formability

1 Scope

This document is applicable to all grades of cold-reduced steel sheet of higher yield strength with improved formability. The steel is made according to fine-grain practice and has a suitable chemical composition to provide improved formability. The product is intended for the fabrication of parts requiring better formability. It is generally used in the delivered condition.

This document does not apply to steels designated as commercial quality or drawing quality (see ISO 3574), steels of structural quality (see ISO 4997) or steels of high tensile strength and low yield point with improved formability (see ISO 14590).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 16162, *Cold-rolled steel sheet products — Dimensional and shape tolerances*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

cold-reduced steel sheet

product obtained from hot-rolled descaled steel sheet by cold-reducing to the required sheet thickness followed by annealing to recrystallize the grain structure

3.2

lot

up to a specified quantity of steel sheet of the same designation rolled to the same thickness

4 Dimensions

Cold-reduced steel sheet of higher yield strength with improved formability is produced in thicknesses from 0,25 mm to 3,2 mm and in widths of 600 mm and over in coils and cut lengths. Product less than 600 mm wide, slit from wide sheet, will be considered as sheet not strip.

5 Conditions of manufacture

5.1 Steelmaking

Unless otherwise agreed, the processes used in making the steel and in manufacturing cold-reduced steel 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 conform to the requirements given in [Tables 1](#) and [2](#).

Table 1 — Chemical analysis (heat analysis)

Mass fractions in percent

Grade	C max.	Mn max.	S max.	Si max.
260Y	0,08	0,60	0,025	0,50
300Y	0,10	0,90	0,025	0,50
340Y	0,11	1,20	0,025	0,50
380Y	0,11	1,20	0,025	0,50
420Y	0,11	1,40	0,025	0,50
490Y	0,16	1,65	0,025	0,60
550Y	0,16	1,65	0,025	0,60

NOTE These steels may contain one or more of the elements niobium, titanium and vanadium up to a total of 0,22 % maximum, or phosphorus up to 0,30 % maximum.

Table 2 — Limits on additional chemical elements

Mass fractions in percent

Element	Cu ^a	Ni ^a	Cr ^{ab}	Mo ^{ab}	Nb ^c	V ^{cd}	Ti ^c
	max.	max.	max.	max.	max.	max.	max.
Heat analysis	0,20	0,20	0,15	0,06	0,008	0,008	0,008
Product analysis	0,23	0,23	0,19	0,07	0,018	0,018	0,018

^a The sum of copper, nickel, chromium and molybdenum shall not exceed 0,50 % 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 apply.

^b 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 apply.

^c For interstitial free steels only, the value of 0,15 % titanium, and 0,10 % maximum for niobium and vanadium are acceptable to ensure that the carbon and nitrogen are fully stabilized.

^d Heat analysis greater than 0,008 % may be supplied after agreement between the manufacturer and purchaser.

5.3 Chemical analysis

5.3.1 Heat analysis

An analysis of each heat of steel shall be made by the manufacturer to determine conformity with the requirements of [Tables 1](#) and [2](#). On request, a report of the heat analysis shall be made available to the purchaser or the purchaser's representative. Each of the elements listed in [Tables 1](#) and [2](#) 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 %".

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. 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
		max.
C	$C \leq 0,15$	0,03
	$0,15 < C \leq 0,16$	0,04
Mn	$Mn \leq 0,60$	0,03
	$> 0,60 < Mn \leq 1,15$	0,04
	$> 1,15 < Mn \leq 1,65$	0,05
S	$\leq 0,025$	0,01
Si	$\leq 0,60$	0,05

NOTE The above maximum tolerance is the allowable excess over the specified requirement and not the heat analysis. For example, for Grade 300Y the following product analysis values are within these tolerances: C 0,13 %; Mn 0,94 %; S 0,035 %; and Si 0,55 %.

5.4 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 obtained in accordance with the requirements of [Clauses 6](#) and [7](#). On request, a report of the mechanical properties shall be made to the purchaser.

NOTE Prolonged storage of the sheet can cause a change in the mechanical properties leading to an adverse effect on formability.

Table 4 — Mechanical properties

Grade	R _{eL} min MPa	R _m min MPa	A min %	
			L ₀ = 50 mm	L ₀ = 80 mm
260Y	260	350	28	26
300Y	300	380	26	24
340Y	340	410	24	22
380Y	380	450	22	20
420Y	420	490	20	18
490Y	490	550	16	14
550Y	550	620	12	10

R_{eL} = lower yield strength

R_m = tensile strength

A = percentage elongation after fracture

L₀ = gage length of original test piece

NOTE 1 MPa = 1 N/mm²

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. Proper identification of the part may include visual examination, prints or description, or a combination of these.

5.6 Weldability

This product is normally suitable for welding if appropriate welding conditions are selected.

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

Because the heat of welding might significantly lower the strength of Grades 490 and 550, these grades are not recommended for welding.

5.7 Surface condition

The condition of the surface of cold-reduced steel sheet is not required to be the same for unexposed parts as it is for exposed parts.

The surface condition of sheet for unexposed parts may contain pores, some slight pitting, small markings, light scratches, and a light discoloration. The surface of sheet for exposed parts shall be reasonably free of these conditions. Unless otherwise agreed, only one side is inspected.

5.8 Surface finish

5.8.1 Cold-reduced steel sheet is normally produced in a matte finish, dull in appearance, which is suitable for ordinary decorative painting but is not recommended for electroplating.

5.8.2 When cold-reduced steel sheet is deformed during fabrication, localized areas may be roughened to some degree and such affected portions of the part might require hand finishing to prepare the surface for the intended application.

5.9 Oiling

As a deterrent to rusting, a coating of oil is usually applied to cold-reduced steel sheet. 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.

5.10 Dimensional and shape tolerances

Dimensional and shape tolerances applicable to cold-reduced steel sheet of higher yield strength with improved formability shall be as in ISO 16162.

6 Sampling — Tensile test

One representative transverse sample from each lot of 50 t or less for shipment shall be taken for the tensile test to verify conformance of the requirements of [Table 4](#).

7 Test methods — Tensile test

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

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

On any tensile test, 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 additional tests shall be conducted on samples at random from the same lot. Both retests shall conform to the requirements of this document; otherwise the lot shall be rejected.

9 Resubmission

9.1 The manufacturer has the right to resubmit, for acceptance, the products that have been rejected during earlier inspection because of unsatisfactory properties, after the rejected products have been subjected to a suitable treatment (e.g. 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 lot.

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

10 Workmanship

10.1 The surface condition shall be that normally obtained in a cold-rolled product.

10.2 The steel sheet in cut lengths shall be free from quantities of laminations, surface flaws, and other imperfections that are detrimental to the final product or to subsequent appropriate processing.

10.3 Processing for shipment in coils does not afford the manufacturer the opportunity to observe readily or to remove nonconforming portions as can be carried out on the cut length product. However, this does not relieve the manufacturer of the responsibility to provide a product that meets the requirements for surface condition normally obtained in a cold-reduced product.

11 Inspection and tests

11.1 Although not usually required for products covered by this document, when the purchaser specifies that inspection and tests for acceptance shall 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 document.

11.2 Steel that is reported to be out of conformance 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 the reported non-conforming material may be properly investigated.