

Continuously hot-dip coated strip and sheet of low carbon steels for cold forming — Technical delivery conditions

The European Standard EN 10327:2004 has the status of a
British Standard

ICS 77.140.50

National foreword

This British Standard is the official English language version of EN 10327:2004. It supersedes BS EN 10142:2000, and together with BS EN 10326:2004, supersedes BS EN 10154:2002, BS EN 10214:1995 and BS EN 10215:1995, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/10, Flat rolled steel products, which has the responsibility to:

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EN 10154:2002,
EN 10214:1995,
and EN 10215:1995

English version

Continuously hot-dip coated strip and sheet of low carbon steels for cold forming - Technical delivery conditions

Bandes et tôles en acier doux revêtues en continu par
immersion à chaud pour formage à froid - Conditions
techniques de livraison

Kontinuierlich schmelztauchveredeltes Band und Blech aus
weichen Stählen zum Kaltumformen - Technische
Lieferbedingungen

This European Standard was approved by CEN on 23 April 2004.

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Foreword

This document (EN 10327:2004) has been prepared by Technical Committee ECISS/TC 27 "Surface coated flat products – Qualities, dimensions, tolerances and specific tests", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2005, and conflicting national standards shall be withdrawn at the latest by January 2005.

This European Standard supersedes EN 10142:2000 and, together with EN 10326, it also supersedes EN 10154:2002, EN 10214:1995 and EN 10215:1995.

This document includes a Bibliography.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

1 Scope

1.1 This document specifies requirements for continuously hot-dip coated products made of low carbon steels for cold forming coated with zinc (Z), zinc-iron alloy (ZF), zinc-aluminium alloy (ZA), aluminium-zinc alloy (AZ) and aluminium-silicon alloy (AS) (see Table 1) with thicknesses of 0,35 mm to 3,0 mm unless otherwise agreed (see 1.2). The thickness is the final thickness of the delivered product after coating.

This document applies to strip of all widths and to sheets cut from it (≥ 600 mm width) and cut lengths (< 600 mm width).

1.2 If agreed at the time of enquiry and order, this document may also be applied to continuously hot-dip coated flat products in thicknesses $> 3,0$ mm. In this case the mechanical property, adhesion of coating and surface condition requirements shall also be agreed at the time of enquiry and order.

1.3 The products covered by this document are mainly used where cold formability and corrosion resistance are the most important factors. Corrosion resistance of the alloy is proportional to the coating thickness, hence to its mass (see also 7.3.2).

1.4 This document is not applicable to:

- continuously hot-dip coated structural steel flat products (see EN 10326);
- electrolytically zinc coated cold rolled steel flat products (see EN 10152);
- continuously organic coated (coil coated) steel flat products (see EN 10169-1, ENV 10169-2 and EN 10169-3);
- continuously hot-dip coated strip and sheet of steels with higher yield strength for cold forming (see EN 10292).

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).

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature.*

EN 10020:2000, *Definition and classification of grades of steel.*

EN 10021:1993, *General technical delivery requirements for steel and steel products.*

EN 10027-1, *Designation systems for steels – Part 1: Steel names, principal symbols.*

EN 10027-2, *Designation systems for steels – Part 2: Numerical system.*

EN 10079:1992, *Definition of steel products.*

EN 10143, *Continuously hot-dip metal coated steel sheet and strip - Tolerances on dimensions and shape.*

EN 10204:1991, *Metallic products – Types of inspection documents.*

ISO 10113, *Metallic materials – Sheet and strip – Determination of plastic strain ratio.*

ISO 10275, *Metallic materials – Sheet and strip – Determination of tensile strain hardening exponent.*

CR 10260, *Designation systems for steel – Additional symbols.*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10021:1993, EN 10079:1992 and EN 10204:1991 and the following apply.

NOTE 1 General guidelines for the protection of iron and steel can be found in EN ISO 14713.

NOTE 2 In the present cases, strip is continuously hot-dip coated in a bath the composition of which is given in 3.1 to 3.4.

3.1

hot-dip zinc coating (Z)

application of a zinc coating by immersing the prepared products in a molten bath containing a zinc content of at least 99 % (see also 7.4.2)

3.2

hot-dip zinc-iron coating (ZF)

application of a zinc coating by immersing the prepared products in a molten bath containing a zinc content of at least 99 % ; subsequent annealing produces an iron-zinc coating with an iron content of normally 8 % to 12 % (see also 7.4.3)

3.3

hot-dip zinc-aluminium alloy coating (ZA)

application of a zinc-aluminium coating by immersing the prepared products in a molten bath which is composed of zinc and approximately 5 % aluminium

3.4

hot-dip aluminium-zinc alloy coating (AZ)

application of an aluminium-zinc coating by immersing the prepared products in a molten bath which is composed of 55 % aluminium, 1,6 % silicon and the balance zinc

3.5

hot-dip aluminium-silicon alloy coating (AS)

application of an aluminium-silicon coating by immersing the prepared products in a molten bath which is composed of aluminium and 8 % to 11 % silicon

3.6 coating mass

total mass of coating including both surfaces of the product (expressed in grams per square metre)

4 Classification and designation

4.1 Classification

In accordance with EN 10020 the steel grades covered by this document are alloy quality steels. They are classified in accordance with their increasing suitability for cold forming as follows (see Table 1):

DX51D: bending and profiling quality;

DX52D: drawing quality;

DX53D: deep drawing quality;

DX54D: special deep drawing quality;

DX55D: special deep drawing quality, (only +AS), heat resistance up to 800 °C;

DX56D: extra deep drawing quality;

DX57D: super deep drawing quality.

4.2 Designation

4.2.1 Steel names

For the steel grades covered by this document, the steel names as given in Table 1 are allocated in accordance with EN 10027-1 and CR 10260.

4.2.3 Steel numbers

For the steel grades covered by this document, the steel numbers as given in Table 1 are allocated in accordance with EN 10027-2.

5 Information to be supplied by the purchaser

5.1 Mandatory information

The following information shall be supplied by the purchaser at the time of enquiry and order:

- a) quantity to be delivered;
- b) type of product (strip, sheet, cut length);
- c) number of the dimensional standard (EN 10143);
- d) nominal dimensions and the tolerances on dimensions and shape and, if applicable, letters denoting relevant special tolerances;
- e) term "steel";
- f) number of this document (EN 10327);
- g) steel name or steel number and symbol for the type of hot-dip coating as given in Table 1;
- h) number designating the nominal mass of coating (e.g. 275 = 275 g/m² including both surfaces, see Tables 3 to 6);
- i) letter denoting the coating finish (N, M or R, see 7.3 and Tables 4 and 5);
- j) letter denoting the surface quality (A, B or C, see 7.5);
- k) letter denoting the surface treatment (C, O, CO, S, P or PO, see 7.6).

EXAMPLE 1 sheet, delivered with dimensional tolerances in accordance with EN 10143 with nominal thickness of 0,80 mm, ordered with special thickness tolerances (S), nominal width 1200 mm, ordered with special width tolerances (S), nominal length 2500 mm, ordered with special flatness tolerances (FS), made of steel DX53D+ZF (1.0355+ZF) in accordance with EN 10327, coating mass 100 g/m² (100), coating finish R, surface quality B, surface treatment oiled (O):

1 sheet EN 10143-0,80Sx1200Sx2500FS
steel EN 10327-DX53D+ZF100-R-B-O

or:

1 sheet EN 10143-0,80Sx1200Sx2500FS
steel EN 10327-1.0355+ZF100-R-B-O

5.2 Options

A number of options are specified in this document and listed below. If the purchaser does not indicate his wish to implement one of these options, the products shall be supplied in accordance with the basis specification of this document (see 5.1).

- a) delivery of products in thicknesses > 3 mm (see 1.2);
- b) verification of the product analysis (see 7.1.2);
- c) products supplied suitable for the manufacture of a specific part (see 7.2.2);
- d) coating masses different from those of Tables 3 to 5 and/or special requirements for different coating masses on each surface (see 7.3.2);
- e) products with pronounced spangle (see 7.4.2.1 or 7.4.5);
- f) special requirements for a maximum Al-Fe-Si alloy layer mass occurring during hot-dip aluminium-silicon coating (see 7.4.6);
- g) requirement for special applications on bright appearance for hot-dip aluminium-silicon coated products (type B surface, see NOTE to 7.5.3);
- h) type of S coating (see 7.6.5);
- i) products supplied free from coil breaks (see 7.7);
- j) products supplied free from stretcher strains when cold forming (see 7.8.2);
- k) special requirements for a maximum or minimum value for the coating mass per product surface (see 7.9.2);
- l) notification of which surface has been inspected (see 7.10.1);
- m) testing for compliance with the requirements of this document (see 8.1.1 and 8.1.2);
- n) supply of an inspection document and type of document (see 8.1.2);
- o) marking desired by branding of the products (see 9.2);
- p) requirement for packing (see Clause 10).

6 Manufacturing process

The processes used in steelmaking and manufacture of the products are left to the discretion of the manufacturer.

7 Requirements

7.1 Chemical composition

7.1.1 The chemical composition according to the cast analysis shall be as specified in Table 1.

7.1.2 If a product analysis is agreed at the time of enquiry and order, the permitted deviations from the cast analysis given in Table 1 shall meet the requirements in Table 2.

7.2 Mechanical properties

7.2.1 The products shall be supplied on the basis of the mechanical property requirements in Table 1.

7.2.2 If so agreed at the time of enquiry and order, products specified in Table 1, except those made of steel grade DX51D, may be supplied with suitability for manufacturing a specific part. In this case the values given in Table 1 do not apply. The reject tolerances arising when the material is processed shall not exceed a specific proportion to be agreed at the time of enquiry and order.

7.2.3 If ordered in accordance with 7.2.1, the mechanical property values in Table 1 apply for the following periods commencing from the date on which the products are made available, unless otherwise agreed at the time of enquiry and order:

- 1 month for steel grades DX51 D, DX52D coated in accordance with Table 1;
- 6 months for steel grades DX53D, DX54D, DX55D, DX56D and DX57D coated in accordance with Table 1.

7.2.4 The tensile test values apply to transverse test pieces and are related to the test piece cross section without coating.

Table 1 — Steel grades and mechanical properties (transverse test pieces)

| Steel grade | Designation Symbols for the types of hot-dip coating | Chemical composition % by mass max. | | | | | | Yield strength R_e^a MPa * | Tensile strength R_m MPa * | Elongation A_{80}^b % min. | Plastic strain ratio r_{90} min. | Strain hardening exponent n_{90} min. |
|-------------|---|---|------|------|------|-------|-------------------------|------------------------------------|------------------------------------|---------------------------------------|--|---|
| | | C | Si | Mn | P | S | Ti | | | | | |
| DX51D | +Z, +ZF, +ZA, +AZ, +AS | | | | | | | 270 to 500 | 22 | - | - | |
| DX52D | +Z, +ZF, +ZA, +AZ, +AS | | | | | | 140 to 300 ^c | 270 to 420 | 26 | - | - | |
| DX53D | +Z, +ZF, +ZA, +AZ, +AS | | | | | | 140 to 260 | 270 to 380 | 30 | - | - | |
| DX54D | +Z, +ZA | | | | | | 120 to 220 | 260 to 350 | 36 | 1,6 | 0,18 | |
| DX54D | +ZF | | | | | | 120 to 220 | 260 to 350 | 34 | 1,4 | 0,18 | |
| DX54D | +AZ | | | | | | 120 to 220 | 260 to 350 | 36 | - | - | |
| DX54D | +AS | 0,12 | 0,50 | 0,60 | 0,10 | 0,045 | 120 to 220 | 260 to 350 | 34 | 1,4 ^{d,e} | 0,18 ^e | |
| DX55D | +AS | | | | | | 140 to 240 | 270 to 370 | 30 | - | - | |
| DX56D | +Z, +ZA | | | | | | 120 to 180 | 260 to 350 | 39 | 1,9 ^d | 0,21 | |
| DX56D | +ZF | | | | | | 120 to 180 | 260 to 350 | 37 | 1,7 ^{d,e} | 0,20 ^e | |
| DX56D | +AS | | | | | | 120 to 180 | 260 to 350 | 39 | 1,7 ^{d,e} | 0,20 ^e | |
| DX57D | +Z, +ZA | | | | | | 120 to 170 | 260 to 350 | 41 | 2,1 ^d | 0,22 | |
| DX57D | +ZF | | | | | | 120 to 170 | 260 to 350 | 39 | 1,9 ^{d,e} | 0,21 ^e | |
| DX57D | +AS | | | | | | 120 to 170 | 260 to 350 | 41 | 1,9 ^{d,e} | 0,21 ^e | |

* 1 MPa = 1 N/mm²

^a If the yield point is not pronounced, the values apply to the 0,2 %-proof strength ($R_{p0,2}$); if the yield strength is pronounced, the values apply to the lower yield point (R_{eL}).

^b For product thicknesses 0,50 mm < $t \leq 0,70$ mm (including coating) the minimum elongation values (A_{80}) shall be reduced by 2 units. For $t \leq 0,50$ mm this reduction shall be 4 units.

^c This value applies to skin passed products only (surface qualities B and C).

^d For $t > 1,5$ mm, the r_{90} -value shall be reduced by 0,2.

^e For $t \leq 0,70$ mm, the r_{90} -value shall be reduced by 0,2 and the n_{90} -value shall be reduced by 0,01.

Table 2 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 1

| Element | Specified limit of the cast analysis in Table 1 % by mass | Permissible deviation of the product analysis % by mass |
|---------|--|--|
| C | 0,12 | + 0,02 |
| Si | 0,50 | + 0,03 |
| Mn | 0,60 | + 0,10 |
| P | 0,10 | + 0,01 |
| S | 0,045 | + 0,005 |
| Tl | 0,30 | + 0,01 |

7.3 Coatings

7.3.1 The products shall be supplied with coatings of zinc (Z), zinc-iron-alloy (ZF), zinc-aluminium-alloy (ZA), aluminium-zinc-alloy (AZ) and aluminium-silicon-alloy (AS) are given in Tables 3 to 6.

7.3.2 The available coating masses are given in Table 3. Deviating coating masses and/or different coating masses on each surface may be supplied if agreed at the time of enquiry and order.

Thicker coatings may limit the formability and weldability of the products. Therefore, the forming and weldability requirements shall be taken into account when ordering the coating mass.

The two surfaces may have a different appearance as a result of the manufacturing process.

7.4 Coating finish (see Tables 4 to 6)

7.4.1 General

Depending on the coating conditions, crystals of different sizes and brightness arise. The quality of the coating is not affected by this.

7.4.2 Zinc coated products (Z)

7.4.2.1 Normal finish (N)

The finish is obtained when the zinc coating is left to solidify normally. Either no spangle or zinc crystals of different sizes and brightness appear depending on the galvanizing conditions. The quality of the coating is not affected by this.

If a pronounced spangle is desired, this shall be indicated specially at the time of enquiry and order.

7.4.2.2 Minimized spangle (M)

The finish is obtained by influencing the solidification process in a specific way. The surface will have reduced spangles, in some cases, not visible to the unaided eye. The finish may be ordered if the normal spangle (see 7.4.1.1) does not satisfy the surface appearance requirements.

7.4.3 Zinc-iron alloy coated products (ZF)

The regular zinc-iron alloy coating (R) results from heat treatment in which iron diffuses through the zinc. The surface has a uniform matt grey appearance.

7.4.4 Zinc-aluminium coated products (ZA)

The coating finish has a metallic lustre, that is the result of unrestricted growth of the zinc-aluminium crystals during normal solidification. Crystals of different sizes and brightness may appear depending on the manufacturing conditions. The quality of the coating is not affected by this.

7.4.5 Aluminium-zinc coated products (AZ)

The products are supplied with a normal spangle.

Normal spangle is a coating finish, having a metallic lustre, that is the result of unrestricted growth of the aluminium-zinc crystals during normal solidification.

If a pronounced spangle is desired, this shall be indicated specially at the time of enquiry and order.

7.4.6 Aluminium-silicon coated products (AS)

Deviating from other hot-dip coated products, a relatively pronounced (Al-Fe-Si) alloy layer is formed over the base material during hot-dip coating. This shall be taken into account for further processing. If a maximum value for the mass of this layer is required, this shall be especially agreed upon at the time of enquiry and order. The test method is described in Annex C.

7.5 Surface quality

7.5.1 General

The products may be supplied with one of the surface qualities described in 7.5.2 to 7.5.4 (see Tables 4 to 6).

7.5.2 As coated surface (A)

Imperfections such as pimples, marks, scratches, pits, variations in surface appearance, dark spots, stripe marks and light passivation stains are permissible. Stretch levelling breaks or run-off marks may appear. Coil breaks and stretcher strains may appear as well.

7.5.3 Improved surface (B)

Surface quality B is obtained by skin passing.

With this surface quality, small imperfections such as stretch levelling breaks, skin pass marks, slight scratches, surface structure, run-off marks and light passivation stains are permissible.

NOTE For special applications and by agreement between the producer and the user, hot-dip aluminium-silicon coated products (AS) may be supplied with a bright appearance. In that case the surface is of type "B".

7.5.4 Best quality surface (C)

Surface quality C is obtained by skin passing.

The controlled surface shall make it possible to apply a uniform high-class paint finish. The other surface shall at least have the characteristics of surface quality B (see 7.5.3).

Table 3 — Available coating masses

| Coating designation | Minimum coating mass ^a , total both surfaces | | Theoretical guidance values for coating thickness per surface in the single spot test | | Density g/cm ³ |
|--|--|------------------|---|--------------------|----------------------------------|
| | g/m ² | | µm | | |
| | Triple spot test | Single spot test | Typical value ^b | Range ^c | |
| Zinc coating masses (Z) | | | | | |
| Z100 | 100 | 85 | 7 | 5 to 12 | 7,1 |
| Z140 | 140 | 120 | 10 | 7 to 15 | |
| Z200 | 200 | 170 | 14 | 10 to 20 | |
| Z225 | 225 | 195 | 16 | 11 to 22 | |
| Z275 | 275 | 235 | 20 | 15 to 27 | |
| Z350 | 350 | 300 | 25 | 19 to 33 | |
| Z450 | 450 | 385 | 32 | 24 to 42 | |
| Z600 | 600 | 510 | 42 | 32 to 55 | |
| Zinc-iron coating masses (ZF) | | | | | |
| ZF100 | 100 | 85 | 7 | 5 to 12 | 7,1 |
| ZF120 | 120 | 100 | 8 | 6 to 13 | |
| ZF140 | 140 | 120 | 10 | 7 to 15 | |
| Zinc-aluminium alloy coating masses (ZA) | | | | | |
| ZA095 | 95 | 80 | 7 | 5 to 12 | 6,9 |
| ZA130 | 130 | 110 | 10 | 7 to 15 | |
| ZA185 | 185 | 155 | 14 | 10 to 20 | |
| ZA200 | 200 | 170 | 15 | 11 to 21 | |
| ZA255 | 255 | 215 | 20 | 15 to 27 | |
| ZA300 | 300 | 255 | 23 | 17 to 31 | |
| Aluminium-zinc alloy coating masses (AZ) | | | | | |
| AZ100 | 100 | 85 | 13 | 9 to 19 | 3,8 |
| AZ150 | 150 | 130 | 20 | 15 to 27 | |
| AZ185 | 185 | 160 | 25 | 19 to 33 | |
| Aluminium-silicon alloy coating masses (AS) | | | | | |
| AS060 | 60 | 45 | 8 | 6 to 13 | 3,0 |
| AS080 | 80 | 60 | 14 | 10 to 20 | |
| AS100 | 100 | 75 | 17 | 12 to 23 | |
| AS120 | 120 | 90 | 20 | 15 to 27 | |
| AS150 | 150 | 115 | 25 | 19 to 33 | |
| ^a See 7.9. ^b Coating thicknesses can be calculated from the coating masses (see 7.9.1). ^c The user can expect, that these limiting values are obtained on the upper surface and on the reverse surface. | | | | | |

Table 4 — Available coatings, finishes and surface qualities for zinc coatings (Z)

| Steel grade | | Coating designation ^a | Coating finish | | | |
|--|--------------------------------------|----------------------------------|----------------|--------------------------------|-----|-----|
| Steel name | Steel number | | N | M | | |
| | | | | Surface qualities ^a | | |
| | | A | A | B | C | |
| DX51D+Z | 1.0226 | Z100 | X | X | X | X |
| | | Z140 | X | X | X | X |
| | | Z200 | X | X | X | X |
| | | (Z225) | (X) | (X) | (X) | (X) |
| | | Z275 | X | X | X | X |
| | | Z350 | X | X | — | — |
| | | (Z450) | (X) | (X) | — | — |
| (Z600) | (X) | (X) | — | — | | |
| DX52D+Z | 1.0350 | Z100 | X | X | X | X |
| | | Z140 | X | X | X | X |
| | | Z200 | X | X | X | X |
| | | (Z225) | (X) | (X) | (X) | (X) |
| | | Z275 | X | X | X | X |
| DX53D+Z DX54D+Z DX56D+Z DX57D+Z | 1.0355 1.0306 1.0322 1.0853 | Z100 | X | X | X | X |
| | | Z140 | X | X | X | X |
| | | Z200 | X | X | X | X |
| | | (Z225) | (X) | (X) | (X) | (X) |
| | | (Z275) | (X) | (X) | (X) | (X) |

^a The coatings and surface qualities given in brackets are available on agreement.

Table 5 — Available coatings, finishes and surface qualities for zinc-iron alloy coatings (ZF)

| Steel grades | Coating designation ^a | Coating finish | | |
|-----------------------------------|----------------------------------|--------------------------------|-----|-----|
| | | R | | |
| | | Surface qualities ^a | | |
| | | A | B | C |
| All grades (+ZF) (see Table 1) | ZF100 | X | X | X |
| | ZF120 | X | X | X |
| | (ZF140) | (X) | (X) | (X) |

^a The coatings and surface qualities given in brackets are available on agreement.

Table 6 — Available coatings, finishes and surface qualities for zinc-aluminium coatings (ZA), aluminium-zinc coatings (AZ) and aluminium-silicon coatings (AS)

| Steel grade | Coating designation | Surface qualities ^a | | |
|--|---------------------|--------------------------------|-----|-----|
| | | A | B | C |
| Zinc-aluminium coatings (ZA) | | | | |
| All grades (+ZA), except DX55D (see Table 1) | ZA095 | X | X | X |
| | ZA130 | X | X | X |
| | ZA185 | X | X | X |
| | ZA200 | X | X | X |
| | ZA255 | X | X | X |
| | ZA300 | X | — | — |
| Aluminium-zinc coatings (AZ) | | | | |
| DX51D, DX52D DX53D, DX54D (+AZ) | AZ100 | X | X | X |
| | AZ150 | X | X | X |
| | AZ185 | X | X | X |
| Aluminium-silicon coatings (AS) | | | | |
| All grades (+AS) (see Table 1) | AS060 | X | X | X |
| | AS080 | X | X | X |
| | AS100 | X | X | X |
| | AS120 | X | X | (X) |
| | AS150 | X | (X) | (X) |

^a The surface qualities given in brackets are available on agreement.

7.6 Surface treatment (surface protection)

7.6.1 General

Hot-dip coated flat products receive one of the following surface treatments at the producer's plant (see 7.6.2 to 7.6.7):

- chemical passivation C
- oiling O
- chemical passivation and oiling CO
- sealed S
- phosphated P
- phosphated and oiled PO

Surface treatment serves, among other things, as a temporary corrosion protection during storage and transportation. The period of protection afforded depends on the atmospheric and storage conditions.

Hot-dip coated flat products are only supplied without surface treatment (untreated (U)) if expressly desired by the purchaser on his own responsibility. In this case, there is increased risk of formation of corrosion products on the surface during storage and transportation.

7.6.2 Chemical passivation (C)

Chemical passivation protects the surface against humidity and reduces the risk of formation of corrosion products during storage and transportation.

Local colour variations as a result of this treatment is permissible and does not impair the quality.

7.6.3 Oiling (O)

This treatment also reduces the risk of formation of corrosion products.

It shall be possible to remove the oil layer with a suitable degreasing solvent which does not adversely affect the coating.

7.6.4 Chemical passivation and oiling (CO)

Agreement may be reached on this combination of surface treatment in accordance with 7.6.2 and 7.6.3 if increased protection against the formation of corrosion products is required.

7.6.5 Sealed (S)

Application of a transparent organic film coating by agreement, on one or both sides, of approximately 1 g/m².

This treatment offers additional corrosion protection, depending on its nature, it increases the protection against fingerprints, it may improve the sliding characteristics during forming operations and can be used as a priming coat for subsequent painting.

The type of S coating should be agreed at the time of enquiry and order.

7.6.6 Phosphated (P)

This treatment improves the adherence and protective effect of a coating applied by the processor. It also reduces the risk of corrosion occurring during transport and storage.

7.6.7 Phosphated and oiled (PO)

This combination of surface treatment may improve formability.

7.7 Freedom from coil breaks

If particular requirements are made for freedom from coil breaks (fluting), it is recommended to order improved surface quality B (see 7.5.3).

7.8 Stretcher strains

7.8.1 In order to avoid the formation of stretcher strains when cold forming, it is recommended to order improved surface quality B (see 7.5.3). As there is a tendency for stretcher strains to form again after some time, it is in the interest of the purchaser to use the products as soon as possible.

7.8.2 Products with the surface condition B or C are free from stretcher strains when cold forming for the following periods commencing from the agreed date on which they are made available:

- 1 month for steel grades DX51D and DX52D,
- 6 months for steel grades DX53D, DX54D, DX55D, DX56D and DX57D.

7.9 Coating mass

7.9.1 The coating mass shall correspond to the data in Table 3. The values apply for the total mass of the coating on both surfaces for the triple spot test and the single spot test (see 8.4.3 and 8.5.3).

The thickness of the coating can be calculated from coating masses, e.g. as follows:

A zinc coating mass of 100 g/m² on both surfaces corresponds to a zinc coating thickness of about 7,1 µm per surface.

$$\frac{\text{zinc coating mass, g/m}^2 \text{ (both surfaces)}}{2 \times 7,1 \text{ g/cm}^3 \text{ (= zinc-density)}} = \text{zinc-coating thickness (}\mu\text{m per surface)}$$

For other coatings similar calculations may be applied (see Table 3).

The coating mass is not always equally distributed on both the product surfaces. However, it may be assumed that a coating mass of at least 40 % of the value given in Table 3 for the single spot test exists on each surface of the product.

7.9.2 A maximum or minimum value for the coating mass per surface of the product (single spot test) for each coating given in Tables 3 to 6 may be agreed upon at the time of enquiry and order.

7.10 Adhesion of coating

The adhesion of the coating shall be tested using a method chosen at the manufacturer's works.

7.11 Surface condition

7.11.1 The surface shall comply with the requirements in 7.4 to 7.6. Unless otherwise agreed at the time of enquiry and order, only one surface shall be inspected at the manufacturer's works. If requested the supplier shall inform the purchaser whether the inspected surface is the top surface or bottom surface.

Small edge cracks which may occur in the case of uncut edges are not a justification for rejection.

7.11.2 When supplying strip in coils, there is greater risk of surface defects than if sheet and cut lengths are supplied as it is not possible for the manufacturer to eliminate all the defects in a coil. This shall be taken into account by the purchaser when evaluating the products.

7.12 Tolerances on dimensions and shape

The requirements of EN 10143 shall apply.

7.13 Suitability for further processing

7.13.1 The products according to this standard shall be suitable for welding using the normal welding methods. With heavier coating masses, special measures shall be taken for welding, as appropriate.

7.13.2 Products complying with the requirements of this document can be bonded together provided an appropriate prior surface treatment is applied to the surfaces to be bonded.

7.13.3 All steel grades and surface conditions are suitable for organic coating provided a prior appropriate surface treatment is applied. The final appearance of the product and its fitness for use will depend on the coating finish (see 7.5).

NOTE Application of surface coatings requires corresponding pre-treatment at the processor's works.

8 Testing

8.1 General

8.1.1 The products may be supplied with or without testing for compliance with the requirements of this document.

8.1.2 If testing is required, the purchaser shall give the following information at the time of enquiry and order:

- type of test (specific or non-specific test, see EN 10021);
- type of inspection document (see EN 10204).

8.1.3 Specific tests shall be carried out in accordance with the requirements in 8.2 to 8.6.

8.2 Test units

The test unit consists of 20 t or a fraction of 20 t of hot-dip coated flat products of the same grade and nominal thickness, coating mass and surface condition. In the case of strip, a coil weighing more than 20 t shall be regarded as one test unit.

8.3 Number of tests

One series of tests shall be carried out per test unit as specified in 8.2 to determine:

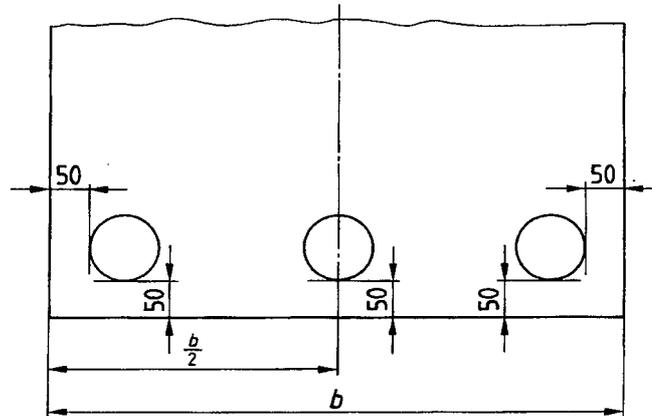
- the mechanical properties (see 8.5.1);
- the *r*- and *n*-values, if specified in Table 1 (see 8.5.2); and
- the coating mass (see 8.5.3).

8.4 Sampling

8.4.1 In the case of strip, the samples shall be taken from the beginning or the end of the coil. In the case of sheet and cut lengths, the selection of the sample shall be left to the discretion of the supplier.

8.4.2 The sample for the tensile test (see 8.5.1) shall be taken in the transverse direction at a distance of at least 50 mm from the edge of the product.

8.4.3 The three samples for testing the coating mass (see 8.5.3) shall be taken as shown in Figure 1 if the product width permits. The samples may be round or square and the individual sample shall be at least 5 000 mm² in area.

**Key**

b Strip or sheet width

Figure 1 — Position of the samples for determining the coating mass

If sampling as shown in Figure 1 is not possible because the product width is too small, only one sample shall be taken with an area of at least 5 000 mm². The coating mass determined from it shall comply with the requirements for the single spot test as specified in Table 3.

8.4.4 All the samples shall be taken and machined, if necessary, in such a way that the results of the tests are not affected.

8.5 Test methods

8.5.1 The tensile test shall be carried out as specified in EN 10002-1 using type 2 test pieces (initial gauge length $L_0 = 80$ mm, width $b = 20$ mm) (see also 7.2.4).

8.5.2 The determination of the plastic strain ratio r and the strain hardening exponent n shall be carried out in accordance with ISO 10113 and ISO 10275.

The plastic strain ratio r and the strain hardening exponent n are determined within the strain range of 10 % to 20 %. As the determination shall be carried out in the range of homogeneous deformation, then if the uniform elongation of the tested material is lower than 20 %, values for the upper limit of the strain range of 15 % to 20 % can be applied.

8.5.3 The coating mass shall be determined from the difference in mass of the samples before and after the coating has been removed chemically. In the test with specimen according to Figure 1, the triple spot test value is the arithmetic mean of the three test results. Each individual result shall meet the requirements of the single spot test as given in Table 3.

Other methods — e.g. non-destructive tests — may be used for continuous checks at the manufacturer's works.

In cases of dispute, the methods described in Annex A (Z, ZA and AZ) or Annex B (AS) of this document shall be used.

8.5.4 If it is agreed to determine the Al-Fe-Si alloy layer resulting from hot-dip aluminium-silicon alloy (AS) coating (see 7.4.6) the method for its determination given in Annex C shall be applied.

8.6 Retests

The requirements of EN 10021 shall apply. In the case of coils, the retest specimens shall be taken from a distance of at least one lap away, but with a maximum of 20 m from the end of the coil.

9 Marking

9.1 A label shall be attached to each coil or bundle containing at least the following information:

- a) name or mark of the manufacturer's works;
- b) designation (consisting of 5.1b) and 5.1f) to 5.1k));
- c) nominal dimensions of the product;
- d) identification number;
- e) order number;
- f) mass of the coil or bundle.

9.2 Marking of the products by branding may be agreed at the time of enquiry and order.

10 Packing

The packing requirements for the product shall be agreed at the time of enquiry and order.

11 Storage and transportation

11.1 Moisture, in particular condensation between the sheets, laps of the coil or other adjacent parts made of hot-dip coated flat products can lead to the formation of corrosion products. The possible types of temporary surface protection are given in 7.6. As a precaution, the products should be transported and stored dry and protected from moisture.

11.2 During transportation, dark spots may appear on the hot-dip coated surfaces as a result of friction. Generally, they only impair the appearance. Friction is reduced by oiling the products. However, the following precautionary measures should be taken: secure packing, laid flat, no local pressure spots.

12 Disputes

EN 10021 is applicable to disputes after delivery and their settlement.

Annex A (normative)

Reference method for determination of the zinc, zinc-aluminium and aluminium-zinc coating mass

A.1 Principle

The sample shall be at least 5 000 mm² in area. Using a sample with a surface area of 5 000 mm², the loss of mass in grams when the coating is dissolved, multiplied by 200, will represent the coating mass in grams per square metre of the product, including both sides.

A.2 Reagent and preparation of the solution

Reagent:

- Hydrochloric acid (HCl $\rho_{20} = 1,19$ g/ml)
- Hexamethylenetetramine

Preparation of the solution:

The hydrochloric acid is diluted with deionized or distilled water in the ratio one part pure HCl to one part water (50 % dilution). Hexamethylenetetramine is then added, stirring, in the ratio of 3,5 g per litre of dilute hydrochloric acid solution.

This prepared solution permits the execution of numerous successive dissolutions under satisfactory conditions of attack of the coating, both from the point of view of speed and accuracy.

A.3 Apparatus

Balance capable of weighing samples to an accuracy of 0,001 g. For the test, use a take-off device.

A.4 Procedure

The following operations are applied to each sample:

- a) if necessary, degrease the sample with an organic solvent which will not attack the coating, then dry the sample;
- b) weigh the sample to an accuracy of 0,001 g;
- c) place the sample in the hydrochloric acid solution with hexamethylenetetramine inhibitor at ambient temperature (20 °C to 25 °C). Leave the sample immersed in the solution until the release of hydrogen ceases or only a few bubbles are released;
- d) after the attack, the sample is washed and brushed under running water, dried with a cloth and then by heating to around 100 °C and cooled or dried by blowing with warm air;
- e) weigh the sample again to an accuracy of 0,001 g;
- f) determine the difference between the mass of the coated sample and that of the sample without its coating. This difference, calculated in grams, represents the mass *m* of the coating.

Annex B (normative)

Reference method for determination of the aluminium-silicon coating mass

B.1 Principle

The method described below is used for determining the coating mass of hot-dip aluminium-silicon coated flat products. The samples are weighed before and after the coating is removed.

B.2 Reagents

- Hydrochloric acid (HCl $\rho_{20} = 1,19$ g/ml).
- Sodium hydroxide solution with 20 % concentration made by dissolving 20 g sodium hydroxide in 80 ml of water.

B.3 Procedure

B.3.1 Samples

The samples are taken from the product in accordance with 8.4.4.

The samples shall be clean. If necessary, they are to be washed firstly with suitable solvents, which will not attack the coating, then secondly in alcohol. Finally, they are thoroughly dried.

B.3.2 Method

After washing as specified in B.3.1, the samples are weighed to an accuracy of 0,001g and then placed in the hot sodium hydroxide solution until the reaction ceases. Then the test samples are taken out of this solution, rubbed under water, roughly dried off with a cloth and placed in cold hydrochloric acid for 2 s to 3 s.

The samples are then rinsed under water and again immersed in the sodium hydroxide solution until no further reaction can be established. This process is to be repeated until no reaction is visible when the sample is dipped into the sodium hydroxide solution. The samples are then washed, dried and re-weighed (accuracy 0,001g).

B.4 Evaluation

The coating mass in grams per square metre of the product (on both sides) is obtained from the formula:

$$\frac{(m_0 - m_1) \times 10^6}{A}$$

where

m_0 is the mass of the sample before the coating is stripped off, in grams;

m_1 is the mass of the sample after the coating has been removed, in grams;

A is the area of the sample used in square millimetre.

Annex C (normative)

Method for determination of the mass of the Al-Fe-Si alloy layer

C.1 Principle

The method described below is used for determining the mass of the alloy layer on samples of hot-dip aluminium-silicon coated flat products. Firstly, the so-called non-alloy layer and secondly the alloy layer are removed, according to the method in Annex B. The method is based on the reaction of tin (II) chloride solution with aluminium to form metallic tin (sponge); this solution does not react with the alloy or with the iron base material. The samples are weighted before and after removal of the alloy layer.

C.2 Reagents

C.2.1 Tin (II) chloride solution

C.2.1.1 To produce the stock solution, 1 000g $\text{SnCl}_2 \times \text{H}_2\text{O}$ are dissolved in 500 ml of diluted hydrochloric acid (1:1). Make up to 1 000 ml adding 5 g to 10 g metallic tin. Heat until the solution is clear.

C.2.1.2 To produce the test solution, 20 ml of stock solution are added to 200 ml H_2O immediately prior to use.

C.3 Procedure

C.3.1 Removal of the non-alloy layer

The samples, taken in accordance with 8.4.4 are cleaned with petroleum ether and immersed in 200 ml of test solution (see C.2.1.2) until the reaction ceases.

Once the test samples have been removed from the solution, the sponge tin is scraped off with a small spatula. The process is repeated until no further reaction takes place. The samples are then washed and dried.

C.3.2 Determination of alloy layer

The test samples prepared in accordance with C.3.1 are treated as described in B.3.2.

C.4 Evaluation

The mass of the alloy layer is calculated using the formula in B.4, from the difference in mass of the samples before and after the test.

Bibliography

- EN 10152, *Electrolytically zinc coated cold rolled steel flat products for cold forming – Technical delivery conditions.*
- EN 10169-1, *Continuously organic coated (coil coated) steel flat products – Part 1: General information (definitions, materials, tolerances, test methods).*
- ENV 10169-2, *Continuously organic coated (coil coated) steel flat products – Part 2: Products for building exterior applications.*
- EN 10169-3, *Continuously organic coated (coil coated) steel flat products – Part 3: Products for building interior applications.*
- EN 10292, *Continuously hot-dip coated strip and sheet of steels with higher yield strength for cold forming – Technical delivery conditions.*
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- EN ISO 14713, *Protection against corrosion of iron and steel in structures - Zinc and aluminium coatings - Guidelines (ISO 14713:1999).*

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