BS EN 10346:2015

BSI Standards Publication

Continuously hot-dip coated steel flat products for cold forming — Technical delivery conditions

bsi.

...making excellence a habit.™

National foreword

This British Standard is the UK implementation of EN 10346:2015. It supersedes BS EN 10346:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/109, Coated and Uncoated Flat Products to be Used for Cold Forming.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Published by BSI Standards Limited 2015

ISBN 978 0 580 82407 4

ICS 77.140.50

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2015.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 10346

July 2015

ICS 77.140.50

Supersedes EN 10346:2009

English Version

Continuously hot-dip coated steel flat products for cold forming - Technical delivery conditions

Produits plats en acier revêtus en continu par immersion à chaud pour formage à froid - Conditions techniques de livraison

Kontinuierlich schmelztauchveredelte Flacherzeugnisse aus Stahl - Technische Lieferbedingungen

This European Standard was approved by CEN on 16 April 2015.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 10346:2015 E

Contents

Page

European foreword

This document (EN 10346:2015) has been prepared by Technical Committee ECISS/TC 109 “Coated and uncoated flat products to be used for cold forming”, the secretariat of which is held by AFNOR.

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 2016, and conflicting national standards shall be withdrawn at the latest by January 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 10346:2009.

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

1 Scope

This European Standard specifies requirements for continuously hot-dip coated products made of low carbon steels for cold forming, of steels for construction and of steels with high proof strength for cold forming coated with zinc (Z), zinc-iron alloy (ZF), zinc-aluminium alloy (ZA), aluminium-zinc alloy (AZ), aluminium-silicon alloy (AS) or zinc-magnesium alloy (ZM) and for continuously hot-dip coated products made of multiphase steels for cold forming coated with zinc (Z), zinc-iron alloy (ZF), zinc-aluminium alloy (ZA) or zinc-magnesium alloy (ZM) in thicknesses of 0,20 mm ≤ *t* < 3,0 mm.

By agreement at the time of enquiry and order, this European Standard is applicable to continuously hot-dip coated flat products of an expanded validity range defined for thicknesses t < 0,20mm or in thicknesses 3,0 mm ≤ t ≤ 6,5 mm with agreed mechanical properties and test specimens, adhesion of coating and surface condition requirements.

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).

NOTE 1 Products coated with (pure) aluminium can also be available, but are not covered by this European standard.

NOTE 2 The products covered by this European Standard are used where cold formability, high strength, a defined minimum yield strength and/or corrosion resistance are the most important factors. Corrosion resistance of the product is proportional to the coating thickness, hence to its mass (see also 7.3.2). The products covered by this European Standard can be used as substrates for organic coated flat products specified in EN 10169 for building and general engineering applications.

NOTE 3 By agreement at the time of enquiry and order, this European Standard is applicable to other continuously hot-dip coated hot rolled steel flat products (e.g. in accordance with EN 10149-2).

2 Normative References

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 606, *Bar coding - Transport and handling labels for steel products*

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

EN 10021:2006, *General technical delivery conditions for steel products*

EN 10027-1, *Designation systems for steels - Part 1: Steel names*

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

EN 10049, *Measurement of roughness average Ra and peak count RPc on metallic flat products*

EN 10079:2007, *Definition of steel products*

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

EN 10204:2004, *Metallic products - Types of inspection documents*

EN 10325, *Steel - Determination of yield strength increase by the effect of heat treatment [Bake-Hardening-Index]*

EN ISO 6892-1:2009, *Metallic materials - Tensile testing - Part 1: Method of test at room temperature (ISO 6892-1:2009)*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10020:2000, EN 10021:2006, EN 10079:2007, EN 10204:2004 and the following apply.

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

3.1
hot-dip zinc coating (Z)
application of a zinc coating by immersing the prepared strip in a molten bath of zinc

Note 1 to entry: The zinc content is at least 99%.

Note 2 to entry: See also 7.4.2.

3.2
hot-dip zinc-iron alloy coating (ZF)
application of a zinc-iron coating by immersing the prepared strip in a molten bath of zinc and a subsequent annealing

Note 1 to entry: The zinc content of the bath is at least 99%.

Note 2 to entry: The annealing produces an iron-zinc coating with an iron content of normally 8 % to 12 %.

Note 3 to entry: See also 7.4.3.

3.3
hot-dip zinc-aluminium coating (ZA)
application of a zinc-aluminium coating by immersing the prepared strip in a molten bath of zinc-aluminium

Note 1 to entry: The composition of the bath is approximately 5% aluminium, small amounts of mischmetal and the balance zinc.

Note 2 to entry: See also 7.4.4.

3.4
hot dip zinc-magnesium coating (ZM)
application of a zinc-magnesium coating by immersing the prepared strip in a molten bath of zinc-aluminium-magnesium

Note 1 to entry: The composition of the bath is sum of aluminium and magnesium from 1,5 % to 8 %, containing minimum of 0,2 % magnesium and the balance zinc.

Note 2 to entry: For information on chemical composition and density, the manufacturer may be asked for advice.

Note 3 to entry: See also 7.4.5.

3.5
hot-dip aluminium-zinc alloy coating (AZ)
application of an aluminium-zinc coating by immersing the prepared strip in a molten bath of aluminium-zinc-silicon

Note 1 to entry: The composition of the bath is 55% of aluminium, 1,6% of silicon and the balance zinc.

Note 2 to entry: See also 7.4.6.

3.6
hot-dip aluminium-silicon alloy coating (AS)
application of an aluminium-silicon coating by immersing the prepared strip in a molten bath of aluminium-silicon

Note 1 to entry: The composition of the bath is 8 % to 11 % silicon and the balance aluminium.

Note 2 to entry: See also 7.4.7.

3.7
bake-hardening steel (B)[1)]
steel exhibiting an increase in proof strength following heating in the region of 170 °C for 20 min

Note 1 to entry: These steels have a good suitability for cold forming and present a high resistance to plastic straining (which is increased on finished parts during heat treatment) and a good dent resistance.

3.8
complex-phase steel (C)[1)]
steel with a multiphase microstructure containing mainly bainite, ferrite, whereas martensite, tempered martensite, retained austenite and pearlite may be present as additional phases

Note 1 to entry: The fine grained microstructure may be generated by retarded recrystallisation or precipitation of micro-alloying elements.

3.9
dual-phase steel (X)[1)]
steel consisting of mainly ferrite and martensite and possible bainite as a complementary phase

Note 1 to entry: According to their high tensile strength levels, dual phase steels show a low yield strength ratio and a high work hardening rate.

3.10
ferritic-bainitic steel (F)[1)]
steel with a matrix of ferrite or strengthened ferrite containing bainite or strengthened bainite

Note 1 to entry: The strengthening of the matrix is caused by a high density of dislocations, by grain refinement and precipitation of micro-alloying elements.

3.11
high strength interstitial free steel (Y)[1)]
steel whose composition is controlled to achieve improved plastic strain ratio *r* and strain hardening exponent *n* values

Note 1 to entry: These steels have both, a high mechanical strength and an excellent suitability for cold forming, due to their solid solution hardening and interstitial free microstructure.

---

1) Symbol used in the steel name (see Tables 3, 4 and 5).

3.12
low alloy/micro-alloyed steel (LA)[1)]
steel containing one or more of alloying elements Nb, Ti and V to achieve required proof strength levels

Note 1 to entry: Combined precipitation and grain refinement hardening modes allow reaching a high mechanical resistance while reducing the content of alloying elements.

Note 2 to entry: Alternatively, carbon-manganese alloying concepts in combination with grain refinement may be used.

3.13
low carbon steel
steel with low carbon content characterized by low yield strength and high ductility

3.14
steel for construction
steel with minimum strength levels and no special demand for suitability for cold forming

3.15
transformation induced plasticity steel (T)[1)]
steel with a ferritic matrix containing retained austenite capable of transformation into martensite during the forming process (TRIP effect)

Note 1 to entry: Because of high work-hardening rate the steel reaches high uniform elongation values and high tensile strength levels.

3.16
coating mass
total mass of coating given for both surfaces (see 7.9)

Note 1 to entry: In combination with the symbol for the coating type (Z, ZF, ZA, ZM, AZ, AS), the nominal coating mass is used as coating designation.

Note 2 to entry: The coating mass is expressed in grams per square metre.

4 Classification and designation

4.1 Classification

4.1.1 General

The steels covered by this document are alloy quality steels (steels in accordance with Tables 1, 3, 4 and 5) or non-alloy quality steels (steels in accordance with Table 2) in accordance with EN 10020:2000.

4.1.2 Low carbon steels for cold forming

The steel grades are classified in accordance with their increasing suitability for cold forming as follows (see Table 7):

— DX51D: bending and profiling quality;

— DX52D: drawing quality;

— DX53D: deep drawing quality;

— DX54D: special deep drawing quality;

— DX55D: special deep drawing quality (only +AS);

— DX56D: extra deep drawing quality;

— DX57D: super deep drawing quality.

4.1.3 Steels for construction

The steel grades are classified in accordance with their increasing minimum proof strength $R_{p0,2}$ (see Table 8).

4.1.4 Steels with high proof strength for cold forming

The steel grades are classified in accordance with their increasing minimum proof strength $R_{p0,2}$ (see Table 9).

4.1.5 Multiphase steels for cold forming

The steel grades are classified in accordance with their increasing minimum tensile strength R_m (see Tables 10 and 11).

4.2 Designation

4.2.1 Steel names

The steel names in accordance with this document are allocated in accordance with EN 10027-1.

4.2.2 Steel numbers

The steel numbers in accordance with this document 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, i.e. EN 10346;

g) steel name or steel number and symbol for the type of hot-dip coating as given in Tables 1 to 5;

h) number designating the nominal mass of coating (e.g. 275 = 275 g/m² including both surfaces, see Table 12);

i) letter denoting the coating finish (N or M, see 7.4.2 and Table 13);

j) letter denoting the surface quality (A, B or C, see 7.5 and Tables 13 to 15);

k) letter denoting the surface treatment (C, O, CO, P, PO or S, 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 1 200 mm, ordered with special width tolerances (S), nominal length 2 500 mm, ordered with special flatness tolerances (FS), made of steel DX53D+Z (1.0951+Z) in accordance with EN 10346, coating mass 100 g/m² (100), minimized spangle (M), surface quality (B), surface treatment oiled (O):

1 sheet EN 10143 — 0,80Sx1200Sx2500FS — steel EN 10346 — DX53D+Z100–M–B–O

or:

1 sheet EN 10143 — 0,80Sx1200Sx2500FS — steel EN 10346 — 1.0951+Z100 –M–B–O.

5.2 Options

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

1) Specification of product thicknesses deviating from those generally covered in the scope (i.e. t < 0,20 mm or 3 mm ≤ t ≤ 6,5 mm) (see Clause 1);

2) Specification of hot rolled products deviating from those generally covered in the scope (see NOTE 3 to Clause 1);

3) verification of the product analysis (see 7.1);

4) date of supply for products free from stretcher strains when cold forming (see 7.2.1.3);

5) products supplied suitable for the manufacture of a specific part (see 7.2.2.2 and 7.2.4.2);

6) coating masses different from those of Table 12 and/or special requirements for different coating masses on each surface (see 7.3.2);

7) special coatings and/or surface qualities (see Tables 13 and 15 footnote a);

8) hot-dip zinc coated products with pronounced spangle (see 7.4.2.1 or 7.4.6);

9) special requirements for a maximum Al-Fe-Si alloy layer mass occurring during hot-dip aluminium-silicon coating (see 7.4.7);

10) hot-dip coated products with surface quality A without skin passing (see 7.5.2.1);

11) requirement for special applications on bright appearance for aluminium-silicon coated products (type B surface, see NOTE to 7.5.2.2);

12) range and verification of surface roughness (see 7.5.3);

13) selection of the protective oil (see 7.6.1);

14) type of S coating (see 7.6.6);

15) products free from coil breaks (see 7.7.1);

16) maximum or minimum value for the coating mass on each product side (see 7.9);

17) type of inspection and, if applicable, inspection document to be delivered (see 8.1);

18) determination of the tensile properties and/or the Bake-Hardening Index BH_2 and/or the coating mass by calculation (see 8.3);

19) notification of which surface has been inspected (see 8.5.4.2);

20) marking desired by branding of the products (see 9.2);

21) requirement for packing (see Clause 10).

6 Manufacturing and processing

6.1 Manufacturing

Unless there are restrictions by the selected steel grade, the processes used in steelmaking and the manufacture of the products shall be left to the discretion of the manufacturer.

6.2 Processing

6.2.1 Ageing

Due to ageing, a reduction in formability can take place for all the products supplied according to this document. Coil breaks or fluting can occur additionally during processing. The risk of coil breaks increases, especially for thicknesses > 0,9 mm, with the duration of storage.

Therefore the user should process the products after their receipt as quick as possible (see 7.2.1.3).

6.2.2 Coating appearance

The coating surface can vary and change to a dark appearance by oxidation.

Due to ageing of the coating a certain cracking of the surface can appear during processing which can consequently reduce abrasion resistance.

The user should take these characteristics into account.

6.2.3 Surface protection

Regarding surface protection during transport and storage the following should be taken into consideration:

— Only a temporary corrosion resistance during transportation or storage is provided by any surface protection applied. Colour changes can occur.

— In particular, protection by oiling is dependent on storage time. The primarily uniform oil film becomes more and more unequal, and bare spots can develop. Different oils can show different behaviour.

7 Requirements

7.1 Chemical composition

The chemical composition according to the cast analysis shall be as specified in Tables 1 to 5.

If a product analysis is agreed at the time of enquiry and order, the permitted deviations from the cast analysis given in Tables 1 to 5 shall meet the requirements in Table 6.

Table 1 — Chemical composition (cast analysis) of low carbon steels for cold forming

Designation			Chemical composition % by mass max.					
Steel grade		Symbols for the types of available coatings	C	Si	Mn	P	S	Ti[a]
Steel name	Steel number							
DX51D	1.0917	+Z,+ZF,+ZA,+ZM,+AZ,+AS	0,18	0,50	1,20	0,12	0,045	0,30
DX52D	1.0918	+Z,+ZF,+ZA,+ZM,+AZ,+AS	0,12		0,60	0,10		
DX53D	1.0951	+Z,+ZF,+ZA,+ZM,+AZ,+AS						
DX54D	1.0952	+Z,+ZF,+ZA,+ZM,+AZ,+AS						
DX55D	1.0962	+AS						
DX56D	1.0963	+Z,+ZF,+ZA,+ZM,+AZ,+AS						
DX57D	1.0853	+Z,+ZF,+ZA,+ZM,+AS						
a By agreement at the time of enquiry and order, the content of Ti for the steel grades mentioned in this Table may be lowered to < 0,05% which means that the steel grade is non alloyed.								

Table 2 — Chemical composition (cast analysis) of steels for construction

Designation			Chemical composition % by mass max.				
Steel grade		Symbols for the types of available coatings	C	Si	Mn	P	S
Steel name	Steel number						
S220GD	1.0241	+Z,+ZF,+ZA,+ZM,+AZ	0,20	0,60	1,70	0,10	0,045
S250GD	1.0242	+Z,+ZF,+ZA,+ZM,+AZ,+AS					
S280GD	1.0244	+Z,+ZF,+ZA,+ZM,+AZ,+AS					
S320GD	1.0250	+Z,+ZF,+ZA,+ZM,+AZ,+AS					
S350GD	1.0529	+Z,+ZF,+ZA,+ZM,+AZ,+AS					
S390GD	1.0238	+Z,+ZF,+ZA,+ZM,+AZ					
S420GD	1.0239	+Z,+ZF,+ZA,+ZM,+AZ					
S450GD	1.0233	+Z,+ZF,+ZA,+ZM,+AZ					
S550GD	1.0531	+Z,+ZF,+ZA,+ZM,+AZ					
By agreement at the time of enquiry and order, if other chemical elements are added, they shall be mentioned on the inspection document which may need a change of classification.							

Table 3 — Chemical composition (cast analysis) of steels with high proof strength for cold forming

Designation			Chemical composition % by mass							
Steel grade		Symbols for the types of available coatings	C max.	Si max.	Mn max.	P max.	S max.	Al_{total}	Nb max.	Ti max.
Steel name	Steel number									
HX160YD	1.0910	+Z,+ZF,+ZA, +ZM,+AZ,+AS	0,01	0,30	0,60	0,060	0,025	≥ 0,010	0,09	0,12
HX180YD	1.0921		0,01	0,30	0,70	0,060	0,025	≥ 0,010	0,09	0,12
HX180BD	1.0914		0,06	0,50	0,70	0,060	0,025	≥ 0,015	0,09	0,12
HX220YD	1.0923		0,01	0,30	0,90	0,080	0,025	≥ 0,010	0,09	0,12
HX220BD	1.0919		0,08	0,50	0,70	0,085	0,025	≥ 0,015	0,09	0,12
HX260YD	1.0926		0,01	0,30	1,60	0,10	0,025	≥ 0,010	0,09	0,12
HX260BD	1.0924		0,10	0,50	1,00	0,10	0,030	≥ 0,010	0,09	0,12
HX260LAD	1.0929		0,11	0,50	1,00	0,030	0,025	≥ 0,015	0,09	0,15
HX300YD	1.0927		0,015	0,30	1,60	0,10	0,025	≥ 0,010	0,09	0,12
HX300BD	1.0930		0,11	0,50	0,80	0,12	0,025	≥ 0,010	0,09	0,12
HX300LAD	1.0932		0,12	0,50	1,40	0,030	0,025	≥ 0,015	0,09	0,15
HX340BD	1.0945		0,11	0,50	0,80	0,12	0,025	≥ 0,010	0,09	0,12
HX340LAD	1.0933		0,12	0,50	1,4	0,030	0,025	≥ 0,015	0,10	0,15
HX380LAD	1.0934		0,12	0,50	1,5	0,030	0,025	≥ 0,015	0,10	0,15
HX420LAD	1.0935		0,12	0,50	1,6	0,030	0,025	≥ 0,015	0,10	0,15
HX460LAD	1.0990		0,15	0,50	1,7	0,030	0,025	≥ 0,015	0,10	0,15
HX500LAD	1.0991		0,15	0,50	1,7	0,030	0,025	≥ 0,015	0,10	0,15

Table 4 — Chemical composition (cast analysis) of multiphase steels for cold forming (cold rolled products)

Designation			Chemical composition % by mass									
Steel grade		Symbols for the types of available coatings	C	Si	Mn	P	S	Al_{total}	Cr + Mo	Nb + Ti	V	B
Steel name	Steel number		max.	max.	max.	max.	max.		max.	max.	max.	max.
dual-phase steels (X)												
HCT 450X	1.0937	+Z,+ZF, +ZA,+ZM	0,14	0,75	2,00	0,080	0,015	0,015 to 1,0	1,00	0,15	0,20	0,005
HCT 490X	1.0995	+Z,+ZF, +ZA,+ZM	0,14	0,75	2,00	0,080	0,015	0,015 to 1,0	1,00	0,15	0,20	0,005
HCT 590X	1.0996	+Z,+ZF, +ZA,+ZM	0,15	0,75	2,50	0,040	0,015	0,015 to 1,5	1,40	0,15	0,20	0,005
HCT 780X	1.0943	+Z,+ZF, +ZA,+ZM	0,18	0,80	2,50	0,080	0,015	0,015 to 2,0	1,40	0,15	0,20	0,005
HCT 980X	1.0944	+Z,+ZF, +ZA,+ZM	0,20	1,00	2,90	0,080	0,015	0,015 to 2,0	1,40	0,15	0,20	0,005
HCT 980XG [a]	1.0997	+Z,+ZF, +ZA,+ZM	0,23	1,00	2,90	0,080	0,015	0,015 to 2,0	1,40	0,15	0,20	0,005
transformation induced plasticity steels (T)												
HCT 690T	1.0947	+Z,+ZF, +ZA, +ZM	0,24	2,00	2,20	0,080	0,015	0,015 to 2,0	0,60	0,20	0,20	0,005
HCT 780T	1.0948	+Z,+ZF, +ZA, +ZM	0,25	2,20	2,50	0,080	0,015	0,015 to 2,0	0,60	0,20	0,20	0,005
complex-phase steels (C)												
HCT 600C	1.0953	+Z,+ZF, +ZA, +ZM	0,18	0,80	2,20	0,080	0,015	0,015 to 2,0	1,00	0,15	0,20	0,005
HCT 780C	1.0954	+Z,+ZF, +ZA, +ZM	0,18	1,00	2,50	0,080	0,015	0,015 to 2,0	1,00	0,15	0,20	0,005
HCT 980C	1.0955	+Z,+ZF, +ZA, +ZM	0,23	1,00	2,70	0,080	0,015	0,015 to 2,0	1,00	0,15	0,22	0,005

[a] XG means dual-phase steel with increased yield strength.

Table 5 — Chemical composition (cast analysis) of multiphase steels for cold forming (hot rolled products)

Designation			Chemical composition % by mass									
Steel grade		Symbols for the types of available coatings	C	Si	Mn	P	S	Al_{total}	Cr + Mo	Nb + Ti	V	B
Steel name	Steel number		max.	max	max.	max.	max.		max.	max.	max.	max.
ferritic-bainitic steels (F)												
HDT450F	1.0961	+Z,+ZF, +ZM	0,18	0,50	2,00	0,050	0,010	0,015 to 2,0	1,00	0,15	0,15	0,005
HDT580F	1.0994	+Z,+ZF, +ZM	0,18	0,50	2,00	0,050	0,010	0,015 to 2,0	1,00	0,15	0,15	0,01
dual-phase steel (X)												
HDT580X	1.0936	+Z,+ZF, +ZM	0,14	1,0	2,20	0,085	0,015	0,015 to 1,0	1,40	0,15	0,20	0,005
complex-phase steels (C)												
HDT750C	1.0956	+Z,+ZF, +ZM	0,18	0,80	2,20	0,080	0,015	0,015 to 2,0	1,00	0,15	0,20	0,005
HDT760C	1.0998	+Z,+ZF, +ZM	0,18	1,00	2,50	0,080	0,015	0,015 to 2,0	1,00	0,25	0,20	0,005
HDT950C	1.0958	+Z,+ZF, +ZM	0,25	0,80	2,70	0,080	0,015	0,015 to 2,0	1,20	0,25	0,30	0,005

Table 6 — Permissible deviations of the product analysis from specified limits on cast analysis given in Tables 1 to 5

Element	Specified limit of the cast analysis in Tables 1 to 5 % by mass	Permissible deviation of the product analysis % by mass
C	≤ 0,32	+ 0,02
Si	≤ 0,60	+ 0,03
	> 0,60 ≤ 0,80	+ 0,05
	> 0,80 ≤ 2,20	+ 0,10
Mn	≤ 2,90	+ 0,10
P	≤ 0,12	+ 0,01
S	≤ 0,015	+ 0,003
	> 0,015 ≤ 0,045	+ 0,005
Al_{total}	≥ 0,010	- 0,005
	≤ 2,00	+ 0,10
Cr + Mo	≤ 1,40	+ 0,05
Nb	≤ 0,09	+ 0,02
Ti	≤ 0,15	+ 0,02
Nb + Ti	≤ 0,25	+ 0,02
V	≤ 0,30	+ 0,02
B	≤ 0,005	+ 0,001

7.2 Mechanical properties

7.2.1 General

7.2.1.1 The tensile test values apply to test piece cross-section without coating, in the test direction given in Tables 7 to 11 and 7.2.5.2.

7.2.1.2 The strain ratio *r* (see Tables 7 and 9) and the strain hardening exponent *n* (see Tables 7 and 9 to 11) shall be determined in the range of homogeneous deformation, within the strain range of 10 % to 20 %.

The uniform elongation A_g of the material to be tested may be lower than 20 %. In this case the uniform elongation A_g represents the upper limit of the strain range, and the lower limit of the strain range shall be agreed at the time of enquiry and order.

7.2.1.3 The specified mechanical properties (and freedom from stretcher strains for surface quality B or C, see 7.5.2 and 7.8) apply for following steel grades and periods commencing from the agreed date on which the products are made available:

a) Mechanical properties:

1) 1 month for steel grades DX51D, DX52D and DX53D and for the steel grades for construction;

2) 3 months for bake-hardening steels and multiphase steels;

3) 6 months for steel grades DX54D, DX55D, DX56D and DX57D and high strength steels, except bake hardening steels.

b) Freedom from stretcher strains for surface quality B or C:

1) 3 months for bake-hardening steels, if storage temperature is below 50°C;

2) 6 months for steel grades DX54D, DX55D, DX56D and DX57D and interstitial free steels;

3) no requirement for a fixed period for all other steels.

7.2.2 Low carbon steels for cold forming

7.2.2.1 The products shall comply with the requirements in Table 7.

7.2.2.2 If so agreed at the time of enquiry and order, products specified in Table 7, 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 7 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.

Table 7 — Mechanical properties (transverse direction) of low carbon steels for cold forming

Designation			Yield strength	Tensile strength	Elongation	Plastic strain ratio	Strain hardening exponent
Steel grade		Symbols for the types of available coatings	R_e[a] MPa[g]	R_m MPa[g]	A_{80}[b] % min.	r_{90} min.	n_{90} min.
Steel name	Steel number						
DX51D	1.0917	+Z,+ZF,+ZA,+ZM,+AZ,+AS,	–	270 to 500	22	–	–
DX52D	1.0918	+Z,+ZF,+ZA,+ZM +AZ,+AS	140 to 300[c]	270 to 420	26	–	–
DX53D	1.0951	+Z,+ZF,+ZA,+ZM +AZ,+AS	140 to 260	270 to 380	30	–	–
DX54D	1.0952	+Z,+ZA	120 to 220	260 to 350	36	1,6[d]	0,18
DX54D	1.0952	+ZF,+ZM	120 to 220	260 to 350	34	1,4[d]	0,18
DX54D	1.0952	+AZ	120 to 220	260 to 350	36	–	–
DX54D	1.0952	+AS	120 to 220	260 to 350	34	1,4[d, e]	0,18[e]
DX55D[f]	1.0962	+AS	140 to 240	270 to 370	30	–	–
DX56D	1.0963	+Z,+ZA	120 to 180	260 to 350	39	1,9[d]	0,21
DX56D	1.0963	+ZF,+ZM	120 to 180	260 to 350	37	1,7[d, e]	0,20[e]
DX56D	1.0963	+AZ, +AS	120 to 180	260 to 350	39	1,7[d, e]	0,20[e]
DX57D	1.0853	+Z, +ZA	120 to 170	260 to 350	41	2,1[d]	0,22
DX57D	1.0853	+ZF,+ZM	120 to 170	260 to 350	39	1,9[d, e]	0,21[e]
DX57D	1.0853	+AS	120 to 170	260 to 350	41	1,9[d, e]	0,21[e]

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 Decreased minimum elongation values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 2 units),
0,35mm < t ≤ 0,50mm (minus 4 units) and
t ≤ 0,35mm (minus 7 units) .

c For surface quality A, the upper value for yield strength R_e is 360 MPa.

d Decreased minimum r_{90}-values apply for product thickness
1,5mm < *t* < 2 mm (minus 0,2)
t ≥ 2 mm (minus 0,4)

e Decreased minimum r_{90}-values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 0,2),
0,35mm < t ≤ 0,50mm (minus 0,4) and
t ≤ 0,35mm (minus 0,6) apply.
Decreased minimum n_{90}-values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 0,01),
0,35mm < t ≤ 0,50mm (minus 0,03) and
t ≤ 0,35mm (minus 0,04) apply.

f The minimum elongation of products made of DX55D+AS which does not follow the systematic order should be noted. DX55D+AS is chararacterized by the best heat resistance.

g 1 MPa = 1 N/mm^2.

7.2.3 Steels for construction

The products shall comply with the requirements in Table 8.

Table 8 — Mechanical properties (longitudinal direction) of steels for construction

Designation			Mechanical properties		
Steel grade		Symbols for the types of available coatings	Proof strength $R_{p0,2}$[a] MPa[d] min.	Tensile strength R_m[b] MPa[d] min.	Elongation A_{80}[c] % min.
Steel name	Steel number				
S220GD	1.0241	+Z,+ZF,+ZA, +ZM, +AZ	220	300	20
S250GD	1.0242	+Z,+ZF,+ZA, +ZM, +AZ,+AS	250	330	19
S280GD	1.0244	+Z,+ZF,+ZA, +ZM, +AZ,+AS	280	360	18
S320GD	1.0250	+Z,+ZF,+ZA, +ZM, +AZ,+AS	320	390	17
S350GD	1.0529	+Z,+ZF,+ZA, +ZM, +AZ,+AS	350	420	16
S390GD	1.0238	+Z,+ZF,+ZA, +ZM, +AZ	390	460	16
S420GD	1.0239	+Z,+ZF,+ZA, +ZM, +AZ	420	480	15
S450GD	1.0233	+Z,+ZF,+ZA, +ZM, +AZ	450	510	14
S550GD	1.0531	+Z,+ZF,+ZA,+ZM, +AZ	550	560	–

a If the yield point is pronounced, the values apply to the upper yield point R_{eH}.

b For all grades except S550GD, a range of 140 MPa can be expected for tensile strength.

c Decreased minimum elongation values apply for product thickness:
0,50mm < t ≤ 0,70mm (minus 2 units),
0,35mm < t ≤ 0,50mm (minus 4 units);
and t ≤ 0,35mm (minus 7 units).

d 1 MPa = 1 N/mm^2.

7.2.4 Steels with high proof strength for cold forming

7.2.4.1 The products shall comply with the requirements in Table 9.

7.2.4.2 If so agreed at the time of enquiry and order, products with suitability for manufacturing a specific part can be supplied. In this case the values in Table 9 do not apply. The reject tolerances arising when the material is processed shall not exceed a specific proportion to be agreed upon at the time of enquiry and order.

Table 9 — Mechanical properties (transverse direction) of steels with high proof strength for cold forming

Designation			Proof strength $R_{p0,2}$[a] MPa[f]	Bake-Hardening Index BH_2 MPa[f]	Tensile strength R_m MPa[f]	Elongation A_{80}[b, c] %	Plastic strain ratio r_{90}[c, d, e]	Strain hardening exponent n_{90}[e]
Steel grade		Symbols for the types of available coatings						
Steel name	Steel number			min.		min.	min.	min.
HX160YD	1.0910	+Z, +ZF, +ZA, +ZM, +AZ, +AS	160 to 220	–	300 to 360	37	1,9	0,20
HX180YD	1.0921		180 to 240	–	330 to 390	34	1,7	0,18
HX180BD	1.0914		180 to 240	30	290 to 360	34	1,5	0,16
HX220YD	1.0923		220 to 280	–	340 to 420	32	1,5	0,17
HX220BD	1.0919		220 to 280	30	320 to 400	32	1,2	0,15
HX260YD	1.0926		260 to 320	–	380 to 440	30	1,4	0,16
HX260BD	1.0924		260 to 320	30	360 to 440	28	–	–
HX260LAD	1.0929		260 to 330	–	350 to 430	26	–	–
HX300YD	1.0927		300 to 360	–	390 to 470	27	1,3	0,15
HX300BD	1.0930		300 to 360	30	400 to 480	26	–	–
HX300LAD	1.0932		300 to 380	–	380 to 480	23	–	–
HX340BD	1.0945		340 to 400	30	440 to 520	24	–	–
HX340LAD	1.0933		340 to 420	–	410 to 510	21	–	–
HX380LAD	1.0934		380 to 480	–	440 to 560	19	–	–
HX420LAD	1.0935		420 to 520	–	470 to 590	17	–	–
HX460LAD	1.0990		460 to 560	–	500 to 640	15	–	–
HX500LAD	1.0991		500 to 620	–	530 to 690	13	–	–

a If the yield strength is pronounced, the values apply to the lower yield point R_{eL}.

b Decreased minimum elongation values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 2 units),
0,35mm < t ≤0,50mm (minus 4 units) and
t ≤ 0,35mm (minus 7 units).

c For AS-, AZ-, ZF- and ZM- coatings, the minimum A_{80} value reduced by 2 units and the minimum r_{90}-value reduced by 0,2 apply.

d Decreased minimum r_{90}-values apply for product thickness
1,5 < *t* < 2 mm (minus 0,2)
t ≥ 2 mm (minus 0,4)

e Decreased minimum r_{90}-values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 0,2),
0,35mm < t ≤ 0,50mm (minus 0,4) and
t ≤ 0,35mm (minus 0,6)
Decreased minimum n_{90}-values apply for product thickness
0,50mm < t ≤ 0,70mm (minus 0,01),
0,35mm < t ≤ 0,50mm (minus 0,03) and
t ≤ 0,35mm (minus 0,04)

f 1 MPa = 1 N/mm^2.

7.2.5 Multiphase steels for cold forming

7.2.5.1 The products shall comply with the requirements in Table 10 or Table 11.

7.2.5.2 The values for the tensile test apply for longitudinal pieces. If ordered in accordance with 7.2.5.1, the mechanical property values in Tables 10 and 11 apply for a period of three months for all grades commencing from the date on which the products are made available by the manufacturer.

Table 10 — Mechanical properties (longitudinal direction) of multiphase steels for cold forming (cold rolled products)

Steel grade +Z, +ZF, +ZA, +ZM		Proof strength	Tensile strength	Elongation	Strain hardening exponent	Bake hardening index
		$R_{p\,0,2}$	R_m	A_{80}[b,c]	$n_{10\text{-}UE}$	BH_2
Steel name	Steel number	MPa[a]	MPa[a]	%		MPa[a]
			min.	min.	min.	min.
dual-phase steels (X)						
HCT450X	1.0937	260 to 340	450	27	0,16	30
HCT490X	1.0995	290 to 380	490	24	0,15	30
HCT590X	1.0996	330 to 430	590	20	0,14	30
HCT780X	1.0943	440 to 550	780	14	—	30
HCT980X	1.0944	590 to 740	980	10	—	30
HCT980XG[d]	1.0997	700 to 850	980	8	—	30
transformation induced plasticity steels (T)						
HCT690T	1.0947	400 to 520	690	23	0,19	40
HCT780T	1.0948	450 to 570	780	21	0,16	40
complex-phase steels (C)						
HCT600C	1.0953	350 to 500	600	16	—	30
HCT780C	1.0954	570 to 720	780	10	—	30
HCT980C	1.0955	780 to 950	980	6	—	30

a 1 MPa = 1 N/mm^2.

b Decreased minimum elongation values apply for product thickness t < 0,60 mm (minus 2 units)

c For ZF coatings the minimum elongation value reduced by 2 units applies. For ZF coatings in product thickness t < 0,60 mm, the minimum elongation value reduced by 4 units applies.

d XG means dual-phase with increased yield strength.

Table 11 — Mechanical properties (longitudinal direction) of multiphase steels for cold forming (hot rolled products)

Steel grade +Z, +ZF, +ZM		Proof strength	Tensile strength	Elongation	Strain hardening exponent
		$R_{p\,0,2}$	R_m	A_{80}	$n_{10\text{-}UE}$
Steel name	**Steel number**	MPa[a]	MPa[a]	%	%
			min.	min.	min.
ferritic-bainitic steels (F)					
HDT450F	1.0961	300 to 420	450	24	—
HDT580F	1.0994	460 to 620	580	15	—
dual-phase steel (X)					
HDT580X	1.0936	330 to 450	580	19	0,13
complex-phase steels (C)					
HDT750C	1.0956	620 to 760	750	10	—
HDT760C	1.0998	660 to 830	760	10	—
HDT950C	1.0958	720 to 950	950	9	—
a 1 MPa = 1 N/mm^2.					

7.3 Type of coatings and coating mass

7.3.1 The products shall be supplied with coatings of zinc (Z), zinc-iron-alloy (ZF), zinc-aluminium-alloy (ZA), zinc-magnesium-alloy (ZM), aluminium-zinc-alloy (AZ) or aluminium-silicon-alloy (AS) as specified in the relevant Table 1, 2, 3, 4 or 5.

7.3.2 The available coating masses are given in Table 12. 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 surfaces may have a different appearance as a result of the manufacturing process.

Table 12 — Coating mass

Coating designation	Minimum total coating mass[a], both surfaces g/m^2		Theoretical guidance values for coating thickness per surface in the single spot test µm		Density g/cm^3
	Triple spot test	Single spot test	Typical value[b]	Range	
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	13 to 27	
Z350[c]	350	300	25	17 to 33	
Z450[c]	450	385	32	22 to 42	
Z600[c]	600	510	42	29 to 55	
Zinc-iron coating masses (ZF)					
ZF100	100	85	7	5 to 12	7,1
ZF120	120	100	8	6 to 13	
Zinc-aluminium alloy coating masses (ZA)					
ZA095	95	80	7	5 to 12	6,6
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[c]	300	255	23	17 to 31	
Zinc-magnesium alloy coating masses (ZM)					
ZM060	60	50	4,5	4 to 8	6,2 to 6,6[d]
ZM070	70	60	5,5	4 to 8	
ZM080	80	70	6	4 to 10	
ZM090	90	75	7	5 to 10	
ZM100	100	85	8	5 to 11	
ZM120	120	100	9	6 to 14	
ZM130	130	110	10	7 to 15	
ZM140	140	120	11	8 to 16	
ZM150	150	130	11,5	8 to 17	

Coating designation	Minimum total coating mass[a], both surfaces g/m^2		Theoretical guidance values for coating thickness per surface in the single spot test µm		Density g/cm^3
	Triple spot test	Single spot test	Typical value[b]	Range	
Zinc-magnesium alloy coating masses (ZM)					
ZM160[c]	160	130	12	8 to 17	6,2 to 6,6[d]
ZM175[c]	175	145	13	9 to 18	
ZM190 [c]	190	160	15	10 to 20	
ZM200[c]	200	170	15	10 to 20	
ZM250[c]	250	215	19	13 to 25	
ZM300[c]	300	255	23	17 to 30	
ZM310[c]	310	265	24	18 to 31	
ZM350[c]	350	300	27	19 to 33	
ZM430[c]	430	365	35	26 to 46	
Aluminium-zinc alloy coating masses (AZ)[e]					
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)[e]					
AS 060	60	45	10	7 to 15	3,0
AS 080	80	60	14	10 to 20	
AS 100[c]	100	75	17	12 to 23	
AS 120[c]	120	90	20	15 to 27	
AS 150[c]	150	115	25	19 to 33	

[a] See 7.9.

[b] Coating thicknesses can be calculated from the coating masses (see 7.9). Thickness values obtained from calculations are for information only.

[c] Only steel grades in accordance with Tables 7 and 8 and LAD steel grades in accordance with Table 9.

[d] For determination of the thickness of ZM coatings, a density of 6,2 to 6,6 g/cm³ can be used as orientation value for calculations (see also 3.4, NOTE).

[e] Not for multiphase steels.

7.4 Coating finish

7.4.1 General

Possible coating finishes are given in Tables 13 to 15 for the relevant types of coating.

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 spangle (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 7.4.2.1) does not satisfy the surface appearance requirements.

7.4.3 Zinc-iron alloy coated products (ZF)

The regular zinc-iron alloy coating 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 Zinc-magnesium coated products (ZM)

Due to the normal solidification of the coating, the surface has a uniform metallic appearance and may be slightly matt to bright. It may also show variations in appearance and a tendency to darkening.

7.4.6 Aluminium-zinc coated products (AZ)

The products are supplied with a normal spangle. Normal spangle is a coating finish, having a metallic lustre, which 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.

7.4.7 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 (see Tables 13 to 15).

Table 13 — Available coatings, finishes and surface qualities for zinc coatings (Z)

Coating designation[a]	N	M		
	Surface quality[a]			
	A	A	B	C
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)	(X)	–
(Z450)	(X)	(X)	–	–
(Z600)	(X)	(X)	–	–

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

Table 14 — Available coatings, finishes and surface qualities for zinc-iron alloy coatings (ZF)

Coating designation	Surface quality		
	A	B	C
ZF100	X	X	X
ZF120	X	X	X

Table 15 — Available coatings, finishes and surface qualities for zinc-aluminium coatings (ZA), zinc-magnesium coatings (ZM), aluminium-zinc coatings (AZ) and aluminium-silicon coatings (AS)

Coating designation	Surface quality[a]		
	A	B	C
Zinc-aluminium coatings (ZA)			
ZA095	X	X	X
ZA130	X	X	X
ZA185	X	X	X
ZA200	X	X	X
ZA255	X	X	X
ZA300	X	–	–
Zinc-magnesium coatings (ZM)			
ZM060	X	X	X
ZM070	X	X	X
ZM080	X	X	X
ZM090	X	X	X
ZM100	X	X	X
ZM120	X	X	X
ZM130	X	X	X
ZM140	X	X	X
ZM150	X	X	X
(ZM160)	(X)	(X)	(X)
(ZM175)	(X)	(X)	(X)
(ZM200)	(X)	(X)	(X)
(ZM250)	(X)	(X)	(X)
(ZM300)	(X)	(X)	(X)
(ZM310)	(X)	(X)	(X)
(ZM350)	(X)	(X)	(X)
(ZM430)	(X)	(X)	(X)
Aluminium-zinc coatings (AZ)			
AZ100	X	X	X
AZ150	X	X	X
AZ185	X	X	X
Aluminium-silicon coatings (AS)			
AS 060	X	X	(X)
AS 080	X	X	X
AS 100	X	X	X
AS 120	X	X	(X)
AS 150	X	(X)	(X)

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

7.5.2 Types of surface qualities

7.5.2.1 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. As coated surface (A) may be delivered with or without skin passing at the discretion of the manufacturer.

7.5.2.2 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 at the time of enquiry and order, hot-dip aluminium-silicon coated products (AS) may be supplied with a bright appearance. In that case the surface is of type "B".

7.5.2.3 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 7.5.2.2).

NOTE For aluminium-silicon coated products (AS) small uncoated spots (< 1 mm Ø) can not be totally excluded. This product can not be used for exterior applications in the car manufacture.

7.5.3 Roughness

A range for surface roughness (*R*a values) and their verification may be agreed at the time of enquiry and order. This does not apply for the non-skin passed condition (surface quality A).

7.6 Surface treatment (surface protection)

7.6.1 General

At the time of enquiry and order one of the following surface treatment conditions shall be agreed:

- chemically passivated C
- oiled O
- chemically passivated and oiled CO
- phosphate P
- phosphated and oiled PO
- sealed S

NOTE 1 The effect of the surface protection "oiled“ especially depends on the temporary impact by storage and transport (see 6.2.3).

The products are only supplied without surface treatment (untreated (U)) if expressively desired by the purchaser on his own responsibility (see also NOTE 2 at the end of this sub-clause).

Usually the products are supplied chemically passivated and/or oiled. In the case of oiling, both sides are corrosion protected by a layer of neutral non-drying oil, free of impurities and uniformly spread. Under normal packing, transportation, loading and storage conditions, there will be no corrosion for up to three months starting from the date when the product is available at the manufacturer's work. However the period of protection afforded depends on the atmospheric and storage conditions.

The layer of oils shall be capable of being removed by alkaline solutions or usual solvents. The choice of protective oils may be agreed at the time of enquiry and order.

If the purchaser does not require the surfaces to be oiled and/or chemically passivated, this shall be clearly indicated at the time of enquiry and order.

If the conditions of transportation or storage are such that special protection against corrosion is required, the purchaser shall inform the manufacturer accordingly at the time of enquiry and order.

NOTE 2 In the case of orders for non-protected products, the manufacturer is not responsible for the risk of corrosion. The purchaser is also advised that there is a greater risk of the appearance of scratches during handling, transportation and application.

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 are permissible and do 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 Phosphating (P)

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

The combination of phosphating and oiling (PO) may improve formability.

7.6.6 Sealing (S)

Sealing consists in adding an 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, 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.

7.7 Coil breaks and bends (kinks)

7.7.1 Freedom from coil breaks

If particular requirements for freedom from coil breaks (fluting) are agreed at the time of enquiry and order, it is recommended to order improved surface quality B (see 7.5.2.2).

7.7.2 Bends (kinks) by winding on coiler drums

For the thickness of the strips ≥ 0,90 mm bends (kinks) shall be expected due to winding the strip on the coiler drum. When processing, appropriate equipment for levelling (with small diameter rolls) has to be used.

7.8 Stretcher strains

In order to avoid the formation of stretcher strains when cold forming, it is recommended to order improved surface quality B (see 7.5.2.2). 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.

7.9 Coating mass

The coating mass shall correspond to the data in Table 12. 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 8.5.5).

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 12 for the single spot test exists on each surface of the product.

A maximum or minimum value for the coating mass per surface of the product (single spot test) for each coating given in Table 12 may be agreed at the time of enquiry and order.

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

A zinc coating mass of 100 g/m^2 on both surfaces corresponds to a zinc coating thickness of about 7,0 µm per surface.

$$\frac{m_z}{2d} = t_z \qquad (1)$$

m_z = zinc coating mass on both surfaces (g/m^2)

d = zinc density (g/cm^3)

t_z = zinc coating thickness (µ*m* per surface)

For other coatings similar calculations may be applied (see Table 12).

7.10 Adhesion of coating

The adhesion of the coating shall be tested by using an appropriate method. The selection of the test method is left to the discretion of the manufacturer.

7.11 Surface condition

7.11.1 The surface shall comply with the requirements in 7.4 to 7.6.

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 document (except products made of the grade S550GD) 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 suitability for use will depend on the coating finish (see 7.4).

8 Inspection

8.1 Types of inspection and inspection documents

8.1.1 Unless otherwise specified at the time of enquiry and order (see 8.1.2 and 8.1.3), the products shall be delivered with non-specific inspection without inspection document.

8.1.2 Specific testing in accordance with the requirements in 8.2 to 8.6 may be specified at the time of enquiry and order.

8.1.3 The type of inspection document to be delivered in accordance with EN 10204:2004, if requested for non-specific inspection (inspection document 2.1 or 2.2) or mandatory to be delivered for specific inspection (inspection document 3.1 or 3.2), shall be specified at the time of enquiry and order.

If an inspection certificate 3.2 is specified, the purchaser shall notify the manufacturer of the name and address of the organization or person who is to carry out the inspection and produce the inspection document. It shall also be agreed which party shall issue the certificate.

8.2 Test units

The test unit consists of a maximum 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 Tests to be carried out

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 Tables 7, 9, 10 or 11 (see 8.5.2);

— the Bake-Hardening Index BH_2, if specified in Tables 9 or 10 (see 8.5.3);

— the coating mass (see 8.5.5).

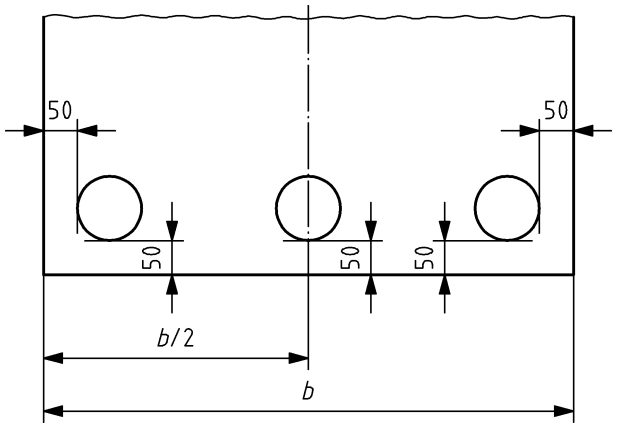
By agreement at the time of enquiry and order, the manufacturer may determine the tensile properties and/or the Bake-Hardening Index BH_2 and/or the coating mass by calculation in accordance with an approved method.

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 specified direction (see Tables 7, 8, 9, 10 and 11) 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 8.5.5) 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 12.

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 Tensile test

The tensile test shall be carried out as specified in EN ISO 6892-1:2009 (see also 7.2.1.1).

The tensile test is carried out by using test pieces with or without coating at the discretion of the manufacturer.

For products with a thickness less than 3 mm the test piece used (initial gauge length L_0 = 80 mm, width b = 20 mm) shall be of type 2 as described in Annex B of EN ISO 6892-1:2009.

8.5.2 Plastic strain ratio and hardening exponent

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, respectively.

8.5.3 Bake Hardening index

The determination of the yield strength increase by the effect of heat treatment (Bake-Hardening-Index BH_2) shall be carried out in accordance with EN 10325.

8.5.4 Surface inspection

8.5.4.1 The product surface shall be visually inspected for verification of conformance with the requirements in 7.4 to 7.6.

8.5.4.2 Unless otherwise agreed at the time of enquiry and order, only one surface shall be inspected at the manufacturer's works. If requested, the manufacturer shall inform the purchaser whether the inspected surface is the top surface or the bottom surface.

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

8.5.4.3 Roughness (*Ra*) measurements, where applicable (see 7.5.3), shall be carried out in accordance with EN 10049.

8.5.5 Coating mass

8.5.5.1 General

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 12.

Other method - e.g. non-destructive tests which could be in-line measurements - may be used for measurements and reporting.

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

8.5.5.2 Special method for determination of the mass of the Fe-Al-Si alloy layer

If it has been agreed to determine the mass of the Al-Fe-Si alloy layer resulting from aluminium-silicon alloy (AS) coating (see 7.4.7), the method for its determination given in Annex C shall be applied.

8.6 Retests

The requirements of EN 10021:2006 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.

Bar coding according to EN 606 can supplement marking, when the abovementioned minimum information is also given in clear text.

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. Additionally, secure packing, transporting the coils laid flat and avoiding local pressure points, reduce the risk of dark spots.

Annex A
(normative)

Reference method for determination of the zinc, zinc-iron, zinc-aluminium, zinc-magnesium 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

A.2.1 Reagent

A.2.1.1 Hydrochloric acid (HCl ρ_{20} = 1,19 g/ml).

A.2.1.2 Hexamethylenetetramine ($C_6H_{12}N_4$).

A.2.2 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/l 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 (see A.2) 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; 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

B.2.1 Hydrochloric acid (HCl ρ_{20} = 1,19 g/ml).

B.2.2 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 8.4.3 and 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 0,001 g 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 0,001 g).

B.4 Evaluation

$$\frac{m_0 - m_1}{A} \qquad \text{(B.1)}$$

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

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 metres.

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 $SnCl_2 \times H_2O$ 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 Formula (B.1) from the difference in mass of the samples before and after the test.

Annex D
(informative)
Technical changes from the previous edition

D.1 Introduction

This informative annex is intended to guide the user to places where significant changes have been introduced into the previous edition of this European standard. Editorial changes and updating of the normative references are not included in this annex. References refer to this edition.

While this annex is intended to be comprehensive, users should satisfy themselves that they fully understand the changes which have been made. The users are ultimately responsible for recognizing any differences between this edition and the previous edition of the document.

D.2 Technical changes

D.2.1 Change of thickness scope to 0,20 mm ≤ t < 3,0 mm (instead of 0,35 mm to 3 mm).

D.2.2 New metallic coating “+ZM” with 17 different coating masses is introduced. See

3.4;

7.1 (Tables 1 to 5);

7.2.1.1 (Tables 7 to 11);

7.3 (Table 12);

7.4.5;

7.5.1 (Table 15);

8.5.5.1.

D.2.3 Determination of mechanical properties remains “the tensile test values apply to the test piece cross section without coating”, but measurement with coating is allowed. See

7.2.1.1;

8.5.1.

D.2.4 “As coated surface (A)” can be delivered with or without skin-pass. A new Option allows ordering steel without skin-pass. See

5.2, Option 10;

7.5.2.1.

D.2.5 Three new steel grades for construction: S390GD, S420GD and S450GD. See 3.14

7.1 (Table 2);

7.2.3 (Table 8).

D.2.6 Existing multiphase steels for cold forming have their chemical analysis and mechanical properties modified. New multiphase steels for cold forming have been introduced in the standard. This involves HCT490X, HCT590X, HCT980XG, HDT580F, HDT760C.

See the following Tables in the document: Tables 4; 5; 10 and 11 depending on the relevant grade and related properties.

D.2.7 MS steel HDT1200M is deleted from the standard. So the whole steel family of MS steels has disappeared (including their definition in Clause 3)

D.2.8 Determination of mechanical properties is carried out only in longitudinal direction. See

7.2.5.2 (Tables 10 and 11) for cold and hot rolled multiphase steels for cold forming.

D.2.9 Several editorial improvements and correction of errors were performed.

Bibliography

[1] EN 10149-2, *Hot rolled flat products made of high yield strength steels for cold forming - Part 2: Technical delivery conditions for thermomechanically rolled steels*

[2] EN 10152, *Electrolytically zinc coated cold rolled steel flat products for cold forming - Technical delivery conditions*

[3] EN 10169, *Continuously organic coated (coil coated) steel flat products –Technical delivery conditions*

[4] EN ISO 14713-1, *Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 1: General principles of design and corrosion resistance (ISO 14713-1:2009)*

[5] EN ISO 14713-2, *Zinc coatings - Guidelines and recommendations for the protection against corrosion of iron and steel in structures - Part 2: Hot dip galvanizing (ISO 14713-2:2009)*

This page deliberately left blank

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™