BS EN 10338:2015

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Hot rolled and cold rolled non-coated products of multiphase steels for cold forming — Technical delivery conditions

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National foreword

This British Standard is the UK implementation of EN 10338:2015.

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.

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Hot rolled and cold rolled non-coated products of multiphase steels for cold forming - Technical delivery conditions

Produits plats non revêtus laminés à chaud et à froid en aciers multiphasés pour formage à froid - Conditions techniques de livraison

Kaltgewalzte und warmgewalzte Flacherzeugnisse ohne Überzug aus Mehrphasenstählen zum Kaltumformen - Technische Lieferbedingungen

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European foreword

This document (EN 10338:2015) 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of an identical text or by endorsement, at the latest by January 2016, and conflicting national standards shall be withdrawn at the latest by January 2016.

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1 Scope

This European Standard applies to hot rolled and cold rolled non-coated steel flat products made of multiphase steels for cold forming. It covers cold rolled products of thicknesses t < 3 mm and hot rolled products of thicknesses t ≤ 6 mm.

These products are delivered in sheet, wide strip, slit wide strip or cut lengths obtained from slit wide strip.

Flat products of multiphase steels for cold forming may be delivered with an electrolytic zinc coating according to EN 10152.

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 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 10051, *Continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels - Tolerances on dimensions and shape*

EN 10079:2007, *Definition of steel products*

EN 10130, *Cold rolled low carbon steel flat products for cold forming - Technical delivery conditions*

EN 10131, *Cold rolled uncoated and zinc or zinc-nickel electrolytically coated low carbon and high yield strength steel flat products for cold forming - 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 377:2013, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:2013)*

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

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 and EN 10204:2004 and the following apply.

3.1
ferritic-bainitic steel (F)
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.

3.2
dual-phase steel (X)
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.

3.3
transformation induced plasticity steel (T)
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.

3.4
complex-phase steel (C)
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.

3.5
martensitic steel (MS)
steel with a martensitic matrix containing small amounts of ferrite and/or bainite

Note 1 to entry: Within the group of multiphase steels the MS steels show the highest tensile strength level.

3.6
multiphase steel (MP)
steel with a multiphase microstructure containing significant amounts of non-ferritic phases as e.g. bainite, martensite and/or tempered martensite

Note 1 to entry: MP steels are multiphase steels that cannot be considered as ferritic-bainitic, dual-phase, TRIP, complex-phase and martensitic steels (see 3.1 to 3.5).

4 Dimensions and tolerances

The tolerances on dimensions and shape shall be those given in EN 10051 for the hot rolled products and in EN 10131 for the cold rolled products.

5 Classification and designation

5.1 Classification

The steel grades covered by this standard are alloy quality steels in accordance with EN 10020:2000. They shall be classified in accordance with their increasing minimum tensile strength (*R*m) (see Tables 1, 2, 4 and 5).

5.2 Designation

The steel names in this European Standard are in compliance with EN 10027-1; the steel numbers are assigned in accordance with EN 10027-2.

The designation consists of the expression “sheet”, “hot rolled wide strip”, “cold rolled wide strip”, “slit hot rolled wide strip”, “slit cold rolled wide strip”, “hot rolled cut length” or “ cold rolled cut length” followed in order by:

— the reference to this European Standard EN 10338;

— the steel name or number of the steel grade according to Table 1, Table 2, Table 4 and Table 5.

EXAMPLE 1 Hot rolled strip delivered with nominal thickness of 2,00 mm, nominal width of 1500 mm in accordance with EN 10051, made of steel HDT450F (1.0961) in accordance with EN 10338:

Hot rolled strip EN 10051 — 2,00x1500 — steel EN 10338 — HDT450F

or

Hot rolled strip EN 10051 — 2,00x1500 — steel EN 10338 — 1.0961

EXAMPLE 2 Cold rolled strip delivered with nominal thickness of 1,5 mm, nominal width of 1000 mm in accordance with EN 10131, made of steel grade HCT690T (1.0947) in accordance with EN 10338:

Cold rolled strip EN 10131 — 1,5x1000 — steel EN 10338 — HCT690T

or

Cold rolled strip EN 10131 — 1,5x1000 — steel EN 10338 — 1.0947

6 Information to be supplied by the purchaser at the time of enquiry and order

6.1 Mandatory information

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

a) full designation as given in 5.2;

b) quantities to be delivered;

c) nominal dimensions, dimensional standard and, if applicable, symbols denoting relevant special tolerances;

d) if inspection documents are required and their type;

e) if an external inspection is to be carried out at the manufacturer's works;

f) if oiling is not required;

g) limits on mass and sizes of coils or individual bundles.

6.2 Options

A number of options are specified in this standard 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 basic specification of this standard (see 6.1).

a) if the products are to be delivered with mill edges or sheared edges;

b) intended application of the products, including the suitability for surface coatings;

c) if the products are to be welded, indication of the method to be used;

d) if the products are to be supplied as suitable for making a specific part;

e) if other protective coatings are required;

f) detailed description of all other special requirements;

g) any special requirements for packing and marking;

h) if the products are to be supplied skin-passed (for hot rolled products);

i) if the products are to be supplied descaled (for hot rolled products);

j) position of the surface of better quality (for cold rolled products);

k) surface finish (for cold rolled products).

7 Manufacturing process and delivery conditions

7.1 Manufacturing process

Unless otherwise agreed at the time of enquiry or order, the steel manufacturing and production process shall be at the manufacturer's option.

They shall be reported to the purchaser upon request.

7.2 Delivery conditions

7.2.1 The hot rolled products shall usually be delivered with their surface as rolled. By agreement at the time of enquiry and order, the products may be delivered with descaled surface. When they are delivered as rolled, they shall be covered with a thin layer of scale of variable coloration.

The products may be supplied with a light skin-pass, either at the manufacturer’s discretion or by agreement at the time of enquiry and order.

7.2.2 The cold rolled products are normally supplied in the skin-passed condition, however if by agreement at the time of the enquiry and order, non-skin-passed products may be supplied.

7.2.3 The descaled hot rolled and cold rolled products shall usually be delivered oiled or prepared with a dry lubricant. In the first case, both surfaces are preserved by a layer of neutral non-drying product, free of impurities, and uniformly spread in such a way that under normal conditions of packaging, transportation, handling and storage the products will show no corrosion for up to three months from the date on which the products are made available. The date of availability shall be notified to the purchaser with reasonable prior notice compatible with the validity of corrosion resistance.

The oil or dry lubricant shall be capable of being removed by alkaline solutions or normal solvents.

The choice of protective oils or dry lubricants may be the subject of a special agreement 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 at the time of enquiry and order.

If the purchaser does not require the surfaces to be treated, this shall be clearly indicated at the time of enquiry and order.

NOTE If the order is for untreated products, the manufacturer is not responsible for the risk of rust. The purchaser is also advised that there is a greater risk of the appearance of light scratches during handling, transportation and putting into application.

7.2.4 Descaled products may be supplied with trimmed edges upon agreement at the time of enquiry and order (designation GK following EN 10051).

8 Requirements

8.1 Chemical composition

8.1.1 The chemical composition according to the cast analysis shall be as specified in Tables 1 and 2.

8.1.2 If a product analysis is agreed at the time of enquiry and order, the permitted deviations from the cast analysis given in Table 1 and Table 2 shall meet the requirements in Table 3.

Table 1 — Chemical composition (cast analysis) - Hot rolled products

Steel grade		**% by mass**									
Steel name	**Steel number**	C max	Si max	Mn max	P max	S max	Al_{total}	Cr + Mo max	Nb + Ti max	V max	B max
ferritic-bainitic steels (F)											
HDT450F	1.0961	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	0,18	0,50	2,00	0,050	0,010	0,015 to 2,0	1,00	0,15	0,15	0,010
dual-phase steel (X)											
HDT580X	1.0936	0,14	1,0	2,20	0,085	0,015	0,015 to 0,1	1,40	0,15	0,20	0,005
complex-phase steel (C)											
HDT760C	1.0998	0,18	1,00	2,50	0,080	0,015	0,015 to 2,0	1,00	0,25	0,20	0,005
martensitic steel (MS)											
HDT1180G1	1.0960	0,25	0,80	2,50	0,060	0,015	0,015 to 2,0	1,20	0,25	0,22	0,005

Table 2 — Chemical composition (cast analysis) - Cold rolled products

Steel grade		% by mass									
Steel name	**Steel number**	C max	Si max	Mn max	P max	S max	Al_{total}	Cr + Mo max	Nb + Ti max	V max	B max
dual-phase steels (X)											
HCT450X	1.0937	0,14	0,75	2,00	0,080	0,015	0,015 to 1,0	1,00	0,15	0,20	0,005
HCT490X	1.0995	0,14	0,75	2,00	0,080	0,015	0,015 to 1,0	1,00	0,15	0,20	0,005
HCT590X	1.0996	0,15	0,75	2,50	0,040	0,015	0,015 to 1,5	1,40	0,15	0,20	0,005
HCT780X	1.0943	0,18	0,80	2,50	0,080	0,015	0,015 to 2,0	1,40	0,15	0,20	0,005
HCT980X	1.0944	0,20	1,00	2,90	0,080	0,015	0,015 to 2,0	1,40	0,15	0,20	0,005
HCT980XG[a]	1.0997	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)											
HCT690T	1.0947	0,24	2,00	2,20	0,080	0,015	0,015 to 2,0	0,60	0,20	0,20	0,005
HCT780T	1.0948	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)											
HCT600C	1.0953	0,18	0,80	2,20	0,080	0,015	0,015 to 2,0	1,00	0,15	0,20	0,005
HCT780C	1.0954	0,18	1,00	2,50	0,080	0,015	0,015 to 2,0	1,00	0,15	0,20	0,005
HCT980C	1.0955	0,23	1,00	2,70	0,080	0,015	0,015 to 2,0	1,00	0,15	0,22	0,005
multiphase steel (MP)											
HCT1180G2	1.0969	0,23	1,20	2,90	0,080	0,015	0,015 to 1,4	1,20	0,15	0,20	0,005

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

Table 3 — Permissible deviations of the product analysis from specified limits on cast analysis given in Table 1 and Table 2

Element	Specified limit of the cast analysis in Table 1 and Table 2	Permissible deviation of the product analysis
C	≤ 0,25	0/+ 0,02
Si	≤ 0,80	0/+ 0,05
	> 0,80 to ≤ 2,20	0/+ 0,10
Mn	≤ 2,50	0/+ 0,10
	> 2,5 to ≤ 2,9	0/+0,12
P	≤ 0,080	0/+ 0,01
S	≤ 0,015	0/+ 0,003
Al	≤ 2,00	0/+ 0,10
Cr + Mo	≤ 1,40	0/+ 0,06
Nb + Ti	≤ 0,25	0/+ 0,025
V	≤ 0,22	0/+ 0,02
B	≤ 0,01	0/+ 0,001

8.2 Mechanical properties

8.2.1 The mechanical properties of the products shall comply with the requirements of Table 4 or Table 5.

8.2.2 The values for the tensile test apply for longitudinal test pieces.

8.2.3 The strain hardening exponent *n* shall be determined in the range of homogeneous deformation, within the strain range of 10 % to UE (Uniform Elongation) %.

The uniform elongation of the material to be tested may be lower than 20 %. In this case the upper limit of the strain range is the uniform elongation (A_g) and the lower limit of the strain range shall be agreed at the moment of order.

8.2.4 The mechanical properties in Table 4 and Table 5 are valid for 3 months, beginning from the agreed availability by the producer.

Table 4 — Hot rolled products - Mechanical properties

Steel grade		**Proof strength**	**Tensile strength**	**Elongation**		**Strain hardening exponent** $n_{10\text{-}UE}$
		$R_{p\,0,2}$	R_m	A_{80}	A_5 for thickness ≥ 3 mm	
Steel name	**Steel number**	MPa[a]	MPa[a] min.	% min.	% min.	min.
ferritic-bainitic steels (F)						
HDT450F	1.0961	300 to 420	450	24	27	
HDT580F	1.0994	460 to 620	580	15	17	
dual-phase steel (X)						
HDT580X	1.0936	330 to 450	580	19	23	0,13
complex-phase steel (C)						
HDT760C	1.0998	660 to 830	760	10	12	
martensitic steel (MS)						
HDT1180G1	1.0960	900 to 1200	1180	4	5	

[a] 1 MPa = 1 N/mm^2

Table 5 — Cold rolled products - Mechanical properties

Steel grade		Proof strength	Tensile strength	Elongation	Strain hardening exponent	Bake hardening index
		$R_{p\,0,2}$	R_m	A_{80} [b]	$n_{10\,-\,UE}$	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	1.0939	290 to 380	490	24	0,15	30
HCT590X	1.0941	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 [c]	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
multiphase steel (MP)						
HCT1180G2	1.0969	900 to 1150	1180	4	—	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] XG means dual-phase with increased yield strength.

8.3 Surface properties

8.3.1 Hot rolled products

The products shall not have any slivers, blow holes, seams, cracks or scratches which would adversely affect their use.

Pores, small pits, small marks, small scratches, kinks from pay-off reels and a slight coloration are permitted.

The imperfections shall not be of such an extent that they might run the risk of causing failure or damage to tooling or welding difficulties when in use.

The surface quality of the unwound coil is assessed as for sheets. However, the percentage of surface imperfections is generally greater than when supplied in sheets. The maximum percentage of permissible rejections shall be fixed by special agreement at the time of enquiry and order.

8.3.2 Cold rolled products

8.3.2.1 Surface quality

The products are supplied with the surface quality A as defined in EN 10130.

8.3.2.2 Surface finish

The requirements of EN 10130 apply.

8.4 Suitability for surface coating

The products may be intended for metallic coating by hot dipping or electro deposition and/or organic or other coatings. When a coating is required, it shall be specified at the time of order.

8.5 Weldability

The welding process should be specified at the time of enquiry and order, essentially in the case of gas welding. For non-descaled hot rolled products, the welding process shall take into account the presence of a layer of scale.

9 Inspection

9.1 Types of inspection and inspection documents

9.1.1 Unless otherwise specified at the time of enquiry and order (see 9.1.2 and 9.1.3), the products shall be delivered with non-specific inspection without inspection document.

9.1.2 Specific testing in accordance with the requirements in 9.2 to 9.6 may be specified at the time of enquiry and order.

9.1.3 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 organisation 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.

9.2 Test units

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

9.3 Tests to be carried out

One series of tests shall be carried out per test unit as specified in 9.2 to determine:

— the mechanical properties (see 9.5.1);

— the *n*-values, if specified in Table 4 or Table 5 (see 9.5.2);

— the Bake-Hardening Index BH_2, in Table 5 (see 9.5.3).

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

9.4 Sampling

9.4.1 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, sampling shall be in accordance with EN ISO 377:2013.

9.4.2 The sample for the tensile test (see 9.5.1) shall be taken in the specified direction (see 8.2.2) at a distance of at least 50 mm from the edge of the product.

9.4.3 All the samples shall be taken in such a way that the results of the tests are not affected.

9.5 Test methods

9.5.1 Tensile test

The tensile test shall be carried out as specified in EN ISO 6892-1:2009.

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.

For products with a thickness greater than or equal to 3 mm the test piece used is the proportional test piece with an initial gauge length L_0 given by the formula:

$$L_0 = 5{,}65\sqrt{S_0}$$

where

S_0 is the original cross-sectional area of the parallel length of the test piece; the maximum parallel width is 30 mm and the thickness that of the sheet.

Test pieces may be non-proportional but in case of dispute proportional test pieces shall be used.

9.5.2 Strain hardening exponent

The determination of the strain hardening exponent n shall be carried out in accordance with ISO 10275.

9.5.3 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 10325:2006.

9.5.4 Surface inspection

9.5.4.1 The product surface shall be visually inspected for verification of conformance with the requirements in 8.3.

9.5.4.2 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.

9.5.4.3 Roughness (*Ra*) measurements, where applicable shall be carried out in accordance with EN 10049

9.6 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.

10 Marking

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 (see 5.2);

c) nominal dimensions of the product;

d) identification number;

e) order number;

f) mass of the coil or bundle.

Marking of the products by branding may be agreed upon at the time of order.

11 Packing

The packing requirements shall be agreed when ordering.

12 Storage and transportation

Moisture, in particular condensation between the sheets, laps of the coil or other adjacent parts can lead to the formation of corrosion products. As a precaution, the products should be transported and stored dry and protected from moisture.

13 Disputes

With regard to any claims and any action arising from them, EN 10021:2006 shall apply.

Bibliography

[1] CEN/TR 10261, *Iron and steel - European standards for the determination of chemical composition*

[2] EN ISO 14284, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284)*

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