

Bright steel products — Technical delivery conditions —

Part 1: General

ICS 77.140.60

National foreword

This British Standard is the UK implementation of EN 10277-1:2008. It supersedes BS EN 10277-1:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/31, Wrought steels.

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

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2008

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ISBN 978 0 580 52920 7

Amendments/corrigenda issued since publication

Date	Comments

English Version

**Bright steel products - Technical delivery conditions - Part 1:
General**

Produits en acier transformés à froid - Conditions
techniques de livraison - Partie 1: Généralités

Blankstahlerzeugnisse - Technische Lieferbedingungen -
Teil 1: Allgemeines

This European Standard was approved by CEN on 4 February 2008.

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Foreword

This document (EN 10277-1:2008) has been prepared by Technical Committee ECISS/TC 23 "Steels for heat treatment, alloy steels and free-cutting steels - Qualities and dimensions", the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2008, and conflicting national standards shall be withdrawn at the latest by September 2008.

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 10277-1:1999.

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This European Standard EN 10277 'Bright steel products - Technical delivery conditions' is subdivided as follows:

Part 1: General;

Part 2: Steels for general engineering purposes;

Part 3: Free-cutting steels;

Part 4: Case hardening steels;

Part 5: Steels for quenching and tempering.

During the preparation of the first edition of this European Standard there were not enough statistical data available concerning mechanical properties of bright bar products. Since then it has been recognized that the proof strength values in the cold drawn condition were too high. In addition, cyclic stresses that occur during straightening can reduce the proof strength (Bauschinger's effect), which was not taken into account when drafting the first edition of this standard. In this second edition the proof strength values of non-alloy and alloy grades in condition +QT+C in parts 3 and 5 have been adjusted downwards compared to the first edition.

1 Scope

This part of EN 10277 specifies the general technical delivery conditions for bright steel bars in the drawn, turned or ground condition, in straight lengths and of the following steel types:

- a) steels for general engineering purposes as specified in EN 10277-2;
- b) free-cutting steels as specified in EN 10277-3;
- c) case hardening steels as specified in EN 10277-4;
- d) steels for quenching and tempering as specified in EN 10277-5.

It does not cover cold rolled products and cut lengths produced from strip or sheet by cutting.

In special cases variations in these technical delivery requirements or additions to them may form the subject of an agreement at the time of enquiry and order (see Annex B).

In addition to the specifications of this European Standard, the general technical delivery requirements of EN 10021 are applicable, unless otherwise specified.

2 Normative references

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

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

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

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

EN 10021, *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 10052, *Vocabulary of heat treatment terms for ferrous products*

EN 10079:2007, *Definition of steel products*

EN 10083-2, *Steels for quenching and tempering – Part 2: Technical delivery conditions for non alloy steels*

EN 10083-3, *Steels for quenching and tempering – Part 3: Technical delivery conditions for alloy steels*

EN 10084, *Case hardening steels – Technical delivery conditions*

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

prCEN/TR 10261, *Iron and steel - Review of available methods of chemical analysis*

EN 10277-2, *Bright steel products - Technical delivery conditions - Part 2: Steels for general engineering purposes*

EN 10277-3, *Bright steel products - Technical delivery conditions - Part 3: Free-cutting steels*

EN 10277-4, *Bright steel products - Technical delivery conditions - Part 4: Case-hardening steels*

EN 10277-5, *Bright steel products - Technical delivery conditions - Part 5: Steels for quenching and tempering*

EN 10278, *Dimensions and tolerances of bright steel products*

EN ISO 377, *Steel and steel products - Location and preparation of samples and test pieces for mechanical testing (ISO 377:1997)*

EN ISO 643, *Steels - Micrographic determination of the apparent grain size (ISO 643:2003)*

EN ISO 3887, *Steels - Determination of depth of decarburization (ISO 3887:2003)*

EN ISO 6506-1, *Metallic materials - Brinell hardness test - Part 1: Test method (ISO 6506-1:2005)*

EN ISO 14284, *Steel and iron - Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

3 Terms and definitions

For the purposes of this European Standard, the terms and definitions given in EN 10021:2006, EN ISO 377:1997, EN ISO 14284:2002 and the following apply.

3.1

non-alloy and alloy steel; quality and special steel

see the terms and definitions in EN 10020:2000

3.2

steel products

steel products are defined according to their shape and dimensions in EN 10079. In particular the following definitions are reproduced

3.2.1

drawn products (3.4.5.1, EN 10079:2007)

products of various cross section shapes obtained, after descaling, by drawing of hot rolled bars or rod on a draw bench (cold deformation without removing material)

NOTE This operation gives the product special features with respect to shape, dimensional accuracy and surface finish. In addition, the process causes cold working of the product, which can be eliminated by subsequent heat treatment. Products in lengths are delivered straightened regardless of size.

3.2.2

turned products (3.4.5.2, EN 10079:2007)

round bars produced by turning on a lathe where the product can be further processed by straightening and polishing

NOTE 1 This operation gives the bar special features with respect to shape, dimensional accuracy and surface finish. The removal of metal is carried out in such a way that the bright product is generally free from rolling defects and surface decarburization.

NOTE 2 For technical reasons some bars ordered as hot rolled products may be delivered roughly turned (peeled), nevertheless such products are treated as hot rolled products and not as bright products.

3.2.3

ground products (3.4.5.3, EN 10079:2007)

drawn or turned round bars given an improved surface quality and dimensional accuracy by grinding or grinding and polishing

3.3

heat treatment terms

terms used in the heat treatment of steel are defined in EN 10052

3.4

ruling section for heat treatment

ruling section for heat treatment of a product is the section for which the mechanical properties have been specified (see Annex A).

Whatever the actual shape and dimensions of the cross section of the product, the size of its ruling section is expressed as a diameter. This corresponds to the diameter of an "equivalent round bar" which, at the position of its cross section specified for taking test pieces for mechanical tests, will, when being cooled from the austenitising temperature, show the same cooling rate as the actual ruling section of the product concerned at its position for taking test pieces

NOTE The term "ruling section" should not be confused with the term "equivalent diameter" as defined in EN 10052.

4 Classification and designation

4.1 Classification

The classification of the relevant steel grades according to EN 10020 is indicated in EN 10277-2 to EN 10277-5.

4.2 Designation

4.2.1 Steel names

For the steel grades covered by this European Standard, the steel names as given in the relevant tables of EN 10277-2 to EN 10277-5 are assigned in accordance with EN 10027-1.

4.2.2 Steel numbers

For the steel grades covered by this European Standard, the steel numbers as given in the relevant tables of EN 10277-2 to EN 10277-5 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 (mass, number of bars) to be delivered;
- b) shape of the product (e.g. round, hexagon, square, flat);
- c) number of the dimensional standard (EN 10278);
- d) dimensions and tolerances on dimensions;

- e) reference to this European Standard including the number of the part (e.g. EN 10277-3);
- f) steel name or steel number (see 4.2);
- g) delivery condition (see 6.3);
- h) class of surface quality (see 7.7 and Table 1);

5.2 Options

The following options may be supplied by the purchaser and as agreed with the manufacturer:

- a) reference testing for products used in the quenched and tempered condition (see B.1);
- b) any fine grain requirement and verification of fine grain size (see 7.4 and B.2);
- c) any requirement for the verification of non-metallic inclusions (see 7.5 and B.3);
- d) depth of decarburization (see 7.6 and B.4);
- e) additional requirements to the tolerances on shape according to EN 10278;
- f) temporary corrosion protection (see B.5);
- g) non-destructive testing (see 7.8 and B.6);
- h) product analysis (see 7.1.2 and B.7);
- i) special marking (see 9 and B.8);
- j) hardenability requirements for grades of EN 10277-4 and EN 10277-5 (see 7.1.1.2 and 7.3 of EN 10277-4 and EN 10277-5);
- k) type of inspection document in accordance with EN 10204 (see 8.1).

EXAMPLE

2 t round bars with nominal diameter 20 mm, tolerance h9, stock length 6000 mm according to EN 10278 made of steel grade 38SMn28 (1.0760) according to EN 10277-3 in the delivery condition +C, surface quality class 3 and a test report 2.2 as specified in EN 10204.

2t round bars EN 10278 - 20 h9 x stock 6000
 EN 10277-3-38SMn28+C - class 3
 EN 10204 – 2.2

or

2t round bars EN 10278 - 20 h9 x stock 6000
 EN 10277-3-1.0760+C - class 3
 EN 10204 – 2.2

6 Manufacturing process

6.1 Steel making process

The steelmaking process shall be at the manufacturer's discretion.

6.2 Manufacture of the product

The manufacturing process route of the steel product shall be at the manufacturer's discretion.

6.3 Delivery conditions

6.3.1 Finished condition

The steel product shall be delivered in one or a combination of the following finished conditions with or without heat treatment:

- a) drawn, symbol +C;
- b) turned, symbol +SH;
- c) ground, symbol +SL.

6.3.2 Cast separation

The products shall be delivered separated by cast.

7 Requirements

7.1 Chemical composition

7.1.1 Cast analysis

7.1.1.1 The chemical composition determined by cast analysis shall be as specified in Table 1 of EN 10277-2 to EN 10277-5.

7.1.1.2 In cases where steels for case hardening (see EN 10277-4) or for quenching and tempering (see EN 10277-5) are ordered with hardenability requirements, such hardenability requirements shall be considered as the governing criterion for acceptance.

In such cases a deviation of the cast analysis with respect to the values indicated in Table 1 of EN 10277-4 and EN 10277-5 is admissible taking into account footnote b of those tables.

7.1.2 Product analysis

The permissible deviations in the product analysis in relation to the specified limits for the cast analysis (see 7.1.1) are specified in Table 2 of EN 10277-2 to EN 10277-5.

The purchaser may specify at the time of enquiry and order that the chemical composition on product analysis shall be verified. In this case reference should be made to B.7.

7.2 Mechanical properties

The mechanical properties of products covered by this European Standard shall meet the specifications stated in 7.2 of EN 10277-2 to EN 10277-5.

7.3 Hardenability

See 7.3 of EN 10277-4 and EN 10277-5 of this European Standard.

7.4 Grain size

Unless otherwise specified by the purchaser at the time of enquiry and order, the grain size of the steel shall be at the discretion of the manufacturer, except for case hardening steels according to EN 10277-4 and for alloy steels for quenching and tempering according to EN 10277-5. Case hardening steels according to EN 10277-4 and alloy steels for quenching and tempering according to EN 10277-5 shall be supplied with fine grain, unless otherwise agreed at the time of enquiry and order.

Where specified by the purchaser at the time of enquiry and order, verification of fine grain size shall be in accordance with B.2.

7.5 Non-metallic inclusions

7.5.1 Microscopic inclusions

Where specified by the purchaser at the time of enquiry and order, microscopic non-metallic inclusions of case hardening steels and of steels for quenching and tempering (see EN 10277-4 and EN 10277-5) shall be verified in accordance with B.3.1.

7.5.2 Macroscopic inclusions

Freedom of macroscopic inclusions cannot be insured in any steel. If agreed at the time of enquiry and order macroscopic inclusions of case hardening steels and of steels for quenching and tempering (see EN 10277-4 and EN 10277-5) shall to be verified in accordance with B.3.2

7.6 Decarburization

Where specified by the purchaser at the time of enquiry and order, for steels for quenching and tempering of EN 10277-5, the permissible depth of decarburization and the method of determination shall be in accordance with B.4.

7.7 Surface condition

Drawn products shall have a smooth, scale free surface. Products in the final heat treated condition shall be free from loose surface scale; their surface might be discoloured or darker. For hexagons, squares, flats and profiles with special cross sections one cannot achieve – for manufacturing reasons – the same quality of surface finish as for round cross sections.

Since surface discontinuities (cracks, overlapping, scale, isolated pores, pits, grooves, etc.) can not be completely avoided during manufacturing (hot and cold formation, heat treatments, handling and storage) and since they are retained when drawing, agreements shall be made regarding surface quality. The surface quality of the products shall be one of the classes according to Table 1. Cold drawn products are normally delivered in class 1, while turned and peeled bars as well as ground bars are delivered in class 3. Different classes may be agreed at the time of enquiry and order.

For flats, squares in sizes greater than 20 mm and hexagons in sizes greater than 50 mm, the maximum possible depth of surface discontinuities shall be agreed at the time of enquiry and order.

NOTE Where automatic testing of the surface is applied, 50 mm of each end of the bar is not normally covered.

Surface defects cannot be eliminated without removal of material. Products in the 'technically crack free by manufacture' condition are only available in the turned and peeled and/or ground conditions.

Table 1 — Surface quality classes

Condition	Class			
	1	2	3	4
Permissible depth of discontinuities	max. 0,3 mm for $d \leq 15$ mm; max. $0,02 \cdot d$ for $15 < d \leq 100$ mm	max. 0,3 mm for $d \leq 15$ mm; max. $0,02 \cdot d$ for $15 < d \leq 75$ mm max. 1,5 mm for $d > 75$ mm	max. 0,2 mm for $d \leq 20$ mm; max. $0,01 \cdot d$ for $20 < d \leq 75$ mm; max. 0,75 mm for $d > 75$ mm	technically crack free by manufacture ^e
Maximum percentage of delivered weight with discontinuities in excess of specified level	4 %	1 %	1 %	0,2 %
Product form ^a				
Rounds	+	+	+	+
Squares	+	+(for $d \leq 20$ mm) ^c	-	-
Hexagons	+	+(for $d \leq 50$ mm) ^c	-	-
Flats	+ ^b	-	-	-
Special sections	+ ^d	-	-	-
NOTE d = nominal diameter of bar and distance across flats of squares and hexagons.				
<p>^a + indicates available in these classes, - indicates not available in these classes.</p> <p>^b Maximum depth of discontinuities refers to respective section (width or thickness).</p> <p>^c Crack detection with eddy current device not possible for $d > 20$ mm or $d > 50$ mm as indicated.</p> <p>^d Reference dimensions to be agreed at the time of enquiry and order</p> <p>^e The surface quality class shall be better than class 3. The requirements and the kind of verification are to be agreed at the time of enquiry and order.</p>				

7.8 Internal soundness

Requirements for internal soundness may be agreed upon at the time of enquiry and order, e.g. on the basis of non-destructive tests (see B.6).

7.9 Dimensions, shape and tolerances

Dimensions and tolerances on dimensions and shape shall be as specified by the purchaser at the time of enquiry and order and shall be in accordance with EN 10278, where applicable.

8 Inspection and testing

8.1 Types and contents of inspection documents

8.1.1 When specifically requested by the purchaser, an inspection document according to EN 10204 shall be supplied. The purchaser shall indicate the type of inspection document required.

8.1.2 If, in accordance with the agreements made at the time of enquiry and order, a test report 2.2 is to be issued, it shall contain the following information:

- a) confirmation that the material complies with the requirements of the order;
- b) results of the cast analysis for all the elements specified for the steel grade concerned.

8.1.3 If, in accordance with the agreements made at the time of enquiry and order, an inspection certificate 3.1 or 3.2 is to be issued, the specific tests described in 8.2 shall be carried out and the results shall be confirmed in the inspection certificate.

In addition, the inspection certificate shall include the following information:

- a) manufacturer's results for the cast analysis of all elements specified for the steel grade concerned;
- b) results of inspections and tests ordered as a result of supplementary requirements (see Annex B);
- c) symbol letters or numbers relating the inspection documents, test pieces and products to each other.

8.2 Specific inspection

8.2.1 Where specified at the time of enquiry and order, product conformity shall be evaluated by specific inspection.

8.2.2 Sampling, inspection, testing and test methods shall be as specified in Table 2.

8.2.3 Sufficient number of products shall be inspected for dimensional compliance.

8.2.4 Where appropriate, retesting shall be in accordance with EN 10021.

9 Marking

The steel product or its packaging shall be marked in such a way as to ensure traceability to the manufacturer, steel grade and cast.

Where specified by the purchaser at the time of enquiry and order, special marking of the steel product shall be in accordance with B.8.

NOTE It is recommended that subsequent processes maintain traceability.

Table 2 — Test conditions for the verification of the requirements given in column 2

No.	Requirements	Test unit ^a	Amount of testing		Sampling and sample preparation	Test method to be used
			Number of samples per test unit	Number of tests per sample		
1	Chemical composition	C	The cast analysis is given by the manufacturer; for product analysis see B.7		EN ISO 14284	prCEN/TR 10261 ^b
2	Mechanical properties				EN ISO 377	Tensile test ^c EN 10002-1
2.1	As rolled and turned	C+D	1	1		
2.2	Cold drawn	C+D	1	1		
2.3	Quenched and tempered, either before or after cold working	C+D+T	1	1		
3	Hardness				EN ISO 6506-1	Brinell hardness test EN ISO 6506-1 ^d
3.1	As rolled and turned	C+D	1	1		
3.2	Heat-treated and turned	C+D+T	1	1		
3.3	Heat-treated and cold drawn	C+D+T	1	1		

^a The tests shall be carried out separately for each cast as indicated by 'C', each dimension as indicated by 'D', and each heat treatment batch as indicated by 'T'.
Products with different thickness may be grouped if the differences in thickness do not affect the properties.

^b For routine testing also other methods are available (e. g. spectrographic).

^c In cases of dispute, the tensile test shall be carried out on proportional test pieces having a gauge length of $L_0 = 5,65 \sqrt{S_0}$, where S_0 is the original cross section area.

^d In cases of dispute, hardness tests shall be performed on the cross section at the same point as specified for the centre line of the tensile test piece.

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Annex A (normative)

Ruling section for mechanical properties

A.1 Definition

See 3.4.

A.2 Determination of the diameter of the ruling section

A.2.1 If the test pieces are taken from products with simple cross sections and from positions with quasi two-dimensional heat flow A.2.1.1 to A.2.1.3 shall apply.

A.2.1.1 For rounds the nominal diameter of the product (not comprising the machining allowance) shall be taken as the diameter of the ruling section.

A.2.1.2 For hexagons the nominal distance between two opposite sides of the cross section shall be taken as the diameter of the ruling section.

A.2.1.3 For square and rectangular bars the diameter of the ruling section shall be determined in accordance with the example shown in Figure A.1.

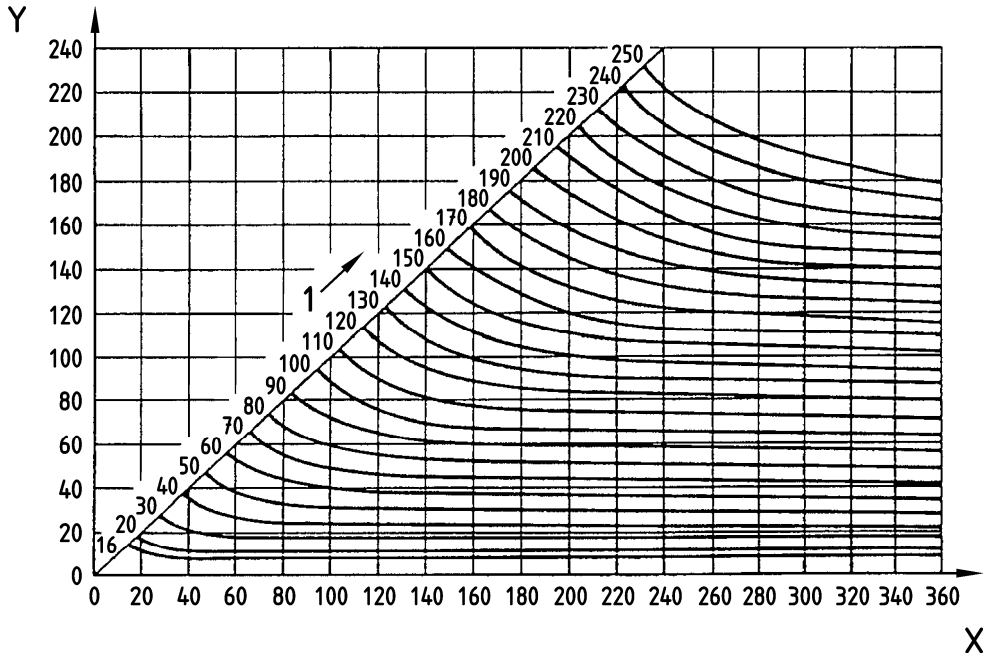
A.2.2 For other product forms the ruling section shall be agreed at the time of enquiry and order.

NOTE For this purpose, the following procedure may serve as a guideline.

The product is hardened in accordance with usual practice. It is then cut so that the hardness and structure at the position of the ruling section provided for taking test pieces can be determined.

From another product of the type under consideration and of the same cast, an end quench test piece is taken from the prescribed position and tested in the usual way. Then the distance is determined at which the end quench test piece shows the same hardness and structure as the ruling section at the position provided for taking test pieces.

On the basis of this distance the diameter of the ruling section is then estimated using Figure A.2 and Figure A.3.

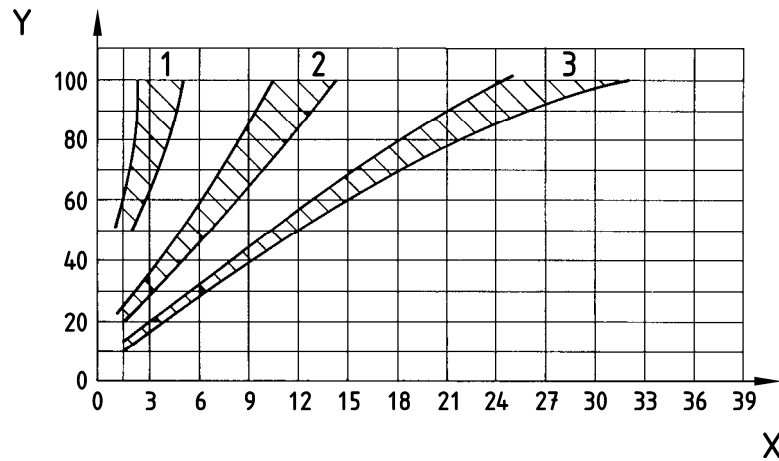


Key

- X Width in mm
- Y Thickness in mm
- 1 Diameter of the ruling cross section in mm

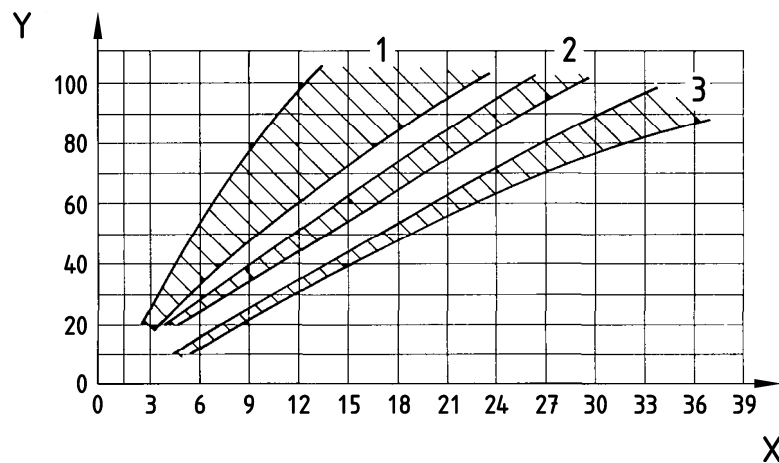
EXAMPLE For a rectangular bar with a section of 40 mm x 60 mm, the diameter of the ruling section is 50 mm.

Figure A.1 — Diameter of the ruling section for square and rectangular bars for quenching in oil or water

**Key**

- X Distance in mm from the quenched end
- Y Bar diameter in mm
- 1 Surface
- 2 3/4 radius
- 3 Centre

Figure A.2 — Relationship between the cooling rates in end quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated water (Source: SAE J406c)

**Key**

- X Distance in mm from the quenched end
- Y Bar diameter in mm
- 1 Surface
- 2 3/4 radius
- 3 Centre

Figure A.3 — Relationship between the cooling rates in end quench test pieces (Jominy test pieces) and in quenched round bars in mildly agitated oil (Source: SAE J406c)

Annex B (normative)

Options

NOTE One or more of the following options may be agreed upon at the time of enquiry and order (see 5.2). The details of these options may be agreed upon between the manufacturer and the purchaser at the time of enquiry and order if necessary.

B.1 Mechanical properties of reference test pieces in the quenched and tempered condition

For products delivered in other than the quenched and tempered condition the requirements for their mechanical properties in the quenched and tempered condition shall be verified on a reference test piece.

For bars the quenched and tempered sample shall have the same cross section as the product under consideration. For other product forms the dimensions and preparation of the sample shall be agreed at the time of enquiry and order taking into consideration, where appropriate, the method for determining the diameter of the ruling section in accordance with Annex A.

The samples shall be quenched and tempered as agreed at the time of the enquiry or order. Details of the heat treatment shall be reported in the inspection document (see 8.1).

Samples for the production of test pieces shall be taken from the product in accordance with EN ISO 377.

B.2 Fine grain steels

B.2.1 Fine grain steel shall have an austenite grain size of five or finer. If specific testing is ordered (see 7.4), the grain size requirement is to be verified by determining the aluminium content or micrographically. If the grain size requirements are verified micrographically sampling and sample preparation shall be as specified in EN ISO 643 and one test piece per cast shall be inspected.

B.2.2 For free-cutting steels when tested in accordance with one of the methods described in EN ISO 643, the grain structure shall be considered satisfactory if 70 % of the area is within the specified size limits.

For case hardening steels the fine grain structure is normally achieved, when the total aluminium content is min. 0,018 %. In such case the micrographic investigation is not necessary. The aluminium content shall be given in the inspection document. Otherwise the steel shall be tested in accordance with Mc-Quaid-Ehn method described in EN ISO 643 and the grain structure shall be considered satisfactory if 70 % of the area is within the specified size limits, for further details see EN 10084.

Steels for quenching and tempering shall be tested by determination of the aluminium content or micrographically. In the first case, the aluminium content shall be agreed. In the second case the steels shall be tested in accordance with one of the methods described in EN ISO 643, for further details see EN 10083-2, A.3 for non alloy steels for quenching and tempering and EN 10083-3, A.2 for alloy steels for quenching and tempering.

B.3 Non-metallic inclusions

B.3.1 Microscopic inclusions

This requirement is applicable for the verification of microscopic non-metallic inclusion content of special steels in EN 10277-4 and EN 10277-5. Non-metallic inclusions and their acceptable levels shall be agreed at the time of enquiry and order. For non-metallic inclusion content for case hardening steels see EN 10084, A.1 and for steels for quenching and tempering see EN 10083-2, A.4 and EN 10083-3, A.3.

B.3.2 Macroscopic inclusions

This requirement is applicable for the verification of the macroscopic inclusions in special steels according to EN 10277-4 and EN 10277-5. If verification is required then the method and acceptance limits shall be agreed at the time of enquiry and order.

B.4 Depth of decarburization

For steels of EN 10277-5, the maximum depth of decarburization shall be agreed at the time of enquiry and order. The depth of decarburization shall be determined in accordance with the micrographic method specified in EN ISO 3887.

B.5 Corrosion protection

A protective medium shall be applied by the manufacturer to give temporary and adequate protection during transport and storage. Where a special protective medium is required it shall be agreed at the time of enquiry and order.

B.6 Non-destructive testing

Products shall be non-destructively tested in accordance with a method and to acceptance criteria as agreed at the time of enquiry and order.

B.7 Product analysis

One product analysis shall be carried out for each cast for the determination of the chemical composition of the product as specified for the cast analysis in Table 1 of EN 10277-2 to EN 10277-5.

Preparation of samples shall be in accordance with EN ISO 14284. In cases of dispute about the analytical method, the chemical composition shall be determined in accordance with a reference method taken from one of the European Standards in prCEN/TR 10261.

B.8 Special marking

Products shall have special markings as agreed at the time of enquiry and order, e.g. by bar coding according to EN 606.

Bibliography

- [1] SAE J406c, Methods of Determining Hardenability of Steels
- [2] ISO 286-1, ISO system of limits and fits - Part 1: Bases of tolerances, deviations and fits

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