

Hot rolled products of structural steels —

Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels

The European Standard EN 10025-4:2004 has the status of a
British Standard

ICS 77.140.10; 77.140.50

National foreword

This British Standard is the official English language version of EN 10025-4:2004. BS EN 10025-4:2004 together with BS EN 10025-1:2004 and BS EN 10025-3:2004 supersedes BS EN 10113-1:1993, and BS EN 10025-4:2004 together with BS EN 10025-1:2004 supersedes BS EN 10113-3:1993, which are withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ISE/12, Structural steels, which has the responsibility to:

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- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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4: Conditions techniques de livraison pour les aciers de
construction soudables à grains fins obtenus par laminage
thermomécanique

Warmgewalzte Erzeugnisse aus Baustählen - Teil 4:
Technische Lieferbedingungen für thermomechanisch
gewalzte schweißgeeignete Feinkornbaustähle

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Foreword

This document (EN 10025-4:2004) has been prepared by Technical Committee ECISS/TC 10 "Structural steels - Grades and qualities", the secretariat of which is held by NEN.

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of an identical text or by endorsement, at the latest by May 2005, and conflicting national standards shall be withdrawn at the latest by May 2005.

This document supersedes together with EN 10025-1:2004, EN 10113-1:1993, *Hot-rolled products in weldable fine grain structural steels - Part 1: General delivery conditions* and EN 10113-3:1993 *Hot-rolled products in weldable fine grain structural steels - Part 3: Delivery conditions for thermomechanical rolled steels*.

The titles of the other parts of this document are:

Part 1: General technical delivery conditions;

Part 2: Technical delivery conditions for non-alloy structural steels;

Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels;

Part 5: Technical delivery conditions for structural steels with improved atmospheric corrosion resistance;

Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition.

This document has been prepared under Mandate M/120 given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of the EU Construction Products Directive (89/106/EEC). For relationship with the EU Construction Products Directive, see informative Annex ZA of EN 10025-1:2004.

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

1 Scope

Part 4 of this document, in addition to Part 1, specifies requirements for flat and long products of hot rolled weldable fine grain structural steels in the thermomechanical rolled condition in the grades and qualities given in Tables 2 to 4 (chemical composition) and Tables 5 to 7 (mechanical properties) in thickness ≤ 120 mm for flat products and in thickness ≤ 150 mm for long products.

In addition to EN 10025-1 the steels specified in this document are especially intended for use in heavily loaded parts of welded structures such as, bridges, flood gates, storage tanks, water supply tanks, etc., for service at ambient and low temperatures.

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.

2.1 General standards

EN 1011-2, *Welding – Recommendations for welding of metallic materials - Part 2: Arc welding of ferritic steels.*

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

EN 10025-1:2004, *Hot rolled products of structural steels - Part 1: General technical delivery conditions.*

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

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

EN 10163-1, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections – Part 1: General requirements.*

EN 10163-2, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections – Part 2: Plates and wide flats.*

EN 10163-3, *Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections – Part 3: Sections.*

EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product - Technical delivery conditions.*

EN 10221, *Surface quality classes for hot-rolled bars and rods - Technical delivery conditions.*

CR 10260, *Designation systems for steels - Additional symbols.*

2.2 Standards on dimensions and tolerances (see 7.7.1)

EN 10017, *Non-alloy steel rod for drawing and/or cold rolling – Dimensions and tolerances.*

EN 10024, *Hot rolled taper flange I sections - Tolerances on shape and dimensions.*

EN 10029, *Hot rolled steel plates 3 mm thick or above - Tolerances on dimensions, shape and mass.*

EN 10034, *Structural steel I and H sections - Tolerances on shape and dimensions.*

EN 10048, *Hot rolled narrow steel strip - Tolerances on dimensions and shape.*

EN 10051, *Continuously hot-rolled uncoated plate, sheet and strip of non-alloy and alloy steels - Tolerances on dimensions and shape.*

EN 10055, *Hot-rolled steel equal flange tees with radiused root and toes - Dimensions and tolerances on shape and dimensions.*

EN 10056-1, *Structural steel equal and unequal leg angles - Part 1: Dimensions.*

EN 10056-2, *Structural steel equal and unequal leg angles - Part 2: Tolerances on shape and dimensions.*

EN 10058, *Hot rolled flat steel bars for general purposes - Dimensions and tolerances on shape and dimensions.*

EN 10059, *Hot rolled square steel bars for general purposes - Dimensions and tolerances on shape and dimensions.*

EN 10060, *Hot rolled round steel bars for general purposes - Dimensions and tolerances on shape and dimensions.*

EN 10061, *Hot rolled hexagon steel bars for general purposes - Dimensions and tolerances on shape and dimensions.*

EN 10067, *Hot rolled bulb flats - Dimensions and tolerances on shape, dimensions and mass.*

EN 10162, *Cold rolled steel sections - Technical delivery conditions - Dimensional and cross-sectional tolerances.*

EN 10279, *Hot rolled steel channels - Tolerances on shape and dimensions.*

2.3 Standards on testing

EN 10160, *Ultrasonic testing of steel flat product of thickness equal to or greater than 6 mm (reflection method).*

EN 10306, *Iron and steel - Ultrasonic testing of H beams with parallel flanges and IPE beams.*

EN 10308, *Non-destructive testing - Ultrasonic testing of steel bars.*

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 10025-1:2004 and the following apply.

3.1**thermomechanical rolling**

rolling process in which the final deformation is carried out in a certain temperature range leading to a material condition with certain properties which cannot be achieved or repeated by heat treatment alone

NOTE 1 Subsequent heating above 580 °C may lower the strength values. If temperatures above 580 °C are needed reference should be made to the supplier.

NOTE 2 Thermomechanical rolling leading to the delivery condition M can include processes with an increasing cooling rate with or without tempering including self-tempering but excluding direct quenching and quenching and tempering.

NOTE 3 In some publications the word TMCP (Thermomechanical Control Process) is also used.

3.2**fine grained steels**

steels with fine grain structure with an equivalent index of ferritic grain size ≥ 6 determined in accordance with EN ISO 643

4 Classification and designation**4.1 Classification****4.1.1 Main quality classes**

All steel grades specified in this document shall be classified as alloy special steels according to EN 10020.

4.1.2 Grades and qualities

This document specifies four steel grades S275, S355, S420 and S460.

All the steel grades may be supplied in the following qualities as specified at the time of the enquiry and order:

- with specified minimum values of impact energy at temperatures not lower than -20 °C, designated as M;
- with specified minimum values of impact energy at temperatures not lower than -50 °C, designated as ML.

4.2 Designation

4.2.1 The designation shall be in accordance with EN 10025-1.

NOTE For a list of corresponding former designations and the former designations from EN 10113-3:1993 see Annex A, Table A.1.

4.2.2 The designation shall consist of:

- number of this document (EN 10025-4);
- steel name or the steel number; the steel name consisting of:
 - symbol S (for structural steel);
 - indication of the minimum specified yield strength for thickness ≤ 16 mm expressed in MPa¹⁾;

¹⁾ 1 MPa = 1 N/mm².

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- delivery condition M;
- capital letter L for the quality with specified minimum values of impact energy at temperatures not lower than -50 °C.

EXAMPLE Thermomechanical rolled structural steel (S) with a specified minimum yield strength at ambient temperature of 355 MPa¹), and with a specified minimum value of impact energy at -50 °C:

Steel EN 10025-4 - S355ML

or

Steel EN 10025-4 - 1.8834

5 Information to be supplied by the purchaser

5.1 Mandatory information

The information that shall be supplied by the purchaser at the time of the order is specified in EN 10025-1.

In addition to EN 10025-1 the following information shall be supplied by the purchaser at the time of the order:

- g) the type of inspection document (see 8.2).

5.2 Options

A number of options are specified in Clause 13. In the event that the purchaser does not indicate his wish to implement any of these options, the supplier shall supply in accordance with the basic specification.

6 Manufacturing process

6.1 Steel making process

The steel making process shall be in accordance with EN 10025-1. If specified at the time of the order the steel making process shall be reported to the purchaser.

See option 1.

6.2 Grain structure

The steels shall have a fine grain structure containing sufficient amounts of nitrogen binding elements (see Table 2).

6.3 Delivery conditions

The products shall be supplied in the thermomechanical rolled condition as defined in Clause 3.

7 Requirements

7.1 General

The following requirements apply when sampling, preparation of test pieces and testing specified in Clauses 8, 9 and 10 are carried out.

7.2 Chemical composition

7.2.1 The chemical composition determined by ladle analysis shall comply with the specified values of Table 2. On special request of the purchaser the manufacturer shall inform the purchaser at the time of the enquiry and order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered.

See option 29.

7.2.2 The upper limits applicable for the product analysis are given in Table 3. The manufacturer shall inform the purchaser at the time of the enquiry and order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered. The product analysis shall be carried out when specified at the time of the order.

See option 2.

7.2.3 The maximum carbon equivalent values based on the ladle analysis, given in Table 4 shall apply. For the carbon equivalent value formula see 7.2.3 of EN 10025-1:2004.

7.2.4 When products are supplied with a control on Si e.g. for hot-dip zinc-coating so that there could be a need to increase the content of other elements like C and Mn to achieve the required tensile properties, the maximum carbon equivalent values of Table 4 shall be increased as follows:

- for $Si \leq 0,030$ %, increase CEV by 0,02 %;
- for $Si \leq 0,25$ %, increase CEV by 0,01 %.

7.3 Mechanical properties

7.3.1 General

7.3.1.1 Under the inspection and testing conditions as specified in Clauses 8, 9 and 10 and in the delivery condition as specified in 6.3 the mechanical properties shall comply with the values given in Tables 5 to 7.

7.3.1.2 For flat products the nominal thickness applies. For long products of irregular section the nominal thickness of that part from which the samples are taken applies (see Annex A of EN 10025-1:2004).

7.3.2 Impact properties

7.3.2.1 The verification of the impact energy value shall be carried out in accordance with EN 10025-1.

Furthermore the verification of the impact energy value shall be carried out, unless otherwise agreed (see 7.3.2.2 and 7.3.2.3) with longitudinal test pieces for:

- M at -20 °C;
- ML at -50 °C.

7.3.2.2 Another temperature (given in Tables 6 and 7) may be agreed at the time of the order.

See option 3.

7.3.2.3 If agreed at the time of the enquiry and order transverse impact energy values as given in Table 7 shall apply instead of longitudinal values.

See option 30.

7.3.3 Improved deformation properties perpendicular to the surface

If agreed at the time of the order flat and long products shall comply with one of the requirements of EN 10164.

See option 4.

7.4 Technological properties

7.4.1 Weldability

The steels specified in this document shall be suitable for welding.

General requirements for arc welding of the steels specified in this document shall be as given in EN 1011-2.

NOTE With increasing product thickness and strength level cold cracking can occur. Cold cracking is caused by the following factors in combination:

- the amount of diffusible hydrogen in the weld metal;
- a brittle structure of the heat affected zone;
- significant tensile stress concentrations in the welded joint.

7.4.2 Formability

NOTE Recommendations regarding hot and cold forming are laid down in ECSC IC 2.

7.4.2.1 Hot forming

Hot forming shall not be undertaken.

NOTE The products ordered and supplied in the thermomechanical rolled condition are not suitable for hot forming.

7.4.2.2 Cold formability

7.4.2.2.1 General

NOTE Cold forming leads to reduction in the ductility. Furthermore it is necessary to draw the attention to the risk of brittle fracture in connection with hot-dip zinc coating.

7.4.2.2.2 Flangeability

If specified at the time of the order plate, sheet, strip and wide flats ordered and supplied in the thermomechanical rolled condition with a nominal thickness ≤ 12 mm shall be suitable for flanging without cracking with the following minimum bend radii:

- 2 times the nominal thickness with the axis of the bend in transverse direction and 2,5 times the nominal thickness in longitudinal direction for the steel grades S275 and S355;

- 4 times the nominal thickness with the axis of the bend in transverse direction and 5 times the nominal thickness in longitudinal direction for the steel grades S420 and S460.

See option 11b.

7.4.2.2.3 Roll forming

If specified at the time of the order plate, sheet and strip with a nominal thickness ≤ 8 mm shall be suitable for the production of sections by cold rolling (for example according to EN 10162), with the same minimum bend radii as given in 7.4.2.2.1.

See option 12.

NOTE The products suitable for roll forming are also suitable for the manufacture of cold-finished square and rectangular hollow sections.

7.4.3 Suitability for hot-dip zinc-coating

Hot-dip zinc-coating requirements shall be agreed between manufacturer and purchaser.

EN ISO 1461 and EN ISO 14713 should be used to set these coating requirements. The definition of suitability classes based upon chemical analysis limitations as laid down in Table 1 can be used for guidance purposes.

Table 1 - Classes for the suitability for hot-dip zinc-coating based on the ladle analysis (for guidance)

Classes	Elements % by mass		
	Si	Si + 2,5 P	P
Class 1	$\leq 0,030$	$\leq 0,090$	-
Class 2 ^a	$\leq 0,35$	-	-
Class 3	$0,14 \leq \text{Si} \leq 0,25$	-	$\leq 0,035$
^a Class 2 applies only for special zinc alloys.			

For class 1 the maximum carbon equivalent value of Table 4 shall be increased by 0,02. For class 3 the maximum carbon equivalent value of Table 4 shall be increased by 0,01 (see 7.2.4).

See option 5.

NOTE Product shape, composition of the zinc bath, other hot-dip treatment settings and other factors should be considered when agreeing upon hot-dip zinc-coating requirements.

7.5 Surface properties

7.5.1 Strip

The surface condition should not impair an application appropriate to the steel grade if adequate processing of the strip is applied.

7.5.2 Plates and wide flats

EN 10163 parts 1 and 2 shall apply for the permissible surface discontinuities and for the repair of surface defects by grinding. Class A, subclass 1 of EN 10163-2 shall apply, class B regarding grinding or subclasses 2 or 3 regarding repair by welding can be agreed at the time of the order.

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See option 15.

7.5.3 Sections

EN 10163 parts 1 and 3 shall apply for the permissible surface discontinuities and for the repair of surface defects by grinding. Class C, subclass 1 of EN 10163-3 shall apply, class D regarding grinding or subclasses 2 or 3 regarding repair by welding can be agreed at the time of the order.

See option 16.

7.5.4 Bars and rods

EN 10221 applies for the permissible surface discontinuities and for the repair of surface defects by grinding. Class A of EN 10221 shall apply, unless otherwise agreed at the time of the order.

See option 17.

7.6 Internal soundness

The permissible level of internal imperfections shall be in accordance with EN 10025-1.

See option 6 (for flat products).

See option 7 (for H beams with parallel flanges and IPE beams).

See option 8 (for bars).

7.7 Dimensions, tolerances on dimensions and shape, mass

7.7.1 Dimensions, tolerances on dimensions and shape shall be in accordance with the requirements given in the order by reference to the relevant documents according to 2.2 and according to 2.2 and 7.7.1 of EN 10025-1:2004.

For hot rolled plate tolerances the basic requirements shall be in accordance with EN 10029, including thickness tolerances to class A, unless otherwise agreed at the time of the order.

See option 18.

For plates cut from continuously hot rolled strip, the thickness tolerances shall be in accordance with EN 10051.

7.7.2 The nominal mass shall comply with EN 10025-1.

8 Inspection

8.1 General

The products shall be delivered with specific inspection and testing to indicate compliance with the order and this document.

8.2 Type of inspection and inspection document

The type of inspection document shall comply with EN 10025-1.

See option 9.

8.3 Frequency of testing

8.3.1 Sampling

The verification of the mechanical properties shall be carried out by cast.

8.3.2 Test units

8.3.2.1 The test unit shall contain products of the same form, grade and of the same thickness range as specified in Table 5 for the yield strength.

For verifying the mechanical properties the following test unit shall apply:

- 40 tonnes or part thereof.

8.3.2.2 If specified at the time of the order for flat products the impact properties only or the impact properties and the tensile properties shall be verified out of each parent plate or coil.

See option 13.

See option 14.

8.3.3 Verification of chemical composition

The verification of the chemical composition shall be in accordance with EN 10025-1.

See option 2.

8.4 Tests to be carried out for specific inspection

8.4.1 The following tests shall be carried out:

- for all products the ladle analysis;
- for all products the tensile test;
- for all products the impact test.

8.4.2 At the time of the order the following additional tests can be agreed:

- a) for all products the impact test at another temperature or on transverse test pieces (see 7.3.2.2 and 7.3.2.3);

See option 3.

See option 30.

- b) the product analysis (see 8.3.3.2 of EN 10025-1:2004).

See option 2.

9 Preparation of samples and test pieces

9.1 Selection and preparation of samples for chemical analysis

The preparation of samples for product analysis shall be in accordance with EN 10025-1.

9.2 Location and orientation of samples and test pieces for mechanical tests

9.2.1 General

The location and orientation of samples and test pieces for mechanical tests shall be in accordance with EN 10025-1.

9.2.2 Preparation of samples

In addition to EN 10025-1 the samples shall be taken:

- from any product of the test unit.

9.2.3 Preparation of test pieces

The preparation of test pieces for mechanical tests shall be in accordance with EN 10025-1.

In addition to EN 10025-1 the following applies:

For the tensile test pieces either the full product thickness or half the product thickness can be used, but one product surface shall be retained. A round test piece with its axis at a quarter of the product thickness may also be used for product thicknesses over 30 mm. In cases of disputes the total thickness of the plate shall be subdivided in equal thick flat test pieces. The average of the individual results of the mechanical tests shall be valid.

9.2.4 Impact test pieces

In addition to EN 10025-1 the following requirement applies:

- impact test pieces shall be taken from $\frac{1}{4}t$ position for plates with nominal thickness ≥ 40 mm.

9.3 Identification of samples and test pieces

The identification of samples and test pieces shall be in accordance with EN 10025-1.

10 Test methods

10.1 Chemical analysis

The chemical analysis shall be in accordance with EN 10025-1.

10.2 Mechanical tests

The mechanical tests shall be in accordance with EN 10025-1.

10.3 Ultrasonic testing

Ultrasonic testing shall be carried out in accordance with EN 10025-1.

10.4 Retests

The retests shall be in accordance with EN 10025-1.

11 Marking, labelling, packaging

The marking, labelling and packaging shall be in accordance with EN 10025-1.

See option 10.

In addition to EN 10025-1 if specified at the time of the enquiry and order there shall be either no die stamping or only die stamping in positions indicated by the purchaser.

See option 31.

12 Complaints

Any complaints shall be dealt with in accordance with EN 10025-1.

13 Options (see 5.2)

The following options of EN 10025-1:2004 apply:

- 1) The steel making process shall be indicated (see 6.1).
- 2) Product analysis shall be carried out; the number of samples and the elements to be determined shall be as agreed (see 7.2.2, 8.3.3 and 8.4.2).
- 3) At which temperature the impact properties shall be verified (see 7.3.2.2 and 8.4.2).
- 4) Products shall comply with one of the improved properties perpendicular to the surface of EN 10164 (see 7.3.3).
- 5) The product shall be suitable for hot-dip zinc-coating (see 7.4.3).
- 6) For flat products in thickness ≥ 6 mm the freedom from internal defects shall be verified in accordance with EN 10160 (see 7.6 and 10.3).
- 7) For H beams with parallel flanges and IPE beams the freedom from internal defects shall be verified in accordance with EN 10306 (see 7.6 and 10.3).
- 8) For bars the freedom from internal defects shall be verified in accordance with EN 10308 (see 7.6 and 10.3).
- 9) Inspection of surface condition and dimensions shall be witnessed by the purchaser at the manufacturer's works (see 8.2).
- 10) The type of marking required (see Clause 11).

In addition to the options of EN 10025-1:2004 the following options apply to products according to EN 10025-4:

- 11b) Sheet, plate, strip and wide flats with a nominal thickness ≤ 12 mm shall be suitable for flanging without cracking (see 7.4.2.2.1).
- 12) Plate, sheet and strip with nominal thickness ≤ 8 mm shall be suitable for the production of sections by cold rolling with bend radii given in 7.4.2.2.1 (see 7.4.2.2.2).
- 13) For flat products out of each parent plate or coil the impact properties only shall be verified (see 8.3.2.2).

- 14) For flat products out of each parent plate or coil the impact properties and the tensile properties shall be verified (see 8.3.2.2).
- 15) For plates and wide flats the permissible surface discontinuities and for the repair of surface defects by grinding and/or welding another class than class A, subclass 1 of EN 10163-2 applies (see 7.5.2).
- 16) For sections the permissible surface discontinuities and for the repair of surface defects by grinding and/or welding another class than class C, subclass 1 of EN 10163-3 applies (see 7.5.3).
- 17) For bars and rods the permissible surface discontinuities and for the repair of surface defects by grinding and/or welding another class than class A of EN 10221 applies (see 7.5.4).
- 18) Other tolerances than class A of EN 10029 for hot rolled plates apply (see 7.7.1).
- 29) The manufacturer shall inform the purchaser at the time of the enquiry and order which of the alloying elements appropriate to the steel grade required will be deliberately added to the material to be delivered (see 7.2.1).
- 30) The impact properties shall be verified on transverse V-notch test pieces (see 7.3.2.3 and 8.4.2).
- 31) Die stamping is not allowed or the position for die stamping shall be as indicated by the purchaser (see Clause 11).
- 32) For railway applications a maximum S content of 0,010 % for ladle analysis and 0,012 % for product analysis is required (see Tables 2 and 3 footnote ^b).

Table 2 - Chemical composition of the ladle analysis for thermomechanical rolled steel

Designation	C % max.	Si % max.	Mn % max.	P % max. ^a	S % max. ^{a, b, i}	Nb % max.	V % max.	Al _{total} % min. ^c	Ti % max.	Cr % max.	Ni % max.	Mo % max.	Cu % max. ^d	N % max.
According EN 10027-1 and CR 10260														
S275M	0,13 ^e	0,50	1,50	0,030	0,025	0,05	0,08	0,02	0,05	0,30	0,30	0,10	0,55	0,015
S275ML				0,025	0,020									
S355M	0,14 ^e	0,50	1,60	0,030	0,025	0,05	0,10	0,02	0,05	0,30	0,50	0,10	0,55	0,015
S355ML				0,025	0,020									
S420M	0,16 ^f	0,50	1,70	0,030	0,025	0,05	0,12	0,02	0,05	0,30	0,80	0,20	0,55	0,025
S420ML				0,025	0,020									
S460M	0,16 ^f	0,60	1,70	0,030	0,025	0,05	0,12	0,02	0,05	0,30	0,80	0,20	0,55	0,025
S460ML				0,025	0,020									

^a For long products the P and S content can be 0,005 % higher.

^b For railway applications a maximum S content of 0,010 % may be agreed at the time of enquiry and order.

See option 32.

^c If sufficient other N-binding elements are present the minimum total Al content does not apply.

^d Cu content above 0,40 % may cause hot shortness during hot forming.

^e For long products a maximum C content of 0,15 % for grade S275 and a maximum C content of 0,16 % for grade S355 applies.

^f For long products of the grades S420 and S460 a maximum C content of 0,18 % applies.

Table 3 - Chemical composition of the product analysis based on Table 2

Designation	C % max.	Si % max.	Mn % max.	P % max. ^a	S % max. ^{a, b, 1}	Nb % max.	V % max.	Al ^{total} . % min. ^c	Ti % max.	Cr % max.	Ni % max.	Mo % max.	Cu % max. ^d	N % max.
According to EN 10027-1 and CR 10260 According to EN 10027-2	0,15 ^e	0,55	1,60	0,035	0,030	0,06	0,10	0,015	0,06	0,35	0,35	0,13	0,60	0,017
				0,030	0,025									
S275M	0,16 ^e	0,55	1,70	0,035	0,030	0,06	0,12	0,015	0,06	0,35	0,55	0,13	0,60	0,017
S275ML				0,030	0,025									
S355M	0,18 ^f	0,55	1,80	0,035	0,030	0,06	0,14	0,015	0,06	0,35	0,85	0,23	0,60	0,027
S355ML				0,030	0,025									
S420M	0,18 ^f	0,65	1,80	0,035	0,030	0,06	0,14	0,015	0,06	0,35	0,85	0,23	0,60	0,027
S420ML				0,030	0,025									
S460M	0,18 ^f	0,65	1,80	0,035	0,030	0,06	0,14	0,015	0,06	0,35	0,85	0,23	0,60	0,027
S460ML				0,030	0,025									

^a For long products the P and S content can be 0,005 % higher.

^b For railway applications a maximum S content of 0,012 % may be agreed at the time of enquiry and order.

See option 32.

^c If sufficient other N-binding elements are present the minimum total Al content does not apply.

^d Cu content above 0,45 % may cause hot shortness during hot forming.

^e For long products a maximum C content of 0,17 % for grade S275 and a maximum C content of 0,18 % for grade S355 applies.

^f For long products of the grades S420 and S460 a maximum C content of 0,20 % applies.

Table 4 - Maximum CEV based on the ladle analysis for thermomechanical rolled steel ^a

Designation		Maximum CEV in % for nominal product thickness in mm				
According EN 10027-1 and CR 10260	According EN 10027-2	≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 120	> 120 ≤ 150 _b
S275M	1.8818	0,34	0,34	0,35	0,38	0,38
S275ML	1.8819					
S355M	1.8823	0,39	0,39	0,40	0,45	0,45
S355ML	1.8834					
S420M	1.8825	0,43	0,45	0,46	0,47	0,47
S420ML	1.8836					
S460M	1.8827	0,45	0,46	0,47	0,48	0,48
S460ML	1.8838					

^a For the optional increase of elements which influence the CEV see 7.4.3.

^b The figures apply only for long products.

Table 5 - Mechanical properties at ambient temperature for thermomechanical rolled steel

Designation	Minimum yield strength R_{eH}^a MPa ^b					Tensile strength R_m^a MPa ^b					Minimum percentage elongation after fracture ^c % $L_0 = 5,65 \sqrt{S_0}$		
	Nominal thickness mm					Nominal thickness mm							
	≤ 16	> 16 ≤ 40	> 40 ≤ 63	> 63 ≤ 80	> 80 ≤ 100	> 100 ≤ 120	d	≤ 40	> 40 ≤ 63	> 63 ≤ 80		> 80 ≤ 100	> 100 ≤ 120
According to EN 10027-1 and CR 10260	275	265	255	245	245	240	370 to 530	360 to 520	350 to 510	350 to 510	350 to 510	350 to 510	24
S275M S275ML	355	345	335	325	325	320	470 to 630	450 to 610	440 to 600	440 to 600	440 to 600	430 to 590	22
S355M S355ML	420	400	390	380	370	365	520 to 680	500 to 660	480 to 640	470 to 630	460 to 620	460 to 620	19
S420M S420ML	460	440	430	410	400	385	540 to 720	530 to 710	510 to 690	500 to 680	490 to 660	490 to 660	17
S460M S460ML	<p>^a For plate, strip and wide flats with widths ≥ 600 mm the direction transverse (t) to the rolling direction applies. For all other products the values apply for the direction parallel (l) to the rolling direction.</p> <p>^b 1 MPa = 1 N/mm²</p> <p>^c For product thickness < 3 mm for which test pieces with a gauge length of $L_0 = 80$ mm shall be tested, the values shall be agreed at the time of the enquiry and order.</p> <p>^d For long products a thickness ≤ 150 mm applies.</p>												

Table 6 - Minimum values of impact energy for impact tests on longitudinal V-notch test pieces for thermomechanical rolled steel

Designation		Minimum values of impact energy in J at test temperatures, in °C						
According EN 10027-1 and CR 10260	According EN 10027-2	+ 20	0	- 10	- 20	- 30	- 40	- 50
S275M S355M S420M S460M	1.8818 1.8823 1.8825 1.8827	55	47	43	40 ^a	-	-	-
S275ML S355ML S420ML S460ML	1.8819 1.8834 1.8836 1.8838	63	55	51	47	40	31	27

^a This value corresponds with 27J at - 30 °C (see Eurocode 3).

Table 7 - Minimum values of impact energy for impact tests on transverse V-notch test pieces for thermomechanical rolled steel, when the impact test on transverse test pieces is agreed at the time of the order

See option 30

Designation		Minimum values of impact energy in J at test temperatures, in °C						
According EN 10027-1 and CR 10260	According EN 10027-2	+ 20	0	- 10	- 20	- 30	- 40	- 50
S275M S355M S420M S460M	1.8818 1.8823 1.8825 1.8827	31	27	24	20	-	-	-
S275ML S355ML S420ML S460ML	1.8819 1.8834 1.8836 1.8838	40	34	30	27	23	20	16

Annex A (informative)

List of corresponding former designations

Table A.1 - List of corresponding former designations

Designation according EN 10025-4		Equivalent former designations in				
		According EN 10113-3:1993		According EU 113-72	Germany	Italy according to UNI
S275M	1.8818	S275M	1.8818	Fe E 275 KG TM	-	Fe E 275 KG TM
S275ML	1.8819	S275ML	1.8819	Fe E 275 KT TM	-	Fe E 275 KT TM
S355M	1.8823	S355M	1.8823	Fe E 355 KG TM	StE355 TM	Fe E 355 KG TM
S355ML	1.8834	S355ML	1.8834	Fe E 355 KT TM	TStE355 TM	Fe E 355 KT TM
S420M	1.8825	S420M	1.8825	Fe E 420 KG TM	StE420 TM	-
S420ML	1.8836	S420ML	1.8836	Fe E 420 KT TM	TStE420 TM	-
S460M	1.8827	S460M	1.8827	Fe E 460 KG TM	StE460 TM	Fe E 460 KG TM
S460ML	1.8838	S460ML	1.8838	Fe E 460 KT TM	TStE460 TM	Fe E 460 KT TM

Annex B
(informative)

List of national standards which correspond with Euronorms referenced

Until the following Euronorms are transformed into European Standards, they may be either implemented or reference made to the corresponding national standards as listed in Table B.1.

NOTE Standards listed in Table B.1 are not supposed to be strictly similar although they deal with the same subjects.

Table B.1 — Euronorms with corresponding national standards

Euronorm	Corresponding national standard in										
	Germany	France	United Kingdom	Spain	Italy	Belgium	Portugal	Sweden	Austria	Norway	
19 ^a	DIN 1025 T5	NF A 45 205	BS 4	UNE 36-526	UNI 5398	NBN 533	NP-2116	SS 21 27 40	M 3262	-	
53 ^a	DIN 1025 T2 DIN 1025 T3 DIN 1025 T4	NF A 45 201	BS 4	UNE 36-527 UNE 36-528 UNE 36-529	UNI 5397	NBN 633	NP-2117	SS 21 27 50 SS 21 27 51 SS 21 27 52	-	NS 1907 NS 1908	
54 ^a	DIN 1026-1	NF A 45 007	BS 4	UNE 36-525	UNI-EU 54	NBN A 24-204	NP-338	-	M 3260	-	
ECSC IC 2	SEW 088	NF A 36 000	BS 5135	-	-	-	-	SS 06 40 25	-	-	

^a This Euronorm is formally withdrawn, but there are no corresponding EN's.

Bibliography

- [1] EN ISO 1461, *Hot dip galvanized coatings on fabricated iron and steel articles - Specifications and test methods (ISO 1461:1999)*.
- [2] EN ISO 14713, *Protection against corrosion of iron and steel structures – Zinc and aluminium coatings – Guidelines (ISO 14713:1999)*.
- [3] ECSC IC 2 (1983)²⁾, *Weldable fine-grained structural steels - Recommendations for processing, in particular for welding*.

²⁾ Until ECSC IC 2 is transformed into a CEN Technical Report, it can either be implemented or reference made to the corresponding national standards, the list of which is given in Annex B to this document.

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