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Weldable structural steels for fixed offshore structures - Technical delivery conditions

Schweißgeeignete Baustähle für feststehende Offshore-Konstruktionen - Technische Lieferbedingungen

Aciers de construction soudables destinés à la fabrication de structures marines fixes - Conditions techniques de livraison

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Weldable structural steels for fixed offshore structures - Technical delivery conditions

Aciers de construction soudables destinés à la fabrication
de structures marines fixes - Conditions techniques de
livraison

Schweißgeeignete Baustähle für feststehende Offshore-
Konstruktionen - Technische Lieferbedingungen

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

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Contents

	Page
Foreword.....	4
1 Scope	5
2 Normative references	5
3 Terms and definitions	7
4 Information to be supplied by the purchaser	9
4.1 General.....	9
4.2 Options	10
5 Dimensions, mass and tolerances.....	10
5.1 Dimensions and tolerances	10
5.2 Mass of steel	11
6 Classification and designation.....	11
6.1 Classification.....	11
6.2 Designation	11
7 Manufacturing process	12
7.1 Steel manufacturing process	12
7.2 Thickness limits and segregation control.....	12
7.3 Delivery condition.....	12
8 Requirements	13
8.1 General.....	13
8.2 Chemical composition	13
8.3 Mechanical properties	16
8.4 Technological properties	17
8.5 Surface condition and internal defects	17
9 Inspection and testing.....	19
9.1 General.....	19
9.2 Ex-mill supply.....	20
9.3 Merchant supply	21
9.4 Identification of cast.....	21
9.5 Delivery	21
10 Sampling	21
10.1 General.....	21
10.2 Frequency of testing	21
10.3 Preparation of samples and test pieces	22
10.4 Verification of chemical composition	24
11 Test methods.....	24
11.1 Chemical analysis	24
11.2 Mechanical tests	24
11.3 Non-destructive tests	25
11.4 Re-tests and re-submission for testing.....	26
12 Marking, bundling and protective coating	26
12.1 Die stamp and paint marking.....	26
12.2 Bundling	27
12.3 Colour coding.....	27
12.4 Protective coating.....	28
13 Options	28

Annex A (normative) Location of test samples for tensile and impact tests	46
Annex B (normative) Location of tensile test piece when two rolled surfaces cannot be retained	48
Annex C (normative when option 2 is specified by the purchaser) Details of manufacturing procedures to be supplied by the manufacturer for steels of groups 2 and 3	49
Annex D (normative when option 16 is specified by the purchaser) Cold forming characteristics for steel plate of groups 2 and 3	50
Annex E (normative when option 18 is specified by the purchaser) Weldability testing for steels of groups 2 and 3 and mechanical testing of butt welds	51
Annex F (normative when option 18 is specified by the purchaser) Weldability testing for steels of groups 2 and 3 - Bead-on-plate	68
Annex G (normative) Weldability testing for steels of groups 2 and 3 - Controlled thermal severity tests (CTS)	70
Bibliography	76

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[SIST EN 10225:2009](#)

<https://standards.iteh.ai/catalog/standards/sist/dc20b8c6-e2a7-43f7-a3c2-bf54ac8e5d0c/sist-en-10225-2009>

Foreword

This document (EN 10225:2009) has been prepared by Technical Committee ECISS/TC 10 “Structural steels - Grades and qualities”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2010, and conflicting national standards shall be withdrawn at the latest by January 2010.

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 10225:2001.

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

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1 Scope

This European Standard specifies requirements for weldable structural steels to be used in the fabrication of fixed offshore structures in the form of plates up to and including 150 mm thick. It also specifies sections up to 63 mm thick except for sections delivered in the as-rolled condition which are permitted up to 25 mm thick only. Seamless hollow sections up to and including 40 mm thick and high frequency electric resistance welded hollow sections up to and including 20 mm thick are specified. Greater thicknesses for sections and hollow sections may be agreed, provided the technical requirements of this European Standard are maintained.

For plates the thickness limitations are:

S355G2+N, S355G5+M, - up to and including 20 mm

S355G3+N, S355G6+M - up to and including 40 mm

S355G7+N, S355G8+N, S355G9+N, S355G10+N - up to and including 150 mm

S355G7+M, S355G8+M, S355G9+M, S355G10+M - up to and including 100 mm

S420G1+QT, S420G1+M, S420G2+QT, S420G2+M - up to and including 100 mm

S460G1+QT, S460G1+M, S460G2+QT, S460G2+M - up to and including 100 mm

The standard is applicable to steels for offshore structures, designed to operate in the offshore sector but not to steels supplied for the fabrication of subsea pipelines, risers, process equipment, process piping, and other utilities. It is primarily applicable to the North Sea Sector, but may also be applicable in other areas provided that due consideration is given to local conditions e.g. temperature.

In the case of hollow sections formed from plate with the seam fusion welded, this European standard covers only the requirements of the plate material.

Minimum yield strengths up to 460 MPa are specified together with low temperature impact properties at temperatures down to -40 °C.

This European standard applies to material supplied ex-mill or from merchant's stock.

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 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

EN 571-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

EN 895, *Destructive tests on welds in metallic materials — Transverse tensile tests*

EN 1011-1, *Welding — Recommendations for welding of metallic materials — Part 1: General guidance for arc welding*

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

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

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

EN 10225:2009 (E)

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

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

EN 10025-3, *Hot rolled products of structural steels — Part 3: Technical delivery conditions for normalized/normalized rolled weldable fine grain structural steels*

EN 10025-4, *Hot rolled products of structural steels — Part 4: Technical delivery conditions for thermomechanical rolled weldable fine grain structural steels*

EN 10025-6, *Hot rolled products of structural steels — Part 6: Technical delivery conditions for flat products of high yield strength structural steels in the quenched and tempered condition*

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

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

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 10045-1, *Metallic materials — Charpy impact test — Part 1: Test method*

EN 10052:1993, *Vocabulary of heat treatment terms for ferrous products*

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

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

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

EN 10079:2007, *Definition of steel products*

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

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

EN 10163-3, *Delivery requirements for surface conditions 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 10204, *Metallic products — Types of inspection documents*

EN 10210-1, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 1: Technical delivery conditions*

EN 10210-2, *Hot finished structural hollow sections of non-alloy and fine grain steels — Part 2: Tolerances, dimensions and sectional properties*

EN 10246-3, *Non-destructive testing of steel tubes — Part 3: Automatic eddy current testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of imperfections*

EN 10246-5, *Non-destructive testing of steel tubes — Part 5: Automatic full peripheral magnetic transducer/flux leakage testing of seamless and welded (except submerged arc welded) ferromagnetic steel tubes for the detection of longitudinal imperfections*

EN 10246-7, *Non-destructive testing of steel tubes — Part 7: Automatic full peripheral ultrasonic testing of seamless and welded (except submerged arc welded) steel tubes for the detection of longitudinal imperfections*

EN 10246-8, *Non-destructive testing of steel tubes — Part 8: Automatic ultrasonic testing of the weld seam of electric welded steel tubes for the detection of longitudinal imperfections*

EN 10246-12, *Non-destructive testing of steel tubes — Part 12: Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections*

EN 10246-14, *Non-destructive testing of steel tubes — Part 14: Automatic ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of laminar imperfections*

EN 10246-15, *Non-destructive testing of steel tubes — Part 15: Automatic ultrasonic testing of strip/plate used in the manufacture of welded steel tubes for the detection of laminar imperfections*

EN 10256, *Non-destructive testing of steel tubes — Qualification and competence of level 1 and 2 non-destructive testing personnel*

EN 10279, *Hot rolled steel channels — Tolerances on shape, dimensions and mass*

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

EN ISO 2566-1, *Steel — Conversion of elongation values — Part 1: Carbon and low alloy steels (ISO 2566-1:1984)*

EN ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers (ISO 4063:1998)*

EN ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method (ISO 6507-1:2005)*

EN ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation (ISO 6947:1993)*

EN ISO 8492, *Metallic materials — Tube — Flattening test (ISO 8492:1998)*

EN ISO 9934-1, *Non-destructive testing — Magnetic particle testing — Part 1: General principles (ISO 9934-1:2001)*

EN ISO 12737, *Metallic materials — Determination of plane-strain fracture toughness (ISO 12737:2005)*

EN ISO 14284:2002, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition (ISO 14284:1996)*

EN ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys (ISO 15614-1:2004+A1:2008)*

3 Terms and definitions

For the purposes of this standard, the following terms and definitions and those given in EN 10020:2000, EN 10021:2006, EN 10052:1993, EN 10079:2007 and EN ISO 14284:2002 apply:

EN 10225:2009 (E)

- 3.1
parent product**
product rolled from one piece of steel
- 3.2
manufacturer**
manufacturer of the steel products
- 3.3
supplier**
manufacturer of material supplied ex-mill or the merchant for material supplied from a merchant's stock (see Clause 1)
- 3.4
purchaser**
purchaser or his representative
- 3.5
concast**
material produced by a continuous casting process route
- 3.6
primary elements**
elements that are essential to the overall integrity of the installation including critical load transfer points and stress concentrations such as nodes
- NOTE This definition also includes bracing and piling.
- 3.7
secondary elements**
elements of minor importance, failure of which would be unlikely to affect the overall integrity of the installation
- 3.8
seamless hollow section (S)**
hollow long product, open at both ends, of circular, square or rectangular section, made by piercing a solid product to obtain a tube hollow which is further processed, hot or cold, into its final dimensions
- 3.9
high frequency welded hollow section (HFW)**
hollow long product, open at both ends, of circular, square or rectangular section, made by pressure welding in a continuous or non-continuous process, in which strip is formed cold into a hollow profile and the seam weld made by heating the adjacent edges through the resistance to the passage of a high frequency current and pressing the edges together
- NOTE The electric current may be applied by direct electrode contact or by induction. After welding, the tube hollow is further processed, hot or cold, into its final dimensions.
- 3.10
normalizing rolling**
rolling process in which the final deformation is carried out in a particular temperature range leading to a material condition equivalent to that obtained after normalizing so that the specified values of the mechanical properties are retained even after normalizing

NOTE 1 For the purposes of this European standard, the designation of this delivery condition and of the normalized condition is +N.

NOTE 2 In international publications for both normalizing rolling and thermomechanical rolling, the expression "controlled rolling" may be found. However, in view of the different applicability of the products a distinction of the terms is necessary.

3.11

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 For the purposes of this European standard, the designation of this delivery condition is +M.

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.

3.12

quenching and tempering

3.12.1

quenching

operation which consists of cooling a ferrous product more rapidly than in still air

NOTE Quenching also includes direct quenching.

3.12.2

tempering

heat treatment applied to a ferrous product generally after quench hardening or other heat treatment to bring the properties to the required level

NOTE 1 It consists of heating to specific temperatures ($< A_c1$) and soaking one or more times followed by cooling at an appropriate rate.

NOTE 2 For the purposes of this European standard, the designation of delivery condition quenched and tempered is +QT.

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4 Information to be supplied by the purchaser

4.1 General

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

- a) details of the product form;
- b) number of this European standard i.e. EN 10225;
- c) the steel grade (steel name or steel number);
- d) the type of inspection documents required (see 9.1);
- e) where applicable, the number of additional copies of inspection documents required and the forwarding address (see 9.2);
- f) nominal dimensions and when necessary tolerances;
- g) where applicable, that the material is required for the manufacture of piling;
- h) purchaser's order number and item number if applicable;
- i) quantity.

EN 10225:2009 (E)**4.2 Options**

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

5 Dimensions, mass and tolerances**5.1 Dimensions and tolerances**

5.1.1 The dimensions and tolerances of the product shall be in accordance with one of the following relevant European Standards and as further specified in 5.1.2 and 5.1.3:

EN 10024, EN 10029, EN 10034, EN 10055, EN 10056-2, EN 10067, EN 10210-2, EN 10279.

5.1.2 Unless otherwise agreed plate thickness tolerances shall be in accordance with EN 10029 Class A.

See option 1.

5.1.3 On plates, with ripples or corrugations less than 2 m apart (peak to peak) the following criteria shall apply.

- a) The flatness tolerance shall, in all cases, be measured to the upper surface of the plate laid on a level surface;
- b) The maximum depth of any ripple or corrugation under the 2 m straight edge shall be 5 mm. The average depth of all ripples on any one plate shall not exceed 4 mm;
- c) The minimum depth to constitute a ripple or corrugation shall be 2 mm;
- d) The maximum number of ripples or corrugations allowed in any one plate shall be as given in Tables 1 and 2, and shall apply to all plates 10 mm thick and over and for all plate widths.

Table 1 — Maximum number of ripples or corrugations in plate with thickness ≥ 12 mm

Length (L) m	Maximum number of ripples or corrugations
$L \leq 6$	2
$6 < L \leq 9$	3
$9 < L \leq 12$	4
$12 < L \leq 15$	5

Table 2 — Maximum number of ripples or corrugations inplate with thickness ≥ 10 mm < 12 mm

Length (L) m	Maximum number of ripples or corrugations
$L \leq 6$	4
$6 < L \leq 9$	5
$9 < L \leq 12$	6
$12 < L \leq 15$	8

5.2 Mass of steel

The calculated mass shall be determined using a density of 7,85 kg/dm³.

6 Classification and designation

6.1 Classification

The steel grade S355 specified in this European Standard is classified as alloy quality steel and the steel grades S420 and S460 specified in this European Standard are classified as alloy special steels according to EN 10020.

This standard includes the following grades:

- Group 1 grades with few changes from EN 10025 Parts 1, 3 and 4 and EN 10210-1: (minor changes to chemical analysis, CEV and impact requirements only);
- Groups 2 and 3 grades substantially modified from EN 10025 Parts 1, 3 and 4 and EN 10210-1 including qualities with enhanced through-thickness ductility.

6.2 Designation

For the steel grades covered by this European Standard the steel names are based on EN 10027-1. The steel numbers are allocated in accordance with EN 10027-2.

The designation consists of:

- the number of this European Standard i.e. EN 10225;
- the symbol S;
- the indication of the minimum specified yield strength for thicknesses ≤ 16 mm expressed in MPa;
- the letter G, followed by the relevant digit(s) characterizing the steel grade;
- where applicable, the letter indicating the delivery condition i.e. +N, +M or +QT (see 7.3).

EN 10225:2009 (E)**7 Manufacturing process****7.1 Steel manufacturing process**

The steels shall be made by the basic oxygen or basic electric arc furnace process. All steels shall be fully killed and made to fine grain practice.

In addition, steels of group 3 shall be vacuum degassed or ladle refined.

See option 2.

7.2 Thickness limits and segregation control

7.2.1 For concast steels of groups 2 and 3, provided that the resultant products comply with all the relevant requirements of this European Standard, the maximum thickness of product from the continuous casting process shall be at the manufacturer's discretion.

See option 3.

7.2.2 The minimum rolling reduction ratio of concast material for plate shall be 4:1 except for piling where it shall be 3:1.

See option 4.

7.2.3 Intermediate or finished products, produced by the continuous casting route shall be examined for centre line segregation in accordance with the manufacturer's procedures and as agreed by the purchaser. This does not apply to seamless hollow sections.

See option 2.

7.3 Delivery condition

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7.3.1 Plates of group 1

Plates shall be supplied in the furnace normalized/normalized rolled (+N) or thermomechanically rolled (+M) condition. The customer shall specify the appropriate grade at the time of enquiry and order.

Delivery conditions (+N) and (+M) are limited to a maximum thickness of 40 mm.

See option 5.

Examples:

- a) Plate to grade S355G2+N

Plate with few changes from EN 10025-3 and with minimum specified $R_e = 355$ MPa and impact values verified at -20 °C, supplied in the normalized or normalized rolled condition.

- b) Plate to grade S355G6+M

Plate with few changes from EN 10025-4 and with minimum specified $R_e = 355$ MPa and impact values verified at -40 °C, supplied in the thermomechanically rolled condition.

7.3.2 Plates of groups 2 and 3

Plates shall be supplied in the furnace normalized (+N), thermomechanically rolled (+M) or quenched and tempered (+QT) condition. The customer shall specify the appropriate grade at the time of enquiry and order.

Delivery condition (+N) is limited to a maximum thickness of 150 mm and delivery conditions (+M) and (+QT) to 100 mm.

See option 5.

EXAMPLE

- a) Plate to grade S355G7+N (or S355G7+M)

Plate substantially modified from EN 10025-3 (or EN 10025-4) and with minimum specified $R_e = 355$ MPa and impact values verified at -40 °C, supplied in the normalized or normalized rolled (or thermomechanically rolled) condition.

NOTE The normalized rolled condition is only permitted when option 5 has been called up.

- b) Plate to grade S460G2+QT (or S460G2+M)

Plate substantially modified from EN 10025-6 (or EN 10025-4), with controlled chemistry, particularly carbon, minimum specified $R_e = 460$ MPa and impact values verified at -40 °C with specified through-thickness properties, supplied in the quenched and tempered (or thermomechanically rolled) condition.

7.3.3 Sections

Sections shall be supplied in the as-rolled, normalized/normalized rolled (+N) or thermomechanically rolled (+M) condition as shown in Tables 11 and 12, at the manufacturer's discretion.

The as-rolled delivery condition is limited to a maximum thickness of 25 mm.

7.3.4 Hollow sections

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Hollow sections shall be supplied in the normalized/normalized rolled (+N) or quenched and tempered (+QT) condition as shown in Tables 13 to 16 at the manufacturer's discretion.

NOTE S420 and S460 grades are normally only available in circular form.

8 Requirements

8.1 General

In addition to the requirements of this European Standard, the general technical delivery requirements specified in EN 10021 also apply.

8.2 Chemical composition

8.2.1 Cast analysis

- The chemical composition for all qualities determined by cast analysis shall comply with the values in Tables 6, 11, 13 and 15.
- For residual element control in steels of groups 2 and 3, boron (B) shall not be intentionally added to the steel. The deliberate addition of any elements other than those listed in Tables 6, 11, 13 and 15 shall not be permitted.
- When a restricted cast analysis is agreed for steels of groups 2 and 3, the steel shall comply with the agreed analysis range.

See option 7.