UDC 669.14-423 : 669.14.018.29 : 620.1

August 1993

Steel products with improved deformation properties perpendicular to the surface of the product

Technical delivery conditions

English version of DIN EN 10 164

DIN EN 10164

Stahlerzeugnisse mit verbesserten Verformungseigenschaften senkrecht zur Erzeugnisoberfläche; technische Lieferbedingungen

Supersedes DIN 50 180, July 1989 edition.

European Standard EN 10 164 : 1993 has the status of a DIN Standard.

A comma is used as the decimal marker.

National foreword

This standard has been prepared by ECISS/TC 10.

The responsible German body involved in its preparation was the *Normenausschuß Eisen und Stahl* (Steel and Iron Standards Committee), Technical Committee *Stähle für den Stahlbau*.

The present standard covers structural steel that is required to have improved deformation properties perpendicular to the surface of the product, and is intended to supplement the requirements already laid down in other relevant quality standards.

In keeping with the specifications given in *Stahl-Eisen-Lieferbedingungen* (Iron and steel delivery conditions) SEL 096 (March 1988 edition), issued by the *Verein Deutscher Eisenhüttenleute* (Society of German Ferrous Metallurgists), this standard specifies three quality classes as a function of the amount of reduction of area based on tensile testing (namely, 15, 25 and 35 %), and specifies the same requirements as SEL 096 with regard to ultrasonic testing.

Standards referred to

See **Normative references.**

Previous edition

DIN 50 180: 07.89.

Amendments

In comparison with the July 1989 edition of DIN 50 180, the following amendments have been made.

a) Improved deformation properties perpendicular to the surface of the product are now characterized by a measure of the reduction of area and by ultrasonic testing, determination of these properties having been brought into line with SEL 096.

b) Some of the specifications given for sampling and the preparation and size of test pieces have been revised.

c) The symbols denoting test piece shape are no longer included.

International Patent Classification

B 22 D 011/12
C 21 D 001/00
C 22 C 038/00
G 01 L 001/00
G 01 N 033/20

Continued overleaf.

EN comprises 6 pages.

Editor's note

*This standard reproduces the official text of the English version of EN 10 164 as issued by CEN. In its preparation for publication as DIN EN 10 164 (English version), certain points have been noted which we consider to be in need of correction. These have been marked *). The suggested amendments are given below and will be forwarded to the responsible CEN Secretariat for its consideration.*

In presentation, orthography, punctuation and hyphenation, the aim has been to implement the PNE Rules consistently. Obvious errors (e.g. redundancies and omissions) have been rectified without further reference.

Suggested amendments

1 *For ease of comprehension, the second sentence of subclause 3.2 should be amended to read: 'In the event ... options, the material shall be supplied in accordance with the general requirements specified here.'*

2 *It should be noted that the last sentence of subclause 6.3.2 does not appear in the German version.*

3 *By way of correction, the second sentence of subclause 6.5 should be amended to read: 'These two products shall satisfy the requirements specified in this European Standard.'*

4 *To avoid confusion, the title of subclause 6.6 should be amended to read: 'Invalid test results' and the associated subclause: 'The specifications of EN 10 021 shall apply with regard to test results which are to be deemed invalid. A fracture in the weld or in the heat-affected zone shall also be reason to consider the test invalid.'*

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 10164

June 1993

UDC 669.14-423 : 669.14.018.29 : 620.1

Descriptors: Iron and steel products, hot rolled products, sheet, plate, wide flats, strip, metal sections, steel, quality classes, tests, delivery.

English version

Steel products with improved deformation properties perpendicular to the surface of the product

Technical delivery conditions

Aciers de construction avec caractéristiques de déformation améliorées dans le sens perpendiculaire à la surface du produit; conditions techniques de livraison

Stahlerzeugnisse mit verbesserten Verformungseigenschaften senkrecht zur Erzeugnisoberfläche; technische Lieferbedingungen

This European Standard was approved by CEN on 1993-06-20.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

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

CEN members are the national standards bodies of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Central Secretariat: rue de Stassart 36, B-1050 Brussels

Ref. No. EN 10 164 : 1993 E

Contents

Foreword

This European Standard has been drawn up by ECISS/TC 10 'Structural steel; quality standards', the Secretariat of which is held by NNI.

This European Standard replaces

EURONORM 164-83 'Steel flat products with specified through thickness properties; technical delivery conditions'.

Within the framework of the European Committee for Iron and Steel Standardization (ECISS) programme, TC 10 was assigned the task of revising the above EURONORM, which dealt only with flat products, and of preparing a more comprehensive European Standard.

At its meeting in September 1991, ECISS/TC 10 approved the present document and agreed to submit it to Formal Vote. The following countries were represented at that meeting: Austria, Belgium, Denmark, Finland, France, Germany, Italy, Luxembourg, the Netherlands, Sweden and United Kingdom.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, and conflicting national standards withdrawn, by December 1993 at the latest.

In accordance with the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Steel plate, strip, wide flats and sections normally have deformation properties perpendicular to the surface ('through thickness', for short) which are different from those parallel to the surface. This anisotropy may lead to difficulties (e.g. lamellar tearing) in welded structures.

It is, however, possible to improve the through thickness properties by means of additional procedures during steelmaking.

Through thickness properties are characterized in this standard by specified minimum values for reduction of area, established during tensile testing.

There is no direct relationship between these values and the integrity of structures, because the risk of lamellar tearing is also affected by the type of structure, weld design and welding procedure. The minimum values for reduction of area specified in this standard cannot therefore by themselves be regarded as ensuring safety against occurrence of lamellar tearing.

However, the reduction of area is a good general guide to lamellar tear resistance, i.e. the risk of lamellar tearing decreases with increased reduction of area during tensile testing.

1 Scope

This European Standard specifies through thickness properties and associated test methods for steel plate, strip, wide flats and sections.

This European Standard may be applied as a supplement to all product standards for plate, strip, wide flats and sections made from killed steels, except for stainless steel. It covers products having a thickness between 15 mm and 250 mm inclusive, made from steel with a specified minimum upper yield strength, R_{eH}, or proof strength, $R_{p0,2}$, $\leq 500\ N/mm^2$ for which improved through thickness properties are required.

The application of this European Standard to other thicknesses and other steel types shall be the subject of agreement at the time of ordering.

Option 1.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 10 002-1	Metallic materials; tensile testing. Part 1: Method of test at ambient temperature
EN 10 021	General technical delivery conditions for steel and steel products
EURONORM 160-85[1)]	Ultrasonic testing of steel plate in thicknesses ≥ 6 mm (reflection method)
EURONORM 186-87[1)]	Ultrasonic testing of broad flanged beams with parallel flanges and IPE beams

3 Information to be supplied by the purchaser

3.1 General

The following information shall be supplied by the purchaser at the time of ordering:

a) the designation of the steel grade (according to the relevant product standard);

b) the symbol denoting the quality class (see table 1).

Where no specific choice is made by the purchaser, the supplier shall consult with the purchaser.

3.2 Options

A number of options is specified in clause 8. 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.*)

4 Designation

Products with requirements for improved deformation properties perpendicular to the surface of the product shall be designated as follows:

- the designation of the steel grade (according to the relevant product standard);
- the number of this European Standard (EN 10 164);
- the symbol denoting the quality class (according to table 1).

EXAMPLE:

Steel in accordance with EN 10 113-2, of grade S355N, with improved deformation properties perpendicular to the surface of the product as specified in EN 10 164, of class Z25:

Steel EN 10 113-2-S355N + EN 10 164-Z25

5 Requirements

5.1 Reduction of area

Table 1 gives minimum values for reduction of area for the specified quality classes.

NOTE: Reduction of area (Z) is defined in EN 10 002-1 : 1990 as

$$\left(\frac{S_o - S_u}{S_o}\right) \times 100,$$

where

S_o is the original cross-sectional area of the parallel length;

S_u is the lowest cross-sectional area after fracture.

The purchaser shall select one of the quality classes at the time of ordering.

For plate, strip and wide flats, the minimum values for reduction of area apply to the whole product.

For sections, the minimum values for reduction of area apply to either the flange or the web, depending on where the samples are taken (see 6.2.3).

Table 1: Quality classes and minimum values for the reduction of area

Quality class	Reduction of area, in %	
	Minimum average value from three tests	Minimum individual value
Z15	15	10
Z25	25	15
Z35	35	25

5.2 Ultrasonic testing

Flat products shall undergo ultrasonic testing in accordance with EURONORM 160-85. Sections shall undergo ultrasonic testing in accordance with EURONORM 186-87.

Unless otherwise agreed at the time of ordering, plate and wide flats shall meet the requirements of class A in accordance with EURONORM 160-85, and sections shall meet the requirements of class 22 in accordance with EURONORM 186-87, table 2.

Option 2.

NOTE: Ultrasonic testing does not give an indication of the susceptibility to lamellar tearing.

[1)] Prior to adoption as European Standards, these EURONORMs or corresponding national standards (the list of which is given in Annex A) may be applied.

6 Testing

6.1 Test units

Each consignment shall be subdivided into test units in accordance with 6.1.1 to 6.1.3.

6.1.1 Sheet, plate and coil

The test units for sheet, plate and coil, of quality class Z15, Z25 or Z35, are based on the sulfur content as determined by ladle analysis, and are given in table 2.

Table 2: Test units for sheet, plate and coil

Quality class	Test unit for $S > 0{,}005\%$ [1]		Test unit for $S \leq 0{,}005\%$ [1]
	Parent plate or coil [2]	max. 40 t [3]	Cast [4]
Z15	Subject to agreement	× [5]	×
Z25	×	–	× [5]
Z35	×	–	× [5]

[1] Determined by ladle analysis.
[2] Coil applies to wide strip, narrow strip and slit strip.
[3] Or part thereof in the case of products originating from the same cast, having undergone the same heat treatment.
[4] Products having undergone the same heat treatment.
[5] Unless otherwise agreed at the time of ordering. Option 3.

6.1.2 Wide flats

The test unit for wide flats shall consist of products from the same cast, having undergone the same heat treatment, with a total mass of max. 10 t for products of nominal thickness ≤ 25 mm and max. 20 t for products of nominal thickness > 25 mm.

6.1.3 Sections

The test unit for sections shall consist of products from the same cast having been subjected to the same heat treatment, with a total mass of max. 40 t or part thereof.

6.2 Sampling and number of test pieces

6.2.1 One sample shall be taken from each test unit according to 6.1, from which six tensile test pieces can be taken.

6.2.2 For flat products according to 6.1.1 and 6.1.2, the sample shall be taken from one end of the product. These samples shall be taken for ingot cast material on the longitudinal axis of the product, and for continuously cast material, they may be taken at the manufacturer's discretion either on the longitudinal axis of the product or from approximately midway between the edge and the longitudinal axis of the product.

6.2.3 For sections, the sample shall be taken from one end of the product. The sample shall be taken from the flange, unless otherwise agreed at the time of ordering. The location from which samples are taken is indicated in figure 1.

Option 4.

6.2.4 Only three tensile test pieces shall be machined from the sample, the remaining test pieces being kept in reserve in the event that retests are required (see 6.4.2.1 to 6.4.2.3).

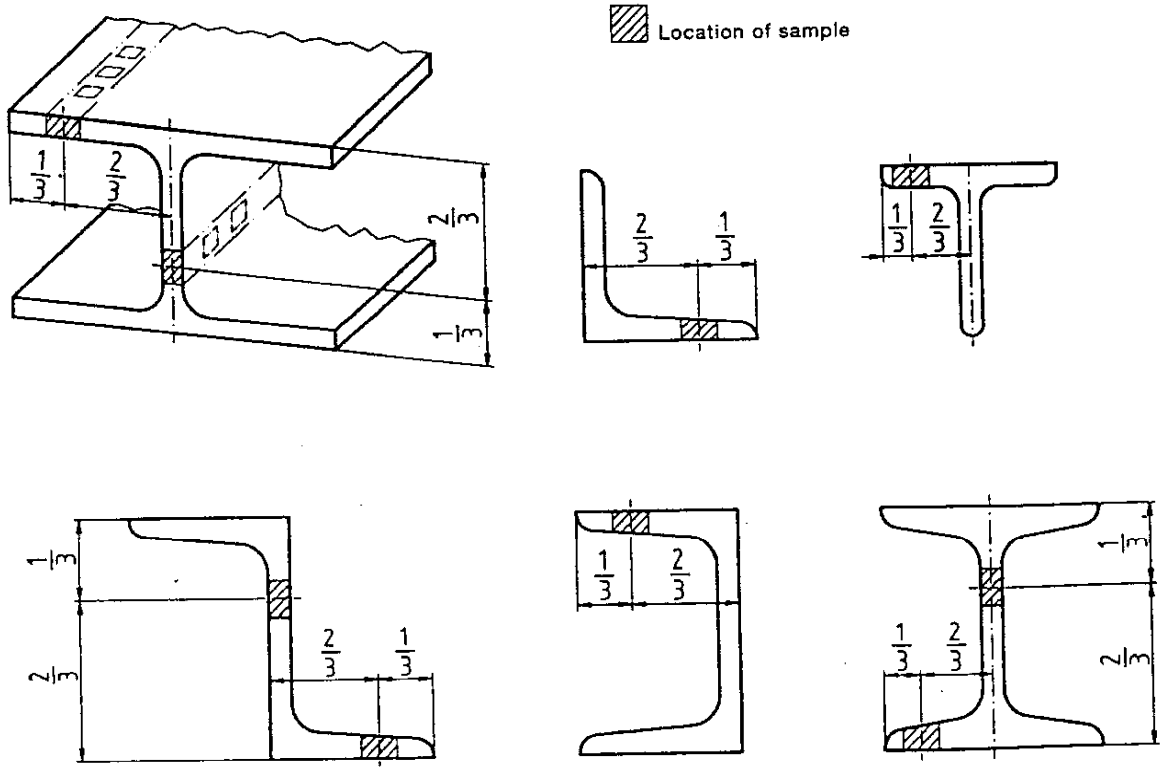

Figure 1: Locations from which samples are to be taken from sections

6.3 Selection and preparation of test pieces

6.3.1 From the sample obtained in accordance with 6.2, three full thickness test pieces shall be taken. The cross section of each test piece shall be sufficient to permit the removal of any heat-affected or work-hardened zone resulting from machining the test pieces. The balance of the sample shall be kept in reserve in the event that retests are required.

6.3.2 From the specimens obtained in accordance with 6.3.1, test pieces with or without extension pieces shall be prepared in accordance with the procedures given in 6.3.2.1 and 6.3.2.2, as appropriate.

Extension pieces are:

- mandatory for 15 mm $\leq t \leq$ 20 mm;
- optional for 20 mm $< t \leq$ 100 mm;
- not permitted for $t >$ 100 mm,

where t the product thickness.

The axis of the test pieces shall be perpendicular to the surface.+)

6.3.2.1 Test pieces with extension pieces (see figure 2)

Prior to any welding, all rust, scale and grease shall be removed from the contact surfaces of the specimen.

a) Extension pieces are welded to both surfaces of the specimen using friction welding or another suitable method, in such a way as to ensure a minimum heat-affected zone.

For specimens taken from sections with non-parallel surfaces, one surface shall be machined so as to be parallel to the other. In the case of I beams with tapered flanges, the inside surface shall always be machined.

b) The test pieces shall have the following diameter, d_o:

d_o = 6 mm or 10 mm for 15 mm $\leq t \leq$ 25 mm;

d_o = 10 mm for 25 mm $< t \leq$ 100 mm,

where t is the product thickness.

c) The parallel length of the test piece, L_c, shall be at least 1,5 × d_o and shall not exceed 10 mm. The heat-affected zone shall not lie along length L_c.

6.3.2.2 Test pieces without extension pieces (see figures 3 and 4)

a) The test pieces shall have the following diameter, d_o:

d_o = 6 mm for 20 mm $< t \leq$ 40 mm;

d_o = 10 mm for 40 mm $< t \leq$ 250 mm,

where t is the product thickness.

b) The parallel length of the test piece, L_c, shall be at least 1,5 × d_o and shall not exceed 100 mm.

c) For products ≤ 100 mm thick, the total length of the test piece, L_t, shall be equal to the full product thickness, t.

d) For products > 100 mm and ≤ 250 mm thick, the total length of the test piece, L_t, shall be such that L_c contains the ¼ thickness position of the product.

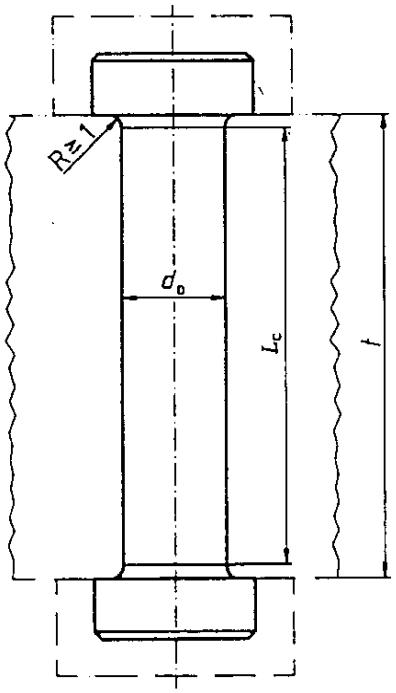

Figure 2: Type and preparation of test pieces with two extension pieces, where 15 mm ≤ t ≤ 100 mm

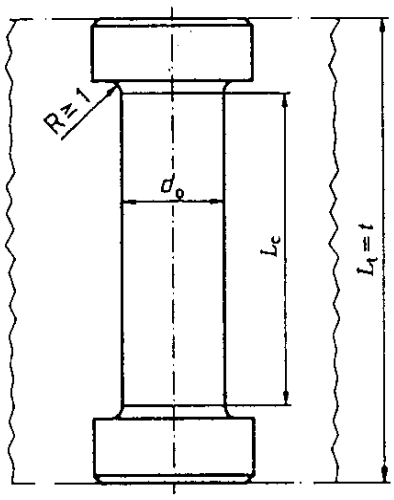

Figure 3: Type and preparation of test pieces without extension pieces, where 20 mm < t ≤ 100 mm

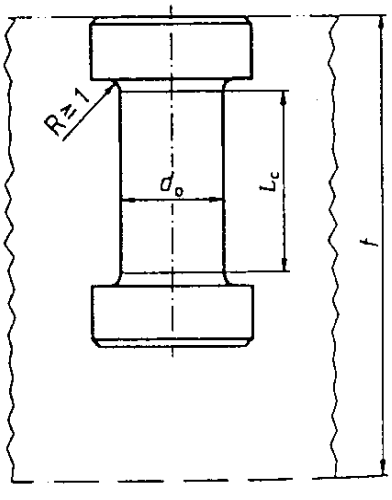

Figure 4: Type and preparation of test pieces without extension pieces, where 100 mm < t ≤ 250 mm

6.4 Testing procedures

6.4.1 The tensile test and the determination of reduction of area shall be carried out in accordance with EN 10 002-1. The assessment of the results shall be based on a sequential method (as defined in EN 10 021). The results established for three test pieces according to 6.2.4 shall comply with the values specified in table 1 for the quality class ordered.

6.4.2.1 The average value from a set of three test pieces shall meet the specified requirement. One individual value may be lower than the specified minimum average value, but not lower than the specified minimum individual value.

6.4.2.2 If the conditions of 6.4.2.1 are not satisfied, then an additional set of three test pieces shall be taken from the same sample and tested. To consider the test unit as conforming to this standard, after testing the second set, all of the following conditions shall be satisfied:

i) the average value from six tests shall be equal to or greater than the specified minimum average value;

ii) not more than two of six individual values shall be lower than the specified minimum average value;

iii) not more than one of six individual values shall be lower than the specified minimum individual value.

6.4.2.3 If these conditions are not satisfied, the sample product shall be rejected and retests carried out on the remainder of the test unit, if applicable (see 6.5).

6.5 Retesting

Except in cases where the test unit is the parent plate or the coil (see 6.1.1), a repeat series of three tests shall be carried out on each of two different products from the remainder of the test unit. These two series of tests shall meet the requirements.*) In this case, 6.4.2.2 and 6.4.2.3 no longer apply.

If one of these retests does not meet the requirements of this European Standard, the remainder of the test unit shall be retested, product by product.

Each tested product which does not meet the requirements shall be rejected.

6.6 Invalidation of tests*)

The requirements of EN 10 021 shall apply with the addition that a fracture in the weld or in the heat-affected zone is also a reason for invalidation.

7 Complaints

EN 10 021 shall apply in respect of complaints after delivery and of handling them.

8 Marking

The product shall be marked according to the relevant product standard and with the quality class (see 5.1).

EXAMPLE:

S355N + Z15

9 Options

1) Whether other product thicknesses or steel grades are applicable (see clause 1).

2) Whether ultrasonically tested plates and wide flats shall meet requirements other than those for class A in accordance with EURONORM 160-85, or whether sections shall meet requirements other than those for class 22 in accordance with EURONORM 186-87, table 2 (see 5.2).

3) Whether different test units are required for flat products (see table 2, footnote 5).

4) Whether the samples are to be taken from a position other than the flange of sections (see 6.2.3).

Annex A (informative)

List of national standards which correspond to the EURONORMs referred to

Prior to adoption as European Standards, these EURONORMs or a corresponding national standard may be applied.

Table A.1: EURONORMs and related national standards

EURONORM	Corresponding national standard in				
	Germany	France	United Kingdom	Spain	Italy
160	SEL 072-77	NF A 04-305	BS 5996	–	UNI-EU 160
186	–	NF A 04-308	–	–	