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Livarstvo – Železove litine s kompaktnim (vermikularnim) grafitom

Founding - Compacted (vermicular) graphite cast irons

Gießereiwesen - Gusseisen mit Vermiculargraphit

Fonderie - Fontes à graphite vermiculaire (compacté)

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Fonderie - Fontes à graphite vermiculaire (compacté)

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Foreword

This document (prEN 16079:2010) has been prepared by Technical Committee CEN/TC 190 "Foundry technology", the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 5 "Grey cast irons and compacted graphite cast irons" to prepare:

prEN 16079, *Founding — Compacted (vermicular) graphite cast irons*

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

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Introduction

This European Standard deals with the classification of compacted (vermicular) graphite cast irons (CGI), in accordance with the mechanical properties of the material.

The properties of compacted (vermicular) graphite cast irons depend on their graphite and matrix microstructure.

The mechanical properties of the material can be evaluated on machined test pieces prepared from

- separately cast samples,
- side by side cast samples;
- cast-on samples, or
- samples cut from a casting

Annex A (informative) gives additional information on properties and typical applications of compacted (vermicular) graphite cast irons.

Compacted (vermicular) graphite cast irons can be used for pressure equipment. Annex ZA gives information relating to the conformance of compacted (vermicular) graphite cast irons to the Pressure Equipment Directive 97/23/EC.

The suitable material grades for pressure applications and the conditions for their use are given in specific product or application standards. For the design of pressure equipment, specific design rules apply.

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1 Scope

This European Standard defines the grades and the corresponding requirements for compacted (vermicular) graphite cast irons.

This European Standard specifies 5 grades of compacted (vermicular) graphite cast iron by a classification based on mechanical properties measured on machined test pieces prepared from cast samples.

This standard does not cover technical delivery conditions for iron castings, see EN 1559-1 [1] and EN 1559-3 [2].

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 10204, *Metallic products — Types of inspection documents*.

EN ISO 945-1, *Cast iron — Designation of microstructure of cast irons — Part 1: Graphite classification by visual analysis* (ISO 945-1:2008)

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

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

NOTE Informative references to documents used in the preparation of this European standard, and cited within square brackets at appropriate places in the text, are listed in the Bibliography.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

compacted (vermicular) graphite cast iron

cast material, iron and carbon based, the carbon being present mainly in the form of compacted (vermicular) graphite particles that appear vermicular on a two-dimensional plane of polish, the graphite particles being embedded in a matrix consisting of ferrite, ferrite/pearlite, or pearlite

3.2

graphite modification treatment

process that brings the liquid iron into contact with a substance to produce graphite in the predominantly compacted (vermicular) form during solidification

3.3

vermicularity

percentage of graphite particles that are of form III according EN ISO 945-1

3.4

cast sample

quantity of material cast to represent the cast material, including separately cast sample, side by side cast sample and cast-on sample

3.5

separately cast sample

sample cast in a separate sand mould under representative manufacturing conditions and material grade

prEN 16079:2010 (E)**3.6****side-by-side cast sample**

sample cast in the mould alongside the casting, with a joint running system

3.7**cast-on sample**

sample attached directly to the casting

3.8**relevant wall thickness**

section of the casting, agreed between the manufacturer and the purchaser, to which the determined mechanical properties shall apply

4 Designation

The material shall be designated either by symbol or by number as given in Table 1.

NOTE Comparison of prEN 16079 grade designations to the grades from the current ISO standard for compacted (vermicular) cast iron, ISO 16112 [3], is given in Annex B.

5 Order information

The following information shall be supplied by the purchaser:

- a) complete designation of the material in combination with the relevant wall thickness;

NOTE The material grade is derived from the relevant wall thickness and the required mechanical properties.

- b) special requirements that have to be agreed upon between the manufacturer and the purchaser by the time of acceptance of the order e.g. technical delivery conditions according to EN 1559-1 and EN 1559-3.

6 Manufacture

The method of producing compacted (vermicular) graphite cast iron and its chemical composition shall be left to the discretion of the manufacturer, who shall ensure that the requirements of this European Standard are met for the material grade specified in the order.

NOTE When compacted (vermicular) graphite cast iron is to be used for special applications, the chemical composition and heat treatment may be agreed between the manufacturer and the purchaser.

7 Requirements**7.1 General**

The property values apply to compacted (vermicular) graphite cast iron cast in sand moulds or moulds of comparable thermal behaviour. Subject to amendments to be agreed upon in the order, they can apply to castings obtained by alternative methods.

The material designation is based on the minimum mechanical properties obtained in cast samples with a thickness or diameter of 25 mm.

Mechanical properties are wall thickness dependant as shown in Table 1.

NOTE Tensile testing requires sound test pieces in order to guarantee pure uni-axial stress during the test.

7.2 Test pieces machined from cast samples

The mechanical properties of compacted graphite cast iron shall be as specified in Table 1

Table 1 — Mechanical properties measured on test pieces machined from cast samples

| Material designation | | Relevant wall thickness t mm | 0,2 % proof strength $R_{p0,2}$ MPa min. | Tensile strength R_m MPa min. | Elongation A % min. |
|----------------------|--------|--------------------------------------|---|--|--------------------------------|
| Symbol | Number | | | | |
| EN-GJV-300 | 5.2100 | $t \leq 30$ | 210 | 300 | 2,0 |
| | | $30 < t \leq 60$ | 195 | 275 | 2,0 |
| | | $60 < t \leq 200$ | 175 | 250 | 2,0 |
| EN-GJV-350 | 5.2200 | $t \leq 30$ | 245 | 350 | 1,5 |
| | | $30 < t \leq 60$ | 230 | 325 | 1,5 |
| | | $60 < t \leq 200$ | 210 | 300 | 1,5 |
| EN-GJV-400 | 5.2201 | $t \leq 30$ | 280 | 400 | 1,0 |
| | | $30 < t \leq 60$ | 260 | 375 | 1,0 |
| | | $60 < t \leq 200$ | 230 | 325 | 1,0 |
| EN-GJV-450 | 5.2300 | $t \leq 30$ | 315 | 450 | 1,0 |
| | | $30 < t \leq 60$ | 280 | 400 | 1,0 |
| | | $60 < t \leq 200$ | 260 | 375 | 1,0 |
| EN-GJV-500 | 5.2301 | $t \leq 30$ | 350 | 500 | 0,5 |
| | | $30 < t \leq 60$ | 315 | 450 | 0,5 |
| | | $60 < t \leq 200$ | 280 | 400 | 0,5 |

NOTE 1 1 MPa = 1 N/mm²

NOTE 2 For relevant wall thicknesses more than 200 mm, the manufacturer and the purchaser shall agree on the type and size of the cast sample and the minimum values to be obtained.

7.3 Test pieces machined from samples cut from a casting

If applicable, the manufacturer and the purchaser shall agree on:

- the location(s) on a casting where the sample(s) shall be taken;
- the mechanical properties that shall be measured;
- the minimum values, or allowable range of values, for these mechanical properties (for information, see Annex D).

NOTE 1 The properties of castings are not uniform, depending on the complexity of the castings and variation in their section thickness.

NOTE 2 Mechanical properties for test pieces cut from a casting are affected not only by material properties (subject of this standard) but also by the local casting soundness (not subject of this standard).

prEN 16079:2010 (E)**7.4 Hardness**

Casting hardness and its range values shall only be specified when agreed between the manufacturer and the purchaser.

Information regarding hardness is given in Annex E.

7.5 Graphite structure

Compacted (vermicular) graphite cast irons shall have a minimum of 80 % of the graphite particles in the vermicular form (form III in accordance with EN ISO 945-1), when viewed on a two-dimensional plane of polish. The remaining 20 % of the graphite particles should be of form IV, form V and form VI in accordance with EN ISO 945-1.

Flake (lamellar) graphite (form I and form II according to EN ISO 945-1) is not permitted, except at the rim zone of the casting. The thickness of the rim zone shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order.

Although the definition of compacted (vermicular) graphite cast iron is within the range of 80 % to 100 % of graphite particles of form III, a separate agreement may be made for a lower limit. However this limit shall be not less than 70 %.

NOTE This could be the case for parts which require higher strength and/or parts with large wall thickness.

Compacted (vermicular) graphite cast iron reference images are shown in Annex F.

8 Sampling**8.1 General**

Samples shall be made from the same material as that used to produce the casting(s) which they represent.

Several types of samples (separately cast samples, cast-on samples, side-by-side cast samples, samples cut from a casting) can be used, depending on the mass and wall thickness of the casting.

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When the mass of the casting exceeds 2 000 kg and its thickness exceeds 100 mm, cast-on samples should preferably be used; the dimensions and the location of the cast-on sample shall be agreed between the manufacturer and the purchaser by the time of acceptance of the order.

All samples shall be adequately marked to guarantee full traceability to the castings which they represent.

If applicable, tensile test pieces shall be machined from the samples after the heat treatment.

8.2 Cast samples**8.2.1 Size of cast sample**

The size of the sample shall be in correspondence with the relevant wall thickness of the casting as shown in Table 2.

If other sizes are used, this shall be agreed between the manufacturer and purchaser.

Table 2 — Types and sizes of cast sample and sizes of tensile test pieces in relation to relevant wall thickness of the casting

| Relevant wall thickness t mm | Type of sample | | | | Preferred diameter of tensile test piece ^a D mm |
|---|--|--|---|----------------------------------|--|
| | Option 1 U-shaped (see Figure 1) | Option 2 Y-shaped (see Figure 2) | Option 3 Round bar (see Figure 3) | Cast-on sample (see Figure 4) | |
| $t \leq 12,5$ | — | I | b, c | A | 7 (Option 3: 14 mm) |
| $12,5 < t \leq 30$ | — | II | a, b, c | B | 14 |
| $30 < t \leq 60$ | b | III | — | C | 14 |
| $60 < t \leq 200$ | — | IV | — | D | 14 |
| a Other diameters, in accordance with Figure 5, may be agreed between the manufacturer and the purchaser. | | | | | |
| b The cooling rate of this cast sample corresponds to that of a 40 mm thick wall. | | | | | |

8.2.2 Frequency and number of tests

Samples representative of the material shall be produced at a frequency in accordance with the in-process quality assurance procedures adopted by the manufacturer.

In the absence of an in-process quality assurance procedure or any other agreement between the manufacturer and the purchaser, a minimum of one cast sample shall be produced to confirm the material grade, at a frequency to be agreed between the manufacturer and the purchaser.

8.2.3 Separately cast samples

The samples shall be cast separately in sand moulds and under representative manufacturing conditions and material grade.

The moulds used to cast the separately cast samples shall have comparable thermal behaviour to the moulding material used to cast the castings.

The samples shall meet the requirements of either Figures 1, 2 or 3.

The samples shall be removed from the mould at a temperature similar to that of the castings.

8.2.4 Side-by-side cast samples

Side-by-side cast samples are representative of the castings concurrently cast and also of all other castings of a similar relevant wall thickness from the same test unit, or produced at the same time interval in accordance with the in process quality assurance procedure used by the manufacturer.

For a series of castings poured from the same ladle, one side-by-side cast sample shall be produced, at a minimum, in the last mould poured.

The samples shall meet the requirements of either Figures 1, 2, 3.