BS EN 16079:2023

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Founding — Compacted (vermicular) graphite cast irons

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The UK participation in its preparation was entrusted to Technical Committee ISE/111, Steel Castings and Forgings.

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

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European foreword

This document (EN 16079:2023) has been prepared by Technical Committee CEN/TC 190 “Foundry technology”, 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of an identical text or by endorsement, at the latest by June 2024, and conflicting national standards shall be withdrawn at the latest by June 2024.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 16079:2011.

Annex F provides details of significant technical changes between EN 16079:2023 and EN 16079:2011.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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Introduction

This document defines the grades 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. A moderate section sensitivity of the properties results from different cooling velocities in different wall thickness of the casting. When designating a material grade, section sensitivity needs consideration.

Table 1 specifies material grades according to their mechanical properties.

Table 1 designates the cast material. The foundry verifies the properties of the castings within its in-process quality assurance. The customer designates the material grade in view of requirements from component design. The choice of cast samples is based on the relevant wall thickness to ensure comparability with the casting.

Table 1 defines minimum property values (ultimate tensile strength) for each material grade, based on **cast samples**. For the casting itself, typical property values are given in Table C.1.

Cast iron materials are molten from steel scraps of different compositions (circular economy), pig iron, alloying elements, carburizers, etc., neither using ready alloys nor applying secondary metallurgical methods. Depending on the production route used, the chemical composition can vary (Clause 6). The mechanical properties prevail.

Material designation. The customer designates the material grade based on design requirements (load). In a casting with complex shape and sections with very different wall thicknesses, property values can vary over the casting, due to section sensitivity of the properties. A single cast sample cannot be representative for all sections of the entire casting.

If only one cast sample is possible (e.g. due to cost reasons, space in the mould, or when cutting a sample from the casting is not possible), the cast sample will represent the most interesting section of the casting, having the relevant wall thickness.

In case of an inappropriate designation of a material grade, the desired properties may not be reached locally, in the most interesting, relevant section of the cast component.

This can be avoided by co-operation of customer and foundry early in the design stage. The foundry can adapt its process in order to fulfil the local properties of the part, defined by the customer.

NOTE The short name is designated according to EN 1560. The designation system by number is based on the structure and rules of EN 10027-2 [3] and so corresponds with the European numbering system for steel and other materials.

Property values. The cast sample represents the properties in the relevant wall thickness section of the casting, given by component design. The minimum tensile properties to be obtained in cast samples represent today's reproducible production processes for all types of compacted graphite cast iron production.

Anticipated values in the casting (Table C.1) are slightly decreasing with increasing wall thickness.

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.

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For many applications, tensile strength and hardness are not the only properties of interest to casting designers. Other mechanical or physical properties can be decisive for the use of compacted (vermicular) graphite cast irons.

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

Annex B describes a procedure for the determination of nodularity of the microstructure. It includes reference images for visual analysis and guidelines for automated image analysis.

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1 Scope

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

This document specifies four grades of compacted (vermicular) graphite cast iron by a classification based on the minimum mechanical properties measured on machined test pieces prepared from cast samples or samples cut from a casting.

This document does not cover technical delivery conditions for iron castings (see EN 1559-1 and EN 1559-3).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1559-1, *Founding - Technical conditions of delivery - Part 1: General*

EN 1559-3, *Founding - Technical conditions of delivery - Part 3: Additional requirements for iron castings*

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

EN ISO 945-1, *Microstructure of cast irons - Part 1: Graphite classification by visual analysis (ISO 945-1)*

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

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

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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

Note 1 to entry: Annex B provides typical compacted (vermicular) graphite cast iron microstructures.

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

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3.3
nodularity
area percentage of spheroidal graphite particles (forms V and VI given in EN ISO 945-1)

Note 1 to entry: Graphite particles in compacted (vermicular) graphite cast irons are predominantly of form III.

Note 2 to entry: A technique for evaluating the nodularity of compacted (vermicular) graphite cast irons is described in Annex B.

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

3.6
side-by-side cast sample
sample cast in a mould alongside the casting, with a connected but separate running system

3.7
cast-on sample
sample attached directly to the running system or to the casting

3.8
sample cut from a casting
sample cut from an individual casting, by agreement between the manufacturer and the purchaser

3.9
relevant wall thickness
wall thickness representative of the casting, defined for the determination of the size of the cast samples to which the mechanical properties apply

4 Designation

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

As a section sensitive material, Table 1 illustrates the wall thickness dependence of mechanical properties of compacted (vermicular) graphite cast irons.

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

The number in position 3 of the designation (symbol) in Table 1 is the minimum tensile strength of the material grade in the wall thickness range t ≤ 30 mm.

Example Material grade EN-GJV-300. To determine the ultimate tensile strength, a 30 mm diameter separately cast sample (3.4 to 3.7, Figures 1 to 4) is poured (Type II according to Table 1). The cooling velocity of a Type II cast sample is the same as a 15 mm thick plate of infinite length, corresponding to a relevant wall thickness 12,5 to 30 mm in the casting. Type II is the most commonly used sample size, used also for designation. The material grade is designated EN-GJV-300 when the tensile strength exceeds 300 MPa.

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In the case of samples cut from the casting, the letter C is added at the end of the designation by symbol. In the case of test pieces prepared from separately cast samples, the letter "S" is added at the end of the grade designation. In the case of test pieces prepared from side-by-side cast or cast-on samples, the letter "U" is added at the end of the grade designation.

NOTE The comparison of EN 16079 grade designations with the grades from the ISO standard for compacted (vermicular) cast irons, ISO 16112:2017 [4], is given in Annex E.

5 Order information

The following information shall be supplied by the purchaser:

a) the number of this document;

b) the designation of the material;

c) the relevant wall thickness;

d) mechanical properties and their values (7.1 to 7.3);

e) the type and size of cast samples, based on relevant wall thickness and load case from design (7.4). If samples cut from a casting are required (7.4), the location(s) of sampling in the casting;

f) the location of sampling for metallographic investigation (7.6);

g) any special requirements.

All requirements shall be agreed 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 manufacture of compacted (vermicular) graphite cast irons and its chemical composition shall be left to the discretion of the manufacturer. The manufacturer shall ensure that the requirements are met for the material grade specified in the order.

When compacted (vermicular) graphite cast irons are to be used for special applications, the chemical composition and heat treatment can be agreed upon between the manufacturer and the purchaser.

7 Requirements

7.1 General

The property values apply to compacted (vermicular) graphite cast irons poured in sand moulds or moulds of comparable thermal behaviour.

Subject to an agreement between the manufacturer and the purchaser, the mechanical properties can apply to castings obtained by alternative methods.

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

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

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7.2 Test pieces machined from separately cast samples

The minimum tensile properties of compacted (vermicular) graphite cast iron, determined using test pieces machined from separately cast samples according to Figures 1, Figure 2 and Figure 3 shall be as specified in Table 1.

7.3 Test pieces machined from side-by-side cast and cast-on samples

The minimum tensile properties of compacted (vermicular) graphite cast iron, determined using test pieces machined from side-by-side cast samples according to Figure 1, Figure 2 or Figure 3 or to cast-on samples according to Figure 4, shall be as specified in Table 1.

Table 1 — Mechanical properties measured on test pieces machined from separately cast, cast side-by-side cast or cast-on samples

Material designation		Relevant wall thickness	0,2 % proof strength	Tensile strength	Elongation
		t	$R_{p0,2}$	R_m	A
		mm	MPa	MPa	%
Symbol	Number		min.	min.	min.
EN-GJV-300	5.2100	12,5 < t ≤ 30	210	300	2,0
		30 < t ≤ 60	195	275	2,0
		60 < t ≤ 200	175	250	2,0
EN-GJV-350	5.2200	12,5 < t ≤ 30	245	350	1,5
		30 < t ≤ 60	230	325	1,5
		60 < t ≤ 200	210	300	1,5
EN-GJV-400	5.2201	12,5 < t ≤ 30	280	400	1,0
		30 < t ≤ 60	260	375	1,0
		60 < t ≤ 200	230	325	1,0
EN-GJV-450	5.2300	12,5 < t ≤ 30	315	450	1,0
		30 < t ≤ 60	280	400	1,0
		60 < t ≤ 200	260	375	1,0
For relevant wall thicknesses greater 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.					

NOTE 1 The mechanical properties of test pieces machined from cast-on samples can be different from the properties of the casting itself, but usually give a better approximation than those obtained from separately cast samples. Additional values are given in Annex A for guidance.

NOTE 2 The percentage reduction in mechanical properties in thick sections depends upon the casting geometry and its cooling conditions.

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