INTERNATIONAL STANDARD

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Compacted (vermicular) graphite cast irons — Classification

Fontes à graphite vermiculaire (compacté) — Classification

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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

ISO 16112 was prepared by Technical Committee ISO/TC 25, *Cast irons and pig irons*, Subcommittee SC 7, *Compacted graphite cast irons*.

Introduction

This International 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,

— samples cast onto either the casting or the running system, hereafter referred to as cast-on samples, or

— samples cut from a casting (only when an agreement is made between the manufacturer and the purchaser).

The material grade is defined by mechanical properties measured on machined test pieces prepared from separately cast samples, cast-on samples, or samples cut from the casting by agreement between the manufacturer and the purchaser.

Some material grades may be suitable for pressure applications.

Annex A (informative) gives typical properties for compacted (vermicular) graphite cast irons obtained in separately cast test bars.

Annex B (informative) gives information on a procedure to determine the graphite nodularity of the microstructure.

Annex C (informative) gives information on the influence of metallurgical variables on the machinability in compacted (vermicular) graphite cast irons.

Annex D (informative) provides information on properties and examples for typical applications of compacted (vermicular) graphite cast irons.

Annex E (informative) provides cross-references of ISO 16112 grade designations to other standard grades of compacted (vermicular) graphite cast iron

Documents used in the preparation of this International Standard are listed in the Bibliography for reference purposes.

Compacted (vermicular) graphite cast irons — Classification

1 Scope

This International Standard specifies five grades of compacted (vermicular) graphite cast irons.

This International Standard specifies five grades based on the minimum mechanical properties measured on machined test pieces prepared from

— separately cast samples,

— cast-on samples, or

— samples cut from a casting.

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.

ISO 945, *Cast iron — Designation of microstructure of graphite*

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

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO/TR 15931, *Designation system for cast irons and pig irons*

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
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 according to ISO/TR 15931. The relevant designations are given in Tables 1 and 2.

5 Order information

The following information shall be supplied by the purchaser:

a) the complete designation of the material;

b) any special requirements which have to be agreed upon between the manufacturer and the purchaser.

All agreements between the manufacturer and the purchaser shall be made by the time of acceptance of the order.

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 International 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

The minimum tensile properties of compacted (vermicular) graphite cast irons shall be as specified in Tables 1 and 2.

Production-test results shall meet the minimum tensile property requirements specified in Table 1 or Table 2. Statistical analysis methods may be used to establish process capability to meet the tensile property requirements.

7.1 Test pieces machined from separately cast samples

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

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

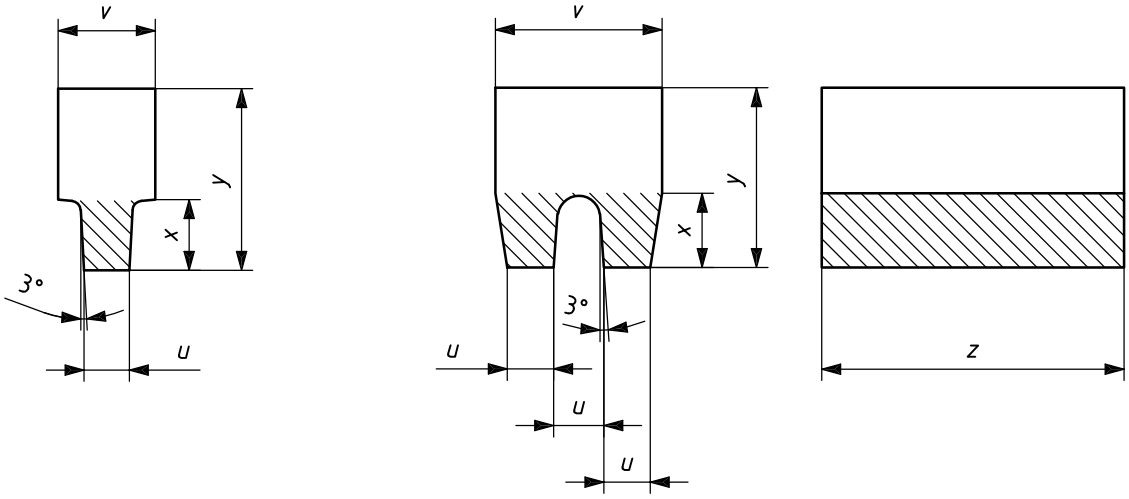
Material designation	Tensile strength R_m N/mm² min.	0,2 % proof strength $R_{p0,2}$ N/mm² min.	Elongation A % min.	Typical Brinell hardness range HBW 10/30
ISO 16112/JV/300/S	300	210	2,0	140 to 210
ISO 16112/JV/350/S	350	245	1,5	160 to 220
ISO 16112/JV/400/S	400	280	1,0	180 to 240
ISO 16112/JV/450/S	450	315	1,0	200 to 250
ISO 16112/JV/500/S	500	350	0,5	220 to 260

NOTE 1 The values for these materials apply to castings cast in sand moulds of comparable thermal behaviour. Subject to amendments agreed upon in the order, they can apply to castings obtained by alternative methods.

NOTE 2 Whatever the method used for obtaining the castings, the grades are based on the mechanical properties measured on test pieces machined from samples separately cast in a sand mould, or a mould of comparable thermal behaviour.

NOTE 3 1 N/mm² is equivalent to 1 MPa.

NOTE 4 Brinell hardness values are provided as a guideline only.



a) **Types I, IIa, and III** b) **Type IIb**

Dimensions in millimetres

Dimension	Type			
	I	IIa	IIb	III
u	12,5	25	25	50
v	40	55	90	90
x	30	40	40 to 50	60
y [a]	80	100	100	150
z [b]	A function of the test-piece length			

[a] For information only.

[b] z shall be chosen to allow a test piece of the dimensions shown in Figure 5 to be machined from the sample.

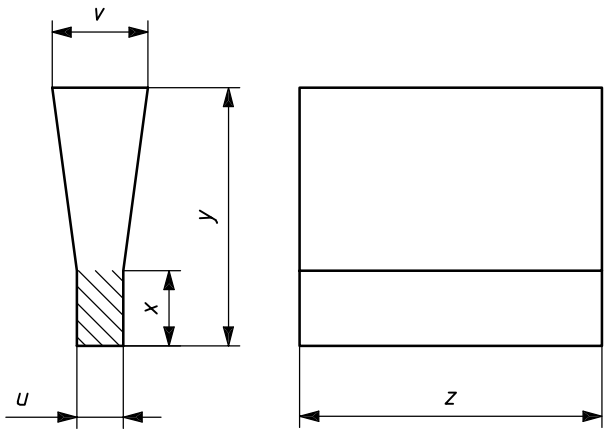
The thickness of the sand mould surrounding the samples shall be

— 40 mm minimum for types I, IIa, and IIb, or

— 80 mm minimum for type III.

NOTE For the manufacture of thin-walled castings or castings in metal moulds, the tensile properties may, by agreement between the manufacturer and the purchaser, be determined on test pieces taken from samples of thickness, u, less than 12,5 mm.

Figure 1 — Separately cast samples (option 1)



Dimensions in millimetres

Dimension	Type		
	I	II	III
u	12,5	25	50
v	40	55	100
x	25	40	50
y [a]	135	140	150
z [b]	A function of the test-piece length		

[a] For information only.

[b] z shall be chosen to allow a test piece of the dimensions shown in Figure 5 to be machined from the sample.

The thickness of the sand mould surrounding the samples shall be

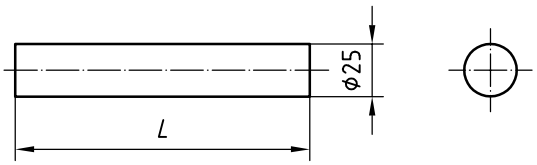
— 40 mm minimum for types I and II, or

— 80 mm minimum for type III.

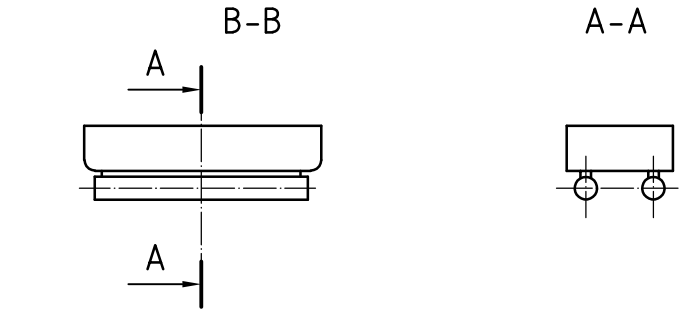
NOTE For the manufacture of thin-walled castings or castings in metal moulds, the tensile properties may, by agreement between the manufacturer and the purchaser, be determined on test pieces taken from samples of thickness, u, less than 12,5 mm.

Figure 2 — Separately cast samples (option 2)

Dimensions in millimetres



a) Sample — Minimum sample length L = 150 mm



b) Schematic drawing of one type of mould, given as an example

Figure 3 — Separately cast samples (option 3)

7.2 Test pieces machined from cast-on samples

The minimum mechanical properties of compacted (vermicular) graphite cast irons, determined using test pieces machined from cast-on samples according to Figure 4, shall be as specified in Table 2.

Table 2 — Mechanical properties measured on test pieces machined from cast-on samples

Material designation	Relevant wall thickness t mm	Tensile strength R_m N/mm^2 min.	0,2 % proof strength $R_{p0,2}$ N/mm^2 min.	Elongation A % min.	Typical Brinell hardness range HBW 10/30
ISO 16112/JV/300/U	$t \leqslant 12,5$	300	210	2,0	140 to 210
	$12,5 < t \leqslant 30$	300	210	2,0	140 to 210
	$30 < t \leqslant 60$	275	195	2,0	140 to 210
	$60 < t \leqslant 200$	250	175	2,0	140 to 210
ISO 16112/JV/350/U	$t \leqslant 12,5$	350	245	1,5	160 to 220
	$12,5 < t \leqslant 30$	350	245	1,5	160 to 220
	$30 < t \leqslant 60$	325	230	1,5	160 to 220
	$60 < t \leqslant 200$	300	210	1,5	160 to 220
ISO 16112/JV/400/U	$t \leqslant 12,5$	400	280	1,0	180 to 240
	$12,5 < t \leqslant 30$	400	280	1,0	180 to 240
	$30 < t \leqslant 60$	375	260	1,0	180 to 240
	$60 < t \leqslant 200$	325	230	1,0	180 to 240
ISO 16112/JV/450/U	$t \leqslant 12,5$	450	315	1,0	200 to 250
	$12,5 < t \leqslant 30$	450	315	1,0	200 to 250
	$30 < t \leqslant 60$	400	280	1,0	200 to 250
	$60 < t \leqslant 200$	375	260	1,0	200 to 250
ISO 16112/JV/500/U	$t \leqslant 12,5$	500	350	0,5	220 to 260
	$12,5 < t \leqslant 30$	500	350	0,5	220 to 260
	$30 < t \leqslant 60$	450	315	0,5	220 to 260
	$60 < t \leqslant 200$	400	280	0,5	220 to 260

NOTE 1 The mechanical properties of test pieces machined from cast-on samples may not reflect exactly the properties of the casting itself, but may be a better approximation than those obtained from a separately cast sample. 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.

NOTE 3 1 N/mm^2 is equivalent to 1 MPa.

NOTE 4 Brinell hardness values are provided as a guideline only.