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Malleable cast iron

Fonte malléable

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 5922 was prepared by Technical Committee ISO/TC 25, *Cast iron and pig iron*, Subcommittee SC 1, *Malleable cast iron*.

This second edition cancels and replaces the first edition (ISO 5922:1981), which has been technically revised.

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Malleable cast iron

1 Scope

This International Standard specifies requirements for two types of malleable cast iron, namely whiteheart malleable cast iron and blackheart malleable cast iron, used in the manufacture of castings.

Classification is given for each type of malleable cast iron on the basis of mechanical properties determined on separately cast test pieces.

This International Standard is applicable only to malleable cast iron cast into sand moulds or moulds of comparable thermal diffusivity.

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 148, *Steel — Charpy impact test (V-notch)*

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

malleable cast iron

heat-treated iron-carbon alloy, which solidifies in the as-cast condition with a graphite-free structure, referred to as white cast iron, the total carbon content being present in the combined form as cementite (Fe_3C)

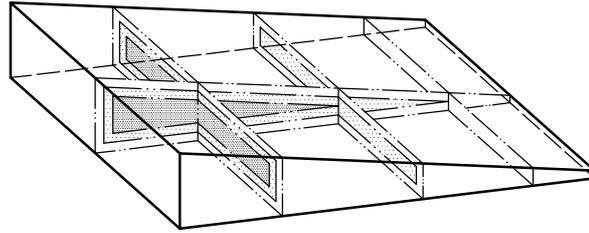
3.2

whiteheart malleable cast iron

white cast iron given a heat treatment in a decarburizing atmosphere to produce a material which is partially or entirely decarburized

NOTE The microstructure of whiteheart malleable cast iron is dependent on section size, as described below. Figure 1 shows the microstructural changes depending on the thickness of the material. For the definition of temper carbon, see ISO 945 (graphite form IV).

- a) Small section size = ferrite (+ pearlite + temper carbon);
- b) Large section size, see Figure 1.



Key

-  core zone: pearlite/ferrite + temper carbon
-  transition zone: pearlite + ferrite + temper carbon
-  rim zone: ferrite

Figure 1 — Microstructure in the core, transition and rim zone

3.3 blackheart malleable cast iron

white cast iron given a non-decarburizing heat treatment

NOTE All of the graphite contained in blackheart malleable cast iron is in the form of temper carbon. For the definition of temper carbon, see ISO 945 (graphite form IV).

3.3.1 blackheart ferritic malleable cast iron

blackheart malleable iron, the microstructure of which has a matrix essentially of ferrite

3.3.2 blackheart pearlitic malleable cast iron

blackheart malleable iron, the microstructure of which has a matrix, according to the grade specified, of various types of pearlite or other transformation products of austenite

3.4 primary graphite

graphite which occurs in flake form

NOTE Primary graphite is more correctly referred to as eutectic graphite.

4 Designation

The types of malleable cast iron covered by this International Standard shall be designated as follows, in accordance with ISO/TR 15931:

- a) by a reference to this International Standard, i.e. ISO 5922:2005;
- b) by three letters designating the type of malleable cast iron as follows.
 - JMW for whiteheart malleable cast iron,
 - JMB for blackheart malleable cast iron;
- c) by three numerals designating the minimum tensile strength, in newtons per square millimetre, of a 12 mm diameter test piece; these numerals shall be followed by a hyphen (-);

- d) by one or two numerals designating the minimum elongation, as a percentage of a 12 mm diameter test piece.

EXAMPLE The designation of a whiteheart malleable cast iron having a pearlitic matrix structure, a minimum tensile strength of 400 N/mm² and a minimum elongation of 5 %, when measured on a 12 mm diameter test piece, shall be ISO 5922/JMW/400-5.

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 between the manufacturer and 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 manufacture of malleable cast iron, as well as its chemical composition and heat treatment, shall be left to the discretion of the manufacturer, who shall ensure compliance with the property requirements given in this International Standard for the grade required in the order.

For malleable cast iron to be used in special applications, the chemical composition and any special heat treatment may be the subject of an agreement between the manufacturer and the purchaser at the time of acceptance of the order.

To optimize the impact resistance of all grades specified in Tables 1 and 2, the phosphorus content should not exceed 0,10 %.

7 Mechanical properties

7.1 Tensile strength and elongation

When tested in accordance with 9.1, the values of tensile strength (R_m) and percentage elongation after fracture ($A_{3,4}$) shall be in accordance with the requirements specified in Tables 1 and 2.

NOTE For definitions of R_m and $A_{3,4}$, see ISO 6892.

7.2 0,2 % Proof strength

When requested by the purchaser and agreed at the time of acceptance of the order, 0,2 % proof strength ($R_{p0,2}$) shall be determined in accordance with 9.2, and 0,2 % proof strength values shall be in accordance with the requirements specified in Tables 1 and 2.

NOTE For the definition of $R_{p0,2}$, see ISO 6892.

7.3 Brinell hardness

When requested by the purchaser and agreed at the time of acceptance of the order, Brinell hardness (HBW) shall be determined in accordance with 9.3. Evaluation of the test results may be based on the informative hardness values listed in Tables 1 and 2.

NOTE For definition of HBW, see ISO 6506-1.

7.4 Impact resistance

When the impact resistance test is requested by the purchaser, the method of testing shall be in accordance with 9.4. Evaluation of impact test values shall be the subject of an agreement between the manufacturer and the purchaser at the time of acceptance of the order. Guidance values are given in Annex A, that are obtained by the impact test procedure applied in accordance with ISO 148. The phosphorus content should not exceed 0,10 %.

Table 1 — Mechanical properties of whiteheart malleable cast iron

Designation	Diameter of test piece ^a mm	Tensile strength	Elongation	0,2 % proof strength	Brinell hardness (for information only) HBW
		R_m N/mm ² min.	$A_{3,4}$ % min.	$R_{p0,2}$ N/mm ² min.	max.
ISO 5922/ JMW/350-4	6	270	10	— ^b	230
	9	310	5	—	
	12	350	4	—	
	15	360	3	—	
ISO 5922/ JMW/360-12	6	280	16	— ^b	200
	9	320	15	170	
	12	360	12	190	
	15	370	7	200	
ISO 5922/ JMW/400-5	6	300	12	— ^b	220
	9	360	8	200	
	12	400	5	220	
	15	420	4	230	
ISO 5922/ JMW/450-7	6	330	12	— ^b	220
	9	400	10	230	
	12	450	7	260	
	15	480	4	280	
ISO 5922/ JMW/550-4	6	—	—	— ^b	250
	9	490	5	310	
	12	550	4	340	
	15	570	3	350	

All grades of whiteheart malleable cast iron can be welded, provided correct procedures are employed. Grade JMW/360-12 should be selected for components where strength and avoidance of post-weld heat treatment is particularly required.

(For a wall thickness exceeding 8 mm, a post-weld heat treatment is recommended.)

^a For choosing the diameter of the test piece, see 8.4.

^b Because of the difficulty in determining the proof strength of small test pieces, the values and the method of measurement shall be agreed between the manufacturer and the purchaser at the time of acceptance of the order.

Table 2 — Mechanical properties of blackheart malleable cast iron

Designation	Diameter of test piece ^{a, b} mm	Tensile strength	Elongation	0,2 % proof strength	Brinell hardness (for information only) HBW
		R_m N/mm ² min.	$A_{3,4}$ % min.	$R_{p0,2}$ N/mm ² min.	
ISO 5922/ JMB/275-5 ^c	12 or 15	275	5	—	150 max.
ISO 5922/ JMB/300-6 ^c	12 or 15	300	6	—	150 max.
ISO 5922/ JMB/350-10	12 or 15	350	10	200	150 max.
ISO 5922/ JMB/450-6	12 or 15	450	6	270	150 to 200
ISO 5922/ JMB/500-5	12 or 15	500	5	300	165 to 215
ISO 5922/ JMB/550-4	12 or 15	550	4	340	180 to 230
ISO 5922/ JMB/600-3	12 or 15	600	3	390	195 to 245
ISO 5922/ JMB/650-2	12 or 15	650	2	430	210 to 260
ISO 5922/ JMB/700-2 ^{d, e}	12 or 15	700	2	530	240 to 290
ISO 5922/ JMB/800-1 ^d	12 or 15	800	1	600	270 to 320

^a Of the two diameters given for the test piece, the manufacturer shall have the option of choosing either size, if this is not specified by the purchaser.

^b Where a 6 mm or 9 mm diameter test piece is representative of the relevant wall thickness of a casting, this size of the piece may be used, by agreement between the manufacturer and the purchaser at the time of acceptance of the order. The minimum properties given in this table shall apply.

^c Grades JMB/275-5 and JMB/300-6 are intended particularly for applications in which pressure-tightness is more important than a high degree of strength, ductility or impact resistance.

^d Oil quenched and subsequently tempered.

^e If this grade is air quenched and subsequently tempered, the 0,2 % proof strength shall be a minimum of 430 N/mm².

8 Sampling

8.1 General

Samples shall be made from the same material as that used to produce the casting(s) which they represent. They shall be separately cast in sand moulds, during the same period as when the castings are made.

In all cases, the test pieces shall be heat-treated by the same process as the castings that they represent.

8.2 Number of test pieces

The number of test piece shall be determined, by agreement between the manufacturer and purchaser at the time of order, in accordance with the tonnage and types of castings to be produced.

Additional test pieces shall be available in the event of retests being required (see Clause 10).

8.3 Tensile test pieces

Tensile test pieces shall be in accordance with the shape and dimensions given in Figure 2 and Table 3 and shall be unmachined.

NOTE It is permissible for the dimensions of the shanks to be modified to suit the holding fixtures of the testing machine, and for the joint line of the test piece to be fettled.

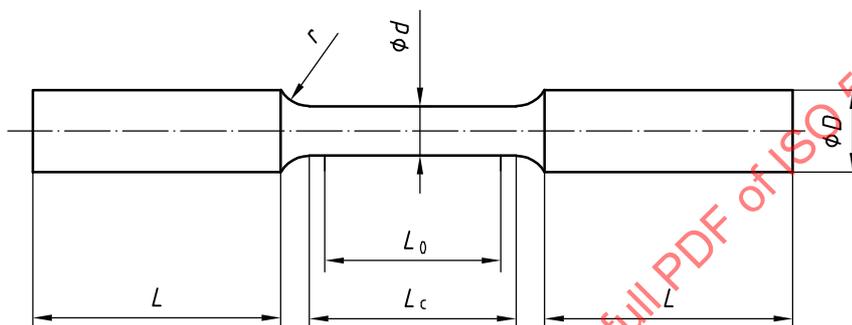


Figure 2 — Tensile test piece

Table 3 — Dimensions of tensile test pieces

Diameter ^a	Tolerance on diameter ^b	Original sectional area	Original gauge length	Minimum parallel length	Minimum radius at shoulder	Shank dimensions ^c (for information only)	
						Diameter	Length
<i>d</i> mm	mm	<i>S</i> ₀ mm ²	$L_0 = 3,4\sqrt{S_0}$ mm	<i>L</i> _c mm	<i>r</i> mm	<i>D</i> mm	<i>L</i> mm
6	± 0,5	28,3	18	25	4	10	30
9	± 0,5	63,6	27	30	6	13	40
12	± 0,7	113,1	36	40	8	16	50
15	± 0,7	176,7	45	50	8	19	60

^a The diameter *d* is obtained from the average of two measurements taken in the same plane at right angles to each other. The two values shall not differ by more than 0,7 mm.

^b The diameter *d* shall not vary along the parallel length by more than 0,35 mm.

^c If necessary, the shanks may be modified to suit the holding fixtures of the testing machine.

8.4 Choice of tensile test pieces

In the case of whiteheart malleable cast iron, the diameter *d* of the tensile test piece shall be representative of the relevant wall thickness of the casting. For the purpose of determining the diameter of the tensile test piece to be used, the purchaser shall, at the time of acceptance of the order, indicate to the manufacturer which are the important sections. In the absence of any direction by the purchaser, the manufacturer may choose the diameter of the tensile test piece to be used.

8.5 Test pieces for Brinell hardness test

The Brinell hardness test may be carried out using a tensile test piece or a casting, provided that the material has not been affected by any prior testing.

If the test is to be carried out on a tensile test piece, then this shall be performed on one of the shanks, either on a prepared surface or on a cross-section.

If the test is to be carried out on one casting, then this shall be performed on one or several points, as defined and agreed between the manufacturer and the purchaser at the time of acceptance of the order.

9 Test methods

9.1 Tensile test

The tensile test for the determination of tensile strength and elongation shall be carried out in accordance with ISO 6892, but using an unmachined tensile test piece produced in accordance with 8.3 and 8.4.

9.2 0,2 % Proof strength test

The determination of the 0,2 % proof strength shall be required only when agreed by the manufacturer and the purchaser by the time of the acceptance of the order. In this case, the test shall be carried out in accordance with ISO 6892, but using an unmachined tensile test piece produced in accordance with 8.3 and 8.4.

For the determination of proof strength, the rate of increase of stress in the elastic range shall not exceed 20 N/mm² per second. When the strain rate can be controlled, a rate of 1 %/min shall be set and maintained throughout the test so that 1 % strain is reached between 30 s and 60 s.

9.3 Brinell hardness test

Determination of the Brinell hardness shall be required only when agreed by the manufacturer and the purchaser by the time of acceptance of the order.

In this case, the test shall be carried out in accordance with ISO 6506-1, preferably with the largest compatible ball diameter in line with this International Standard.

If the test is performed on one or several points on a casting, the result can be obtained from a single determination or from a statistical method.

9.4 Impact resistance test

When the impact resistance test is requested by the purchaser, the method of testing shall be the subject of an agreement between the manufacturer and the purchaser at the time of acceptance of the order.

10 Retests

10.1 Need for retests

Retests shall be carried out if a test is not valid (see 10.2).

It is permitted to carry out retests if a test result does not meet the mechanical property requirements for the specified grade (see 10.3).

10.2 Test validity

A test is not valid if there is

- a) a faulty mounting of the test piece or defective operation of the test machine,
- b) a defective test piece because of incorrect pouring or incorrect machining,
- c) a fracture of the tensile test piece outside the gauge length, or
- d) a casting defect in the test piece, evident after fracture.

In the above cases, a new test piece shall be taken from the same sample, or from a duplicate sample cast at the same time. The result of the retest shall be substituted for the result of the invalid test.

10.3 Nonconforming test results

If any test gives results which do not conform to the specified requirements, for reasons other than those given in 10.2, the manufacturer shall have the options to conduct retests. If the manufacturer conducts retests, two retests shall be carried out for each failed test.

If the results of both retests meet specified requirements, the material shall be deemed to conform to this International Standard.

If the results of one or both retests fail to meet the specified requirements, the material shall be deemed not to conform to this International Standard.

10.4 Heat treatment of samples and castings

In the case of castings for which the test results are not satisfactory, the manufacturer shall be permitted to re-heat-treat the castings and the representative samples. In this event, the samples shall receive the same number of heat treatments as the castings.

If the results of the tests carried out on the test pieces from the re-heat-treated samples are satisfactory, then the re-heat-treated castings shall be regarded as conforming to the specified requirements or to this International Standard.

The number of re-heat-treatment cycles shall not exceed two.