



SLOVENSKI STANDARD
oSIST prEN 1561:2021

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Livarstvo - Siva litina (z lamelastim grafitom)

Founding - Grey cast irons

Gießereiwesen - Gusseisen mit Lamellengraphit

Fonderie - Fontes à graphite lamellaire

Ta slovenski standard je istoveten z: prEN 1561

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Founding - Grey cast irons

Fonderie - Fontes à graphite lamellaire

Gießereiwesen - Gusseisen mit Lamellengraphit

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 190.

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prEN 1561:2020 (E)

European foreword

This document (prEN 1561:2020) 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.

This document will supersede EN 1561:2011.

Within its programme of work, Technical Committee CEN/TC 190 requested CEN/TC 190/WG 5 “Grey cast iron and compacted graphite cast iron” to revise EN 1561:2011.

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Introduction

This document deals with the classification of grey cast irons, subdivided into two groups, specified by their tensile strength or hardness, respectively.

The properties of grey cast iron depend on the form and distribution of the graphite and the structure of the matrix, resulting from different cooling velocities in different wall thickness of the casting.

Section sensitivity is more pronounced for grey cast irons EN-GJL, compared to other cast iron materials. When designating a grey cast iron material grade, section sensitivity needs consideration.

Table 1 defines material grades according to their mechanical properties, which is relevant for most EN-GJL material orders.

- 1) Table 1 designates (verifies) the cast material in the foundry (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.
- 2) 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 E.1.

Table 2 defines material grades according to their maximum hardness, e.g. for wear resistance.

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. (standards.iteh.ai)

Material designation.

The customer designates the material grade based on design requirements (load). In a casting with complex shape and different wall thickness, property values can vary over the casting, due to section sensitivity. An 'over all' designation of the entire casting by only one cast sample is not representative.

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), then it represents the most interesting, relevant wall thickness.

Since EN 1561:2011, the material designation is based on cast samples with comparable solidification as the casting (Table 3 specifies different sample sizes, representing different relevant wall thickness).

The 30 mm separately cast sample can still be used for designating the material grade, e.g. for simple casting shapes. It cannot properly represent property values in heavier sections of the casting.

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

EXAMPLE A heavy-wall casting from EN-GJL-250 is designated using the 30 mm separately cast sample, but the relevant section of the component has 100 mm wall thickness. A minimum UTS of 250 MPa will not be reached in the heavy section.

This can be avoided by co-operation of customer and foundry early in the design stage. The foundry can control the solidification of the casting and thus fulfil locally required properties.

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

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Property values. The cast sample represents the properties in the relevant wall thickness section of the casting, given by component design. Compared to EN 1561:2011, the minimum tensile properties to be obtained in cast samples were slightly adapted to consider section sensitivity. They represent recent process ability for all types of grey cast iron production (long-series with machine moulding, short-series with hand moulding, with small to heavy wall thickness).

Anticipated values in the casting (Table E.1) have been adapted, using the finer wall thickness grading (e.g. 6 steps for EN-GJL-250, with 4 steps < 40 mm). Property values were subsequently decreased with increasing wall thickness.

The tensile test piece given in Figure 5 is used to achieve reproducible results. For serial production of grey iron castings using statistical methods, the position of the scatter-band and its lower boundary depends on wall thickness. Lower property values often do not result in poor process control but in microstructural effects becoming less pronounced when using bigger test pieces.

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;
- samples cut from a casting.

Hardness of the material can also be evaluated on the casting.

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 grey iron. For example:

- the thermal capacity and the thermal diffusivity for disc brakes;
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- the damping capacity for engine blocks or machine beds;
- the thermocycle fatigue for exhaust manifolds or ingot moulds.

Therefore, Annex A (informative) provides additional information on mechanical and physical properties.

Annex G, Table G.1 provides details of significant technical changes between this document and the previous edition.

1 Scope

This document specifies the properties of unalloyed and low-alloyed grey cast irons used for castings, which have been manufactured in sand moulds or in moulds with comparable thermal behaviour.

NOTE This document can also be applicable to grey cast irons cast in permanent moulds, provided the related cast samples are casted under the same conditions as the castings.

This document specifies the characterizing properties of grey cast irons by either

- a) the tensile strength of cast samples,
- b) if agreed by the manufacturer and the purchaser, the tensile strength of samples cut from a casting,
- c) the hardness determined on the castings or on a cast-on knob.

If agreed by the manufacturer and the purchaser, the combination of both tensile strength from option a) and hardness from option c) can be specified.

This document specifies six grades of grey cast iron by a classification based on tensile strength determined on machined test pieces prepared from cast samples (see Table 1) and six grades of grey cast iron by a classification based on Brinell hardness (see Table 2).

This document does not cover technical delivery conditions for iron castings; see EN 1559-1 [3] and EN 1559-3 [4].

This document does not apply to grey cast irons used for pipes and fittings according to EN 877 [5].

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 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 <http://www.electropedia.org/>

prEN 1561:2020 (E)**3.1****grey cast iron**

cast material, mainly iron and carbon based, carbon being present mainly in the form of flake (lamellar) graphite particles

Note 1 to entry: Grey cast iron is also known as flake graphite cast iron, and less commonly as lamellar graphite cast iron.

Note 2 to entry: Graphite form, distribution and size are specified in EN ISO 945-1.

3.2**cast sample**

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

3.3**separately cast sample**

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

3.4**side-by-side cast sample**

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

3.5**cast-on sample**

sample attached directly to the casting

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3.6**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

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4 Designation

The material shall be designated either by symbol or by number, as given in either Table 1 or Table 2.

NOTE 1 The designation system is given in EN 1560.

The number in position 3 of the designation in Table 1 is the minimum tensile strength of the grades as determined on test pieces machined from 30 mm test bars (15 mm relevant wall thickness), separately cast or cast side-by-side. The wall thickness range 10 mm to 20 mm is used for designation.

Alternatively, the designation may be based on cast-on samples. In this case, the minimum tensile strength is lower due to cooling conditions. By comparing the values in the far-right column of Table 1 with the values from the separately cast test bar, the correct material designation can be obtained.

The number in position 3 of the designation in Table 2 is the maximum Brinell hardness value of the grade for relevant wall thickness ≥ 50 mm. A designation based on thin walls does not reflect hardness increase due to accelerated cooling.

In the case of samples cut from the casting the letter C is added at the end of the designation by symbol. Guidance values anticipated in the casting are given in Table E.1. Those property values are not intended for material designation.

NOTE 2 Comparison of EN 1561 grade designations to the grades from the ISO standard for grey cast irons (ISO 185:2020 [6]) is given in Annex B.

5 Order information

The order shall specify, in an unambiguous manner, whether the tensile strength measured on cast samples, or the Brinell hardness determined on the casting, is the characterizing property. If it does not do so, then the manufacturer shall characterize the material according to tensile strength.

The following information shall be supplied by the purchaser:

- a) the number of this European standard;
- b) the designation of the material;
- c) the relevant wall thickness;
- d) 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.

When specifying a combination of tensile strength and hardness, it is recommended to consult the information in Annex C.

6 Manufacture

Unless otherwise specified by the purchaser, the method of manufacture of grey cast irons to obtain the specified mechanical properties and its chemical composition shall be left to the discretion of the manufacturer.

The manufacturer shall ensure that the requirements defined in this document are met for the material grade specified in the order.

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

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

7 Requirements

7.1 Mechanical properties

The order shall specify in an unambiguous manner whether the characterizing property is:

- 1) tensile strength determined on test pieces machined from separately cast or side-by-side cast samples;
- 2) tensile strength determined on test pieces machined from cast-on samples;
- 3) tensile strength determined on test pieces machined from samples cut from a casting;
- 4) Brinell hardness determined on the casting;
- 5) a combination of both tensile strength and Brinell hardness.

If the order does not specify Brinell hardness, then the manufacturer shall characterize the material according to tensile strength.

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7.2 Tensile properties

7.2.1 General

The property values apply to grey cast irons 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.

Tensile 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.

7.2.2 Test pieces machined from cast samples

The tensile properties of the six grades of grey cast irons specified by tensile strength, when determined according to 9.1 using test pieces machined from cast samples according to Table 3, shall be in accordance with the requirements of Table 1. The maximum tensile strength of the grade is the minimum value plus 100 MPa. This shall ensure that the material is correctly designated.

For process quality assurance purposes, 30 mm test bars are commonly used.

7.2.3 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 minimum value, or allowable range of values, for the tensile properties (for information, see Table E.1).

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

NOTE 2 Tensile 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 document).

Table 1 — Tensile properties of grey cast irons measured on test pieces machined from cast samples

Material designation		Relevant wall thickness		Tensile strength R_m^a		
				Mandatory values		in cast-on samples
Symbol	Number	>	min.	in separately cast or side-by-side cast samples		
				MPa		min.
		t				min.
		mm				
EN-GJL-100	5.1100	5	40	100	200	–
EN-GJL-150	5.1200	2,5 ^b	5	150	250	–
		5	10			–
		10	20			–
		20	40			125
		40	80			110

Material designation		Relevant wall thickness		Tensile strength R_m^a		
				Mandatory values		in cast-on samples
Symbol	Number	t mm		in separately cast or side-by-side cast samples		
		>	min.	MPa min. ≤		
		80	150			100
		150	300			90
EN-GJL-200	5.1300	2,5 ^b	5	200	300	-
		5	10			-
		10	20			-
		20	40			170
		40	80			155
		80	150			140
		150	300			130
EN-GJL-250	5.1301	5 ^b	10	250	350	-
		10	20			-
		20	40			210
		40	80			190
		80	150			170
		150	300			160
						10 ^b
EN-GJL-300	5.1302	20	40	250		
		40	80	225		
		80	150	210		
		150	300	190		

For relevant wall thicknesses more than 300 mm, the manufacturer and the purchaser should agree on the type and size of cast sample and the minimum values to be obtained.

NOTE 1 The designation is based on the 30 mm separately cast sample

NOTE 2 For high damping capacity and thermal conductivity, EN-GJL-100 (5.1100) is the most suitable material.

NOTE 3 The figures given in bold indicate the minimum tensile strength to which the material designation of the grade is related. The values relate to an as-cast sample diameter corresponding to the applicable relevant wall thickness range according to Table 3.

^a If tensile strength is specified as a characterizing property, the type of the sample (see 8.2) should also be stated in the order. If not stated in the order, the type of sample is left to the discretion of the manufacturer.

^b This value is included as the lower limit of the relevant wall-thickness range.