

Founding - Grey cast irons

## EESTI STANDARDI EESSÕNA

## NATIONAL FOREWORD

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English Version

## Founding - Grey cast irons

Fonderie - Fontes à graphite lamellaire

Gießereiwesen - Gusseisen mit Lamellengraphit

This European Standard was approved by CEN on 20 November 2023.

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## European foreword

This document (EN 1561:2023) 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of an identical text or by endorsement, at the latest by June 2024, and conflicting national standards shall be withdrawn at the latest by June 2024.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 1561:2011.

Annex G provides details of significant technical changes between this European Standard and the 2011 edition (previous edition).

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.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.

## 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 of the properties 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 of the properties needs consideration.

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

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 specifies 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 specifies 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.

### 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. 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.

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 diameter separately cast sample (Type II) can still be used for designating the material grade, e.g. for simple casting shapes. It cannot properly represent property values in sections with greater wall thickness of the casting.

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.

**EXAMPLE** A thick-walled casting is designated as EN-GJL-250 using the 30 mm diameter separately cast sample (Type II), but the relevant section of the component has 100 mm wall thickness. The minimum tensile strength of 250 MPa will not be reached in the thick-walled section.

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 [4] 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. Compared to EN 1561:2011, the minimum tensile properties to be obtained in cast samples were slightly adapted to consider section sensitivity. They represent today's reproducible production processes for all types of grey cast iron production (long-series with machine moulding, short-series with hand moulding, with smaller to greater wall thicknesses).

Anticipated values in the casting (Table E.1) have been adapted, using the finer wall thickness grading (e.g. 6 ranges for EN-GJL-250, with 3 ranges < 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.

When using larger cast samples, microstructural effects become less pronounced. Lower property values often do not result from poor process control but from slower solidification and statistical effects.

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 conductivity for brake disks;
- 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 poured 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 five 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 and EN 1559-3.

This document does not apply to grey cast irons used for pipes and fittings which are covered by to EN 877 [1].

## 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)*