RECOMMENDATIONS FOR OBTAINING SAMPLES OF CASTING PARTS

This manual has been put together to clarify the methods that should be used to obtain samples of material (commonly known as specimens), representing the cast parts' mechanical and metallographic characteristics, whether Grey or Spheroidal casting.

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1. Introduction

The material's mechanical characteristics can be assessed in machined specimens made from: independent samples, samples attached to the part, samples included in the part and/or samples cut from the part.

Due to the size and type of the parts cast at Fumbarri, whenever a material's mechanical characteristics are going to be assessed, we recommend you use the samples included in the part, as they are the ones that best represent the parts' characteristics.

There are currently two standards that set the methodology for defining samples, and these standards are as follows: UNE-EN 1561:2012 "Founding. Grey Cast-irons" and UNE-EN 1563:2019 "Founding. Spheroidal Graphite Cast-irons".

2. Terms and Definitions

- Casting sample: An amount of cast material that represents the casting material, including independent samples, attached samples and samples included in the part. The specimen to be tested will be obtained from these samples through machining.
- Independent samples: Sample cast in an independent sand mould under the representative manufacturing conditions and type of material.
- Sample attached to the part: Sample cast in the mould along with the part, with a common filling system.
- Sample included in the part: Sample that is directly joined to the casting part. At Fumbarri we recommend this system to obtain samples.
- Deciding wall thickness: The wall thickness that is representative of the casting parts, and which is defined by determining the size of the casting samples for which the mechanical properties are applied.

3. Grey Cast-irons

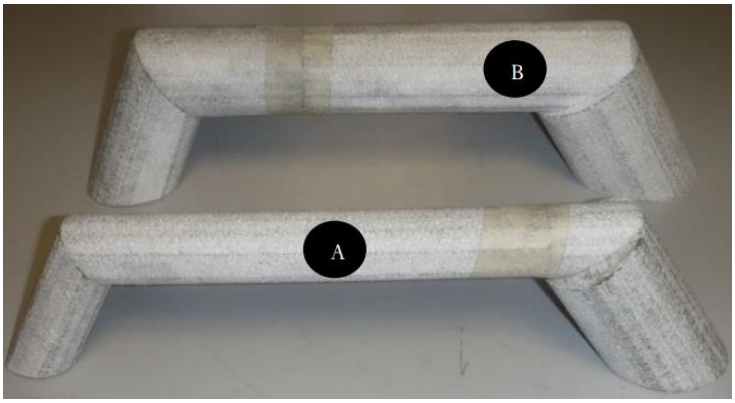
3.1. Tensile and HB hardness characteristics of grey cast-iron, measured in machined specimens using casting samples.

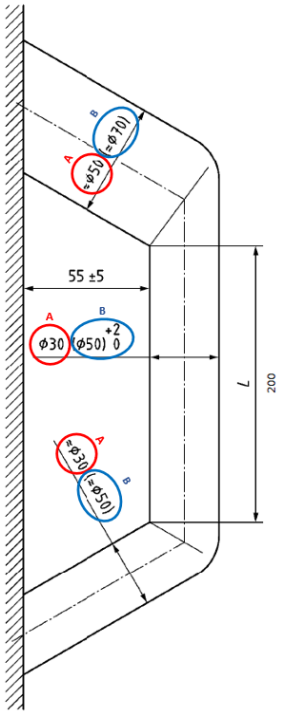
NAME OF MATERIAL		DECIDING WALL THICKNESS mm		Minimum Tensile Strength MPa	HB Hardness
Symbolic	Numerical	>	≤		
EN-GJL-250 (GG25)	5.1301	50	100	220	160 to 220
		100	200	200	*
EN-GJL-300 (GG30)	5.1302	50	100	260	180 to 240
		100	200	240	*

* For deciding wall thicknesses of t>100mm, the casting types are not classed according to their hardness. As the deciding thickness increases, the hardness decreases. For further details on hardness, please see the UNE-EN 1561:2012 standard "Founding – Grey Cast-irons".

3.2. Definition of samples for tensile testing

DECIDING WALL THICKNESS mm		Type 1 Sample included in part See Figure 1	Diameter of the tensile specimen
>	≤		
50	100	30 mm (A)	20
100	200	50 mm (B)	32





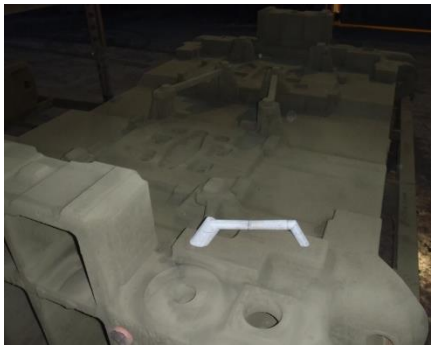
3.3. Additional information on the mechanical and physical characteristics of the casting samples with a crude casting diameter of 30 mm.

Characteristic	Symbol	SI Unit	Name of material	
			EN-GJL-250	EN-GJL-300
Tensile strength	Rm	MPa	250 to 350	300 to 400
Conventional yield strength at 0.1%	Rp0.1	MPa	165 to 228	195 to 260
Lengthening	A	%	0.8 to 0,3	0.8 to 0.3
Compressive strength		MPa	3.01 x R_m	2.87 x R_m
Conventional yield strength at 0.1% compression		MPa	325	390
Bending strength		MPa	1.66 x R_m	1.60 x R_m
Shear strength		MPa	290	345
Torsional strength		MPa	1,36 x R_m	
Modulus of elasticity	E	GPa	103 to 118	108 to 137
Poisson's Ratio	V	-	0.26	
Flexural fatigue strength		MPa	0.46 x R_m	
Repeated alternate tensile / compression strength		MPa	0.34 x R_m	
Torsional fatigue strength		MPa	0.38 x R_m	
Fracture toughness	K_{Ic}	MPa.$m^{1/2}$	20	19
Density	P	t/m^3	7.2	7.3
Specific heat capacity Between 20°C and 200°C Between 20°C and 600°C	C	J/(kg.K)	460 535	
Linear expansion coefficient Between -100°C and + 20°C Between 20°C and 200°C Between 20°C and 400°C	α	µm/(m.K)	10.0 11.7 13.0	
Thermal conductivity At 100°C At 200°C At 300°C At 400°C At 500°C	A	W/(m.K)	 48.5 47.5 46.5 45.0 44.5	 47.5 46.0 45.0 44.0 43.0
Resistivity	P	Ω.mm^2/m	0.73	0.70
Coercitivity	H_c	A/m	560 to 720	
Maximum permeability	µ	µH/m	220 to 330	
Loss due to hysteresis at B=1T		J/m^3	2500 to 3000	

1 MPa equals 1 N/mm^2

3.4. Placing the sample in the part

The sample will be stuck to the model, on the working side, and in a horizontal position (good side). It should never be placed on the bottom of the bases or inside the drawers, or in a vertical position, as the material's characteristics can be altered by the mould filling process.

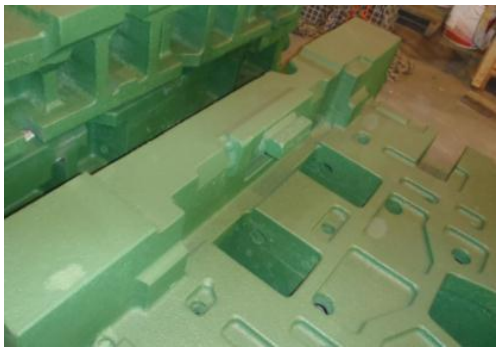



3.5. Errors in samples

For Grey Cast-iron, only the geometry of the previously shown sample should be applied, as otherwise the specimen obtained will not be representative of the material's characteristics. Common errors:

- Use samples for Spheroidal Cast-iron in Grey Cast-iron.


- Place samples inside the drawers or in a vertical position. This should be avoided, as the filling process or the residue deposits from the polystyrene combustion are left inside the specimens, making them invalid for the purpose in question, which is to represent the part's characteristics and its deciding thickness.

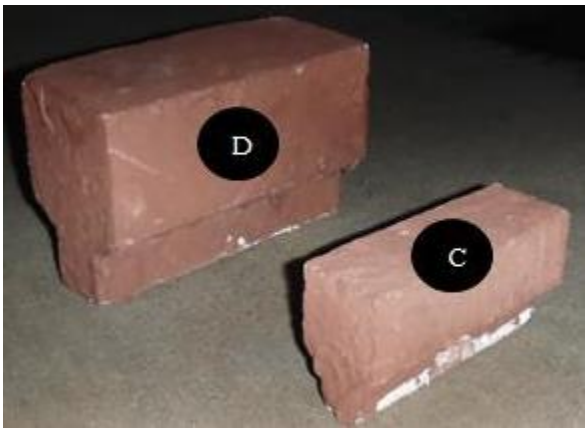
4. Spheroidal Graphite Cast-irons

4.1. Tensile and HB hardness characteristics of spheroidal cast-iron, measured in machined specimens using casting samples.

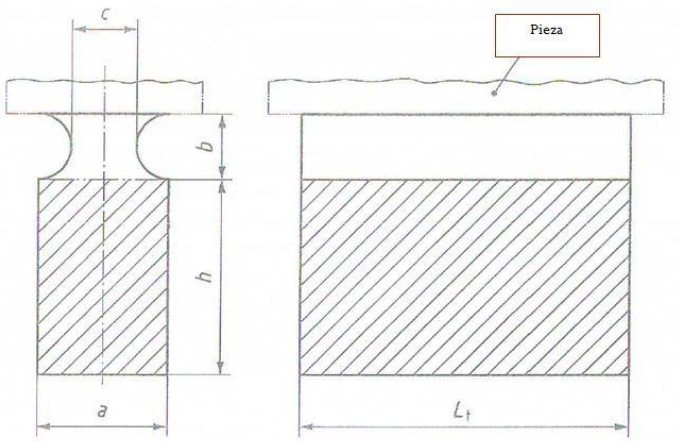
Characteristic	Symbol	SI Unit	Name of material	
			EN-GJL-250	EN-GJL-300
Tensile strength	Rm	MPa	250 to 350	300 to 400
Conventional yield strength at 0.1%	Rp0.1	MPa	165 to 228	195 to 260
Lengthening	A	%	0.8 to 0,3	0.8 to 0.3
Compressive strength		MPa	3.01 x R_m	2.87 x R_m
Conventional yield strength at 0.1% compression		MPa	325	390
Bending strength		MPa	1.66 x R_m	1.60 x R_m
Shear strength		MPa	290	345
Torsional strength		MPa	1,36 x R_m	
Modulus of elasticity	E	GPa	103 to 118	108 to 137
Poisson's Ratio	V	-	0.26	
Flexural fatigue strength		MPa	0.46 x R_m	
Repeated alternate tensile / compression strength		MPa	0.34 x R_m	
Torsional fatigue strength		MPa	0.38 x R_m	
Fracture toughness	K_{Ic}	MPa.$m^{1/2}$	20	19

4.2. Definition of samples for tensile testing

ESPESOR DETERMINANTE DE LA PARED mm		Tipo de Muestra Incluida en la Pieza Véase Figura 5	Diámetro de la probeta de tracción
>	≤		
30	60	C	14
60	200	D	14



TYPE OF SAMPLE	DECIDING THICKNESS OF THE PART	a	b Max.	C Min.	h	Lt
C	30 to 60	40	30	20	40 to 65	150
D	60 to 200	70	52.5	35	65 to 105	150



4.3. Additional information about the characteristics of spheroidal casting

Characteristic	Unit	EN-GJS-400-18	EN-GJS-500-7	EN-GJS-600-3	EN-GJS-700-2 EN-GJS-700- 2L
Shear strength	MPa	360	450	540	630
Torsional strength	MPa	360	450	540	630
Modulus of elasticity E (tensile & compressive strength)	GN/m²	169	169	174	176
Poisson's Ratio v	-----	0.275	0.275	0.275	0.275
Fatigue limit (rotating bending) without notch (Ø10.6 mm)	MPa	195	224	248	280
Fatigue limit (rotating bending) with notch (f10.6 mm)	MPa	122	134	149	168
Compressive strength	MPa	700	800	870	1000
Fracture toughness	MPa.$\sqrt{m}$	82	63	38	30
Thermal conductivity at 300°C	W/(K.m)	36.2	35.2	32.5	31.1
Specific heat capacity from 20°C to 500°C	J/(kg.K)	515	515	515	515
Linear expansion coefficient from 20°C to 400°C	µm/(m.K)	12.5	12.5	12.5	12.5
Density	Kg/dm³	7.1	7.1	7.2	7.2
Maximum permeability	µH/m	2136	1596	866	501
Loss due to hysteresis	J/m³	600	1345	2248	2700
Resistivity	µΩ.m	0,50	0.51	0.53	0.54
Main mould structure		Ferrite	Ferrite-Pearlite	Pearlite-Ferrite	Pearlite

4.4. Placing the sample in the part

The sample will be stuck to the model, on the working side, and in a horizontal position (good side). It should never be placed on the bottom of the bases or inside the drawers, or in a vertical position, as the material's characteristics can be altered by the mould filling process.

4.5. Errors in samples

For Spheroidal Cast-iron, only the geometry of the previously shown sample should be applied, as otherwise the specimen obtained will not be representative of the material's characteristics.

Never place the samples inside the drawers or in a vertical position, as the residue deposits from the polystyrene combustion would be left in the specimens, altering the material's characteristics.

Samples stuck to copies or profiles should not be placed, as this would cause hot spots that may lead to contraction defects (shrinkages).