

## Technical information No. 1

### Grey lamellar graphite cast iron

#### Definition

Grey (lamellar graphite) cast iron is a cast material, iron and carbon based, carbon being present mainly in the form of lamellar graphite particle (flake graphite). Its properties mainly depend on the amount of graphite, the graphite shape and graphite distribution in the metallic matrix.

The European norm classifies grey (lamellar graphite) cast iron according to its mechanical properties. The material grades are either specified by tensile strength or by Brinell hardness.

#### Relevant standards

Material designation and material properties: DIN EN 1561 Grey lamellar graphite iron

General Tolerances and machining allowance: DIN ISO 8062 valid for all designs made since August 1998 (DIN 1686, valid for designs created before August 1998)

Metallic materials – Brinell hardness test: DIN EN ISO 6506.

Metallic Material – Tensile testing at ambient temperature: DIN EN 10002-1

#### Influence of the chemical composition

##### a) Basic Elements

Cast iron is an alloy consisting of iron and 5 main attendant elements C, Si, Mn, P and S. The element C and Si have got the most important influence on the ultimate tensile strength and Brinell hardness (HB). The higher the C and Si content, the higher are the values of  $R_m$  and HB. Mn, P and S have got a minor influence.

##### b) Alloying elements

If special properties are required, these may be achieved by adding certain alloying elements. These specific properties can not be integrated in the systematic approach given below.

#### Mechanical properties of lamellar graphite cast iron

The cooling rate during solidification and during the following phase transformations has a significant influence on the material's strength as well as on its hardness. The values, given in the table below, refer to separately cast samples with a diameter of 30 mm, which correspond to a wall thickness of 15 mm.

Nowadays significantly thinner walls can be cast. Generally higher values of strength than those values that are listed in the table below are found in these thin walls.

By adding alloying elements special properties can be realised. These alloyed material grades are not included in the presented scheme.

#### Mechanical properties of separately cast samples (30 mm diameter)

Material designation		EN-GJL-150	EN-GJL-200	EN-GJL-250	EN-GJL-300	EN-GJL-350
Material No.		EN-JL 1020	EN-JL 1030	EN-JL 1040	EN-JL 1050	EN-JL 1060
Out-dated designation DIN 1693		GG 15	GG 20	GG 25	GG 30	GG 35
Microstructure		ferr./pearl.			pearlitic	
Tensile strength	$R_m$ [N/mm <sup>2</sup> ]	<b>150</b> <sup>1</sup> -250	<b>200</b> -300	<b>250</b> -350	<b>300</b> -400	<b>350</b> -450
0,1%-proof stress	$R_{p0,1}$ [N/mm <sup>2</sup> ]	98-165	130-195	165-228	195-260	228-285
Elongation at fracture	A [%]	0,8-0,3	0,8-0,3	0,8-0,3	0,8-0,3	0,8-0,3
Compression strength	$\sigma_{dB}$ [N/mm <sup>2</sup> ]	600	720	840	960	1080
0,1% compression yield point	$\sigma_{d0,1}$ [N/mm <sup>2</sup> ]	195	260	325	390	455
Bending strength	$\sigma_{bB}$ [N/mm <sup>2</sup> ]	250	290	340	390	490
Shear strength	$\sigma_{aB}$ [N/mm <sup>2</sup> ]	170	230	290	345	400
Torsional strength	$T_{tB}$ [N/mm <sup>2</sup> ]	170	230	290	345	400
Modulus of Elasticity <sup>3)</sup>	E [kN/mm <sup>2</sup> ]	78-103	88-113	103-118	108-137	123-143
Poisson ratio	$\mu$	-	0,260	0,260	0,260	0,260
Bending fatigue strength <sup>4)</sup>	$\sigma_{bW}$ [N/mm <sup>2</sup> ]	70	90	120	140	145
Fatigue limit under reversed tension-compression stresses <sup>5)</sup>	$\sigma_{zdW}$ [N/mm <sup>2</sup> ]	40	50	60	75	85
Fracture toughness	$K_{IC}$ [N/mm <sup>3/2</sup> ]	320	400	480	560	650

1) When there are special requirements relation to machinability or magnetic properties, the grade EN-GJL-100 may be used. The required properties can be obtained by means of a structure changing heat treatment process. This grade is not referred to in this table.

2) The bold printed numbers are the required minimum values for ultimate tensile strength. They are referred to in the designation of the respective material grade.

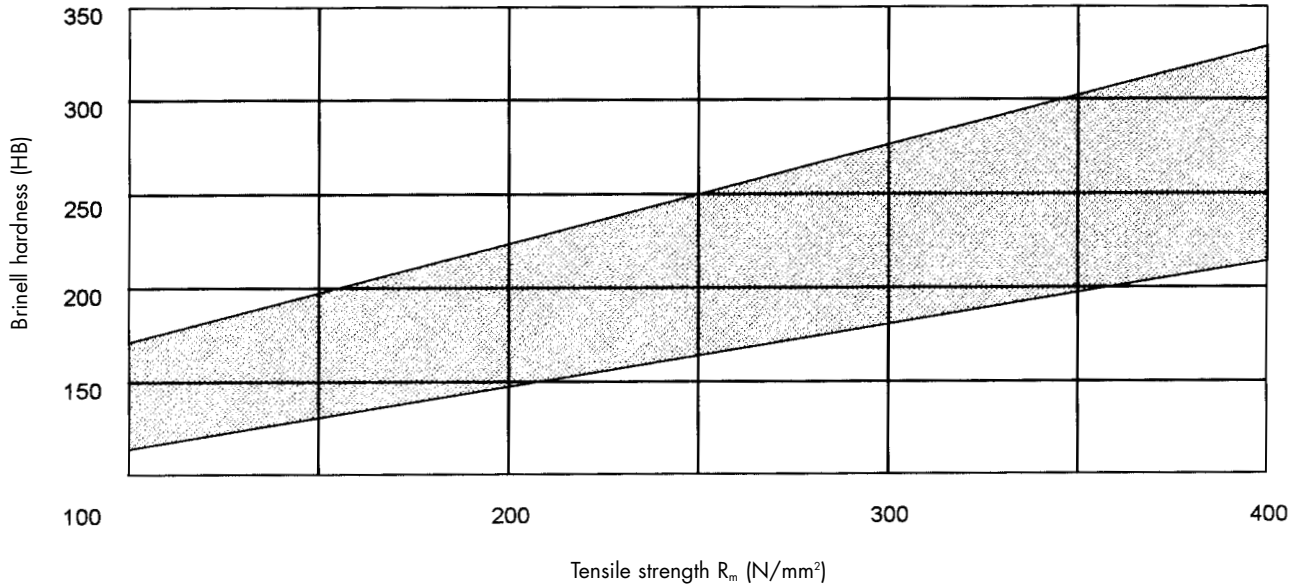
3) Depending on the quantity and form of the graphite as well as on the stress level and the testing method

4) The following approximately applies:  $\sigma_{bW} \cong 0.35$  to  $0.5 \cdot R_m$

5) The following approximately applies:  $\sigma_{bW} \cong 0.53 \cdot \sigma_{bW} = 0.26 R_m$

torsional fatigue strength:  
 $T_{tW} \cong 0,42 \cdot R_m$

## Relationship between hardness and tensile strength of grey (lamellar graphite) cast iron:



### Brinell hardness of castings made of grey (lamellar graphite) iron, mandatory and anticipated values at the agreed test position

Material- designation <sup>1)</sup>	Material No.	Wall thickness [mm]		Brinell hardness <sup>2)</sup> HB 30	
		>	Up to	Min.	Max.
EN-GJL-HB 155 <i>out-dated designation GG-150 HB</i>	EN-JL 2010	2,5	5	–	210
		5	10	–	185
		10	20	–	170
		20	40	–	160
		40	80	–	155
EN-GJL-HB 175 <i>out-dated designation GG-170 HB</i>	EN-JL 2020	2,5	5	170	260
		5	10	140	225
		10	20	125	205
		20	40	110	185
		40	80	100	175
EN-GJL-HB 195 <i>out-dated designation GG-190 HB</i>	EN-JL 2030	4	5	190	275
		5	10	170	260
		10	20	150	230
		20	40	135	210
		40	80	120	195
EN-GJL-HB 215 <i>out-dated designation GG-220 HB</i>	EN-JL 2040	5	10	200	275
		10	20	180	255
		20	40	160	235
		40	80	145	215
EN-GJL-HB 235 <i>out-dated designation GG-240 HB</i>	EN-JL 2050	10	20	200	275
		20	40	180	255
		40	80	165	235
EN-GJL-HB 255 <i>out-dated designation GG-260 HB</i>	EN-JL 2060	20	40	200	275
		40	80	185	255

<sup>1)</sup> The values in the material designation refer to the anticipated values of Brinell hardness at a wall thickness of 15 mm.  
The grades EN-GJL-HB 175 up to EN-GJL-HB 255 approximately correspond to the grades EN-GJL-150 to EN-GJL-350.

<sup>2)</sup> On agreement between the manufacturer and the purchaser a narrower hardness range may be adopted at the position on the casting, provided that this is not less than 40 Brinell hardness units.