

GB/T 9439-2010 灰铸铁件

1. Scope

This standard specifies the terms and definition, designation, technology requirements, sampling requirements, tests method, inspection rules of grey cast iron and the casting identification, packaging storage and transportation requirements.

2. Normative references

3. Terms and definitions

GB/T 5611 determine the terms and the following terms and definitions are applicable to the standard

Relevant wall thickness

Relevant wall thickness is point to casting fracture surface thickness of used to decide the mechanical properties, have to be agreed between the manufacturer and the purchaser.

4. Grey cast iron designation

The material designation representation of the standard, shall be in accordance with the requirements of GB/T 5612.

The standard according to the measured in minimum tensile strength value of machined from separately cast test-bar diameter of 30 mm standard tensile samples, grey cast iron will to be divided into HT100, HT150, HT200, HT225, HT250, HT275, HT300, and HT350 eight grades, see table 1.

Table 1 the designation and mechanical property of grey cast iron

Designation	Casting wall thickness		minimum tensile strength		Tensile strength anticipated values in casting R_m (min) MPa
			R_m (Mandatory value)(min)		
	>	≤	separately cast Test Sample MPa	Attached cast test sample or test pieces MPa	
HT100	5	40	100	-	-
HT150	5	10	150	-	155
	10	20		-	130
	20	40		120	110
	40	80		110	95
	80	150		100	80
	150	300		90	-
HT200	5	10	200	-	205
	10	20		-	180
	20	40		170	155
	40	80		150	130
	80	150		140	115
	150	300		130	-

HT225	5	10	225	-	230
	10	20		-	200
	20	40		190	170
	40	80		170	150
	80	150		155	135
	150	300		<i>145</i>	-
HT250	5	10	250	-	250
	10	20		-	225
	20	40		210	195
	40	80		190	170
	80	150		170	155
	150	300		<i>160</i>	-
HT275	10	20	275	-	250
	20	40		230	220
	40	80		205	190
	80	150		190	175
	150	300		<i>175</i>	-
HT300	10	20	300	-	270
	20	40		250	240
	40	80		220	210
	80	150		210	195
	150	300		<i>190</i>	-
HT350	10	20	350	-	315
	20	40		290	280
	40	80		260	250
	80	150		230	225
	150	300		<i>210</i>	-

Note 1: when casting wall thickness exceeding 30mm, the mechanical property have to be agreed between the manufacturer and the purchaser.

Note 2: This column gives guidance only about the likely variation in tensile strength for different casting wall thicknesses when a casting of simple shape and uniform wall thickness is cast in a given grey cast-iron material. For castings of non-uniform wall thickness, or castings containing cored holes, the table values are only an approximate guide to the likely tensile strength in different sections, and casting design should be based on the measured tensile strength in critical parts of the casting.

Note 3: The **italics** numerical values are guideline values, the others tensile strength are mandatory, tensile strength anticipated values in casting are not mandatory.

5. Order requirements

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 the purchaser.

6. The method of producing chemical composition

6.1 The method of producing

The moulding sand or thermal conductivity and moulding the relative sand produce gray cast iron pieces.

The method of producing grey cast iron shall be left to the discretion of the supplier, if purchaser has any special requirements (other moulding way or heat treatment and so on) which have to be agreed between the manufacturer and the purchaser.

6.2 Chemical composition

When if the technology requirements of purchaser include the acceptance requirement of chemical composition, according to the provision of supplier carry out.

When purchaser has no requirements about chemical composition, the chemical composition decided by supplier, the chemical composition is not as the basis of acceptance of casting. But the select of chemical composition must be ensured casting material meeting the requirement of mechanical property and metallographic structure in provision of the standard.

7. Technology requirement

7.1 Mechanical properties

whether the mechanical properties measured on separately cast samples or on the casting, whether tensile strength or Brinell hardness as the acceptance indexes, all must be specify, in an unambiguous manner in the order or the technology requirement of supplier. The mechanical properties acceptance indexes of casting shall explicitly stipulated in order.

The mechanical properties and physical properties of grey cast iron test samples see **appendix A**

The standard specified mechanical properties indexes and metallographic structure is main indexes of the casting acceptance.

7.1.1 Tensile strength

7.1.1.1 The tensile strength of separately cast samples

The standard according to the measured in minimum tensile strength value of machined from separately cast test-bar diameter of 30 mm standard tensile samples, grey cast iron will to be divided into eight grades, the minimum tensile strength of each grade shall be in accordance with the requirements of Table 1.

7.1.1.2 The tensile strength of attached cast test sample (test pieces)

The tensile strength of attached cast test sample (test pieces) shall meet the provision of table 1.

7.1.1.3 The tensile strength of casting itself

Table 1 gives each different grades of wall thickness of grey cast iron itself tensile strength references

7.1.1.4 Sampling position of casting itself

The sampling position, sample size and tensile strength of casting itself have to be agreed between the manufacturer and the purchaser, if when the purchaser has the explicitly provision.

When purchaser request sampling from casting itself, but unspecified the sampling position of casting itself, the supplier can decide the sampling position according to casting structure and loading condition, the size of the casting itself see table 5.

The frequency of inspection and quantity of tensile strength of casting itself has to be agreed between the manufacturer and the purchaser.

7.1.2 Hardness grades and casting hardness

The Brinell hardness values of the six grades of grey cast iron specified by hardness, see Table 2. The hardness of each hardness grades is the maximum hardness value of main wall thickness $t > 40$ mm and $t \leq 80$ mm.

Table 2 the hardness grades and casting hardness of grey cast iron

Hardness grades	The main wall thickness of casting/mm		The hardness range of casting/ HBW	
	>	≤	min	max
H155	5	10	-	185
	10	20	-	170
	20	40	-	160
	40	80	-	155
H175	5	10	140	225
	10	20	125	205
	20	40	110	185
	40	80	100	175
H195	4	5	190	275
	5	10	170	260
	10	20	150	230
	20	40	125	210
	40	80	120	195
H215	5	10	200	275
	10	20	180	255
	20	40	160	235
	40	80	145	215
H235	10	20	200	275
	20	40	180	255
	40	80	165	235
H255	20	40	200	275
	40	80	185	255

Note1: Information on the relationship between Brinell hardness and tensile strength is indicated in Annex B, and on the relationship between Brinell hardness and relevant wall thickness is indicated

in Annex C.

Note 2: The figures given in bold indicate the minimum and maximum Brinell hardness.

Note 3: By agreement between the manufacturer and the purchaser, a narrower hardness range may be adopted at the agreed position on the casting, provided that this is not less than 40 Brinell hardness units

When purchaser request the hardness as the acceptance indexes, the frequency of inspection and quantity of hardness has to be agreed between the manufacturer and the purchaser, and choose one of the following the acceptance rules:

a) The hardness of casting itself shall be in accordance with the requirements of Table 2.

b) When measure the hardness of machined from separately cast test-bar, shall be in accordance with the requirements of Table 3.

When purchaser has the specific provision to inspection position and hardness value, shall be in accordance with the requirements of purchaser drawing and technology requirements.

Note 1: This classification is applicable principally where machinability or wear resistance of importance.

Note 2: For a relevant wall thickness $t > 80$ mm, grades are not classified by hardness.

7.2 Metallographic structure

The inspection method and inspection items of grey cast iron metallographic structure shall be in accordance with the requirements of GB/T 7216. When purchaser has the specific provision to the quantity, distribution, grades and sampling of each inspection items, shall be in accordance with the requirements of purchaser drawing and technology requirements.

7.3 Geometrical dimension

The geometrical dimension of casting shall be in accordance with the requirements of purchaser drawing and technology requirements.

7.4 Dimensional tolerance

The casting dimensional tolerance shall be in accordance with the requirements of purchaser drawing and technology requirements. If purchaser has no special requirements, shall be in accordance with the requirements of GB/T 6414.

7.5 Working allowance

The working allowance of casting shall be in accordance with the requirements of purchaser drawing and technology requirements. If purchaser has no special requirements, shall be in accordance with the requirements of GB/T 6414.

7.6 Weight deviation

The weight deviation of casting shall be in accordance with the requirements of purchaser drawing and technology requirements. If purchaser has no special

requirements, shall be in accordance with the requirements of GB/T 11351.

7.7 Surface quality

The surface quality of casting include outside surface and internal surface.

7.7.1 The surface roughness of the casting shall be shall be in accordance with the requirements of GB/T 6060.1 or the requirements of purchaser drawing and technology requirements.

7.1.2 Casting should clean up, finishing the spare parts, removing feeding residual, core bar, adhering sand and entocoele residues etc. the feeding residual, joint flash, Flying Spur residual entocoele cleanness etc. of Casting allowed, shall be in accordance with the requirements of purchaser drawing and technology requirements or the order agreement of between supplier and purchaser.

7.7.3 Unless otherwise specified, the castings are in as-cast delivery.

7.7.4 The delivery process of Casting shall be in accordance with the protection, packaging and storage and transportation regulations of purchaser.

7.8 Casting defects

7.8.1 Not allow the defects of effect casting operating property exiting existing, such as cracks, cold shut, shrinkage cavity etc.

7.8.2 Casting machining surface allowance the existence defects in machining allowance range

7.8.3 Casting non-processing surface and internal casting allowance the variety, scope, quantity, shall be in accordance with the requirements of purchaser drawing and technology requirements or the order agreement of between supplier and purchaser.

7.8.4 Casting machining surface may not welding, repair in principle, but by the authority of purchaser, on condition that not affected mechanical processing conditions, Defects which not affect the structure property can welding, repair

7.9 Special requirements

When purchaser has request for MT, UT, RT etc. shall be agreed between the manufacturer and the purchaser

8. Sampling requirements

8.1 General

If heat treatment is used to modify the properties of the material, then the samples shall be heat-treated in the same way as the castings they represent.

8.2 Tensile test

8.2.1 Separately cast samples

The separately cast samples used to establish the material grade shall be cast vertically as the castings they represent in similar cooling conditions and thermal conductivity moulding sand(see figure 1). The moulds may be made for casting more than three pieces samples simultaneously, the minimum distance among the moulds are not less than 50mm, the length of samples L shall be determined according to the sample and the length of clamping device, see Figure 1.

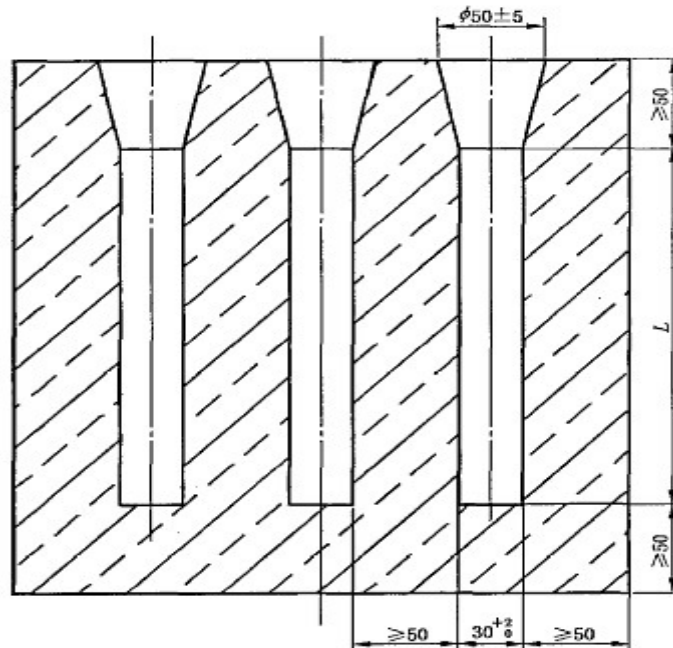


Figure 1 — Separately cast samples

The length of samples L shall be determined according to the length of the test piece A or B (see 9.2) and the length of clamping device.

Other dimensions of the samples shall meet the dimensional requirements of Figure 1.

The dimension of the samples made from separately cast samples, see Table 4.

When purchaser has special request for separately cast samples and machining samples dimension, shall be in accordance with the requirements of purchaser.

Samples must be pouring from the same liquid, and at the later period of the batch pouring liquid pour samples.

The frequency of casting the separately cast samples shall be in accordance with the requirement of the 10.3.

The samples shall be removed from the mould at a temperature ≤ 500 °C. If the castings need heat treatment, the samples with the represent castings shall be handled; when the castings carry out the ageing treatment of eliminate stress, the samples may not be handled.

NOTE: By agreement between the manufacturer and the purchaser, samples may be removed from the mould at a temperature ≥ 500 °C, if the castings are also to be removed from the moulds at this higher temperature.

8.2.2 Attached cast samples (pieces)

When a casting is more than 20 mm thick and the mass is less than 2000 kg, the test pieces used for the tests shall be machined from a attached cast samples (see figure 2) or attached cast pieces (see figure 3). The type of sample shall be chosen in such a way as to provide approximately the same cooling conditions as for the casting. The sample used to determination of tensile strength, the measured result is more approximate to the property of casting than the tensile strength of separately cast samples.

The type of sample (pieces), and the location of the sample (pieces) on the casting, shall be agreed between the manufacturer and the purchaser. If there is no such agreement, the manufacturer shall decide on the type of sample and it shall be located at a representative position on the casting. The length of test bar or test pieces L shall be determined according to the length of the samples and the length of clamping device. The numeral in bracket apply to the test bar of diameter 50 mm and the test pieces of radius 25mm separately.

If the castings need heat treatment, attached cast samples (pieces) shall be cut from a casting after heat treatment.

The length of test bar or test pieces L (see Figures 2 and 3) shall be determined according to the length of the samples and the length of clamping device.

Note: the test bar of diameter 30mm and the test pieces of radius 15mm used for castings less than 80 mm wall thickness, the test bar of diameter 50mm and the test pieces of radius 25mm used for castings more than 80 mm wall thickness.

8.2.3 Casting itself samples

The sampling of casting itself samples have to be agreed between the manufacturer and the purchaser.

The processing size of casting itself samples see Table 5.

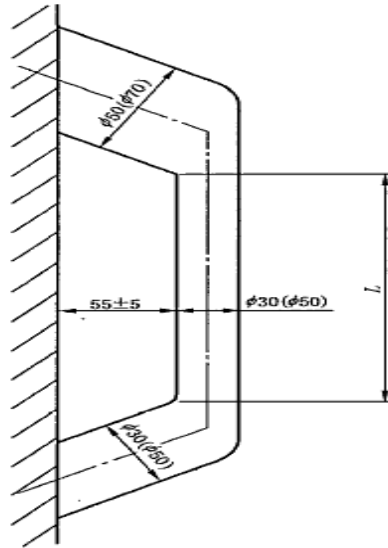


Figure 2 — Cast-on test bar

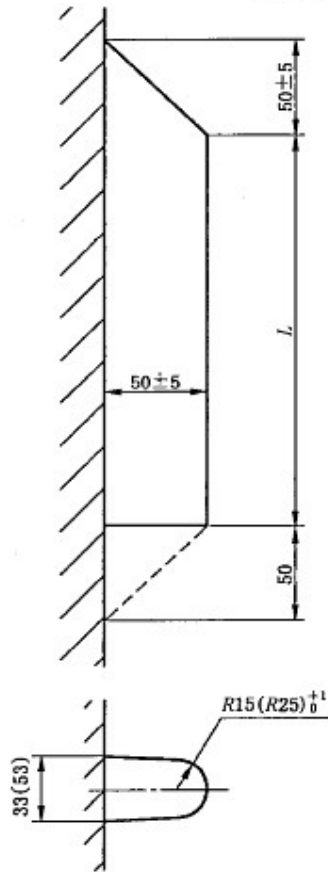


Figure 3 — Cast-on test block

8.3 Hardness test blocks

When purchaser will regard hardness as the acceptance indexes, hardness shall be in accordance with the requirements of 7.1.2.

Measuring hardness will on separately cast samples. The hardness value see Table 3.

Table 3 the tensile strength and hardness value of separately cast samples

Desingnation	Minimum tensile strength R_m (min) MPa	Brinell Hardness HBW
HT100	100	≤170
HT150	150	125~205
HT200	200	150~230
HT225	225	170~240
HT250	250	180~250
HT275	275	190~260
HT300	300	200~275
HT350	350	220~290

The position of the Brinell knob, and its size and shape, shall be agreed between the manufacturer and purchaser, or on a test piece (“Brinell knob”) which is cast-on to the casting as shown in Figure 4. The test piece used for a casting is more than 20 mm thick, test piece shall be cut from a casting.

If the casting is heat-treated, the Brinell knob shall not be detached from the casting until the heat-treatment process has been concluded.

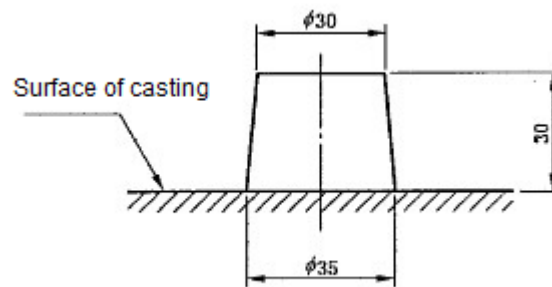


Figure4—Brinell Hardness test blocks

9. Test methods

10. Inspection rules

11. Casting identification, packaging storage and transportation requirements

Annex A
(informative)

Mechanical and physical properties of Gray cast iron

Information on mechanical properties of separately and attached cast test pieces with diameter 30 is given in Table A.1

Information on physical properties of separately and attached cast test pieces with diameter 30 is given in Table A.2

Table A.1- mechanical properties of separately and attached cast test pieces with diameter 30

characteristic	Material designation ^a						
	HT150	HT200	HT225	HT250	HT275	HT300	HT350
	Basic structure						
	Ferrite/ pearlite	pearlite					
Tensile strength Rm/Mpa	150~250	200~300	225~325	250~350	275~375	300~400	350~450
Yield strength Rp0.1/Mpa	98~165	130~195	150~210	165~228	180~245	195~260	228~285
Elongation A/%	0.3~0.8	0.3~0.8	0.3~0.8	0.3~0.8	0.3~0.8	0.3~0.8	0.3~0.8
Compression strength σ_{db} / Mpa	600	720	780	840	900	960	1080
Compression	195	260	290	325	360	390	455

yield point $\sigma_{d0.1} / Mpa$							
Bending strength σ_{bB} / Mpa	250	290	315	340	365	390	490
Shear strength σ_{aB} / Mpa	170	230	260	290	320	345	400
Torsional Strength ^b τ_{tB} / Mpa	170	230	260	290	320	345	400
Modulus of elasticity ^c $E / kMpa$	78~103	88~113	95~115	103~118	105~128	108~137	123~143
Poisson's ratio (ν)	0. 26	0. 26	0. 26	0. 26	0. 26	0. 26	0. 26
Bending fatigue Strength ^d σ_{bW} / Mpa	70	90	105	120	130	140	145
Fatigue limit under reversed tensioncompression stresses ^e σ_{zdW} / MPa	40	50	55	60	68	75	85
Fracture toughness $K_{IC} / MPa^{3/4}$	320	400	440	480	520	560	650
<p>a When there are special requirements relating to machinability or magnetic properties, then HT100 is used. The required properties can be obtained by means of a structure-changing heat-treatment process. HT100 is not cited here.</p> <p>b Torsional fatigue strength $\tau_{tW}(\text{MPa}) \approx 0.42R_m$.</p> <p>c Depends on the quantity and form of the graphite, as well as on the loading.</p> <p>d The following approximately applies: $\sigma_{bW} \approx (0.35 \sim 0.50)R_m$.</p> <p>e The following approximately applies: $\sigma_{zdW} \approx 0.53\sigma_{bW} \approx 0.26R_m$.</p>							

Table A.2- mechanical properties of separately and attached cast test pieces with

diameter 30

Characteristic		Material designation ^a						
		HT150	HT200	HT225	HT250	HT275	HT300	HT350
Density ρ (kg/mm ³)		7.10	7.15	7.15	7.20	7.20	7.25	7.30
Specific heat Capacity J/(kg·K)	Between 20°C and 200 °C	460						
	Between 20°C and 600 °C	535						
Linear expansion Coefficient $\mu\text{m/m}\cdot\text{K}$	between- 100°C and + 20 °C	10.0						
	Between 20 °C and 200 °C	11.7						
	Between 20 °C and 400 °C	13.0						
Thermal Conductivity W/(m·K)	at 100 °C	52.5	50.0	49.0	48.5	48.0	47.5	45.5
	at 200 °C	51.0	49.0	48.0	47.5	47.0	46.0	44.5
	at 300 °C	50.0	48.0	47.0	46.5	46.0	45.0	43.5
	at 400 °C	49.0	47.0	46.0	45.0	44.5	44.0	42.0
	at 500 °C	48.5	46.0	45.0	44.5	43.5	43.0	41.5
Resistivity $\Omega\cdot\text{mm}^2 / m$		0.80	0.77	0.75	0.73	0.72	0.70	0.67
Coercivity A/m		560 to 720						
Maximum permeability at room temperature $\mu\text{H/m}$		220 to 330						
Hysteresis losses at B = 1 T J/m ³		2 500 to 3 000						
<p>a When there are special requirements relating to machinability or magnetic properties, then HT100 is used. The required properties can be obtained by means of a structure-changing heat-treatment process.HT100 is not cited here.</p>								

Annex B
(informative)
Additional information on the relationship between hardness and tensile strength
of grey cast irons

Hardness and tensile strength, as well as modulus of elasticity and the modulus of rigidity of grey cast iron of a given grade, are approximately related to each other. In most cases, an increase in the value of one property results in an increase in the values of other properties. Grey cast irons naturally divide into a family or series of grades having different relative hardness (RH) or tensile-strength-to-hardness (T/H) ratios. This Annex briefly discusses RH and T/H for grey cast irons.

B.1 Relative hardness

The following empirical relationship between Brinell hardness (HBW) and tensile strength R_m exists:

$$HBW = RH \times (A + B \times R_m)$$

Commonly accepted values for the constants are:

$$A = 100 \quad B = 0,44$$

where RH is the relative hardness. RH has been found to vary between 0,8 and 1,2 (see Figure B.1).

The factor RH is influenced mainly by the raw materials, the melting process, and the metallurgical workingmethod. Within one foundry, these influences can be maintained

nearly constant. Therefore, the manufacturer can indicate both hardness and the corresponding tensile strength.

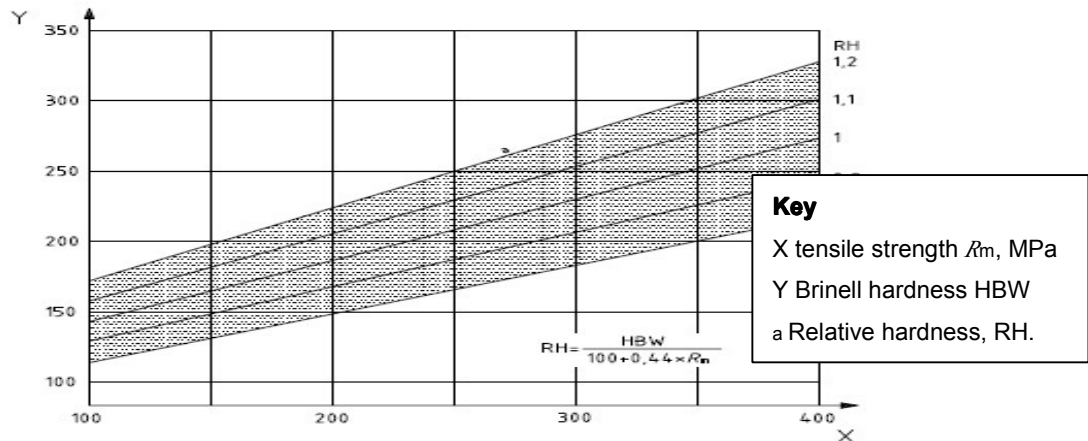


Figure B.1 — Relative hardness (RH) relationship between Brinell hardness and tensile strength of grey cast irons

B.2 Tensile-strength-to-hardness ratio

Tensile-strength-to-hardness (T/H) ratios are regulated by the eutectic graphite content, up to the eutectic composition shown in Figure B.2, with carbon equivalent (CE) as the graphite parameter. Using tensile strength in N/mm², or MPa and Brinell hardness in HBW, the T/H ratios of grey cast irons range from approximately 0,8 to 1,4. A decline in T/H ratio continues as CE increases above the eutectic, but at a much smaller and less predictable rate. Constant T/H lines in Figure B.2 are essentially lines of constant graphite effect on mechanical properties. Properties sensitive to both graphite and matrix, such as bulk tensile strength and bulk hardness, vary in constant proportionality to each other and to their matrix counterparts (matrix tensile strength and matrix hardness) along constant T/H lines. Elastic modulus and damping capacity vary mainly only with graphite and are, therefore, highly uniform along the constant T/H lines. Since these lines are also lines of constant eutectic graphite and carbon equivalent, the most important castability parameters, they are logical grade lines for foundry control, as well as for mechanical property control.

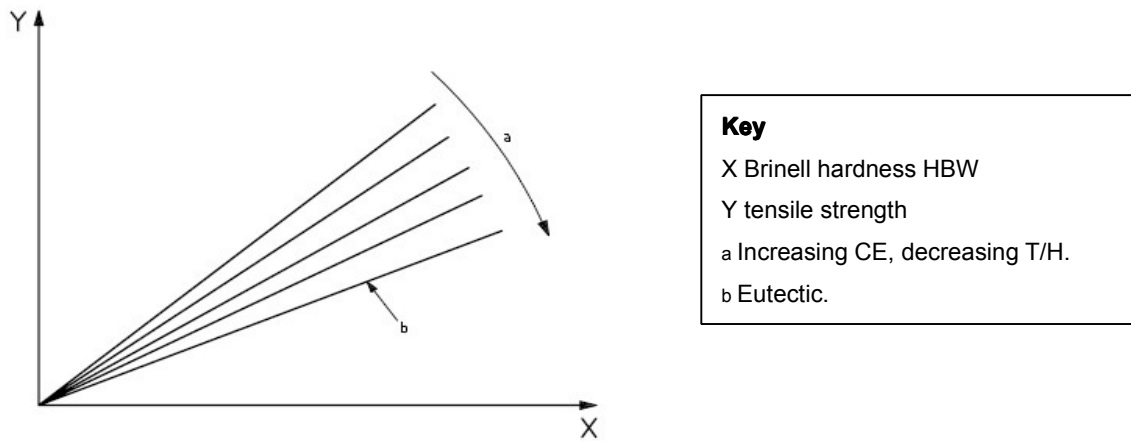


Figure B.2 — Tensile-strength-to-hardness relationship (T/H ratio) between Brinell hardness and tensile strength of grey cast irons

Annex C

(informative)

Additional information on the relationship between tensile strength, hardness and wall thickness of grey iron castings

Figure C.1 provides additional general information on the expected relationship between minimum tensile strength and relevant wall thickness. Figure C.2 provides information on average Brinell hardness and relevant wall thickness of castings. This illustrates the importance of reaching an agreement between the manufacturer and the purchaser on the specification of the hardness required in castings, and also the location where a hardness test should be carried out.

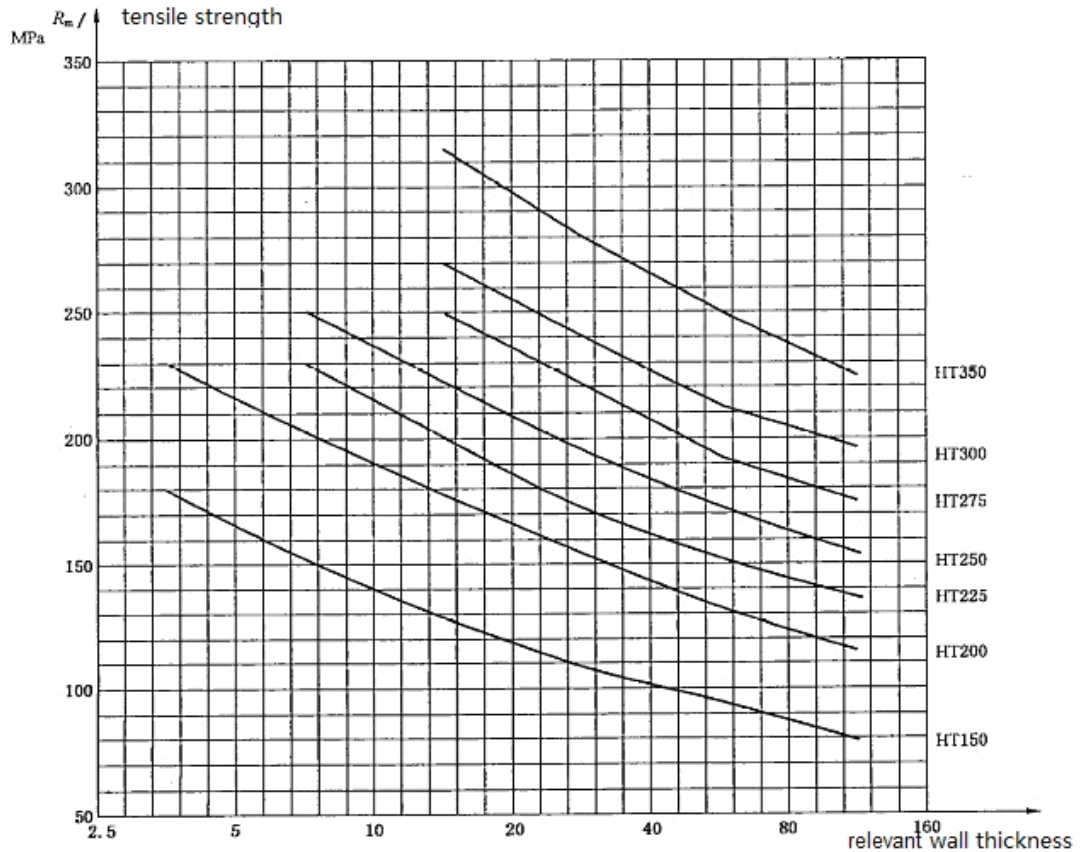


Figure C.1 — Examples of relationship between minimum values of the tensile strength and the relevant wall thickness of simple shaped castings

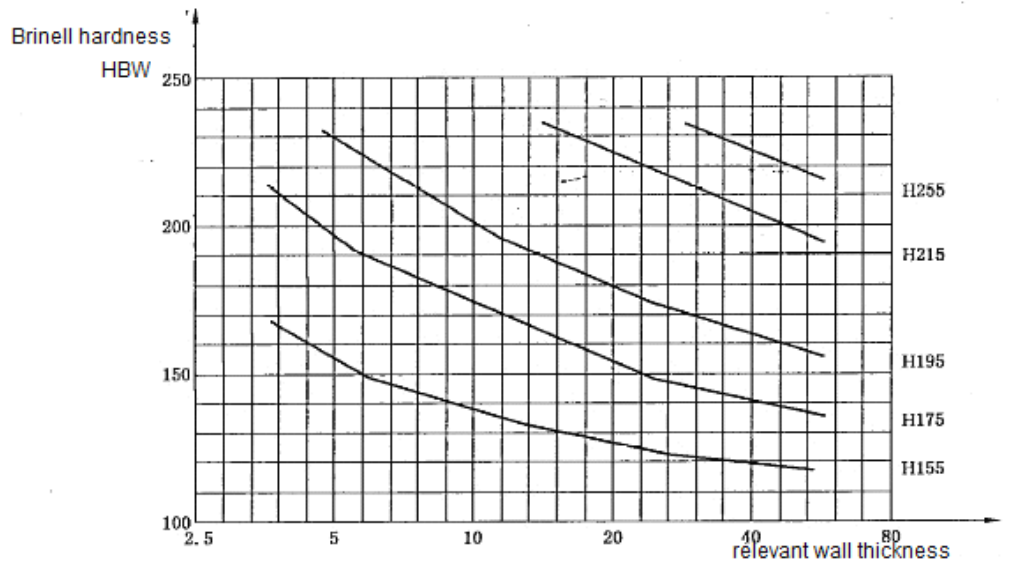


Figure C.2 — Typical relationship between average values of the Brinell hardness and the relevant wall thickness of simple shaped castings

Annex D

(informative)

Penetration strength

Penetration strength test usually refers to limitation of sample size to detect a detection method for gray cast iron body strength. The sample size is usually (6x20x32) mm (minimum accuracy of 0.05mm). In the penetration device, loaded by top sword and press sword, the penetration sample truncated. The ratio of penetration pressure and the transaction area, this is Penetration strength, is as judgment basis of the gray cast iron property.

By agreement between the manufacturer and the purchaser, the penetration strength test may be applied as an alternative to the tensile test.

D.1 Calculation method of penetration strength

Penetration strength (R_k) calculation, is according to penetration pressure (F) and the transaction area (S).

$$R_k = F/S$$

D.2 Conversion relationship of Penetration strength and tensile strength

Conversion relationship of Penetration strength and Tensile strength, usually can use the following formula.

$$\text{Tensile strength } R_m = 1.86 \times R_k - 64$$

$$\text{Or, } R_m = 1.80 \times R_k - 55$$

Acting lode speed should be less than or equal to 10 MPa/s during the test.