UDC 669.131.8 : 001.4

January 1982

Malleable cast iron

Concept, properties

DIN 1692

Temperguss; Begriff, Eigenschaften

Supersedes 06.63 edition

As it is current practice in standards published by the International Organization for Standardization (ISO), the comma has been used throughout as a decimal marker.

For connection with International Standard ISO 5922 – 1981, see Explanations.

1 Field of application

This standard specifies material properties of malleable cast iron. It applies in conjunction with

DIN 1690 Part 1 Technical delivery conditions for castings made of metallic materials; general conditions

2 Concept

Malleable cast iron is an iron-carbon material for casting, the composition of which is so adjusted, particularly with regard to the carbon and silicon content, that the casting with a design appropriate to the material solidifies without any free graphite, i.e. the total carbon content is present in the white iron in the combined form as iron carbide (cementite).

The white iron is subjected to a heat treatment resulting in the complete decomposition of the eutectic iron carbide. The chemical composition of the white iron and the type of temperature-dependent and time-dependent heat treatment applied determine the material structure and thus its properties and applications.

3 Material groups and classification of grades

3.1 Groups of malleable cast iron

Depending on the type of heat treatment used, two groups of malleable cast iron are distinguished, their original terms being derived from the appearance of the fracture:

non-decarburized-annealed malleable cast iron (blackheart malleable cast iron, GTS),

decarburized-annealed malleable cast iron (whiteheart malleable cast iron, GTW).

3.1.1 Non-decarburized-annealed malleable cast iron (GTS)

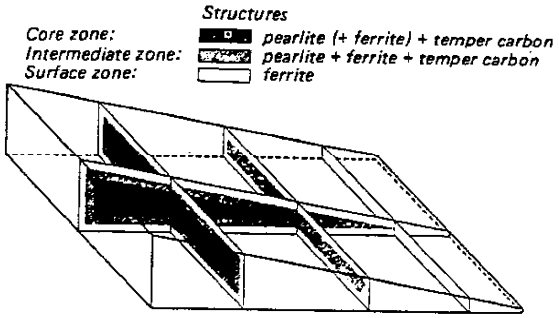
The structure of non-decarburized-annealed malleable cast iron is almost uniform throughout the entire cross section, independent of the wall thickness. A minor decarburation in the edge zone depends on the metal treatment.

3.1.2 Decarburized-annealed malleable cast iron (GTW)

The structure of decarburized-annealed malleable cast iron depends on the wall thickness (see diagrammatic representation of the structure in a casting made of decarburized-annealed malleable cast iron of graduated wall thickness in the form of a wedge specimen).

3.2 Classification of grades

The above groups of malleable cast iron are classified into grades according to the strength properties determined on separately cast tensile specimens, see tables 1 and 2.



4 Designation

The symbols designating the grades of malleable cast iron are composed of the code letters identifying the particular group of malleable cast iron and an identification number for the minimum value of tensile strength and the elongation of the particular grade of malleable cast iron, determined on a 12 mm diameter tensile specimen.

Examples: Designation of a non-decarburized-annealed malleable cast iron grade (code letter GTS-) having a minimum tensile strength of 450 N/mm² and a 6 % elongation (identification number 45-06) and material number 0.8145:

Malleable cast iron DIN 1692 – GTS-45-06

or

Malleable cast iron DIN 1692 –0.8145

Designation of a decarburized-annealed malleable cast iron grade (code letter GTW-) having a minimum tensile strength of 400 N/mm² and a 5 % elongation (identification number 40-05) and material number 0.8040:

Malleable cast iron DIN 1692 – GTW-40-05

or

Malleable cast iron DIN 1692 – 0.8040

In addition, tables 1 and 2 list the previous DIN symbols and the symbols specified in ISO 5922.

Continued on pages 2 to 5

Table 1. Properties of non-decarburized-annealed malleable cast iron (GTS)

Grade Symbol		Material number	Diameter of tensile specimen [1]	Tensile strength	0,2 % proof stress [2]	Elongation	Brinell hardness	Characteristic structural constituents	ISO symbol
new designation	previous designation		mm	R_m N/mm²	$R_{p\,0,2}$ N/mm²	A_3 %	HB		ISO 5922
				min.	min.	min.			
GTS-35-10	GTS-35	0.8135	12 or 15	350	200	10	max. 150	ferrite + temper carbon	B 35-10
GTS-45-06	GTS-45	0.8145	12 or 15	450	270	6	150 to 200	pearlite (flake up to granular) [4] + ferrite + temper carbon	P 45-06
GTS-55-04 [3]	GTS-55	0.8155	12 or 15	550	340	4	180 to 230	pearlite (flake up to granular) [4] + temper carbon, ferrite portion	P 55-04
GTS-65-02 [3]	GTS-65	0.8165	12 or 15	650	430	2	210 to 260	pearlite (flake up to granular) [4] + temper carbon	P 65-02
GTS-70-02	GTS-70	0.8170	12 or 15	700	530	2	240 to 290	heat-treatable structure [5] + temper carbon	P 70-02

[1]) to [5]) see page 3

Table 2. Properties of decarburized-annealed malleable cast iron (GTW)

Grade Symbol		Material number	Diameter of tensile specimen [6]	Tensile strength	0,2 % proof stress	Elongation	Brinell hardness [7]	Characteristic structural constituents	ISO symbol
new designation	previous designation		mm	R_m N/mm²	$R_{p\,0,2}$ N/mm²	A_3 %	HB		ISO 5922
				min.	min.	min.	max.		
GTW-35-04	GTW-35	0.8035	9	340	—	5	230	see illustration of wedge specimen	W 35-04
			12	350	—	4	230	compared with GTW-40 larger	
			15	360	—	3	230	variation permissible	
GTW-40-05	GTW-40	0.8040	9	360	200	8	220	see illustration of wedge specimen	W 40-05
			12	400	220	5	220	core: (flake up to granular)	
			15	420	230	4	220	pearlite + temper carbon	
GTW-45-07	GTW-45	0.8045	9	400	230	10	220	see illustration of wedge specimen	W 45-07
			12	450	260	7	220	core: (granular) pearlite [9]	
			15	480	280	4	220	+ temper carbon	
GTW-S 38-12 [8]	GTW-S 38	0.8038	9	320	170	15	200	see illustration of wedge specimen	W 38-12
			12	380	200	12	200	decarburation to	
			15	400	210	8	200	$C_R \leq 0{,}3\,\%$	
								for wall thickness < 8 mm	

[6]) to [9]) see page 3

5 Manufacturing process

Unless anything to the contrary has been agreed, the manufacturing process is left to the discretion of the manufacturer producing the castings.

6 Requirements

6.1 Chemical composition

The choice of the chemical composition of the white iron is left to the manufacturer's discretion.

6.2 Mechanical properties

6.2.1 Properties in separately cast tensile specimens

The mechanical properties listed in tables 1 and 2 are determined on separately cast unmachined tensile specimens having the specified diameters. The tensile test shall be carried out according to DIN 50 149.

6.2.2 Properties in tensile specimens taken from the casting (reference values)

If manufacturer and purchaser agreed that testing of the mechanical properties shall be carried out on specimens taken from the casting (as specified in DIN 1690 Part 1, subclause 4.4, August 1981 edition) the values for 0,2 % proof stress in table 3 apply. The position of the place where the samples shall be taken from the casting must be agreed so that short proportional specimens according to DIN 50 125 can be prepared. The location of sampling must be marked in the drawing accompanying the order.

Table 3. **Properties in test bars taken from the casting** (reference values)

Grade (symbol)	Material number	0,2 % proof stress (N/mm^2) [1]
GTS-35-10	0.8135	190
GTS-45-06	0.8145	260
GTS-55-04	0.8155	320
GTS-65-02	0.8165	380
GTS-70-02	0.8170	500

[1] These values for 0,2 % proof stress apply to wall thicknesses up to 30 mm. In the case of larger wall thicknesses, the values must be agreed between customer and manufacturer.

6.3 Form dimensions and machining allowances

In addition to DIN 1690 Part 1, the specifications of DIN 1680 Part 1 and Part 2 as well as of DIN 1684 Part 1 apply to castings made of malleable cast iron.

7 Physical properties (reference values)

7.1 Density

Weight calculations must be based on a mean density of 7,4 kg/dm^3.

For details see VDG Instruction sheet W 20*).

7.2 Other physical properties

See VDG Instruction sheet W 20*).

7.3 Shrinkage

The extent of shrinkage depends on the material and its metallurgical conditions, on the wall thickness, and the shape of the castings, and on the casting mould.

For preparing patterns the following average shrinkage values may be taken as a basis:

non-decarburized-annealed malleable cast iron (GTS): 0 to 1,5 %

decarburized-annealed malleable cast iron (GTW): 1 to 2 %

8 Weldability

Carbon content and carbon distribution (bound or graphitic) in the region of the weld are decisive factors with regard to weldability of malleable cast iron grades.

For details on production welding, construction welding and maintenance welding of malleable cast iron, see VDG Instruction sheet N 70*).

For construction welding without postweld heat treatment only GTW-S 38-12 grade is suitable, the carbon content of which is reduced to 0,3 % in wall thicknesses less than 8 mm as a result of extremely intensive decarburized annealing. To guarantee adequate decarburization in the cross-sectional area to be welded, the drawing must furnish particulars of the places suitable for construction welding.

*) In each case the latest edition applies. The instruction sheets are obtainable from Bibliothek des Vereins Deutscher Giessereifachleute, Postfach 82 25, D-4000 Düsseldorf 1

Footnotes to tables 1 and 2

1) For castings with a mean wall thickness of less than 6 mm, tensile specimens with other specimen cross section adapted to the wall thickness may be used.

2) In the case of grades with marked yield point, e.g. ferritic grades, the yield point may be determined instead of the 0,2 % proof stress, see Explanations.

3) Also replaces GTW-55 or GTW-65, see Explanations.

4) Preferably air quenched and subsequently tempered

5) Oil quenched and subsequently tempered

6) For castings with a mean wall thickness of less than 6 mm, tensile specimens with other specimen cross section and the associated values of mechanical properties may be agreed.

7) If necessary, a lower limit of hardness must be agreed between manufacturer and purchaser.

8) For malleable cast iron suitable for construction welding, quality class A, without thermal postweld treatment, see also clause 8.

9) Preferably air quenched and subsequently tempered.

9 Edge zone hardening (surface hardening)

Edge zone hardening is possible with all malleable cast iron grades. For details on the type of process to be used and possibly required pretreatment, see VDG Instruction sheet N 21*).

10 Machinability

The machining properties of the individual grades depend on their structure. The graphite being present in the form of temper carbon has a favourable influence on machinability; for details see VDG Instruction sheet K 30*).

11 Testing of material

In addition to DIN 1690 Part 1 the following specifications apply.

11.1 Tensile test

The tensile test shall be carried out according to DIN 50 149 on separately cast unmachined tensile specimens with the diameters specified in tables 1 and 2. The specifications described in DIN 50 145 must be observed.

11.2 Hardness testing

The Brinell hardness shall be tested according to DIN 50 351 on the casting and/or on the test bar with a $F/D^2 = 30$ load ratio using a 10 or 5 mm diameter ball.

11.3 Number of specimens

The number of specimens must be agreed on ordering.

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*) see page 3

Standards referred to and other documents

DIN 1680 Part 1	Rough castings; general tolerances and machining allowances
DIN 1680 Part 2	Rough castings; general tolerance system
DIN 1684 Part 1	Rough castings made of malleable cast iron; general tolerances, machining allowances
DIN 1690 Part 1	Technical delivery conditions for castings made of metallic materials; general conditions
DIN 50 125	Testing of metallic materials; tensile specimens, directions for their preparation
DIN 50 145	Testing of metallic materials; tensile test
DIN 50 149	Testing of malleable cast iron; tensile test
DIN 50 351	Testing of metallic materials; Brinell hardness testing
ISO 5922 – 1981	Malleable cast iron
VDG Instruction sheet K 30	Machining of malleable cast iron, turning
VDG Instruction sheet N 21	Surface hardening of malleable cast iron
VDG Instruction sheet N 70	Welding of malleable cast iron
VDG Instruction sheet W 20	Quality properties of malleable cast iron

Previous editions

DIN 1692: 01.30; 03.40; 11.50; 06.63

Amendments

Compared with the June 1963 edition the following amendments have been made:

Contents completely revised in accordance with ISO 5922 – 1981. Symbols changed. Values for tensile strength and 0,2 % proof stress converted to N/mm^2. Clauses on technical delivery conditions replaced by referring to DIN 1690 Part 1 in the "Field of application" clause. Editorially revised.

Explanations

Correspondence with

ISO 5922 – 1981

E: Malleable cast iron

and DIN 1692 has been demonstrated in the column "ISO symbols" of tables 1 and 2. However the non-decarburized-annealed malleable cast iron grades B 30-06, B 32-12, B 50-05, B 60-03 and B 80-01 specified in ISO 5922 have not been adopted, because they are not considered customary.

Compared with DIN 1692, June 1963 edition, the classification of grades has been changed.

Table 2 only lists the materials with GTW symbol, the properties of which are determined by the decarburized-annealed treatment. The former GTW-55 and GTW-65 grades, the properties of which are determined by the pearlitic matrix structure, have been included in the group of blackheart malleable cast iron with pearlitic or heat-treatable structure (table 1). In accordance with ISO 5922 the material symbol has been amended to the effect that the cast iron symbol (GTS or GTW) is not only followed by an identification number for the tensile strength but by a number combining tensile strength and elongation.

When adapting this standard to ISO 5922 the reduction of some values for elongation turned out to be unavoidable.

Moreover all passages of this standard dealing with technical delivery conditions could be omitted, as in August 1981 the general technical delivery conditions for castings had been published in DIN 1690 Part 1.

The growing interest shown by the users of malleable cast iron in details on properties which could be attained in the casting itself gave rise to adopting values determined on specimens which had been taken from the casting, for the first time in a standard on malleable cast iron. Investigations have shown that in the case of an agreed location for sampling generally binding values can only be specified for the 0,2 % proof stress. The values for 0,2 % proof stress listed in table 2 are reference values which after conclusion of adequately significant large-scale investigations will be converted into standard values.

Usually the 0,2 % proof stress is determined in the tensile test. In the case of grades with a marked yield point, i.e. predominantly with ferritic grades, it is possible to measure the yield point which can be more easily determined. For this measurement the same accuracy must be applied as for the 0,2 % proof stress. However, the following restricted procedures compared with DIN 50 145 must be observed:

- measurement of the yield point must be effected on the non-prestressed test bar
- rate of stress increase when applying a continuous load between 0,5 times the yield point and 1,2 times the yield point must not exceed 2 $N/mm^2 \cdot s$; until fracture of the test bar it must not exceed 10 $N/mm^2 \cdot s$.