



Fig. 4 Range of tensile strength and elongation values for as-cast and heat-treated ductile irons.

Table 1 Compositions and general uses for standard grades of ductile iron

Specification No.	Grade or class	UNS	TC(a)	Typical composition, %				Description	General uses
				Si	Mn	P	S		
ASTM A395; ASME SA395	60-40-18	F32800	3.00 min	2.50 max(b)	...	0.08 max	...	Ferritic; annealed	Pressure-containing parts for use at elevated temperatures
ASTM A476; SAE AMS 5316C	80-60-03	F34100	3.00 min(c)	3.0 max	...	0.08 max	0.05 max	As-cast	Paper mill dryer rolls, at temperatures up to 230 °C (450 °F)
ASTM A536	60-40-18(d)	F32800						Ferritic; may be annealed	Shock-resistant parts; low- temperature service
	65-45-12(d)	F33100						Mostly ferritic; as-cast or annealed	General service
	80-55-06(d)	F33800						Ferritic/ pearlitic; as-cast	General service
	100-70-03(d)	F34800						Mostly pearlitic; may be normalized	Best combination of strength and wear resistance and best response to surface hardening
	120-90-02(d)	F36200						Martensitic; oil quenched and tempered	Highest strength and wear resistance
ASTM A716	60-42-10	F32900						Centrifugally cast	Culvert pipe
ASTM A746	60-42-10	...						Centrifugally cast	Gravity sewer pipe
ASTM A874(e)	45-30-12	...	3.0-3.7	1.2-2.3	0.25 max	0.03 max	...	Ferritic	Low-temperature service
SAE J434	D4018(f)	F32800	3.20-4.10	1.80- 3.00	0.10- 1.00	0.015- 0.10	0.005-0.035	Ferritic	Moderately stressed parts requiring good ductility and machinability

(continued)

Note: For mechanical properties and typical applications, see Table 2. (a) TC, total carbon. (b) The silicon limit may be increased by 0.08%, up to 2.75 Si, for each 0.01% reduction in phosphorus content. (c) Carbon equivalent, CE, 3.8-4.5; $CE = TC + 0.3(Si + P)$. (d) Composition subordinate to mechanical properties; composition range for any element may be specified by agreement between supplier and purchaser. (e) Also contains 0.07% Mg (max), 0.1% Cu (max), 1.0% Ni (max), and 0.07% Cr (max). (f) General composition given under grade D4018 for reference only. Typically, foundries will produce to narrower ranges than those shown and will establish different median compositions for different grades. (g) For castings with sections 13 mm ($\frac{1}{2}$ in.) and smaller, may have 2.75 Si max with 0.08 P max, or 3.00 Si max with 0.05 P max; for castings with section 50 mm (2 in.) and greater, CE must not exceed 4.3.

Table 1 (continued)

Specification No.	Grade or class	UNS	TC(a)	Typical composition, %				Description	General uses
				Si	Mn	P	S		
SAE J434	D4512(f)	F33100						Ferritic/pearlitic	Moderately stressed parts requiring moderate machinability
	D5506(f)	F33800						Ferritic/pearlitic	Highly stressed parts requiring good toughness
	D7003(f)	F34800						Pearlitic	Highly stressed parts requiring very good wear resistance and good response to selective hardening
	DQ&T(f)	F30000						Martensitic	Highly stressed parts requiring uniformity of microstructure and close control of properties
SAE AMS 5315C	Class A	F33101	3.0 min	2.50 max(g)	...	0.08 max	...	Ferritic; annealed	General shipboard service

Note: For mechanical properties and typical applications, see Table 2. (a) TC, total carbon. (b) The silicon limit may be increased by 0.08%, up to 2.75 Si, for each 0.01% reduction in phosphorus content. (c) Carbon equivalent, CE, 3.8–4.5; CE = TC + 0.3 (Si + P). (d) Composition subordinate to mechanical properties; composition range for any element may be specified by agreement between supplier and purchaser. (e) Also contains 0.07% Mg (max), 0.1% Cu (max), 1.0% Ni (max), and 0.07% Cr (max). (f) General composition given under grade D4018 for reference only. Typically, foundries will produce to narrower ranges than those shown and will establish different median compositions for different grades. (g) For castings with sections 13 mm (1/2 in.) and smaller, may have 2.75 Si max with 0.08 P max, or 3.00 Si max with 0.05 P max; for castings with section 50 mm (2 in.) and greater, CE must not exceed 4.3.

Table 2 Mechanical properties and typical applications for standard grades of ductile iron

Specification No.	Grade or class	Hardness, HB(a)	Tensile strength, min(b)		Yield strength, min(b)		Elongation in 50 mm (2 in.) (min), % (b)	Typical applications
			MPa	ksi	MPa	ksi		
ASTM A395; ASME SA395	60-40-18	143–187	414	60	276	40	18	Valves and fittings for steam and chemical plant equipment
ASTM A476(c); SAE AMS 5316	80-60-03	201 min	552	80	414	60	3	Paper mill dryer rolls
ASTM A536	60-40-18	...	414	60	276	40	18	Pressure-containing parts, such as valve and pump bodies
	65-45-12	...	448	65	310	45	12	Machine components subject to shock and fatigue loads
	80-55-06	...	552	80	379	55	6	Crankshafts, gears, and rollers
	100-70-03	...	689	100	483	70	3	High-strength gears and machine components
	120-90-02	...	827	120	621	90	2	Pinions, gears, rollers, and slides
SAE J434	D4018	170 max	414	60	276	40	18	Steering knuckles
	D4512	156–217	448	65	310	45	12	Disk brake calipers
	D5506	187–255	552	80	379	55	6	Crankshafts
	D7003	241–302	689	100	483	70	3	Gears
	DQ&T	(c)	(d)	(d)	(d)	(d)	(d)	Rocker arms
SAE AMS 5315C	Class A	190 max	414	60	310	45	15	Electric equipment, engine blocks, pumps, housings, gears, valve bodies, clamps, and cylinders

Note: For compositions, descriptions, and uses, see Table 1. (a) Measured at a predetermined location on the casting. (b) Determined using a standard specimen taken from a separately cast test block, as set forth in the applicable specification. (c) Range specified by mutual agreement between producer and purchaser. (d) Value must be compatible with minimum hardness specified for production castings.

castings themselves. Both ASTM and SAE specifications are standards for tensile properties and hardness. The tensile properties are quasi-static and may not indicate the dynamic properties, such as impact or fatigue strength.