Low carbon steel

Description

Image



Caption

1. Paper clips. © Granta Design 2. Tower crane atop Mont Blanc. © Kristoferb at en.wikipedia - (CC BY-SA 3.0) 3. Girders (or beams) being placed in construction. © pkeleher at Flickr - (CC BY 2.0)

The material

Think of steel and you think of railroads, oilrigs, tankers, and skyscrapers. And what you are thinking of is not just steel, it is carbon steel. That is the metal that made them possible - nothing else is the same time so strong, so tough, so easily formed - and so cheap. Carbon steels are alloys of iron with carbon and, often a little manganese, nickel, and silicon. Low carbon or "mild" steels have the least carbon - less than 0.25%. They are relatively soft, easily rolled to plate, I-sections or rod (for reinforcing concrete) and are the cheapest of all structural metals - it is these that are used on a huge scale for reinforcement, for steel-framed buildings, ship plate and the like.

Composition (summary)

Fe/0.02 - 0.3C

General properties

Density		487	- 493	lb/ft^3
Price	*	0.236	- 0.263	USD/lb
Date first used		1610		

Mechanical properties

Young's modulus		29	- 31.2	10^6 psi
Shear modulus		11.5	- 12.2	10^6 psi
Bulk modulus		22.9	- 25.4	10^6 psi
Poisson's ratio		0.285	- 0.295	
Yield strength (elastic limit)		36.3	- 57.3	ksi
Tensile strength		50	- 84.1	ksi
Compressive strength		36.3	- 57.3	ksi
Elongation		26	- 47	% strain
Hardness - Vickers		108	- 173	HV
Fatigue strength at 10^7 cycles	*	29.4	- 42.5	ksi
Fracture toughness	*	37.3	- 74.6	ksi.in^0.5
Mechanical loss coefficient (tan delta)	*	8.9e-4	- 0.00142	

Thermal properties

Melting point		2.7e3	- 2.78e3	°F
Maximum service temperature	*	662	- 752	°F
Minimum service temperature	*	-90.7	- -36.7	°F

Thermal conductor or insulator?	Good conductor			
Thermal conductivity	28.3	-	31.2	BTU.ft/h.ft^2.F
Specific heat capacity	0.11	-	0.121	BTU/lb.°F
Thermal expansion coefficient	6.39	-	7.22	µstrain/°F

Electrical properties

Electrical conductor or insulator?	Good conductor			
Electrical resistivity	15	-	20	µohm.cm

Optical properties

Transparency	Opaque

Processability

Castability	3			
Formability	4	-	5	
Machinability	3	-	4	
Weldability	5			
Solder/brazability	5			

Eco properties

Embodied energy, primary production	* 2.71e3	-	3e3	kcal/lb
CO2 footprint, primary production	* 1.72	-	1.9	lb/lb
Recycle	✓			

Supporting information

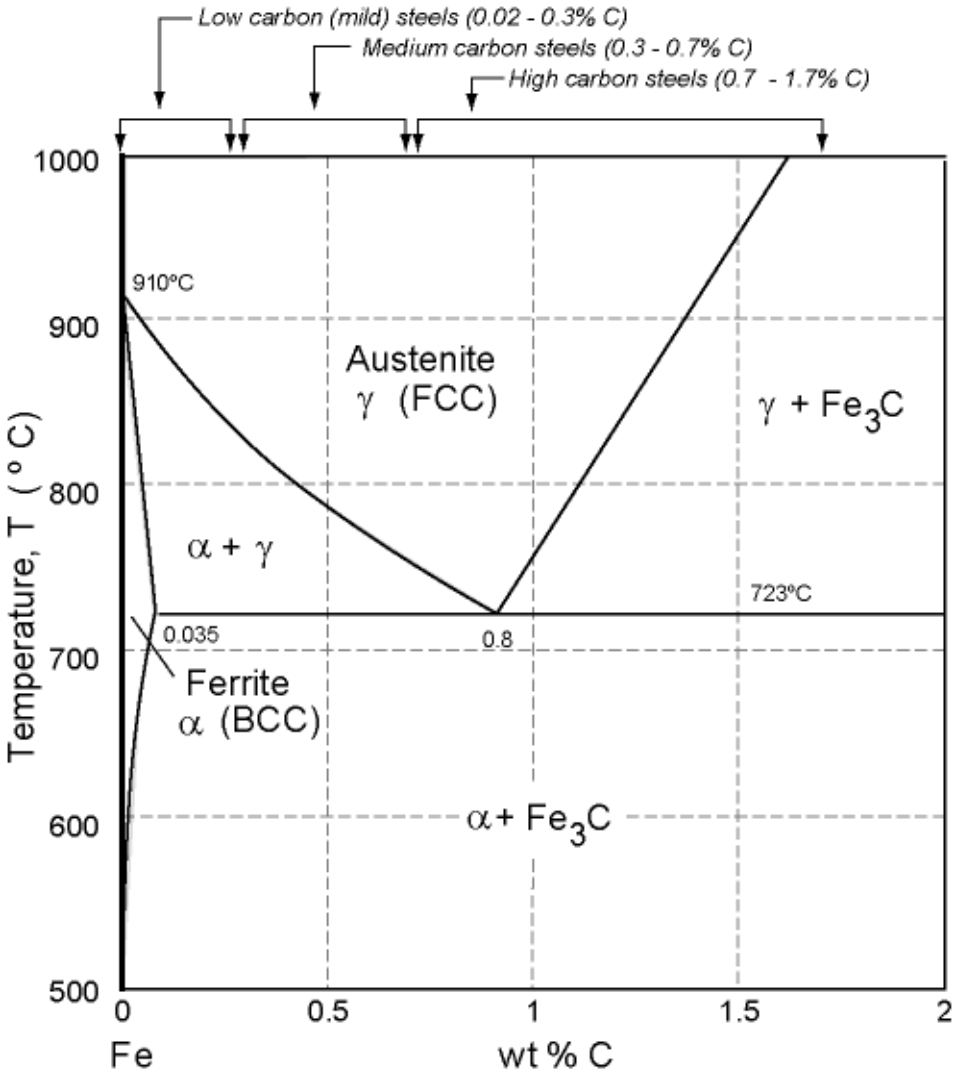
Design guidelines

Hardenability measures the degree to which it can be hardened in thick sections. Low carbon steels have too little carbon to harden much, and have poor hardenability - additional alloying elements are used to increase it (see Low alloy steels).

Technical notes

The two standard classifications for steels, the AISI and the SAE standards, have now been merged. In the SAE-AISI system, each steel has a four-digit code. The first two digits indicate the major alloying elements. The second two give the amount of carbon, in hundredths of a percent. Thus the plain carbon steels have designations starting 10xx, 11xx, 12xx or 14xxx, depending on how much manganese, sulfur and phosphorus they contain. The common low-carbon steels have the designations 1015,1020, 1022, 1117,1118; the common medium carbon steels are 1030,1040, 1050, 1060, 1137, 1141, 1144 and 1340; the common high alloy steels are 1080and 1095. More information on designations and equivalent grades can be found on the Granta Design website at www.grantadesign.com/designations

Phase diagram



Phase diagram description

Low carbon steels are alloys of iron (Fe) with 0.02 - 0.3% carbon (C), for which this is the phase diagram.

Typical uses

Low carbon steels are used so widely that no list would be complete. Reinforcement of concrete, steel sections for construction, sheet for roofing, car body panels, cans and pressed sheet products give an idea of the scope.

Links

Reference

ProcessUniverse

Producers