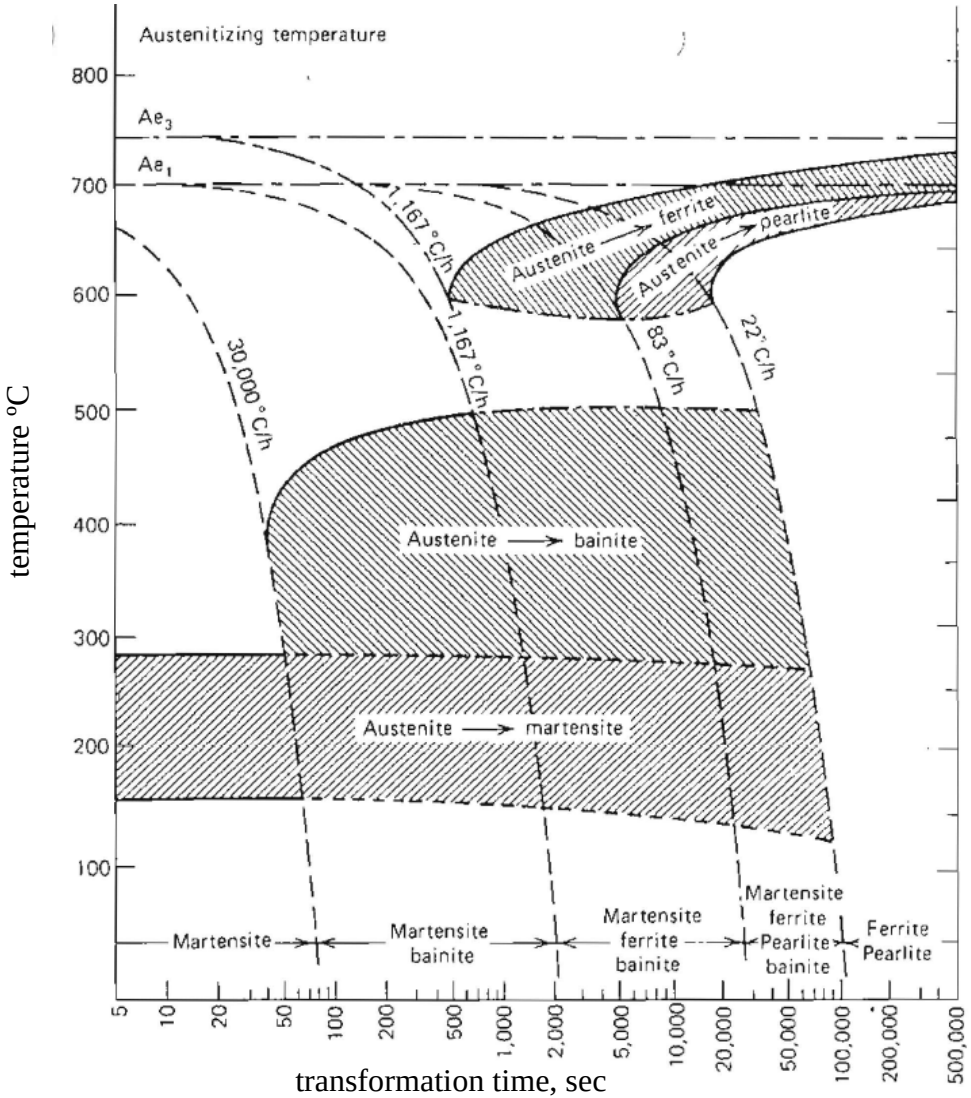
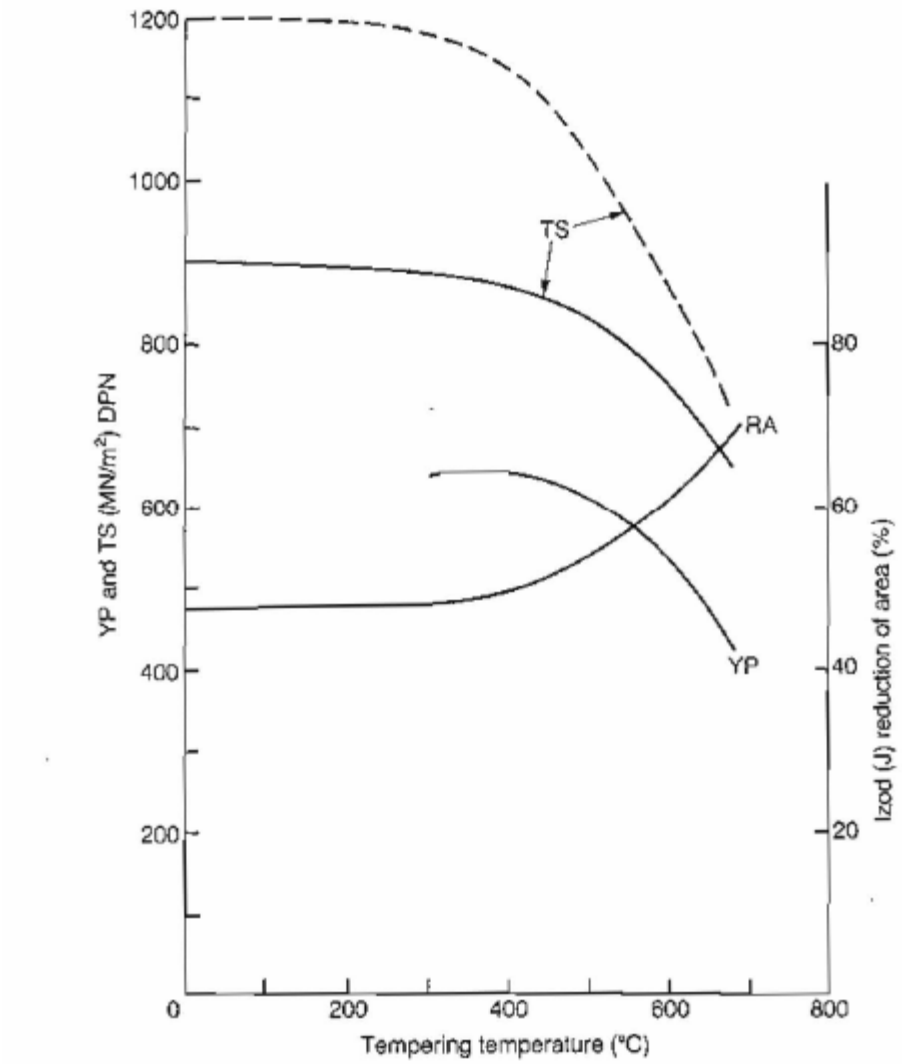


Continuous-cooling transformation diagram for a type 4340 alloy steel with superimposed cooling curves illustrating the manner in which transformation behavior during continuous cooling governs the final micro-structure. (Adapted from Mechanical Engineers' Handbook, 2nd Ed., M. Kutz, Ed. Wiley-Interscience, 1998).

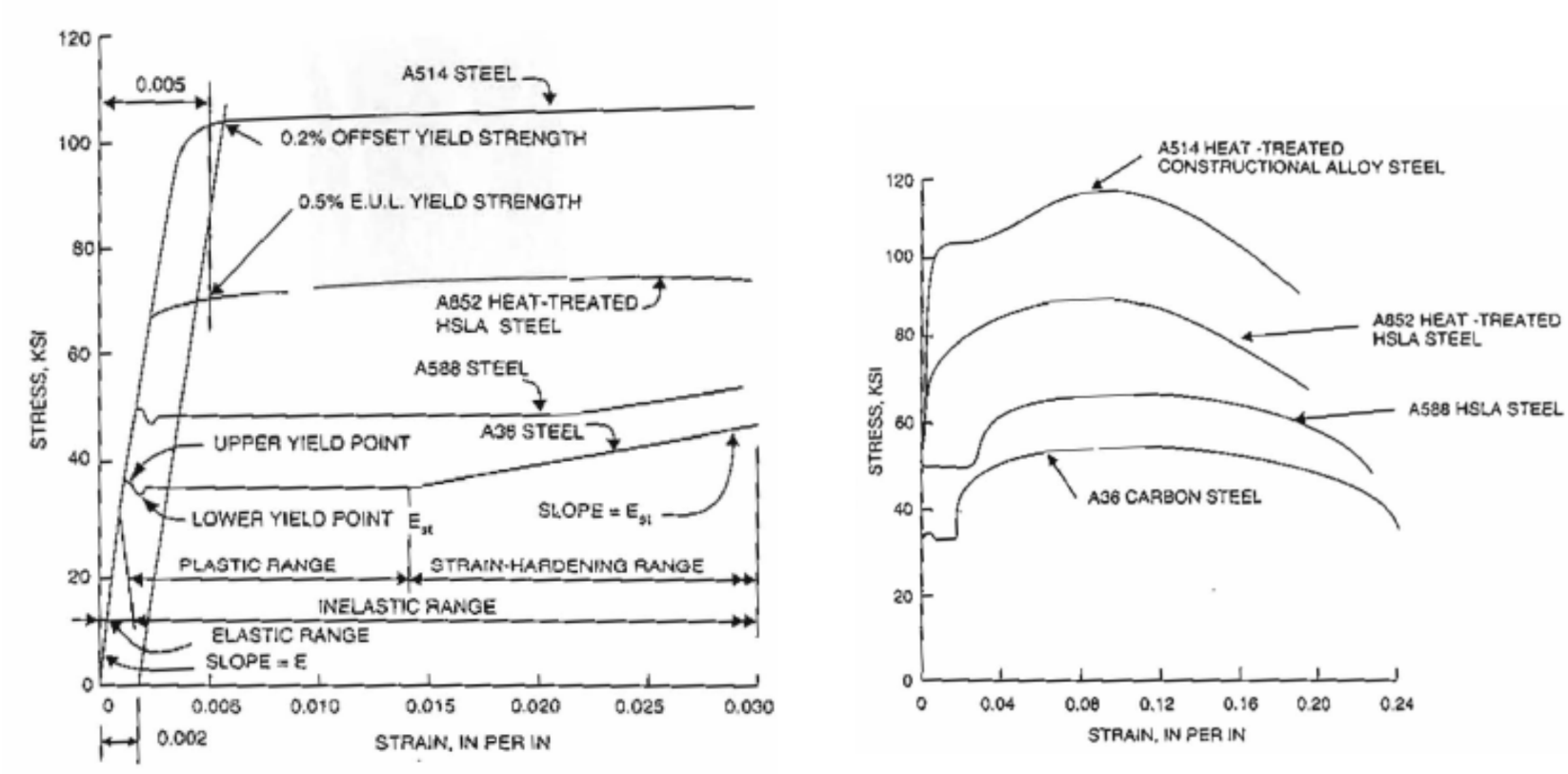


Variations in properties of 1% Ni steel with varying tempering temperatures. TS denotes tensile strength; RA denotes reduction in area; and YP denotes yield point. (From O.H. Wyatt and D. Dew-Hughes (1974) Metals, Ceramics and Polymers, Cambridge University Press.)

Standard numerical designations of plain carbon and constructional alloy steels in the AISI-SAE system. (Adapted from Mechanical Engineers' Handbook, 2nd Ed., M. Kutz, Ed. Wiley-Interscience, 1998).

Series Designation[a]	Types	Series Designation[a]	Types
10xx	Nonresulfurized carbon-steel grades	47xx	1.05% Ni–0.45% Cr–0.20% Mo
11xx	Resulfurized carbon-steel grades	48xx	3.5% Ni–0.25% Mo
12xx	Rephosphorized and resulfurized Carbon-steel grades	50xx	0.28 or 0.40% Cr
13xx	1.75% Mn	51xx	0.80, 0.90, 0.95, 1.00, or 1.05% Cr
23xx	3.50% Ni	5xxxx	1.00% C–0.50, 1.00, or 1.45% Cr
25xx	5.00% Ni	61xx	0.80 or 0.95% Cr–0.10 or 0.15% V
31xx	1.25% Ni–0.65% Cr	86xx	0.55% Ni–0.50 or 0.65% Cr–0.20% Mo
33xx	3.5% Ni–1.55% Cr	87xx	0.55% Ni–0.50% Cr–0.25% Mo
40xx	0.25% Mo	92xx	0.85% Mn–2.00% Si
41xx	0.50 or 0.95% Cr–0.12 or 0.20% Mo	93xx	3.25% Ni–1.20% Cr–0.12% Mo
43xx	1.80% Ni–0.50 or 0.80% Cr–0.25% Mo	98xx	1.00% Ni–0.80% Cr–0.25% Mo
46xx	1.55 or 1.80% Ni–0.20 or 0.25% Mo		

[a]The first figure indicates the class to which the steel belongs; 1xxx indicates a carbon steel, 2xxx a nickel steel, and 3xxx a nickel-chromium steel. In the case of alloy steels, the second figure generally indicates the approximate percentage of the principal alloying element. Usually, the last two or three figures (represented in the table by x) indicate the average carbon content in points or hundredths of 1 wt %. Thus, a nickel steel containing a 3.5% nickel and 0.30% carbon would be designated as 2330.



Comparative tensile stress vs. strain curves for different types of structural steels at low strains ($\varepsilon<.03$) and at much higher strains. The curves have been modified to reflect minimum strength properties of the various steel types.

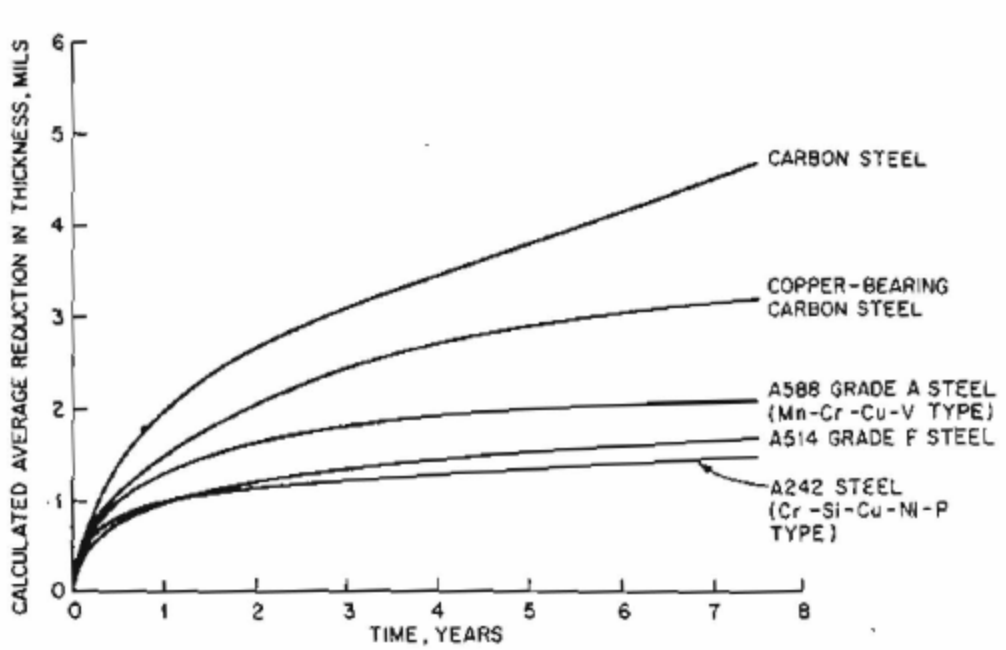
Specified minimum properties for structural steel shapes and plates.

ASTM designation	Plate-thickness range, in	ASTM group for structural shapes†	Yield stress, ksi	Tensile strength, ksi‡	Elongation, % In 2 in§	Elongation, % In 8 in
		Carbon steels				
A36	8 maximum	1–5	36	58–80	23–21	20
	over 8	1–5	32	58–80	23	20
A573						
Grade 58	1½ maximum	¶	32	58–71	24	21
Grade 65	1½ maximum	¶	35	65–77	23	20
Grade 70	1½ maximum	¶	42	70–90	21	18
		High-strength low-alloy steels				
A242	¾ maximum	1 and 2	50	70	21	18
	Over ¾ to 1½ max	3	46	67	21	18
	Over 1½ to 4 max	4 and 5	42	63	21	18
A588	4 maximum	1–5	50	70	21	18
	Over 4 to 5 max	1–5	46	67	21	18
	Over 5 to 8 max	1–5	42	63	21	—
A572						
Grade 42	6 maximum	1–5	42	60	24	20
Grade 50	4 maximum	1–5	50	65	21	18
Grade 60	1¼ maximum	1 and 2	60	75	18	16
Grade 65	1¼ maximum	1	65	80	17	15
		Heat-treated carbon and HSLA steels				
A633						
Grade A	4 maximum	¶	42	63–83	23	18
Grade C	Over 2½ to 4 max	¶	50	70–90	23	18
Grade D	Over 2½ to 4 max	¶	50	70–90	23	18
Grade E	4 maximum	¶	60	80–100	23	18
	Over 4 to 6 max	¶	55	75–95	23	18
A678						
Grade A	1½ maximum	¶	50	70–90	22	—
Grade B	2½ maximum	¶	60	80–100	22	—
Grade C	¾ maximum	¶	75	95–115	19	—
	Over ¾ to 1½ max	¶	70	90–110	19	—
	Over 1½ to 2 max	¶	65	85–105	19	—
Grade D	3 maximum	¶	75	90–110	18	—
A852	4 maximum	¶	70	90–110	19	—
		Heat-treated constructional alloy steels				
A514	2½ maximum	¶	100	110–130	18	—
	Over 2½ to 6 max.	¶	90	100–130	16	—

*The following are approximate values for all the steels:
Modulus of elasticity—29 × 10^3 ksi.
Shear modulus—11 × 10^3 ksi.
Poisson's ratio—0.30.
Yield stress in shear—0.57 times yield stress in tension.
Ultimate strength in shear—⅔ to ¾ times tensile strength.
Coefficient of thermal expansion—6.5 × 10^{-6} in per in per deg F for temperature range −50 to +150°F.
Density—490 lb/ft³.
†See ASTM A6 for structural shape group classification.
‡Where two values are shown for tensile strength, the first is minimum and the second is maximum.
§The minimum elongation values are modified for some thicknesses in accordance with the specification for the steel. Where two values are shown for the elongation in 2 in, the first is for plates and the second for shapes.
¶Not applicable.

Comparative room temperature physical properties of aluminum, steel, and stainless steel

	Aluminum	Steel	Stainless steel
Average weight density ($kg\ m^{-3}$)	2700	7850	7900
Melting point (°C)	658	1450–1530	1450
Linear thermal expansion coefficient ($°C^{-1}$)	24×10^{-6}	12×10^{-6}	17.3×10^{-6}
Specific heat ($cal\ g^{-1}$)	0.225	0.12	0.12
Thermal conductivity (cal cm s °C)	0.52	0.062	0.035
Electrical resistivity ($\mu\Omega$ cm)	2.84	15.5	70
Young's modulus ($N\ mm^{-2}$)	68 500	206 000	206 000



Comparative rate of dry corrosion curves for structural steels in an industrial atmosphere. (From R.L. Brockenbrough and B.G. Johnston, USS Steel Design Manual, R.L. Brockenbrough & Associates, Inc., Pittsburgh, PA).