MATERIALS · CHEAT SHEET

ASTM steel *grade reference*.

Common ASTM steel grades — yield strength, tensile strength, and typical applications. The **quick reference for picking the right steel** for structural, pressure, machining, and corrosion-resistant applications.

The chart

DESIGNATION	TYPE	YIELD (KSI)	TENSILE (KSI)	TYPICAL USE
A36	Carbon structural	36	58-80	General construction — beams, plate, angle iron. Most common low-strength structural steel.
A572 Gr 50	HSLA structural	50	65 min	Bridges, buildings — higher strength than A36 at similar cost.
A992	Wide-flange beams	50-65	65 min	W-shape structural beams (replaced A36/A572 for W-shapes since 1998).
A500 Gr B	HSS structural tube	46 (rect.) / 42 (round)	58 min	Square / rectangular structural tubing. Common in modern construction.
A572 Gr 65	HSLA high-strength	65	80 min	High-strength bridges, heavy industrial.
A1011 / A1018	Carbon sheet/plate	30-50	49-65	Commercial-quality steel sheet — cold or hot rolled.
A283 Gr C	Low-carbon plate	30	55-75	Storage tanks, general structural plate.
A53 Gr B	Pipe (structural + flow)	35	60 min	Standard pipe — Type E (electric welded), Type F (furnace butt-welded).
A106 Gr B	Seamless pipe (high temp)	35	60 min	Pressure / high-temperature steam service.
A516 Gr 70	Pressure vessel plate	38	70 min	Boilers, pressure vessels — moderate / low temperature.
A537 Cl 1	Pressure vessel (Q&T)	50	70-90	Higher-strength pressure vessels, quenched and tempered.
1018	Low carbon (cold rolled)	54	64	Machine shafts, general purpose, weldable. Easy to machine.
1045	Medium carbon	45-60	82-91	Higher-strength shafts, axles. Flame / induction hardenable.
1144	Free-machining stressproof	100	115	Resulfurized, prehardened. Better machinability than 1045.
4140	Alloy (Cr-Mo)	60-200	90-220	Heat-treatable. Shafts, gears, high-strength fasteners. Hardenable to 50+ HRC.
4340	Alloy (Ni-Cr-Mo)	60-220	100-260	Aircraft, high-strength shafts. Superior toughness vs 4140.
8620	Low-alloy carburizing	40-90	55-180	Gears, camshafts. Surface-hardened by carburizing.

DESIGNATION	TYPE	YIELD (KSI)	TENSILE (KSI)	TYPICAL USE
304 / 304L	Austenitic stainless	30	75	Food, chemical, kitchen. Non-magnetic, weldable. The default stainless.
316 / 316L	Austenitic stainless (Mo)	30	75	Marine, chemical. Better corrosion (chloride) resistance than 304.
17-4 PH	Precipitation-hardened	170	190	Aerospace shafts, valves. Heat-treatable to high strength.
410	Martensitic stainless	35-85	70-110	Hardenable. Valve stems, fasteners, cutlery.
416	Martensitic (free-machining)	40-85	75-110	Free-machining version of 410. Valve parts.
A588 (Cor-Ten)	Weathering steel	50	70	Forms a protective rust patina — used in bridges, architecture.
A572 Gr 60	HSLA	60	75 min	Bridges (between Gr 50 and Gr 65 use cases).
A656 Gr 80	Microalloyed HSLA	80	90 min	Heavy-equipment frames, where high strength matters.

About these designations. ASTM (American Society for Testing and Materials) designations begin with 'A' for ferrous metals; the number is the standard number, not a property. Yield and tensile values shown are *minimum* spec — actual material typically tests 10-20% higher. For heat-treatable alloys (4140, 4340, etc.), the strength range reflects different heat-treat conditions.

Common applications

APPLICATION	RECOMMENDED GRADE	REASON
Residential beams, columns	A36 or A992	Cheap, weldable, code-accepted
Commercial steel framing	A992 (W-shapes), A500 (HSS)	Modern standards
Bridges	A572 Gr 50, A588	Higher strength + weatherproof
Pressure vessels (moderate T)	A516 Gr 70	Standard ASME pressure vessel grade
Hydraulic cylinder shaft	1045 or 4140 (hardened)	Wear resistance, strength
Bolts (Grade 5 equivalent)	Medium carbon, SAE J429	SAE 4140 for high-grade variants
Gear teeth	8620 (carburized) or 4140	Surface hardness + tough core
Marine hardware	316 stainless	Chloride corrosion resistance
Food / kitchen contact	304 stainless	Easy to clean, non-reactive
Architectural exposed	A588 (Cor-Ten) or 316 stainless	Weather resistance

APPLICATION	RECOMMENDED GRADE	REASON
Machine shop general stock	1018	Easy to machine, weld; cheap

Common pitfalls

- **'Steel' alone is ambiguous.** A36 and 4340 are both 'steel' but differ by 5× in strength. Always specify a grade.
- **Stainless isn't immune to corrosion.** 304 corrodes in saltwater; 316 is better but still pits eventually. For severe chloride or acid environments, use duplex, super duplex, or specialized alloys.
- **Yield ≠ working strength.** Allowable stress for structural design is typically 60-66% of yield (ASD method) — never the full yield value. Code-mandated safety factors apply.
- **Hardness ≠ strength directly.** A 50 HRC tool steel can be very strong AND very brittle. Working strength requires both strength AND toughness. Quenched-and-tempered 4140 at 30 HRC may be more useful than untempered 4140 at 60 HRC for many applications.
- **Welding considerations vary widely.** A36 welds easily with no preheat. 4140 needs preheat and post-weld stress relief to avoid cracking. High-strength steels (above ~80 ksi yield) often have welding restrictions.
- **Tensile vs yield: don't confuse.** Yield is where the steel permanently deforms. Tensile is where it breaks. The ratio (yield/tensile) tells you ductility — higher ratios mean more brittle. 4340 quenched and tempered has yield close to tensile; A36 has wide gap (high ductility).

Common questions

What's the difference between A36 and A572?

A36 is structural carbon steel with a yield strength of 36 ksi (250 MPa) — the most common, cheapest, easiest to weld. A572 Grade 50 is a high-strength low-alloy steel with 50 ksi (345 MPa) yield, used when you need more strength-to-weight in beams and columns. A572 is harder to weld and slightly more expensive but lets you use smaller sections for the same load.

Is A992 the same as A572 Grade 50?

They're close but not identical. A992 is the modern standard for W-shape (wide-flange) structural beams and has a tighter yield-strength range (50-65 ksi) than A572 Grade 50 (50 ksi minimum). A992 also limits carbon content for better weldability. If a drawing calls for A572 Grade 50

beams, A992 will satisfy it; the reverse isn't always true.

Can I substitute A53 for A500 HSS?

Not interchangeably. A53 is a pipe spec — round only, lower yield (35 ksi for Grade B). A500 is hollow structural section for round, square, or rectangular tubing with higher yield (46 ksi for Gr B rectangular, 42 ksi for round). Round A53 looks similar to round A500 but has different mechanical properties; always verify the drawing's exact callout.

Why are some grades measured in ksi and others in MPa?

It's a regional convention, not a material difference. ASTM uses ksi (kips per square inch) because it's the US/customary standard; European EN standards use MPa (megapascals). 1 ksi ≈ 6.895 MPa, so 36 ksi = 248 MPa, 50 ksi = 345 MPa. Material data sheets often list both for international use.

Which grade should I use for a residential project?

For most residential and light-commercial construction, A36 (plates and angles) and A992 (W-shape beams) cover the vast majority of uses. A36 is forgiving, weldable, and inexpensive. Use higher grades like A572 or A913 only when the structural engineer specifies them for span or load reasons — they cost more and offer no benefit unless the design uses the extra strength.

Sources

- **Structural:** AISC Steel Construction Manual; ASTM A6 (general requirements for rolled structural steel).
- **Pipe:** ASTM A53, A106, A312 (stainless pipe).
- **Pressure vessel:** ASTM A516, A537; design per ASME BPVC Section VIII.
- **Alloy steels:** AISI/SAE designations; ASTM grade tables in ASM Metals Handbook.