

MatWeb, The Online Materials Database**ASTM A36 Steel, bar****Subcategory:** ASTM Steel; Carbon Steel; Low Carbon Steel; Metal**Key Words:** UNS K02600

Component	Wt. %
C	0.26
Cu	0.2
Fe	99
Mn	0.75
P	Max 0.04
S	Max 0.05

Material Notes:

Minimum Cu content when copper steel is specified. Used for guardrails.

Physical Properties	Metric	English	Comments
Density	7.85 g/cc	0.284 lb/in ³	

Mechanical Properties

Tensile Strength, Ultimate	400 - 550 MPa	58000 - 79800 psi	
Tensile Strength, Yield	250 MPa	36300 psi	
Elongation at Break	20 %	20 %	in 200 mm
Elongation at Break	23 %	23 %	In 50 mm.
Modulus of Elasticity	200 GPa	29000 ksi	
Compressive Yield Strength	152 MPa	22000 psi	Allowable compressive strength
Bulk Modulus	140 GPa	20300 ksi	Typical for steel
Poisson's Ratio	0.26	0.26	
Shear Modulus	79.3 GPa	11500 ksi	

References are available for this material.

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Aluminum 6061-T6; 6061-T651

Subcategory: 6000 Series Aluminum Alloy; Aluminum Alloy; Metal; Nonferrous Metal

Close Analogs:

Composition Notes:

Aluminum content reported is calculated as remainder.

Composition information provided by the Aluminum Association and is not for design.

Key Words: al6061, UNS A96061; ISO AlMg1SiCu; Aluminium 6061-T6, AD-33 (Russia); AA6061-T6; 6061T6, UNS A96061; ISO AlMg1SiCu; Aluminium 6061-T651, AD-33 (Russia); AA6061-T651

Component	Wt. %	Component	Wt. %	Component	Wt. %
Al	95.8 - 98.6	Mg	0.8 - 1.2	Si	0.4 - 0.8
Cr	0.04 - 0.35	Mn	Max 0.15	Ti	Max 0.15
Cu	0.15 - 0.4	Other, each	Max 0.05	Zn	Max 0.25
Fe	Max 0.7	Other, total	Max 0.15		

Material Notes:

Information provided by Alcoa, Starmet and the references. General 6061 characteristics and uses: Excellent joining characteristics, good acceptance of applied coatings. Combines relatively high strength, good workability, and high resistance to corrosion; widely available. The T8 and T9 tempers offer better chipping characteristics over the T6 temper.

Applications: Aircraft fittings, camera lens mounts, couplings, marines fittings and hardware, electrical fittings and connectors, decorative or misc. hardware, hinge pins, magneto parts, brake pistons, hydraulic pistons, appliance fittings, valves and valve parts; bike frames.

Data points with the AA note have been provided by the Aluminum Association, Inc. and are NOT FOR DESIGN.

Physical Properties	Metric	English	Comments
Density	2.7 g/cc	0.0975 lb/in ³	AA; Typical

Mechanical Properties

Hardness, Brinell	95	95	AA; Typical; 500 g load; 10 mm ball
Hardness, Knoop	120	120	Converted from Brinell Hardness Value
Hardness, Rockwell A	40	40	Converted from Brinell Hardness Value
Hardness, Rockwell B	60	60	Converted from Brinell Hardness Value
Hardness, Vickers	107	107	Converted from Brinell Hardness Value
Ultimate Tensile Strength	310 MPa	45000 psi	AA; Typical
Tensile Yield Strength	276 MPa	40000 psi	AA; Typical
Elongation at Break	12 %	12 %	AA; Typical; 1/16 in. (1.6 mm) Thickness
Elongation at Break	17 %	17 %	AA; Typical; 1/2 in. (12.7 mm) Diameter
Modulus of Elasticity	68.9 GPa	10000 ksi	AA; Typical; Average of tension and compression. Compression modulus is about 2% greater than tensile modulus.

Notched Tensile Strength	324 MPa	47000 psi	2.5 cm width x 0.16 cm thick side-notched specimen, $K_t = 17$.
Ultimate Bearing Strength	607 MPa	88000 psi	Edge distance/pin diameter = 2.0
Bearing Yield Strength	386 MPa	56000 psi	Edge distance/pin diameter = 2.0
Poisson's Ratio	0.33	0.33	Estimated from trends in similar Al alloys.
Fatigue Strength	96.5 MPa	14000 psi	AA; 500,000,000 cycles completely reversed stress; RR Moore machine/specimen
Fracture Toughness	29 MPa-m ^{1/2}	26.4 ksi-in ^{1/2}	K_{IC} ; TL orientation.
Machinability	50 %	50 %	0-100 Scale of Aluminum Alloys
Shear Modulus	26 GPa	3770 ksi	Estimated from similar Al alloys.
Shear Strength	207 MPa	30000 psi	AA; Typical

Electrical Properties

Electrical Resistivity	3.99e-006 ohm-cm	3.99e-006 ohm-cm	AA; Typical at 68°F
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Thermal Properties

CTE, linear 68°F	23.6 $\mu\text{m/m-}^\circ\text{C}$	13.1 $\mu\text{in/in-}^\circ\text{F}$	AA; Typical; Average over 68-212°F range.
CTE, linear 250°C	25.2 $\mu\text{m/m-}^\circ\text{C}$	14 $\mu\text{in/in-}^\circ\text{F}$	Estimated from trends in similar Al alloys. 20-300°C.
Specific Heat Capacity	0.896 J/g-°C	0.214 BTU/lb-°F	
Thermal Conductivity	167 W/m-K	1160 BTU-in/hr-ft ² -°F	AA; Typical at 77°F
Melting Point	582 - 652 °C	1080 - 1205 °F	AA; Typical range based on typical composition for wrought products 1/4 inch thickness or greater; Eutectic melting can be completely eliminated by homogenization.
Solidus	582 °C	1080 °F	AA; Typical
Liquidus	652 °C	1205 °F	AA; Typical

Processing Properties

Solution Temperature	529 °C	985 °F	
Aging Temperature	160 °C	320 °F	Rolled or drawn products; hold at temperature for 18 hr
Aging Temperature	177 °C	350 °F	Extrusions or forgings; hold at temperature for 8 hr

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Standard gray iron test bars, as cast, ASTM class 40

Subcategory: Gray Cast Iron; Metal

Component	Wt. %	Component	Wt. %	Component	Wt. %
C	3.25 - 3.5	Mn	0.5 - 0.9	P	Max 0.12
Cr	0.05 - 0.45	Mo	0.05 - 0.1	S	Max 0.15
Cu	0.15 - 0.4	Ni	0.05 - 0.2	Si	1.8 - 2.3

Material Notes:

1440 kg transverse load on test bar.

Physical Properties	Metric	English	Comments
Density	7.15 g/cc	0.258 lb/in ³	Typical for Gray Cast Iron
Mechanical Properties			
Hardness, Brinell	235	235	
Hardness, Knoop	262	262	Converted from Brinell hardness.
Hardness, Rockwell C	17.9	17.9	Approximated. Converted from Brinell hardness. Value below normal HRC range, for comparison purposes only.
Hardness, Vickers	248	248	Approximated. Converted from Brinell hardness.
Tensile Strength, Ultimate	293 MPa	42500 psi	
Modulus of Elasticity	110 - 138 GPa	16000 - 20000 ksi	
Ultimate Compressive Strength	965 MPa	140000 psi	
Poisson's Ratio	0.29	0.29	Calculated
Fatigue Strength	128 MPa	18600 psi	Reversed bending fatigue limit.
Shear Modulus	44 - 54 GPa	6380 - 7830 ksi	
Shear Strength	393 MPa	57000 psi	Torsional shear strength.

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