

Table 100 Creep and rupture properties of alloy 7050-T3651 plate

Temperature °C	°F	Time under stress h	Rupture stress		Stress for creep of:							
			MPa	ksi	1.0%		0.5%		0.2%		0.1%	
			MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi
24	75...	0.1	510	74	496	72	476	69	455	66	448	65
		1	503	73	483	70	462	67	448	65	441	64
		10	490	71	469	68	455	66	441	64	441	64
		100	476	69	455	66	448	65	441	64	434	63
		1000	469	68	448	65	441	64	...	...	...	...
100	212...	0.1	441	64	434	63	427	62	421	61	414	60
		1	427	62	414	60	407	59	400	58	386	56
		10	407	59	393	57	386	56	372	54	359	52
		100	379	55	372	54	365	53	345	50	331	48
		1000	359	52	352	51	345	50	317	46	...	...
149	300...	0.1	372	54	365	53	359	52	345	50	324	47
		1	345	50	338	49	324	47	303	44	290	42
		10	310	45	303	44	290	42	269	39	228	33
		100	262	38	255	37	241	35	193	28	152	22
		1000	179	26	179	26	165	24	145	21	124	18

Volumetric: $68 \times 10^{-3} \text{ m}^3/\text{m}^3\cdot\text{K}$ ($3.78 \times 10^{-5} \text{ in.}^3/\text{in.}^3\cdot^\circ\text{F}$) at 20 °C (68 °F)
 Specific heat: 893 J/kg·K (0.213 Btu/lb·°F) at 20 °C (68 °F)
 Thermal conductivity: O temper: 227 W/m·K (131 Btu/ft·h·°F) at 20 °C (68 °F)

Electrical Properties

Electrical conductivity. Volumetric, O temper: 60% IACS at 20 °C (68 °F)
 Electrical resistivity. 28.7 nΩ·m at 20 °C (68 °F); temperature coefficient, 0.1 nΩ·m per K at 20 °C (68 °F)
 Electrolytic solution potential. -0.96 V vs 0.1N calomel electrode in an aqueous solution containing 53 g NaCl plus 3 g H₂O₂ per litre at 25 °C (77 °F)

Chemical Properties

General corrosion behavior. High resistance to general corrosion. Provides galvanic protection when used as cladding on several different alloys.

Fabrication Characteristics

Annealing temperature. 343 °C (650 °F)

Table 101 Mechanical-property limits for alloy 7072 fin stock

Temper	Tensile strength				Yield strength (min)		Elongation (min), % ^(a)
	Minimum MPa	ksi	Maximum MPa	ksi	MPa	ksi	
O.....	55	8.0	90	13.0	21	3	15 to 20
H14.....	97	14.0	131	19.0	83	12	1 to 3
H18.....	131	19.0	...	...	...	...	1 to 2
H19.....	145	21.0	...	...	...	...	1
H25.....	107	15.5	148	21.5	83	12	2 to 3
H111, H211.....	62	9.0	97	14.0	41	6.0	12

(a) In 2 in. or 50 mm. where a range of values appears in this column, specified minimum elongation varies with thickness of the mill product.

0.10 max Mg; 0.10 max Mn; 0.7 max Si + Fe; 0.8 to 1.3 Zn; 0.05 max others (each); 0.15 max others (each); rem Al

Applications

Typical uses. Fin stock. Cladding alloy for alclad sheet, plate, and tube products with the following core alloys: 2219, 3003, 3004, 5050, 5052, 5154, 6061, 7075, 7475, 7178

Mechanical Properties

Tensile properties. See Table 101.
 Shear strength. O temper, 55 MPa (8 ksi); H12 temper, 62 MPa (9 ksi); H14 temper, 69 MPa (10 ksi)
 Hardness. O temper, 20 HB; H12 temper, 28 HB; H14 temper, 32 HB; all values obtained with 500-kg load, 10-mm diam ball and 30-s duration of loading
 Poisson's ratio. 0.33
 Elastic modulus. Tension, 68 GPa

(9.9×10^6 psi); compression, 70 GPa (10.1×10^6 psi)

Mass Characteristics

Density. 2.72 Mg/m³ (0.098 lb/in.³) at 20 °C (68 °F)

Thermal Properties

Liquidus temperature. 657 °C (1215 °F)
 Solidus temperature. 641 °C (1185 °F)
 Coefficient of thermal expansion. Linear:

Temperature range	°C	°F	Average coefficient	
			μm/m·K	μin./in.·°F
-50 - +20	-58	+68...	21.8	12.1
20 - 100	68	-212...	23.6	13.1
20 - 200	68	-392...	24.5	13.6
20 - 300	68	-572...	25.5	14.2

7075, Alclad 7075 5.6Zn-2.5Mg-1.6Cu-0.23Cr

Specifications

AMS. See Table 102.
 ASTM. See Table 102.
 SAE. J454
 UNS number. A97075
 Government. See Table 102.
 Foreign. Austria: Onorm AlZnMg-Cul.5. Canada: CSA ZG62, ZG62Al-clad. France: NF A-Z5GU. Spain: UNE L-371. Switzerland: VSM Al-Zn-Mg-Cu; Alclad, Al-Zn-Mg-Cu-pl. United Kingdom: BS L.95, L.96. Germany: DIN AlZnMgCul.5; Werkstoff-Nr. 3.4365. ISO: AlZn6MgCu

Chemical Composition

Composition limits. 7075: 1.20 to 2.0 Cu; 2.1 to 2.9 Mg; 0.30 max Mn; 0.40 max Si; 0.50 max Fe; 0.18 to 0.28 Cr; 5.1 to 6.1 Zn; 0.20 max Ti; 0.05 max others (each); 0.15 max others (total); rem Al. Alclad 7075: 7072 cladding—0.10 max Cu; 0.10 max

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Mg; 0.10 max Mn; 0.7 max Si + Fe; 0.8 to 1.3 Zn; 0.05 max others (each); 0.15 max others (total); rem Al

Applications

Typical uses. Aircraft structural parts and other highly stressed structural applications where very high strength and good resistance to corrosion are required

Precautions in use. Caution should be exercised in T6 temper applications where sustained tensile stresses are encountered, either residual or applied, particularly in the transverse grain direction. In such instances, the T73 temper should be considered, at some sacrifice in tensile strength

Mechanical Properties

Tensile properties. See Tables 103 and 104.

Shear strength. Bare and alclad products, O temper: 152 MPa (22 ksi). Bare products—T6, T651 tempers: 331 MPa (48 ksi); Alclad T6, T651: 317 MPa (46 ksi)

Hardness. O temper, 60 HB; T6, T651 temper, 150 HB; data obtained using 500-kg load, 10-mm diam ball and 30-s duration of loading

Poisson's ratio. 0.33

Elastic modulus. Tension, 71.0 GPa (10.3×10^6 psi); shear, 26.9 GPa (3.9×10^6 psi); compression, 72.4 GPa (10.5×10^6 psi)

Fatigue strength. T6, T651, T73 tempers: 159 MPa (23 ksi) at 5×10^8 cycles in R. R. Moore type test of smooth (unnotched) specimens

Plane-strain fracture toughness. See Table 105.

Directional properties. Transverse mechanical properties of many products, particularly tensile strength and ductility in the short transverse direction, are less than those in the longitudinal direction.

Mass Characteristics

Density. 2.80 Mg/m³ (0.101 lb/in.³) at 20 °C (68 °F)

Thermal Properties

Liquidus temperature. 635 °C (1175 °F)

Solidus temperature. 477 °C (890 °F); eutectic temperature for nonhomogeneous as-cast or wrought material that has not been solution heat treated

Incipient melting temperature. 532 °C (990 °F) for homogenized (so-

Table 102 Standard specifications for alloy 7075

Mill form and condition	AMS	ASTM	Government
Bare products			
Sheet and plate	4038	B209	QQ-A-250/2
	4044	...	...
	4045	...	...
	4078	...	...
Wire, rod, and bar (rolled or cold finished)	4122	B211	QQ-A-225/9
	4123	...	...
	4124	...	...
Rod, bar, shapes, and tube (extruded)	4154	B221	QQ-A-200/11
	4167	...	...
	4168	...	...
	4169	...	...
Tube (extruded, seamless) .....	...	B241	...
Tube (drawn, seamless) .....	...	B210	...
Forgings and forging stock	4139	B247	QQ-A-367
	...	...	MIL-A-22771
	...	...	MIL-A-12545
Impacts	4170	...	QQ-A-430
Rivets .....	...	B316	...
Alclad Products			
Sheet and plate	4039	B209	QQ-A-250/13
	4048	...	...
	4049	...	...
Tapered sheet and plate	4047	...	...
Alclad One Side Products			
Sheet and plate	4046	B209	QQ-A-250/18

Table 103 Typical tensile properties for alloy 7075 at various temperatures

Temperature °C	°F	Tensile strength(a)		Yield strength(a)(b)		Elongation(c), %
		MPa	ksi	MPa	ksi	
T6, T651 Tempers						
-196	-320	703	102	634	92	9
-80	-112	621	90	545	79	11
-28	-18	593	86	517	75	11
24	75	572	83	503	73	11
100	212	483	70	448	65	14
149	300	214	31	186	27	30
204	400	110	16	87	13	55
260	500	76	11	62	9	65
316	600	55	8	45	6.5	70
271	700	41	6	38	4.6	70
T73, T7351 Tempers						
-196	-320	634	92	496	72	14
-80	-112	545	79	462	67	14
-28	-18	524	76	448	65	13
24	75	503	73	434	63	13
100	212	434	63	400	58	15
149	300	214	31	186	27	30
204	400	110	16	90	13	55
260	500	76	11	62	9	65
316	600	55	8	45	6.5	70
371	700	41	6	32	4.6	70

(a) Lowest strength for exposures up to 10 000 h at temperature, no load; test loading applied at 5000 psi/min to yield strength and then at strain rate of 5%/min to fracture. (b) 0.2% offset. (c) In 50 mm or 2 in.

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lution heat treated) wrought material
 Coefficient of thermal expansion.
 Linear:

Temperature range		Average coefficient	
°C	°F	μm/ m·K	μin./ in.·°F
-50 - +20	-58 - +68	21.6	12.0
20 - 100	68 - 212	23.4	13.0
20 - 200	68 - 392	24.3	13.5
20 - 300	68 - 572	25.2	14.0

Volumetric, $68 \times 10^{-6} \text{ m}^3/\text{m}^3\cdot\text{K}$
 ($3.78 \times 10^{-5} \text{ in.}^3/\text{in.}^3\cdot\text{°F}$) at 20 °C (68 °F)

Specific heat, 960 J/kg·K (0.23 Btu/lb·°F) at 100 °C (212 °F)

Thermal conductivity. At 20 °C (68 °F). T6, T62, T651, T652 tempers: 130 W/m·K (75 Btu/ft·h·°F). T76, T7651 tempers: 150 W/m·K (87 Btu/ft·h·°F). T73, T7351, T7352 tempers: 155 W/m·K (90 Btu/ft·h·°F)

Electrical Properties

Electrical conductivity. Volumetric, at 20 °C (68 °F). T6, T62, T651, T652 tempers: 33% IACS. T76, T7651 tempers: 38.5% IACS. T73, T7351, T7352 tempers: 40% IACS

Electrical resistivity. At 20 °C (68 °F). T6, T62, T651, T652 tempers: 52.2 nΩ·m. T76, T7651 tempers: 44.8 nΩ·m. T73, T7351, T7352 tempers: 43.1 nΩ·m. Temperature coefficient, all tempers: 0.1 nΩ·m per K at 20 °C (68 °F)

Fabrication Characteristics

Annealing temperature. 413 °C (775 °F)

Solution temperature. 466 to 482 °C (870 to 900 °F) depending on product

Aging temperature. T6 temper: 121 °C (250 °F); T7 temper: two-stage treatment—107 °C (225 °F) followed by 163 to 177 °C (325 to 350 °F), depending on product

7175

5.6Zn-2.5Mg-1.6Cu-0.23Cr

Commercial Names

Trade name. AA7175

Specifications

AMS. 4109, 4148, 4149, 4179

Table 104 Tensile properties of alloy 7075

Temper	Tensile strength		Yield strength		Elongation(a), %
	MPa	ksi	MPa	ksi	
Typical Properties					
O	228	38	103	15	17
T6, T651	572	83	503	73	11
T73	503	73	434	63	...
Alclad O	221	32	97	14	17
T6, T651	524	76	462	67	11
Property Limits					
	Minimum		Minimum		Minimum
Sheet and Plate					
O	276 (max)	40 (max)	145 (max)	21 (max)	10
Sheet					
T6, T62					
0.008-0.011 in. thick	510	74	434	63	5
0.012-0.039 in. thick	524	76	462	67	7
0.040-0.125 in. thick	538	78	469	68	8
0.126-0.249 in. thick	538	78	476	69	8
T73	462	67	386	56	8
T76	503	73	427	62	8
Plate					
T62, T651					
0.250-0.499 in. thick	538	78	462	67	9
0.500-1.000 in. thick	538	78	469	68	7
1.001-2.000 in. thick	531	77	462	67	6
2.001-2.500 in. thick	524	76	441	64	5
2.501-3.000 in. thick	496	72	421	61	5
3.001-3.500 in. thick	490	71	400	58	5
3.501-4.000 in. thick	462	67	372	54	3
T7351					
0.250-2.000 in. thick	476	69	393	57	6-7
2.001-2.500 in. thick	455	66	359	52	6
2.501-3.000 in. thick	441	64	338	49	6
T7651					
0.250-0.499 in. thick	496	72	421	61	8
0.500-1.000 in. thick	490	71	414	60	6
Alclad Sheet and Plate					
O					
0.008-0.062 in. thick	248 (max)	36 (max)	138 (max)	20 (max)	9-10
0.063-0.187 in. thick	262 (max)	38 (max)	138 (max)	20 (max)	10
0.188-0.499 in. thick	269 (max)	39 (max)	145 (max)	21 (max)	10
0.500-1.000 in. thick	276 (max)	40 (max)	...	...	10
Alclad Sheet					
T6, T62					
0.008-0.011 in. thick	469	68	400	58	5
0.012-0.039 in. thick	483	70	414	60	7
0.040-0.062 in. thick	496	72	427	62	8
0.063-0.187 in. thick	503	73	434	63	8
0.188-0.249 in. thick	517	75	441	64	8
T73					
0.040-0.062 in. thick	434	63	352	51	8
0.063-0.187 in. thick	441	64	359	52	8
0.188-0.249 in. thick	455	66	372	54	8
T76					
0.125-0.187 in. thick	469	68	393	57	8
0.188-0.249 in. thick	483	70	407	59	8

(continued)

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Table 104 (continued)

Temper	Tensile strength		Yield strength		Elongation(a), %
	MPa	ksi	MPa	ksi	
Alclad Plate					
T62, T651					
0.250-0.499 in. thick ...	517	75	448	65	9
0.500-1.000 in. thick ...	538(b)	78(b)	469(b)	68(b)	7
1.001-2.000 in. thick ...	531(b)	77(b)	462(b)	67(b)	6
2.001-2.500 in. thick ...	524(b)	76(b)	441(b)	64(b)	5
2.501-3.000 in. thick ...	496(b)	72(b)	421(b)	61(b)	5
3.001-3.500 in. thick ...	490(b)	71(b)	400(b)	58(b)	5
3.501-4.000 in. thick ...	462(b)	67(b)	372(b)	54(b)	3
T7351					
0.250-0.499 in. thick ...	455	66	372	54	8
0.500-1.000 in. thick ...	476	69	393	57	7
T7651					
0.250-0.499 in. thick ...	476	69	400	58	8
0.500-1.000 in. thick ...	490(b)	71(b)	414(b)	60(b)	6

(a) In 2 in. or 4d, where d is diameter of reduced section of tensile test specimen. Where a range appears in this column, the specified minimum elongation varies with thickness of the mill product. (b) For plate 0.500 in. or over in thickness, listed properties apply to core material only. Tensile and yield strengths of composite plate are slightly lower than listed value, depending on thickness of cladding.

Table 105 Typical plane-strain fracture toughness of alloy 7075

Product and temper	Minimum		Average		Maximum	
	MPa	ksi	MPa	ksi	MPa	ksi
LT Orientation						
T651	27.5	25	28.6	26	29.7	27
T7351 .....	...	...	33.0	30	...	...
Extruded shapes						
T6510,1	28.6	26	30.8	28	35.2	32
T7310,1	34.1	31	36.3	33	37.4	34
Forgings						
T652	26.4	24	28.6	26	30.8	28
T7352	29.7	27	34.1	31	38.5	35
TL Orientation						
Plate						
T651	22.0	20	24.2	22	25.3	23
T7351	27.5	25	31.9	29	36.3	33
Extruded shapes						
T6510,1	20.9	19	24.2	22	28.6	26
T7310,1	24.2	22	26.4	24	30.8	28
Forgings						
T652 .....	...	...	25.3	23	...	...
T7352	25.3	23	27.5	25	28.6	26
SL Orientation						
Plate						
T651	16.5	15	17.6	16	19.8	18
T7351	20.9	19	22.0	20	23.1	21
Extruded shapes						
T6510,1	19.8	18	20.9	19	24.2	22
T7310,1 .....	...	...	22.0	20	...	...
Forgings						
T651 .....	...	...	18.7	17	...	...
T7351	20.9	19	23.1	21	27.5	25

UNS number. A97175

Chemical Composition

Composition limits. 1.2 to 2.0 Cu; 2.1 to 2.9 Mg; 0.10 max Mn; 0.15 max Si; 0.20 max Fe; 0.18 to 0.28 Cr; 5.1 to 6.1 Zn; 0.10 max Ti; 0.05 max others (each); 0.15 max others (total)

Consequence of exceeding impurity limits. Degraded fracture toughness

Applications

Typical uses. Die and hand forgings for structural parts requiring very high strength, such as aircraft components. T736 tempers supply high strength, resistance to exfoliation corrosion and stress-corrosion cracking, high fracture toughness and good fatigue resistance.

Mechanical Properties

Tensile properties. Typical. Tensile strength: T66 temper, 593 MPa (86 ksi); T736 temper, 524 MPa (76 ksi). Yield strength: T66 temper, 524 MPa (76 ksi); T736 temper, 455 MPa (66 ksi). Elongation: 11% in 50 mm or 2 in. See also Table 106.

Shear strength. Typical. T66 temper: 324 MPa (47 ksi); T736 temper: 290 MPa (42 ksi)

Hardness. Typical. T66 temper, 150 HB; T736 temper, 145 HB; data obtained with 500-kg load, 10-mm diam ball and 30-s duration of loading

Poisson's ratio. 0.33

Elastic modulus. Tension, 72 GPa (10.4 × 10⁶ psi)

Fatigue strength. Typical. T66 and T736 tempers: 159 MPa (23 ksi)

Plane-strain fracture toughness. See Table 107.

Mass Characteristics

Density. 2.80 Mg/m³ (0.101 lb/in.³)

Thermal Properties

Liquidus temperature. 635 °C (1175 °F)

Incipient melting temperature. 532 °C (990 °F) for homogenized (solution heat treated) wrought material

Eutectic temperature. 447 °C (890 °F) for nonhomogeneous as cast or wrought material that has not been solution heat treated

Coefficient of thermal expansion. Linear: