Typical Mechanical Properties of Wrought Aluminum Alloys at Various Temperatures

Different types of data are shown in each table of typical mechanical properties at various temperatures.

Tensile properties at subzero temperatures were determined with 0.5 in. (13 mm) diameter tensile in accordance with ASTM B 557 and E 8. In addition, during the tests the specimens were held in cryostats containing the following cryofluids to reach different temperatures:

- For −18 °F (−28 °C), dry ice and alcohol
- For −112 °F (−80 °C), liquefied petroleum gas
- For −320 °F (−196 °C), liquefied nitrogen
- For −423 °F (−253 °C), liquefied hydrogen
- For −452 °F (−269 °C), liquefied helium

Generally a series of tests were made over the range of temperatures, excluding −423 °F (−253 °C) and −452 °F (−269 °C), which required special setups and were run only on special alloys intended for cryogenic service. Load-strain curves were plotted in each test with autographic extensometers, and yield strength (and, in some cases, moduli) values were determined at 0.2% offset by analysis of the curves. The resultant data for tensile strength, yield strength, modulus, and elongation were plotted, and average lines were constructed over the temperature range. The table values are the averages from intersections with the respective temperatures.

Tensile properties and modulus of elasticity at temperature after various holding times were determined with 0.5 in. (12.5 mm) diameter specimens in accordance with applicable editions of ASTM E 21 from room temperature to 700 °F (370 °C). The tests were made 0.5 h after the specimens reached test temperature; for longer soak times, the specimens were held in ovens before being placed in the testing machines. Load-strain curves were plotted in each test with autographic extensometers, and 0.2% offset yield strength (and, in some cases, moduli) values were determined by analysis of the curves. The resultant data for tensile strength, yield strength, modulus, and elongation were plotted, and average lines were constructed over the temperature range. The table values are the averages from intersections with the respective temperatures.

Tensile properties at room temperature after exposure at various temperatures for various holding times were determined with 0.5 in. (12.5 mm) diameter specimens in accordance with applicable editions of ASTM E 8 after the specimens had been soaked in furnaces from 0.5 to 10,000 h from room temperature to 700 °F (370 °C). Load-strain curves were plotted in each test with autographic extensometers, and yield strength (and, in some cases, moduli) values were determined by analysis of the curves. The resultant data for tensile strength, yield strength, modulus, and elongation were plotted, and average lines were constructed over the temperature range. The table values are the averages from intersections with the respective temperatures.

Creep rupture strengths for various times at various temperatures and stresses required to generate various amounts of creep in various lengths of time were determined with 0.5 in. (12.5 mm) diameter specimens in accordance with ASTM applicable editions of E 139 from room temperature to 700 °F (370 °C). Extensometers were used to measure strain versus time during the test, and stresses for various amounts of creep were obtained from various cross-plots of temperature, strain, time, and stress. Time to rupture was also recorded. The creep and rupture data were analyzed not only with direct cross-plots but also with various time-temperature parameters, such as the Larson-Miller, Dorn-Shepperd, and Manson-Haferd parameters.

Stress-relaxation measurements were obtained using 0.5 in. (12.5 mm) diameter specimens in accordance with applicable versions of ASTM E 328. The specimens were held at various temperatures under fixed amounts of strain in specially adapted creep machines in which the rate of relaxation of stress can be detected by the change in the force required to maintain the fixed total stain. The resultant data from a number of tests were cross-plotted and analyzed, and average lines were constructed to represent the typical behavior.

For additional information on standards for aluminum alloys and their applications, please refer to the following:

- D.G. Altenpohl, *Aluminum, Technology, Applications, and Environment,* The Aluminum Association and TMS, 1998
- *The Aluminum Design Manual,* The Aluminum Association, 1994
- *Aluminum Standards & Data,* The Aluminum Association, 1997

Wrought Alloys: 1*xxx* Pure Al

Principal characteristics and applications of the 1*xxx* series of aluminum alloys include:

- Strain hardenability
- High formability, corrosion resistance, and electrical conductivity
- Electrical and chemical applications
- Representative designations: 1100, 1350
- Typical ultimate tensile strength range: 10 to 27 ksi (70 to 185 MPa)

The 1*xxx* series represents commercially pure aluminum, ranging from the baseline 1100 (99.00% min Al) to the relatively purer 1050/1350 (99.50% min Al) and 1175 (99.75% min Al). Some compositions, such as 1350 (formerly known as EC) that is used especially for electrical applications, have relatively tight controls on impurities that provide exceptionally high electrical conductivity.

The 1*xxx* series are strain-hardenable, but they are not be used where strength is a prime consideration. Rather, the emphasis is on applications where extremely high corrosion resistance, formability, and/or electrical conductivity are required, such as foil and strip for packaging, chemical equipment, tank car or truck bodies, spun hollowware, and elaborate sheet metal work.

1060-O: Typical Tensile Properties

Temperature			At temperature indicated						
			Tensile strength		Yield strength			Modulus of elasticity(a)	
°F	°C	Time at temperature, h	ksi	MPa	ksi	MPa	Elongation in 2 in. (50 mm), %	10^6 psi	GPa
−320	−196	…	22	150	4.8	33	53	…	…
−112	−80	…	12	85	4.1	28	46	…	…
−18	−28	…	11	75	4.0	28	44	…	…
75	25	…	10	70	4.0	28	43	10	69
212	100	0.5	7.5	52	3.6	25	45	…	…
		10	7.5	52	3.6	25	45	…	…
		100	7.5	52	3.6	25	45	…	…
		1,000	7.5	52	3.6	25	45	…	…
		10,000	7.5	52	3.6	25	45	…	…
300	150	0.5	6.0	41	3.1	21	60	…	…
		10	6.0	41	3.1	21	60	…	…
		100	6.0	41	3.1	21	60	…	…
		1,000	6.0	41	3.1	21	60	…	…
		10,000	6.0	41	3.1	21	60	…	…
350	177	0.5	5.2	36	2.8	19	65	…	…
		10	5.2	36	2.8	19	65	…	…
		100	5.2	36	2.8	19	65	…	…
		1,000	5.2	36	2.8	19	65	…	…
		10,000	5.2	36	2.8	19	65	…	…
400	205	0.5	4.4	30	2.5	17	70	…	…
		10	4.4	30	2.5	17	70	…	…
		100	4.4	30	2.5	17	70	…	…
		1,000	4.4	30	2.5	17	70	…	…
		10,000	4.4	30	2.5	17	70	…	…
500	260	0.5	3.0	21	2.0	14	75	…	…
		10	3.0	21	2.0	14	75	…	…
		100	3.0	21	2.0	14	75	…	…
		1,000	3.0	21	2.0	14	75	…	…
		10,000	3.0	21	2.0	14	75	…	…
600	315	0.5	2.2	15	1.6	11	80	…	…
		10	2.2	15	1.6	11	80	…	…
		100	2.2	15	1.6	11	80	…	…
		1,000	2.2	15	1.6	11	80	…	…
		10,000	2.2	15	1.6	11	80	…	…
700	370	0.5	1.7	12	1.2	8.0	85	…	…
		10	1.7	12	1.2	8.0	85	…	…
		100	1.7	12	1.2	8.0	85	…	…
		1,000	1.7	12	1.2	8.0	85	…	…
		10,000	1.7	12	1.2	8.0	85	…	…

(a) Average of tensile and compressive moduli
Source data are in English units; metric values are converted and rounded.

1060-O: Creep-Rupture and Creep Properties

Temperature			Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep	
°F	°C	Time under stress, h	ksi	MPa	ksi	MPa	ksi	MPa
400	205	1000	2.3	16	0.9	6.0	0.8	6.0

Source data are in English units; metric values are converted and rounded.

1100-O: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated						
			Tensile strength		Yield strength		Elongation in 4*D*, %	Modulus of elasticity(a)	
°F	°C		ksi	MPa	ksi	MPa		10^6 psi	GPa
−452	−269	…	46	315	8.4	58	37		
−320	−196	…	25	170	6.0	41	55	11.1	77
−112	−80	…	15	105	5.5	38	43	10.4	72
−18	−28	…	14	95	5.0	34	40	10.1	70
75	25	…	13	90	5.0	34	40	9.9	68
212	100	0.5	11	75	4.6	32	45	…	…
		10	11	75	4.6	32	45	…	…
		100	11	75	4.6	32	45	…	…
		1,000	11	75	4.6	32	45	…	…
		10,000	11	75	4.6	32	45	…	…
300	150	0.5	8.5	59	4.2	29	55	…	…
		10	8.5	59	4.2	29	55	…	…
		100	8.5	59	4.2	29	55	…	…
		1,000	8.5	59	4.2	29	55	…	…
		10,000	8.5	59	4.2	29	55	…	…
350	177	0.5	7.5	52	3.8	26	60	…	…
		10	7.5	52	3.8	26	60	…	…
		100	7.5	52	3.8	26	60	…	…
		1,000	7.5	52	3.8	26	60	…	…
		10,000	7.5	52	3.8	26	60	…	…
400	205	0.5	6.0	41	3.5	24	65	…	…
		10	6.0	41	3.5	24	65	…	…
		100	6.0	41	3.5	24	65	…	…
		1,000	6.0	41	3.5	24	65	…	…
		10,000	6.0	41	3.5	24	65	…	…
450	230	0.5	5.0	34	3.1	21	70	…	…
		10	5.0	34	3.1	21	70	…	…
		100	5.0	34	3.1	21	70	…	…
		1,000	5.0	34	3.1	21	70	…	…
		10,000	5.0	34	3.1	21	70	…	…
500	260	0.5	4.0	28	2.6	18	75	…	…
		10	4.0	28	2.6	18	75	…	…
		100	4.0	28	2.6	18	75	…	…
		1,000	4.0	28	2.6	18	75	…	…
		10,000	4.0	28	2.6	18	75	…	…
600	315	0.5	2.9	20	2.0	14	80	…	…
		10	2.9	20	2.0	14	80	…	…
		100	2.9	20	2.0	14	80	…	…
		1,000	2.9	20	2.0	14	80	…	…
		10,000	2.9	20	2.0	14	80	…	…
700	370	0.5	2.1	14	1.6	11	85	…	…
		10	2.1	14	1.6	11	85	…	…
		100	2.1	14	1.6	11	85	…	…
		1,000	2.1	14	1.6	11	85	…	…
		10,000	2.1	14	1.6	11	85	…	…

(a) The modulus of elasticity in compression is about 2% greater than in tension.
Source data are in English units; metric values are converted and rounded.

1100-O: Creep-Rupture and Creep Properties

Temperature			Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep	
°F	°C	Time under stress, h	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
75	25	0.1	13	90	11	75	10	70	9.5	66	8.0	55
		1	12	85	10	70	9.5	66	8.5	59	7.0	48
		10	12	85	9.5	66	9.0	62	7.5	52	6.0	41
		100	11	75	9.0	62	8.0	55	6.5	45	5.5	38
		1000	11	75	8.5	59	7.5	52	6.0	41	5.0	34
212	100	0.1	11	75	7.5	52	7.0	48	5.5	38	4.5	31
		1	10	70	6.5	45	5.5	38	4.6	32	4.0	28
		10	8.5	59	5.5	38	4.8	33	4.0	28	3.6	25
		100	7.0	48	4.3	30	4.0	28	3.6	25	3.3	23
		1000	5.5	38	3.8	26	3.4	23	3.2	22	3.1	21
300	150	0.1	8.0	55	6.0	41	5.0	34	4.0	28	3.5	24
		1	7.0	48	4.7	32	4.0	28	3.4	23	3.0	21
		10	6.0	41	3.8	26	3.3	23	3.0	21	2.8	19
		100	4.8	33	3.2	22	2.9	20	2.7	19	2.5	17
		1000	3.8	26	2.8	19	2.6	18	2.5	17	2.3	16
350	177	0.1	7.0	48	4.8	33	4.1	28	3.4	23	3.0	21
		1	6.0	41	3.9	27	3.3	23	3.0	21	2.6	18
		10	4.8	33	3.2	22	2.9	20	2.6	18	2.3	16
		100	3.9	27	2.8	19	2.5	17	2.3	16	2.1	14
		1000	3.2	22	2.5	17	2.3	16	2.1	15	1.9	13
400	205	0.1	5.5	38	4.0	28	3.5	24	3.0	21	2.6	18
		1	4.9	34	3.2	22	2.9	20	2.6	18	2.3	16
		10	4.0	28	2.7	19	2.5	17	2.3	16	2.0	14
		100	3.1	21	2.4	17	2.2	15	2.0	14	1.8	12
		1000	2.6	18	2.1	14	2.0	14	1.8	12	1.6	11
500	260	1000	2.0	14	…	…	…	…	…	…	…	…

Source data are in English units; metric values are converted and rounded.

1100-H12: Typical Tensile Properties

Temperature			At temperature indicated						
			Tensile strength		Yield strength			Modulus of elasticity(a)	
°F	°C	Time at temperature, h	ksi	MPa	ksi	MPa	Elongation in 4*D*, %	10^6 psi	GPa
−320	−196	…	28	195	17	115	46	…	…
−112	−80	…	18	125	16	110	27	…	…
−18	−28	…	17	115	15	105	25	…	…
75	25	…	16	110	15	105	25	10	69
212	100	0.5	14	95	13	90	25	…	…
		10	14	95	13	90	25	…	…
		100	14	95	13	90	25	…	…
		1,000	14	95	13	90	25	…	…
		10,000	14	95	13	90	25	…	…
300	150	0.5	11	75	10	70	30	…	…
		10	11	75	10	70	30	…	…
		100	11	75	10	70	30	…	…
		1,000	11	75	10	70	30	…	…
		10,000	11	75	10	70	30	…	…
350	177	0.5	10	70	9.0	62	35	…	…
		10	10	70	9.0	62	35	…	…
		100	10	70	9.0	62	35	…	…
		1,000	10	70	9.0	62	35	…	…
		10,000	10	70	9.0	62	35	…	…
400	205	0.5	9.0	62	7.5	52	40	…	…
		10	9.0	62	7.5	52	40	…	…
		100	9.0	62	7.5	52	40	…	…
		1,000	9.0	62	7.5	52	40	…	…
		10,000	9.0	62	7.5	52	40	…	…
500	260	0.5	6.5	45	5.0	34	50	…	…
		10	6.5	45	5.0	34	50	…	…
		100	5.0	34	4.0	28	75	…	…
		1,000	4.0	28	2.6	18	75	…	…
		10,000	4.0	28	2.6	18	75	…	…
600	315	0.5	2.9	20	2.0	14	80	…	…
		10	2.9	20	2.0	14	80	…	…
		100	2.9	20	2.0	14	80	…	…
		1,000	2.9	20	2.0	14	80	…	…
		10,000	2.9	20	2.0	14	80	…	…
700	370	0.5	2.1	14	1.6	11	85	…	…
		10	2.1	14	1.6	11	85	…	…
		100	2.1	14	1.6	11	85	…	…
		1,000	2.1	14	1.6	11	85	…	…
		10,000	2.1	14	1.6	11	85	…	…

(a) Average of tensile and compressive moduli
Source data are in English units; metric values are converted and rounded.

1100-H12: Creep-Rupture and Creep Properties

Temperature			Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep	
°F	°C	Time under stress, h	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
75	25	0.1	16	110	15	105	15	105	15	105	14	95
		1	15	105	15	105	15	105	14	95	12	85
		10	15	105	15	105	15	105	13	90	11	75
		100	15	105	15	105	14	95	12	85	9.5	66
		1000	14	95	14	95	14	95	11	75	8.0	55
212	100	0.1	13	90	…	…	…	…	…	…	…	…
		1	12	85	…	…	…	…	…	…	…	…
		10	11	75	…	…	…	…	…	…	…	…
		100	10	70	…	…	…	…	…	…	…	…
		1000	9.5	66	…	…	…	…	…	…	…	…
300	150	0.1	11	76	10	70	9.5	66	8.5	59	6.0	41
		1	9.5	66	9.0	62	8.0	55	6.0	41	4.1	28
		10	8.5	59	7.5	52	6.5	45	4.5	31	2.8	19
		100	7.5	52	6.5	45	5.5	38	3.5	24	2.1	14
		1000	6.5	45	5.5	38	4.6	32	3.0	21	1.6	11
400	205	0.1	8.0	55	7.0	48	6.0	41	4.6	32	3.0	21
		1	7.0	48	5.0	34	4.3	30	2.9	20	1.8	12
		10	5.5	38	3.8	26	3.0	21	2.0	14	1.3	9
		100	4.2	29	2.8	19	2.2	15	1.5	10	1.0	7
		1000	3.0	21	2.0	14	1.5	10	1.2	8.0	0.9	6

Source data are in English units; metric values are converted and rounded.

1100-H14: Typical Tensile Properties

Temperature			At temperature indicated						
			Tensile strength		Yield strength			Modulus of elasticity(a)	
°F	°C	Time at temperature, h	ksi	MPa	ksi	MPa	Elongation in 4*D*, %	10^6 psi	GPa
−452	−269	…	50	345	23	160	34	…	…
−320	−196	…	30	205	20	140	45	11.1	77
−112	−80	…	20	140	18	125	24	10.4	72
−18	−28	…	19	130	17	115	20	10.1	70
75	25	…	18	125	17	115	20	9.9	68
212	100	0.5	16	110	15	105	20	…	…
		10	16	110	15	105	20	…	…
		100	16	110	15	105	20	…	…
		1,000	16	110	15	105	20	…	…
		10,000	16	110	15	105	20	…	…
300	150	0.5	14	95	12	85	23	…	…
		10	14	95	12	85	23	…	…
		100	14	95	12	85	23	…	…
		1,000	14	95	12	85	23	…	…
		10,000	14	95	12	85	23	…	…
350	175	0.5	13	90	9.5	66	24	…	…
		10	13	90	9.5	66	24	…	…
		100	13	90	9.5	66	24	…	…
		1,000	13	90	9.5	66	24	…	…
		10,000	13	90	9.5	66	24	…	…
400	205	0.5	11	75	7.5	52	26	…	…
		10	11	75	7.5	52	26	…	…
		100	11	75	7.5	52	26	…	…
		1,000	11	75	7.5	52	26	…	…
		10,000	10	70	7.5	52	26	…	…
450	230	0.5	9.5	66	5.5	38	28	…	…
		10	9.5	66	5.5	38	28	…	…
		100	8.0	55	5.5	38	30	…	…
		1,000	6.0	41	3.9	27	60	…	…
		10,000	5.0	34	3.1	21	65	…	…
500	260	0.5	6.5	45	3.4	23	35	…	…
		10	4.5	31	2.6	18	75	…	…
		100	4.0	28	2.6	18	75	…	…
		1,000	4.0	28	2.6	18	75	…	…
		10,000	4.0	28	2.6	18	75	…	…
600	315	0.5	2.9	20	2.0	14	80	…	…
		10	2.9	20	2.0	14	80	…	…
		100	2.9	20	2.0	14	80	…	…
		1,000	2.9	20	2.0	14	80	…	…
		10,000	2.9	20	2.0	14	80	…	…
700	370	0.5	2.1	14	1.6	11	85	…	…
		10	2.1	14	1.6	11	85	…	…
		100	2.1	14	1.6	11	85	…	…
		1,000	2.1	14	1.6	11	85	…	…
		10,000	2.1	14	1.6	11	85	…	…

(a) The modulus of elasticity in compression is about 2% greater than in tension.
Source data are in English units; metric values are converted and rounded.

1100-H14: Creep-Rupture and Creep Properties

Temperature			Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep	
°F	°C	Time under stress, h	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
75	25	0.1	18	125	…	…	…	…	…	…	…	…
		1	18	125	…	…	…	…	…	…	…	…
		10	17	115	…	…	…	…	…	…	…	…
		100	16	110	…	…	…	…	…	…	…	…
		1000	15	105	…	…	…	…	…	…	…	…
212	100	0.1	15	105	…	…	…	…	…	…	…	…
		1	14	95	…	…	…	…	…	…	…	…
		10	13	90	…	…	…	…	…	…	…	…
		100	12	85	…	…	…	…	…	…	…	…
		1000	10	70	…	…	…	…	…	…	…	…
300	150	0.1	13	90	12	85	12	85	10	70	7.5	52
		1	12	85	11	75	10	70	7.5	52	5.0	34
		10	11	75	9.0	62	7.5	52	5.0	34	3.2	22
		100	9.0	62	7.0	48	5.5	38	3.8	26	2.0	14
		1000	7.0	48	4.5	31	3.9	27	2.6	18	1.3	9.0
400	205	0.1	10	70	9.0	62	7.5	52	4.8	33	3.0	21
		1	9.0	62	6.0	41	4.2	29	2.5	17	1.6	11
		10	6.5	45	3.4	23	2.4	17	1.5	10	1.0	7.0
		100	4.2	29	2.2	15	1.5	10	1.0	7.0	…	…
		1000	3.0	21	1.6	11	1.1	8.0	…	…	…	…

Source data are in English units; metric values are converted and rounded.

1100-H18: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated							At room temperature after heating				
			Tensile strength		Yield strength		Elongation in 4*D*, %	Modulus of elasticity(a)		Tensile strength		Yield strength		Elongation in 4*D*, %
°F	°C		ksi	MPa	ksi	MPa		10^6 psi	GPa	ksi	MPa	ksi	MPa	
−320	−196	...	24	165	26	180	30	...	...	...	...	...	...	...
−112	−80	...	26	180	23	160	16	...	...	...	...	...	...	...
−18	−28	...	25	170	23	160	15	...	...	...	...	...	...	...
75	25	...	24	165	22	150	15	9.9	68	24	165	22	150	15
212	100	0.1	...	...	...	...	...	...	...	24	165	22	150	15
		0.5	21	145	19	130	15	...	...	24	165	22	150	15
		10	21	145	19	130	15	...	...	24	165	22	150	15
		100	21	145	19	130	15	...	...	24	165	22	150	15
		1,000	21	145	19	130	15	...	...	24	165	21	145	15
		10,000	21	145	19	130	15	...	...	24	165	21	145	15
		100,000	21	145	19	130	15	...	...	24	165	20	140	15
300	150	0.1	...	...	...	...	...	...	...	24	165	22	150	15
		0.5	18	125	14	95	20	...	...	24	165	22	150	15
		10	18	125	14	95	20	...	...	23	160	22	150	16
		100	18	125	14	95	20	...	...	22	150	21	145	17
		1,000	18	125	14	95	20	...	...	21	145	20	140	18
		10,000	18	125	14	95	20	...	...	20	140	19	130	19
		100,000	18	125	14	95	20	...	...	19	130	18	125	19
350	177	0.5	15	105	10	70	22	...	...	23	160	21	145	16
		10	15	105	10	70	22	...	...	22	150	21	145	17
		100	15	105	10	70	22	...	...	21	145	20	140	19
		1,000	15	105	10	70	24	...	...	17	115	16	110	23
		10,000	14	95	10	70	40	...	...	16	110	15	105	29
		100,000	9.0	62	6.5	45	60	...	...	14	95	13	90	31
400	205	0.5	13	90	7.5	52	25	...	...	22	10	21	145	17
		10	13	90	7.5	52	25	...	...	20	140	19	130	19
		100	12	85	7.5	52	25	...	...	18	125	16	110	22
		1,000	8.0	55	5.5	38	50	...	...	13	90	5.5	38	40
		10,000	6.0	41	3.5	24	65	...	...	12	85	4.5	31	45
		100,000	6.0	41	3.5	24	70	...	...	12	85	4.0	28	47
450	230	0.5	9.5	66	4.6	32	35	...	...	22	10	20	140	19
		10	8.0	55	4.3	30	45	...	...	16	110	14	95	30
		100	5.5	38	3.2	22	70	...	...	14	95	5.0	34	35
		1,000	5.0	34	3.1	21	70	...	...	12	85	3.5	24	50
		10,000	5.0	34	3.1	21	70	...	...	12	85	3.5	24	50
		100,000	5.0	34	3.1	21	70	...	...	12	85	3.5	24	50
500	260	0.5	5.5	38	3.0	21	55	...	...	21	145	19	130	22
		10	4.0	28	2.6	18	75	...	...	13	90	4.0	28	45
		100	4.0	28	2.6	18	75	...	...	12	85	3.5	24	45
		1,000	4.0	28	2.6	18	75	...	...	12	85	3.5	24	50
		10,000	4.0	28	2.6	18	75	...	...	12	85	3.5	24	50
		100,000	4.0	28	2.6	18	75	...	...	12	85	3.5	24	50
600	315	0.5	2.9	20	2.0	14	80	...	...	13	90	4.0	28	45
		10	2.9	20	2.0	14	80	...	...	12	85	3.5	24	50
		100	2.9	20	2.0	14	80	...	...	12	85	3.5	24	50
		1,000	2.9	20	2.0	14	80	...	...	12	85	3.5	24	50
		10,000	2.9	20	2.0	14	80	...	...	12	85	3.5	24	50
		100,000	2.9	20	2.0	14	80	...	...	12	85	3.5	24	50
700	370	0.5	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
		10	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
		100	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
		1,000	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
		10,000	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
		100,000	2.1	14	1.6	11	85	...	...	12	85	3.5	24	50
800	425	...	1.5	10	1.3	9.0	90	...	...	...	...	...	...	...

(a) The modulus of elasticity in compression is about 2% greater than in tension.
Source data are in English units; metric values are converted and rounded.

1100-H18: Creep-Rupture and Creep Properties

Temperature			Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep	
°F	°C	Time under stress, h	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
75	25	0.1	24	165	23	160	22	150	21	145	20	140
		1	23	160	22	150	21	145	19	130	18	125
		10	22	150	21	145	20	140	18	125	16	110
		100	20	140	19	130	18	125	16	110	14	95
		1,000	18	125	17	115	16	110	14	95	11	75
212	100	0.1	20	140	18	125	17	115	14	95	12	85
		1	18	125	16	110	14	95	11	75	9.0	62
		10	15	105	12	85	10	70	7.0	48	5.0	34
		100	12	85	8.5	59	7.5	52	4.0	28	3.3	23
		1,000	11	75	7.5	52	5.5	38	3.0	21	1.9	13
		10,000	9.0	60	5.5	38	3.4	23	2.1	14	1.3	9.0
		100,000	6.5	45	3.5	24	2.4	17	1.4	10	1.0	7.0
300	150	0.1	17	115	16	110	15	103	12	83	9.5	66
		1	15	105	13	90	10	70	7.5	52	5.0	34
		10	12	85	8.5	59	6.5	45	4.0	28	2.4	17
		100	8.5	59	5.5	38	3.7	26	2.3	16	1.4	10
		1,000	6.0	41	3.4	23	2.4	17	1.4	10	1.0	7.0
		10,000	3.7	26	2.4	17	1.6	11	1.0	7.0	…	…
350	177	0.1	14	95	13	90	12	83	8.5	59	6.5	45
		1	12	85	9.0	62	7.0	48	4.6	32	2.8	19
		10	9.0	62	5.5	38	4.0	28	2.4	17	1.6	11
		100	6.0	41	3.4	23	2.5	17	1.5	10	1.1	8.0
		1,000	3.8	26	2.4	17	1.6	11	1.3	9.0	0.9	6.0
400	205	0.1	12	85	10	70	8.5	59	5.5	38	3.8	26
		1	9.5	66	6.0	41	4.8	33	2.8	19	1.8	12
		10	6.5	45	3.6	25	2.7	19	1.7	12	1.2	8.0
		100	3.8	26	2.4	17	1.8	12	1.2	8.0	1.0	7.0
		1,000	2.7	19	1.8	12	1.4	10	1.0	7.0	0.8	6.0
450	230	0.1	9.0	62	6.5	45	5.0	34	3.5	24	2.4	17
		1	6.5	45	3.7	26	3.2	22	2.2	15	1.7	12
		10	4.1	28	2.5	17	2.1	14	1.6	11	…	…
		100	2.8	19	1.8	12	1.6	11	…	…	…	…
		1,000	2.2	15	1.5	10	1.3	9.0	…	…	…	…
500	260	0.1	4.2	29	2.8	19	2.7	19	2.5	17	2.2	15
		1	3.5	24	2.3	16	2.2	15	2.0	14	1.4	10
		10	2.9	20	2.0	14	1.7	12	1.5	10	…	…
		100	2.2	15	1.6	11	1.4	10	…	…	…	…
		1,000	2.0	14	1.3	9.0	1.2	8.0	…	…	…	…

Source data are in English units; metric values are converted and rounded.

1100-H112 One Sample of 1 in. (25 mm) Plate: Tensile Properties

Temperature			At temperature indicated						
			Tensile strength		Yield strength			Modulus of elasticity(a)	
°F	°C	Time at temperature, h	ksi	MPa	ksi	MPa	Elongation in 4*D*, %	10^6 psi	GPa
75	25	…	15	105	9.5	66	37	9.9	68
212	100	0.5	13	90	9	62	44	…	…
300	150	0.5	10	70	8	55	69	…	…

(a) The modulus of elasticity in compression is about 2% greater than in tension.
Source data are in English units; metric values are converted and rounded.

1100-H112 One Sample of 1 in. (25 mm) Plate: Stress-Relaxation Properties

Temperature		Stress relaxation	
°F	°C	Time under strain, h	Loss in stress(a), %
75	25	1	12
		10	19
		100	27
		1,000	37
		10,000	46
212	100	1	36
		10	44
		100	53
		1,000	65
		10,000	81
300	150	1	54
		10	61
		100	69
		1,000	77
		10,000	87

(a) Stressed in tension to 60% of the tensile yield strength at the stressing temperature. Strain held constant during exposure.

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