

Wrought Alloys: 6xxx Al-Mg-Si Alloys

Principal characteristics and applications of the 6xxx series of aluminum alloys include:

- Heat treatable
- High corrosion resistance, excellent extrudability; moderate strength
- Building and construction, highway, automotive, marine applications
- Representative alloys: 6061, 6063

- Typical ultimate tensile strength range: 18 to 58 ksi (125 to 400 MPa)

The 6xxx alloys are heat treatable and have moderately high strength coupled with excellent corrosion resistance. They are readily welded. A unique feature is the extrudability, which makes them the first choice for architectural and structural members where unusual or complex shapes or particularly strength- or stiffness-criticality is important.

Alloy 6063 is perhaps the most widely used

because of its extrudability; it was a key in the recent all-aluminum bridge structure erected in only a few days in Foresmo, Norway, and it is the choice for the Audi automotive space frame members.

Higher strength alloy 6061 finds broad use in welded structural members, such as truck and marine frames, railroad cars, and pipelines. Specialty alloys in the series include 6066-T6 for high strength forgings; 6111 for automotive body panels with high dent resistance; and 6101 and 6201 for high-strength electrical bus and electrical conductor wire, respectively.

6005-T5 Extrusions: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated					At room temperature after heating				
			Tensile strength		Yield strength		Elongation in 2 in. (50 mm), %	Tensile strength		Yield strength		Elongation in 2 in. (50 mm), %
°F	°C	ksi	MPa	ksi	MPa	ksi		MPa	ksi	MPa	ksi		MPa
75	25	...	44	305	39	270	12	44	305	39	270	12
212	100	0.1	39	270	36	250	14	44	305	39	270	12
		0.5	39	270	36	250	14	44	305	39	270	12
		10	39	270	36	250	14	44	305	39	270	12
		100	39	270	36	250	13	45	310	40	275	12
		1,000	41	285	38	260	12	46	315	42	290	11
300	150	10,000	41	285	38	260	12	46	315	42	290	11
		0.1	34	235	32	220	14	44	305	39	270	12
		0.5	34	235	32	220	14	44	305	40	275	12
		10	35	240	33	230	13	45	310	41	285	12
		100	34	235	33	230	12	44	305	41	285	11
350	177	1,000	28	195	26	180	15	38	260	34	235	12
		10,000	24	165	21	145	18	30	205	25	170	13
		0.1	32	220	30	205	14	44	305	39	270	12
		0.5	32	220	30	205	13	44	305	40	275	12
		10	31	215	30	205	12	43	295	40	275	11
400	205	100	26	180	24	165	14	36	250	32	220	12
		1,000	21	145	18	125	19	29	200	23	160	14
		10,000	17	115	13	90	26	22	150	15	105	17
		0.1	28	195	27	185	13	44	305	39	270	12
		0.5	28	195	27	185	13	43	295	39	270	11
450	230	10	23	160	22	150	18	36	250	29	200	13
		100	18	125	16	110	22	28	195	21	145	15
		1,000	13	90	10	70	29	21	145	13	90	18
		10,000	8.5	59	6.0	41	50	14	95	7	48	35
		0.1	26	180	25	170	12	43	295	38	260	12
500	260	0.5	25	170	24	165	13	...	...	...	...
		0.1	20	140	19	130	12	38	260	35	240	12
600	315	0.5	17	115	16	110	20	...	...	...	...
		0.1	11	75	10	70	22	30	205	24	165	14
700	370	0.5	9.0	62	8.5	59	30	...	...	...	...
		0.1	...	...	...	...	...	21	145	11	75	17

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

6061-O: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated							At room temperature after heating				
			Tensile strength		Yield strength		Elongation in 4D, %	Modulus of elasticity(a)		Tensile strength		Yield strength		Elongation in 4D, %
°F	°C	ksi	MPa	ksi	MPa	10 ⁶ psi		GPa	ksi	MPa	ksi	MPa		
-320	-196	...	33	230	10	70	45	11.1	77	...	...	...	...	...
-112	-80	...	20	140	8.5	59	37	10.4	72	...	...	...	...	...
-18	-28	...	19	130	8.0	55	33	10.1	70	...	...	...	...	...
75	25	...	18	125	8.0	55	30	9.9	68	18	125	8.0	55	30
212	100	0.1	18	125	8.0	55	30	9.5	66	18	125	8.0	55	30
		0.5	18	125	8.0	55	30	9.5	66	18	125	8.0	55	30
		10	18	125	8.0	55	30	9.5	66	18	125	8.0	55	30
		100	18	125	8.0	55	30	9.5	66	18	125	8.0	55	30
		1,000	18	125	8.0	55	30	9.5	66	18	125	8.0	55	30
		10,000	18	125	8.5	59	30	9.5	66	19	130	10	70	30
300	150	0.1	16	110	8.0	55	35	9.1	63	18	125	8.0	55	30
		0.5	16	110	8.0	55	35	9.1	63	18	125	8.0	55	30
		10	16	110	8.0	55	35	9.1	63	18	125	8.0	55	30
		100	16	110	8.5	59	35	9.1	63	18	125	8.5	59	30
		1,000	16	110	9.0	62	35	9.1	63	18	125	9.0	62	30
		10,000	15	105	9.5	66	35	9.1	63	18	125	10	70	30
350	177	0.1	14	95	8.0	55	45	8.9	61	18	125	8.0	55	30
		0.5	14	95	8.0	55	45	8.9	61	18	125	8.0	55	30
		10	14	95	8.0	55	45	8.9	61	18	125	8.0	55	30
		100	14	95	8.5	59	45	8.9	61	18	125	6.5	45	30
		1,000	13	90	8.5	59	45	8.9	61	18	125	9.0	62	30
		10,000	12	85	8.5	59	45	8.9	61	18	125	9.5	66	30
400	205	0.1	11	75	8.0	55	60	8.6	59	18	125	8.0	55	30
		0.5	11	75	8.0	55	60	8.6	59	18	125	8.0	55	30
		10	11	75	8.0	55	60	8.6	59	18	125	8.0	55	30
		100	11	75	8.0	55	60	8.6	59	18	125	9.0	62	30
		1,000	11	75	8.0	55	60	8.6	59	18	125	8.5	59	30
		10,000	10	70	7.5	52	60	8.6	59	18	125	8.0	55	30
450	230	0.1	8.5	59	6.5	45	75	8.3	57	18	125	8.0	55	30
		0.5	8.5	59	6.5	45	75	8.3	57	18	125	8.0	55	30
		10	8.5	59	6.5	45	75	8.3	57	18	125	8.0	55	30
		100	8.5	59	6.5	45	75	8.3	57	18	125	8.0	55	30
		1,000	8.5	59	6.5	45	75	8.3	57	18	125	8.0	55	30
		10,000	8.5	59	6.0	41	75	8.3	57	18	125	8.0	55	30
500	260	0.1	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		0.5	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		10	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		100	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		1,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		10,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
		100,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
600	315	0.1	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		0.5	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		10	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		100	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		1,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		10,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		100,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
700	370	0.1	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		0.5	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		10	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		100	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		1,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		10,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		100,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
800	425	...	2.8	19	2.2	15	80	...	...	...	...	...	...	...
900	480	...	2.2	15	1.6	11	80	...	...	...	...	...	...	...
1000	540	...	1.6	11	1.2	8.0	65	...	...	...	...	...	...	...

(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.

6061-O: Creep and Stress-Relaxation Properties

Temperature		Time under stress, h	Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep		Stress relaxation	
°F	°C		ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	Time under strain(a), h	Loss in stress, %
75	25	0.1	18	125	17	115	17	115	17	115	17	115	...	...
		1	18	125	17	115	17	115	17	115	17	115	1	2.0
		10	18	125	17	115	17	115	17	115	17	115	10	7.0
		100	18	125	17	115	17	115	17	115	17	115	100	11
		1,000	18	125	17	115	17	115	17	115	17	115	1,000	18
212	100	...	...	...	...	...	...	...	...	...	...	...	10,000	27
		0.1	18	125	17	115	17	115	17	115	17	115	...	...
		1	18	125	17	115	17	115	17	115	17	115	1	2.0
		10	18	125	17	115	17	115	17	115	17	115	10	15
		100	18	125	17	115	17	115	17	115	17	115	100	29
300	150	1,000	18	125	17	115	17	115	17	115	17	115	1,000	43
		...	...	...	...	...	...	...	...	...	...	...	10,000	62
		0.1	16	110	14	95	13	90	11	75	10	70	...	...
		1	16	110	14	95	13	90	10	70	9.5	66	1	27
		10	16	110	13	90	12	85	10	70	9.0	62	10	41
350	177	100	16	110	13	90	12	85	10	70	9.0	62	100	55
		1,000	16	110	13	90	12	85	10	70	9.0	62	1,000	72
		...	...	...	...	...	...	...	...	...	...	...	10,000	100
		0.1	14	95	11	75	10	70	8.0	55	7.5	52	...	...
		1	14	95	10	70	9.0	62	7.5	52	7.0	48	...	...
400	205	10	13	90	9.0	62	8.0	55	6.5	45	6.0	41	...	...
		100	12	85	8.5	59	7.5	52	6.0	41	5.5	38	...	...
		1,000	9.5	66	8.0	55	7.0	48	6.0	41	5.5	38	...	...
		0.1	11	75	8.0	55	7.5	52	6.5	45	6.0	41	...	...
		1	10	70	7.0	48	6.5	45	6.0	41	5.5	38	...	...
450	230	10	8.5	59	6.0	41	5.5	38	5.0	34	4.8	33	...	...
		100	7.0	48	5.5	38	5.0	34	4.6	32	4.4	30	...	...
		1,000	5.5	38	4.7	32	4.5	31	4.3	30	4.1	28	...	...
		10,000	4.8	33	...	...	...	...	...	...	...	...	...	...
		0.1	8.5	59	6.5	45	6.0	41	5.5	38	5.0	34	...	...
500	260	1	7.5	52	5.5	38	5.0	34	4.9	34	4.6	32	...	...
		10	6.5	45	5.0	34	4.8	33	4.5	31	4.2	29	...	...
		100	5.5	38	4.6	32	4.5	31	4.1	28	3.8	26	...	...
		1,000	4.7	32	4.0	28	3.9	27	3.7	26	3.5	24	...	...
		0.1	7.0	48	5.5	38	4.9	34	4.5	31	4.3	30	...	...
600	315	1	6.0	41	4.7	32	4.4	30	4.1	28	3.9	27	...	...
		10	5.0	34	4.3	30	4.1	28	3.8	26	3.6	25	...	...
		100	4.3	30	3.9	27	3.8	26	3.4	23	3.2	22	...	...
		1,000	3.8	26	3.4	23	3.3	23	3.1	21	2.9	20	...	...
		0.1	4.7	32	3.6	25	3.4	23	3.2	22	3.0	21	...	...
700	370	1	4.0	28	3.2	22	3.1	21	2.9	20	2.7	19	...	...
		10	3.4	23	2.9	20	2.8	19	2.6	18	2.3	16	...	...
		100	2.9	20	2.6	18	2.5	17	2.2	15	2.0	14	...	...
		1,000	2.3	16	2.2	15	2.1	14	1.9	13	1.7	12	...	...
		10,000	1.7	12	...	...	...	...	...	...	...	...	...	...
700	370	0.1	3.0	21	2.5	17	2.4	17	2.2	15	2.1	14	...	...
		1	2.7	19	2.3	16	2.2	15	2.0	14	1.9	13	...	...
		10	2.4	17	2.0	14	1.9	13	1.8	12	1.7	12	...	...
		100	2.1	14	1.8	12	1.7	12	1.6	11	1.5	10	...	...
		1,000	1.8	12	1.6	11	1.5	10	1.4	10	1.3	9.0	...	...

(a) Stressed in tension to 60% of the tensile yield strength at the stressing temperature. Strain held constant during exposure. Source data are in English units; metric values are converted and rounded.

6061-T4, -T451: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated							At room temperature after heating				
			Tensile strength		Yield strength		Elongation in 4D, %	Modulus of elasticity(a)		Tensile strength		Yield strength		Elongation in 4D, %
°F	°C	ksi	MPa	ksi	MPa	10 ⁶ psi		GPa	ksi	MPa	ksi	MPa		
-423	-253	...	85	585	38	260	41	...	...	...	...	...	...	...
-320	-196	...	53	365	29	200	31	11.1	77	...	...	...	...	...
-112	-80	...	39	270	23	160	27	10.4	72	...	...	...	...	...
-18	-28	...	37	255	22	150	26	10.1	70	...	...	...	...	...
75	25	...	35	240	21	145	25	9.9	68	35	240	21	145	25
212	100	0.1	32	220	21	145	27	9.5	66	...	...	...	...	...
		0.5	32	220	21	145	27	9.5	66	35	240	21	145	25
		10	32	220	21	145	27	9.5	66	...	...	...	...	...
		100	35	240	26	180	26	9.5	66	...	...	...	...	...
		1,000	38	260	31	215	24	9.5	66	...	...	...	...	...
		10,000	41	285	34	235	22	9.5	66	...	...	...	...	...
		100,000	42	290	36	250	18	9.5	66	...	...	...	...	...
300	150	0.1	30	205	20	140	28	9.1	63	...	...	...	...	...
		0.5	30	205	20	140	28	9.1	63	35	240	22	150	25
		10	32	220	23	160	27	9.1	63	(b)	(b)	(b)	(b)	...
		100	38	260	36	250	22	9.1	63	(b)	(b)	(b)	(b)	...
		1,000	38	260	36	250	18	9.1	63	(b)	(b)	(b)	(b)	...
		10,000	33	230	31	215	19	9.1	63	(b)	(b)	(b)	(b)	...
		100,000	29	200	27	185	21	9.1	63	35	240	(b)	(b)	...
350	177	0.1	29	200	20	140	27	8.9	61	...	...	...	...	...
		0.5	29	200	20	140	26	8.9	61	38	260	29	200	...
		10	36	250	35	240	22	8.9	61	(b)	(b)	(b)	(b)	...
		100	34	235	32	220	18	8.9	61	(b)	(b)	(b)	(b)	...
		1,000	30	205	28	195	19	8.9	61	(b)	(b)	(b)	(b)	...
		10,000	24	165	22	150	22	8.9	61	33	230	27	185	18
		100,000	20	140	17	115	28	8.9	61	28	195	21	145	19
400	205	0.1	29	200	22	150	24	8.6	59	...	...	...	...	...
		0.5	30	205	28	195	22	8.6	59	41	285	34	235	17
		10	30	205	30	205	18	8.6	59	40	275	(b)	(b)	16
		100	27	185	25	170	19	8.6	59	35	240	30	205	17
		1,000	22	150	20	140	23	8.6	59	31	215	24	165	17
		10,000	17	115	14	95	28	8.6	59	26	180	18	125	19
		100,000	13	90	9.0	62	40	8.6	59	21	145	11	75	24
450	230	0.1	28	195	27	185	20	8.3	57	...	...	...	...	...
		0.5	29	200	28	195	18	8.3	57	40	275	34	235	16
		10	24	165	23	160	18	8.3	57	34	235	28	195	17
		100	19	130	18	125	23	8.3	57	29	200	21	145	18
		1,000	15	105	13	90	30	8.3	57	25	170	15	105	19
		10,000	12	85	8.5	59	40	8.3	57	20	140	11	75	24
		100,000	9.0	62	6.5	45	70	8.3	57	18	125	8.0	55	30
500	260	0.1	25	170	24	165	17	7.9	54	...	...	...	...	...
		0.5	23	160	22	150	16	7.9	54	35	240	29	200	16
		10	18	125	16	110	20	7.9	54	29	200	20	140	18
		100	13	90	11	75	29	7.9	54	25	170	14	95	20
		1,000	10	70	8.0	55	45	7.9	54	21	145	10	70	24
		10,000	8.0	55	6.0	41	65	7.9	54	18	125	8.0	55	30
		100,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
600	315	0.1	14	95	13	90	18	6.8	47	...	...	...	...	...
		0.5	12	85	11	75	23	6.8	47	27	185	17	115	19
		10	9.0	62	8.0	55	30	6.8	47	23	160	12	85	22
		100	6.0	41	4.5	31	65	6.8	47	20	140	8.5	59	29
		1,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		10,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		100,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
700	370	0.1	8.5	59	8.0	55	35	5.5	38	...	...	...	...	...
		0.5	7.0	48	6.5	45	35	5.5	38	23	160	12	85	22
		10	3.8	26	3.0	21	80	5.5	38	19	130	8.0	55	30
		100	3.6	25	3.0	21	80	5.5	38	19	130	8.0	55	30
		1,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		10,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		100,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
800	425	0.1	3.8	26	3.2	22	65	...	...	...	...	...	...	...
		0.5	3.0	21	2.4	17	80	...	...	...	...	...	...	...
900	480	...	2.2	15	1.6	11	80	...	...	...	...	...	...	...
1000	540	...	1.6	11	1.2	8.0	65	...	...	...	...	...	...	...

(a) The modulus of elasticity in compression is about 2% greater than in tension. (b) Greater than values for 0.5 h holding period
 Source data are in English units; metric values are converted and rounded.

6061-T6 Sheet and Rolled-and-Drawn Products: Typical Tensile Properties

Temperature		Time at temperature, h	At temperature indicated						At room temperature after heating					
			Tensile strength		Yield strength		Elongation in 4D, %	Modulus of elasticity(a)		Tensile strength		Yield strength		Elongation in 4D, %
			ksi	MPa	ksi	MPa		10 ⁶ psi	GPa	ksi	MPa	ksi	MPa	
°F	°C													
-452	-269	...	74	510	53	365	27	...	...	...	...	...	...	...
-423	-253	...	74	510	53	365	27	...	...	...	...	...	...	...
-320	-196	...	58	400	46	315	23	11.1	77	...	...	...	...	...
-112	-80	...	49	340	42	290	19	10.4	72	...	...	...	...	...
-18	-28	...	47	325	41	285	18	10.1	70	...	...	...	...	...
75	25	...	45	310	40	275	17	9.9	68	45	310	40	275	17
212	100	0.1	41	285	38	260	18	9.5	66	45	310	40	275	17
		0.5	41	285	38	260	18	9.5	66	45	310	40	275	17
		10	41	285	38	260	18	9.5	66	45	310	40	275	17
		100	41	285	38	260	18	9.5	66	45	310	40	275	17
		1,000	42	290	39	270	18	9.5	66	46	315	41	285	17
		10,000	42	290	39	270	18	9.5	66	46	315	42	290	17
		100,000	42	290	39	270	17	9.5	66	45	310	41	285	17
300	150	0.1	38	260	36	250	20	9.1	63	45	310	40	275	17
		0.5	38	260	36	250	20	9.1	63	45	310	40	275	17
		10	38	260	36	250	19	9.1	63	46	315	41	285	16
		100	38	260	36	250	18	9.1	63	45	310	41	285	16
		1,000	38	260	36	250	18	9.1	63	43	295	40	275	16
		10,000	33	230	31	215	19	9.1	63	39	270	35	240	17
		100,000	29	200	27	185	21	9.1	63	35	240	30	205	17
350	177	0.1	36	250	35	240	21	8.9	61	45	310	40	275	17
		0.5	36	250	35	240	21	8.9	61	45	310	40	275	17
		10	36	250	35	240	18	8.9	61	44	305	40	275	16
		100	34	235	32	220	18	8.9	61	41	285	38	260	16
		1,000	30	205	28	195	19	8.9	61	38	260	34	235	16
		10,000	24	165	22	150	22	8.9	61	33	230	27	185	18
		100,000	20	140	17	115	28	8.9	61	28	195	21	145	19
400	205	0.1	33	230	32	220	20	8.6	59	44	305	39	270	18
		0.5	34	235	32	220	19	8.5	59	44	305	40	275	17
		10	30	205	30	205	18	8.6	59	40	275	36	250	16
		100	27	185	25	170	19	8.6	59	35	240	30	205	17
		1,000	22	150	20	140	23	8.6	59	31	215	24	165	17
		10,000	17	115	14	95	28	8.6	59	26	180	18	125	19
		100,000	13	90	9.0	62	40	8.6	59	21	145	11	75	24
450	230	0.1	29	200	28	195	19	8.3	57	43	295	38	260	16
		0.5	29	200	28	195	17	8.3	57	42	290	38	260	16
		10	24	165	23	160	18	8.3	57	34	235	28	195	17
		100	19	130	18	125	23	8.3	57	29	200	21	145	18
		1,000	15	105	13	90	30	8.3	57	25	170	15	105	19
		10,000	12	85	8.5	59	40	8.3	57	20	140	11	75	24
		100,000	9.0	62	6.5	45	70	8.3	57	18	125	8.0	55	30
500	260	0.1	25	170	24	165	17	7.9	54	41	285	36	250	15
		0.5	23	160	22	150	16	7.9	54	39	270	33	230	16
		10	18	125	16	110	20	7.9	54	29	200	20	140	18
		100	13	90	11	75	29	7.9	54	25	170	14	95	20
		1,000	10	70	8.0	55	45	7.9	54	21	145	10	70	24
		10,000	8.0	55	6.0	41	65	7.9	54	18	125	8.0	55	30
		100,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30
600	315	0.1	14	95	13	90	18	6.8	47	32	220	25	170	17
		0.5	12	85	11	75	23	6.8	47	27	185	17	115	19
		10	9.0	62	8.0	55	30	6.8	47	23	160	12	85	22
		100	6.0	41	4.5	31	65	6.8	47	20	140	8.5	59	29
		1,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		10,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
		100,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30
700	370	0.1	8.5	59	8.0	55	35	5.5	38	27	185	17	115	20
		0.5	7.0	48	6.5	45	35	5.5	38	23	160	12	85	22
		10	3.8	26	3.0	21	80	5.5	38	19	130	8.0	55	30
		100	3.6	25	3.0	21	80	5.5	38	19	130	8.0	55	30
		1,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		10,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
		100,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30
800	425	0.1	3.8	26	3.2	22	65	...	...	...	...	...	...	...
		0.5	3.0	21	2.4	17	80	...	...	...	...	...	...	...
900	480	...	2.2	15	1.6	11	80	...	...	...	...	...	...	...
1000	540	...	1.6	11	1.2	8.0	65	...	...	...	...	...	...	...

(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.

6061-T6 Sheet and Rolled-and-Drawn Products: Creep-Rupture and Creep Properties

Temperature		Time under stress, h	Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep	
°F	°C		ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
75	25	0.1	45	310	45	310	44	305	43	295	42	290
		1	45	310	45	310	43	295	42	290	42	290
		10	45	310	44	305	43	295	42	290	42	290
		100	45	310	44	305	42	290	42	290	41	285
		1,000	45	310	43	295	42	290	41	285	41	285
212	100	0.1	41	285	40	275	40	275	39	270	38	260
		1	40	275	39	270	39	270	38	260	37	255
		10	39	270	38	260	38	260	37	255	36	250
		100	38	260	37	255	37	255	...	...	...	...
		1,000	37	255	...	...	...	...	...	...	...	...
300	150	0.1	37	255	36	250	36	250	35	240	34	235
		1	36	250	34	235	34	235	32	220	31	215
		10	34	235	32	220	32	220	30	205	28	195
		100	31	215	30	205	29	200	27	185	24	165
		1,000	27	185	26	180	25	170	21	145	17	115
350	177	0.1	34	235	33	230	33	230	32	220	30	205
		1	32	220	31	215	31	215	29	200	27	185
		10	30	205	29	200	28	195	26	180	23	160
		100	26	180	25	170	24	165	22	150	17	115
		1,000	20	140	19	130	18	125	15	105	12	85
400	205	0.1	31	215	30	205	29	200	28	195	26	180
		1	28	195	27	185	26	180	24	165	22	150
		10	24	165	24	165	23	160	20	140	17	115
		100	20	140	19	130	18	125	15	105	10	70
		1,000	14	95	13	90	12	85	8.5	59	6.5	45
450	230	10,000	10	70	...	...	...	...	...	...	...	...
		0.1	25	170	24	165	24	165	23	160	20	140
		1	22	150	21	145	21	145	19	130	16	110
		10	17	115	16	110	15	105	13	90	11	75
		100	13	90	12	85	11	75	8.5	59	6.0	41
500	260	1,000	9.5	66	8.5	59	7.0	48	...	...	...	...
		0.1	20	140	19	130	19	130	18	125	16	110
		1	17	115	16	110	16	110	14	95	12	83
		10	12	85	11	75	11	75	9.0	62	7.0	48
		100	8.5	59	8.0	55	7.0	48	5.5	38	4.2	29
600	315	1,000	6.5	45	5.5	38	4.7	32	...	...	...	...
		0.1	11	75	10	70	9.5	66	9.0	62	8.0	55
		1	9.5	66	8.0	55	8.0	55	7.0	48	6.0	41
		10	7.0	48	6.0	41	5.5	38	4.5	31	3.2	22
		100	3.6	25	3.0	21	2.8	19	2.2	15	2.0	14
		1,000	2.3	16	2.2	15	2.1	14	1.9	13	1.7	12
		10,000	1.7	12	...	...	...	...	...	...	...	...

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

6061-T6, -T651, -T6511 (Except for T6 Sheet and Rolled-and-Drawn Products): Typical Tensile Properties

Temperature			At temperature indicated							At room temperature after heating						
			Tensile strength		Yield strength		Elongation in 4D, %	Modulus of elasticity(a)		Tensile strength		Yield strength		Elongation in 4D, %		
			ksi	MPa	ksi	MPa		10 ⁶ psi	GPa	ksi	MPa	ksi	MPa			
°F	°C	Time at temperature, h														
-452	-269	...	74	510	53	365	27	...	...	...	...	...	...	...	...	...
-423	-253	...	74	510	53	365	27	...	...	...	...	...	...	...	...	...
-320	-196	...	60	415	47	325	22	11.1	77	...	...	...	...	...	...	...
-112	-80	...	49	340	42	290	19	10.4	72	...	...	...	...	...	...	...
-18	-28	...	47	325	41	285	18	10.1	70	...	...	...	...	...	...	...
75	25	...	45	310	40	275	17	9.9	68	45	310	40	275	17	...	...
212	100	0.1	41	285	38	260	18	9.5	66	45	310	40	275	17	...	...
		0.5	41	285	38	260	18	9.5	66	45	310	40	275	17	...	...
		10	41	285	38	260	18	9.5	66	45	310	40	275	17	...	...
		100	41	285	38	260	18	9.5	66	45	310	40	275	17	...	...
		1,000	42	290	39	270	18	9.5	66	46	315	41	285	17	...	...
		10,000	42	290	39	270	18	9.5	66	46	315	42	290	17	...	...
		100,000	42	290	39	270	17	9.5	66	45	310	41	285	17	...	...
300	150	0.1	38	260	36	250	20	9.1	63	45	310	40	275	17	...	...
		0.5	38	260	36	250	20	9.1	63	45	310	40	275	17	...	...
		10	38	260	36	250	19	9.1	63	46	315	41	285	16	...	...
		100	38	260	36	250	18	9.1	63	45	310	41	285	16	...	...
		1,000	38	260	36	250	18	9.1	63	43	295	40	275	16	...	...
		10,000	33	230	31	215	19	9.1	63	39	270	35	240	17	...	...
		100,000	29	200	27	185	21	9.1	63	35	240	30	205	17	...	...
350	177	0.1	36	250	35	240	21	8.9	61	45	310	40	275	17	...	...
		0.5	36	250	35	240	21	8.9	61	45	310	40	275	17	...	...
		10	36	250	35	240	18	8.9	61	44	305	40	275	16	...	...
		100	34	235	32	220	18	8.9	61	41	285	38	260	16	...	...
		1,000	30	205	28	195	19	8.9	61	38	260	34	235	16	...	...
		10,000	24	165	22	150	22	8.9	61	33	230	27	185	18	...	...
		100,000	20	140	17	115	28	8.9	61	28	195	21	145	19	...	...
400	205	0.1	33	230	32	220	20	8.6	59	44	305	39	270	18	...	...
		0.5	34	235	32	220	19	8.6	59	44	305	40	275	17	...	...
		10	30	205	30	205	18	8.6	59	40	275	36	250	16	...	...
		100	27	185	25	170	19	8.6	59	35	240	30	205	17	...	...
		1,000	22	150	20	140	23	8.6	59	31	215	24	165	17	...	...
		10,000	17	115	14	95	28	8.6	59	26	180	18	125	19	...	...
		100,000	13	90	9.0	62	40	8.6	59	21	145	11	75	24	...	...
450	230	0.1	29	200	28	195	19	8.3	57	43	295	38	260	16	...	...
		0.5	29	200	28	195	17	8.3	57	42	290	38	260	16	...	...
		10	24	165	23	160	18	8.3	57	34	235	28	195	17	...	...
		100	19	130	18	125	23	8.3	57	29	200	21	145	18	...	...
		1,000	15	105	13	90	30	8.3	57	25	170	15	105	19	...	...
		10,000	12	85	8.5	59	40	8.3	57	20	140	11	75	24	...	...
		100,000	9.0	62	6.5	45	70	8.3	57	18	125	8.0	55	30	...	...
500	260	0.1	25	170	24	165	17	7.9	54	41	285	36	250	15	...	...
		0.5	23	160	22	150	16	7.9	54	39	270	33	230	16	...	...
		10	18	125	16	110	20	7.9	54	29	200	20	140	18	...	...
		100	13	90	11	75	29	7.9	54	25	170	14	95	20	...	...
		1,000	10	70	8.0	55	45	7.9	54	21	145	10	70	24	...	...
		10,000	8.0	55	6.0	41	65	7.9	54	18	125	8.0	55	30	...	...
		100,000	7.0	48	5.5	38	80	7.9	54	18	125	8.0	55	30	...	...
600	315	0.1	14	95	13	90	18	6.8	47	32	220	25	170	17	...	...
		0.5	12	85	11	75	23	6.8	47	27	185	17	115	19	...	...
		10	9.0	62	8.0	55	30	6.8	47	23	160	12	85	22	...	...
		100	6.0	41	4.5	31	65	6.8	47	20	140	8.5	59	29	...	...
		1,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30	...	...
		10,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30	...	...
		100,000	5.0	34	4.2	29	80	6.8	47	18	125	8.0	55	30	...	...
700	370	0.1	8.5	59	8.0	55	35	5.5	38	27	185	17	115	20	...	...
		0.5	7.0	48	6.5	45	35	5.5	38	23	160	12	85	22	...	...
		10	3.8	26	3.0	21	80	5.5	38	19	130	8.0	55	30	...	...
		100	3.6	25	3.0	21	80	5.5	38	19	130	8.0	55	30	...	...
		1,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30	...	...
		10,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30	...	...
		100,000	3.6	25	3.0	21	80	5.5	38	18	125	8.0	55	30	...	...
800	425	0.1	3.8	26	3.2	22	65	...	...	...	...	...	...	...	...	...
		0.5	3.0	21	2.4	17	80	...	...	...	...	...	...	...	...	...
900	480	...	2.2	15	1.6	11	80	...	...	...	...	...	...	...	...	...
1000	540	...	1.6	11	1.2	8.0	65	...	...	...	...	...	...	...	...	...

(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.

6061-T6, -T651, -T6511 (Except for T6 Sheet and Rolled-and-Drawn Products): Creep and Stress-Relaxation Properties

Temperature		Time under stress, h	Rupture stress		Stress at 1.0% creep		Stress at 0.5% creep		Stress at 0.2% creep		Stress at 0.1% creep		Stress relaxation	
°F	°C		ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa	Time under strain(a), h	Loss in stress, %
75	25	0.1	45	310	45	310	44	305	43	295	42	290	...	...
		1	45	310	45	310	43	295	42	290	42	290	1	2.0
		10	45	310	44	305	43	295	42	290	42	290	10	2.0
		100	45	310	44	305	42	290	42	290	41	285	100	3.0
		1,000	45	310	43	295	42	290	41	285	41	285	1,000	4.0
212	100	...	...	...	...	...	...	...	...	...	...	...	10,000	5.0
		0.1	41	285	40	275	40	275	39	270	38	260	...	...
		1	40	275	39	270	39	270	38	260	38	260	1	4.0
		10	39	270	38	260	38	260	38	260	37	255	10	7.0
		100	38	260	38	260	38	260	37	255	37	255	100	10
300	150	1,000	37	255	37	255	37	255	37	255	36	250	1,000	14
		...	...	...	...	...	...	...	...	...	...	...	10,000	16
		0.1	37	255	36	250	36	250	35	240	35	240	...	...
		1	36	250	35	240	35	240	35	240	34	235	1	8.0
		10	35	240	34	235	34	235	34	235	33	230	10	12
350	177	100	34	235	34	235	34	235	33	230	32	220	100	18
		1,000	31	215	31	215	31	215	31	215	30	205	1,000	28
		...	...	...	...	...	...	...	...	...	...	...	10,000	43
		0.1	34	235	34	235	34	235	33	230	33	230	...	...
		1	33	230	33	230	33	230	32	220	32	220	1	15
400	205	10	32	220	32	220	32	220	31	215	30	205	10	22
		100	29	200	29	200	29	200	28	195	26	180	100	33
		1,000	25	170	25	170	25	170	24	165	22	150	1,000	47
		...	...	...	...	...	...	...	...	...	...	...	10,000	62
		0.1	32	220	32	220	32	220	31	215	30	205	...	...
450	230	1	30	205	30	205	30	205	29	200	28	195	1	29
		10	27	185	27	185	26	180	25	170	24	165	10	39
		100	23	160	22	150	22	150	21	145	19	130	100	52
		1,000	18	125	18	125	18	125	16	110	14	95	1,000	67
		...	...	...	...	...	...	...	...	...	...	...	10,000	67
500	260	0.1	27	185	27	185	27	185	27	185	26	180	...	...
		1	25	170	25	170	25	170	24	165	23	160	...	...
		10	20	140	20	140	20	140	19	130	17	115	...	...
		100	16	110	16	110	16	110	14	95	12	85	...	...
		1,000	12	85	12	85	11	75	...	...	...	...	...	...
600	315	0.1	21	145	21	145	21	145	21	145	20	140	...	...
		1	19	130	19	130	19	130	18	125	17	115	...	...
		10	14	95	14	95	14	95	13	90	11	75	...	...
		100	11	75	10	70	10	70	8.5	59	6.0	41	...	...
		1,000	7.5	52	7.0	48	6.5	45	...	...	...	...	...	...
600	315	0.1	11	75	10	70	9.5	66	9.5	66	8.5	59	...	...
		1	9.5	66	8.5	59	8.5	59	7.5	52	7.0	48	...	...
		10	7.0	48	7.0	48	6.5	45	5.5	38	4.4	30	...	...
		100	3.6	25	3.0	21	2.8	19	2.2	15	2.0	14	...	...
		1,000	2.3	16	2.2	15	2.1	14	1.9	13	1.7	12	...	...
10,000	1.7	12	...	...	...	...	...	...	...	...	...	...

(a) Stressed in tension to 60% of the tensile yield strength at the stressing temperature. Strain held constant during exposure. Source data are in English units; metric values are converted and rounded.