	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

1 **GENERAL**

7049 and 7149 are wrought heat treated aluminum alloys which are used in the aerospace industry. In the T73 or T76 temper they have high strength and fracture toughness coupled with a high resistance to stress corrosion cracking in heavy sections.

In T73 temper, 7049 appears to have fatigue properties similar to 7075-T6 and 7079-T6 (1), and strength fracture toughness and stress corrosion properties similar to 7050-T73.

7149 is a high purity version of 7049. It has higher fracture toughness than 7049, but similar strength, fatigue, and corrosion properties (11, 12).

1.01 **Commercial Designation**

7049 (or 7149) -T73 and 7049-T7352 (forgings).
7049-T7351 (plate).
7049-T73511, 7049-T73510, 7049-T76511, and 7049-T76510 (extrusions).

1.02 **Alternate Designation**

UNS A97049.

1.03 **Specifications**

7049-T73 forgings: QQ-A-367 (28)
MIL-A-22771 (29)
AMS4111 (30).
7149-T73 forgings: AMS4320 (31).
7049-T73510 and -T73511 extrusions: AMS4157 (32).
7049-T76510 and -T76511 extrusions: AMS4159 (33).
7149-T73510 and -T73511 extrusions: AMS4343 (34).
7049-T7351 plate: AMS4200 (35).

1.04 **Composition**

Chemical compositions of 7049 and 7149, Table 1.04.

1.05 **Heat Treatment**

Both T73 and T76 tempers are solution heat treated and aged to different degrees past maximum strength, T6.

The product is usually stress relieved by stretching (final digit of temper designation = 1) or by compressing (final digit = 2).

The heat treatment procedure for forgings and extrusions that are not stress relieved by stretching or compression is given in MIL-6088. Users may obtain details from the producer of heat treatments for other products or for specific applications.

1.06 **Hardness**

(See also Figure 3.027232).

1.061 Typical hardness: 145 Brinell (500 kg load, 10 mm ball) (2) -T73
82 to 87 R_B (3) -T73
105 to 110 R_E (20) -T7351.

1.07 **Forms and Conditions Available**

7049 is currently available in die and hand forgings and heavy section extrusions up to 5 inch in thickness and in rolled plate form up to 4-1/4 inch in thickness. Other forms are subject to inquiry.

1.08 **Melting and Casting Practices**

1.09 **Special Considerations**

The plane strain fracture toughness of this alloy, like other high strength aluminum alloys, is sensitive to the content of the impurity elements iron and silicon. Reducing the content of these elements increases the fracture toughness with no change in tensile properties (see Tables 3.0214 and 3.027211) and no change in fatigue or corrosion behavior (11, 12).

As has been reported for other heat treated aluminum alloys (23), strength, hardness, and fracture toughness vary throughout the thickness of heavy sections of 7049 (see Figure 3.027232). Care should be taken that property comparisons are made at similar test sample locations, and that the data used are relevant to the section used in service.

2 **PHYSICAL AND CHEMICAL PROPERTIES**

2.01 **Thermal Properties**

2.011 Melting range.
2.012 Phase changes, alloy is subject to precipitation.
2.0121 Time-temperature-transformation diagrams.
2.013 Thermal conductivity: 89 Btu ft per (hr ft^2 F).
2.014 Thermal expansion, Figure 2.014.
2.015 Specific heat.
2.016 Thermal diffusivity.

2.02 **Other Physical Properties**

2.021 Density: 0.099 lb per $in.^3$ (6, 8), 2.74 gr per cm^3
0.102 lb per $in.^3$ (1), 2.82 gr per cm^3.
2.022 Electrical properties.
2.0221 Electrical conductivity, 38 percent minimum IACS (2).
20222 Electrical conductivity and yield strength of 7049-T7351 plate, Table 2.0222.
2.0223 Correlation of electrical conductivity and yield strength of 7049 Plate, Figure 2.0223 (7). (See also Table 3.0214.)
2.023 Magnetic properties, alloy is nonmagnetic.
2.024 Emissivity.
2.025 Damping capacity.

2.03 **Chemical Environments**

2.031 Corrosion performance of 7049 is similar to that of 7075, 7178, 7175, and 7050. Exfoliation resistance is good (3, 7, 13, 21).
2.0311 Results of accelerated exfoliation tests on 7049-T73 forgings, Table 2.0311.
2.032 Stress corrosion properties of this alloy in the T73 or T76 conditions are good (see data that follow). The slightly overaged T7X tempers are used in preference to T6 tempers because of their superior resistance to stress corrosion.
2.0321 Stress corrosion data from tests in industrial atmosphere, Table 2.0321.

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

2.0322 Stress corrosion data from alternate immersion tests in artificial seawater, Table 2.0322.

2.0323 Percent survival of 7049-T7 die forgings versus ST yield strength when exposed to alternate immersion after 30 days and after 84 days, Figure 2.0323.

2.0324 Estimates of K_{Iscc} values for 7049-T73 forging in various media, Table 2.0324.

2.0325 K_{Iscc} estimates for 7049-T7351 plate in various media using samples with fatigue cracks, Table 2.0325.

2.0326 K_{Iscc} estimates for bolt-loaded DCB specimens of 7049-T7351 plate having pop-in precracks and tested under constant deflection conditions, Table 2.0326.

2.0327 Crack-growth rate versus initial stress intensity for 7049-T73 plate specimens exposed at Daytona Beach, Figure 2.0327.

2.0328 Crack growth in fatigue precracked DCB specimens of 3-inch 7049-T7351 plate in SL orientation under a constant load, Table 2.0328.

2.0329 Comparison of SCC results for 7049-T7351 plate based on selected exposure periods in several test media, Table 2.0329.

2.0330 Crack growth in fatigue precracked 1.25-inch 7049-T73 temper plates exposed to salt-chromate solution (7), Figure 2.0330.

2.0331 Crack growth in DCB specimen with pop-in precracks from 7049-T73 temper plates exposed at Daytona Beach (2), Figure 2.0331.

2.0332 Crack velocity versus K_i plot for 7049-T7351 plate at Daytona Beach, Figure 2.0332.

2.04 Nuclear Properties

3 MECHANICAL PROPERTIES

3.01 Specified Mechanical Properties

3.011 Aluminum Association mechanical property limits for T73 die forgings, Table 3.011.

3.012 Tentative minimum mechanical properties for die forgings and hand forgings, Table 3.012.

3.02 Mechanical Properties at Room Temperature

3.021 Tension.

3.0211 Tensile properties of 7049-T7351 plate from 1.25-inch to 4.25-inch thickness, Table 3.0211.

3.0212 Tensile properties of 7049-T73 hand forgings, Table 3.0212.

3.0213 Tensile properties of 7049-T73 die forgings, Table 3.0213.

3.0214 Tensile properties of 7049-T73511 and -T76511 extrusions of different chemical impurities, Table 3.0214.

3.0215 Tensile and other mechanical properties of 7049-T76 extrusions, Table 3.0215.

3.0216 Compression, shear, and bearing properties of 7049-T73 die forgings, Table 3.0216.

3.0217 Compression, shear, and bearing properties of 7049-T73 hand forgings, Table 3.0217 (see also Figure 3.06221).

3.0218 Compression and shear properties of 7049-T7351 plate, Table 3.0218.

3.0219 Effect of exposure at elevated temperature on room temperature tensile properties of forgings, Figure 3.0219.

3.022 Compression (see also Section 3.032).

3.0221 Stress-strain diagrams (see Section 3.032).

3.023 Impact.

3.0231 Charpy V-notch: 4.1 ft-lbs (8); 5.8 ft-lbs (longitudinal); 3.3 ft-lbs (transverse) (6); and see also Figure 3.0331 and Table 3.0215.

3.024 Bending.

3.025 Torsion and shear (see also Figure 3.0351 and Tables 3.0216, 3.0217, and 3.0218).

3.026 Bearing (see Figure 3.0361 and Tables 3.0216 and 3.0217).

3.027 Stress concentration.

3.0271 Typical notch tensile data (K_t = 3.0): Longitudinal = 103 ksi and transverse = 102 ksi (2).

3.0272 Fracture toughness.

3.02721 Extrusions.

3.027211 Fracture toughness of 7049-T73511 and -T76511 extrusions of different purity levels, Table 3.027211.

3.027212 Fracture toughness of 7049-T73 and -T76 extrusions of different dimensions, Table 3.027212.

3.02722 Forgings.

3.027221 Fracture toughness of die and hand forgings of 7049-T73, Table 3.027221.

3.027222 Fracture toughness of 7049-T73 hand forgings of different dimensions, Table 3.027222.

3.027223 Kahn tear test data for die forgings of 7049-T73, Table 3.027223.

3.02723 Plate.

3.027231 Fracture toughness of 7049-T7351 rolled plate of various thicknesses, Table 3.027231.

3.027232 Variation in hardness, fracture toughness, and tensile properties through the thickness of a 4.25-inch and a 2.5-inch thick rolled 7049-T7351 plate, Figure 3.027232.

3.03 Mechanical Properties at Various Temperatures

3.031 Tension.

3.0311 Stress-strain curves.

3.03111 Typical longitudinal stress-strain curves in tension for 5-inch forgings at room and elevated temperatures, Figure 3.03111.

3.03112 Typical transverse stress-strain curves in tension for 5-inch forgings at room and elevated temperatures, Figure 3.03112.

3.03113 Typical tensile stress-strain curves in longitudinal direction for 7049-T76 extrusions, Figure 3.03113.

3.03114 Typical tensile stress-strain curves in transverse direction for 7049-T76 extrusions, Figure 3.03114.

3.0312 Effect of exposure and test temperature on tensile properties of forgings, Figure 3.0312.

3.0313 Effect of temperature on tensile properties of 5-inch forgings, Figure 3.0313.

3.0314 Effect of temperature on the tensile properties and tensile modulus of 7049-T76 extrusions, Figure 3.0314.

3.0315 Tensile property data for the longitudinal direction for 7049-T73 extrusion and bar, and 7049-T76 extruded bar, Figure 3.0315.

3.0316 Tensile property data for the transverse direction for 7049-T73 bar and extrusion, and 7049-T76 extruded bar, Figure 3.0316.

3.0317 Tensile property data for the short transverse direction for 7049-T73 bar and extrusion, and 7049-T76 extruded bar, Figure 3.0317.

3.032	Compression. (See also Table 3.0215 for modulus data.)
3.0321	Stress-strain curves.
3.03211	Typical longitudinal stress-strain curves in compression for 5-inch forgings at room and elevated temperatures, Figure 3.03211.
3.03212	Typical transverse stress-strain curves in compression for 5-inch forgings at room and elevated temperatures, Figure 3.03212.
3.03213	Typical longitudinal compressive stress-strain curves for 7049-T76 extrusion, at room and elevated temperatures, Figure 3.03213.
3.03214	Typical transverse compressive stress-strain curves for 7049-T76 extrusion, at room and elevated temperatures, Figure 3.03214.
3.0322	Effect of exposure and test temperature on compressive yield strength of 5-inch forgings, Figure 3.0322.
3.0323	Effect of temperature on compressive yield strength of 5-inch forgings, Figure 3.0323.
3.0324	Effect of temperature on the compressive properties of 7049-T76 extrusion, Figure 3.0324.
3.033	Impact.
3.0331	Effect of temperature on Charpy V-notch impact energy, Figure 3.0331.
3.034	Bending.
3.035	Torsion and shear.
3.0351	Effect of exposure and test temperature on ultimate shear strength of forgings as determined with double shear test specimen, Figure 3.0351.
3.036	Bearing.
3.0361	Effect of exposure and test temperature on bearing properties of 5-inch forgings, Figure 3.0361.
3.037	Stress concentration.
3.0371	Notch properties.
3.038	Combined properties.
3.04	**Creep and Creep-Rupture Properties**
3.041	Creep-rupture curves for 5-inch forgings at 250, 300, and 500 F, Figure 3.041.
3.042	Creep curves for 5-inch forgings showing time for 0.2 percent plastic deformation, Figure 3.042.
3.043	Creep-rupture and creep deformation in transverse direction for 7049-T76 extrusions at various temperatures, Figure 3.043.
3.05	**Fatigue Properties**
3.051	Fatigue data for smooth and notched specimens from forgings at room and elevated temperatures, Table 3.051.
3.052	Axial load fatigue curves at room and elevated temperatures, Figure 3.052.
3.053	Axial load fatigue curves for smooth and notched specimens from 3-inch forgings at room temperature, Figure 3.053.
3.054	Axial load fatigue curve for notched specimens from forgings, Figure 3.054.
3.055	Axial load fatigue curves for notched specimens at room and elevated temperatures, Figure 3.055.
3.056	Notched and smooth fatigue data for 7049-T73511 extrusions of different purities, Figure 3.056.
3.057	Axial stress fatigue data for notched and smooth 7049-T73 integrally stiffened extrusions, Figure 3.057.
3.058	Notched axial stress fatigue data for a 7049-T73 extrusion, Figure 3.058.
3.059	Axial stress fatigue data for smooth and notched 7049-T73 extrusions at 250 F, Figure 3.059.
3.0510	Notched and smooth axial stress fatigue data for 7049-T73 and-T76 extrusions at 350 F, Figure 3.0510.
3.0511	Axial stress fatigue data for notched and smooth 7049-T73 integrally stiffened extrusions at 350 F, Figure 3.0511.
3.0512	Notched axial stress fatigue data for 7049-T76 extrusions at room and elevated temperatures, Figure 3.0512.
3.0513	Smooth axial stress fatigue data for 7049-T76 extrusions at various temperatures, Figure 3.0513.
3.0514	Unnotched axial stress fatigue data in the transverse direction for 7049-T7351 plate at various temperatures, Figure 3.0514.
3.0515	Notched axial stress fatigue data for 7049-T7351 plate at various temperatures, Figure 3.0515.
3.0516	Fatigue crack-growth data for 7049-T73 hand forging in different environments, Figure 3.0516.
3.0517	Effect of salt fog on the fatigue life of 7049-T73 forgings, Figure 3.0517.
3.0518	Fatigue crack-growth rate curves for 7149-T73511 and -T76511 extrusions in laboratory air and high humidity air, Figure 3.0518.
3.0519	Fatigue crack-growth rate curves for medium purity 7049-T73511 and -T76511 extrusions in laboratory air and high humidity air, Figure 3.0519.
3.0520	Fatigue crack-growth rate curves for low purity 7049-T73511 and -T76511 in laboratory air and high humidity air, Figure 3.0520.
3.06	**Elastic Properties**
3.061	Poisson's ratio.
3.062	Modulus of elasticity.
3.0621	Effect of temperature on modulus of elasticity, Figure 3.0621.
3.0622	Compression modulus.
3.06221	Effect of temperature on compression modulus, Figure 3.06221.
3.063	Modulus of rigidity.
3.064	Tangent modulus.
3.0641	Typical longitudinal curves in compression for 5-inch T73 forgings at room and elevated temperatures, Figure 3.0641.
3.0642	Typical transverse curves in compression for 5-inch T73 forgings at room and elevated temperatures, Figure 3.0642. (See also Figures 3.0643 and 3.0644.)
3.0643	Typical longitudinal tangent modulus curves in compression for T76 extrusions at room and elevated temperatures, Figure 3.0643.
3.0644	Typical transverse tangent modulus curves in compressions for T76 extrusions at room and elevated temperatures, Figure 3.0644.

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

4 FABRICATION

4.01 Forming

Specific data on the fabrication characteristics of this alloy are not available at this time. Because of similarity in chemical composition, the formability is expected to be similar to 7075 and 7078 in comparable heat treat conditions.

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

4.02 **Machining and Grinding**

For detailed information, refer to the Machinability Data Center, Metcut Research Associates, Inc., in Cincinnati, Ohio.

4.03 **Joining**

(See also 7075.)

4031 General. Weldability is limited because of crack sensitivity or loss in resistance to corrosion and loss of mechanical properties. Resistance spot welding can be done with special techniques that may require development (1).

4.04 **Surface Treatment**

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	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049 (2)	7049 (3, 4, 35)		7149 (3, 4, 31)
Composition	Percent Nominal	Percent Min	Max	Percent Max
Zn	7.6	7.2	8.2	8.2
Mg	2.5	2.0	2.9	2.9
Cu	1.5	1.2	1.9	1.9
Cr	0.15	0.10	0.22	0.22
Si	–	–	0.25	0.15
Fe	–	–	0.35	0.20
Ti	–	–	0.10	0.10
Mn	–	–	0.20	0.20
Others				
Each	–	–	0.05	0.05
Total	–	–	0.15	0.15
Al	Balance	Balance		Balance

TABLE 1.04. CHEMICAL COMPOSITIONS OF 7049 AND 7149 (2,3,4,31,35)

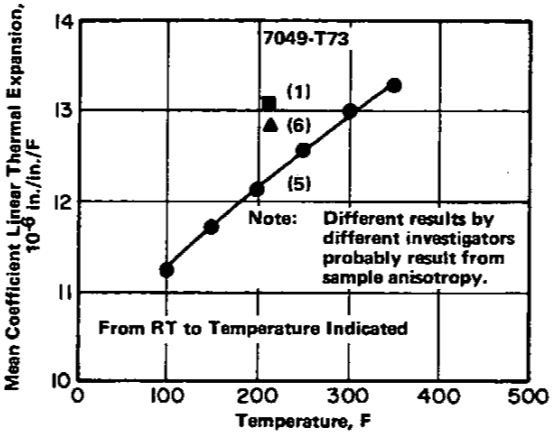


FIGURE 2.014. THERMAL EXPANSION (1,5,6)

Alloy	7049-T7351			
Form	Plate			
	Electrical Conductivity, percent IACS		Yield Strength, ksi	
Thickness, inch	Min Age	Typical Age	Min Age	Typical Age
1.25	40.8	42.5	71.5	67.0
3.00	40.1	41.7	69.8	65.3

TABLE 2.0222. ELECTRICAL CONDUCTIVITY AND YIELD STRENGTH OF 7049-T7351 PLATE (7)

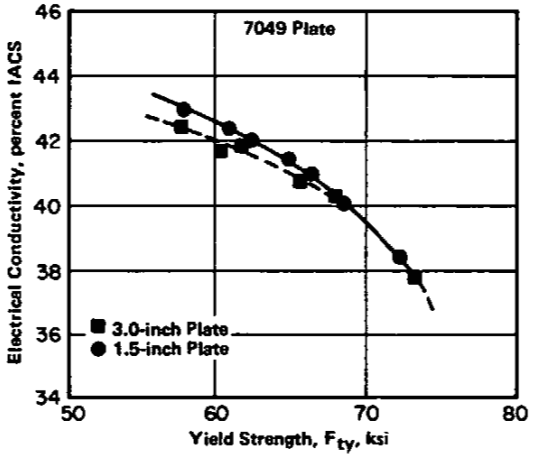


FIGURE 2.0223. CORRELATION OF ELECTRICAL CONDUCTIVITY AND YIELD STRENGTH OF 7049 PLATE (7)

Alloy	7049-T73	
Form	Forgings	
Sample Thickness or Dimensions, inch	Visual Rating(a)	
	EXCO(b)	Salt Spray(c)
Die Forgings		
≤1.000	P	–
≤1.000	P (T/2)	–
1.001 to 2.000	P	E-A
	E-A(T/2)	–
2.001 to 3.000	P	–
	P	–
1.001 to 2.000	P	–
2.001 to 3.000	P	–
4.001 to 5.000	P	–
Hand Forgings		
2 x 16	P	P
3 x 16	E-A	–
4 x 16	P	–
5 x 20	E-B	E-A

Note: All test specimens were located within 10 percent of the product thickness, except those noted to be T/2, mid-thickness.

(a) ASTM Method G34-72: P = pitting, and E = exfoliation; severity is denoted by the letter A, B, or C in increasing severity.

(b) Total immersion in 4N. NaCl + 0.5N. KNO_3 + 0.1N. HNO_3 solution for 48 hours.

(c) Total immersion in acidified salt solution for 1 week.

TABLE 2.0311. RESULTS OF ACCELERATED EXFOLIATION TESTS ON 7049-T73 FORGINGS (13)

Alloy	7049-T73		
Form	4.5-inch diam Die Forging		
Test	Stress Corrosion[a]		
Specimen	Battelle Type[b]		
Forging Number	Grain Direction	Stress, ksi	Days to Failure
1	ST	55	NF[c]
2	ST	55	NF
3	ST	55	NF
1	ST	45	NF
2	ST	45	NF
3	ST	45	NF
1	ST	35	NF
2	ST	35	NF
2	ST	35	NF

(a) Industrial atmosphere in Renton, Washington.
(b) Battelle tuning-fork type specimen – chromic acid anodized to minimize general corrosion.
(c) NF – no failure in 90 days.

TABLE 2.0321. STRESS CORROSION DATA FROM TESTS IN INDUSTRIAL ATMOSPHERE (3)

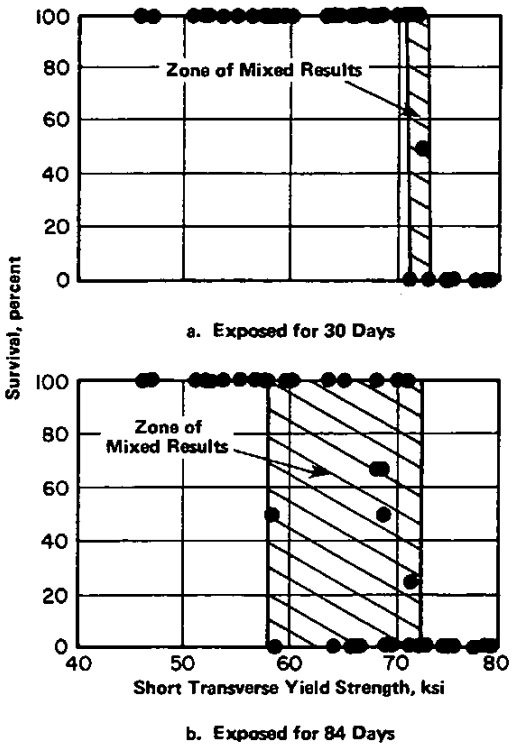


FIGURE 2.0323. PERCENT SURVIVAL OF 7049-T7X DIE FORGINGS VERSUS ST YIELD STRENGTH WHEN EXPOSED TO ALTERNATE IMMERSION AFTER 30 DAYS AND AFTER 84 DAYS (24)

Alloy	7049-T73			
Form	Forgings			
Test	Stress Corrosion[a]			
Sustained Stress,[a] ksi	Exposure Days[b]	F_{tu}, ksi (Residual)	F_{tu} (R)[c] / F_{tu}(O)	e, percent (Residual)
45	84 NF	69.7	0.90	3.3
45	84 NF	63.4	0.82	2.8
45	84 NF	65.2	0.85	2.2
45	84 NF	54.1	0.70	0.6
45	84 NF	64.9	0.84	1.9
40	84 NF	65.7	0.85	1.9
40	84 NF	65.8	0.85	0.0
40	84 NF	68.8	0.89	1.5

Note: Axial (constant load).

(a) Alternate immersion in substitute ocean water per ASTM D1141-52. Solution pH between 7.8 and 8.2. Cycle consisted of 10 minutes immersion and 50 minutes air dry each hour for 84 days or until failure.
(b) NF = No failure.
(c) Ratio of ultimate strength: R = Residual and O = Original.

TABLE 2.0322. STRESS CORROSION DATA FROM ALTERNATE IMMERSION TESTS IN ARTIFICIAL SEAWATER (4)

Alloy	7049-T73			
Form	3 x 4 x 48-inch Forged Block			
Direction	K_{Ic}, ksi$\sqrt{in.}$	Environment[a]	$\frac{K_{Iscc}}{K_{Ic}}$, percent	K_{Iscc}, ksi$\sqrt{in.}$
LT	38	STW	55	21.0
		SCS	73	27.6
		FCS	>75	>28.5
TL	23	STW	87	20.0
SL	23	STW	80	18.5

(a) STW (sump tank water) – see Code 3221, Table 2.0335, SCS (shop cleaning solvent) – aliphatic naphtha, and FCS (field cleaning solvent) – trisodium phosphate.
(b) Fatigue crack specimens treated in laboratory air.

TABLE 2.0324. ESTIMATES OF K_{Iscc} VALUES FOR 7049-T73 FORGING IN VARIOUS MEDIA (14)

Al
7.6 Zn
2.5 Mg
1.5 Cu
0.15 Cr

7049

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T7351				
Form	Plate				
Type of Tests	Constant Load				
Test Direction	LT	SL	SL		
Plate Thickness, inch	Yield Strength, ksi	K_{Ic}, ksi$\sqrt{in.}$	K_{Iscc}, ksi$\sqrt{in.}$(a)		
			Synthetic Seawater(b)	Salt-Chromate Solution(c)	Daytona Beach
3.0	65.1	25.1	23.2 (23.0)(d)	<23.2 (22.0)	– –
1.25	67.0	25.3	20.0 (21.5)	13.2 (<16.0)	19.1 (23.0)

(a) Stress intensity at which crack-growth rate decreased to 1 x 10^{-5} in./hr.
(b) Alternate immersion, 10 minutes in solution plus 50 minutes in air.
(c) Constant immersion in 0.6 M. NaCl + 0.02 M. $Na_2Cr_2O_7$ + 0.07 M. $NaC_2H_3O_2$ + $HC_2H_3O_2$ to pH = 4.
(d) Numbers in parentheses are K_{Iscc} estimates based on specimens containing pop-in precracks and tested under constant deflection conditions.

TABLE 2.0325. K_{Iscc} ESTIMATES FOR 7049-T7351 PLATE IN VARIOUS MEDIA USING SAMPLES WITH FATIGUE CRACKS (7)

Alloy	7049-T7351						
Form	Plate						
Plate Thickness, inch	LT Yield Strength, ksi	SL K_{Iscc}, ksi$\sqrt{in.}$(a)			TL K_{Iscc}, ksi$\sqrt{in.}$(a)		
		Daytona Beach	Synthetic Seawater(b)	Salt-Chromate Solution(c)	Daytona Beach	Synthetic Seawater(b)	Salt-Chromate Solution(c)
1.25	67	23	21.4	<15.9	26.8	26.4	26.4
3.00	65	23	23.0	21.8	26.4	25.9	>26.8

(a) Stress intensity at which crack-growth rate decreased to 1 x 10^{-5} in./hr.
(b) Alternate immersion, 10 minutes in solution plus 50 minutes in air.
(c) Constant immersion in 0.6 M. NaCl + 0.02 M. $Na_2Cr_2O_7$ + 0.07 M. $NaC_2H_3O_2$ + $HC_2H_3O_2$ to pH = 4.

TABLE 2.0326. K_{Iscc} ESTIMATES FOR BOLT-LOADED DCB SPECIMENS OF 7049-T7351 PLATE HAVING POP-IN PRECRACKS AND TESTED UNDER CONSTANT DEFLECTION CONDITIONS (7, 21)

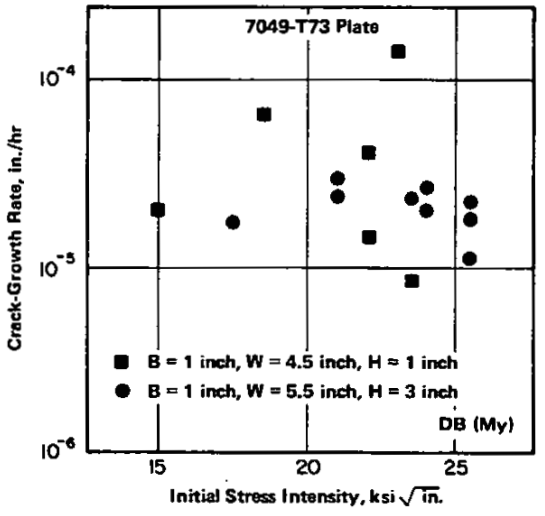


FIGURE 2.0327. CRACK-GROWTH RATE VERSUS INITIAL STRESS INTENSITY FOR 7049-T73 PLATE SPECIMENS EXPOSED AT DAYTONA BEACH (7)

Al	
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T7351					
Form	Plate					
Yield Strength(a), ksi	K_{Ic}, ksi$\sqrt{in.}$	Exposure Time, days	Stress Intensity,(b) ksi$\sqrt{in.}$	Crack Extension, inch	Average Crack Velocity, 10^{-8} in./sec	Measured Range of Velocity, 10^{-8} in./sec
Synthetic Seawater(c)						
65.1	25.1	61 90	24.6 to 25.1 23.3 to 23.7	0.0315 0.0197	0.59 0.24	0.51 to 0.55 0.16 to 0.59
Salt-Chromate Solution(d)						
65.1	25.1	90 67	24.5 to 27.1 22.4 to 24.2	0.150 0.098	1.93 1.69	0.98 to 1.65 0.67 to 1.81

(a) Test direction for yield strength only was LT.
(b) Initial applied stress intensity.
(c) Alternate immersion, 10 minutes in solution plus 50 minutes in air.
(d) See Table 2.0326.

TABLE 2.0328. CRACK GROWTH IN FATIGUE PRECRACKED DCB SPECIMENS FROM 3-INCH 7049-T7351 PLATE IN SL ORIENTATION UNDER A CONSTANT LOAD (7)

Alloy	7049-T7351							
Form	3-inch Plate							
Stress, percent F_{ty}(b)	Failure Ratio(a)							
	Kennedy Space Center Seacoast			Alternate Immersion in Salt Water(c)			Alternate Immersion in Seawater(c)	
	12 mo	24 mo	38 mo	0.3 mo	0.7 mo	3 mo	1 mo	3 mo
75	0/8	0/8	3/8	0/3	0/3	2/3	0/3	0/3
100	0/8	5/8	7/8	0/3	0/3	3/3	0/3	0/3

(a) Number of specimens failed/number of specimens exposed.
(b) Smooth round ST axial stress specimens.
(c) Ten minutes in solution plus 50 minutes in air.

TABLE 2.0329. COMPARISON OF SCC RESULTS FOR 7049-T7351 PLATE BASED ON SELECTED EXPOSURE PERIODS IN SEVERAL TEST MEDIA (22)

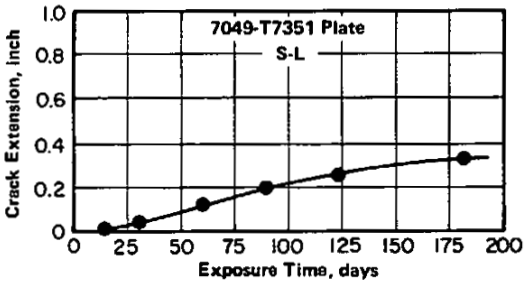


FIGURE 2.0330. CRACK GROWTH IN FATIGUE PRE-CRACKED 1.25-INCH 7049-T73 TEMPER PLATES EXPOSED TO SALT-CHROMATE SOLUTION (7)

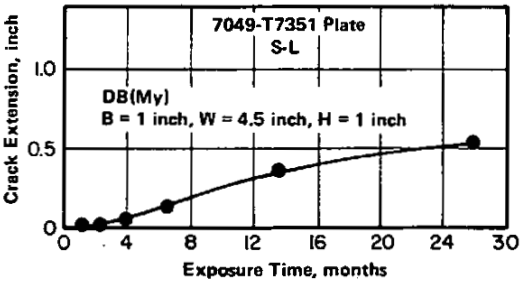


FIGURE 2.0331. CRACK GROWTH IN DCB SPECIMENS WITH POP-IN PRECRACK FROM T73 TEMPER PLATES EXPOSED AT DAYTONA BEACH (21)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

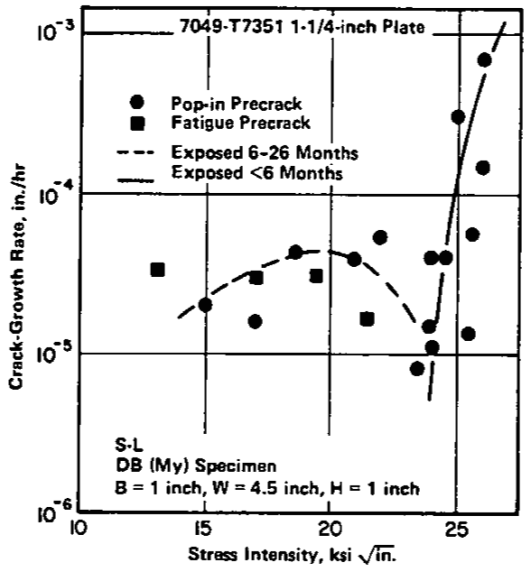


FIGURE 2.0332. CRACK VELOCITY VERSUS STRESS INTENSITY PLOT FOR 7049-T7351 PLATE AT DAYTONA BEACH (21)

Alloy	7049-T73					
Form	Die Forgings[a]					
	F_{tu}, ksi (Min)		F_{ty}, ksi (Min)		e, percent[b] (Min)	
Thickness, inch	A	B	A	B	A	B
Up thru 1.000	72.0	71.0	62.0	61.0	7	3
1.001 to 2.000	72.0	70.0	62.0	60.0	7	3
2.001 to 3.000	71.0	70.0	61.0	60.0	7	3
3.001 to 4.000	71.0	70.0	61.0	60.0	7	2
4.001 to 5.000	70.0	68.0	60.0	58.0	7	2

(a) A -- parallel to grain flow and B – not parallel to grain flow.
(b) 2 inch or 4D gage length.

TABLE 3.011. ALUMINUM ASSOCIATION MECHANICAL PROPERTY LIMITS FOR T73 DIE FORGINGS (9)

Alloy		7049-T73							
Form		Die Forgings[a]					Hand Forgings		
Thickness, inch		≤1.000	1.001 to 2.000	2.001 to 3.000	3.001 to 4.000	4.001 to 5.000	2.001 to 3.000	3.001 to 4.000	4.001 to 5.000
F_{tu}, ksi (Min)	L	72	72	71	71	70	71	69	67
	T	–	–	–	–	–	71	69	67
	ST	71	70	70	70	68	69	67	66
F_{ty}, ksi (Min)	L	62	62	61	61	60	61	59	56
	T	–	–	–	–	–	59	57	56
	ST	61	60	60	60	58	58	56	55
F_{cy}, ksi (Min)	L	64	64	63	63	62	61	59	57
	T	–	–	–	–	–	60	58	56
	ST	58	58	59	57	56	62	60	59
F_{su}, ksi (Min)		40	40	40	40	39	40	39	38
e, percent (Min)	L	7	7	7	7	7	9	8	7
	T	–	–	–	–	–	4	3	3
	ST	3	3	3	2	2	3	2	2

(a) For die forgings, the L and ST values are for the directions parallel (within ± 15 degrees) and not parallel (as close as possible to ST direction) respectively, to the forging flow lines.

TABLE 3.012. DESIGN MECHANICAL PROPERTIES FOR DIE FORGINGS AND HAND FORGINGS (1)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T7351								
Form	Plate								
Thickness, inch	Source	F_{tu}, ksi			F_{ty}, ksi			e, percent		
		L	LT	ST	L	LT	ST	L	LT	ST
3.00	(6)	75.5	74.6	–	66.5	64.7	–	13.0	10.7	–
3.00	(7)	75.1	76.2	72.5	65.5	65.3	60.4	12.0	9.8	5.0
1.25	(7)	77.5	75.5	71.9	67.6	67.0	63.3	12.3	11.0	4.0
1.50 (1 lot)	(17)	79.4	76.7	75.8	70.3	67.4	63.3	12.5	11.5	8.0
2.00 (2 lots)	(17)	77.3	77.6	76.0	68.6	68.3	64.0	12.7	10.4	7.7
2.50 (1 lot)	(17)	74.2	74.9	71.5	63.7	64.0	59.3	12.5	10.5	7.0
3.50 (2 lots)	(17)	73.9	74.0	71.6	64.0	62.8	59.2	12.5	10.6	5.5
3.75 (1 lot)	(17)	76.9	77.4	75.1	69.1	67.1	63.8	13.0	10.0	6.4
4.00 (1 lot)	(17)	75.3	75.4	70.0	65.9	64.5	58.5	11.0	11.5	6.0
4.25 (2 lots)	(17)	71.4	71.6	68.4	60.7	59.7	56.8	11.9	11.0	4.5

TABLE 3.0211. TENSILE PROPERTIES OF 7049-T7351 PLATE FROM 1.25-INCH TO 4.25-INCH THICKNESS (6, 7, 17)

Alloy	7049-T73						
Form	Hand Forgings						
			Tensile				
Source	Size or Thickness, inch	Direction	F_{tu}, ksi	F_{ty},(a) ksi	e (in 4D), percent	RA, percent
(13)	2 x 16	L	76.4	68.8	11.0	30
		LT	75.1	67.0	10.5	24
		ST	70.6	62.4	3.1	4
(13)	3 x 16	L	74.2	65.4	13.0	34
		LT	75.2	66.2	11.5	27
		ST	72.2	62.3	7.5	12
(13)	11 x 16	L	80.0	72.8	12.5	31
		LT	76.4	68.5	9.5	17
		ST	75.5	67.5	7.9	16
(13)	5 x 20	L	70.3	60.1	13.5	31
		LT	68.4	58.1	12.0	23
		ST	68.1	59.1	6.0	6
(15)	3	L	73.8	64.6	13.2	–
		LT	76.8	68.7	10.8	–
		ST	73.8	67.4	8.0	–
(16)	5	L	72.9	64.2	8.8	–
		LT	74.9	66.5	11.0	–
		ST	70.9	61.9	6.0	–
(14)	3(b)	L	76	67.0	12.0	33
		LT	73	64.0	9.0	13
		ST	74	62.0	9.0	–

(a) The values at 0.2 percent offset.
(b) This 3-inch forging is T7352.

TABLE 3.0212. TENSILE PROPERTIES OF 7049-T73 HAND FORGINGS (13, 14, 15, 16)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T73					
Form	Die Forgings					
Forging Size	Direction	Source	F_{tu}, ksi	F_{ty}, ksi	e, percent	RA, percent
≤1.000 inch	L	(13)	81.3	74.5	13.5	32.0
	ST		71.9	61.8	10.0	22.0
1.001 to 2.000 inch (Avg 4 Lots)	L	(13)	78.9	72.0	12.7	30.0
	ST		75.6	67.9	8.4	10.0
	L(a)	(4)	77.5	69.1	11.5	25.6
	T(a)	(4)	71.7	61.8	8.9	17.1
	ST(b)	(4)	76.9	68.7	9.0	17.7
2.001 to 3.000 inch (Avg 3 Lots)	L	(13)	79.0	71.5	12.5	30.0
	ST	(13)	74.0	65.3	7.7	11.0
4.001 to 5.000 inch	L	(13)	76.5	65.7	12.5	26.0
	ST	(13)	73.3	65.5	2.9	4.0
24 lb	L	(14)	77.0	68.0	13.0	31.0
24 lb	ST	(14)	74.0	67.0	6.0	16.0
24 lb	L	(14)	88.0	74.0	12.0	–
24 lb	T	(14)	77.0	70.0	6.0	–
24 lb	ST	(14)	74.0	69.0	4.0	–

(a) L and T samples from 4.5-inch thick section.
(b) ST samples from 1.3-inch thick section.

TABLE 3.0213. TENSILE PROPERTIES OF 7049-T73 DIE FORGINGS (4, 13, 14)

Alloy	7049-T73511 and -T76511									
Form	1.5 x 4.5-inch(a) Extruded Rectangles									
				T73511 (11)(b)				T76511 (12)			
Chemical Purity	Si, percent	Fe, percent	Direction	F_{tu}, ksi	F_{ty}, ksi	e, percent	RA, percent	F_{tu}, ksi	F_{ty}, ksi	e, percent	RA, percent
High(c)	0.08	0.09	L	83.9	76.7	13.3	35.6	83.3	74.6	12	31
			T	78.5	70.3	12.5	26.8	78.2	69.6	9	14
			ST	74.8	65.3	8.0	11.7	77.6	64.9	10	11
Medium	0.11	0.20	L	82.5	75.4	12.4	29.8	83.7	74.1	11	26
			T	76.5	69.2	10.5	18.2	79.8	71.4	11	17
			ST(d)	54.1	38.4	11.3	14.7	75.9	66.6	8	10
Low	0.16	0.37	L	80.0	73.1	11.6	27.1	81.7	73.3	10	22
			T	75.7	68.6	9.0	11.6	74.9	67.8	7	10
			ST	69.2	62.3	5.0	5.0	73.9	64.9	8	9

(a) Average of two or three specimens.
(b) Electrical conductivity (percent IACS): high–40.3; medium–40.5; and low–40.1.
(c) Equivalent of 7149.
(d) Anomalous T7351 result recognized, no explanation found.

TABLE 3.0214. TENSILE PROPERTIES OF 7049-T73511 AND -T76511 EXTRUSIONS OF DIFFERENT CHEMICAL IMPURITIES (11, 12)

Alloy	7049-T76					
Form	Extrusions					
	4 x 4 inch (18)			3-1/4 x 3-1/2 inch (10)		
Direction	L	T	ST	L	T	ST
F_{tu}, ksi	83.4	76.2	76.3	82.7	76.7	75.1
F_{ty}, ksi	75.9	67.4	67.7	75.5	68.6	65.8
e, percent	12.7	11.2	11.7	11.6	11.3	8.3
RA, percent	35.6	23.3	22.6	31.0	29.0	18.0
Modulus, 1000 ksi	10.7	9.9	10.4	–	–	–
F_{cy}, ksi	78.8	74.7	–	–	–	–
Compression Modulus, 1000 ksi	10.9	10.5	–	–	–	–
F_{su}, ksi	45.4	42.8	–	–	–	–
Charpy-V, ft-lbs	5.8	1.3	–	–	–	–

TABLE 3.0215. TENSILE AND OTHER MECHANICAL PROPERTIES OF 7049-T76 EXTRUSIONS (10, 18)

Alloy	7049-T73						
Form	Die Forgings						
Thickness Range, inch	Direction	F_{cy}, ksi	F_{su}, ksi	F_{bru}, ksi e/D=1.5	F_{bru}, ksi e/D=2.0	F_{bry}, ksi e/D=1.5	F_{bry}, ksi e/D=2.0
≤1.000	L	75.5	45.1	114.9	148.0	92.7	114.2
	ST	65.5	43.9	–	–	–	–
1.001 to 2.000	L	76.8	47.4	115.0	155.6	98.1	119.7
	ST	71.4	46.8	–	–	–	–
2.001 to 3.000	L	75.4	45.9	118.6	147.7	99.2	113.5
	ST	67.9	44.6	–	–	–	–
4.001 to 5.000	L	70.1	44.8	110.6	138.8	97.0	113.8
	ST	68.3	44.1	–	–	–	–

TABLE 3.0216. COMPRESSION, SHEAR, AND BEARING PROPERTIES OF 7049-T73 DIE FORGINGS (13)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T73						
Form	Hand Forgings						
Size, inch	Direction	F_{cy}, ksi	F_{su}, ksi	F_{bru}, ksi e/D=1.5	F_{bru}, ksi e/D=2.0	F_{bry}, ksi e/D=1.5	F_{bry}, ksi e/D=2.0
2 x 16	L	75.5	45.3	103.1	133.8	95.1	108.0
	LT	70.2	45.7	106.4	137.7	100.3	113.4
	ST	71.9	43.5	–	–	–	–
3 x 16	L	66.5	44.8	118.0	153.0	101.4	118.2
	LT	67.0	42.3	107.0	139.1	88.2	105.8
	ST	65.4	43.2	–	–	–	–
4 x 16	L	66.5	44.8	108.5	150.0	91.8	116.3
	LT	69.8	43.6	112.2	145.8	98.4	118.8
	ST	73.4	44.2	–	–	–	–
5 x 20	L	62.6	42.6	98.1	139.9	86.2	107.5
	LT	62.1	40.7	100.3	126.8	86.4	105.5
	ST	61.3	41.2	–	–	–	–

TABLE 3.0217. COMPRESSION, SHEAR, AND BEARING PROPERTIES OF 7049-T73 HAND FORGINGS (13)

Alloy	7049-T7351						
Form	Plate						
Thickness, inch	Source	No of Tests	F_{cy}, ksi L	F_{cy}, ksi T	F_{cy}, ksi ST	F_{su}, ksi L	F_{su}, ksi T
1.50	(17)	1	72.5	73.9	75.9	42.9	41.8
2.00	(17)	2	71.3	75.8	75.5	45.2	44.7
2.50	(17)	1	65.0	70.3	70.3	43.8	44.0
3.50	(17)	1	65.0	69.9	72.2	43.3	43.2
3.75	(17)	1	64.4	69.6	68.4	43.7	43.4
4.00	(17)	1	65.5	68.4	68.9	44.1	43.4
4.25	(17)	2	61.4	66.0	66.9	42.8	42.4
3.00	(6)	3	64.1	69.2	–	46.1	45.4

TABLE 3.0218. COMPRESSION AND SHEAR PROPERTIES OF 7049-T7351 PLATE (6, 17)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

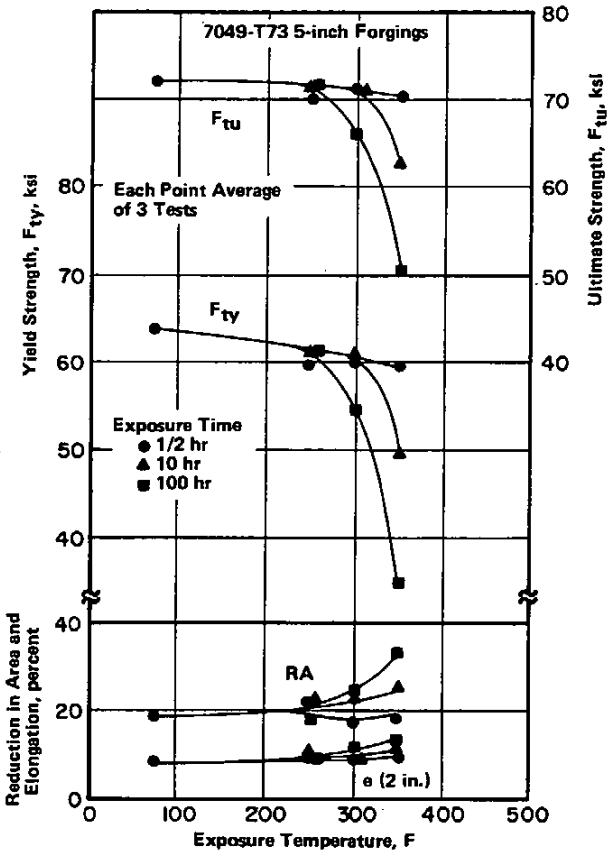


FIGURE 3.0219. EFFECT OF EXPOSURE AT ELEVATED TEMPERATURE ON ROOM TEMPERATURE TENSILE PROPERTIES OF FORGINGS (27)

Alloy	7049-T73511 and -T76511						
Form	Extrusion, 1.5 x 4.5 inch Rectangle						
				T73511		T76511	
Chemical Purity	Si, percent	Fe, percent	Direction	K_{Ic}, ksi$\sqrt{in.}$	F_{ty}, ksi	K_{Ic}, ksi$\sqrt{in.}$	F_{ty}, ksi
High[a]	0.08	0.09	LT	33.9	76.7	33.0	74.6
			TL	26.0	70.3	23.0	69.6
Medium	0.11	0.20	LT	29.7	75.4	29.0	74.1
			TL	22.1	69.2	21.0	71.4
Low	0.16	0.37	LT	23.8	73.1	23.0	73.3
			TL	18.1	68.6	17.0	67.8

(a) Equivalent of 7149 composition.

TABLE 3.027211. FRACTURE TOUGHNESS OF 7049-T73511 AND -T76511 EXTRUSIONS OF DIFFERENT PURITY LEVELS (11, 12)

Alloy	7049-T73 and -T76		
Form	Extrusions		
		K_{Ic}, ksi$\sqrt{in.}$ (Avg of Three Tests)		
Sample and Size, inch	Direction	Room Temp	0 F	-64 F
T73, Integrally Stiffened, 3 x 11-1/4 Section	LT	28.1	25.9	24.7
	TL	25.2	24.1	23.2
	ST	20.3	21.1	22.2(a)
T73, Bar, 3-1/4 x 3-1/2	LT	33.2	34.2	31.4
	TL	22.0	20.6	20.0
	ST	23.0	21.5	20.7(b)
T76, Bar, 3-1/4 x 3-1/2	LT	32.7	33.1	30.4
	TL	20.0	20.2	19.2(a)
	ST	20.9(a)	20.8	19.4

(a) Two tests only.
(b) One test only.

TABLE 3.027212. FRACTURE TOUGHNESS OF 7049-T73 AND -T76 EXTRUSIONS OF DIFFERENT DIMENSIONS (10)

Al
7.6 Zn
2.5 Mg
1.5 Cu
0.15 Cr

7049

Alloy	7049-T73			
Form	Forgings			
Size and Forging	Direction	K_{Ic} or K_Q, ksi$\sqrt{in.}$(a)	K_c, ksi$\sqrt{in.}$(b)	Test Specimen Thickness, inch
24 lb Die	LT	(26)	–	1.00
		28	–	1.00
24 lb Die	LT	(50)	–	1.50
		(37)	–	1.50
3 x 24 x 48-inch Hand	LT	(39), 39, 38	–	2.00
		(38), (37)	55, 51	1.25
	LT	(20), (26)	–	1.50
	SL	23	–	1.25
	LT	(39), (40)	83, 87	0.75

(a) K_Q values, which are invalid K_{Ic} data, are in parentheses.
(b) Plane stress K_c determined by 25 percent secant offset on ASTM E561 compact tension specimen.

TABLE 3.027221. FRACTURE TOUGHNESS OF DIE AND HAND FORGINGS OF 7049-T73 (14)

Alloy	7049-T73(a)				
Form	4.5-inch diam Die Forgings				
Orientation	Transverse to Grain Flow				
Tear Strength, ksi	Tear Strength / Yield Strength	Energy Required to Initiate / Propagate a Crack, in.-lb		Total Energy, in.-lb	Unit(b) Propagation Energy, in.-lb/in.^{2}
41.6	0.68	16.6	14.8	31.4	74.1

(a) Each value average of three tests; Kahn tear test specimen was employed.
(b) Unit propagation energy is a measurement of unstable crack growth. The higher values represent higher toughness.

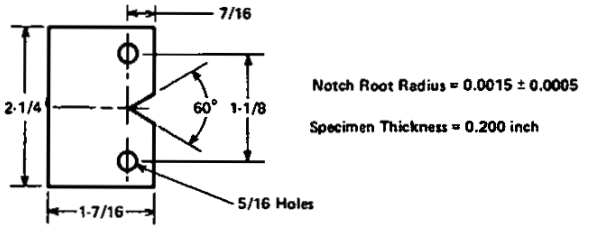


TABLE 3.027223. KAHN TEAR TEST DATA FOR DIE FORGINGS OF 7049-T73 (4)

Alloy	7049-T73	
Form	Hand Forgings	
Dimension, inch	Direction	K_{Ic}, ksi$\sqrt{in.}$(a) (or Meaningful K_Q per ASTM B645)
2 x 16	LT	27.2
	TL	18.9
	SL	16.6
3 x 16	LT	30.8
	TL	23.2
	SL	22.5
4 x 16	LT	32.8
	TL	21.0
	SL	20.8
5 x 20	LT	26.6
	TL	18.4(b)
	SL	19.8

(a) Average of two tests.
(b) One test only.

TABLE 3.027222. FRACTURE TOUGHNESS OF 7049-T73 HAND FORGINGS OF DIFFERENT DIMENSIONS (13)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

Alloy	7049-T7351			
Form	Plate			
Thickness, inch	Source	Fracture Toughness (K_{Ic}), ksi $\sqrt{in.}$		
		LT	TL	SL
1.25	(7)	35.8	28.4	25.3
1.50	(20)	39.7	31.2	–
2.50	(20)	40.6	33.9	28.2
3.00	(7)	30.1	24.7	25.1
3.00	(6)	34.0	28.1	–
4.00	(20)	43.2	32.4	30.2
4.25	(20)	40.2	35.9	31.3

TABLE 3.027231. FRACTURE TOUGHNESS OF 7049-T7351 ROLLED PLATE OF VARIOUS THICKNESSES (6, 7, 20)

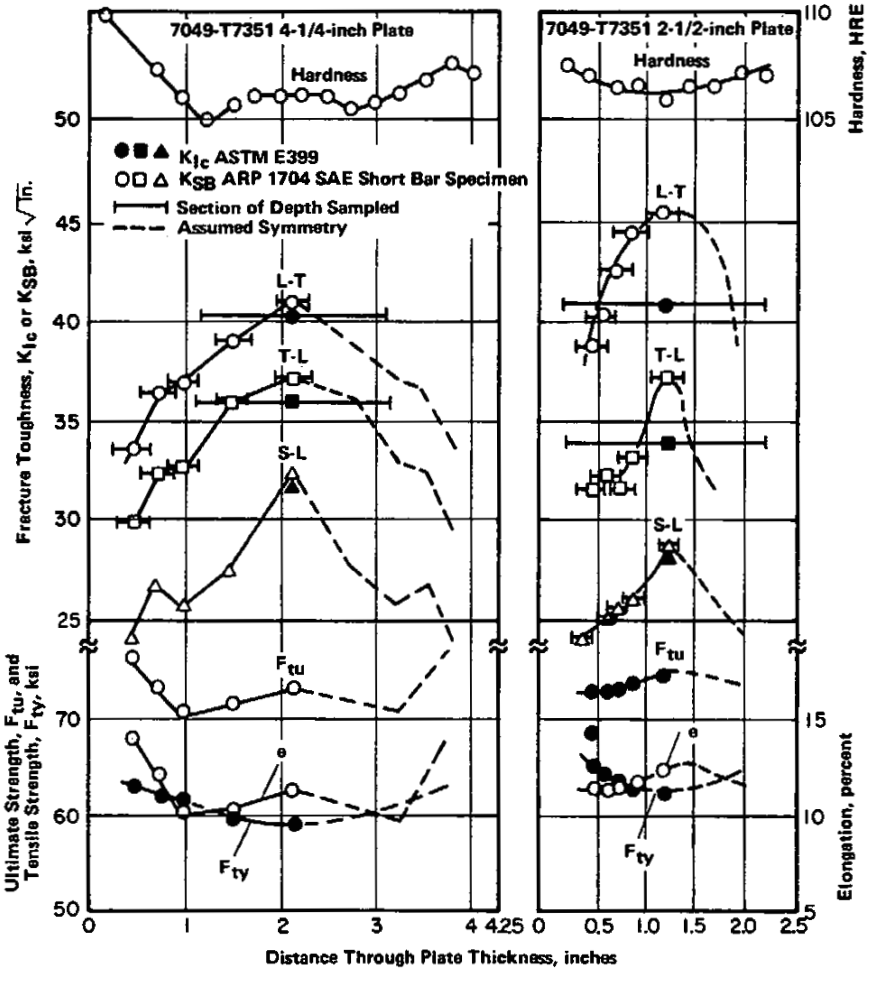


FIGURE 3.027232. VARIATION IN FRACTURE TOUGHNESS, HARDNESS, AND MECHANICAL PROPERTIES THROUGH THE THICKNESS OF 4.25-INCH AND 2.5-INCH THICK ROLLED 7049-T7351 PLATE (20)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

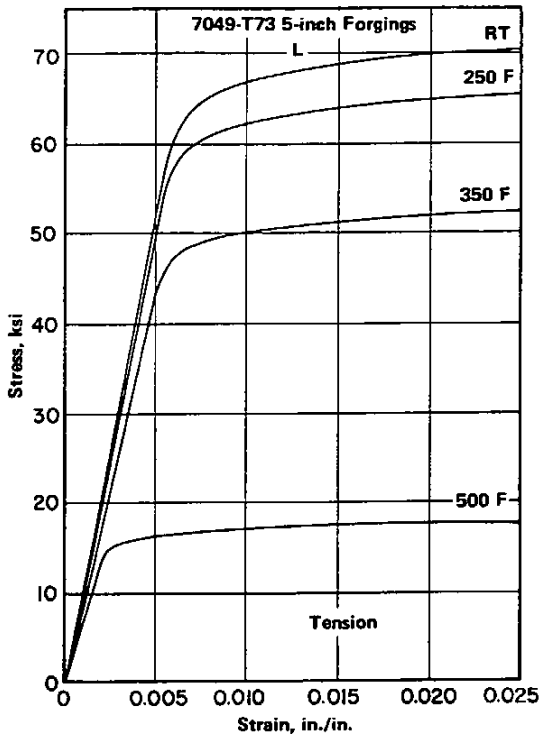


FIGURE 3.03111. TYPICAL LONGITUDINAL STRESS-STRAIN CURVES IN TENSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

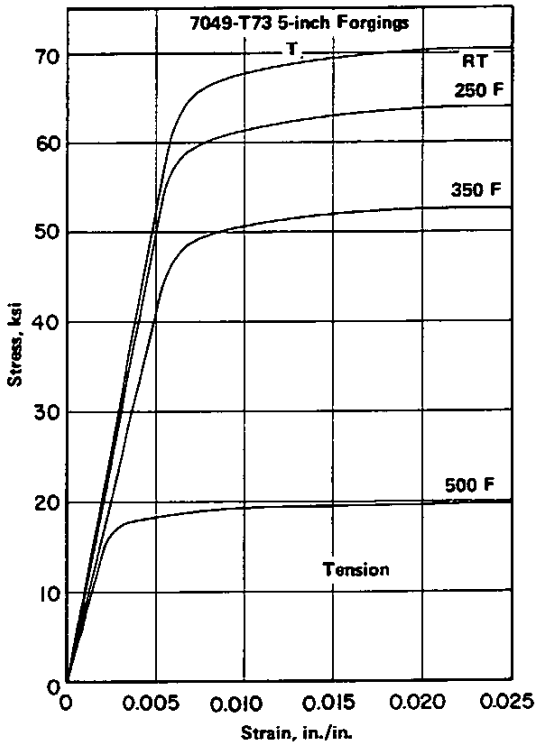


FIGURE 3.03112. TYPICAL TRANSVERSE STRESS-STRAIN CURVES IN TENSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

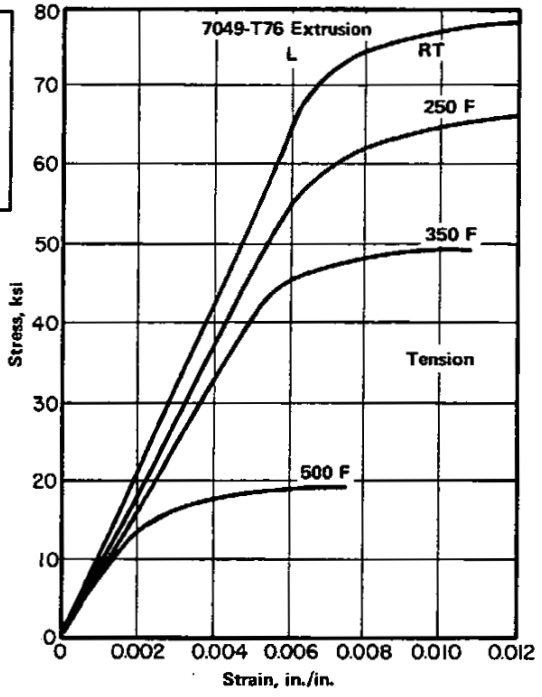


FIGURE 3.03113. TYPICAL TENSILE STRESS-STRAIN CURVES IN LONGITUDINAL DIRECTION FOR 7049-T76 EXTRUSIONS (18)

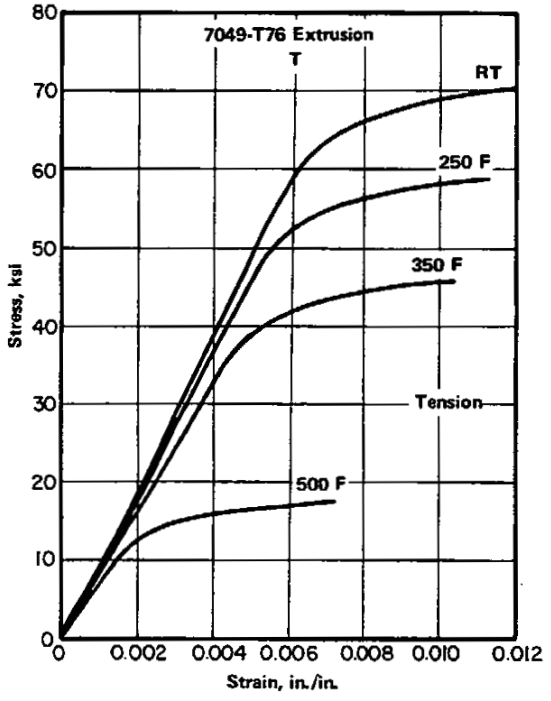


FIGURE 3.03114. TYPICAL TENSILE STRESS-STRAIN CURVES IN TRANSVERSE DIRECTION FOR 7049-T76 EXTRUSIONS (18)

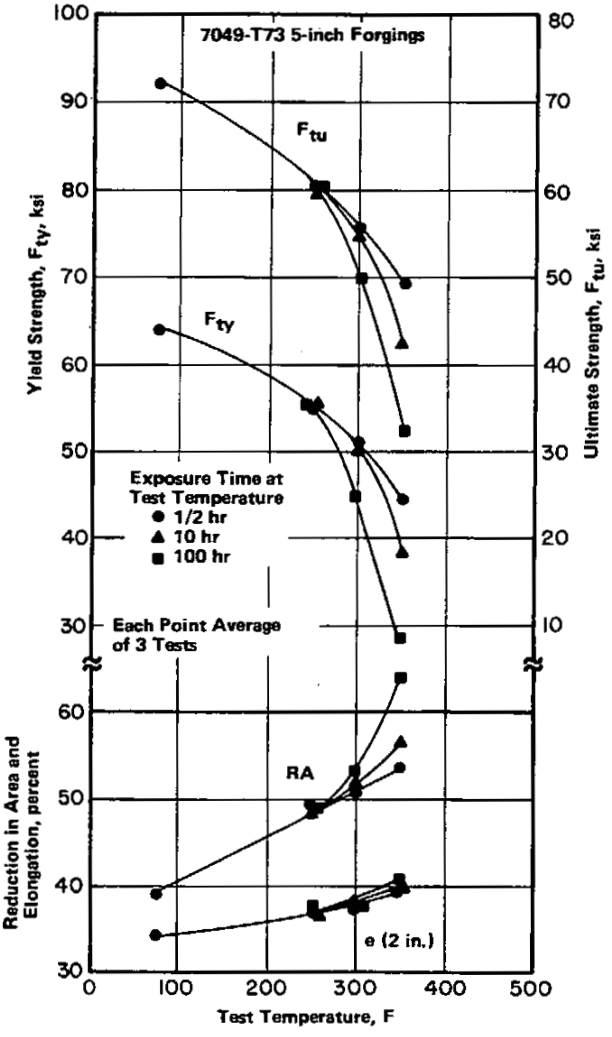


FIGURE 3.0312. EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF FORGINGS (27)

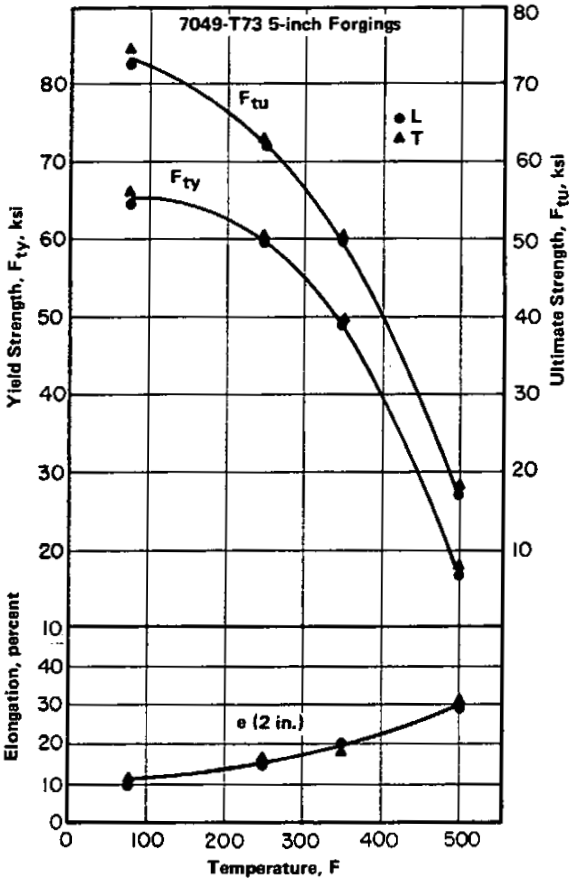
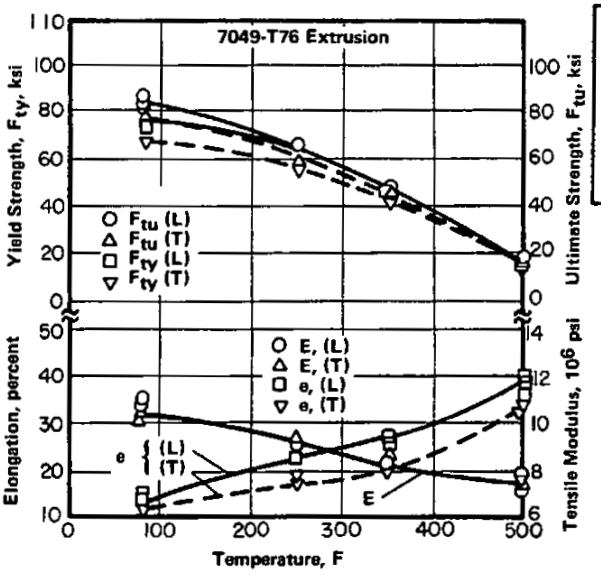


FIGURE 3.0313. EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF 5-INCH FORGINGS (8)



	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

FIGURE 3.0314. EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES AND TENSILE MODULUS OF 7049-T76 EXTRUSION (18)

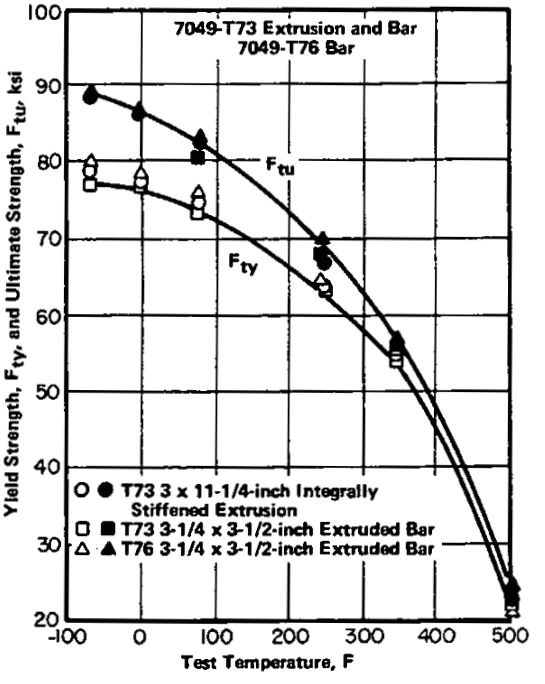


FIGURE 3.0315. TENSILE PROPERTY DATA FOR THE LONGITUDINAL DIRECTION FOR 7049-T73 BAR AND EXTRUSION AND 7049-T76 EXTRUDED BAR (10)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

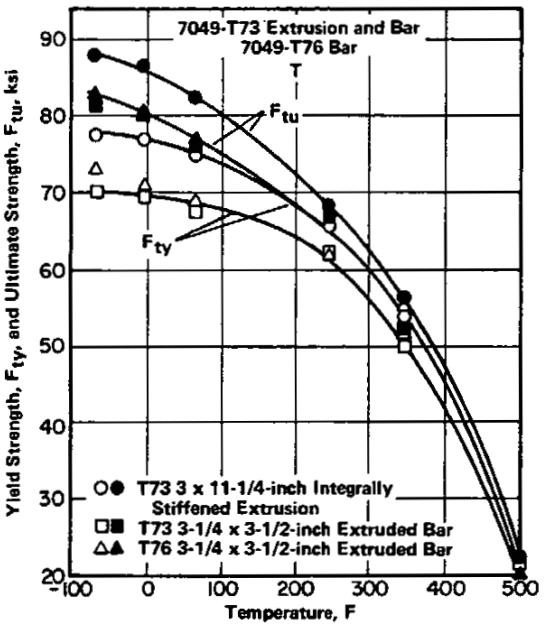


FIGURE 3.0316. TENSILE PROPERTY DATA FOR THE TRANSVERSE DIRECTION FOR 7049-T73 BAR AND EXTRUSION, AND 7049-T76 EXTRUDED BAR (10)

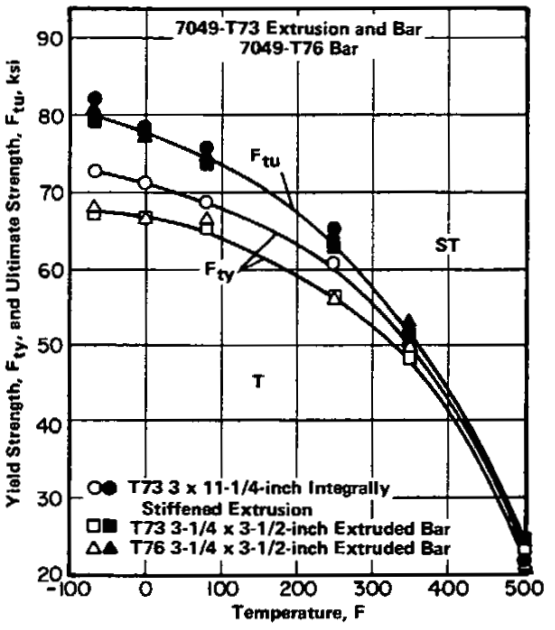


FIGURE 3.0317. TENSILE PROPERTY DATA IN THE SHORT TRANSVERSE DIRECTION FOR 7049-T73 BAR AND EXTRUSION, AND 7049-T76 EXTRUDED BAR (10)

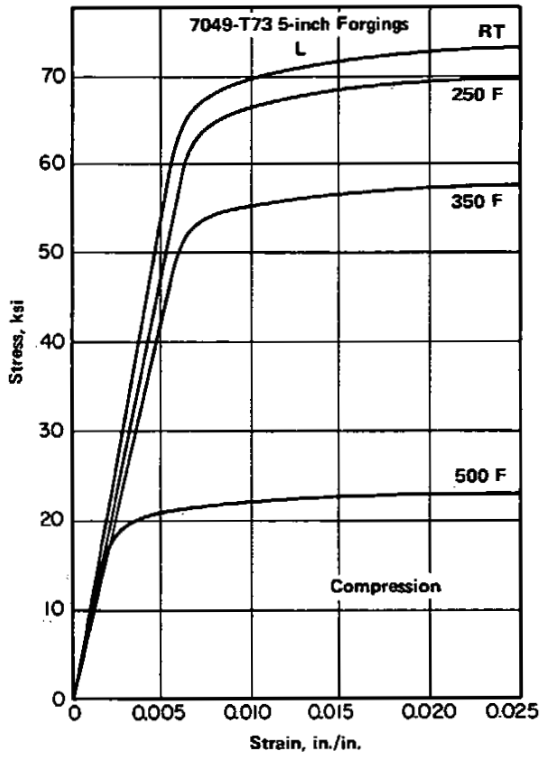


FIGURE 3.03211. TYPICAL LONGITUDINAL STRESS-STRAIN CURVES IN COMPRESSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

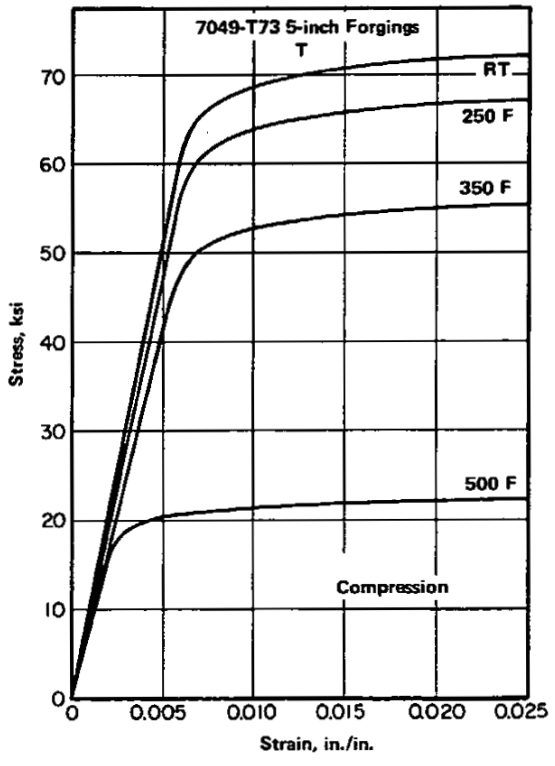


FIGURE 3.03212. TYPICAL TRANSVERSE STRESS-STRAIN CURVES IN COMPRESSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

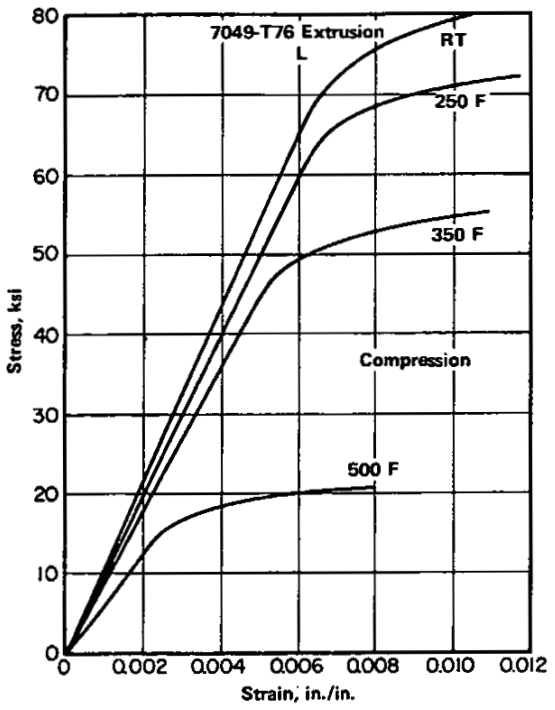


FIGURE 3.03213. TYPICAL LONGITUDINAL COMPRESSIVE STRESS-STRAIN CURVES FOR 7047-T76 EXTRUSION AT ROOM AND ELEVATED TEMPERATURES (18)

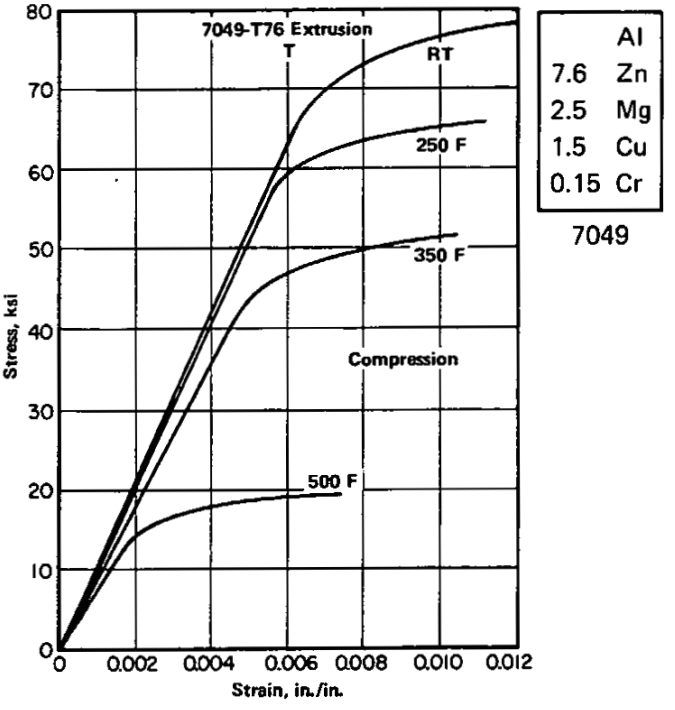


FIGURE 3.03214. TYPICAL TRANSVERSE COMPRESSIVE STRESS-STRAIN CURVES FOR 7049-T76 EXTRUSION AT ROOM AND ELEVATED TEMPERATURES (18)

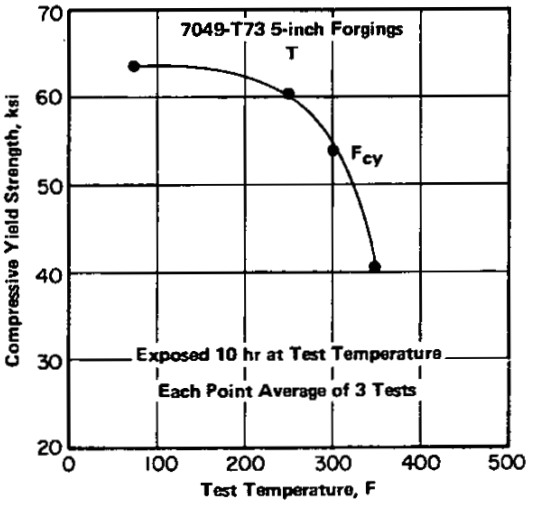


FIGURE 3.0322. EFFECT OF EXPOSURE AND TEST TEMPERATURE ON COMPRESSIVE YIELD STRENGTH OF 5-INCH FORGINGS (27)

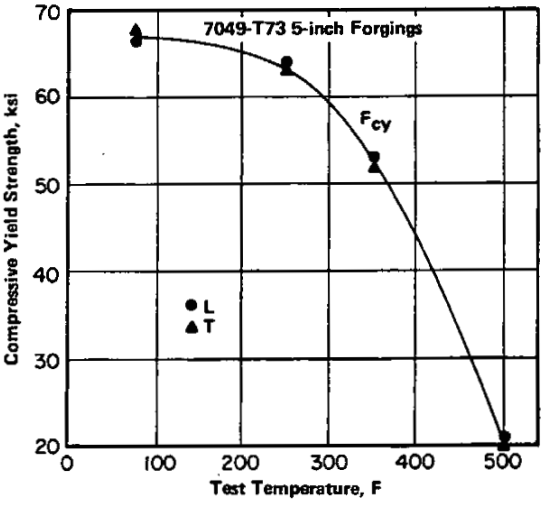


FIGURE 3.0323. EFFECT OF TEMPERATURE ON COMPRESSIVE YIELD STRENGTH OF 5-INCH FORGINGS (8)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

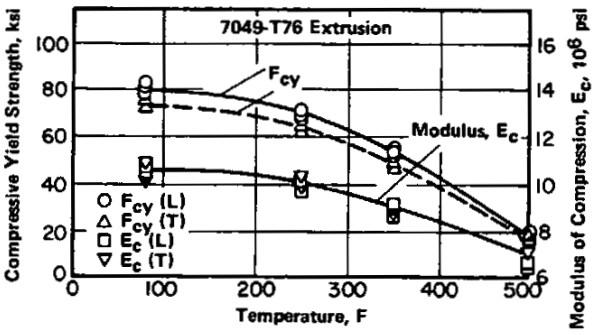


FIGURE 3.0324. EFFECT OF TEMPERATURE ON THE COMPRESSIVE PROPERTIES OF 7049-T76 EXTRUSION (18)

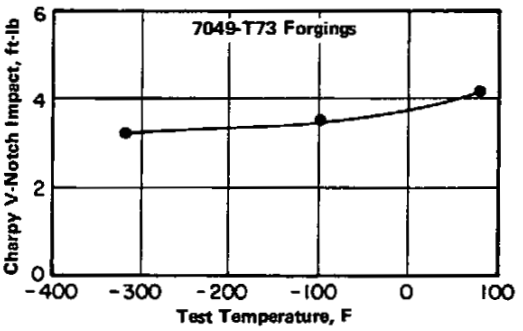


FIGURE 3.0331. EFFECT OF TEMPERATURE ON CHARPY V-NOTCH IMPACT ENERGY (8)

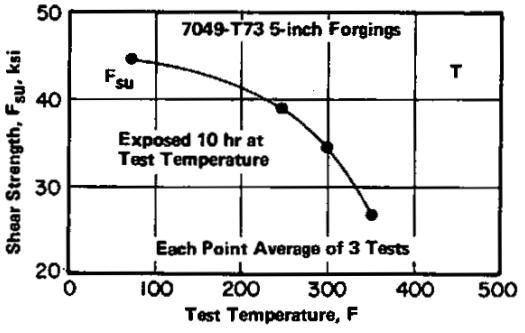


FIGURE 3.0351. EFFECT OF EXPOSURE AND TEST TEMPERATURE ON ULTIMATE SHEAR STRENGTH OF FORGINGS AS DETERMINED WITH DOUBLE SHEAR TEST SPECIMEN (27)

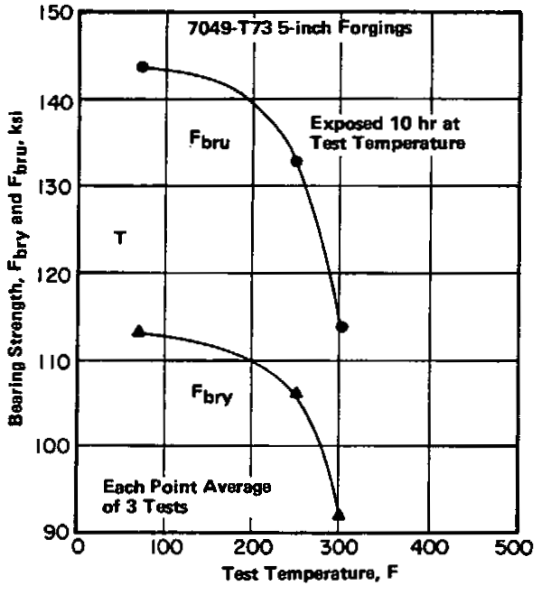


FIGURE 3.0361. EFFECT OF EXPOSURE AND TEST TEMPERATURE ON BEARING PROPERTIES OF 5-INCH FORGINGS (27)

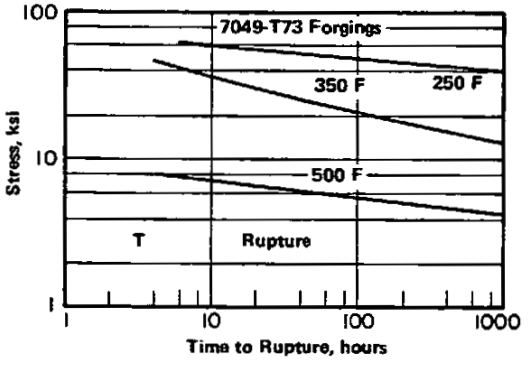


FIGURE 3.041. CREEP RUPTURE CURVES FOR 5-INCH FORGINGS AT 250, 350, AND 500 F (8)

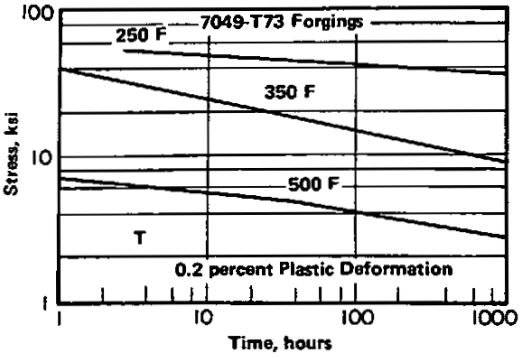


FIGURE 3.042. CREEP CURVES FOR 5-INCH FORGINGS SHOWING TIME FOR 0.2 PERCENT PLASTIC DEFORMATION (8)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

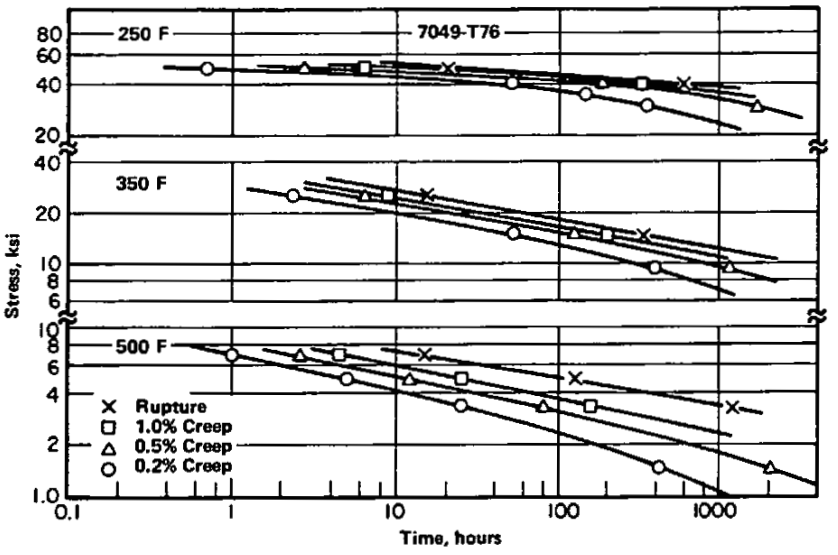


FIGURE 3.043. CREEP RUPTURE AND CREEP DEFORMATION IN TRANSVERSE DIRECTION FOR 7049-T76 EXTRUSIONS AT VARIOUS TEMPERATURES (18)

Alloy	7049-T73		
Form	5-inch Forgings		
Orientation	Transverse		
Test Temperature, F	RT	250	350
Test	Axial Fatigue Strength, ksi[a]		
Smooth, R = 0.1			
10^3 Cycles	73	71	70
10^5 Cycles	57	53	48
10^7 Cycles	46	40	38
Notched, R = 0.1 (K_t = 3.0)			
10^3 Cycles	50	50	50
10^5 Cycles	21	20	19
10^7 Cycles	16	13	11

(a) Stress for number of cycles indicated.

TABLE 3.051. FATIGUE DATA FOR SMOOTH AND NOTCHED SPECIMENS FROM FORGINGS AT ROOM AND ELEVATED TEMPERATURES (8)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

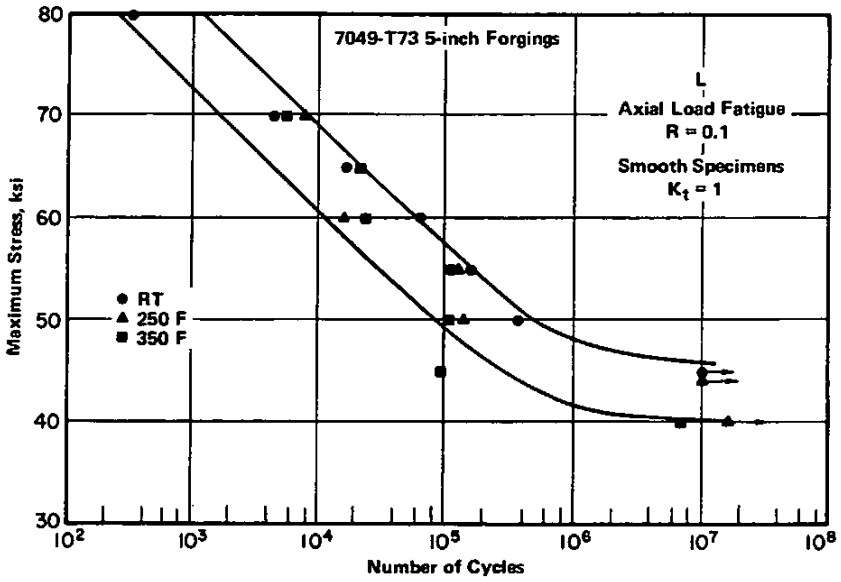


FIGURE 3.052. AXIAL LOAD FATIGUE CURVES AT ROOM AND ELEVATED TEMPERATURES (16)

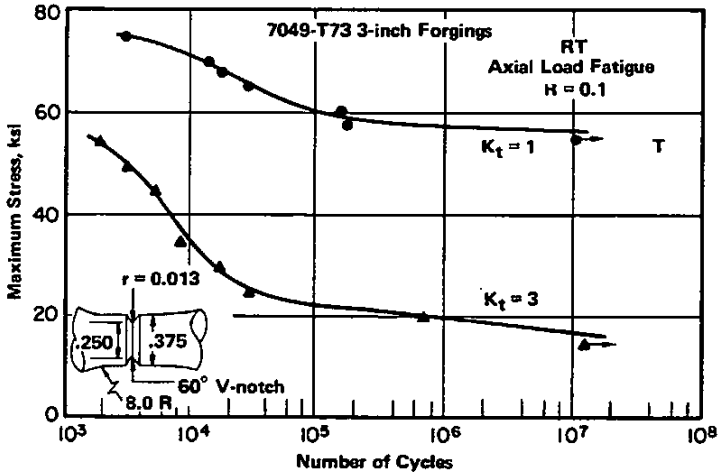


FIGURE 3.053. AXIAL LOAD FATIGUE CURVES FOR SMOOTH AND NOTCHED SPECIMENS FROM 3-INCH FORGINGS AT ROOM TEMPERATURE (15)

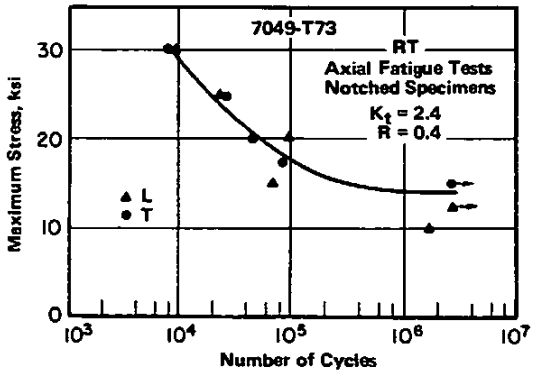


FIGURE 3.054. AXIAL LOAD FATIGUE CURVE FOR NOTCHED SPECIMENS FROM FORGINGS (4)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

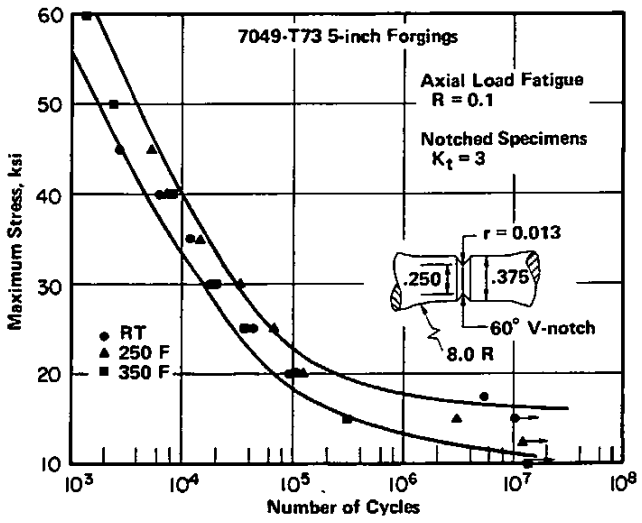


FIGURE 3.055. AXIAL LOAD FATIGUE CURVES FOR NOTCHED SPECIMENS AT ROOM AND ELEVATED TEMPERATURES (16)

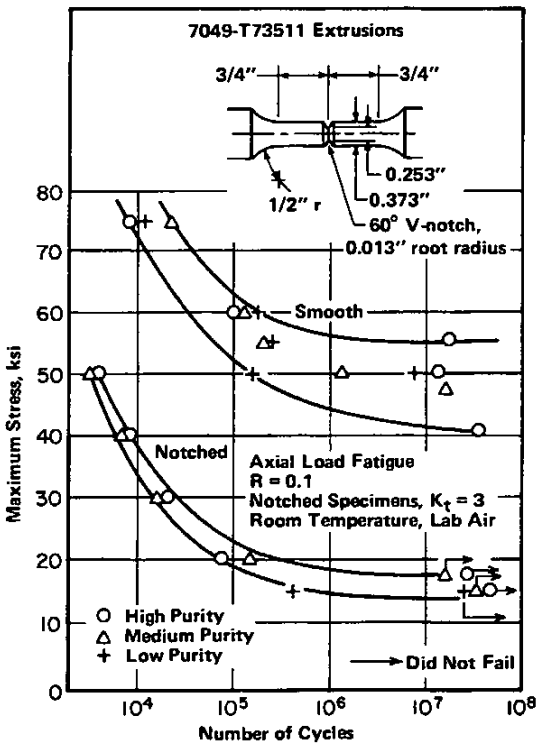


FIGURE 3.056. NOTCHED AND SMOOTH FATIGUE DATA FOR 7049-T73511 EXTRUSIONS OF DIFFERENT PURITIES (11)

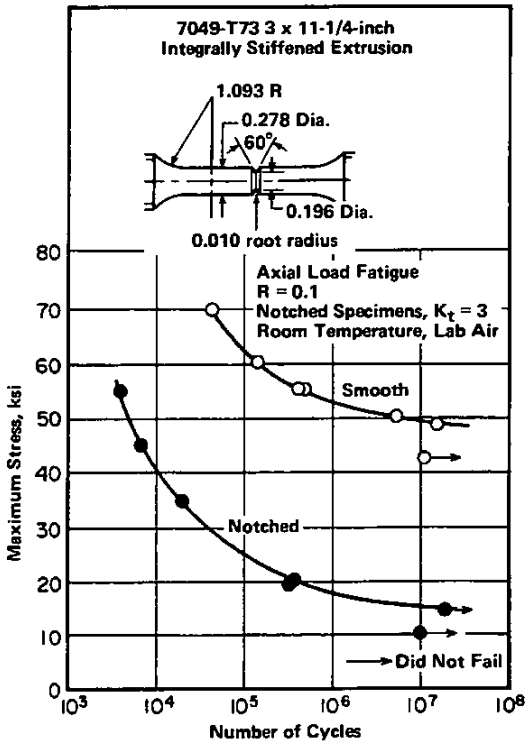


FIGURE 3.057. AXIAL STRESS FATIGUE DATA FOR NOTCHED AND SMOOTH 7049-T73 INTEGRALLY STIFFENED EXTRUSIONS (10)

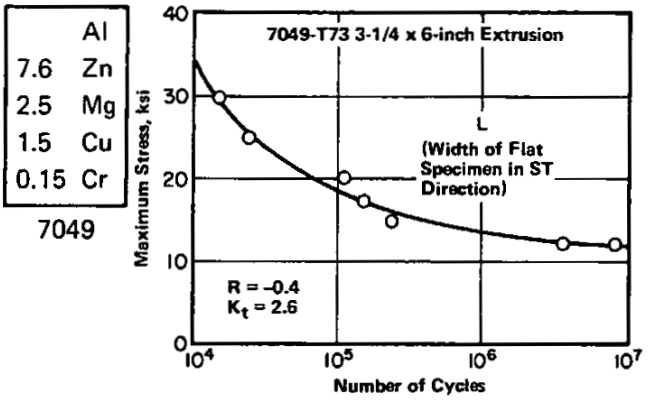


FIGURE 3.058. NOTCHED AXIAL STRESS FATIGUE DATA FOR A 7049-T73 EXTRUSION (19)

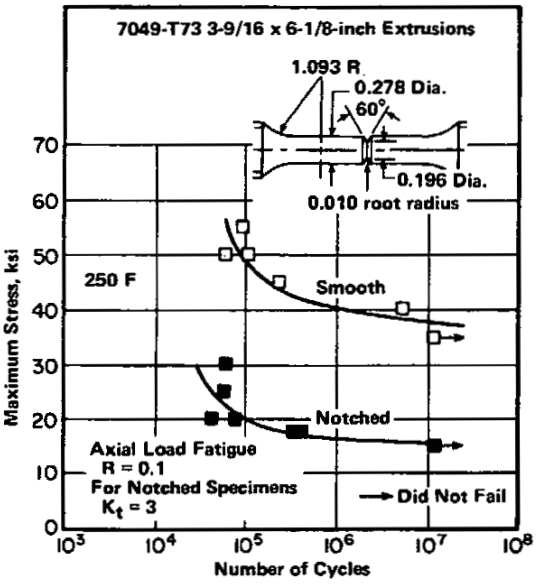


FIGURE 3.059. AXIAL STRESS FATIGUE DATA FOR SMOOTH AND NOTCHED 7049-T73 EXTRUSIONS AT 250 F (10)

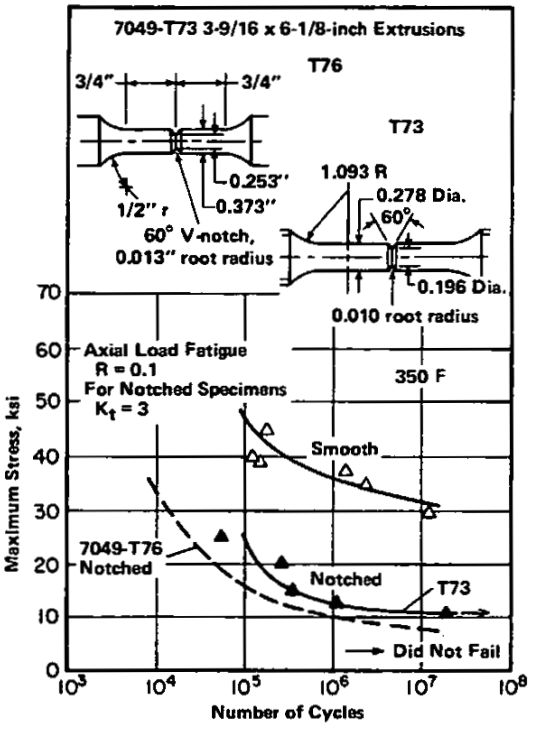


FIGURE 3.0510. NOTCHED AND SMOOTH AXIAL STRESS FATIGUE DATA FOR 7049-T73 AND T76 EXTRUSIONS AT 350 F (10,18)

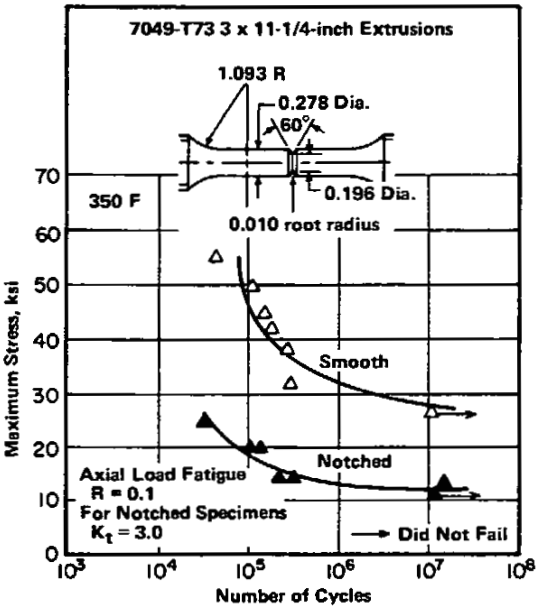


FIGURE 3.0511. AXIAL STRESS FATIGUE DATA FOR NOTCHED AND SMOOTH 7049-T73 INTEGRALLY STIFFENED EXTRUSIONS AT 350 F (10)

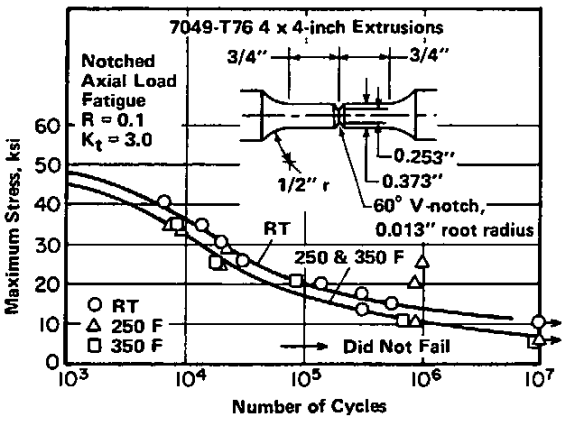


FIGURE 3.0512. NOTCHED AXIAL STRESS FATIGUE DATA FOR 7049-T76 EXTRUSIONS AT ROOM AND ELEVATED TEMPERATURES (18)

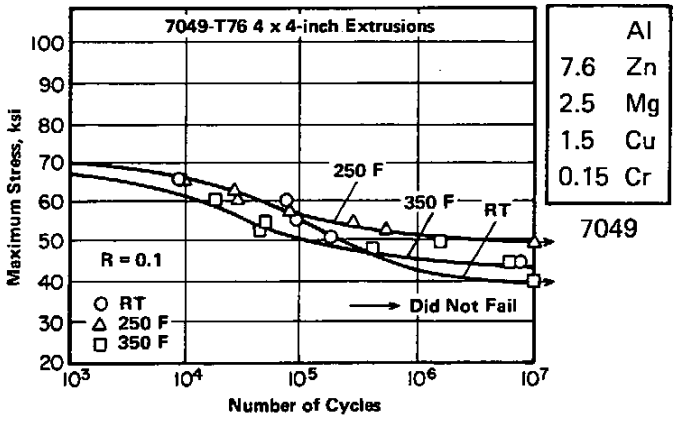


FIGURE 3.0513. SMOOTH AXIAL STRESS FATIGUE DATA FOR 7049-T76 EXTRUSIONS AT VARIOUS TEMPERATURES (18)

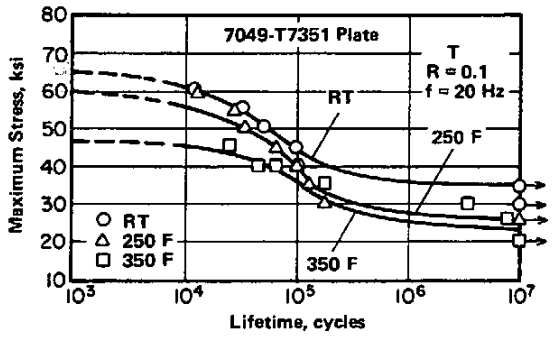


FIGURE 3.0514. UNNOTCHED AXIAL STRESS FATIGUE DATA IN THE TRANSVERSE DIRECTION FOR 7049-T7351 PLATE AT VARIOUS TEMPERATURES (18)

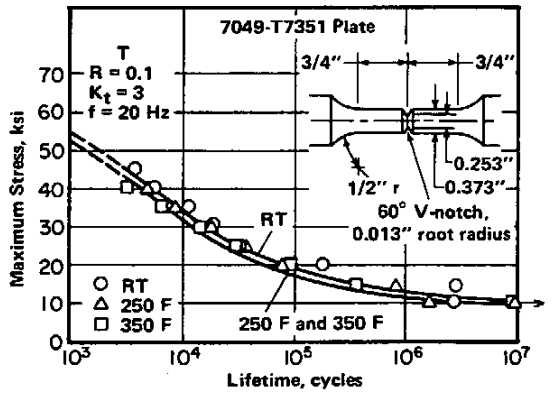


FIGURE 3.0515. NOTCHED AXIAL STRESS FATIGUE DATA FOR 7049-T7351 PLATE AT VARIOUS TEMPERATURES (18)

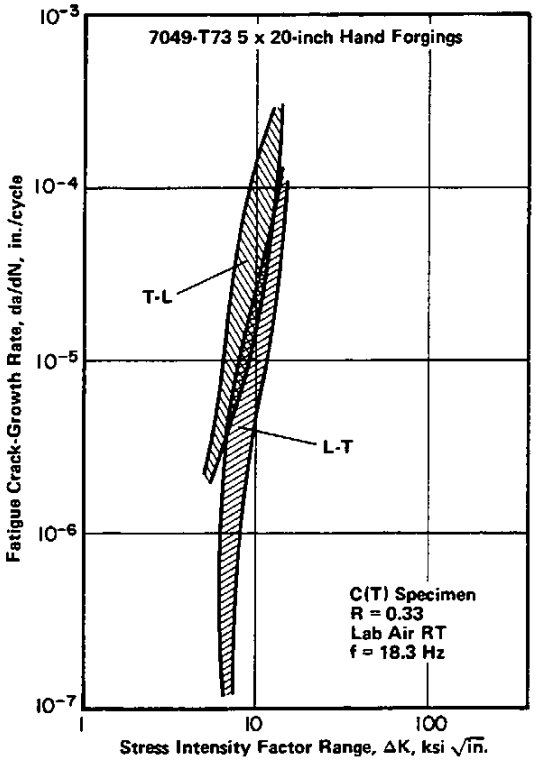


FIGURE 3.0516. FATIGUE CRACK-GROWTH DATA FOR 7049-T73 HAND FORGING IN DIFFERENT ENVIRONMENTS (13)

	Al
7.6	Zn
2.5	Mg
1.5	Cu
0.15	Cr

7049

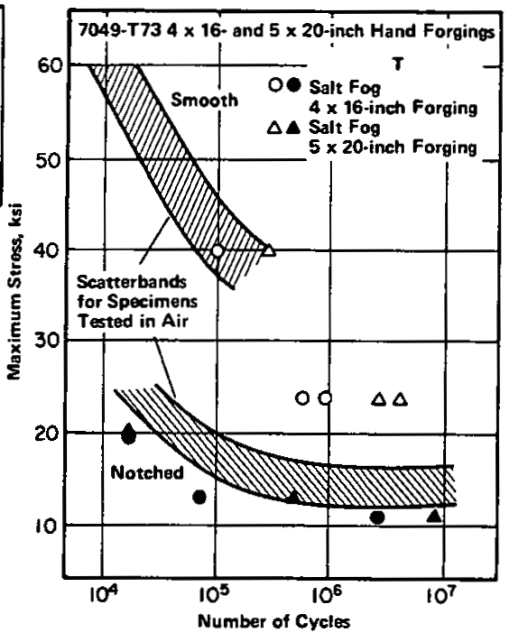


FIGURE 3.0517. EFFECT OF SALT FOG ON THE FATIGUE LIFE OF 7049-T73 FORGINGS (13)

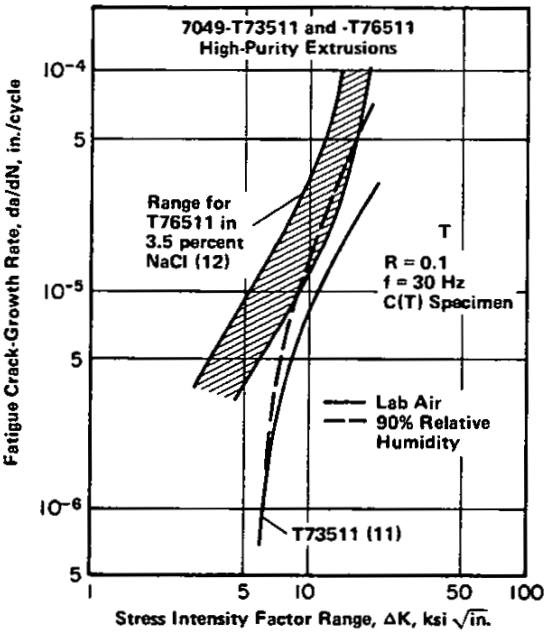


FIGURE 3.0518. FATIGUE CRACK-GROWTH RATE CURVES IN HIGH PURITY 7149-T73511 AND -T76511 EXTRUSIONS IN LABORATORY AIR AND HIGH HUMIDITY AIR (11,12)

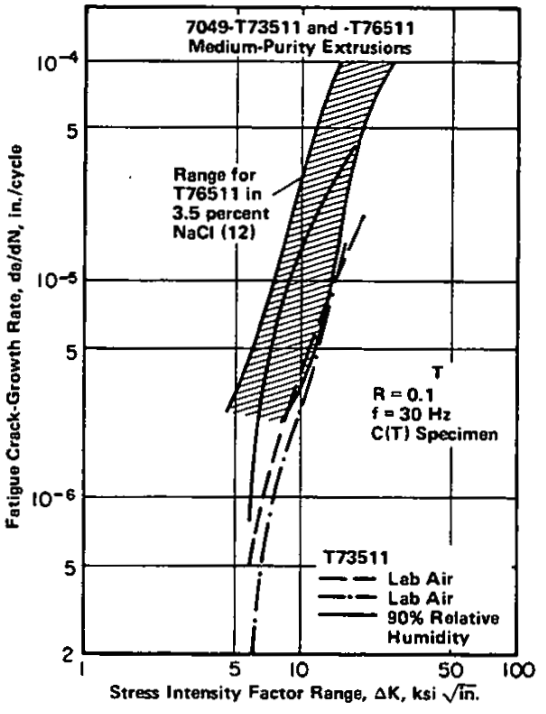


FIGURE 3.0519. FATIGUE CRACK-GROWTH RATE CURVES FOR MEDIUM PURITY 7049-T73511 AND -T76511 EXTRUSIONS IN LABORATORY AIR AND HIGH HUMIDITY AIR (11,12)

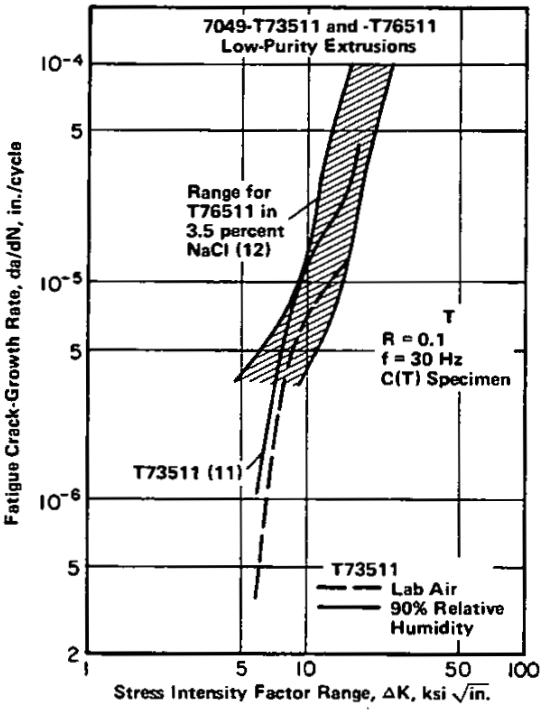


FIGURE 3.0520. FATIGUE CRACK-GROWTH RATE CURVES FOR LOW PURITY 7049-T73511 AND -T76511 IN LABORATORY AIR AND HIGH HUMIDITY AIR (11,12)

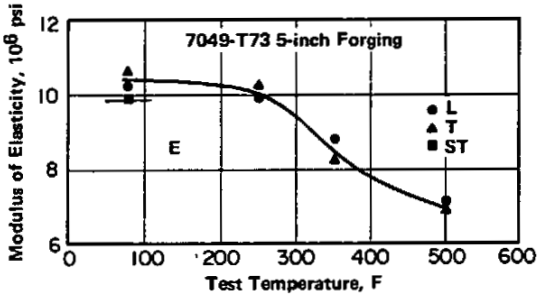


FIGURE 3.0621. EFFECT OF TEMPERATURE ON MODULUS OF ELASTICITY (8)

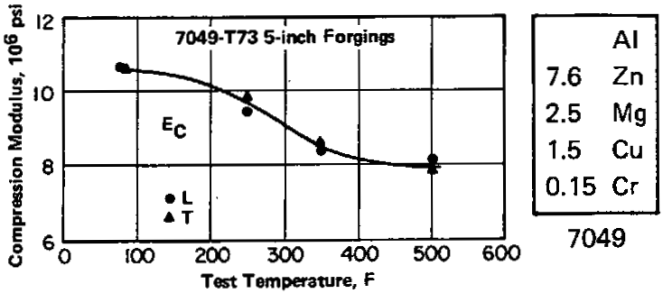


FIGURE 3.06221. EFFECT OF TEMPERATURE ON COMPRESSION MODULUS (8)

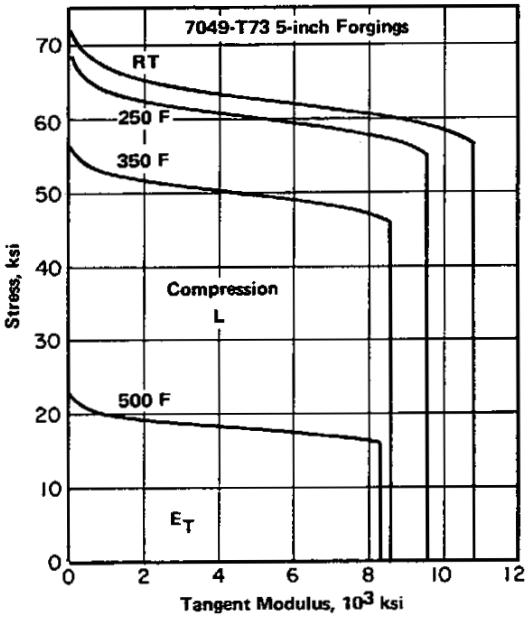


FIGURE 3.0641. TYPICAL TANGENT MODULUS CURVES IN COMPRESSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

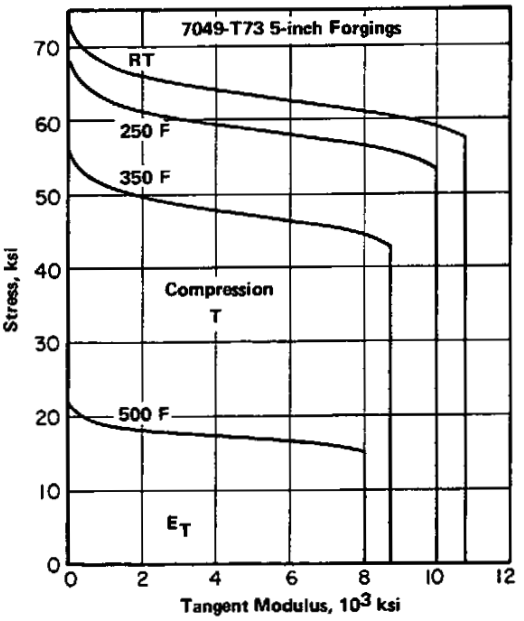


FIGURE 3.0642. TYPICAL TANGENT MODULUS CURVES IN COMPRESSION FOR 5-INCH FORGINGS AT ROOM AND ELEVATED TEMPERATURES (16)

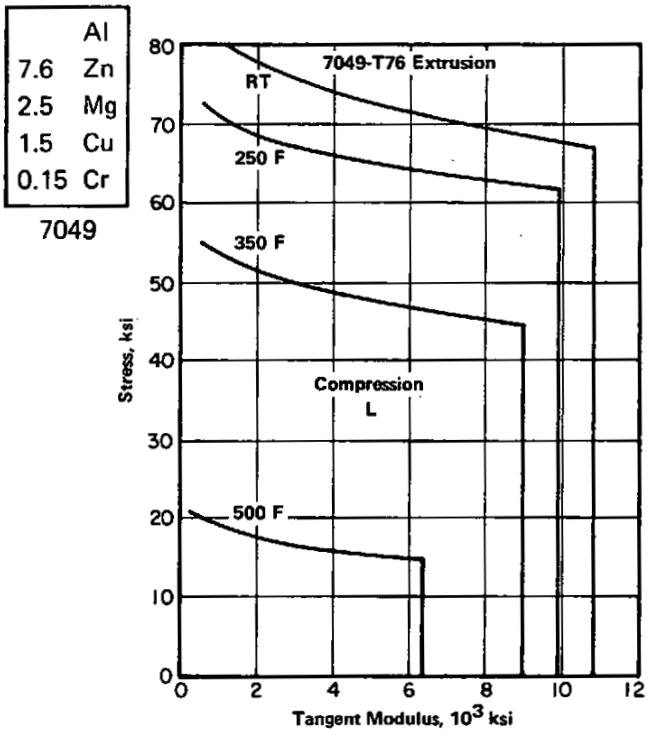


FIGURE 3.0643. TYPICAL LONGITUDINAL TANGENT MODULUS CURVES IN COMPRESSION FOR T76 EXTRUSIONS AT ROOM AND ELEVATED TEMPERATURES (18)

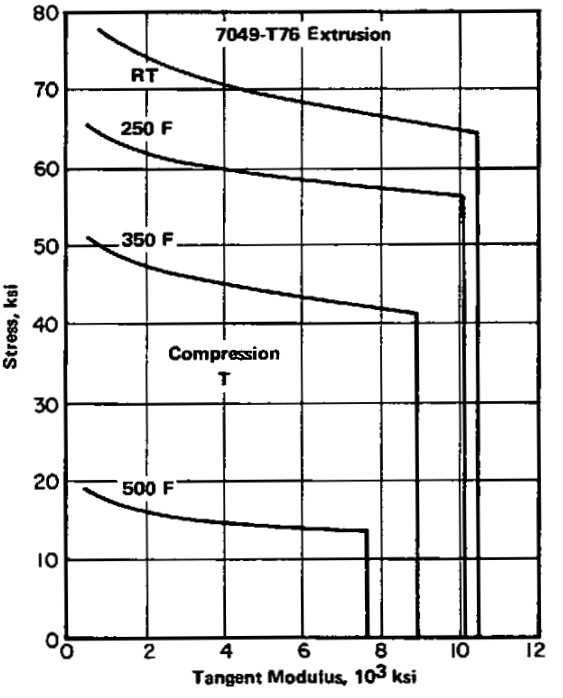


FIGURE 3.0644. TYPICAL TRANSVERSE TANGENT MODULUS CURVES IN COMPRESSION FOR T76 EXTRUSIONS AT ROOM AND ELEVATED TEMPERATURES (18)