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MECHANICAL-PROPERTY DATA Ti-6Al-4V-3Co

Aged Bar

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Air Force Materials Laboratory
Air Force Systems Command
Wright-Patterson Air Force Base, Ohio

att: mmm

March, 1968

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This data sheet was prepared by Battelle Memorial Institute under Contract F33615-67-C-1292. The contract was initiated under Project No. 7381, "Materials Application", Task No. 738106, "Design Information Development". The major objectives of this program are to evaluate newly developed structural materials of potential Air Force weapons-system interest and then to provide data-sheet-type presentations of mechanical data. The program was assigned to the Structural Materials Engineering Division at Battelle under the supervision of Mr. Walter S. Hyler. Project engineer was Mr. Omar Deel. The program was administered under the direction of the Air Force Materials Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, by Mr. Marvin Knight, project engineer.

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Ti-6Al-4V-3Co

The 3Co addition to the normal Ti-6Al-4V composition is a recent development to attempt to improve the properties of titanium alloys. Additions of 2 and 4 percent cobalt have also been studied. This particular material was obtained from the Cobalt Information Center in the form of round bar and was heat treated (as suggested by the Center) as follows: solution treat at 1450 F for 45 minutes, water quench, temper at 900 F for 4 hours. As can be seen from the data, the mechanical properties are improved over the conventional 6Al-4V alloy. However, the fatigue data show the material to be more notch sensitive than Ti-6Al-4V. From the creep and rupture data it can be seen that the 6Al-4V-3Co alloy has excellent creep-rupture strength at 500 F; however, it is very sensitive to small changes in stress. Also, at 700 and 850 F, short times at temperature show very good strength properties. A rapid drop in strength appears at long times at temperature.

Ti-6Al-4V-3Co Data(a)

Condition: STA
 Thickness: 1/2- and 7/8-Inch Round Bar

Properties	Temperature, F			
	RT	500	700	850
<u>Tension</u>				
F _{tu} , ksi	203.6	170.0	158.3	124.3
F _{ty} , ksi	194.6	145.0	129.0	108.3
e _t , percent in 2-in.	12.5	17.8	21.6	35.7
E _t , 10 ⁶ psi	17.6	15.6	14.4	12.2
<u>Compression</u>				
F _{cy} , ksi	197.0	147.3	130.7	116.0
E _c , 10 ⁶ psi	17.8	15.9	14.9	13.0
<u>Shear</u> ^(b)				
F _{su} , ksi	122.6	U ^(c)	U	U
<u>Impact</u> (V-notch Charpy)				
	U	U	U	U
<u>Fracture Toughness</u> , K _{Ic} , ksi √in. ^(d)				
	U	U	U	U
<u>Axial Fatigue</u> ^(e)				
Unnotched, R = 0.1				
10 ³ cycles, ksi	214	200	U	156
10 ⁵ cycles, ksi	167	140	U	106
10 ⁷ cycles, ksi	135	135	U	95
Notched (K _t = 3.0), R = 0.1				
10 ³ cycles, ksi	115	115	U	105
10 ⁵ cycles, ksi	50	50	U	41
10 ⁷ cycles, ksi	46	46	U	40
<u>Creep</u>				
0.2% plastic deformation				
100 hr, ksi	NA	110.0	58.0	6.0
0.2% plastic deformation				
1000 hr, ksi	NA	90.0	38.5	2.0
<u>Stress Rupture</u>				
Rupture 100 hr, ksi	NA	165.0	123.0	61.0
Rupture 1000 hr, ksi	NA	165.0	119.0	40.0

Properties	Temperature, F			
	RT	500	700	850

Stress Corrosion

F _{ty} , 1000 hr max	U	--	--	--
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Coefficient of Thermal Expansion

5.71 x 10⁻⁶ in. /in. /F (70-900 F)

Density

- (a) Data are average of triplicate tests conducted at Battelle unless otherwise indicated. Fatigue, creep, and stress-rupture values are from data curves generated using a greater number of tests.
- (b) Double-shear pin type specimen, 1/2-inch diameter.
- (c) U, unavailable; NA, not applicable.
- (d) Subject material was in round-bar form and not of sufficient size to conduct conventional fracture-toughness tests.
- (e) "R" represents the algebraic ratio of the minimum stress to the maximum stress in one cycle; that is $R = S_{min} / S_{max}$. "K_t" represents the Neuber-Peterson theoretical stress-concentration factor.

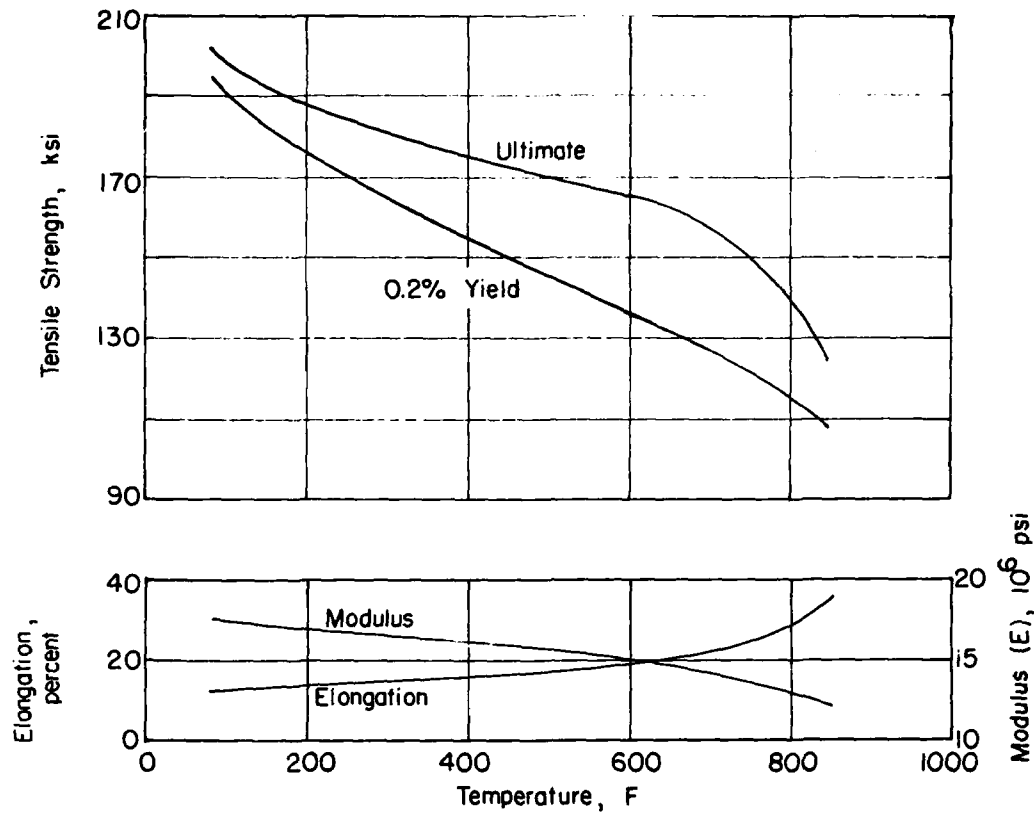


FIGURE 1. EFFECT OF TEMPERATURE ON THE TENSILE PROPERTIES OF Ti-6Al-4V-3Co ROUND BAR

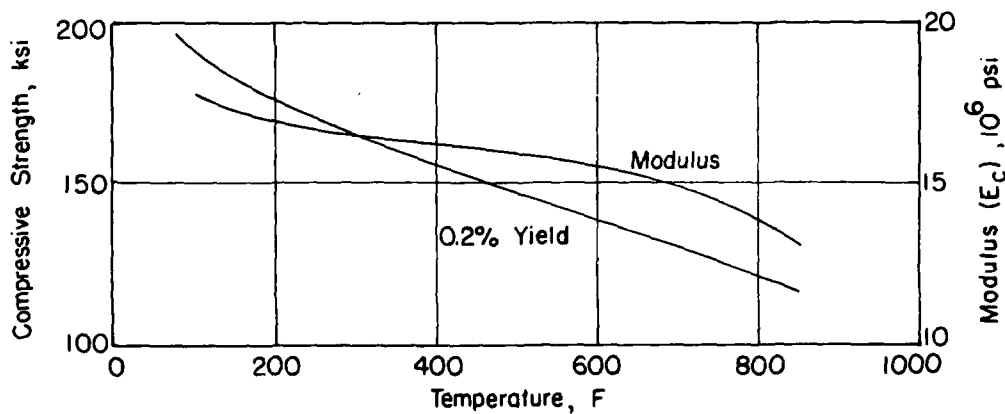


FIGURE 2. EFFECT OF TEMPERATURE ON THE COMPRESSION PROPERTIES OF Ti-6Al-4V-3Co ROUND BAR

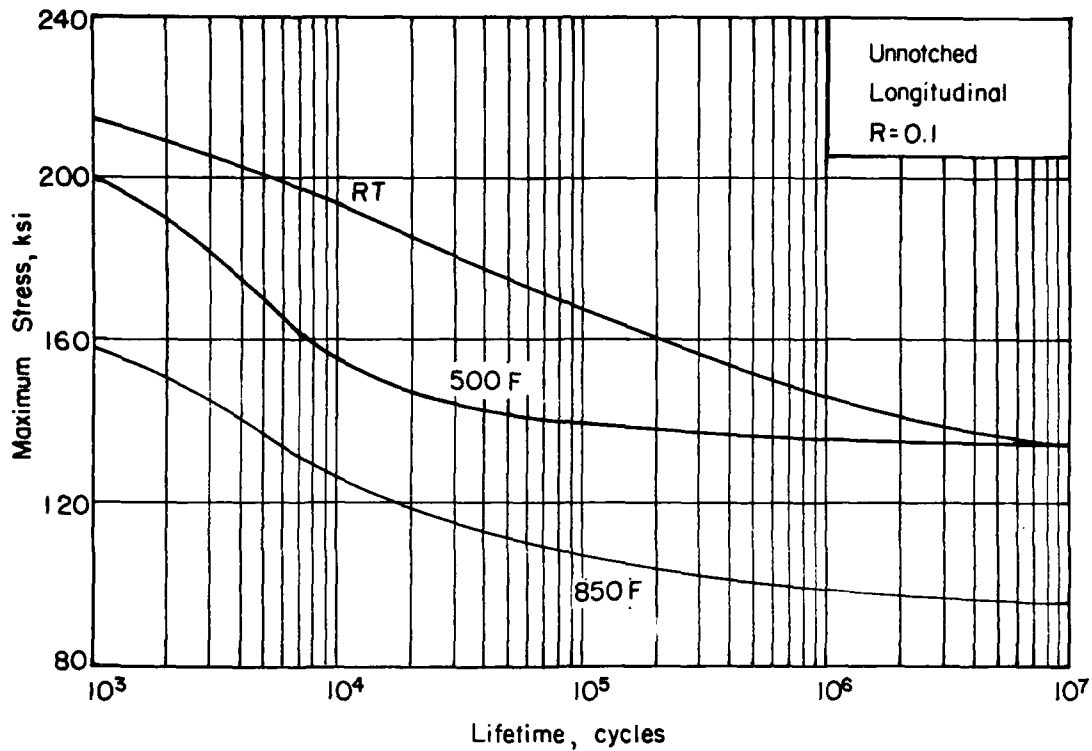


FIGURE 3. AXIAL-LOAD FATIGUE RESULTS FOR Ti-6Al-4V-3Co ROUND BAR AT THREE TEMPERATURES

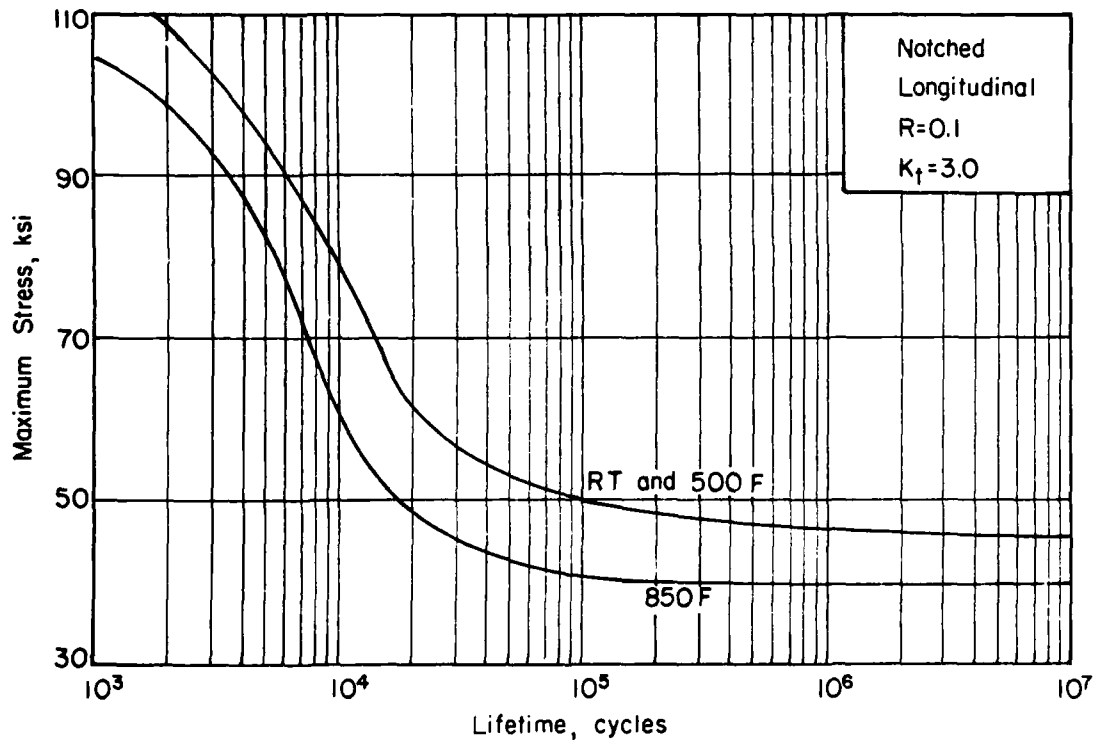


FIGURE 4. AXIAL-LOAD FATIGUE RESULTS FOR NOTCHED ($K_t = 3.0$) Ti-6Al-4V-3Co ROUND BAR AT THREE TEMPERATURES

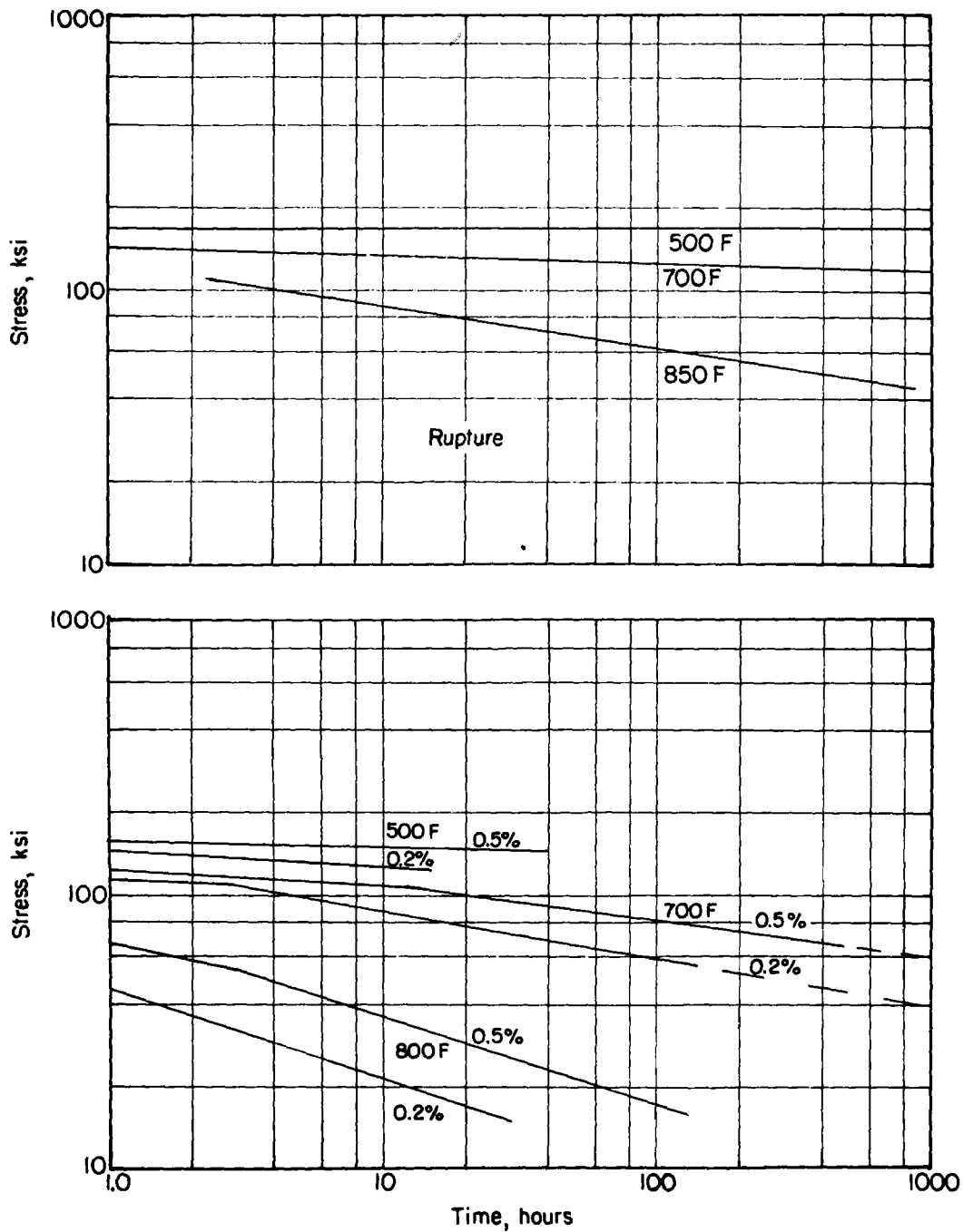


FIGURE 5. STRESS-RUPTURE AND PLASTIC DEFORMATION CURVES FOR Ti-6Al-4V-3Co ROUND BAR

REFERENCES

- (1) Diderrich, E., "Contribution to the Study of a High-Strength Titanium Alloy", paper published by "Centre D'Information du Cobalt", Brussels, also published in Cobalt, No. 31, June 1966, pp 78-82.
- (2) Sparks, R. B., "Preliminary Investigation of Ti-6Al-4V-3Co Alloy", Report No. RD 67-137, M. D. & E. No. 254, Wyman-Gordon Company.
- (3) Diderrich, E., "Addition of Cobalt to the Ti-6Al-4V alloy", paper presented at the 96th Annual AIME Meeting, Los Angeles, California, February, 1967.