

Fatigue Crack Propagation

Fracture mechanics methods are used to characterize fatigue crack growth:

- compact tension specimen most common test coupon (ASTM E 647)
- constant amplitude testing performed
- a vs. N recorded (see Figure 8.29)
- data reduced to give da/dN (or $\Delta a/\Delta N$) vs. ΔK
log-log plots
(see Figures 8.30, 8.31)
- Paris equation used most often:

$$da/dN = A (\Delta K)^m$$

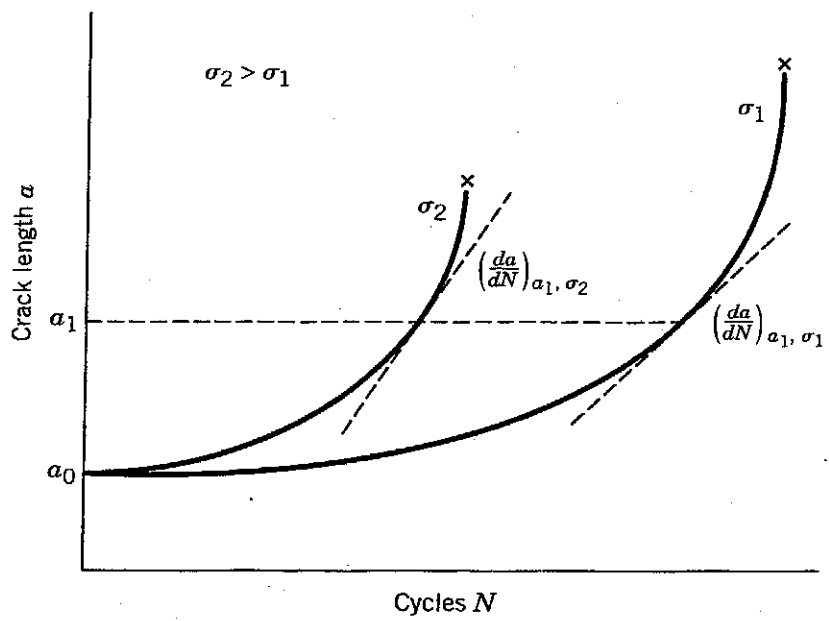


FIGURE 8.29 Crack length versus the number of cycles at stress levels σ_1 and σ_2 for fatigue studies. Crack growth rate da/dN is indicated at crack length a_1 for both stress levels.

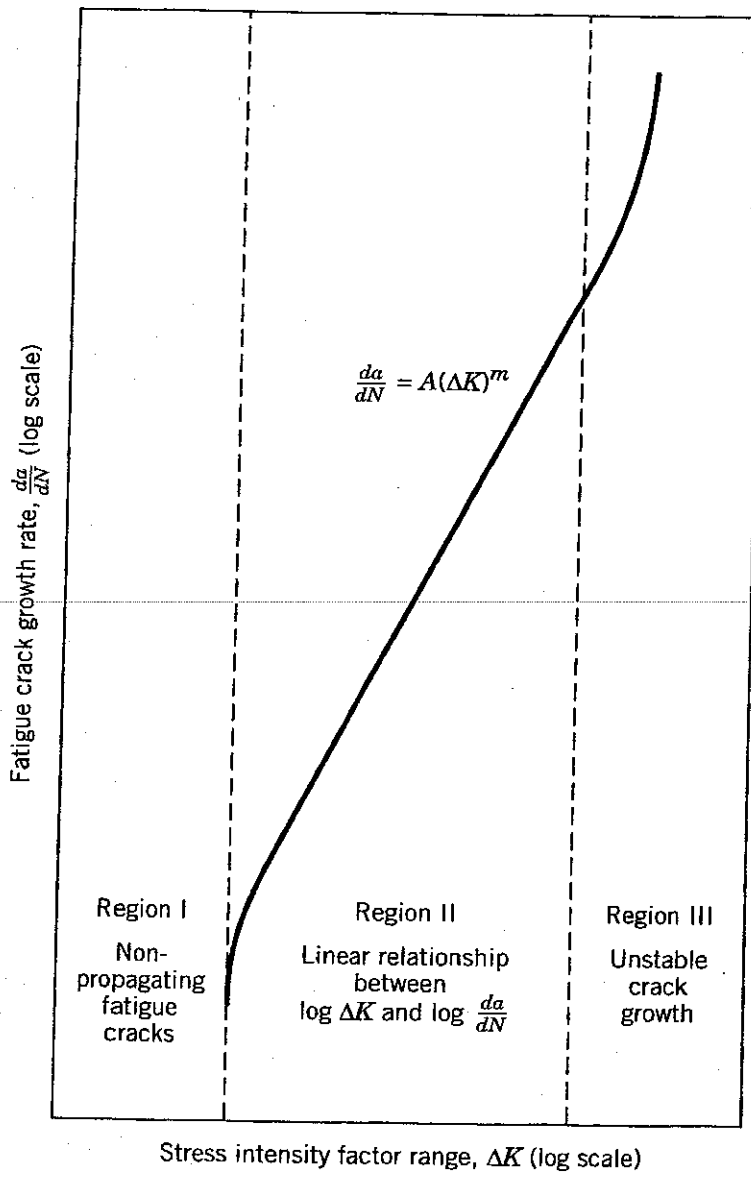


FIGURE 8.30 Schematic representation of logarithm crack propagation rate da versus logarithm stress intensity factor range ΔK . The three different crack growth (I, II, and III) are indicated (Reprinted with permission of ASM International, Metals Handbook, Vol. 9, Part 2, OH 44073-9989. W. G. C. "How Fatigue Crack Initiation and Growth Properties Affect Selection and Design Criteria," *Metals Engineering Quarterly* 14, No. 3, 1974.)

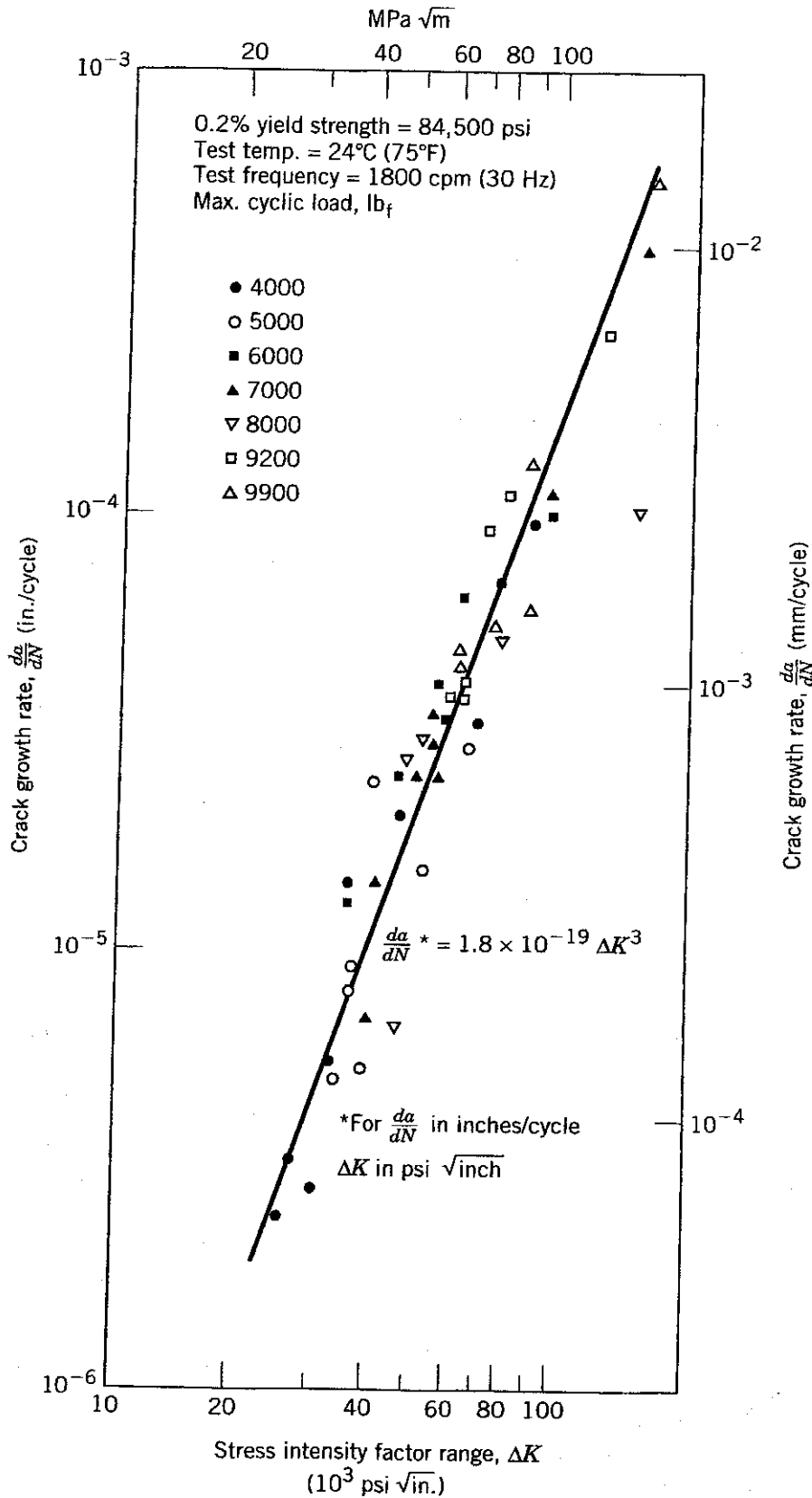


FIGURE 8.31 Logarithm crack growth rate versus logarithm stress intensity factor range for a Ni-Mo-V steel. (Reprinted by permission of the Society for Experimental Mechanics, Inc.)

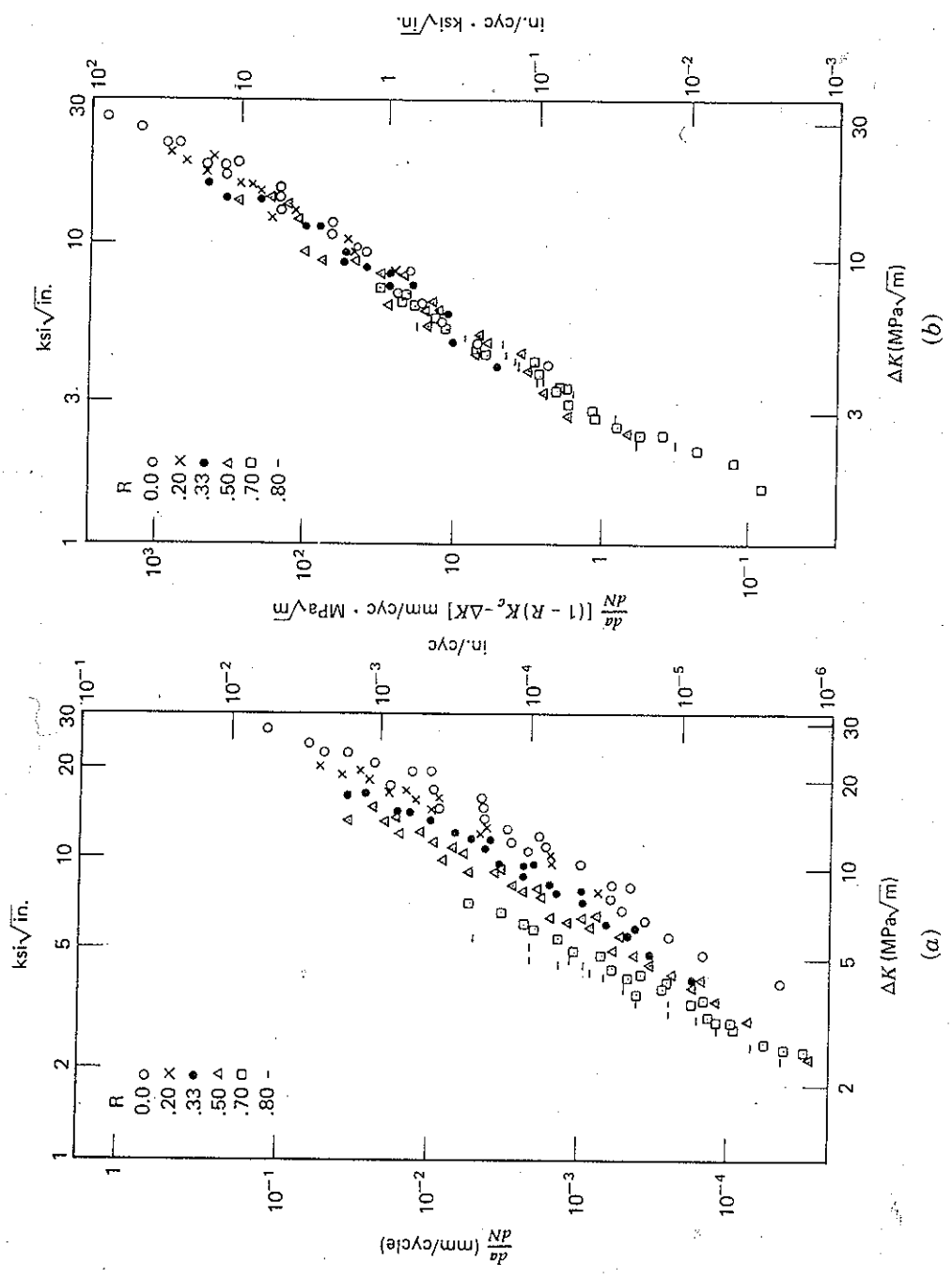


FIGURE 13.17 Fatigue crack propagation in 7075-T6 aluminum alloy showing effect of load ratio R and applicability of Forman, Kearney, and Engle relation. (a) ΔK vs. da/dN ; (b) ΔK vs. $[(1-R)K_c - \Delta K]$ da/dN . Note less scatter in b. (Data from Hudson.)

C, m - material constants
 K_c - fracture toughness
 $R = \frac{K_{min}}{K_{max}}$
 $\Delta K = K_{max} - K_{min}$

$$da/dN = \frac{C \Delta K^m}{(1-R)K_c - \Delta K}$$