Fatigue Problems:

1. A fatigue test was conducted in which the mean stress was 70 MPa (10,000 psi), and the stress amplitude was 210 MPa (30,000 psi).

    - Compute the maximum and minimum stress levels.
    - Compute the stress ratio.
    - Compute the magnitude of the stress range.

2. A cylindrical 1045 steel bar (fig 1) is subjected to repeated compression-tension stress cycling along its axis. If the load amplitude is 66,700N (15,000lbf), compute the minimum allowable bar diameter to ensure that fatigue failure will not occur. Assume a safety factor of 2.0.

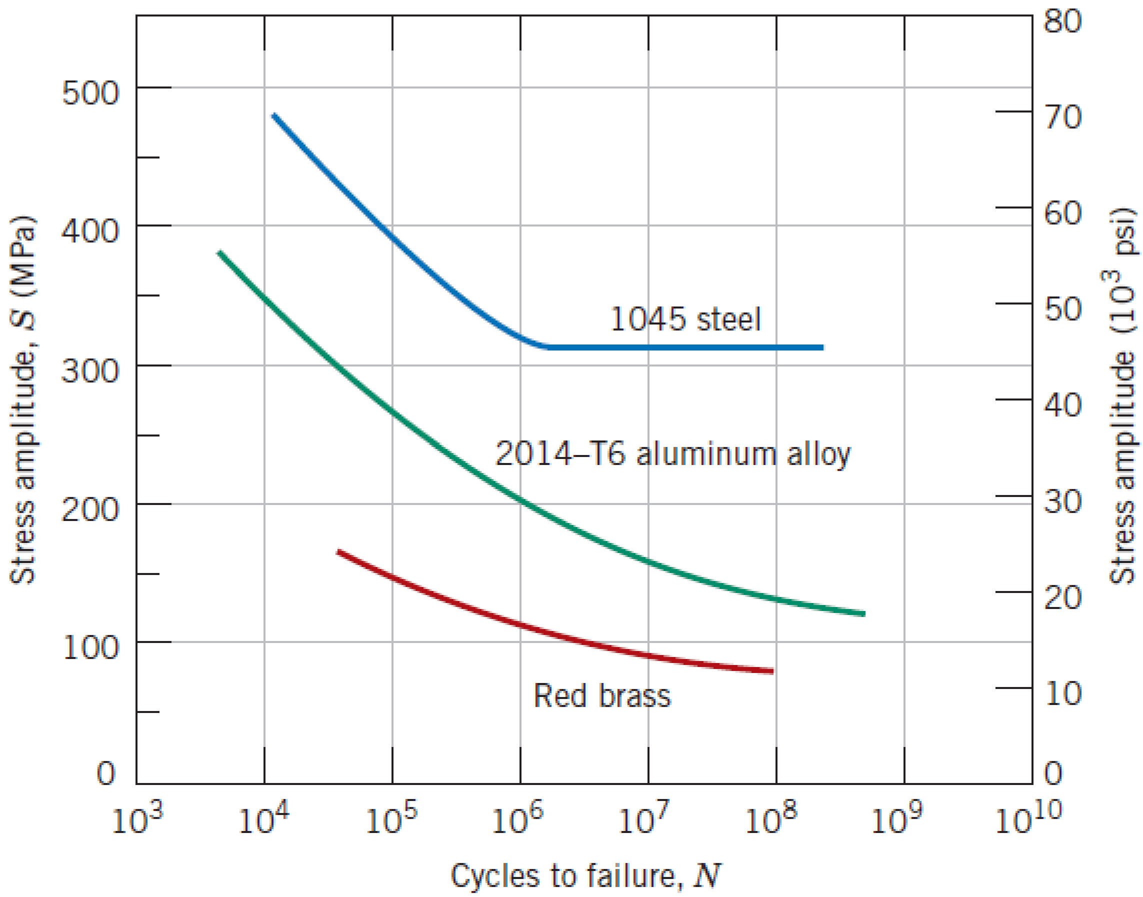

Fig.1 Stress magnitude *S* versus the logarithm of the number *N* of cycles to fatigue failure for red brass, an aluminum alloy, and plain carbon steel

3. A 6.4 mm (0.25 in.) diameter cylindrical rod fabricated from a 2014-T6 aluminum alloy (Fig 1) is subjected to reversed tension compression load cycling along its axis. If the maximum tensile and compressive loads are +5340N (+1200 lbf) and -5340 N (-1200 lbf) respectively, determine its fatigue life. Assume that the stress plotted in (Fig 1) is stress amplitude.

4. A 15.2 mm (0.60 in.) diameter cylindrical rod fabricated from a 2014-T6 aluminum alloy (Fig 1) is subjected to a repeated tension compression load cycling along its axis. Compute the maximum and minimum loads that will be applied to yield a fatigue life of 1.0 x 10^8 cycles. Assume that the stress plotted on the vertical axis is stress amplitude, and data were taken for a mean stress of 35MPa (5000psi).

Creep Problems:

1. A specimen 1015 mm (40 in.) long of a low carbon–nickel alloy (Fig. 1) is to be exposed to a tensile stress of 70 MPa (10,000 psi) at 427°C. Determine its elongation after 10,000 h. Assume that the total of both instantaneous and primary creep elongations is 1.3 mm (0.05 in.).

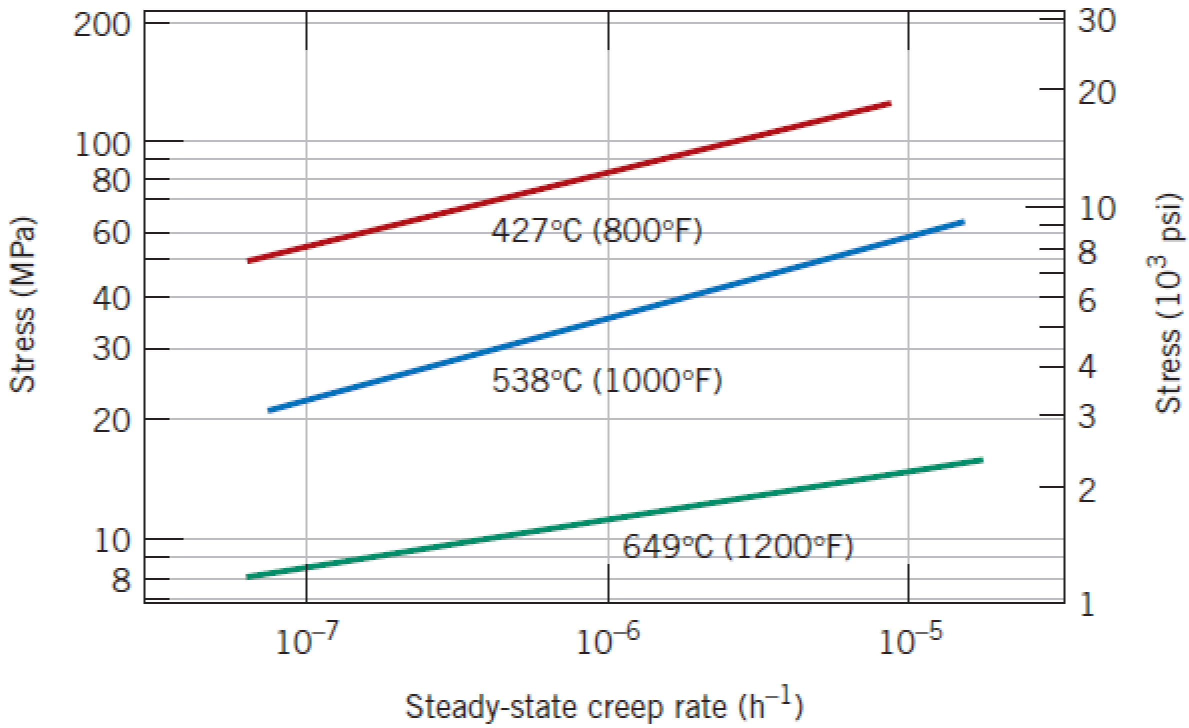

Fig.1 Stress (logarithmic scale) versus rupture lifetime (logarithmic scale) for a low carbon–nickel alloy at three temperatures

2. For a cylindrical low carbon–nickel alloy specimen (Fig. 1) originally 19 mm (0.75in.) in diameter and 635 mm (25 in.) long, what tensile load is necessary to produce a total elongation of 6.44 mm (0.25 in.) after 5000 h at 538°C? Assume that the sum of instantaneous and primary creep elongations is 1.8mm (0.07 in.).

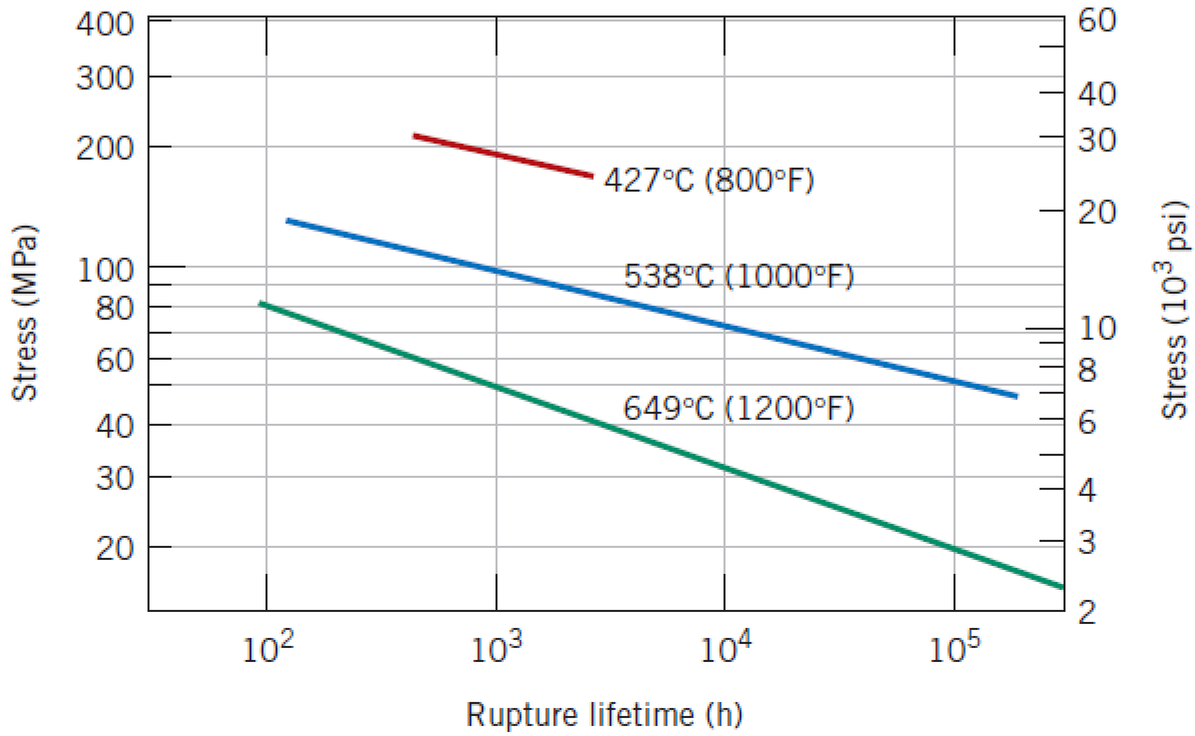

Fig. 2 Stress (logarithmic scale) versus rupture lifetime (logarithmic scale) for a low carbon–nickel alloy at three temperatures

3. If a component fabricated from a low carbon–nickel alloy (Fig. 2) is to be exposed to a tensile stress of 31MPa (4500psi) at 649^{o}C, estimate its rupture lifetime.

4. A cylindrical component constructed from a low carbon–nickel alloy (Fig. 2) has a diameter of 19.1 mm (0.75 in.). Determine the maximum load that may be applied for it to survive 10,000 h at 538^{o}C.

Data Extrapolation Problems:

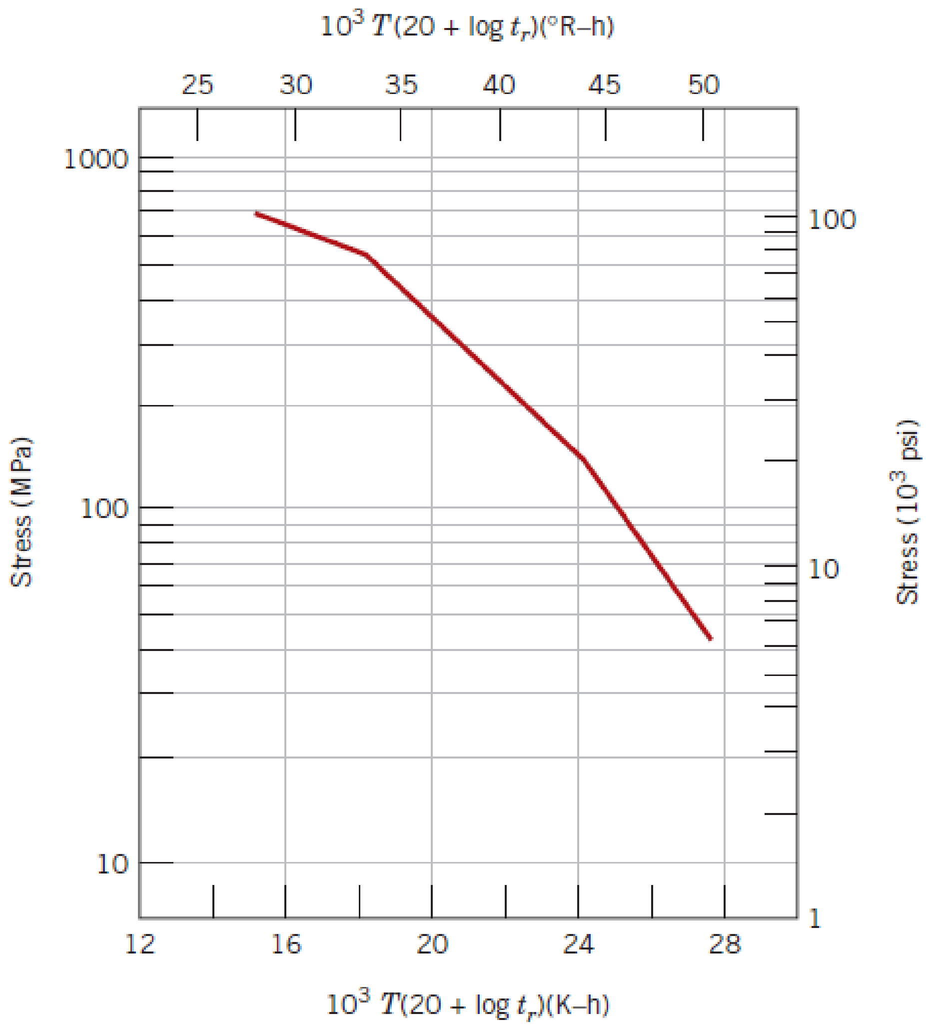

Fig.1 Logarithm stress versus the Larson–Miller parameter for an S-590 iron

1. An S-590 iron component (Fig.1) must have a creep rupture lifetime of at least 20 days at 650°C (923 K). Compute the maximum allowable stress level.

2. Consider an S-590 iron component (Fig.1) that is subjected to a stress of 55MPa (8000 psi). At what temperature will the rupture lifetime be 200 h?

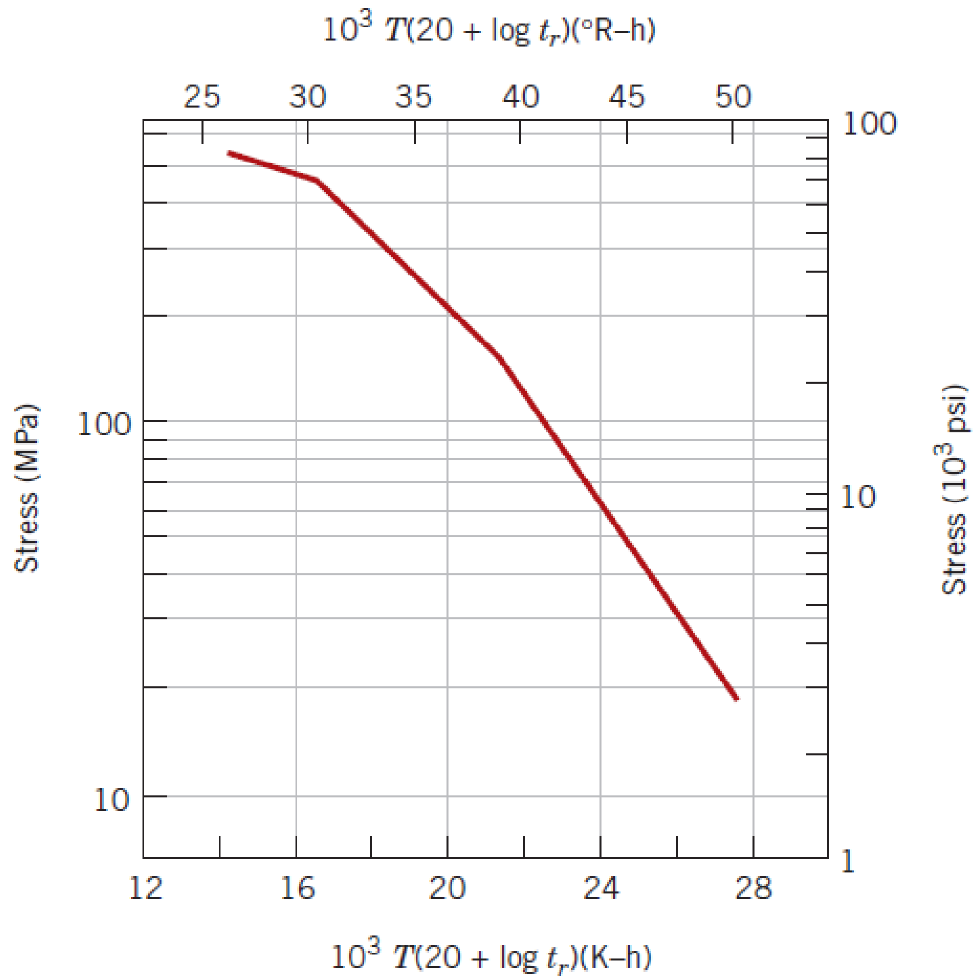

Fig.2 Logarithm stress versus the Larson–Miller parameter for an 18-8 Mo stainless steel

3. For an 18-8 Mo stainless steel (Fig.2), predict the time to rupture for a component that is subjected to a stress of 100 MPa (14,500 psi) at 600°C (873 K).

4. Consider an 18-8 Mo stainless steel component (Fig.2) that is exposed to a temperature of 650°C (923 K).What is the maximum allowable stress level for a rupture lifetime of 1 year? 15 years?