any portion of the waveform could be in the compressive-stress regime as well.) Any of these waveforms can be characterized by two parameters, their mean and alternating components, their maximum and minimum values, or ratios of these values.

The **stress range** $\Delta\sigma$ is defined as

$$\Delta\sigma = \sigma_{max} - \sigma_{min} \tag{6.1a}$$

The **alternating component** σ_a is found from

$$\sigma_a = \frac{\sigma_{max} - \sigma_{min}}{2} \tag{6.1b}$$

and the **mean component** σ_m is

$$\sigma_m = \frac{\sigma_{max} + \sigma_{min}}{2} \tag{6.1c}$$

Two ratios can be formed:

$$R = \frac{\sigma_{min}}{\sigma_{max}} \qquad A = \frac{\sigma_a}{\sigma_m} \tag{6.1d}$$

where R is the **stress ratio** and A is the **amplitude ratio**.

When the stress is fully reversed (Figure 6-6*a*), $R = -1$ and $A = \infty$. When the stress is repeated (Figure 6-6*b*), $R = 0$ and $A = 1$. When the maximum and minimum stresses have the same sign as in Figure 6-6*c*, both R and A are positive and $0 \le R \le 1$. These load patterns may result from bending, axial, torsional, or a combination of these types of stresses. We will see that the presence of a mean-stress component can have a significant effect on the fatigue life.

Service Equipment Loading

The character of the load-time function for service equipment is not so easily defined as for rotating machinery. The best data come from actual measurements made on equipment in service or operated under simulated service conditions. The automotive industry subjects prototype vehicles to test-track conditions that simulate various road surfaces and curves. The test vehicles are extensively instrumented with accelerometers, force transducers, strain gages, and other instruments that feed voluminous amounts of data to on-board computers or telemeter it to stationary computers where it is digitized and stored for later analysis. The aircraft industry also instruments test-aircraft and records in-flight force, acceleration, and strain data. The same is done with ships and offshore oil platforms, etc.

Some examples of these in-service stress-time waveforms are shown in Figure 6-7, which depicts a simulated general loading case in (*a*), a typical pattern for a ship or offshore platform in (*b*), and a pattern typical of a commercial aircraft in (*c*). These patterns are semirandom in nature, as the events do not repeat with any particular period. Data such as these are used in computer simulation programs that calculate the cumulative fatigue damage based on either a strain-based model, a fracture-mechanics model, or a combination of both. The stress-life model is not able to deal as effectively with this type of loading history.