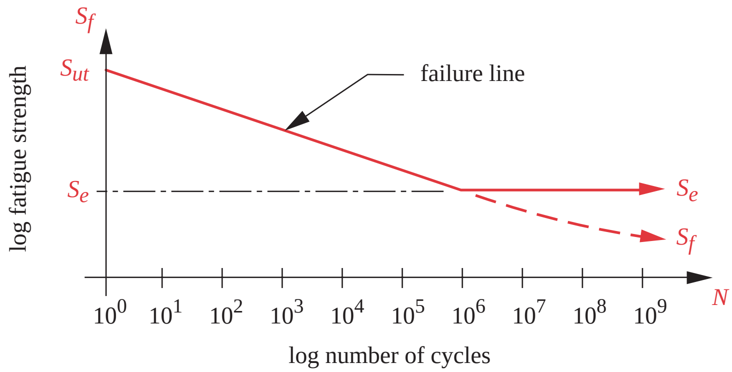

An endurance limit S_e exists for some ferrous metals and titanium alloys. Other materials show no endurance limit.

FIGURE 2-10

Wohler Strength-Life or *S-N* Diagram Plots Fatigue Strength Against Number of Fully Reversed Stress Cycles

It is important at this stage to remember that the tensile stress-strain test does not tell the whole story and that a material's static strength properties are seldom adequate by themselves to predict failure in a machine-design application. This topic of fatigue strength and endurance limit is so important and fundamental to machine design that we devote Chapter 6 exclusively to a study of fatigue failure.

The rotating-beam test is now being supplanted by axial-tension tests performed on modern test machines which can apply time-varying loads of any desired character to the axial-test specimen. This approach provides more testing flexibility and more accurate data because of the uniform stress distribution in the tensile specimen. The results are consistent with (but slightly lower-valued than) the historical rotating-beam test data for the same materials.

Impact Resistance

The stress-strain test is done at very low, controlled strain rates, allowing the material to accommodate itself to the changing load. If the load is suddenly applied, the energy absorption capacity of the material becomes important. The energy in the differential element is its **strain energy density**, (strain energy per unit volume U_0) or the area under the stress-strain curve at any particular strain.

$$U_0 = \int_0^{\varepsilon} \sigma \, d\varepsilon \tag{2.6a}$$

The strain energy U is equal to the strain energy density integrated over the volume v.

$$U = \int_v U_0 \, dv \tag{2.6b}$$

The **resilience** and **toughness** of the material are measures, respectively, of the strain energy present in the material at the elastic limit or at the fracture point.