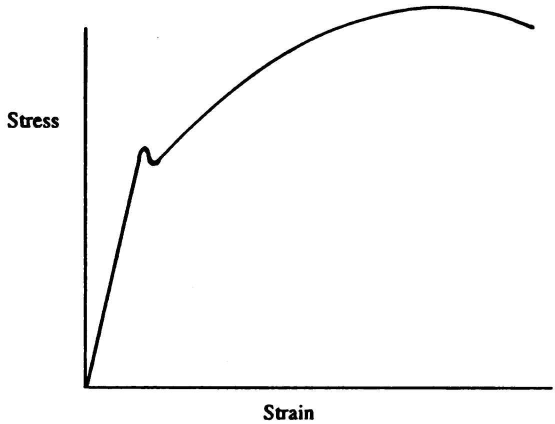

Figure 1.1 Typical stress–strain curve.

members in a given structure by allowing redistribution of stresses due to yielding.

A typical stress–strain diagram for structural steel is shown in Figure 1.1. If we look at this diagram, it can be observed that steel obeys Hooke's law up to the first yield. In this region, stress is directly proportional to strain. Beyond this point, steel experiences a plastic condition momentarily and then enters into the strain-hardening state. At failure, the strain ranges from 150 to 200 times the elastic strain. During strain hardening, the stress continues to increase to a maximum and then drops slightly before failure. At the end of the strain-hardening state, the cross section of the tension specimen is reduced. This characteristic is referred to as *necking*.

1.3 APPLICATIONS

The diagram shown in Figure 1.2 represents a typical interior panel of a library stack room's framing system. It has a reinforced concrete floor slab $4\frac{1}{2}$ in. thick. Tiling weighs 1 lb/ft^2, and ceiling loads are equivalent to 10 lb/ft^2.

Example 1.1

(a) Determine the uniform load on a typical beam and express it in pounds per linear foot.

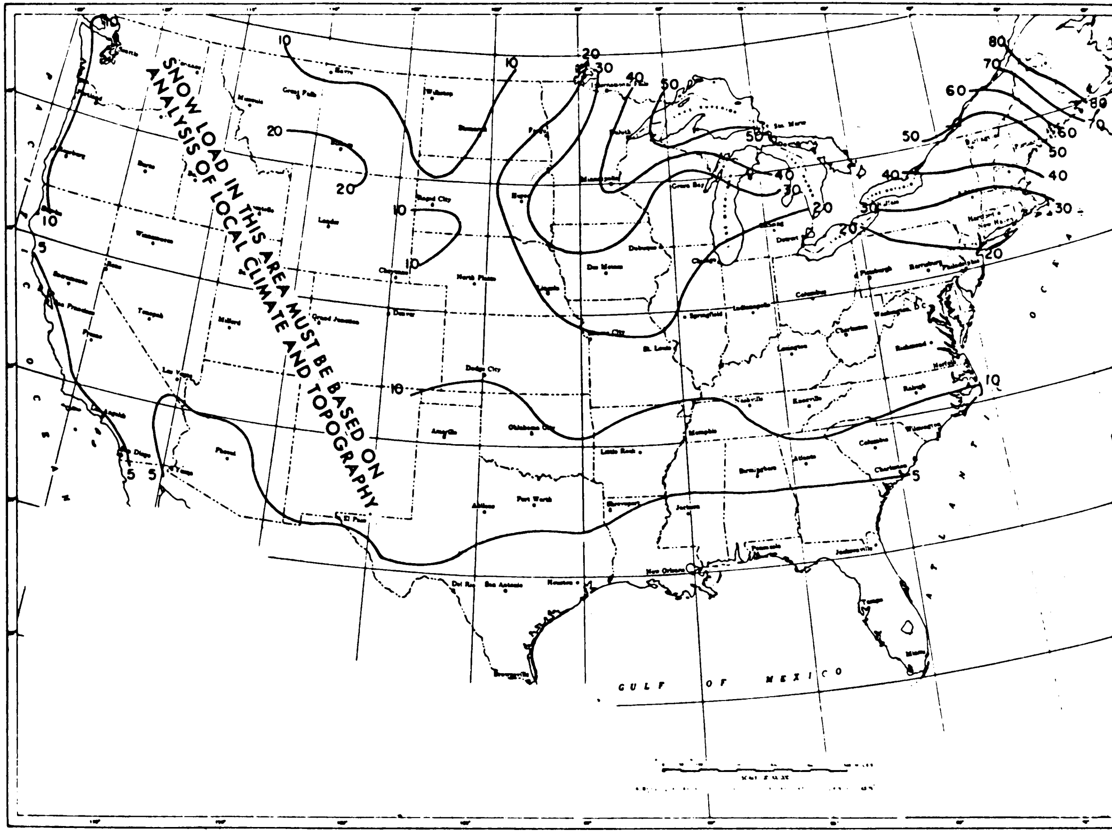

Figure 1.6 Snow load in pound-force per square foot on the ground, 5-year mean recurrence interval.

When the load is transmitted directly to each of the cross-sectional elements by connectors, the effective area A_e is equal to the net area A_n. If the load is transmitted by bolts or rivets through some but not all the cross-sectional elements of the member, the effective net area A_e is computed by

$$A_e = UA_n$$

where

A_n = net area of the member (in.^{2})
U = reduction coefficient

The following values of U are taken from the AISC specifications, LRFD and ASD, B3:

(a) W, M, or S shapes with flange widths not less than two-thirds the depth and structural tees cut from these shapes, provided the connection is to the flanges. Bolted or riveted connections shall have no fewer than three fasteners per line in the direction of the stress: $U = 0.90$.
(b) W, M, or S shapes not meeting the conditions of the above, structural tees cut from these shapes and all other shapes, including built-up cross sections. Bolted or riveted connections shall have no fewer than three fasteners per line in the direction of the stress: $U = 0.85$.
(c) All members with bolted or riveted connections having only two fasteners per line in the direction of the stress: $U = 0.75$.

For pin-connected members

$$P = 0.45F_yA_e \tag{2.3}$$

The allowable bearing load on the pin

$$P = 0.90F_yDt \tag{2.4}$$

where D and t are the diameter of the pin and thickness of the plate, respectively.

2.4 LRFD METHOD

Structural steel is a ductile material as shown in Figure 2.3. Due to strain hardening, a member without holes and subjected to purely tensile forces

In determining the net area, the diameter of the hole is considered to be $\frac{1}{8}$ in. larger than that of the fastener. This is to allow for the damage in punching of the hole and clearance to facilitate construction. Table 2.1 can be used to obtain the reduction in the area once the thickness of the material and nominal diameter of the hole are known.

Example 2.2

A tension member is made up of a single angle 8 in. × 6 in. × $\frac{5}{8}$ in. with a gross area of 8.36 in.^{2} Two rows of $\frac{3}{4}$-in.-diameter bolt are used. Find the net area. See Figure 2.5.

Solution

Gross area	= 8.36 in.^{2}
Diameter of hole ($\frac{3}{4}$ + $\frac{1}{8}$)	= $\frac{7}{8}$ in.
Thickness of the leg of the angle	= $\frac{5}{8}$ in.
Reduction of area (Table 2.1), 2 at 0.547	= 1.094 in.^{2}
Net area	= 7.266 in.^{2}

2.6 EFFECTIVE AREA FOR STAGGERED HOLES OF TENSION MEMBERS

When there is more than one row of bolts and rivets, it is more efficient to stagger the holes. In the case of no stagger, the net area is determined by subtracting the area taken by the holes from the gross area, as has been shown in Section 2.5. In Figure 2.6a or 2.6b, the net area is the product of the thickness of the plate and the effective width that is obtained by subtracting the sum of the diameter of the holes existing in one column from the gross width of the plate.

For staggered holes as in Figure 2.7, the net width is obtained by deducting from the gross width the sum of the diameters of all holes in the chain, and adding for each gage space in the chain the quantity

$$s^2/4g$$

where

s = longitudinal center-to-center spacing (pitch) of any two consecutive holes (in.)

g = transverse center-to-center spacing (gage) between fastener gage lines (in.)

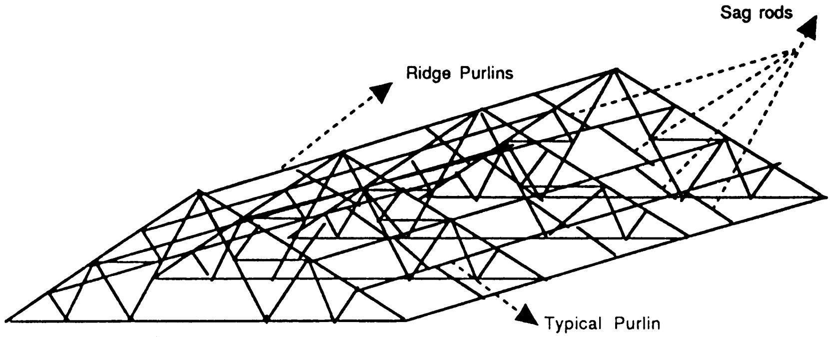

Figure 2.8 Roof truss framing system.

Figure 2.9b. Even though the sag rods cut the span of the purlins in the weak direction, the stress in that direction can be significant and must be accounted for.

2.8 LIMITATION OF LENGTH OF TENSION MEMBERS ON STIFFNESS: SLENDERNESS RATIO

Tension members are not subjected to buckling, and hence the slenderness ratio is not critical in their design. However, to prevent excessive deflection and/or vibration, the AISC specifications impose a limit on the slenderness ratio of 300 (LRFD, First Edition, Part 6, Section B7; ASD, Ninth Edition, Part 5, Section B7). The maximum ratio of 300 is not applicable to rods, which is left to the judgment of the designer.

2.9 APPLICATIONS

Example 2.3

Figure 2.10 shows the plan and a typical truss for the roof system of a warehouse. The warehouse is located in the central United States. The roof is to be constructed of lightweight materials such as corrugated steel sheets. All structural members are to be sprayed with fireproof material good for 1 hr. Determine the loads on the truss, analyze the truss,