Figure 4.27. The steep faces preferred by ice climbers are swept frequently by dry loose avalanches. (Photo by D. McClung)

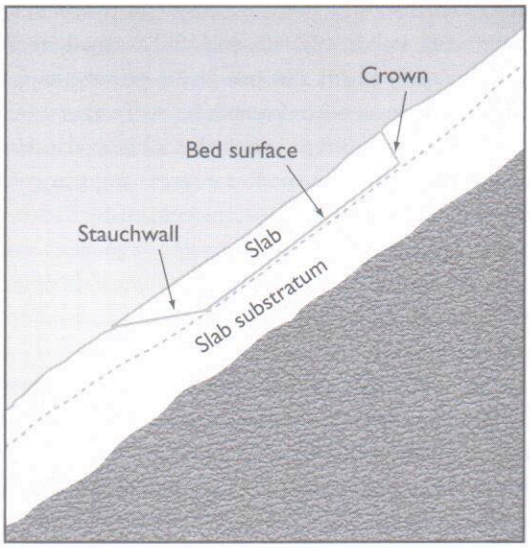

Figure 4.28. Cross-section of a typical snow slab.

since they can be more massive with much higher snow density than dry loose avalanches. When non-cohesive snow is present or expected, it appears that cold or very warm extremes in weather form the prototypes for loose-snow avalanche formation.

Wet loose avalanches can affect highways with adjacent steep slopes and can be large enough to damage vehicles and structures. Loose-snow avalanches have two other important effects: (1) they tend to prevent slab-avalanche formation on steep slopes by sluffing activity, and (2) they may serve as a trigger for slab avalanches on slopes below.

SNOW-SLAB NOMENCLATURE AND FRACTURE GEOMETRY

A snow slab is a cohesive layer of snow with a thinner, weaker failure layer beneath it. A snow slab becomes a slab avalanche once it is cut out around all boundaries by fractures (see Figures 4.3 and 4.4, and Figure 5.29 in Chapter 5).

A standard nomenclature has been developed with respect to the prominent features of a fallen snow slab. These terms are discussed here (see Figures 4.3 and 4.28) in the order that fractures take place.

Bed Surface

This is the surface over which the slab slides. It may or may not be close to the initial shear-failure surface under the slab because a shallow slab can sweep out a deeper slab during downhill motion (a common occurrence above depth hoar). The bed surface can be the ground.

Crown

This is the breakaway wall of the top periphery of the slab. It is usually at a right angle to the bed surface. It is formed by dynamic tension fracture through the depth of the slab from bottom to top. Fracture toughness in tension, not tensile strength, governs the tension fracture.

Flanks

These are the left and right sides of the slab. Downslope motion of the slab causes the fractures at the flanks. All fractures associated with dry slab release propagate rapidly once they initiate. The flanks are usually smooth surfaces formed by shear fractures or tension fractures (indicated by a saw-tooth pattern), or a combination of shear and tension fractures.

Stauchwall
This is the lowest downslope fracture surface. It is usually overridden by the slab material and it consists of a diagonal shear fracture of wedgelike shape. The stauchwall appears to form at about the same time as the flanks just before the slab moves downhill.

CHARACTERISTICS OF DRY SLAB AVALANCHES

The characteristics of slab features measured at fracture lines in the field provide important information that can affect decisions about travel in avalanche terrain. They also provide important information about how snow slabs fail.

Slope Angle

The normal range of slope angles for slab-avalanche release is about 25° to 55°. For slopes with inclinations of less than 25°, the shear stress and shear deformation are apparently not large enough to cause failure and fracture (Figure 4.29). For steeper slopes (>55°), sluffing (loose-snow avalanching) routinely prevents slabs from forming. It is possible for a traveler to trigger slabs on slopes above while skiing on a horizontal or low-angle surface under highly unstable conditions with thick layers of persistent forms (fatalities have occurred by this mechanism). In this case, it is observed that a shear fracture that runs upslope underneath a slab may cut it free, with the fracture line occurring above on a slope of 25° or more. Secondly, even though sluffing (not slab formation) is usually expected on slopes in excess of 55°, there is no *guarantee* that a slab cannot be produced on such steep slopes as well.

Figure 4.29 illustrates a distribution of dry slab avalanches as a function of slope angle measured at the crown. The distribution shows that about two-thirds of avalanches in the sample (about 200 slabs) occur for slopes with inclines between 30° to 45°, with the peak in frequency near 40°. This distribution is expected to change only slightly for different snow climates if at all. Field observations show that instability (and the chance of avalanching) increases with increasing slope angle. For this reason, terrain features such as convex rolls must be dealt with carefully (see Chapter 5).

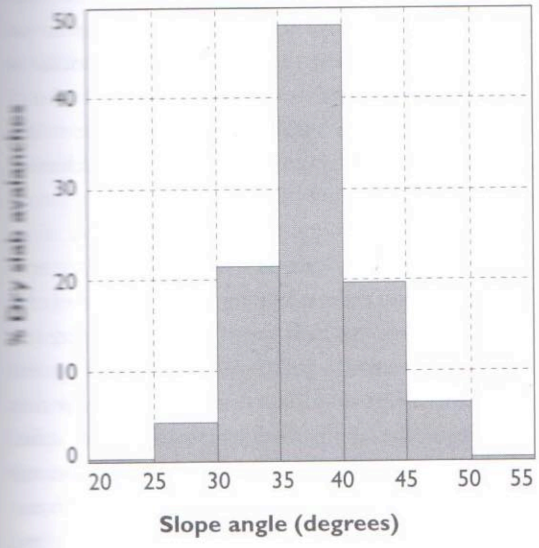

Figure 4.29. Slope angle dependence from fracture-line studies.

Crown Thickness

Figure 4.30 shows a frequency distribution taken from 200 dry slabs. The average value is about two-thirds of a meter, with a range from about 0.1 to 2 m. Field data show that slabs thicker than 2 m can release, particularly when large explosives are used.

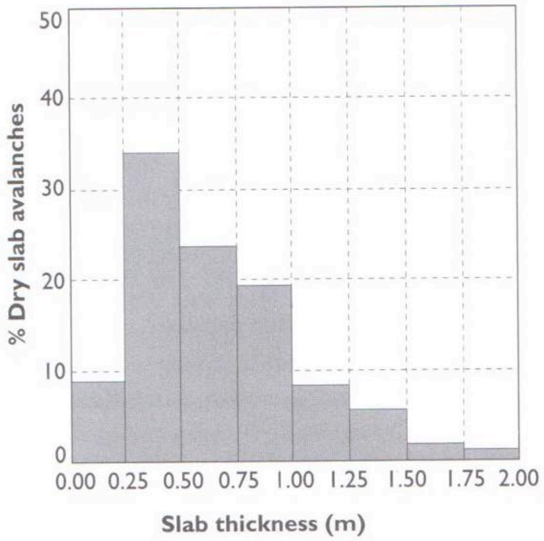

Figure 4.30. Distribution of slab thickness from fracture-line studies.