13.1.3 Frost Depth

The water in soil freezes and expands, then contracts again when it thaws. This phenomenon is called *frost heave.* Footings and foundations must be set below the winter frost line to avoid damage from frost heave. The depth to which the soil freezes depends not only on climate and geographic location, but also on soil composition, altitude, and weather patterns. The maps in *Fig. 13-3* show average depth and average maximum depth of frost penetration.

13.1.4 Surcharge

Additional loads are created by operating automobiles, trucks, or construction equipment on the soil surface behind a retaining wall or basement wall. If activities of this nature are anticipated, the design must make allowance for the increased lateral pressures that will be imposed on the wall.

13.1.5 Overturning and Sliding

Retaining walls must safely resist overturning and sliding forces induced by the retained earth. Unless otherwise required by code, the factor of safety against overturning should not be less than 2.0, and against sliding 1.5. In addition, the bearing pressure under the footing should not exceed the allowable soil bearing pressure. In the absence of controlled tests substantiating the actual bearing capacity of the soil, building codes list allowable pressures for different types of soil. Local requirements may vary slightly and should be checked to assure design conformance.

13.1.6 Expansion and Control Joints

The size and location of expansion or control joints should be calculated on the basis of expected movement. Joints should always be provided at wall offsets and at abrupt changes in height or thickness. Joints should be designed with a shear key for lateral stability, but still allow for longitudinal movement (refer to Chapter 9). Weep-hole openings should be protected at the back to prevent clogging with backfill material.

13.1.7 Materials

Brick masonry for earth retaining structures should be ASTM C62, ASTM C216, or ASTM C652, Grade SW, with a minimum strength of 5000 psi. Hollow concrete units should be ASTM C90 normal weight, with an oven-dry density of 125 lb/cu ft or more. Special interlocking concrete segmental retaining wall block should meet the requirements of ASTM C1372. Mortar should comply with the requirements of ASTM C270, Type M, and grout with ASTM C476. Mortar and grout should be moist-cured for 7 days before backfilling. Concrete for footings should have a minimum compressive strength of 2000 psi, or as required by structural analysis.

13.2 FOUNDATION WALLS

For both residential and commercial buildings, it is often economical to use masonry walls to enclose basements, crawl spaces, or underground parking

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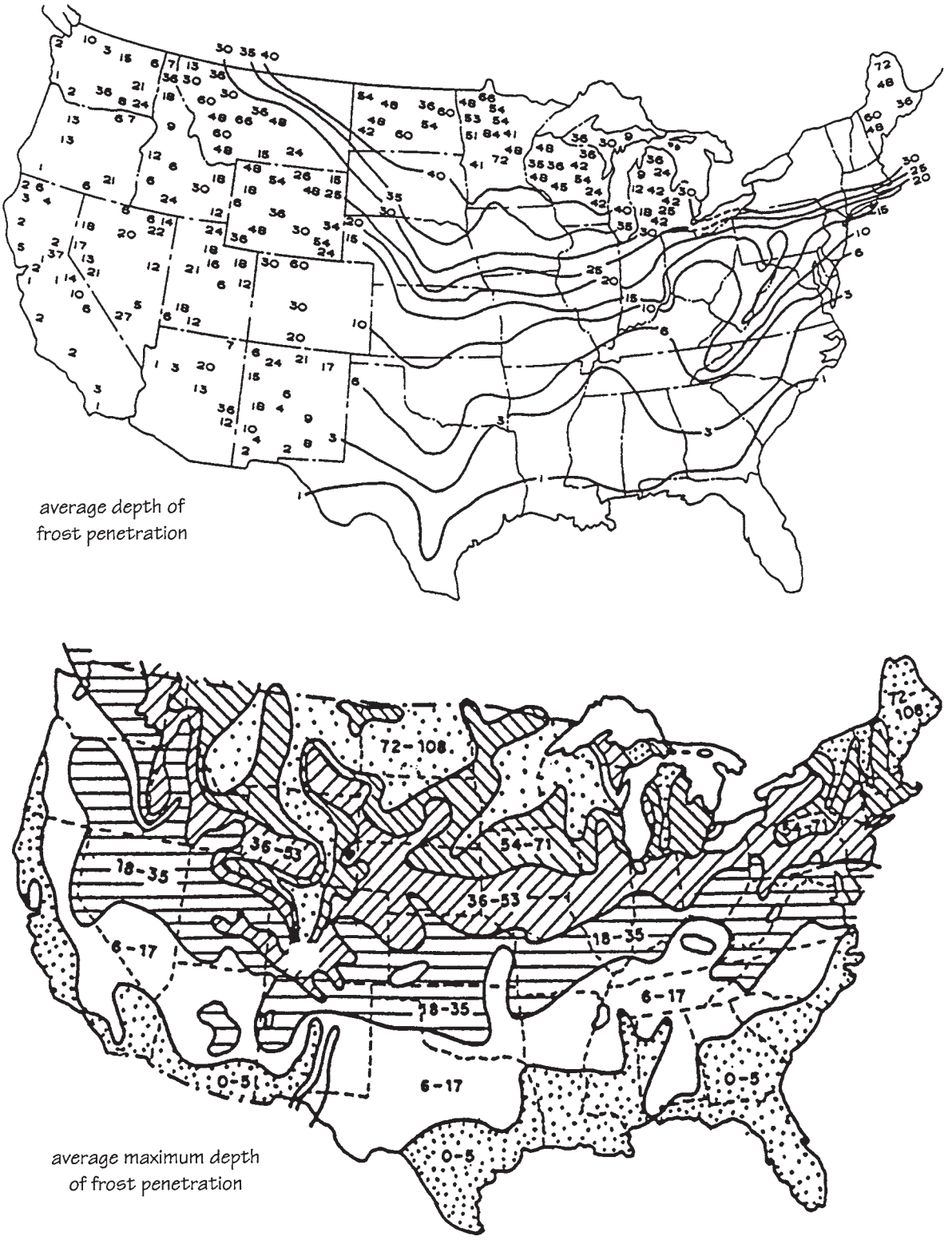

Figure 13-3 Frost depth averages in the continental United States. (*From U.S. Weather Bureau.*)

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