8. Use of dense units and mortar, which absorb moisture through unrepaired cracks and are then slow to dry out

To minimize the possibility of efflorescence, the following measures are of greatest importance:

1. Use only units of low to moderate absorption or specify that the brick be tested for efflorescing potential in accordance with ASTM C67 and rated as "not effloresced."
2. Use only low-alkali, non-staining cements in the mortar.
3. Properly protect materials before and during construction.
4. Install flashing and weep holes, caulking, and sealants at strategic locations to expedite the removal of moisture that has entered the wall.
5. Achieve good bond with compatible units and mortar.
6. Most important of all, construct full mortar joints.

These precautions are particularly important in regions with high annual rainfall. ASTM C1400, *Guide for the Reduction of Efflorescence Potential in New Masonry Walls*, addresses issues of moisture penetration, moisture drainage, design, and construction practices which will minimize the risk of this type of staining.

Efflorescence will often disappear with normal weathering if the source of moisture is located and stopped. Efflorescence can also be dry brushed, washed away by a thorough flushing with clean water, or scrubbed away with a brush.

Clear water repellents are often recommended as a solution to effloresc-ing problems. However, if the water repellent is applied to a wall that still contains both moisture and salts, the resulting problems may be even more damaging than the stain. The water in the wall will still take the salts into solution, and as it migrates toward the outer face, most of it will stop at the inner depth of the water repellent. The water will then evaporate through the surface as a vapor and deposit the salts inside the masonry unit. This interior crystalline buildup (sometimes called *subflorescence*) can exert tremendous pressure capable of spalling the unit face (*see Fig. 16-4*). Clear water repellent applications are generally not recommended as a treatment for efflorescence unless the chain of contributory conditions (moisture, salts, and migration paths) is also broken.

Calcium carbonate stains occur when calcium hydroxide from the mortar is leached to the surface, where it reacts with atmospheric carbon dioxide to form calcium carbonate. The calcium hydroxide (lime) is present not only in portland cement–lime mortars, but in masonry cement mortars as well, because it is a natural by-product of the cement hydration process itself. As the cement cures, it produces 12 to 20% of its weight in calcium hydroxide. Extended saturation of a wall through construction defects prolongs the hydration process and maximizes the amount of lime produced. The excess moisture also carries the calcium hydroxide to the wall surface where it reacts with carbon dioxide in the air to form calcium carbonate (limestone). The stains usually occur as hard, encrusted streaks coming from the mortar joints, and are sometimes referred to as "lime deposits" or "lime run" (*see Fig. 16-5*).

Before calcium carbonate stains can be removed, the source of moisture must be located and stopped. Once that is done, the stain and surrounding area should be saturated with water, and a dilute solution of 1 part hydrochloric (muriatic) acid to 9 parts water applied. With a stiff fiber-bristle

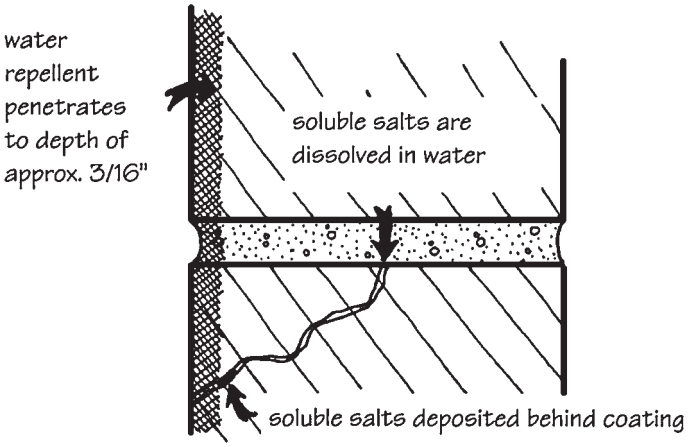

Figure 16-4 Water-repellent coatings can trap salts inside masonry. (*Courtesy Acme Brick Company, Fort Worth, Texas.*)

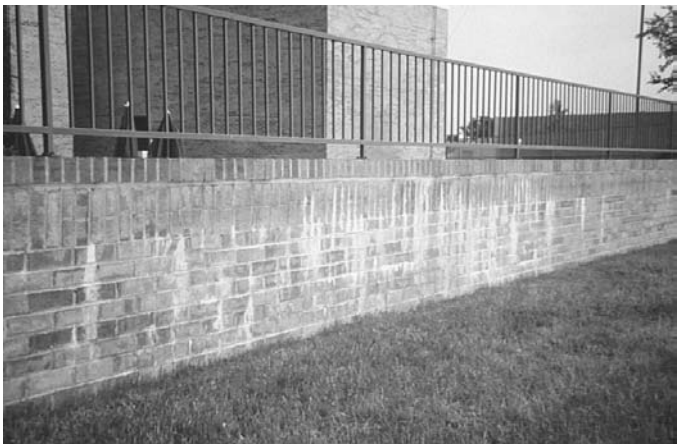

Figure 16-5 Calcium carbonate stain.

brush, the stain can be scrubbed away and the wall thoroughly rinsed with water to remove the acid and residue.

16.2.2 Vanadium and Manganese Stains

Two stains that are peculiar to clay products are green or yellow vanadium stains and brown manganese stains. *Vanadium* salts originate in the raw materials used to manufacture brick, and the stains occur on white or light-colored units. The chloride salts of vanadium require highly acidic leaching solutions, and the problem of green stain often does not occur unless the walls are washed down with a muriatic acid solution. To minimize the occurrence of green stain, do not use acid solutions to clean light-colored brick, and follow the recommendations of the brick manufacturer for the proper cleaning compounds and solutions. If green stains do appear as a result of acid washing, flush the wall with clean water and then wash or spray with a