that drive the pumps are also not 100 percent efficient. To account for the inherent inefficiency of pumps and motors, the formula is modified by an efficiency factors E_p and E_m:

$$\text{hp} = \frac{(F, \text{gal/min})\,(H, \text{ft})}{3960 \times E_p \times E_m}$$

In most pumps and motors efficiency ranges from 50 to 85 percent and 80 to 90 percent, respectively.

Plazas and Patios

The use of plazas or patios in the site plan has become all but essential in most projects. The choices of materials and approaches differ primarily by the type of surface material. All such areas should be designed to be fairly level but with enough pitch to provide adequate drainage. Surfaces should be even and free of trip or slip hazards. The base should be sufficiently substantial to resist loads from expected traffic and to resist frost damage. Surface materials can range from poured concrete, pavers, flagstone, or brick (see Figs. 4.71 and 4.72). The base may be open-graded or impermeable. (Materials are discussed earlier in this chapter.) Bricks and pavers should always conform to the requirements of *ASTM C 902 Specification for Pedestrian and Light Traffic Paving Brick* or *ASTM C 1272 Specification for Heavy Vehicular Paving Brick,* depending on the expected volume and weight of traffic. *ASTM C 1272*– compliant brick is not necessary for most landscape and site planning functions. While the dimension tolerances and chip resistance are important, the critical elements in selecting brick or pavers for a patio are the durability and abrasion of the material.

Durability is graded as Nx, Mx, and Sx. Nx pavers or bricks should be used only for interior applications where wetting and freezing will not be issues. Mx and Sx pavers are used for exterior applications, but Sx is selected where freezing will occur. Abrasion resistance is graded as either type I, II, or III in decreasing resistance to abrasion. Type III pavers are adequate for residential or light-duty patios. Type I pavers are used for heavy traffic areas including driveways or commercial entrances. Type II pavers might be selected for restaurant entrances or similar situations.

Although concrete provides a durable and cost-competitive surface, it offers little in the way of esthetic contribution to the project. Many concrete stains and patterning methods exist to improve the appearance of poured concrete. The use of such additional steps may reduce or even eliminate the cost savings. The use of color or stains on concrete may be affected by the aggregate used in the mix. If coal ash is used, tests should be done to determine if it will affect any color applied to the concrete.

Brick paving is attractive and durable if properly specified materials are used. Brick surfaces may be either rigid or flexible depending on whether or not mortar is used to set the brick. Mortarless patios are the most common form, and they may be set over a wide range of base materials. This type of paving is at least minimally porous to allow for some infiltration of precipitation. It is