Figure 5-11 Rubble stone veneers.

becoming softer in shape without losing their sense of strength and durability. Elaborately carved ornaments and lettered panels require stones of fine grain to produce and preserve the detail of the artist's design.

The compressive strength of stone was of great importance when large buildings were constructed of loadbearing stone walls and foundations. Today however, stone is more often used as a thin veneer over steel, concrete, or unit masonry structures, or as loadbearing elements only in low-rise structures. In these applications, the compressive loads are generally small, and nearly all of the commonly used building stones are of sufficient strength to maintain structural integrity.

In terms of practicality and long-term cost, durability is the most important consideration in selecting building stones. Suitability will depend not only on the characteristics of the stone, but also on local environmental and climatic conditions. Frost is the most active agent in the destruction of stone. In warm, dry climates, almost any stone may be used with good results. Stones of the same general type such as limestone, sandstone, and marble differ greatly in durability, depending on softness and porosity. Soft, porous stones are more liable to absorb water and to flake or disintegrate in heavy frosts, and may not be suitable in the colder and more moist northern climates.

Figure 5-12 Stone veneer slabs.

Weathering of stone is the combined chemical decomposition and physical disintegration of the material. The thinner the stone is cut, the more susceptible it is to weathering. Marble naturally has a lower fatigue endurance than other stones, and there are a number of variables that affect its strength and stiffness. Certain environmental conditions will weaken marble over time, causing panels to fracture, crumble, or bow.

Most stone used for exterior building construction is relatively volume-stable, returning to its original dimensions after undergoing thermal expansion and contraction through a range of temperatures. Some fine-grained, uniformly textured, relatively pure marbles, however, retain small incremental volume increases after each heating cycle. Marble is actually composed of layers of crystals, and repeated thermal and moisture cycles tend to make these crystals loosen and slide apart. The marble becomes less dense when it expands during heating, but does not return to its prior state during the cooling cycle. This irreversible expansion is called *hysteresis.* In relatively thick veneers, the greater expansion on the exposed exterior surface is restrained or accommodated by the unaffected interior mass. In thin veneers, however, dilation of the surface region can easily overcome the restraint of the inner layers, causing a dishing effect because the greatest expansion is across the diagonal axis.

Expansion of the exterior face of marble panels increases the porosity of the stone and its vulnerability to attack by atmospheric acids and cyclic freezing. Thermal finishes, in addition to reducing the effective thickness of marble and granite panels, also cause micro-fracturing of the stone. The microcracks, in turn, permit moisture absorption to depths of at least ¼ in., which can result in physical degradation if the stone freezes while it is saturated.