Physical Properties and Minimum ASTM Requirements

Stone Type	Maximum Absorption by Weight, ASTM C97 (%)	Minimum Density, ASTM C97 (%)	Minimum Compressive Strength, ASTM C170 (psi)	Minimum Modulus of Rupture, ASTM C99 (psi)	Minimum Abrasion Resistance ASTM C241 (hardness)	Minimum Flexural Strength, ASTM C880 (psi)	Maximum Acid Resistance, ASTM C217 (in.)	Thermal Expansion Coefficient (10^{-6}/°F)	Modulus of Elasticity (psi)	Ultimate Shear Strength (psi)	Ultimate Tensile Strength (psi)
Marble ASTM C503								3.69–12.30	1,970,000 to 14,850,000	1638 to 4812	50 to 2300
I. Calcite	0.20	162	7500	1000	10	1000	N/A				
II. Dolomite	0.20	175	7500	1000	10	1000	N/A				
III. Serpentine	0.20	168	7500	1000	10	1000	N/A				
IV. Travertine	0.20	144	7500	1000	10	1000	N/A				
Limestone ASTM C568								2.4–3.0	3,300,000 to 5,400,000	900 to 1800	300 to 715
I. Low Density	12.0	110	1800	400	10	—	N/A				
II. Medium Density	7.5	135	4000	500	10	—	N/A				
III. High Density	3.0	160	8000	1000	10	—	N/A				
Granite ASTM C615	0.40	160	19000	1500	—	—	N/A	6.3–9.0	5,700,000 to 8,200,000	2000 to 4800	600 to 1000
Quartz-based stone ASTM C616								5.0–12.0	1,900,000 to 7,700,000	300 to 3000	280 to 500
I. Sandstone	20.0	135	2000	300	8	—	N/A				
II. Quartzite Sand-stone	3.0	150	10000	1000	8	—	N/A				
III. Quartzite (Bluestone)	1.0	160	20000	2000	8	—	N/A				
Slate ASTM C629								9.4–12.0	9,800,000 to 18,000,000	2000 to 3600	3000 to 4300
I. Exterior	0.25	—	—	across grain 9000	8	—	0.015				
II. Interior	0.45	—	—	along grain 7200	8	—	0.025				

Figure 5-1 Properties of building stone.

Durability of stone, or its resistance to wear and weathering, is also considered roughly analogous to silica content. This is perhaps the most important characteristic of stone because it affects the life span of a structure. The stones traditionally selected for building construction have exhibited almost immeasurable durability compared to other building materials.

5.3 PRODUCTION

Stone is quarried from its natural bed by various techniques, depending on the nature of the rock. The most basic, and the oldest, method is drilling and splitting. With stratified material such as sandstone and limestone, the process is facilitated by natural cleavage planes, but also limited in the thickness of stone that can be produced. Holes are drilled close together along the face of the rock, and plugs and wedges are then driven in with sufficient pressure to split the rock between holes. For stratified rock, holes are drilled only on the face perpendicular to the bed, but non-stratified material must be drilled both vertically and horizontally. Channeling machines are often used on sandstone, limestone, and marble, but cannot be used with granite or other very hard stone. Wire saws are now used by most stone producers to cut a smoother surface, reduce the required mill finishing, and to subdivide large blocks of stone for easier transport, handling, and finishing.

The first stones cut from the quarry are large, with rough, irregular faces (*see Fig. 5-2*). These monolithic pieces are cut or split to the required rough size, then dressed at the mill with power saws and/or hand tools. Finished stone surface textures may vary from a rough rock face to a more refined hand-tooled or machine-tooled finish. For thin facings of marble or granite, gang saws cut several slabs from a block of stone at the same time. Although the sawing is a slow process, the surface it produces is so even that much work is saved in later dressing and polishing. Other saws, such as chat saws, shot saws, and diamond saws, are used to cut rough blocks of stone to required dimensions. Each type of saw produces a different surface texture.

In the 1970s the Italian stone industry developed new technology that enabled it to produce thin sliced marble and granite panels that were light enough to clad high-rise buildings and inexpensive enough to dress the lobbies of speculative office buildings. Diamond-studded cables were devised to cut large blocks of stone from the quarry with little waste, and large diamond-tipped blades were ganged together to cut the slabs into ¾-, 1¼-, and 1½-in. thicknesses. Ultra-thin marble and granite tiles could also be cut in ¼- and ⅜-in. thicknesses and then gang-ground and polished with large multi-headed machines. While the cost of other cladding materials went up, the price of stone came down because of this new capability of producing more surface for less cost. Between 1980 and 1985, the use of travertine in the United States increased 600%, marble 625%, and granite an astonishing 1735%.

For exterior use, a minimum thickness of 2 in. is usually necessary. The use of veneers less than 2 in. thick is still relatively new compared to the long history of stone masonry, and much is still being learned about their in-service behavior and long-term performance. Thinner stone veneers typically are more problematic.

In addition to sawed finishes, stone may also be dressed with hand or machine tools. Planing machines prepare a surface for hammered finishes, for polished finishes, and for honed or rubbed finishes. A carborundum machine, used in place of a planer, will produce a very smooth finish. Honing is accomplished by rubbing the stone surface with an abrasive such as silicon carbide or sand after it has been planed, while a water spray is used to control