Granite and Marble

Two types of stone, granite and marble, have been used since ancient times for building, decoration, and sculpture. Granite is used particularly in applications that require great resistance to weathering, such as in monuments, tombstones, road curbings, building facings, and foundations.

Granite is the most common igneous rock (formed from solidified magma), and is found in masses that may extend for tens or hundreds of miles. Granite varies in color and is usually light, with gray predominating, but is also found in pink, yellow, red, and green. The coloration is determined by impurities in granite's most dominant mineral constituents, feldspar and quartz. Other components of granite include muscovite, biotite, pyroxene, and hornblende.

In addition to its pleasing colors, granite has several other advantages: it possesses great strength and durability, has a homogeneous texture, and is not too difficult to work with. Granite is the hardest of all building stones. Disadvantages include its rough surface (which takes on a dirty appearance) and its tendency to spall, or crumble, when directly exposed to fire. Prior to World War II, the widespread use of macadam and concrete for roads, along with the occurrence of the Great Depression of the 1930s (which brought construction to a virtual standstill), caused a downturn in granite production that lasted until the post-war building boom.

Marble, a metamorphic rock usually derived from limestone (in which the calcite has been recrystallized), is a favorite stone of architects because of its beauty and the ease with which it can be worked, as well as the warmth of its polished surfaces. The calcite grains in marble reflect light penetrating through minute cracks in the surface, producing a luminescence. Marble's resistance to abrasion makes it popular for stair treads and flooring. The hardness of marble is 3 on the Mohs scale. Marble has been used in constructing such famous landmarks as the Parthenon in Athens, the Taj Mahal in India, the Lincoln Memorial in Washington D.C., and St. Peter's Basilica in Rome.

Because granite and marble have been extensively used since ancient times, quarrying of the stone was a major industrial activity. Beginning in ancient Egypt, granite or marble quarries were the sites for large construction projects. From these sites, the Egyptians could move blocks weighing up to a million kilograms, hauling them to distant building sites. Most of these quarries were open-faced, though workers could extend tunnels several hundred meters into cliffs to reach inclusions of high-quality granite or marble.

After stripping away the top layers of dirt and weathered stone, rows of holes were drilled into the exposed rock with metal bow drills. Wooden wedges were driven tightly into the holes, then doused with water; the wood absorbed the water, which expanded the wedges enough to crack the rock along the line of holes. Since granite is much harder than marble, workers used not only picks but also pounding balls of dolerite (a very hard, coarse basalt) weighing up to 5 kg. Wherever possible, workers took advantage of natural joints in the rock to facilitate easy splitting.

In modern granite-quarrying operations, similar methods are used to split the blocks. Holes, about 2 cm, are drilled 8–13 cm into the rock; inside each hole is placed a set of steel "feathers" (half-round shims) and a wedge plug. The plug is successively driven between the feathers; the force is eventually sufficient to split the rock.

Marble blocks are quarried with the same technique, though the softer marble requires the drilling of deeper holes. Wire saws may also be used—a single-strand or three-strand wire runs as a belt over the rock, cutting by abrasion as sand and water are fed into it. Explosives are almost never used for marble quarrying because of the danger of shattering the rock.

Masons finished rough marble stones to the proper dimensions at the building site itself, using metal chisels and mallets, squares, plumb bobs, and straightedges. Such tools remained standard until the 1800s, when power machinery and explosives began to be widely used. Mill sawing of marble into slabs is currently done with parallel iron blades fed by sand and water. For finishing, marble may be machined with lathes and carburundum wheels.

In quarrying, at least one half of the marble is wasted because of breakage. The waste marble is crushed or powdered for use in stucco or mosaics. Small spheres made of waste marble chips—called "marbles"—were used in 17th-century childrens' games; toy marbles are now usually made out of glass.

Since granite is the hardest and most durable of typical building stones, historically it was the most widely used material for foundations and structural work. The Egyptians used both granite and marble, as well as quarried sandstone and limestone, for their massive constructions. The Romans imported marbles and granites of different colors from various parts of the Empire. They treated marble mainly as a decorative rock, setting it into cement or applying it in slabs to cover brick walls. The Romans also used marble for pavement that was set in geometric patterns or mosaics.

Marble is perhaps most famous, however, for its prevalent use in fine sculpture. Granite, with its salt-and-pepper coloring and irregular glinting from embedded mica and quartz crystals, is much less favored than the fine, nearly translucent white marbles. The practice of sculpting in marble started in ancient Greece and continued through the Renaissance to modern times. Michelangelo, Donatello, and Antonio Canova used marble, as did their ancient predecessors Phidias and Praxiteles.

Typically, a sculptor starts with a block of stone and a pointed chisel, knocking off large chunks that will not be included in the finished piece. Holding the chisel at an acute angle, the sculptor roughs out the approximate shape of the statue, paying close attention to the grain or stratification of the marble, since a misdirected blow could disastrously split the piece. Carving around the stone, the sculptor crisscrosses the direction of each set of trimming. The detail work is completed with successively finer chisels, rasps, files, and abrasives, until the finished sculpture is polished.

Today, unfortunately, the widespread use of fossil fuels in our industrialized society poses a theat—in the form of "acid rain" and other pollution—to marble sculpture and fine stonework displayed outside. Sulfur dioxide in the air transforms calcite on the surface of the marble into gypsum, and the process of recrystallization causes severe damage to the stone. Migrating salts, such as nitrates or chlorides, also harm the internal structure of marble as they travel into deep pores and expand during recrystallization. Many efforts are currently underway to protect and restore classic works of architecture and sculpture.

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https://doi.org/10.1557/S0883769400047199 Published online by Cambridge University Press

Contents of Volume 16, number 5, May 1993

https://doi.org/10.1557/S0883769400047199 Published online by Cambridge University Press

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