

Imitating Nature's Rock Features

With a Little Help from Specialized Shotcrete Rock-Carving Techniques

By Oscar Duckworth

It is said that imitation is the greatest form of flattery; but in the case of imitating nature's many natural rock features, Mother Nature can be quite elusive. It may appear simple to recreate common stone formations by duplicating their shapes, patterns, and colors in concrete. Natural stone's complex texture and mineral variations, however, can make the accurate reproduction of even the simplest stone formations seem dull and unrealistic.

Texturing concrete surfaces to resemble natural stone has been a common architectural feature since the first use of concrete. Genuine stone walls or natural rock formations carry far more visual interest than ordinary concrete surfaces. Historically, concrete features constructed to resemble stone have been either hand-textured, precast, or created with conventional form liners. Although precast concrete technology has made huge steps in duplicating natural stone qualities, form liners and other conventional cast-in-place methods fall short of capturing the intricate, random features of natural rock formations.



Fig. 1: Large sandstone formation displays common iron pigmentation and layered texture. Note the similar angle of the fracture lines

Recently, concrete artisans have adapted specialized shotcrete placement techniques to realistically duplicate stone's complex shapes and textures by carving these features into freshly applied shotcrete. Pneumatically applied shotcrete's unique placement method provides a medium to duplicate random shapes and surface textures that is superior to any other available method. Skilled shotcrete craftsmen manipulate shotcrete's qualities by creating shapes, textures, and colors to realistically replicate nearly any desired stone formation's appearance.

Identifying the Stone's Prominent Features is the First Step

Different stone formations display unique shapes, textures, and colors that are common to that type of stone. Prominent minerals within a formation will impart specific signature colors. Iron is the most common mineral found within rock and soil. Iron-bearing materials will show a rich red to tan coloration, whereas other minerals may display beautiful green, blue, and black hues. Igneous and metamorphic formations can appear as blended shapes or carry evidence of extreme heat and pressure. Igneous basalt features may resemble beautiful vertical columns with prominent angular features so perfectly formed they can appear man-made. Sedimentary formations usually display a richly colored, stacked, multi-layered appearance with well-defined fracture lines that may not follow a horizontal plane.

Sedimentary sandstone formations are common in the western U.S. Prominent sandstone outcroppings are typical features in hilly areas (Fig. 1). In this region, large shotcrete earth retention walls are often carved, textured, and colored to resemble these local stone formations. Rock-carving experts will replicate a sedimentary sandstone formation by manipulating the freshly placed shotcrete surface with trowels, cutting tools, and unique texturing devices. Skilled nozzle men work from photographs or renderings to emulate random, irregular surfaces common to local stone formations. Finishers then carve ledges, fracture lines, and

outcroppings into the freshly applied material (Fig. 2). After the initial shape has been established, a release agent is generously applied to the fresh work. Final texturing is then tediously impressed into the plastic shotcrete by the use of texture pads or other devices (Fig. 3(a) and (b)). This essential step adds a realistic appearance to the finished product by creating an intricate final surface in which to blend the colors.

High-Quality Details Require High-Quality Methods

Many carved shotcrete walls provide a realistic effect with only a minimal amount of detail work. Carved walls surrounding freeways or work visible only from great distances need not display intricate surface textures to capture the appearance of a stone outcropping. Highly visible walls or work within sight of the public may require accurate duplication of local features, high-quality surface textures, and complex coloration.

Boulderscape, Orange County, CA, has been an industry leader in the design and construction of carved, colored shotcrete walls for nearly twenty years. Steve Jimenez, Operations manager at Boulderscape, states that “specific projects call for unique placement procedures.” Large custom homes with rock work around pools, spas, and small lakes require the highest in rock detail. To create a carved rock feature that is acceptable in these environments requires planning and highly skilled artisans. Once the visuals for the project have been approved by the client, the creation of the reinforcing bar structure and rock panels begins. Many high-end rock-work projects require special custom-cast work.

Cast creations start by locating a natural rock formation that closely resembles what is proposed for the project. After getting permission from the landowner, a release spray is applied over the natural rock formation. A urethane is applied in several coats to the rock formation. After the urethane has cured, fiberglass is applied over the urethane. The cured coating is cut into large panels, numbered, and delivered to the job site for custom rock panel fabrication.

The panels are now used as molds to create cast rock panels. While the panels are being created, reinforcing bars are doweled into the existing pool, spa, or lake edge. The reinforcing bar is shaped and tied to produce a rough outline of the final rock formation. Stainless steel threaded dowels of 5/8 in. (16 mm) in diameter are located where each casting will be placed. When all reinforcing bar and threaded rods have been tied in, the structural shotcrete layer is

placed. The shotcrete must encase the reinforcing bar by a minimum of 2 in. (50 mm) on all sides of the reinforcement. The structural shotcrete thickness will range from 5 to 8 in. (130 to 200 mm).

After the shotcrete has cured for a minimum of 48 hours, the hanging of the casting panels will begin (Fig. 4). Holes are drilled through the casting panels where the threaded rods are located. The threaded rods are guided through



Fig. 2: Finisher carves initial fracture lines into freshly placed shotcrete



Fig. 3: (a) Texture pads; or (b) common paint rollers covered in aluminum foil impart intricate surface textures



Fig. 4: Reinforcing bar and structural shotcrete being installed in preparation for the hanging of castings



the casting panels. The rods (stainless steel) receive a nut and washer and are tightened against each of the casting panels. Once all the casting panels are installed, grout is pumped behind the casting panels, filling in all voids between the panel and the shotcrete substrate (Fig. 5(a), (b), and (c)).

Casting usually makes up 60 to 70% of a casting project. Castings can only fit in certain areas of a rock project. When you include multiple cascading waterfalls, swim-in grottos, underwater swim caves, wine bars, and other add-on features, castings become too complicated for the tight areas. This takes away from the natural appearance.

Where castings don't fit, detailed hand carving must fill the gaps. Highly detailed hand-carved rock work requires special mortars that will retain intricate textures. This mortar is applied over the structural shotcrete layer. Once the mortar has been applied, urethane texture mats taken from the same rock the casting panels were made from are used. The artisans, well-versed in geology and concrete artistry, will carve all the necessary strata, fracturing, and exfoliations so they match the geological theme produced by the cast panels already installed. Once the texture mortar has cured, stains are applied to create the varying colors found in the natural geological formation from which the panels were cast (Fig. 6).

Rock Carving in Paradise

Greg Perrin, CEO of American Standard Concrete Pumping, Honolulu, HI, creates beautiful landscape features using shotcrete rock-carving techniques. Blending carved rockscape features with Hawaii's dramatic natural landscape presents

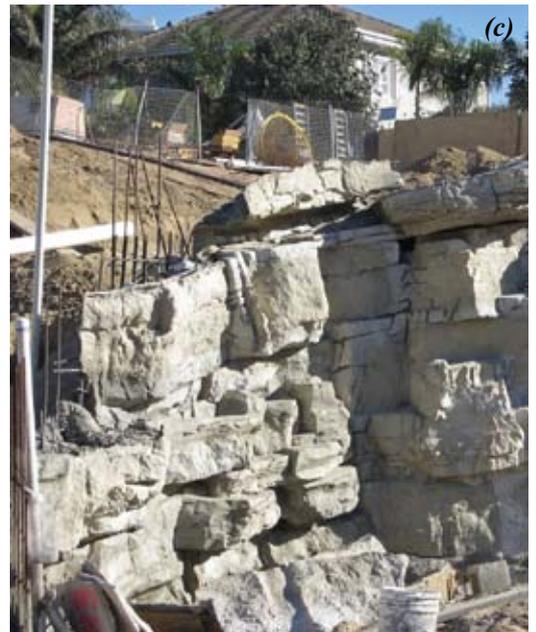


Fig. 5: (a) Hanging; (b) grouting; and (c) final hand-blending of castings

unique challenges to the area's concrete artisans. Hotels, resorts, and private landowners desire elaborate, natural appearing landscape or water features that are similar to local rock formations. "We shoot using various nozzle techniques to create a porous, deformed surface. The carve team follows the nozzleman, who creates the initial rock shape. The artisans carve using carpet knives, dental tools, and scrapers to add the rock lines. It is very important to not make rounded lines in the rock carving, as most rock faces do not have round lines but, rather, straight edges with sharp breaks. As the carving progresses, the nozzleman may choose to add more dimension to areas of the rock-carved wall surface. The surface is rubbed with hand gloves, paint brushes, and wire brushes to impart the various surface textures common to Hawaii's local stone," says Perrin.

Color Choices Add Realism

Natural stone formations gather their intricate color and patina from pigments formed by exposure to mineral deposits over immense time. Most professional stone artists color pigments use similar naturally occurring mineral-based coloring components as the actual stone formations they wish to duplicate (Fig. 7). Commercially available coloring agents containing ferro sulphate, copper sulphate, and many nitrogen-based fertilizer products can impart a permanent mineral deposit into the cementitious paste portion of the shotcrete surface. Their permanent effect is similar to leaving a rusty metal wrench on a wet garage floor for the winter.

Perrin's island-style carved rock surfaces require accurate surface coloration to add realism to the feature (Fig. 8(a) and (b)). "Initial coloring is applied to the cracks to develop definition. This highlights the individual rocks and will help identify any final changes needed. Hawaii's basalt and lava formations are dark brown to black with tan, red, or orange tones. When matching these colors, it has been our experience to begin with light, diluted colors and add multiple layers to darken as we see what the mix will produce. Always try to start in an area least viewable if possible." Accurate coloration is an essential step in creating believable, realistic rock formations in concrete. Professionals may use many different pigments applied at different times to generate an authentic-looking concrete surface.

Common Details Can Create the Desired Effect

The simple carved rock detail in Fig. 9 adds excellent visual interest to a very old gunite (dry-mix shotcrete) wall. Common tools and methods were used to create this surface during

the construction of this wall. Coloring, if required, was a basic mineral stain applied with a sprayer or sponge. These common details are still popular choices for new architectural shotcrete wall surfaces. Landscape details, such as providing irrigated planting areas within the work, introducing climbing vegetation, or planting indigenous trees nearby can add natural beauty to any carved shotcrete wall.

Shotcrete specialty contractors use carved shotcrete methods to create realistic boulders,



Fig. 6: Finished view from poolside toward grotto. Four waterfalls and one misting ledge (right side of photograph) are included in this face



Fig. 7: Carved rock feature accurately depicts local volcanic basalt formation

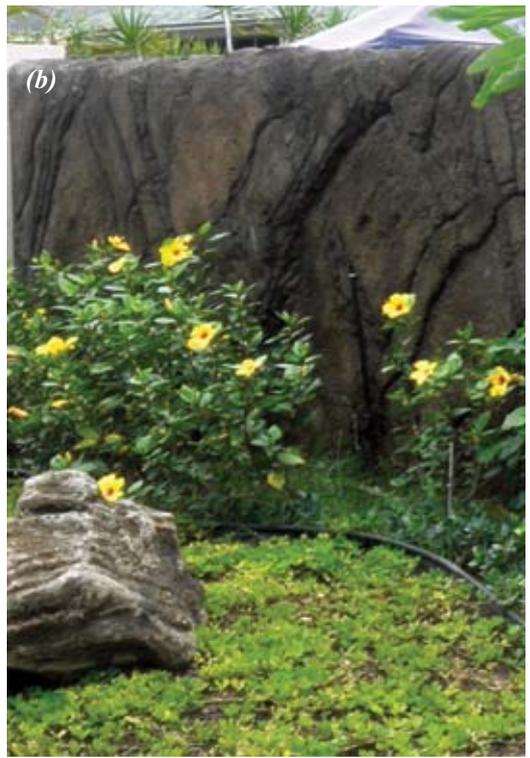


Fig. 8(a) and (b): Subtle coloration differences created by multiple applications of various mineral-based stains accurately emulate Hawaii's natural volcanic rock formations



Fig. 9: Eighty-year-old hand-textured concrete wall displays timeless beauty

rock outcroppings, and stone ledges that can add spectacular visual interest to landscaping, water features, or other site work. The shotcrete process eliminates historic barriers to creating random shapes and surface textures with traditional cast concrete construction methods. Skilled shotcrete artisans routinely duplicate natural stone's intricate features so precisely that it can be difficult to distinguish the shotcrete reproductions from the genuine stone.

Natural stone is the world's oldest, most imitated construction material. While it may never be possible to exactly reproduce genuine stone's random shapes, textures, and colors, using shotcrete rock-carving techniques is the ideal method to create the desirable visual qualities of natural rock features.

All photos courtesy of Steve Jimenez, Operations Manager, Boulderscape, Orange County, CA, and Greg Perrin, CEO, American Standard Concrete Pumping, Honolulu, HI.



*ACI Certified Nozzleman **Oscar Duckworth** is an ASA and ACI member with over 15,000 hours of nozzle time. He has worked as a nozzleman on over 2000 projects. Duckworth is currently an ACI Examiner for the wet- and dry-mix process. He continues to work as a shotcrete consultant and certified nozzleman.*