Tile and Stone Finishes for Restrooms

Values, challenges, and avoiding failure

by Donato Pompo, CSI, CDT, CTC, MBA

Ceramic tile, natural stone, and glass tile not only add elegance and value to restrooms, but these finishes are also ideal for hospitality, institutional, and multi-family dwelling projects where longevity is essential. Their look can also help achieve the upscale image important for hotels and condos that want to add value to support their high-end offerings. However, these finishes also come with some important moisture-related considerations. In an increasingly litigious environment, there is a growing challenge to ensure tile and stone bathroom selections are suitable for their application, and installed correctly, to avoid failures and the ensuing lawsuits.

As one might expect, there are tradeoffs with the various types of stone and tile finishes. The problem is most specifiers—and their suppliers—do not fully understand these tradeoffs when it comes to a restroom setting. However, selecting the right product for the appropriate application is only the first important step; the next one is to make sure it gets installed correctly.

Photo courtesy Ceramic Tile and Stone Consultants

The major cause of tile and stone failures in bathrooms is faulty installation, often caused by labor error, bad design, or an unfortunate combination thereof. While there are some excellent standards provided by the Tile Council of North America (TCA), the American National Standards Institute (ANSI), the Ceramic Tile Institute of America (CTIOA), and the Marble Institute of America (MIA), there still seem to be two primary problems:

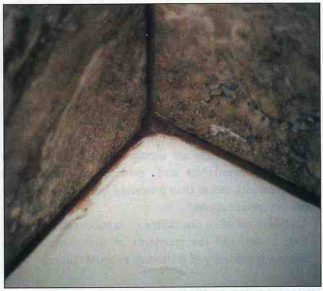
1. Too often, specifiers are simply calling out the various reference standards and general quality control requirements, rather than providing specific and detailed project specifications.
2. Installers are often not skilled or experienced enough to fully understand the standards or the comprehensive approach necessary in restrooms to avoid failures.

This photo illustrates carpeting at the shower receptor. There is water damage along the transition joint and under the carpet.

Water intrusion problems

The predominant failure in bathrooms is due to water intrusion, normally in the shower area. This can be particularly expensive when mold develops, but it is important to understand mold is not the cause of the problem, but rather a symptom of a water intrusion problem. With the number of cases that have been in front of the courts over the last several years, it is clear the presence of mold can lead to expensive litigation and a pricey remediation process.

As such, it is critical to understand where failures normally occur, and then design and install the bathroom tile and stone correctly to avoid water intrusion problems. The only



Photos courtesy Ceramic Tile and Stone Consultants

The photo at left illustrates the application of a moisture barrier over the flashing for a tub installation. At right, horizontal and vertical joints are properly caulked with a proper sealant.

way to ensure a successful installation is to write complete and specific specifications and to employ a detailed quality control process throughout the installation process.

Slippery When Wet?

ASTM International's static coefficient of friction test (ASTM C 1028, *Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-meter Method)* has been the norm for gauging slip resistance in the ceramic tile industry for years. Most agencies call out codes and recommendations based on this test, while manufacturers use it to imply the slip resistance of their tiles. The test has recently been withdrawn from ASTM testing standards, but is expected to be adjusted and renewed.

Various testing laboratories and the Ceramic Tile Institute of America (CTIOA) have reported ASTM C 1028 is unreliable in determining whether a ceramic tile surface will have a propensity to be slippery. CTIOA is now recommending the more reliable British Pendulum Test for the field testing of ceramic tile to determine their tendency to be slippery. It has been reported the adjusted ASTM C 1028 test will only be promoted as a measure of the texture of the tile, and will not suggest its slipperiness. As such, this author recommends using both test methods.

Considering the number of failures in bathroom showers (and their ensuing cost), one might think a substantial amount of attention and effort should be focused in this space during the design and construction process. It has been extrapolated the amount of water to which a shower environment is subjected, based on one person taking a 12-minute daily shower in an average-sized stall with reasonable water pressure and an appropriate shower head, can be the equivalent of a roof being hit by more than 25.4 m (83 ft) of water annually.[1] Nevertheless, tile and stone restroom finishes simply do not get the attention they deserve during design and installation. Architects should employ the services of outside tile and stone consultants as they do with other products and applications.

Product suitability

Ceramic tile, natural stone, and glass tile can be excellent finishes for restroom floors, walls, ceilings, and showers. However, not all tiles and stones are equal and one must consider the desired performance when specifying materials. For example, the floor finish must be slip-resistant enough to be safe and meet presiding codes such as the *Americans with Disabilities Act (ADA)* requirements for public areas (See "Slippery When Wet?"). On the other hand, when the floor is too textured, it can become unsightly and lead to maintenance problems.

None of the finishes discussed in this article are waterproof in themselves, so they need to be installed with an installation system that provides waterproofing. Some types of stone are more durable, porous, and water-sensitive than other stones and thus need to be properly treated and

maintained in wet areas. Additionally, some products are more hygienic in the respect they do not as readily retain contaminates (germs) and can be more readily sanitized; these finishes are often easier to maintain than others, which can also be critical in public restrooms.

This author has seen far too many bathrooms with a nice tile or stone finish, where the abuse at the urinals causes an unsightly and unhealthy condition. The problem is usually poor maintenance, combined with the use of a product unsuitable for the application. A maintenance plan should be clearly called out in the specification relative to the intended use.

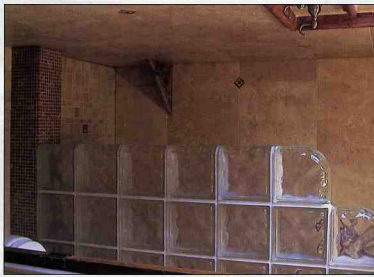
Natural stone

Natural stone can be used in bathrooms and showers, but these products are going to require more maintenance, with the level differing between material types. For example, granite is typically very dense and resistant to chemicals and moisture. Other products, like some limestones and travertines, are normally more sensitive to moisture and staining, while those in the marble family tend to be more sensitive to chemicals and scratching.

Even within one category of stone, the physical properties of various sources can vary tremendously, depending on the location and the timing of its extraction from its source. As such, a particular type of limestone from one source might be relatively dense and moisture-resistant, where another source for this same type of material could yield something very porous and relatively moisture sensitive.

Since stone is a natural resource, it cannot be manufactured to meet performance requirements; rather, the material must be selected to meet those requirements. There are industry standards for testing each category of stone to understand the physical properties and limitations. MIA recommends stone be tested to determine whether it meets the ASTM standards for that particular type of material:

- ASTM C 503-99e1, *Standard Specification for Marble Dimension Stone;*
- ASTM C 568-99, *Standard Specification for Limestone Dimension Stone;*



Regardless of the finish, when a material is specified for a restroom environment, one must understand all the design implications to ensure there is protection again water intrusion problems.

- ASTM C 615-99, *Standard Specification for Granite Dimension Stone;* and
- ASTM C 1527-02, *Standard Specification for Travertine Dimension Stone.*

There is also a test for determining the moisture sensitivity of a stone called the Gabbrielli British Standards (BS) EN 14617-12, *Dimensional Stability Test.* Suppliers should provide the results of these tests for the current stones they are offering, and architects should require these results as part of their quality control and performance requirements of their specifications.

Ceramic tile

While ceramic tile is not 'naturally' made, it comprises natural products such as clay, feldspar, and water, which are then kiln-fired. Ceramic tile comes in many forms and its performance and suitability vary substantially. For example, it can have a glazed surface, which, depending on composition and application, affects the surface, making it more or less impervious, slip-resistant, abrasion-resistant, and/or chemical resistant. The other category of ceramic tile is unglazed ceramic or through-body tile. Again, physical properties depend on the clay body composition and how it was manufactured.

Porcelain tiles are made up of ultra-purified, highly ground kaolin clays with silica and feldspar additives that provide an impervious body. The porcelain tile can be made with or without a glazed surface, which has an impact on its visual and performance characteristics. The quality and price of this category of ceramic tile can also vary drastically, depending on how it is manufactured.

Porcelain tends to be a very durable finish, but there are cases where other types of tile are more suitable for certain applications or designs in terms of aesthetic appeal or flexibility. (For example, most residential applications do not require the level of physical performance of porcelain—other clay body tiles are quite suitable and will perform well.) ANSI 137.1, *American National*

Standard Specifications for Ceramic Tile, can help qualify what is standard-grade material. It is currently being updated to include newer products. It is also important to make certain the tile's manufacturer recommends it for the project's intended use.

Glass tile

Glass tile is also made of natural products. There are generally two basic categories—cast and fused—but there is art glass used for certain applications. The glass properties require the use of the most stable substrates and specific installation methods and products. Some glass tiles are limited to wall use, but others can be employed on floors of limited use. The proper use of expansion joints is particularly important, and is explored later in this article.

There are currently no ANSI material standards for glass tile, but some ANSI and TCA standards for the installation of glass tile will soon be published. It is important to verify the suitability of the glass tile and to ensure it is installed correctly with the appropriate products. There are many smaller manufacturers who do not provide testing on their products, although a few larger companies do.

One recurring problem concerns glass mosaics being mounted on unsuitable backing. The intent is to provide +305 x 305-mm (+12 x 12-in.) sheets of glass mosaics to facilitate the installation of the small tiles. However, the mounting might have excessive webbing or glue limiting adhesion to the tile. Another problem is some of the backing is paper or water-sensitive glue unsuitable for wet areas such as pools and showers.

At this time, the only standard one can reference is the aforementioned ANSI A 137.1. Section 5.1.1.2.9 (unglazed tile) states back- and edge-mounted tile assemblies must have sufficient exposure of tile and joints surrounding each tile to comply with bond strength requirements. Manufacturers of the tile assemblies should specify their suitability for wet or exterior areas.

Bathroom installation guidelines

Restrooms are either considered "wet areas" or "limited water exposure areas" under the definitions set out in the *TCA Handbook.* The former can be anything from a steam room to a shower, while the latter is generally a surface subjected to moisture, without becoming saturated. Of course, anywhere in a bathroom could become a wet area under the wrong circumstances—where there is plumbing, there is a potential moisture problem. Industry standards and practices normally recommend a waterproof membrane on bathroom floors outside the wet areas, and this author always specifies it as such.

Photo courtesy Ceramic Tile and Stone Consultants

Water damage seen on water sensitive wood floor, which should not be within 610 mm (24 in.) of the wet area.

There are many great products meeting ANSI A 118.10, *Load-bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installations,* which can be simply applied to the tile substrate to allow direct tile attachment. That said, one must always run the membrane continuously over the floor and up the walls at least 76 mm (3 in.). This author commonly sees water-sensitive materials being used right outside the showers (and they almost always exhibit some degree of damage). CTIOA recommends finished materials that are not affected by moisture be used on horizontal surfaces within at least 610 mm (24 in.) of the wet area. All shower horizontal surfaces must be waterproofed to include seats, shelves, and window ledges. All horizontal surfaces should be sloped to drain at 60 mm/m (0.06 in./in.), which includes the top of the dam, shampoo shelves, seats, widow ledges, and receptor ledges. (The exception is the shower receptor, which should be 20 mm/m [0.25 in./ft].)

Critical steps for shower installation

It seems an obvious point, but a waterproof membrane is a must in the shower receptor. While there can be bathtubs or prefabricated shower receptors that are in themselves waterproof, these applications require special attention at the transition area from the wall to the receptor/tub. All tubs and prefabricated receptors must have a continuous flange for transitioning to the wall.

It is also critical the mortar bed receptor waterproof membrane be applied on a pre-sloped bed that provides a 20-mm/m positive slope to the top of the drain body flange or collar, where the membrane will be clamped to the drain providing a watertight seal. The membrane must overlap

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Hall Is Named One of Construction's Top 25 Newsmakers of 2005

Dennis J. Hall, FAIA, FCSI, managing principal of Hall Architects in Charlotte, NC has been named by the editors of *Engineering News Record* as one of the top 25 newsmakers of 2005 in the design/construction industry, for innovations and achievements featured in the magazine in 2005. Hall was cited for his leadership in the development of *MasterFormat* 2004, the industry standard for organizing construction information, used by architects, engineers, facility owners, and contractors throughout the US and Canada.

Hall will be honored at lunch and dinner events on April 6, 2006 in New York City. He is also in consideration to receive the Award of Excellence, ENR's highest honor, which will be announced in April.

For more information see www.enr.com/people/people/archives/060109-1.asp

CSI Congratulates Board Member Dennis Hall

and clap into the drain flange, and turn up the wall at least 76 mm (3 in.) above the shower curb, and with special attention at corner transitions. The membrane must also extend up and over the dam down the face to the floor. Weep holes in the drain collar have to be covered and left open—something that is not always done. The membrane then needs to be water-tested, after which the mortar bed is applied over the top, achieving a finish surface resulting in a 20-mm/m positive slope to the top of the drain.

Shower wall

A moisture barrier is required in all shower walls and needs to properly transition into the shower receptor. In some cases, the substrate backer board acts as the moisture barrier when it is designed to do so. However, cementitious backer board units (CBU) are not moisture barriers and, as such, require them. (On a similar note, water-resistant gypsum board is not recommended for showers or any designed wet area.)

Normally, the moisture barrier is a breathable membrane and not a vapor barrier. Starting at the bottom of the wall, it is to be placed so it overlaps the receptor waterproof membrane or the tub/receptor flange. Subsequent rows of the membrane are weather-lapped over its lower row before a scratch and mortar bed is applied over top. If a backer board is used, the studs have to be furred out to allow the board to overlap the flange and remain plumb, and extend down to allow a 6.4-mm (0.25-in.) sealant joint at the tub/receptor ledge. This tub/receptor ledge must be sloped to drain.

Flashing transitions

This author sees many failures at the transition areas (*e.g.* between the receptor and the wall, or at the dam

and shower wall to the outside of the shower). Flashing is an easy and inexpensive method of adding a substantial safety factor to preventing water intrusion. At least 152 mm (6 in.) of flashing is recommended by CTIOA at the wall-to-tub/receptor transitions and at the shower-dam/curb-and-threshold transition areas to the outside of shower.

Blocking for the flashing needs to be applied where necessary. This author normally uses a bituminous flashing that adheres on both sides. (The product comes in a 152-mm wide roll.) It should be applied before the moisture barrier, with all transitions in the shower flashed to include flanges, ledges, corners, shampoo shelves, seats, and windows.

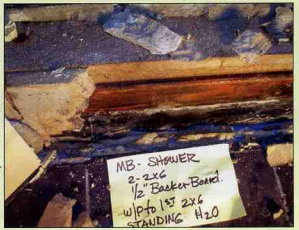
Transition joints and sealants

All vertical and horizontal transition joints, and particularly shower transition joints, are supposed to be filled with a proper sealant per TCA EJ 171-05, *Movement Joints—Vertical and Horizontal.* Most of the time, these joints are hard-grouted in and end up cracking, allowing water intrusion. The few times this author does see them caulked, a latex-type caulking is employed (that does not perform well, last long, or meet the industry standard).

Even when joints are caulked, they are not always installed correctly. Transition joints should be designed per TCA EJ 171, caulked with a sealant that meets

This shower had a prefabricated receptor using a backer board substrate. It lacked a transition joint, was not sloped to drain, and had inadequate adhesive coverage.

Photos courtesy Ceramic Tile and Stone Consultants



Moisture damage at a shower curb that had improper waterproofing.

ASTM C 920, *Standard Specification for Elastomeric Joint Sealants,* and installed per the sealant manufacturers' explicit instructions. Proper installation requires priming, using a polyethylene backup strip or tape, and achieving two-point attachments with a limited sealant thickness.

The tub/prefabricated-receptor-to-wall transition joint has shown many problems in the past. There is a lot of movement at this location when the tub/receptor cycles from being occupied and full of water to empty. When the joint is not designed correctly and a proper sealant is not used, it normally fails. Assuming there is flashing and a moisture barrier behind the location, this author recommends filling the space under the backer board or mortar with polyethylene foam (leaving no void) before applying the sealant per the manufacturer's instructions. This allows no more moisture than the substrate can store, before it is cycled out through grout joints during the dry period.

Quality assurance and quality control

No matter which method of application is used, the most important part of a project is having adequate—and specific—quality assurance (QA) and quality control (QC). Often these sections of the specification are cut-and-paste, and left up to the subcontractor to implement himself. This can be a mistake, as these sections are critical to project success, regardless of the method of application.

To substantiate suitability, the specification should be performance-driven for both the tile and/or stone products and their installation materials. The execution portion of the specification should provide clear details and instructions for transitions, flashing, and sealant joints.

The transition areas (such as this tub-to-wall interface) for restroom applications can be especially sensitive to cracking.

Photo courtesy Ceramic Tile and Stone Consultants

A specific QC plan should be included to quantitatively inspect critical stages of the installation by a qualified third-party inspector.

The tile and stone trades are not unlike other trades where those in labor get most of their training on-the-job. A good quality control plan becomes a great learning experience for the installers since they are taught the correct methods—by the end of the project they have practiced it enough where it becomes the easiest and most intuitive method for future projects.

Using ceramic tile, natural stone, and glass tile for bathroom finishes can yield benefits in terms of function, image, and value. They can be very durable, largely trouble-free, and long-lasting if specified correctly to include these sorts of project-specific quality assurance and quality control sections.

As with all building materials, there are tradeoffs depending on the product and installation methods one selects. Nevertheless, when one correctly specifies a legitimate method, and provides adequate quality control, there is a far greater opportunity to have restrooms that provide a design statement and perform as they were intended, and avoid the costs of litigation.

Notes

[1] The precise calculation is reported in *Rainfall Inside My House* (technical report 11-29-02) by Don Halvorson of Forensic Tile Consultants.

Additional Information

Author

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Abstract

The result of bad designs or labor error, faulty installation is the predominant cause of tile and stone failures in bathrooms. There are certain tradeoffs with ceramic, natural stone, and glass products, but with good quality control plans and clear specifications, the risks can be minimized. This article discusses product suitability and installation guidelines to help prevent water-intrusion problems.